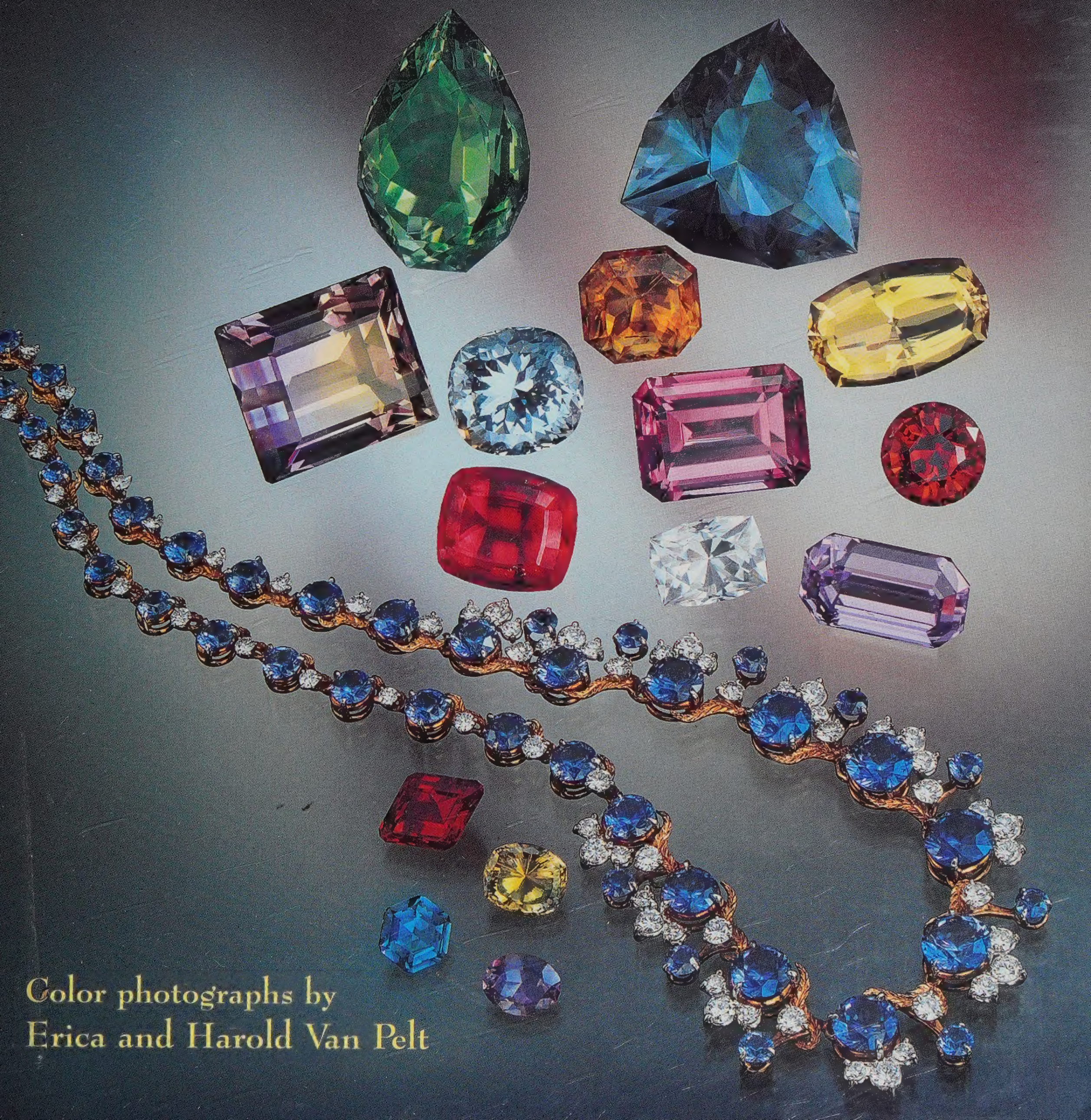
GEMSTONES of NORTH AMERICA

VOLUME III

John Sinkankas



Color photographs by
Erica and Harold Van Pelt

GEMSTONES
of
NORTH AMERICA

VOLUME III

GEMSTONES OF THE WORLD SERIES

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GEMSTONES OF NORTH AMERICA, VOLUME III
by John Sinkankas

ON THE COVER

North American gems from the Michael M. Scott Collection as photographed by Erica and Harold Van Pelt. Size may be estimated from the pale rectangular step cut amethyst (left, upper group) which measures about 25 mm (1 in.) across.

TOP GROUP. Green fluorite (121.39 ct), Westmoreland, New Hampshire; blue fluorite (132.12 ct), Illinois; square cut particolor amethsyt (78.70 ct), Hallelujah Junction, Nevada; blue, cushion cut topaz (25.30 ct), Ramona, California; brownish yellow octagonal calcite (21.30 ct), Montana; light yellow orthoclase feldspar (25.03 ct), Idaho; rectangular step cut purplish pink elbaite tourmaline (30.89 ct), Maine; round brilliant red-orange spessartine garnet (16.62 ct), Ramona, California; deep red cushion cut rhodochrosite (25.56 ct), Sweet Home Mine, Colorado; colorless scheelite (19.66 ct), Kern County, California; octagonal step cut violetish pink kunzite (26.61 ct), Pala, California.

NECKLACE. Vivid blue matched benitoite gems from San Benito County, California, consisting of 52 benitoites and 75 diamonds set in gold. The necklace is 45 cm (18 in.) long.

BOTTOM GROUP. Deep, spinel red oligoclase feldspar (5.04 ct), Oregon; and three Montana sapphires, violetish blue (2.52 ct), yellow (4.17 ct), and pinkish purple (1.35 ct).

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DEDICATED

TO

June Culp Zeitner, of Rapid City,
South Dakota, for her lifelong
devotion to the study and description
of North American gemstones.

FOREWORD

Few mineralogists of this century have contributed more to the fund of gemological knowledge than John Sinkankas. His works are known to almost every collector, gem cutter, gemologist, and mineralogist. His writings always reflect his deep admiration of minerals and gems, and at the same time provide an enormous amount of information presented in the easily understood prose that is his writing hallmark.

The present volume of *Gemstones of North America*, the third in the series, continues the contributions that began with the issuance of the first volume in 1959, followed by a second volume in 1976 which also incorporated a large bibliography and history of North American gemological literature. These volumes were inspired by and carry on the tradition established by Dr. George F. Kunz, of Tiffany & Company, New York City, whose famous *Gems and Precious Stones of North America* (1890–92) provided the first comprehensive monograph on the subject.

Since the appearance of Sinkankas' first two volumes, the interval of two decades has seen much activity taking place in older deposits and the discovery of new deposits in various places, especially in regard to diamond occurrences which promise to make the North American continent an important producer of these gemstones. The present volume summarizes activity in older deposits and thoroughly describes newer events to bring the history of North American gem mining up to date.

Here, then, is the latest, most complete information on North America's gemstones based on Sinkankas' extensive correspondence with miners and dealers and interviews with persons actively engaged in mining gemstones. Pertinent references are furnished throughout the text and include professional as well as popular journal reports and newspaper accounts of important events.

—Peter C. Keller
Series Editor

PREFACE

Since publication of Volume II of *Gemstones of North America* in 1976, a surprisingly large number of developments in the gemstone industry encouraged the preparation of this third volume in the series. Among recent major discoveries are the promising diamond fields being vigorously explored in Canada and the United States. Experts agree that in several years production should begin from one or more diamond-bearing kimberlite bodies, most likely in Canada. Systematic large-scale mining of sapphire-bearing gravels in Montana is beginning and is expected to produce large quantities of rough for many years. The sapphire "ore" has increased in value and profitability due to the development of heat treatment techniques which now convert formerly lackluster sapphire crystals into gemstones of much improved clarity and color. Beautiful, intense red beryl crystals, many of facet-grade, found in the Wah Wah Mountains of Utah are to be mined by conventional open-pit methods and the enclosing rock crushed and treated to release the crystals. Red beryl gems, resembling the finest red spinels in color, are being established in the world market and fetch prices comparable to similar size-range emeralds. The United States continues to supply the major weight of turquoise and peridot, although for the latter gem, much larger facetable rough crystals appear with some regularity from sources in Myanmar (Burma) and Pakistan. In addition to these examples, many smaller discoveries are recounted in this edition, and references are included in the body of the text immediately after the subjects to which they pertain. It is expected that this procedure will make it easier for readers to investigate the gem literature further or to obtain those references which they may need for their own purposes.

As to the future of gemstone discovery and production in the continent, there is little doubt that many regions remain unexplored because of terrain and/or climatic difficulties, especially in the Far North. Even in densely populated regions, the Appalachians of the East, and the Sierras and Cascades of the West, for examples, dense forest covers extend over thousands of square miles and very likely conceal numerous gem deposits. One needs only to consider the significant number of diamond crystals that have been found in Appalachia and in the western foothills of the Sierra Nevadas to appreciate that many diamond-bearing kimberlite bodies must exist from which these stones were derived. It is now considered unlikely that these crystals were transported to their sites of discovery by glaciation, although that is possible in certain other areas, as around the Great Lakes region.

Numerous small discoveries of gem materials took place all over the continent in the last several decades, and these illustrate the fact that careful, intensive prospecting can pay. Some years ago I recommended to a large California amateur mineral and gemstone organisation that a useful club project could be the systematic prospecting of the western flank of the Sierra Nevadas by club members. Searches could be confined to terrains and creek beds that expose types of rocks in which sought-for minerals have occurred elsewhere. The geological information on which such prospecting would be based is largely available from government sources in the form of detailed area reports and corresponding geological maps. I have no doubt that such a prospecting campaign would produce results, or, in the worst case, eliminate barren areas from further consideration. As events in the past few decades have shown, much of North America has yet to yield up treasures of gemstones, but one must look for them!

J.S.

San Diego, California

ACKNOWLEDGMENTS

I take this opportunity to thank the many persons who have contributed in some way to the completion of this third volume in my series describing the gemstones of North America. My function in such writing mainly has been to collect these contributions, compare them with others, and set them down in what I believe to be the most reliable accounts. In this process I was aided by the writers of the many articles that have appeared in the periodical literature, especially in *Rocks & Minerals*, *Rock & Gem*, *Lapidary Journal*, *The Mineralogical Record*, *Mineral News*, *Colored Stone*, and *Gems & Gemology*. Many of these articles are directly referenced in the text because they contain firsthand information on gemstone deposits, and, in many instances, furnish advice on how to reach them and what to look for. My inclusion of such articles not only serves to guide readers to helpful additional information but also acknowledges my indebtedness to the authors concerned.

Among many, I specifically acknowledge assistance from Angie Alkema, Lakewood,CO; Dr. Joel E. Arem, Laytonsville, MD; Epp Aruja, Northwest Territories Economic Development and Tourism Office, Yellowknife, NWT; Gordon T. Austin, commodity specialist (gemstones), U.S. Bureau of Mines; William & Joan Baltzley, owners & operators, Morefield Mine, Amelia, VA; Max & Suzy Berchtold, Royal Rainbow Mine, Laytonville, CA; Ralph E. Brandle, Tucson, AZ; Wayne O. Brown, Brown Brothers Lapidary, Safford, AZ; Rhonda Bell, NWT Geology Division, Yellowknife, NWT; John & Carol Cantlin, Ellis, ID; Jeannette B. Carillo, Gem Center USA, El Paso, TX; Gary Christopher, The Prospectors Cache, Englewood, CO; Larry Cohen, Oso Famoso, Ben Lomond, CA; Martin J. Colbaugh, Kingman, AZ; Ramon S. DeMark, Marquette, MI; Michael Dettamanti, Southwest Stone, Kanab, UT; Charles E. Doyle, Wewehatchka, FL; Dr. Peter V. Fankboner, Burnaby, BC; James P. Flohr, Burnett Petrified Wood, Lebanon, OR; Dr. Eric Fritzsch, South Dakota School of Mines and Technology, Rapid City, SD; John R. Fuhrbach, Amarillo, TX; Lawrence A. Funt, Washington, DC; Michael & Patricia Gray, Graystone Enterprises, Missoula, MT; William D. Gregorio, Fayetteville, PA; Jeanne Gurski, Jeanne's Rock & Jewelry, Southeast Houston, TX; Dr. George E. Harlow, American Museum of Natural History, New York, NY; Wayne Hartgraves, Plush, OR; Dr. W. Dan Hausel, WY Geological Survey, Laramie, WY; Jonathan Herndon, Center Ossipee, NH; Raymond Hietapakka, Thunder Bay, ONT; Pat Hodge, Palmer's Trading Post, Cave-in-Rock, IL; Dr. J. Michael Howard, Arkansas Geological Commission, Little Rock, AR; Richard W. Hughes, Boulder, CO; Duane L. Johnson, Rocky Mountain Soapstone, Butte, MT; Chris I. Johnston, Royal, AR; Robert W. Jones, Scottsdale, AZ; Richard A. & Tresa L. Kosnar, Golden, CO: Virginia & Larry Kribs, Desert Dog Mines, Bend, OR; Guy Langelier, Montreal, QUE; Dr. R. L. Langenheim, University of Illinois, Urbana-Champaign, IL; William Larson, Pala International, Fallbrook, CA; John R. Latendresse, American Pearl Co., Nashville, TN; Otto J.

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I also wish to call special attention to the skilled faceting work of Arthur Grant of Hannibal, New York, who sought out and cut many rare minerals, including the splendid iridescent twinned calcite faceted gems of very large size that now grace various public and private collections; his name appears frequently in the text in connection with these rarities. Lastly, I wish to again thank my wife, Marjorie Jane Sinkankas, for her unstinting support during the troublesome early phases of gathering information, and for putting up with the occasional fits of temper when something did not go strictly according to plan. As in past writings, she has greatly smoothed the path that leads to a finished book.

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The superb color photographs in this work have been made possible through the coordinated efforts of five individuals. The publisher gratefully acknowledges their outstanding contributions to provide readers and users of this volume with such a fine presentation of North American gems. William R. Rohtert, Manager of Gemstones, Kennecott Exploration Co. and Robert Kane of America Gem Corp. contributed substantial funding for the color insert section. Erica and Harold Van Pelt provided all the photography for the twenty color images. William Larson, Pala International, provided many of the specimens for the photographs and conceived of the idea for this special color insert section.

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15. Elbaite tourmalines (California)
16. Turquoise

1. Polished cross-sections of stalactitic growths of azurite/malachite from copper mines of Morenci and Bisbee, Arizona. William Larson collection. *Van Pelt photo.*

2. Cut gems of benitoite from the Dallas Gem Mine, San Benito County, California. The loose gems in center range in size/weight from 6.62 mm/1.23 ct (bottom) to 10.84 mm/6.70 ct (top). The necklace is set with 52 benitoites weighing altogether 33 carats and ornamented with 75 diamonds. The length of the necklace is 45 cm (18 in.). Michael M. Scott Collection. *Van Pelt photo.*

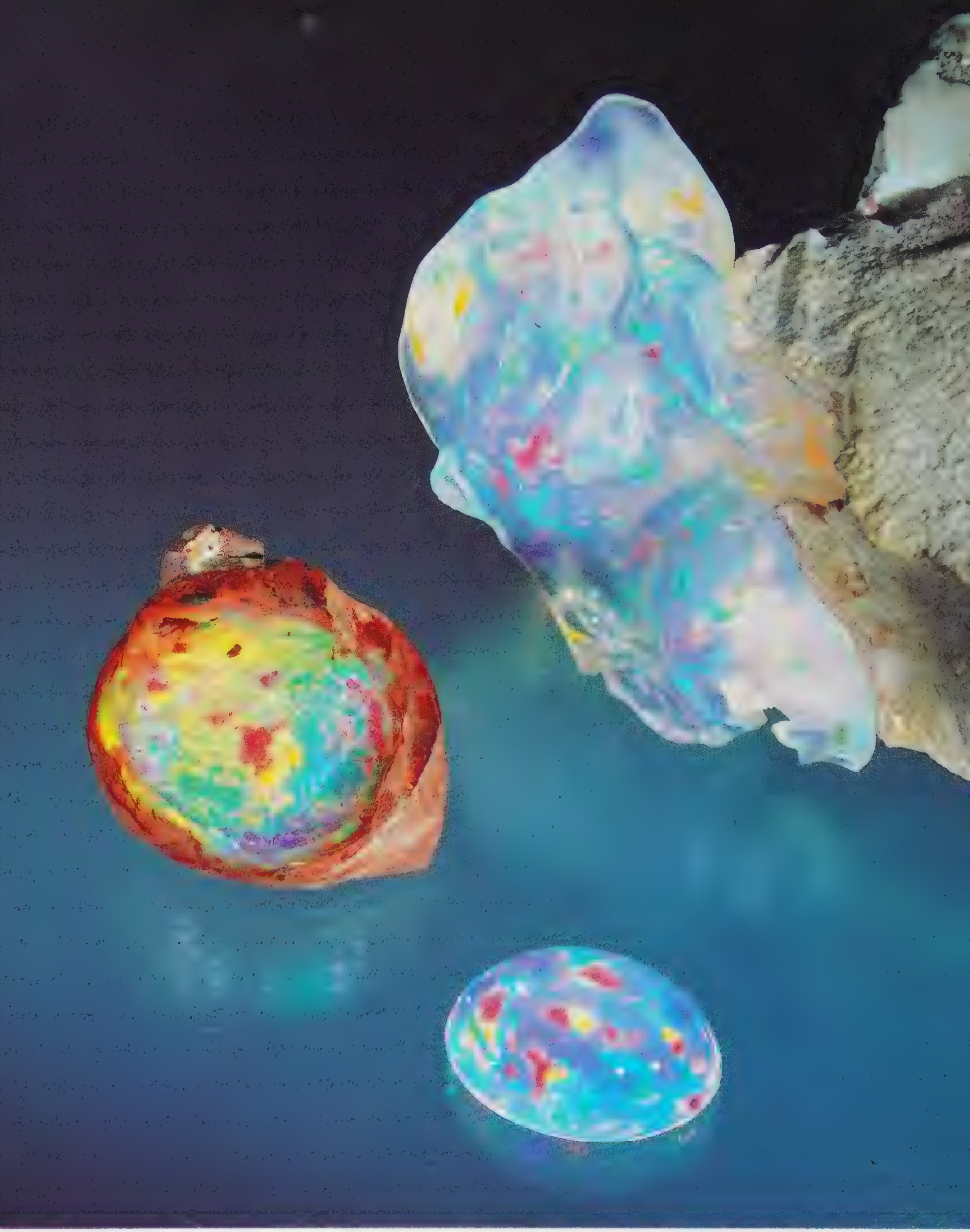
3. Red beryls from the Wah Wah Mountains, Iron County, Utah. Typical terminated hexagonal prism in matrix of whitish altered rhyolite rock (Gemological Institute of America Collection, donated by Kennecott Corporation). Faceted gem of 2.44 carats in Rex Harris Collection. The matrix crystal measures 12 mm (0.5 in.) in length. *Van Pelt photo.*

4. Morganite beryls from the White Queen Mine, Pala, San Diego County, California. The etched rough is all that remains of a formerly much larger crystal. Cut gem measures 65 x 60 mm (2.6 x 2.4 in.) and weighs 74.47 carats. Pala International Collection, Fallbrook, California. *Van Pelt photo.*

5. Aquamarine beryl crystal from Sawtooth Mountains, Idaho, 68 mm (2.75 in.) long, 18 mm (0.7 in.) in diameter, weight 156 carats. William Larson Collection, Fallbrook, California. *Van Pelt photo.*

6. Superb suite of Montana sapphires showing the permanent colors achieved after heat treatment of the rough. Nearly every known sapphire color is represented, including pink and the true red of ruby. The gems range in weight from 0.92 ct to 5.68 cts and are from Rock Creek, Dry Cottonwood Creek, or Eldorado Bar on the Missouri River. American Gem Corporation collection. *Van Pelt photo.*

7. Spessartine garnet necklace set with faceted gems cut from rough mined in the Little Three Mine, Ramona, California by Louis Spaulding, Jr. The pendant gem measures 20.63 x 16.74 mm (0.76 x 0.74 in.) and weighs 39.65 cts. A total of 63 spessartines and 136 round and 17 baguette diamonds are set in 18k gold in this piece designed by Ron Hentges of D'Lanor Jewelers, Carmel Valley, California. The necklace extends overall to 45 cm (18 in.). Michael M. Scott Collection. *Van Pelt photo.*

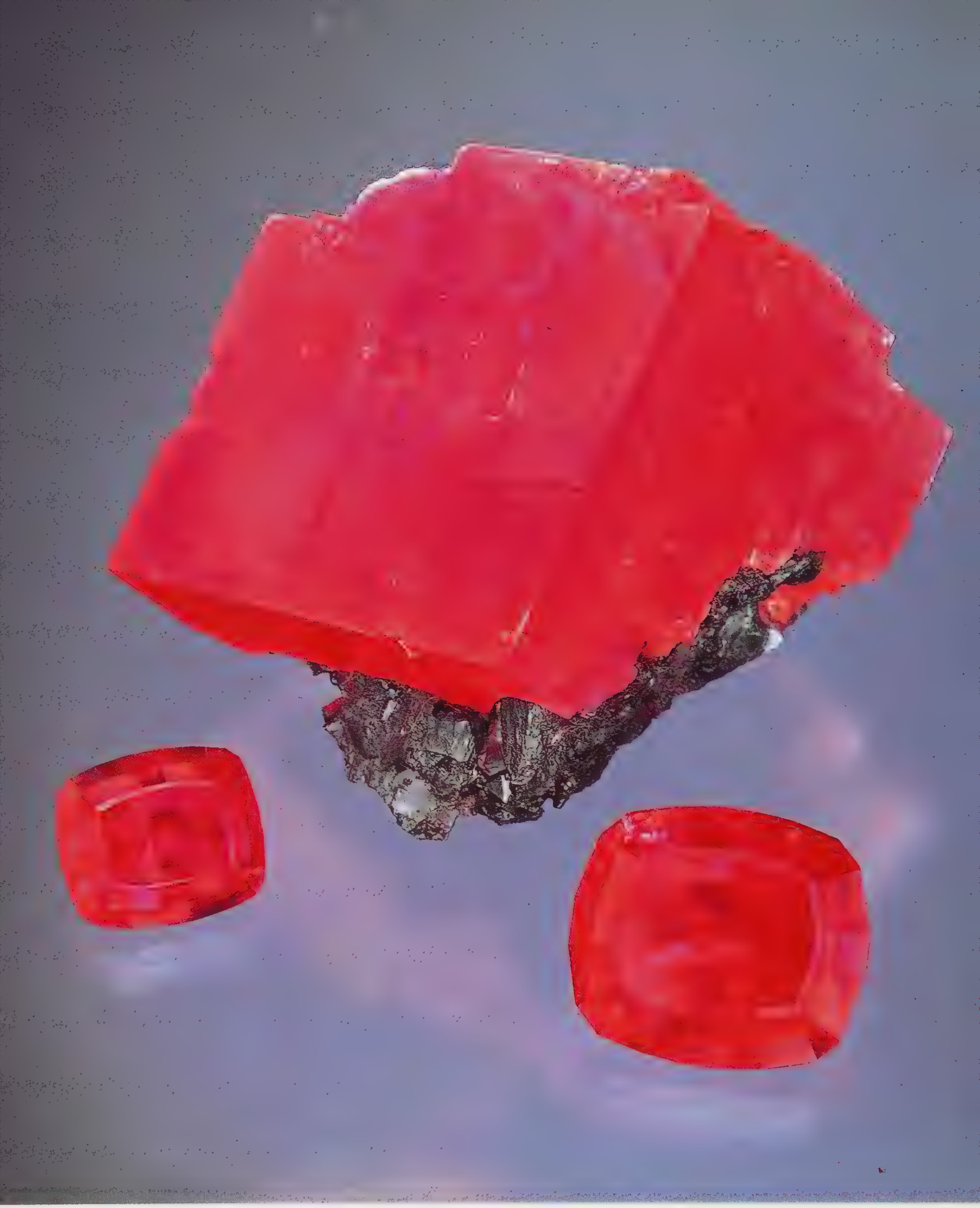


8. Precious opal in nodular masses found in cavities in rhyolite in Mexico. The large specimen, still attached to matrix, measures 55 x 34 mm (2.2 x 1.3 in.). The loose nodule of fine gem material weighs 80.09 carats and displays *lluvisnando* or "floating light." The cabochon gem weighs 16.37 carats. William Larson Collection, Fallbrook, California. *Van Pelt photo.*

9. Black pearls from La Paz, Baja California Sur, Mexico, fished from rejuvenated oyster beds in the past decade. The largest loose round pearl measures 9 mm (0.35 in.) in diameter. The jewelry, embodying Baja pearls and diamond accents was designed by Ilka Bahn. Courtesy of The Collector Fine Jewelry, La Jolla, California. *Van Pelt photo.*

10. Highly translucent chalcedony colored by minute inclusions of chrysocolla and forming the so-called "gem silica" or "chrysocolla chalcedony." The rough was obtained from the Inspiration copper mine in Miami, Arizona. The sphere is 24 mm (1 in.) in diameter and weighs 87.60 carats while the faceted gem weighs 10.88 cts and the cabochon 15.22 cts. The freeform sculpture by Glenn Lehrer weighs 124.30 cts. William Larson Collection, Fallbrook, California. *Van Pelt photo.*

11. Amethyst crystal group from Guerrero, Mexico, showing intense purple color in interiors of crystals and colorless external zones. Height of group 90 mm (3.6 in.); faceted gem weight 41.97 carats. Courtesy Pala International, Fallbrook, California. *Van Pelt photo.*



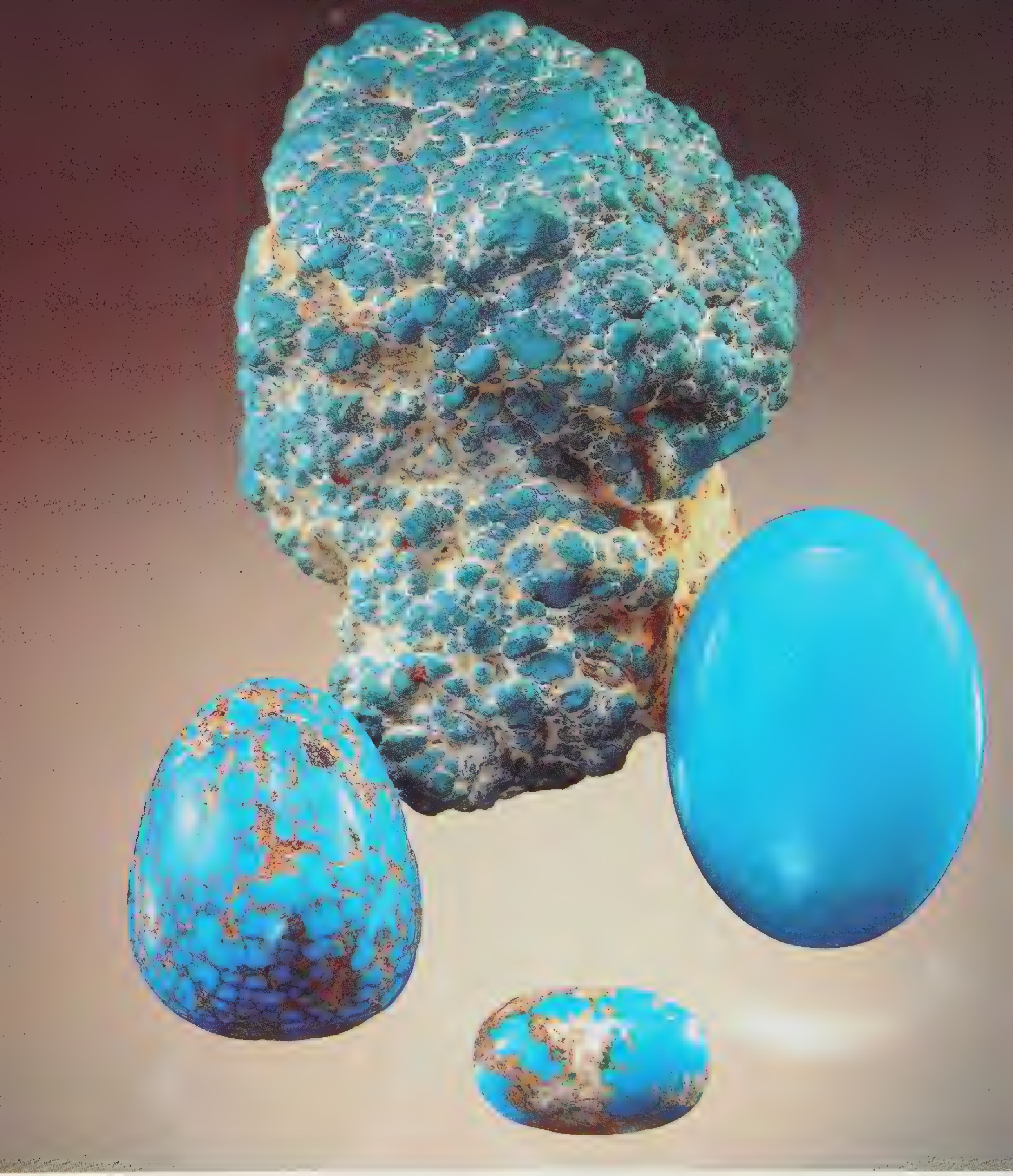
12. Rhodochrosite crystal, 45 x 42 x 41 mm (1.75 x 1.65 x 1.64 in.) from Sweet Home Mine, Alma, Colorado, with a suite of faceted gems. The two largest gems weigh 25.56 and 61.24 carats. Michael M. Scott Collection. *Van Pelt photo.*

13. Two famous North American spodumene crystals. The purplish pink, "Roman sword" crystal of kunzite is from the Pala Chief Mine, Pala, California, and measures 160 x 105 mm (6.3 x 4.2 in.). It appears in Figure 39, *Gemstones of North America, Volume 1*, being held by Dr. George F. Kunz, and earlier, in color, in the latter's *Gems, Jewelers' Materials and Ornamental Stones of California*. The vivid green crystal, measuring 50 x 6 mm (2 x 0.3 in.), 21.75 carats, is pictured in Plate 3 of Kunz's *History of the Gems Found in North Carolina*. William Larson Collection, Fallbrook, California. *Van Pelt photos.*

14. Elbaite tourmalines from Maine. Terminated bicolor crystal in background from Newry, Oxford County, also the green crystal at left and the "watermelon" slice at right. In foreground, the remarkable multicolored slender prism, 53 mm (2.2 in.) long, is from Poland, Androscoggin County. The faceted gems are a rubellite, 15.22 ct, and a fine green gem, 6.89 ct, both cut from Newry material. William Larson Collection, Fallbrook, California. *Van Pelt photo.*

15a. Elbaite tourmaline from Pala, San Diego County, California. The Tourmaline Queen Mine furnished the now distinctive "blue-cap" crystal group while other crystals provided rough for cut gems of 3.65 ct, round brilliant, deep red cushion of 16.28 ct, and large octagonal mixed cut of 90.05 ct. The light pink rectangular gem at upper left is from the Stewart Lithia Mine. Courtesy Pala International, Fallbrook, California. *Van Pelt photo.*

15b. Bicolor elbaite tourmalines from Himalaya Mine, Mesa Grande, San Diego County, California. The terminated crystal cluster is 76 mm (3 in.) tall and the cut gem weighs 21.50 carats. The masterfully carved elephant by Wolfgang Klein of Idar-Oberstein, Germany, weighs approximately 300 carats and measures 65 x 38 mm (2.25 x 1.5 in.). Courtesy The Collector Fine Jewelry, Fallbrook, California. *Van Pelt photos.*



16. Turquoise from southwestern United States. Exceptional, gem-quality nodular mass from Fox Turquoise Mine, Lander County, Nevada, measures 88 x 63 mm (3.4 x 2.5 in.). Large, uniformly textured cabochon of top grade weighs 108.70 carats and is from the Sleeping Beauty Mine, Gila County, Arizona, while the spiderweb, 148.30 carats, is from Bisbee, Cochise County, Arizona. The smallest mottled cabochon, 14.35 carats, is from Cerillos, New Mexico, and is pictured in the color frontispiece of *Story of the Gems* by Herbert Whitlock. Courtesy Pala International, Fallbrook, California. *Van Pelt photo.*

Notes on the Organization of the Text

As in the previous two volumes of *Gemstones of North America*, occurrences under each gemstone are mostly arranged in geographical order from northeast to south to southwest. As an example, QUARTZ localities begin in Canada and end in Panama. Occurrences are grouped under convenient political divisions such as Greenland, provinces of Canada, states of the United States, Caribbean Islands, states of Mexico, and Central American countries. Where numerous occurrences are found in any division, the arrangement follows that previously noted, that is, from northeast to southwest.

Information from previous volumes is not repeated except where needed to provide an introduction to the presentation of new data. References to gemstones and their occurrences were listed in Volume II (Append. I, pp. 374–462), and some are repeated here. However, most references in the present volume are those that have been published since 1976, when Volume II made its appearance. In some instances where no new information has been developed on occurrences, references are given nevertheless to guide the reader to useful sources of information, particularly to magazine articles that describe field trips and give detailed information on how to reach gemstone deposits. References include both those utilized in the text and those additionally supplied for possible research use.

ACTINOLITE

According to Arem (1987, p. 38), actinolite crystals from Chester, Windsor County, Vermont, "could provide [faceted] stones to about 10 carats."

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., col. pls.

ADAMITE

Arem (1987, p. 38) records a 4.38 ct faceted pink adamite from Mexico, probably from Mina Ojuela, Mapimi, Durango. Bank & Becker (1982) describe reddish, pink, and violet facet-grade crystals from this deposit and provide the following optical properties: n_x-1.712–1.710, n_y-1.736–1.735, n_z-1.760–1.758; diff. 0.048; G 4.68.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit., NY: Van Nostrand Reinhold, 248 p., col. illust.

BANK, H. & BECKER, G. (1982) Durchsichtiger rötlichen, rosa farbener und violetter Adamin aus Mapimi, Mexico. *Z. Dt. Gemmol. Ges.* 31, 3, 195–6.

ALABASTER, *see* GYPSUM

ALGODONITE

The latest information on this massive copper arsenide appears in Heinrich (1976, p. 37) who also furnishes numerous references to this material. The principal finds are in Keweenaw County, Michigan, especially from the Mohawk Mine and the Ahmeek Mines No. 3 and No. 4.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., col. illust. p. 39.

HEINRICH, E. W. (1976) The Mineralogy of Michigan. *Michigan Geological Survey Division Bull.* 6, 225 p., illust. (col.).

MOORE, P. B. (1962) Copper arsenides at Mohawk, Michigan. *Rocks & Minerals* 37, 1 & 2, 24–26.

ALLANITE, *see* EPIDOTE

AMBER

By far the most important amber development in North America, if not in the world, is the enormously increased production of amber in the Dominican Republic. In Volume 2 it was reported that the first significant marketing of this amber took place in 1974 when Geological Enterprises of Ardmore, Oklahoma, offered amber specimens that contained insect inclusions. At that time only a few informal mining endeavors by local residents produced the amber, but as the abundance of insect and animal inclusions in the material came to the attention of paleontologists, the deposits assumed greatly increased importance and the demand for amber rose steeply. At about the same time the amber resources of Chiapas, Mexico were investigated more scientifically and more of the fine gem quality material began to make its way into the market. At the present time, however, it is far easier to purchase Dominican amber, which is marketed by a number of firms both here and abroad.

Faked inclusions in amber, especially lizards, have been sold to the unwary for several hundred years in Europe, but similar fakes based on American amber are a relatively recent development. William Getler, writing in the *Wall Street Journal* (Wed., July 7, 1993, p. A1, A4) ruefully remarks that he had been taken in by a large "amber" specimen displaying a fine lizard which proved to be a polyester plastic enclosing a modern Caribbean anole! Getler cites several amber authorities who indicated that with the excitement created by the moving picture *Jurassic Park*, fakes with reptilia in them are becoming common and are being made in Chiapas, among other places. It will be recalled that Michael Crichton's novel (and the movie) was based on the recovery of DNA from an insect that had sucked the blood of a dinosaur before being trapped in sticky tree resin and preserved for eternity. Remarks on this theme are made by Dr. David Grimaldi of the American Museum of Natural History, who reported that from investigations on Dominican Republic amber, a team of scientists in the Molecular Systematics laboratory, American Museum of Natural History, New York, "recently succeeded in amplifying and sequencing DNA from a 30-million-year-old termite preserved in an amber globule from the Dominican Republic" (Grimaldi, 1993, p. 59).

Among recent publications that deal with North American amber in whole or part, the books by Poinar (1992, 1994) are especially recommended as is the standard amber text by Rice (1987) which contains much material based on personal visits to some of the mines. Poinar's books, as their titles suggest, are primarily treatises on insect and small animal paleontology, but provide much on all aspects of amber both in the North American Continent and elsewhere in the world, with particularly valuable essays on Mexican and Dominican ambers and their deposits.

GRIMALDI, D. (1993) Forever in amber. *Natural History* 102, 6, p. 58–61, illust. (col.).

POINAR, G. O. (1992) *Life in Amber.* Stanford, CA: Stanford U. Press, 350 p., illust. (col.), maps.

POINAR, G. & POINAR, R. (1994) *The Quest for Life in Amber*. Reading, MA: Addison-Wesley Publ. Co., 219 p., illust. (col.).

RICE, P. C. (1987) *Amber: Golden Gem of the Ages*. NY: Kosciusko Foundation, Inc., 289 p., illust., maps.

SAUNDERS, W. B., MAPES, R. H., CARPENTER, F. M. & ELSIK, W. C. (1974) Fossiliferous amber from the Eocene (Claiborne) of the Gulf Coast plain. *Geol. Soc. Amer. Bull.* 85, p. 979–984.

GREENLAND. No new developments.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Med. om. Grønland* 149, 442 p., illust., map. Amber indexed as "retinite."

GIESECKE, C. (1878) *Gieseckes Mineralogiske Rejse i Grønland ved F. Johnstrup*. Kjøbenhavn: Bianco Lunos, 372 p., map.

______, (1910) Karl Ludwig Gieseckes mineralogisches Reisejournal über Grønland. 1806–13. 2te vollst. Ausgabe. *Meddelelser om Grønland* 35.

CANADA. The following are general references to Canadian occurrences; provincial remarks follow.

ELWORTHY, R. T. (1924) Some Canadian fossil resins. *Can. Dept. Mines, Mines Br., Summ. Rept.* CY 1922, publ. no. 605, p. 47–57. Coalmont; Cedar Lake.

HARRINGTON, B. J. (1878) Notes: mineral resins. *Geol. Survey Can. Rept. Progress 1876–77*, 1878, p. 471–473. Amber in coals & lignites.

KLOTZ, O. J. (1892) Survey of amber locations. *Ann. Rept. Dept. Interior* (Canada), for 1891, (No. 13-1891), pt. 2, Rept. 7.

McALPINE, J. F. & MARTIN, J. E. H. (1969) Canadian amber—a paleontological treasure-chest. *The Canad. Entomologist* 101, p. 819–838.

______, (1979) Amber in Canada. *Canad. Rockhound* 23, 5, p. 4–13, map.

MANITOBA. The well-known locality at Cedar Lake has been inundated by the waters of a reservoir since 1963 and finds are no longer possible.

CARPENTER, F. M. (1935) Fossil insects in Canadian amber. *Univ. Toronto Studies*, Geol. Ser., 38, p. 69.

CARPENTER, F. M., *et al* (1937) Insects and arachnids from Canadian amber. *Ibid.* 40, p. 7–62.

FIELD, D. S. M. (1949) Canadian gems and gem localities, pt. 3, gems of British Columbia. *J. Gemm.* 2, 1, p. 6–15; amber p. 8. Mentions Cedar Lake.

FIELD, D. S. M. (1949) Canadian amber. *The Mineralogist* 17, p. 382.

HARRINGTON, B. J. (1891) On the so-called amber of Cedar Lake, north Saskatchewan[sic], Canada. *Amer. J. Sci.* 42, p. 331–335.

KLEBS, R. (1897) Cedarit, ein neues bernsteinähnliches fossiles Harz Canadas und sein Vergleich mit anderen fossilien Harzen. *Jb. d. K. preuss. Geol. Landesanstalt u. Bergakademie* 17, 1896, p. 199–230.

TYRRELL, J. B. (1892) Fossil resin ("amber"). *Geol. Survey Canada, Ann. Rept.* 5, pt.1, p. s14–s15.

BRITISH COLUMBIA. Dawson (1889) noted amber in the possession of the natives which was said to be derived from the west coast of the Queen Charlotte Islands. Field (1947) regarded the Coalmont, B.C., amber as perhaps the most promising for gem purposes of all Canadian ambers. He notes that "most of the Coalmont amber is transparent to translucent, varying in colour from pale yellow through brown to bottle-green and black. The darker specimens are almost invariably opaque. Some pieces are quite transparent and free from flaws, and are bright, pleasing cherry-red colour." The latter resembled "clear Mexican and Nevada opal of a similar tint." Field reported on the chemical testing of this amber undertaken by the Mines Department. It was found that the amber contained only a small amount of succinic acid and therefore was classified as retinite; it was much less soluble in ether than the Prussian amber. "The finer grade selected pieces are quite suitable for beads, pipe stems, cigar and cigarette holders, carved objects and the like."

DAWSON, G. M. (1889) *The mineral wealth of British Columbia. With an annotated list of localities*... Geol. Nat. Hist. Survey Canada, Montreal, 163 p.

FIELD, D. S. M. (1947) Canadian amber. *J. Gemm.* 1, 3, p. 8–9.

_____, (1949) Op. cit.

MUSTOE, G. E. (1985) Eocene amber from the Pacific Coast of North America. *Geol. Soc. Amer. Bull.* 96, 12, p. 1530–6. Coalmont amber.

ROBERTSON, I. (1965) Quesnel amber. *Canad. Rockhound* 9, p. 84–86.

WILSON, A. W. G. (1923) Coalmont amber. *Canad. Dept. Mines, Summ. Rept.* 1921, No. 586, p. 7–8.

ALASKA. No new developments.

HURD, P. D., SMITH, R. F. & USINGER, R. L. (1958) Cretaceous and Tertiary insects in Arctic and Mexican amber. *Proc. 10th Internat. Congr. Entomology*, Montreal, 1956, 1, p. 851.

HURD, P. D. (1960) The present status of studies dealing with insects preserved in amber from Mexico and Alaska. *Entomol. Soc. Amer. Bull.* 6, 3, p. 128.

LANGENHEIM, R. L., SMILEY, C. J. & GRAY, J. (1960) Cretaceous amber from the Arctic coastal plain of Alaska. *Geol. Soc. Amer. Bull.* 71, p. 1345–56.

USINGER, R. L. & SMITH, R. F. (1957) Arctic amber. *Pacific Discovery* 10, p. 15–19.

EASTERN UNITED STATES. Amber finds in states of the Atlantic Seaboard are treated by Kunz (1892, p. 199–203) wherein are noted occurrences in Massachusetts, New York, New Jersey, Delaware, Maryland, and North Carolina. The list of general references is followed by discussions for the several states in which deposits are found.

BERRY, E. W. (1907) Coastal-plain amber. *Torreya* 7, p. 4–6.

DURHAM, J. W. (1957) Amber through the ages. *Pacific Discovery* 10, 2, p. 3–5.

HAGEN, H. A. (1874) On amber in North America. *Boston Soc. Nat. Hist. Proc.* 16, p. 296–302.

HOLLICK, C. A. (1905) The origin and occurrence of amber in the Eastern United States. *Amer. Naturalist* 39, p. 137–145, illust.

HOLMES, W. H. (1907) Amber. [An article in:] Handbook of American Indians north of Mexico. *Smithson. Inst. Bur. Amer. Ethnol. Bull.* 30, pt. 1, p. 48.

KUNZ, G. F. (1892) *Gems and Precious Stones of North America.* New York: Scient. Publ. Co., 367 p., illust. (col.).

LANGENHEIM, J. H. & BECK, C. W. (1968) Catalogue of infrared spectra of fossil resins (ambers). I. North and South America, *Harvard U. Leaflets* 22, 3, p. 65–120, illust.

LANGENHEIM, J. H. (1969) Amber: a botanical inquiry. *Science* 163, p. 1157–1169, illust.

McKINLEY, W. C. (1935) Amber in America. *Gemmologist* 4, p. 369–371.

SAUNDERS, W. B., *et al* (1974) *See above.*

SCHLEE, D. (1990) Das Bernstein-Kabinett. *Stuttgarter Beiträge zur Naturkunde*, Ser. c., 28, 100 p., illust. (col.).

ZEITNER, J. C. (1981) Amber and jet. *Lapidary J.* 35, 1, p. 92–99, *passim*, maps.

MASSACHUSETTS. "It ought not be forgotten," states Hitchcock (1841, p. 187), "that fragments of this mineralized resin, which makes very pretty ornaments, has [sic] been found at Gay Head [Martha's Vineyard]; and a mass on Nantucket weighing a pound: and that the tertiary deposits of those islands are precisely of the character most likely to yield this substance." Amber was also noted in lignite beds of Gay Head by Shaler (1888, p. 330). Goldsmith (1879) drew attention to the insect inclusions in amber collected on Nantucket by Wm. L. Maetier, noting that the amber "is of a fine pale claret color without being at all variegated" and that the specimen he examined was "an irregular mass of about eleven centimetres in length [4.4 in]." He further describes the tests he subjected the amber to. No recent information on the ambers of these islands has been published.

GOLDSMITH, E. (1879) On amber containing fossil insects. *Proc. Acad. Nat. Sci. Phila.*, pt. 2, p. 207–208.

HITCHCOCK, E. (1841) *Final Report on the Geology of Massachusetts.* Amherst, MA: J. S. & C. Adams, 831 p., maps. pls.

SHALER, N. S. (1888) Report on the geology of Martha's Vineyard. *7th Ann. Rept. USGS for 1885–86*, p. 297–363, maps, pls.

NEW YORK. The amber locality at Kreischerville, Staten Island, is no longer accessible.

HOLLICK, C. A. (1904) A recent discovery of amber and other fossil plant remains at Kreischerville. *Nat. Sci. Assoc. Staten I., Proc.* 9, p. 31–32.

______, (1905) A recent discovery of amber on Staten Island. *NY Bot. Garden J.* 6, p. 45–48, illust.

______, (1905) Additional notes on the occurrence of amber at Kreischerville. *Nat. Sci. Assoc. Staten I., Proc.* 9, p. 35–36.

______, (1906) Origin of the amber found on Staten Island. *NY Bot. Garden J.* 7, p. 11–12.

______, (1908) Chemical analysis of Cretaceous amber from Kreischerville. *Staten I. Assoc. Arts & Sci. Proc.* 2, p. 34.

NEW JERSEY. Steven Spielberg's movie *Jurassic Park* increased interest in the little-known amber deposits of the clays and lignites of Sayreville, Middlesex County. Since the 1970s numerous amateur and scientific diggers have tried their luck in the former lignite mines hoping to find the nodular masses of Cretaceous amber that occur in the lignite beds. According to Secher (1995), who depicts Cretaceous insects in pieces of Sayreville amber and gives several views of the shallow-pit diggings, "the ground around Sayreville . . . has yielded a trove of Cretaceous-era amber, some of it featuring remarkable insect inclusions." Among these he notes midges, cockroaches, spiders and vegetable remains. The yellowish amber ranges from "thumbnail-sized fragments of 'jewelry grade' to chunks of extremely rough amber the size of softballs," or up to about 5 in (12.5 cm) across. The site is on private land but may be commercialized in the future; access has been granted to both amateur and scientific groups. Sayreville is located between the cities of New Brunswick and South Amboy and is accessible from either the Garden State Turnpike or the New Jersey Turnpike.

ABBOTT, C. C. (1883) Occurrence of amber near Trenton, New Jersey. *Science* 1, p. 594.

COOK, G. H. (1868) *Geology of New Jersey.* Newark, NJ: Daily Advertiser, 899 p., illust., maps. Cited by Kunz, 1892, p. 200.

GOLDSMITH, E. (1880) Asphaltum and amber from Vincenttown, New Jersey. *Acad. Nat. Sci. Phila. Proc.* 31, p. 39–42.

GRIMALDI, D. A., *et al* (1989) Occurrence, chemical characteristics and paleontology of the fossil resins from New Jersey. *Amer. Mus.*, Nov., 2948, 28 p.

KUNZ. G. F. (1883) On a large mass of Cretaceous amber from Gloucester County, New Jersey. *NY Acad. Sci. Trans.* 2, p. 85–87.

______, (1892) *Gems and Prec. Stones.* N.A., *op cit.*

SECHER, A. (1995) Cretaceous Park, *Lapidary J.* 49, 1, p. 99–102, 105, illust. (col.).

MARYLAND. Housing built over the site renders it inaccessible.

TROOST, G. (1821) Description of a variety of amber and of a fossil substance supposed to be the nest of an insect, discovered at Cape Sable, Magothy River, Anne Arundel County, Maryland. *Amer. J. Sci.* 3, p. 8–15. Cited by Kunz (1892, *op cit*).

NORTH CAROLINA. No new developments.

HIDDEN, W. E. (1883) [Amber in marl beds.] *NY Acad. Sci. Trans.* 2, p. 79, 86.

SOUTH CAROLINA. No new developments.

BERRY, E. W. (1914) The Upper Cretaceous and Eocene floras of South Carolina and Georgia. *USGS* PP 84, 200 p., pls. Amber p. 11.

SHEPARD, C. U. (1870) On ambrosine, a new organic mineral substance. *Rural Carolinian* 1, p. 311. Amber near Charleston.

MISSISSIPPI. No new developments.

BERRY, E. W. (1919) Upper Cretaceous floras of the eastern Gulf Region in Tennessee, Mississippi, Alabama, and Georgia. *USGS* PP 112, 177 p., pls. Amber p. 14.

LOWE, E. N. (1919) Mississippi, its geology, geography, soil, and mineral resources. *MS Geol. Survey Bull.* 14, 346 p., figs., map. Amber p. 150.

_____, (1925) Geology and mineral resources of Mississippi. *MS Geol. Survey Bull.* 20, 140 p., figs. Amber p. 45.

SAUNDERS, W. B., *et al* (1974) Fossiliferous amber from the Eocene (Claiborne) of the Gulf Coast plain. *Geol. Soc. Amer. Bull.* 85, p. 979–984.

KANSAS. The locality for "kansasite" amber, renamed "jelinite" by Buddhue (1938), is now under the waters of Lake Kanopolis and is no longer accessible. Its exact position is NW¼, SW ¼, Sec. 18, T16S, R6W, Ellsworth County. The amber occurred as nodules, like walnuts in size and shape, sometimes larger, in a layer of yellow clay between two thin lignite layers on a river bluff, south bank, former Smoky Hill Reservoir (Langenheim, *et al*, 1965, p. 286).

BUDDHUE, J. (1938) Some new carbon minerals—kansasite described. *The Mineralogist* 6, p. 7–8, 20.

_____, (1938) Jelinite and associated minerals. *Ibid.* p. 9–10.

LANGENHEIM, R. L., BUDDHUE, J. D. & JELINEK, G. (1965) Age and occurrence of the fossil resins bacalite, kansasite, and jelinite. *J. Paleont.* 39, 2, p. 283–287.

SCHOEWE, W. H. (1942) Kansas amber. *KS Acad. Sci. Trans.* 45, p. 262.

TEXAS. No new developments.

KING, E. A. (1961) Texas gemstones. *Univ. TX Bur. Econ. Geol., Rept. Invest.* 42, 42 p., illust.

WYOMING. According to the gem occurrences map of Sutherland (1990), amber occurs 6 miles (9.6 km) east of Gillette, Campbell County, north of Highway I-90. Another locality is 9 miles (14 km) north-northwest of Sheridan, Sheridan County. In Johnson County, near the east edge of Buffalo, small pieces of amber were found in the Healy coal bed. Amber has been found over a broad area centered about 10 miles (16 km) southeast of Moran in Teton County. Another broad area is about 20 miles (32 km) across and is centered about 5 miles (8 km) north of Hanna, Carbon County. Sutherland further notes that "gem-quality early Eocene amber with deep reddish-brown color was found by J. D. Love in 1934 in the Hanna formation in Hanna Basin, Carbon County. A few sizeable lumps of amber have been found associated with Late Cretaceous (Mesa Verde equivalent) coaly shale in the Jackson Hole area, Teton County." Small pieces of amber were found in a drill core run through the Healy coal bed in 1975. Another source of amber as small nodules and veins is in the Upper Cretaceous coals of the Adaville formation, and in Paleocene and Eocene coals in the Powder River Basin, Natrona County. Veins of amber, 3 inches (7.5 cm) thick and several feet long occur in the Wyodak coal near Gillette. Sutherland is of the opinion that "amber in small amounts may be found in all of the basins of Wyoming."

ROOT, F. K. (1972) Minerals and rocks of Wyoming. *Geol. Survey WY Bull.* 56, 56 p., col. pl. of amber cabochon from Hanna Basin.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., localities map.

WASHINGTON. Ellis (1961) collected early Tertiary amber from a gray shale and sandstone associated with fragments of carbonized wood at a locality about 15 miles (24 km) east of Seattle, King County. The deposit is in an area of abandoned coal mines in the N portion, Sec. 13, T23N, R6E, and is reached by road via Issaquah. It is noted that the amber fractures readily which would limit its use in jewelry despite its being transparent and yellow in color. The same locality, given as Tiger Mountain, was also described by Mustoe (1985). Schlee (1990) briefly mentions the amber and provides a color photograph of a matrix specimen showing a seam of brownish-yellow amber displaying a bluish "bloom."

ELLIS, R. C. (1961) Amber near Seattle, Washington. *Gems and Minerals* 291, p. 24, illust., map.

MUSTOE, G. E. (1985) Eocene amber from the Pacific Coast of North America. *Geol. Soc. Amer. Bull.* 96, p. 1530–1536.

SCHLEE, D. (1990) Das Bernstein-Kabinett. *Stuttgarter Beiträge zur Naturkunde*, Ser. C, H. 28, 100 p., illust. Issaquah amber p. 55–56.

CALIFORNIA. No new developments.

MURDOCH, J. (1934) Amber in California. *J. Geol.* 42, p. 309–310.

BAJA CALIFORNIA. In 1935, Buddhue published information on amber from Baja California Norte which he named "bacalite." However, Langenheim, *et al* (1965, p. 254) suggest that this specimen actually came from the Chiapas locality, acknowledging the fact that Buddhue had not collected the specimen from any then-known deposit in Baja, and its provenance therefore remains in doubt. Amber has been found in Baja, collected personally by Langenheim, *et al*, and identified as coming from Cretaceous rocks of Punta Baja, south of El Rosario, and also coming from another series of occurrences along the Pacific coastline between Punta San Jose and Punta Cabras, about 20 mi (32 km) south-southwest of Santo Tomas. Nodules of amber, 1.5–2 in (3.7–5 cm) in diameter were collected from siltstones or sandstones exposed in the sea cliffs. The El Rosario occurrences are also in sea cliffs west of the town and just north of Punta Baja. Despite later intensive searches by geologists from San Diego State University, only very small grains of amber were found.

BUDDHUE, T. (1935) Mexican amber. *Rocks & Minerals* 10, 11, p. 170–171.

LANGENHEIM, R. L., BUDDHUE, J. D. & JELINEK, G. (1965) Age and occurrence of the fossil resins bacalite, kansasite, and jelinite. *J. Paleont.* 39, 2, p. 283–287, maps.

OAXACA. Salinas (1923, p. 279) notes occurrences of succinite amber upon the Isthmus of Tehuantepec and the cuesta of Tlanjuapan.

SALINAS, L. S. (1923) Catalogo sistematico de especies minerales de Mexico y sus aplicaciones industriales. *Inst. Geol. Mex. Bol.* 40, 290 p.

CHIAPAS. Based on his visits to the amber deposits, Schlee (1990, p. 56) describes them, as well as the numerous specimens of Chiapas material preserved in the "Amber Cabinet" of the Museum at Lion's Gate in Stuttgart, Germany. He also gives valuable notes upon the considerable local industry that has developed around the amber and its manufacture into personal ornaments. The industry is centered on the small village of Simojovel which lies nearly in the geographical center of the state and is conveniently reached by a road that branches off to the northeast from the Pan American Highway at Chiapa de Corzo, the latter place being about 10 miles (15 km) east of the city of Tuxtla Gutierrez. There are dozens of pits, tunnels, or simply slide areas from which amber nodules are obtained. According to the map provided by Poinar (1992, p. 40–41) upon which are marked amber localities, the majority of workings lie within a west-east belt that parallels the Rio Ancora beginning just to the west of Simojovel and extending to the east for a distance of about 20 miles (32 km) (*see* Fig. 1). A number of other proven deposits and some unverified ones are also shown on this map, and according to Bryant (1982), a recent visitor, two recent discoveries of amber have been made in the Totolapa area. The latter village lies about 42 air miles (70 km) almost due south of Simojovel and is reached by turning off the Pan American Highway near Chiapa de Corzo, then heading southeast along a paved road to Acala, and shortly thereafter along a passable dirt road to Totolapa. Bryant suggests that the similarity of local geology to that of the Simojovel area indicates that other amber deposits will be found in the interval, and indeed Poinar shows on his map a verified source at Ixtapa just northeast of Chiapa de Corzo.

In the Simojovel district, amber is recovered simply and directly by hand tools. The diggers, called *ambareros*, especially seek out contact zones between lignitic layers and enclosing sediments, and regard pieces of jet as certain indicators of the presence of amber, calling the jet fragments "hermanos del ambar," or "brothers of amber." The jet is quite useful for ornamental purposes, and is therefore also collected and fabricated just like the amber if it is of lapidary quality to begin with. Schlee notes that this jet has been known to the inhabitants of the region since antiquity. The museum in Oaxaca that exhibits pre-Columbian artifacts dug from Mexican graves has pieces that

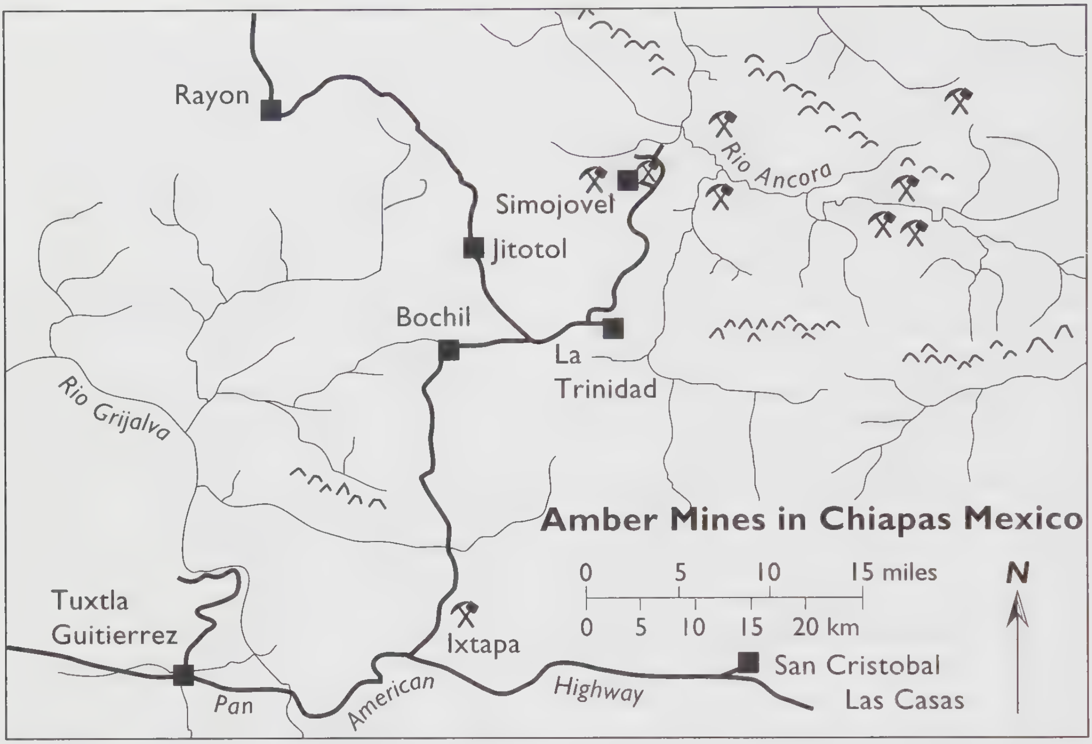


FIGURE 1. Sketch map showing approximate locations of amber mines in the Simojovel area, north central Chiapas, Mexico. After Fig. 10 of G. O. Poinar, 1992.

are made of gold, amber, quartz, and jet. Judging from the abundance of the material and the size of the amber nodules recovered from the Chiapas deposit, it is likely that a substantial amber-mining industry existed here for hundreds of years prior to the arrival of Europeans. Inquiries among miners and tradesmen indicate that the annual production of amber is 100–200 kg (220–440 lb). Schlee depicts, in excellent color, prize specimens of amber, including a fine yellow rough mass, almost flawless, measuring 16 x 14 cm (6.3 x 5.5 in), also a large, blue-fluorescing piece, also very clear, and a raw nodule with a whitish calcareous coating that measures 17 x 11 cm (6.75 x 4.3 in). Much larger roughs have been found, up to 40–50 cm (15.75–19.7 in) and 10–20 cm (6.8–7.9 in) in cross-section, but such large masses are always found fractured in pieces. Some such masses reach 5 kg (11 lb) in weight, with Schlee especially remarking on one giant specimen that measured 18 x 15 x 2.5 cm (7.2 x 5.9 x 1 in) before it was cut up; it was estimated to weigh 2–3 kg (4.4–6.6 lb).

Organic inclusions in Chiapas amber and commonly include bees, ants, other insects, a scorpion, and vegetable matter. Many such inclusions are described in detail by Schlee & Glockner (1978). It is assumed that the amber is derived from the resin of a member of the *Hymenea* deciduous tree family, as is also believed to be true for the amber of the Dominican Republic. Chiapas amber lies within ocean sediments, with oysters as marker fossils, and some nodules are encrusted with barnacles. Other amber was washed into the sea, then covered with sediments, and the entire sequence of sediments raised to their present altitude. The age is reckoned to be about 20–30 million years, or Tertiary/Oligocene/Miocene; this is also thought to be true for the Dominican amber.

In terms of future production, there appear to be very large sediment layers that could be exploited under the present mining system, but large amounts of overburden probably would make mechanical excavation too costly.

BLOM, F. (1959) Historical notes relating to the pre-Columbian amber trade from Chiapas. *Mitt. d. Mus. f. Völkerkunde*, Hamburg, 25, p. 24–27.

BÖSE, E. (1905) Resena acerca de la geologia de Chiapas y Tabasco. *Inst. Geol. Mex. Bol.* 20, p. 1–116. Discusses the amber deposits.

BRYANT, D. D. (1983) A recently discovered amber source near Totolapa, Chiapas, Mexico. *Amer. Antiquity* 48, p. 354–357.

BUDDHUE, J. (1935) Mexican amber. *Rocks & Minerals* 10, p. 170–171.

DUBY, G. (1957) On the amber trail in Chiapas. *Pacific Discovery* 10, 2, p. 8–14.

FRANCIS, P. (1988) Simojovel, Mexico, valley of amber. *Lapidary J.* 42, 8, p. 55–62.

FRONDEL, J. W. (1967) X-ray diffraction study of some fossil and modern resins. *Science* 155, p. 1411–1413.

HURD, P. D. & SMITH, R. F. (1957) The meaning of Mexico's amber. *Pacific Discovery* 10, 2, p. 6–7.

HURD, P. D., SMITH, R. F. & USINGER, R. L. (1958) Cretaceous and Tertiary insects in Arctic and Mexican amber. *10th Internat. Congr. Entomol. Montreal, 1956, Proc.* 1, p. 851.

HURD, P. D., SMITH, R. F. & DURHAM, J. W. (1962) The fossiliferous amber of Chiapas, Mexico. *Ciencia*, Mex. D. F., 21, 3, p. 107–118, col. pls.

LANGENHEIM, J. H. (1964) Present status of botanical studies of ambers. *Harvard Univ. Bot. Leaflets*, 20, 8, p. 225–287, pls. Much on Chiapas.

______, (1965) Baltic amber as compared with Mexican amber. *Amer. Phil. Soc. Yearbook*, 1965, p. 332–333.

______, (1966) Botanical source of amber from Chiapas, Mexico. *Ciencia*, Mex. D. F., 24, 5-6, p. 201–210.

______, (1967) Preliminary investigations of *Hymenaea courbaril* as a resin producer. *Arnold Arboretum J.* 48, 3, p. 203–227.

LICARI, R. (1960) Geology and amber deposits of the Simojovel area, Chiapas, Mexico. *Univ. Calif. Dept. Geol. unpubl. MA thesis*, Berkeley.

NAVARRETE, C. & LEE, T. E. (1969) Apuntes sobre el trabajo del ámbar en Simojovel, Chiapas. *Inst. Nac. Anthropol. Hist.*, Mex. D. F., Bol. 3., p. 13–19.

POINAR, G. O. (1992) *Life in Amber.* Stanford, CA: Stanford U. Press, 350 p., illust. (col.), maps.

POINAR, G. & POINAR. R. (1994) *The Quest for Life in Amber.* Reading, MA: Addison-Wesley Publ. Co., 219 p., illust. (col.). Chiapas p. 79–90.

RICE, P. C. (1987) *See above.*

RUZIC, R. H. (1973) Amber in Chiapas, Mexico. *Lapidary J.* 27, 8, p. 1300–1305, *passim;* 9, p. 1400–1406; illust.

SCHLEE, D. & GLÖCKNER, W. (1978) Bernstein. *Stuttgarter Beiträge zur Naturkunde*, Ser. c., 8, 1, p. 1–72, illust. (col.).

SCHLEE, D. (199O) Das Bernstein-Kabinett. *Ibid.* 28, p. 1–100, illust. (col.). Chiapas p. 56–61.

NICARAGUA. According to Schlee (1990, p. 61), German geologists recently found amber deposits whose material is "clear-yellow pieces, like the best ornamentally useful Mexican and Dominican ambers; there are also reds." The age is estimated as early Tertiary or about 20 million years. The locality is about 80 km (50 mi) southeast of Corinto on the Pacific Coast.

SCHLEE, D. (1990) Das Bernstein-Kabinett, *Ibid.*

COSTA RICA. I have not been able to find the following reference.

MICHAUD, G. (1911) Resinas fosile en Costa Rica. *Costa Rica Bol. de Fomento* 1, p. 131–132.

DOMINICAN REPUBLIC. In the astonishingly short space of two decades, from about 1973 to 1993, enormous quantities of amber have been extracted from numerous deposits in the republic. Yellow and red types, also brown, have been made into ornamental objects and stones for jewelry, thus providing a welcome alternate source of amber that competes with the Baltic amber. However, the loudest and most sincere praise awarded the Dominican amber comes from a host of paleontologists who are astounded and overjoyed by the wealth of animal and plant remains in the amber. Dieter Schlee (1984, p. 63) gives us

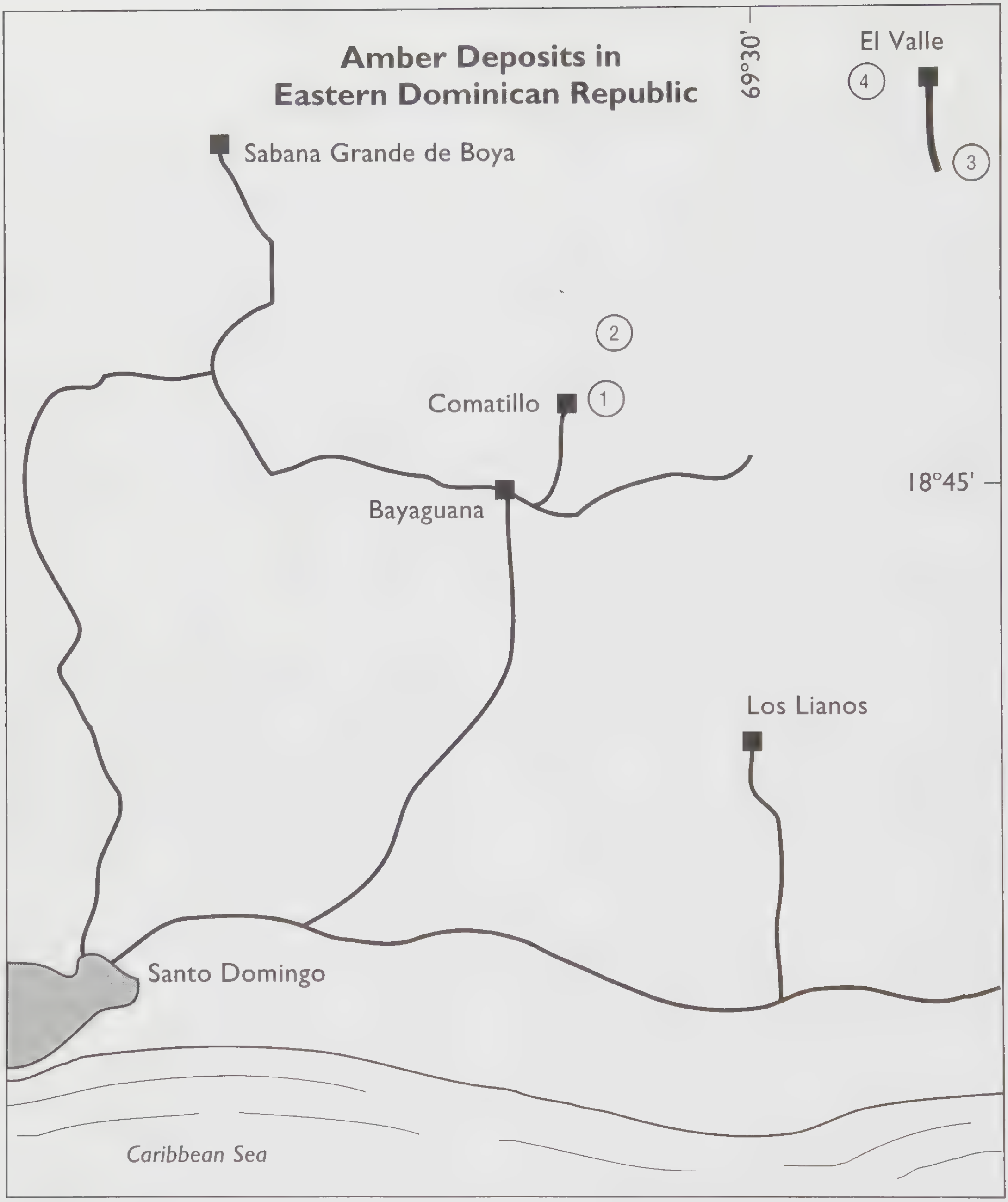


FIGURE 2. Sketch map showing amber deposits in eastern Dominican Republic. 1. Comatillo; 2. Sierra de Agua; 3. La Medita; 4. YaNigua. After Fig. 6 of G. O. Poinar, 1992.

these superlatives: "the greatest abundance of fossil inclusions ever, the richest content of fauna of all ambers, the best amber fossils from the Tropics, the best condition of the inclusions," and so on.

In her visit to the mines in 1979, Rice (1979) noted that the local amber industry, based on modest production from informal mining, was begun by Dr. P. Brower, Minister of Social

Security at the time in 1949, but the finished products attracted only slight attention until polished specimens with significant fossil inclusions were offered for sale in the early 1970s. At this time Rice examined the largest amber mass so far mined: a lump, still partly covered with sediment, that measured 18 inches long, 12 inches across, and 8 inches in depth (45 x 30.5 x 20.3 cm). It weighed 18 lb (8.16 kg). Systematic mining was taking place at Palo Alto, directly south of the north coast seaport village of Puerta Plata and northeast of the city of Santo Domingo. In a later paper, Rice (1981) describes the methods of mining in the several areas and discusses the geology, the structure and nature of the deposits, and the types of amber furnished from each. A recent, valuable paper is by Merette (1983), who gives a thorough study of the occurrences and of the distinctions in properties of ambers from various deposits.

Schlee (1984) photographed some of the astonishing life forms found in the amber, including such unheard-of objects as a 9 mm (3/8 in) tiny frog, the first-ever record of a real frog inclusion, faked ones having been seen in the past in Baltic amber. He also portrays a gecko which must "belong to the super-rarities, because genuine examples have never been found in Baltic ambers." Also depicted are spiders, ants, millipedes, flies, and other life forms, all beautifully encapsulated and preserved in remarkably transparent amber. Bits and pieces of plant matter are also abundant, and, as a confirmation of a possible source tree, some specimens were found containing recognizable leaves of a *Hymenaea* tree, ancestor to the modern *H. courbaril*, which still flourishes in Mexico, Dominica, and elsewhere in the tropics. Schlee's plates 18, 19, 20, and 21 depict this tree with another excellent photograph of fruit, leaves, seeds, etc. by Armstrong (1993).

In another place, Schlee (*Ibid.*, p. 63), discusses the properties and other features of the amber and notes the predominance of yellow coloration, with brown being next most common, followed by reds, greens, and sometimes almost colorless in small pieces. Poinar (1992) states that blue and green ambers are mostly clear and insects are rarely found in them, and those insects that do occur in the blue amber appear to be "washed out," as if they had been partially dissolved (p. 11). The blue color is unstable; after several years it disappears or changes to green.

The locations of mines in the Dominican Republic are given by Martinez & Schlee in Schlee, *et al* (1984) and by Poinar (1992), who provides two maps, one showing mines in the eastern portion of the republic, located generally northeast of the city of Santo Domingo, and another showing numerous mines north and northeast of the city of Santiago in the mountain range known as the Cordillera Septentrional (*see* Figs. 2 & 3). These mines include the Palo Quemado, possibly the first mine to be operated in a formal fashion, according to Kunz (1904) who obtained his information from Mr. C. W. Kempton of the Progressive Mining Company of New York who explored the property. This locality is at 1,800 feet altitude near the top of a hill known as the Palo Quemado at the headwaters of the Licey River, on a small branch called the Miguel Sanchez. The amber collected by Kempton varied from yellow to rich brown in color, "always showing the petroleum-like fluorescence." In the same tight group of mines Poinar's map shows a total of 16 mines, while on the eastern map four mines are shown. Poinar (*Ibid.*, p. 32–33) provides a table showing the most important mines, their locations, ages of the formations, and the characteristics of the amber found in them. If fossils are contained in such ambers, this is mentioned by type.

A record mass of amber from the Palo Alto mine weighed 33 "libras" or over 13 kilograms (28.6 lb), but later was found to be a conglomerate of several smaller masses. Other large specimens from this mine group weighed 7 to 9 kg (15–20 lb). Poinar & Poinar (1994) depict a nodular mass of 17.5 lb (8 kg) (p. 118).

In summary, Dominican amber is both abundant and high in quality, and more likely to be clear than ambers from other sources, save those from Chiapas, which are similar. The amber is likely to be readily available for many years

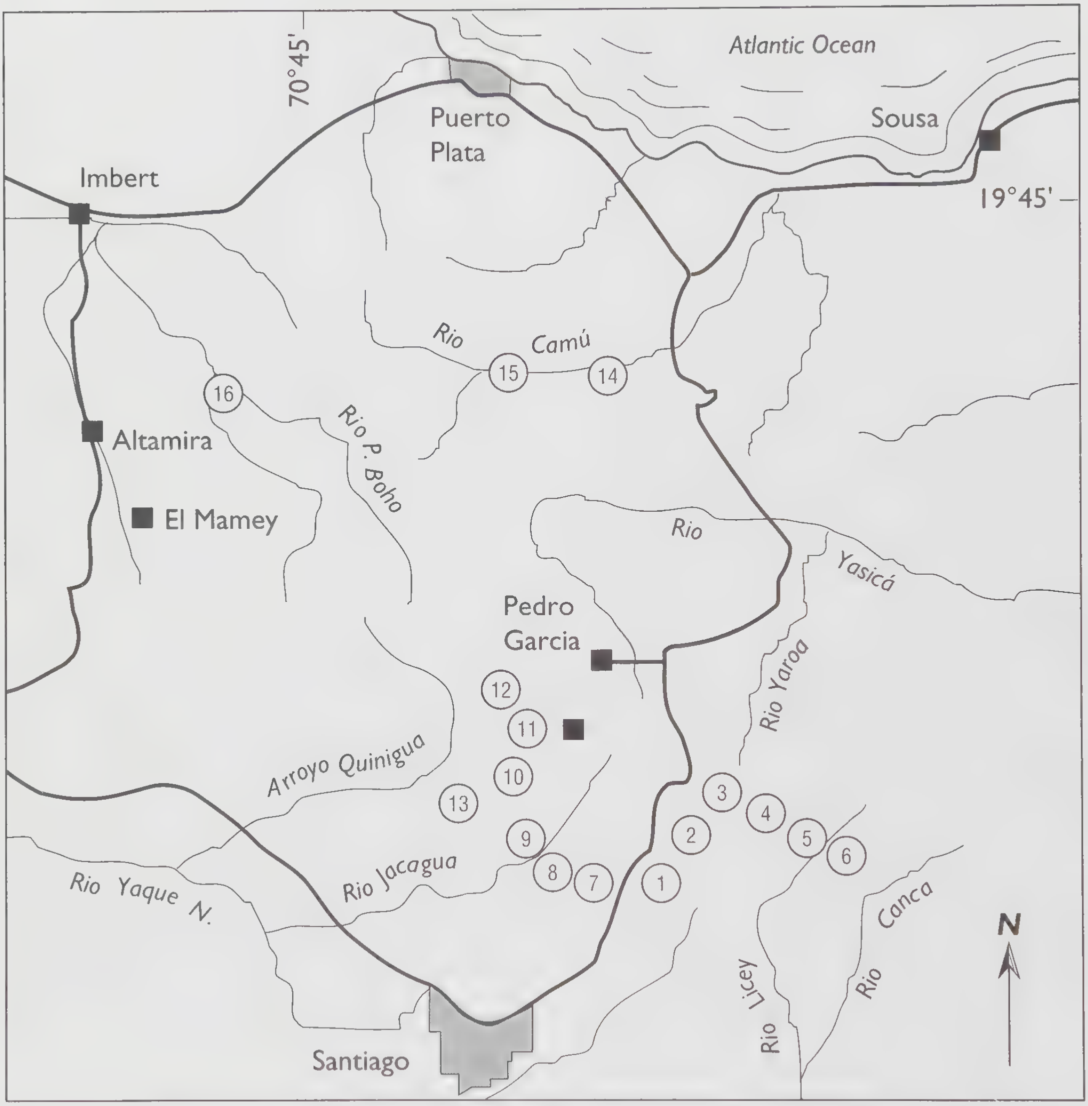


FIGURE 3. Principal amber mines in the mountainous region of northern Dominican Republic: 1. Palo Quemado; 2. Las Cacaos; 3. La Toca; 4. La Cumbre; 5. Carlos Diaz; 6. Villa Trina; 7. Los Higos; 8. La Bucara; 9. Aguacate; 10. Palo Alto; 11. Las Auyomas; 12. Los Aguitos; 13. El Arroyo; 14. Juan de Nina; 15. El Naranjo; 16. Pescado Bobo. After G. O. Poinar and others.

because the sediments in which it occurs are very widespread and far from being fully explored. Gem grade material is yellow, often rich golden in tone, orange, brownish-yellow, and more rarely almost colorless, lemon yellow, greenish, or red. Some is strongly fluorescent in blue, this being obvious even in daylight and extremely vivid when illuminated with ultraviolet light in darkness. Aside from ornamental applications, the most prized specimens are those which contain inclusions of organic matter, especially distinct insects, etc. Because of their remarkable clarity, such pieces are readily appreciated and provide spectacular collector items. The retail prices for polished included amber can be very high, as is evident from a 1993 price list of an American dealer who offered a spider in a 0.40 grams piece for US $100.00 and a 6.72 grams piece containing a perfectly preserved cockroach for $3,000.00. Another large polished mass of 105.49 grams, 5.5 x 11.2 cm (2.25 x 4.5 in) and containing a large moth, a cricket, a millipede, and a spider was offered at US $5,000.00.

Despite the abundance of fossiliferous amber in the Dominican Republic, the government took steps to conserve these resources and published a decree, effective June 5, 1987, requiring an official permit issued by the National Museum of Natural History before such amber could be exported (Balaguer, 1987). It is probable that

FIGURE 4. Entrance to the La Toca amber mine, Dominican Republic. *Courtesy Byron Lewis, The Amber Company, North Hollywood, California.*

amber deposits will be found in adjacent Haiti whenever that troubled country settles into a peaceful state. It is interesting to note that some amber has been found farther east on the Island of Puerto Rico.

ARMSTRONG, W. P. (1993) Neotropical amber. *Ornament* 17, 1, p. 58–61, illust.

BALAGUER, J. (1987) Decree on the exportation of amber fossils from the Dominican Republic. Decree No. 228–87, effective June 5, 1987. *El Caribe* (newspaper), Santo Domingo, June 6, 1987, p. 8.

BROUWER, S. B. & BROUWER, P. A. (1980) Geologia de la region ambarifera oriental de la Republica Dominicana. *9a Conf. Geol. Caribe Memorias*, 1980, 716 p., Santo Domingo p. 304–322.

FRAQUET, H. R. (1982) Amber from the Dominican Republic. *J. Gemm.* 18, 4, p. 321–333.

KUNZ, G. F. (1904) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1903*, p. 964–965.

LENGWEILER, W. (1936) Minerals in the Dominican Republic. *Rocks & Minerals* 11, 7, p. 102–103.

______, (1939) *Rocas y Minerales de la Republica Dominicana.* Ciudad Trujillo, 91 p., illust., maps.

MERETTE, L. M. DE (1983) A new look at Dominican amber. *Jewelers/Gem Business* 7, 5, p. 9–19.

MÜLLENMEISTER, H. J. (1988) Neuentdecktes im dominikanischen Bernstein. *Zs. Dt. Gemmol. Ges.* 37, 1–2, p. 1–25, illust. (col.).

POINAR, G. O. (1992) *Life in Amber.* Stanford, CA: Stanford U. Press, 350 p., illust. (col.), maps.

POINAR, G. & POINAR, R. (1994) *The Quest for Life in Amber.* Reading, MA: Addison-Wesley Publ. Co., 219 p., illust. (col.), p. 102–118.

RICE, P. C. (1979) Dominican amber. *Gems and Minerals* 504, p. 68–71.

______, (1979) Amber of Santo Domingo—mining in the Dominican Republic. *Lapidary J.* 33, 8, p. 1804–1810, map.

______, (1981) Amber mining in the Dominican Republic. *Rocks & Min.* 56, 4, p. 145–152, maps.

ROOD, C. (1981) Best Dominican lapidary speaks on amber. *Lapidary J.* 35, 6, p. 1342–1344.

SAMPLE, C. C. (1905) Amber in Santo Domingo. *Eng. & Min. J.* 80, p. 250–251.

SANDERSON, M. W. & FARR, T. H. (1960) Amber with insect and plant inclusions from the Dominican Republic. *Science* 131, p. 1313.

SCHLEE, D., *et al* (1984) Bernstein-Neuigkeiten. *Stuttgarter Beiträge z. Naturkunde*, Ser. C., 18, 100 p. Many col. photos. Includes remarkable specimens, *Arachnidae*, deposits in the Northern Cordillera, and treatment and trade in the amber.

SCHLEE, D. (1986) Der Bernsteinwald. Paläo-Umwelt in Bernsteinstück. *Mineralientage München Katalog 1986*, p. 68–80, also separate, many col. photos of Dominican amber.

VAUGHAN, T. W. (1921) A geological reconnaissance of the Dominican Republic. *Geol. Survey Dom. Republ. Memoir* 1, 268 p., amber noted.

ZOPPIS, R. (1949) Informe sobre los yacimientos del ambar y lignito de Santiago. Santo Domingo: Archivo Centro de Documentacion. Unpubl. report, 7 p.

PUERTO RICO. According to Ray (1941), amber has been found in the eastern part of the island, in the Barrio Mariana of Humacao, where pieces have been picked up in farm fields at a place about 5 miles (8 km) due west of Humacao. "The amber occurs in small pieces, rarely as large as a walnut and many specimens show an alteration or oxidation to a yellowish opaque material but their centers are always clear." Ray states that he has never seen any inclusions in the amber but "the amount is considerable and at one time the local church used it as an incense—may do so yet. It burns with a very pleasant odor."

RAY, H. C. (1941) Minerals of Porto Rico. *Rocks & Minerals* 16, 10, p. 355–359, amber p. 358.

AMBLYGONITE, *see* MONTEBRASITE

AMMOLITE—CALCENTINE—KORITE

The above names have been variously applied to the strongly iridescent outer layers of fossil ammonites found in Alberta, but the term "ammolite," as irritating as this must be to mineralogists who wish to reserve the "ite" ending for established mineral species, has now become the standard designation. This colorful material was introduced to the public in the form of cabochons, and later, as problems developed with stability of the material, as triplets in which the

FIGURE 5. Views in the Blood Mine of Korite Minerals, Ltd., taken in 1955 near Lethbridge, Alberta. Top: "Pay dirt" is struck at 20 feet (6 m) below the surface. Bottom: Examining concretions for presence of suitable ammolite. *Courtesy Pierre Paré, Korite Minerals, Ltd.*

iridescent layer was sandwiched between a stone base and a colorless cap of rock crystal or synthetic spinel. The trade name of ammolite was first used by Ammolite Minerals, Ltd., of Calgary, Alberta (Kraus, 1982). Difficulties with the cabochons due to the continued flaking of the iridescent layer called for an investigation to improve the stability. Accordingly, in 1970, Santo Carbone of the Geological Survey of Canada worked out a process for stabilizing the material before it was introduced into gems. Carbone joined Calgary jeweler Thomas McArthur to market the finished gems, adopting the trade name Calcentine Limited, the term itself derived from *Cal*gary's *Cen*tennial and adding "ine." However, Carbone left this venture to begin a new one with Roy Kormos, a rancher upon whose property were to be found numerous suitable ammonites, and thus was formed Korite Minerals, Ltd., in Calgary. This company remains active, and much of the information contained herein is owing to Pierre Paré, its president (*Pers. comm.* 12/92).

The ammonites generally are 8 to 10 inches (20-25.5 cm) in diameter in the more common, larger species known as *Placenticeras meeki*, and somewhat smaller in *P. intercalare*, a rare but also iridescent species. These fossils occur in the Bearpaw formation, 360 feet thick (125 m), consisting of shales and siltstones of Upper Cretaceous age. These beds are exposed along rivers and gullies in an area about 10 miles (16 km) south of Lethbridge in southern Alberta (Wight, 1993). The largest mine is an open pit operated by Korite Minerals, Ltd., who excavate approximately 2 acres (0.81 hectare) per year to a depth of 50–60 ft (15–18 m), using heavy equipment (*see* Fig. 5). Paré notes that "the concretions are so hard that they are not damaged by the equipment." The rough is then shipped to Calgary for processing. It is believed by Paré and others that the ancient pressure of sediments on the fossils caused crackling of the iridescent layer followed by re-healing which resulted in the typical checkerboard patchwork or mosaic of colorful platelets which Wight (1981, p. 409) likens to "a stained-glass window with small patches of brilliant colours framed by darker, non-iridescent lines." Paré also believes that a "sealing" process took place during the course of fossilization such that concretions were formed around the ammonites, sealing them in, and preventing the aragonite of the shell from reverting to calcite. These natural processes appear to be so effective as preservatives that no special treatments are provided to further stabilize the material as was necessary decades ago in other types of ammolite. Accordingly, the company unconditionally guarantees their triplet gems to last for ten years with normal use, and states that "our percentage of returns for the past 15 years has been a fraction of 1%." Another class of ammolite gems are called "naturals" because they are simply cut and polished as cabochons without backing or capping and "are not stabilized in any way." These cabochons therefore appear as thin layers of iridescent crackled material resting upon their matrices, somewhat like some boulder opals of Australia. Triplets are constructed of a layer of natural shale matrix upon which is laid the thin layer of iridescent material, the latter covered with a cap of synthetic colorless spinel. Each layer is epoxy-bonded and all finished gems tested. Jarand (1982) provides an interesting account of his experimentation with ammolite material to create durable cabochon gems.

The properties of ammolite were determined by Wight (1981) as follows: refractive indexes 1.520–1.670, birefringence 0.150; specific gravity taken in heavy liquids 2.67–2.85, hydrostatically, 2.80 ± 0.01. Hardness 4. Kraus (1982) obtained RI 1.52–1.68, birefr. 0.155; SG 2.70, H 4. Wight found trace elements Sr, Fe, Si, Ti, Al, Ba, Cr, Cu, Mg, Mn, and V. Other components are water and organic material. It is emphasized that the primary mineral in ammolite is aragonite, the orthorhombic calcium carbonate, and not calcite, its hexagonal chemical equivalent. Aragonite is relatively soft for a gem material and rubbing of unprotected stones against hard substances is to be avoided as also contact with any type of acid, which could etch the surface polish.

It is estimated that 80% or more of the market for this fascinating material and its finished products is controlled by Korite Minerals, Ltd., with about 50% of sales being loose stones and 50% finished jewelry incorporating ammolite gems. Some rough is also sold. A large portion of retail sales goes to tourists in Japan, Hong Kong, and Korea, according to Paré. Much of the ammolite-set jewelry sells in the retail range of US $100 to $1,000.

In the fall of 1994, the G.R.B. International Mining Company of Lethbridge, Alberta, introduced another ammonoid fossil of the same general character as that just described: the baculite. This fossil is relatively abundant in the Cypress Hills. The host material, according to the Fraziers (1994, a,b) is "soft, poorly consolidated, Upper Cretaceous marine shales and clays," deposited upon the floor of an ancient sea millions of years ago. The calcareous baculites are simple tapering rod-like shapes of roughly elliptical cross-section, which when sanded and polished display characteristic lines of pale tan against darker brownish-red backgrounds. The patterns resemble the intricate ins-and-outs of acanthus leaves. A fancied resemblance to shields in such patterns led the company to call their material shieldstone. Various shapes have been cut from this material, including cabochons for settings in jewelry.

Closely resembling the ammolite in its play of color is a grayish limestone from Carinthia, Austria, which is incidentally described in an interesting article by G. Niedermayr (1994). Ornamental objects made from this co-called "lumachelle" have retained their colors over hundreds of years of exposure to ordinary atmospheres and illuminations.

CROWNINGSHIELD, R. (1977) A new jewelry item. *Gems & Gemology* 15, 10, p. 312. "Calcentine" appears on the market.

FRAZIER, S. & FRAZIER, A. (1994) Nemo nightmares. *Lapidary J.* 48, 6, p. 63–72, *passim*, illust. (col.).

______, (1994) Post-Jurassic gem. *Ibid.* p. 533–562, *passim*, illust. (col.).

GÜBELIN, E. (1980) Ammolite—a new fossil gemstone. *Lapis* 5, 4, p. 19–24.

HADLEY, W. D. (1981) A new gemstone, "Korite." *Rock & Gem* 11, 3, p. 44–46; 4, p. 60-61, illust. (col. excellent!).

JARAND, W. H. (1982) Processing ammonite shell. *Lapidary J.* 36, 5, p. 948.

KRAUS, P. D. (1982) Korite from Alberta, Canada. *Lapidary J.* 35, 10, p. 1994–1996.

LEIPER, H. (1969) A new fossil gem is found in Alberta. *Lapidary J.* 23, 7, p. 932, 937, illust. (col.).

NIEDERMAYR, G. (1994) The Bleiberg box. *Lapidary J.* 48, 6, p. 37–40, 42, illust. (col.).

POUGH, F. H. (1980) Ammolite, grandmother-of-pearl. *Lapidary J.* 39, 10, p. 35–41. An excellent survey.

STAFFORD, P. (1973) Ammonites and baculites in southern Alberta. *Gems & Minerals* 424, p. 32–44; 425, p. 27, 42–44; 426, p. 30, 31, 41–43.

WIGHT, Q. (1993) Canadian ammolite. *Rock & Gem* 23, 12, p. 42–47.

WIGHT, W. (1981) "Korite"—fossil ammonite shell from Alberta, Canada. *J. Gemm.* 17, 6, p. 406–415. Definitive treatment.

ZEITNER, J. C. (1978) Calcentine is ammolite is nacre. *Lapidary J.* 32, 2, p. 622–628.

AMPHIBOLE—ORTHOAMPHIBOLE—NUUMMITE

GREENLAND. An attractive, brown, granular amphibolite (rock) which shows strong golden reflections from its constituent grains has been found in Greenland recently. Virtually all of the grains are orthoamphibole (mineral) with average refractive index of alpha 1.64, gamma 1.66, birefringence 0.02, specific gravity 3.20–3.37. It has been found at eight places in the vicinity of Nuuk (Godthaab) on the west coast at about latitude 64°10'N. The name "nuummite" was given to the material after the Greenland capital Nuuk, formerly Godthaab. Gem material occurs in lenses up to 1 meter (3 ft) wide enclosed in the country rock. According to Petersen & Secher (1993), "cut and polished cabochons show a sparkling iridescence ranging from metallic blue and green through yellow to golden, reddish and rarely violet colors. The matrix . . . ranges from pale gray to almost black, sometimes with a brown hue." Excellent color photographs of cabochons are shown in Appel & Jensen (1987). Crowningshield (1993) examined a necklace of this material and found the additional property of magnetism, which suggests the presence of magnetite, a not unexpected mineral in such an igneous rock.

APPEL, P. M. U. & JENSEN, A. (1987) A new gem material from Greenland: iridescent orthoamphibole. *Gems & Gemology* 23, 1, p. 36–42, illust. (col.), map.

CROWNINGSHIELD, C. R. (1993) Iridescent orthoamphibole, "Nuumite." Gem Trade Lab notes, *Gems & Gemology* 29, 4, p. 281, illust.

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Mineralogical Record* 24, 2, p. 1–65, illust. (col.), maps.

WISCONSIN. Lovvik (1976) describes a new amphibolite rock cutting material, collectible at Big Falls on the Eau Claire River, near Eau Claire. The rock has been satisfactorily polished into cabochons and small objects.

LOVVIK, D. V. (1976) Chippewa amphibolite: a new collecting material. *Rockhound* 5, 6, p. 16, 18, map.

WYOMING. An amphibolite rock displaying strong golden reflections, very much like that described above for the Greenland material, has been found 11 miles (17.5 km) southwest of Douglas, Converse County (Dietrich, *et al*, 1988). It is a granular rock composed of randomly oriented crystals of orthoamphibole that reach 3/8 in (1 cm) in diameter. The body color is dark brown but the grains show strong golden reflections and some display reddish hues. In a brief note in *Lapidary Journal* (43, 10, 1990, p. 6), Paragon Minerals, Inc., calls this rock "wildfire" and states its intention to market it under that name.

DIETRICH, R. V., *et al* (1988) A gem-quality iridescent orthoamphibole from Wyoming. *Gems & Gemology* 24, 3, p. 161–164, illust. (col.).

ANALCIME—ANALCITE

QUEBEC. Clear, ball-like crystals several millimeters in diameter occur at the famous mineral locality of Mont St.-Hilaire. The locality has produced some of the world's largest and finest crystals of this species, but only the very small individuals are clear enough to facet small gems of less than one carat.

MICHIGAN. In the Keweenaw Peninsula copper deposits, splendid crystals of analcime are found, Whitney (1859) noting that "the finest locality . . . is at the Copper Falls and Northwestern mines, Keweenaw County," and "the analcime occurs in large and almost transparent crystals forming geodes in the greenish magnesian silicate which is the principal gangue of the vein [of the Northwestern Mine]."

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Dept. Nat. Resources, Geol. Survey Div. Bull.* 6, 225 p., illust. (col.).

WHITNEY, J. D. (1859) Notice of new localities, and interesting varieties of minerals, in the Lake Superior region, etc. *Amer. J. Sci.* 2nd ser., 28, p. 8–20.

ANATASE

COLORADO. No new developments.

ECKEL, E. B. (1961) Minerals of Colorado, a 100-year record. *USGS Bull.* 1114, 399 p.

LARSEN, E. S. & HUNTER, J. F. (1914) Melilite and other minerals from Gunnison County, Colorado. *J. Wash. Acad. Sci.* 4, 16, p. 473–479.

ANDALUSITE—CHIASTOLITE

NORTHWEST TERRITORIES. Relf (1993) reports on chiastolite crystals, about 8 cm (3 in) long and 1 cm (1/2 in) thick, with a good cruciform internal pattern, embedded in metamorphic rocks in the Bathurst Inlet area, 29 km (18 mi) east-northeast of Bathurst Inlet Lodge. They appear suitable for polished specimens in host rock but are too far removed from markets to be mined commercially.

RELF C. (1993) Report on lapidary occurrences in the Bathurst Inlet area, N.W.T. *NWT Geol. Div. EGS* 1993–03, 6 p., illust., maps.

MAINE. Bradshaw (in press) notes an extremely rare example of a terminated andalusite crystal found in quartz lenses in schist at Smalls Point, Phippsburg, Sagadahoc County, that yielded a faceted gem from a clear area. The gem, a square cut, weighed 1.50 ct. Faceted andalusites were recorded from South Dakota in Volume II, but this appears to be a first occurrence for Maine. Further details on the Smalls Point locality are given by King & Foord (1994, p. 26).

BRADSHAW, J. J. (in Press) Gemstones of Maine. In KING, V. T., ed., *The Mineralogy of Maine.* Augusta, ME, Geological Survey of Maine. Excerpt: [21] p.

KING, V. T. & FOORD, E. E. (1994) *Mineralogy of Maine.* Volume I. Descriptive Mineralogy, Augusta, ME Geol. Survey, 418 p., illust. (col.).

MASSACHUSETTS. No new developments.

BARON, D. H. (1981) Three choice collecting sites for New England collectors. *Lapidary J.* 34, 12, p. 2508–2520, *passim.*

JACKSON, C. T. (1834) An account of the chiastolite or macle of Lancaster (Massachusetts). *Boston J. Nat. Hist.* 1, p. 55–62.

SHAUB, B. M. (1953) Chiastolite of Lancaster, Massachusetts. *Rocks & Minerals* 28, p. 3–8.

TAPAROWSKY, J. J. (1976) Chiastolite, a Massachusetts classic. *Rocks & Minerals* 51, 5, p. 245–247, map.

CALIFORNIA. No new developments.

BERKHOLZ, M. F. (1953) Fresno goes after chiastolite. *Gems & Minerals* 192, p. 7–9, map. Madera.

BROWN, W. L. (1936) Chiastolite crystals, Madera, California. *The Mineralogist* 4, p. 9.

GROSS, E. B. & PARWEL, A. (1968) Rutile mineralization at the White Mountain andalusite deposit, California. *Arkiv f. Mineralogi och Geologi* 4, 29, p. 493–497.

KERR, P. F. (1932) The occurrence of andalusite and related minerals at White Mountain, Calif. *Econ. Geol.* 27, 7, p. 614–643, figs.

MELHASE, J. (1925) Andalusite in California. *Eng. & Min. J. Press* 120, 3, p. 91–94, illust. Inyo Range.

NOREN, C. A. (1935) Fine chiastolite is found in California. *The Mineralogist* 3, 1, p. 34, 51.

______, (1956) Chiastolite from Madera County, California. *Gems & Minerals* 222, p. 18–21.

ANHYDRITE

NEWFOUNDLAND. Sabina (1976) reports massive anhydrite, light blue and blue-gray in color, semitransparent, from the Flat Bay gypsum quarry, St. George Bay area, near Corner Brook. It is suitable for carving.

SABINA, A. P. (1976) Rocks and minerals for the collector: the Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, p. 157.

ONTARIO. According to Arem (1987, p. 43), the Faraday Mine, Faraday Township, Hastings County, produced "large purplish masses [of anhydrite], some facetable," and there is a faceted pink-blue gem of 2.86 ct in a private collection. Properties: refractive indexes 1.57–1.61, specific gravity 2.9–2.98, and hardness 3–3.5.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* NY: Van Nostrand Reinhold, 2nd edit., 248 p., illust. (col.).

APATITE

D. McConnell published a monograph on apatite in 1973 which provides information on all species and occurrences both inorganic and organic. His information on Durango gem grade apatite is taken from Young, *et al* (1969), and nothing is said about other gem species or varieties.

McCONNELL, D. (1973) *Apatite: Its Crystal Chemistry,* etc. NY: Springer Verlag, 111 p., illust.

ONTARIO. In 1975, the famous Liscombe Mine, near Wilberforce, Concession XV, Lot 34, Monmouth Township, Haliburton County, was reopened by Trilliumite Explorations, Ltd., of Toronto for the purpose of recovering large apatite crystals containing clear green areas suitable for faceted gems. These gems were touted as "Canada's new gemstone," and dubbed "trilliumite" (*Lapidary J.*, Feb. 1976, p. 2017). The finest rough was offered at $3.00/ct, and rough containing flaws was offered for less. The company offered a "museum special" faceted green apatite, said to be "the largest gem apatite in the world, 86.89 cts., emerald cut fine chrome green color, flawless" at $8,700.00 U.S. funds. Wight (1991) records a faceted gem from this mine as "a superb, intense, slightly yellowish-green, oval brilliant cut, weighing 65.52 carats," and notes others from the same deposit of 24.64, 7.49, and 6.28 carats. These gems are in the collection of the Canadian Museum of Nature in Toronto.

The Liscombe Mine exploits one of the unique calcite-cored pegmatite veins that occur abundantly in Ontario and Quebec. Large, stubby to moderately elongated, simple hexagonal prisms of apatite occur frozen in coarse granular calcite. In some crystals, clear areas exist despite the usual pervasive shattering characteristic of frozen crystals. It is from such crystals that the Liscombe facet-grade apatite comes. Information on these remarkable deposits is summarized in Adams & Barlow (1910) and other references as noted below.

In regard to the properties of the apatite, inclusions were found that consist of clouds of negative crystals, biotite mica, and planar "lily-pad" separations and two-phase inclusions. Properties reported by Shearer (1976) are refractive index ca 1.63–1.64, birefringence 0.002–0.006, specific gravity 3.18, and hardness 5. There is no distinct cleavage. The dichroism is blue and bluish-green. Bank (1975) gave the following properties on this apatite: refractive indexes epsilon 1.628, omega 1.632, birefringence 0.004 and specific gravity 3.16.

Elsewhere in Haliburton County, Harper (1992) reported exploration of his "Harper Deposit," located adjacent to Hill or Long Lake in Monmouth Township and reached via Madill Road from Bear Lake Road. Stubby to long crystals of greenish apatite are recovered from a calcite-cored pegmatite. Clear fragments have been faceted into gems up to 3 ct; recent finds suggest that clean gems to about 10 ct will be cut.

ADAMS, F. D. & BARLOW, A. E. (1910) Geology of the Haliburton and Bancroft areas, Province of Ontario. *Geol. Survey Canada Memoir* 6, 419 p., illust., maps.

BANK, H, (1975) Grüner Edelapatit aus Kanada. *Zs. Dt. Gemmol. Ges.* 24, 4, p. 246–7.

BOYD, W. F. & WIGHT, W. (1983) Gemstones of Canada. *J. Gemm.* 18, 6, p. 544–562, maps. Includes apatite.

FIELD, D. S. M. (1951) Sodalite and apatite from Canada. *Canad. Mining J.* 72, 9, p. 82–83.

HARPER, S. E. (1992) The Harper apatite-biotite-hornblende-titanite deposit, Haliburton Co., southern Ont., Canada. *Mineral News* 8, 6, p. 1–2.

HARRINGTON, B. J. (1879) Report on the minerals of some of the apatite-bearing veins of Ottawa County, Quebec, etc. *Geol. Survey Canada Rept. Progress* 1877–78, Rept. G., 37 p., illust.

MEEN, V. B. & GORMAN, D. H. (1953) Mineral occurrences of Wilberforce, Bancroft and Craigmont-Lake Clear areas, southeastern Ontario. *Geol. Soc. Amer. & Geol. Assoc. Canada Guide Book* 2, Toronto, 23 p., map. Liscombe Mine p. 11.

PETERSON, H. (1973) Apatite in Ontario and Quebec. *Lapidary J.* 27, 8, p. 1320–1322.

ROBINSON, G. & CHAMBERLAIN, S. C. (1982) An introduction to the mineralogy of Ontario's Grenville province. *Min. Rec.* 13, 2, p. 71–86.

SATTERLY, J. (1943) Mineral occurrences in the Haliburton area. *Ont. Dept. Mines Ann. Rept.*, 52, pt. 2, 106 p., illust., maps.

SHEARER, J. (1976) Excerpts from the discourse on his find in the Bancroft area of Ontario of a source of gem apatite named "trilliumite." *Canad. Gemm.* 1, p. 10–12.

SPENCE, H .S. (1920) Phosphate in Canada. *Canada Dept. Mines, Mines Br. No.* 396, 156 p., maps, illust.

SPENCE, H. S. & CARNOCHAN, R. K. (1930) The Wilberforce radium occurrence. *Canad. Inst. Min. & Metall. Trans.* 33, p. 34–73, maps.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map. Apatite p. 30–33.

WIGHT, W. (1991) Check-list for rare gemstones: apatite. *Canad. Gemm.* 12, 1, p. 14–17.

MAINE. Under FLUORAPATITE, King & Foord (1994, p. 152–154) describe the famous gemmy purple crystals found in several pegmatite deposits of southwestern Maine, and not only furnish details of past finds, sometimes quoting previously published accounts, but also describe types of crystals, sizes, qualities, etc., along with reproductions of crystal drawings. A splendid, lustrous group of purple crystals, measuring about 1 in (2.2 cm) across, in the Harvard Mineralogical Museum collection, appears in color upon the cover of the above reference. The authors state that a new discovery of "royal purple" fluorapatite was made in 1992 by Duddy Groves and Dick Dionne in a small prospect pit located about 100 m (110 yd) west of the Wade Quarry in Auburn.

BANCROFT, P. (1984) *Gem & Crystal Treasures.* Fallbrook, CA: Western Enterprises, 488 p., illust. (col.), Pulsifer apatite p. 15–18.

BRADSHAW, J. J. (*in press*) Gemstones of Maine. In KING, V. T., ed. *Mineralogy of Maine.* Maine Geol. Survey, (21) p.

DOYLE, R. G. (1960) An authoritative and official guide describing gemstones and mineral localities in Maine. *Lapidary J.* 14, 3, p. 264–278, maps.

FISHER, L. W. & BERNARD, R. B. (1934) Mount Apatite; a famous mineral locality. *Rocks & Minerals* 9, 2, p. 13–16.

GOSSE, R. C. (1963) Apatite in the New England States. *Lapidary J.* 16, 12, p. 1134–1135.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive Mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col).

MAINE GEOLOGICAL SURVEY (1957) Maine pegmatite mines and prospects and associated minerals. *Minerals Resources Index* No. 1, 43 p., maps.

MORRILL, P. (1956) *Maine Mines and Mineral Locations.* Naples, ME: Dillingham Nat. Hist. Mus., 47 p., maps.

_____, (1958) *Maine Mines and Minerals.* Vol. 1, Western Maine. Winthrop, ME: priv. publ., 81 p., maps.

_____, (1963) *Mineral Guide to New England.* 41 p., maps.

SZENICS, T. (1967) The richest find of royal purple apatite in more than fifty years. *Lapidary J.* 20, p. 1178–1189, *passim,* illust. (col.).

THOMPSON, W. B., *et al.* (1991) A collector's guide to Maine mineral localities. *Maine Geol. Survey Bull.* 41, 2nd edit., 104 p., illust. (col). maps.

WILSON, W. E. (1977) The Pulsifer Quarry. *Min.Rec.* 8, 2, p. 72–77, illust.

WOLFF, J. E. & PALACHE, C. (1902) Ueber Apatit von Minot, Maine. *Zs. Krist.* 36, 5, p. 438–448.

_____, (1902) Apatite from Minot, Maine. *Amer. Acad. Arts & Sci. Proc.* 37, 18, p. 517–528, pl.

GEORGIA. Cook (1978, p. 97) records that "exceptional transparent crystals of light yellow hydroxyl-apatite up to one inch (2.5 cm) in diameter occur in green talc at the Verde Antique Quarry, 2 miles (3.2 km) SW of Holly Springs," in Cherokee County. Arem (1987, p. 44) gives properties for a Holly Springs apatite as refractive indexes omega 1.651, epsilon 1.644, birefringence 0.007, specific gravity 3.21. Another occurrence of gem quality crystals: "transparent light-green apatite . . . reported from a road cut along Georgia Highway 17, several miles southeast of Nacoochee . . . in biotite gneiss containing pegmatitic granite."

AREM, J. E. (1987) Color *Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).

COOK, R. B. (1978) Minerals of Georgia: their properties and occurrences. *GA Geol. Water Resources Div. Bull.* 92, 189 p.

NEW MEXICO. Mr. R. S. De Mark of Marquette, Michigan, informs me that transparent faceted gems of yellow apatite up to 5 carats may be cut from crystals found in Rock Springs Canyon, Organ Mountains, Dona Ana County (*Pers. comm.* 4/4/94). The crystals occur in miarolitic cavities in a quartz monzonite.

CALIFORNIA. During the 1988 to 1990 mining seasons at the Himalaya Mine, Mesa Grande, San Diego County, tourmaline pockets yielded many fine pink apatite crystals of stout prismatic to tabular habit. Some were clear and yielded excellent faceted gems up to about ten carats which were sold by Pala Properties International, of Fallbrook, California, owners and operators of the mine. Prices of \$50 to \$100 per carat were obtained for the gems. These pink gems, however, must be kept in the dark if their original color is to be maintained; otherwise they change to light blue after prolonged exposure to daylight (*Pers. comm.* W. Larson).

DURANGO. Recent visitors to the famous and still productive locality for bright yellow, gemmy apatite crystals at the iron mine near Ciudad Durango, Durango State report that the mine was closed as of 1993, but local guides were available to take one to places upon the site where apatite crystals could be found. For example, Megaw (1993) found such crystals but cemented together with chalcedony and associated with the martite that forms the principal iron mineral of the orebody. Bowser (1993) also found crystals,while some members of his party found facet grade apatite "in sufficient amounts to make the trip more than worthwhile."

BOWSER, W. (1993) Fall mineral safari in Mexico. *Mineral News* 9, 12, p. 5–7.

BURKART, H. J. (1871) Ueber Fundorte mexicanischer Meteoriten und über Apatit von Durango. *N. Jb. Min.* 1871, p. 851–855.

FOSHAG, W. F. (1928) Mineralogy and geology of Cerro Mercado, Durango, Mexico. *U.S. Nat. Mus. Proc.* 74, art. 23, p. 1–27, 4 pls.

MEGAW, P. (1993) News from Mexico. *Mineral News* 9, 7, p. 1, 8.

PANCZNER, W. D. (1987) *Minerals of Mexico.* NY: Van Nostrand Reinhold, 459 p., illust. (col.), maps.

SALINAS, L. S. (1923) Catalogo sistematico de especies minerales de Mexico y sus aplicaciones industriales. *Inst. Geol. Mex. Bol.* 40, 290 p.

SALINAS, L. S., *et al* (1923) El Cerro de Mercado, Durango. *Inst. Geol. Mex. Bol.* 44, 96 p., pls., maps. Ch. on gem apatite by A. R. M. Quintero.

YOUNG, E. J., *et al* (1969) Mineralogy and geochemistry of fluorapatite from Cerro de Mercado, Durango, Mexico. *USGS PP* 650-D, p. 84–93, illust.

ARGILLITE

NORTHWEST TERRITORIES. An argillite, much used by Inuit carvers of the province, consists of a metamorphosed, laminated sedimentary rock that occurs at Arctic Bay and Sanikiluaq in the Belcher Islands of southeastern Hudson Bay (Gibbins, 1987).

GIBBINS, W. A. (1987) Carvingstone and Inuit carvings: unique Northern Canadian resources. *NWT Geol. Div. EGS* 1987-7, 22 p. Argillite p. 8.

BRITISH COLUMBIA. The celebrated argillite carvings of the Haida are fully explored in an excellent monograph by Drew & Wilson (1980), who also devote much space to the source of the material in the Queen Charlotte Islands and provide remarks on its nature and the techniques employed in carving.In a recent visit to Alaska, I found Haida carvings of modern vintage, but fully in the spirit of the older work, for sale in various curio stores at prices which reflect both the rarity of this kind of carving and the obvious skill of its carvers. Totem poles of about 8 inches (20 cm) tall were offered for about $1,100 each (!) while small, flattish pendants, shallowly incised in Haida motifs and measuring about 2 x 2 x 1/8 in (5 x 5 x 0.3 cm), sometimes fitted with small "eyes" of local abalone shell, sold for $100 to $150 each. Many of these pieces were made more attractive by clever frosting of certain surfaces to contrast with the high polish of other areas.

BARBEAU, M. (1953) Haida myths illustrated in argillite carvings. *Nat. Mus. Canada Bull.* 127, Anthropol. ser. 32, 417 p., illust.

______, (1957) Haida carvers in argillite. *Nat. Mus. Canada Bull.* 139, Anthropol. ser. 38, 214 p., illust.

DANNER, W. R. (1976) Gem materials of British Columbia. *Montana Bur. Mines & Geol. Spec. Publ.* 74, p. 157–69, illust. Argillite p. 169, 171.

DAWSON, G. M. (1880) Report on the Queen Charlotte Islands, 1878. *Geol. Survey Canada Rept. Progress*, 1878–9, B1–B101 p., maps.

DOCKSTADER, F. J. (1962) Kwawhil carvings from Skidegate. *Nat. Hist.* 71, 9, p. 30–39, illust.

DREW, L. & WILSON, D. (1980) *Argillite Art of the Haida.* N. Vancouver, BC: Universe, 313 p., illust. (col.).

HARRINGTON, L. (1949) Last of the Haida carvers. *Nat. Hist.*, May, p. 200–205, illust.

MUNRO, J. (1953) Slate carving in the Queen Charlotte Islands. *Lapidary J.* 7, 4, p. 318–321.

SUTHERLAND-BROWN, A. (1968) Geology of the Queen Charlotte Islands, British Columbia. *BC Dept. Mines & Petrol. Res. Bull.* 54, 226 p.

ARIZONA. No new developments.

BARTLETT, K. (1939) A prehistoric "mine" of red argillite resembling pipestone, near Del Rio, Arizona. *Mus. North. Ariz. Mus. Notes* 11, 12, p. 75–78, a fig.

AUGELITE

CALIFORNIA. Bank (1975) determined properties of gem augelite from the Champion Mine, White Mountains, Mono County, as follows: refractive indices alpha 1.570, gamma 1.590, birefringence 0.020. Mr. Arthur Grant (*Pers. comm.* 1991) advises me that he has cut a flawless, colorless faceted gem from this material that weighs 1.44 carats.

BANK, H. (1975) Durchsichtiger farbloser bis gelblicher schleifwürdiger Augelith vom White Mountain (Kalifornien/USA). *Zs. Dt. Gemm. Ges.* 24, 2, p. 88–9.

GROSS, E. B. & PARWEL, A. (1968) Rutile mineralization at the White Mountain andalusite deposit, California. *Arkiv f. Min. o. Geol.* 4, 29, p. 493–497.

JEFFREY, J. A. & WOODHOUSE, C. D. (1931) Note on a deposit of andalusite in Mono County, California. *Calif. Min. Bur. Rept.* 27, p. 459–464.

KERR, P. F. (1932) Occurrence of andalusite and related minerals at White Mountain, California. *Econ. Geol.* 27, p. 614–643.

LEMMON, D. M. (1935) Augelite from Mono County, California. *Amer. Min.* 20, p. 666–8.

PEACOCK, M. A. & MODDLE, D. A. (1941) On a crystal of augelite from California. *Min. Mag.* 26, p. 105–115.

WISE, W. S. (1977) Mineralogy of the Champion Mine, White Mountains, California. *Min. Rec.* 8, 6, p. 478–486, map. Depicts a crystal 2.5 cm long.

WOODHOUSE, C. D. (1951) The Mono County andalusite mine. *Rocks & Min.* 26, 9–10, p. 486–493, illust.

AXINITE

CALIFORNIA. Splendidly crystallized axinite, determined to be ferroaxinite, was found in cavities in the exposed walls of a spillway constructed for the New Melones Dam, Calaveras County. The rocks are metagabbros and metabasalts through which pass veins filled with massive albite and ferroaxinite, with occasional cavities that allowed euhedral crystallization. The cavities contain typical knife-edge clove-brown crystals up to 6.8 cm (2.75 in) across, with gemmy crystals of 3.45–4.5 cm (1.4–1.75 in) (Pohl, *et al*, 1982; Crowley, 1983). The latter author states that some crystals were 4 inches (10 cm) across, and that almost without exception they were very bright, glassy individuals, usually translucent but fairly often completely transparent and almost flawless. Crowley states that flawless gems were faceted up to several carats weight, but attempts to facet larger stones met with disappointment because the stones proved to be too dark. In his article, Crowley provides fine color photographs depicting roughs and faceted gems, the latter of 1.25 to 2.25 ct in various styles of cut. This find brought forth what are among the finest of all American axinites, but larger, clean faceted gems were cut from the crystals previously reported from the Mina Olivia, Baja California Norte. In any event, this find, made in a typical Alpine "Kluft," speaks promisingly of similar finds that might be made if similar rock terrains are carefully prospected.

The splendid gem-quality axinite crystals shown in Volume I, Figure 111, whose exact provenance was kept secret by its finder, aroused the curiosity of Mr. T. Szenics who went to the considerable trouble of tracking down the locality. This proved to be a relatively small excavation at Thornberry Mountain, near Coarse Gold, Madera County (Szenics, 1990). While convinced that the long-lost locality had been found, Szenics realized that a great deal of work would have to be done before anything more could be learned about the deposit. So far nothing further has been done on this deposit.

Also in California's Gold Country, Mr. Daniel-Harry Steward of Seattle, Washington, collected splendid specimens of crystallized axinite from a road cut, site now obliterated, between Lake Oroville and the general store at Yankee Hill, one mile (1.6 km) southwest of the store, Butte County. According to Steward, "a few of the loose crystals were of faceting quality and I have a pale plum colored brilliant of 2.3 cts." The specimens examined by me display small, typically wedge-shaped crystals of very pale brownish color on matrix of dolomitic(?) rock along whose fractures both axinite and albite have crystallized.

In San Diego County, a vague reference to the discovery of axinite crystals near Bonsall can be clarified to some extent by referring to Schaller's account of 1911: "In 1903–4 some large brownish crystals were found in Moosa Canyon, near Bonsall, San Diego County, by Mr. T. Freeman and forwarded . . . to Dr. G. F. Kunz of New York, who determined them as axinite." Schaller visited the locality in 1904 and collected specimens which were then chemically analyzed. Thus the locality can be accepted as bona fide, but since Schaller's time no collector has taken the trouble to look again into the deposit (if it can be certainly located!).

In a recent visit (Fall 1993) to Mr. Louis Spaulding, Jr.'s Little Three Mine properties near Ramona, I was shown about 20 pieces of very dark brown axinite crystals and fragments that Spaulding had recovered from small pockets in granitic pegmatite during his mining for the beautiful spessartine garnets for which this area is justly famed. The axinite occurred in association with typical fine-bladed white cleavelandite, acicular and prismatic schorl, spessartine garnet, and some epidote. One euhedron measured one inch (2.5 cm) across but was only 1/8-inch (3 mm) thick. The largest crystals, among the largest ever found in California, aside from those mentioned above in Calaveras County, were up to two inches (5 cm) across. Although these crystals were translucent to transparent, hair-like inclusions of schorl would bar cutting any gem larger than a small fraction of a carat. However, as further work is done on this deposit, it is likely that better, more facetable crystals will be found.

CROWLEY, J. A. (1983) Axinite—old and new. *Lapidary J.* 37, 3, p. 444-448, illust. (col.).

JACOBY, D. & JACOBY, W. (1968) Gem axinite, treasure of California's Feather River Canyon. *Lapidary J.* 21, 11, p. 1332–1333, illust.

POHL, D. *et al.* (1982) Ferroaxinite from New Melones Lake, Calaveras County, California, a remarkable new locality. *Min. Rec.* 13, 5, p. 293–302, illust., maps.

SCHALLER, W. T. (1911) Mineralogical notes. Ser.1, *USGS Bull.* 490, p. 37–41.

SINKANKAS, J. (1967) Notes on some minerals from San Diego County, California. *Gems & Minerals* 363, p. 34–35. Ramona axinite.

SZENICS, T. (1990) The rediscovery of axinite at Thornberry Mountain near Coarsegold, Madera County, California. *Min. Rec.* 21, 2, p. 127–132, map.

BAJA CALIFORNIA. Gem quality clove-brown axinite from Mina La Olivia, as described by Sinkankas (1965), provided a stepcut gem of 23.6 carats which was sold to the U.S. National Museum, Washington, D.C. Faceted gems of this axinite weighing 10.90 and 6.90 cts are in the gem collection of the National Museum of Canada (Wight, 1984).

JOHNSON, P. W. (1963) El Fenomeno Mine. *The Mineralogist* 31, 5, p. 4–8, 10, maps. Source of gem axinite.

SINKANKAS, J. (1965) Spectacular strike of axinite in Baja California. *Lapidary J.* 19, 4, illust., maps. Mina La Olivia axinite.

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

AZURITE

ALASKA. Under the ludicrous designation "Arctic opal," a souvenir company in Alaska offered (1993) a breccia-like rock consisting of azurite and malachite that was said to come from the Wrangell-Chugach mountain area. Their advertisement stated that "we have densified the permeable Arctic-Opal into a cohesive and integrous block which our cutters can fashion into a multitude of stone sizes."

COLORADO. At the Tucson Show of February 1994, an attractive azurite-containing massive ornamental stone was being offered for bookends and similar applications. Some could be used for cabochon work although the matrix consisted of fine-granular marble which took only a glossy finish rather than a glassy polish. The azurite spots were interspersed in part with spots of malachite. This material comes from the Copper River Mine, Sinbad Valley, Mesa County, very close to the border with Utah.

CALIFORNIA. A very compact, fine-granular massive azurite, dubbed "royal gem azurite," was being mined from the long-abandoned Copper World Mine, located just north of Interstate Highway I-15 just west of the California/Nevada border (Bancroft, 1978). The mine property is in the Clark Mountain district upon Sec. 6, T16N, R13E, S.B.M. in San Bernardino County. The property was reinvestigated in 1971 by Philip Rivera who obtained mining rights from the Dan Murphy Foundation in 1977. Bancroft provides much historical background as well as a color photograph of rough and polished specimens of the deep blue azurite cut as cabochons and some stones set in jewelry. An earlier geological study, cited by Bancroft, indicates that the malachite occurs as seam fillings in a broad contact zone between porphyry and limestone, which in places is as much as 200 ft (60 m) wide.

It is not known if the massive azurite unfortunately called "stellarite" in *Lapidary Journal* 29, 9, 1975, p. 174, came from the Copper World Mine, but the literature on the mine does not mention the term. As the *Journal* pointed out, both *stellerite* and *stellarite* were already in use and applied to totally different materials.

BANCROFT, P. (1978) Royal gem azurite. *Lapidary J.* 32, 1, p. 66-74, *passim*, 124–129, *passim*, illust. (col.).

ARIZONA. The demand for gem material, especially of colorful sorts, leads to material that was once considered too porous to be useful, including granular azurite. Jones (1993) reports on the activities of Rincon Minerals of Tucson who recover massive finely dispersed azurite from the huge Jerome open pit copper mine, in addition to some material that is satisfactory "as is" for larger ornamental objects. The massive material occurs in fractured limestone on the edges of the pit, and occasionally some more compact material, sometimes attractively admixed with malachite, is used for cabochons. The pit is located close to the town in Yavapai County, about 35 miles by road northeast of Prescott. In places, the azurite is so scattered in the limestone that the entire mass is crushed and the azurite/malachite separated and recombined with epoxy under high pressure to form compact, colorful material that is then suitable for lapidary treatment. According to Jones, plans have been made to refine the separation process to obtain relatively pure azurite and malachite and to offer these on the market as "natural" paint pigments. The use of high-pressure impregnation is most attractive because of the relatively enormous amounts of otherwise unsatisfactory porous material that can now be reclaimed. It is said that a 600-ton press is used in the process and the material afterward called "stabilized azurite-malachite block." This material was offered in 1994 at $0.05/gm.

According to Henn (1994), an imitation stone of azurite/malachite appeared in Germany in about 1991 which when examined proved to be a mixture of powdery, plastic-impregnated gibbsite, an aluminum hydroxide, colored green in a convincing malachite-like hue, and an azurite-blue material, also gibbsite, but colored by addition of an ultramarine pigment. This substitute can be easily mistaken for similar material made from genuine malachite and azurite.

In another area of long-established copper mining in Arizona, the huge open pit of Phelps-Dodge's Morenci Mine, Greenlee County, is producing a remarkable, fine-grained azurite that is so dense that it appears black at a casual glance. It is being recovered by Mr. Wayne A. Thompson of Phoenix, Arizona, who obtained the concession to collect mineral specimen and gem material in the one-mile-wide pit. In addition to the massive azurite, he has also obtained attractive masses and sheets of azurite/malachite as well as crystallized specimens. The seams of azurite/malachite occur as tenacious coatings on country rock, or as nodules and stalactitic growths in and on a gray, quartzitic matrix. The seam material seems particularly dense, hence capable of taking a splendid polish. Much of this slabby material is trimmed with country rock attached, and the layer of azurite/malachite is ground, sanded, and polished, or even shallowly sculptured to add interest. Such seams are from 1/4 inch (0.5 cm) to 2 inches (5 cm) thick and in some pieces may cover rock areas of 10 to 12 inches (25–30 cm) across. Because of its very compact nature, the material also lends itself to the production of beads, cabochons, and small carvings. The rough retailed in 1994 for $30 to $200 per pound (ca $60–$400/kg). Cabochons were sold for $.30 to $3.00–$4.00/carat (*Pers. comm.* W. A. Thompson, 6/93).

In regard to carvings in azurite from the Morenci material, Douglas J. Parsons of Fallbrook, California, exhibited dozens of small carvings made in China from this material, combining the well-known skills of the traditional Chinese jade and stone carver with a unique material, but using naturalistic animal and bird motifs. The carvings ranged in size from about 2 inches (5 cm) to 6 inches (15 cm) and very realistically depicted cats, bears, mice, lizards, etc. Skillful use was made of matte finishes or minute groovings along with polished areas to produce very effective results. Prices for these sculptures, among the best ever produced in azurite, ranged from about $200 to $1,200, depending on size and complexity. Because of the very fine grain and compactness, the carvings appear very dark in hue, almost the same color as large crystals of azurite.

Interest in the curious small azurite/malachite spherical geodes that are found in the Azurite Mine ("Blue Ball Mine") located in the Pinal Mountains, 6 to 7 miles (9.6–11 km) south of Miami, Gila County, has been restored and the miniature geodes are being used for a variety of jewelry applications. As Jones (1980) points out, most of these are solid and some attractively banded when cut across in slices and polished. The nodules occur in a clay zone between overlying Gila conglomerate and Schultz granite. Experiences in mining these nodules is recounted by Vacek (1980) while Grant (1989) describes the geology and mineralogy of the deposit and gives its location as 3 miles (4.8 km) south of Miami and reached via dirt road. Grant also provides a history of the workings and notes that "the present-day operation is being conducted by Graham Sutton and Carl Barnt, who are open-pit mining for the nodules.

BLAIR, G. (1971) Arizona treasure mines. *Lapidary J.* 29, 8, p. 1064–1090, *passim*, illust. (col.). Azurite sources included.

GRANT, R. (1989) The Blue Ball Mine, Gila County, Arizona. *Min. Rec.* 20, 6, p. 447–450, illust. (col.).

HENN, U. (1994) Azurit-Malachit—Verwechslungsmöglichkeiten und Imitationen. *Zs. Dt. Gemm. Ges.* 43, 3/4, p. 127–132, illust. (col.).

JONES, R. W. (1980) Blue Ball azurite. *Rock & Gem* 10, 9, p. 48–51, 81.

______, (1993) Azurite. *Rock & Gem* 24, 2, p. 64–69, *passim.*, illust. (col.).

VACEK, J. (1980) Blueberries! In Arizona? *Lapidary J.* 34, 9, p. 1942–1944, illust. (col.).

CHIHUAHUA. Vacek (1983) described massive, banded azurite/malachite that was found in a highly altered andesite tuff-breccia in the Cerro de Cobre Mine, located in the Sierra Madre Mountains, possibly near a village named Choix. The locality is very remote and difficult to reach. The material has been used to some extent in jewelry but "due to differential hydration of some of the material, stabilization methods were employed" for porous material.

VACEK, J. (1983) Sierra Madre azurite-malachite. *Lapidary J.* 37, 1, p. 50, 52, 54, illust. (col.).

BARITE

BRITISH COLUMBIA. Arem (1987) reports a faceted cushion-cut gem, golden brown, of 42 carats from this province; it probably was cut from barite from the Rock Candy Mine, Kennedy Creek, north of Grand Forks.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).

DOLMAGE, V. (1929) Rock Candy. *Geol. Survey Canada Econ.* Ser. 6, p. 22–28.

NAGEL, J. (1981) The Rock Candy Mine, British Columbia. *Min. Rec.* 12, 2, p. 99–101, illust., map.

NEW YORK. No new developments.

GOSSE, R. C. (1968) Barite, New York's banded gemstone. *Rocks & Minerals* 43, 2, p. 83–84, illust. Pillar Point locality.

GEORGIA. Many colorless, flawless tabular crystals of remarkable perfection have been found in the Cartersville, Bartow County district in excavations along the old road to the Georgia Peruvian Ocher Company's mine. Clear crystals are also found on the Jones property, 1.5 miles (2.4 km) south-southwest of Emerson, and also on the adjacent Puckett property (Cook, 1978). Faceted gems of at least 5–10 carats can be cut from such crystals.

COOK, R. B. (1978) Minerals of Georgia: their properties and occurrences. *GA Geol. Water Res. Div. Bull.* 92, 189 p.

HULL, J. P. D. (1920) Report on the barite deposits of Georgia. *GA Geol. Survey Bull.* 36, 146 p.

COLORADO. The famous blue barite crystal deposit near Stoneham has been vigorously worked and many fine matrix specimens obtained, as well as some clear faceting material. Elsewhere in the state, the deposit of colorless barite crystals in the Grand Junction district continues to furnish splendid and near-perfect crystals of unmatched flawlessness. Further information on the barite from Grand Junction is provided by Cajori (1976), who notes that some crystals reach lengths of 15 cm (6 in) and that the barite occurs in cracks and central cavities in calcareous sandstone concretions which may be as much as 1.5 to 4.5 m (5–15 ft) in diameter and up to 1 m (3 ft) thick. The crystals occur loose in the cavities or attached to the walls.

BENNETT, N. L. (1986) Stoneham barite locality, Colorado. *Mineralogical Rec.* 17, 4, p. 255–258, illust. (col.).

CAJORI, F. A. (1976) Grand Junction barite. *Mineralogical Rec.* 7, 4, p. 169.

ELLERMEIER, G. H. (1946) Blue barite near Sterling, Colorado. *Rocks & Minerals* 23, 1, p. 21.

MODRESKI, P. J., LEES, B. & WILSON, D. (1990) New explorations at the Stoneham, Colorado, barite locality. *Rocks & Minerals* 65, 3, p. 202–222, illust. map.

SOUTH DAKOTA. A record-size dark brown, oval faceted gem of 108 carats in a private collection must have been cut from a very large crystal of Elk Creek barite, according to Arem (1987). Wight (1984) records a step cut gem of 5.65 carats in the collection of the National Museums of Canada. An excellent survey of collecting activity in the Elk Creek locality is given by Campbell, *et al* (1987).

According to Fousek (1991), who recently collected at Elk Creek, the barite crystals typically occur in ovate concretions that may be as much as two feet (0.6 m) in diameter and may contain remains of ammonite fossils. The concretions weather from Pierre shale, this formation yielding barite concretions from place to place "in a band that is about 20 miles [32 km] wide and stretches in a broad arc beginning on the northern edge of the White River Badlands west of Scenic, South Dakota, and stretches through Owanka in Pennington County, Union Center in Meade County, and eventually pinches out in eastern Butte County."

CAMPBELL, T., CAMPBELL, D. R. & ROBERTS, W. L. (1987) Famous mineral localities: Elk Creek, South Dakota. *Min. Rec.* 18, 2, p. 125–130.

FOUSEK, R. (1991) Badlands rarities. *Rock & Gem* 21, 5, p. 26–28, 30, illust., map.

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

BENITOITE

During the 1970s, the mining campaign begun at the Dallas Gem Mine, San Benito County, California, by Elvis Gray and William Forrest concentrated upon the considerable alluvium that had accumulated over great periods of time just below the deposit outcrop and sloped gently toward the floor of the valley and the intermittent stream that passed through its center. This stream was later ponded to accumulate water which would then be forcibly directed against the alluvial material to wash away soil and allow a clear view of possible benitoite vein debris. This gamble paid well—an excellent recovery of large and small blocks of vein material was made, also loose crystals of benitoite, and neptunite and other associated species. According to Michael Gray, son of Elvis Gray, some of the excessively rare pink benitoite was found in the mine opencut alongside the outcrop, and a 0.5 ct flawless pink gem was faceted (*Pers. comm.* 1992). This appears to be the only verified faceted pink benitoite in existence.

FIGURE 6. The Dallas benitoite mine looking northwest, San Benito County, California. The mine is near the crest of the hill with recent alluvial washing shown below to left (as of 1992). *Courtesy Michael Gray, Graystone Enterprises, Missoula, MT.*

In 1983, heavy machinery was brought in to explore deeper alluvial beds, although the limiting factor in processing the loosened material remained the local water supply, obtained solely from the stream which was reduced to a mere trickle in summer and fall. However, as a result of this work, some splendid new finds were made, including four very remarkable spinel twins of benitoite, which are flattened along the *c*-axis and present a six-pointed "Star of David" configuration. The largest of these twins is about an inch (25 mm) in diameter. However, to the gem community the most astonishing news was the cutting of the world's largest clean, faceted gem of benitoite, owned by Gray & Forrest, which weighs no less than 15.42 carats! It far outweighs the previous record-holder, a fine blue gem of 7.5 carats in the U.S. National Museum of Natural History. According to Michael Gray, the new gem is clean, a fine blue, and cut as a triangular cushion (*Pers. comm.* 1993).

The most complete geological and mineralogical study of this famous deposit was published by Wise & Gill (1977). This article also provides an excellent chronology of events in the history of this mine, including the attempts at mining of various parties since the beginning of the century. Wise and Gill identify the following minerals in the deposit: benitoite, neptunite, joaquinite, digenite, djurleite, covellite, jonesite, serandite, albite, apatite, natrolite, analcime, calcite, actinolite and crossite. Of these associates only the natrolite occasionally occurs in prisms large enough to facet gems of less than one carat.

A brief but interesting pictorial history of the locality appears in Bancroft (1984, p. 92–7), and includes excellent color photographs of specimens, cut gems, and the celebrated necklace of matched faceted benitoite which later was stolen and then recovered, sans a pendant which boasted a 6.53 carat faceted benitoite. More history is given by the Fraziers (1990), and an excellent annotated bibliography of benitoite appears in the same issue of *Lapidary Journal.* The historical aspects of benitoite are so interesting that they led to the formation of the Benitoite Gem Historical Society, based in Arroyo Grande, California. This group has already contributed valuable data to that already known;for example it uncovered legal claim documents which show that the discovery date of the benitoite mine is February 22, 1907, and that formal claims were filed eight days later on March 2, 1907 at Hollister, the county seat (*Lapidary J.*, 1988). "The claims were registered as lead claims for secrecy to prevent a stampede to the then-thought 'blue diamond' discovery area." Among other curious facts concerning benitoite, there may be mentioned the long-sustained and eventually successful attempt to persuade the state government to officially adopt benitoite as the state gem. Ultimately, through the efforts of Swarts (1984) and others, benitoite was designated as such by the California Legislature in Assembly Bill 2357, effective October 1, 1985 (*California Division of Mines and Geology*, 1985). A good chronology of the events appears in *Gems & Minerals* (1985). Benitoites set in jewelry were presented to President and Mrs. Reagan by Betty Llewellyn in Dallas, 1982 (Llewellyn, 1986).

As a final note, I was informed by Elvis Gray that as of April 10, 1993, the last alluvial material from the benitoite mine was processed and this operation then ceased. However, efforts are now being directed to entering the deposit via tunnel to explore for natrolite veins containing benitoite and neptunite.

ARNOLD, R. (1908) Notes on the occurrence of the recently discovered gem mineral, benitoite. *Science* 27, p. 312–314.

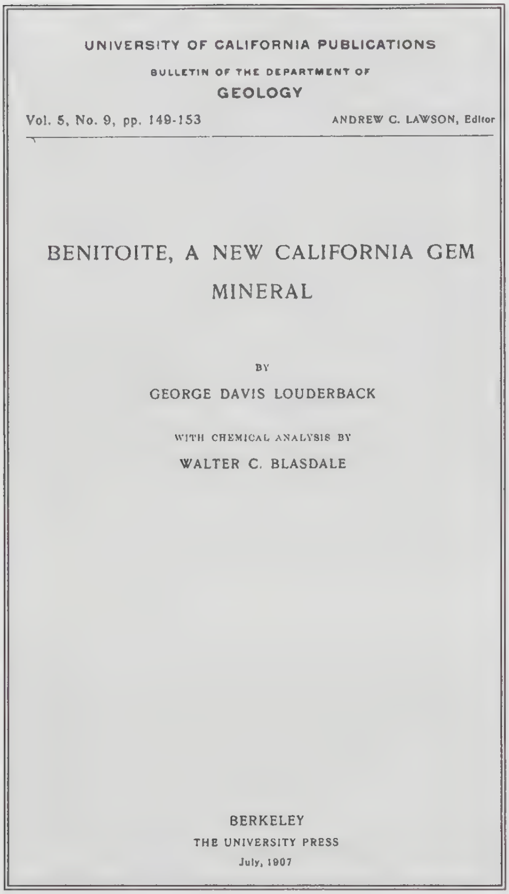
BANCROFT, P. (1984) *Gem & Crystal Treasures.* Fallbrook, CA: Western Enterprises, 438 p., illust. (col.).

BERKHOLZ, M. F. (1956) New Idria-Clear Creek collecting area. *Gems & Minerals* 225, p. 26–27, map.

BOURDEAU, L. (1987) Ah, mining! Memories of a benitoite prospector. *Lapidary J.* 41, 4, p. 36.

CALIFORNIA DIVISION OF MINES AND GEOLOGY (1985) Benitoite: California state gem. DMG Note 11.

FIGURE 7. Washing rig recovering benitoite and other minerals from the alluvial material below the deposit outcrop, San Benito Co., CA. *Courtesy Michael Gray.*



UNIVERSITY OF CALIFORNIA PUBLICATIONS

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BENITOITE, A NEW CALIFORNIA GEM MINERAL

BY

GEORGE DAVIS LOUDERBACK

WITH CHEMICAL ANALYSIS BY

WALTER C. BLASDALE

BERKELEY

THE UNIVERSITY PRESS

July, 1907

FIGURE 8. Title page of Dr. G. D. Louderback's bulletin providing the first announcement of the discovery of benitoite with remarks on the deposit and the properties of the new gemstone.

CHROMY, B. (1969) [Pink benitoite.] *Gems & Minerals* 379, p. 32.

COOK, R. B. (1994) Benitoite, San Benito County, California. *Rocks & Minerals* 69, 6, p. 392–395, illust.

COUCH, O. (1961) *The Benitoite Story.* Arroyo Grande, CA: priv. publ., [24] p., illust.

FRAZIER, S. & FRAZIER, A. (1990) A rare bit of history. *Lapidary J.* 44, 8, p. 46–49.

_____, (1990) A benitoite bibliography. *Ibid.* p. 61–68.

DUPRAS, D. (1986) California's new official gem benitoite. *California Geology* 39, 1, p. 3–4, illust.

GEMS & MINERALS (1985) Benitoite—California's blue gem. No. 572, p. 6, 7, 23, illust.

GRAY, M. (1986) Benitoite mining today. *Canad. Gemm.* 7, 3, p. 82–85.

_____, (1992) Recent developments at the benitoite mine. *Ibid.* 13, 4, p. 118–120.

KUNZ, G. F. (1908) Precious stones. Ch. in *The Mineral Industry,* NY: McGraw-Hill, vol. 16, p. 790–812; benitoite p. 793–795.

LAIRD, J. & ALBEE, A. L. (1972) Chemical composition and physical, optical, and structural properties of benitoite, neptunite, and joaquinite. *Amer. Min.* 57, p. 85–102.

LAPIDARY JOURNAL (1988) Benitoite history. Vol. 42, 1, p. 8.

LLEWELLYN, B. H. (1986) Benitoite for the President. *Gems & Minerals* 583, p. 40–41, illust.

LOUDERBACK, G. D. & BLASDALE, W. C. (1907) Benitoite, a new California gem mineral, with chemical analysis by Walter C. Blasdale. *Univ. Calif. Dept. Geol. Sci. Bull.* vol. 5, 9, p. 149–153, illust. Reprint: The Gemmary, Redondo Beach, CA, 1985.

_____, (1908) Benitoite, its mineralogy, paragenesis, and geological occurrence. *Science* 27, p. 411.

_____, (1909) Benitoite, its paragenesis and mode of occurrence. *Univ. Calif. Dept. Geol. Bull.* vol. 5, 23, p. 331–380, pls. 27–39 (col.). Also reprinted by The Gemmary and combined with previous paper.

MELHASE, J. (1938) Benitoite, a rare gemstone. *The Mineralogist* 6, 11, p. 7–8, 27–29.

MITCHELL, R. K. (1980) The fluorescence of benitoite. *J. Gemm.* 17, 3, p. 149.

MOLLER, W. F. (1965) Minerals of southern San Benito County, California. *Gems & Minerals* 331, p. 28–32.

PALACHE, C. (1909) Note on the crystal form of benitoite. *Amer. J. Sci.* 27, p. 398.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps. Benitoite, neptunite p. 466–472, illust.

QUICK, L. (1957) The story of benitoite, the world's rarest gem. *Lapidary J.* 10, 6, p. 510–518, *passim.*

SWARTS, C. (1984) Benitoite—proposed California state gem. *Gems & Minerals* 557, p. 16–19, illust. (col.).

VAN AMRINGE, E. V. (1934) Benitoite, neptunite, and joaquinite. *Oregon Mineralogist* 2, 11, p. 9–10.

WARD, T. W. (1937) Benitoite, a California gemstone. *The Mineralogist* 5, 9, p. 18–19.

WHITE, J. S. (1989) Provenance of large Smithsonian benitoite. *Gems & Gemology* 25, 1, p. 42–43.

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

WILKE, R. M. (1908) Benitoite and neptunite. *The Mineral Collector* 14, p. 167–168.

WISE, W. S. & GILL, R. H. (1977) Minerals of the benitoite gem mine. *Min. Rec.* 8, 6, p. 442–52, illust.

YAECKEL, M. P. (1934) Benitoite, California's exclusive gem. *Oregon Mineralogist* 2, 10, p. 26–27.

ZEITNER, J. C. (1987) Four American beauties. *Lapidary J.* 41, 4, p. 34–41, illust. (col.). Benitoite p. 36–38.

BERYL

Gem varieties of beryl continue to be mined in many places in the United States, among them, pegmatite deposits in Maine and California, emerald in North Carolina, red beryl in Utah, and aquamarine in Idaho and Colorado. Details on many of these deposits were not available in Volume II, but may be found in my *Emerald and Other Beryls*, 1981, reprinted 1989. The following general references are of interest:

BRUCE, A. (1814) Emerald. *The Amer. Mineral. J.* 1, p. 263–265. New England green beryl (but not emerald).

BUCHI, S. D. H. (1962) Studies on the natural history of beryl. *Univ. Mich. Doctoral Dissert.*, unpubl., 170 p., illust.

FORD, W. E. (1906) Some interesting beryl crystals and their associations. *Amer. J. Sci.* 22, p. 217–223.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America*, NY: Scient. Publ. Co., 336 p., illust., pls. (col.). Beryl p. 87–95.

PETAR, A. V. (1929) Beryllium and beryl. *U.S. Bur. Mines Inform. Circ.* 6190, 20 p.

ROBINSON, S. (1825) *A Catalogue of American Minerals with their Locations.* Boston, MA: Cummings, Hilliard & Co., 316 p. Beryl in New England.

SINKANKAS, J. (1971) Beryl. *Rock & Gem* 1, 3, p. 38–44, illust.

_____, (1981) *Emerald and Other Beryls.* Radnor, PA: Chilton Book Co., reprinted by Geoscience Press, Tucson, AZ.

CANADA. The following is a general reference covering all the provinces:

MULLIGAN, R. (1968) Geology of Canadian beryllium deposits. *Geol. Survey Canada Econ. Geol. Rept.* 23, 109 p., maps.

ONTARIO. No new developments.

ELLSWORTH, H. V. (1927) Lyndochite—a new mineral in the euxenite-polycrase group from Lyndoch Township, Renfrew County, Ontario. *Amer. Min.* 12, p. 212–218.

_____, (1932) Rare-element minerals of Canada. *Geol. Survey Canada Econ. Geol.* Ser. 11, 272 p., maps.

HAWK, J. (1973) Beryl's bonanza. *Rockhound* 2, 6, p. 6, 8, 9, maps. Quadeville.

HOGARTH, D. D., *et al* (1983) Classic mineral collecting localities in Ontario and Quebec. *XXIV Internat. Geol. Congr. Montreal, 1972, Guidebook, Geol. Survey Canada Misc. Rept.* 37, Ottawa, 1983, 79 p., maps.

McLAREN, D. C. (1946) The Lyndoch beryl deposit. *Canad. Min. J.* 67, p. 857–862.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. 2. *Geol. Survey Canada Misc. Rept.* 8, 252 p., illust., maps.

WALKER, T. W. & PARSONS, A. L. (1927) Beryl and associated minerals from Lyndoch Township, Renfrew County, Ontario. *Univ. Toronto Studies, Geol. Series, Contrib. Canad. Mineralogy* 24, p. 12–14.

MANITOBA. Some beryl crystals with clear areas affording small faceted gems were found on the Evans Claim on the water's edge of the south side of Winnipeg River, about 14 km (9 mi) above Pointe du Bois (Stockwell, 1932).

STOCKWELL, C. H. (1932) Lithium Deposits in Geology and mineral deposits of a part of southeastern Manitoba, by J. F. Wright. *Geol. Survey Canada Memoir* 169, p. 108–126.

NORTHWEST TERRITORIES. Green, light blue, yellow, and colorless beryls are widespread in granitic pegmatites of the Mackenzie District (Great Slave Lake-Yellowknife-Beaulieu areas), but only small clear sections in much larger crystals furnish a little faceting material.

JOLIFFE, A. W. (1944) Rare-element minerals in pegmatites. Yellowknife-Beaulieu area, Northwest Territories. *Geol. Survey Canada Paper* 44-12, 23 p.

KRETZ, R. (1968) Study of pegmatite bodies and enclosing rocks, Yellowknife-Beaulieu region, District of Mackenzie. *Geol. Survey Canada Bull.* 159, 111 p.

MULLIGAN, R. (1968) Geology of Canadian beryllium deposits. *Geol. Survey Canada Econ. Geol. Rept.* 23, 109 p., illust., maps.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. 1. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

MAINE. For reference purposes, the most generally useful works are those by Cameron, *et al* (1954), which cover the many granitic pegmatite occurrences in detail for all of New England; Stevens (1972) and Perham (1987), which provide a wealth of historical as well as mineralogical information on Maine gem mines; and the old but still useful work on Maine pegmatites by Bastin (1911). Recent works include Thompson, *et al* (1991), Bradshaw (in press), and the just published descriptive mineralogy of Maine by King & Foord (1994), which contains a large section on the beryls of the state along with much quoting from previous writings and histories of Maine mineral collecting.

In recent years, and today, active gem mining produces gemstones from many quarries, but outstanding is the recent production of morganite beryl from the Bennett Quarry, while significant finds are being made in Stoneham and at Mount Mica where determined exploration promises interesting finds.

BARTON, W. R. & GOLDSMITH, C. E. (1968) New England beryllium investigations. *U.S. Bur. Mines Rept. Invest.*, 177 p.

BASTIN, E. S. (1911) Geology of the pegmatites and associated rocks of Maine. *USGS Bull.* 445, 152 p., illust., maps.

BLAKEMORE, J. (1976) *We Walk on Jewels: Treasure Hunting in Maine for Gems and Minerals.* Rockland, ME: Courier Of Maine Books, 175 p., illust.

BRADSHAW, J. J. (*in press*) Gemstones of Maine, p. 1–21, in KING, V.T., ed. *Mineralogy of Maine*, Maine Geol. Survey.

CAMERON, E. N., *et al* (1954) Pegmatite investigations 1942-1945 New England. *USGS Prof. Paper* 255, 325 p. illus., maps.

CLOUD, P. E. (1934) Mineral collecting in the vicinity of Paris, Maine. *Rocks & Minerals* 9, 12, p. 183–185.

HESS, F. L., *et al* (1943) The rare alkalis in New England. *U.S. Bur. Mines Info. Circ.* 7232, 51 p.

JORGENSEN, N. (1950) Some mines of Oxford County. *Rocks & Minerals* 25, 3–4, p. 158–159.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive Mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

LANDES, K. K. (1925) The paragenesis of the granite pegmatites of Central Maine. *Amer. Mineral.* 10, p. 355–411.

MAINE GEOLOGICAL SURVEY (1957) Maine pegmatite mines and prospects and associated minerals. *Mineral Resources Index* 1, 43 p.

PERHAM, J. P. (1987) *Maine's Treasure Chest.* 2nd edit. [of Stevens 1972]. West Paris, ME: Quicksilver Publs., 269 p., illust., maps.

STEVENS, J. P. (1972) *Maine's Treasure Chest, Gems and Minerals of Oxford County.* West Paris, ME: priv. publ., 216 p., illust.

THOMPSON, W. B., *et al* (1991) A collector's guide to Maine mineral localities. *Maine Geol. Survey Bull.* 41, 2nd edit. 104 p., illust., maps.

The following localities are in Oxford County. In an earlier period, the beryl quarries on Plumbago Mountain produced mostly ore beryl, but Bastin (1911, p. 78) reported some gem material while Fraser (1930) examined the Dunton pegmatite and noted that some, green well-formed crystals were found in pockets and at times were transparent and largely free of flaws. Some gem quality beryl has been found in the Hedgehog Hill pegmatite, 7 mi (11 km) south-southeast of Rumford (ME Geol. Survey 1957; Cameron, *et al*, 1954). Fine beryl and aquamarine have been reported from Speckled Mountain, northwest of North Lovell (Sterrett, 1914). The Emmons Quarry on the east face of Uncle Tom Mountain in Greenwood Township produced a very large pink beryl crystal whose clear portion contained an estimated 5,000 carats of gem material capable of being cut into gems of several carats each and larger (Stevens, 1972, p. 55).

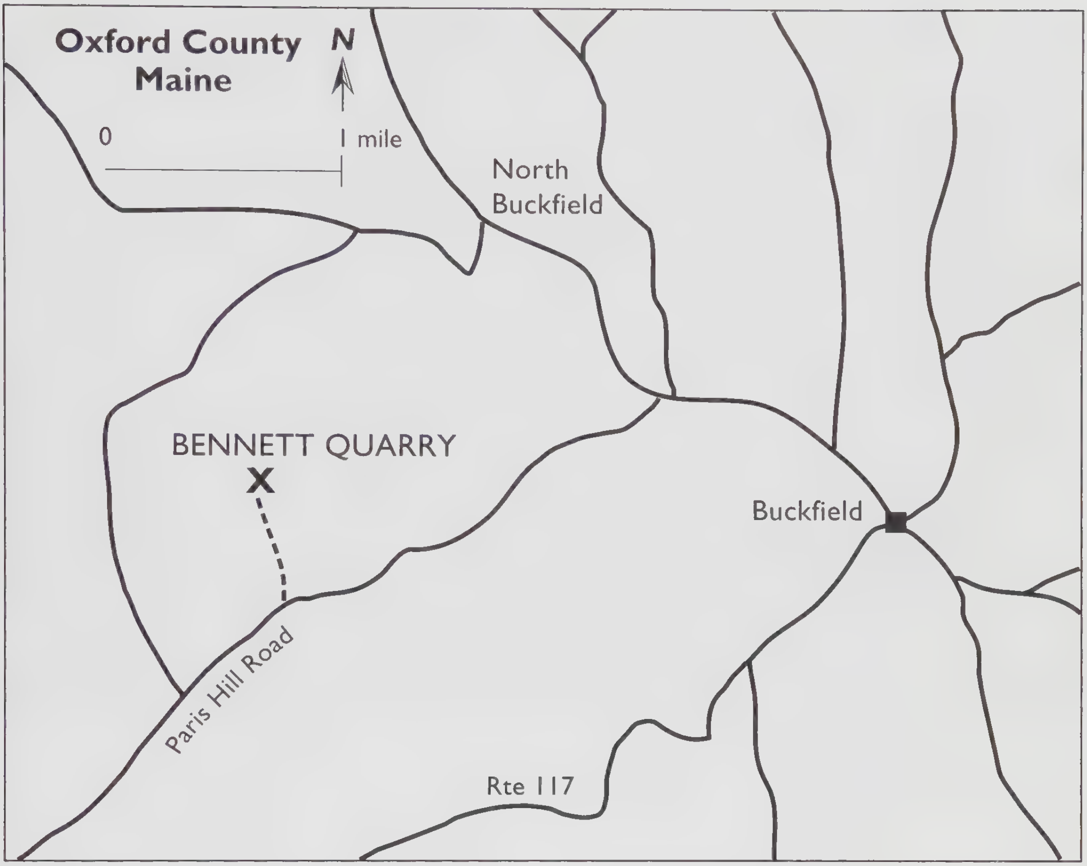

FIGURE 9. Map showing location of the Bennett Quarry, Buckfield, Oxford County, Maine.

About 3.8 mi (8.8. km) north-northeast of Stow, Stoneham Township, a cluster of pegmatites yielded fine aquamarine crystals. The famous Stoneham cushion brilliant aquamarine, first reported by Kunz (1884) as the largest American aquamarine gem to date, has now been reweighed and found to be 137.6 ct instead of the previously published value of 133.8 ct., according to Bradshaw (in press), who also calls attention to Stoneham aquamarines of 76.50 ct in Harvard's Museum Collection and a 44.94 ct fáceted rectangle in the collection of the American Museum of Natural History in New York. The second largest Maine aquamarine faceted gem, a pear shape of 128 carats, was cut from a crystal found by Rupert Aldrich in the 1980s in his Aldrich Prospect on Sugar Hill, Stoneham. Aside from a few acicular inclusions the gem is very clean and is now in Perham's Museum in West Paris. An early record of fine heliodor gems from Stoneham is given by Chadbourne (1904), who records faceted gems of 36-1/8 and 34-11/16 ct; Bradshaw *(Ibid.)* states that the whereabouts of these gems are unknown.

The Melrose Quarry on Sugar Hill (Sugarloaf Mountain) produced some gem blue aquamarine and golden beryl (Stevens, 1972, p. 35).

The major beryl find in recent years is the 1989 discovery of a series of gem pockets in the long dormant Bennett Quarry located about 3 mi (4.8 km) west of Buckfield Village and just north of

FIGURE 10. Scene in the Bennett Quarry showing Dennis Holden standing next to excavated pockets in the north wall of the quarry (as of 1990). *Courtesy Woodrow Thompson, Maine Geological Survey.*

the Bennett Farmhouse, Buckfield Township (*see* Figs. 9 & 10). The most important find took place on October 7, 1989, when the brothers Ronald E. Holden and Dennis Holden, organized as Sugar Hill Minerals, entered a large pocket in the floor of the quarry from which they eventually extracted morganite crystals of record size for Maine and North America. The story was carried by the *Portland Press Herald*, October 28, 1989, and by the *Advertiser Democrat* of Norway, October 19, 1989. Thompson (1989) noted that the largest crystal, a transparent morganite of peach color, called "The Rose of Maine," after its hue, measured 12 in (30 cm) in diameter and 9 in (23 cm) deep. Color photos of the pockets and the crystals appear on p. 15 of Thompson, *et al* (1991). Unable to sell the crystal entire, the Holdens decided to divide it into three sections of 17.6 lb (8 kg), 13.2 lb (6 kg), and 4.4 lb (2 kg), plus miscellaneous fragments of 16 lb (8 kg). The 13.2 lb (6 kg) piece was bought by the Harvard Museum in preference to any others because it retained some of its original crystal faces. The smallest block was taken by Dennis Holden as his share in the find; it was said to contain 9,000 carats of cuttable material. At the time that the large crystal was found, another was also removed from the same cavity which was called "The Peach," again in allusion to its color. As has been shown to be the case with other beryls of this distinctive peach or apricot hue, it turns to pink upon exposure to daylight, and this is reported to have happened with the Bennett Quarry morganite. In regard to the morganite, Bradshaw (1992) estimated that about ten percent was facet grade but clean gems of only twenty or so carats could be cut. Also, as is typical of much morganite, the color is fairly intense only in large gems, while small gems would appear too faintly hued to be attractive. It appears that the very high values originally assigned to the rough may have been inspired by the strong color of the very large crystals without considering the lessening in hue intensity when the rough is cut into gems.

An excellent account by one of the miners, Ronald Holden, appears in *Rocks & Minerals* (1990). Holden noted that in addition to the beryls, some colored tourmalines were found. A much more elaborate account of the geology, mineralogy, and history of the Bennett pegmatite is that of Wise, *et al* (1994), who provide excellent color photographs and diagrams of local geology as well as descriptions of all of the mineral species found to date. S. P. Sweeny (1991) gives a brief account of the cutting of the largest faceted gem from the Bennett morganite one of 184.26 carats; the gem is now in the collection of the Maine State Museum in Augusta, while another gem of 66.65 carats has been placed in the Harvard Mineralogical Museum.

Gem beryl has been previously reported from Mount Mica, better known for its colored tourmalines, but also producing gemmy beryl crystals from time to time. R. & T. Kosnar (*Pers. comm.* 8/10/1994) own a 47.58 carat fantasy-cut, clean, pale orangish-pink morganite faceted gem cut from material found during Dean McCrillis' mining campaign during the summer of 1979.

CHADBOURNE, E. R. (1904) The minerals of Maine. *Mineral Collector* 11, 5, p. 67–69. Heliodor, Stoneham.

FRASER, H. J. (1930) Paragenesis of the Newry pegmatite. *Amer. Mineral.* 15, p. 349–364.

HAMLIN, A. C. (1895) *The History of Mount Mica of Maine.* Bangor, ME: priv. publ., 72 p., color plates, photos.

HOLDEN, R. E. (1990) The Bennett Quarry, Buckfield, Maine. *Rocks & Minerals* 65, 6, p. 498–504. Giant morganite crystals.

HURLBUT, C. S. & WENDEN, H. E. (1951) Beryl at Mount Mica, Maine. *Amer. Mineral.* 36, p. 751–759, illust.

JORGENSEN, N. (1960) A beryl occurrence at Moody Mountain, Oxford County, Maine. *Rocks & Minerals* 35, 11–12, p. 547–549.

KUNZ, G. F. (1883) A note on the finding of two fine American beryls. *Amer. Assoc. Adv. Sci. Proc.* 32, p. 275–276. Stoneham aquamarine.

_____, (1884) Topaz and associated minerals at Stoneham, Maine. *Amer. J. Sci.* 3rd ser., 27, p. 212–216. Aquamarine.

_____, (1886) Rare gems and interesting minerals. *NY Acad. Sci. Trans.* 5, p. 131–133. Largest Stoneham aquamarine, illust.

_____, (1895) Precious stones. Ch. in USGS Min. Res. U.S. for 1894, pt. 4, *16th. Ann. Rept. USGS*, p. 595–605.

_____, (1897) Precious stones. Ch. in USGS Min. Res. U.S. for 1896, pt. 5, *18th Ann. Rept. USGS*, p. 1183–1217.

_____, (1899) Precious stones. Ch. in USGS Min. Resources U.S. for 1898, pt. 4, of *20th Ann. Rept. USGS*, p. 557–600. (1930) Precious and semi-precious stones. Ch. 3 in *The Mineral Industry During 1929*, NY: McGraw-Hill, vol. 38, p. 530–554.

LAPIDARY JOURNAL (1971) [Large aquamarine crystal found at Mt. Mica.] 25, 2, p. 368–369.

MARBLE, C. F. (1927) Mineral localities of Maine, the Rumford tin mine. *Rocks & Minerals* 2, 4, p. 125. Gem beryl.

SHAININ, V. E. (1948) Economic geology of some pegmatites in Topsham, Maine. *ME Geol. Survey Bull.* 5, 32 p., maps. Gem beryl.

_____, (1955) Pegmatites and associated rocks in the Newry Hill, area, Oxford County, Maine. *ME Geol. Survey Bull.* 6, 58 p., maps.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *USGS Min. Resources U.S. for 1913*, p. 649–708.

SWEENY, S. P. (1991) White square brilliant. *Lapidary J.* 44, 11, p. 89. Cutting gems from Bennett Quarry morganite.

THOMPSON, W. B. (1989) New discoveries at the Bennett Quarry, Buckfield, Maine. *Mineral News* 5, 12, p. 1–3. Giant morganite crystals.

WISE, M. A., ROSE, T. R. & HOLDEN, R. E. (1994) Mineralogy of the Bennett pegmatite, Oxford County, Maine. *Min. Rec.* 25, 3, p. 175–184, illust. (col.), maps.

NEW HAMPSHIRE. Bradshaw (1990) provides an excellent compilation of information on the gemstones of this state, including data on notable faceted gems cut from New Hampshire material. Some of these are a 50.32 ct aquamarine from the Keyes Mine, Orange Township, Grafton County, located 3 mi (4.8 km) north-northeast of Orange; and a goshenite of 5.74 ct from the Island Mica Mine, Alstead Township, Cheshire County, located south of East Alstead: this same mine produced the rough for a series of faceted gems up to 18 ct that are now in the New York State Museum gem collection in Albany. A heliodor gem of 5.55 ct is also mentioned; it came from the Kirk No. 3 Mine in Gilsum Township, Cheshire County. Austin (1991) reports a most interesting "confirmed" occurrence of emerald in New Hampshire, involving two specimens from an unspecified pegmatite found by George Elberfeld in 1991.

ALLEN. C. A. (1899) Beryl Mountain. *Mineral Collector* 6, 6, p. 98–101.

AUSTIN, G. T. (1991) Don't take New Hampshire for granite. *Colored Stone* 4, 6, p. 26, 28, map.

BANNERMAN, H. M. (1943) *New Hampshire Mineral Resources Survey.* Pt. 4: Structural and economic features of some New Hampshire pegmatites. NH State Planning & Development Comm., 22 p.

BARTON, W. R. & GOLDSMITH, C. E. (1968) New England beryllium investigations. *U.S. Bur. Mines Rept. Invest.* 7070, 177 p., maps.

BARTSCH, R. C. B. (1940) Collecting at Alstead, N.H. *Rocks & Minerals* 15, 4, p. 124. Beryl at Golding-Keane Mine.

BRADSHAW, J. J. (1990) Gemstones of New Hampshire. *Rocks & Minerals* 65, 4, p. 300–305, illust.

CAMERON, E. N., *et al* (1954) Pegmatite investigations 1942–45 New England. *USGS Prof. Paper* 255, 352 p., illust., maps.

FLINT, G. M. (1919) Famous mineral localities: Beryl Hill, Grafton, New Hampshire. *Amer. Mineral.* 4, 1, p. 21–22.

GOSSE, R. C. (1962) Cat's-eye aquamarine and heliodor discovered in New Hampshire. *Lapidary J.* 16, 5, p. 534–537, illust., map.

HOLDEN, E. F. (1918) Famous mineral localities: Beryl Mountain, Acworth, New Hampshire. *Amer. Mineral.* 3, p. 199–200.

HUBBARD, O. P. (1852) Beryls in Grafton, New Hampshire. *Amer. J. Sci.* 13, p. 264–265.

JACKSON, C. T. (1856) [On the geology of Alger's Beryl Hill, Grafton, New Hampshire.] *Boston Soc. Nat. Hist. Proc.* 6, p. 23.

KUNZ, G. F. (1886) Precious stones. Ch. in *USGS Min. Resources U.S. for 1885*, p. 437–444.

_____, (1931) Precious and semi-precious stones. Ch. in *Mineral Industry*, NY: McGraw-Hill, 39, p. 506–528.

LEVIN, S. B. (1948) Beryl Mountain, Sullivan County, New Hampshire. *U.S. Bur. Mines Rept. Invest.* 4216, 3 p., maps.

LEVIN, S. B. & MOSIER, M. (1949) Investigation of Big Mica Mine, Cheshire County, N.H. *U.S. Bur. Mines Rept. Invest.* 4410, 16 p., maps.

_____, (1949) Investigation of Blister Mica Mine, Cheshire County, N.H. *U.S. Bur. Mines Rept. Invest.* 4409, 12 p., maps.

LISLE, T. O. (1947) Beryl hunting in New Hampshire. *Rocks & Minerals* 22, 11, p. 1018–1022, illust.

MODELL, D. (1931) The pegmatites near Gilsum, N.H. *Rocks & Minerals* 6, 1, p. 18–22. Aquamarine.

MORRILL, P. (1955) The New Hampshire gem mines. *Rocks & Minerals* 30, 5–6, p. 247–251. Aquamarine.

MYERS, T. R. & STEWART, G. W. (1956) *The geology of New Hampshire. Pt. 3: Minerals and mines.* NH State Plan. and Devlop. Comm., 108 p.

PAGE, L. R. & LARRABEE, D. M. (1962) Beryl resources of New Hampshire. *USGS Prof. Paper* 353, 49 p., illust., maps.

PENNYPACKER, C. H. (1896) New Hampshire beryls. *The Mineral Collector* 3, 10, p. 155–157.

SAMPTER, E. L. (1949) My mineralogical activities for the 1949 season. *Rocks & Minerals* 24, 11–12, p. 594–596.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *USGS Min. Resources U.S. for 1913*, p. 649–708.

_____, (1915) Gems and precious stones. Ch. in *USGS Min. Resources U.S. for 1914*, p. 307–346.

SWITZER, G. (1938) The paragenesis of the Center Strafford, New Hampshire pegmatite. *Amer. Mineral.* 23, p. 811–820, illust.

TESCHEMACHER, J. E. (1844) [On the beryls from Acworth, New Hampshire.] *Boston Soc. Nat. Hist. Proc.* 1, p. 191–192.

ULRICH, J. M. (1937) Minerals and mines of Springfield, New Hampshire. *Rocks & Minerals* 12, 10, p. 308–309.

VERROW, H. J. (1941) Pegmatite minerals of the Palermo Quarry, North Groton, N.H. *Rocks & Minerals* 16, 6, p. 208–211. Gem beryl.

VOYNICK, S. (1989) New Hampshire beryl localities. *Rock & Gem* 19, 6, p. 40–46, *passim*, 79, map.

MASSACHUSETTS. The several authentic gem beryl sources in this state, as at Beryl Hill, Royalston, Worcester County, and Rollstone Hill near Fitchburg, among others, have not been worked in many decades.

EMERSON, B. K. (1895) A mineralogical lexicon of Franklin, Hampshire, and Hampden counties, Massachusetts. *USGS Bull.*, 126, 180 p.

HESS, F. L., *et al* (1943) The rare alkalis in New England. *U.S. Bur. Mines Info. Circ.* 7232, 51 p.

HITCHCOCK, E. (1841) *Final Report on the Geology of Massachusetts.* Amherst, MA: J. S. & C. Adams, 831 p., illust., maps.

HITCHEN, C. S. (1935) The pegmatites of Fitchburg, Massachusetts. *Amer. Mineral.* 20, 1, p. 1–24, illust.

KUNZ, G. F. (1911) Precious stones. Ch. in *Mineral Industry During 1910.* NY: McGraw-Hill, vol. 19, reprint of 27 p.

SCHALLER, W. T. (1915) Gems and precious stones. Ch. in *USGS Min. Resources U.S. for 1915*, p. 843–858.

_____, (1916) Precious stones. Ch. in *USGS Min. Resources U.S. for 1916*, p. 887–899.

SHAUB, B. M. (1954) The Walnut Hill spodumene ledge near South Worthington, Massachusetts. *Rocks & Minerals* 29, 7–8, p. 339–343.

STERRETT, D. B. (1907) Precious stones. Ch. in *USGS Min. Resources U.S. for 1906*, p. 1213–1252.

_____, (1912) Precious stones. Ch. in *USGS Min. Resources U.S. for 1911*, p. 1047–1078.

_____, (1914) Precious stones. Ch. in *USGS Min. Resources U.S. for 1913*, p. 649–708.

_____, (1915) Precious stones. Ch. in *USGS Min. Resources U.S. for 1914*, p. 307–346.

CONNECTICUT. Baron (1981) reported on several collecting sites in New England, among them the Case Quarries near Portland where some facet grade aquamarine was found. Sweeney (1991) described a "superb" faceted beryl gem that he cut from Merryall Mine material; it weighs 8.78 ct and is in the collection of the U.S. National Museum of Natural History. A detailed, handsomely illustrated account of the now defunct and inaccessible Gillette Quarry at Haddam Neck was published by Scovil (1992) and is the best description of the complex mineralization of this famous granitic pegmatite body yet to appear. In this connection it is interesting to note the remarks made about the quarry by Davis (1901) who specially noted that the quarry produced white, pale green, and pale rose beryl, with a monster rose crystal of about twenty pounds presented to the American Museum of Natural History in New York by Ernest Schernikow who was active in mineral collecting and selling. In modern times, before the Gillette Quarry was placed off limits, Gino Vitali (1979) wrote about his collecting experiences revolving mainly about finding a succession of richly crystallized gem pockets. This article elicited an equally interesting reminscence of even earlier collecting experiences by Dr. Harold T. Stearns (1980). At the western end of Connecticut, Vitali also told of his collecting gem quality aquamarine and golden beryl from the Roebling Quarry at Merryall. I have visited both of these deposits and in my opinion neither one is exhausted but exploitation is a legal problem rather than one of natural resources.

BARON, D. H. (1981) Three choice collecting sites for the New England collectors. *Lapidary J.* 34, 12, p. 2508–2520, *passim.*

BARTON, W. R. & GOLDSMITH, C. E. (1968) New England beryllium investigations. *U.S. Bur. Mines Rept. Invest.* 7070, 177 p.

BOOS, M. F., *et al* (1949) Investigation of Portland beryl-mica district, Middlesex County, Conn. *U.S. Bur. Mines Rept. Invest.* 4425, 26 p.

CAMERON, E. N. & SHAININ, V. E. (1947) The beryl resources of Connecticut. *Econ. Geol.* 42, p. 353–367, illust., maps.

CAMERON, E. N., *et al* (1954) Pegmatite investigations 1942–45 New England. *USGS Prof. Paper* 255, 352 p., illust., maps.

DAVIS, J. W. (1901) The minerals of Haddam, Connecticut. *The Min. Collector*, 8, p. 50–55.

FORD, W. E. (1906) Some interesting beryl crystals and their associations. *Amer. J. Sci.* 22, p. 217–223. Morganite, Gillette Quarry.

FOYE, W. G. (1922) Mineral localities in the vicinity of Middletown, Connecticut. *Amer. Mineral.* 7, 1, p. 4–12.

HILLER, J. (1971) *Connecticut Mines and Minerals.* Shelton, CT: priv. publ., 61 p.

JANUZZI, R. E. (1959) *The Minerals of Western Connecticut and Southeastern New York State.* Danbury, CT: The Mineralogical Press, 106 p., illust.

______, (1961) *The Mineralogy of Connecticut and Southeastern New York State.* Danbury, CT: The Mineralogical Press, 257 p., illust., maps.

JENKS, W. F. (1935) Pegmatites at Collins Hill, Portland, Connecticut. *Amer. J. Sci.* ser. 5, 30, p. 177–197.

KUNZ, G. F. (1887) Precious stones. Ch. in *USGS Min. Resources U.S. for 1886*, p. 595–605.

______, (1899) Precious stones. Ch. in USGS Min. Res. U.S., *20th Ann. Rept. USGS for 1898*, pt. 6, p. 557–600.

SCHAIRER, J. F. (1931) The minerals of Connecticut. *CT State Geol. Nat. Hist. Survey Bull.* 51, 121 p.

SCOVIL, J. (1992) The Gillette Quarry, Haddam Neck, Connecticut. *Min. Rec.* 23, 1, p. 19–28, 80, illust., maps.

SEAMAN, D. M. (1963) The Walden Gem Mine. *Rocks & Minerals* 38, 7–8, p. 355–362.

SHAININ, V. E. (1946) The Branchville, Connecticut pegmatite. *Amer. Mineral.* 31, p. 329–345.

SHANNON, E. V. (1920) Strickland's Quarry, Portland, Connecticut. *Amer. Mineral.* 5, 1, p. 51–54.

SHEPARD, C. U. (1837) *A Report on the Geological Survey of Connecticut.* New Haven, CT: B. L. Hamlen, 188 p. Morganite, Gillette Quarry.

SOHON, J. A. (1951) Connecticut minerals: their properties and occurrence. *CT State Geol. Nat. Hist. Survey Bull.* 77, 133 p.

STEARNS, H. T. (1980) The Connecticut pegmatites in their heyday. *Lapidary J.* 33, 10, p. 2266–2268.

STERRETT, D. B. (1915) Gems and precious stones. Ch. in *USGS Min. Resources, U.S. for 1914*, p. 307–346.

STOBBE, H. (1949) The Gillette Quarry, Haddam Neck, Connecticut. *Rocks & Minerals* 24, 9–10, p. 496–502.

STUGARD, F. (1958) Pegmatites of the Middletown area, Connecticut. *USGS Bull.* 1042-Q, p. 613–683.

SWEENEY, S. P. (1991) White square brilliant. *Lapidary J.* 44, 11, p. 89.

VITALI, G. (1979) Nostalgia—twenty years of collecting in Connecticut pegmatites. *Lapidary J.* 33, 7, p. 1598–1610, illust.

ZODAC, P. (1962) World news on mineral occurrences. *Rocks & Minerals* 37, 9–10, p. 479. Slocum Quarry golden beryl, photo.

NEW YORK. Gem beryls are rare in this state as shown by the single example in the collection of the New York State Museum, Albany, where an aquamarine cabochon is included, cut from material found at Batchellerville; it weighs 3.25 gm and was originally in the Elmer Rowley Collection (Schimmrich & Campbell, 1990). Far more interesting are the small aquamarines and golden beryls that were cut many years ago from beryls found in granitic pegmatites during building excavations upon Manhattan Island, New York. Those shown by Manchester (1931) were obtained from an excavation at Broadway and 157th Street and from another site one block farther uptown.

CHAMBERLAIN, B. B. (1886) Minerals of Harlem and vicinity. *NY Acad. Sci. Trans.* 5, p. 74–77. Gem aquamarine.

GOSSE, R. C. (1963) Some notes on the Batchellerville, New York quarry. *Rocks & Minerals* 38, 7–8, p. 402–403.

JENSEN, D. E. (1978) *Minerals of New York State.* Rochester, NY: Wards Natural Science Establishment, 219 p., illust. (col.).

MANCHESTER, J. G. (1931) The minerals of New York City and its environs. *NY Mineralogical Club Bull.* 3, 1, 169 p., illust., map.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum gem collection catalogue. *NY State Mus. Open File Rept.* 8m106, 47 p.

PENNSYLVANIA. No new developments.

GENTH, F. A. (1875) Preliminary report on the mineralogy of Pennsylvania. *Second Geol. Survey PA, Harrisburg*, Vol. B (1874), 206 p.

GORDON, S. G. (1922) The Mineralogy of Pennsylvania. *Acad. Nat. Sci. Philadelphia Spec. Publ.* 1, 255 p., illust.

KUNZ, G. F. (1892) *Gems and Precious Stones of North America.* 2nd edit. NY: Scientific Publ. Co., 367 p., illust. (col.).

STERRETT, D. B. (1915) Gems and precious stones. Ch. in *USGS Min. Resources U.S. for 1914*, p. 307–346.

MARYLAND. No new developments.

OSTRANDER, C. W. & PRICE, W. E. (1940) *Minerals of Maryland.* Baltimore, MD: The Natural History Society of Maryland, 92 p.

VIRGINIA. Despite the large number of granitic pegmatites that have been mined for mica and feldspar, beryl occurs in only a few of them, seldom in large amounts, and rarely in gem grade. In Chesterfield County, Penick (1992) reported aquamarine crystals up to 3 in (7.5 cm) in pegmatite dikes cutting Petersburg granite in the Dale Quarry. Small clear fragments were found in the Abner Pinchbeck Mine, Amelia County, located about 0.5 mi (0.8 km) east of Amelia. According to Brown (1945) gemmy beryl was reported from the Truehart, Champion, and Morefield mines, and clear bluish material from James Anderson Prospect in the Amelia area. In Powhatan County, facet grade blue-green beryl was found in Baltzley's Beryl Mine, also called the Jervey Mica-Beryl Mine, near Fine Creek Mills. The commonly terminated crystals were about one inch (2.5 cm) in diameter and about twice as long (Penick, *Ibid.*). Brown *(Ibid.)* reported small, colorless to golden beryl crystals, some of gem grade, from Williams Prospect, 0.3 mi (0.5 km) south of U.S. Highway 58, 3 miles (4.8 km) southwest of Martinsville.

BROWN, W. R. (1945) Some recent beryl finds in Virginia. *Rocks & Minerals* 20, 6, p. 264–265.

______, (1962) Mica and feldspar deposits of Virginia. *VA Div. Min. Resources Rept.* 3, 195 p., illust., maps.

DIETRICH, R. V. (1970) Minerals of Virginia. *VA Polytech. Inst. Research Div. Bull.* 47, 325 p., illust.

GEEHAN, R. W. (1953) Morefield pegmatite mine, Amelia County, Virginia. *U.S. Bur. Mines Rept. Invest.* 5001, 41 p., map.

LEMKE, R. W., JAHNS, R. H. & GRIFFITTS, W. R. (1952) Mica deposits of the Southeastern Piedmont. Part 2. Amelia District. *USGS Prof. Paper* 248-B, p. 103–139, illust., maps.

PEGAU, A. A. (1932) Pegmatite deposits of Virginia. *VA Geol. Survey Bull.* 33, 123 p., illust., maps.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 28, 3, p. 17–26, illust.

NORTH CAROLINA. New information on the history of the Hiddenite area emerald mines is to be found in my *Emerald and Other Beryls* (1989) and is not repeated here. Other historical remarks and records of finds, also records of cut gems, are given in Wilson & McKenzie (1978), who depict in color the famous large double crystal of emerald that is said to have come from the Adams Farm site in the Hiddenite area. This splendid specimen is now in the U.S. National Museum of Natural History. Especially valuable are the historical details published by Zeitner (1982) which include notes on the deposits, the mines, and the discoveries of record roughs and cut gems. The largest faceted emerald from North Carolina, 15.465 ct, was cut from a crystal of 142.25 ct and is named after June Culp Zeitner to honor her activities in promoting the earth sciences in the United States. The most important emerald production has been from various informal diggings, usually by fee-basis visitors to the Hiddenite area in Alexander County.

Modern exploitation of these deposits began with William D. Baltzley's work expended upon approximately 200 acres of ground just northwest of Hiddenite village in 1969. Two parcels of land, known as the Rist property and Ellis property, were acquired by Charles G. Rist of Fairfield, Pennsylvania, who formed American Gems, Inc., to mine the emerald deposits upon these properties. Numerous finds were made by Baltzley and fee-diggers, and included the remarkable crystals described by Sinkankas (1976;1989) and Zeitner (1982). Baltzley worked the fields from 1969 to 1974, and thereafter the property was worked only by fee-diggers. Zeitner (1982) describes a major find of splendid emerald crystals from one pocket found in March, 1979 by Glenn and Kathleen Bolick. The lot consisted of 3,507.35

carats of emeralds, from which the June Culp Zeitner Emerald was cut as mentioned above. The cut gems were examined by the Gemological Institute of America, Santa Monica, California, and these properties determined: refractive index 1.580-1.590, birefringence 0.010, and specific gravity of 2.73-2.75. The fine double crystal that was found upon the Adams Farm was originally purchased from its finder by David Wilber in 1973, and after several changes in ownership, came into the possession of Dr. Lawrence A. Funt of Washington, D.C., who kindly informed me that he had donated the specimen to the Smithsonian Institution on December 27, 1978 (*Pers. comm.*, 1981).

After the Rist operation, the properties were purchased by LKA Holdings in December 1982, according to *Penny Stock News*, Feb. 20, 1987, p. 3, or, according to Austin (1991, p. 32), purchased by LKA International, a Nevada corporation, for the sum of $500,000. In the summer of 1983, a preliminary geological evaluation was conducted which included considerable test-pitting and cleaning of mined material to recover emeralds. In 1984 the largest single emerald crystal ever found here or anywhere on the North American Continent was discovered. It is a stubby hexagonal prism that weighs 1,686.3 carats. In 1986, the company was acquired by DIA-M Resources International, in British Columbia, with the name changed in 1987 to DIA EM Resources, Ltd. DIA EM commissioned economic geologist Delmer L. Brown of Lakewood, Colorado, operating as International Geoscience, Inc., to examine and evaluate the potential of the Rist/Ellis tracts. His report, dated October 31, 1986, concluded that these properties "warrant a serious systematic evaluation" and recommended that a pilot test program be initiated using the "beryllometer," a detection device that depended upon irradiation from a radioactive source in the device to detect the presence of beryl. Brown's report was included in DIA EM's stock prospectus of May 28, 1987. The report describes the properties, the local geography and geology, previous mining efforts, the deposits and their mineralogies. Brown concluded that hand-sorting of excavated vein and country rock would be far too time-consuming and "economically prohibitive as a method of extraction." He therefore recommended the use of a conveyor belt upon which the ore material would be thrown and then passed under the detection head in the beryllometer and its appended sorting machinery designed to remove parts of the ore containing beryl, thus achieving a concentration. A prototype of the recovery unit was built and successfully tested in the field in the fall of 1985. According to *Penny Stock News (Ibid.)*, the recovery unit and beryllometer cost over $425,000 to design and manufacture. It was also noted that LKA had spent over $850,000 on property acquisition, geological evaluations, and machinery, and that they followed one promising vein to about 30 ft (9 m) below the surface. Austin (1988) reported that approximately 3,000 carats of emeralds were mined but it became apparent that large scale mining would not pay and in 1989 the company planned to dispose of the properties and sell both the 1,438 carat "Stephenson Emerald," which they had found, as well as the larger 1,686.3 ct "LKA Emerald,™" named after the company.

The latest news on these properties, now known as "Emerald Hollow Mines," by Foster (1992), states that they were purchased sometime in the 1980s by Mr. and Mrs. Michael Watkins who offered fee-collecting to visitors. Watkins had found a cluster of emerald crystals on the Rist tract in 1982 that weighed together 62 carats from which were cut a 16.3 ct gem estimated to be worth $21,000 per ct. Another gem cut from this cluster weighed 5.24 ct, is of dark green color and exceptional clarity. A recent find is a 300 lb (136 kg) smoky quartz crystal of considerable clarity and perfection.

In Mitchell County, the Big Crabtree Mountain emerald deposit has been mined commercially from 1968–1974, during which time fee collecting on the dumps was allowed. Adams (1976) noted that "a 200-carat emerald crystal was found at the Big Crabtree Emerald Mine near Little Switzerland, North Carolina. The stone appeared to be of fine quality and could yield a stone of 40 carats if cut. It would be larger than the Carolina emerald of 14 carats." In the 1980s the mine was closed to collecting for some time, but according to *Gems & Minerals* (1982) it was reopened to the public. A recent account by Watkins (1991) describes current mining activity and notes that the mineral rights were purchased in 1984, and a partnership formed to actively operate the mine. Hardrock mining is necessary and is conducted at the base of a steep incline descending to 200 ft (60 m) below the surface to follow an emerald-bearing vein. Watkins furnishes several entertaining stories about remarkable emerald finds, including the discovery of a 1,676 ct crystal of fine quality that was located by a psychic who directed the miners to the exact spot! This find was made in 1977 but the whereabouts of the crystal are now unknown. In 1985, Seth Hammer, son of Dr. and Mrs. Daniel Hammer of Springfield, New Jersey, visited the Crabtree Mine dumps and found a splendid dark green crystal encased in biotite mica that was later found to measure 1.5 x 0.8 x 0.7 in (36.8 x 20.2 x 16.5 mm) and weighed 83.11 carats. During this period the mine was called "Gem Haven," and collecting was confined strictly to the dumps. The mine was owned by a partnership of Ted Ledford, Bert Roper, and D. E. Duppenthaler (Strip & Hammer, 1986). Other finds mentioned by Watkins *(Ibid.)* include a cluster of crystals that weighed 40 carats, and a "high quality" aquamarine that weighed 46 carats. The characteristic matrix material continues to be found and is now regularly used in cabochons, or sometimes sliced into slabs for polishing. As of 1994, it is reported that regular public collecting is no longer permitted but that prearranged group visits might be accommodated.

In the Spruce Pine area, Fechenbach (1979) described collecting at the Carter Ridge Aquamarine Mine located several miles southeast of the town of Spruce Pine. The mine was originally operated for its fine white china clay which resulted from the weathering of pegmatite feldspar. According to Fechenbach, this mine was operated at one time by Tiffany's of New York for the sake of its gem quality aquamarine and golden beryl that are found imbedded in the white clay. The mine was opened to public collecting in 1978 on a fee basis. Several important finds have been made recently, including a 28 lb (12.7 kg) aquamarine said to be facet grade, and another crystal of 9 lb (4 kg). It is not known if gems have been cut from them.

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BERNHEIM, L. C. (1883) Hidden and hiddenite: a sketch of the life and labors of . . . Charlotte: *At Home and Abroad* 5, p. 1–10, portrait.

BOLICK, K. (1982) We mined for emeralds. *Lapidary J.* 36, 2, p. 410–412.

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BROUGHTON, P. L. (1974) Emerald deposits of western North Carolina. *Earth Science* 27, p. 222–228, illust., map.

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FECHENBACH, M. F. (1979) Sahkanaga aquamarine. *Gems & Minerals* 503, p. 82, map.

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GEMS & MINERALS (1982) Crabtree emerald mine in production again. No. 538, p. 5–6, illust.

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HIDDEN, W. E. (1889) Addendum to the minerals and mineral localities of North Carolina. *J. Elisha Mitchell Scient. Soc.* 6, p. 45–79.

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PRATT, J. H. (1897) Notes on North Carolina minerals. *Elisha Mitchell Scient. Soc. J.* 14, 2, p. 61–83.

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PRATT, J. H. (1933) Gems and gem minerals of North Carolina. *Amer. Mineral.* 18, p. 148–159.

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

BULLETIN NO. 12

HISTORY OF THE GEMS FOUND IN NORTH CAROLINA

BY

GEORGE FREDERICK KUNZ, PH.D.

RALEIGH

E. M. UZZELL & CO., PUBLIC PRINTERS AND BINDERS

1907

FIGURE 11. Title page of Kunz's description of North Carolina gemstones, with much information on the emerald deposits. This work is noted for its magnificent chromolithographs of rough and cut gemstones.

______, (1888) Ueber Beryll, Monazit . . . von Alexander County, Nord-Carolina. *Zs. Kryst.* 13, p. 595–598.

SINKANKAS, J. (1969) *Report on emerald deposits of American Gems, Inc., near Hiddenite, Sharpes Township, Alexander County, North Carolina.* Unpubl. rept., 10 p.

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______, (1982) Alpine type beryl-emerald deposits near Hiddenite, North Carolina. *Amer. Mineral.* 67, p. 181.

STEPHENSON, J. A. D. (1888) *Gems of North Carolina.* Manuscript in Kunz Coll. USGS Library, Reston, VA. 27 p.

STERRETT, D. B. (1908) Precious stones. Ch. in *USGS Min. Resources U.S. for 1907*, p. 795–842.

______, (1910) Gems and precious stones. Ch. in *USGS Min. Resources U.S. for 1909*, p. 739–808.

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______, (1923) Mica deposits of the United States. *USGS Bull.* 740, 342 p. Pegmatite mines in North Carolina.

______, (1958) "Old Plantation" emerald mine. *Rocks & Minerals* 33, 7–8, p. 302–307, illust.

STRIPP, D. M. & HAMMER, L. (1986) Beginner's luck. *Lapidary J.* 40, 9, p. 24–26, 28–32.

SUMMER, G. (1972) The fabulous emeralds of Hiddenite. *Rockhound* 1, 1, p. 4–11, illust., map.

TRAPP, F. W. (1968) The "Land of the Sky" and emeralds. *Lapidary J.* 22, 4, p. 586, 588–592, 594–596, illust.

______, (1970) "Green bolts" are found again near Hiddenite, NC. *Lapidary J.* 24, 1, p. 116–118, 120, 122, 126, illust.

______, (1971) Emeralds are "in" at Hiddenite, NC. *Lapidary J.* 25, 3, p. 524.

______, (1972) Rebirth of an aquamarine mine. *Rock & Gem* 2, 2, p. 10–14, illust. Wiseman Mine, NC.

WATKINS, J. (1991) Green bolts from the Big Crabtree. *Lapidary J.* 45, 4, p. 57, 58, 62, 64, 66.

WILSON, W. F. & McKENZIE, B. J. (1978) Mineral collecting sites in North Carolina. *NC Dept. Nat. Resources and Community Develop. Info. Circ.* 24, 122 p., illust., maps.

ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps.

______, (1982) The quest for green bolts. *Lapidary J.* Part 1, 36, 2, p. 378–410, *passim;* Part 2, 3, p. 558–560, illust., maps.

SOUTH CAROLINA. Sloan (1908) stated that "good [beryl] crystals occur in the pegmatites in the southwestern portion, notably in Anderson County, where high-grade gems have been obtained." Since that time no gem beryl has been reported.

SLOAN, E. (1908) Catalogue of the mineral localities of South Carolina. *SC Geol. Survey Bull.* 2, ser. 4, 505 p.

McCAULEY, C. K. (1964) Gemstone resources of South Carolina. *SC Div. Geol. Bull.* 30, 34 p., maps.

GEORGIA. Cook (1978) notes that beryl has been reported from about 60 places in 22 counties of Georgia, with much common, or ore beryl having been the major production, but very little gem material. Recent information below is from Sinkankas' *Emerald and Other Beryls* (1989), among other sources that yielded information since publication of my *Gemstones of North America*, Vol. 2 (1976).

Cook (1978) reported small, deep green beryl crystals, described as "emeralds," of not more than 0.25 in (6 mm) in size, from the Springer Mountain Mica Mine, Chattahoochee National Forest, Fannin County. Bluish-green, blue, and yellow crystals, some of gem grade, were found in the Beck Beryl Mine, located about 1.5 mi (2 km) south of War Woman Creek, or 7.5 mi (12 km) southeast of Clayton, Rabun County (McCallie, 1926; Sterrett, 1911). In Habersham County, transparent crystals were reported from the Arrendale property, 1.4 mi (2.3 km) south of Batesville (Heinrich, *et al*, 1953). In Hart County, gem crystals of beryl were found in the Waterhole Mine on the Martin Farm, 1.4 mi (2.2 km) southwest of Crossroads (Griffitts, *et al*, 1953). In Pickens County, gem quality aquamarine and golden beryl were found on the R. H. Cook Farm, 4 mi (6.4 km) west of Tate in the bed of Rock Creek (Furcron, 1953). Babin (1976) reported facet-grade aquamarine and golden beryl at Smoke Rise KOA Campground, near Commerce, Jackson County. This same occurrence is described by Hudson (1977, 1980), who stated that the larger beryl crystals sometimes contained clear areas suitable for faceted gems; he found that the greenish-hued aquamarine could turn to blue when heat-treated.

In Clarke County, small yellow-green gem quality beryl crystals were found along Alps Road near Athens (Furcron, 1959), but Cook (1978) believes this site is now covered by a shopping center. Float beryl crystals, some said to be gem quality, were picked up on G. C. Malcolm property near New Hope School, Walton County (Furcron, 1958; Cook, 1978). In Morgan County, green and yellow crystals were found in a mica prospect on the Adair Plantation just west of Appalachee; among them was found a perfectly clear crystal of 1.5 in (3.8 cm), according to Furcron (1959) and Cook (1978). Spalding County produced some fine pale blue faceted gems of 1.5 to 2 carats from beryl crystals found on the T. J. Allen Farm, about 2 mi (3.2 km) east of Vaughn (Galpin, 1915; Heinrich, *et al*, 1953; Furcron, 1959; Cook, 1978; Sterrett, 1915).

By far the most important occurrence of gem beryl remains the Hogg, Foley, or Mineral Processing mine near Lagrange in Troup County, noted especially for its considerable production of gem aquamarine and rose quartz (Sinkankas, 1976, 1981). The granitic pegmatite body eventually produced 86 tons of industrial grade beryl and an estimated 1.5 tons (1,360 kg) of gemmy beryl, much of it light to deep blue, and with clear areas capable of cutting gems of 15 carats. W. D. Hudson of Stone Mountain, Georgia, for example, cut a flawless blue tear-shaped faceted gem that weighed 22 carats (Hudson, 1977). Much of the mine production consisted of well-formed beryl crystals, many of 50 lb (22.7 kg) or more in weight, and some reaching a diameter of 18 in (45 cm).

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FURCRON, A. S. & TEAGUE, K. H. (1943) Mica-bearing pegmatites of Georgia. *GA Geol. Survey Bull.* 48, 192 p.

FURCRON, A. S. (1953) Aquamarine prospect, Pickens County. *GA Geol. Survey, Georgia Mineral Newsletter* 6, p. 40–41.

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GALPIN, S. A. (1915) A preliminary report on the feldspar and mica deposits of Georgia. *GA Geol. Survey Bull.* 30, 190 p., maps.

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HEINRICH, E. W., *et al* (1953) Mica deposits of the Southeastern Piedmont. Part 9. Thomaston-Barnesville district, Georgia. Part 10. Outlying deposits in Georgia. *USGS Prof. Paper* 248-F, p. 327–400, illust., maps.

HUDSON, S. (1977) Hunting the hexagons: in search of Georgia beryl. *Lapidary J.* 31, 5, p. 1116–1128, *passim*, map.

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WILLMAN, L. D. (1963) *Gem and Mineral Localities of Southeastern United States.* Vol. I., Anniston, AL, 97 p., map.; Vol. II., Jacksonville, AL, 271 p., maps; priv. publ. 1970.

WOOLARD, W. J. (1994) Georgia aquamarines. *Rock & Gem* 24, 5, p. 26–28, 30, 32. illust., map. LaGrange.

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ALABAMA. Very little prospecting for beryl has taken place in the past several decades. Willman (1964) reported gem quality beryl from an open-cut in the Wilborn Ayers Farm and at various places on the surface where mica has been mined. This site is just southeast of Micaville in Randolph County. Cook & Smith (1982) mention gem beryl in the cores of giant beryl crystals that reached 20 in (50 cm) in diameter and 47 in (120 cm) long from the Williams Prospect about 5 mi (8 km) south of Rockford in Coosa County.

CLARK, G. H. (1921) Mica deposits of Alabama. *Geol. Survey AL Bull.* 24, 115 p.

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120, 2825 p., col. pls.

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PALLISTER, H. D. (1953) Beryl in Alabama. *AL Acad. Sci. J.* 25, p. 42–44.

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ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps.

SOUTH DAKOTA. According to E. Fritzsch of the South Dakota School of Mines and Technology, there are over 114 occurrences of beryl in the Black Hills, but only a few produced any gem grade material. Among these, golden beryl fragments were found in the Rainbow #4 pegmatite, Custer County, and aquamarine in the Dan Patch West pegmatite, Pennington County (*Pers. comm., E. Fritzsch*, 1993). Roberts & Rapp (1965) reported gem quality "bottle-green" beryl crystals up to 2.5 in (6.3 cm) that furnished flawless cut gems up to 3 carats from the Wonder Lode, located 1 mi (1.6 km) west of the Mayo School, about 6 mi (9.6 km) south of Custer. The John Ross (Highland Lode) Mine, 4 mi (6.3 km) west of Custer, furnished massive golden beryl, in part gem quality. The Helen Beryl Mine, 6 mi (9.6 km) south of Custer, provided some clear material in the cores of large beryl crystals, but flawless gems of only a few carats could be cut.

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SINKANKAS, J. (1976) *Gemstones of North America.* NY: Van Nostrand Reinhold. 2 vol. 675, 494 p., illust. (col.), maps.

______, (1981) *Emerald and Other Beryls.* Tucson, AZ: Geoscience Press. 665 p., illust. (col.), maps.

STAATZ, M. H., *et al* (1963) Exploration for beryllium at the Helen Beryl, Elkhorn and Tin Mountain pegmatites, Custer County, South Dakota. *USGS Prof. Paper* 297-C, p. 129–197.

MONTANA. A. H. Welling (*CA Min. J.*, 1963) reported finding beautifully colored emeralds of good quality, similar to those of Chivor, Colombia, at an undisclosed locality near Superior, Mineral County. Most of the crystals were said to be opaque but some had clear green portions. This find is unconfirmed.

In Jefferson County, C. Van Laer (*Pers. comm.* 1993) found beryls at several hitherto unrecorded places, along with Arthur Bowler, who had recovered "a small, flattened nearly colorless beryl crystal about 1.5 in [3.5 cm] long" on Timber Butte in the Boulder Batholith in 1986. In 1987, while prospecting East Ridge, just east of Butte, Van Laer found a small vug in pegmatite which contained smoky quartz crystals, microcline, schorl, and "a single, gem quality aquamarine of pale green color nearly 5.0 cm [2 in] long." Additional blue beryl, though not of gem quality, was found in the Homestake Pass area. These discoveries suggest that all of the Boulder Batholith should be thoroughly examined, especially the fringe areas in which most granitic pegmatites can be expected to occur.

CALIFORNIA MINING JOURNAL (1963) A. H. Welling finds valuable emerald deposits near Superior, Montana. Vol. 23, 2, p. 7.

STOLL, W. C. (1950) Mica and beryl pegmatites in Idaho and Montana. *USGS Prof. Paper* 229, 64 p., maps.

WYOMING. A little aquamarine is found from time to time in the granitic pegmatites scattered throughout the state. The most recent find was reported by Kraft's Fine Jewelry and Art of Sheridan in 1988, who stated that rough aquamarine was found in "a discard pile of pegmatitic rocks near a pegmatite composed primarily of plagioclase and microcline feldspars, quartz, and mica." Geologists examined the deposit and suggested that additional aquamarine might be recovered if blasting and hand-picking the pegmatite rock is resorted to. No specific place is given for this potential source except "the Boston mine in the Big Horn Mountains." From this beryl, two faceted gems of aquamarine were sent for examination to the Gemological Institute of America, Santa Monica, California. The largest stone was 2.06 ct, light blue, and gave refractive indexes of 1.572–1.579. A smaller stone, very slightly bluish green, gave 1.573–1.581. Both gems were transparent and gave a specific gravity of 2.70 (Koivula & Kammerling, 1989).

Gem aquamarine was also reported recently from pegmatite near Hoodoo Creek along the south side of Copper Mountain in Hot Springs County (Sutherland,1990). The area is given as Secs. 22, 27, and 28, T40N, R93W. The "crystals vary from light green to pale blue elongate euhedral prisms to aggregates of small anhedral blebs," and were formed sizes from less than 0.5 in (1 cm) to 6.8 in (17.5 cm) in diameter.

Sutherland (1990) also describes another occurrence in pegmatite in the Anderson Ridge area of South Pass, Fremont County. McLaughlin (1940) notes that pegmatites in this county, located about 15 mi (24 km) north-northeast of Shoshoni, provide beryl with lepidolite and muscovite, with the beryl as pale blue elongated prisms to 8 in (20 cm) in diameter; a few such crystals contain gemmy areas.

HANLEY, J. B., HEINRICH, E. W. & PAGE, L. R. (1950) Pegmatite investigations in Colorado, Wyoming and Utah. *USGS Prof. Paper* 227, 125 p., illust., maps.

HAUSEL, W. D. (1986) Minerals and rocks of Wyoming. *Geol. Survey WY Bull.* 66, 117 p., illust. (col.), maps.

KOIVULA, J. I. & KAMMERLING, R. C. (1989) Aquamarine found in Wyoming. Gem News. *Gems & Gemology* 25, 2, p. 110–111.

McLAUGHLIN, T. G. (1940) Pegmatites of the Bridger Mountains, Wyoming. *Amer. Mineral.* 25, p. 46–68. Gem aquamarine.

OSTERWALD, F. W. & OSTERWALD, D. B. (1952) Wyoming mineral resources. *WY Geol. Survey Bull.* 45, 215 p. Gem aquamarine.

OSTERWALD, F. W., *et al* (1959) Mineral resources of Wyoming. *WY Geol Survey Bull.* 50, 259 p.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., maps.

COLORADO. Only the pegmatite deposits atop Mount Antero and White Mountain of Chaffee County continue to yield aquamarine crystals to the hardy amateur collector, but these are mainly mineralogical specimens rarely containing enough clear material within them to afford faceted gems of generally disappointingly weak hue. For the most complete and authoritative treatment of this famous locality see the articles by M. I. Jacobson and his culminating treatise of 1993.

Richard and Tresa Kosnar of Golden, Colorado, found 1 cm "flawless, gem crystals with steep pyramidal terminations and good heliodor color" on Crystal Mountain, Larimer County (*Pers. comm.* 8/10/94). While these crystals would afford small gems, they are "too nice and important to cut."

From Jefferson County, the Kosnars also report pale blue gem aquamarine rough crystal sections found in a beryllium prospect pit at Squaw Pass, on the road to Mt. Evans. Several dozen clean faceted gems from 2 to 5.5 carats were cut from this material. The rough was found "in association with large pieces of dark olive-green chrysoberyl and very dark reddish-brown almandine—none of which had any gem material—plus white quartz, muscovite and plagioclase." Elsewhere in Jefferson County, pale bluish-green aquamarine was found in a pegmatite on the northwest flank of Centennial Cone, about 7 mi (11 km) west of Golden. Other pegmatites are located in this area and may yield small clear areas in beryl crystals found in them. Important pegmatite mines were once worked in the Cañon City and Eight Mile Park district of Fremont County, and extending from this place west-northwest to a point about 1.6 mi (2.5 km) west of Royal Gorge Bridge. Heinrich (1948) plotted and described 18 mines here. Occasionally small clear areas are found in some of the beryl crystals (Sinkankas, 1981). In the Texas Creek district, about 6 mi (9.5 km) north of the town, or about 26 mi (42 km) west of Cañon City, Sterrett (1908) reported gem aquamarine from Royal Gorge mines operated by C. A. Beghtol & Co. Elsewhere, beryl crystals, some with gemmy areas, were said to be plentiful on the Amazon Claim of J. D. Endicott, located 6.5 mi (10 km) north of Texas Creek in East Gulch.

The summits of Mount Antero and adjacent White Mountain are the highest gemstone localities in North America, Antero being 14,245 ft (4,432 m) and White Mt. 13,900 ft (4,267 m) above sea level. These peaks are at the south end of the Sawatch Range, about 15 mi (24 km) northwest of Salida or about 8 mi (13 km) west of Nathrop, Chaffee County. Because of the variety of species found here and the beauty of the aquamarines, an extensive literature about them has grown, as is evident from the references below. According to Jacobson (1993), Nelson D. Wanamaker first discovered the Antero deposits sometime between 1881 and 1884. The minerals found here were noted as early as 1885 by Kunz (1885), who compared them to similar species found in miarolitic cavities in the granite of Mourne Mountains, Ireland. Cross (1887) attributed the discovery of this mineralized area to Wanamaker in 1885. Kunz (1889) reported on Wanamaker's activities, noting that from among 100 crystals of aquamarine recovered in 1888, cut gems to 12 carats were obtained. During 1909–1910, the locality was worked by J. D. Endicott, a Colorado mineral dealer (Sterrett, 1910). No doubt due to the high altitude and short collecting season, not much was collected for many years until Edward Over worked the area for several years (Over, 1928, 1935; Montgomery, 1938). Switzer made an extended visit to the locality not long after (Switzer, 1939), and described the beryls and associated species. A little gem aquamarine was also found from time to time in a deposit on White Mountain in the 1930s (Landes, 1934). This deposit was also

FIGURE 12. Mount Antero, Chaffee County, Colorado, looking to the southwest from near Buena Vista.

described by Adams (1953). Because of increased interest in this area in the 1970s, and spurred on by various collecting accounts, a steep four-wheel drive automobile road was constructed to the collecting area which enabled collectors to exhaust themselves by collecting rather than by climbing. Lupton (1984) recounted his collecting experiences and the cutting of an elongated mixed-cut faceted gem of 12.56 carats from a crystal collected on the mountain in 1983. The original crystal, a very pale blue prism, measured about 2.5 in (6.2 cm) long and weighed about 80 gm. In view of the trouble and effort in obtaining the rough, he named the cut gem "Revenge on Antero."

Heinrich (1985) discusses the several types of deposits in which beryllium minerals may occur in Colorado (and elsewhere), with further notes on the Mount Antero types, plus a note on the California Mine in Brown's Gulch. As mentioned before, Jacobson's treatise is indispensable for anyone interested in this locality, either as an armchair connoisseur of its minerals, or as an active collector. Jacobson's work neglects no aspect of the geologic history of the deposit and even discusses the very real health hazards that may attend collecting at such a high altitude.

On Tappen Mountain, several miles north of Lake George, between Lake George and the town of Tarryall in Park County, the Kosnars report gem aquamarine crystals "in and on pale smoky quartz crystals" that will cut faceted gems of small size. These specimens were found on the dumps of the U.S. Beryllium Corporation prospect pits that were opened between 1959 and 1961. The deposits consist of pegmatites and greisen pipes "with an unusually high percentage of euclase crystals" of small size "but some pale blue, relatively translucent to nearly opaque ... up to 1 cm long, usually on quartz crystals." The Kosnars further note that in Redskin Gulch, "all of the beryllium stored and shipped was in fact euclase which the company had erroneously called bertrandite." Dark olive-green gem crystals of beryl up to 5 cm (2 in) long and 1 cm (0.4 in) in diameter capable of being cut into faceted gems of up to 5 carats were mined in 1959 by the above corporation from the Boomer Mine, Badger Flats, near Lake George, Park County.

ADAMS, J. W. (1953) Beryllium deposits of the Mt. Antero region, Chaffee County, Colorado. *U.S. Geol. Survey Bull.* 982-D, p. 95–119, maps.

ARGALL, G. O. (1949) Industrial minerals of Colorado. *CO School of Mines Quart.* 44, 2, p. 48–69.

COOK, W. (1967) Gem digging on the high and mighty—Mt. Antero. *Lapidary J.* 21, 1, p. 85–93, *passim*, illust. (col.), map.

CROSS, R. T. (1887) Notes on aquamarines from Mount Antero, Colorado. *Amer. J. Science* 33, p. 161–162.

ECKEL, E. B. (1961) Minerals of Colorado: a 100-year record. *U.S. Geol. Survey Bull.* 1114, 399 p.

HANLEY, J. B., HEINRICH, E. W. & PAGE, L. R. (1950) Pegmatite investigations in Colorado, Wyoming and Utah, 1942–1944. *U.S. Geol. Survey Prof. Paper* 227, 125 p., illust., maps.

HANTLA, J. P. (1968) Prospecting in high Colorado. *Lapidary J.* 22, 8 p. 1054–1058, illust. Mt. Antero.

HEINRICH, E. W. (1948) Pegmatites of the Eight Mile Park, Fremont County, Colorado. *Amer. Mineral.* 33, p. 420–448, 550–587, maps.

______, (1985) A Mount Antero postscript. *Rocks & Minerals* 60, 1, p. 14–16.

HILLS, R. C. (1886) Beryl on Mount Antero, Colorado. *CO Sci. Soc. Proc.* 2, p. 138.

______, (1889) Etched beryls from Mount Antero, Colorado. *CO Sci. Soc. Proc.* 3, p. 191–192.

JACOBSON, M. I. (1979) Mount Antero. *Min. Rec.* 10, 6, p. 339–346, illust., maps.

______, (1984) Mt. Antero mineral locality, Chaffee County, Colorado. *Rocks & Minerals* 59, 1, p. 13–17, illust.

______, (1993) *Antero Aquamarines; Minerals from the Mount Antero-White Mountain Region, Chaffee County, Colorado.* Coeur d'Alene, ID: L. R. Ream Publishing, xvi, 126, (2) p., maps, diagrams, col. photos.

KUNZ, G. F. (1886) Precious stones. Ch. in *USGS Min. Resources U.S. for 1885*, p. 437–444.

______, (1889) Precious stones. Ch. in *USGS Min. Resources U.S. for 1888.* p. 580–585.

LANDES, K. K. (1934) The beryl-molybdenite deposit of Chaffee County, Colorado. *Econ. Geol.* 29, p. 697–702.

LUPTON, R. (1984) Revenge on Antero. *Lapidary J.* 38, 5, p. 668–670, 672.

MONTGOMERY, A. (1938) Storm over Antero. *Rocks & Minerals* 13, 12, p. 355–369.

OVER, E. (1928) Mineral localities in Colorado—the Mt. Antero aquamarine locality. *Rocks & Minerals* 3, 4, p. 110–111.

______, (1935) Further explorations on Mt. Antero, Colorado. *Rocks & Minerals* 10, 1, p. 27–29.

PENFIELD, S. L. (1890) Some observations on the beryllium minerals from Mt. Antero, Colorado. *Amer. J. Sci.* 40, p. 488–491.

SINKANKAS, J. (1976) *Gemstones of North America.* 2 vols. NY: Van Nostrand Reinhold, 675, 494 p., illust. (col.).

______, (1981) *Emerald and Other Beryls.* Tucson, AZ: Geoscience Press, 665 p., illust. (col.), maps.

SPOMER, R. (1975) Mt. Antero—the high and mighty. *Lapidary J.* 29, 9, p. 1634–1648, *passim*, illust.

STERRETT, D. B. (1908) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1907*, p. 795–842.

______, (1909) Same. for 1908, p. 805–859.

______, (1910) " " 1909, p. 739–808.

______, (1923) Mica deposits of the United States. *U.S. Geol. Survey Bull.* 740, 342 p.

SWITZER, G. (1939) Granite pegmatites of the Mt. Antero region, Colorado. *Amer. Mineral.* 24, p. 791–809, illust.

VOYNICK, S. (1984) Antero revisited. *Gems & Minerals* 560, p. 32–36.

______, (1993) Mt. Antero aquamarine. *Rock & Gem* 23, 10, p. 48–50, 88–89, illust.

WALDSCHMIDT, W. A. & ADAMS, J. W. (1942) The beryl-monazite pegmatite dike at Centennial Cone, Colorado. *CO School Mines Quart.* 37, 3, p. 29–38.

NEW MEXICO. Numerous granitic pegmatites outcrop in the mountainous regions of north-central New Mexico, and considerable ore beryl has been extracted from them, but very little gem beryl of any kind. A summary of deposits is given in Sinkankas (1981, p. 585–7). Perhaps some gem beryl could be found if the lead of Jahns (1946, p. 227) is followed up, for he states that at the Sunnyside Mine, Petaca district, Rio Arriba County, he found blue "cigar-shaped" crystals up to 7 in (17.5 cm) in length in the schist surrounding the pegmatite, and "many specimens should have value as gem and ornamental material."

The famous Harding pegmatite produced beryl, but little gem material. However, R. S. De Mark of Marquette, Michigan, informs me that very light pink morganite from here was cut into faceted gems up to two carats (*Pers. comm.* 4/4/1994).

In 1979, the extremely rare red beryl, hitherto known only from the rhyolite of Utah, was found by P. E. Haynes in Paramount Canyon on the west side of Black Range, in the northwest part of Sierra County. The claim, Beryllium Virgin, is located in Sec. 22, T10S, R11W. The regional rocks are mid-Tertiary or younger rhyolites, basalts, and clastic sediments, with the minute red beryl crystals found in vesicles in rhyolite associated with quartz, hematite (specularite), and pseudobrookite, very much as in the cavities of the Thomas Mountains, Utah, occurrence. The crystals are simple, tabular, with basal planes and prism planes, pale pink to raspberry red, sometimes color-zoned parallel to the *c*-axis. So far they have been found only in sizes from 1 to 3 mm (Kimbler & Haynes, 1980).

JAHNS, R. H. (1946) Mica deposits of the Petaca district, Rio Arriba County, New Mexico. *NM Bur. Mines Min. Resources Bull.* 25, 294 p., pls., maps.

KIMBLER, F. S. & HAYNES, P. E. (1980) An occurrence of red beryl in the Black Range, New Mexico. *NM Geology* 2, 1, p. 15.

SINKANKAS, J. (1981) *Emerald and Other Beryls.* Tucson, AZ: Geoscience Press, 665 p., illust. (col.), maps.

IDAHO. In Latah County, numerous granitic pegmatites, originally exploited for mica, occur on a spur of the Thatuna Range about 3 mi (4.7 km) north of Avon, or about 23 mi (37 km) northeast of Moscow. Shannon (1927, p. 294) noted gemmy aquamarine areas in large beryl crystals that were found in the Levi Anderson and Muscovite mines, repeating information from Sterrett (1923).

The rugged Sawtooth Range of mountains, largely underlain by the granitic rocks of the Idaho Batholith, straddles the meeting point of Boise, Custer, Blaine, and Elmore counties. It is centered about 70 mi (112 km) northeast of Boise. Much of the region is included in the Sawtooth National Recreation Area, which means that "recreational" mineral collecting is forbidden, and if fanatical environmentalists have their way, no one can set foot within the area at all!

The geology of the region and its beryllium deposits were described by Reid & Choate (1960) and Reid (1963). According to Van Laer & Ream (1986) and Van Laer (*Pers. comm.* 3/1993), "the Sawtooth Batholith is one of many of Tertiary age, miarolitic granite intrusions that are found throughout central Idaho. The rock is composed of fine to medium-grained white to pink micro-miarolitic granite and quartz monzonite, with primary minerals typical for most light-colored intrusives." In regard to the cavities in which aquamarine crystals may occur, "these are common in some areas and inexplicably absent in others." Van Laer remarks that cavities are generally small, less than a few inches in depth, but he has found some that are almost 10 ft (3 m) in depth but whose contents are commonly scoured out by glacial action. The following species have been found in addition to beryl: smoky quartz, often in fine sharp crystals, microcline, also sharply formed, albite, topaz (see this species for description), spessartine (not gem grade), helvite, bertrandite, phenakite, carpholite, hematite, zinnwaldite, apatite, cassiterite, fluorite, siderite replaced by goethite, and some unidentified uranium minerals. Recently tourmaline has been found as acicular inclusions in the topaz, also fayalite and columbite-tantalite.

During an excursion into the Sawtooths in July, 1986, Van Laer and Peter Ditton found numerous aquamarine crystals in an area just northeast of Ardeth Lake. The largest crystal measured 7 x 1.6

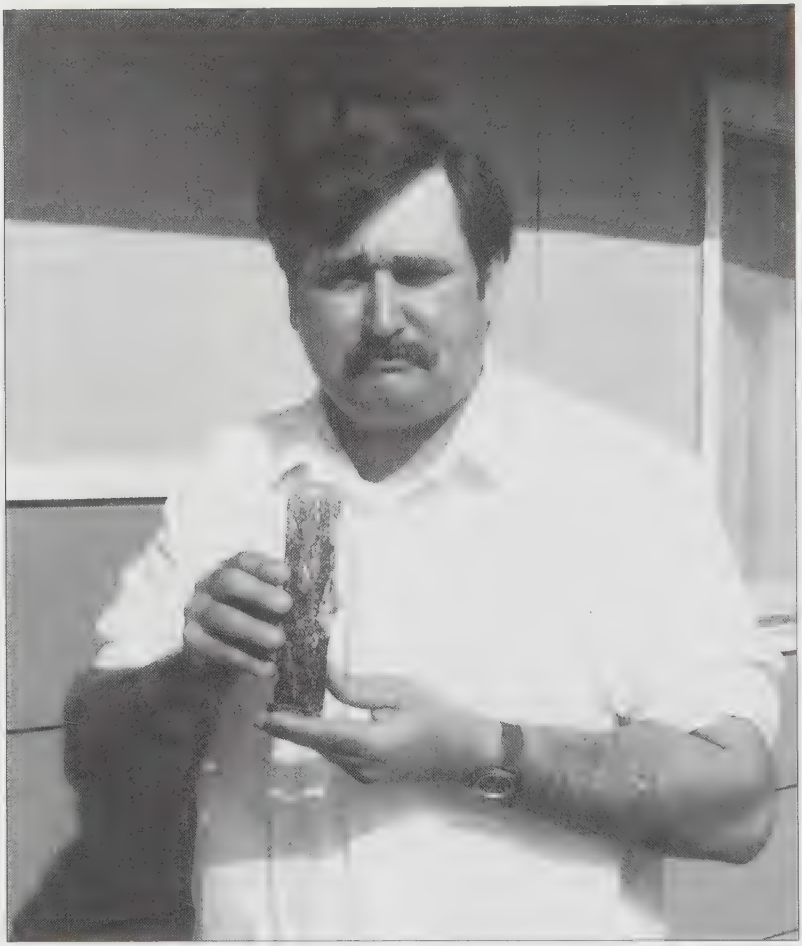

FIGURE 13. Chris Van Laer of Missoula, Montana, holding his prize aquamarine found by him in the Sawtooth Range, Idaho. The crystal is deeply corroded and repaired, and measures 7.5 x 1.5 in. (19 x 3.5 cm). *Courtesy Chris Van Laer.*

x 1.5 in (17.7 x 4.2 x 3.3 cm) and weighed 535.6 gm or 2,678 ct. "It is deep greenish-blue to cobalt-blue at the base, grading into slightly paler shade near the pinacoidal termination." As is typical of many of these crystals, however, it is deeply corroded, and while gemmy in many areas, it contains many fibrous or tubular inclusions parallel to the *c*-axis which prevent its being used for facet material. Despite this, Van Laer points out that "I have cut superior cabochons from this material."

In regard to the color of Sawtooth beryl, it is nearly always some shade of blue, rarely with a greenish tinge, and very rarely yellow. However, Richard & Tresa Kosnar of Golden, Colorado, note fine golden yellow crystals up to 3.7 cm (2.6 in) long and 1 cm (0.4 in) in diameter that would cut clean gems of 5 to 6 carats from an area in the Sawtooths placed closest to Iron Bridge, Stanley Village (*Pers. comm.* 8/10/1994). They also own a splendid faceted blue aquamarine, flawless, of 28.78 carats, cut from a mass of beryl that Richard Kosnar had collected in his July, 1975 mining trip into the Sawtooths. The Kosnars also "had several superb carvings made in Idar-Oberstein [Germany] from this excellent material." The collecting site was near Hart Lake.

In many Sawtooth pockets, splendid, sharp smoky quartz crystals occur, as well as excellent topaz crystals, and it is as superb mineral specimens that these species are mostly prized, rather than for any cutting value except for the fine blue aquamarine faceted gems which are comparable to the better grades of Brazilian aquamarine in respect to the purity and the intensity of the blue color. Remarks on the associated species are given in Ream (1989, p. 65-67). Guides to possible collecting areas appear in Reid & Choate (1960), who especially note concentrations of beryl on the west side of Flytrap Lake, also on the east side of Hart Lake and along two ridges south of Spangle Lakes and west of Glens Peak. *See also* the remarks of Killsgaard, *et al*, 1970.

In Boise County some fine aquamarine crystals were found lately in the Centerville area pegmatite, characterized by Ream (1989, p. 125-9) as "possibly the best aquamarine from a United States locality." Ream depicts a crystal (Fig. 118) that is 3 in (7.2 cm) long, now owned by Joan & Bryant Harris of Missoula, Montana. Other crystals found here measured as much as 6.75 in (17 cm) long and 0.75 in (2 cm) in diameter.

ANDERSON, A. L. (1923) Mica deposits of Latah County, Idaho. *ID Bur. Mines Geol. Pamphlet* 14, 15 p., map.

BECKWITH, J. A. (1972) *Gem Minerals of Idaho.* Caldwell, ID: Caxton Printers, 129 p., illust. (col.), map.

FORRESTER, J. D. (1942) Mica and beryl occurrence in eastern Latah County, Idaho. *Id. Bur. Mines Geol. Pamphlet* 58, 16 p., illust., map.

KILLSGAARD, T. H., *et al* (1970) Mineral resources of the Sawtooth Primitive Area, Idaho. *U.S. Geol. Survey Bull.* 1319-D, 174 p., illust., maps.

REAM, L. R. (1989) *Idaho Minerals.* Coeur d'Alene, ID: priv. publ., 329 p., illust., maps.

REED, G. C. (1946) Exploration of the Avon mica district, Latah County, Idaho. *U.S. Bur. Mines Rept. Invest.* 3898, 23 p., maps.

REID, R. R. & CHOATE, R. (1960) Prospecting for beryllium in Idaho. *ID Bur. Mines Geol. Infor. Circ.* 7, [21] p., maps. Sawtooth Mts.

REID, R. R. (1963) Reconnaissance geology of the Sawtooth Range. *ID Bur. Mines Geol. Pamphlet* 129, 37 p.

SHANNON, E. V. (1926) The minerals of Idaho. *U.S. Nat. Mus. Bull.* 131, 483 p., illust.

STERRETT, D. B. (1923) Mica deposits of the United States. *USGS Bull.* 740, 342 p., illust., maps.

STOLL, W. C. (1950) Mica and beryl pegmatites in Idaho and Montana. *USGS Prof. Paper* 229, 64 p., illust., maps.

VAN LAER, C. & REAM, L. R. (1986) Sawtooth Mountains, Boise, Custer, and Elmore counties, Idaho. *Mineral News* 2, 1, p. 5–7; 2, p. 5–7; 3, p. 7–9; 4, p. 5–8.

UTAH. Stowe, *et al* (1977, p. 40) report blue beryl and gem quality aquamarine from a granitic pegmatite on Porcupine Ridge, the summit ridge of the Mineral Mountains in Beaver County. The locality is given as in Secs. 18 & 20, T28S, R8W. The beryl crystals are up to 7 cm (2.75 in) in length and are frozen in the pegmatite; aquamarine is rare and gemmy crystals only occasionally yield facet areas.

The production of red beryl from the Wah Wah Mountains continues, but it is reported that the productive claims have been purchased by Kennecott Mining Company, who plans to quarry the beryl-bearing rock on a large scale and crush same to a given minimum size, then process this "ore" chemically to dissolve the enclosing powdery altered rhyolitic rock, then recovering the red beryl crystals from the resulting slurry. It will be recalled that the claims, Violet 1 to 8, acquired by Edward, Rex, and Robert Harris of Delta, Utah, are located in Secs. 19 & 30, T29S, R14W, or about 26 mi (41 km) west-southwest of Milford or about 43 mi (69 km) almost due west of Beaver. The deposits resemble those of the Thomas Mountains but the crystals are larger, clearer, and more intensely colored. In the Wah Wah deposit the crystals are short to medium-long simple hexagonal prisms, terminated by *c*-0001 faces; traces of pyramidal faces are sometimes found. Typical dimensions are less than 0.25 in (5 mm) long to as much as 1 in (25 mm) long with diameters of about 0.12 to 0.5 in (3-12 mm). Many crystals grow in porous, friable whitish altered rhyolite composed largely of clay minerals, and commonly include same within themselves with the result that some crystals are found composed of at least 50% by volume of the enclosing material and the color of the crystals then appears pink. It is the very rare exception that a crystal grows in an open space large enough to allow its best development and its best color, sharpness of crystal forms, and internal clarity.

The Harrises (*Pers. comm.* 2/1994) inform me that the small facet rough is sent to Bangkok, Thailand, for faceting into tiny gems which, though small, are still richly colored. Rough that would yield gems of one carat or more is faceted domestically, and stones of several carats weight may fetch $3,000 to $5,000 per carat. These prices are matched only by those of the finest quality emeralds of comparable size. Outstanding mineral specimens of red beryl are extremely rare, and if crystals are attractively perched on matrix, may fetch prices which go into many thousands of dollars per specimen. One such specimen is illustrated in my *Emerald and Other Beryls* (1981), and other color photographs are reproduced in Ream (1979) and Shigley & Foord (1984).

In addition to the account of mining activity at the red beryl mine by Ream (1979), Shigley & Foord (1984) provide an exceptionally complete description of the geology, mineralogy, and min-

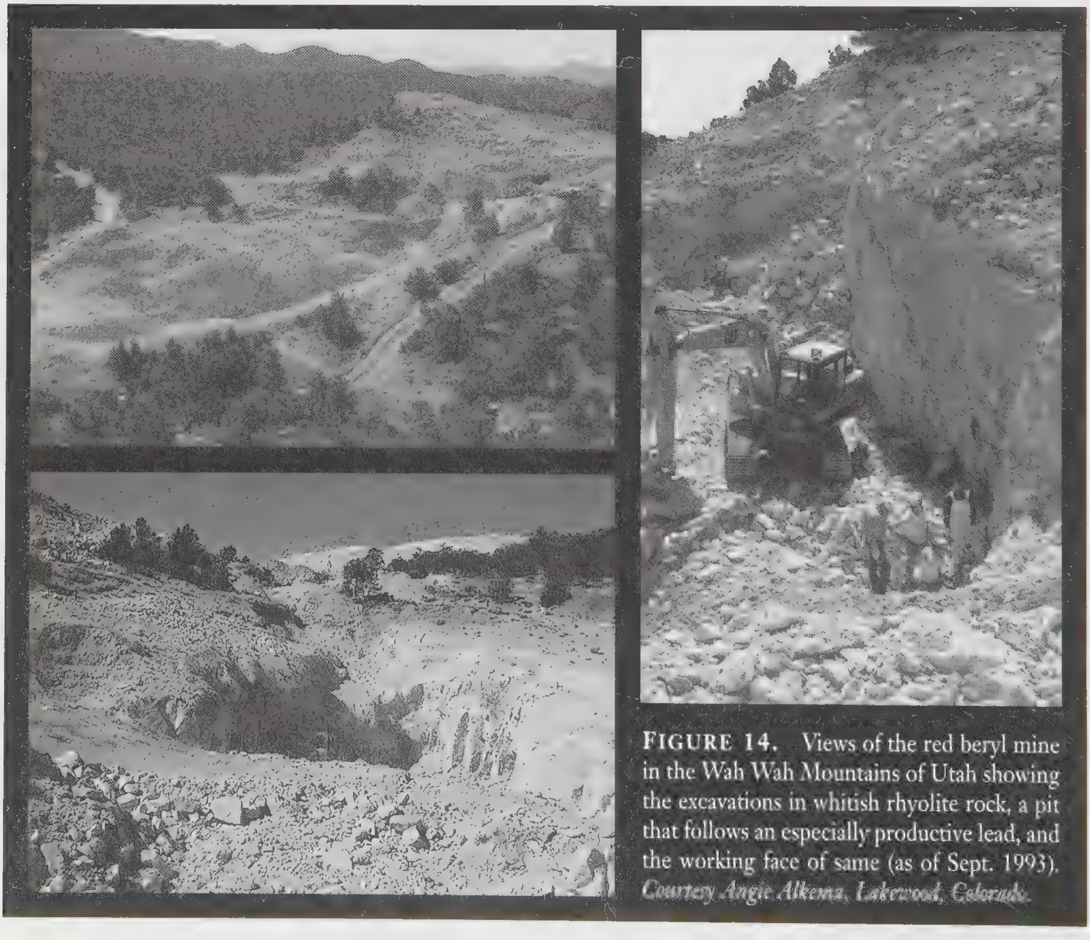

FIGURE 14. Views of the red beryl mine in the Wah Wah Mountains of Utah showing the excavations in whitish rhyolite rock, a pit that follows an especially productive lead, and the working face of same (as of Sept. 1993). *Courtesy Angie Alkema, Lakewood, Colorado.*

ing of red beryl, along with a map of the mine area, color photographs of the opencuts in the rhyolite, and of rough and cut red beryls. The rhyolite, according to their examinations, is uniform in color and texture, being light gray to light reddish-gray, almost white, and very fine-grained with small phenocrysts of feldspars, garnets, and biotite. The beryl is sometimes accompanied by small formless grains of black bixbyite. It has been found that the beryl crystals occur mostly in fracture fillings, or sometimes in cavities within otherwise solid rhyolite. Unlike the occurrence at Thomas Mountain, topaz is absent.

Properties of the red beryl were determined by Miley (1981): refractive indexes 1.561 (± 0.001) – 1.569 (± 0.001); birefringence 0.008; specific gravity 2.65. The dichroism is purplish-red and orangey-red; inert in SW and LW ultraviolet; no spectra observed; fingerprint inclusions. Shigley & Foord (1984) noted a relatively high content of Mn, Ti, Zn, Sn, Cs, Li, Rb, B, Pb, Nb, Sc, Zr, and Ga. They found refractive indexes of epsilon 1.564–1.569, omega 1.567–1.568 on refractometry, and epsilon 1.567–1.568 and omega 1.574 on grains in RI liquids; birefringence usually 0.006 to 0.008, and as low as 0.004 in some samples. They record similar dichroism, UV inertness, etc. as given above by Miley but found a number of absorption bands in their spectroscopic examinations. Under the microscope, they found healed fractures, 2-phase inclusions, quartz and black bixbyite, which mineral they believe may have served as a seed crystal for growth of beryl. Further observations on red beryl properties were made by Hosaka, *et al* (1993) as follows: R.I. epsilon 1.561–1.565, omega 1.567–1.571; birefringence 0.004; specific gravity (heavy liquids) 2.63–2.72. An orange-red/purplish-red dichroism was seen and a content of 0.23 wgt. % Mn and 1.3% Fe determined.

BANK, H. & BANK, F. H. (1982) Schleifwürdige rote Beryll aus Utah, USA mit niedrigen Brechungssindizen. *Zs. Dt. Gemm. Ges.* 31, 1/2, p. 87–88.

BARLOW, F. J. (1979) Red beryl of the Wah Wahs. *Lapidary J.* 32, 12, p. 2540–2570, *passim*, illust., map.

FLAMINI, A., *et al* (1983) Sulle carrateristiche particolari del berillo rosso dell' Utah. *La Gemmologia* 9, 1/2. p. 12–20, illust.

HOSAKA, M., *et al* (1993) Observations of red beryl crystals from the Wah Wah Mountains, Utah. *J. Gemm.* 23, 7, p. 409–411.

MILEY, F. (1981) An examination of red beryl. *Gems & Gemology* 16, 12, p. 405–408, illust. (col.).

REAM, L. R. (1979) The Thomas Range, Wah Wah Mountains and vicinity, Western Utah. *Min. Rec.* 10, 5, p. 261–278, illust., map.

SCHMETZER, K., *et al* (1974) Eine seltene rote Varietät der Mineralart Beryll (früher Bixbit genannt). *Zs. Dt. Gemm. Ges.* 23, 2, p. 139–141.

SHIGLEY, J. E. & FOORD, E. E. (1984) Gem-quality red beryl from the Wah Wah Mts., Utah. *Gems & Gemology* 20, 4, p. 208–221, illust., map.

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STOWE, C., *et al* (1977) *Collector's Guide to Mineral and Fossil Localities in Utah.* UT Geol. Min. Survey, 112 p., maps.

VERBIN, E. (1994) Argyle diamonds' RTZ options red beryl mine. *Colored Stone* 7, 4, p. 1, 25, 26, illust. (col.).

ZEITNER, J. C. (1987) Four American beauties. *Lapidary J.* 41, 4, p. 34–41, *passim*, illust. (col.). Utah red beryl included.

ARIZONA. According to Anthony, *et al* (1977, p. 54), "gem quality aquamarine crystals affording stones to 40 carats have been found in some quantity from pegmatites in the vicinity of the Sierrita Mountains," Pima County.

ANTHONY, J. W., *et al* (1977) *Mineralogy of Arizona.* Tucson, AZ: Univ. Arizona Press, 241 p., illust. (col.).

NEVADA. In 1938, Ball (1939) reported discovery of emerald as deep-colored outer zones on otherwise pale-colored beryl crystals in a pegmatite intruding limestone in Nevada. At this time the crystals were said to be too small and too flawed to be useful for gems. Christopher W. Ralph (*Pers. comm.* 5/10/1993) visited the locality and states that the deposit is in the Oreana Mine, east of Rye Patch Reservoir, Pershing County. More details are furnished by Johnson (1977). According to Ralph, "the green beryl crystals from this deposit are a medium color, but rich enough to be considered emerald, and are, as reported by Ball, darkest in the exterior portions. They range in size up to about 1/2 inch [1.2 cm] in diameter. Smaller crystals from this deposit are the most uniform in color. All beryl crystals from this deposit grew fully surrounded by solid rock matrix and are quite opaque. None of this beryl is suitable for faceting, though it is possible small cabs might be cut from some of this material." Ralph also notes that some of the material is "very reminiscent of 'emerald-in-matrix' from the Crabtree Mine of North Carolina." Characteristic of the Oreana matrix specimens is the presence of fluorescent scheelite.

BALL, S. H. (1939) Gemstones. Ch. in *U.S. Bur. Mines Min. Yearbook for 1938*, p. 1385–1396.

JOHNSON, M. G. (1977) Geology and mineral deposits of Pershing County, Nevada. *NV Bur. Mines Geol. Bull.* 89, p. 61, 85.

CALIFORNIA. Morganite continues to be the principal beryl variety produced in California from pegmatite mines in San Diego County. Some pale-hued aquamarine has been found in this county also but is not an important gem material.

Recent mining in the pegmatites of Coahuila Mountain in Riverside County produced some gemmy aquamarine. Sinkankas (1981) includes a watercolor drawing of a greenish, deeply corroded crystal, probably from the Fano Mine, that measures 5.35 x 1.6 in (13.8 x 4.3 cm); it is in the William Larson collection, Fallbrook, California. The F. D. Mears property, located about 2 mi (3.4 km) east of Riverside at the base of Box Springs Mountain, contains a pegmatite which yielded 20 lb (9 kg) of beryl crystals, some suitable for gems, according to Sterrett (1908). Murdoch & Webb (1966) note that a little aquamarine was found in the S. P. Silica Quarry near Nuevo, between Perris and Hemet. Near the latter town, Kunz, in his precious stones chapter, 1905, reported a find of rose beryl. The Fano Mine, mentioned above, had produced in earlier years 250 lb (116 kg) of beryl, but according to Kunz (1905), "only about five percent of it [was] available for gem purposes."

In the northern part of San Diego County, a small quantity of gem beryl was mined from a pegmatite dike in Elder Canyon in the Anza-Borrego State Park near the Riverside County border, according to Weber (1963). This locality is 11 mi (17.5 km) northeast of Warner Springs. At the Blue Bell claim on the northeast flank of Chihuahua Valley 7.5 mi (12 km) north of Warner Springs, colorless to very pale yellowish-green prismatic crystals of gemmy aquamarine were recovered from pockets in pegmatite. These crystals are slender, beautifully formed, but too small for substantial gems and, in any event, too pale in color to be worth cutting. The famous blue topaz pegmatites atop Aguanga Mountain, especially the claim known as the Emeralite No. 2, located 9.25 mi (15 km) northwest of Warner Springs, also produced a little pink, pale blue and golden gem quality beryl (Kunz, 1905; Ware, 1935; Weber, 1963; Sinkankas, 1976, 1981).

Farther south in the Rincon district, no pegmatite mining has been attempted in several decades, while attempts to obtain mining rights upon the lands of the Rincon Indian Reservation have not met with success despite its being known that gemmy aquamarine crystals were produced from several pegmatites many years ago.

The Mesa Grande district, centered about 4.36 mi (6.8 km) southwest of Lake Henshaw Dam, or about 10 mi (16 km) northwest of Santa Ysabel, is best known for its colored tourmalines, but fine cabinet specimens of morganite have been found in the Esmeralda Mine and orange to pink etched masses of morganite in the tourmaline pockets of the Himalaya Mine pegmatites. Some recent finds in spring, 1993, according to William Larson of Pala Properties International, owners and operators of the Himalaya Mine, are only about one inch (2.5 cm) in diameter, nearly colorless and deeply etched, sometimes to the point where original crystal faces have been obliterated.

In the Pala district, a road constructed upon the north slope of Tourmaline Queen Mountain provides an alternate route to the pegmatite mines near the summit from that which led up the south face. This road was put in by Roland Reed, Michael Lopez, James Brown, and Helmuth

FIGURE 15. Roland Reed, owner and miner of the Elizabeth R. pegmatite mine, Pala, San Diego County, California, showing a just-opened pocket lined with quartz and morganite beryl crystals. *Courtesy Roland Reed, El Cajon, CA.*

Röhrl, who formed a partnership to explore the Tourmaline Queen Mine, taking an open-ended lease for same from owner Edward Swoboda. Some clean-out and drifting has been done and a new tunnel begun in untouched pegmatite south of the main workings. While this mine is best known for its magnificent pink tourmaline crystals of large size, some excellent specimens of morganite, many as fine euhedral crystals, have also been recovered. Next to this mine are the Ed Fletcher and Tourmaline King mines, but no work has been done on them in many decades. It is reported that the Ed Fletcher Mine property has been deeded to the Pala Indian Reservation and any mining that is contemplated in the future must be arranged through their tribal council.

Below the Tourmaline Queen Mine, the very large pegmatite of the Stewart Lithia Mine continues to produce a little pink morganite in addition to some colored tourmaline. The mine is being worked by Blue Sheppard, who markets his material from a shop at Pala. Across the valley to the east, the Pala Chief Mine on Pala Chief Mountain was leased by Robert Dawson of Temecula from its owner, Oscar Nukka of Oceanside, who also owns the adjacent Goddess claim. These claims are just south of Roland Reed's Elizabeth R. and Hazel W. claims on the same ridge near the mountain's summit. By far the greatest amount of work was accomplished upon these two properties by Reed, who acquired these mines in 1973 and worked them more or less steadily into 1993. The early history of this endeavor is told in Sinkankas (1976, vol. 2) and summarized in Sinkankas (1981). The sheet-like pegmatite body lies like a blanket along the west slope of the Pala Chief Mountain and is reached by a road from the east and by mine roads which connect several levels about 100 ft (30 m) apart along the dip. It is estimated that there exist 1,000 ft (300 m) of tunnel and stope in the Ellzabeth R. workings. Reed explored a vertical mineralized streak of pockets which yielded hundreds of quartz crystals as well as large crystals of feldspar. It is estimated that three to four tons of quartz crystals were produced, and several hundred pounds (ca 100 kg) of morganite crystals in all grades from etched masses to splendant euhedral crystals of classic form and transparency. While considerable clear material suitable for faceted gems was found in the crystals, the color is generally so pale that faceting gems would be a waste of otherwise excellent crystallized specimen material. Most of the morganite, therefore, has been sold accordingly. Consistent with its behavior elsewhere, the morganite from the Elizabeth R. Mine also fades to pink upon exposure to daylight, the final intensity of pink hue depending on the original peach hue intensity. The crystals range from small tabular, modified individuals to some as large as 5 in (12.5 cm) across and up to 3 in (7.5 cm) in depth. The ratios of diameter to depth are about 3:1, but several crystals examined in Reed's stock were almost 1:1. Many crystals are glassy, others completely etched, and still others curiously etched by a series of very deep, very narrow cavities parallel to the *c*-axis, and further etched along the prism faces with surfaces that are left glassy smooth.

Reed's prize specimen, found in 1992, is worth a few words of description because it appears to be the best matrix specimen of morganite found in San Diego County, and is certainly among the best found anywhere. It is a thick, septum-like mass of small-bladed white cleavelandite upon which are sprinkled glassy, transparent morganite crystals of tabular habit. There are seven large crystals, and others smaller, the largest crystal measuring 6 in (15 cm) in diameter, and all crystals remarkable for containing central zones of pale aquamarine. The specimen was found broken into three sections and these were cemented together to form a single mass measuring 13 in (31 cm) long, 8 in (21 cm) wide, and about 6 in (16 cm) deep.

Despite the considerable quantity of gem morganite recovered from the Elizabeth R. pegmatite, only a very small amount proved to be useful for faceted gems. None appeared colored unless cut to about 15 carats weight. I am told that Elvis Gray cut a faceted gem from this material which weighed over 100 carats and is virtually flawless.

The associated minerals within the Elizabeth R. consist primarily of quartz crystals, some as much as 100 lb (45 kg); large microcline/orthoclase crystals, one of which, seen in Reed's stock, is almost 2 ft (60 cm) across; morganite crystals; cleavelandite coatings and linings in the pockets; much extremely fine-grained lepidolite, and a greenish mica that is believed to be this species; muscovite; schorl crystals, some very sharp and bright (but no colored tourmaline); pale green and grayish apatite crystals, none of gem quality; and also rarities such as a suite of alteration products derived from triplite and forming aggregates similar to the phosphates of Stewart Lithia Mine. More rarely found are flattened striated crystals of black mangano-columbite up to 2 in (5 cm) across, and in one pocket were found very sharp, textbook-perfect cubic crystals of pyrite completely replaced by goethite and perched on bladed cleavelandite. A disappointing aspect of the work in the Elizabeth R. was the regular finding of casts and impressions which told of the former presence of giant spodumene crystals, perhaps even larger than those that were found just a few yards away in the Pala Chief Mine. Some of these crystal casts or impressions measured over 12 in (30 cm) in length and 6 in (15 cm) in width! Just recently, clinobisvanite, namibite, and beyerite have been identified from among the pocket minerals found in this mine.

On Hiriart Hill, just to the east of Pala Chief Mountain, the White Queen Mine, after a legal determination, was returned to the ownership of the Pala Indian Reservation. Recent work in the mine, accomplished in 1990, consisted of a tunnel driven below the previous opening on the west slope of Hiriart Hill to intersect the very large system of pockets which had formerly yielded morganite, aquamarine, and very attractive inclusion-filled quartz crystals. This work was done by the team of Robert and Kenneth Dawson, sons of the former owners of the claim, also Marty Misslin, and Maury Morgenstein. Soon after reaching the pegmatite, they encountered a pocket from which they obtained 150–200 specimens of peach-salmon morganite, with the best crystals being 2–3 in (508 cm) in diameter and about 1.5 in (4 cm) thick. An outstanding pink morganite crystal attached to a bit of matrix is shown in color in Bancroft's *The World's Finest Minerals and Crystals*, 1973.

In the Ramona district, the pegmatite mines still produce spessartine of fine gem quality, but beryl only rarely appears as long-prismatic pink crystals, much clouded with inclusions and none cuttable. In other places, the rare crystals may be aquamarines or typical tabular morganites of small size.

The interest of local collectors in San Diego County turned in recent years to the relatively unexplored pegmatite fields of the southeastern portion, spurred on by the discovery of gemmy spodumene crystals on the flank of Tule Mountain. A series of vein-like granitic pegmatite bodies, formerly known as the Crystal Gem Mine, according to Weber (1963, p. 101), were first noted by Kunz (1905, p. 152), who remarked upon a modest production of pink and green beryls and spessartine garnet from these mines. The mines are on granitic pegmatite bodies that are more or less parallel to each other and elongated in a north-south direction, and outcrop close to Sacatone Spring, about 8 mi (13 km) northwest of Jacumba. They are on the northwest flank of Tule Mountain in the NW¼ of the NW¼ of Sec. 11, T11S, R7E, San Bernardino Meridian. Ownerships for some of the claims are obscure, but one property, later named the Packrat Claims, has been registered by Frederick L. Stevens, formerly of Descanso, San Diego County, and now a resident of Auburn, California. He began work in 1981, mining steadily to 1991, at which time his claims were sold to Gary J. Wallace of El Cajon, California. In 1975, Loren Beebe, then residing in El Cajon and now in Apple Valley, California (1994), while seeking a reported garnet mine in this area, came upon a small pocket in pegmatite from which he extracted quartz crystals, feldspar crystals, and a kunzite crystal. He thereupon registered a claim which was named the "Beebe Hole," and in due course found other pockets from which he retrieved quartz crystals and pink morganite crystals (*Pers. comm.* 6/1993). He then abandoned the claim because of moving out of the county, leaving the claim to be re-registered by F. L. Stevens, as noted above. For further details on Beebe and his mining of spodumene, see under that gemstone.

According to Gary J. Wallace (*Pers. comm.* 6/1993), who actively mines the Packrat, the north-south distance covered by the three sets of claims is about 4,000 ft (1,400 m), with the Packrat at the north end, the Rose Marie Claim (owned by P. Padalino of El Cajon) in the center, and the Green Ledge (owned by Tom Hussman of El Cajon) at the south end. Two parallel dikes are present, the uppermost dike reaching a maximum width of 25 ft (7.5 m), and the lower dike reaching a width of about 15 ft (4.5 m). Pockets in them range from small vugs to chambers that measured 14 ft (4.2 m) along the strike, and up to 10 ft (3 m) along the dip. Stevens (*Pers. comm.* 6/1993) recalls one pocket which produced 600 lb (270 kg) of quartz crystals, including a single 27 in (67 cm) tall and nearly the same in circumference. It is now in the collection of the Los Angeles County Natural History Museum and is said to be one of the finest smoky quartz crystals ever found in North America. Other smoky quartz crystals from this deposit weighed from 4 to 57 lb (1.8–26 kg). Some of the crystals examined in Wallace's collection are very much like the best found in the Swiss Alps. In addition to the quartzes, Stevens also remembers that his largest pocket yielded about 4,000 lb (1,800 kg) of feldspar crystals and much beryl, largely as greenish and translucent to transparent crystals. The best of the beryl crystals, a hexagonal prism of 6.5 lb (3 kg), was also placed in the Los Angeles museum. The finest aquamarines from here are always of very pale greenish hue, not large, generally only 3.5 in (9 cm) long, or less, and about 5/8 in (1.5 cm) in diameter. As is so often the case, the smaller crystals are of far better quality in regard to perfection of faces and internal clarity.

From some of them faceted gems of one to five carats have been cut, but these are so faintly hued that they appear to be goshenite, unless one places them upon a sheet of white paper to allow the color to be seen. By far the greatest value of this aquamarine lies in their being attractive mineral specimens.

Among the remarkable associates to beryl found in these cavities are the spodumene crystals, which are colorless, pale greenish, pale yellowish, and rarely, a distinct lilac or kunzite color, with the largest crystals about 4 x 5 in (10 x 12.5 cm). So far as I can determine, none have been faceted although some crystals contain clear areas. There were also found sharp hexagonal prisms of apatite in dull colors and not gem quality, the largest seen being about 4 in (10 cm) tall, a very large size for an apatite from a granitic pegmatite! Herderite crystals to 2 in (5 cm) were found, also helvite crystals, columbite in typical tabular crystals, and very small black crystals which may be cassiterite. Considerable spessartine garnet also occurs, often as a coating on pocket and fractured rock surfaces; while euhedral, these crystals are generally small, less than 0.25 in (0.5 cm), but some have been cut into fairly attractive faceted gems, according to Stevens, but always below one carat in weight. Wallace possesses a faceted gem of about two carats, but its color is quite dark, resembling that of brownish almandine and not the vivid reddish-orange of Ramona spessartine. Gary Wallace (*Pers. comm.* 1/10/1994) informs me that he has also identified wedge-shaped crystals of danburite from the Packrat pegmatite which are yellowish in color and less than 0.5 in (1.2 cm) in size, also mitridadite and purpurite.

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BERYLLONITE

The best accounts of the occurrence of beryllonite in Maine appear in Stevens (1972, p. 25–36) and King & Foord (1994, p. 57–59). Stevens notes that the Melrose Quarry, "sometimes referred to as Sugar Hill" is given as the specific locality but King & Foord (p. 57) remark that many mineral specimen labels "incorrectly attribute the Beryllonite locality to the Melrose Quarry" and "only one locality in Maine has produced loose beryllonite crystals found in soil: Beryllonite locality, Sugarloaf Mountain, Stoneham." This particular spot is "a mudslide-covered area just to the east of the Melrose Quarry." Bradshaw (1992, p. 14) notes the locality but avoids discussing the controversy surrounding its exact location. Dunn (1975) described typical inclusions in the beryllonite and found the most obvious to be very fine tubes parallel to [010], also healed fractures, and gas-liquid inclusions. Numerous examples of cut gems are given by Stevens and Bradshaw while Wight (1984) records a faceted gem from Stoneham in the Canadian National Collection that weighs 6.59 ct. An exceptional gem in the Harvard Mineralogical Museum, a rectangular cushion, slightly included, weighs 24.96 ct. There is also a splendid barion-cut faceted gem of 6.22 ct. *See also* Arem (1987) for other examples.

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PALACHE, C. & SHANNON, E. V. (1928) Beryllonite and other phosphates from Newry, Maine. *Amer. Mineral.* 13, p. 392–396.
STEVENS, J. P. (1972) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* West Paris, ME: Perham's Maine Mineral Store, 216 p., illust.
WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

"BLACK GRANITE"

This is the name popularly applied to a unique igneous rock that is quarried in San Diego County, California, for special engineering applications. It is actually a medium-fine-grained hypersthene or hornblende gabbro, also called "black diorite," which is primarily used to fashion "surface" blocks, or flats that have been lapped and polished to a very high degree of flatness. Such blocks are used as precision surface plates, vee-blocks, parallels, straight-edges, and master flats, all finding use in industry for checking the accuracy of machine components and assemblies. This specific rock was chosen because of its remarkable dimensional stability despite temperature changes. Most of the quarrying activity takes place in San Marcos and Escondido, extending southward to follow the rock outcrops to workings in Lakeside and Santee.

The rock, which appears very dark gray, almost black, consists of tightly interlocked grains of plagioclase feldspar, pyroxene, and hypersthene or hornblende, and with minute grains of magnetite, which mineral appears as dots of semi-metallic luster sprinkled uniformly throughout the rock. This "black granite" has also found considerable use as an ornamental stone in building and counter facings, and in sculptures, bookends, and other applications. Apparently the quantities are unlimited. Other granitic rocks in the same region are also described in Hoppin & Norman (1950).

HOPPIN, R. A. & NORMAN, L. A. (1950) Commercial "black granite" of San Diego County, California. *CA Div. Mines Spec. Rept.* 3, 19 p., map.
STERNER, F. (1964) Precision on a colossal scale. *Gems & Minerals* 324, p. 20, 21, illust. Manufacture of precision plates.

BOLEITE

This rare mineral was named after its discovery in a copper mine at Boleo, Santa Rosalia, Baja California. It is a complex lead-silver-copper chloride, formula $Pb_9 Ag_3 Cu_8 Cl_{12} (OH)_{16} . H_2O$, which grows as intensely blue pseudocubic crystals that are rarely over 0.5 in (1 cm) across. The refractive indexes are 2.03–2.05, hardness 3–3.5, and specific gravity 5.05. There is a perfect cleavage which causes some trouble when the rare clear fragment is faceted; the largest clear faceted gems can seldom exceed a fraction of a carat in weight. A 1993 price asked for a faceted gem of 0.44 ct was $85.00 or $195.00 per carat.

For an account of a recent reopening of the mine and the collecting of boleite and its associated species, see Swoboda (1976).

BANCROFT, P. (1984) *Gem and Crystal Treasures.* Fallbrook, CA: Western Enterprises, illust. (col.). Boleo: p. 116–119.
CUMENGE, E. & BOUGLISE, G. DE LA (1885) *Étude sur le district cuprifère de Boleo—Basse Californie.* Paris: Librairie Centrale des Chemins de Fer.
FABREGAT, F. J. (1963) Revision critica de los minerales Mexicanos. 1.-La boleita. *Univ. Nac. Autonoma de Mexico, Inst. Geol.* Bol. 66, 106, p., illust. (col.).

SWOBODA, E. (1976) Boleo—a classic locality reworked. *Lapidary J.* 30, 10, p. 1814–1830, illust.

WILSON, I. F. (1955) Geology and mineral deposits of the Boleo copper district, Baja California, Mexico. *USGS Prof. Paper* 273, 134 p., illust., maps.

BRUCITE

Although relatively common, brucite, formula $Mg(OH)_2$, is very rarely found in transparent form suitable for faceted gems. The only source so far known for such material is the Jeffrey Mine, Asbestos, Quebec, better known as a source of fine facet-grade grossular garnet. Here it is reported as pale blue massive material, according to Arem (1987, p. 58), with a note that faceted gems somewhat over one carat have been cut. Wight (1986) records a 1.05 ct triangular stepcut gem described as "translucent, light green," acquired in 1985. Brucite properties are: refractive indexes omega 1.559–1.590, epsilon 1.580–1.600; birefringence 0.010–0.020; hardness 2.5; specific gravity 2.39.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

BURBANKITE, *see* REMONDITE

BUSTAMITE

COLORADO. A nodular mass of fine-grained pink bustamite measuring 12 x 12 x 8 cm (4.8 x 4.8 x 3.25 in) was found in the Argentine Vein, Idarado Mine, Telluride, San Miguel County, according to R. & T. Kosnar of Golden, Colorado (*Pers. comm.* 8/10/1994). It was found associated with kutnahorite crystals and native gold in a quartz-sulfide vein and is considered a fine carving material. According to Arem (1987, p. 58–9), bustamite is a manganese-calcium silicate, formula $(Mn,Ca)_3Si_3O_9$, triclinic; refractive indexes alpha 1.662–1.692, beta 1.674–1.705, gamma 1.676–1.707; birefringence 0.014–0.015; biaxial (–); H 5.5–6.5; specific gravity 3.32–3.43. Fine crystals have been found in the Franklin, New Jersey, zinc deposit but are rarely cut as cabochons and never as faceted gems.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* NY: Van Nostrand Reinhold, 248 p., illust. (col.).

CALCITE

By far the most calcite used in the lapidary arts is the familiar massive material, either the metamorphic marbles or the water-deposited calcite onyxes. However, some calcite occurs in perfectly transparent and flawless crystals from which splendid faceted gems have been cut. Absolutely remarkable are the very large colorless faceted gems cut by Arthur Grant of New York, who has made a specialty of faceting large gems, including calcites. These gems are spectacular, displaying vivid flashes of all rainbow colors because of diffractive/reflective effects caused by light interactions at twinning planes, across which the refractive index changes sufficiently to give rise to this effect. More will be said about these gems later.

A recent work, in German, by Dr. Werner Lieber of Heidelberg, deals with all aspects of calcite, including its ornamental applications. It is very worthwhile reading, and one only wishes that it could be translated into English to increase its readership. It is included among the general references given below, which also include references to minor calcite deposits in various states.

BOWLES, O. (1940) Onyx marble and travertine. *U.S. Bur. Mines Info. Circ.* 6751 (rev. of I. C. 6751, 1933), 11 p.

BURNHAM, S. M. (1883) *History and Uses of Limestones and Marbles.* Boston, MA: S. E. Cassino, 392 p., illust. (col.). Much on deposits in all of N.A.

DE KALB, C. (1896) Onyx marbles. *Amer. Inst. Min. Eng. Trans.* 25, p. 557–569.

______, (1898) The onyx marbles. *Stone*, 17, p. 397–405.

FALKENAU, L. (1892) Onyx on the Pacific Coast. *Technical Soc. Pacific Coast Trans.* 8, p. 199–202.

GORBY, S. S. (1899) The onyx deposits of Barren County, Kentucky. *Eng. & Min. J.* 67, p. 707–708.

GORDON, C. H. (1912) Cave marble (cave onyx) in

Tennessee. *TN Geol. Survey, Resources of TN Bull.* 2, p. 307–317.

GREENE, W. D. (1962) Gems of the fossil world. *Lapidary J.* 16, 2, p. 262–264, illust. Fossils of calcite used ornamentally.

HOPKINS, T. C. (1893) Marbles and other limestones. *Geol. Survey Arkansas, Ann. Rept. for 1890*, vol. 4, 443 p., illust.

HUGHES, H. H. (1931) Iceland spar and optical fluorite. *U.S. Bur. Mines Info. Circ.* 6468, 17 p.

LIEBER, W. (1990) *Calcit, Baustein des Lebens.* Munich: Münchener Mineralientage Fachmesse GmbH, 112 p., illust. (col.).

McCALLIE, S. W. (1907) A preliminary report on the marbles of Georgia. *Geol. Survey GA Bull.* 1, 126 p., pls., maps. Second edit.

McMACKIN, C. E. (1979) Calcite onyx. *Lapidary J.* 33, 11, p. 1824–1828, illust.

MERRILL, G. P. (1895) The onyx marbles: their origin, composition, and uses, both ancient and modern. *U.S. Nat. Mus. Ann. Rept. for 1893*, p. 539–585, illust.

______, (1895–1896) The onyx marbles, etc. *Stone* 11, p. 495–502; 12, p. 1–8, 116–121, 228–236, 326–330, 425–429, 559–564; 13, p. 9–12, 116–120. Plates 5–18.

MOORE, F. H. (1935) Marbles and limestones of Connecticut. *CT Geol. Nat. Hist. Survey Bull.* 56, 56 p., 14 pls.

PERKINS, G. H. (1933) The marble industry of Vermont. *VT State Geologist 18th Rept. 1931–32*, p. 1–315, 52 figs.

POUGH, F. H. (1989) Mineral notes: calcite. *Lapidary J.* 43, 1, p. 22–26.

VAN LANDINGHAM, S. L. (1962) Marble. *Gems & Minerals* 302, p. 30–32, 34–37.

NEWFOUNDLAND. Sabina (1976) notes various occurrences of attractive, lapidary quality marble in outcrops along both the north and south sides of the entrance to Canada Bay, located on the east side of the Great North Peninsula near its north end. Marble is also found in Limestone Junction Quarry, overlooking Humber River not far from Corner Brook; the material is much fractured but the pieces are large enough for most lapidary purposes. Similar material is found in the Dormstone Quarry near Corner Brook, and at Doncers Brook near Sops Arm near the south end of White Bay on the north shore of the Great North Peninsula.

SABINA, A. P. (1976) Rocks and minerals for the collector: the Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, 199 p., illust., maps.

TRAILL, R. J. (1983) Catalogue of Canadian minerals. *Geol. Survey Canada Paper* 80-18, 432 p., map.

ONTARIO. Astonishingly beautiful optical effects were obtained in faceted, colorless calcite crystals removed from the Faraday Mine, Faraday Township, Hastings County (as large twinned crystals). As mentioned before, the twinning and the large double-refraction work together to disperse light into its color components. In some of the larger faceted gems the variety and richness of the color sparks reminds one of the dispersion in diamond, or even a clear colorless opal of the Mexican type in which the colors appear to be suspended in the transparent body of the gem. An exceptionally large faceted stone of this material, cut by Arthur Grant of Hannibal, New York, weighs 1,156 carats (Hurlbut & Francis, 1984).

In Lanark County, Sabina (1987) describes several marble quarries that produce fine-grained carving stone, notably the Angelstone (Tatlock) and Omega quarries, located close to each other about 20 km (12.5 mi) northwest of Lanark. Other marble sources are also to be found in the vicinity of Madoc (Adams & Barlow, 1910; Parks, 1914).

ADAMS, F. D. & BARLOW, A. E. (1910) Geology of the Haliburton and Bancroft areas, Province of Ontario. *Canada Geol. Survey Mem.* 6, 419 p., maps.

HURLBUT, C. S. & FRANCIS, C. A. (1984) An extraordinary calcite gemstone. *Gems & Gemology* 20, 4, p. 222–225, illust. (col.). Explains causes of colors.

SABINA, A. P. (1987) Rocks and minerals for the collector: Hull-Maniwaki, Quebec; Ottawa-Peterborough, Ontario. *Geol. Survey Canada Misc. Rept.* 41, 141 p., illust., maps.

NORTHWEST TERRITORIES. Dolomitic marble has been quarried for carving purposes by the Inuit at sites east of Chantry Inlet, lat. 68°04' N, long. 93°09' W in the Murchison River district; also at a place north of Victoria Headland.

GEBERT, J. (1992) *Assessment of lapidary and carving-stone sites, etc.* NWT Dept. Energy, Mine and Petrol. Resources, [19] p., maps.

MANITOBA, SASKATCHEWAN, ALBERTA.

PARKS, W. A. (1915) Report on the building and ornamental stones of Canada. Vol. IV. Provinces of Manitoba, Saskatchewan, and Alberta. *Canada Dept. Mines, Mines Br.* No. 388, 333 p., illust. (col.). Marbles, and limestones.

PUGH, F. (1935) Manitoba tapestry limestone. *Canad. Met. Bull.* 28, 274, p. 117–121, illust.

ALASKA. There are numerous deposits of marble on the mainland and on some of the islands of Southeastern Alaska (Schoonover, 1964; Soeldner, 1974). Gary A. McWilliams of Wrangell collected pebbles of calcified corals on beaches of Prince of Wales and Kuiu islands, Southeastern Alaska. They all polished handsomely and clearly displayed the coralline structures. Coarse-figured *Hexagonaria* was found on Prince of Wales Island, as well as a favosid coral displaying a fine tubular structure. Kuiu Island produced coral showing the large circular structures of *Zathrensis* coral.

BURCHARD, E. F. & CHAPIN, T. (1920) Marble resources of Southeastern Alaska. *USGS Bull.* 682, 118 p., illust. (col.), maps.

SCHOONOVER, M. (1964) Sourdough rockhounding. *Lapidary J.* 18, 1, p. 164–169, illust.

SOELDNER, M. (1974) Minerals and fossils in Southeast Alaska. *Lapidary J.* 28, 5, p. 871–875.

BRITISH COLUMBIA. Many localities for decorative limestones and marbles are given in the following references but that of Parks is the most complete and best illustrated.

DANNER, W. R. (1976) Gem materials of British Columbia. *Montana Bur. Mines Geol. Spec. Publ.* 74, p.157-169, illust.

DAWSON, G. M. (1889) *The Mineral Wealth of British Columbia.* Montreal, QUE: Geol. Nat. Hist. Survey Canada, 163 p.

PARKS, W. A. (1917) Report on the building and ornamental stones of Canada. Vol. V. Province of British Columbia. *Canada Dept. Mines, Mines Br.* No. 452, 236 p., illust. (col.).

SABINA, A. P. (1965) Rock and Mineral collecting in Canada. Vol. I. Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps.

NEW YORK. Splendid, colorless facet-grade crystals of twinned calcite are found in a zinc mine at Balmat, St. Lawrence County, about 10 mi (15.2 km) southeast of Gouverneur. From them, Arthur Grant of Hannibal, New York, cut spectacularly colorful faceted gems of large size, as previously noted under ONTARIO. Two large gems weigh 1,077 and 1,830.65 carats respectively; also an outstanding cushion brilliant of 1,842 ct is now in the collection of the New York State Museum in Albany (Schimmrich & Campbell, 1990). Another Balmat gem is a delicate pink stone of 61.95 ct. Wight & Wight (1989), who describe the cutting efforts of Grant, note that the New York Museum stone is named the "Robinson Calcite," after Dr. George Robinson of the National Museum of Canada. A photograph of a faceted octagonal calcite cut by Grant is shown by Stripp (1988); it weighs 1,077 carats and was first exhibited at the Tucson Show in 1986.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum gem collection catalogue. *Open File Rept.* 8m106, 47 p.

STRIPP, D. M. (1988) The soft touch. *Lapidary J.* 42, 6, p. 20–22, 26–28, 30–36, illust. (col.).

WIGHT, Q. & WIGHT, W. (1989) Art Grant: a cut above the rest. *Canad. Gemm.* 10, 4, p. 98–101.

VIRGINIA. Penick (1992) compiled the following notes on lapidary grade calcite and its stone varieties. In Appomattox County, a pink and white marble provides attractive color patterns even in small ornamental objects. It is found in the Appomattox Lime Company's quarry near Oakville. In Rockingham County, clear, optical grade calcite suitable for faceted gems is found near Timberville. Also in this county, and in Botetort and Rockbridge counties, commercial quantities of fibrous, translucent brownish "cave onyx" have been quarried and manufactured into souvenir items. A black, white-veined, attractive limestone is found in a quarry at the northern limit of the city of Harrisonburg in Rockingham County. White to pinkish marbles occur at several places in Rockingham County, as at Poages Run, near Fancy Hill, where an outcrop offers unlimited quantities, and similar material on the Junior Martin Farm near Wesley Chapel, and lastly, pink limestone on Maury River, near Rockbridge Baths on the south side of State Highway 39.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

MICHIGAN. Petoskey stone, the attractively patterned calcite replacement of coral, has been officially designated the state stone of Michigan. It continues to be abundant on long stretches of northern Michigan beaches; despite collecting for decades, the supply of waterworn pebbles of this fossil limestone appears limitless. The beach area extends from Little Traverse Bay to Alpena and on lake shores in between (Zeitner, 1988). According to Heinrich (1976), the replaced coral is the species *Hexagonaria percarinata*, a Devonian reef coral which commonly is found in the limestones of Charlevoix, Emmet, Cheboygan, Presque Isle, and Alpena counties. The lapidary treatment of this material is explained by Blomberg (1972).

BLOMBERG, I. (1972) *All About Petoskey Stone.* Priv. publ., 20 p., illust.

BRADLEY, K. (1959) Notes on Petoskey stones. *Lapidary J.* 13, 1, p. 134–137.

COURTER, W. E. (1977) Michigan's favorite gemstones. *Lapidary J.* 31, 1, p. 150–158, *passim*, illust.

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Bull.* 6, 225 p., illust.

HUDSON, S. (1987) Michigan Petoskey stone. *Rock & Gem* 17, 10, p. 16–19, map.

KIRKBY, R. A. (1962) Beachcombing for fossils that polish. *Gems & Minerals* 296, p. 20–21, illust.

MICHIGAN MINERALOGICAL SOCIETY (1947) Mineral collecting in the Lower Peninsula of Michigan. *Publ. No. 2*, 16 p., illust.

ROHN, K. H. (1985) The land of the Petoskey stone. *Gems & Minerals* 569, p. 28–30.

SCHULZE, N. E. (1972) Collecting Michigan's Petoskey stone. *Gems & Minerals* 416, p. 26, 43, illust., map.

ZEITNER, J. C. (1988) *Midwest Gem, Fossil and Mineral Trails, Great Lakes States.* Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps.

IOWA. Horick (1974, p. 18) briefly describes "cave onyx," a brownish, banded calcite rock suitable for lapidary purposes which is found in caverns in Winneshiek and Dubuque counties, also along Great River Road leading into Buena Vista, Clayton County. Fibrous "satin spar" calcite has been found in the Ste. Genevieve limestone (Pella Beds), about 2.5 mi (4 km) due south of Pella in Marion County (p. 21). Massive calcite replacements of coral are also found which can be readily cut and polished into slabs, plaques, bookends, and the like, and are even useful for cabochons. The material displays the same markings of *Hexagonaria* as are so familiar in the Petoskey stone of Michigan. Horick (p. 21) notes that it is "widespread in the Cedar Valley Formation along the Iowa and Cedar River valleys and quarries in Black Hawk, Buchanan, Benton, Cedar, and Johnson counties." Specific collecting sites are given by Rose (1967). Calcite sometimes replaces wood, and a dark-colored type is found in many coal strip mines in Marion, Mahaska, and Monroe counties.

HORICK, P. J. (1974) The minerals of Iowa. *IA Geol. Survey Educ.* Ser. 2, 88 p., figs., photos (col.).

ROSE, J. N. (1967) The fossils and rocks of Eastern Iowa. *IA Geol. Survey Educ.* Ser. 1, 147 p., figs., plates.

TEXAS. In an area north of Brownwood, Brown County, the limestone is rich in fossils, especially bryozoa and corals, the more solid masses furnishing excellent lapidary material for larger cabochons, carvings and ornamental objects (Dalquest, 1976). Both Simpson (1958) and Mitchell (1991) describe handsome ornamental limestone that is well patterned with fossils, in Coryell County in the area generally between Gatesville, Moody, and McGregor; material is obtained from road cuts and other exposures along the highways. Towner (1972, 1974) describes handsome crinoidal limestone from the C. B. Lambert Ranch, southwest of San Saba, San Saba County. This locality is also described by Simpson (1958).

DALQUEST, W. W. (1976) Fossil gemstone bryozoa and coral from Central Texas. *Lapidary J.* 30, 9, p. 2152–2157, illust.

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA. Gem Guides Book Co., 104 p., illust., maps.

SIMPSON, B. W. (1958) *Gem Trails of Texas.* Dallas, TX: Newman Stationery, 88 p., illust., maps.

TOWNER, J. M. (1972) Crinoids in black limestone, San Saba, Texas. *Lapidary J.* 26, 4, p. 580–592, *passim*, illust.

______, (1974) Crinoids and opal in the heart of Texas. *Lapidary J.* 28, 5, p. 832–836, illust.

ZEITNER, J. C. (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps.

MONTANA. No new developments.

MANSFIELD, G. R. (1933) Some deposits of ornamental stones in Montana. *USGS Circ.* 4, 22 p.; calcite onyx.

COLORADO. A very fine-grained white marble, claimed to be equal if not superior to the finest Carrara marble for statuary purposes, has been quarried for many years from a huge deposit along Yule Creek, just south of the small town of Marble, Gunnison County. The quarry is actually an opening underground penetrating the side of Whitehouse Mountain (Voynick, 1993). This deposit provided the marble for the columns of the Lincoln Memorial in Washington, D.C., and other important monuments and buildings in the capital and elsewhere in the United States. Most of the marble, still much in demand for carvings and sculpture, is pure white, but there is also a range of delicately tinted marbles in hues of pink, yellow, etc. The marble beds along Yule Creek were discovered in 1873, and by the late 1880s active quarrying was well established. After many years of profitable operation, the quarries were abandoned for a long period, but lately work has been resumed by the Colorado-Yule Marble Company, who ship most of the large blocks to Italy for sectioning and finishing. The best statuary-grade rock fetches $30 per cubic foot, and some is utilized by Colorado sculptors (Voynick 1993). The history of the marble industry and the town that supported it is told in excellent detail in McCollum (1992) and earlier by Vandenbusche & Myers (1970).

McCOLLUM, O. (1992) *Marble, a town built on dreams.* Sundance, 352 p., illust.

VANDENBUSCHE, D. & MYERS, R. (1970) *Marble, Colorado: city of stone.* Denver, CO: Golden Bell Press, 227 p., illust., maps.

[VOYNICK S.] (1993) Yule marble. *Compressed Air Mag.* 98, 2, p. 6–13, illust.

WYOMING. Osterwald, *et al* (1966) reported mottled brown onyx marble of "pleasing appearance" from the Jay Em Stone and Gem Shop quarry, T29N, R63W, and a variegated reddish to whitish marble quarried in Muskrat Canyon, T30N, R65W, Goshen County. In Platte County, Sutherland (1990) reported banded, white, white and brown, and greenish calcite onyx that has been quarried in several places in the Hartville Formation and in the Guernsey limestone in Secs. 1, 2, 10, 11, 15, T27N, R66W; Sec. 36, T28N, R66W; and Sec. 29, T29N, R65W. Osterwald, *et al* (1966) also note the commercial production of onyx marble from a limestone cavern deposit near Hartville: "the onyx was obtained from stalactites and stalagmites." They also state that a rich, amber-colored onyx was once quarried near Cokeville, Lincoln County; the stone was used for building purposes and "compared quite favorably with Mexican onyx."

OSTERWALD, F. W., *et al* (1966) Mineral resources of Wyoming. *Geol. Survey WY Bull.* 50, 287 p., illust.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectables in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., pocket maps.

UTAH. A high quality white calcite onyx, attractively banded in red, much sought by lapidaries,

FIGURE 16. A variety of objects fashioned from the Picasso marble found in Beaver County, Utah. *Courtesy Lita R. Smith-Gharet, Steel Eagle Mining Co., Tigard, OR.*

comes from a deposit on Mt. Nebo, about 12 mi (19 km) by road northeast of Nephi, Juab County (Spendlove, 1978, 1987; Mitchell, 1984, 1987).

An exceptionally handsome marble, noted for its numerous dark veinlets forming abstract, almost geometrical patterns against light tan or light gray to reddish and purplish backgrounds, is called by its miner "Picasso marble." It is produced from shallow surface workings in the Mineral Range, Beaver County, near Minersville, by the claim owner and marketer, Lita R. Smith-Gharet of the Steel Eagle Mining & Manufacturing Company, Tigard, Oregon. According to Smith-Gharet (1990), the marble occurs in a narrow layer, 12–20 in (30–75 cm) wide in a contact zone where an overlying limestone rests upon granite. The numerous criss-cross veinlets suggest that the marble was formed by local metamorphism and then repeatedly fractured and the thin openings filled in with pigmented calcite. Another marble produced by this company is called "Zebra marble" because of its striking pattern of alternating black-and-white stripes. Some of it tumbles satisfactorily and accepts dyes.

MITCHELL, J. R. (1984) Nephi red onyx. Rock & Gem 14, 12, p. 32–35, illust. (col.), map.

_____, (1987) *Gem Trails of Utah.* Baldwin Park, CA: Gem Guides Book Co., 111 p., illust. (col.), maps.

SMITH-GHARET, L. R. (1990) "Picasso" marble. *Lapidary J.* 44, 4, p. 65–70, *passim*, illust. (col.).

SPENDLOVE, R. (1978) Salt Creek onyx. *Rock & Gem* 8, 9, p. 52–55, map.

_____, (1987) Red-banded onyx. *Lapidary J.* 41, 8, p. 45–47, 50, illust. (col.).

NEVADA. At one time an excellent quality building marble was quarried from extensive beds in the Bare Mountains, south-southeast of Beatty, Nye County. The place and settlement was called Carrara, after the famous Italian marble source. Active quarrying took place in the early 1900s, but by the 1920s all work had ceased and the town and quarries were abandoned (Strong, 1968).

STRONG, M. F. (1968) Marble at Old Carrara. *Gems & Minerals* 366, p. 18–20, illust., map.

ARIZONA. Excellent banded calcite onyx has been found in a number of places in the state, and the deposits are far from exhausted. Blair (1992) gives directions for collecting this material near Kingman, Mayer, Superstition Mountains (marble), near Carefree (Cave Creek), and near Wenden. Paige (1909) describes white marbles from the Chiricahua Mountains of Cochise County. Another old reference is that by Merrill (1893) on the famous Cave Creek deposits in Maricopa County. Other guides to collecting sites appear in the references below.

BLAIR, G. (1992) *The Rockhound's Guide to Arizona.* Helena, MT: Falcon Press, 165 p., illust. (col.), maps.

McKEE, E. D. (1946) Onyx marble in northern Arizona. *Plateau* 10, 1, p. 9–14.

McMACKIN, C. A. (1977) Onyx Peak adventure. *Rockhound* 6, 6, p. 35–37, map. Tonto National Forest, north of Globe.

MERRIAM, R. (1988) *Arizona Minerals and How to Find Them.* Tucson, AZ: Treasure Chest Publs., 73 p., maps. Mayer & Cave Creek.

MERRILL, G. P. (1893) The onyx deposits of Cave Creek, Arizona. *Stone* 6, 3, p. 204–205.

_____, (1895) The onyx marbles. *U.S. Nat. Mus. Rept. for 1893*, p. 539–585, pls. Arizona p. 561–564.

MITCHELL, J. R. (1980) An onyx foursome. *Gems & Minerals* 511, p. 38–41, 48, maps. Mayer, Ash Fork, Globe, and Wenden.

_____, (1980) The abundant onyx of Mayer Junction. *Rockhound* 8, 6, p. 14–15, map.

PAIGE, S. (1909) Marble prospects in the Chiricahua Mountains, Arizona. *USGS Bull.* 380, p. 299–311, map.

PEPPER, S. J. (1982) A Carefree adventure. *Lapidary J.* 36, 6, p. 1104–1105, map.

SIMPSON, B. W. (1984) *Gem Trails of Arizona.* 6th. rev. edit. Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps. Kingman onyx.

STRONG, M. F. (1962) Pink marble in Arizona. *Gems & Minerals* 296, p. 26–29, illust., map. Wenden locality.

CALIFORNIA. Interest in the considerable variety of calcareous rocks suitable for lapidary purposes has lately risen because of a parallel rise in the hobby of sculpture, from small, delicate animal carvings, to pieces of large "studio" size. As can be seen from the recent references to collecting this material, amateur lapidaries continue to be active quarriers of onyxes, marbles, and limestones. Notable deposits available to collectors include the Rainbow Mine in Inyo County, which furnishes colorful banded onyx in yellowish, brownish, and reddish bandings from a deposit about 22 mi (35 km) east of Tecopa (French, 1978; Perry, 1983). Another popular fee-collecting site for banded calcite onyx is the Aquarius Travertine Mine, about 15 mi (24 km) north of Trona in San Bernardino County, and the nearby Onyx Mine (Mitchell, 1981, 1986, Perry, 1985). Furthermore, Perry (1982) describes brownish, banded onyx from Pipes Canyon, west of Pioneertown in San Bernardino County. Another locality for onyx, called "strawberry onyx," is given by Perry (1983) as northeast of Ludlow, about 17 mi (27 km) by road. An onyx deposit is described by Laymon (1985) upon a claim maintained by the Sierra Pelona Club at a place about 5 mi (8 km) north of Highway 58 between Mojave and Boron, Kern County. The long out-of-print *Bulletin* 38 of the California State Mining Bureau cites numerous localities for all of the calcareous building and ornamental stones.

BERKHOLZ, M. F. (1956) Marble and memories of Ballarat. *Gems & Minerals* 229, p. 36, 38, 40, map.

_____, (1956) Verde antique and garnet. *Gems & Minerals* 230, p. 22–24, illust., map. Sidewinder Mountains.

_____, (1961) Aragonite in Holcomb Valley. *Gems & Minerals* 287, p. 14–16, illust., map. This material is probably calcite onyx.

CALIFORNIA STATE MINING BUREAU (1906) The structural and industrial minerals of California. *Bull.* 38, 412 p., illust. Numerous sites.

COLE, O. N. (1974) Aquarius travertine—a rockhound's treasure. *Rockhound* 3, 1, p. 21–22, illust.

FRENCH, B. (1978) Gemstone discovery in the desert. *Gems & Minerals* 486, p. 10, 11, 73, 74, illust. Rainbow Mine, Inyo County.

GEMS & MINERALS (1957) Arroyo Grande travertine. No. 243, p. 46, map. San Luis Obispo County.

HAINES, S. (1960) Fabulous Lake County. *Gems & Minerals* 270, p. 32, 34, 36. "Pillsbury onyx," near lake of same name.

HENLEY, R. F. (1948) Onyx quarry at Tolenas Springs, California. *Rocks & Minerals* 23, 11/12, p. 913.

LAYMON, A. (1985) The Sierra Pelona Club travertine claim. *Gems & Minerals* 577, p. 16–19, map.

LISLE, T. O. (1946) Banded aragonite and wavy onyx at Fairfield, California. *Rocks & Minerals* 21, 10, p. 659.

MERRILL, G. P. (1895) The onyx marbles. *U.S. Nat. Mus. Rept. for 1893*, p. 539–585, illust. Near Musick, San Luis Obispo County.

MITCHELL, J. R. (1981) Panamint onyx. *Rock & Gem* 11, 7, p. 48–51, map.

_____, (1986) *Gem Trails of California*. Rev. edit. Baldwin Park, CA: Gem Guides Book Co., 159 p., illust., maps.

PACK, R. W. (1914) Ornamental marble near Barstow, California. *USGS Bull.* 540, p. 363–368.

PEMBERTON, H. E. (1983) *Minerals of California*. NY: Van Nostrand Reinhold, 591 p., illust., maps. Onyx in Colusa and Inyo counties.

PERRY, L. E. (1982) Pipes Canyon onyx. *Rock & Gem* 12, 1, p. 36–39, map.

_____, (1983) Inyo rainbow "onyx." *Rock & Gem* 13, 4, p. 52–55, maps.

_____, (1983) Strawberry onyx. *Rock & Gem* 13, 5, p. 56–59, map.

_____, (1985) The Aquarius Travertine Mine. *Gems & Minerals* 574, p. 38–40, map.

SCHWEITZER, C. G. (1954) California onyx locality. *The Mineralogist* 22, 3, p. 99–100, illust. Arroyo Grande locality.

STRICKLER, C. (1972) Candy colored onyx mountain. *Desert Magazine* 35, 11, p. 34–37, illust. Death Valley site.

STRONG, M. F. (1967) Collecting along Furnace Creek Wash. *Gems & Minerals* 363, p. 20–21, map. Death Valley, Inyo County.

_____, (1972) Sidewinder Mountains marble quarries. *Ibid.* 413, p. 28–29, map. North of Victorville.

_____, (1973) "Queen's lace" travertine. *Desert Magazine* 36, 6, p. 14–18, illust., map. Inyo County.

BAJA CALIFORNIA NORTE. In recent years, quarried onyx blocks from the famous El Marmol deposit were shipped north to San Diego, California, by truck for processing, but lately the quarries have lain dormant.

JOHNSON, P. W. (1969) El Marmol. *Gems & Minerals* 387, p. 36–39.

KRUTCH, J. W. (1962) The onyx of El Marmol. *Pacific Discovery* 15, 1, p. 20–21.

MERRILL, G. P. (1893) A new source of Mexican onyx. *Science*, April 21, p. 221.

_____, (1894) The onyx marbles. *U.S. Nat. Mus. Rept. for 1893*, p. 539–585, illust. Much information on Baja onyx.

_____, (1897) Notes on the geology and natural history of the peninsula of Lower California. *U.S. Nat. Mus. Rept. for 1895*, p. 969–994, illust., map.

MERRILL, G. P. (1897) *Stones for Building and Decoration*. NY: John Wiley, 2nd edit., 506 p., illust. Baja onyx p. 158–159.

SHEDENHELM, W. R. C. (1976) El Marmol. *Rock & Gem* 6, 6, p. 48–51.

_____, (1980) *Rockhounding in Baja*. Glendale, CA: La Siesta Press, 48 p., maps. Onyx p. 26–31, *passim*.

WALKER, C. (1970) The onyx and opal cutting industry in Baja California. *Lapidary J.* 24, 1, p. 280–284, illust.

COAHUILA. No new developments.

ORDONEZ, E. (1901) The onyx marble deposits of Jimulco, Coahuila. *Soc. Cientifica "Antonio Alzate," Memorias* 15, p. 381–385.

_____, (1905) Los criaderos de marmol-onix de la hacienda de Jimulco. *Secretaria de Fomento, Mexico, Bol.* 2, 5, II, p. 164–174.

PUEBLA. The finest, most colorful banded calcite onyx that Mexico produces is generally conceded to be that found in various places in the region southeast of Puebla between Tecali, Tzicatłacoya, and Tepene, according to Merrill (1897, p. 153). He further remarks on the lore that surrounded this material in the time of the Aztecs, and provides useful remarks on the quarrying and processing of the stone, including notes on various falsifications and deceptive practices by which defective or low-grade material is enhanced. Earlier remarks on the industry were made by Ramirez (1884), while recent visitors tell us that the industry is very much alive and prospering, as may be judged in the accounts of Barbour (1964) and Burton (1976).

The finest material came from the La Pedrara deposit, located about 21 mi (33 km) from Puebla in the Tecali district, where a relatively small area of outcropping onyx provides "very fine quality of green, ranging from a very light to very dark tint, and, as a rule, showing a slight dash of red or pink." The next most important deposit is Antigua Salines, Tehuacan district, and ranking third is La Sopresa, located about 35 mi (53 km) west of Antigua Salines in the same district. "The onyx from this quarry is semitranslucent, white, totally devoid of colors, save where an occasional mass of green is found." Another quarry is located at La Mesa, directly east of La Sopresa. This is a large quarry but the variegated onyx "lacks the brilliancy shown in the stone of Antigua Salines." Among other smaller workings, Merrill mentions those known as El Mogote, Lajas, Agua Esconda, Desamparo, Mehuantepec, Tepeyac, Tecoluco, La Paoma, and La Reforma. Puebla calcite onyx is very widely distributed, even throughout the world, and objects made from it are prized for their beauty without costing a great deal, as would the same pieces if made from harder stones.

BARBOUR, J. (1964) How the Mexicans work calcite onyx. *Gems & Minerals* 321, p. 14–18, illust.

BARCENA, M. (1874) Las rocas de Tecali. *La Naturaleza* 3, p. 7–9.

_____, (1876) The rocks known as Mexican onyx. *Acad. Nat. Sci. Phila. Proc.* 28, p. 166–168.

BURTON, L. W. (1976) The land of onyx. *Lapidary J.* 30, 6, p. 1422–1425, illust., map. Puebla region.

DE KALB, C. (1895) Marmoles-onix. *El Minero Mexicano* 27, nos. 11 & 12.

_____, (1896) Onyx-marbles. *Trans. Amer. Inst. Min. Eng.* 25, p. 557–569.

ENGINEERING AND MINING JOURNAL (1891) Mexican onyx mines. Vol. 52, 26, p. 729.

KASPER, J. (1949) Stone and gem cutting in Mexico. *The Gemm.* 18, p. 168–175.

LAWTON, E. M. (1910) Genesis and classification of Mexican onyx. *Mining & Scientific Press*, vol. 100, p. 791–792.

MAZA, F. DE LA (1966) *El alabastro en el arte colonial de Mexico.* Mexico, D. F.: Inst. Nac. Antropologia Historia, 146 p., illust.

MERRILL, G. P. (1894) The onyx marbles. *U.S. Nat. Mus. Rept. for 1893*, p. 539–585, illust.

_____, (1897) *Stones for Building and Decoration.* 2nd edit. NY: 506 p., illust. Mexican onyx p. 152–159.

RAMIREZ, S. (1884) *Noticias Historica de la Riqueza Minera de Mexico*, etc. Mexico: Oficina Tipo. Secretar. Fomento, p. 231–237. Onyx sources.

WITTICH, E. (1926) Los depositos de Tecal (onix-marmol) y las salinas de la region de Chila y Tulcinga, Estado de Puebla. *Soc. Cientifica "Antonio Alazate," Memorias y revistas* 45, 1-6, p. 115–128.

OAXACA. No new developments.

KEILHACK, K. (1907) Ueber das Onyxvorkommen von Etla, Oaxaca. *Internat. Geol. Congress X, Mexico, 1906, Comptes rendus*, p. 759–762.

COSTA RICA. No new developments.

DONDOLI, B. C. (1941) Piedras ornamentales de Costa Rica: marmoles y granitos. *Costa Rica Dept.*

Nac. Agricultura, Bol. tecnico, 37, ser. geol. 4, 10 p., illust.

CANCRINITE

GREENLAND. Most cancrinite that lapidaries cut into cabochons is typically orangey-yellow, but from Greenland comes a blue cancrinite, as reported by Koivula, *et al* (1993). The cancrinite occurs in nepheline syenite dikes at the head of Kagssortoq Fjord, just south of Skjoldungen Island, 63°14'N, 42°W. Several kilograms of the material were sent to Copenhagen for examination at the university, and a number of cabochons were cut from same, ranging in weight from 8.61 to 57.11 ct (40 x 22 mm). The cancrinite occurs intergrown with white to pale gray sodalite and albite and contains inclusions of calcite, hematite, mica, pyrite and rutile. The color is pale, slightly purplish blue, much lighter than the usual run of sodalite with which it might be confused. At the University of Copenhagen the following properties were determined: refractive indexes omega 1.499; epsilon 1.493, birefringence 0.006; specific gravity 2.43 ± 0.01; hardness 5–6. The cancrinite fluoresces dark red to purple under SW UV and dark violet under LW UV.

KOIVULA, J. I., *et al* (1993) Blue cancrinite from Greenland. Gem News. *Gems & Gemology* 29, 2, p. 131–132.

CANADA No new developments.

ADAMS, F. D. & BARLOW, A. E. (1908) The nepheline and associated syenites of eastern Ontario. *Trans. Roy. Soc. Canada* 2, sect. 4, p. 3–76, illust. maps.

______, (1910) Geology of the Haliburton and Bancroft areas, Province of Quebec, *Geol. Survey Canada Mem.* 6, 419 p., illust. maps.

BARLOW, A. E. (1897) On the occurrence of cancrinite in Canada. *Canad. Rec. Science* 7, p. 228.

FOYE, W. G. (1915) Nephelite syenites of Haliburton County, Ontario. *Amer. J. Sci.* 40, p. 413–436.

MAINE. The cancrinite associated with sodalite in a rock called "litchfieldite" (after the locality) has been collected from drift boulders on Dennis Hill and several small areas north of the hill in Litchfield, Kennebec County; a map for the locality is provided by Thompson, *et al* (1991, p. 42). Details on the history and mineralogy of this occurrence are given in King & Foord (1994, p. 71–72).

BAYLEY, W. S. (1892) Eleaolite-syenite of Litchfield, Me., etc. *Geol. Soc. Amer. Bull.* 3, p. 231–252, map.

CLARKE, F. W. (1886) The minerals of Litchfield, Maine. *Amer. J. Sci.* 31, p. 262–272; also in *USGS Bull.* 42, p. 28–38.

JACKSON, C. T. (1845) [On the minerals from Litchfield, Maine.] *Assoc. Amer. Geol. & Nat. Proc.* 6, p. 44–49.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

THOMPSON. W. B., JOYNER, D. L., WOODMAN, R. G. & KING, V. T. (1991) A collector's guide to Maine mineral localities. 2nd edit. *Maine Geol. Survey Bull.* 41, p. 42, illust., map.

CARLETONITE

QUEBEC. Among the rarest of minerals that have been faceted into gems is carletonite, a beautiful blue mineral of complex composition, formula $KNa_4Ca_4Si_8O_{18}(CO_3)_4(OH,F)\cdot H_2O$, hence a potassium-sodium-calcium silicate-carbonate. Its beautiful vivid blue square prismatic crystals are found large enough to facet small gems only in the St. Hilaire quarries. According to Wilson (1988), Gilles Haineault, a mineral collector of Quebec, found a large mass of carletonite in the wall of the Poudrette Quarry, and within this mass a vug was lined with euhedral crystals more than 2 cm long, from some of which faceted gems of fine blue color were cut to several carats weight. Horvath & Gault (1990) note that these crystals are of a "most attractive, vivid, cornflower-blue color," with some crystals as much as 5 cm (2 in) long, but only the terminations containing clear material. They record a dark blue faceted gem of 0.24 ct. Pough (1989) records a faceted gem of 1.48 ct. Guy Langelier of Montreal informs me that he has two blue carletonite faceted gems, one of 1.48 ct but with inclusions, and another of 0.34 ct that is clean (*Pers. comm.* 10/15/1993). Recently I was told that a 0.18 ct carletonite faceted stone was offered @ $270.00 or $1,500.00/ct.

The carletonite finds were made in the period 1983–1987, although the mineral was described earlier in 1971 and 1972. Properties of this mineral are given by Mandarino & Anderson (1989): tetragonal, uniaxial(-); refractive indexes omega 1.521, epsilon 1.517; weakly pleochroic, but darker crystals show strong pleochroism in blue and pinkish-brown; perfect basal cleavage, and good prismatic cleavage; specific gravity 2.45. The cleavages and softness of the mineral require the utmost care on the part of the cutter if he or she is to do more than reduce a fine crystal to a mass of shreds.

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont Saint-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 281–359, illust.

KOIVULA, J. I., *et al* (1992) Rare gemstones from Quebec, by E. Fritsch in: Gem News. *Gems & Gemology* 28, 2, p. 134.

MANDARINO, J. A. & ANDERSON, V. (1989) *Monteregian Treasures: The Minerals of Mont Saint-Hilaire, Quebec.* NY: Cambridge Univ. Press, 281 p., illust. (col.), p. 52.

POUGH, F. H. (1989) Carletonite. Mineral Notes. *Lapidary J.* 43, 4, p. 16–18.

WIGHT, W. (1993) Check-list for rare gemstones–carletonite. *Canadian Gemm.* 14, 1, p. 14–17.

WILSON, W. E. (1988) What's new in minerals? *Min. Rec.* 19, 3, p. 209.

CASSITERITE

YUKON TERRITORY. According to Sabina (1965), the term "Yukon diamond" has been applied locally to polished massive fibrous cassiterite of the "wood tin" variety. The nodules are found in various streams, with Dominion Creek in the Dawson area mentioned as a good source of rough.

SABINA, A. P. (1965) Rock and mineral collecting in Canada. Vol. I. Yukon, etc. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps. p. 14.

MEXICO. No new developments.

FOSHAG, W. F. & FRIES, C. (1942) Tin deposits of the Republic of Mexico. *USGS Bull.* 935-C, p. 99–176, maps. Wood tin.

______, (1946) Los yacimientos de estano de la Republica Mexicana. *Comite Directivo para la Investigacion de los Recursos Minerales de Mexico, Bol.* 8, 66 p., maps.

NEWHOUSE, W. H. & BUERGER, M. J. (1928) Observations on wood tin nodules. *Econ. Geol.* 23, p. 185–192.

SMITH, W. C., SEGERSTROM, K. & GUIZA, R. (1950) Tin deposits of Durango, Mexico. *USGS Bull.* 962-D, p. 155–204, plates, maps. Sources of wood tin.

CATAPLEIITE

QUEBEC. This hydrous zirconium silicate, formula $Na_2ZrSi_3O_9 \cdot H_2O$, has been found in small, transparent colorless crystals at Mont St.-Hilaire. Some crystals are large enough to afford faceted gems of less than one carat (Henn & Redmann, 1991). Although Mandarino & Anderson (1989) state that the mineral is common, apparently clear areas in the crystals are rare. Horvath & Gault (1990) do not mention faceted stones. Properties are: pseudo-hexagonal monoclinic, biaxial (+); refractive indexes alpha 1.588, beta 1.591, gamma 1.624; hardness 5½; specific gravity 2.774–2.812 (Mandarino & Anderson, p. 53). Henn & Redmann give alpha 1.590, beta 1.609, gamma 1.62, difference 0.039; specific gravity 2.72; hardness 6. There is a perfect basal cleavage. Guy Langelier of Montreal notes that the average size of the colorless faceted gems is under one carat, but he owns a gem of 1.86 ct (*Pers. comm.* 10/15/1993).

HENN, U. & REDMANN, M. (1991) Geschliffener, klar durchsichtigen, farblosen Katapleit vom Mont Saint-Hilaire, Kanada. *Zs. Dt. Gemmol. Ges.* 40, 4, p. 197–200, illust.

MANDARINO, J. A. & ANDERSON, V. (1989) *Monteregian Treasures: the Minerals of Mont Saint-Hilaire, Quebec.* NY: Cambridge Univ. Press, 281 p., illust. (col.).

WIGHT, W. (1992) Check-list for rare gemstones—catapleiite. *Canadian Gemm.* 13, 2, p. 46–49.

CATLINITE

Catlinite now enjoys a revival in its application to carving by others besides American Indians because of its fine texture, uniformity, and ease of working and finishing. The original deposit in the Pipestone National Monument in Minnesota continues to be quarried, and the catlinite is carved into a large variety of objects and ornaments by members of the Pipestone Indian Shrine Association, headquartered in the monument, who issue a color brochure showing their wares, and a price list for same. As of October, 1994, they offered a variety of ceremonial pipes in small and large sizes ranging in price from $30 to $560, while many kinds of small articles such as necklaces, pendants, earrings, animalistic carvings, bolas, and pen bases sold for from $4.25 to $80. Additionally, freshly dug catlinite that occurs outside the monument at a place several miles south of Pipestone is being worked by Jak of Ihken, Minnesota, whose factory produces numerous forms of pipes, plain or with images, and also inlaid with lead, as well as effigies, paperweights, and personal ornaments. The largest and most elaborate carvings may fetch as much as $200. The rough is sold in layer sections from one-half to three inches (1.25–7.5.cm) thick, rarely up to ten inches (25.5 cm) thick, and weighing five to one hundred pounds (2.3–45 kg), for from $1.25 to $3.00 per pound. Comparable material, sold by Jetco Enterprises, Ltd., of Scottsdale, Arizona, in 1976, was offered in wholesale lots at $5.00 per pound for jet and from $.85 to $1.25 per pound for pipestone, depending on amount ordered.

An interesting and invaluable use of catlinite in early high-pressure experimentation by Percy Bridgman that ultimately led others to succeed in making diamonds is recorded by Hazen (1993, p. 51, 102–3). Bridgman found that of all materials tested, the catlinite best produced seal rings that kept in the necessary high pressures without leaking. The best such rings were made from "Sioux Indian pipestone, a soft, carvable rock," that in 1950, at the time of his work, was "the only satisfactory high-pressure gasketing material . . . high-grade Indian pipestone from quarries in Minnesota located on a Native American Reservation." It was later found that pyrophyllite rock from South Africa served even better, and this became the standard seal material.

The Minnesota occurrence, the quarries, their working, and the carving of the catlinite are well recorded by many visitors, especially Holmes (1919) and Winchell (1878). A recent visit to the monument is described by Musgrove (1980), while Spendlove (1986) describes the highly detailed and imaginative sculptures that are being produced from Arizona catlinite, especially by artisans of Sedona. The Arizona raw material probably comes from the deposits near Prescott that were described in Volume I. It is available in colors of purple, maroon, pink, and red, sometimes with spots of contrasting colors. Further information on this material is given in Spendlove (1990), along with remarks on carving techniques.

BARBER, E. A. (1883) Catlinite, its antiquity as a material for tobacco pipes. *Amer. Naturalist* 17, p. 245.

BARRETT, S. A. (1926) Field studies for the catlinite and quartzite groups. *Mus. City of Milwaukee, Yearbook Publ.*, 1924, p. 7–21.

______, (1935) Prehistoric mining in the Southwest. *Mus. North. Arizona, Mus. Notes* 7, 10, p. 41–44. Catlinite in Arizona.

BARTLETT, K. (1939) A prehistoric "mine" of red argillite, resembling pipestone, near Del Rio, Arizona. *Mus. North. Ariz., Mus. Notes* 11, 12, p. 75–78.

BERG, E. L. (1938) Notes on catlinite and the Sioux quartzite. *Amer. Mineral.* 23, p. 258–268.

BROUGHTON, P. L. (1973) The catlinite quarries of southwestern Minnesota. *Earth Science* 26, p. 126–130.

BROWN, C. E. (1914) A Wisconsin catlinite quarry. *Wisc. Archeologist* 13, p. 80–82.

CATLIN, G. (1841) *Eight years among the North American Indians.* Catlinite of the Midwest, vol. 2, p. 164.

COE, J. C. (1971) A monument to a stone. *Lapidary J.* 25, 8, p. 1072, 1074, illust. (col.). Pipestone National Monument.

HAYDEN, F. V. (1867) [On the pipestone quarries of Dakota.] *Acad. Nat. Sci. Phila. Proc. for 1866*, p. 291–292.

______, (1867) Sketch of the geology of northeastern Dakota, with a notice of a short visit to . . . pipestone quarry. *Amer. J. Science* 43, p. 15–22.

HAZEN, R. M. (1993) *The New Alchemists: Breaking Through the Barriers of High Pressure*. NY: Times Books, Random House, 287 p., illust.

HEIKE, R. (1954) The Indians were rock hunters. *The Mineralogist* 22, 3, p. 101–103, illust.

HELLAND, J. A. (1954) Barron County, Wisc., pipestone locality. *Rocks & Minerals* 29, 7/8, p. 396–397.

HOLMES, W. H. (1892) Sacred pipestone quarries of Minnesota and ancient copper mines of Lake Superior. *Amer. Assoc. Advancement Science Proc.* 41, p. 277–279.

______, (1919) Handbook of aboriginal American antiquities. Part I. Introd., the lithic industries. *Smithson. Inst. Bur. Amer. Ethnol. Bull.* 60, 380 p., illust., maps. Catlinite p. 253–264, illust., maps.

HOWELL, D. H. (1940) Pipestone and red shale artifacts. *Amer. Antiquity* 756, 1, p. 45–62.

McGUIRE, J. D. (1899) Pipes and smoking customs of the American aborigines. *U.S. Nat. Mus. Ann. Rept. 1896–1897*, p. 351–645. Catlinite.

MUSGROVE, M. R. (1980) Pipestone. *Lapidary J.* 34, 5, p. 1174–1177, illust. Carving catlinite from Minnesota.

NELSON, D. K. (1994) Really smoking. *Lapidary J.* 48, 1, p. 73–84, *passim*, illust. How to carve catlinite.

NYDAHL, T. L. (1950) The Pipestone Quarry and the Indians. *Minnesota History* 31, 4, p. 193–208.

RANSOM, J. E. (1955) Peace pipe paradise. *The Mineralogist* 23, 1, p. 12, 14, 16. Pipestone, MN, and quarries.

SPENDLOVE, E. (1986) Arizona pipestone. *Rock & Gem* 16, 10, p. 36–39. From near Prescott.

______, (1990) Pipestone carvings. *Rock & Gem* 20, 9, p. 66–71. From Arizona material.

WEST, G. A. (1910) Pipestone quarries in Barron County. *Wisc. Archeologist* 9, p. 31–34.

______, (1934) Tobacco, pipes and smoking customs of the American Indians. *Milwaukee Public Mus. Bull.* 17, part 1.

WINCHELL, N. H. (1878) The geology of Rock and Pipestone counties. *Geol. Nat. Hist. Survey MN, 6th Ann. Rept. for 1877*, p. 93–111, maps. History, geology, mineralogy of the catlinite deposit.

______, (1884) The geology of Minnesota. Vol. I. *Final Rept. Geol. Nat. Hist. Survey MN*, 687 p., illust. (col.), maps.

WITTHOFT, J. (1949) Stone pipes of the historic Cherokees. *Southern Indian Studies.* Vol. 1, 2, p. 43–62.

WOODMAN, E. E. (1882) The pipestone of Devil's Lake. *Wisc. Acad. Sci. Arts Ltrs. Trans.* 5, p. 251–254.

WRAY, C. F. (1969) Stone pipes of the New York State Indians. *Lapidary J.* 23, 3, p. 492–498, illust. Many types of stone.

CELESTITE

ONTARIO. The Canadian Museum of Nature, Ottawa, includes in its gem collection a faceted orange Forks of Credit celestite weighing 3.11 ct (Wight, 1986).

NEW YORK. From a local limestone outcrop about 0.5 mi (0.8 km) below Chittenango Falls, Madison County, parallel-fibrous pale blue celestite has been found in seams that are sufficiently thick to yield cabochons showing a good cat's-eye effect (Young & Lenhard, 1989). Pale blue faceted gems of celestite from this area are in the New York State Museum, Albany and include five gems of various cutting styles ranging from 2.17 to 3.85 ct (Schimmrich & Campbell, 1990, p. 10).

POUGH, F. H. (1989) Mineral notes. Celestite. *Lapidary J.* 43, 5, p. 14, 16–18.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection catalogue. Albany: *Open file Report* 8m106, 47 p.

WIGHT, W. (1986) Canadian gems in the National Museum of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

YOUNG, J. R. & LENHARD, J. A. (1989) Cat's-eye celestite. *Lapidary J.* 43, 7, p. 59, 60, illust. (col.).

CERUSSITE

A lead carbonate, formula $PbCO_3$, cerussite is sometimes found in clear, colorless crystals which can be faceted, with difficulty, into striking, highly dispersive gems of considerable beauty (*see* Semmes, 1981). A white variety filled with extremely fine parallel tubular inclusions can be cut into cat's-eye gems displaying a sharp and strong streak of light. Arem (1987, p. 63, 64) gives the properties as follows: refractive indexes alpha 1.804, beta 2.076, gamma 2.079; birefringence 0.274; biaxial (-); specific gravity 6.55; hardness 3–3.5.

ARIZONA. Fine, strongly reflective cat's-eye cabochons of 2–6 ct have been cut from cerussite from the Mammoth-St. Anthony Mine, Tiger, Pinal County.

ANTHONY, J. W., WILLIAMS, S. A. & BIDEAUX, R. A. (1977) *Mineralogy of Arizona.* Tucson, AZ: Univ. AZ Press, 241 p., illust. (col.). p. 65–68.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.) p. 63–64.

SEMMES, J. L. (1981) How to facet cerussite. *Gems & Minerals* 521, p. 8, 14, illust.

CHABAZITE

BRITISH COLUMBIA. Vargas & Vargas (1985) report that small crystals of the chabazite variety *phacolite* from near Victoria have yielded very small colorless faceted gems.

VARGAS, G. & VARGAS, M. (1985) *Descriptions of Gem Materials.* 3rd edit. Thermal, CA: priv. publ., 180 p.

CHAMBERSITE

TEXAS. As a curiosity, faceted gems of one or two carats have been cut from this rare oxychloride, formula $Mn_3B_7O_{13}Cl$, which is obtained in cuttable crystals only from the Barber's Hill salt dome, Chambers County. The crystals are tetrahedral in form but orthorhombic in crystallization, occurring as single, glassy, sharp-edged individuals to about one-half inch across, of purplish-brownish color. According to Arem (1987, p. 64–65), the "cut stones are in a sense, truncated crystals with their surfaces polished." They are not fully transparent. Refractive indexes: alpha 1.732, beta 1.737, gamma 1.744; biaxial (+), birefringence 0.012; specific gravity 3.49. Surprisingly, the hardness is 7! Bank (1976) in his examination of chambersite, probably from the same source, found refractive indexes of 1.735, 1.740, and 1.745; birefringence 0.010; specific gravity about 3.50.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 245 p., illust. (col.).

BANK, H. (1976) Durchsichtiger Chambersit. *Zs. Dt. Gemm. Ges.* 25, 4, p. 219.

CHIOLITE

GREENLAND. Clear facet-grade material affording tiny gems comes from the famous cryolite deposit at Ivigtut in Southwest Greenland. Arem (1987, p. 65–66) gives the following properties for this fluoride mineral, formula $Na_5Al_3F_{14}$: refractive indexes omega 1.349, epsilon 1.342; birefringence 0.007; tetragonal, uniaxial (-); specific gravity 2.998; hardness 3.5–4. The locality is described by Petersen & Secher (1993, p. 29–36).

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 1–165, illust. (col.), maps.

CHLORASTROLITE

In Volume I of this work I noted the uncertainty surrounding the identity of chlorastrolite, remarking that "apparently no one has taken the trouble to determine its true identity." To some extent the mystery of its composition has been solved, as will be seen below. The stone, polished into cabochons, was first given its name by Whitney (1847) with more details furnished by Whitney in 1848. However, it was not until 1953 that Coombs published his essay on the pumpellyite mineral series in which he identified chlorastrolite as a variety of pumpellyite. As stated by Huber (1975, p. 59), "pumpellyite has been adopted as the only valid name for the mineral species, although chlorastrolite is still useful as a term to designate the variety with the peculiar crystal habit of the Isle Royale 'greenstone.'" In a paper that received very little notice, Williams (1957) studied chlorastrolite and concluded in his abstract that "chlorastrolite is a distinct mineral species and not a mixture. Zonochlorite has been shown to be identical with chlorastrolite." Williams further notes, however, that "the relations between pumpellyite and chlorastrolite are somewhat obscure, but it seems possible that they are closely related." In view of Williams' study, the most thorough study of chlorastrolite so far, I shall retain the name of chlorastrolite in this book, and many readers will join me in this preference, I am sure, especially since the name has been used to designate Michigan's "official gem" (Courter, 1974). The last reference, incidentally, contains an excellent historical review of chlorastrolite from its first identification to the present. Further highly interesting remarks on chlorastrolite appear in Huber *(Ibid.)* and Clarke (1980), the latter also giving historical notes and some of the surrounding lore, and noting that "gem quality stones larger than 1/2-inch are rarely ever found for sale, and a stone of gem quality larger than 3/4-inch is museum material." A price of $10.00/ct is commonly asked for stones of only several carats weight.

CARTER, L. (1969) Footnote on chlorastrolites. *Lapidary J.* 23, 7, p. 1026, 1027, illust.

CLARKE, J. R. (1980) Chlorastrolite—the Keweenawan gemstone. *Rock & Gem* 10, 9, p. 40–42.

COOMBS, D. S. (1953)The pumpellyite mineral series. *Mineralogical Mag.* 30, p. 113–115.

COURTER, E. W. (1974) The chlorastrolite now Michigan's official gem. *Lapidary J.* 28, 8, p. 1296–1301.

FOOTE, A. E. (1873) On zonochlorite, a new hydrous silicate from Neepigon Bay, north shore of Lake Superior. *Amer. Assoc. Adv. Science, Dubuque Meeting,* 21, p. 65–66.

HAWES, G. W. (1878) On zonochlorite and chlorastrolite. *Amer. J. Sci.* 10, p. 24–26.

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Dept. Nat. Resources, Geol. Survey Div. Bull.* 6, 225 p., illust. (col.), p. 171–174.

HUBER, N. K. (1975) The geologic story of Isle Royale National Park. *USGS Bull.* 1309, 66 p., illust., map.

LACROIX, A. (1887) Études critiques de minéralogie. *Soc. Franc. Min., etc., Bull.* 10, p. 142–152. Believed chlorastrolite=thomsonite.

LUOMA, H. L. (1946) Isle Royale greenstone—chlorastrolite. *The Mineralogist* 14, 3, p. 115–117; 5, p. 238, 239.

______, (1946) New chlorastrolite find. *Ibid.* 8, p. 399, 400. The Delaware Mine, Keweenaw County.

WAITE, G. G. (1961) Gemstones along Lake Superior shores. *Lapidary J.* 15, 4, p. 434–451, *passim.*

WHITNEY, J. D. (1847) Description and analysis of three minerals from Lake Superior. *Boston J. Nat. Hist.* S, p. 486–489. I. Royale chlorastrolite.

______, (1848) Chlorastrolite from Isle Royale, Lake Superior. *Proc. Boston Soc. Nat. Hist.* 3, p. 12.

WILLIAMS, S. A. (1957) A study of chlorastrolite. *Michigan College of Mining and Technology: MS Thesis,* 54 p., map.

WINCHELL, N. H. (1899) Chlorastrolite and zonochlorite from Isle Royale. *Amer. Geologist* 23, p. 116–118.

CHONDRODITE

NEW YORK. Januzzi (1966, p. 21) records faceted gems from Tilly Foster material of 2.5 and 1 ct in the American Museum of Natural History, New York City.

DANA, E. S. (1875) Preliminary notice of chondrodite crystals from the Tilly Foster Iron Mine, Brewster, N.Y. *Amer. J. Sci.* 9, p. 63, 64.

______, (1875) On the chondrodite from Tilly Foster iron mine, Brewster, New York. *Amer. J. Sci.* 10, p. 89–103. Also in *Conn. Acad. Arts Sci. Trans.* 3, p. 67–96.

JANUZZI, R. E. (1959) *The minerals of Western Connecticut and Southeastern New York State.* Danbury, CT: The Mineralogical Press, 106 p., maps.

______, (1966) *A Field Mineralogy of the Tilly Foster Iron Mine at Tilly Foster, Brewster, New York.* Danbury, CT: The Mineralogical Press, 161 p., illust.

CHRYSOBERYL

MAINE. This desirable gemstone remains scarce in this state, and, for that matter, elsewhere in North America. The earliest mention of chrysoberyl in New England, then termed *cymophane*, was by Haüy (1811); subsequently the species was mentioned in many treatises on the mineralogy of this part of the United States. The first modern account, however, to describe a verified faceted gem was by Marble (1927), who noted the occurrence of crystals of chrysoberyl on the steep south slope of Hedgehog Hill, Oxford County. A broken crystal "originally must have been 1/2 inch and 2 inches in diameter. From this crystal a perfect stone, of about 1 carat, was cut . . . the color being greenish straw-yellow." This occurrence is mentioned by Bradshaw (In press), who also notes that two small faceted chrysoberyls from Ragged-Ass Jack Mountain in Hartford, Oxford County, total weight 0.47 ct, are in the Harvard Mineralogical Museum collection; these were obtained by Harvard in 1990. The localities mentioned are further described by Thompson, *et al* (1991). In the pegmatite of Hooper's Ledge, on the south part of Paris Hill, Oxford County, large masses of chrysoberyl were found which according to Stevens (1972) yielded no gem material. Complete details on Maine chrysoberyl and its occurrence appear in King & Foord (1994, p. 81–84).

BRADSHAW, J. J. (In press) Gemstones of Maine. In KING, V. T., edit., *The Mineralogy of Maine*, Augusta, ME: Geol. Survey. [21] p.

HAÜY, R. J. (1811) Sur les cymophanes des États-Unis. *Mus. Hist. Nat. Ann.* 18, p. 57–69; also *J. d. Mines* 30, p. 321–334, 1811; *Ann. Physik* 41, p. 53–61, 1812.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 330 p., illust. (col.), p. 97–98.

MARBLE, C. F. (1927) Mineral localities of Maine—the Peru Mica Mine. *Rocks & Minerals* 2, 2, p. 49.

STEVENS, J. P. (1972) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* Trap Corner, ME: Perham's Mineral Store, 216 p., illust., maps.

THOMPSON, W. B., *et al* (1991) A collector's guide to Maine mineral localities. 2nd edit. *ME Geol. Survey Bull.* 41, 104 p., illust. (col.), maps.

NEW YORK. No new developments.

WHITLOCK, H. P. (1903) List of New York mineral localities. *State Univ. of New York Bull.* 298, 108 p. Chrysoberyl p. 88.

COAL

PENNSYLVANIA. In a brief note to the *Lapidary Journal* (vol. 31, 2, 1977, p. 641), Henry T. Levi of Nanticoke (in the coal-mining region) comments on the suitability of anthracite for carving, noting that "coal carving is concentrated in towns of eastern Pennsylvania, a notable center being Wilkes-Barre area in Luzerne County." High quality anthracite, according to Levi, comes from mines at Ashley, Mountain Top, and Nanticoke. Charles (1970), who gives an excellent historical review of the carving of coal in Pennsylvania, provides numerous illustrations of small objects carved from coal but also mentions that blocks of sound, fracture-free coal were used to construct buildings near White Sulphur Springs in West Virginia! My own recollections from childhood in New Jersey and from visits to relatives who were coal miners in Scranton, Pennsylvania, include memories of numerous small carvings and ornamental objects made from coal that were to be found in practically all homes, and also of the much larger blocks of anthracite that were placed before the offices of coal dealers to advertise their products. These were faced flat, polished, then etched deeply with the advertising message. The toughness and non-smearing qualities of anthracite actually make this material a satisfactory one for cabochons and small carvings that can be set in jewelry, *Jewelers' Circular-Keystone* of February, 1987, p. 130, noting its use for just this purpose by New York jewelry designer Richard Palermo. Meier (1992) describes the work of noted Midwest sculptor Robert Miller who has used anthracite in his carvings.

WEST VIRGINIA. Cannel coal, a "dense, tough, black bituminous coal," according to Kirsten (1982), "is found in many places in West Virginia. One location is the No. 5 Block coal seam, Cannel Coal Hollow, 2 miles southeast of Bickmore, Clay County." This material finds considerable use as a carving material and even in jewelry.

CHARLES, R. J. (1970) The challenge of carving coal. *Lapidary J.* 23, 12, p. 1662–1667; 24, 1, p. 138, 139, illust.

KIRSTEN, D. (1982) Gemstones of West Virginia. *WV Geol. Econ. Survey, Mountain State Magazine*, 1982, p. 34–36, illust.

MEIER, M. (1992) Carver of the Midwest. *Lapidary J.* 45, 12, p. 31–34, illust. (col.).

COBALTITE

ONTARIO. No new developments.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.), p. 69.

HEWITT, D. F. & FREEMAN, E. B. (1972) Rocks and minerals of Ontario. *Ont. Dept. Mines Geol. Circ.* 13, p. 38.

COLEMANITE

CALIFORNIA. Colorless, transparent colemanite faceted gems from this state were examined by Bank (1973), who found refractive indexes alpha 1.585, beta 1.591, and gamma 1.615; birefringence 0.030; specific gravity 2.40. These values do not differ materially from previously published values.

BANK, H. (1973) Farbloser durchsichtiger schleifwürdiger Colemanit. *Zs. Dt. Gemm. Ges.* 22, 4, p. 188–189.

EAKLE, A. S. (1902) Colemanite from southern California. *Univ. Calif. Dept. Geol. Bull.* 3, 2, p. 31–50, illust.

FOSHAG, W. F. (1922) Calico Hills, San Bernardino County, California. *Amer. Mineral.* 7, p. 208–209. Facet grade material.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., p. 246–251.

CONGLOMERATE

ONTARIO. Sabina (1974) mentions attractive, polishable "Cobalt conglomerate," found in many mine dumps of the Cobalt area. The rock is fine-grained black siliceous material which encloses pink to red granite pebbles of less than an inch to several inches in diameter. "The rock takes a good polish and is suitable for use as an ornamental stone."

SABINA, A. P. (1974) Rocks and minerals for the collector. Cobalt-Belleterre-Timmins; Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, 199 p., illust., (maps), p. 20.

TEXAS. A colorful, dense, polishable conglomerate that is useful for bookends and the like, is described by Mitchell (1991) as being found upon the C. J. Young Ranch, just off Highway 281, about 8 mi (13 km) south of Mineral Wells, Palo Pinto County.

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps.

COPPER

MICHIGAN. An attractive massive copper-bearing rock has gained some vogue among lapidaries in the Keweenaw Peninsula area; it is basalt mottled and veined with native copper, which when slabbed and polished provides a surface of generally dull reddish hue but much enlivened by the metallic luster and color of the copper. On close inspection, the rock appears to be a finely-comminuted breccia in which the native copper solidly cements the mass. More lately, several firms in the Copper Country mined large masses of copper which were sectioned into slabs or made into bookends, then polished and heavily lacquered to prevent tarnishing.

CORAL

FLORIDA. Black coral, actually false black or Gorgonian coral, and commonly called *flexible* or *horny coral*, has been found washed up on the beaches of the Florida Keys according to Sheets (1971). This appears to be the first report of this material from Florida. More information was given by Getsee (1973), mainly on his methods of cleaning a black coral "tree" and otherwise preparing the coral for lapidary work. His "fishing" grounds were the shallows surrounding the Keys. Farther north along the Atlantic Coast of Florida, Lucian (1981) recommends beach-combing for black coral in a stretch just south of the inlet jetty to Port Everglades in the city of Fort Lauderdale. The coral is most likely to be found after a storm. In view of these discoveries, it now seems likely that black coral debris can be found upon almost any suitable beach along Florida's Atlantic side.

GETSEE, G. P. (1973) More about Florida black coral, *Lapidary J.* 27, 2, p. 416, 417.

LUCIAN, A. C. (1981) Coral in Florida. *Rock & Gem* 11, 1, p. 66–68, map.

SHEETS, J. (1971) Black coral in Florida. *Gems & Minerals* 402, p. 24–25.

GRAND CAYMAN ISLAND. In 1968 black coral was discovered in the reefs around this island, which lies south of Cuba in the Caribbean Sea. An article describing the work of Bernard K. Passman (1982) tells of his production of a wide variety of items from the coral, from small items of jewelry, to larger and more elaborate sculptures of famous personages, sometimes embellished with other materials and precious metals. The coral is said to be fished at depths as great as 200 ft (60 m).

LAPIDARY JOURNAL (1982) Bernard K. Passman: introduction to black coral. Vol. 36, 8, p. 1378–1380, illust.

QUINTANA ROO, YUCATAN PENINSULA. The island of Cozumel just off the northeast coast of the Yucatan Peninsula is the home of black coral fishermen and artisans who have developed cottage industries and sell small jewelry and ornamental items to tourists. According to Steinhilber (1981), a visitor to the area, black coral was discovered by Jacques Cousteau on the Palancar Reef in 1960 at a depth of 200 ft (60 m). Not long after, native fishermen began diving for the coral, but by government regulations they were allowed to remove only branches from each "tree" but not the "trunk." The jewelry industry that arose from these early fisheries, and the need to organize all aspects of the industry, led to formation of a divers cartel to control the harvest of coral. Furthermore, it was decreed that "all of the coral that is gathered must go to a central clearing house. This in turn is sold to the craftsmen." Some of the finished items depicted by Steinhilber are necklaces made of highly polished black coral beads of various shapes, but with other beads whose shape makes it obvious that they are made from conch shells.

Kammerling (1990) visited Cozumel in the summer of 1990 to observe and report on the local coral industry, which consists of numerous small factories, many of which process raw coral into finished objects within their shops, or even in open-air areas along the streets, exposed to the gaze of passersby, as in the town of San Miguel de Cozumel. Kammerling notes that "the coral requires approximately 50 years to grow to an average of 3 cm long and 5 mm wide" and "today it is recovered primarily by divers from caves and crevices at depths of 95 m [315 ft]." The species is the gorgonacean coral *Gorgonia*, unlike the Hawaiian *Antipathes* black coral. Kammerling expressed surprise at finding good specimens of the coral "while exploring beaches on the southwest coast of Cozumel Island," but as remarked above under Florida, fragments of the branches probably can be found along vast stretches of Caribbean beach as well as along beaches marginal to the Gulf Stream.

KAMMERLING, R. C. (1990) Gem news: black coral industry on the Mexican Caribbean. *Gems & Gemology* 26, 4, p. 301–302, illust.

STEINHILBER, N. (1981) The black coral of Cozumel. *Lapidary J.* 34, 10, p. 2280–2281, illust.

HAWAII. The earliest mention of true coral in the Hawaiian Islands is found in Baker (1977), who noted that some pink coral was caught up in a fishing net and dragged up to the surface; it was not deemed to be worth anything at that time. According to Grigg (1977), black coral was discovered in 1958 by scuba divers Jack Ackerman and Larry Windley, who, together with John Stewart and Cliff Slater, formed Maui Divers. The beds of black coral discovered by them still furnish considerable material. Grigg, remarking on the intensive coral fishing of the Japanese upon the Milwaukee Banks, located 400 mi (615 km) northwest of Hawaii, noted that "in one year, more than one hundred coral boats were dredging there." He gave no details on the identity of this coral.

In 1966, Ted Chamberlain and Vernon Brock rediscovered pink coral, *Corallium secundum*, in commercial quantities at a depth of about 1200 ft (360 m) on Makapuu Beds in the Molokai Channel just off the southeast corner of Oahu Island. To harvest this coral, special cutting and collecting mechanisms were installed in the nose of the deep-diving submersible, Star II, used by the Maui Divers to reach these extremely deep beds which are far beyond the scope of individual divers. The Star II, a 17-ft (5 m) long submarine, is leased from the Electric Boat Division of General Dynamics Corporation. However, as in the case of black coral, much of this is collected by scuba divers operating independently and selling their coral to Maui Divers (Baker, *Ibid.*).

In 1970, the now well-known "gold coral," or *Gerardia*, sp.=*Parazoanthus*, was discovered in the same general areas as the pink coral, and is said by Brown (1980) to grow in a symbiotic relationship with the latter. Brown states that commercial harvesting of the gold coral was begun in 1973 by Maui Divers, who used their submersible to retrieve the branches. Between 1975 and 1977, they collected 1,307 kg of gold coral, valued at $160,000.00. Brown also describes a kind of "gold" coral from the Philippine Islands that is similar to the Hawaiian material and appears upon the market in competition with Gerardia. It is, however, the horny axis of a whip coral, probably of the genus *Cirripathes*, which due to its dark color is treated with chemicals to lighten its tone to make it more closely resemble the Hawaiian material. Brown suggests that dilute nitric acid is used for bleaching, but others state that ordinary hydrogen peroxide solution works as well. Brown tested both types of "gold coral" and found that the Hawaiian gave refractive index 1.56, specific gravity 1.44, and hardness 2–3, while the Philippine coral gave 1.55–1.56, SG 1.40, and H 2.

Gerardia gold coral is popular because of its attractive color and the considerable chatoyancy upon polished surfaces, which somewhat resembles that of tigereye. Unlike the Philippine material, its color is solid throughout its stems; it is recognizable in the rough by this feature and by the numerous closely-spaced, parallel striations, mostly less than 1 mm apart, that run in the same directions as the stems.

A thriving manufactury is operated by the Maui Divers in Honolulu where gold, pink, and black corals are cleaned, cured, and made into items of ornament and jewelry. State and federal laws regulate the fisheries under the provisions of the Federal Conservation and Management Act of 1976, which exercises control over marine resources within a belt of 200 miles wide along the island coastlines. Because of the expense and uncertainties surrounding the harvesting of pink and gold corals at such great depths, Baker *(Ibid.)* noted at the time that prime quality pink coral fetched $400.00 per pound.

More details on the operations of Maui Divers are given by Kraus (1981), who noted their move from Maui Island to Oahu Island in 1962. In 1978, the company was sold to the Colgate-Palmolive Company. At this time it had 200 employees and sales in 1977 of $7 million. Stock in the company was held by 30 shareholders. In 1978, sales were expected to reach $11 million, and the workforce increased to 320 employees. Hiss (1988) reported on the industry, citing Cliff Slater, President of the company, who stated that the black coral, harvested by scuba divers at a depth of about 225 ft (68 m), is plentiful and constantly regrows, although it takes 30 to 50 years for a black coral tree to grow large and thick enough to be worth harvesting. Divers select trees that are at least 3/4 in (2 cm) thick at the base; anything smaller is not worth the processing cost. The best quality material is found in coastal waters of Maui near Lahaina. Hiss also noted the following then-current prices: "a 10-by-8 mm cabochon of black or pink coral retails for about $20. As size increases, the price of pink seems to rise more quickly than black."

Colhour (1971) describes her search for a pink coral tree which led her to the Jacobson Brothers, Inc. of Seattle, Washington, specialists in the recovery of objects from the ocean floor and operators of the 110-ft salvage vessel *Sonar Belle.* Alan and Bryan Jacobson had tried their hand at fishing for pink coral, *Corallium niveum*, also known as "angel skin" coral, from unspecified off-shore areas in the Hawaiian Islands, using for the purpose a specially designed, remotely-controlled sled-like platform that could be lowered to great depths (to 1,500 ft, ca 460 m) to seek out coral trees and selectively shear them off to recover them. While the operation did retrieve coral, the expedition was not repeated. The largest "tree" recovered measured about 24 in (60 cm) across and 14 in (36 cm) tall. The color is a delicate pink to white, as described by Colhour, who further describes her methods of cleaning the coral preparatory to further work.

Urged on by the Hawaiian Jewelers Association, the State of Hawaii passed a bill on April 4, 1987 that made black coral the official state gem.

BAKER, E. (1975) Exotic treasures from the sea. *Lapidary J.* 29, 6, p. 1200–1201.

BAUGHMAN, C. A. (1981) Lapidary use of black coral. *Lapidary J.* 35, 1, p. 142, 144, illust.

BROWN, G. (1980) Gold corals—some thoughts on their discrimination. *Gems & Gemology* 16, 8, p. 240–244, illust.

COLHOUR, O. M. (1971) The pink harvest. *Lapidary J.* 25, 3, p. 444–446, illust.; 4, p. 564–567, 570, 571, illust. (col.).

GRIGG, R. W. (1977) *Hawaii's precious corals.* Norfolk Island, Australia: Island Heritage, Ltd., 64 p., many col. pls.

HISS, D. A. (1988) Black coral: Hawaii's state gem. *Jewelers' Circular-Keystone*, October, p. 256.

KRAUS, P. D. (1981) A visit with the Maui Divers. *Lapidary J.* 25, 1, p. 118–134, *passim*, illust., map.

STEWART, J. (1962) The Hawaiian black coral story. *Lapidary J.* 16, 4, p. 388–390, 392, 490–491, illust.

CORAL, PETOSKEY, *see* CALCITE

CORDIERITE (IOLITE)

NORTHWEST TERRITORIES. According to Bell (1992), recent visits to a number of places reported to have produced gem quality cordierite failed to locate any deposits, namely, upon Garnet Island, Markham Bay, off the south shore of MetaIncognita Peninsula, Baffin Island, and also localities near Ghost Lake, Wecho Lake, and sites in a region located about 150-160 km (95 mi) north of Yellowknife.

BELL, R. (1992) Report on the compilation of lapidary sites. *NWT Dept. Energy, Mines & Petrol. Resources, EGS* 1992–14, 157 p., maps.

FOLINSBEE, R. E. (1941) Optic properties of cordierite . . . *Amer. Mineral.* 26, p. 485–500. Gem iolite near Great Slave Lake.

______, (1949) Lac-de-Gras. *Geol. Survey Canada Map* 977A. Mentions gem cordierite from several places in NWT.

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55; notes 3.93 cts faceted gem from Great Slave Lake and 1.51 cts gem from Ghost Lake.

QUEBEC. Sabina (1971) reports "blue cordierite suitable for lapidary purposes is found in gneiss . . . associated with deep red granular garnet" exposed in a pit opened for pegmatite upon the Albert Richard property located 3.2 mi (5.3 km) north-northwest of Otter Lake Village, Leslie Township, Pontiac County.

SABINA, A. P. (1971) Rocks and minerals for the collector: Ottawa to North Bay, Ontario; Hull to Waltham, *Quebec. Geol. Survey Canada Paper* 70-50, 130 p., illust., maps, p. 92, 95, map.

ONTARIO. Wight *(see above)* also reports two fine blue faceted gems of cordierite from The GECO Mine, Manitouwadge, Thunder Bay District, one of 2.20 cts and the other of 2 cts.

CONNECTICUT. Amplifying previous remarks on cordierite found in this state, Schairer (1931, p. 98) notes gem grade material in a cordierite gneiss along the road at the south end of Bigelow Pond, Union Township; it is a "coarse-grained rock containing large and small blue or blue-gray transparent to semi-transparent crystals of iolite (cordierite) which have been cut as gems."

SCHAIRER, J. F. (1931) The minerals of Connecticut. *CT State Geol. Nat. Hist. Survey Bull.* 51, 121 p.

WYOMING. Cordierite has been found in Wyoming and has been mentioned by Osterwald, *et al* (1966) but is not mentioned by Sutherland (1990).

OSTERWALD, F. W., *et al* (1966) Mineral resources of Wyoming. *Geol. Survey WY Bull.* 50, 287 p. Cordierite p. 64–65.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., map.

MANITOBA. Wight (1986) briefly describes two faceted cordierites from Snow Lake, one 1.15 cts, dark blue, and the other 1.10 cts, also dark blue.

ROBERTSON, D. S. (1953) Batty Lake map area, Manitoba. With Map 1006A. Mentions gem iolite.

WIGHT, W. (1986) Canadian gems in the National Museum of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

CALIFORNIA. Pemberton (1983, p. 447) cites Brice (1953) as stating that purple cordierite in a "gem stone" prospect, SE¼ SE¼ Sec. 20, T12N, R7W, M.D.M., was originally described as amethystine quartz.

BRICE, J. C. (1953) Geology of the Lower Lake Quadrangle. *CA Div. Mines Bull.* 166, 72 p., map.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust. (maps).

CORUNDUM

Ruby corundum has been found in Greenland, but clear areas in the crystals are so small that only fraction-carat stones can be cut. No corundum mining is taking place in Canada. Some grayish corundum found on the Alaska mainland has been cut into small star stones. A few deposits in Wyoming appear promising for finding clear gem material, but so far only in small sizes. Tourists pan gem gravels in several places in North Carolina where the "ore" is sometimes artificially "enriched." A recent find of sapphire in Idaho produced a geuda-type material that was heat-treated to blue, but again the clear areas are so small that only correspondingly small gems can be cut. These are not important nor promising. Only Montana's sapphire-laden gravels continue to produce stones both for tourists and for several commercial operations. The famous in-situ source at Yogo Gulch continues to tantalize rather than to reward those who try their hand at mining for its wafer-thin fine blue crystals. The following general references are of interest, especially the large treatises of Barlow (1915), Hughes (1990, 1995), King (1894), Pratt (1901, 1906), and Themelis (1992).

BARLOW, A. E. (1915) Corundum, its occurrence, distribution, exploitation, and uses. *Geol. Survey Canada Mem.* 57, 377 p., illust. (col.), maps. Much general information, worldwide.

GENTH, F. A. (1873) Corundum, its alterations and associated minerals. *Amer. Phil. Soc. Proc.* 13, p. 361–406.

____, (1874) [On corundum.] *Amer. Phil. Soc. Proc.* 14, p. 216–218; also *Amer. J. Sci.* 8, p. 221–223.

HOLMES, J. A. (1896) Corundum deposits of the southern Appalachian region. *USGS 17th Ann. Rept.*, pt. 3, p. 935–943, map.

HUGHES, R. W. (1990) *Corundum.* London: Butterworth-Heinemann, 314 p., illust. (col.). Includes North American deposits.

______, (1995) *Ruby & Sapphire.* Boulder, CO: priv. publ. In press.

JENKS, C. W. (1877) *A paper on corundum and its gems,* read before the Society of Arts, Technological Institute, Dec. 14, 1876, Boston, Press of John Wilson And Son, 17 p.

KING, F. P. (1894) A preliminary report on the corundum deposits of Georgia. *Geol. Survey GA Bull.* 2, 138 p., plates, map. Short, excellent history of corundum; bibliography of corundum in U.S.A.

PENNYPACKER, C. H. (1901) About corundum. *The Mineral Collector* 8, p. 36–39.

PRATT, J. H. (1901) The occurrence and distribution of corundum in the United States. *USGS Bull.* 180, 98 p., plates.

______, (1906) Corundum and its occurrence and distribution in the United States, *USGS Bull.* 269, 175 p., plates. Revision of above.

THEMELIS, T. (1992) *The Heat Treatment of Ruby and Sapphire.* Clearwater, FL: Gemlab, Inc., 236 p., illust. (col.).

GREENLAND. Light pink to red corundum occurs as crude crystals up to 3 in (7.5 cm) in size in a greenish metamorphic rock rich in tschermakitic amphibole and associated with gedrite, sapphirine, plagioclase and mica in the Fiskenaesset village area on the west coast about 100 mi (160 km) south of Godthaab. Here occur metamorphosed anorthosite-norite rocks, extensively pegmatized, in which zone are found bands of corundum-plagioclase-phlogopite rocks (Geisler, 1976; Goodger, 1976; Gray, 1976). According to Peterson & Secher (1993), these deposits were first discovered in the mid 1960s, and by 1976, the ruby, in "green pargasite matrix, which may include iolite, kornerupine, sapphirine or spinel", was being sold as specimen material or for cutting by Fiscanex Limited of Willowdale, Ontario (advert. *in Canad. Gemm.* 1, 2, 1976, p. 5). Goodger (1976) recalls a fine gem ruby of 20 points, or one-fifth carat, that was cut from rough extracted from the host rock. He lists the following species associated within the host rock: kornerupine, pargasite, sapphirine, gedrite, cordierite (iolite), phlogopite, and spinel. While facetable ruby is almost absent, Peterson & Secher note that satisfactory cabochon material is more abundant, and quite attractive when polished.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Meddelelser om Grønland* Bd. 149, no. 3, 442 p., illust., map. Corundum, but not gem, p. 107–108.

GEISLER, R. A. (1976) The ruby deposits at Fiskenaesset, Greenland. *Canad. Gemm.* 1, 2, p. 4.

GOODGER, W. D. (1976) Ruby with kornerupine and associated minerals from Greenland. *Canad. Gemm.* 1, 2, p. 2–3.

GRAY, R. (1976) The geology of the Fiskenaesset area. *Canad. Gemm.* 1, 2. p. 5.

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 1–65, illust. (col.), maps, p. 12.

ONTARIO. Wight (1986) lists the following corundum cut gems that are in the National Museums collections: a black star sapphire with a good star, some flaws, 14.40 ct, from the Little Robertson Corundum Showing, Bancroft; a medium blue cabochon with a poor star, 8.80 ct, from York River, Dungannon Township, Hastings County; another from this locality, a black star of 6.79 ct; a triangular freeform faceted gem, medium, only semi-transparent, 1.00 ct, from York River; another, medium blue, semi-transparent, emerald step cut of 6.02 ct; also another of 2.77 ct, translucent medium blue; lastly, a double cabochon, opaque dark metallic brown, with star, from the Gutz Farm, Brudenell Township, Renfrew County.

BAKER, M. B. (1904) On the occurrence and development of corundum in Ontario. *Canad. Mining Inst. J.* 7, p. 410–421.

BARLOW, A. E. (1899) *Summary report on the operations of the Geological Survey* [of Canada] *for the year 1897.* Corundum: p. 47–60, 127–128, map.

______, (1905) On corundum in Ontario and on surveys near Lake Timagami. *Geol. Survey Canad. Summ. Rept. 1904*, Ann. Rept. 16, p. 190–194.

______, (1915) Corundum, its occurrence, distribution, exploitation, and uses. *Geol. Survey Canad. Mem.* 57, 377 p., illust. (col.), map.

BLUE, A. (1899) Corundum in Ontario. *Canad. Inst. Proc.* 2, p. 15–22; also *Ont. Bur. Mines* 8, p. 241–249, 1899; *Amer. Inst. Min. Eng. Trans.* 28, p. 565–578, 1899.

COLEMAN, A. P. (1899) Corundiferous nepheline syenite. *Ont. Bur. Mines Rept.* 8, p. 250–253.

______, (1899) Corundiferous nepheline syenite from eastern Ontario. *J. Geol.* 7, p. 437–444.

EARDLEY-WILMOT, V. L. (1927) Abrasives, products of Canada, technology and application. Part I. Corundum and diamond. *Canada Dept. Mines Publ.* 675, 51 p., plates.

FIELD, D. S. M. (1951) Ruby and sapphire in Canada. *Canad. Mining J.* 72, 7, p. 75–77.

GIBSON, T. W. (1899) The corundum deposits of Ontario. *Eng. & Min. J.* 67, p. 500.

HAULTAIN, H. E. T. (1907) Corundum at Craigmont [Ontario]. *Canad. Mining J.* 28, 12, p. 291–296.

HEWITT, D. F. (1953) Petrology of the nepheline and corundum rocks, Bancroft area, eastern Ontario. *Geol. Soc. Amer. & Geol. Assoc. Canada, Guide Book, Field Trip* 1, Nov. 12–14, 1953, 28 p., illust., maps.

______, (1954) Geology of the Brudenell-Raglan area. *Ont. Dept. Mines 62nd Ann. Rept.* vol. 52, pt. 5, 1953, 123 p., illust., maps, p. 46–65, 102–116.

______, (1961) Nepheline syenite deposits of southern Ontario. *Ont. Dept. Mines* vol. 69, pt. 8, 1960, 194 p., illust., maps.

HOGARTH, D. D., *et al* (1983) Classic mineral collecting localities in Ontario and Quebec. *Geol. Survey Canad. Misc. Rept.* 37, 79 p., maps. Corundum p. 50–53.

JOHNSON, L. P. (1982) Collecting in the Bancroft area. *Gems & Minerals* 536, p. 16–22. Star corundum.

KERR, D. G. (1905) Corundum in Ontario. *Inst. Min. Eng. Trans.* 30, p. 143–157.

MILLER, W. G. (1899) Corundum and other minerals. *Ont. Bur. Mines Rept.* 8, p. 205–240.

______, (1899) Notes on the corundum-bearing rocks of eastern Ontario, Canada. *Amer. Geol.* 24, p. 276–282, map.

______, (1899) Notes on prospecting for corundum. *Canad. Inst. Proc.* 2, p. 23–26.

MOYD, L., MOYD, P. & NOBLITT, H. L. (1961) The Monteagle nepheline-corundum-mica deposit, Hastings County, Ontario. *Amer. Inst. Min. Eng. Trans.* 65, p. 261–268, maps.

PETCH, H. E. (1967) Bancroft's star sapphire. *Canad. Rockhound* 11, 4, p. 117–122.

______, (1967) *Same.* In: *Rocks & Minerals* 42, 8, p. 563–566.

SABINA, A. P. Rocks and minerals for the collector. Ottawa to North Bay, Ontario; Hull to Waltham, Quebec. *Geol. Survey Canada Paper* 70-50, 130 p., illust., maps, p. 43–46.

SATTERLEY, J. (1943) Mineral occurrences in the Haliburton area. *Ont. Dept. Mines Ann. Rept.* 52, part 2, 106 p., illust., maps, p. 21–23.

STEACY, H. R., *et al* (1982) Some classic mineral localities in southeastern Ontario. *Min. Rec.* 13, 4, p. 197–203, illust., maps.

THOMSON, J. E. (1943) Mineral occurrences in the North Hastings area. *Ont. Dept. Mines, 52nd Ann. Rept.*, part 3, 80 p., illust., map.

TRAILL, R. J. (1983) Catalogue of Canadian minerals. Rev. 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map, p. 119–121.

WIGHT, W. (1986) Canadian gems in the National Museum of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

NORTHWEST TERRITORIES. No new developments.

ELLSWORTH, H. V. & JOLIFFE, F. (1937) Some recently discovered minerals of the Great Slave Lake area, Northwest Territories. *Univ. Toronto Studies, Geol. Ser. 40, Contrib. Canad. Mineralogy*, 1936–1937, p. 71–81. Brief mention of gemmy corundum.

MAINE. Numerous reports of corundum occurrances are shown by King & Foord (1994, p. 97–99) to be largely unsubstantiated, especially in the few instances where gem varieties were claimed to have been found.

NEW JERSEY. No new developments.

FOWLER, S. (1832) An account of the sapphire and other minerals in Newton Township, Sussex County, New Jersey. *Amer. J. Sci.* 21, p. 319–320.

PENNSYLVANIA. No new developments.

LEIDY, J. (1872) Notice of a corundum mine [Unionville,Chester County]. *Acad. Nat. Sci. Phila. Proc.* 24, p. 238–239.

McKINSTRY, H. E. (1921) The Unionville, Pennsylvania, corundum mines. *Amer. Mineral.* 6, p. 135–137.

NORTH CAROLINA. One of the problems associated with attracting large numbers of tourists to try their hands at panning gem-bearing gravels of the Franklin area is the "salting" of the gravels, as without "enrichment" these would be simply too poor to reward the efforts expended upon them. The pressure to salt the gravels first began with use of gem rough from other local sources. By 1986, the Franklin Area Chamber of Commerce, Inc., published a leaflet for tourists that briefly described the local attractions and facilities of twelve "mines" in the area that offered recovery of ruby and other "native" stones, but also noted that some mines offered "enriched" gravels, that is, enriched by introducing gem materials not locally obtained.

Another problem connected with tourist mining is the unwarranted publicity given to discovery of large crystals or masses of corundum which are then claimed by their finders to be worth fortunes. For example, *Jewelers' Circular-Keystone*, May, 1988, reported that a "giant star sapphire" of 3,500 cts "possessing potential asterism" had been found by a pair of diggers in the mountains of western North Carolina. In another instance, a few years earlier, the Gregory Ruby Mine in Cowee Valley reported a ruby stone of 456 cts, 3 in (7.5 cm) in diameter, and one in (2.5 cm) thick, said to be 85% ruby and "conservatively valued at $20,000." Another large ruby of 163 cts from Cowee Valley was noted in a U.S. Bureau of Mines report for 1981. K. Sexton, writing in the *Franklin Press*, April 11, 1988, cited remarks made by John S. White, then in the Department of Mineralogy, U.S. National Museum of Natural History, discounting claims that large corundum specimens found in this area were worth huge sums of money. From the complete absence of verified large faceted or star stones placed upon the market from North Carolina sources, one must draw the conclusion that every "giant" ruby or sapphire so far found is specimen rather than gem material.

Themelis (1992, p. 217) heat-treated North Carolina corundum and found that "some silky . . . pink sapphire/rubies, opaque, dull, pinkish, silky pink sapphire, heated to 1730°C [3114°F] in air for a few minutes, produced dark blue, non-uniform color." He also stated that "the commercial potential of gem quality North Carolina corundum is non-existent."

In Haywood County, the Old Pressley Sapphire Mine, now known as J. R. B. Mines, Inc., operated by the Trantham Family of Canton, is yielding corundum, especially the variety in which six-rayed whitish inclusions create star stones of the kind known as "fixed star sapphires," because the reflections of light do not move from side to side as the stone is tilted, as happens in a true star sapphire. A flume is provided where gravel and rock can be washed to recover stones.

In Macon County, bronzey corundum crystals are found in the Mincey Mine, near Ellijay, on a branch of the north prong of Ellijay Creek, about 7 mi (11 km) east of Franklin. The strong bronzey reflections appear atop cabochons whose bases coincide with the basal plane *c*-0001 of the crystals. Broughton (1975) identifies the responsible inclusions as very fine platelets of hematite.

Hudson (1976) reported the reopening of the old Corundum Hill workings located southeast of Franklin. Rights to the property were purchased in January, 1974 by D. Marguerite Enterprises. All mining is being conducted underground in two adits. At the time of Hudson's visit, about 8,000 gm (17.6 lb) of mine-run corundum was in stock, and "of this, at least one hundred grams appear to be of a quality that could yield faceted stones" and "these should average about a carat apiece, and one crystal shows two clear areas that ought to cut stones of about three carats each."

As can be seen from the abundant literature below, the intriguing prospect of valuable finds of gem corundum in North Carolina resulted in much being written about the deposits from the last century, and still appearing in our own, but without much to show for all of the effort that has been expended on corundum mining in this state. Typical small gems, ranging from 1.03 to 2.00 cts in faceted stones and from 3.5 to 8.9 cts for cabochons, are shown in color in the article by Mount (1984), these despite their small size, are perhaps about as good as one can expect from these deposits.

AMERICAN PROSPECTING AND MINING COMPANY (1899) *Reports upon the property.* New York: 40 p. Macon Co., NC ruby deposits.

AUSTIN, G. T. (1990) North Carolina: the "Big" state. *Colored Stone* 3, 3, p. 22–24. Corundum.

BALLARD, T. J. (1947) Corundum Hill Mine, Macon County, North Carolina. *U.S. Bur. Mines Rept. Invest.* 4042, 10 p., illust., maps.

______, (1947) Buck Creek corundum, Clay County, North Carolina. *Ibid.* 4052, 34 p., illust., maps.

BRADY, J. P. (1965) Corundum Hill will be opened for prospecting. *Lapidary J.* 19, 1, p. 182–183, map.

BROUGHTON, P. L. (1975) Bronze sapphires at the Mincey Mine. *Gems & Minerals* 454, p. 36–37, map.

BROWN, C. B. (1899) Report on the Cowee Valley ruby mines in North Carolina, *Amer. Prospecting and Mining Co. Reports*, p. 21–30.

CHATARD, T. M. (1887) The gneiss dunyte contacts of Corundum Hill, North Carolina, in relation to the origin of corundum. *USGS Bull.* 42, p. 45–63.

COBB, M. C. (1924) The origin of corundum associated with dunite in western North Carolina. *Dissert. Bryn Mawr Coll., PA*, 43 p., 7 plates, map.

CONLEY, J. F. (1958) Mineral localities of North Carolina. Rev. by O. F. Patterson & G. R. Ganis, reprinted 1973. *NC Dept. Nat. Econ. Res. Info. Circ.* 16, 128 p., illust., maps.

EIN, D. A. (1992) Sapphire surprise. *Lapidary J.* 45, 12, p. 91–93, map. Fee digging sites.

FAFARD, R. (1965) *The Cowee Valley Ruby Mining Story.* Franklin, NC: Cowee Gem Shop, 23 p., illust.

GENTH, F. A. (1882) Contributions to mineralogy no. 20. *Amer. Phil. Soc. Proc.* 20, p. 381–404. NC corundum.

GORDON, S. G. (1922) Corundum Hill (Franklin), Macon County, North Carolina. *Amer. Mineral.* 7, p. 189–190.

HADLEY, J. B. (1949) Preliminary report on corundum deposits in the Buck Creek peridotite, Clay County, North Carolina. *USGS Bull.* 948-E, p. 103–128.

HARSHAW, L. (1978) *The Rubies of Cowee Valley, Franklin, North Carolina.* Rev. edit. Hexagon Co., 72 p., illust., maps.

HICKS, T. (1988) An American beauty. *Lapidary J.* 42, 6, p. 44–48, illust., map. On mines around Franklin.

HIDDEN, W. E. & PRATT, J. H. (1899) Report and description of a new ruby district discovered and controlled by the American Prospecting and Mining Company. New York: *Amer. Prospect. Min. Co. Rept.*, p. 1–16.

HIDDEN, W. E. (1902) Corundum twins. *Amer. J. Sci.* 13, p. 474. From Caler Fork, Cowee Creek.

HOLMES, J. A. (1896) Corundum deposits of the southern Appalachian region. *USGS 17th Ann. Rept.*, part 3, p. 935–943, map.

HUDSON, S. (1976) The mountain of gems comes of age. *Lapidary J.* 30, 9, p. 2092–2101, maps.

______, (1978) The valley of red rocks: hunting rubies in the Cowee Valley. *Lapidary J.* 32, 8, p. 1754–1766, maps. Thorough survey.

______, (1980) The rubies of Macon County, North Carolina. *Rockhound* 9, 4, p. 18–23, map.

HUNTER, C. L. (1853) Notices of rare minerals and new localities in western North Carolina. *Amer. J. Sci.* 15, p. 373–378.

JENKS, C. W. (1872) Corundum of North Carolina. *Amer. J. Sci.* 3, p. 301–302.

______, (1874) Notes on the occurrence of sapphires and rubies *in situ* with corundum at the Culsagee corundum mine in Macon County, North Carolina. *Geol. Soc. Quart.* 30, p. 303–305.

______, (1896) Corundum in North Carolina. *Mineral Industry* 5, p. 15–23.

JUDD, J. W. & HIDDEN, W. E. (1899) On a new mode of occurrence of ruby in North Carolina. With crystallographic notes by J. H. Pratt. *Amer. J. Sci.* 8, p. 370–381; also in *Min. Mag.* 12, ½/139–151, 1899.

KENNICUTT, W. (1981) The ruby mines of Franklin. *Lapidary J.* 35, 3, p. 744–746.

______, (1981) The rubies of Cowee Valley. *Gems & Minerals* 529, p. 44–47, map.

KORWIN, A. (1987) Finders keepers. *Lapidary J.* 41, 1, p. 53–56.

KUNZ, G. F. (1883) [North Carolina gemstones.] *NY Acad. Sci. Trans.* 3, p. 53. "Perhaps the most perfect star sapphire found in the U.S."

______, (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). NC p. 40–48.

______, (1907) History of the gems found in North Carolina. *NC Geol. Econ. Survey Bull.* 12, 60 p., illust. (col.), p. 10.

LAPIDARY JOURNAL (1961) North Carolina sapphire hoax exposed. Vol. 15, 4, p. 489.

LEIDY, J. (1872) Notice of corundum. *Acad. Nat. Sci. Phila. Proc.* 24, p. 19.

LEWIS, J. V. (1896) Corundum of the Appalachian crystalline belt. *Amer. Inst. Min. Eng. Trans.* 25, p. 852–906.

______, (1896) Corundum and the basic magnesian rocks of Western North Carolina. *NC Geol. Survey Bull.* 11, 107 p., plates, map.

MARSHALL, C. A. (1959) Digging for rubies in Cowee Valley, N.C. *Rocks & Minerals* 34, p. 298–300.

McCARTHA, W. (1967) The Cowee Creek ruby mines. *Gems & Minerals* 361, p. 20–21, map.

MILLER, R. J. (1978) There are still rubies in North Carolina. *Gems & Minerals* 489, p. 56, 62–64, map. Franklin area mines.

MITCHELL, J. R. (1984) Sapphires at the Old Pressley Mine. *Gems & Minerals* 560, p. 10–12, map.

MOUNT, K. (1984) Modern times in Franklin, North Carolina. *Lapidary J.* 38, 1, p. 50–56, *passim*, 80–82, illust. (col.), map.

POOLE, G. R. (1956) *Occurrence of gem corundum in North Carolina.* Charlotte, NC: priv. publ., 4 p.

PRATT, J. H. (1898) On the origin of the corundum associated with the peridotites of North Carolina. *Amer. J. Sci.* 6, p. 49–65, maps.

______, (1899) On the crystallography of the rubies from Macon County, North Carolina. *Mineral. Mag.* 12, p. 150–151.

______, (1900) On two new occurrences of corundum in North Carolina. *Amer. J. Sci.* 10, p. 295–298. Sheffield Mine, Macon County.

______, (1901) Corundum and its occurrence and distribution in the United States. *USGS Bull.* 180, 98 p., illust.

______, (1906) *Same. USGS Bull.* 269, 175 p., illust.

______, (1902) Corundum in North Carolina and Georgia. *Scient. Amer. Suppl.* 53, p. 22110.

______, (1905) Corundum and peridotites of western North Carolina. *NC Geol. Survey*, Vol. 1, 464 p., illust., maps.

______, (1933) Gems and gem minerals of North Carolina. *Amer. Mineral.* 18, p. 148–159.

RAYMOND, R. W. (1879) The Jenks corundum mines, Macon Co., N.C. *Amer. Inst. Min. Eng. Trans.* 7, p. 83–90.

SCROGGS, F. O. (1939) North Carolina ruby. *The Mineralogist* 7, 4, p. 186–187.

SEXTON, K. (1988) Value of gemstones questioned. *Franklin* [NC] *Press*, April 11.

SHEPARD, C. U. (1872) On the corundum region of North Carolina and Georgia, with description of two gigantic crystals of that species. *Amer. J. Sci.* 4, p. 109–114, 175–180.

SHERMAN, J. J. (1974) *Gems in the Rough.* Priv. publ., 20 p. Cowee Valley.

SIZE, G. F. (1961) Giant sapphire strike in North Carolina called a hoax. *Rocks & Minerals* 36, p. 563.

SMITH, C. D. (1875) Corundum and its associated rocks. In KERR,W. C., *Rept. Geol. Survey NC*, vol. 1, append., p. 91–97.

______, (1881) Corundum. *Geol. Survey NC*, 2, p. 42.

SMITH, J. L. (1873) Notes on the corundum of North Carolina, Georgia and Montana, with a description of the gem variety of corundum from these localities. *Amer. J. Sci.* 6, p. 180–186.

SMITH, M. (1950) The rubies of Cowee Valley, North Carolina. *Rocks & Minerals* 25, 9–10, p. 474–480, map.

STONE, A. M. (1898) Corundum mining in North Carolina. *Eng. Min. J.* 65, p. 490.

THEMELIS, T. (1992) *The Heat Treatment of Ruby and Sapphire.* Clearwater, FL: Gemlab Inc., 236 p., illust. (col.).

WALKER, D. & WALKER, C. (1990) Laurel Valley mine. *Lapidary J.* 44, 7, p. 104, map.

WATKINS, J. (1991) Carolina corundum. *Lapidary J.* 45, 1, p. 97–98, 100.

WILLCOX, J. (1878) Corundum in North Carolina. *Acad. Nat. Sci. Phila. Proc.* 30, p. 223.

WILSON, W. F. & McKENZIE, B. J. (1978) Mineral collecting sites in North Carolina. *NC Geol. Survey Sect. Info. Circ.* 24, 122 p., illust. (col.), maps.

ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps.

GEORGIA. Cook (1978, p. 44-47) briefly describes a number of deposits of corundum in the northern part of the state but notes attractive red cabochon material only from Morgan County and a star stone from a deposit in Oconee County.

BALLARD, T. J. (1946) Exploration of the Hog Creek corundum mine, Towns County, Georgia. *U.S. Bur. Mines Rept. Invest.* 3855, 3 p., illust.

______, (1948) Investigation of Track Rock corundum mine, Union County, Georgia. *U.S. Bur. Mines Rept. Invest.* 4309, 5 p., illust.

COOK, R. B. (1978) Minerals of Georgia: their properties and occurrences. *GA Geol. and Water Res. Div. Bull.* 92, 189 p.

FURCRON, A. S. (1960) Corundum in Georgia. GA Geol. Survey, Georgia *Mineral Newsletter* 13, p. 167–177, illust., maps.

KING, F. P. (1894) A preliminary report on the corundum deposits of Georgia. *Geol. Survey GA Bull.* 2, 138 p., plates, map.

______, (1906) Basic magnesian rocks associated with the corundum deposits of Georgia. *Johns Hopkins Univ. Dissert.*, 32 p.

McCALLIE, S. W. (1910) A preliminary report on the mineral resources of Georgia. *Geol. Survey GA Bull.* 23, 208 p. Corundum p. 78–86.

SMITH, J. L. (1873) Notes on the corundum of North Carolina, Georgia and Montana with a description of the gem variety of corundum from these localities. *Amer. J. Sci.* 6, p. 180–186.

SOUTH CAROLINA. McCauley (1964, p. 11) notes that sapphires have been reported from several localities in Cherokee County, and that "delicate shades of pink and blue corundum crystals have been reported from Anderson County."

BALLARD, T. J. (1948) Investigation of Rickard corundum mine, York County, South Carolina. *U.S. Bur. Mines Rept. Invest.* 4310, 6 p., illust.

McCAULEY, C. K. & McCAULEY, J. F. (1964) Corundum resources of South Carolina. *SC Geol. Survey Bull.* 29.

McCAULEY, C. K. (1964) Gemstone resources of South Carolina. *SC Div. Geol. Bull.* 30, 34 p. Corundum p. 16–17.

SLOAN, E. (1908) Catalogue of the mineral localities of South Carolina. *SC Geol. Survey Bull.* 2, ser. 4, 505 p., maps.

ALABAMA. Cook & Smith (1982, p. 79) report float corundum, some of gem grade, collected in the late 19th century at the Robert Goodman Farm, south of Alexander City, Coosa County, in Sec. 36, T22N, R20E in the vicinity of old Fosheeton.

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120, 285 p., illust. (col.), map.

ALASKA. In 1964, prospector Ray Gatz discovered a deposit of corundum crystals in alkalic pegmatite dikes that outcrop on the south flank of Mentasta Mountains of the Eastern Alaska Range, about 20 mi (32 km) east-southeast of the town of Slana, lat. 62°36'N, long. 143°21'N. According to Richter (1971), most crystals are gray, up to 8 cm (3 in) long, and while "asteriated stones have been cut from the larger corundum crystals . . . the poor quality and scarcity of the crystals preclude an economic gem industry."

RICHTER, D. H. (1971) A corundum occurrence in the eastern Alaska Range, Alaska. *USGS Prof. Paper* 700-C, p. 98–102, maps.

NORTH DAKOTA. *Northwest Magazine*, vol. 12, no. 6, 1894, p. 26, reported "rubies" in the state but no specific place; this report is unsubstantiated.

MONTANA. A more or less steady production of alluvial sapphires continues from a number of tourist fee-collecting sites, while some production is recorded from the *in situ* deposit of Yogo Gulch. Because of the enormous reserves of "ore" now thought to be present in the Yogo Gulch dike system, plans are underway to continue mining, but on a larger scale, as indicated below. In regard to original sources of the alluvial sapphires in several areas of the state, Pough (1993) speculates that on the basis of their wide variations in color, unlike corundums from other sources, and crystal habits, several modes of metamorphic formation may be responsible for differences in the host rocks from which the sapphires were derived. He notes the interesting occurrence of rounded nodules of limonitized echinoid and brachiopod fossils and rounded nodules of former pyrite that accompany the sapphire crystals in some of the river gravels.

Considerable improvement in color of the "river" crystals occurs after heat treatment, but not all stones respond to such treatment, and in the case of the beautifully and uniformly colored crystals from the Yogo Gulch deposit no heat treatment could possibly improve the fine color bestowed by Nature. The purveyors of Yogo

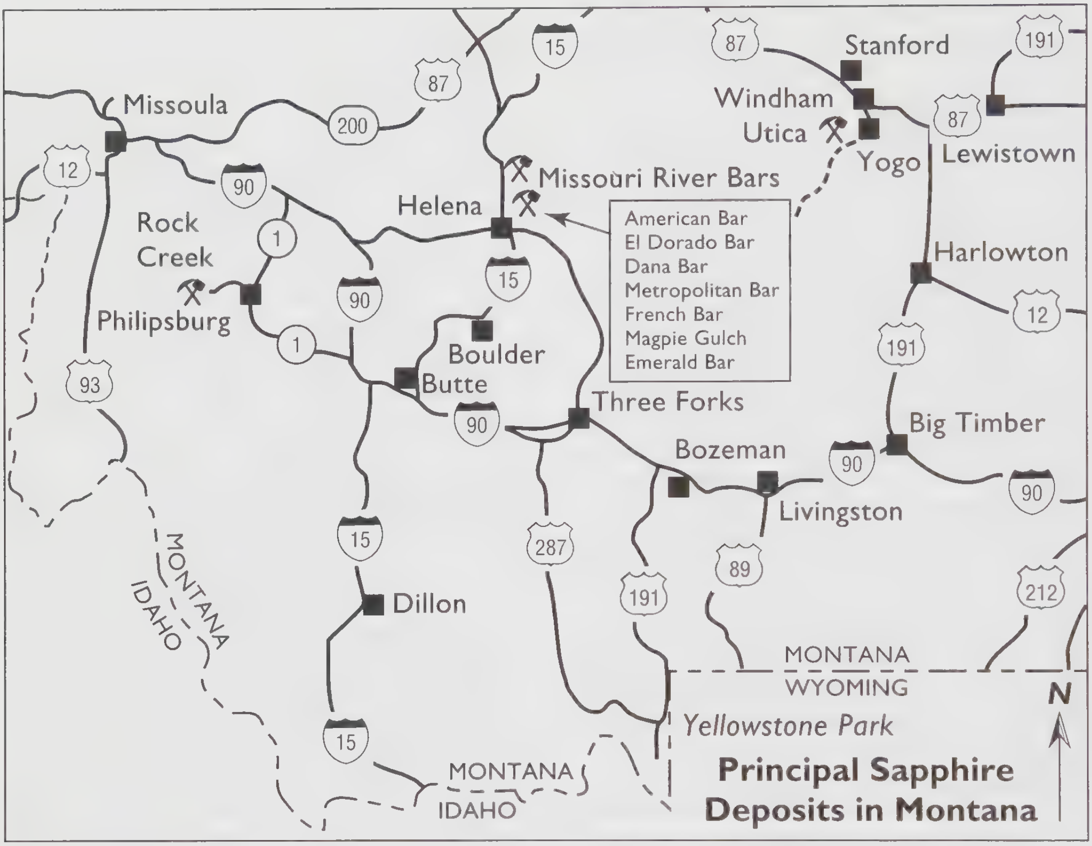

FIGURE 17. Sketch map of southwestern Montana showing locations of sapphire deposits.

gems, countering the claims of heat-treatment specialists, are now prepared to issue certificates guaranteeing that Yogo stones have *not* been heat-treated! More information on heat-treatment of Montana sapphires appears in the excellent treatises of Hughes (1990, 1995), Nassau (1994) and Themelis (1992). Hughes (1995) provides a splendid chronological summary of sapphire discovery and mining in Montana from 1865 to the present.

AUSTIN, G. T. (1990) Montana gem production on the rise. *Colored Stone* 3, 2, p. 14–15.

_____, (1993) The changing color of U.S. sapphires, *Ibid.* 6, 1, p. 370–371, illust.

CLABAUGH, S. E. (1952) Corundum deposits of Montana. *U.S. Geol. Survey Bull.* 983, 100 p., illust., maps.

DWIGHT, A. S. (1892) Notes on Montana sapphires. *Colorado Scientific Society Proc.* 4, p. 174–175.

EDDINGFIELD, F. T. (1902) Corundum in Montana. *Mining & Scient. Press* 84, p. 21.

FELDMAN, R. (1985) *The Rockhound's Guide to Montana.* Helena, MT: Falcon Press, 154 p., illust., maps. Corundum p. 35–37, 88–93, 121–124.

HOWARD, J. W. (1936) The search for sapphire. *Rocks & Minerals* 11, 8, p. 118–120.

HUGHES, R. W. (1990) *Corundum.* London: Butterworth-Heinemann, 314 p., illust. (col.).

_____, (1995) *Ruby & Sapphire.* Boulder, CO: priv. publ. *In press.* U.S. corundum p. 363–379, illust.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient, Publ. Co., 336 p., illust. (col.), p. 48–49.

_____, (1892) Montana sapphires. *Jewelers Weekly*, May 11, p. 23.
_____, (1893) Precious stones. *USGS Min. Resources for 1891*, p. 542–544.
_____, (1893) *Same*, for 1892, p. 761–762.
_____, (1894) *Same*, for 1893, p. 692–693.
_____, (1896) Precious Stones. *USGS 17th Ann. Rept. for 1895–96*, p. 909.
_____, (1897) *Same*, for 1896–97, p. 1199–1202.
_____, (1897) The sapphires from Montana. *Jewelers' Circular* 35, 20, p. 37.
_____, (1899) Precious stones. *USGS 20th Ann. Rept. for 1898–99*, p. 568–569.
_____, (1901) Precious stones. *USGS Min. Resources for 1900*, p. 22–23.
_____, (1902) *Same*, for 1901, p. 736–739.
_____, (1906) *Same*, for 1905, p. 19–21.
MINING JOURNAL (1891) The Sapphire and Ruby Co. of Montana, Ltd. Vol. 61, p. 1234–1235.
_____, (1892) Montana sapphires and rubies. Vol. 62, p. 117.
MONTANA MINING REVIEW (1932) Sapphires. Vol. 34, no. 36, p. 5.
NASSAU, K. (1994) *Gemstone Enhancement.* 2nd edit. Oxford: Butterworth/Heinemann, 252 p, illust. (col.). Corundum p. 122–140.
NORTHWEST MAGAZINE (1889) Montana jewels. Vol. 7, no. 8, p. 33.
_____, (1891) Montana sapphires. 8, 3, p. 36.
_____, (1891) A visit to the gem fields of Montana. 9, 6, p. 36.
_____, (1893) The sapphires of Montana. 11, 6, p. 14.
_____, (1896) Sapphires in Montana. 14, 7, p. 34.
_____, (1896) Back-yard sapphires. 14, 11, p. 47.
_____, (1901) Montana sapphire. 19, 5, p. 60.
POUGH, F. H. (1993) Montana originals. *Lapidary J.* 47, 6, p. 47–50, illust.
PRATT, J. H. (1897) On the crystallography of the Montana sapphires. *Amer. J. Sci.* 4, p. 424–428, figs.
ROPES, L. S. (1901) Montana corundum. *Eng. Min. J.* 72, p. 787.
ROSENHOUSE, L. (1977) Quest for Montana sapphires. *Gems & Minerals* 478, p. 44–45, 69, 71.
ROWE, J. P. (1909) Development of Montana's sapphire mines. *Mining World* 31, p. 921–923.
STERRETT, D. B. (1908) Precious stones. *USGS Min. Resources U.S. for 1907*, p. 816–824.
_____, (1911) Gems and precious stones. *USGS Min. Resources U.S. for 1910*, p. 877–884.
_____, (1912) Gems and precious stones. *USGS Min. Resources U.S. for 1911*, p. 1064–1065.
THEMELIS, T. (1992) *The Heat Treatment of Ruby and Sapphire.* Clearwater, FL: Gemlab, Inc., 236 p., illust.
VOYNICK, S. J. (1985) *The Great American Sapphire.* Missoula, MT: Mountain Press, 256 p., illust.
WILSON, M. M. (1986) Big Sky sapphire. *Lapidary J.* 40, 1, p. 26–36, *passim*, illust.
ZEIHEN, L. (1987) The sapphire deposits of Montana. In: Directory of Montana mining enterprises for 1986, *MT Bur. Mines Geol. Bull.* 126, 56 p., illust., (col.), map. Zeihen p. 28–40, illust.

The most detailed and comprehensive history of sapphire mining at Yogo Gulch is that of Stephen M. Voynick entitled *The Great American Sapphire* (see above). Also of much value is the summary of Montana sapphire deposits and their mining by Lester G. Zeihen, and R. M. Allen's recent article. Much of the information below is taken from these publications and some others listed in the references. The geology of the Yogo Gulch deposit has been studied by geologist Delmer L. Brown, whose report (1978), issued in only a few copies and now almost impossible to obtain, is discussed by Voynick (p. 154 ff). The westward extension of the dike system, now known as the Vortex Mine, is thoroughly described by Mychaluk (1995), who notes that he "was the first geologist to study the Vortex mine, an extension of the Yogo sapphire deposit developed in 1987," (p. 28), of which more will be said below.

In Volume II of the present treatise, an account was given of the innovative Sapphire Village, organized on the concept that buying lots on ground adjacent to the sapphire-bearing dike would entitle owners to engage in digging limited quantities of ore. Unfortunately, not long after the launching of this enterprise, the promoters failed to make a profit and sold their mining rights to Sapphire International Corp., Chikara Kunisaki of Oxnard, California, president. According to Voynick (p. 142). Kunisaki's has become "the first truly serious effort since the days of the English Mine" to actually mine the deposit on a professional basis. However, and despite hiring 40 men to work the mine and driving a 3,000 ft (915 m) adit, very little sapphire-ore was found, and in 1976 all operations were stopped. As explained by several authorities, the dike orebody is not like a uniformly mineralized ore vein from which equal values can be obtained all along the vein, but appears to be enriched in sapphires in certain places, and very poor in others. Thus the driving of the adit, predicated upon a uniform per-foot return, proved to be far more costly than anticipated. The next organisation to tackle the problem of making Yogo pay was Sapphire-Yogo Mines, Inc., headed by Victor Di Suvero, who leased rights in 1977, but again too few sapphires were found, and in 1979 the lease was surrendered to Kunisaki in 1979, who then put up the property for sale for a price of $6 million.

In 1980, a new company, American Yogo Sapphire, Ltd., bought the property, with Harry Bullock, a mining engineer familiar with the Yogo deposit, acting as one of the principals. Voynick (p. 152) notes that this company became the fourteenth American company to try its luck at mining Yogo, and, taking advantage of favorable world financial conditions, they managed to raise $7.2 million in 1981 as start-up capital. It was during this period that the geology and mineralogy of the dike was studied by D. L. Brown, as mentioned above, thus forming the "most thorough geological investigation . . . ever taken [of Yogo]," according to Voynick (p. 154). Guided by Brown's findings, the company developed methods of selective mining designed to produce the richest ore at the least cost. In 1980, for example, they were able to produce 35,000 carats of rough which included a high percentage of the prized pure blue crystals. In order to increase demand

FIGURE 18. Yogo Gulch, Montana, looking north from the cliff directly overlooking the mine and mill on the floor of the gulch. *D. B. Sterrett photo, U.S. Geological Survey.*

for their stones and to raise profitability, the company decided to promote Yogo sapphires as internationally acceptable gems, no longer selling rough but processing all crystals within their organization and creating an in-house jewelry-making capability so that all stones were embodied in their own line of jewelry. Insofar as cutting was concerned, the very finest rough was cut in the United States, other stones in Idar-Oberstein, Germany, and the small stones sent to Bangkok to take advantage of low labor costs there. To lend prestige to their products the company coined the trademark term "The Royal American Sapphire," and to further distinguish their stones they would furnish a certificate stating that their gems were "the world's only guaranteed untreated sapphires," here alluding to sapphires from other sources, even those in Montana, which were heat-treated to improve their color and/or clarity.

By the end of 1984, Intergem, Ltd., as the company now called itself, had sold $3 million worth of goods, and their jewelry was featured in about one thousand retail outlets. Voynick (p. 185) estimated that by the end of 1985, "the retail network will have reached 2,000 stores," with sales of jewelry incorporating Yogo stones projected at 8,000 carats worth $6 million at wholesale. Zeihen (1987, p. 34) gave retail prices for Yogo sapphire cut gems of good quality ranging from $200 to $300 per carat for gems of less than a carat, to $1,000 to $1,500 per carat for gems of one carat, and from $5,000 to $7,000 for gems of 2 carats, while the very rare 3-carat stones sold for $15,000 to $20,000.

Despite their ambitious program, by 1985 Intergem's financial problems were close to crisis level, according to Smith (1985), and in 1986 they were forced to return the mine property to Sapphire International Corporation, which is now known as Roncor, Ltd., of Los Angeles, Ronald L. Kunisaki, president. Roncor now resumed the selling of lots in the Sapphire Village complex, and as of 1993, was still engaged in mining sapphires from the dike.

In 1984, an unexplored westward group of dikes, part of the general Yogo dike system, was found and promptly claimed by a local group comprised of L. Perry, J. Perry, C. Ridgeway, M. Ridgeway, and P. Ecker, calling themselves Vortex Mining, and headquartering in Utica, Montana. According to Zeihen (1987, p. 33), "this small operation may prove to be the only economically successful Yogo sapphire operation since the days of the English syndicate." The Vortex washing plant was completed in 1987 within the mine site located just a few hundred meters southwest of the American Mine and immediately south of the intersection of Kelly Coulee with Yogo Gulch. The site occupies 160 acres of U.S. National Forest land (*Jeweler's Circular-Keystone*, 1987). More details on the dike rocks, sapphires, and the mining operation of Vortex are provided by Mychaluk (1995).

Vortex not only mines the sapphires but also cuts its gems locally whenever they exceed 0.35 ct, but smaller stones are being sent for cutting to Bangkok, Thailand. Wholesale prices charged for cut stones averaged about $20 per ct for 0.20 ct gems, up to $400 per ct for gems of 0.5 ct. According to Allen (1991), Vortex concentrated its efforts upon brecciated portions of the dike which were found to be soft, easily excavated, and readily washable. Such portions of the dike were known to Brown *(Ibid.)* and others to be richer in sapphires than the normal, vein-like parts. Allen provides an illuminating discussion of the origin of the host ouachitite dike rock, how it was initially emplaced, and its subsequent brecciation and alteration/mineralization. *See also* the remarks of Hughes (1990), who summarizes the work of Brown insofar as the origin and features of the dike are concerned, and the findings of Mychaluk (1995).

Vortex, following an earlier practice, exposes its ore to the elements to aid its disintegration, then sluices the material to recover sapphire crystals from riffles where they concentrate because they are of higher specific gravity than other dike rock components. These concentrates are further washed and the sapphires picked out. During his visit, Allen *(Ibid.)* found that the mine could produce about 20 cubic meters (26 cubic yards) of ore per day, from which about 400 carats of sapphire crystals were recovered, about half of them suit-

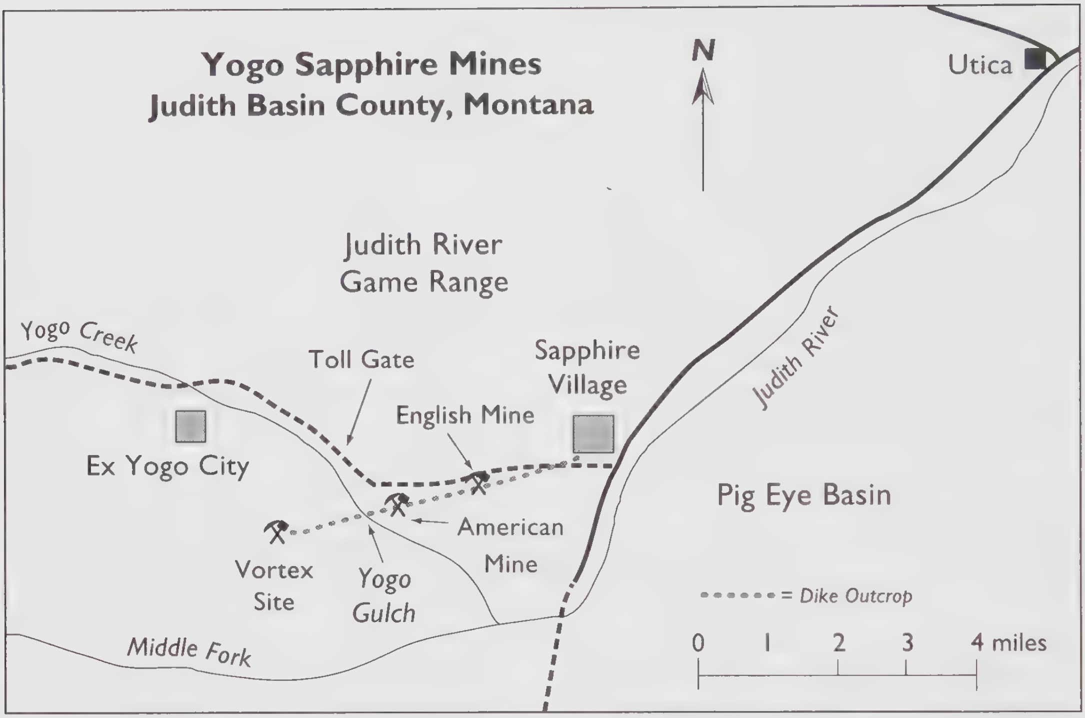

FIGURE 19. Sketch map of Yogo Gulch area sapphire deposits with sapphire-bearing dike system indicated.

able for cutting. He estimates that through 1980 the total production from all sections of the dike is close to 20 millions of carats, of which 5 million may have been gem quality. Since the dike system may extend to a depth of at least 2,000 m (2,200 yd), "the probable reserves of sapphires are enormous." Typical retail prices for cut stones "ranged from about $200/ct for melee to over $12,000/ct for top quality 2 carat plus stones." According to Mychaluk (1995, p. 40), the Vortex Mine produced about 5,000 carats of sapphire crystals in 1992, none in 1993, and about 12,000 carats in 1994. He updates the total production figures of Clabaugh (1952) for all of the Yogo mines taken together as about 18.2 million carats of which about 2.55 million carats were of gem quality, perhaps ultimately yielding about one-half million carats of cut gems.

Projections of enormous reserves apparently influenced the latest development in the Yogo story when it was announced that AMAX, the energy and mining giant, signed an exploration lease with Roncor, Inc., after four years of private negotiations (Verbin, 1993). Ronald Kunisaki of Roncor stated that the mine produces from 30,000 to 50,000 ct of rough each year. This production, plus the fact that the dike is 5 miles (7.9 km) long, about 8 ft (2.4 m) wide, and is now estimated to extend as much as 7,000 ft (2,130 m) below the surface, are the factors which AMAX considered in risking their capital. According to representatives of AMAX, that concern would own all the rough produced by them from their deep mining, while Kunisaki would retain rights to carry on his current surface mining. According to Voynick (1995, p. 200), AMAX retired from the venture after determining that further work would be unprofitable.

The following chronology of events at Yogo, from 1948 to 1995, has been largely assembled from data in Voynick *(Ibid.)*.

1949. Yogo Sapphire Mining Corporation, T. P. Sidwell, principal officer, attempt to acquire New Mine Sapphire Syndicate property but legal problems intervene.
1952. S. E. Clabaugh publishes his influential Corundum Deposits of Montana, *USGS Bull.* 983. Charles Gadsden, former mine operator, dies.
1956. Ownership of Yogo passes to Yogo Sapphire Mining Corp., who reorganizes under old name of New Mine Sapphire Syndicate.
1957. Production begins, and by 1959 is estimated at 50,000 cts.
1959. Mining ceases; property left unguarded with much informal collecting taking place.
1963. Siskon, Inc., a Nevada construction firm, acquires the property for $75,000 at a forced sale to satisfy creditors.
1965. Arnold Baron Group from Montana lease mine for two years with option to buy at end of term.
1968. Sapphire Village, Inc., buy property from Siskon, Inc.
1973. Chikara Kunisaki of Oxnard, California, a former partner in the Sapphire Village venture, buys the property as Sapphire International Corporation; commences driving a 3,000 ft tunnel.
1976. Sapphire International Corp. ceases mining.
1977. Sapphire-Yogo Mines, Inc., Victor di Suvero, principal officer, obtains "perpetual" lease on property; establishes Sapphire Trading Co., Inc., of San Francisco, California, to market the stones.
1979. Sapphire-Yogo Mines, Inc., relinquishes lease; Sapphire International Corp., C. Kunisaki, puts up the property for sale for $6 million.
1980. American Yogo Sapphire, Ltd., a group led by H. C. Bullock, agree to buy at the price specified.
1981. Sapphire International changes name to Roncor, Inc., of Los Angeles, California.
1981. American Yogo Sapphire, Ltd., raises $7.2 million capital.
1982. American Yogo Sapphire, Ltd., changes name to Intergem, Ltd., and calls the Yogo sapphire "The Royal American Sapphire," a trademarked name.
1983. Intergem Ltd., advertises that their Yogo gems are the world's only guaranteed untreated sapphire.
1984. L. Perry, C. Ridgeway, and families, discover unmined westward extension of dike system; stake fourteen claims; they form Vortex Mining, of Utica, Montana, and begin mining.
1986. Financial problems force Intergem, Ltd., to return property to Roncor, Inc., who again puts property up for sale but resume limited mining.
1992. Roncor, Inc., finds magnificent 11 cts sapphire said to be worth more than $100,000; it is a "perfect specimen of cornflower blue."
1993. AMAX Exploration, Inc., leases Roncor, Inc., property for twenty-two months with option to buy at end of term; begins exploration in June.
1994. AMAX discovers another sapphire-bearing dike northeast of main dike.
1995. AMAX Exploration ceases mining and retires from the field.

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ALLEN, R. M. (1991) The Yogo sapphire deposit. *Gemological Digest* 3, 2, p. 9–16, illust. (col.), map.

AUSTIN, G. (1993) The changing color of U.S. sapphires. *See above.*

BAKER, D. W. (1994) Montana sapphires—the value of color. *Northwest Geology* 23, p. 61–75.

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CLAREMONT, L. (1906) *The Gem-Cutter's Craft.* London: George Bell And Sons, 296 p., plates, figs. Good description of Yogo & photos.

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DROULLARD, S. (1978) Yogo, Montana, sapphire. *Gems & Minerals* 490, p. 40, 41, 61, 62, map (of Helena Bar diggings). Historical on Yogo.

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HOWARD, D. L. (1962) No ghosts at Yogo. *Lapidary J.* 16, 1, p. 65–77; 2, p. 228–241, *passim*, illust.

HUGHES, R. W. (1990) *Corundum. See above.*

______, (1995) *Ruby & Sapphire. See above.*

JEWELERS CIRCULAR-KEYSTONE (1987) February, p. 337. On Yogo.

JOHNSON, B, J. (1974) Montana's famed Yogo Gulch. *Gems & Minerals* 437, p. 30–31, illust.

JOHNSON, F. L. (1959) The Montana sapphire country. *Lapidary J.* 13, 1, p. 108–114, *passim.*

KUNZ, G. F. (1897) On the sapphires from Montana, with special reference to those from Yogo Gulch in Fergus County. *Amer. J. Sci.* 4, p. 417–420.

______, (1897) Precious stones. *USGS 18th Ann. Rept. for 1896-97*, p. 1183–1217. Sapphires from Montana p. 1199–1202.

______, (1899) Precious stones. *USGS 20th Ann. Rept. for 1898–99*, p. 557–602, color plate. Perhaps the first color representation of Yogo crystals and cut gems.

LEIPER, H. (1969) Five miles of sapphires, famous Yogo, Montana, sapphire mine to be reopened. *Lapidary J.* 22, 10, p. 1278–1286, *passim.*

MEYER, H. O. A. & MITCHELL, R. H. (1988) Sapphire-bearing ultramafic lamprophyre from Yogo, Montana: an ouachitite. *Canad. Mineral.* 26, Part 1, p. 81–88.

MYCHALUK, K. A. (1995) The Yogo sapphire deposit. *Gems & Gemology* 31, 1, p. 28–41, illust. (col.), map.

NEW MINE SAPPHIRE SYNDICATE (1914) *A Royal Gem: A Monograph on the Sapphire with a Brief History of the "New Mine."* London, 44 p., 6 col. plates, illust. By the company mining at Yogo.

NORTHWEST MAGAZINE (1892) The English sapphire company. Vol. 10, 11, p. 42.

______, (1899) Yogo sapphire mine interests sold. Vol. 17, 8, p. 40.

______, (1901) Yogo sapphire. Vol. 19, 1, p. 43.

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VERBIN, E. (1993) AMAX breaks ground for U.S. gems. *Colored Stone* 6, 4, p. 1, 19–22, illust.

VOYNICK, S. (1985) The sapphire of Yogo Gulch. *Rock & Gem* 15, 4, p. 52–57, *passim*, illust.

______, (1985) *The Great American Sapphire.* Missoula, MT: Mountain Press Publ. Co., 199 p., illust. (col.), maps. Rev. edit. issued in 1987.

______, (1987) New Yogo sapphire. *Rock & Gem* 17, 8, p. 24–28.

______, (1993) Montana sapphire. *Compressed Air Magazine* 98, 8, p. 18–25, illust. (col.).

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ZEIHEN, L. (1987) The sapphire deposits of Montana. In Directory of Montana Mining Enterprises for 1986. *MT Bur. Mines & Geol. Bull.* 126, 56 p., maps. Zeihen p. 28–40, illust.

According to Zeihen (*see above*, p. 38) an unimportant gravel sapphire deposit is located in Benton Gulch Creek, about 9 mi (14 km) west of Fort Logan on the east flank of the Big Belt Mountains in eastern Meagher County.

In the sapphire-bearing gravel stretches of the Missouri River, in the area located approximately 21 mi (34 km) northeast of Helena, Lewis & Clark County, from five to seven sapphire mining operations may be active at one time. A variable number are open to the public on a fee basis for digging and washing gravels, or purchasing "concentrated" gravel by the bucket and then washing the contents. Collecting experiences are recorded by many persons in the references given below. Clabaugh (1952) notes that gravels containing sapphires mostly lie upon benches or terraces that border the river and rise to elevations as much as 200 ft (60 m) above river level. These "bars" have been flooded in part by the waters impounded behind dams along the Missouri River. Nevertheless there are many exposures of gravel that are thick and cover considerable area, suggesting that very large reserves of "ore" remain to be exploited. The origin of these sapphires remains unknown, but their abraded appearance suggests transport from some distant source. Zeihen (1987, p. 35) states that he "has never seen crystals from the Missouri River bars that did not have a frosted and partially rounded appearance, even though many retain easily recognizable hexagonal prisms, basal pinacoids and rhombohedral faces." These are the crystals that are washed from the gravels by visitors to the fee-digging operations, of which Ream (1992) identified only two that were operating recently, one upon the Spokane Bar and the other on the Eldorado Bar. Other bar mines that have operated in the past include the Lovestone, Castles, and the French Bar Mine, the last described by Voynick (1988). The lure of possibly finding a truly fine gem sapphire is powerful, and each year draws thousands of visitors to try their luck.

An ingenious though financially unsuccessful attempt to dredge for sapphires from the bed of Hauser Lake, which floods a part of the Missouri River Valley in the area, was made by Mac M. Mader, Jr., in 1971 (Voynick, 1988; Zeihen, 1987; Zeitner, 1978). This is probably the dredge referred to by Austin (1993), which recovered one of the largest river sapphires, a crystal of 24 carats from which was cut a fine blue mixed-cut faceted gem of 12.54 ct. It is illustrated in color on the cover of Zeihen (1987). The gem measures 13.44 x 12.98 x 8.50 mm; however, Austin (1990, p. 15), in discussing Mader's dredge, gives the rough weight as 29.75 ct and the cut weight as 13.54 ct. Austin also mentions that the largest stone known to him from the Missouri River gravels weighed 72 ct in the rough and was reddish-purple in color; from it were faceted a 14.75 ct gem and two smaller gems. In discussing the large faceted gem of 12.54 (13.54 ct?), dubbed the "Big Sky Sapphire," Voynick (1988) estimated its value at $250,000.

Among the more interesting recent visitor accounts is that of Selbert (1993) who noted that in the Spokane Bar Mine, operated by D. Thompson, the largest recorded sapphire crystal weighed 155 carats, while "good sapphires weighing 20 to 30 carats are not too unusual." The owner of the property possesses a 50 ct blue crystal and 10 ct yellow crystal.

The recovery of sapphires from the gravels of the bars is essentially a simple earth-moving process using heavy equipment, trucks for transport, and mechanized washing/sorting equipment to minimize the amount of concentrates from which the stones may be picked. In 1991, for example, Gem Resources Management Corporation of Helena, Montana, placed an advertisement in *Lapidary Journal* (44, 11, p. 11) showing a view of their earth-moving operation which involved digging to considerable depth into lower layers of the bar gravel deposit using bulldozers and large trucks for haulage. In their advertisement they offered mine run rough, 2 to 15 ct sizes, 80%–90% clean, for $4,000 per kilogram (5,000 ct), and heat-treated rough at $10,000 per kilogram. Austin (1993) reported a rumor that a parcel of 3–10 ct stones, suitable for faceting, fetched $40,000 per kilogram, but stated that a more realistic price would be in the range of $5,000 per kilogram, with "many kilograms of mine-run rough selling for $1,000 per kilogram." Insofar as amateur digging is concerned, Zeihen (1987) noted that daily fees ran about $25 to $30 a day per person, or $40 for a couple. Concentrate buckets (five mine-run buckets reduced to one) sold for $25 to $30 per bucket. Voynick (1988) cites production figures from the Montana Bureau of Mines and Geology, who estimate that the total Missouri River production since 1865 is over 100,000 ounces to as much as one-half million ounces or 64 million carats.

As an interesting sidelight on digging in the Missouri River gravels, *Jewelers Circular-Keystone* (Jan. 1986, p. "g") carried a story of the Internal Revenue Service refusing to allow deductions for expenses in connection with a mining venture which they claimed was no more than an abusive tax shelter.

The discovery of the effectiveness of heat treatment in bettering the color of some corundums, especially for stones of a milky cast from Sri Lanka and elsewhere, understandably led to experiments directed toward improving Montana stones. Such heat treatments could improve color, or change color from an indifferent to a more desirable one, or eliminate annoying centrally-located inclusions in certain Montana River sapphires which reduced their brilliancy when cut. Themelis (1992, p. 211) describes results obtained by systematically subjecting gravel sapphires to heat treatments of several types. Improvements that could be expected were a desirable change of the greenish-blue color in many stones to a pure blue, although these attempts were not always successful. Austin (1993) believes that from 20% to 30% of all Missouri River stones are routinely heat treated from colorless, or faintly colored, or greenish, to pale to deep blue.

AUSTIN, G. T. (1990) Montana gem production on the rise. *Colored Stone* 3, 2, p. 14–15.

_____, (1993) The changing color of U.S. sapphires. *Colored Stone* 6, 1, p. 370–371.

BANCROFT, P. (1984) *Gem & Crystal Treasures.* Fallbrook, CA: Western Enterprises, 488 p., illust. (col.). Early sapphire mining in Montana; color photo of "Big Sky" sapphire gem.

BARGERON, F. (1981) Rainbows on the river. *Lapidary J.* 25, 4, p. 966–968, illust. Collecting experiences.

BIRDSALL, M. (1979) Eldorado's sapphires. *Lapidary J.* 33, 2, p. 524–536, illust. Details on recovery machinery.

CLABAUGH, S. E. (1952) Corundum deposits of Montana. *USGS Bull.* 983, 100 p., illust., maps.

DROULLARD, S. (1978) Yogo, Montana sapphire. *Gems & Minerals* 490, p. 40, 41, 61, 62. Includes notes on the river diggings.

HARRIS, H. (1964) Digging sapphires in Montana. *Lapidary J.* 18, 5, p. 616–619.

HARSTAD, A. J. (1926) Montana sapphires. *Rocks & Minerals* 1, 3, p. 21–22.

HUGHES, R. W. (1990) Corundum; *Ruby & Sapphire* (1995). *See above.*

HUME, E. (1962) Sapphire safari. *Lapidary J.* 16, 2, p. 286–288.

JOHNSON, B. (1972) Sapphire hunting deluxe. *Lapidary J.* 26, 4, p. 614– 615, map.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). Missouri River stones p. 48–49.

_____, (1892) (1) Tysonite . . . (4) Sapphire. *Min. Mag.* 9, p. 394–396.

MAGGART, H. (1980) Fee digging in the Northwest. *Lapidary J.* 34, 3, p. 710–714, illust. Includes Missouri River.

_____, (1981) Sapphires of Montana. *Lapidary J.* 35, 7, p. 1444–1448, illust.

MUNDAY, V. F. (1978) Sapphire mining in Big Sky country. *Lapidary J.* 31, 10, p. 2190–2193, map.

MURDOCK, H. E. (1939) Sapphire mining in Montana. *The Mineralogist* 7, 11, p. 399–400.

NORTHWEST MAGAZINE (1891) Sapphires in Helena, Montana. Vol. 3, 8, p. 41.

_____, (1893) Sapphire fields of El Dorado Bar. Vol. 11, no. 8, p. 36.

POUGH, F. H. (1993) Montana revival. *Lapidary J.* 47, 5, p. 65–74, *passim*, illust. On sapphire mining in general.

_____, (1993) Montana originals. *Lapidary J.* 47, 6, p. 47–50, illust. (col.). On the sapphires.

REAM, L. R. (1992) *The Gem, Mineral & Fossil Collector's Guide to Montana.* Vol. 1, Coeur d'Alene, ID: L. R. Ream Publ., 40 p., illust., maps, p .19.

SCHOOLER, R. (1977) Sapphire country, where and how to find the gem of many colors. *Lapidary J.* 31, 7, p. 1646–1651, map.

SELBERT, P. (1993) Bar on the terrace. *Lapidary J.* 46, 11, p. 67–74, *passim*, illust. Spokane Bar.

SPENDLOVE, E. (1983) French Bar sapphire. *Rock & Gem* 13, 11, p. 52–55, 72–73, map.

THEMELIS, T. (1992) *The Heat Treatment of Ruby and Sapphire.* Clearwater, FL: Gemlab, Inc., 236 p., illust. (col.).

TOWNER, J. M. (1981) Sapphire and gold. *Lapidary J.* 35, 3, p. 640–644, illust.

UNDERWOOD, W. D. (1900?) *Prospectus of the Montana Gem Stone and Gold Mining and Milling Co.*, 30 p. No place, no date. Eldorado Bar.

VOYNICK, S. (1985) *The Great American Sapphire.* Missoula, MT: Mountain Press Publ. Co., 199 p., illust. (col.), maps. Rev. edit. 1987.

______, (1988) French Bar sapphires. *Rock & Gem* 18, 12, p. 16– 26, *passim*, map.

[VOYNICK, S.] (1993) Montana sapphire. *Compressed Air Magazine* 98, 8, p. 18–25, illust. (col.). Excellent review.

WALKER, D. & WALKER, C. (1990) Montana mining. *Lapidary J.* 44, 3, p. 73–75, maps. Includes Missouri River mines.

WILLIAMS, A. K. (1945) Pioneer sapphires. *Rocks & Minerals* 20, 10, p. 476.

WILSON, M. M. (1976) Montana's treasure. *Lapidary J.* 30, 1, p. 100–114, *passim;* 2, p. 494–502, *passim*, illust.

______, (1977) Sapphire blue. *Lapidary J.* 31, 1, p. 32–44. *passim*, illust. (col.).

WURFEL, D. M. (1979) Mining for Montana sapphire, a collector's guide to five mines. *Lapidary J.* 33, 4, p. 752–755, maps. Missouri River; Rock Creek.

YOUNG, M. W. (1969) Sapphire on Eldorado Bar. *Gems & Min.* 383, p. 28–31, map.

ZEIHEN, L. (1987) The sapphire deposits of Montana. In *MT Bur. Mines & Geol. Bull.* 126, 56 p., maps. Zeihen p. 28–40, illust.

ZEITNER, J. C. (1978) The Big Sky sapphire. *Lapidary J.* 32, 6, p. 1244–1254, *passim*, illust.

In another area, Zeihen (1987) locates the Big Spring Creek deposit, mined originally for gold but yielding a few sapphires, as about 13 mi (20 km) northwest of Rock Creek in Granite County. In the 1920s and 1930s some mining was done here, but recent investigations show that the ground is too swampy and bouldery to be mined profitably.

The sapphires of the Rock Creek area are to be found primarily in the gravel-floors of Sapphire (Meyer) and Anaconda gulches, on the northern side of the West Fork of Rock Creek, Granite County, about 16 mi (25 km) southwest of Philipsburg. According to Clabaugh (1952), the beds range from 30 to 200 ft (9–60 m) wide and from a foot (30 cm) to 8 to 10 ft (2.4–3.3 m) in depth. However, Jones (1977) reports that "pay dirt" gravel ranges from 3 to 6 ft (1–2 m) deep and lies upon bedrock; it must be exposed by bulldozing away an overburden that is 10 to 20 ft (2.2–4.4 m) deep.

The Rock Creek properties are owned in part by Skalkaho Sapphires, Marc Bielenberg of Hamilton, Montana, president, who acquired them in 1964. Two adjacent parcels are owned and operated by Buster Hess and Will Chaussee. The Bielenberg property was thoroughly examined and opened to public fee-digging in 1976. Chaussee's venture is called the M. T. Chaussee Sapphire Corporation, headquartered in Philipsburg. According to Young (1981), the Chaussee property was once known as the American Bar Sapphire Mine and owned by Mr. & Mrs. William Eaton of Seattle, Washington, who sold the property in 1966 or 1967 to Chaussee. The property again changed hands in 1980 when it was sold to Richard & Joan Tapin who then gave it the name of Gem Mountain Sapphire Mine. The mine office is located on Highway 38, about 40 mi (63 km) east of Grantsdale. In 1993, they offered 3 lb (1.36 kg) bags of concentrate via mail-order for $17.50 per bag, or two bags for $30.00. In 1992, according to Catalano (1992), Joel E. Arem of Laytonsville, Maryland, acquired a part ownership in some of the Rock Creek property, now known as Skalkaho Grazing, Inc., and announced plans to extensively exploit the deposits in which it is estimated that over 100 million carats of sapphires remain. The average size of the crystals is expected to fall in the range of 0.5 to 1.5 carats.

While the average size of Rock Creek area sapphire crystals is small, the crystals can be much larger, as evidenced by the faceted gem known as the *Chaussee Queen*, as described in a story in the *Montana Standard*, June 20, 1983, Butte. The rough crystal was mined at least 40 years ago but

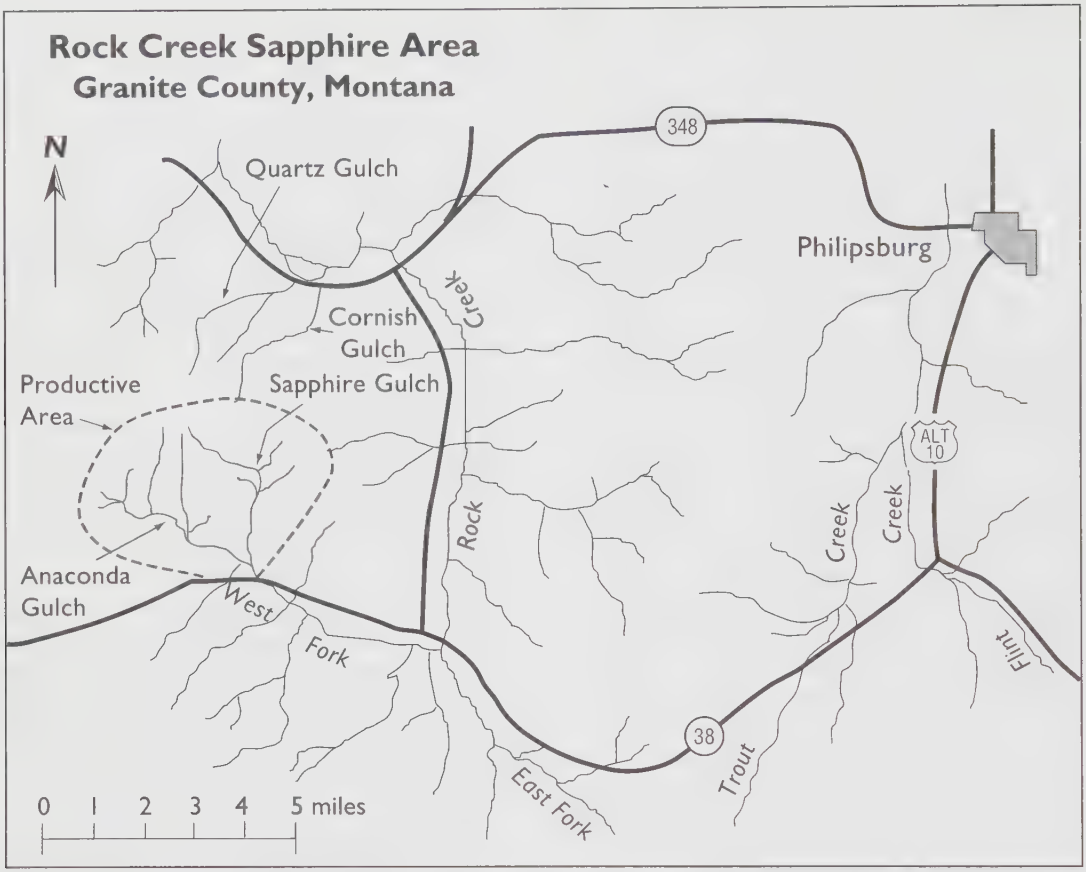

FIGURE 20. Sketch map of Rock Creek, Granite County, Montana, sapphire area showing productive gulches.

was traced by the present owner of the gem, Ken Clevish, to Los Angeles, where it was purchased, and returned to Montana. The crystal was then cut into the gem mentioned, weight 14.75 carats, and two smaller gems. The gem was placed on exhibit in the Chaussee jewelry store in Missoula.

Rock Creek area crystals are typically somewhat larger than those from the Missouri River bars and cover a wider range of hues (Austin, 1993). Zeihen (1987) states that they "have perhaps the widest range of colors (black to clear) of any deposit in the world." He notes that although deep blue sapphires and true rubies are very rare, other colors are "unequaled and include pale ruby, pink, salmon that passes into yellow, pure yellow, yellowish brown, deep brown, pale blue, bluish green and green." Multicolor crystals are common, often with one color surrounding a core of a different hue. Occasionally a fine orange stone will be found, a true padparadscha, and then it is worth more than the ordinary run of sapphire.

Jones (1977) notes the common presence of fibrous rutile inclusions or "silk" in the stones, which at times are so abundant that some stones can be cut to yield cat's-eyes, while others may show some asterism, especially in crystals that contain numerous negative crystals or are brown in color.

In regard to heat treatment aimed at improving color and/or eliminating inclusions, Themelis

(1992, p. 212) states that about one-third of Rock Creek crystals need no treatment, but some that show "fancy colors" do, and also those that contain silk. Such crystals "may be heated to improve their transparency, reduce purplishness and generally, improve their overall appearance." J. E. Arem (*Pers. comm.* 2/93), preparing to intensively heat-treat Rock Creek sapphires, notes that these stones possess the requisite "internal chemistry" which enables heat treatment to succeed. Much of the silk in the stones is re-dissolved within the crystal structure of corundum not only to be removed as an impediment to the passage of light through the stone, but also to contribute titanium ions which provide blue color centers. Arem's experiments in heat treatment suggest that the standard practise should be to heat-treat all stones, from which, claims Arem, "we get 50 percent in blue and 50 percent in fancy [colors]." O'Donoghue (1992) states that "the best Rock Creek stones are sent to Dale Sigford of Philipsburg, Montana . . . for heating," and "the process gives fine blues and greens but I found the pinks, orange and yellows particularly fine and able to compare with heated or natural corundum from any other world source." O'Donoghue also notes that heat treatment is now routinely performed for stones from Dry Cottonwood Creek as well as from Eldorado Bar, Missouri River. Similar comments appear in Koivula & Kammerling (1991), who furnish two-color photographs showing significant improvement in color due to heat treatment.

The latest and most authoritative study of the heat treatment of Rock Creek corundum was published in 1993 by Emmett & Douthit, who provide a valuable preliminary historical sketch of Rock Creek mining since its beginning in the last century and follow this with the results of meticulously performed tests upon large samples of rough supplied to them by Skalkaho Grazing. These experiments were motivated by renewed interest in the feasibility of large-scale mining as mentioned above. From previous core drilling results performed by the Day Mining Company in 1972 and 1973, it was found that an ore sample of 3,700 cubic yards yielded 47 carats of sapphires per cubic yard, and that "subsequent studies conservatively calculated a recoverable reserve over 25 million carats for the portion studied" (Emmett & Douthit, 1993, p. 252). The significant results of heat treatment show that in over 75,000 stones studied, about 65% to 70% of the pale blue, pale green, and near-colorless crystals could be changed to "well-saturated blue and yellow colors." This success in converting rather drab hues to those that are lively and more commercially acceptable casts new light on the feasibility of large-scale, profitable mining of sapphire-bearing gravels in Montana.

AUSTIN. G. T. (1993) The changing color of U.S. sapphires. *Colored Stone* 6, 1, p. 370–371, illust.

CATALANO, D. A. (1992) Hot sapphires are overflowing in Rock Creek. *Colored Stone* 5, 2, p. 1, 29, illust. (col.).

CHRISTENSEN, S. L. (1959) Cornish sapphire. *Gems & Minerals* 502, p. 46, 59, map. Sapphire from Cornish Gulch, Philipsburg area.

CLABAUGH, S. E. (1952) Corundum deposits of Montana. *USGS Bull.* 983, 100 p., illust., maps.

EMMETT, J. L. & DOUTHIT, T. R. (1993) Heat treating the sapphires of Rock Creek, Montana. *Gems & Gemology* 29, 4, p. 250–272, illust. (col.).

JONES, R. (1977) Rock Creek sapphires. *Rock & Gem* 7, 12, p. 36–40, 42, 86–89, illust.

KOIVULA, J. I. & KAMMERLING, R. C. (1991) Gem news. Montana sapphire heat treatment. *Gems & Gemology* 27, 3, p. 186, illust.

LAPIDARY JOURNAL (1975) Skalkaho Sapphire, Inc., progress report. Vol. 29, 9, p. 1696–1697.

O'DONOGHUE, M. (1992) *Gemmological Newsletter*, vol. 22, 2.

SPENDLOVE, E. (1982) Gem Mountain Sapphire Mine. *Rock & Gem* 12, 5, p. 52–55.

______, (1985) Gem Mountain sapphire. *Rock & Gem* 15, 11, p. 48–51, map.

THEMELIS, T. (1992) *The Heat Treatment of Ruby and Sapphire.* Clearwater, FL: Gemlab, Inc., 236 p., illust. (col.).

VOYNICK, S. (1987) Rock Creek sapphire. *Rock & Gem* 17, 12, p. 44–46, 48, 50, 79, map.

WURFEL, D. M. (1979) Mining the Montana sapphire, a collector's guide to five mines. *Lapidary J.* 33, 4, p. 952–955, maps. Includes Rock Creek area.

WINTER, J. B. (1958) A new sapphire diggings. *Lapidary J.* 12, 1, p. 78, 80. Philipsburg area.
YOUNG, M. W. (1981) Sapphire at Gem Mountain. *Gems & Minerals* 526, p. 82–85, map.
ZEIHEN, L. G. (1987) The sapphire deposits of Montana. In: Directory of Montana mining enterprises for 1986. *MT Bur. Mines & Geol. Bull.* 126, 56 p., illust., maps, p. 29–40.

The Dry Cottonwood Creek sapphire gravel area is located about 8 mi (13 km) due east of Warm Springs, Deer Lodge County, or about 12 mi (19 km) northwest of Butte. The gravels, originally mined many years ago for gold, occur in the upper 4 mi (6.4 km) of the South Fork, Dry Cottonwood Creek, at an altitude of over 6,000 ft (1,830 m). Apparently the sapphires do not provide large cut gems because, as Zeihen (1987) notes, "a large percentage of the material recovered was not suitable for cutting into gemstones and, as usual, those that would net more than a carat were rare." The early history of mining here is given in considerable detail by Voynick (1990), who notes that Marc Bielenberg acquired mining rights in 1964 from the owners, the Nat Simon family. In this same year Bielenberg also acquired a part of the Rock Creek deposit. His sale of this property in 1988 enabled him to acquire the Dry Cottonwood Creek property. With his patented adjacent claims, Bielenberg now owns 1,090 acres at Dry Cottonwood Creek.

Themelis (1992, p. 214) notes that the predominant colors of these sapphires are blue, blue-green, and green-blue, with fancy colors of pink to salmon, and others. Heat treatment yields results that approximate those obtained on other Montana river stones. Koivula & Kammerling (1991) provided color photographs showing enhancement in blue and yellow stones by heat treatment, noting that Bielenberg "has been working with Dale E. Siegford of Missoula, Montana, a specialist in the heat treatment of Montana sapphires" from Bielenberg's Dry Cottonwood Creek Mine. The blue crystals showed the greatest improvement. Some of the silk-included crystals were also improved. Themelis is of the opinion that the rate of improvement in heat treatment is greater for the Dry Cottonwood Creek stones than for Missouri River stones.

KOIVULA, J. I. & KAMMERLING, R. C. (1991) Montana sapphire heat treatment. Gem news. *Gems & Gemology* 27, 3, p. 186–187, illust. (col.).
THEMELIS, T. (1992) *The Heat Treatment of Ruby and Sapphire.* Clearwater, FL: Gemlab, Inc., 236 p., illust. (col.).
VOYNICK, S. (1990) The sapphire of Dry Cottonwood Creek. *Rock & Gem* 20, 10, p. 48–51, 82, 84, 85, illust.
ZEIHEN, L. G. (1987) The sapphire deposits of Montana. In: Directory of Montana mining enterprises for 1986. *MT Bur. Mines Geol. Bull.* 126, 56 p., illust., maps.

A minor sapphire gravel deposit is located along Loveland Creek, located about 12 mi (19 km) north of Butte, between the Ruby Mine and Boulder River, Silver Bow County. According to Zeihen (see above), a dredge worked the gravels in the lower part of the creek but recovered only a few sapphires. Sapphires have also been reported from Browns Creek where the gravels were washed for gold originally but did produce a few sapphires; this locality is about 3 mi (5 km) northwest of Butte, Silver Bow County. Zeihen mentions other minor occurrences of sapphires near Bozeman, from Sweetwater Creek on the Upper Ruby River, Madison County, from Alder Creek near Virginia City, Madison County, and Camp Creek southeast of Dillon in Beaverhead County. He concludes that sapphires will be discovered in many areas of southwestern Montana, but the fact remains that "the biggest problem with Montana sapphires is their small size, and it seems unlikely that a deposit of significantly larger stones will be discovered."

WYOMING. Gem quality corundum has been reported in only a few places in the state, although it is possible that more intensive searches may uncover other deposits. Love (1990) explored various occurrences in the Granite Mountains of central Wyoming; these and other occurrences are described by Sutherland (1990) as follows.

Ruby of doubtful usefulness for faceted gems has been found in several places in the Granite Mountains at a place 16 mi (26 km) north-northeast of Jeffrey City, Fremont County, also 7 mi (11 km) west-northwest of Jeffrey City, with sapphire; another site is 23.5 mi (37.5 km) west of Jeffrey City, or 7.5 mi (12 km) southwest of Split Rock. In Albany County, a considerable field in which sapphire finds have been made is centered about 27 mi (43 km) northeast of Rock River; also ruby is reported at a site 16 mi (25 km) east-northeast of Bosler Junction.

LOVE, J. D. (1970) Cenozoic geology of the Granite Mountains area, central Wyoming. *USGS Prof. Paper* 495-C, 154 p., illust., maps.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., maps.

IDAHO. Shannon (1926, p. 193–194) describes blue and green sapphire found near Pierce in Clearwater County, "especially along Rhodes and Orofino Creeks." He examined a large lot of crystals that had been recovered from placer gravel and which varied greatly in color, "ranging from deep blue through pale blue to greenish, chatoyant blue and opaque gray," and some that had blue cores surrounded by shell zones of gray to green corundum. He notes that "none of the material approaches gem quality," but Beckwith (1977) states that "much of the translucent to semi-transparent material—mostly pinkish-gray—if cut in cabochon will display a chatoyancy and an occasional asterism." Themelis (1987) describes his heat treatment of corundum obtained from a deposit of whitish sapphires found in 1982 at a claim located east of Clarkia in an area called the Floodwood Drainage near the Goat Mountains, but in his book on heat treatment of corundums of 1992, he renders the locality name as *Flatwood* Drainage. Here the milky sapphire occurs mostly as crystal fragments in clay and in some specimens, associated in rock with mica and feldspar. Some crystals display hexagonal pyramidal habit and weigh up to 2 gm. They may be derived from pegmatite, some stringers of which have been noted in the vicinity. "Over 65% of these crystals are opaque, (2–3 grams); 30% are translucent, (usually under 1 gram); about 5% are translucent to semi-transparent (up to half carat) and suitable for use as cabochons." Themelis heated these crystals, which resemble the whitish "geuda" crystals of Sri Lanka corundum, in a reducing atmosphere at 1800°C for one hour, and found that over 80% turned medium to dark blue but that there was a distinct patchiness in color. He deems the commercial potential of this material as nil. After heat treatment he found the following properties: specific gravity 3.98–4.2 (hydrostatically); refractive indexes 1.762, 1.770; distinct dichroism of sea-green and medium blue. He found an absorption band in the visible spectrum at 445–455 nm and a weak band at 460 nm.

In Adams County, gray, pink, and pale purple crystals occur in the gold placers of Rock Flat near Meadows, paralleling Brundage Mountain Recreation Area road. Some of these crystals are said to be gem quality with pink and blue stones cut to one half carat (Ream, 1989, p. 158). Beckwith (1977) noted a silky sheen in some of the crystals which would furnish star or chatoyant cabochons. He states that "excellent sapphires of highly desirable gem quality came from material recovered at this location" (p. 70).

Both Ream (1992) and Beckwith (1977) remark on the bronzey-lustered sapphires found in Ruby Creek, southeast of Burgdorf, and along Lake Creek to Burgdorf, in Idaho County. Beckwith also stated that some blue gem quality transparent crystals have been found here.

BECKWITH, J. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: Caxton Printers, 129 p., illust. (maps).

BELL, R. (1907) Sapphires in Idaho. *Mining World* 26, p. 449.

NORTHWEST MAGAZINE (1897) A valuable Idaho sapphire. Vol. 15, 6, p. 42.

OLSON, B. (1938) Gem minerals of the region about Orofino, Idaho. *Rocks & Minerals* 13, 5, p. 148–149.

REAM, L. R. (1989) *Idaho Minerals.* Coeur d'Alene, ID: L. R. Ream Publ. Co., 329 p., illust. (maps).

______, (1992) *The Gem & Mineral Collector's Guide to Idaho.* Vol. 1. Coeur d'Alene, ID: L. R. Ream Publ. Co., 34 p., illust. (maps).

SHANNON, E. V. (1926) The minerals of Idaho. *U.S. Nat. Mus. Bull.* 131, 483 p., illust. Corundum p. 193–194.
THEMELIS, T. (1987) Idaho geuda. *Lapidary J.* 40, 11, p. 57–62, *passim*, illust. (col.).

UTAH. No new developments.

CRAWFORD, A. L. (1936) Hunting sapphires in Utah. *UT Acad. Sci. Proc.* 13, p. 95.

BAJA CALIFORNIA NORTE. Johnson (1963) described a new discovery of blue corundum in the central part of the Sierra Juarez, about 70–80 miles south of the California border and southwest of the El Fenomeno Mine. The find was made by a Sr. Frederico Urias and at the time was placed under claim. The rhombohedral crystals are rough and reached more than one inch long, but "clear material has not come to light at this locality."

JOHNSON, P. W. (1963) New sapphire find in Baja California. *Lapidary J.* 17, 4, p. 449, illust.

OAXACA. Kunz (1883) noted a rolled pebble of sapphire that had been found near San Geronimo.

KUNZ, G. F. (1883) Sapphire from Mexico. *Amer. J. Sci.* 26, p. 75.

COVELLITE

The massive form of this copper sulfide consists of finely-laminar growths of extremely thin crystals. The basic color is grayish-yellow, but upon exposure to air the surfaces quickly tarnish to a rich purplish-blue. The formula is CuS; properties are: refractive index 1.45, uniaxial (+); specific gravity 4.68; hardness 1.5–2. Cabochons or flats cut from massive covellite are so easily damaged that they are cut only as curious cabinet display pieces. Massive material has been found in the Kennecott, Copper River, deposit in mainland Alaska, and in the bottom of the open pit at Butte, Montana, now under water. Butte material has been offered as lately as 1994.

MENDENHALL, W. C. (1905) Geology of the central Copper River Region, Alaska. *USGS Prof. Paper* 41, 133 p., illust., maps.
WEED, W. H. (1912) Geology and ore deposits of the Butte district, Montana. *USGS Prof. Paper* 74, 262 p., illust., maps.

CREEDITE

This rare calcium aluminum sulfate-fluoride, formula $Ca_3Al_2(SO_4)(F,OH)_{10} \cdot 2\ H_2O$, sometimes furnishes faceted gems not over two carats from clear areas within bladed crystals. Properties are: refractive index alpha 1.461, beta 1.478, gamma 1.485, biaxial (-); birefringence 0.024; specific gravity 2.71–2.73. hardness 4. The principal locality for crystals large enough to facet has been Santa Eulalia, Chihuahua, Mexico, especially from the El Potosi Mine in the Municipio de Aguiles Serdan. According to Panczner (1987, p. 172), a watercourse was discovered in the mine in 1984 "that was lined with creedite . . . crystals up to 8 cm (3 in) were found . . . of the deepest violet color ever found within this district." Arem (1987, p. 75) records a 0.96 ct purple faceted gem in a private collection, probably cut from the same material.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).
PANCZNER, W. D. (1987) *Minerals of Mexico.* NY: Van Nostrand Reinhold, 459 p., illust. (col.).

CRYOLITE

This mineral is known principally from the unique pegmatite deposit, now mined out, on Arsuk Fjord, southwestern Greenland. Recently, cryolite from Mont St.-Hilaire, Quebec, has been cut into small, colorless faceted gems. Cryolite is sodium aluminum fluoride, formula Na_3AlF_6; properties: refractive index alpha 1.338, beta 1.338, gamma 1.339, biaxial (+); birefringence 0.001; specific gravity 2.97; hardness 2.5. Its refractive indexes are so low that small clear fragments placed in water disappear from view. Despite its great abundance at Ivigtut, Arsuk Fjord, where it was mined as a flux for the Hall aluminum process, clear areas in its crystals apparently occurred so seldom that there seems to be no record of a faceted cryolite from Greenland. Lately, Arthur Grant of Hannibal, New York, faceted a colorless gem of 1.75 carats from Mont St.-Hilaire material, from rough that must have been found recently as neither Mandarino & Anderson (1989) nor Horvath & Gault (1990) mention cryolite in crystals larger than 2 mm.

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont Saint-Hilaire. *Min. Rec.* 21, 4, p. 281–368, illust. (col.), maps, p. 303–304.

MANDARINO, J. A. & ANDERSON, V. (1989) *Monteregian Treasures: The Minerals of Mont Saint-Hilaire, Quebec.* NY: Cambridge Univ. Press, 281 p., illust. (col.), p. 61.

PETERSEN, O. V. & SECHER, K. (1993) The mineralogy of Greenland. *Min. Rec.* 24, 2, p. 1–65, illust. (col.), p. 25–36.

CUPRITE

In the first volume, cuprite was mentioned in connection with the copper-bearing metarhyolites of Adams County, Pennsylvania, wherein cuprite formed haloes around small blebs of copper, from which it originated (Vol. I, p. 547). This material has been used in cabochons and small ornamental objects. Conceivably, some of the larger crystals of cuprite from Bisbee and other American copper deposits could afford very small faceted gems, although I know none from this continent. However, in another habit of cuprite, in the variety *chalcotrichite*, wherein it forms very slender hair-like crystals, a unique cabochon material has lately come to notice because of a quartzose, possibly chalcedonic rock impregnated by so much chalcotrichite that it appears vivid golden-reddish in color. This material has been found in the large open pit copper mine at Ray, Arizona, and was offered for sale in polished masses at Tucson in February, 1994. Some cabochons of this material are spectacular, especially when bluish chrysocolla inclusions are also present in the chalcedony (*Pers comm.*, W. A. Thompson, Phoenix, 6/93).

"CUPRITE," *see* METARHYOLITE

"DALLASITE"

This term, not approved by the International Mineralogical Association, is a local term in British Columbia for a kind of brecciated basalt rock whose angular fragments are cemented with white chalcedony and quartz. With care, it can be cut and polished into larger objects as bookends. It is found in the Parkville-Qualicum Beach area on the east coast of Vancouver Island and along the shores of Horne Lake and Rosewall Creek (Hutchinson & Hutchinson, 1971). Danner (1976) has also found this material around Buttle Lake and Quadra Island, and also on the west coast of Vancouver Island. The name comes from Dallas Road in Victoria where specimens were found.

DANNER, W. R. (1976) Gem materials of British Columbia. *Montana Bur. Mines & Geol. Spec. Publ.* 74, p. 157–169, illust.

HUTCHINSON, B. & HUTCHINSON, J. (1971) *Rockhounding & Beachcombing on Vancouver Island.* Rev. edit. Victoria, BC: Tom and George Vaulkhard, 59 p., illust., maps.

DANBURITE

NEW YORK. Agar (1923, p. 130) notes the occurrence of gem quality danburite crystals from a place "four and a quarter miles southwest of Russel *[sic]*, and one fifth of a mile southeast from the road between Russel and Edwards, there occurs a concentration of the rare mineral danburite, as beautiful crystals and as massive vein material in a pyroxene schist." He then cites a manuscript of C. D. Nim which describes "danburite in magnificent crystals, some of the smaller size perfect gems, brilliant, transparent, beautifully modified, some of the larger are five inches in diameter and a foot long." However, Agar hastened to add that nothing could be found of this material unless blasting is used to reveal new masses. Possibly from this find came the colorless, round brilliant faceted gem of 1.05 carats in the

FIGURE 20a. Record size danburite crystal group from Charcas, San Luis Potosi, Mexico, standing 23 cm (9 in.) tall (central crystal). Fenn's Gems & Minerals, Las Cruces, New Mexico. *Photo by Jeff Scovil.*

collection of the New York State Museum (Schimmrich & Campbell, 1990). An affirmation of the existence of gem quality material from this locality comes to me from R. & T. Kosnar of Golden, Colorado who sent me a photocopy of a magnificent specimen in their collection which Kosnar believes "to be the best danburite crystal from the U.S." and is from the Russell, St. Lawrence County, locality (*Pers. comm.* 8/10/1994). The very faintly pink transparent and mostly flawless terminated prism measures 2.25 in (58 mm) long and 0.75 in (20 mm) broad and is estimated to be cuttable as a clean gem between 5 and 9 carats.

AGAR, W. M. (1923) Contact metamorphism in the western Adirondacks. *Proc. Amer. Phil. Soc.* 62, 3, p. 95–174, illust.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection Catalogue. *Open File Report* 8m106, 47 p.

SAN LUIS POTOSI. The classic continental source of splendid crystallized specimens of danburite, as well as facet-grade material, is the Charcas area, especially the Mina La Aurora and Mina San Bartolo. Some of the newest material is also the largest and best that has ever been produced. In recent mineral shows at Tucson, Arizona, Benjamin Fenn of Fenn's Gems & Minerals, Las Cruces, New Mexico, offered for sale kilograms of faceting crystals, colorless as usual, and also, as usual, with clear tip portions of the typically wedge-shaped crystals. The sizes easily provide clean material capable of cutting faceted gems of 15 to 25 ct! Some of the major crystals include singles that are as much as 9 in (23 cm) tall and 3.5 in (9 cm) wide, simple in habit, and mostly milk-white except in the terminations. They are commonly coated with small scalenohedra of white calcite. William Larson of Pala Properties, International of Fallbrook, California, showed me a clear crystal tip section that weighed 205 ct and is expected to facet into a gem of at least 100 carats, which should establish a world record for this species.

DATOLITE

NEW JERSEY. In the period 1991–1992, collectors found clear, faintly green datolite crystals in the Millington Quarry, Somerset County that measured up to one inch (2.5 cm) across and yielded clean faceted gems up to 5 carats (*Pers. comm.*, R. & T. Kosnar, 8/10/1994).

MICHIGAN. Massive datolite nodules, so characteristic of the copper deposits of the Lake Superior region, are still being found in many mine dumps in the Copper Country of Keweenaw Peninsula. They are also being mined, as noted below. One of the earliest mentions of this form of datolite is that in Foster & Whitney (1850, p. 88), who noted its presence in veins on Isle Royale. Several years later, Whitney (1859) mentioned its abundance in massive form on "Kewenaw Point," describing it as "massive, translucent, highly vitreous in lustre, and of light flesh-red color, owing to the presence of a minute quantity of suboxyd of copper [cuprite] diffused through it," and occurring in the Hill vein at the Copper Falls location. Furthermore, "at the Minnesota mine . . . some singular nodules were observed looking like rusty cannon balls. On breaking one of these open and examining it, it was found to be datholite *[sic]*, in a singular and hitherto unobserved form." Whitney noted the conchoidal fracture and the resemblance of the datolite to "the purest and most close-grained marble. Its hardness = 4.5; specific gravity 2.983."

The datolite nodules are now treasured collector's items because of their considerable variety of colors and subtle color zonings in some specimens. Heinrich (1976) employs such a polished nodule in a color photograph on the cover of his book; Wilson & Dyl (1992) provide a full color page of nodules, while others are splendidly depicted in color by Sukow (1991). The origin of the colors within the nodules has been minutely examined by Sukow who provides the first scientific study of the nodule color problem. The nodules for this study were selected from specimens obtained from over 30 mines on the Keweenaw Peninsula, and also several from non-mine sources. Many were chosen from specimens in the Seaman Museum, Michigan Technological University, Houghton, and from various private collections, especially the Jackman Collection.

Sukow provides a table of nodule colors and the features of such nodules. The hues are reds, oranges, yellows, greens, blues, violets, black, browns, and white, and some are variegated. He is convinced that the reds are colored by the finely fibrous chalcotrichite variety of cuprite and not by native copper as is commonly assumed. The yellow color appears to be inherent in the datolite and is not due to inclusions; a similar finding applies to green nodules. However, "the more

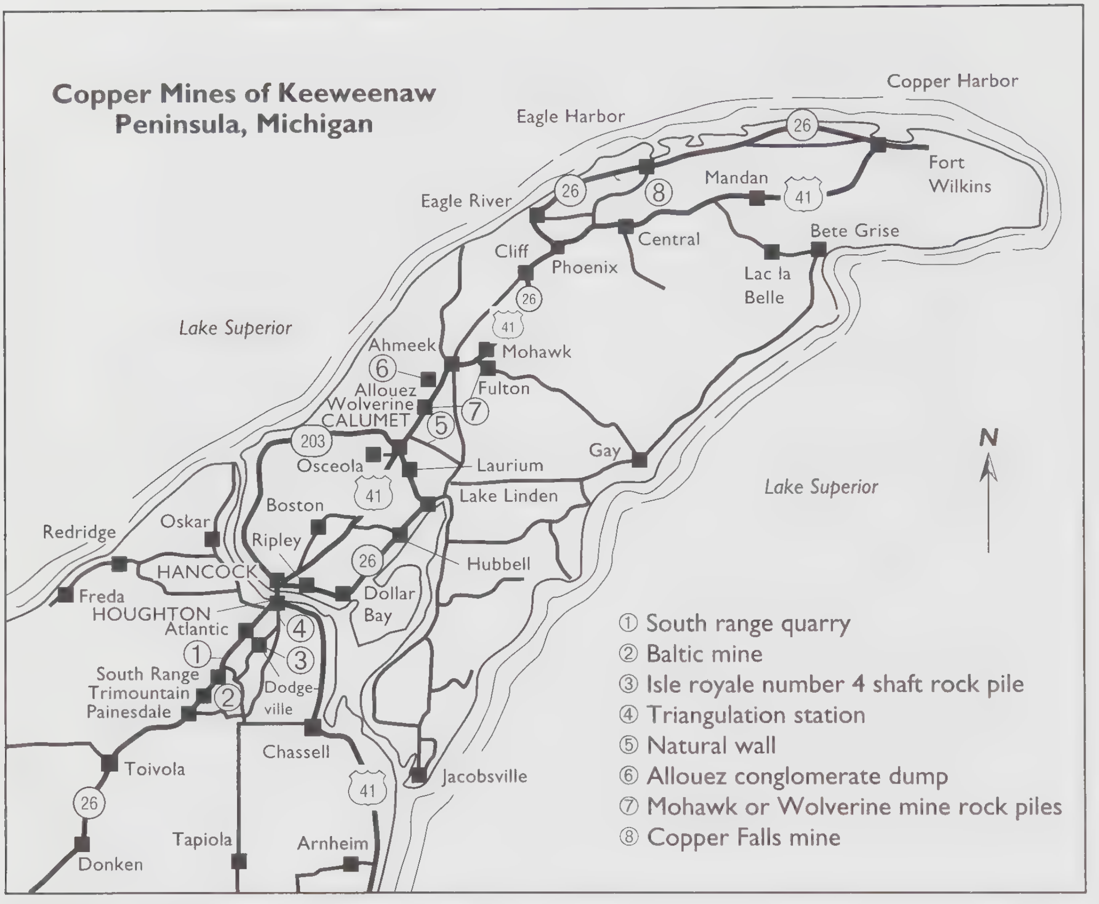

FIGURE 21. Sketch map of copper mine locations and collecting sites on the Keeweenaw Peninsula of Michigan.

common green is an opaque green-on-white due to very tiny raspberry shaped copper aggregates that have an outer coating of green malachite." No specific cause of color is assigned to nodules of blue, violet, or black; however, in the case of brown nodules, the color appears to be due in part to native copper specks. In his concluding remarks, Sukow suggests the following copper minerals as possible coloring agents: chalcotrichite, cuprite, malachite, tenorite and bornite.

In the past several years, Richard Whiteman, President of Red Metal Minerals of Hancock, Michigan, has turned his company's efforts toward mining datolite nodules in the Caledonian Mine, Knowlton Lode, Ontonagan County. His miner also produce specimens of native copper. Whiteman (*Pers. comm.* 2/92) states that the white and colored datolite nodules occur in fissures whose wider parts may be filled with a soft clay-like material, commonly with native copper present. Generally the nodules are no larger than an inch or two, with those of several inches being rare. His largest nodule weighed 5 lb (2.3 kg); he has seen nodules from other mines that weigh as much as 50 lb (23 kg). Whiteman also notes that datolite nodules are sometimes recovered by scuba divers from places offshore where veins outcrop.

BROCKETT, B. O. (1972) Rock trails in Michigan's copper country. *Lapidary J.* 26, 3, p. 490–499, illust., map.

_____, (1974) Four thousand years of copper mining. *Lapidary J.* 28, 4, p. 712–721, illust., map.

FOSTER, J. W. & WHITNEY, J. D. (1850) *Report on the Geology and Topography of a Portion of the Lake Superior Land District.* Part I. Copper Lands. Washington, House of Rep., 224 p., plates, maps.

HARRINGER, R. V. (1990) Copper country. *Lapidary J.* 44, 1, p. 65–74, *passim*, map.

HAYES, A. A. (1859) Datolite from Lake Superior. *Proc. Boston Soc. Nat. Hist.* 1859, p. 348, 349, 354.

_____, (1861) On the occurrence of massive datolite in the mines of Lake Superior. *Ibid.* vol. 8, p. 62–64.

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Div. Bull.* 6, 225 p., illust.

MIHELCIC, J. F. (1956) Datolite in the copper country. *Gems & Minerals* 223, p. 19, 77.

OLDERS, S. (1975) Michigan's copper country. *Rock & Gem* 5, 1, p. 24–26, 50, 51, 79, 81, illust.

OSANN, A. (1895) Ueber Datolith vom Lake Superior und die ihn begleitenden Mineralien. *Zs. Krist.* 24, 6, p. 543–554, plate. Crystals.

PUMPELLY, S. (1871) The paragenesis and derivation of copper and its associates on Lake Superior. *Amer. J. Sci.* 2, 34 p.

SPIROFF, K. (1967) *Guidebook for mineral collectors in the Keweenaw copper country.* Houghton, MI: MI Tech. Univ. Press, 10 p., figs., map.

SUKOW, W. W. (1991) Datolite data. *Lapidary J.* 45, 1, p. 34–46, *passim*, illust. (col.).

WHITNEY, J. D. (1859) Notice of new localities, and interesting varieties of minerals in the Lake Superior region: supplementary to the chapter on this subject, in Part II of the Report of Foster and Whitney. *Amer. J. Sci.* ser. 2, 28, p. 8–20.

WILSON, M. L. & DYL, S. J. (1992) The Michigan copper country. *Min. Rec.* 23, 2, p. 1–72, figs., illust. (col.). Datolite p. 61–62.

ZEITNER, J. C. (1987) Four American beauties. *Lapidary J.* 41, 4, p. 34–41, illust. (col.). Datolite p. 40–41.

_____, (1988) *Midwest Gem, Fossil and Mineral Trails: Great Lakes States.* Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps.

MINNESOTA. Berkey (1895) noted datolite nodules found with other pebbles on the shore of Lake Superior near Flood Bay, Sec. 29, T53N, R10W by Mr. Brandt and Mr. A. H. Elftman. The material was pure white and "all tests agree perfectly for datolite."

BERKEY, C. P. (1985) Notes on Minnesota minerals. *Minn. Geol. Sur. Annual Report* 23, p. 194–202.

DIAMOND

Perhaps the single most important event that has recently taken place is the confirmation of diamonds *in situ* at numerous points in the continent, from Canada into the United States. Only a few years ago the sole *in situ* occurrence was that at Murfreesboro in Arkansas, but now diamonds have been found where previous speculations said they would be found—in the glaciated portions of ancient crustal rocks of the North. It is helpful here to provide a general review of the nature of the rocks in which diamonds occur, and the places where such are likely to be found. Excellent summaries are provided by Kirkley, *et al* (1991) and Levinson, *et al* (1992, from which treatises most of the information below is derived.

Levinson, *et al* (1992) point out that despite a possible 100,000+ carats production from the Arkansas diamond-bearing pipe deposit, this mine and some other diamond deposits recently discovered are uneconomical to operate. However, this picture may change as further discoveries are made in those regions of the continent favorable to intrusion by diamondiferous igneous rocks. Economic kimberlites, the most abundant diamond host rocks, are concentrated in the earliest-formed portions of the earth's crust, known as *cratons*, which are of Archean age, generally older than 2,500 million years, and remained unchanged by deformations for very long periods of time, mostly more than 1,500 millions of years. Janse (1984, 1994) divided cratons into three age groups:

1. Archons—Archean age, older than 2,500 MY.
2. Protons—early to middle Proterozoic age, 2,500–1,600 MY.
3. Tectons—late Proterozoic age, 1,600–800 MY.

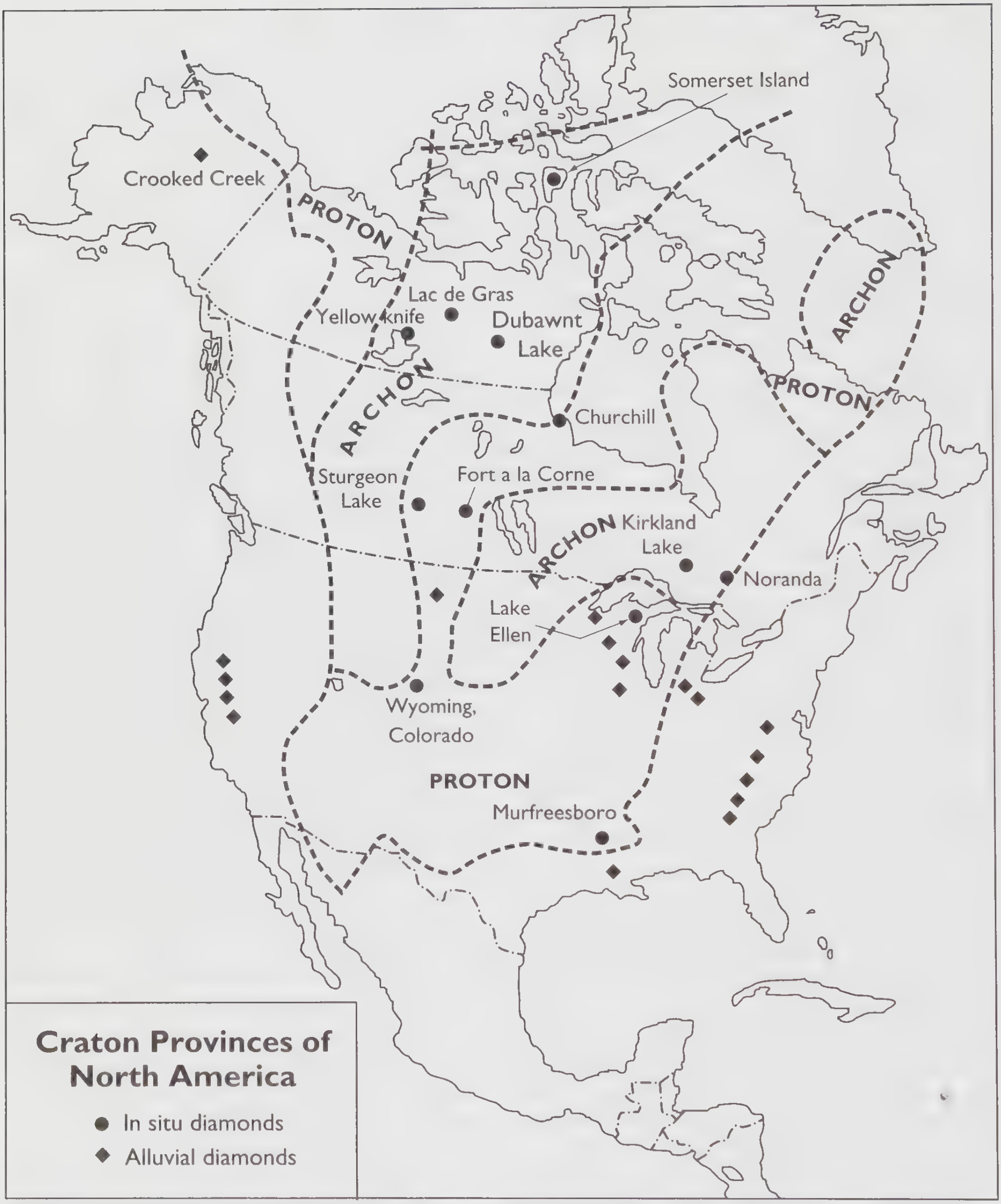

FIGURE 22. Generalized map showing approximate extents of cratonic rocks in the North America, with locations of *in situ* and alluvial diamond fields indicated.

Up to now, all economic diamond deposits have been found in Archons, while in Protons, in which a diamondiferous rock known as lamproite occurs, only the very large and highly productive Argyle deposit in Western Australia and the Murfreesboro pipes in Arkansas yield diamonds. However, another group of kimberlite dikes, confirmed recently as containing many very small diamonds extends in a north-south belt from the southeastern corner of Wyoming into adjacent Colorado to the south. It is possible that an economic deposit will be worked here, as evidenced by the discovery in 1994 of splendid gem quality crystals in two bodies at Kelsey Lake in Colorado (*see below*). The largest crystal weighed 14.2 carats.

The third group of cratonic rocks, the Tectons, do not contain any known diamond deposits. Figure 22, after Levinson, *et al* (1992), shows that enormous regions of North America are underlain by the several types of cratonic rocks. According to these authors (p. 247), "North America contains the largest known craton in the world," and "on the basis of this favorable geology and the intensity of the current exploration, we predict that Canada will be a major producer of diamonds by the second decade of the 21st century." The most recent reviews of kimberlite and lamproite occurrences in the United States are by W. D. Hausel (1994, 1995).

The special diamondiferous rocks, kimberlite and lamproite, as explained by Kirkley, *et al* (1991), are "only the transporting mechanisms for bringing diamonds to the surface" from deep-seated sources. Furthermore, they are "not genetically related to diamonds." In fact, most kimberlites only contain very small, uneconomic quantities of diamonds or do not contain any diamonds at all. When fresh, kimberlite is dark colored, hence the name "blue ground" applied to it in the South African diamond deposits. It reaches the surface via a long pipe or fissure which typically flares outward into a trumpet-like shape near the surface. It weathers easily and therefore tends to form shallow, commonly circular depressions, known as "pans" in South Africa, and spotted by aircraft in Siberia where they cast conspicuous shadows during hours of low-angle sunlight. In Canada, and elsewhere, all such depressions, which are often filled with water and form small lakes, are now being looked into as possible weathered outcrops of kimberlite.

The numerous minerals that occur in kimberlites and lamproites are listed by Kirkley, *et al*, *ibid.*, and include commonly: olivine, garnet, ilmenite, pyroxene, chromite, diopside, and phlogopite. In gravels derived from the weathering of these rocks may be found (and especially looked for) red garnets, green diopside, and grains of black, heavy chromite. Further chemical testing may be conducted upon these minerals to detect elements which have been shown to be characteristic components in verified diamond-bearing kimberlites or lamproites. Prospectors generally sample gravels in the areas suspected of containing these rocks and then follow up trails of these "indicator" minerals to their sources. Airborne electronic methods are also used to cover broad areas of suspect terrain in as short a time as possible. Recent references to diamond prospecting in North America appear below, with general, earlier references given later.

BRUMMER, J. J. (1978) Diamonds in Canada. *Canad. Inst. Mining Bull.*, Oct., p. 64–79.

_____, (1984) Diamonds in Canada. In GUILLET, G. R. & MARTIN, W., eds., The Geology of Industrial Minerals in Canada, *Canad. Inst. Min. Met. Spec. Vol.* 29, p. 311–320.

HAUSEL, W. D. (1994) Diamonds, kimberlites, lamproites, and related rocks in the United States. *Wyoming Geol. Survey Mineral Rept.* MR 94–2, 72 p..

_____, (1995) Diamonds, kimberlites, lamproites and related rocks in the United States. *Exploration and Mining Geol.* 4, 3, p. 1–28.

_____, (1995) Diamonds and their host rocks in the United States. *Mining Engineering* 47, 8, p. 723–732.

JANSE, A. J. A. (1984) Kimberlites—where and when. In GLOVER, J. E. & HARRIS, P. C., eds., Kimberlite occurrence and origin: a basis for conceptual models in exploration. *Dept. Geol. & Univ. ext., Univ. West. Australia Publ.* No. 8, p. 19–61.

_____, (1994) Is Clifford's Rule still valid? Affirmative examples from around the world. In MEYER, H. O. A. & LEONARDOS, O., (eds.). *Proceedings*

Fifth Internat. Kimberlite Conf. 2, Diamonds: Characterization, genesis, and exploration, p. 215–235. Dept. Nac. Produção Mineral, Brasilia.

JANSE, A. J. A. & SHEAHAN, P. A. (1995) Catalogue of worldwide diamond and kimberlite occurrences: a selective and annotative approach. *J. Chem. Exploration* 53, p. 73–111, maps. Includes North America.

KIRKLEY, M. B., GURNEY, J. J. & LEVINSON, A. A. (1991) Age, origin, and emplacement of diamonds: scientific advances in the last decade. *Gems & Gemology* 27, 1, p. 2–25, illust. (col.), map.

LEVINSON, A. A., GURNEY, J.J. & KIRKLEY, M. B. (1992) Diamond sources and production: past, present, and future. *Gems & Gemology* 28, 4, p. 234–254, illust. (col.), maps.

RICHARDS, B. (1992) Diamond find sparks rush to Canada. *Wall Street J.*, Oct. 20, 1992, p. A2, A5.

STRNAD, J. (1991) The discovery of diamonds in Siberia and other northern regions. *Earth Science History* 10, 2, p. 227–246, maps.

WALDMAN, M. & MEYER, H. O. A. (1992) Great expectations in North America. *Diamond International*, May/June, p. 42–48.

WALSH, M. W. (1992) The great Canadian diamond rush. *Los Angeles Times*, Oct. 4, p. D1, D8.

The following references apply to all diamond discoveries and problems in North America; specific deposits will be treated below.

BELL, R. (1906) The occurrence of diamonds in the drift of some of the northern states. *Eng. & Min. J.* 82, p. 819; *Canad. Min. Inst. J.* 9 p. 124–127, 1906.

BLANK, E. W. (1929) Diamonds in the United States. *Rocks & Minerals* 4, 2, p. 37–40, map.

______, (1934) Diamond finds in the United States. *Ibid.* 9, 10, p. 147–150; 11, p. 163–166; 12, p. 179–182; 1935, 10, 1, p. 7–10; 2, p. 23–26; 3, p. 39–40.

BRANNER, G. C. (1929) Geology of America's diamond fields. *Pan-American Geologist* 51, 5, p. 339–353, illust.

FARRINGTON, O. C. (1908) Correlation of copper and diamonds in the glacial drift of the Great Lakes Region. *Science* 27, p. 729.

FIELD, D. S. M. (1949) The question of diamonds in Canada. *J. Gemm.* 2, 3, p. 103–111, map.

______, (1950) Diamond pipes in Canada. *Canad. Mining J.* 71, 7, p. 54–57, map.

______, (1978) Are there diamond pipes in Canada? *Canad. Gemm.* 2, 3, p. 8–13.

GOLD, D. P. (1968) Natural and synthetic diamonds and the North American outlook. *Penn. State Univ., Earth & Min. Sci.* 37, p. 37–43, illust.

GUNN, C. B. (1967) The origin of diamonds in the drift of the north central United States: a discussion. *J. Geol.* 75, p. 232–233.

______, (1968) A descriptive catalog of the drift diamonds of the Great Lakes region, North America. *Gems & Gemology* 12, 10, p. 297–303; 11, p. 333–334.

HOBBS, W. H. (1899) Emigrant diamonds in America. *Popular Sci. Monthly* 56, p. 73–83; *Smithson. Inst. Ann. Rept. 1901*, 1902, p. 359–366, illust.

______, (1899) The diamond field of the Great Lakes. *J. Geol.* 7, p. 375–388, illust.

______, (1901) Diamantiferous deposits in the United States. *Mineral Industry* 9, p. 301–304.

______, (1953) The diamond fields of the Great Lakes. Reprint: *Precambrian*, Mar., p. 17–20.

HOLDEN, R. J. (1944) The "Punch" Jones and other Appalachian diamonds. *Virginia Polytech. Inst. Bull, 37, 4, Eng. Exper. Sta.*, ser. 56, 32 p.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). Diamond p. 13–38.

______, (1905) Occurrence of diamond in North America. *Geol. Soc. Amer. Bull.* 17, p. 692–694.

______, (1931) Diamonds in North America. *Geol. Soc. Amer. Bull.* 42, 1, p. 221–222.

LEVINSON, A. A., GURNEY, J. J. & KIRKLEY, M. B. (1992) Diamond sources and production: past, present, and future. *Gems & Gemology* 28, 4, p. 234–254, illust. (col.), maps. N.A. included.

MILLAR, A. Q. (1911) Summary of diamonds and diamond mines. *Mining World* 34, p. 1125–1127, 1188–1190.

MITCHELL, R. H. (1991) Kimberlites and lamproites: primary sources of diamond. *GeoScience Canada* 18, 1, p. 1–16.

MUNDORFF, F. (1921) Diamond mining in America. *The Keystone*, Feb., p. 109, 111, 113, illust.

PATTERSON, R. M. (1850) Ueber die Beschaffenheit und das Vorkommen des Goldes, Platins und der Diamanten in den Vereinigten Staaten. *Dt. Geol. Ges. Zs.* 2, p. 60–64.

SCHNEIDER, P. F. (1908) A unique collection of peridotite. *Science* 28, p. 92–93.
SCHWARCZ, H. P. (1965) The origin of diamonds in the drift of the north central United States. *J. Geol.* 73, p. 657–663.
STORMS, W. H. (1893) Occurrence of diamonds. *Min. & Scient. Press* 66, p. 117–118.
TIFFANY & COMPANY (1885) *Catalogue of the Collection of Rough Diamonds, Now on Exhibition.* NY: 23 p. Includes North American specimens.
VOYNICK. S. (1994) North American diamonds. *Rock & Gem* 24, 12, p. 18–20, 22, 24, illust., map.
ZEITNER, J. C. (1988) U.S. diamond prospects. *Lapidary J.* 41, 12, p. 21–27, *passim*, illust. (col.).

CANADA. In the summer of 1994, ENERSOURCE of Calgary, Alberta, published a large colorful "Diamond Activity Map," measuring 39 in (99 cm) tall and 27 in (69 cm) broad, showing in colors and symbols the claims for diamonds staked by worldwide and domestic companies in Manitoba, Saskatchewan, Alberta, and Northwest Territories. Participating companies, of which there are thirty, plus others offering support services, are shown in panels surrounding the map proper. The geographic areas are color coded to the companies concerned and kimberlite pipes indicated by a lozenge symbol on Somerset Island, in the Lac De Gras area, also in other areas in the Northwest Territories, and in the Prince Albert area of Saskatchewan. These will be discussed below.

RICHARDS, W. (1992) Diamond find sparks rush to Canada: De Beers, Broken Hill, Rio Tinto stake major claims. *Wall St. J.*, Oct. 20, p. A2, A5.

QUEBEC. In 1966, a kimberlite body was discovered on Ile Bizard, about 9.5 mi (15 km) west of Montreal; a sample of the rock was sent off to South Africa for testing, and the presence of small diamond crystals was confirmed, (Traill, 1983, p. 129). Five of these crystals are in the National Mineral Collection in Ottawa. However, Traill notes that "the possibility exists that the diamonds may be contamination from previous samples in the milling system." He also reports that diamond fragments were found in rock cuttings recovered from a diamond-drill hole after the drill had been stopped by hard material at a place in Range VII, Vassan Township, Abitibi District, citing Field (1951). The tests in this case were also inconclusive. As mentioned above, it is to be noted that much of Quebec is underlain by the Archon cratonic rocks, favorable for the finding of kimberlite bodies.

According to A. J. A. Janse (*Pers. comm.* 8/94), a miniature "diamond rush" was set off in 1993 in Le Tac Township when drillers looking for gold ore found kimberlite in a core which was sent for examination to De Beers in South Africa, who found a single micro-diamond. But no more were found in the kimberlite and it is believed now that the diamond could have been dislodged from the core drill-bit.

Verified diamonds of very small size are now known to occur in at least two kimberlite bodies in the Kirkland Lake (Ontario) kimberlite field where it extends eastward into Quebec just across the border from New Liskeard. The specific localities are Nédélec and Guiges townships (Janse, *Ibid.*).

COLLINS, B. (1962) Occurrences of diamonds in matrix in Canada. *Lapidary J.* 6, 1, p. 45. Minute xls claimed for Val D'Or.
FIELD, D. S. M. (1951) The James Bay Diamond Syndicate. *J. Gemm.* 3, 1, p. 15–21, illust.; 3, p. 119–128.
TRAILL, R. J. (1983) Catalogue of Canadian minerals rev. 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map. Diamond p. 128–129.

ONTARIO. In an early report cited by Traill (1983, above), microscopic diamonds were said to be present in chromite deposits and altered pyroxenite in Reaume Township at a place about 20 mi (32 km) north of Porcupine. The occurrence is unconfirmed. In 1967 discoveries of alluvial kimberlite indicator minerals were made in the James Bay Lowland, according to Brown, *et al* (1967). Results of recent searches for kimberlites are reported in Reed & Sinclair (1991), but no diamonds were mentioned. I am now informed by A. J. A. Janse (*Pers. comm.* 8/94) that MONOPROS of De Beers found a field with at least 15 kimberlite bodies, some diamondiferous, along the Attawapiskat River, which empties into James Bay opposite Akimiski Island on the west side of the bay. The field is located about 100 km (63 mi) west of the village of Attawapiskat, near the river's mouth. In 1994, another diamondiferous pipe was drilled by KWG Resources of Montreal at Kyle Lake, located about 15 km (9.5 mi) west of the north end of Missisa Lake, the latter located about 200 km (125 mi) west-southwest of Attawapiskat village. Initial sampling of a 100 kg core lot disclosed about 100 diamond crystals that measured from 0.3 to 0.7 mm; the tenor of the ore may fall between 0.7 and 1.2 carats/ton.

Farther south in Ontario, the first authenticated *in situ* diamond was found in 1984 when several crystals were recovered from a drill core by MONOPROS (De Beers), who were drilling a kimberlite body at Nickila Lake, about 10 km (6 mi) northeast of Kirkland Lake (town). The circumstances that led to the discovery of the Kirkland Lake diamondiferous field, which straddles the N-S boundary between Quebec (east) and Ontario (west), are explained in detail in the large papers of Brummer, *et al* (1992). They give the history of early searches for traces of valuable mineral deposits, including diamond, on the basis of sampling glacial drift materials and alluvia. Studies in the Kirkland Lake area led to the identification of pyrope garnet grains and chrome diopside grains concentrated in a center that was "down-ice" from Gauthier Township. Aeromagnetic surveys resulted in the finding of four kimberlite bodies north of Kirkland Lake and one to the south. Sixteen diamonds, ranging from 0.005 ct to 0.17 ct, were recovered from drill cores. In color the crystals ranged from white to yellow to brown, many with inclusions. Some crystals were etched, and crystallographically the forms displayed were an octahedron and a tetrahexahedron. Drilling and sampling programs were carried out by both LAC Minerals, Ltd., and MONOPROS with the first named sending their cores to their kimberlite processing plant at Fort Collins, Colorado, and MONOPROS sending their samples to Anglo American Research Laboratories in Johannesburg, South Africa. The tenor of the kimberlite ore so far tested suggests that yields of diamonds may run from 5 to 15 cts per 100 tons. A map constructed by the authors shows a broad band of crustal rifting that extends from near Ottawa toward the James Bay Lowlands. The kimberlite bodies appear to be associated with these rifts, and it is deemed likely that many more kimberlite bodies will be found in this zone as further aeromagnetic surveys are made and promising indications verified by ground inspections.

One of the important results of the above-noted systematic sampling of glacial materials is the discovery not only of pyrope and chrome diopside indicator minerals but also of glacial erratic boulders composed of kimberlite. The Geological Survey of Canada recently published reports on the extent and distribution of indicator minerals and kimberlite boulders in glacial deposits "down-ice" from known kimberlites (*see* Averill & McClenaghan, 1994; McClenaghan, 1996). It is easy now to visualize and confirm what was once a matter of speculation: as the glacial sheets moved south across this region, the upper parts of kimberlite bodies were torn asunder, some fragments being worn into boulders and pebbles, and others completely disintegrated, their component, resistant minerals, including diamond, being released to the finer alluvial debris. On the basis of finds of pyrope and chrome diopside, as well as of occasional diamond, it now seems that enormous quantities of diamond may exist in the Canadian-Great Lakes region of glacial outflow materials, if only some economical method could be found to recover them. A tempting thought is that if operators of gravel and sand pits in the region could be persuaded to install some sort of diamond recovery system, they might be rewarded with more than the price of gravel and sand, perhaps even with the occasional Cullinan!

AVERILL, S. A. & McCLENAGHAN, M. B. (1994) Distribution and character of kimberlite indicator minerals in glacial sediments, C 14 and Diamond Lake kimberlite pipes, Kirkland Lake, Ontario. *Geol. Survey Canada Open File Rept.* 2819, 48 p.

BLUE, A. (1900) Are there diamonds in Ontario? *Ont. Bur. Mines, 9th Ann. Rept.*, p. 119–124; *Canad. Inst. J.* 3, p. 149–160.

BROWN, D. D., BENNET, G. & GEORGE, P. T. (1967) The sources of alluvial kimberlite indicator minerals in the James Bay Lowlands. *Ont. Dept. Mines. Misc. Paper* 7, 25 p., maps.

BRUMMER, J. J. (1978) Diamonds in Canada. *Canad. Min. Metall. Bull.* 71, No. 798, p. 67–79.

BRUMMER, J. J., MACFADYEN, D. A. & PEGG, C. C. (1992) Discovery of kimberlites in the Kirkland Lake area, Northern Ontario, Canada. Part I, *Explor. Mining Geol.* 1, 4, p. 339–350, illust., maps; Part II: p. 351–370, illust., maps.

JANSE, A. J. A. (1994) More evidence that Wisconsin diamonds come from Canadian pipes. In Gem News—Diamond. *Gems & Gemology* 30, 3, p. 122–123.

McCLENAGHAN, M. B., *et al.* (1996) Mineralogy and chemistry of the B 30 kimberlite and overlying glacial sediments, Kirkland Lake, Ontario. *Geol. Survey Canada, Open File Rept.* 3295, 245 p.

REED, L. E. & SINCLAIR, I. G. L. (1991) The search for kimberlite in the James Bay Lowlands of Ontario. *Canad. Inst. Min. Metall.* 84, 947, p. 132–139.

SAGE, R. P. (1996) Kimberlites of the Lake Timiskaming structural zone, Ontario. *Ont. Geol. Survey Open File Rept.* 5937, 435 p.

SASKATCHEWAN. Diamonds were reported found in 1945 by John J. Johnson, a prospector, who claimed he had found five stones, one as large as a marble, valued by a jeweler at $300. It was removed from a "wall of blue clay within 100 miles of Flin Flon" (Field, 1949, p. 111). The Saskatchewan government offered Johnson a tax-free concession of 300 acres, providing he would verify the occurrence of diamond *in situ;* this he refused. Nothing further was heard from this supposed find, and no diamond prospecting carried out until June, 1961 when a claim-staking "rush" occurred for areas around Prince Albert, a city in the approximate geographical center of the province. By September, 1961, about 500 claims had been filed, and it is said that two diamonds were found at a place about 6 mi (9.7 km) west of Prince Albert.

After the 1960s' flurry of activity, nothing further happened until the discovery of a diamondiferous kimberlite on the north bank of Sturgeon Lakes River, north of Shellbrook, as announced in November 1988 by De Beers Consolidated Mines, Ltd. The site was discovered by Jacques Letendre of Prince Albert, acting for MONOPROS, Ltd., a subsidiary of De Beers; it is located at about 30 mi (48 km) northwest of Prince Albert. The discovery was officially confirmed by the Saskatchewan Department of Energy and Mines in 1988 (Strnad, 1991, p. 242–243). Gent (1989) notes that the kimberlites have been found in a broad belt that takes in much of the sedimentary basin of the south half of the province. The *Leader-Post* of Regina, November 9, 1990, p. B-11, reported discovery of diamonds by Uranerz Exploration & Mining "about 30 km NW of Melfort" in the Fort a la Corne area located about 37 mi (58 km) due east of Prince Albert. The diamond crystals are small, only from 2 to 4 mm diameter. Other diamonds found in the same general area are also reported as small, generally 1 mm or less in size. In another report in the *Northern Miner,* December 17, 1990, p. 6, it was noted that Uranerz, with partner CAMECO, recovered four "large" stones from the Fort a la Corne project; one is 4 mm in diameter and "therefore the largest ever recovered from kimberlite in Canada." According to Koivula & Kammerling (1991), diamonds recovered by Uranerz/Cameco in 1991 "range up to 0.6 ct (5.5 mm in diameter), the larger stones (over 0.5 mm in diameter) appear to be of gem quality." All samples were obtained from core drills. So far as is known, explorations in this region are progressing, but little news of results is forthcoming. In 1992 Monopros (De Beers' Canadian diamond exploration subsidiary) joined Uranerz/Cameco as a third partner and took over as exploration manager of the project. The largest diamond found so far weighed over three carats, but the economic potential of the area is still unclear. According to Gent (1992), "over seventy *in situ* kimberlite pipes are known," and aerial surveys indicate that there may by many more in the Prince Albert region.

A second diamondiferous kimberlite field now has been found at Candle Lake, 80–100 km (50–60 mi) northwest of Fort a la Corne, at present consisting of three pipes discovered by aeromagnetic survey by Uranerz/War Eagle, Inc., in 1994. Astonishingly enough, it has been found that these bodies are covered by at least 100 m (328 ft) of glacial sediments, confirming the value of aeromagnetic detection methods.

FIELD, D. S. M. (1949) The question of diamonds in Canada. *J. Gemm.* 3, 2, p. 103–111.

FREEMAN, A. (1989) Claim stakers are seeking diamonds in rough gravel pits of Saskatchewan. *Wall Street J.*, April 24, p. A9A.

GENT, M. R. (1989) Regional phanerozoic anomalies of Saskatchewan. *Sask. Geol. Survey Summ. Invest.* 1989, p. 162–167, maps.

______, (1992) Diamond exploration in Saskatchewan. *Canad. Inst. Min. Met. Proc.* 84, 956, p. 64–71, maps.

______, (1992) Diamonds and precious gems of the Phanerozoic Basin, Saskatchewan: preliminary investigations. *Sask. Geol. Survey Open File Rept.* 92–2, 67 p., maps.

KOIVULA, J. I. & KAMMERLING, R. C. (1991) Gem news. *Gems & Gemology* 27, 3, p. 180.

LEHNERT-THIEL, K., *et al.* (1992) Diamond-bearing kimberlites in Saskatchewan, Canada: the Fort a la Corne case history. *Exploration and Mining Geol.* 1, 4, p. 391–403.

STRNAD, J. (1991) The discovery of diamonds in Siberia and other northern regions. *Earth Sci. Hist.* 10, 2, p. 227–246, maps.

SWANSON, F. J. & GENT, M. R. (1992) Preliminary results of reconnaissance sampling for diamond indicator minerals. In MacDONALD, T. I. I., *et al*, eds., Summ. of Invest., *Sask. Geol. Survey Misc. Rept.* 92–4, p. 199–203.

NORTHWEST TERRITORIES. In the Far North, Somerset Island yielded a few diamonds, according to Brummer (1978). Godwin & Price (1986) report that testing of kimberlite in the central Mackenzie Mountains in 1981 "resulted in the discovery of several microdiamonds in heavy mineral concentrate;" (*see also* Strnad, 1991, p. 229).

The greatest interest in diamond prospecting, however, is directed towards the Lake de Gras–Contwoyto Lake area, 250–380 km (160–240 mi) northeast of Yellowknife. The prospector responsible for setting off the rush is Charles E. Fipke, who was working for himself and Broken Hill Proprietary (BHP) in a company called Dia Met Minerals, and found diamonds in a kimberlite pipe beneath the waters of Point Lake in the Lac de Gras area. The find was made in 1991 when Fipke's core drill brought up the stones. According to Ulbrich (1994), "since November 1991, when the first test drilling . . . turned up diamonds, 237 companies have staked out nearly 75,000 square miles in the biggest mineralrush in Canadian history." In contrast, Ulman (1994) writes that "more than 150 mining companies, including some of the world's largest, have spent hundreds of millions of dollars to explore claims staked over an area the size of Ireland." He further notes that BHP (Broken Hill Proprietary), one of the giants referred to, "has agreed to invest up to $500 million to acquire a 51% interest in the million acres of claims that Fipke and his partners have staked." BHP has completed a several thousand-ton sampling program at Koala Camp, near Lac de Gras, where four diamondiferous pipes are to be explored, three of which are under lakes; one kimberlite is to be sampled by an incline tunnel which will go below the lake bottom and through enclosing granite (Ulbrich, *Ibid.*). According to *Wall Street Journal* (Aug. 22, 1994, p. A5F), "analysts believe the planned mine near Lac de Gras, in which Australia's Broken Hill Proprietary Co. has a stake, will come on stream in 1997 or 1998, producing high-quality gems of the sort available from Russia." Furthermore, it was noted, "De Beers has bought ground near Lac de Gras hoping for a similar source of high-quality gems." In this connection, *Wall Street Journal* (Dec.13, 1994, p. A10) reported that BHP and Dia Met "provided the Canadian government with an updated project plan, proposing to develop five kimberlite pipes in the Northwest Territories instead of three." Tests upon the additional pipes "indicate richer diamond deposits than in the original three pipes." Mine construction was expected to begin in 1996 and "commercial production could start in the third quarter of 1997." A summary of 53 pages of the enormously voluminous Environmental Impact Statement—a stack about a meter tall—of the NWT Diamond Project has been published in 1995 by BHP/DiaMet. The area in which this project is located is now called Exeter Lake, located 30 km (20 mi) north of Lac de Gras. A recent decision in June 1996 by the Canadian government granted proceeding with development of the mine. It is now likely that initial production will begin in late 1997.

At Twi Kli Cho Lake, located south of Lac de Gras, a diamondiferous kimberlite sampled economically on the surface proved to be uneconomical when an incline tunnel was sunk into the pipe from the side to obtain a bulk sample of 5,000 tons (Janse, A. J. A., 1994). The work, carried out by DHK Resources Ltd., (Dentonia Resources, Ltd. + Horseshoe Gold Mining, Inc. + Kettle River Resources, Ltd.) in conjunction with Kennecott Mining, began in late 1993, but by July of 1994 was discontinued because "the sample, processed at the pilot plant in Yellowknife, contained two separate rock types. The lowgrade intrusive kimberlite of 1,258 dry tonnes averaged 0.013 ct/tonne and the pyroclastic material of 3,003 dry tonnes resulted in 0.359 carats/tonne . . . it is expected that the carat value may be too low to warrant an economic mine" (Kettle River Resources, Ltd., Greenwood, B.C., Sept. 8, 1994, *Fact Sheet*, p. 2). This company's annual report for 1993–1994 gives the chronology of events in the above testing program and contains photographs of the incline tunnel opening, an underground photo showing the contact between two rock types, and a color photograph of a 1.724 ct yellowish diamond from the bulk sample which exhibits a rounded shape, possibly a much dissolved dodecahedron.

In 1994, prospecting focused north upon the Contwayto Lake area where a cluster of four diamondiferous kimberlite pipes were discovered by the Mill City/Tanqueray group near Yamba Lake, northwest of Yellowknife. Monopros (DeBeers) joined in the project but later withdrew. The pipes, Jericho 1 and 2, found in 1995 by the Lytton/New Indigo group, this time on dry ground and not underwater, provided promising drill core samples, with evaluation work still in progress. The most promising find so far, which may develop into a second mine in NWT, was made in mid-1994 by Aber Resources. By drilling in Lac de Gras itself, they found several small kimberlite bodies, labeled A 154 North, A 154 South, and A 418, from which high-grade cores were obtained as well as large diamond crystals. Two crystals, 0.75 and 2.75 carats respectively, were visible in the first drill core. According to A. J. A. Janse (*Pers. comm.* 8/1994), such a find is "extraordinary considering the minute part of the whole pipe represented by the drill core sample" and "Kennecott is earning a 60% interest in this project by collecting a 5,000 ton bulk sample through an inclined underground tunnel."

Also in the region northeast of Yellowknife, NWT, another very promising find was made in 1995 by Mountain Province Mining Inc. of Vancouver, BC, who found a very high-grade kimberlite pipe (Pipe #5034) at Kennedy Lake, 170 mi (275 km) northeast of Yellowknife, from which it is planned to obtain and evaluate a bulk sample. Other pipes have been found in the nearby Back Lake-Camsell Lake area, 125 mi (200 km) northeast of Yellowknife by Winspear, Aber, and other companies: a "potential new diamondiferous cluster" of pipes whose economics remain to be determined (*Wall St. J.*, 5/15/1994).

The most westerly pipes were found in 1994 by Ashton Mining of Canada in the Cross Lake area, north of Yellowknife, and by prospector David Smith at Drybones Bay, due east of Yellowknife. A most unexpected discovery was the appearance of numerous tiny diamond crystals in a dike near Gibson Lake, 75 mi (120 km) northwest of Rankin Inlet, Hudson Bay, or about 500 mi (800 km) almost due east of Lac de Gras. According to MacRae, *et al*, (1995) the rock is not kimberlite, nor lamproite, but an apparently common type of lamprophyre which contains several thousands of diamond crystals in only tens of kilograms of rock, but with the crystals so minute that they are measured in thousandths of an inch (tens of microns). The presence of diamond in this rock remains a scientific puzzle.

BHP/DIAMET (1995) NWT Diamond Project. A summary of the Environmental Impact Statement. Vancouver, BC: BHP Diamonds, Inc., 53 p.

BRUMMER, J. J. (1978) Diamonds in Canada. *Canad. Inst. Min. Met. Bull.* 71, 798, p. 64–79.

CARLSON, J. A., KIRKLEY, M. B. & ASHLEY, R. M. (1996) The discovery and exploration of kimberlites on the BHP/DiaMet claims, Lac de Gras region, Northwest Territories, Canada. *The Gangue* (Geol. Assoc. Canada, Min. Deposits Div.), No. 52, May, p. 5–6.

ENGINEERING & MINING JOURNAL (1994) [BHP Minerals Canada, Ltd., & Dia Met Minerals, Ltd., agree to feasibility study of a prospective diamond mine in NWT]. August, p. 20.

GODWIN, C. I. & PRICE, B. J. (1986) Geology of the Mountain diatreme kimberlite, north-central Mackenzie Mountains, District of Mackenzie, Northwest Territories. In MORIN, J. A., ed., Mineral deposits of Northern Cordillera, *Canad. Inst. Min. Met.* Spec. Vol. 37, p. 298–310.

JANSE, A. J. A. (1994) Canadian diamond rush bruised but still alive. In Gem News—Diamond, *Gems & Gemology* 30, 4, p. 271–272.

KOIVULA, J. I., *et al*, eds. (1992) Gem News. *Gems & Gemology* 28, 3, p. 198.

MacRAE, N. D., *et al* (1995) A diamondiferous lamprophyre dike, Gibson Lake, Northwest Territories. *Internat. Geol. Review* 37, p. 212–229.

NORTHWEST TERRITORIES (1993) *Diamonds and the Northwest Territories, Canada.* Dept. Energy, Mines and Petrol. Resources, 52 p. + append. of vii p., illust., map.

RICHARDS, B. (1992) Diamond find sparks rush to Canada. *Wall St. J.*, Oct. 20, p. A2, A5.

STRNAD, J. (1991) The discovery of diamonds in Siberia and other northern regions. *Earth Science Hist.* 10, 2, p. 227–246, maps.

ULBRICH, J. (1994) Canadian diamond rush is Klondike of 1990s. *Internat. Calif. Mining J.* 63, 7, p. 9–12.

ULMAN, N. (1994) Great diamond rush is bringing new ways to Northern Canada. *Wall St. J.*, May 27, p. A1, A4.

WALL STREET JOURNAL (1994) De Beers joins Canada diamond rush . . . July 19, p. 34.

ALBERTA. Diamonds were said to have been found in several localities in central and southeastern Alberta, but very few factual data have been published to date. Some occurrences have been confirmed and are described in Dufresne, *et al* (1994). Details also appear in the forthcoming publication of the Geological Survey of Canada's "Searching for Diamonds in Canada," *Open File Report* 3228.

DUFRESNE, M. B., *et al* (1994). The diamond potential of Alberta: a regional synthesis of the structural and stratographic setting, and other preliminary indications of diamond potential. *Alberta Geol. Survey Open File Rept.* OFR 94–10, 101 p.

BRITISH COLUMBIA. The unconfirmed report of diamond in the Yale District resulted from the examination of peridotite by chemist G. C. Hoffmann (1911). The sample, obtained from a chromite deposit on the east slope of Olivine Mountain, about 2 mi (3.2 km) to the south of Tulameen River, when dissolved released "sharply angular particles, many of which exhibited a distinct octahedral form, and . . . were perfectly isotropic. . . . very hard and . . . scratched sapphire with facility . . ." He further found them to be transparent to X-rays, "a fact which in itself alone points conclusively to the identity of this substance with the mineral diamond." However, as Traill (1983) notes, "the supposed microscopic-sized diamonds were subsequently shown to be periclase (A. H. Lang, 1956 in *Geol. Survey Canad. Econ. Geol.* Ser. 7, p. 298)."

CAMSELL, C. (1911) A new diamond locality in the Tulameen district, British Columbia. *Econ. Geol.* 6, p. 604–611.

______, (1912) Note on the occurrence of diamonds at Tulameen and Scottie Creek, near Ashcroft, B.C. *Geol. Survey Canad. Summ. Rept. for 1911*, p. 123–124.

CANADIAN MINING JOURNAL (1958) Royal Canadian venturers. Vol. 79, p. 154. Mentions small diamonds found in gravels near Princeton.

HOFFMANN, G. C. (1911) [Chemistry.] In *Geol. Survey Canad. Summ. Rept. for 1910*, p. 262–263.

JOHNSTON, R. A. A. (1915) A list of Canadian mineral occurrences. *Geol. Survey Canada Mem.* 74, No. 1497, 275 p.

McCANN, W. S. (1922) Geology and mineral deposits of the Bridge River map area, British Columbia. *Geol. Survey Canad. Mem.* 130, 115 p.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canad. Paper* 80-18, 432 p., map. Diamond p. 128–129.

ALASKA. The occurrence of alluvial diamonds is now verified and has inspired prospecting aimed specifically at finding the indicator minerals from kimberlite, such as pyrope garnet and chrome diopside, and tracing them to their sources. Forbes, *et al* (1987) report on the verified occurrence of three crystals in Crooked Creek, just west of Central in the Yukon River drainage in east-central mainland Alaska, at about lat. 65°10'N, long. 145°W. The first stone was found by Don Lasley in Crooked Creek in the summer of 1982 during gold sluicing on the Jim Regan claim. It is a clear, colorless rounded octahedron of one-third carat. The next stone, found by Mary Warren, came from gold-sluicing at a placer several miles distant from the Regan claim. This crystal is yellow-white, a rounded octahedron, and weighs 1.4 carats. The third stone was found by Paul Manuel near the Warren discovery. It is light yellow, resembles a twinned dodecahedron, and weighs 0.83 ct. Forbes, *et al (Ibid.)* note that the diamonds "display percussion marks, fractures, and rounded interfacial edges that suggest a long and possibly complicated alluvial history." They further state that "to our knowledge, the Crooked Creek stones are the only documented diamond discoveries in Alaska, with the exception of two microdiamonds obtained from the insoluble residue of dissolved platinum alloy nuggets (Mertie, 1976) and a 'single tiny diamond' recovered from a core sample from bottom sediments in Goodnews Bay (Hoare and Cobb, 1977)."

In 1987, Ashton Mining, the major Australian diamond mining concern, conducted preliminary explorations for diamond in the Crooked Creek area and signed a lease with Hansen Properties to explore for diamond in the Goodnews Bay area on the southwest coast of mainland Alaska. According to G. T. Austin (*Pers. comm.* 11/4/87), "work on Goodnews Bay in 1986 and 1987 resulted in the recovery of some micro industrial diamonds."

FORBES, R. P., KLINE, J. J. & CLOUGH, A. H. (1987) A preliminary evaluation of alluvial diamond discoveries in placer gravels of Crooked Creek, Circle District, Alaska. *AK Div. Geol. Geophys. Surveys, Rept. Invest.* 87–1, 8 p., illust., maps.

HOARE, J. M. & COBB, E. H. (1977) Mineral occurrences . . . in the Bethel, Goodnews, and Russian Mission quadrangles, Alaska. *USGS Open File Rept.* 77–156, 98 p.

MERTIE, J. B. (1976) Platinum deposits of the Goodnews Bay district. *USGS Prof. Paper* 938, 42 p., illust., maps.

NORTH CAROLINA. The most recent diamond find occurred in 1988 (?) according to Austin (1988), who reported that a 0.25 ct "industrial grade" diamond was recovered during test of a bulk sample from a gold mine.

AMERICAN JOURNAL OF SCIENCE (1846) Diamonds in North Carolina. Vol. 2, p. 119. Diamond in Rutherford County.

AUSTIN, G. T. (1988) Gemstones. Ch. in *U.S. Bur. Mines Min. Yearbook*, p. 1–12.

ENGINEERING & MINING JOURNAL (1887) North Carolina diamond. Vol. 44, p. 22. Dysortville diamond of 4.33 ct.

HUNTER, C. L. (1853) Notices of rare minerals and new localities in western North Carolina. *Amer. J. Sci.* ser. 2, 15, p. 373–378.

KUNZ, G. F. (1887) A North Carolina diamond. *Science* 10, p. 168. Dysartville diamond.

______, (1887) A North Carolina Diamond. *Amer. J. Science* 34, p. 490, fig. Dysartville diamond.

______, (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). NC diamond p. 17–21.

______, (1907) History of the gems found in North Carolina. *NC Geol. Econ. Survey Bull.* 12, 60 p., illust. (col.). Diamond p. 5–9.

SHEPARD, C. U. (1846) On three new mineral species from Arkansas and the discovery of diamond in North Carolina. *Amer. J. Sci.* 2, p. 249–754. Diamond at Twitty's Mine, Rutherford Co., p. 253–254.

SOUTH CAROLINA. According to the U.S. Geological Survey's *Mineral Resources of the United States for 1883*, 1884, p. 729–730, a 1.5 ct diamond valued at $400 was found in the early 1880s in this state, based on information from an article in the *New York Sun.*

GEORGIA. Diamond finds are summarized by Cook (1978)—an earlier account appears in

Furcron (1948). As was the case in North Carolina, most crystals were found in connection with sluicing gold-bearing gravels.

In White County, four small crystals were found in 1871 in gold placers of the Nacha-coochee Valley; in 1866 two small stones were found in the Harshaw Gold Mine near Loudsville. In 1843, Dr. M. F. Stephenson found a diamond of over six carats while panning for gold near Winns or Williams Ferry, near Muddy Creek and its junction with the Chattahoochee River in Hall County. Other finds, but of doubtful validity, have been reported from this county. In Burke County, a diamond crystal of 7.11 carats was found at Old Shell Bluff Post Office. Clayton County furnished a 4.35 ct octahedron in 1887, found 1.5 mi (2.4 km) northeast of Morrow Station; it was slightly yellow in color. Another stone reported from this county is unverified. McCallie (1910, p. 119) reported several stones from Twiggs County at a place about 11 mi (17.7 km) southeast of Macon on the Nelson property, or 1.5 mi (2.4 km) northeast of Pikes Peak Station. In Lee County, a stone of 3.5 ct, white, but with a greenish tinge, was reported sold to Tiffany & Co. of New York for $80; however, Cook believes this report really refers to its finding in Lee County, Alabama. No details are available on two stones reported from Camden County.

COOK, R. B. (1978) Minerals of Georgia: their properties and occurrences. *GA Geol. Water Resources Div. Bull.* 92, 189 p.

FURCRON, A. S. (1948) Diamonds in Georgia. *GA Min. Soc. Newsletter* 1, 2, p. 3.

JACKSON, C. T. (1859) Sur la bornite de Dahlonega et sur les diamants de l'État de Georgie. *Acad. Sci. Paris C.R.* 48, p. 850–851.

McCALLIE, S. W. (1910) A preliminary report on the mineral resources of Georgia. *Geol. Survey GA Bull.* 23, 208 p., plates.

ALABAMA. Cook & Smith (1982) provide corrections and amplifications to my previously published information on diamonds in Alabama. The 4.25 ct crystal from "near Birmingham" actually was found at a place about 30 mi (48 km) south of the city; it was an octahedron of faint yellowish color (Sinkankas, 1959, p. 34). Cook & Smith also suggest that the 3.5 cts crystal claimed to be from Lee County, Alabama, actually came from the county of the same name in Georgia just across the border from Alabama at a place north of Phenix City. It was purchased in 1901 by Tiffany & Co. of New York for $80. A possible second stone from this county is mentioned in *U.S. Geological Mineral Resources of the United States for 1901*, 1902.

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120, 285 p.

SINKANKAS, J. (1959) *Gemstones of North America.* NY: Van Nostrand Reinhold, 675 p., illust. (col.).

LOUISIANA. No new developments.

MOUNCE, C. E. (1969) Large diamond found in Louisiana. *Gems & Gemology* 13, 4, p. 134.

INDIANA. No new developments.

BLATCHLEY, W. S. (1903) Gold and diamonds in Indiana. *IN Dept. Geol. Nat. Resources Ann. Rept.* 27, p. 11–47

ERD, R. C. & GREENBERG, S. S. (1960) Minerals of Indiana. *IN Geol. Survey Bull.* 18, 73 p.

WADE, F. B. (1949) Another rough diamond found in Indiana. *Gems & Gemology* 6, 8, p. 249–250, illust.

KENTUCKY. Bolivar (1982) conducted a thorough study of the kimberlites of Elliott County but failed to detect any diamonds.

BOLIVAR, S. L. (1982) Kimberlite of Elliott County, Kentucky. *KY Geol. Survey Thesis* Series 2, 5, 37 p., illust., map.

CRANDALL, A. R. & DILLER, J. S. (1887) Report on the geology of Elliott County by A. R. Crandall. Also notes on the trap dikes of Elliott County by A. R. Crandall and J. S. Diller. *Geol. Survey KY,* 28 p., plates, maps.

DILLER, J. S. (1886) Notes on the peridotite of Elliott County, Kentucky. *Amer. J. Science* 32, p. 121–125.

______, (1887) Peridotite of Elliott County, Kentucky. *USGS Bull.* 38, 31 p., illust., map.

DILLER, J. S. & KUNZ, G. F. (1887) Is there a diamond field in Kentucky? *Science* 10, p. 140–142.

KENTUCKY TRANSVAAL DIAMOND MINING

CO. (1906) *Prospectus*. [Willard, KY]. [16] p. Reports by Donald Draper and Samuel Pearson.

KUNZ, G. F. (1889) Mineralogical notes . . . diamond found on Henry Burris Farm, Russell County, Kentucky. *Amer. J. Science* 38, p. 72–74.

ARKANSAS. Since its establishment in 1972, the Crater of Diamonds State Park near Murfreesboro, Pike County, continues to draw hordes of visitors, up to about 85,000 annually, who try their hand at finding diamonds in the outcrop of the diamondiferous pipe body. Many visitors do find diamonds and these finds are recorded by the park officials. A brochure issued by the park providing statistics for the period 1972 to 1989 shows that 12,958 diamonds were found, with a total weight of 2,784.82 carats, the average per stone being 0.21 ct. In this period 18 stones were found that exceeded five carats and ranged up to 16.37 carats. In 1993, park authorities reported, visitors found 800 stones that totalled 144.44 carats, although not all finders made their finds known since such reporting of finds is entirely voluntary. It is estimated that during its entire career, the Murfreesboro pipe may have yielded between 50,000 and 100,000 carats of diamonds. The crystals from this deposit are usually rounded in shape, sometimes flattened like a lentil, and about 40% colorless, 33% yellowish, 37% brownish, and 1% industrial borts. According to Howard (1989) "rarely stones are seen with a blue or pink tinge."

The famous stones from this deposit include the *Uncle Sam*—40.42 cts, found in 1924; the *Star of Murfreesboro*—34.25 cts, found in 1964; the *Amarillo Starlight*—16.37 ct, found in 1975; the *Star of Arkansas*—15.31 ct, found in 1956; and several others over five carats in weight.

Recent examinations of the pipe have identified three types of igneous rock: lamproite, lamproitic breccia, and tuff. Only the breccia, comprising about 40% of the 73 acres of pipe outcrop, produces diamonds. This rock quickly weathers to a sticky clay and it is from this material that visitors recover their diamonds.

An excellent summary of the history of the mine and the local geology and mineralogy are given by Kidwell (1990). In the latest developments, it was reported in 1985 that Jean-Raymond Boulle of Dallas, Texas, obtained leases on ground surrounding the Crater of Diamonds State Park for the purpose of helicopter exploration. At about the same time, the Sunshine Mining Company began a joint venture with three other organizations, the group calling themselves the Arkansas Diamond Development Corporation, for the purpose of obtaining rights to test-drill the pipe in the park to determine its potential for diamond production. Sunshine Mining, a company over one hundred years in existence, is based in Idaho and is noted for its production of silver from mines in that state. The consortium announced their willingness to commit $3 million to the venture. In this connection, a statement by the governor of Arkansas noted that despite a fee charged to visitors at the park, the state lost more than $80,000 in the last three years (*Arkansas Democrat*, November 17, 1989). The proposed venture was approved in 1987 when the state legislature passed the necessary enabling bill, but rights were granted for only a portion of the outcrop area. A governor's task force appointed to examine the problems involved recommended going ahead in 1989, and formal permission was granted to Arkansas Diamond Development Corporation to proceed. Their plan called for drilling 30 holes to a depth of 1,000 ft in an area of about 50 x 100 ft over a period of about three months (*Wall Street Journal*, 1992). Drilling began in 1990, and four holes were completed before a court order, issued on behalf of the Sierra Club and other environmental groups, called a halt to the operation. However, in 1992, this order was reversed by the Eighth U.S. Circuit Court of Appeals in St.Louis, and test drilling resumed in June, 1992. The first phase of the drilling operation ended with completion of 25 test holes. In March, 1993, a decision was made by the corporation to stop further exploration. The results of the drilling have not been made public.

According to A. J. A. Janse (*Pers. comm.* 9/1994), the Texas Star Resources Company of Houston, Texas, obtained a lease on the Twin

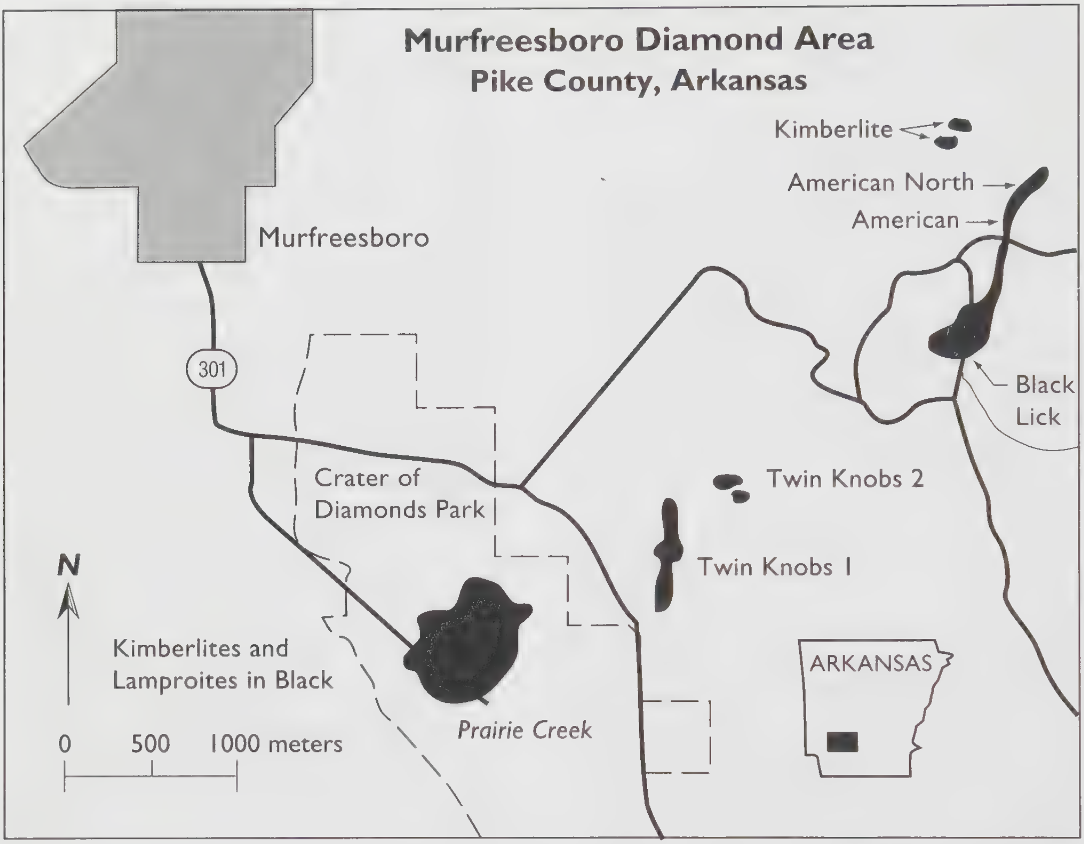

FIGURE 23. Sketch map of the Murfreesboro, Pike County, Arkansas, diamond areas showing the outcrops of several small kimberlite bodies as well as the diamond-bearing lamproite rock outcrop of Prairie Creek, the principal source of diamonds. Modified from J. M. Howard, *Finding Diamonds in Arkansas*, AR Geol. Commission, 1989.

Knobs lamproite deposit, located about 3 mi (5 km) northeast of the Crater of Diamonds on private property; they erected a pilot processing plant and began actual mining of diamonds in November 1993. It is an open-pit mine but not open to visitors. No production data are available.

ARKANSAS DIAMOND COMPANY (1908) *Diamonds in Arkansas: A Brief Account . . . Official Reports of Geologist* [H. S. Washington] *and Mining Engineer* [John T. Fuller] *on the Occurrence of Diamonds in Pike Co., Ark.* Little Rock, 38 p.

ARKANSAS GEOLOGICAL & CONSERVATION COMMISSION (1959) Mineral resources of Arkansas, *Bull.* 6, rev., 84 p.

AUSTIN, G. T. (1992) Quartz and diamonds; Arkansas' significant gemstone production. *Colored Stone* 5, 3, p. 26–27.

BRANNER, J. C. & BRACKETT, R. N. (1889) The peridotite of Pike Co., Ark. *Amer. J. Sci.* 38, p. 50–59, map. *See also* WILLIAMS, J. F. (1891).

BRANNER, J. C. (1909) Some facts and corrections regarding the diamond region of Arkansas. *Eng. & Min. J.* 87, p. 371–372.

______, (1942) Mineral resources of Arkansas. *AR Geol. Survey Bull.* 6, 101 p.

BROUGHTON, P. L. (1975) America's only diamond mine. *Rock & Gem* 5, 4, p. 16–21, illust. Collecting advice.

DAVIES, A. I. (1981) Arkansas diamond lakes country. *Lapidary J.* 35, 2, p. 428, 430, 432. Collecting experiences.

EBERLE, F. (1909) The Arkansas diamond fields. *Mining World* 31, p. 285–286.

ENGINEERING & MINING JOURNAL (1907) Diamonds in Arkansas. Vol. 84, p. 270.

FULLER, J. T. (1908) Report on the property of the Arkansas Diamond Company. In Arkansas Diamond Company, *Diamonds in Arkansas*, Little Rock, p. 10–30.

______, (1909) Diamond mine in Pike County, Arkansas. *Eng. & Min. J.* 87, p. 152–155, 616–617.

______, (1910) The Arkansas diamond fields in 1909. *Ibid.* 89, p. 767–768.

______, (1911) [Same], *Ibid.* 91, p. 6.

______, (1912) " " 93, p. 6.

______, (1913) " " 95, p. 75.

______, (1914) " " 97, p. 52.

GLENN, L. C. (1912) The Arkansas diamond-bearing peridotite area. Abstr.: *Science* 35, p. 312, with discussion by A. H. Purdue, 23, p. 726, 1912.

GROSS, M. L. (1959) The incredible American diamond mine mystery. *True*, September, p. 52–55, 98–102, illust. Early history.

HARRIS, G. D. (1909) Magnetic rocks [peridotite intrusives about Murfreesboro, Arkansas]. *Science* 29, p. 384.

HENSON, P. (1940) Arkansas' diamond field. *Gems & Gemology* 3, 7, p. 109–112.

HERNDON, B. (1951) America's only diamond mine. *Collier's Mag.*, August 25, illust.

HOTHEM, L. L. (1974) Arkansas' Crater of Diamonds. *Gems & Minerals* 441, p. 32–34, map.

HOWARD, D. L. (1951) Diamond mines of Arkansas. *Lapidary J.* 5, p. 248–254, 256.

HOWARD, J. M. (1989) *Finding diamonds in Arkansas!* AR Geol. Comm. folding brochure, 2 sides, maps.

FIGURE 24. View of the diamond-bearing ground in the Crater of Diamonds State Park near Murfreesboro, Arkansas. Frequent scraping of the surface uncovers fresh digging ground for visitors. *Courtesy P. L. Broughton.*

JACKSON, J. A. (1983) Arkansas diamond hunting. *Earth Science*, Summer issue, p. 22–23.

JEWELERS' CIRCULAR-KEYSTONE (1985) More diamonds in Arkansas? October, p. "o."

KIDWELL, A. L. (1990) Famous mineral localities: Murfreesboro, Arkansas. *Min. Rec.* 21, 6, p. 545–555, illust., maps.

KIMBERLEY TOWNSITE AND LAND COMPANY (1909) *Kimberley, the Diamond City of America.* Issued by the company, Nashville, AR: The News Print, [16] p., illust. Promotional brochure.

KUNZ, G. F. & WASHINGTON, H. S. (1907) Occurrence of diamonds in Arkansas. In Prec. stones ch., *USGS Min. Res. U.S. for 1906*, p. 1247–1251.

_____, (1907) Notes on the forms of Arkansas diamonds. *Amer. J. Sci.* 24, p. 275–276.

_____, (1908) Diamonds in Arkansas. *Amer. Inst. Min. Eng. Bimonthly Bull.*, p. 187–194; also in *Trans.* 39, p. 169–176.

_____, (1908) Diamonds in Arkansas. *Mining World* 28, p. 443.

_____, (1908) Diamonds in Arkansas. *Mines and Minerals* 28, p. 552–553.

KUNZ, G. F. (1909) Diamond mines in Pike County, Arkansas. *Eng. & Min. J.* 87, p. 963.

KROL, L. G. (1988) Prairie Creek kimberlite (lamproite). Proc. 22nd Forum on Geol. Industrial Min., G. W. COLTON, ed., *AK Geol. Comm.* MP 21, p. 73–75.

LEIPER, H. (1957) Arkansas diamonds, *J. Gemm.* 6, 2, p. 63–71, illust.

_____, (1957) Diamonds for the finding. *Lapidary J.* 11, 1, p. 4–6, 8, 10, 12, illust.

_____, (1966) America's only diamond-bearing peridotite pipe. *Lapidary J.* 20, 6, p. 714–718, 722–733, illust. (col.).

_____, (1969) Two former owners of portions of Arkansas peridotite diamond dike sell to one owner. *Lapidary J.* 23, 2, p. 366–371, illust., map.

_____, (1969) "Crater of Diamonds" is reopened to the public. *Lapidary J.* 23, 7, p. 970, 972, 973, illust.

McCORD, R. S. (1956) Fifty years of dreaming and digging in North America's only diamond mine. Little Rock: *Arkansas Democrat*, Sunday Mag., August 5, p. 1, 7, 9, illust.

McCOURT, W. E. (1910) Diamonds in Arkansas. *Acad. Sci. St. Louis Trans.* 18, p. lix-lx. Abstr. *Science* 30, p. 127, 1910.

MEYER, H. O. A., *et al* (1977) Prairie Creek kimberlite, Murfreesboro, Pike County, Arkansas. *2nd Internat. Kimberlite Conf. Field Guide*, 14 p.

MILLAR, A. Q. (1909) The Arkansas diamond field. *Min. & Scient. Press* 99, p. 534.

MILLAR, H. A. (1976) *It Was Finders-Keepers at America's Only Diamond Mine.* NY: Carleton Press, 175 p., illust.

MISER, H. D. (1914) New areas of diamond-bearing peridotite in Arkansas. *U.S. Geol. Survey Bull.* 540, p. 534–546, illust., map.

MISER, H. D. & ROSS, C. S. (1922) Diamond-bearing peridotite in Pike County, Arkansas. *Econ. Geol.* 17, p. 662–674, illust., map. Abstr. *Smithson. Inst. Ann. Rept. for 1923*, 1925, p. 261–272, illust.

_____, (1923) Diamond-bearing peridotite in Pike County, Arkansas. *U.S. Geol. Survey Bull.* 735-I, p. 279–322, illust.

MITCHELL, G. J. (1923) Diamond deposits in Arkansas. *Eng.& Min. J. Press* 116, 7, p. 285–287.

MORRISON, L. M. (1978) "Crater of Diamonds," a short history: 1906 to 1978. *Lapidary J.* 32, 5, p. 1064–1072, *passim*, illust.

PURDUE, A. H. (1908) A new discovery of peridotite in Arkansas. *Econ. Geol.* 3, 6, p. 525–528, map.

REYBURN, S. W. & ZIMMERMAN, S. H. (1920) Diamonds in Arkansas. *Eng. & Min. J.* 109, p. 983–986.

ROHN, K. H. (1982) South to the Ozarks. *Gems & Minerals* 542, p. 44–47, 50, 51, map. Digging in Crater of Diamonds.

SANSOM, W. J. (1948) Arkansas diamond mine. *Gemmologist* 17, p. 58–65.

SCHNEIDER, P. F. (1907) *A Descriptive Catalogue of the Diamond-Bearing Rocks. To Accompany the Exhibit of Peridotite Rock at Bureau of Mines, Manufactures and Agriculture.* Little Rock, AR: 3 p.

_____, (1907) *A Preliminary Report on the Arkansas Diamond Field.* AR Bur. Mines. Manuf. Agri., Little Rock, 16 p.

_____, (1908) Geology and mining in Arkansas diamond field. Abstr. *Mining World* 28, p. 255–257.

SCOTT SMITH, B. H. & SKINNER, E. M. W. (1983) Kimberlite and American Mines near Prairie Creek, Arkansas. *Ann. Scient. Univ. Clermont Ferrand*, II, no. 74, p. 27–36.

SELBERT, P. (1992) Combing the crater. *Lapidary J.* 46, 8, p. 53, 54, 84–92, *passim*, illust. (col.). Historical notes, digging advice.

STERRETT, D. B. (1907) Precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1906*, p. 1213–1252. "Occurrence of dias. Ark." by Kunz & Washington, p. 1247–1251.

THOENEN, J. R. *et al*, (1949) Investigation of the Prairie Creek diamond area, Pike County, Arkansas. *U.S. Bur. Mines Rept. Invest.* 4549, 24 p., maps.

WALDMAN, M. A., *et al* (1985) Geology and mineralogy of the Twin Knobs #l lamproite, Pike County, Arkansas. *Geol. Soc. Amer., Southeastern Section, preprint*, 17 p.

WHEELER, H. E. (1945) Diamonds in Arkansas. *AR Mineralogical Soc. Mineral Bull.* 4, p. 1–3.

WILLIAMS, J. F. (1891) The igneous rocks of Arkansas. Vol. 2, *Ann. Rept. Geol. Survey AR for 1890*, 457 p., illust. Branner & Brackett: on peridotite, Pike Co., p. 377–391.

WOODFORD, E. G. (1908) Report . . . *on Properties of Ozark Diamond Mining Company, Little Rock, Arkansas* . . . [14] p., fold. map.

WOODS, C. L. (1980) Update on Crater of Diamonds State Park. *Gems & Minerals* 507, p. 58–59, map.

MICHIGAN. Previous diamond finds in Michigan were reviewed by Middlewood (1978) who described a new addition to the list of authenticated Michigan diamonds in the "Bergquist diamond," found appropriately enough by Dr. S. G. Bergquist, a professor in Michigan State University, during a field lecture to his class held upon the Mason esker in Ingham County in 1954. The stone is a pale yellow octahedron of about one carat.

Greatly increased prospecting for diamonds in the last decade, and somewhat earlier, resulted in the discovery of kimberlite bodies in northern Michigan, according to Cannon & Mudrey (1981), who cite the discovery of the Lake Ellen kimberlite, about 10 mi (15 km) northeast of Crystal Falls and about 1 mi (1.5 km) west of Lake Ellen, Iron County. At this time no diamonds had been found in the samples taken from the deposit, but such sampling was admittedly inadequate. Cannon & Mudrey also provide an excellent historical review of diamond finds in this region and furnish photographs of the Saukville 6.57 carats and Burlington 2.11 carats diamonds.

In 1983, the Michigan Department of Natural Resources affirmed the discovery of kimberlite in the Crystal Falls area, and stated that Dow Chemical Company planned to mine a 30-ton sample for determining diamond content. Further official reports from the State indicated that in 1986, diamond prospecting continued over 60,000 acres in Iron and Dickinson counties. In 1988, Dow sold their six-year-old project rights in the Upper Peninsula to Crystal Exploration, Inc., of Denver, Colorado, a subsidiary of Restech International of Sydney, Australia (*Lapidary J.* 1989). By this date Dow had discovered seven kimberlite pipes, and core-drilling revealed scatterings of sand-grain-sized diamond crystals. The Dow venture was described by *The Mining Journal* (1988) who added the note that the crystals were "too few and too small for commercial production." The general aspects of this field, which extends over the border into eastern Wisconsin, are discussed by Jarvis & Kalliokoski (1988). In 1991, Crystal Exploration sold their interest to Ashton Mining of Australia, now known as Ashton Mining of Canada. In late 1995 this company sold their interest in the Great Lakes region to Pathfinder Resources of Vancouver, BC. So far, 25 kimberlite bodies have been found, but almost all are barren, and those that do contain diamonds appear to be uneconomical to mine.

CANNON, W. F. & MUDREY, M. G. (1981) The potential for diamond-bearing kimberlite in Northern Michigan and Wisconsin. *U.S. Geol. Survey Circ.* 842, 15 p.

DAILY MINING GAZETTE (1990) [Report on Crystal Explorations, Inc. prospecting.] March 1, p. 3.

JARVIS, W. & KALLIOKOSKI, J. (1988) Michigan kimberlite province. In *34th Ann. Mtg., Marquette, MI, Inst. on Lake Superior Geol., Proc. & Abstracts*, vol. 34, part 1, p. 46–48, map.

LAPIDARY JOURNAL (1989) Drilling hits diamonds. Vol. 42, 10, p. 5–6.

MIDDLEWOOD, E. A. (1978) Michigan's diamonds. *Lapidary J.* 31, 2, p. 2598–2599.

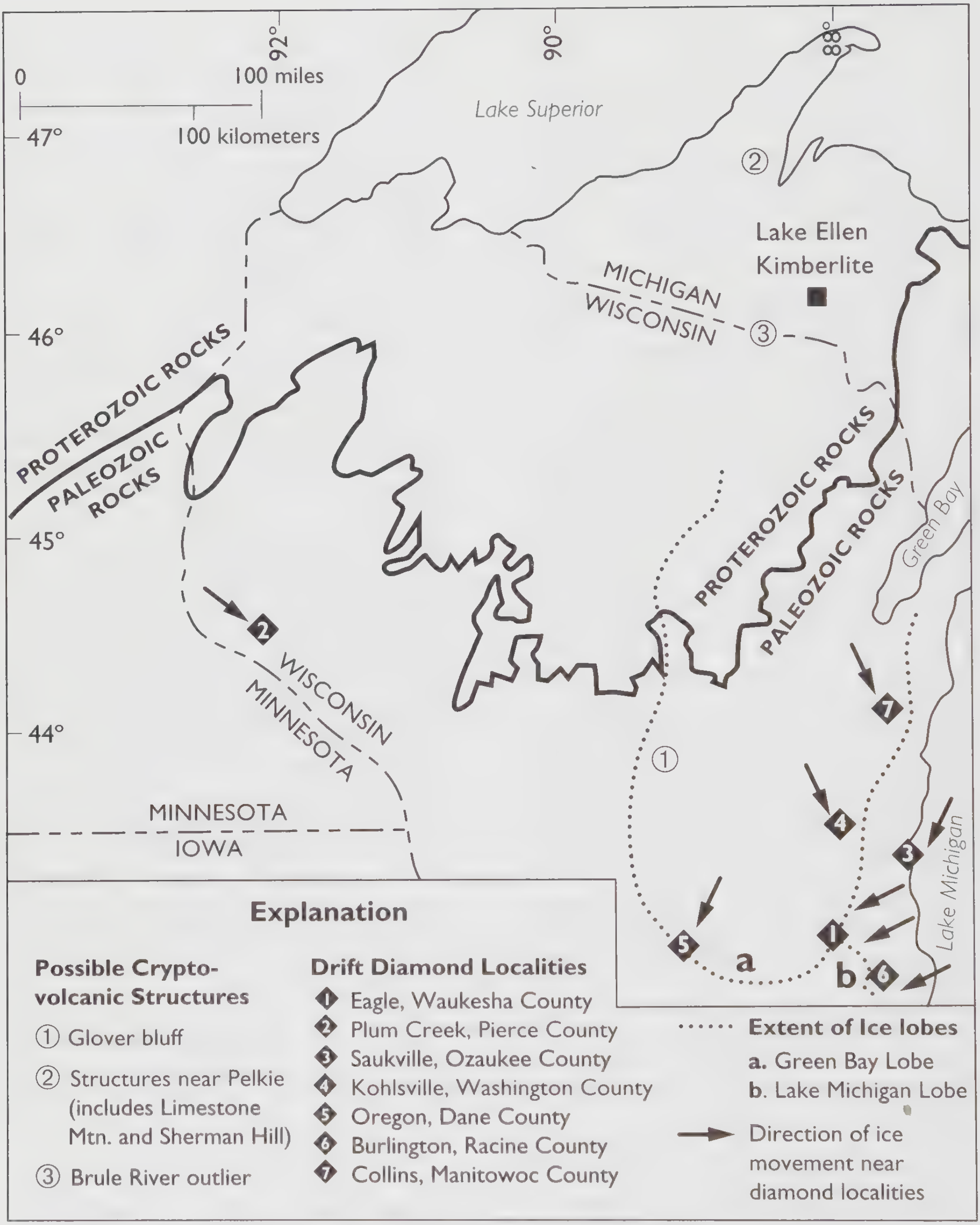

FIGURE 25. Diamond discovery sites in Wisconsin and Michigan showing glacier moraine margins and directions of ice sheet movements. W. F. Cannon & M. G. Mudrey, Jr., *U.S. Geological Survey Circular* 942, 1981.

MINING JOURNAL (1988) [Diamond mining in MI.] September 23, p. 4-A. Marquette.

______. (1990) [Kimberlite prospecting, Upper Peninsula.] April 13.

WISCONSIN. The adventures of the Eagle diamond, found by farm tenant Mrs. Clarissa Woodin 1876 near the village of Eagle, Waukesha County, are recounted by Crowns (1975), who reviews the legal battle that ensued when the finder sold the stone for $1.00, then found later that the fifteen-plus carats stone was worth far more. The case eventually reached the Supreme Court of the State of Wisconsin which held that no fraud had been and that the buyer, a Colonel Samuel B. Boynton of Milwaukee, was entitled to the stone. He later sold the stone to Tiffany & Co. of New York, and the crystal eventually came to rest in the collection of the American Museum of Natural History. Westman (1983) calls attention to the use of the "old" carat when the Eagle was originally weighed in at 16.25 carats; its weight has now officially been corrected to 15.37 carats.

"In 1984, Al Falster of Wausau, Wisconsin, recovered three one-millimeter octahedral diamond crystals from the fine sand and gravel in a gravel pit located near Antigo, Langlade County. He employed a modification of an old technique for diamond recovery from washed gravel, namely, passing such gravel over a cardboard that had been coated with butter, to which the diamond adheres much more firmly than other minerals. One of the crystals was detected from its fluorescence under untraviolet light (Hayes, 1984)."

CROWNS, B. C. (1975) The case of the Eagle diamond. *Lapidary J.* 29, 2, p. 534–535.

HAYES, PAUL G. (1984) Glint of diamonds in grains of sand? State News, *The Milwaukee Journal,* Oct. 14, p. 1, 3.

HOBBS, W. H. (1894) On a recent diamond find in Wisconsin and on the probable source of this and other Wisconsin diamonds. *Amer. Geologist* 14, p. 31–35, map. Diamond from Oregon, Dane Co.

______, (1895) A contribution to the mineralogy of Wisconsin. *Univ. Wisc. Sci. Ser. Bull.* 1, 4, p. 109–156, illust., p. 152–154.

______, (1896) Diamanten von Wisconsin. *N. Jb. Min.* 2, p. 249–251.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. Wisc. diamond p. 35.

______, (1891) On the occurrence of diamonds in Wisconsin. *Geol. Soc. Amer. Bull.* 2, p. 638–639.

______, (1894) Mineralogical notes. [Diamonds from Wisconsin, etc,] *NY Acad. Sci. Trans.* 13, p. 144–145.

OLSON, E. E. (1953) History of diamonds in Wisconsin. *Gems & Gemology* 7, 9, p. 284–285.

VIERTHALER, A. A. (1961) There are diamonds in Wisconsin. *Lapidary J.* 15, 1, p. 18–26.

______, (1961) Wisconsin diamonds. *Gems & Gemology* 10, 7, p. 210–215, illust.

WESTMAN, B. J. (1983) The "Eagle" diamond, a case of misplaced carats. *Calif. Mining J.,* December, p. 67–68, 70–75.

IOWA. According to Horick (1974, p. 55), "some years ago a gem quality green diamond about the size of a pea was found in gravel deposits at Dubuque and sold for a good price to a Chicago jeweler."

HORICK, P. J. (1974) The minerals of Iowa. Edit. by O. Knauth & S. J. Tuthill. *IA Geol. Survey Educ.,* Ser. 2, 88 p., illust. (col.), map.

MONTANA. In an astounding bit of luck, Darlene Dennis of Craig, Montana, found the "Lewis and Clark" diamond crystal of 14 carats while strolling along a rural road near Craig, Lewis and Clark County. The beautiful, perfectly smooth, somewhat oval-shaped crystal is slightly yellowish in hue. It is a rounded octahedron of gem quality! The circumstances surrounding the find are given in Zeitner (1991), who also provides a color photograph of the crystal. The stone was sold to Alexander Acevedo, Alexander Gallery, New York City, for the sum of $80,000. It was Acevedo who gave the crystal its name. Zeitner also mentions that in 1990 an 8 cts diamond was brought into Great Falls for examination by a jeweler, but the finder and the site of the find were not specified.

Hearn & McGee (1983) discuss garnets in the kimberlites of Montana, suggesting their useful-

FIGURE 26. The Lewis and Clark Diamond, found by Darlene Dennis, of Craig, Montana, in July, 1990 near Craig, Lewis and Clark County, Montana. The splendid crystal weighs 14 carats and is gem quality. *Courtesy J. C. Zeitner, Rapid City, South Dakota.*

ness as prospecting key minerals that may be traceable to a kimberlite source. Kimberlites discovered in central Montana are also treated by McGee (1987). An encouragement to diamond prospectors in this state is that it is underlain by the Archon group of cratonic basement rocks, as mentioned above under the initial general discussion of diamonds in North America.

HEARN, B. C. & McGEE, E. S. (1983) Garnets in Montana diatremes: a key to prospecting for kimberlites. *U.S. Geol. Survey Bull.* 1604, 33 p., illust., map.

KUNZ, G. F. (1883) [Diamond found at Blackfoot, Deer Lodge Co., MT.] *America*, p. 30–31.

McGEE, E. S. (1987) Garnet xenocryst analyses: potential for diamonds in the Williams kimberlite, north-central Montana and Lake Ellen kimberlite, northern Michigan. *U.S. Geol. Survey Open File Rept.* 87–418, 15 p.

ZEITNER, J. C. (1991) The Lewis and Clark diamond. *Lapidary J.* 45, 5, p. 79–88, *passim*, color photo.

WYOMING. Aside from the diamonds and other precious stones that were "salted" in an area south of Rock Springs in 1871 in a celebrated hoax (Harpending, 1913), no other diamonds were found that could be called "native" until 1975. In that year, kimberlite bodies in the southeastern region were found to contain small diamonds. This region, along with its corresponding region reaching south into Colorado, will be further discussed under that state. Elsewhere in Wyoming, as listed by Sutherland (1990), two diamonds were found in gold placers along Cortez Creek in 1977 at the northern end of the Medicine Bow Mountains, Secs. 34 & 35, T17N, R81W, or about 18 mi (29 km) east-southeast of Saratoga, Carbon County. One stone, yellowish in hue, weighed 0.1 ct; the other, a colorless crystal, weighed 0.035 ct. Their identity was established by X-ray diffraction at Wyoming Geological Survey. Another possible area, because of the discovery of pyrope garnet and chrome diopside upon ant hills there, is Cedar Mountain, Green River Basin, T15N, R111–112W, or about 50 mi (80 km) southwest of Rock Springs. Despite these promising indicator species, no diamonds have been found.

EGGLER, D. H. (1975) Diamond-bearing peridotite nodule in a Wyoming kimberlite pipe, *Geol. Soc. Amer. Abstract* 7, p. 1065.

HARPENDING, A. (1913) *The Great Diamond Hoax and Other Stirring Incidents in the Life of Asbury Harpending.* J. H. WILKINS, ed., San Francisco, CA: The James H. Barry Co., 285 p., illust. Reprinted 1958.

HAUSEL, W. D., GLAHN, P. R. & WOODZICK, T. L. (1981) Geological and geophysical investigations of kimberlite in the Laramie Range of Southern Wyoming. WY *Geol. Survey Prelim. Rept.* 18, 13 p., maps.

HAUSEL, W. D. (1982) Ore deposits of Wyoming. *Geol. Survey WY Prelim. Rept.* 19, 39 p. Kimberlite, p. 17–20, map.

_____, (1996) Diamond exploration potential of the Wyoming craton, Western United States. *Soc. Mining, Metall. and Exploration, SME Ann. Mtg., Phoenix, AZ, Mar. 1996; preprint* 96–27, 10 p.

McCALLUM, M. E., *et al* (1975) Kimberlite diatremes and dikes in the Iron Mountain area, southern Laramie Range, Wyoming. *Geol. Soc. Amer. Abstracts* 7, p. 628.

McCALLUM, M. E. & EGGLER, D. H. (1976) Diamonds in upper mantle peridotite nodule from kimberlite in Southern Wyoming. *Science* 192, p. 253–256.

McCANDLESS, T. E. (1982) The mineralogy, morphology, and chemistry of detrital minerals of a kimberlitic and eclogitic nature, Green River Basin, Wyoming. *MS Thesis, Univ. Utah, Salt Lake City,* 107 p.

McCANDLESS, T. E. & NASH, W. P. (1996) Detrital mantle indicator minerals in southwestern Wyoming, U.S.: evaluation of mantle environment, igneous host, and diamond exploration significance. *Exploration and Mining Geol.* 5, 1, p. 33–44.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., maps.

WYOMING-COLORADO KIMBERLITE PROVINCE. As shown in Figure 27, the occurrences of kimberlite extend over a north-south distance of about 120 mi (190 km), from the Sheep Rock area in the Laramie Range of Wyoming to as far south as the Green Mountain occurrence just west of Boulder, Colorado. According to Hausel, *et al* (1985), this large belt is conveniently divided into six districts: (1) Happy Jack-Pole Mountain area, between Cheyenne and Laramie, but no diamonds reported; (2) Sheep Rock, 45 mi (72 km) north of the state line, one kimberlite body only, no diamonds reported; (3) Iron Mountain, about 6 mi (9.6 km) southeast of the above, near the hamlet of Farthing, 57 kimberlite occurrences but no diamonds reported; (4) State Line district, 2.6 mi (4.2 km) north into Wyoming and about 12 mi (19 km) south into Colorado, about 40 kimberlites, of which at least 15 contain diamonds; (5) Estes Park, a single kimberlite dike, located a short distance south of the town, no diamonds reported; and (6) Green Mountain, a kimberlite pipe located immediately west of Boulder, Colorado. According to Collins (1982), kimberlite bodies had been overlooked or misidentified for a number of years, and one body, the Sloan I. diatreme, located just a little south of the hamlet of Virginia Dale, Larimer County, and only a few miles south of the Wyoming border, had been quarried for decorative serpentine rock! In 1964, however, McCallum established the true identity of this body, which led to re-evaluation of other similar bodies in the region that had gone unrecognized as kimberlites (Hausel, *et al*, 1987). As a result of this identification effort, over 100 kimberlite bodies are now recognized in this Wyoming-Colorado belt, and according to Sutherland (1990), "many of these kimberlites have not been adequately tested for the presence of diamonds." However, the state of Wyoming and private concerns carry on systematic testing of stream gravels to detect the presence of indicator minerals such as pyrope and chrome diopside. Many such promising sites have been found and "the potential for the discovery of previously unknown kimberlites in Wyoming is high." Kimberlite bodies thus far found range in size

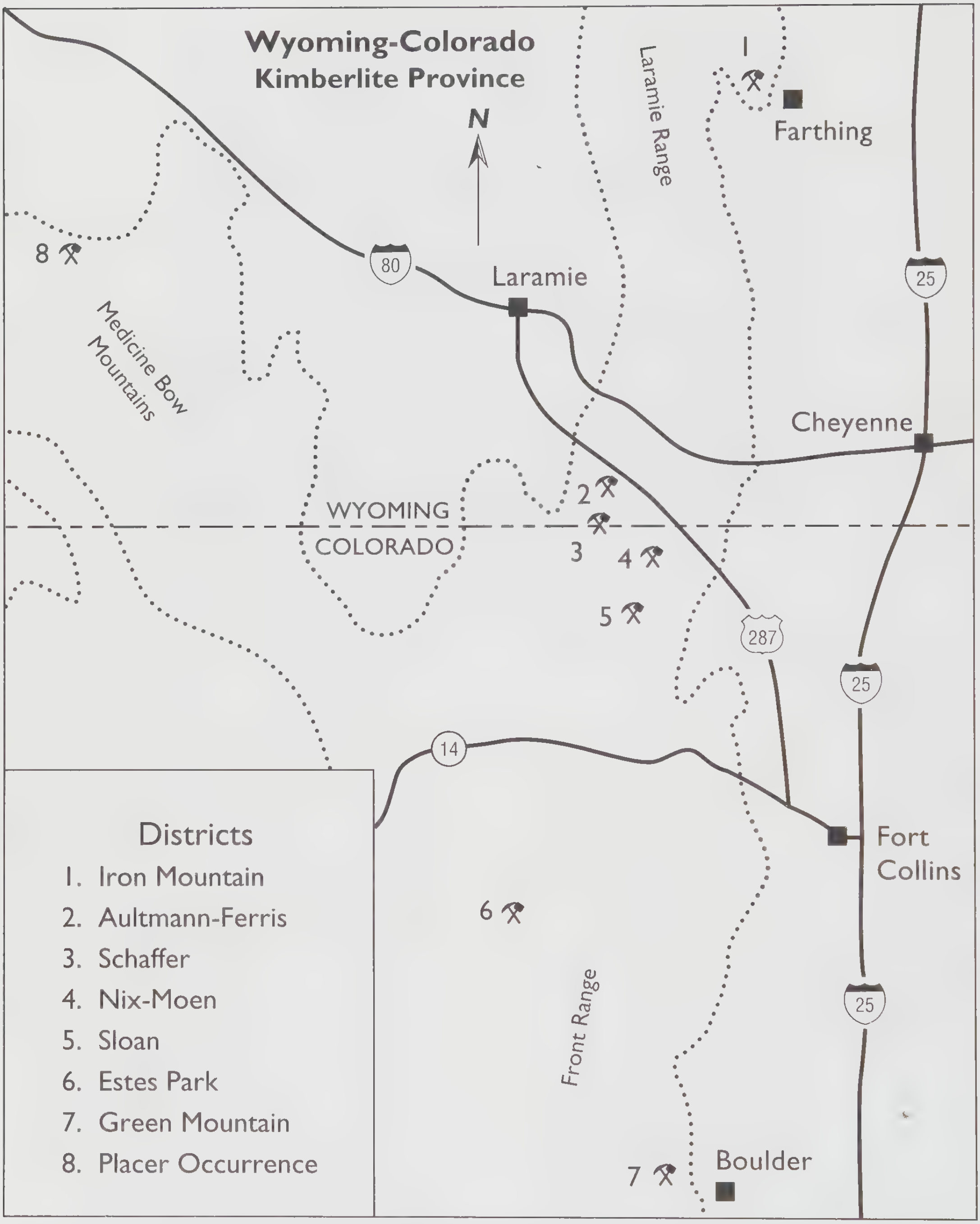

FIGURE 27. Kimberlite fields in the Wyoming-Colorado region. Modified from W. D. Hausel, Ore Deposits of Wyoming, *Geological Survey WY Report* 19, 1982.

from dike-like forms only one yard (1 m) wide to other bodies that are as much as 600 yards (550 m) across. On the Wyoming side of the State Line district, at least twelve bodies contain diamonds of industrial and gem grades, nearly 50% of them being gem grade, largely clear and mostly colorless. The largest crystal so far found in Wyoming is a clear stone of 0.86 ct. Hausel, *et al* (1985) report that Cominco American, Inc., tested 8,000 short tons of ore from a series of pipes and found a tenor of 0.005 to 0.01 ct/ton, the largest stone being only about one carat. "On the basis of testing . . . and comparison with economic pipes worldwide, the State Line kimberlites represent a low grade diamond resource with subeconomic mineralization" (Hausel, *et al*, *Ibid.*).

However, in August, 1994, the *Engineering & Mining Journal* (p. 20) reported the finding of "a 14.2 ct fine white octahedral gem diamond" in a bulk sample of kimberlite ore taken from near Kelsey Lake. This diamond appears to be the eighth largest diamond found in North America. The sample of ore is being processed by Colorado Diamond Corporation from ore mined from the KL-1 and KL-2 pipes, with "some 60% of the diamonds recovered . . . of gem quality." The Kelsey Lake area is located almost on the State Line between Wyoming and Colorado but is in the latter state. According to A. J. A. Janse (*Pers. comm.* 8/1994), stones found earlier include a 6 carats gem crystal and "an exceptional brilliant" stone of 1.1 ct of "the best gem quality." The prospects for establishing an economic diamond mine in this district are promising. Bulk sampling and evaluation during 1994 and 1995 of the two Kelsey Lake kimberlites led to the development of a small diamond mine, 50 mi (90 km) northwest of Fort Collins, Colorado. The two kimberlite bodies have a combined surface area of over 20 acres (10 ha). Although the overall grade of ore is low, the quality and average size of the diamond crystals are high. Annual production targets for 1996 and 1997 are 25,000 carats and 100,000 carats respectively. The mine was formally opened on June 1, 1996 (Coopersmith, H. G., 1994; Algeo, D., 1996; Baun, R. 1996).

McCallum & Mabarak (1976) provide numerous photographs of diamond crystals collected in the State Line district. The surface features of kimberlite outcrops which may be helpful to prospectors are described by Hausel, *et al* (1979). Additional details on the diamond crystals also appear in McCallum, *et al* (1979) along with fine photographs of crystals generally well below a carat in weight. In an interesting article, Cannon (1977) describes several pipe bodies and notes that the scratches from minute diamond crystals in a thin rock section that was being polished for petrographic examination led to the first verification of diamond in this district in 1975.

ALGEO, D. (1996) Colorado mine turns out rich diamond haul. *Denver Post*, Jun. 14, p. 1D & 8D.

BAUN, R. (1996) Lone U.S. commercial diamond dig is just a stone's throw away. *Fort Collins Coloradoan*, Jun. 14, p. A1 & A14.

CANNON, M. C. (1977) Diamonds discovered along Colorado-Wyoming border. *Lapidary J.* 31, 5, p. 1220–1224.

COLLINS, D. S. (1982) Diamond collecting in northern Colorado. *Min. Rec.* 13, 4, p. 205–209, illust., maps. Excellent guide.

COLLINS, D. S. & HEYL, A. V. (1984) History of the Colorado-Wyoming State Line diatremes. *Rocks & Minerals* 59, 1, p. 35–37, map.

COOPERSMITH, H. G. (1994) Diamondiferous kimberlite at Kelsey Lake, southern Wyoming archaean province. In: DUNNE, K. P. E. & GRANT, B., eds., Mid-continent diamonds, *GAC–MAC Symposium Volume*, p. 85–88. Vancouver, Mineral Deposits Division GAC, Univ. Brit. Columbia, 160 p.

EGGLER, D. H. & McCALLUM, M. E. (1974) Colorado-Wyoming kimberlite diatremes; Part II, a view of the upper mantle from nodules. *Geol. Soc. Amer. Abstracts* 6, p. 440.

HAUSEL, W. D., McCALLUM, M. E. & WOODZICK, T. L. (1979) Exploration for diamond-bearing kimberlite in Colorado and Wyoming: an evaluation of exploration techniques. *Geol. Survey WY Rept. Invest.* 19, 29 p., illust.

HAUSEL, W. D. (1983) Diamond-bearing kimberlite pipes in Wyoming and Colorado. *Rocks & Minerals* 58, 2, p. 241–244, illust., maps.

HAUSEL, W. D., McCALLUM, M. E. & ROBERTS, J. T. (1985) The geology, diamond testing procedures, and economic potential of the Colorado-Wyoming kimberlite province: a review. *Geol. Survey WY Rept. Invest.* 31, 22 p., illust., map.

McCALLUM, M. E. & EGGLER, D. T. (1971) Mineralogy of the Sloan diatreme. A kimberlite pipe in northern Larimer County, Colorado. *Amer. Mineral.* 56, 9–10, p. 1735–1749, maps.

McCALLUM, M. E. & MABARAK, C. D. (1976) Diamond in State-Line kimberlite diatremes, Albany Co., Wyoming, Larimer Co., Colorado. *Geol. Survey Wy, Rept. Invest.* 12.

_____, (1976) Diamond in kimberlite diatremes of northern Colorado. *Geology* 4, p. 467–469.

McCALLUM, M. E., MABARAK, C. D. & COOPERSMITH, H. G. (1979) Diamonds from kimberlites in the Colorado-Wyoming state line district. In BOYD, F. R. & MEYER, H. O., eds., Kimberlites, diatremes, and diamonds: their geology, petrology, and geochemistry. *Proc. 2nd Internat. Kimberlite Conf., Vol. 1, Washington, D.C.*, p. 42–58, illust.

SMITH, C. B., *et al* (1979) Petrochemistry and structure of kimberlites in the Front Range and Laramie Range, Colorado-Wyoming. In BOYD, F. R. & MEYER, H. O. A. [*Ibid.*], p. 179–189.

VOYNICK, S. (1994) North American diamonds. *Rock & Gem* 24, 12, p. 18–20, 22, 24, illust., map. Includes Colorado.

THE GREAT DIAMOND HOAX. As will be recalled by many readers, this hoax was perpetrated by several clever swindlers upon San Francisco financiers and investors by "salting" a remote spot with an unlikely assortment of gem stones, some even partially cut, and then obtaining a large sum of money to take the dupes to the place where they could scratch around and find gems for themselves. Rosenhouse (1976) locates the salting site in Brown's Park, in the northwest corner of Colorado. According to the Craig District Office, Bureau of Land Management, U.S. Department of the Interior, the exact place is W½, Sec. 22, T12N, R102W. Various parties visited the site to see if they could find more gems, but as Rosenhouse suggests, it is likely that Clarence King, when he closely examined the site to confirm that salting had taken place, took away most of the stones. A recent account of King's expose of the swindle appears in Wilkins (1988, p. 171–185, 195).

AVERITT, P. (1956) Diamond fraud exposed: an episode in the life of Clarence King. *GeoTimes* 1, 4, p. 11, 12, 18, 18.

FARISH, T. E. (1919) The great diamond swindle. *Arizona Mining J.* 3, p. 23–26.

FAUL, H. (1972) Century-old diamond hoax reexamined. *GeoTimes* 17, p. 23–25.

HARPENDING, A. (1913) *The Great Diamond Hoax and Other Stirring Incidents in the Life of Asbury Harpending.* Edit. by James H. Wilkins. San Francisco, CA: The James H. Barry Co. 285 p., illust. Reprinted: 1961, Norman, OK: Univ. Ok. Press, 211 p.

KING, C. (1872?) The diamond discovery of 1872. In *Records of the U.S. Geological Survey, Geologists Field Notebooks No. 1113, National Archives Records Group* No. 57, 19 p.

KING, C. (1872) Official letter, dated November 11, 1872, to Board of Directors of the San Francisco and New York Mining and Commercial Company, stating that the new diamond field in the Southwest is a fraud: 12 p. Copy in Kunz Coll., U.S. Geol. Survey Library.

MINING & SCIENTIFIC PRESS (1872) The Arizona diamond fields, 25, p. 316. The diamond swindle, p. 344.

RICKARD, T. A. (1932) *A History of American Mining.* NY: McGraw-Hill Book Co., 419 p., illust; ch. 17 on the hoax, p. 380–396.

_____, (1935) The great diamond hoax. *Eng. & Min. J.* May 30.

ROSENHOUSE, L. (1976) Ralston's fabled diamond field. *Gems and Minerals* 465, p. 54–55, 65–69, map.

WILKINS, T. (1988) *Clarence King, a Biography.* Albuquerque, NM: Univ. New Mexico Press, 524 p. illust. Hoax p. 171–185, 195.

WOODARD, B. A. (1967) *Diamonds in the Salt.* Boulder, CO: Pruett Publishing Co., 200 p.

CALIFORNIA. The probability that an important *in situ* deposit of diamond in California will be discovered soon was increased by recent discoveries of diamonds far larger than any that have been found in this state before (Kopf, *et al*, 1990). During the 1980s four large diamonds were found in Trinity County by retired geologist/miner Edgar J. Clark. The first, a stone called "Jeopardy," weighs 3.90 cts and consists of a core crystal surrounded by additional overgrowths of diamond; its color is yellowish-brown. The stone was found in gold-bearing gravels of Hayfork Creek, a tributary of the South Fork of Trinity River. The year of discovery was either 1982 or 1983. The second stone, called "Serendipity," weighs 14.33 cts, is highly irregular in shape, pale grayish-green in color, and was found in January, 1987. The third stone, the "Enigma," weighs 17.83 cts, is grayish-brown, and is very rough upon its exterior. It was found in June, 1987. The last stone, the "Doubledipity," weighs 32.99 cts and is a yellowish-brown, very crudely formed crystal. It was found in the same month. None of the stones are gem grade and their very rough exteriors caused by overgrowths upon an earlier formed crystal suggest a common origin and a common, as yet undiscovered source. In addition to describing these stones, Kopf, *et al* also provide a useful summary of previous diamond finds in California.

CARLSON, D. W. & CLARK, W. B. (1954) Mines and mineral resources of Amador County, California. *CA Div. Mines, CA J. Mines & Geol.* 50, 1, p. 149–285, illust., map. Diamonds mentioned.

CLARK, W. B. (1970) Gold districts of California. *CA Div. Mines & Geol. Bull.* 193, 186 p., illust., map. Diamonds p. 36–67.

EVANS, B. (1916) Diamonds of Smiths Flat. *Eng. Min. J.* 102, 19, p. 814–815. Thirty-three crystals from list kept by a resident.

GOODYEAR, W. A. (1873) Diamonds in El Dorado County. In RAYMOND, R. W., 4th Rept. Min. Res. States & Terr. West of Mississippi, 42nd Congress, 2nd Sess., *House Executive Document* 211, p. 27

HANKS, H. G. (1870) Diamonds in California. *Min. Scient. Press* 20, p. 162.

______, (1882) Diamonds in California. *CA State Min. Bur., 2nd Ann. Rept. of State Mineralogist,* 226 p. Diamonds p. 241–254.

______, (1884) *CA State Min. Bur., Fourth Annual Report of the State Mineralogist.* 410 p., illust. Diamond, p. 159–172; woodcut of crystal.

HILL, M. (1972) *Hunting Diamonds in California.* Rev. edit. Healdsburg, CA: Naturegraph Publ., 80 p., illust.

KOPF, R. W. (1989) First diamond find in California—when and where? *California Geology* 42, 7, p. 160–162.

KOPF, R. W., HURLBUT, C. S. & KOIVULA, J. I. (1990) Recent discoveries of large diamonds in Trinity County, California. *Gems & Gemology* 26, 3, p. 212–219, illust. (col.), map.

KUNZ, G. F. (1885) Gems and precious stones. Ch. in *U.S. Geol. Survey Min. Res. U.S. for 1883-1884,* p. 723–782. CA diamonds p. 730–732.

______, (1905) Gems, jewelers' materials and ornamental stones of California. *CA Div. Mines Bull.* 37, 171 p., illust. (col.), p .40.

LYMAN, C. S. (1849) Platinum and diamonds in California. *Amer. J. Sci.* 8, p. 294.

MINING AND SCIENTIFIC PRESS (1870) California diamonds. Vol. 20, p. 194.

MURDOCK, J. & WEBB, R. W. (1966) Minerals of California. *CA Div. Mines & Geol. Bull.* 189, 559 p., illust. (col.). Diamond finds list p. 170–171.

PAGES OF HISTORY (1959) *Diamonds in California.* Sausalito, CA: priv. publ., 56 p., illust. *See* HILL, M., *above.*

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps. Diamond p. 53–55; crystal illustrated.

TRAYWICK, B. (1967) Diamond dilemma in California. *Desert Mag.* 30, 6, p. 16–17. Cherokee Flat diamonds.

ROSENHOUSE, L. (1975) Diamonds along the Feather River. *Gems & Minerals* 456, p. 36–38, 53–55, illust. Excellent historical review.

SCHALLER, W. T. (1916) *U.S. Geological Survey Mineral Resources of the U.S. for 1915,* part 2, p. 848–849. Over 25 diamond finds in Sierra Nevada gold regions described.

SCOTT, W. (1925) Diamond quest in California. Cherokee mine may become a diamond mine. *Scient. Amer.* 134, p. 312.

SILLIMAN, B. (1867) Notices of new localities of diamonds in California. *CA Acad. Sci. Proc.* 3, p. 354–355.

______, (1867) On new localities of diamonds in California. *Amer. J. Sci.* 44, p. 119.

______, (1873) On the probable existence of microscopic diamonds with zircons and topaz, in the sands of hydraulic washings in California. *Amer. Inst. Min. Eng. Trans.* 1, p. 371–373.

SPERISEN, F. J. (1938) Gem minerals of California. *CA Div. Mines Rept.* 34, p. 34–74, illust. (col.). Diamonds p. 38–40.
STORMS, W. H. (1917) Diamonds in California. *Min. Scient. Press* 114, p. 273–275.
TURNER, H. W. (1899) The occurrence and origin of diamonds in California. *Amer. Geologist* 23, p. 182–191; *Min. Scient. Press* 78, p. 586, 613. List of localities.
WOODS, M. C. (1986) Diamond finds in California. *California Geology* 39, 8, p. 186–187.
YALE, C. G. (1885) California diamonds. *West. American Scientist* 2, p. 60.

SONORA-CHIHUAHUA(?). Leiper (1965) provides an entertaining account of possible diamond finds in some remote area of northern Mexico, perhaps in an area in Sonora adjacent to Chihuahua. Diamonds were found in the possession the Ontiveros Family of Queretaro, mineral and gem dealers, and a crystal found in the Ontiveros shop in El Paso, Texas, ostensibly from Mexico, was bought by Leiper; it is a "dodecahedron of a peculiar greenish color and is in the author's collection today." Sam Brinkley of San Diego procured two octahedral diamond crystals approximately 1/4 carat each, from Ernesto Ontiveros, while visiting his shop in Queretaro. One of these is depicted in the article and is a rough-surfaced twinned octahedral crystal. These are still in Brinkley's possession (*Pers. comm.* 5/94).

LEIPER, H. (1965) Diamonds in Mexico. *Lapidary J.* 19, 1, p. 40, 42.

DIASPORE

PENNSYLVANIA. Isaac Lea (1867) describes the several minerals found at the corundum locality near Unionville, Chester County, noting that the "most important and rarest mineral of this locality is, however, Diaspore . . . in lamellated masses of two to three inches and often of adamantine brilliancy." He describes a series of specimens, the best crystals of which are "fawn-colored" and resemble topaz. While the clear fragments may have been large enough to facet gems, I have not been able to find any record of a cut stone either from this locality or from the Chester, Massachusetts one (Lincks, 1978).

LEA, I. (1867) On two new minerals from Chester Co., Penn. *Proc. Acad. Nat. Sci. Phila.* 2, p. 44–45.
LINCKS, G. F. (1978) The Chester emery mines. *Min. Rec.* 9, 4, p. 235–242, illust., map.
McKINSTRY, H. E. (1921) The Unionville, Pennsylvania, corundum mine. *Amer. Mineral.* 6, p. 135–137.
PALACHE, C. & WOOD, H. O. (1909) Crystallographic notes on minerals from Chester, Mass. *Amer. Acad. Arts Sci. Proc.* 44, p. 641–652.

DIATOMITE (Diatomaceous Earth)

CALIFORNIA. Harden (1962) describes diatomite rock that was quarried locally at Coalinga, Fresno County, by Permi-Arts Company and sold under the trade name of "Maple-Rok." It is an easily worked material that can be finished in several ways to provide different textures and colors.

HARDEN, C. (1962) Diatomite as a carving medium. *Gems & Minerals* 301, p. 18–19, illust.
KADEY, F. C. (1975) Diatomite. In LEFOND, S. J., Editor-In-Chief, *Industrial Minerals and Rocks*, 4th edit., NY: Amer. Inst. Min. Met. & Petrol. Eng., 1360 p., illust. Diatomite p. 605–635.

DICKINSONITE

CONNECTICUT. This phosphate species, formula $(K,Ba)(Na,Ca)_5(Mn,Fe,Mg)_{14}Al\ (PO_4)_{12}(OH,F)_2QY$, is found in granitic pegmatites where its monoclinic, greenish tabular crystals ordinarily occur in minute individuals. Properties are: refractive indexes alpha 1.648–1.658, beta 1.655–1.662, gamma 1.662–1.671, biaxial (+), birefringence 0.013–0.014; hardness 3.5–4; specific gravity 3.38-3.41. There is a perfect cleavage. According to Arem (1987), "very fine green gems less than 1 to 2 carats, have been cut from Connecticut material," presumably from the pegmatite near Branchville, Fairfield County, where this mineral was first found.

FIGURE 28. View of the De Kalb, St. Lawrence County, New York, diopside quarry during the 1971 exploration by S. Alverson and others. *Courtesy George Robinson, Manotick, Ontario.*

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* NY: Van Nostrand Reinhold, 248 p., illust. (col.), p. 82.

PALACHE, C., BERMAN, H. & FRONDEL, C. (1951) *The System of Mineralogy.* 7th edit. Vol. II, p. 717–719.

DIGENITE

MONTANA. Digenite is Sulfide of copper, formula Cu_9S_5, isometric, hardness 2.5–3, specific gravity 5.5–5.7, color black to blue, often associated with chalcocite, which it resembles. At Butte, it is reported to have furnished material for cabochons.

DIOPSIDE

NEW YORK. The famous De Kalb, St. Lawrence County, deposit of gem quality green diopside crystals was once again quarried, and more specimen and gem material obtained, during intermittent operations between 1971 and 1981 (Robinson, 1990). The first modern exploration was by Szenics (1968), followed by a brief working by the New York State Museum in the same year. In early 1971 the property was acquired by S. Alverson, R. Dow and G. W. Robinson, who produced several hundred crystals in 1971, from 1 to 8 cm (3/8–3 in). A faceted gem of 11.4 cts from this find is now in the collection of the Canadian Museum of Nature. As of 1990, the property was owned by Schuyler Alverson of Rensselaer Falls, New York, and Robert Dow, of Canton, New York. So far as Robinson *(Ibid.)* was able to discover, the largest diopside crystal from this locality is a 5 x 10 cm (2 x 4 in) individual in the Bement Collection, American Museum of Natural History, New York City. According to Arem (1987), this museum also owns the largest recorded faceted diopside from De Kalb, a gem of

38 cts. The Elmer Rowley Collection contributed four faceted gems to the New York State Museum Collection, ranging from 2.75 to 6.60 cts (Schimmrich & Campbell, 1990). The best account of the deposit, its minerals, and the details on crystallography, etc., of the diopside appears in Robinson (1990). The future of quarrying here is uncertain because it requires the use of explosives, the enclosing rock being tough.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* NY: Van Nostrand Reinhold., 2nd edit. 248 p., illust. (col.).

BATES, A. C. (1929) Little journeys. *Rocks & Minerals* 4, 3, p. 94.

ROBINSON, G. (1973) De Kalb diopside. *Lapidary J.* 27, 7, p. 1040–1042, 1058, 1059, illust. (col.).

_____, (1990) Famous mineral localities: De Kalb, New York. *Min. Rec.* 21, 6, p. 535–541, illust. (col.), maps.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection. *Open File Rept.* 8m106, 47 p.

SZENICS, T. (1968) World-famous lost American diopside locality rediscovered. *Lapidary J.* 21, 10, p. 1232–1239, illust. (col.).

DOLOMITE

NORTHWEST TERRITORIES. With the encouragement of stone carving by the natives of the Arctic and sub-Arctic regions, government geologists have examined and reported on discoveries of suitable materials, including dolomite. Carving grade dolomite occurrences are listed by McDermott (1992), with sites given in latitudes and longitudes, plus comments on local geologies and the nature of the material, etc. For the most part, the deposits are inaccessible for much of the year. Other collecting sites are given by Bell (1992).

BELL, R. (1992) Compilation of lapidary sites of the Northwest Territories. *NWT Geol. Div. EGS* 1992–14, 157 p , maps.

McDERMOTT, G. (1992) Carvingstone occurrences of the Northwest Territories. *NWT Geol. Div. EGS* 1992–15, 185 p.

SASKATCHEWAN. A handsome, tan to pink or light red, very fine-grained dolomite containing beautiful dendrites occurs as cobbles in a quarry in the vicinity of Naicam, central Saskatchewan, or about 75 air miles (120 km) southeast of Prince Albert. The quarry is on Highway 6. The dendritic markings are dark and sharply defined. Cabochons of several inches across have been cut from this material (Balacko, 1977).

BALACKO, T. (1977) Dendritic dolomite of Saskatchewan. *Lapidary J.* 31, 5, p. 1238–1239, illust.

VERMONT. In Chittenden County, massive, fine-grained banded dolomite, red, white, gray, and orange, occurs in the Dunham dolomite facies in a quarry on Highway 2 between Chimney Corner and Sand Bar Bridge. The Swanton red marble of Franklin County occurs in a quarry of the Vermont Marble Company, located a short distance south of the place where Highway 7 crosses the Missisquoi River.

MORRILL, P. & CHAFFEE, R. G. (1964) *Vermont Mines and Mineral Localities.* Hanover, NH: Dartmouth College Museum, 57 p., maps.

VERMONT, STATE OF (1990?) *Rockhounding in Vermont.* VT Agency of Development and Community Affairs, 12 p.

MICHIGAN. No new developments.

COURTER, W. E. (1977) Michigan's favorite gemstone. *Lapidary J.* 31, 1, p. 150–158, *passim*, illust. Includes Kona dolomite.

MARKERT, R. (1961) "Kona dolomite"—the Cinderella mineral of the Midwest. *Rocks & Minerals* 36, 5–6, p. 238–239, illust.

VAN HISE, C. R. & BAYLEY, W. S. (1897) The Marquette iron-bearing district of Michigan. *U.S. Geol. Survey Mono.* 28, 608 p., illust. (col)., maps. Kona dolomite and jaspilites.

ZEITNER, J. C. (1988) *Midwest Gem, Fossil and Mineral Trails: Great Lakes States.* Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps, p. 61.

MINNESOTA. An attractive fine-grained dolomite is quarried in the area between Kasota and Mankato in LeSuer and Blue Earth counties. The colors are predominantly yellowish, tan, or reddish-tan, but a pale gray variety is also quarried (Thiel & Dutton, 1935).

THIEL, G. A. & DUTTON, C. E. (1935) The architectural, structural, and monumental stones of Minnesota. *MN Geol. Survey Bull.* 25, 160 p., figs., 12 color plates.

TEXAS. Carving grade, very fine-grained, white to pink dolomite with handsome dendritic markings occurs near Greenbelt Reservoir and along the Red River Valley, northeast of Clarendon, Donley County (Mitchell, 1991). It is hard and dense, and takes a good polish.

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps.

GRAND CAYMAN ISLANDS. A micro- to cryptocrystalline pale cream to brownish orange dolomite is being quarried from the eastern end of Grand Cayman and Cayman Brac islands, according to advice from Gerald Kirkconnell, of Kirk Freeport Plaza (Koivula, *et al*, 1994). The attractive material has been cut into cabochons and beads and locally sold in tourist-type jewelry. The properties correspond to those of dolomite, e.g., refractive index of about 1.6, hardness 6–7, specific gravity average 2.63, and a confirmatory X-ray pattern coincided with a standard pattern.

KOIVULA, J. I., *et al* (1994) "Caymanite" from the Grand Cayman Islands, Caribbean. Gem News. *Gems & Gemology* 30, 3, p. 193, illust. (col.).

DOMEYKITE

MICHIGAN. No new developments.

MOORE, P. B. (1962) Copper arsenides at Mohawk, Michigan, *Rocks & Minerals* 37, 1–2, p. 24–26.

DURANGITE

DURANGO. This rare arsenate, formula $NaAlF(AsO_4)$, was found in the type locality of Barranca tin mines, 18 mi (30 km) northeast of Coneto or about 90 mi (145 km) northeast of the city of Durango. Recently G. & M. Vargas (1985) listed it in their compilation of gem materials and noted that "it is seldom cut, but makes good faceted gems." Properties: monoclinic, refractive indexes 1.634–1.685, biaxial (-), birefringence 0.051. Hardness 5, specific gravity 3.97–4.07.

PALACHE, C., BERMAN, H. & FRONDEL, C. (1951) *The System of Mineralogy.* 7th edit. Vol. 2. NY: John Wiley, 1124 p., illust.

VARGAS, G. & VARGAS, M. (1985) *Descriptions of Gem Materials.* 3rd edit. Thermal, CA: priv. publ., 180 p.

ENSTATITE

Enstatite, an end-member in the pyroxene series of silicates, formula $MgSiO_3$, sometimes occurs in crystals sufficiently clear to afford faceted gems. Properties are: refractive indexes alpha 1.650–1.665, beta 1.653–1.671, gamma 1.658–1.680, birefringence 0.010, biaxial (+), orthorhombic. Hardness 6, specific gravity 3.20–3.30. The bronzite variety is noted for its semi-metallic, bronzey reflections from individual crystal grains, and sometimes affords attractive cabochon or ornamental stone material. Pough (1991) illustrates such a cabochon made from Wyoming material, but without identifying the locality.

POUGH, F. H. (1991) Enstatite. *Lapidary J.* 45, 3, p. 14, 16, illust. (col.).

NORTH CAROLINA. In 1971, chatoyant brownish-yellow enstatite was found in the tourist Rockhound Heaven Mine near Cowee Valley by Shaw (1976). The specimen of about seven carats was identified by the U.S. National Museum of Natural History in Washington, D.C. An additional note on subsequent finds of enstatite in North Carolina appeared in the next year (Shaw, 1977), in which it was noted that "a transparent brown pea-size pebble [found] several years ago at the Jacobs Mine" was "faceted . . . into a 4½ mm. round brilliant." Another crystal found here was a "grayish 5/16-inch crystal of square shape . . . brownish and translucent rather than transparent when held up to the light." It was thought to be suitable for a cat's-eye or star cabochon.

SHAW, J. L. (1976) The "Wizard." *Lapidary J.* 30, 8, p. 1952–1958, illust.

_____, (1977) More about "wizards." *Lapidary J.* 31, 3, p. 549.

ALABAMA. In a letter to Joan L. Shaw, finder of the North Carolina enstatite mentioned above, geologist Thornton L. Neathery informed her that he had found "some gem enstatite crystals inside boulders of enstatite" from a site north and east of Dadeville, Tallapoosa County. A subsequent search for the exact place by Shaw was unsuccessful. Cook & Smith briefly note Neathery's locality but do not mention if gem enstatite occurs there.

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120, 285 p., illust. (col.), map, p. 221.

NEATHERY, T. L. (1968) Talc and anthophyllite asbestos deposits in Tallapoosa and Chambers counties, Alabama. *AL Geol. Survey Bull.* 90, 98 p.

SHAW, J. L. (1978) Alabama rocks and rockhounds. *Lapidary J.* 32, 3, p. 818–822, illust., map.

ARIZONA. Facet grade, dark green enstatite grains occur within the granular peridot nodules found in basalt on the San Carlos Indian Reservation, Gila County. Most grains are so dark in color that at first glance they appear black, and as a result, only gems of less than 10 carats can be cut that may show reflected colors, but better results occur if only several-carat gems are cut. Some of the grains contain fibrous inclusions and make cat's-eyes. Details on the mineralogy of these nodules appears in Dunn (1975).

DUNN, P. J. (1975) Properties of enstatites and bronzites compared. *Gems & Gemology* 15, 4, p. 118–122.

See also PERIDOT.

EPIDOTE

VERMONT. In June 1969, Richard A. Kosnar of Golden, Colorado, collected flawless dark green crystals of epidote, 1.5–2 cm (0.6–0.7 in) long, from the asbestos mine locality of Eden Mills, Lamoille County. The crystals "will cut 1–2 ct. clean stones, 31" (*Pers. comm.* 8/10/1994).

VIRGINIA. The black, radioactive epidote-group mineral known as allanite has been polished into cabochons that resemble obsidian. The material comes from a granitic pegmatite located 0.5 mi (0.8 km) west of Lynchburg Reservoir, Amherst County (Penick, 1992).

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 1–16, p. 1.

EUDIALYTE

This is a rare zirconium silicate with the complex formula $Na_4(Ca,Fe,Ce,Mn)_2\ ZrSi_6)_{17}\ (OH,Cl)_2$. Properties: refractive indexes omega 1.591–1.623, epsilon 1.594–1.633, uniaxial (+), birefringence 0.003–0.010. Hardness 5–5.5, specific gravity 2.74–2.98. It occurs generally in some shade of brownish-red, pink, or red, and rarely is translucent to transparent. These properties are from Arem (1987), but *see* Henn (1985), who first described clear facet-grade material; *see also* Fritsch (1993).

QUEBEC. Very small clear faceted gems of rose-red hue have been cut from material found in the Kipawa complex, Temiscamingue County. Wight (1986) records faceted gems of 0.30 and 0.40 ct, intense red, from the Kipawa complex exposure at Sheffield Lake, Villedieu Township, while Fritsch (1993) mentions faceted eudialytes in the possession of Guy Langelier, Montreal, one of which was orangey-pink in hue and weighed 0.36 ct. Constants determined on same were: refractive indexes 1.599–1.602, birefrigence 0.003, specific gravity about 2.81–3.12; inert to all ultraviolet radiation. Henn (1985) tested Kipawa facet-grade material and found indexes of omega 1.596–1.597, epsilon 1.600–1.601, birefrigence 0.004.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).

FRITSCH, E. (1993) Rare gemstones from Quebec. In Gem Trade Lab Notes. *Gems & Gemology* 29, 4, p. 287–288.

HENN, U. (1985) Eudialyt aus Kanada. *Zs. Dt. Gemm. Ges.* 34, 1–2, p. 76, 78.

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55, p. 40, 41.

ALASKA. Gary A. McWilliams of Wrangell, southeastern Alaska, found a rare and attractive cabochon material which consists of purplish-red eudialyte crystals, along with black prismatic crystals of riebeckite, in a matrix of very fine-grained, white albite. The material comes from an undisclosed occurrence upon Prince of Wales Island. Some of the rock has been cut into spheres and eggs, up to 1.5 in (4 cm) across. The largest egg, shown during the Tucson Show in 1994, displaying much eudialyte, measures 4.25 in (11 cm) by 2.75 in (7.4 cm) and weighs about 2 lb (0.9 kg).

FAUSTITE

Faustite is an inadequately described mineral which resembles turquoise in its massive form and is further confused with that species because of its similar chemistry, color, etc. The formula is $(Zn,Al)_6(PO_4)_4(OH)_8 \cdot 5H_2O$. It was described from a locality in Nevada (*see* Vol. 1, p. 125, 130–131). Faustite results when zinc substitutes for copper in what would otherwise be turquoise; it is possible that some greenish "turquoise" found in some western states deposits may be faustite. Properties: specific gravity, massive, 2.76–2.91; hardness 5.5.; refractive index, massive, about 1.61.

ERD, R. C., FOSTER, M. D. & PROCTOR, P .D. (1953) Faustite, a new mineral, the zinc analogue of turquoise. *Amer. Mineral.* 38, p. 964–972.

LIDDICOAT, R. T. & FRYER, C. W. (1974) Three new gem materials. *Zs. Dt. Gemm. Ges.* 23, 2, p. 125–127.

FELSITE

NEWFOUNDLAND. Sabina (1976) remarks upon a variety of "attractively-patterned, fine-grained volcanic rocks" that occur as pebbles and boulders along the east shore of Avalon Peninsula, south of St. John's, and elsewhere in many beaches of the island. These are felsites.

SABINA, A. P. (1976) Rocks and minerals for the collector. The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75–36, 199 p., illust., maps, p. 61.

FELDSPAR

As befits such an abundant mineral, the gem varieties continue to be found throughout the continent. Mexico just recently produced astonishingly large straw-yellow facet-grade grains from volcanic rocks, much larger than any found before of the labradorite species. Additionally, amazonite continues to be found in Virginia and Colorado, while the sunstones of Oregon are now becoming important gems in international trade. Zeitner (1974) provides a review of occurrences in the United States, while a view of the gem varieties is furnished by the Fraziers (1993). Internal characters and structures of feldspars, some related to special optical effects, are discussed in Ribbe (1975) and Smith & Brown (1988).

FRAZIER, S. & A. (1993) The gem feldspars. Lapidary J., 47, 5, p. 35–39, 110, 112, 117.

RIBBE, P. H. (1975) Exsolution features and interference colors (in feldspars) In *Mineralogical Soc. Amer. Short Course Notes*, Vol. 2, p. R73-96, illust.

SMITH, J. V. & BROWN, W. L. (1988) Feldspar minerals. Vol. 1. Crystal Structures, Physical, chemical and Microtextural Properties. 2nd edit. Berlin: Springer Verlag, 828 p., illust.

ZEITNER, J. C. (1974) Feldspar gems in the United States. Lapidary J., 28, 8, p. 1204–1216, *passim*.

GREENLAND. A few newer accounts are available and given herein. A translucent to transparent soda-orthoclase, in cleavage fragments up to 10 cm (4.5 in), and in crystals with some translucent-transparent areas, is suitable for gems and has been found on Kungnat (Kuunnaat) Mountain, near the entrance to Arsuk Fjord and opposite the cryolite mine in southwestern Greenland (Petersen & Secher, 1993). The feldspar is classed as cryptoperthite and displays a gray-blue "moonstone" reflection.

Farther south along the coast belt, a good grade of amazonite is found in granitic pegmatites on the Nunarssuit Peninsula, especially in the area around Torsukattak Fjord in the Julianehaab (Qaqortoq) district; the crystals reach 10 cm (4.5 in) across.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Meddelelser om Grønland* Bd. 149, nr. 3, 442 p., illust., map, p. 361–388.

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 1–65, illust. (col.), maps, p. 47; 17–18.

TIDSSKRIFTET GRØNLAND (1967) Aedelstene på Grønland. Copenhagen, Apr. 1967, p. 115–126, illust.

CANADA. The following provide general information on the gem feldspars of Canada. Specific localities are given by Traill (1983). Much useful information appears in the treatises by De Schmid and Spence, both names having been used by the same Canadian geologist.

DE SCHMID, H. S. (1916) Feldspar in Canada. *Canada Dept. Mines, Mines Br.* 125 p., illust., maps.

FIELD, D. S. M. (1951) The gem varieties of Canadian feldspars. *Canad. Mining J.* 72, 7, p. 73–74, illust.

SPENCE, H. S. (1916) Feldspar in Canada. *Canada Dept. Mines, Mines Br.* No. 401, 125 p., illust., maps.

______, (1932) Feldspar. *Canada Dept. Mines, Mines Br.* No. 731, 145 p., illust., maps.

TRAILL, R. J. (1983) A catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

LABRADOR. The first description of the classic labradorite is from the pen of A. G. Werner, who remarked upon this colorful feldspar in his translation of the third edition of A. F. Cronstedt's text on mineralogy entitled *Axel von Kronstedts Versuch einer Mineralogie*, Leipzig, 1780, of 254 pages (De Waard, 1969). Werner describes the basic color, the reflection colors, and physical properties, and noted that this material was unknown in Europe until five or six years previously: it was found by Moravian missionaries who had established a colony among the Eskimos. Werner thought that the color probably was due to a "finely divided iron earth which had been caught up between the laminae." According to J. D. Dana, *System of Mineralogy*, 5th edition, 1868, p. 343, labradorite was first brought out by a Mr. Wolfe, a Moravian missionary, about the year 1770. De Waard also noted that the first description of the hypersthene which is associated with the labradorite appeared in an article by C. A. S. Hoffmann in 1789. A short, colorful description of the labradorite appeared in an article published in the *Transactions of the Geological Society of London*, 1814. A brief account of a personal visit to the locality is given by J. Bagsby (1824) in his list of minerals occurring in Canada.

The labradorite rock, technically an anorthosite gabbro, occurs over far wider areas than is generally supposed, inasmuch as most accounts only emphasize its presence upon Tabor's Island, a small islet in the Nain Archipelago, and specifically in Tabor's Quarry, located on the "southwest side of a small island called by the Eskimo, Napoktulagatsuk. It lies within one fourth of a mile from the mainland" (Daly, 1902, p. 217). Steinhauer, writing in 1814, had already noted that labradorite is also from "particularly near a lagoon about 50 or 60 miles inland, in which Nain North River terminates," and "its flashing colours darting through the limpid crystal of the lake, and flashing from the cliffs more especially when moistened by a shower of rain, changing continually with every alteration of the position of the boat, are described as almost realizing a scene in a fairy land" (Isachsen, 1969, p. 3). This remote area may be the same as that noted by E. P. Wheeler (Isachsen, p. 196), who remarked on an "unusually extensive and rich development of iridescent plagioclase crystals, some nearly equant with the largest edge over 76 cm [30 in] long" at the east end of Tessiarsuyungoakh [lake], or about 40 km [30 mi] west of Nain.

When Labrador was politically consolidated with Newfoundland in 1976, labradorite became the Official Provincial Mineral. Watson (1980) states that the provincial government sent a survey expedition to the labradorite areas in 1979 to determine resources of same and to establish a procedure for quarrying the stone. A total of 156 locations were visited, and seven areas were found that offered "immediate labradorite production."

There were also twenty sites of future interest, but the seven sites mentioned contained "large reserves of gem quality labradorite, sufficient to supply the needs of local and other crafts people for the forseeable future," the emphasis being placed on reserving first exploitation rights for natives. In general, labradorite occurs in a large region that extends from Nain southward to near Kamarsuk, or a distance of about 25 km (16 mi), with most localities being accessible only by small boat.

Watson notes that the local Inuit have begun to utilize the labradorite for carvings in traditional designs from crystals that may be as much as 8 x 8 cm (3 x 3 in).

In 1834, the Louis Wheelock expedition from the United States quarried 180 tons of rock from the Tabor Island Quarry, of which a select 45 tons were shipped to the United States. Proceeds from the sale of this material went to the International Grenfell Association, which held the mineral rights to the island up to 1963 (Watson, *Ibid.*). In 1961 to 1963, BRINEX Company quarried 65 tons, and since 1964, small quantities have been removed by others. At the present time, Newfoundland law governs collecting upon the island with regulations issued by the Newfoundland Department of Mines and Energy, St. John's, but their policy is to issue quarry permits only to residents of the northern Labrador coast.

Watson *(Ibid.)* gives the following localities where commercial production of labradorite would be feasible in the future:

1. Tabor Island—at present the only commercial source; crystals reach 50 x 50 cm (20 x 20 in), set in a fine-grained matrix of labradorite and hypersthene; about 6,000 kg (3 tons) of high quality stock are already quarried and in place at the site, as of 1976.

2,3. John Hay's Harbour, Kikkertavik Island, located about 19 km (12 mi) south-southeast of Nain; easily accessible by boat; large reserves.

4. Satosoak Island, 12 km (7.5 mi) southwest of Nain; the labradorite is noted for its coppery-bronze luster.

5. Pearly Gates, located about 16 km (10 mi) west of Nain; difficult access but "unlimited resources."

6. Nochalik Island, located about 33 km (20 mi) southeast of Nain; a small island but with excellent material.

7. Small islets located between Satosoak and Palungitak islands, or about 11 km (7 mi) almost directly south of Nain.

BIGSBY, J. (1824) A list of minerals and organic remains occurring in the Canadas. *Amer. J. Sci.* article 8, p. 60–88.

BREWSTER, D. (1831) On certain new phenomena of colour in Labrador feldspar, with observations on the nature and cause of its changeable tints. *Roy. Soc. Edinburgh Trans.* 11, p. 322–331.

CHRISTIE, A. M. (1952) Geology of the northern coast of Labrador, from Grenfell Sound to Port Manvers, Newfoundland. *Geol. Survey Canada Paper* 52-22, 16 p., maps.

COHEN, E. W. (1885) Das labradoritführende Gestein der Küste von Labrador. *N. Jb. Min.* 1, p. 131–185.

COLEMAN, A. P. (1921) Northeastern part of Labrador, and New Quebec. *Geol. Survey Canada Mem.* 124, 68 p., 10 pls., 3 maps, p. 50.

CRONSTEDT, A. F. (1758) *Forsök til Mineralogie eller Mineral-Rikets Upställning.* Stockholm: Wildiska Tryck, 251 p. First mention of L.

DALY, R. A. (1902) The geology of the northeast coast of Labrador. *Mus. Comp. Zool. Harvard* 38, Geol. Ser. 5, p. 205–270.

DE WAARD, D. (1969) Annotated bibliography of anorthosite petrogenesis. In ISACHSEN (1969) *below*, p. 1–11.

FLEENER, F. L. & WILSON, B. H. (1950) Labradorite a colorful gem. *The Mineralogist* 18, p. 236–240, *passim.*

HAÜY, R. J. (1803) Observations sur la substance minérale appelée labradorische hornblende (hornblende du Labrador) par les minéralogistes allemands. Paris.

ISACHSEN, Y. W., ed. (1969) Origin of anorthosite and related rocks. *NY State Mus. & Sci. Service Mem.* 18, 466 p., illust.

KINDLE, E. M. (1924) Geography and geology of Lake Melville district, Labrador Peninsula. *Geol. Survey Canada Mem.* 141, 105 p., illust., maps.

Labradorite boulders on south shore Lake Melville, p. 69.

KRANCK, E. H. (1939) Bedrock geology of the seaboard region of Newfoundland Labrador. *Newfoundland Geol. Survey Bull.* 19, p. 19, 33.

LOW, A. P. (1896) Report on explorations in the Labrador Peninsula, etc. in 1892-1895. *Geol. Survey Canada Ann. Rept.* 8, p. L 1–311. Labradorite p. 285, 286, 289.

MAWDSLEY, J. B. (1929) *Canadian Field Naturalist* 43. Contains notes on labradorite.

ROCKS & MINERALS (1935) Labradorite from Nepoktulegatsuk [Tabor's Island]. Vol. 10, 10, p. 150, 151.

RONSON, S. (1964) Mining "fire rock" in the "frozen north." *Rocks & Minerals* 39, 3–4, p. 134–137, illust. Describes personal quarrying.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. III. New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland. *Geol. Survey Canada Misc. Rept.* 8, 103 p., illust., maps.

SAGE, B. G. (1814) Observations sur la pierre de Labrador. *J. Physique* 39, p. 136–137.

SNELGROVE, A. K. (1953) *Newfoundland Department of Mines Information Circular* 4, includes labradorite in Labrador.

STEINHAUER, Rev. Mr. (1814) Notice relative to the geology of the Coast of Labrador. *Trans. Geol. Soc. London* 2, p. 488–494.

VOGELSANG, H. (1868) Sur le labradorite coloré de la côte du Labrador. *Archives Neerlandaises* 3, p. 1–32.

WATSON, D. M. (1980) Preliminary report on labradorite occurrences near Nain, Labrador. *Mineral Development Div., Govt. Nfld. & Labrador, Open File Rept.* 234, 10 p., maps.

WHEELER, E. P. (1942) Anorthosite and associated rocks about Nain, Labrador. *J. Geol.* 50, 6, p. 611–642, illust., maps.

NEWFOUNDLAND. A light gray labradorite rock displaying light to medium labradorescence occurs at Indian Head on the north shore of St. George's Bay (Sabina, 1975)

SABINA, A. P. (1975) Rocks and minerals for the collector. The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, 167 p., illust., maps.

QUEBEC. Peristerite is to be found in the Coté Quarry, north-northeast of Cantley, and in the Leduc Mine, located between Lac Lucerne and the west arm of Lac St. Pierre; the latter deposit also contains amazonite (Sabina, 1987). White peristerite suitable for gem purposes is found in the Mabey (Burnham) Mine, located about 35 km (22 mi) north of Kingston. Similar material occurs in the Maisonneuve Mine, about 15 km (9.5 mi) west of St.-Michel-des-Saints. Amazonite is reported from the Lac à la Mère Mica Mine, about 10 km (6 mi) north of St.-Nazaire (Sabina, 1983). Very small colorless faceted gems have been cut from albite from the Mont St.-Hilaire quarries. A coarse-grained anorthite containing grains of labradorite large enough for cabochons occurs in roadcuts along Highway 170 between Larouche and Chicoutimi and on the Port Arvida Road at 1.1 km (0.5 mi) north of Highway 170 (Sabina, 1983). Peristerite occurs in the Waltham quarry, located just north of Waltham Station, the latter located about 20 km (12.5 mi) northeast of Pembroke (Ontario); a blue sheen appears in this plagioclase from a pegmatite dike on the property of William Lamarche of Waltham (Sabina, 1971). Sabina (1974) also reports "apple-green to emerald-green" amazonite of gem quality in a pegmatite on an island in the north end of Lac Sairs, east of Kipawa, in the extreme west of the province.

CLAVEAU, J. (1949) Upper Romaine River area, Saguenay County. *Quebec Dept. Mines, Geol. Survey Br. Rept.* 38, 35 p., illust., maps.

HOGARTH, D. D., *et al* (1972) Classic mineral collecting localities in Ontario and Quebec. *XXIV Internat. Geol. Congr., Montreal Guidebook*, Excursions A47–C47, 79 p., maps. Reprint: 1983 as *GSC Misc. Rept.* 37.

PARKS, W. A. (1913) The building and ornamental stones of Quebec. *Canada Dept. Mines, Mines Br. Summ. Rept. for 1912*, p. 76–79.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. II. Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 8, 252 p., illust. maps.

___, (1971) Rocks and minerals for the collector: Ottawa to North Bay, Ontario; Hull to Waltham, Quebec. *Geol. Survey Canada Paper* 70-50, 130 p., illust., maps.

_____, (1975) *Same.* The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, 167 p., illust., maps.

_____, (1983) *Same*, Kingston, Ontario to Lac St.-Jean, Quebec. *Geol. Survey Canada Misc. Rept.* 32, 130 p., illust., maps. Originally *GSC Paper* 67–51, 1968.

_____, (1987) *Same.* Hull-Maniwaki, Quebec; Ottawa-Peterborough, Ontario. *Geol. Survey Canada Misc. Rept.* 41, 141 p., illust., map.

SELWYN, A. R. C. (1889) *Geological Survey of Canada, Annual Report for the Years 1888–1889*, vol. 4, p. A1–66. Labradorite near Sheldrake, QUE.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

ONTARIO. Perhaps the first mention of labradorite in this province occurred in 1824 when J. Bigsby published a list of minerals in Canada. The labradorite was to be found along the western shore of Parry Island, Lake Huron. This occurrence was noted later by Walker (1913).

The well-known albite-peristerite of the Bancroft area was studied by Ribbe (1975), who provides photographs of the fine structure of the mineral (p. R-80); in the case of labradorite, he concludes that the colors appear to vary according to the composition. In a later, large and detailed work on feldspars, Smith & Brown (1988) summarize findings of many investigators concerning the fine structure exhibited by perthites, moonstones, sunstones, etc., and discuss peristerite and labradorite (p. 605, 612).

Recent visits to and studies of gem feldspar deposits in Ontario are described in Steacy, *et al* (1982) who speak particularly of the perthite from North Burgess Township, Lanark County, while other classic sources, particularly of peristerites, are given in Hogarth, *et al* (1983). The latest survey of Canadian amazonites is given by Hogg (1989), who calls attention to large crystals coming from the Blue Star Mine, outside Sundridge in northern Ontario, where a granitic pegmatite has been quarried for feldspar. The largest amazonite crystal, a blocky specimen, weighed 96 lb (43.5 kg) and is now in the National Museum of Natural Sciences in Ottawa. Another large crystal of 65 lb (30 kg) was found in 1979.

Sabina (1971) describes the following gem feldspar localities: in the J. G. Gole Quarry, 2 mi (3.2 km) north of Madawaska (p. 54), peristerite and sunstone; peristerite in the Cameron and Aleck Quarry, 3 mi (4.8 km) northwest of Madawaska (p. 55–56); a pink peristerite with blue reflection, in the Carey Quarry, near Deep River Cub Camp, Renfrew area (p. 64); amazonite in the McMeckin occurrence located 7 mi (11 km) due east of Madawaska (p. 67); and peristerite in the Caribou Lake occurrence on the south shore at its west end narrows (p. 74).

ADAMS, F. D. & BARLOW, A. E. (1910) Geology of the Haliburton and Bancroft areas, Province of Ontario. *Geol. Survey Canada Mem.* 6, 419 p., illust., maps.

BARLOW, A. E. (1893) [Summ. rept., field work, Nipissing region.] *Geol. Survey Canada, Summ. Rept. for 1892, Ann. Rept.* 6, p. A34–35.

BIGSBY, J. (1824) A list of minerals and organic remains, occurring in the Canadas. *Amer. J. Sci.* article 8, p. 60–88.

GEOLOGICAL SURVEY OF CANADA (1913) *Guide Book No. 2, Excursions in the eastern townships of Quebec and the eastern part of Ontario.* 142 p., maps.

GOLDICH, S. S. & KINSER, J. H. (1939) Perthite from Tory Hill, Ontario. *Amer. Mineral.* 24, p. 407–427.

HOGARTH, D. D., *et al* (1983) Classic mineral collecting localities in Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 37, 79 p., maps.

HOGG, K. Y. (1989) Canadian amazonite. *Rock & Gem* 19, 6, p. 56–59, illust. (col.).

PARKS, W. A. (1910) Preliminary report on the building and ornamental stones of Ontario, south of the Ottawa and French rivers. *Canada Dept. Mines, Mines Br., Summ. Rept. for 1910*, p. 110–114.

PARSONS, A. L. (1930) Iridescent color in peristerite. *Amer. Mineral.* 15, p. 85–97.

_____, (1934) The utilization of the semi-precious and ornamental stones of Canada. *Univ. Toronto Studies*, Geol. Ser., 36, p. 13–21, Color plate. Includes feldspars.

PYE, E. G. (1969) Geology and scenery: north shore of Lake Superior. *Ont. Dept. Mines Guide Book* 2, 148 p., illust., maps.

RIBBE, P. H. (1975) Exsolution features and interference colors[in feldspars]. In *Mineralogical Soc. Amer. Short Course Notes*, vol. 2, p. R73–96, illust.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. II. Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 8, 252 p.

_____, (1971) Rocks and minerals for the collector: Ottawa to North Bay, Ontario; Hull to Waltham, Quebec. *Geol. Survey Canada Paper* 70-50, 130 p., illust., maps.

SATTERLEY, J. (1942) Mineral occurrences in Parry Sound district. *Ont. Dept. Mines Ann. Rept.* 1942, p. 51, 2, 86.

SMITH, J. V. & BROWN, W. L. (1988) *Feldspar minerals. Vol. I. Crystal Structures, Physical, Chemical and Microtextural Properties.* 2nd edit. Berlin: Springer Verlag, 828 p., illust.

STEACY, H. R., *et al* (1982) Some classic mineral localities of southeastern Ontario. *Min. Rec.* 13, 4, p. 197–203, illust.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

WALKER, T. L. (1913) The Precambrian of Parry Island and vicinity. *12th Internat. Geol. Congr. Toronto, 1913, Guidebook* 5, p. 98–100.

MAINE. Graphic granite is abundant in many pegmatites and the references to same are numerous (Bastin, 1910, 1911; Cameron, *et al*, 1954; Watts, 1916). In contrast, other gem or ornamental varieties of feldspar are conspicuous by their absence. Bradshaw (in press) mentions amazonite from the Bar Harbor area, and a colorless, clear 1.77 ct faceted albite (cleavelandite) cut from Dunton Quarry, Newry, Oxford County, material, which gem, along with cabochons of the amazonite, is in the Harvard Mineralogical Museum.

BASTIN, E. S. (1910) Economic geology of the feldspar deposits of the United States. *U.S. Geol. Survey Bull.* 420, 85 p., maps.

_____, (1911) Geology of the pegmatites and associated rocks of Maine. *U.S. Geol. Survey Bull.* 445, 152 p., illust., maps.

BRADSHAW, J. J. (In press) Gemstones of Maine. In Maine Geol. Survey: *Mineralogy of Maine*, p. 1–21.

CAMERON, E. N., *et al* (1954) Pegmatite investigations, 1942–45, New England. *U.S. Geol. Survey Prof. Paper* 255, 352 p., illust., maps.

JACKSON, C. T. (1859) [Crystals of green feldspar, Mount Desert.] *Boston Soc. Nat. Hist. Proc.* 7, p. 160.

PERHAM, J. C. (1987) *Maine's Treasure Chest: Gems and Minerals of Oxford County*. 2nd edit. West Paris, ME: Quicksilver Publs., 269 p., illust. (col.), maps.

STEVENS, J. P. (1972) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* Trap Corner, ME: Perham's Maine Mineral Store, 216 p. illust. (col.), maps.

THOMPSON, W. B., *et al* (1991) A collector's guide to Maine mineral localities. *Maine Geol. Survey Bull.* 41, 2nd edit., 104 p., illust. (col.), maps.

WATTS, A. S. (1916) The feldspars of the New England and Appalachian states. *U.S. Bur. Mines Bull.* 92, 181 p., maps.

NEW HAMPSHIRE. Samuelson, *et al* (1990, p. 292) report that the amazonite recently found on Hurricane Mountain, Carroll Co., occurs as "blue-green crystals, comparable in color to those from Colorado" and that these crystals "are the finest ever found in the Conway and Mount Osceola granites."

SAMUELSON, P. B., HOLLMAN, K. & HOLT, C. (1990) Minerals of the Conway and Mount Osceola granites of New Hampshire. *Rocks & Minerals* 65, 4, p. 286–296, illust.

CONNECTICUT. Schairer (1931, p. 98) records a cordierite-gneiss outcrop at the south end of Bigelow Pond, Union Township, from which he collected oligoclase moonstone that was cut into several cabochons.

SCHAIRER, J. F. (1931) The minerals of Connecticut. *CT State Geol. & Nat. Hist. Survey Bull.* 51, 121 p.

NEW YORK. Anorthosite rock containing grains of color-reflecting labradorite is abundant in Essex County in the Adirondack region of northeastern New York. As early as 1837, Emmons (1837, p. 109) published a brief account of the rock, noting that it forms entire mountain masses. Large expanses have also been noted on Oregon Dome between North Creek and Speculator, also Grant Mountain, 35 mi (55 km) north-northeast of North Creek (De Waard, 1969, p. 3–4). From Mineville, Essex County, Anderson (1915) examined cleavage fragments of an aventurine "of strong red color, with patches of a green substance not identified," but lamellae of hematite were believed to be responsible for the sunstone effect. The green color, however, suggests the presence of an alteration product of copper. Labradorite stream pebbles showing blue, green and yellow reflections are found immediately west of the North Hudson exit on Interstate Highway 87 (Zabriskie, 1992). Gosse (1962) notes that the majority of labradorite grains in the Adirondack anorthosite are 0.5 in (1 cm) or less in size but some reach 2 in (5 cm), and very rarely some attain as much as 10 in (25 cm) across. The usual rock is therefore suitable mainly for larger lapidary objects such as bookends, and only rarely are crystals found large enough to provide cabochons comparable to those obtainable from Labrador material.

Elsewhere, Rowley (1984) describes exposures of labradorite rock in a road cut on Highway 28 between North Creek, Warren County, and Indian Lake, Hamilton County. Here the labradorite crystals are large and associated in a pegmatitic anorthosite with phlogopite, brown tourmaline (non-gem), pyrrhotite, and enstatite; its colors are "suggestive of opal." Unfortunately, most of the material is badly fractured.

Tervo (1967) claims that a red and tan sunstone found on Palmer Hill, north of Ausable Forks, Essex County, is the "best sunstone yet to be discovered in the United States." This material was found in the dumps of abandoned iron mines. Gosse (1962) records moonstone, but with the feldspar species unidentified, occurring in the Overlook Quarry, just east of Overlook, on the south shore of Sacandaga Reservoir, Day Township, Saratoga County.

Among the feldspar gems in the collection of the New York State Museum in Albany are: albite-peristerite, Saranac Lake, a brownish cabochon; labradorite cabochons from Indian Lake, Tahawus, and Saranac Lake; orthoclase sunstone, brownish body color cabochons from Star Lake, Ausable Forks, and Malone; orthoclase moonstones from Saranac Lake and Newcomb (Schimmrich & Campbell, 1990).

ANDERSON, O. (1915) On aventurine feldspar. *Amer. J. Sci.* 4th ser., 40, 238, p. 351–398, illust.

BRISTOL, R. E. (1965) Leib's moonstone mine. *Rocks & Minerals* 40, 10, p. 750. Near Saranac Lake.

BURR, F. F. (1915) Occurrence of amazon stone at North White Plains, N.Y. *Columbia School Mines Quart.* 36, p. 186–188.

DE WAARD, D. (1969) Annotated bibliography of anorthosite petrogenesis. In Y. W. ISACHSEN, ed., Origin of anorthosite and related rocks. *NY State Museum & Science Service Mem.* 18, p. 1–11.

EMMONS, E. (1837) First annual report of the Second Geological District of the State of New York: *Communication from the Governor, relative to the geological survey of the state.* Albany, p. 97–153.

GOSSE, R. C. (1962) Iridescent labradorite in New York State. *Lapidary J.* 16, 1, p. 94–95, illust., map.

_____, (1962) Moonstone discovered at Day, Saratoga County, New York. *Lapidary J.* 16, 2, p. 278–281, illust., map.

_____, (1964) "Sunstone-moonstone" discovered in New York. *Lapidary J.* 17, 12, p. 1190.

ROWLEY, E. B. (1984) Plagioclase feldspars from the Adirondacks of Eastern New York State. *Rocks & Minerals* 59, 3, p. 120–124, illust.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) The New York State Museum gem collection catalogue. Albany: *Open File Rept.* 8m106, 47 p.

SHAUB, B. M. (1953) Moonstone from Olmstedville, New York. *Rocks & Minerals* 28, 9–10, p. 451–455, illust.

STIVERS, G. V. W. (1961) Sacandaga River Labradorite. *Rocks & Minerals* 36, 7–8, p. 364–365.

TERVO, W. A. (1967) *The Rock Hound's Guide to New York State Minerals,* Fossils and Artifacts. NY: Exposition Press, 148 p.

ZABRISKIE, D. & ZABRISKIE, C. (1992) *Rockhounding in Eastern New York State and Nearby New England.* Albany, NY: Many Facets, 49 p., maps.

NEW JERSEY. In addition to the sunstone in gabbro collected by the author on Mine Hill, near Dover, Morris County, Leeds (1872) much earlier mentioned an aventurine orthoclase from the Ogden Mine, Sparta Township, Sussex County.

These occurrences suggest that searching the dumps of the long-abandoned iron mines of northern New Jersey may produce additional supplies of this attractive material.

LEEDS, A. R. (1872) Note upon the aventurine orthoclase, found at the Ogden Mine, Sparta Township, Sussex Co., N.J. *Amer. J. Sci.* 3, p. 433–434.

PENNSYLVANIA. Noted biologist, mineralogist, and connoisseur of gems Isaac Lea (1792–1886) devoted much time and effort to collecting and studying the feldspars of Chester and Delaware counties in southeastern Pennsylvania (Lea, 1866). A greenish feldspar from near the village of Lenni in Delaware County was named "lennilite" by him, in the belief that it was a distinct species of feldspar. Similarly, he named another kind "delawareite" from its first discovery between Glen Riddle and Lenni in Delaware County, and, lastly, he coined the name "cassinite" for still another variety to honor John Cassin, a mineral collector. These remarks, suitably amplified, appear in the feldspar sections of Genth & Sadtler (1875, p. 57–95). A sunstone albite found near Media was described by Anderson (1915) as "fresh, transparent, grayish or colorless," and "showed a strong aventurization." All of this is also summarized in Gordon (1922, p. 72–77).

ANDERSON, O. (1915) On aventurine feldspar. *Amer. J. Sci.* 4th ser. 40, 238, p. 351–398, illust.

GENTH, F. A. & SADTLER, S. P. (1875) Preliminary report on the mineralogy of Pennsylvania. *2nd Geol. Survey PA 1874, B,* 206 p., map.

GORDON, S. G. (1922) The mineralogy of Pennsylvania. *Acad. Nat. Sci. Phila. Spec. Publ.* 1, 255 p., illust.

HAMBURGER, A. (1892) Vanarsdalen's quarry, a prolific locality in Bucks Co., Pa. *The Mineralogist's Monthly* 7, p. 52–54. Labradorite.

LEA, I. (1866) Notes on some members of the feldspar family. *Proc. Acad. Nat. Sci. Phila.* 2, p. 110–113.

RAND, T. D. (1871) Notes on feldspars and some other minerals of Philadelphia and vicinity. *Acad. Nat. Sci. Phila. Proc.* 23, p. 299–304.

FIGURE 29. Morefield pegmatite mine near Amelia, Amelia County, Virginia, showing the old shaft and hoisting arrangements. *Courtesy W. D. Baltzley, Powhatan Mining Co., Amelia, VA.*

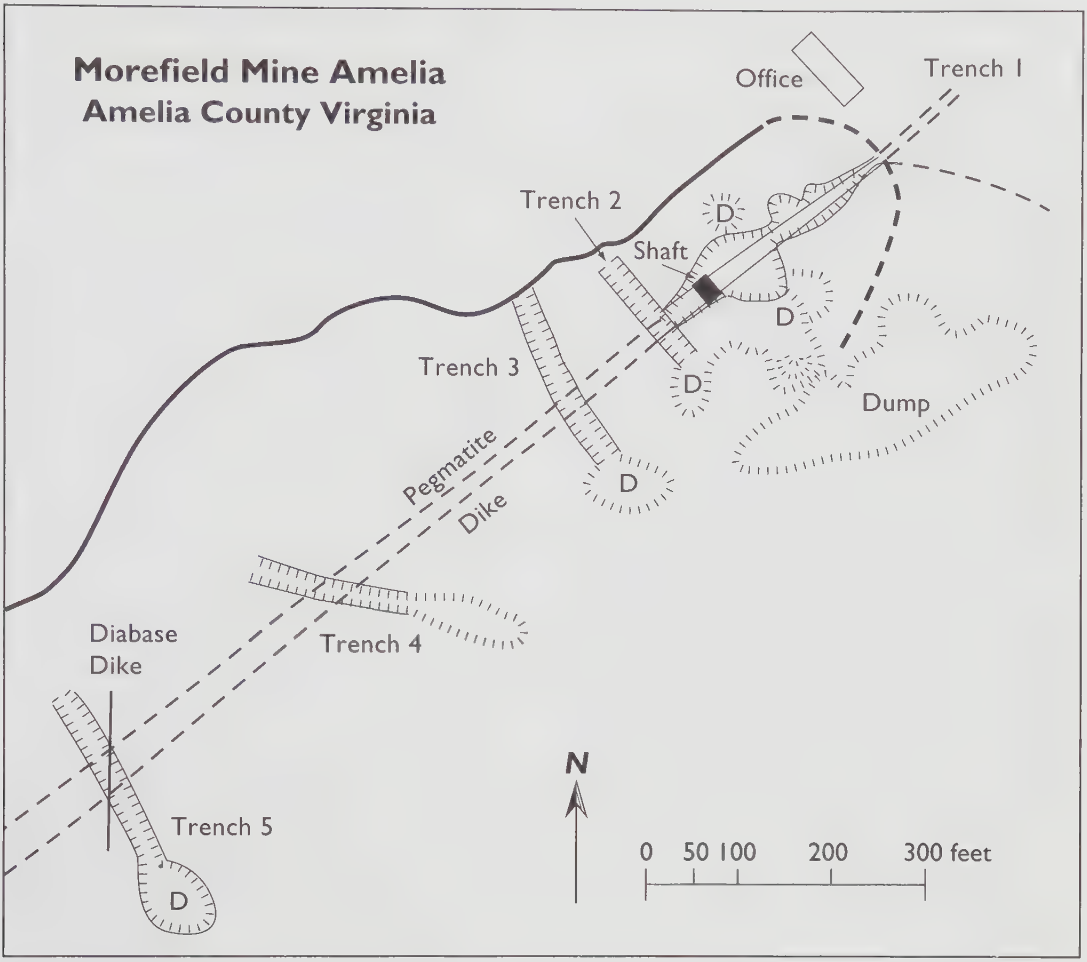

FIGURE 30. Exploration map of the Morefield pegmatite body, Amelia, Virginia. *Courtesy W. D. Baltzley.*

VIRGINIA. The complexly mineralized granitic Morefield pegmatite is located about 4 mi (6.5 km) northeast of Amelia, Amelia County. This property was purchased in the spring of 1985 by Warren D. Baltzley, who had previously mined the Rutherford Mines near Amelia. The promise of substantial quantities of rich blue-green amazonite from the pegmatite, plus other saleable minerals, and coupled with the creation of a tourist attraction on the site, inspired Baltzley to re-open the mine's underground workings. The title to the property is formally invested in Powhatan Mining, Inc., of Amelia, Virginia, with Baltzley acting as president. The property encompasses 80 acres and is open to fee-collecting from March through December (*Pers. comm.*, W. D. Baltzley, 1/93).

The nearly vertical Morefield pegmatite outcrops over a distance of about 2,000 ft (610 m) and has been tested to a depth of nearly 300 ft (90 m). A new shaft was sunk to a depth of 45 ft (27 m) at a point 129 ft (34 m) northeast of the original Morefield shaft. A tunnel driven through the core in a northeast direction found complex mineralization and much amazonite over a distance of 60 feet (18 m). In addition to the expected amazonite, massive smoky quartz was found, also many rare minerals, especially a series of aluminofluorides such as elpasoite, chiolite, cryolite, pachnolite, ralstonite, thomsenolite, and prosopite. Common species found include albite, perthite, beryl (non-gem), spessartine (largely non-gem), columbite-tantalite, and others. These species are described by Kearns (1993), who studied the deposit and thoroughly examined its minerals.

While the amazonite is fine in color, it is largely disappointing in its solidity, which is much disturbed by numerous fractures and cleavage separations which make it difficult to use the material for anything larger than cabochons and beads of normal size. In the core unit the working face often exposes large individuals of amazonite which may be as much as 18 in (45 cm) across but still filled with fractures and incipient cleavages.

In the Herbb #2 Mine, located about 4 mi (6.3 km) northeast of Flat Rock on Highway 60, dark green amazonite fragments continue to be found either in the dumps or in the core unit which is accessible to fee-collectors (McCrery, 1983; Richardson, 1985). Details on this mine appear under TOPAZ.

GEEHAN, R. W. (1953) Morefield pegmatite mine, Amelia County, VA. *U.S. Bur. Mines Rept. Invest.* 5001, 41 p., maps.

KEARNS, L. E. (1993) Minerals of the Morefield pegmatite, Amelia County, Virginia. *Rocks & Minerals* 68, 4, p. 232–242, illust. (col.), map.

LAPIDARY JOURNAL (1987) More on Morefield. Vol. 41, 1, p. 21–26, map.

McCRERY, P. A. (1983) That magic moment, etc. *Lapidary J.* 37, 4, p. 586–594, illust., map.

PAGE, C. C. (1885) Amazonstone from Amelia County, Virginia. *The Virginias* 6, p. 24–25.

RICHARDSON, D. (1985) Herbb #2 Mine update. *Lapidary J.* 39, 2, p. 286–287.

SINKANKAS, J. (1959) A new orthoclase moonstone. *Rocks & Minerals* 34, 5–6, p. 195–198.

STRIPP, D. M. (1987) More on Morefield. *Lapidary J.* 41, 1, p. 21–24, illust. (col.), map.

WALKER, D. & WALKER, C. (1990) Room for more. *Lapidary J.* 43, 12, p. 51, 52, map. Morefield Mine collecting.

MICHIGAN. Heinrich (1976, p. 76) notes the occurrence of pebbles of albite-peristerite at Five Mile Point and Seven Mile Point near Ahmeek, Keweenaw County, also from Agate Beach, Misery Bay, Houghton County, 10 mi (16 km) west of Toivola.

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Div. Bull.* 6, 225 p., illust. (col.).

NORTH CAROLINA. Roell (1979) reports finding pale green amazonite as crude crystals and masses in a granitic pegmatite of the Mchone Mine, and its dumps, in Mitchell County. The mine is located on Mchone Road near Spruce Pine and is open to fee-collecting.

CLARKE, F. W. (1890) Oligoclase from Bakersville, North Carolina. *U.S. Geol. Survey Bull.* 60, p. 129–130.

KUNZ, G. F. (1888) Mineralogical notes. [3. a remarkable variety of transparent oligoclase, from Hawk, N.C.] *Amer. J. Sci.* 36, p. 222–224.

PENFIELD, S. L. & SPERRY, E. S. (1888) Mineralogical notes. *Amer. J. Sci.* 36, p. 317–331. Oligoclase, Hawk, N.C.

ROELL, D. A. (1979) North Carolina amazonite. *Gems & Minerals* 505, p. 6.

GEORGIA. Cook (1978) notes amazonite from a mica mine on the Joe Speed Farm, about 0.5 mi (0.8 km) from Pine Mountain Road, 7 mi (11 km) from Clayton, Rabun County. Microcline moonstone has been found on Lowe Farm, near Buford, Forsyth County, and similar material is found near Sheltonville.

COOK, R. B. (1978) Minerals of Georgia. *GA Geol. Water Res. Div. Bull.* 92, 189 p.

GALPIN, S. L. (1915) A preliminary report on the feldspar and mica deposits of Georgia. *Geol. Survey GA Bull.* 30, 190 p., illust.

MISSISSIPPI. According to the Foiles (1973), colorless, white, bluish, reddish, brownish, green and black feldspar moonstone, showing silvery reflections from cleavage fragments has been found in gravels dredged from the Mississippi River and deposited by barge at Greenville, Washington County. The fragments reach 1.5 in

(3.8 cm) across and are found up and down the river wherever gravels are brought up.

FOILES, L. & FOILES, R. (1973) There is moonstone in Mississippi. *Lapidary J.* 27, 8, p. 1176, 1178.

TEXAS. No new developments.

BENTON, J. R. (1968) Texas labradorite find. *Lapidary J.* 22, 1, p. 78, 80, 82.

IVES, R. L. (1940) Sanidine or labradorite? *Rocks & Minerals* 15, 10, p. 330–331. Trans-Pecos.

KING, E. A. (1961) Texas gemstones. *TX Bur. Econ. Geol. Rept. Invest.* 42, 42 p., illust.

SOUTH DAKOTA. Roberts & Rapp (1965, p. 80) note that "beautiful red cleavable masses of microcline . . . suitable for fashioning into cabochon gemstones occur at the Lofton mine one mile northwest of Pringle," in Custer County. Similar material is found in the Lincoln #6 pegmatite.

ROBERTS, W. L. & RAPP, G. (1965) Mineralogy of the Black Hills. *SD School Mines & Tech. Bull.* 18, 268 p., illust.

COLORADO. The Pikes Peak batholith, covering portions of Jefferson, Douglas, Park, and Teller counties, continues to furnish splendid smoky quartz and microcline (amazonite) crystals, among other species (now numbering 45) from float and from pockets uncovered mostly by amateur collectors. For example, Ream, in his *Mineral News*, June, 1993, p. 3, notes that "three cavities, up to 10 feet [3 m] in length, were recently discovered that contained high quality amazonite, smoky quartz, and some combinations with fluorite and other minerals." These occurrences were in the Lake George area, Park County. *See also Mineral News* 9, 8, 1993, for additional amazonite finds in this area.

As noted before, the amazonite is pale, and little actually suitable for gem purposes, and the consistent occurrence of sharp crystals makes this material of far greater interest and value for mineral specimen purposes than as gem stock. However, T. & R. A. Kosnar of Golden, Colorado, note that the "finest dark blue-green color [amazonite] ever found in Colorado" came from an area near Lake George in Park and Teller counties and furnished material capable of turning out cabochons up to 6 cm (2.4 in) across. According to the Kosnars (*Pers. comm.* 8/10/1994), the following claims produced especially superior quality amazonite: C. G. Coil Claim, Park County; the RAK claims at Yucca Hill, Park County; and at Raspberry Hill and Aspenwood, Teller County, the last having produced some translucent amazonite crystals.

The early history of amazonite discovery and exploitation in Colorado is ably presented by Odiorne (1978) in what is the first monograph in English on this feldspar. Amazonite is also ably featured by the Muntyans (1985), who describe the minerals of the Pikes Peak granite cavities. A special study of amazonite from the batholith pegmatites has been published by Foord & Martin (1979), who estimate that "several tens of thousands of pockets have been excavated," but "perhaps 20 to 30 percent have contained amazonite of various hues. The remaining 70 to 80 percent have contained ordinary microcline." They include valuable information on the surface signs by which collectors can be led to pockets. In such pockets, microcline is the predominant mineral, followed by quartz, much of it smoky, very minor albite, topaz, fluorite, goethite, and hematite, with the last two species usually being the last to form and thus found perched upon or coating earlier-formed crystals. Much of the pocket contents are heavily coated with extremely fine, scaly hematite which presents difficulties in cleaning because of its tenacious character. Foord & Martin present evidence that the cause of the green color in amazonite is lead. More on lead as the coloring agent appears in Hofmeister & Rossman (1985).

CROSS, C. W. (1884) On sanidine and topaz, etc., in the nevadite of Chalk Mountain, Colorado. *Amer. J. Sci.* 27, p. 94–96.

FOORD, E. E. & MARTIN, R. F. (1979) Amazonite from the Pikes Peak batholith, *Min. Rec.* 10, 6, p. 373–384, illust. (col.), map.

GEFFNER, P. (1993) Amazonite discovery, Lake George, Colorado. *Mineral News* 9, 8, p. 1–2, illust .

HANTLA, J. P. (1971) Two microcline amazonite pockets. *Lapidary J.* 24, 11, p. 1497–1503. illust. Collecting experiences.

HARRIS, A. G. & MOONEY, E. (1979) The amazonites of Colorado, geology of the Crystal Peak area. *Lapidary J.* 33, 6, p. 1306–1308, 1310.

HOFMEISTER, A. M. & ROSSMAN, G. R. (1985) A spectroscopic study of irradiation coloring of amazonite: structurally hydrous, Pb-bearing feldspar. *Amer. Mineral.* 70, 7–8, p. 794–804, illust.

KOENIG, G. A. (1876) Microcline, Pikes Peak region, El Paso and Douglas counties. *Acad. Nat. Sci. Phila. Proc.* 28, p. 156.

LAKES, A. (1899) The Florissant Basin. *Mines and Minerals* 20, p. 179–180. Amazonite in Crystal Peak area.

LUCIAN, A. C. (1980) Amazonite at Florissant. *Rock & Gem* 10, 9, p. 70–73, map.

MODRESKI, P. J. (1986) *Colorado pegmatites* [Symposium paper]. Denver, CO: CO Ch. Friends of Mineralogy, 161 p., illust., maps.

MUNTYAN, B. L. & MUNTYAN, J. R. (1985) Minerals of the Pikes Peak granite. *Min. Rec.* 16, 3, p. 217–230, illust.

ODIORNE, H. H. (1978) *Colorado Amazonstone, the Treasure of Crystal Peak.* Denver, CO: Forum Publ. Co., 51 p., illust. (col.).

RATH, G. V. (1876) Krystalle des Amazonsteins entdeckt in Jahre 1875 unfern des Pikes Peak in Colorado. *Niederrh. Ges. Natur-u. Heilk., Sitzungsber* 33, p. 102–103.

REITSCH, C. W. (1939) Smoky quartz and amazonstone at Pine Creek, Colorado. *Rocks & Minerals* 14, 9, p. 270–271.

NORTHWEST TERRITORIES. In 1970, V. B. Meen of the Royal Ontario Museum in Toronto commissioned the cutting of a "light blue" oligoclase of 7.34 cts from material collected by himself on Baffin Island. This gem, presently in the collection of the ROM, may be from the same occurrence described by Grice & Gault (1983), who depict attractive, white oligoclase, suitable for cabochons, and a clear faceted gem of 6.8 ct, 1.3 cm (0.5 in) in diameter that is now in the National Museum of Natural Sciences in Ottawa. Wight (1986) records three oligoclase faceted gems from Lake Harbour, Baffin Island: 6.65 ct, colorless; 6.80, very light blue; and 6.36 ct, very light blue; all are transparent. According to Grice & Gault, the oligoclase formed a large pod, 2 m x 1 m (80 x 40 in), of superb quality material that ranged in color from white to pale blue. The cabochons cut from this material exhibit a "slight chatoyance" and display the typical twinning striae of plagioclase feldspars. The locality, near Lake Harbour in southern Baffin Island, is also noted for the occurrence of gem quality lapis lazuli. Grice (1989) mentions that the plagioclase occurs in large, cleavable crystals, with faces up to 40 cm (16 in) across.

In 1985, in the Great Slave Lake region, R. K. Stevenson found granite studded with 2–20 mm (ca. 0.75 in) intense green amazonite crystals at lat. 60°10'N, long. 109°08'W, near Portman Lake, southeast of Great Slave Lake (Bell, 1992).

BELL, R. (1992) Report on the compilation of lapidary sites [in NWT]. *Northwest Terr. Dept. Energy, Mines & Petrol. Res., EGS* 1992–14, 157 p., maps.

GRICE, J. D. & GAULT, R. A. (1983) Lapis lazuli from Lake Harbour, Baffin Island, Canada. *Rocks & Minerals* 58, 1, p. 12–19, maps.

GRICE, J. D. (1989) *Famous mineral localities of Canada.* Ottawa: Nat. Mus. Nat. Sci., 190 p., illust. (col.).

WIGHT, W. (1986) Canadian gems in the National Museum of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

ALASKA. In a visit to Adak Island in the Aleutian Chain in the summer of 1976, Donald B. Hoover of Lakewood, Colorado, received grains of facet-grade anorthite which had been found on Great Sitkin Island by Boy Scouts during a field trip to that island. It was thought to be calcite and a "quart jar" was filled with the stones which measured from "pea to thumbnail" in size (*Pers. comm.* Sept. 4 & Nov. 26, 1976). Testing in the U.S. showed the stones to be anorthite plagioclase, with the following properties: specific gravity ca 2.71, refractive indexes 1.58–1.595. Much of the material is suitable for faceted gems, and it appears that a considerable quantity may be available in the beach deposits of the island.

OREGON. In 1980, logging crews engaged in bulldozing access roads in the Ochoco National Forest of northeastern Harney County (southeastern Oregon), dug into decomposed basalt flows and uncovered the *in situ* source of the beautiful, gem quality spinel-red labradorite which has appeared on the market in the last few years. The discovery led to staking of claims by Charles Weightman of Burns, Oregon, and John Hinton of Hines, Oregon (Pough, 1983). At the time, their association was known as H. & W. Mining Company, later as One Track Mines, of Boise, Idaho; today they are calling themselves Ponderosa Mines, Inc., and are headquartered in Burns, Oregon, and are owned entirely by Lawrence Gray of Burns. Weightman's interest is restricted to the production of faceted gems and other lapidary products such as small carvings made from the labradorite. On occasion, such carvings are made on commission by the well-known carver in gem materials, Michael Dyber of New Hampshire (*Pers. comm.*, Weightman & Gray, 8/93). Christopher L. Johnston, who was associated with the company in its early years, left it in early 1993. The Ponderosa claims are in the process of being patented. A wide variety of gem materials is being produced from them as described below, with the finest facet material cut by Charles Weightman and his wife, and the carvings commissioned elsewhere as noted above. The faceting of very small gems, generally less than one carat, is accomplished in Bangkok, to which center the rough is sent by Gray.

Another potential source of similar labradorite is known at a place about 4 mi (6.3 km) southwest of the headquarters of Whitehorse Ranch in the southeastern corner of Harney County (Geitgey, 1987), but its exact locality is uncertain, according to Gray (*Pers. comm.* 8/93), who has attempted to find it but without success. As Geitgey notes, both areas are characterized by relatively small flows of basalt, perhaps only a square mile (2.6 sq km) in area as compared to the relatively huge area of the earlier-known labradorite field in Lake County. Nevertheless, the occurrence of such basalt flows throughout much of southern Oregon and extending southward into California and even Nevada, suggests that an enormous region is available for careful prospecting and possible additional finds of gem labradorite. Geitgey is of the opinion that other productive basalt flows will be found in this region.

The Ponderosa claims are located on Donnelly Butte, about 6–7 mi (10 km) southwest of Snow Mountain, the latter located about 30 mi (48 km) northwest of Burns. According to Johnston (1991), there are four distinct basalt flows at the site, all of similar character, but only one flow contains an economic abundance of feldspar crystals which appear as more or less slabby, blocky, broken, and etched fragments without crystal faces. At first they were recovered from surface soil by sifting and washing, but now mechanical equipment is used to excavate the "ore" and separate the crystals from the friable basalt rock. The crystals range in size from less than 0.5 in (1 cm) across to as much as 4 x 2 x 2 in (10 x 5 x 5 cm); the largest can weigh nearly a pound (0.5 kg). However, gem areas within such stones are much smaller than these dimensions would suggest: and in the finest grades of spinel-red labradorite, clear areas rarely afford clean gems of more than 10 carats. On the other hand, cabochon material is far more abundant in a wide range of qualities and colors and has been carved into small objects, one of which, mentioned by Weightman, weighed 84 carats.

The colors of this labradorite are truly remarkable, ranging from the ordinary straw-yellow typical of so much North American labradorite, or even colorless, to light pinks, salmon pinks, red-oranges, reddish-browns, and browns, the last said to be due to the simultaneous existence of green and red phases within the same stone. The rarest colors are true spinel-reds, also greens and blues, and sometimes several of these hues appear in one crystal. Such multicolored stones can be advantageously faceted to best display a bicolor or tricolor effect. Gems cut from the most esteemed color, the spinel-red, fetch prices as high as $1,750 per carat, according to Gray (*Pers. comm.* 8/93), while lower grades in this color begin at about $10 per carat, all prices retail. In 1993/1994 retail prices asked by one large supply house for faceted stones that ranged in weight from 0.16 to

6.73 carats were from $150 per carat to a high of $5,000 per carat, depending on quality of color, lack of flaws, size, etc. However, by far most gems weighed less than two carats, and the most common prices ranged from $500 to $700 per carat. Cabochons cost less, about $200 per carat, while a few fancy stones in peach and bluish green fetched prices between $400 and $2,000 per carat.

In regard to the small carvings mentioned above, these receive an enthusiastic response from buyers, but carvers must be very careful in the choice of orientation within the rough because the inclusions or centers which give rise to color and reflections are commonly confined to very thin, sharply defined planes, with considerable clear space between. If misoriented, these "gaps" can become conspicuous in the finished gem or carvings.

In regard to the aventurescence in these stones, it will be recalled that Anderson (1915), when he examined similar labradorite, concluded that the coppery reflections were, indeed, due to copper, but this conclusion came to be discounted in view of the fact that sunstones from many other localities contain reflective spangles of hematite. Now it has been shown conclusively that Anderson was correct after all, as demonstrated in the work of Hofmeister & Rossman (1985), who studied the chemistry of the Oregon material and established the presence of native copper therein and the presence of copper in the composition of the feldspar itself. They suggest that such colors as red, green, and blue do not arise from the free copper but from the copper in the crystal structure of the feldspar. According to their findings, pale yellow Oregon labradorite contains 0.002% structural copper, the green about 0.012%, and the red up to about 0.02%.

Johnston (1991) notes two perfect cleavage planes in the crystals, and a third parting plane nearly as perfect. Properties are: refractive indexes 1.556–1.557, birefringence 0.007, hardness 6–6.5, specific gravity 2.71.

In Lake County, the much longer-known area for gem quality labradorite, the sunstone-producing sites are located about 22 mi (35 km) N 5° E of Plush, in Sec. 10, T33S, R42E, and are easily reached by road. They have been known since 1908, according to Aitkens (1931). The best description of the deposits and their exploitation, and with advice to collectors, is contained in Pough (1983). In this article he advocates using the term "heliolite" for the sunstone as most appropriate for aventurescent labradorite found here and elsewhere; however, this suggestion has been challenged (*see* "Letters," *Gems & Gemology* 28, 1992, p. 220).

In an early paper, Stewart, *et al* (1966) tested this labradorite and remarked on crystal fragments up to 8.3 x 2.6 x 0.8 cm (3.25 x 1 x 0.25 in) which were found loose in the topsoil. Crystals were identified in a decomposed lava flow of about 10 ft (3 m) in depth. In 1971, the Secretary of the Interior, upon the advice of geologists and other officials of the State of Oregon, set aside 2,560 acres (ca 1,000 hectares) of land for public sunstone collecting, a reservation which still remains in effect. In an earlier period, sunstone collecting merely involved wandering over the flat, brush-covered area and picking up the stones. Today, however, digging is required to reach the rotted basalt layer in which the stones occur, but, as Christopher W. Ralph of Reno, Nevada, remarks, much material is still available. He writes (5/93): "I recently spent three full days collecting there and recovered 4,485 grams of feldspar crystals of all types and qualities."

A commercial venture to mine the Plush area sunstone upon Bureau of Land Management land claims was begun in 1989, and was continued until recently, by Wayne Hartgraves and D. A. Hohman, who called themselves the Diamond Works of Plush, Oregon. In 1993, the claims, totaling 450 acres, were sold to James Cowan and Sheridan Atkinson, who formed Cowan-Atkinson, Inc., for continuation of the milling. According to Salwitz (1994), they have completed their first successful year of operation and have accumulated a stock of rough, some of which has been faceted in Bangkok and in the United States. The claim area is located 27 miles (43 km) north and slightly west of Plush. Previously, Hartgraves & Hohman (*Pers. comm.* 2/1993) found feldspar

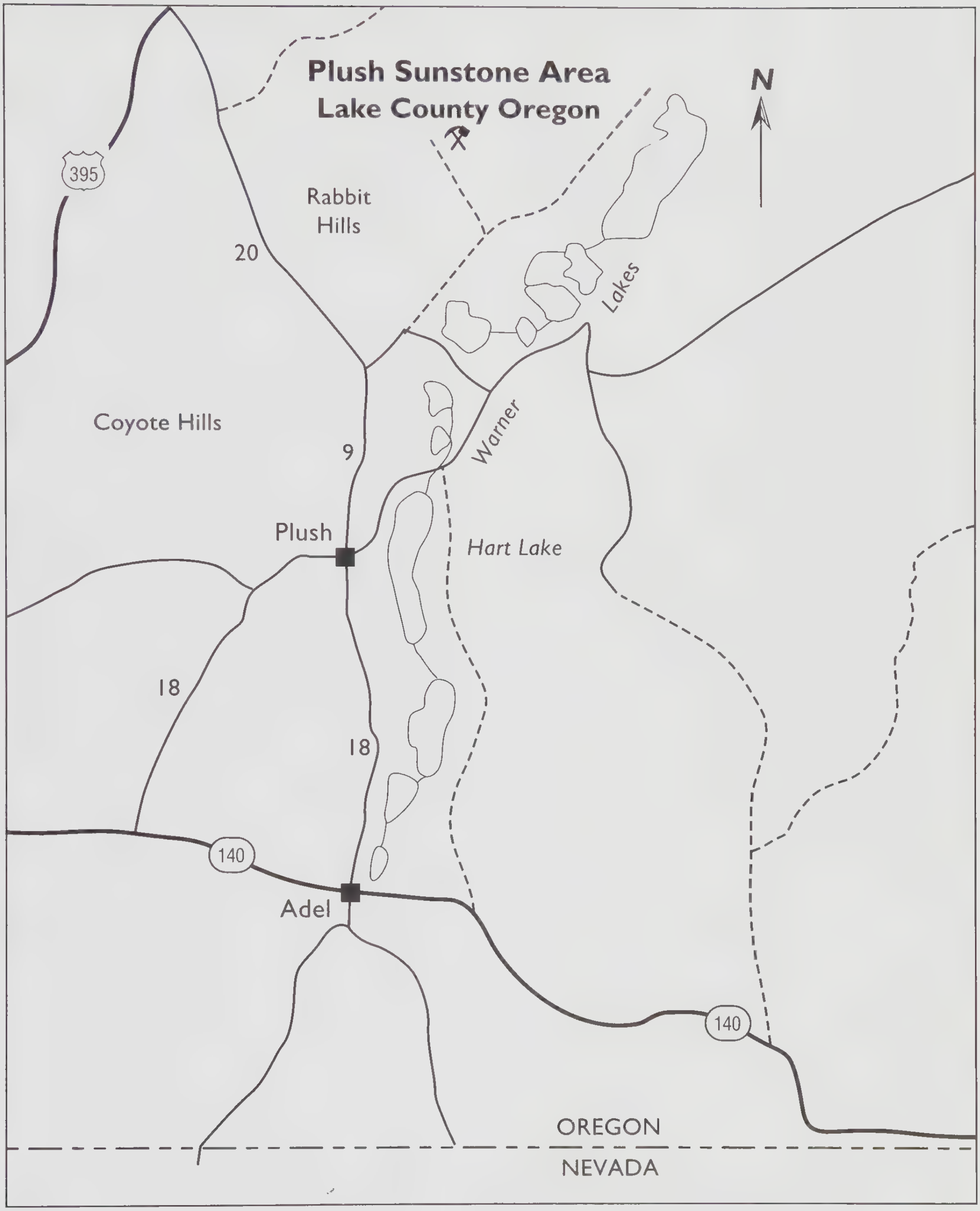

FIGURE 31. The area north of Plush, Lake County, Oregon, where facet grade feldspar and sunstone have been found.

rough in a variety of colors including green, dark red, red, pink, and colorless, with some stones bi- or tri-colored. The rough was sold for prices as low as $0.05 per carat to as high as $10.00 per carat, depending on the usual factors of color, freedom from flaws, size, etc. Cut stones were sold for from $6.00 for colorless faceted gems to as much as $1,000.00 per carat for the finest color and quality gems. No prices were announced by the new mine operators.

Several investigators measured properties of the yellow labradorite and generally found refractive indexes of alpha 1.562 and gamma 1.571, birefringence 0.009, specific gravity 2.71 (Bank, 1970, 1973; Carlson & Kircher, 1976; Stewart, *et al*, 1966). Henn & Bank (1993) measured red material and found refractive indexes of alpha 1.555, beta 1.558, and gamma 1.563, birefringence 0.008, and specific gravity 2.70.

On a closing note, the abundance and high quality of labradorite found in Oregon led to the designation of Oregon Sunstone as the official state gemstone as of August 4, 1987. Among notable faceted gems are a splendid spinel-red specimen of 10.67 carats, owned by Lawrence Gray of Burns, which he calls the "Ponderosa Queen," and believes to be the largest faceted red labradorite of this quality in existence. A pale yellow clean faceted gem of 30.68 carats is in the Royal Ontario Museum in Toronto. A pendeloque gem, rich yellow in color but containing numerous streaks of extremely fine copper inclusions, is called "the Promise" by its owners, and weighs 54.78 carats. It is illustrated in color in *Lapidary Journal*, Feb. 1993, p. 7. The rough was found upon the claims of Oregon Sunstone, Inc., of Plush. To further celebrate Oregon's official gemstone, the Columbia-Willamette Faceters Guild cut and polished colorless, pale yellow, pink, and red labradorites which were then set into a 16-stone bracelet which was presented to the state of Oregon as a commemorative gift by the Oregon Retail Jewelers Association. The stones are from deposits in Harney and Lake counties.

AITKENS, I. (1931) Feldspar gems. *U.S. Bur. Mines Info. Circ.* 6533, 10 p.

BALESTRA, E. (1975) A hunt for sunstones. *Lapidary J.* 29, 8, p. 1578–1583, map.

BANK, H. (1970) Durchsichtiger blassgelber Plagioklas aus den USA. *Zs. Dt. Gemm. Ges.* 19, 3–4, p. 134–136.

______, (1973) Klar durchsichtige Labradorit aus Oregon, U.S.A. *Ibid.* 22, 2, p. 58–59.

CARLSON, E. H. & KIRCHER, M. A. (1976) A pleochroic variety of gem labradorite from the Rabbit Hill area, Lake County, Oregon. *Gems & Gemology* 15, 6, p. 162–167, illust.

DAKE, H. C. (1938) The gem minerals of Oregon. *OR State Dept. Geol. Min. Industries Bull.* 7, 16 p., map. Feldspar p. 14.

DUNN, H. M. (1973) Collecting sunstones in Lake County, Oregon. *Gems & Minerals* 431, p. 26–28, 39, illust., maps (claim map).

FEATHER, R. C. (1992) Inclusion of the month: copper in labradorite. *Lapidary J.* 46, 1, p. 24.

FERGUSON, R. W. (1982) Sunstones by the square mile. *Lapidary J.* 36, 3, p. 570–578, illust., maps.

______, (1985) In search of a blue sunstone. *Lapidary J.* 39, 1, p. 194–199, illust.

GEITGEY, R. P. (1987) Oregon sunstones. *Oregon Geology* 49, 2, p. 23–24.

HEFLIN, E. (1963) Oregon's radiant sunstones. *Lapidary J.* 12, 12, p. 929–930, map.

HENN, U. & BANK, H. (1992) Klar durchsichtiger roter Labradorit aus Oregon, USA. *Zs. Dt. Gemm. Ges.* 41, 1, p. 49–51.

HOFMEISTER, A. M. & ROSSMAN, G. R. (1985) Exsolution of metallic copper from Lake County labradorite. *Geology* 13, p. 644–647.

JOHNSTON, C. (1991) Mining the sun. *Lapidary J.* 44, 11, p. 75–86, *passim*, 153, illust. (col.).

JOHNSTON, C. L., GUNTER, M. E. & KNOWLES, C. R. (1992) Sunstone labradorite from the Ponderosa Mine, Oregon. *Gems & Gemology* 27, 4, p. 220–233, illust. (col.), map. The most detailed and authoritative study.

McLEOD, E. R. (1949) We found ant hills covered with jewels. *Desert Mag.* 13, 2, illust., map. Plush area.

MITCHELL, J. R. (1989) *Gem Trails of Oregon.* Pico Rivera, CA: Gem Guides Book Co., 119 p., illust., maps, p. 88–89.

PETERSON, N. V. (1972) Oregon "sunstone." OR Dept. Geol. Min. Industries. *The Ore Bin* 34, 12, p. 197–215, illust., maps.

POUGH, F. H. (1983) Heliolite, a transparent facetable phase of calcic labradorite. *J. Gemm.* 18, 6, p. 503–514, illust. (col.), map.

SALWITZ, R. (1994) Cowan-Atkinson succeeds with sunstone. *Colored Stone* 7, 6, p. 17, illust.

STEWART, D. B., *et al* (1966) Physical properties of calcic labradorite from Lake County, Oregon. *Amer. Mineral.* 51, p. 177–197, illust.

STRONG, M. F. (1973) Sunny sunstone. *Desert Mag.*, May, p. 28–31, map.

YOUNG, M. W. (1979) I'll find you one of those red rocks. *Gems & Minerals* 500, p. 48–50, map.

IDAHO. In his still unsurpassed monograph on Idaho minerals, Shannon (1926) describes transparent, tabular crystals of andesine scattered throughout the volcanic debris on the flanks of Crystal Butte in Fremont County, about 18 mi (28 km) north of St. Anthony. The crystals are well-formed and reach about 2.75 in (7 cm) in diameter, and "in color, they vary from colorless to pale yellow, and some small pieces are of gem quality." He notes similar material at Mac's Butte nearby. Essentially the same information is given by Ream (1989, 1992). A recent account of collecting at Crystal Butte is given by Rohn (1986).

In Clark County, Ream (1989) describes gem quality labradorite crystals in the volcanic debris of Cinder Butte, located about 18 mi (28 km) southeast of Spencer. The crystals are between 0.5 and 1.25 in (1–3 cm) across, and broken fragments are common among the debris. I was shown a number of iron oxide-coated tabular crystals that had been found by Geary Murdock which may be from the same locality. The late Leo Horensky, San Diego, faceted several fine, flawless gems of straw-yellow labradorite from such crystals. The coating of iron oxides is so thick and tenacious that scraping or grinding is needed to reveal the presence of the facet-grade material underneath.

According to Austin (1989), adularia moonstone displaying white or blue sheen is found in several places in Camas County, with some gems cut from this material said to be as fine as any from Sri Lanka. He also includes a report on the occurrence of pale yellow orthoclase from Boise, Lemhi, and Owyhee counties. No specific localities are given.

AUSTIN, G. T. (1989) Idaho gem stone production. *Colored Stone* 2, 6, p. 21–22, map.

BECKWITH, J. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: Caxton Printers, 129 p., illust., maps.

REAM, L. R. (1989) *Idaho Minerals.* Coeur d'Alene, ID: L. R. Ream Publ., 329 p., illust., maps.

______, (1992) *The Gem & Mineral Collector's Guide to Idaho.* Vol. 1. Coeur d'Alene, ID: L. R. Ream Publ., 34 p., illust., maps.

ROHN, K. H. (1986) Cinder cones and mountains. *Gems & Minerals* 582, p. 48–50, map.

SHANNON, E. V. (1926) The minerals of Idaho. *U.S. Nat. Mus. Bull.* 131, 483 p., illust.

UTAH. T. & R. A. Kosnar of Golden, Colorado, inform me that they own an exceptionally fine pale yellow faceted Clear Lake labradorite, a modified emerald cut, weighing 13.93 carats and absolutely flawless.

BULLOCK, K. C. (1967) Minerals of Utah. *UT Geol. & Min. Survey Bull.* 76, 237 p., maps. Millard Co. labradorite p. 42.

MITCHELL, J. R. (1983) Gem labradorite. *Rock & Gem* 13, 8, p. 52–55, map.

______, (1987) *Gem Trails of Utah.* Baldwin Park, CA: Gem Guides Book Co., 111 p., illust., maps. Clear Lake site p. 54.

SIMPSON, B. W. (1975) *Utah Gem Trails.* Rev. edit. Glen Rose, TX: Gem Trails Publ., 88 p., illust., maps. Clear Lake p. 48.

SPENDLOVE, E. (1986) Delta sunstone. *Rock & Gem* 16, 4, p. 52, 53, 55, 56.

______, (1993) Utah sunstone. *Rock & Gem* 23, 5, p. 48–51, 84, 85, map.

STOWE, C. *et al* (1977) *Collector's Guide to Mineral and Fossil Localities in Utah.* UT Geol. & Min. Survey, Salt Lake City, 112 p., text maps + pocket map. Clear Lake p. 81.

NEVADA. The Zapot Claim, in the Gillis Range, Mineral County, operated by Harvey Gordon of Harvey Gordon Minerals, Reno, includes a granitic pegmatite from which Gordon has extracted core unit pockets that contain smoky quartz crystals, pale blue topaz crystals, albite, mica, dark green acicular tourmaline crystals, fluorite, and small gemmy spessartine crystals in addition to the fine blue-green amazonite crystals for which this deposit is best known. C. W. Ralph of Reno (*Pers. comm.* 5/93) states that the color of the amazonite "ranks with any that I have ever seen from Colorado (even in museums)." The amazonite is conceded to be far more blue in hue than any hitherto mined in North America. Some of the crystals, according to Gordon (*Pers. comm.* 7/93), are blocky shapes of nearly a foot across (ca 30 cm) and from one such crystal he had cut an 8 in (20 cm) sphere.

NEW MEXICO. In Catron County, Merrill O. Murphy of Albuquerque reports "a facetable labradorite, darker yellow than the Oregon material . . . from about 16 miles [25 km] southwest of Reserve" (*Pers. comm.* 11/28/1994).

The fine moonstones of the Black Range, Grant County, were described as early as 1947 by Kelley & Branson, with another report by Murphy in 1964. A formal study of the geology and mineral resources of the Black Range was published by Erickson, *et al* (1970), who noted that "the rhyolite porphyry at Rabb Peak in the southwest corner of the study area contains pegmatite dikes in which there are large moonstone crystals [p. 38–39]." However, they had little success in finding gem material, all easily found specimens apparently having been removed long since. A subsequent visit to the locality by Lindberg (1988) placed the occurrence in a small basin, called Rabb Park, lying between the crest of the Black Range and the Mimbres River of eastern Grant County, lat. 32°54'55"N, long. 107°53'40"W. According to Koivula & Kammerling (1988), the moonstone-bearing feldspar is being mined by D. Menzie and R. Boltz of Faywood, New Mexico, who have obtained unstated quantities of blue- and silver-sheen transparent sanidine of gem quality. They illustrate two faceted gems: blue-sheen, 4.39 cts, and silver-sheen, 3.63 cts.

In another area of the state, Lindberg (1984) describes the occurrence of brown olivine, peridot, euhedral octahedra of black spinel, and an unidentified colorless feldspar whose grains are large enough to afford small faceted gems. The locality is Mineral Ridge, Riley Maar, a volcanic crater located about 45 mi (72 km) west of El Paso, Texas, in Dona Ana County, New Mexico. More exactly, the site is in the West Potrillo Mountains, on U.S. Geological Survey Mount Riley 15-minute quadrangle map, Sec. 31, T237S, R3W. Mr. R. S. De Mark of Marquette, Michigan, informs me that he has faceted gems up to 6 carats from straw-yellow labradorite from grains found on the Black Hills, near Rincon in Dona Ana County (*Pers. comm.* 4/3/94).

ERICKSEN, G. E., WEDOW, H. & EATON, G. P. (1970) Mineral resources of the Black Range Primitive Area, Grant, Sierra, and Catron counties, New Mexico. *U.S. Geol. Survey Bull.* 1319-E, 162 p., 2 maps.

JAHNS, R. H. (1946) Mica deposits of the Petaca District, Rio Arriba County, New Mexico. *NM Bur. Mines Min. Resources Bull.* 25, 294 p., illust., maps. Mentions amazonite.

KELLEY, V. C. & BRANSON, O. T. (1947) Shallow, high-temperature pegmatites, Grant County, New Mexico. *Econ. Geol.* 42, p. 699–712, illust., map.

KOIVULA, J. I. & KAMMERLING, R. C., eds. (1988) Gem News: New Mexico moonstone. *Gems & Gemology* 24, 3, p. 177–178, illust. (col.).

LINDBERG, J. D. (1967) A variety of minerals near Rincon, New Mexico. *Lapidary J.* 21, 7, p. 930–931, illust.

LINDBERG, J. D. (1984) Olivine, spinel, feldspar and other curiosities from Riley Maar, New Mexico. *Lapidary J.* 38, 9, p. 1192–1194, illust.

_____, (1988) Rabb Canyon sanidine. *Lapidary J.* 42, 1, p. 39, 40, 42, 44, illust. (col.).

MURPHY, M. O. (1964) Moonstone of the Black Range, New Mexico. *Lapidary J.* 18, 1, p. 144–153, illust., maps.

_____, (1971) Bytownite bonanza, *Lapidary J.* 25, 1, p. 170–178, illust., map.

NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ. NM Press, 665 p., map. Amazonite p. 352.

NEW MEXICO-ARIZONA. In an interesting and informative letter, Ralph E. Brandle of Tucson, Arizona, (3/1993) writes about his collecting much fine quality facet-grade bytownite from areas on the border between Apache-Greenlee counties in extreme eastern Arizona and adjoining areas in Catron County, New Mexico. Brandle notes that "in the last few years, the areas of Arizona and New Mexico along their common border in the Apache Sitgreaves and Gila National Forests, are producing some very nice gem material, some pieces weigh as much as fifty grams, and all 100 percent cuttable." He also refers to the area around Pueblo Park in Gila National Forest, New Mexico, earlier described by Murphy (1971, *see above*), and states that it is still producing material in large sizes. He has found facet-grade bytownite in a more than 15-mile (24-km) radius around Pueblo Park in "an area that stretches from Luna Lake in east central Arizona on the west to U.S. Route 180 on the east [in New Mexico]." As to success in collecting, "in the last two years, I have collected only briefly, and I have gotten pieces weighing fifty grams on the average, but the larger ones are there and with a little diligence and patience they await the collector." In addition to the areas mentioned, Brindle also found cuttable feldspar as far as 25 mi (40 km) north of Pueblo Park on the New Mexico side in the area known as Black Mountain. Brindle's largest cut stone is a flawless "champagne golden" faceted gem of 18.62 carats.

In Cochise County, Arizona, Anthony, *et al* (1977, p. 170) records sanidine phenocrysts in rhyolites in Cottonwood Canyon, Peloncillo Mountains, which display a blue sheen, but they do not say if the material has been cut.

ANTHONY, J. W., WILLIAMS, S. A. & BIDEAUX, R. A. (1977) *Mineralogy of Arizona.* Tucson, AZ: Univ. AZ Press, 241 p., illust. (col.), maps.

CALIFORNIA. In 1917, Anderson published a paper on aventurescent labradorite from California, basing his studies on material in the U.S. National Museum in Washington, D.C., which gave the locality as Modoc County. Unfortunately, no better information was supplied with the specimens in question, and by repeating this locality in my *Gemstones of North America*, Vol. 1, p. 148, I aroused the curiosity of Christopher W. Ralph of Reno, Nevada, who with other collectors attempted to find this occurrence. Their attempts met with no success (*Pers. comm.* 5/93). In his letter, Ralph tells of their attempts to explore possible sites and notes that despite the lack of success so far, they propose to continue searches of Modoc County to determine if a deposit of sunstone exists. However, if Anderson's sunstone actually came from Modoc County, the locality is lost.

In Inyo County, pale green amazonite useful for cabochons occurs in granitic pegmatites on Kern Knob, just 4 mi (6.2 km) due east of Lone Pine, the latter town being on Route 395. This occurrence has been described by Strong (1964) and recently by Shedenhelm (1981), who provides a detailed road map. Attractive amazonite crystals, from which beautiful cabochons have been cut, occur in a pair of parallel granitic pegmatites in the New York Mountains, east of Baker in San Bernardino County, which are under claim and being mined by Robert Reynolds, Deputy Director and Curator, San Bernardino County Museum, Redlands (*Pers. comm.* 6/93). The amazonite occurs as crystals lining cavities in the pegmatites and associated with smoky quartz and topaz crystals (non-gem). The pair of bodies are about 400 ft (120 m) long and only about 2.5 ft (75 cm) wide; they dip 75° to the north-northeast. Most of the amazonite output is in the form of mineral specimens. The amazonite has been tested chemically and found to have a high lead content.

ANDERSON, O. (1917) Aventurine labradorite from California. *Amer. Mineral.* 2, p. 91.

SHEDENHELM, W. R. C. (1981) Kern Knob amazonite. *Rock & Gem* 11, 6, p. 40, 41, map.

STRONG, M. B. (1964) Gem valley of the Inyo Mountains. *Gems & Minerals* 317, p. 18–20, map.

CHIHUAHUA. A new gem feldspar occurrence was reported by Jones (1979) as a poorly-defined locality near Casas Grandes in the northwestern part of the state. At this time, the material had been obtained by Fenn's Gems & Minerals of Las Cruces, New Mexico, and the locality redefined as near Nuevo Casas Grandes, with the collecting area said to be in "the mountainous area dividing the Mexican state of Chihuahua [east] and Sonora [west] by Lindberg (1990). Jones mentioned faceted yellow stones, clean, of 47 and 65 carats, while Lindberg noted a cut gem of about 92 carats. In a personal interview with Mr. Fenn at Tucson, February 1993, he stated that the stones, typically sand-blasted, had eroded from basalt, and that clean, faceted gems as much as 145 carats in weight had been cut from them. At the time, he had many pounds of rough of all grades and in all sizes, all astonishingly large as compared to labradorite grains hitherto found in North America, and matched in size only by those from the Pinacate region of Sonora. The latest discovery of gem feldspar in Chihuahua is well documented by Panczner (1994), who describes the discovery of "world-class" blue-sheen moonstone in the early 1970s by Enrique Jurado, a miner of fire agate. In 1982, an opencut upon the site produced over 100 kg (220 lb) of "water-clear gem crystals up to 2 inches [5 cm] in size with outstanding 'ghostly' blue-white adularescence or sheen." The deposit further produces a true cabinet specimen rarity in the form of crystal groups displaying sheen. These were identified as sodium-rich oligoclase moonstone by Dr. David London of the University of Oklahoma at Norman. In the present find, the crystal clusters range in size from about one inch (2.5 cm) to almost 6 inches (15 cm) across with single crystals averaging about one inch (2.5 cm) in size, although some have been found as much as two inches (5 cm) in size. The basic color is mostly yellowish but can also be pale green, golden-brown, or gray. Associated species include brilliant crystals of augite up to one inch (2.5 cm) long and acicular crystals of actinolite.

The mine properties, named the Mina de La Pili by the owner, are located in the Municipio La Cruz on two mining claims southeast of Naica and southwest of Conchos. The claims cover 64 hectares, or about 160 acres, and several pits have been dug, as well as a shaft to a depth of 10 meters (12 yd), to exploit several feldspar-rich zones. The faceting material depicted in Panczner's article appears to be mostly cuboid fragments, some of the larger having yielded faceted gems to about 8 carats, but recent finds of larger clear pieces suggests that flawless, blue-sheen gems over ten carats can be cut. The only comparable feldspar is the Black Range, New Mexico, material (*see above*) which has been produced only in very limited quantities, therefore making the present find the most important for gem moonstone in North America. For mineral collectors, the crystallized specimen groups appear to be the finest yet known from our continent.

A blue-sheen moonstone, obtained from the Sierra Madre Mountains and weighing 2.75 carats, is in the National Natural History Museum of Canada. Its refractive indexes are 1.575 and 1.581. Lindberg gives refractive indexes of 1.561 and 1.569, specific gravity ca 2.715 for a yellow gem of 92 cts. The Royal Ontario Museum in Toronto owns pale yellow, clean faceted gems of 30.68 and 30.61 cts.

JONES, R. W. (1979) A new gemstone from Mexico. *Rock & Gem* 9, 11, p. 32–33.

LINDBERG, J. D. (1990) Golden labradorite. *Lapidary J.* 44, 3, p. 20, 22, 24. illust. (col.).

PANCZNER, W. (1994) Mexican moonstone. *Rock & Gem* 24, 11, p. 52, 53, 78, illust. (col.).

SONORA. *See* Volume 2 for information on the facet grade feldspar.

FORD, W. E. & BRADLEY, W. M. (1910) Chemical and optical study of a labradorite. *Amer. J. Sci.* 30, p. 151–153. Village of Altar locality.

GUTMAN, J. T. (1974) Tubular voids within labradorite phenocrysts from Sonora, Mexico. *Amer. Mineral.* 55, p. 666–672, illust.

IVES, R. L. (1964) The Pinacate Region, Sonora, Mexico. *Occasional Papers, Calif. Acad. Sci.* 47, 43 p., illust., map. A guide but not to mineral localities.

KUNZ, G. F. (1911) Labradorite from Sonora, Mexico. *NY Acad. Sci. Ann.* 20, p. 43.

FERGUSONITE

The mineral is generally pitch-black, often slightly radioactive, and occurs in some granitic pegmatites. Chemically it is a rare-earth niobate with the general formula: $(RE)NbO_4$, with RE one or more of Ce, La, Nd, or Y. Hardness 5.5; specific gravity about 5.6. Pitch-like material has been faceted into curious gems.

VIRGINIA. Penick (1992) reports crude, dark brown, squarish prismatic crystals from the Rutherford Mine #2, Amelia, Amelia County, that have been cut into small faceted gems.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–16, illust.

FIBROLITE, *see* SILLIMANITE

FLUORITE

Among the truly outstanding exhibits displayed at the Tucson Show in February, 1994, one must draw special attention to that of Mr. Arthur Grant of Hannibal, New York, who has developed a special expertise in the faceting of soft and troublesome gem materials. His exhibit this year displayed superbly faceted fluorites from many sources in the world, but with fine examples from North American localities as follows: pale colored from Mont St.-Hilaire, Quebec and Madoc, Ontario; greens from Penfield, Niagara Falls, and Gouverneur, New York; a rare example from Thomaston, Connecticut; large yellows from Elmwood, Tennessee; from Newport, Michigan; blue from Bingham, New Mexico; others from Durango and Mapimi, Mexico. The prize example was a mixed square-cut faceted gem, flawless, of beautiful blue color, and weighing 3,965.35 carats! It is perfectly cut and polished and must rank as one of the finest faceted fluorites in existence. The material came from the Minerva Mine No. 2, Cave-in-Rock, Illinois. It was recently donated to the Smithsonian Institution by its purchasers, Harold and Doris Dibble of Buffalo, New York (*Lapidary J.* 46, 8, p. 10, 1992).

The problems of faceting fluorite, including very large gems, are discussed by Gray & Gray (1992) and Stripp (1988). A broad survey of fluorite as a mineral and as gem material is provided by Pough (1992).

GRAY, M. & GRAY, P. (1992) Faceting fluorite. *Lapidary J.* 46, 4, p. 91–93.
LAPIDARY JOURNAL (1992) Facets. Vol. 46, 8, p. 10.
POUGH, F. H. (1992) Mineral notes: fluorite. *Lapidary J.* Part I, 45, 10, p. 14, 16; II, 11, p. 16, 18; III, p. 14, 16; IV, 46, 1, p. 16, 18, 20, 22; V 2, p. 16, 18; illust. (col.).
STRIPP, D. M. (1988)The soft touch. *Lapidary J.* 42, 6, p. 20–22, 26–28, 30–35, illust. (col.). On the lapidary work of Arthur Grant.

NEWFOUNDLAND. Attractive massive granular fluorite, often banded in several colors, e.g., purple, blue, and green, and sometimes compact enough for the manufacture of larger ornamental objects, occurs in several localities in the extreme southern part of Burin Peninsula, just north of St. Lawrence Harbor on the south coast of the Island (Broughton, 1975).

BROUGHTON, P. L. (1975) Newfoundland fluorites. *Rock & Gem* 5, 8, p. 20–26, map.
WARREN, F. J. (1980) *Gemstones of Newfoundland and Labrador.* St. John's, NF: Tourist Services Div., (9) p., illust., map.

QUEBEC. As a colorful curiosity, Arthur Grant faceted several small gems, 1.54 and 4.75 carats, from banded fluorite found in a road cut near Old Chelsea, Highway 105, Hull Township, Gatineau County. The stones were oriented in such a way as to show a purple stripe passing across a predominantly green body color.

GRICE, J. (1981) Hexoctahedral fluorite crystals from Old Chelsea, Quebec. *Min. Rec.* 12, 2, p. 103, 104, illust.

ONTARIO. The clear Madoc fluorites are well represented as faceted gems in the collection of the Royal Ontario Museum in Toronto. Four gems cut in various styles weigh 8.20 to 15.66 carats, mostly greens, but there is also a deep blue-green gem of 8.30 carats. A recent account of the Madoc mines appears in Melanson & Robinson (1982).

MELANSON, F. & ROBINSON, G. (1982) The fluorite mines of Madoc, Ontario. *Min. Rec.* 13, 2, p. 87–92, illust., map.

SABINA, A. P. (1987) Rocks and minerals for the collector: Hull-Maniwaki, Quebec; Ottawa-Peterborough, Ontario. *Geol. Survey Canada Misc. Rept.* 41, 141 p., illust., maps.

WALKER, T. L. (1919) Fluorite from Madoc, Ontario. *Amer. Mineral.* 4, p. 95–96.

WILSON, M. E. (1921) Fluorspar deposits of Madoc district, Ontario. *Canada Dept. Mines, Mines Br. Summ. Rept.* 1920, Pt. D, p. D 41–78.

______, (1929) Fluorspar deposits of Canada. *Canada Dept. Mines, Mines Br. Econ.* Geol. Ser. 6, 97 p., illust., maps.

NEW HAMPSHIRE. The splendid light green fluorite from Westmoreland and Chesterfield townships, Cheshire County, continues to be found but in diminishing quantities, and the rough is now quite scarce. The largest faceted gems are the flawless stone in the Harvard University collection of 191.70 cts and the record stone of 416.33 cts (Bradshaw, 1991). The largest gems in the U.S. National Museum of Natural History weigh 124.5 and 229 carats (Arem, 1987). Wight (1984) records a green gem of 24.85 carats in the Canadian National Collection.

In Carroll County, just east of the well-known ski resort of Cranmore Mountain, a patch of ground on the northwest flank of Black Cap Mountain is studded with curious pipe-like/pegmatite structures which are characterized by milky quartz cappings, which, when removed, lead downward into brecciated ground, filled with rusty clay, and with considerable amethyst, smoky quartz, and fluorite (Herndon, 1994 & *Pers. comm.* 3/23/94). The locality is almost exactly 2.5 mi (4 km), bearing 85° true from North Conway, and about 0.75 mi (1.2 km) south-southwest of Hurricane Mountain in Conway Township. According to Herndon, exploitation of these quartz-fluorite pipes began in the mid-1960s, and he dug them in 1983, at which time he recovered 90 lb (41 kg) of amethyst crystals. At this time, the selected pipe had been sunk to 21 ft (6 m) below the surface. In the summer of 1993, work was resumed, and more amethyst, smoky quartz, and fluorite were found, some of the last being clear enough for faceted gems. Many faceted gems have been cut from this reddish material, including an octagon barion of 138 cts by William Brown of Raymond, New Hampshire.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* NY: Van Nostrand Reinhold, 248 p., 2nd edit., illust. (col.).

BANNERMAN, H. M. (1941) The fluorite deposits of Cheshire County, N.H. *NH Min. Resources Survey Part* V, 11 p., maps.

BARDILL, A. E. (1946) Exploration of the Stoddard fluorite mine, Cheshire County, New Hampshire. *U.S. Bur. Mines Rept. Invest.* 3937, 6 p., maps.

BRADSHAW, J. J. (1990) Gemstones of New Hampshire. *Rocks & Minerals* 65, 4, p. 300–305, illust. (col.).

GREGORY, G. E. (1969) The fluorite mines of Westmoreland, New Hampshire. *Gems & Minerals* 382, p. 23, 36, 37, map.

HERNDON, J. (1994) Black Cap revisited. *Mineral News* 10, 2, p. 4, 5, illust.

MARSHALL, J. (1969) Bonanza at the Wise. *Rocks & Minerals* 44, 3, p. 163–171, illust.

WETHERBEE, J. (1954) The fluorite deposits of Westmoreland, New Hampshire. *Rocks & Minerals* 29, 3–4, p. 142–143, map.

WIGHT, W. (1984) The gem collection of the National Museum of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

YOUNG, J. (1990) Fluorite deposits of Westmoreland, New Hampshire. *Rocks & Minerals* 65, 4, p. 328–335, illust., map.

NEW YORK. The locality for green fluorite mentioned by Kunz (1889) near Macomb, St. Lawrence County, may have been relocated by Brown (1983). The New York State Museum Collection includes these faceted gems from the state: green and blue from Macomb, 12.60 and 5.25 cts respectively, also smaller stones cut from the green material; from Penfield, a blue gem of 21.24 cts; a blue gem from Theresa of 79.70 cts; the last two localities are not further identified. Wight (1984) records a blue faceted gem of 6.27 cts, from the Walworth Quarry, again not further identified.

BROWN, C. E. (1983) Mineralization, mining, and natural resources in the Beaver Creek area of the Grenville Lowlands in St. Lawrence County, New York. *U.S. Geol. Survey Prof. Paper* 1279, 21 p., col. photos, maps.

KUNZ, G. F. (1889) A remarkable locality of American fluorite. *NY Acad. Sci. Trans.* 8, p. 59–60. Macomb locality.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) The New York State Museum gem collection catalogue. *Open File Report* 8m106, Albany, 47 p.

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

ILLINOIS. An abundance of splendid facetable fluorite in crystals and cleavage fragments continues to be mined in southern Illinois fluorite deposits. From time to time, shallow surface deposits are also exploited for specimens and cutting material. In 1992, Palmer's Trading Post in Cave-in-Rock sold colorful cabochon/carving grade material for $5.00 per pound, but facet-grade material fetched prices up to $100 per pound, depending on size, flawlessness, color, and expected return in finished gems. Most facetable fluorite from this area is blue-green to sky-blue, but other hues are known. For example, Michael Gray of Missoula, Montana, cut an enormous, flawless, vivid yellow triangular faceted gem of 1,031 carats in 1993, shown in color on the cover of *Lapidary Journal* vol. 37, no. 8, with article on same p. 1199. For a time this beautiful gem held the size record until the cutting, by Arthur Grant, of Hannibal, New York, of a huge square faceted gem of 3,965.35 carats, of an intense blue color, reminiscent of a top-grade sapphire in hue. Gray's yellow gem is in the collection of the Los Angeles County Natural History Museum while Grant's stone was recently acquired by the U.S. National Museum of Natural History. The rough for both stones came from southern Illinois.

BAIN, H. F. (1905) The fluorspar deposits of southern Illinois. *U.S. Geol. Survey Bull.* 255, 75 p., illust.

BASTIN, E. S. (1931) The fluorspar deposits of Hardin and Pope counties, Illinois. *IL State Geol. Survey Bull.* 58, 116 p., illust., maps.

CURRIER, L. W. & HUBBERT, M. K. (1944) Geological and geophysical survey of the fluorspar areas in Hardin County, Illinois. *U.S. Geol. Survey Bull.* 942, 150 p., illust., plates.

GLATTHAAR, K. & GLATTHAAR, N. (1972) Exploring the fluorspar mines of southern Illinois. *Rockhound* 1, 6, p. 25, 28, 29, map.

HUTCHESON, D. W., ed. (1974) A symposium on the geology of fluorspar. *Proc. Ninth Forum on Geol. Industrial Minerals, April 26–28, Paducah, KY. KY Geol. Survey Spec. Publ.* 22, 107 p., maps, sections.

PITTMAN, J. T. (1983) Stalking the wild fluorspar. *Gems & Minerals* 550, p. 14, 15, 30, 31, 55, 68, illust., map.

POGUE, J. E. (1922) Optical fluorite in southern Illinois. *IL Geol. Survey* 38, p. 419–425.

WELLER, J. M., *et al* (1952) Geology of the fluorspar deposits of Illinois. *IL State Geol. Survey Bull.* 76, 147 p., illust., maps.

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14. Records 69.69 cts yellow and 43.25 cts blue faceted gems from Illinois.

BRITISH COLUMBIA. The geology and mineralogy of the Rock Candy Mine, located on Kennedy Creek, about 15 mi (24 km) north of Grand Forks, has been described by Nagel (1981); some of the fluorite from here has been faceted.

GRICE, J. D. (1989) *Famous mineral localities of Canada.* Markham, ONT: Fitzhenry & Whiteside, for National Museum of Natural Sciences, 190 p., illust. (col.). Rock Candy Mine p. 40–47.

NAGEL, J. (1981) The Rock Candy Mine, British Columbia. *Min. Rec.* 12, 2, p. 99–101, illust., map.

COLORADO. T. & R. A. Kosnar of Golden, Colorado, provided the following localities for gem fluorite. In Routt County from Walden, a rich emerald-green massive fluorite was sent to Germany for the manufacture of carvings that resembled "imperial jade." Veins up to 10 in (25 cm) thick furnished the rough. The Henderson Mine, Berthoud Pass, Clear Creek County, furnished facetable green octahedral crystals that cut clean gems of 2 to 3 carats; similar crystals have been found in the Urad Mine nearby and are capable of yielding faceted gems up to about 10 carats. The Climax Mine, Lake County, furnished green crystals and also some of purple/green, and rarely pink, capable of cutting gems to several carats. The Sweet Home Mine near Alma, Lake

County, provided dark purple rough and banded massive material useful for cabochons or faceted stones. A 4.20 carats pear-shaped flawless faceted gem was cut from such banded fluorite. Sand Hill on Crystal Creek, near Lake George, Park County, furnished facet grade-green crystals that would cut flawless gems of over twenty carats. Emerald green to pale blue octahedral crystals with facetable areas were found atop Mount Antero, Chaffee County, a blue rough furnishing a faceted gem, slightly flawed, of 34.10 carats in 1973. In 1993, the RAK Trail Creek Prospect, Teller County, provided rough for a dark green flawless faceted gem of 49.52 carats. Small faceted gems can be cut from green crystals from the Sunnyside Mine, Gladstone, San Juan County.

NEW MEXICO. R. S. De Mark, of Marquette, Michigan, states that the following fluorite faceted gems have been cut from New Mexican material (*Pers. comm.* 4/4/1994): from Grant County, the Bluebird Mine in the Gold Hill district, where fluorite occurs in fissures in Precambrian granite, green gems with purple tints to 8 carats; from Ash Spring Canyon Prospect, from a fissure filling in limestone, green gems to 8 carats; in Luna County, from fissure veins in Tertiary igneous rocks, dark purple and green gems up to 64 carats. Numerous localities for fluorite are given in Northrop (1959) but without comment as to usefulness for lapidary purposes.

NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ. New Mexico Press, 665 p. Fluorite p. 238–244.

ROTHROCK, H. E., JOHNSON, C. H. & HAHN, A. D. (1946) Fluorspar resources of New Mexico. *NM Bur. Mines & Min. Resources Bull.* 21, 245 p., illust., maps.

CALIFORNIA. Michael Gray, of Missoula, Montana, faceted a 30.9 carats round brilliant green gem from material collected by Robert Housley in the Felix Mine, Los Angeles County, 0.5 mi (0.8 km) east of the north end of Asuza Avenue (Pemberton, p. 188). The gem is the largest recorded from this deposit and is now in the San Bernardino County Museum (*Friends of Mineralogy, Southern California, Newsletter,* March, 1994).

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps.

DURANGO. In 1993, there appeared upon the market a very attractive, massive banded fluorite of high transparency, though largely with inclusions, from a commercial fluorite mine on the Rio Nazas, not far from Rodeo on the highway between Parral on the north and Durango on the south (*Pers. comm.*, Jack Young, 6/93). The material is eminently suitable for tumbled gems, cabochons, and small carvings, and occurs in various tints of blue, greenish-blue, green, purple, and pink. Small faceted gems can be cut from some of the material. Most of the pieces range from 10 to 50 grams, and in 1993 were offered at $.20/gram retail.

FLOWERSTONE

BRITISH COLUMBIA. The name “flowerstone” was given to what Leaming (1973, p. 39) calls “snowflake porphyry,” defined as “plagioclase phenocrystals set in matrix of gabbro or diorite.” These rocks, being very dark brownish or greenish in color, sometimes black, offer a suitable contrasting background to the sharp, cream-colored rectangular crystals of feldspar. Ordinary porphyry contains single crystals of feldspar, but the flowerstone, found in such profusion in splendid specimens in this province, exhibits its feldspar crystals in radiating clusters which when cut through resemble a miniature chrysanthemum flower. Stones of this kind, called “suiseki” in Japan, are much prized by the Japanese (Sato, 1967). Unfortunately, the same degree of appreciation is not accorded the remarkable stones described in the numerous articles by J. & W. Hutchinson *(see below)*. Leaming *(Ibid.)* notes that the flowerstone rocks intrude the Sicker Group of rock formations on Salt Spring Island and Vancouver Island. According to the Hutchinsons (1975), virtually every beach on Vancouver Island should be looked over for flowerstones, but those in the southern end of the island appear to be favored. In 1993, a rock shop in British Columbia offered flowerstone for carvings and larger ornamental items, but I have seen no advertisements for this material since then.

DANNER, W. R. (1976) Gem materials of British Columbia. *Montana Bur. Mines Geol. Spec. Publ.* 74, p. 157–169, illust. Flowerstones p. 169.

HUTCHINSON, J. & HUTCHINSON, BILL (1966) Beachcombing around southern Vancouver Island. *Lapidary J.* 20, 7, p. 898–901, illust.

______, (1968) More about British Columbia's "flower rocks." *Ibid.* 22, 2, p. 358–359, illust.

______, (1968) Rockhounding in British Columbia. *Ibid.* 22, 8, p. 1086–1088, illust.

HUTCHINSON, BILL & HUTCHINSON, J. (1973) Suiseki in British Columbia. *Lapidary J.* 26, 11, p. 1550, 1552, 1554, illust.

______, (1975) Feldspar flowers. *Ibid.* 28, 11, p. 1704–1706, illust.

______, (1975) Vancouver Island beachcombing. *Ibid.* 29, 5, p. 1024–1031, illust.

______, (1975) *Rockhounding & Beachcombing on Vancouver Island.* Victoria, BC: Tom and Georgie Vaulkhard, 76 p., illust. (col.), maps.

______, (1976) Rockhounds are gamblers. *Lapidary J.* 30, 2, p. 642–644, illust.

______, (1976) Mud saw. *Ibid.* 30, 4, p. 1048–1054, illust. Sawing very large flowerstone boulders.

______, (1976) Variations and oddities. *Lapidary J.* 30, 6, p. 1496–1500, illust.

______, (1977) Vancouver Island rockhounding. *Lapidary J.* 30, 12, p. 2822–2328, illust.

LEAMING, S. (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, 138 p., illust., maps.

SATO, T. (1967) Suiseki. *Gems & Minerals* 358, p. 14–17, illust.

FUCHSITE (QUARTZITE)

Fuchsite is both the name for a mica colored green by the presence of chromium and for a fine-grained quartzite in which this mica is present and hence imparts a green color (*see also* MARIPOSITE).

GREENLAND. According to Petersen & Secher (1993), a handsome fuchsite quartzite occurs in considerable quantity at Isukasia, in the Godthaabsfjord (Nuup Kangerlua) area on the west coast. It has been used for cabochons and small carvings. Locally the material is called "grønlandite", and having been dated to 3.8 billion years it may be the oldest known gem rock in the world! The deposit is still productive and others like it are located nearby.

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 1–65, illust. (col.), maps, p. 14.

NEWFOUNDLAND. "An attractive emerald-green rock composed of aggregates of green chrome-mica in quartz" occurs in two road cuts on Highway 410 at Flatwater Pond, 27.7 mi (44 km) and 28.1 mi (46 km) from its junction with the Trans-Canada Highway, according to Sabina (1976, p. 116–117). Locally the rock is called "virginite" and "it takes a good polish and is used as an ornamental stone for jewellery and other purposes."

SABINA, A. P. (1976) Rocks and minerals for the collector: The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, 199 p., illust., maps.

QUEBEC. No new developments.

PARKS, W. A. (1913) The building and ornamental stones of Quebec. *Canada Dept. Mines, Mines Br. Summ. Rept.* 1912, p. 76–79. Fuchsite noted.

ONTARIO. A white massive quartz containing bright green fuchsite mica and locally used as an ornamental stone is found on the dumps of the Kenilworth (Naybob) Mine located 3.8 mi (6 km) south of Timmins by road (Sabina, 1974, p. 150). Similar material occurs near the Anoki Mine, Gauthier Township, Temiskaming (*Ibid.*, p. 32).

SABINA, A. P. (1974) Rocks and minerals for the collector: Cobalt-Belleterre-Timmins; Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, 199 p., illust., maps.

MANITOBA. Stockwell (1932) mentions a fuchsite rock that is suitable for stucco purposes.

STOCKWELL, C. H. (1932) "Fuchsite-bearing rock suitable for stucco material." In WRIGHT, J. F., Geology and mineral deposits of a part of southeastern Manitoba, *Geol. Survey Canada Memoir* 169, 150 p., illust., map. Stockwell p. 108–128.

WYOMING. Massive quartzite containing fuchsite in very small platelets and forming an attractive aventurine rock outcrops in a band that extends for several miles from a central point located 13 mi (20 km) due east of Boysen, S½, Sec. 7, T40N, R92W, in northeast Fremont County (Sutherland, 1990). Another occurrence is near the border with Albany County, about 19 mi (30 km) southwest of Wheatland, Sec. 36, T23N, R71W in the Laramie Mountains. Similar material, but lighter green, was once quarried in the Medicine Bow Mountains, Albany County, at a place 14 mi (22 km) east of Tenmile.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., map.

GABBRO, HYPERSTHENE,

see "BLACK GRANITE"

GARNET

Gem quality garnets continue to be found throughout the continent, with the most important occurrences being the grossular from the Jeffrey Mine in Quebec, the dark almandines from the Adirondacks of New York and from Idaho, the important spessartine production from Ramona, California, and, recently, interesting grossular and andradite from Mexican sources. The following are general references on garnet.

DUNN, P. J. (1978) On the composition of some Canadian green garnets. *Canad. Mineral.* 16, p. 205–206.

FIELD, D. S. M. (1951) Gem quartz and garnet in Canada. *Canad. Mining J.* 72, 10, p. 81–83, illust.

MODRESKI, P. J. (1993) Garnet. *Rocks & Minerals* 68, 1, p. 20–23, illust.

MYERS, W. M. & ANDERSON, C. O. (1925) Garnet: its mining, milling and utilization. *U.S. Bur. Mines Bull.* 256, 54 p., illust.

PEARL, R. M. (1975) *Garnet: Gem and Mineral.* Colorado Springs, CO: Earth Science Publ. Co., 24 p., illust. General survey.

POUGH, F. H. (1990) Garnet and garnets. *Lapidary J.* 44, 6, p. 48–64, *passim*, illust. (col.). General survey with emphasis on gemstones.

ROUSE, J. D. (1986) *Garnet.* London: Butterworths, 134 p., illust. (col.). Includes U.S. localities; most complete reference available.

SKINNER, B. J. (1956) Physical properties of the end-members of the garnet group. *Amer. Mineral.* 41, p. 428–436, illust.

ZEITNER, J. C. (1990) Gathering garnets. *Lapidary J.* 44, 6, p. 81–88, illust. (col.). Localities in Maine, Virginia, North Carolina, South Dakota, Colorado, and Idaho.

NORTHWEST TERRITORIES. Bell (1992) followed up a lead to garnet, said to be of gem quality, occurring on Garnet Island, in Markham Bay, on the south shore of Metaincognita Peninsula, South Baffin Island. There are several cut gems in the Royal Ontario Museum and the Canadian Museum of Nature, but recent attempts to relocate the site were unsuccessful. Wight (1986) records a triangular brilliant faceted gem of almandine of 6.33 carats from Garnet Island (?), Franklin District.

BELL, R. (1992) Report on the compilation of lapidary sites [in NWT]. *NWT Dept. Energy, Mines, Petrol. Resources, EGS* 1992–14, 157 p., maps.

WIGHT, W. (1986) Canadian Gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

QUEBEC. The long-lost source of the first recorded gem quality grossular from Quebec (Kunz, 1884) has been rediscovered by staff members of the Mineral Sciences Section, Canadian Museum of Nature (Velthuisen & Wight, 1993). The deposit is now known to be upon the McBride property, located in Lot 6, Range 1, Wakefield Township, Hull County, according to old information, now corrected to Lot 6, Range 1, Canton Wakefield, Comte Papineau. The search for this deposit extended over six years but at last a small prospect pit was found from which only a few specimens were obtained despite considerable excavation efforts.

This prospect was first worked in 1877 and specimens distributed by Philadelphia mineral dealer A. E. Foote. According to Velthuisen & Wight *(Ibid.)*, "thirteen cut stones are noted in the catalogue of the Paris Exposition of 1900 to have been displayed at the exposition. Four faceted stones from the McBride property are housed in the National Collection, Canadian Museum of Nature . . . 0.45 ct . . . 0.68 ct . . . 0.35 ct . . . and . . . 0.22 ct." It was found that the grossular occurs in skarn rock, imbedded in massive sulfide pods, but "more commonly, specimens were found as isolated euhedra in homogenous marble associated with phlogopite, diopside/hedenbergite and rare vesuvianite." Such crystals ranged in size up to 3 in (8 cm) but averaged only one-half inch (1 cm). They are colorless to light yellow, to light to dark orange. Faceted stones give an average R.I. of 1.742. The pit and dumps have been leveled and the locality is no longer open to collecting.

Despite the ill-advised and scientifically inaccurate accusations made against chrysotile asbestos, such as that mined in the Jeffrey open pit at Asbestos, Quebec, the mining and recovery of same continues without let-up. The pit is located immediately adjacent to the town, about 100 mi (160 km) east of Montreal; it is the second largest open pit mine in the world, first honor going to another asbestos open pit in the Urals of Russia, near a town named Asbest after the mineral. Historically, Jeffrey pit was opened in 1881, and by 1885 was producing 2,300 tons of crude asbestos fiber each year (Grice & Williams, 1979). The property was acquired in 1916 by Canadian Johns-Manville Company who remains the current owner and operator. The minerals of interest to collectors, grossular, vesuvianite, prehnite, pectolite, wollastonite, and others, occur in rodingite rock or in joint fillings in altered diorite (Grice & Wight, 1986; Wight & Grice, 1982). The grossular crystals, often heaped in glittering groups upon matrix, range in hue from colorless to increasingly enriched tints of yellowish to brownish-orange due to the presence of iron, or, more rarely, greenish due to the presence of chromium. Only the orangey crystals furnish clear areas large enough for faceted gems of substantial size. Wight & Grice (1982) record colorless to slightly yellowish faceted gems of 1.64 to 7.08 cts, R.I. 1.733 ± 0.002, while Arem (1987) records faceted gems of normal orangey color of 23.94, 13.40, and 8.50 cts in the National Museums of Canada collections, and colorless gems of 4.68 and 2.94 cts in the same institution. The Royal Ontario Museum possesses an orange faceted gem of 15.91 cts. At times, crystals as large as 1.5 in (4 cm) in diameter have been found, but they are too clouded with inclusions to afford fine gems.

Grice & Wight (1986) note that green crystals occur that are somewhat less than 0.5 in (1 cm) in diameter, but most are smaller, and the National Museum of Natural Sciences collection contains only a one-quarter carat cut gem with many inclusions. However, colorless crystals have been faceted to as much as 7 carats. Some otherwise colorless crystals are remarkable for containing small core areas of green color derived from minute chromite crystals; when properly oriented, faceted gems are suffused with green color.

The crystals predominantly display faces of the rhombic dodecahedron [110] and trapezohedron [211], singly or together, and sometimes occurring alternately such that the faces are covered with fine grooves and the crystal approaches a ball-like shape. Colorless grossular approaches the pure end-member composition of $Ca_3Al_2(SiO_4)_3$, with R.I. 1.734. With increase in iron, the color assumes an orangey tint that darkens to a brownish-orange; the refractive index also rises from 1.736 to 1.741 (Grice & Wight, 1986).

While beautiful faceted gems have been cut from the Jeffrey grossular, by far most specimens are more highly prized as cabinet pieces. In a few rare cases, small groups of free crystals lend themselves to mounting as pendants, and other single crystals have been set in rings "as is." No standard prices have been published on faceted gems, but one may expect these to begin at $20 to $50 per carat for small stones, and reach several hundred dollars per carat for fine gems of five carats or more. Values of gem material and cabinet specimens probably will rise in the future because collecting is strictly limited in the open pit. In 1992, the government of Canada authorized issue of a C$0.42 denomination postage stamp which depicted grossular crystals, in color, from the Jeffrey Mine.

AKIZUKI, M. (1989) Growth structures and crystal symmetry of grossular garnets from the Jeffrey Mine, Asbestos, Quebec. *Amer. Mineral.* 74, 7–8, p. 859–864.

CHAMBERLAIN, S. C. (1980) Wollastonite, vesuvianite, native copper, and diopside from the Jeffrey Mine, in Asbestos, Quebec, Canada. *Rocks & Minerals* 55, 5, p. 188–191, illust.

GREGORY, G. E. (1967) A visit to the Jeffrey open pit mine in Asbestos, Quebec, Canada. *Rocks & Minerals* 42, 10, p. 738–742, illust.

GRICE, J. D. & WILLIAMS, S. R. (1979) Famous mineral localities: The Jeffrey Mine, Asbestos, Quebec. *Min. Rec.* 10, 2, p. 69–80, illust., map.

GRICE, J. D. & WIGHT, W. (1986) Correlation of colour and chemistry in grossular and vesuvianite from the Jeffrey Mine, Quebec, Canada. *Internat. Min. Assoc. IMA 1982, Mineralogy and phase equilibria of minerals,* p. 433–440.

KUNZ, G. F. (1884) On a white garnet from near Hull, Canada. *Amer. Assoc. Adv. Sci. Proc.* 32, p. 269–270.

______, (1884) On the white garnet from Wakefield, Quebec. *Amer. J. Sci.* 27, p. 306.

POITEVIN, E. & GRAHAM, R. P. D. (1918) Contributions to the mineralogy of the Black Lake area, Quebec. *Geol. Survey Canada Mus. Bull.* 27, 103 p., illust., map.

ROSS, J. G. (1931) Chrysotile asbestos in Canada. *Canad. Dept. Mines Publ.* 707, 146 p. Mentions grossular in Quebec.

VELTHUISEN, J. V. & WIGHT, W. (1993) The McBride property. *Min. Rec.* 24, 1, p. 68.

WIGHT, W. & GRICE, J. D. (1981) Colourless grossular and green vesuvianite gems from the Jeffrey Mine, Asbestos, Quebec. *Canad. Gemm.* 3, 2, p. 2–6.

______, (1982) Grossular garnet from the Jeffrey Mine, Asbestos, Quebec, Canada. *J. Gemm.* 18, 2, p. 126–130

MAINE. Bradshaw (*in press*) records several minor occurrences of facet grade almandine as do King & Foord (1994, p. 13–15).

BRADSHAW, J. J. (*in press*) Gemstones of Maine. In KING, V.T., ed. *The Mineralogy of Maine,* Augusta, ME: Geol. Survey ME, excerpt 21 p.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

VERMONT. The colorful crystals of grossular found in various asbestos deposits led to its adoption as the official gem of Vermont in 1991. Small faceted gems have been cut up to one carat from grossular crystals found at Belvidere Mountain asbestos quarries in Lowell, Orleans County.

NEW HAMPSHIRE. Bradshaw (1990) records a stepcut faceted almandine of 2.15 cts from the Turner Mine, Marlow, Cheshire County.

BRADSHAW, J. J. (1990) Gemstones of New Hampshire. *Rocks & Minerals* 65, 4, p. 300–305.

NEW YORK. The Barton Garnet Mine near North Creek, Warren County, is open to visitors on a guided tour basis during which time collecting is permitted (Zabriskie, 1992). There is no shortage of cuttable almandine, although by far most gems cut from this material are too dark if more than a carat or two in weight. The New York State Museum collection includes over a dozen faceted gems ranging from less than a carat to the largest stone of 6.50 cts (Schimmrich & Campbell, 1990). According to Smoak (1985) the Barton Mines Corporation, which has been owned continuously by the same family since mining began in 1878, moved its mining and ore processing operations from Gore Mountain to adjacent Ruby Mountain in 1982. "The output of the Barton open pit mines and mill is sold directly to consumers, chiefly in the Northeastern States, as graded material [i.e., abrasive grain]."

CIURCA, S. J. (1962) Garnet on Gore Mountain. *The Mineralogist* 30, p. 10–13, map.

CORNWALL, J. H. (1965) Garnet—gem, rock-builder and abrasive. *Lapidary J.* 19, 6, p. 650–760, *passim,* illust.

———, (1981) That's only garnet? *Lapidary J.* 34, 10, p. 2120–2163, *passim*, illust.

HOFFMAN, A. C. (1979) The garnet—Empire State's gem of many facets. *Lapidary J.* 33, 5, p. 1132–1134, illust.

KELLY, W. M. (1992) Gore Mountain's garnets. *Natural History*, 5/92, p. 33.

LISLE, T. O. (1945) Red garnets by the ton, a remarkable quarry near Lake George, N.Y. *Rocks & Minerals* 20, 10, p. 471.

MAGNUS, H. C. (1904) Abrasives of New York State. *NY State Geol. Survey Ann. Rept.* 23, p. 158–179.

MANCHESTER, J. G. & STANTON, G. S. (1917) A discovery of gem garnet in New York City. *Amer. Mineral.* 2, p. 85–86.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) The New York State Museum gem collection catalogue. *Open File Rept.* 8m106, 47 p.

SMOAK, J. F. (1985) Garnet. In Mineral facts and problems, 1985 edition. *U.S. Bur. Mines Bull.* 675; reprint of 8 p.

STANTON, G. S. (1891) The occurrence of garnets and beryls on New York Island. *NY Acad. Sci. Trans.* 10, p. 50–51.

ZABRISKIE, D. & ZABRISKIE, C. (1992) *Rockbounding in Eastern New York State and Nearby New England.* Albany, NY: Many Facets, 49 p., illust., maps.

ZIRLIN, S. H. (1984) A visit to the Barton Garnet Mine, New York. *Lapidary J.* 37, 11, p. 1850–1854, map.

PENNSYLVANIA. Wight (1984) notes that a 6.60 ct dark orange spessartine faceted gem from an unstated source in Pennsylvania is in the Canadian National collection.

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

VIRGINIA. The dumps of the Rutherford Mine #2 at Amelia, Amelia County, still furnish spessartine etched crystal masses to persistent diggers. For example, a splendid etched gemmy mass of orange spessartine weighing 2,829 carats was uncovered in September, 1991 by Richard Seaver, while another found by Sean Sweeney of Rockville, Maryland, weighed 6,720 carats, and still another etched mass, weighing 1,675 carats, was found by John Nygaard of Cumberland, Virginia (Penick, 1992). The Smithsonian gem collection contains a 40.1 cts orange faceted gem from this deposit, but as a general rule with this spessartine, inclusions are abundant in such etched masses, save for small areas, and most persons cutting this garnet count themselves lucky if they can produce a flawless faceted gem of five carats or thereabouts.

William D. Baltzley, owner and operator of the Morefield pegmatite mine not far outside Amelia, reports recovery of considerable spessartine in similar etched masses, one of which, about 4 in (6 cm) in diameter, proved to be composed of smaller, interlocked masses. One mass weighs 2,829 carats and measures 3.5 x 3.25 x 3.3 in (9 x 8 x 8.5 cm) (*Pers. comm.* 1/93). His spessartine resembles that found by both of us while working the Rutherford Mine #2 many years ago (Sinkankas, 1968), and apparently the large rounded masses represent earlier-formed crystals which then fractured and became severely etched during the late stages of pocket formation in the core of the pegmatite. It further appears that such huge crystals began as almandine-rich garnet, then progressively lost iron and gained manganese, changing in color from dark brownish red to orange. This conclusion is supported by an analytical study of spessartine composition versus color (Sinkankas & Reid, 1966), which shows such progressive change of color/composition.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

SINKANKAS, J. & REID, A. M. (1966) Colour-composition relationship in spessartine from Amelia, Virginia. *J. Gemm.* 10, 4, p. 125–134.

SINKANKAS, J. (1968) Geology and mineralogy of the Rutherford Pegmatites, Amelia, Virginia. *Amer. Mineral.* 53, p. 377–405, illust., map.

NORTH CAROLINA. Hudson (1980) describes almandine garnet crystals found on the Tweedy Garnet Mine property, owned by Mr. Charles Tweedy of Morganton, Burke County, some of which contain clear areas suitable for faceted gems, while others, far more rare, furnish star cabochons. The faceted gems may be as large as eight carats, but Fechenbach (1981) states that most cut stones are less than a carat. As with much almandine, the darkness of color is so great that stones larger than several carats appear almost black in reflected light. The crystals are rude trapezohedrons, generally in the size range of several inches in diameter or less, although giant crystals have been found, as illustrated by Hudson, that may be as large as a grapefruit, or about 4 to 5 inches in diameter. Tweedy noted some crystals that weighed over 6 lbs (2.7 kg). The area is regularly bulldozed to expose more garnet-bearing decomposed country rock and fee digging is permitted. The site is located just southeast of Morganton (on Interstate Highway 40), west of Statesville.

Lesure (1982, p. 21) cites local residents of Buncombe County who reported that "gemstone garnet was produced . . . at Potato Field Gap," in the Great Craggy Mountains, on Blue Ridge Parkway about 10 mi (16 km) northeast of Asheville. However, Lesure's prospecting failed to uncover the site although "garnets as large as 5 cm [2 in] are common in outcrop and float material. Many of the crystals are highly fractured . . . a few handpicked gem quality stones might be recovered." This is almandine garnet. At Mason Mountain, Macon County, the original *in situ* source of the famous rhodolite garnet was reopened by Andrew W. Reid of Franklin, North Carolina (Page, 1961). The largest cut stone owned by Reid weighed over 7 carats. A faceted gem of 16.5 cts is in the Smithsonian collection. More detail on this mining venture was provided by Hudson (1969), who noted that the site was open to fee-digging. The garnets were found in a dike-like body of about 200 ft (60 m) in thickness which passes through gneiss. The garnetiferous rock consists of hypersthene, biotite, anthophyllite, and rhodolite. In places the rhodolite makes up as much as 70% of the volume, but all of it is badly fractured and only small clear fragments can be obtained that are large enough to cut faceted stones of less than one carat or two carats at most. However, a story makes the rounds that a gem of 20 carats was cut from this material.

BROUGHTON, P. L. (1975) Mason Mountain rhodolite. *Gems & Minerals* 453, p. 30–31, illust., map.

FECHENBACH, M. F. (1981) Close encounters of the rockhound kind. *Gems & Minerals* 528, p. 50, 51, 77, map.

HEINRICH, E. W. (1950) Paragenesis of the rhodolite deposit, Masons Mountain, North Carolina. *Amer. Mineral.* 35, p. 764–771.

HENDERSON, E. P. (1931) Notes on some minerals from the rhodolite quarry near Franklin, N.C. *Amer. Mineral.* 16, 12, p. 563–568.

HIDDEN, W. E. & PRATT, J. H. (1898) On rhodolite, a new variety of garnet. *Amer. J. Sci.* 5, p. 294–296.

_____, (1898) On the associated minerals of rhodolite. *Amer. J. Sci.* 6, p. 463–468, illust.

HUDSON, S. (1969) Mason Mountain rhodolite. *Rock & Gem* 15, 6, p. 24–28, 31, 69, map.

_____, (1980) A Carolina sojourn. *Lapidary J.* 34, 9, p. 1898, 1899, 1902–1904, illust. (col.), map.

KUNZ, G. F. (1907) History of the gems found in North Carolina. *NC Geol. Econ. Survey Bull.* 12, 60 p., illust. (col.).

LESURE, F. G., *et al* (1982) Mineral resources of the Craggy Mountain Wilderness study area and extension, Buncombe County, North Carolina. *U.S. Geol. Survey Bull.* 1515, 27 p., illust., maps.

MARTIN, B. F. (1970) A study of rhodolite garnet. *J. Gemm.* 12, 2, p. 298–36, illust. Inclusions in.

PAGE, R. H. (1961) North Carolina's "rhododendron" garnet. *Gems & Minerals* 280, p. 31–32.

SHAW, J. L. (1973) North Carolina gem mining: Cowee and Spruce Pine. *Lapidary J.* 27, 9, p. 1392–1399, *passim*, illust.

GEORGIA. The following localities have been described recently by Cook (1978). In Cherokee County, gem crystals of almandine of about 0.8 in (2 cm) were found between Canton and Ball Ground (Hurst, 1956). Gem quality almandine crystals were found loose in the soil in an area about 3 mi (4.8 km) southwest of Epworth in Fannin County; they reach a diameter of 1.5 in (3.8 cm). In Lumpkin County, gem garnet is reported from near Porter Springs and in a decomposed rock near Dahlonega. Fine, euhedral crystals of almandine, many of textbook perfection, some containing clear areas, are found loose in the soil on Garnet Hill and vicinity, about 3 mi (4.8 km) northwest of Hiram in Paulding County. The crystals may be as large as 4 in (10 cm) in diameter and are simple dodecahedrons weathered from chlorite and amphibole schists.

COOK, R. B. (1978) Minerals of Georgia: their properties and occurrence. *GA Geol. Water Resources Div. Bull.* 92, 189 p.

HURST, V. J. (1956) Mineralogical notes. *Georgia Mineral Newsletter* 9, 1, p. 19.

MONTANA. Hearn & McGee (1983) point out the usefulness of garnets as clues to the presence of kimberlite bodies which may also contain diamonds. "The most distinctive indicators are Mg- and Cr-rich purple garnets [mostly pyropes]." They also describe other color groups and evaluate them for their indicator usefulness. The kimberlite intrusive bodies in Montana occur in an area in the north-central part of the state in the Missouri River Breaks, centered at lat. 47°51'N, long. 108°42'W. The authors do not indicate the quality of the garnets they examined, but it is known that facet grade pyropes occur under similar circumstances elsewhere.

Small, rolled almandine garnet crystals of not more than 3/8 inch (4–6 mm) diameter occur in the gravels of the Ruby River in the Alder area of Madison County in southwest Montana (Spendlove, 1984). The stones, however, are only good for cabochons or beads.

HEARN, B. C. & McGEE, E. S. (1983) Garnets in Montana diatremes: a key to prospecting for kimberlites. *U.S. Geol. Survey Bull.* 1604, 33 p., map.

SPENDLOVE, E. (1984) Ruby Lake garnets. *Rock & Gem* 14, 8, p. 48–51, map.

WYOMING. Osterwald, *et al* (1966, p. 75) mention that "several hundred clear crystals [of garnet] from a deposit in about Sec. 11, T27N, R65W, have been cut, polished, and sold as gem stones," citing as authority the *Unpublished field notes for the Vaughn arsenopyrite claim, 1943.* Nothing further is known of either the locality or the kind of garnet found. Hausel (1993) notes the occurrence of pyrope and Cr-diopside in ant hills of the Green River Basin, but gives no exact locality. In view of the recent discoveries of kimberlites, some diamondiferous, in the southeast corner of Wyoming, gem pyropes may be found in the future (*see* DIAMOND).

HAUSEL, W. D. (1993) Metal and gemstone deposits of Wyoming. In SNOKE, A. W., *et al*, eds., Geology of Wyoming, *Geol Survey of WY Mem.* 5 (in press).

OSTERWALD, F. W., *et al* (1966) Mineral resources of Wyoming. *Geol. Survey WY Bull.* 50, rev. by W. H. Wilson, 287 p.

NEW MEXICO—UTAH—ARIZONA PYROPE REGION. On the basis of chemical compositions determined on numerous garnet grains from the Arizona-New Mexico Navajo Indian Reservation kimberlites, Switzer (1977) concludes that diamond probably would not be found in these bodies because the garnet compositions are unlike those of the garnets found as inclusions in diamond. According to R. S. DeMark, Marquette, Michigan (*Pers. comm.* 4/4/1994), small green faceted gems of andradite of less than one carat have been cut from material screened from a garnet-rich tactite in the Apache Hills, Hidalgo County, New Mexico.

ALLEN, J. E. & BALK, R. (1954) Mineral resources of Fort Defiance and Tohatchi quadrangles, Arizona and New Mexico. *NM Bur. Mines Bull.* 36, 192 p., maps.

BANION, E. L. (1965) Gems of the Navajo country, U.S.A. *Lapidary J.* 19, 1, p. 108–117, illust., maps.

GREGORY, H. E. (1916) Garnet deposits on the Navajo Reservation, Arizona and Utah. *Econ. Geol.* 11, p. 223–230.

______, (1917) Geology of the Navajo country. A reconnaissance of parts of Arizona, New Mexico, and Utah. *U.S. Geol. Survey Prof. Paper* 93, 161 p., illust, maps.

KIERSCH, G. A. (1955) *Mineral resources, Navajo-Hopi Indian reservations, Arizona-Utah.* Vol. II, Nonmetallic minerals. Tucson, AZ: Univ. AZ Press, 105 p., illust., maps. Garnet p. 90–95, maps.

KILDARE, M. (1970) Arizona rubies. *Desert Mag.* 33, 6, p. 8–11, illust.

MALDE, H. E. & THADEN, R. E. (1963) Serpentine at Garnet Ridge. *U.S. Geol. Survey Bull.* 1103, p. 54–61.

McGETCHIN, T. R. & SILVER, L. T. (1970) Compositional relations in minerals from kimberlites and related rocks in the Moses Rock dike, San Juan County, Utah. *Amer. Mineral.* 55, p. 1738–1771, illust.

O'HARA, M. J. & MERCY, E. L. P. (1966) Eclogite, peridotite and pyrope from the Navajo country, Arizona and New Mexico. *Amer. Mineral.* 51, p. 336–352, illust.

REAGAN, A. B. (1927) Garnets in Navajo country. *Amer. Mineral.* 12, p. 414–415.

REID, A. M., FRAZER, J. Z. & FUJITA, H. (1969) Garnet analysis. *Scripps Inst. Oceanography Reference* 69–21, 10 p. AZ pyropes included.

SWITZER, G. S. (1977) Composition of garnet xenocrysts from three kimberlite pipes in Arizona and New Mexico. *Smithson. Contrib. Earth Sciences* No. 19, p. 1–21, illust.

WOODS, B. (1952) We explored the valley of thundering water. *Desert Magazine* 15, 4, p. 4–8. Pyrope, AZ.

ARIZONA. White (1992) describes a locality on Ash Creek near Hayden, Pinal County, that is similar in most respects to the Topaz Mountain, Utah locality insofar as spessartine garnet is concerned. Here a light gray rhyolite contains cavities in which are found very dark red spessartine crystals, along with small topaz crystals, quartz, bixbyite and pseudobrookite. "The larger crystals [of spessartine] appear to be quite gemmy and are a deep orange-red, but too dark for gemstone use." These crystals range up to 1.3 in (3.4 cm) across. Despite the statement of White, this paragenesis suggests that facet-grade material may be found here in the future.

ROSS, C. P. (1925) Geology and ore deposits of the Aravaipa and Stanley mining districts, Graham County, Arizona. *U.S. Geol. Survey Bull.* 763, 120 p., illust., maps.

TAYLOR, F. (1952) Garnets aplenty at Stanley. *Desert Magazine* 15, 4, p. 10–11.

WHITE, J. S. (1992) An occurrence of bixbyite, spessartine, topaz and pseudobrookite from Ash Creek near Hayden, Arizona. *Min. Rec.* 23, 6, p. 487–492, illust.

IDAHO. Agee (1965) researched the history of the discovery and exploitation of the garnet deposits of the Emerald Creek area in Benewah County and found that in 1904, loggers in this area were known to have picked up garnet crystals but no one systematically collected them. Apparently the first attempt at commercial exploitation took place sometime in the 1930s when the Spokane Garnet Company was organized to mine the stones for abrasive purposes. In 1939, the Spokane Garnet Sand and Sales Company set up recovery machinery and commenced mining. During World War II, a great demand arose for garnet abrasives and the company produced about 3,000 tons per year of garnet. Agee notes that "by 1963, the annual production reached 10,000 tons a year," and still "it is estimated that there is enough garnet left that can be mined to produce 10,000 tons a year for twenty to thirty years."

In 1969, several privately-operated collecting areas along Emerald Creek passed to the control of the U.S. Forest Service upon being acquired by the U.S. government (*Gems & Minerals*, 1969). While such "acquired lands" are not open to mining, as is the case in most other U.S. forest lands in the West, fee-digging is to be allowed on a concession basis. Leases are to be sold to private parties who then operate under the regulations issued by the U.S. Forest Service; this area was called the St. Joe National Forest, later the Idaho Panhandle National Forest.

During the 1980s, the Emerald Creek Garnet Milling Company of Fernwood, Idaho, mined alluvial garnet using dragline equipment along Emerald Creek and Carpenter Creek (Smoak, 1985). Spendlove (1986) visited the area and reported that amateur diggers were allowed to collect 4 lb (1.8 kg) of garnet per day when digging in concession areas in Pee Wee Gulch and Shorty's Diggings, both on Emerald Creek. "Shorty" Sexton of Fernwood, proprietor of the diggings, sold garnet at $25 per lb. Forest Service officials stated that good quality 4-ray star material was valued at $15 to $25 per carat, and 6-ray stones at $35 to $50 per carat.

Mayerle (1988), citing a preliminary report on Idaho gemstone production, noted that since 1974, fee-digging areas along Emerald Creek have been operated by the Forest Service for

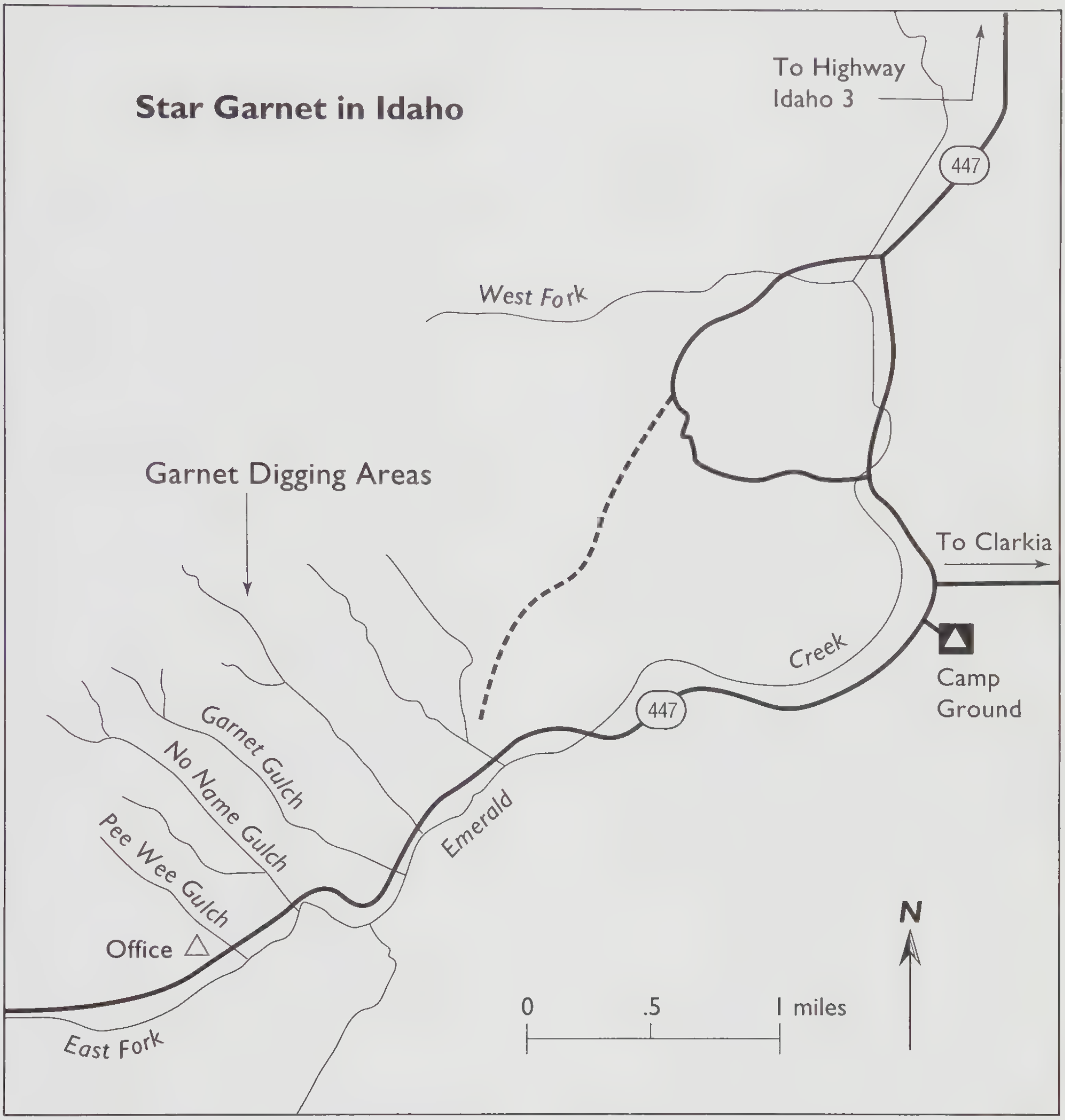

FIGURE 32. Star garnet collecting sites in the valley of Emerald Creek, Benewah County, Idaho.

about 100 days each year. In 1987 they issued 1,027 one-day permits that cost $5 each. "In addition, a private concessionaire sold 737 permits, at the same price, to sort through piles of oversize material (greater than 1/4 in) from industrial garnet mining operations on the East Fork [of Emerald Creek]." The concessionaire paid 7% of the $5 fee as a royalty to the Forest Service. "The rough garnet wholesales for $10/lb for facet-grade material to $450/lb for exceptional six-ray star material—the most prized variety; the average value for all material is about $30/lb," and, further, "faceted garnet sells for about $5 to $10 per carat, and cabochon-cut star garnets sell for about $15 per carat to as much as $100 per carat for flawless material with very distinct six-ray stars." It is estimated that about 100,000 lb (45,350 kg) of garnet have been mined, valued at about $3 millions, and "substantial reserves remain." In 1989 the U.S. Bureau of Mines listed Shorty's Dig, Idaho Panhandle National Forest, Garnet Queen Mine, and the Garnet Vein as operators of garnet mines.

Gem garnet is also found along the Little North Fork and North Fork of the Clearwater River, including around Dworshak Reservoir. Mayerle (1988) notes that some of the garnet is designated as "special pink," surely a euphemism, for very pale hues as implied by use of this term are unknown among the garnets of this area. Nevertheless, he reports that the Garnet Queen Mine, in 1987, recovered 200 lb (91 kg) of excellent facet material valued at about $13,500 or $68/lb. A round brilliant gem of this garnet, which appears brownish-red in a color photograph, is described by Koivula (1986); it is classified as almandine-spessartine and weighs 11.06 cts. Shannon (1926) apparently knew of this garnet because he says "red garnet, mainly of the purplish shade indicative of a notable content of spessartite, occurs commonly in the heavy residues from gravel worked for gold, in various localities in Clearwater County." He gives many examples of specimens from this county and notes that the refractive index is generally 1.807 to 1.818. However, Shannon does not give any localities in Benewah County.

In Shoshone County, Ream (1989) mentions garnet crystals, "probably almandine," over 2.5 cm (1 in) across that are found along Glover Creek near a bridge over the creek above its confluence with Homestead Creek. A few of these crystals have been cut into "poor quality star stones."

AGEE, L. M. (1969) Asterism in garnets. *Lapidary J.* 19, 8, p. 910–916, illust., map.

AUSTIN, G. T. (1991) Gem stone production in Arizona, Colorado, Idaho, Montana, North Carolina, Oregon, Maine, Utah, Nevada and Tennessee. *U.S. Bur. Mines Mineral Industry Surveys,* Annual Advance Summ., 35 p., maps.

BECKWITH, T. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: Caxton Printers, 129 p., illust., maps.

BROUGHTON, P. L. (1974) Digging for star garnets at Idaho's Emerald Creek. *Rockhound* 3, p. 8–10, 12–18, maps.

DAKE, H. C. (1962) *Northwest Gem Trails.* 3rd edit. Mentone, CA: Gem Books, 95 p., map.

DUNN, P. J. (1975) Inclusions in gem almandine from Idaho and New York, *J. Gemm.* 14, 6, p. 273–280, illust.

GEMS & MINERALS (1960) A field trip guide, Garnet Gulch, Emerald Creek, Idaho. No. 276, p. 46, map.

______, (1969) National Forest Service announces new arrangements for garnet collecting at Emerald Creek, Idaho. No. 382, p. 11-12.

KOIVULA, J. I., ed. (1986) New source of gem garnets from Idaho. Gem News. *Gems & Gemology* 22, 3, p. 187.

LAME, C. C. (1953) *Star Garnet and Opal from Idaho, the Gem State, etc.* Lewiston, ID: Commercial Print., 16 p., map.

LUCHTMANN, R. W. (1966) Collecting Idaho's star garnet. *Gems & Minerals* 346, p. 14–17, map.

LUVAAS, M. J. (1979) Garnet hunting in Idaho. *Lapidary J.* 33, 6, p. 1440–1443, illust.

MAYERLE, R. T. (1988) *Memorandum* to Gordon T. Austin, Commodity Specialist (Gemstones), U.S. Bur. Mines, Oct. 14, 1988, with enclosure on Idaho gemstone production.

McMACKIN, C. E. (1977) We seek the stars—the garnets of Emerald Creek. *Lapidary J.* 31, 7, p. 1525–1528, illust., map.

REAM, L. R. (1989) *Idaho Minerals.* Coeur d'Alene, ID: L. R. Ream Publ., 329 p., illust.

______, (1992) *The Gem and Mineral Collector's Guide to Idaho.* Coeur d'Alene, ID: Vol. I. L. R. Ream Publ., 34 p., illust., maps.

SELBERT, P. (1991) Red gold fever. *Lapidary J.* 43, 1, p. 75–80, *passim,* illust. (col.).

SHANNON, E. V. (1926) The minerals of Idaho. *U.S. National Museum Bull.* 131, 483 p., illust.

SMOAK, J. F. (1985) Garnet. Mineral Facts and Problems, 1985 edition. *U.S. Bur. Mines Bull.* 675, offprint, 8 p.

SPENDLOVE, E. (1986) Emerald Creek today. *Gems & Minerals* 542, p. 6–8, 30, 31, illust., map.

STEWART, D. (1966) Orienting Idaho star garnet. *Gems & Minerals* 351, p. 28–29, illust.

TRAPP, F. (1967) A true story about an Idaho garnet at the Smithsonian. *Lapidary J.* 20, 10, p. 1238, illust.

VIKEN, B. & SUTTON, R. (1990) The star garnets of Emerald Creek. *Rock & Gem* 20, 11, p. 18–20, 22–24, map.

NEVADA. Since the report by Pabst (1938) on the fine, euhedral spessartine crystals that occur in cavities in the rhyolite atop Garnet Hill, west of Ely, White Pine County, other visitors have reported their collecting experiences e.g., Weight (1950), Endres (1971), Marquis (1973), Hollabaugh & Purcell (1987), and most recently Mitchell (1991). Because of the large area of outcropping garnet-bearing rhyolite, the deposit is unlikely to be exhausted, but increasingly hard work will be necessary to excavate fresh rock to expose cavities. The most informative account of the occurrence is to be found in Hollabaugh & Purcell (1987). While some of the crystals have been faceted, the spessartine is so dark (indeed, at first glance, the crystals appear black) that only gems of a carat or two can return enough reflection to show color. The average diameter of the crystals is only about 1/8 in (4 mm), but some have been found as large as 1.5 in (35 mm), such as a specimen I had in my collection for many years.

In the late 1980s, a remarkable iridescent andradite garnet was found in the Mexican state of Sonora (*see below*) but apparently an even earlier occurrence of a similar garnet in Nevada was described by Ingerson & Barksdale in 1943, and is here summarized for its possible elucidation of the occurrence in Sonora. The Nevada andradite garnet crystals, "rarely over two centimeters in diameter, more often under half a centimeter," were found in a "lime-rich layer in the contact zone of a granodiorite stock" located about 8 air miles (13 km) south-southeast of Golconda, and 4 mi (6.3 km) east of Adelaide in Humboldt County. The garnet's specific gravity ranges between 3.50 (light honey-color) and 3.64 (dark brown). The colored iridescence was believed due to reflection and interference phenomena related to the fine twin lamellae. No mention was made of the suitability of this garnet for gem purposes.

ENDRES, M. H. (1971) Garnet country. *Gems & Minerals* 407, p. 26–27, map.

HOLLABAUGH, C. L. & PURCELL, V. L. (1987) Garnet Hill, White Pine County, Nevada. *Min. Rec.* 18, 3, p. 195–198, illust., map.

INGERSON, E. & BARKSDALE, J. D. (1943) Iridescent garnet from the Adelaide mining district, Nevada. *Amer. Mineral.* 28, p. 303–312, illust. (col.), map.

MARQUISS, K. (1973) Garnets for grabs. *Desert Mag.* 36, 3, p. 12–14, 36–37, illust.

MITCHELL, J. R. (1991) *Gem Trails of Nevada.* Baldwin Park, CA: Gem Guides Book Co., 119 p., illust., maps.

PABST, A. (1938) Garnets from vesicles in rhyolite near Ely, Nevada. *Amer. Mineral.* 23, 2, p. 101–103.

WEIGHT, H. O. (1950) In the garnet fields of Ely. *Desert Mag.* 13, 3, p. 15–20, illust., map.

WASHINGTON. Almandine garnets, some of which can be cut into 4-ray star stones, and similar to those found in Idaho, are reported from within gneiss and in debris derived from its weathering on Sloan Creek, Snohomish County, by Ream (1985). The crystals are dark purplish-red and occur as trapezohedrons and dodecahedrons, with some reaching 4 in (10 cm) diameter. Ream reports that "as in the Idaho star garnets most of the star producing 'silk' is concentrated near the center of the crystals."

Ream *(Ibid.)* also describes gem quality massive grossular that is very fine-grained, white, or white with greenish markings, and "it is semi-translucent and cuts and polishes very well." This material is found in Deer Creek north of Oso in Skagit and Snohomish counties, and in the gravels of Brooks Creek. Nephrite jade is said to accompany the garnet pebbles. This massive garnet may be the same that was examined in the Gemological Institute of America, Santa Monica, California, and described by Johnson (1994). The material is stated to occur in the northern part of the state, without a specific locality given. X-ray work confirmed that the fine-granular rock is composed of diopside, grossular, idocrase (vesuvianite) and clinochlore. The miners of the rock claim that they core-drilled an *in situ* occurrence and established that a layer of this material exists that is as much as 35 feet (10.6 m) thick and that blocks of about 110 lbs (50 kg) have been cut from the rock at their quarry. Also in Snohomish County, Bart Cannon found gem quality grossular crystals as reported by Koivula & Kammerling (1988). The locality is not likely to be overrun by collectors because it is located in a small opencut above the perpetual snow line near the summit of Vesper Peak, altitude 6,190 ft (1,885 m), about 33 mi (53 km) due east of Everett. The deposit is in skarn, and the small, bright orange crystals, of considerable perfection of face and form, occur on a matrix of greenish diopside. Some small slabs with such crystals have been set in jewelry as pendants. The faceted gems are small, probably less than a carat for the most part, but appear to be the only facetable garnet found thus far in Washington. This locality is also given in Cannon (1975, p. 99).

CANNON, B. (1975) *Minerals of Washington.* Mercer Island, WA: Cordilleran, 184 p., illust., map.

JOHNSON, M. L. (1994) Grossular-diopside rock. Gem trade lab notes. *Gems & Gemology* 30, 3, p. 186, illust. (col.).

KOIVULA, T. I. & KAMMERLING. R. C. (1988) Washington State garnets. Gem news. *Gems & Gemology* 24, 3, p. 177.

REAM, L. R. (1985) *Gems and Minerals of Washington.* Renton, WA: Jackson Mountain Press, 217 p., illust., maps.

MONTANA. Facet grade almandine garnet has been collected in gravels in the vicinity of the Ruby Reservoir and dam near Virginia City, Madison County (Feldman, 1985, p. 103–105).

FELDMAN, R. (1985) *The Rockhound's Guide to Montana.* Helena, MT: Falcon Press, 154 p., illust., maps.

OREGON. No new developments.

DAKE, H. C. (1934) Oregon "jade." *Oregon Mineralogist* 2, p. 5.

______, (1938) The gem minerals of Oregon. *OR State Dept. Geol. & Min. Industries Bull.* 7, 16 p., illust.

______, (1962) *Northwest Gem Trails.* 3rd edit. Mentone, CA: Gem Books, 95 p., illust., maps.

CALIFORNIA. A new gem garnet occurrence is reported by Butler (1993) in Riverside County, in rodingite rock found at a place about 2.5 mi (4 km) northeast of Augustine Pass, the latter reached via the Bradshaw Trail Road from Ford Lake off-ramp on Interstate Highway 10. The garnet is a colorless grossular which is found as dodecahedral crystals, some having mauve-pink or chocolate brown centers, and others of cinnamon color. The crystals range from a fraction of an inch to about 3/4 in (3–15 mm). The cavities within the rodingite are said to be "palm size," and according to Butler, "a few of our grossular crystals were large enough to be worked by faceting equipment and would have made lovely finished gems." Other rodingite veins were seen in the area, and it is possible that further finds of gem grossular will be made through intensive prospecting.

In San Benito County, waterworn pebbles of green and yellowish-brown andradite were found in a streambed (locality not specified) prior to 1952 by William Culver (Payne, 1981). Additional finds were made in 1952 and 1978, and a company calling itself Greenfire Mining was organized by partners P. Maddox, W. Culver, R. Quackenbush, and S. Bouch to exploit the alluvial deposits. The garnet apparently is derived from the weathering of serpentine bodies in which the garnet may have grown originally. The rough yielded faceted gems, not always free of flaws, and of small size, generally less than one carat. Cabochons were cut of about three carats. The colors of the garnet range from emerald-green to orange-brown, and in a few crystals a cat's-eye type cabochon can be cut from the brownish material.

The splendid, bright orange-red spessartine crystals found in various granitic pegmatites in the Little Three Mine area, east of Ramona in San Diego County, continue to appear for owner-miner Louis B. Spaulding, Jr. His production is mostly sold as rough along with sales of specimen topaz, tourmaline, quartz, etc., which all taken together enable him to continue mining. In recent months (1993–1994), some fine large roughs have been found, several reaching about 70 carats, virtually flawless, and of shapes conducive to maximum recovery of finished weight. The rough is remarkably uniform in color, not only within each crystal but also from crystal to crystal and pocket to pocket. There is little doubt that this is the finest spessartine currently available from any source. Spaulding sells his fully cuttable rough at $8 per carat for smalls which can produce faceted gems to two carats, and $10 per carat for roughs that are about 15 to 20 carats in weight. For rough that is estimated to cut flawless gems of 15 or more carats, $25 per carat is charged. Some of the largest, clean cut gems may sell for from $1,500 to $2,000 per carat.

Foord & Kleck (1993) analyzed Ramona spessartine and found it to be the nearly pure end-member. Foord, *et al* (1991) estimate that this district produced about 70,000 carats of spessartine up to that date.

The occurrence of corroded spessartine crystals and formless fragments that represent remnants of broken and dissolved crystals indicate that a special set of circumstances attended the formation of spessartine in the Ramona pegmatites. In these bodies the lower portions consist of fine-grained, marble-like feldspar and quartz, along with very small black tourmaline crystals; this so-called "line rock" also contains numerous spessartine/almandine crystals of ball-like shape, invariably badly shattered and fully enclosed by the rock. Toward the lowest parts of the line rock, the garnet crystals tend to be small, only several millimeters in diameter, and of brownish-red hue due to the iron in their composition. However, as the crystals occur closer to the midline of the pegmatite, they become larger and more orangey in color, and many are seen to be about one centimeter across, but always badly fractured. At this point, no more spessartine occurs in the line rock; accordingly, no spessartine is found in the ordinary midline pockets. However, some pockets and irregular cavities do contain spessartine crystals and etched masses of the kind described above, and their presence can be explained as follows. After the initial formation of the pegmatite, the country rock surrounding it was fractured by earth movements which opened channels below that enabled hydrothermal solutions to arise and dissolve minerals along the way. According to field evidence in the Ramona district, such ascending solutions (1) dissolved quartz rods from graphic granite, leaving corresponding openings in the host feldspar crystals, (2) re-deposited the quartz in narrow openings as solid white or "bull" quartz and as crystals in openings, and also as overgrowths on broken graphic granite, (3) dissolved albite from early-formed perthite and deposited such albite as cleavelandite in pockets and other openings, (4) dissolved spessartine from fractured line rock and redeposited same in cavities; this is evident from the numerous garnet-crystal-shaped openings in such feldspar, and lastly, in the special associations for which the Ramona pegmatites are noted, spessartine grew as new crystals in cavities along with smoky quartz, schorl tourmaline crystals, and cleavelandite blades. Elsewhere, loose garnet grains and partly developed crystals of spessartine have been found associated with acicular to fibrous crystals of schorl, acicular crystals of epidote, and tabular crystals of axinite.

In another area of San Diego County, a little dark reddish-brown spessartine has been cut into faceted gems of one or two carats from material found in the Pack Rat and adjoining claims on the northwest flank of Tule Mountain, 8 mi (13 km) northwest of the town of Jacumba in the southeast corner of the county. Further details appear under BERYL and in Weber (1967).

ANDERSON, B. W. (1961) Spessartite garnets. *The Gemmologist* 30, p. 108–109. Absorption spectra of California specimens included.

BERKHOLZ, M. F. (1954) Garnet and epidote, a field trip. *Gems & Minerals* 200, p. 22–24, illust, map.

BUTLER, G. A. (1993) Chuckawalla crystal pockets. *Rock & Gem* 24, 2, p. 21–28, *passim*, illust.

FOORD, E. E., *et al* (1989) Mineralogy and paragenesis of the Little Three Mine pegmatites, Ramona district, San Diego County, California. *Min. Rec.* 20, 2, p. 101–127, illust., map.

FOORD, E. E. & KLECK, W. D. (1993) Garnets in the gem-bearing pegmatite dikes of San Diego County, California. *Min. Rec.* 24, 1, p. 66–67.

KRAFT, J. L. (1947) *Adventure in Jade.* NY: Henry Holt, 81 p., illust. (vol.). "Californite" p. 30–37.

KUNZ, G. F. (1903) Californite (vesuvianite): a new ornamental stone. *Amer. J. Sci.* 4th ser., 16, p. 397–398. Also massive garnet.

PABST, A. (1936) Vesuvianite from Georgetown, California. *Amer. Min.*, 21, p. 1–10. Also massive grossular.

PAYNE, T. (1981) The andradites of San Benito County, California. *Gems & Gemology* 17, 3, p. 157–160, illust.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps, p. 494 ff.

ROGERS, A. F. (1947) Garnet-idocrase rock, a pseudo-jade from Placer County, California. Abstract: *Geol. Soc. Amer. Bull.* 58, p. 1222.

SIMPSON, D. R. (1965) Geology of the central part of the Ramona pegmatite district, San Diego County, California. *CA Div, Mines & Geol. Spec. Rept.* 86, p. 3–23, illust., map.

SNYDER, D. (1962) Epidote and garnet in San Diego County. *Gems & Minerals* 292, p. 22–23, illust.

STERRETT, D. B. (1911) Gems and precious stones. Ch. in *USGS Min. Res. U.S.*, Part 2, p. 847–900. "Californite."

TILSHER, W. G. (1957) Garnets in the Inkopah Gorge. *Desert Mag.* 20, 6, p. 21–24, illust., map.

TISDALL, F. S. H. (1961) Spessartite garnet from California. *The Gemmologist* 30, p. 61–62. From San Diego County.

WEBER, F. H. (1963) Geology and mineral resources of San Diego County, California. *CA Div. Mines & Geol. County Rept.* 3, 309 p., illust., maps.

COAHUILA. In 1994, Graham Sutton, mineral dealer of Phoenix, Arizona, uncovered a remarkable crystallized grossular from the classic idocrase area of Lake Jaco in the Sierra Cruces Mountains. The new material is intensely colored orange-red, forming crude or only partly-developed crystals on matrix that sometimes reach 1.5 in (3.8 cm) in diameter, although most are far smaller. Small clean areas have been seen in some crystals which may yield faceted gems of only several millimeters across, but so far, as is known to Sutton, none have been cut (*Pers. comm.* 3/94).

SONORA. A very remarkable iridescent olive-greenish body color andradite garnet from this state captured interest because of displaying vividly-colored, narrow, parallel strips of contrasting hues, reminiscent of opal, upon certain layers within the garnet which are now known to be parallel to the planes of the dodecahedron. By careful cutting, it is possible to expose such layers, but as for fire agate, overcutting is easy and results in loss of color. In 1987, a cut stone, set in a ring, was examined by the Gemological Institute of America and identified as andradite garnet by X-ray method. At this time the source was said to be "a calcite mine located about 145 km northeast of Hermosillo, Sonora, Mexico" (Koivula, 1987). Robinson & King (1993) examined some of this material at the Tucson Show and stated that it came from the "Rainbow garnet mine (rumored to be near Hermosillo) in Sonora" and "the crystals are centimeter-sized green-brown dodecahedrons, somewhat resembling those from Stanley Butte, Arizona." Some cut stones were offered for sale by International Mineral Exchange of Costa Mesa, California (J. & G. Clark). McCarthy (1993) interviewed a lapidary who had cut the material and divulged his methods for processing the crystals, and noted that "the garnet's fire is usually contained in one thin layer, often only 1/32 of an inch thick." This cutter also mentioned the possible appearance of either a cat's-eye effect or star effect if the garnet crystal is ground to a dome shape, but he prefers to work the crystal on a relatively flat surface in order to expose the maximum color-strip effect.

Reporting on a visit to the locality, whose exact site is still unrevealed, McCarthy (1994) notes that mining was conducted by Neal Dwire and Terry Glockner who used power-drilling to blast away the skarn rock in which the garnets are found. According to Clark (1994), "the iridescent andradite crystals tend to have an outer layer of yellow green to light brown andradite over an inner core of dark brown andradite." The deposit is a metamorphic skarn in which the principal minerals are hematite, calcite, garnet and quartz, with minor amounts of magnetite and epidote, while the "multiple phantoms in some of the garnets suggests their mineralization occurred in several phases." Excellent color photographs of this garnet appear in both McCarthy articles.

In connection with the above, attention is invited to the article by Ingerson & Barksdale (1943) cited under NEVADA *above*; these authors presented essentially similar structural/optical features discovered by them in the Nevada andradite, but with much difference in chemical composition. In the latest development in the Sonora andradite occurrence, small crystals of clear andradite were found from which a brilliant faceted gem was cut of 0.89 carat of pale yellowish-green color (Koivula, *et al*, 1994). This is depicted in their article along with a thumb-size cluster of euhedral crystals of considerable translucency. According to Koivula, *et al*, "the color of these . . . andradites would classify them as the demantoid variety [and] . . . we concluded that the faceted stone was a very pure andradite, with no chromium and only a small trace of manganese." This composition differs greatly from that given for the Nevada andradite above. They also concluded that the color is due solely to the presence of iron. Nothing was said about the kind of inclusions present in the faceted gem, if any, especially the "horsetail" inclusions so typical of Russian demantoids.

CLARK, G. (1994) "Rainbow Garnet": the Mystery of Iridescent Andradite. Transl. of article from *Lapis*, Apr. 1994, p. 23–26. Priv. publ.

KOIVULA, J. I., ed. (1987) Gem news. *Gems & Gemology* 23, 3, p. 173–175, illust. (col.).

KOIVULA, J. I., *et al*, eds (1994) Demantoid garnet from Mexico. *Gems & Gemology* 30, 3, p. 194, illust. (col.).

McCARTHY, C. (1993) Rainbows. *Lapidary J.* 47, 5, p. 22–27, illust. (col.).

_____, (1994) Thrill on Rainbow Hill. *Ibid.* 48, 2, p. 28–33, illust. (col.).

ROBINSON, G. W. & KING, V. T. (1993) What's new in minerals? *Min. Rec.* 24, 5, p. 392.

MORELOS. The white to pink grossular garnets, typically in unmodified rhombic dodecahedra, from Xalostoc continue to be mined from time to time to keep the specimen market supplied. None of it now appears in any gem- or ornamental-stone application.

LANDERO, C. F. De (1890) La grosularita rosa de Xalostoc. *Soc. cient. "Antonio Alzate," mem. y rev.* 4, p. 243–356.

_____, (1891) On pink grossularite from Mexico. *Amer. J. Sci.* 41, p. 321–323.

_____, (1891) Mexican pink grossularite. *The Mineralogists' Monthly* 6, p. 73–75.

McCONNELL, D. (1933) Garnets from Sierra Tlayacac, Morelos, Mexico. *Amer. Mineral.* 18, p. 25–29.

GLASS, VOLCANIC ASH

A glass gem material has recently appeared on the market that is called "emerald obsidianite," suggesting that it is a kind of obsidian, when in reality it is manufactured by fusion of volcanic ash obtained from Mt. St. Helens, Washington. One advertisement states that "the beautiful gem-like stone is fused from rock gathered after the 1981 eruption of Mt. St. Helens" and "the pulverized rock is fused under exact laboratory conditions at temperatures of 2700°F. The trace elements of chromium, iron and copper create the rich, emerald color when fused in a reducing (oxygen-free) environment." In 1993, gems cut from this glass were being sold by the firm of Emerald Fox of Vashon, Washington. Nassau (1988) examined a green glass, presumably the same noted above, and found refractive index 1.508, specific gravity 2.448. He attempted to duplicate this material by fusing his own samples of Mt. St. Helens volcanic ash but made only an essentially black glass with R.I. 1.500–1.526, and S.G. 2.485.

NASSAU, K. (1988) Mt. Saint Helens ashes. *Lapidary J.* 42, 4, p. 41–42.

GOETHITE

MICHIGAN. Heinrich (1976) describes fibrous, mammillary goethite of dark brown to black color, sometimes attractively banded in yellow, that occurs in various iron mines in Marquette County. It can be cut into cabochons and small carvings.

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Bull.* 6, 225 p., illust. (col.).

GOLD IN QUARTZ,
see QUARTZ, CALIFORNIA

GRAHAMITE

WEST VIRGINIA. In a short paper on the gemstones of this state, Kirstein indicates that both cannel coal and grahamite have been used for jewelry purposes despite their softness. Grahamite is defined by him as "jet-black solid natural asphalt; a hydrocarbon resembling coal. It occurs as a vein up to five feet thick in sandstone and shale exposed by Macfarlan Creek, two miles northeast of Macfarlan, Ritchie County . . . Most of the vein was mined years ago."

KIRSTEIN, D. (1982) Gemstones of West Virginia. *WV Geol. Econ. Survey: Mountain State Geology Magazine*, p. 34–35, illust.

GRANITE AND GRANODIORITE

Ordinarily, these abundant rocks are too coarse-grained for cabochons and similar small objects, but some are very tightly-grained, as for example the unakites of the Appalachians, which are satisfactory even for small beads and cabochons. However, much granite and granodiorite is eminently suited for lamp bases, plinths, bookends, and the like, and with some inquiries to makers of monuments, the lapidary may find all the material he could possibly use, sometimes imported from distant sources but locally available.

Much granite is just sufficiently porous that it can accept aniline dyes which can be applied to tumbled stones and afterwards sealed in with molten wax. Thus a large commercial tumbling house utilizes a whitish granite from Georgia that is light enough in hue to show off well the color with which it is dyed.

GANNETT, H., ed. (1883) Report on the building stones of the United States for 1880. *Tenth Census*, 410 p., 58 plates (col.).

HULL, E. (1872) *A Treatise on the Building and Ornamental Stones of Great Britain and Foreign Countries.* London: Macmillan Co., 333 p., 4 plates. Includes North American stones.

MERRILL, G. P. (1885) Building and ornamental stones of the United States. *Popular Sci. Monthly* 27, p. 520–532.

______, (1889) The collection of building and ornamental stones in the U.S. National Museum: a handbook and catalogue. *Smithsonian Inst. Ann. Rept. 1886*, Part 2, p. 277–648, illust.

______, (1891) *Stones for Building and Decoration.* NY: John Wiley & Sons, 453 p., illust. 3rd edit. 1903, 551 p., illust.

______, (1904) *The Nonmetallic Minerals; Their Occurrence and Uses.* NY: John Wiley & Sons, 414 p., illust.

MERRILL, G. P., MOODEY, M. W. & WHERRY, E. T. (1922) Handbook and descriptive catalogue of the collections of gems and precious stones in the United States National Museum. *U.S. Nat. Mus. Bull.* 118, 225 p., illust. (col.).

VAN LANDINGHAM, S. L. (1959) The gem granites. *Gems & Minerals* 256, p. 24–29, 88, maps; 257, p. 21–27, maps.

WATSON, J. (1911) *British and Foreign Building Stones. A Descriptive Catalogue of the Specimens in Sedgwick Museum, Cambridge.* Cambridge, U.K.: University Press, 483 p.

______, (1916) *British and Foreign Marbles and Other Ornamental Stones. A Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge.* Cambridge, U.K.: University Press, 485 p.

CANADA. The most comprehensive treatment of Canadian building and ornamental stones appears in Parks (1912–1917) along with other separate works by the same author as shown below. Sabina (1974, Ontario, etc.) notes an attractive, polishable hornblende granite, locally called "four-color granite" because of its content of greenish feldspar, rose-colored feldspar, colorless quartz, and dark green hornblende, that is found on hills and ridges east of Laverlochere in extreme western Quebec, east of Cobalt (Ontario). Another handsome granodiorite described by Sabina (1974, Quebec), is composed of a white to slightly greenish feldspar, quartz of a bluish-mauve color, and dark green, almost black ferromagnesian minerals, which takes a good polish and is found on the dumps of the Perron, Beaufor (Cournor) mine, just west of

Pascalis, the latter community located 11 mi (17 km) northeast of Val d'Or.

PARKS, W. A. (1910) Preliminary report on the building and ornamental stones of Ontario, south of the Ottawa and French rivers. *Canada Dept. Mines, Mines Br. Summ. Rept.* 1910, p. 110–114.

______, (1912) The building and ornamental stones of the Maritime Provinces. *Canada Dept. Mines, Mines Br. Summ. Rept.* 1911, p. 84–86.

______, (1912–1917) Report on the building and ornamental stones of Canada. Vol. I–V, *Canada Dept. Mines, Mines Br.*, illust., maps.

SABINA, A. P. (1974) Rocks and minerals for the collector, Cobalt-Belleterre-Timmins; Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, 199 p., illust., maps.

______, (1974) Same; Kirkland Lake-Noranda-Val d'Or; Ontario and Quebec. *Geol. Survey Canada Paper* 73-30, 162 p., illust., maps.

NORTHWEST TERRITORIES. Bell (1992) reports a porphyritic granodiorite suitable for lapidary purposes that contains crystals of amazonite (2mm–2 cm). The locality is on the southeast shore of a lake about 5 km (3.2 mi) northeast of the east end of Portman Lake, lat. 60°10'N, long. 109°08'W.

BELL, R. (1992) Report of a compilation of lapidary sites. *Northwest Terr. Geol. Div. EGS* 1992–14, 157 p.

NEW ENGLAND. No new developments.

DALE, T. N. (1907) Granites of Maine. *U.S. Geol. Survey Bull.* 313, 202 p., illust., map.

______, (1908) The chief commercial granites of Massachusetts, New Hampshire and Rhode Island. *U.S. Geol. Survey Bull.* 354, 228 p., illust., maps.

DALE, T. N. (1909) The granites of Vermont. *U.S. Geol. Survey Bull.* 404, 138 p., illust., map.

DALE, T. N. & GREGORY, H. E. (1912) Granites of Connecticut. *U.S. Geol. Survey Bull.* 484, 137 p., illust., map.

DALE, T. N. (1922) The commercial granites of New England. *U.S. Geol. Survey Bull.* 738, 488 p., illust., maps.

NEW JERSEY. No new developments.

LEWIS, J. V. (1909) Building stones of New Jersey. *Geol. Survey NJ Ann. Rept. 1908*, p. 53–124, illust. (col.).

MARYLAND. No new developments.

MERRILL, G. P. (1898) The physical, chemical, and economic properties of building stone. In The building and decorative stones of Maryland, *MD Geol. Survey*, vol. 2, p. 47–123, illust.

VIRGINIA. No new developments.

WATSON, T. L. (1907) *Mineral Resources of Virginia.* The Virginia Jamestown Exposition Commission. Lynchburg, VA: J. P. Bell Co., 618 p., illust., maps.

NORTH CAROLINA. No new developments.

LEWIS, J. V. (1893) Notes on building and ornamental stone. *NC Geol. Survey, First Bienn. Rept. State Geologist, 1891-'92*, p. 57–107, illust.

PRATT, J. H. (1906) The building and ornamental stones of North Carolina; a review. *Elisha Mitchell Scient. Soc. J.* 22, p. 63–79.

WATSON, T. L. & LANEY, F. B. (1906) Building and ornamental stones of North Carolina. *NC Geol. Survey Bull.* 2, 283 p., illust., maps.

SOUTHEASTERN UNITED STATES. No new developments.

WATSON, T. L. (1910) Granites of the Southeastern Atlantic States. *U.S. Geol. Survey Bull.* 426, 282 p., illust., maps.

WISCONSIN. No new developments.

BUCKLEY, E. R. (1898) On the building and ornamental stones of Wisconsin. *WI Geol. Nat. Hist. Survey Bull. 4, Econ. Geol.* Ser. 2, 544 p., illust. (col.).

MINNESOTA. No new developments.

BOWLES, O. (1918) The structural and ornamental stones of Minnesota. *U.S. Geol. Survey Bull.* 663, 225 p., illust., maps.

SCHWARTZ, G. M. & THIEL, G. A. (1960) Guide to the minerals and rocks of Minnesota. Rev. 1960. *MN Geol. Survey*, 29 p.

THIEL, G. A. & DUTTON, C. E. (1935) The architectural, structural, and monumental stones of Minnesota. *MN Geol. Survey Bull.* 25, 160 p., illust. (col.).

WINCHELL, N. H. (1884) The geology of Minnesota. *Final Rept. Geol. Nat. Hist. Survey of Minn.* Vol. I. Building stones p. 142–204, illust. (col.).

MISSOURI. No new developments.

KELLER, W. D. (1945) The common rocks and minerals of Missouri. *Univ. MO Bull.* 46, 5, 78 p. Rev. edit.: Bull. 62, no. 27. *Missouri Handbook* No. 1, 78 p.

KEYES, C. R. (1896) Missouri building and ornamental stones. *Stone* 12, p. 432–436, 546–557; 13, p. 30–32.

OKLAHOMA. No new developments.

REDFIELD, J. S. (1927) Mineral resources in Oklahoma. *OK Geol. Survey Bull.* 42, 130 p.

TEXAS. No new developments.

BARNES, V. E., DAWSON, R. F. & PARKINSON, G. A. (1942) Building stones of Central Texas. *Univ. TX Publ.* No. 4246, 198 p.

GIRARD, R. M. (1964) Texas rocks and minerals; an amateur's guide. *TX Bur. Econ. Geol. Guidebook* 6, 109 p., illust., map.

NEVADA. No new developments.

REID, J. A. (1904) Preliminary report on the building stones of Nevada, etc. *Univ. NV Bull. Dept. Geol. Mining,* 1, 1, [63]p.

BRITISH COLUMBIA. No new developments.

DAWSON, G. M. (1889) *The mineral Wealth of British Columbia. With an annotated list of localities . . .* Geol. & Nat. Hist. Survey Canada, Montreal, 163 p.

LEAMING, S. (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, 138 p., illust., maps.

PARKS, W. A. (1917) Building and ornamental stones of British Columbia. *Canada Dept. Mines, Mines Br., Summ. Rept. 1916,* p. 59–60.

WASHINGTON. No new developments.

SHEDD, S. (1903) The building and ornamental stones of Washington. *WA State Geol. Survey Ann. Rept. 1902,* 2, p. 1–163, illust.

CALIFORNIA. No new developments.

AUBURY, L. E. (1906) The structural and industrial minerals of California. *CA State Mining Bur. Bull.* 38, 412 p., illust.

GRAPHIC GRANITE

Almost any district in North America in which granitic pegmatites occur can supply almost unlimited quantities of graphic granite, ranging from some very fine-patterned material to some that is so coarse it cannot be used for anything except larger ornamental objects such as book ends. The most striking graphic granite is that in which dark smoky quartz rods penetrate vivid green amazonite, but by far most kinds consist simply of pale tan to reddish feldspar plus the rods mentioned of smoky quartz or pale gray quartz. Inherently graphic granite is weak because of the perfect cleavages of the host feldspar and the further weakening caused by the quartz rods. For these reasons, only the finest-textured graphic granite is useful for cabochons, and even so, thin edges should be avoided to prevent chipping. Polishing is made difficult by the considerable hardness difference between feldspar, H 5, and quartz, H 8, which commonly results in an uneven finished surface because the feldspar polishes away at a faster rate than the quartz. Some kinds of graphic granite can be dyed.

An excellent description of graphic granite and many localities for same are to be found in Van Landingham (1963). Many others appear in Spence (1932) but for Canada mostly, while the structures in graphic granite are discussed in Smith & Brown (1988). Other references appear under FELDSPAR.

ADAMS, F. D. & BARLOW, A. E. (1910) Geology of the Haliburton and Bancroft areas, Province of Ontario. *Geol. Survey Canada Mem.* 6, 419 p., illust., maps.

BASTIN, E. S. (1910) Geology of the pegmatites and associated rocks of Maine. *U.S. Geol. Survey Bull.* 445, 132 p., illust., map.

DE SCHMID, H. S. (1916) Feldspar in Canada. *Canada Dept. Mines, Mines Br.* 125 p., illust., maps. Same as SPENCE (1932).

FIELD, D. S. M. (1951) The gem varieties of Canadian feldspars. *Canad. Mining J.* 72, 8, p. 73–74, illust.

HEWITT, D. F. (1954) Geology of the Brudenell-Raglan area. *Ont. Dept. Mines 62nd Ann. Rept.* 62, 5, 123 p., illust., maps.

KUNZ, G. F. (1905) Gems, jewelers' materials, and ornamental stones of California. *CA State Min. Bur. Bull.* 37, 171 p., illust. (col.).

SABINA, A. P. (1971) Rocks and minerals for the collector, Ottawa to North Bay, Ontario; Hull to Waltham, Quebec. *Geol. Survey Canada Paper* 70-50, 130 p., illust., maps.

______, (1983) *Same;* Kingston, Ontario to Lac St.-Jean, Quebec. *Geol. Survey Canada Misc. Rept.* 32, 130 p., illust., maps.

SABINA, A. P. (1987) Rocks and minerals for the collector, Hull-Maniwaki, Quebec; Ottawa-Peterborough, Ontario. *Geol. Survey Canada Misc. Rept.* 41, 141 p., illust., maps.

SATTERLEY, J. (1943) Mineral occurrences in Parry Sound District. *Ont. Dept. Mines 51st Ann. Rept.* 51, pt. 2, 86 p., lllust., maps.

______, (1943) Mineral occurrences in the Haliburton area. *Ont. Dept. Mines 52nd Ann. Rept.* 52, pt. 2, 106 p., illust., maps.

SMITH, J. V. & BROWN, W. L. (1988) *Feldspar Minerals.* Vol. I, crystal structures, physical, chemical and microtextural properties. 2nd edit. Berlin: Springer-Verlag, 828 p., illust.

SPENCE, H. S. (1916) Feldspar in Canada. *Canada Dept. Mines, Mines Br.* 401, 125 p., illust., maps.

______, (1932) Feldspar. *Canada Dept. Mines, Mines Br.* No. 731, 145 p., illust., maps. Rev. of No. 401.

THOMSON, J. E. (1943) Mineral occurrences in the North Hastings area. *Ont. Dept. Mines 52nd Ann. Rept.* 52, pt. 3, 80 p., illust., maps.

VAN LANDINGHAM, S. L. (1963) Graphic granite. *Gems & Minerals* 305, p. 24–27, 63, illust., maps.

GRUNERITE

WYOMING. A rock containing about 75% grunerite and about 20% garnet, according to Zeitner (1966), found near Douglas, Converse County, is remarkable for a silky chatoyancy from its component grains of red or gold color. It has been collected and sold by Eloxite Corporation of Wheatland, Wyoming. However, attention is drawn to AMPHIBOLE above, under which heading is included ORTHOAMPHIBOLE from Wyoming (Dietrich, *et al*, 1988), which material and the locality appear to be the same as the GRUNERITE herein recorded. Grunerite, incidentally, is also a member of the amphibole group.

ZEITNER, J. C. (1966) Grunerite and other gems from eastern Wyoming. *Lapidary J.* 20, 9, p. 1094–1102, *passim*, illust.

GYPSUM, ALABASTER

Because of its availability in large, flawless masses of very fine-grained material eminently suited for carvings and many types of ornamental objects, the alabaster variety continues to be quarried for artistic purposes. There are very many localities where it is obtainable throughout the continent, and only a few of the readily accessible sites will be noted below. Several general references follow.

COLE, L. H. (1930) The gypsum industry of Canada. *Canada Mines Br. Publ.* 714, 164 p., illust., map.

GRIMSLEY, G. P. & BAILEY, E. H. S. (1899) Special report on gypsum and gypsum cement plasters of the United States. *Kansas University Geol. Survey* 5, 183 p., illust., maps.

STONE, R. W., *et al* (1920) Gypsum deposits of the United States. *U.S. Geol. Survey Bull.* 697, 326 p., illust., maps.

WILDER, F. A. (1923) Gypsum: its occurrence, origin, technology, and uses, with special chapters devoted to gypsum in Iowa. *IA Geol. Survey* vol. 28, p. 47–537, illust.

NEWFOUNDLAND. Sabina (1976) records a very fine-grained white alabaster from the Flintkote Company's quarry at Flat Bay, St. George's Bay.

SABINA, A. P. (1976) Rocks and minerals for the collector, the Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, 199 p., illust., maps.

WYOMING. Sutherland (1990) remarks on alabaster suitable for carving that occurs in outcrops of the Goose Egg formation, Freezeout Hills, Secs. 1 & 12, T25N, R80W in Carbon County; similar material is found in the West ½, Sec. 29, T45N, R83W, Johnson County, and also, white, yellow, and red material from the Lower Chugwater formation along Little Pope Agie

Creek in Fremont County and in the Spearfish formation east and north of Newcastle.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectables in Wyoming. *Geol. Survey WY Open File Rept.* 90-9, 53 p., map.

TEXAS. Carving-grade alabaster is to be found in extensive gypsum outcrops along Highway 70 from Red River south to an area north of Turkey, and also along the Pease River between Turkey and Childress in Hall County (Mitchell, 1991).

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Rev. edit. Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps, p. 68,

SOUTH DAKOTA. Zeitner (1972) described the sculptures of artist Arthur La Croix of Rapid City, made from alabaster found in beds around the Black Hills, apparently in unlimited quantities, much of it entirely suitable for carving.

ZEITNER, J. C. (1972) Art and alabaster. *Lapidary J.* 25, 12, p. 1625–1633, illust. (col.).

UTAH. Sculpture-quality alabaster in various colors as pink, beige, light green, brown, and white, sometimes finely banded, is being produced by the Southwest Stone Company, Michael Dettamanti and Donald Wood, proprietors, of Kanab, and distributed to customers all over the United States and elsewhere. Large quantities and large sizes are available. Some of this material may be mined from the deposits along the western margin of the San Rafael swell as shown on the map in Lupton (1913). According to this reference, "the greater part of the deposits take the form of alabaster. The gypsum of the upper zone has a reddish tint and is not quite so pure as the lower deposits, which are white. The gypsum of both zones is so compact and firm that it can be readily carved." Lupton examined outcrops from a point about 12 mi (19 km) east of Castledale in Emery County, south-southwestward through the southern boundary of the county into adjacent Wayne County, then recurving eastward to terminate at Cainesville. Eight sites were examined altogether.

DETTAMANTI, M. (1994) *Pers. comm.*

LUPTON, C. T. (1913) Gypsum along the west flank of the San Rafael Swell, Utah. *U.S. Geol. Survey Bull.* 530, p. 221–231, map.

ARIZONA. The satin spar variety is reported by Anthony, *et al* (1977, p. 112) from the Mammoth Claim, 60 mi (95 km) southeast of Kingman, Mohave County. No details are supplied on its lapidary suitability.

ANTHONY, J. W., WILLIAMS, S. A. & BIDEAUX, R. A. (1977) *Mineralogy of Arizona.* Tucson, AZ: Univ. AZ Press, 255 p., illust., maps.

CALIFORNIA. Although little has been written about lapidary-quality gypsum in California, there must be enormous quantities of suitable material available, to judge from information in Aubury (1906) and Ver Planck (1957), especially the latter. Berkholz (1955) describes suitable carving grade gypsum from a deposit located about 3 mi (4.8 km) southeast of Ventucopa in Ventura County; it is found on the crest of a ridge and is of excellent quality, occurring in translucent, white, pale grayish, and salmon tints.

AUBURY, L. E. (1906) The structural and industrial materials of California. *CA State Min. Bur. Bull.* 38. Gypsum, p. 281–288, illust.

BERKHOLZ, M. F. (1955) Alabaster, gem for the carver. *Gems & Minerals* 218, p. 20–22, illust., map.

VER PLANCK, W. E. (1957) Gypsum. In Mineral commodities of California. *CA Div. Mines Bull.* 176, WRIGHT, L. A. ed., p. 231–240, many refs.

HAMBERGITE

CALIFORNIA. During their 1988–1990 mining campaign in the Himalaya Mine, Mesa Grande, San Diego County, Pala Properties International, of Fallbrook, found hambergite crystals with clear areas with some large enough to facet two gems of about one carat each, but not entirely clean (*Pers. comm.*, W. Larson, 12/21/93). One of the gems was sold for $200. The largest hambergite crystal from the Himalaya Mine is in the William Larson Collection, Fallbrook, and is a squarish, pointed prism, white in color, and approximately 5.5 cm (2.25 in) long and 1.8 cm (0.75 in) in cross-section.

Briefly, hambergite is a beryllium borate, formula Be_2BO_3 (OH,F), orthorhombic, with a hardness of 7, specific gravity of 2.36, and one good cleavage; its refractive index 1.55–1.63. It occurs only as colorless or white crystals (Pough, 1992). It has also been found in the Little Three Mine area of Ramona, San Diego County, but not in facet-grade material (Switzer, *et al*, 1965).

POUGH, F. H. (1992) Hambergite. Mineral Notes. *Lapidary J.* 46, 9, p. 14, 112, 114, illust. (in col). Himalaya hambergite crystals.

SWITZER, G., CLARKE, R. S., SINKANKAS, J. & WORTHING, H. W. (1965) Fluorine in hambergite. *Amer. Mineral.* 50, p. 85–95.

HAÜYNE

NEW YORK. The New York State Museum in Albany includes two "lapis lazuli" cabochons from Balmat, one 16 x 25 mm, and the other, from Edwards, 22 x 30 mm (Schimmrich & Campbell, 1990). Both may be haüyne, as discussed by Bates (1973) and in Vol. II. of the present treatise.

BATES, B. J. (1973) Haüynite: alias Adirondack lapis lazuli. *Lapidary J.* 26, p. 1777–1779.

LESSING, P. & GROUT, C. M. (1971) Haüynite from Edwards, New York. *Amer. Mineral.* 56, p. 1096–1100.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection Catalogue. *Open File Rept.* 8m106, 47 p.

HEMATITE

MICHIGAN. Iron ore deposits yield handsome bright red jaspers, often brecciated, and containing considerable hematite which polishes to a silvery metallic luster. Much material is available, and it all deserves more lapidary attention than it gets in view of its solidity, color, patterning, and general usefulness for larger objects such as bookends. Difficulties are experienced in polishing this material, however, because of the tendency of the hematite portions to undercut. The material is found throughout the Vulcan iron formation of the Menominee Range, Dickinson County, and similarly in the iron ore deposits of Marquette County.

Kidney ore suitable for lapidary work has been found in the Geneva-Davis Mine, Gogebic Range, Gogebic County (Heinrich, 1976).

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Bull.* 6, 222 p., illust. Hematite p. 133–134.

MINNESOTA. The best grade hematite for cabochons is to be found in the Grand Rapids Mine, Mesabi Range, Itasca County (Zeitner, 1988).

ZEITNER J. C. (1988) *Midwest Gem, Fossil and Mineral Trails: Great Lakes States*, etc. Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps, p. 17.

TEXAS. Mitchell (1991) reports massive hematite suitable for cabochons of small size from an area at Possum Kingdom Lake, located north of Brad, Palo Pinto County.

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps.

ARIZONA. Botryoidal hematite crusts, thick enough for cutting cabochons, occur at Bouse, Yuma County (Simpson & Simpson, 1984).

SIMPSON, B. W. & SIMPSON, H. M. (1984) *Gem Trails of Arizona: A Field Guide*, etc. Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps.

YUKON TERRITORY. According to Sabina (1964), the term "black diamond," or "Alaska black diamond," refers to a siliceous massive hematite found as pebbles in various stream beds in the Klondike and Mayo districts as in Hunker, Bonanza, Secret, Clear creeks, and in Dublin Gulch. The material takes a brilliant polish, and "rings, pendants, earrings and brooches made from the pebbles are widely sold in Canada, especially in the west and northwest."

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. I. Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps.

HEMIMORPHITE

CHIHUAHUA. Large, clear crystal blades of this species were previously reported from Santa Eulalia, Chihuahua, capable of being cut into colorless faceted gems of generally less than one carat (Pough, 1993). In 1990, a singular discovery furnished more clear, colorless crystals, but some were over 2.5 in (6–7 cm) and largely flawless at their terminations. Faceted gems of from 5 to 10 carats are expected to be cut from them; these would be by far the largest faceted hemimorphites in existence.

POUGH, F. H. (1993) Hemimorphite. Mineral notes. *Lapidary J.* 47, 2, p. 14, 112, 113, illust. (col.).

HEXAGONITE, *see* TREMOLITE

HODGKINSONITE

NEW JERSEY. With the permanent closure of the zinc mines in Franklin, Sussex County, no more hodgkinsonite is likely to be found except in those specimens that are already in the hands of collectors or in museums. In a recent article describing properties of a very small faceted gem of hodgkinsonite, Bank & Henn (1990) found the following properties: refractive indexes n_x 1.720, n_y 1.739, n_z 1.743, diff. 0.023; G 3.98. Other property determinations appear in Dunn & Bostwick (1982).

BANK, H. & HENN, U. (1990) Geschliffener, rosafarbener Hodgkinsonit aus Franklin Furnace, New Jersey, USA. *Zt. Dt. Gemm. Ges.* 39, p. 273–274.

DUNN, P. J. & BOSTWICK, R. C. (1982) Hodgkinsonite from Franklin and Sterling Hill, New Jersey: a review. *Min. Rec.* 13, 4, p. 229–232, illust.

PALACHE, C. & SCHALLER, W. T. (1913) Hodgkinsonite, a new mineral from Franklin, N.J. *Wash. Acad. Sci. J.* 3, p. 474–478.

_____, (1914) Hodgkinsonit, ein neueres Mineral von Franklin, N.J. *Zs. Kryst.* 53, p. 529–532, 675–676.

POUGH, F. H. (1993) Hodgkinsonite and howlite. Mineral notes. *Lapidary J.* 47, 5, p. 16, 118, 119.

SCHALLER, W. T. (1916) Mineralogical notes. Series 3. *U.S. Geol. Survey Bull.* 610, p. 159–160.

HORNBLENDE

BAFFIN ISLAND, NWT. Fine, clean reddish-brown faceted gems up to several carats have been cut from rough recently obtained as crystals in marble at a site about 9.5 mi (15 km) north-northwest of Lake Harbour in the southern end of Baffin Island. The locality is in the valley of the Soper River (Wight, 1986). Cut stones of 3.03, 3.00, 1.91 and 1.62 carats are now in the collections of the National Museum of Natural Sciences, Ottawa. Under SW UV, they glow a moderate yellow but are inert under LW UV. Properties are: refractive indexes alpha 1.625–1.627, beta 1.632–1.633, gamma 1.644–1.647; birefr. 0.020; biaxial (+); hardness 5.5.; specific gravity 3.09 ± 0.01. A strong pleochroism is characteristic: green/orange/brownish-orange.

WIGHT, W. (1986) Gem hornblende from Baffin Island, NWT, Canada. *J. Gemm.* 20, 2, p. 100–107, illust. (col.), maps.

HOWLITE

CALIFORNIA. Nodules of black-veined howlite from Tick Canyon, Los Angeles County, continue to be produced by various amateur digging parties, and the supply is not exhausted. It continues to be processed as tumbled stones which are then dyed various colors, turquoise-blue being a favorite (Shedenhelm, 1984). Howlite also makes its appearance at various shows as slabs painted with scenes or portraits that take advantage of the designs created naturally by the black veinings.

EAKLE, A. S. (1911) Neocolemanite, a variety of colemanite, and howlite from Lang, Los Angeles County, California. *Univ. CA Bull. Dept. Geol.* 6, 9, p. 179–189, illust.

JOHNSON, F. V. (1984) Howlite and other minerals from Tick Canyon. *Gems & Minerals* 558, p. 16–19, map.

MASIMER, G. E. (1966) Tick Canyon revisited. *Gems & Minerals* 347, p. 30–33, map.

MITCHELL, J. R. (1986) *Gem Trails of California.* Baldwin Park, CA: Gem Guides Book Co., 159 p., illust, maps, p. 81–82.

PEMBERTON, H. E. (1968) The minerals of the Sterling Borax Mine, Los Angeles County, California. *The Mineral Explorer* 3, 1, 11 p., illust.
POUGH, F. H. (1993) Hodgkinsonite and howlite. Mineral notes. *Lapidary J.* 47, 5, p. 16, 118, 119, illust.
ROBERTSON, D. (1974) Sure, they're still digging at Tick Canyon. *Rockhound* 3, 6, p. 18–21, map.
SHEDENHELM, W. R. C. (1984) Tick Canyon howlite. *Rock & Gem* 14, 3, p. 48–51, map.
VAN AMRINGE, E. V. (1939) The story of howlite. *The Mineralogist* 7, 2, p. 51, 64–65, illust.
WOOD, R. (1969) Tick Canyon, Spring 1969. *Lapidary J.* 23, 3, p. 430, 432, illust.

HURLBUTITE

NEW HAMPSHIRE. Bradshaw (1990) records a colorless faceted gem from the G. E. Smith Mine, Newport, Sullivan County. It weighs only 0.10 ct and is in the Smithsonian collection.

BRADSHAW, J. J. (1990) Gemstones of New Hampshire. *Rocks & Minerals* 65, 4, p. 300–305, illust. (col.).

HYPERSTHENE

CANADA. In October, 1993, the Kent Mines Co. of Southfield, Michigan, advertised that "this newly found material has a chatoyant black and silver sheen, with exotic Zebra striped patterns" and said that it is suitable for cabochons, carvings, etc. I have not seen this material and no exact locality is given.

HYPERSTHENE GABBRO,
see "BLACK GRANITE"

IDOCRASE, *see* VESUVIANITE

IVORY

In 1989, the Convention on International Trade in Endangered Species (CITES) resolved to ban the trade in elephant ivory, effective January 18, 1990, and to reconsider this ruling at subsequent meetings. As a result of the ban, trade in elephant ivory dropped sharply, stocks in existence quickly gained value, and all who manufactured articles from genuine elephant ivory hastened to employ substitutes or imitations. Among these are Avory, a "cultured" ivory substitute, publicized in 1979 (*Lapidary J.* 33, 7, p. 1652), and the tagua nut or bean, a kind of vegetable "ivory" that is very close to elephant ivory in color and texture; tagua nut has been extensively employed for carving small objects, such as Japanese netsuke, which are suitably stained to impart an appearance of antiquity (Millette, 1991). In an attempt to conserve other forms of natural ivory, the Jonathan Starr Company of Tucson, Arizona, impregnated various fossil ivories, including mastodon, mammoth, and the more recent walrus tusks, with plastics in much the same way that porous turquoise is being processed ("stabilized"). Presumably, hot, pressure impregnation is employed to insure penetration of the plastic throughout the masses of ivory (Rotstein, 1986).

Relatively large resources of fossil or buried ivory exist in the Subarctic and Arctic regions of the continent. Rasmussen (1962), for example, tells of his experiences in gravel gold mining in the Fairbanks area of Alaska, where he collected mastodon and mammoth ivory, and the so-called "fossil" walrus ivory of ancient Eskimo kitchen middens near Cape Newenham near Platinum on the Bering Sea. He writes that "frequently old bones and tusks were brought up with the gravel" but "most of the material was considered a nuisance and shunted off to the tailing or waste piles." He found most tusks to be fragmentary, but occasionally a complete one would be found that could weigh as much as 180 lbs (80 kg) and measure as much as 12 in (30 cm) in diameter at the butt. Rasmussen found that the stainings from the outside did not penetrate more than about 1/8 in (5 mm), with the interior remaining white. Walrus ivory is structured differently, as explained in much detail in the excellent article by Thimes (1985), but it is generally found in much sounder

FIGURE 33. A remarkably detailed carving in Alaska fossil walrus ivory fashioned by the skilled artisans of Indonesia. *Courtesy Artifactual Import, Aptos, California. Harold & Erica Van Pelt photo, copyrighted.*

condition than the large elephantine tusks. Rasmussen, in 1962, noted that "a single well colored tusk may bring $100.00 . . . average length of a walrus tusk is 26 inches and may run to 36 inches and 12 pounds in weight." Much detail on fossil ivory is to be found in Kunz (1916) although the work itself is rarely available in most libraries. Recent finds in Alaska are described by Roy (1986) and Wendt (1993).

A number of companies are catering to the increasing popularity of fossil ivory in jewelry and as wearable small ornaments, pins, etc. The pins and brooches carefully engraved with scenes in the very old technique of scrimshaw are especially popular, while small carvings of animals, hunters, etc., made by the natives, and reflecting a primitive charm, fetch very high prices because they are considered true works of unsophisticated art. A small quantity of modern walrus ivory is obtained through a carefully regulated program of allowed kills by Arctic natives. This material is snow-white as compared to the long-buried walrus tusks which assume pale to dark tan hues, and even dark browns, sometimes mottled and streaked.

Larry Cohen of Oso Famoso, of Ben Lomond, California, importers of ivories, notes that the largest quantity of fossil walrus ivory comes from St. Lawrence Island in the northern extremity of the Bering Sea just south of Bering Strait. This island is almost 100 miles (160 km) long and thus offers a great potential for further finds of the ivory from ancient kitchen middens. Cohen writes that "fossil walrus [ivory] is excavated by the Yupil Eskimos living in the 2 villages on the island. Gambell, being quite an old settlement, is pockmarked in many places by digging holes. Savoonga, a fairly recent settlement (around 1910 or so) is free of digging sites, and the natives of both villages dig primarily in very old ancestral sites scattered throughout the island and digging is all by hand, pick and shovel, year after year expanding the same holes in the summer months of thaw."

In 1988, Korite Minerals, Ltd., of Calgary, Alberta, best known for their exploitation of ammolite, formed a subsidiary called Millenia Designs to merchandise fossil ivory jewelry and ornaments. According to the president, Mr. Pierre Paré, they will create their pieces from "tons of mammoth tusks from Siberia" (*Pers. comm.* 6/93). While this material may come from Siberia, its utilization will encourage exploitation of similar material in Alaska and the North American Arctic in general. Weldon (1991) examined the ivory industry and provides a useful survey of the burgeoning market; he estimates that about 20,000 natives of the Far North depend on this industry in one way or another.

As a lapidary material, walrus ivory is predictable in hardness, texture, and toughness, thus making its shaping relatively simple. Very seldom must the tools be of steel, which metal is quite hard enough to easily abrade the ivory. Williams (1964) depicts the primitive but effective tools used by the natives for carving ivory, while other references below may be consulted for explanations of modern ivory carving techniques. Because of its uniform character, ivory is now a favorite carving material among the traditional, skilled carvers of the Island of Bali in Indonesia. They are now directing their skills toward creating and exporting fantastically detailed carvings, such as frogs whose entire surfaces are covered with small warts, each carefully and distinctly shaped so as to rise above the general skin level. In Alaska and Canada, the skill is of a far lower order, and there is little inclination to spend the many long hours that the Balinese are willing to invest in their carvings. While both cultures use the same material, it is at once apparent to which culture any carving belongs. The Arctic natives excel at creating small figures of animals and persons which capture the essence of the subject in an artlessly charming way. The inhabitants of St. Lawrence Island apparently do very little carving work of any kind, but sell the raw material they exhume for about $150 per pound for light-colored walrus ivory and $150 per pound for dark-colored tusks. Purchasers then send the material to Bali for carving. The intensive labor expended upon Balinese carvings is not without concurrent cost: at the Tucson Show in February 1994, a seller of such carvings displayed walrus tusks from

St. Lawrence Island material, 16 in (40 cm) tall, completely and elaborately carved, offered wholesale for $4,600 each!

Fossil mastodon and mammoth tusks are far more difficult to handle than the walrus ivory, tending to split and disintegrate as they dry after removal from the ground. Although the material is hard and splintery, it has the advantage of occurring in more colorful pieces because it absorbs natural stains, a blue stain being particularly prized. Cohen *(Ibid.)* notes that "when mammoth and mastodon tusks are viewed in their entirety they are not hard to differentiate: the mastodon tusk being generally longer, slimmer, more dramatically curved and with a thinner bark than the mammoth . . . but the grained material beneath the bark appears almost indistinguishable, one from the other, to my eyes. And while native Eskimos do excavate some of this material in certain coastal villages, far greater amounts are exposed by gold miners, mostly throughout the interior of Alaska (and Canada's Yukon) using powerful hydraulic equipment." Wendt (1993) particularly comments on such finds and shows pictures of recently found tusks. The "stabilization" of such material has already been mentioned (Rotstein, 1986).

BUDDHUE, J. D. (1936) Fossil ivory. *Rocks & Minerals* 11, 10, p. 207–210, fig.

DAWSON, G. M. (1894) Notes on the occurrence of mammoth remains in the Yukon district of Canada and in Alaska. *Geol. Soc. London, Quart. Journal* 50, p. 1–8.

HOWARD, M. A. (1979) White gold. *Lapidary J.* 33, 7, p. 1564–1571, illust.

KUNZ, G. F. (1916) *Ivory and the Elephant.* Garden City, NY: Doubleday, Page & Co., 527 p., illust.

LAPIDARY JOURNAL (1979) Scientific breakthrough Avory cultured ivory. Vol. 33, 7, p. 1652, illust.

LONG, F. W. (1964) Craftsmen of the Far North. *Lapidary J.* 18, 9, p. 1050–1055, illust. Part l (Part 2 on jade).

MANJE, D. (1989) Sensible scrimshaw. *Lapidary J.* 43, 5, p. 74–81, illust.

MENDENHALL, H. E. (1967) The rockhound and the Last Frontier. *Lapidary J.* 20, 10, p. 1252–1255, illust. Collecting experiences.

MILLETTE, L. (1991) An answer to ivory. *Lapidary J.* 44, 12, p. 49, illust. (col.). Tagua nut.

RASMUSSEN, C. (1962) Ivory hunting in Alaska. *Lapidary J.* 16, 1, p. 149.

ROTSTEIN, A. H. (1986) Fossil ivory: stable and usable. *Lapidary J.* 40, 2, p. 35–36, illust.

ROY, S., Ed. (1986) *Alaska—a Guidebook for Rockhounds.* Anchorage, AK: Chugach Gem and Mineral Society, [48] p., maps. Ivory sites.

THIMES, J. L. (1985) Ivory identification. *Lapidary J.* 38, 10, p. 1320–1327, illust.

WELDON, R. (1991) Fossil mammoth ivory: a new choice for jewelers. *Jewelers' Circular Keystone* 162, 8, p. 154–156.

WENDT, R. (1993) A bone to pick. *Lapidary J.* 47, 4, p. 51, 52, 54, 56, illust.

WILLIAMS, L. G. (1964) Eskimo ivory carvings. *Lapidary J.* 18, 3, p. 396–397, illust.

WILLIAMSON, G. C. (1938) *The Book of Ivory.* London: Frederick Muller, 247 p., illust. Includes mammoth ivory.

ZEITNER, J. C. (1989) Eskimo staples [ivory, stone, bone]. *Lapidary J.* 43, 5, p. 59–65, illust. (col.).

"IVORYITE," *see* MAGNESITE

JADE (NEPHRITE & JADEITE)

Nephrite from North American sources continues to be an important gemstone, but the large-scale mining of only a few decades ago is now much diminished, especially in British Columbia. Large stocks were built up of both Canadian and Alaskan material while production of top grade nephrite from Wyoming sources was very small as most of the easily collectible "float" boulders had long since disappeared. It may be some years before consumption of stockpiles calls for renewed prospecting and mining. The picture for jadeite is somewhat different, the only source of commercially useful jadeite being the Motagua River Valley in Guatemala. The beautiful jadeite objects treasured in Central American and Mexican museums and collections all came from sources which remain unknown. This may not be surprising, since so many people who find valu-

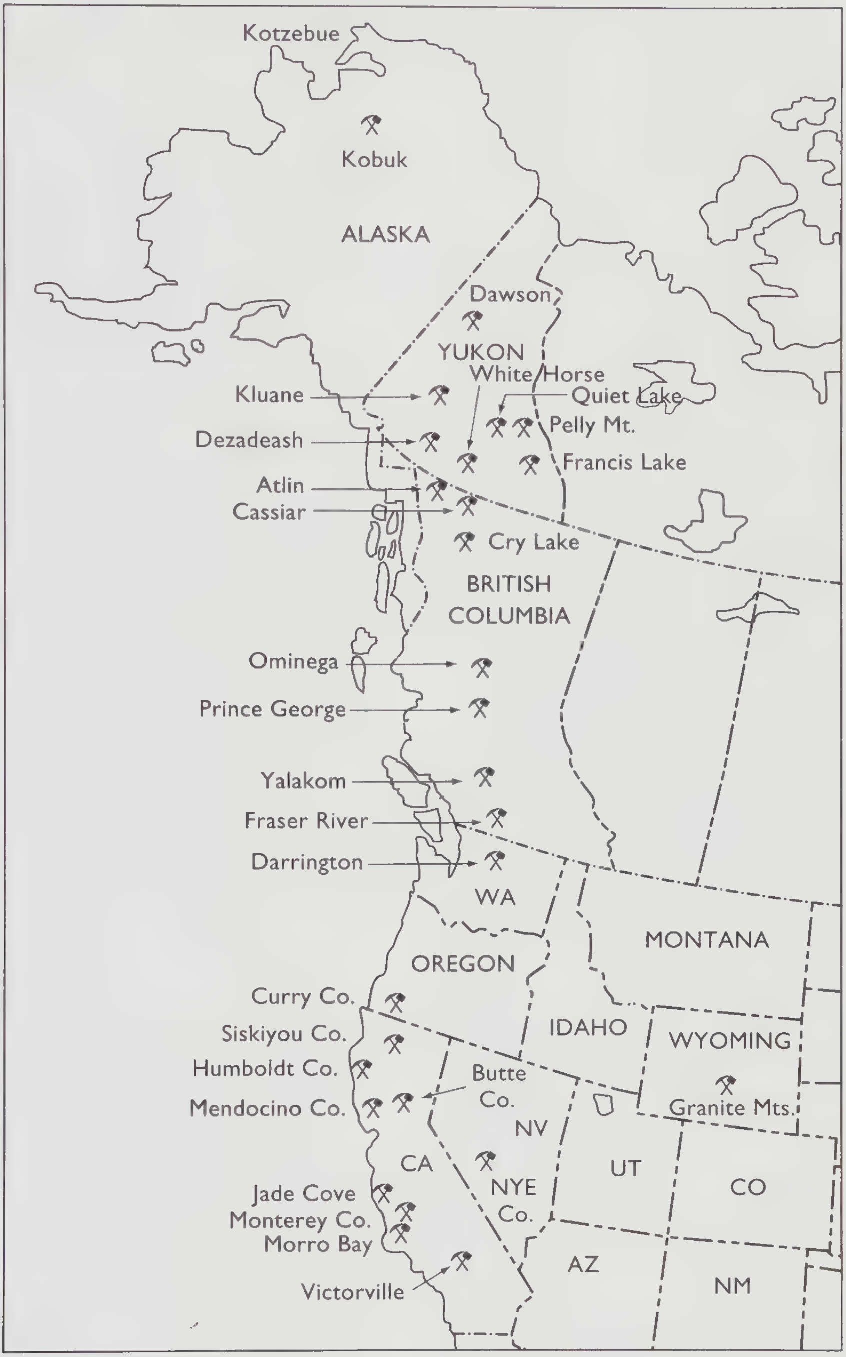

FIGURE 34. Occurrences of jade, mostly nephrite, from Alaska to California, associated with serpentinous rocks.

able gem deposits keep their precise locations secret or issue misleading clues to them, a practise which has made my own research difficult at times. Thus, human nature being constant, one can only assume that deposits of truly valuable jadeite in prehistoric Mexico and Central America were treated in the same way by their discoverers and exploiters. This is truly to be regretted, because specimens of jadeite artifacts that have been found can be as vivid green as the prized material from the jade deposits of Myanmar (Burma), while some of the material found in Costa Rica possesses delicate hues and a high degree of translucency.

In the past few decades, British Columbia has far surpassed all other sources of North American nephrite, including Alaska and Wyoming. While some excellent black nephrite is still produced from time to time in Wyoming, no good green material is being mined because of the high cost of the hard-rock mining necessary to follow veins of nephrite through the country rock. Production continues in British Columbia, but on a much reduced scale. In times past so much was produced that green nephrite was being sawn up and made into polished tiles for floor and wall coverings! According to Leaming (1991, p. 313), who provides a summary of the commercial production of jade in North America, about 4,000 metric tons valued at over C$16 million have been produced up to 1989 from British Columbia deposits, with the Omineca region being the chief producer. In 1988 alone, Omineca produced 247 metric tons while the Liard region produced 451 metric tons. However, these figures cannot be regarded as more than approximate, and it is known that considerably more jade was mined than was reported. For example, Leaming suggests that at least 200 metric tons must have been produced from the Hasselberg Lake area in the Yukon.

In Alaska, the still important and seemingly inexhaustible nephrite jade deposits in the Kobuk River Valley in the northwestern corner of the Alaskan mainland are quiescent. Rights to many of the deposits have been turned over to the native population who mine select nephrite boulders only as demand develops. Much raw jade is stockpiled in several towns and cities in Alaska and easily satisfies the needs of native carvers and other lapidaries, professional and amateur. Most such material is high quality, because only the best was selected at the sites in Kobuk for air shipment, the only feasible means of transport. As was true for British Columbia jade, the bulk of Alaskan material was shipped to lapidary shops in Taiwan, and more lately to China. Here, cheap labor, plus long-established expertise in carving hard stones, resulted in the production of thousands of trinkets made from the nephrite in addition to more ambitious artistic sculptures. Upon the suggestion of Pacific Northwest and Alaskan importers of such objects, the nephrite was often manufactured into highly finished carvings of bears, seals, wild fowl, and other naturalistic subjects which were then put up for sale in dozens of souvenir and curio shops in tourist villages, towns and cities up and down the coast. Because distinctions between nephrites are often extremely obscure, especially for those of North American origin, British Columbia nephrite could be worked up into carvings in Taiwan or China, then sold in Alaska as Kobuk River material! As Clarke & Merrill (1888, p. 15) remarked many years ago, "all of the Alaskan jades are true nephrites, indistinguishable in most particulars from the nephrites of Siberia, New Zealand, and the Swiss lake dwellings."

For a few hopeful years, earnest efforts were made to establish a school of jade carving in British Columbia to take advantage of the fine material that was being mined and of the talents of local artists. Leaming (1991, p. 314) describes these efforts and how they eventually withered away, as the financial rewards were too low for so much work expended on the carvings. A small number of nephrite pieces are carved by amateurs in the United States, but commercial carving is accomplished mostly in the Orient, some in Idar- Oberstein in Germany, and a little in modern Russia. In a shipboard visit to various ports in Alaska in the fall of 1993, I saw many fine carvings of animals in high quality nephrite, labeled "Alaskan Jade," but nothing was said about where they were carved; obviously they were Oriental work.

Among general treatises on North American jades, much of value will be found in Thomas Wilson's lengthy article that was published in 1900 but is difficult to obtain because of the rarity of the journal itself (Wilson, 1900). Much historical detail also appears in Ruff (1959, 1960–61), while Hardinge (1961) provides a most interesting review of certain misconceptions concerning jade, including those found in the Americas. Another recent work is that by Desautels (1986), which discusses North American jades, among others. For jade in Canada, one must consult Leaming (1978, 1991), while Wyoming jade is treated by MacFall (1980). Kraft (1947) describes United States jades and other jade-like stones. The jades of Meso-America are treated by Bishop, *et al* (1991), Digby (1972), Easby (1968), and Lange (1993).

BERGSTEN, L. J. (1964) Jade occurrences in North America. *Lapidary J.* 18, 1, p. 124–128.

BRADT, R. C., NEWNHAM, R. E. & BIGGERS, J. V. (1973) The toughness of jade. *Amer. Mineral.* 58, p. 727–732.

BISHOP, R. L., LANGE, F. W. & EASBY, E. K. (1991) Jade in Meso-America. In KEVERNE, R., ed., *Jade.* London: Anness Publ., p. 316–341, illust. (col.).

CLARKE, F. W. & MERRILL, G. P. (1888) On nephrite and jadeite. *Proc. U.S. Nat. Mus.* 11, p. 115–130, plate.

DENMAN, C. (1945) Jade—a comprehensive bibliography. *Amer. Oriental Soc. J.* 65, p. 117–126.

DESAUTELS, P. E. (1986) *The Jade Kingdom.* NY: Van Nostrand Reinhold, 118 p., illust. (col.).

DIGBY, A. (1972) *Maya Jades.* London: Brit. Mus., 32 p., illust. (col.).

EASBY, E. K. (1968) *Pre-Columbian Jade From Costa Rica.* NY: A. Emmerich, 103 p., illust. (col.), map.

FISCHER, L. H. (1880) *Nephrit und Jadeit.* 2nd edit. Stuttgart: Schweizerbart, 412 p., illust. (col.).

FISCHER. L. H. (1881) Ueber die mineralogisch-archäologischen Beziehungen zwischen Asien, Europa und Amerika. *N. Jb. Min.* 2, p. 199–227.

HALPERN, J. M. (1953) Arctic jade. *Rocks & Minerals* 28, 5–6, p. 237–242.

HANNEMAN, W. W. (1975) Toughness . . . hallmark of jade. *Gems & Minerals* 457, p. 27–28.

HARDINGE, C. (1961) *Jade: Fact and Fable with Lists of Reported Finds* . . . London: Luzac & Co., 67 p.

HEMRICH, G. I. (1966) *The Handbook of Jade.* Mentone, CA: Gem Books, 81 p., illust.

KRAFT, J. L. (1947) *Adventure in Jade.* NY: Henry Holt, 83 p., illust. (col.).

KUNZ, G. F. (1887) On jade and jadeite. *NY Acad. Sci. Trans.* 6, p. 139–141.

LANGE, F. W., Ed. (1993) *Precolumbian Jade.* Salt Lake City, UT: Univ. Utah Press, 378 p., illust. (col.), maps.

LEAMING, S. F. (1978) Jade in Canada. *Geol. Survey Canada Paper* 78-19, 59 p., illust., maps.

_____. (1991) Jade in North America. In KEVERNE, R., ed., *Jade.* London: Anness Publ., p. 296–315, illust. (col.).

MacFALL, R. P., Ed. (1980) *Wyoming Jade. A Pioneer Jade Hunter's Story.* San Diego, CA: Lapidary J., 56 p., illust., maps.

RONZIO, A. R. & SALMON, M. (1970) Trace elements in jade. *Gems & Minerals* 389, p. 24, 25, 45.

RUFF, E. (1959) Jade story—American. *J. Gemm.* 7, p. 18–31, 141–160, 236–246.

_____. (1960–1961) The Jade story: Jade in America. *Lapidary J.* in parts 1–8, October 1960 to December 1961, illust.

SCHIELTZ, N. C. & RONZIO, A. R. (1973) An X-ray diffraction study of jade. *Gems & Minerals* 431, p. 30–31.

SCHMIDT, S. (1975) The use of jade among the natives of North America. *Canad. Rockhound* 19, 2, p. 4–8; 5, p. 11–16.

WARD, F. (1987) Jade—stone of heaven. *Nat. Geogr.* 172, 3, p. 282–315, illust. (col.).

WILSON, T. (1900) Jade in America. *Congres Internat. Americanistes 1900, XII Session*, p. 141–187, 2 col. pls.

GREENLAND. Bøggild (1953) discusses reports of jade occurrences in several places but finally states that the identifications "cannot be regarded as certain, and thus it has not yet been proved that this rare and valuable mineral occurs in Greenland (p. 288)." Leaming (1991, p. 305) considers the geological likelihood of nephrite occurring in the places where it had been previously reported and notes that "a communication with the Greenland Geological Survey some years ago disclaimed any knowledge of jade deposits."

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Meddelelser om Grønland* Bd. 149, 3, 442 p., illust., map.

LEAMING, S. F. (1991) Jade in North America, etc. In R. KEVERNE, ed., *Jade*. London: Anness Publ., p. 297–315.

NORTHWEST TERRITORIES. An old report of nephrite boulders on Rae River, Coronation Gulf Region (Richardson, 1851) is still unconfirmed.

RICHARDSON, J. (1851) *Arctic Searching Expedition:* a Journal of a Boat-Voyage through Rupert's Land and the Arctic Sea, in search of . . . Sir. J. Franklin. London, 2 vol., illust.

NEWFOUNDLAND. Leaming (1991, p. 305) expresses surprise that nephrite "has not been widely found in eastern North America" in view of the fact that "the Appalachian Mountains are similar in many ways to the Cordilleran belt in that serpentine belts and contact rocks would seem to provide similar geological conditioning to those in the west. Asbestos, talc-carbonate and chlorite reaction zones have been commonly described but jade is rarely mentioned," and quite naturally, "the question arises as to whether or not it may have been bypassed in the search for other economic minerals in the serpentine belts." Based on a personal communication with R. Stevens in 1985, Leaming notes a "reliable" account of nephrite in Milan Arm near the north tip of Newfoundland, and the occurrence of similar rocks in Noddy Bay nearby; "there are references to nephrite from this locality." F. J. Warren (no date), does not mention nephrite as a provincial gemstone. In Labrador, Leaming notes that "prospecting in the serpentine belts along the Labrador coast in 1984 failed to reveal any nephrite sources."

LEAMING, S. F. (1991). *See above*.

WARREN, F. J. (ca 1985) *Gemstones of Newfoundland and Labrador*. St. John's: NF Dept. Tourism, [7] p., map.

EASTERN CANADA. Leaming (1978) briefly discusses possible jade sources in Quebec and Ontario where serpentine bodies may eventually yield masses of nephrite. He discounts the report of Greenlee (1962) on the finding of smooth boulders of nephrite along the north shore of Lake Huron near Kettle Point, Ontario, because a complete petrographic study of the material has not been made. However, "the possibility of finding nephrite occurrences among the many serpentinite bodies in eastern Canada should not be discounted before a complete search has taken place." Further, he notes that "nephrite is not as rare as commonly believed, but deposits may be small and easily overlooked."

GREENLEE, J. (1962) Hunting for jade in Michigan. *Lapidary J.* 16, 1, p. 78–81, illust.

LEAMING, S. F. (1978) Jade in Canada. *Geological Survey of Canada Paper* 78-19, 59 p., illust., maps.

RHODE ISLAND. Bowen's "nephrite," called "bowenite" at the time (1822), was later shown to be serpentine, but in view of Leaming's comments above under NEWFOUNDLAND, perhaps more searching in this district could find nephrite.

BOWEN, G. T. (1822) Nephrite from Smithfield, R.I. *Amer. J. Sci.* 5, p. 39; with analysis p. 346–348.

NORTH CAROLINA. Zeitner (1981) reported "nephrite" as having been discovered by Mr. J. C. Dawes near Mt. Tirzah, Person County; the material was subsequently quarried and sold by the Dawes Jade Company for ornamental purposes. Leaming (1991, p. 305) notes that the reported specific gravity and refractive index tests were correct for nephrite but the "characteristic texture has not been proven." In their recent report on the minerals of North Carolina, Wilson & McKenzie (1978) do not mention this material, but perhaps they did not have the opportunity to examine it.

LEAMING, S. F. (1991). *See above*.

WILSON, W. F. & McKENZIE, B. J. (1978) Mineral collecting sites in North Carolina. *NC Geol. Survey Info. Circ.* 24, 120 p., illust., maps.

ZEITNER, J. C. (1981) North Carolina nephrite. *Lapidary J.* 35, 6, p. 1180–1192, *passim*, illust., map.

MICHIGAN. The "jade" reported by Greenlee (1962) is discounted by Leaming: *see* discussion under NEWFOUNDLAND.

WISCONSIN. The "nephrite" jade of Rib Creek area near Wausau, Marathon County, described by Wilson (1958) was further placed in the news by a story carried in 1972 by the *Marshfield News-Herald*, but nothing further has been published on this material, nor has any mention of it appeared in the gemstone market.

WILSON, G. (1958) Nephrite jade discovered in Wisconsin. *Lapidary J.* 12, 1, p. 76.

WYOMING. Historically, nephrite jade was first noted in 1936 in a discovery site in the Granite Mountains of south-central Wyoming. Several years later it was reported in *Rocks & Minerals* (1939), which article named the discoverers as W. L. Marion and L. B. Curtis, with the initial find made on May 15, 1936. A. Branham (1950–1966), B. A. Rhoads (1943), and others began collecting the jade, mainly as float boulders lying on the surface or partly imbedded in the soil. Numerous accounts of prospecting and recovery of jade were published in the period 1939 to 1964, with the last year notable for the appearance of Crippen's first professional description of the geology and mineralogy of several nephrite deposits. However, the first detailed study that explained the origin of in-place nephrite in the Wyoming occurrence was prepared by Sherer (1969) whose findings are embodied in a University of Wyoming doctoral dissertation that is not readily available to the public. In the next year, the very important deposits in the Granite Mountains region were described by Love (1970) in a large, detailed U.S. Geological Survey professional paper. Additional valuable information on these jade sources appears in Madsen (1979, 1983). Recently, Sutherland (1990) summarized knowledge of Wyoming gemstone resources, including jade, and provided specific locality information based on the township location system.

Almost all major jade occurrences lie within the areas shown in Figure 35, which embraces lode deposits in the Granite Mountains and elsewhere, as well as the much broader areas over which float nephrite has been found. The intriguing aspect of such float areas is that much nephrite must lie just below the surface but remain undetectable. As scoured as these areas are, jade is still being found; for example, Hausel (1986, p. 52) reported discovery of a 7-ton boulder of black jade found in the early 1970s at the southern end of the Wind River Range. In 1977, a 4,200 lb (1,900 kg) boulder was displayed in the lobby of the First National Bank Building in Denver, Colorado, presumably a recent find. For the benefit of seekers of jade float, Root (1977) offered these hints on how to detect nephrite upon the surface and how to distinguish it from ordinary, fine-grained rocks which it may resemble:

1. Nephrite, size for size, is usually heavier than other rocks as tested by "hefting" in the hands.
2. Nephrite cannot be scratched with the point of a steel pocket knife.
3. Exposed pebbles and boulders may be naturally polished to smooth, waxy surfaces; such pebbles are called "slicks."
4. Breaking off a chip of nephrite is difficult, but if done, the fracture surface should be carefully examined. If it is felty or fibrous it may be nephrite; if it sparkles (from grain cleavage reflections) it is not nephrite. A magnifying glass is helpful here.

However, as pointed out by Hausel (1986), "positive identification of nephrite almost always requires testing by X-ray diffraction. Rocks that are often mistaken for nephrite include fine-grained quartzite, serpentinite, epidotite and even metadiabase." Many of these rocks occur in the same places as nephrite but are usually distinguishable by scratch test or by noting difficulty in fracturing them.

In regard to *in situ* deposits of nephrite, Sutherland (1990) notes that "only six active jade-mining permits" had been registered with the state authorities at the time of writing.

As to the origin of nephrite, Sherer *(Ibid.)* suggests that it was formed by the alteration of amphibolite, with water being necessary in a

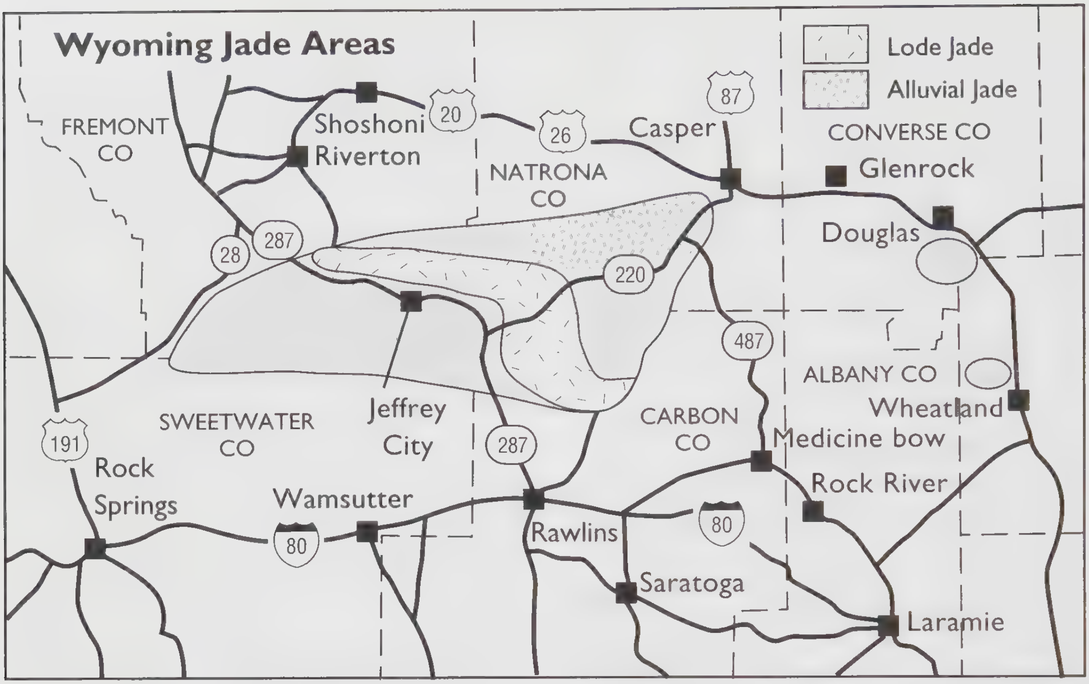

FIGURE 35. Generalized areas in which nephrite jade occurs. Modified from W. D. Hausel, *Geological Survey WY Bull.* 66, 1986.

process by which the rock-forming mineral hornblende is altered to prismatic actinolite, thence to the fibrous form which is characteristic of nephrite. The final reactions in this series of chemical events produce chlorite and talc, and lastly serpentine. The water needed in this process enabled the nephrite to form as veins, pods, and even as replacements of other minerals, including quartz crystals (Kohn, 1957). As noted before in Volume II of this work, such replacements appear as vein sections of completely solid greenish-gray nephrite showing distinct hexagonal outlines of former quartz crystals. Sherer suggests that the transitions described occurred in the range of temperatures 400°C–450°C and pressures of 4–5 kilobars. He does not believe that rock movements that create "shear stresses" played an important role in Wyoming nephrite formation.

Specific nephrite locality data appear in Sherer (1969), Love (1970), and Sutherland (1990). Spendlove (1994) describes recent collecting in the Jeffrey City region. Sherer advises prospectors seeking nephrite to look for amphibolite rock bodies, then those that are associated with quartz bodies or veins, pegmatites, and quartz diorite. If epidote-rich rocks are present they suggest that nephrite formation could have taken place. In Sherer's opinion, direct searches for such rock outcrops is likely to be more rewarding than trying to trace float back to an *in situ* source. Other useful advice on prospecting is given by Love (1970), who provides a table of occurrences of jade and notes that the most productive sources have been the boulders of jade found on the western side of Crooks Mountain in the Crooks Gap conglomerate and in the Wasatch and Battle Springs formations. "This locality yielded the largest tonnage and the largest individual boulders (some more than 3,000 pounds) of apple-green jade in the entire Granite Mountains area." Most of the prized apple-green variety has been found chiefly in Quaternary gravels in the northeast part of the Granite Mountains area between the Grieve Oil Field and a place at lat. 42°36.3'N, long. 107°04'W. "The original source [of the boulders] was probably in Precambrian rocks southeast of the Rattlesnake Hills." Dark green jade occurs in the Gas Hills and west of them, lat. 42°43', long. 107°45'W, in the Wind River formation and "deposited by north-flowing streams from a Precambrian source in the Granite Mountains." Dark green jade has also been found in Precambrian rocks and in the gravels derived from them on the north sides of the Ferris Mountains and Seminoe Mountains.

The many hues and inclusions in Wyoming nephrite led geologist Madson (1975) to classify them and their associated rocks into 23 grades correlated with then-prevailing price ranges. For example, the top grade, designated "Apple A" grade, was valued at $100 to $450 per pound, while the so-called "pink jade," a rock colored by thulite, was valued at only $.25 to $3.00 per pound. In a further contribution, Madson (1979) provides chemical analyses of Wyoming nephrites correlated to their colors, and found that among such color types as light sage-green, dark emerald green, pastel gray, dark olive, and black, the paler varieties contained less iron. The Wyoming nephrites examined by Madson are identified as tremolite amphiboles, and "nephrite from the Granite Mountains may be considered as near end members of the series tremolite-tschermakite and tremolite-pargasite as Na and Al content increases."

Virtually no Wyoming nephrite is currently advertised for sale, but considerable quantities are still available among dealers at gem and mineral shows. One dealer sells Edwards black jade from Wyoming, noting that "its reputation as the best black jade found in the U.S. speaks for itself," and offers rough in one-quarter to one-pound pieces in the price range 1/4-lb $30 to 1 lb $95.

BERGSTEN, L. J. (1964) Inclusions in jade. *Lapidary J.* 17, 11, p. 1076–1078, 1080; 12, p. 1196–1199, illust.

______, (1964) History of the Wyoming jade region. *Lapidary J.* 18, 6, p. 632–643, *passim*, illust.

BRANHAM, A. (1941) Jade found in Wyoming. *The Mineralogist* 9, p. 79–80.

______, (1946) A new discovery of jade that resembles Fraser River material. *Rocks & Minerals* 21, 12, p. 838.

______, (1947) The finding of a great gem stone. *Rocks & Minerals* 22, 5, p. 414–415.

______, (1950) Jade is where you find it. *The Mineralogist* 18, p. 233–235.

______, (1965-1966) The jade beyond. *Lapidary J.* 25 parts from 19, 2, p. 240–245, p. 612. Reprinted in MacFall & Branham (1980).

COBB, H. S. (1949) The Long Creek jade deposit. *The Mineralogist* 17, p. 44.

CRIPPEN, R. A. (1964) A geological visit to Wyoming jade areas. *Lapidary J.* 18, 6, p. 644–653, illust., map.

DAKE, H. C. (1942) Jade in Wyoming—new discoveries. *The Mineralogist* 10, p. 275–276.

ELOXITE CORPORATION (no date) *Wyoming Localities & Latest Collecting Information.* Wheatland, WY: [35] p., maps.

GREGORY, G. E. (1969) Jade hunting at Jeffrey City, Wyoming. *Lapidary J.* 22, 11, p. 1476, 1478, 1481, illust., map.

HAUSEL, W. D. (1986) Minerals and rocks of Wyoming. *Geol. Survey WY Bull.* 66, 117 p., illust. Jade, p. 51–52.

HEMRICH, G. I. (1975) The game warden's jade. *Gems & Minerals* 457, p. 8–14, 62, illust. A new locality at base of Wind River Mts.

HILL, R. (1979) Nephrite, jadeite—jade! *Gems & Minerals* 504, p. 61, 62, 67, 80, 81, map.

KEHOE, J. J. (1957) Wyoming jade—notes and news. *The Mineralogist* 25, p. 183–185.

KOHN, W. (1957) Quartz crystals in jade. *Gems & Minerals* 240, p. 22–24, illust.

LOVE, J. D. (1970) Cenozoic geology of the Granite Mountains area, central Wyoming. *U.S. Geol. Survey Prof. Paper* 495-C, 154 p., illust., maps.

MacFALL, R. P. (1976) Wyoming jade. *Lapidary J.* 30, 1, p. 182–194, map.

MacFALL, R. P. & BRANHAM, M. K. (1980) *Wyoming Jade: A Pioneer Jade Hunter's Story.* San Diego, CA: Lapidary Journal 56 p., illust., maps.

MADSON, M. E. (1975) *It Ain't Jade: The Wyoming Jade Story.* Riverton, WY: priv. publ., 40 p., illust.

______, (1979) Nephrite occurrences in the Granite Mountains region of Wyoming. *Lapidary J.* 33, 9, p. 2008–2013.

______, (1983) Wyoming jade. *Rocks & Minerals* 58, 2, p. 218–222, map.

MINERALOGIST, THE (1955) Jade found in 1936. Vol. 23, 4, p. 58.

OLES, F. (1970) A nephrite mother lode. *Gems & Minerals* 399, p. 30–31, 46. Eugene F. Clark black jade mine.

OSTERWALD, F. W., *et al* (1959) Mineral resources of Wyoming. Rev. 1966. *Geol. Survey WY Bull.* 50, 287 p., maps.

RHOADS, B. A. (1943) Hunting jade in Wyoming. *The Mineralogist* 11, p. 371–373, 382.

ROCKS & MINERALS (1939) Nephrite in Wyoming. Vol. 14, 7, p. 210–211. Initial discovery jade float Sweetwater River region.

ROOT, F. K. (1977) Minerals and rocks of Wyoming. *Geol. Survey WY Bull.* 56, 84 p.

SHEPPARD, K. R. (1972) Wyoming jade. *Lapidary J.* 25, 12, p. 1596–1608, *passim*, maps.

SHERER, R. L. (1969) Nephrite deposits of the Granite, the Seminoe, and the Laramie Mountains, Wyoming. *Ph.D. Dissert., Laramie WY:, Univ. WY,* 194 p., illust.

______, (1972) Geology of the Sage Creek nephrite deposit, Wyoming. *WY Univ. Contrib. Geol.* 11, 2, p. 83–86.

SPENDLOVE, E. (1982) Sagebrush, antelope and jade. *Gems & Minerals* 537, p. 10, 14, 26–28, map. Jade near Jeffrey City.

______, (1994) Jeffrey City jade. *Rock & Gem* 24, 4, p. 49–56, *passim*, illust.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geological collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., map. Jade p. 35–39.

WATSON, E. (1969) Thunder will reign, etc. *Lapidary J.* 23, 2, p. 374–375, illust. Donal Hord's sculpture in Wyoming nephrite.

YOUNG, M. W. (1972) You can still find jade in Wyoming. *Gems & Minerals* 420, p. 26–28, 39, map.

ALASKA. Clarke & Merrill (1888) were the earliest scientists to study the nephrites of Alaska, beginning by examining Eskimo artifacts collected throughout the mainland and four specimens of raw jade brought back by G. M. Stoney from his expedition up the Kobuk River to Jade Mountain. Stoney's account was published in 1899. Other early accounts of Alaskan jade are included in the references below, but a particularly lively and interesting history is furnished in *Alaska Geographic* (1981), where the adventures in jade mining by prospector Archie Ferguson are related. Ferguson stated that the first jade claim, as such, was staked by Hugo Echardt, a trader and Harry Brown, "who ran a store and post office at Kobuk"; these "claims fell to Tom Berryman, a Kotzebue trader." The claims were sporadically and mostly ineffectually worked up into the 1940s. However, among the more notable episodes during this period was the shipping out of a 728 lb boulder in 1947 by freelance writer George Van Hagen and his friend Harry Coleman of Chicago (Kemp, 1979). The large boulder of stream-worn nephrite was sawn up in Chicago by a monument maker, yielding, among other pieces, two 75 lb slabs of fine quality material. A 30 lb section was sent to Hong Kong where it was carved in the traditional Chinese manner by T. C. Chang into a matching pair of chained-lid vases, each standing about 9.5 in tall (Van Hagen, 1966). These vases were first exhibited in the Hong Kong Pavilion in the 1965 New York World's Fair, then in the Smithsonian, and finally they were sold to the Lizzadro Museum of Lapidary Art in Elmhurst, Illinois, in 1974. A short account of this episode, with pictures, and a splendid full-page color photograph of the vases, appears in Lytle (1982, p. 14–17).

Other parties producing jade from the Kobuk River Valley region are noted in the *Alaska Geographic* (1981), notably Ferguson, mentioned above, who introduced wire sawing in 1952. In 1954, the Bureau of Indian Affairs, working with the Alaska Rural Development Board, erected workshops to be run by natives in the village of Shungnak and planned another workshop in Noorvik for 1959, but "neither venture was long-lived." A large article is devoted to this attempt by Long (1965), who depicts the processes of turning rough jade into finished jewelry stones.

During the 1960s and 1970s much jade was produced and exported to China, among other markets. Gene Joiner, previously mentioned in

FIGURE 36. View along jade-rich Dahl Creek in northwestern mainland Alaska as of June 1987. *Courtesy Oro R. Stewart.*

Volume II, a local miner of jade at Kobuk, "became known as the Jade King of the Arctic until, in 1976, he sold his 22 claims to NANA, the Kobuk area regional corporation established in Alaska under the Federal Native Land Claims Settlement Act." The NANA Development Corporation then expanded Joiner's operation in the Jade Mountains and formed Jade Mountain Products, "building a small airport and a bunkhouse called Bigfoot Lodge at the mountain site and a $700,000 facility at Kotzebue to cut and polish large boulders." During this period, boulders were mined by a seven-man crew and sledded in winter to the Kobuk River for shipment to Kotzebue the following spring. According to Williams (1993), Jade Mountain Products manufactured finished jade pieces in Kotzebue, but "jade carving is done in Taiwan and returned to the United States for sale. NANA markets the finished jade products through both Jade Mountain Products (Kotzebue) and a crafts subsidiary called InuCraft in Anchorage." Williams notes also that the local Eskimos prefer to call themselves Inupiats, hence explaining the company name.

In the 1960s to 1980s, one of the most vigorous and sustained jade mining campaigns was conducted by Herbert Ivan Stewart and his wife, Oro Stewart, of Anchorage. Through the kindness of Mrs. Oro R. Stewart (*Pers. comm.* 1992), and the writings of W. O. Proctor (1977) and others, it is now possible to fill in more jade mining history in the Kobuk River region. In 1965, Stewart began setting up camp in the Dahl Creek area, just north of Kobuk village near the airstrip. This jade area is located in the southeastern portion of the

FIGURE 37. A bonanza of waterworn nephrite boulders uncovered close to the Stewart Jade Mine, Dahl Creek, Alaska. *Courtesy Oro R. Stewart.*

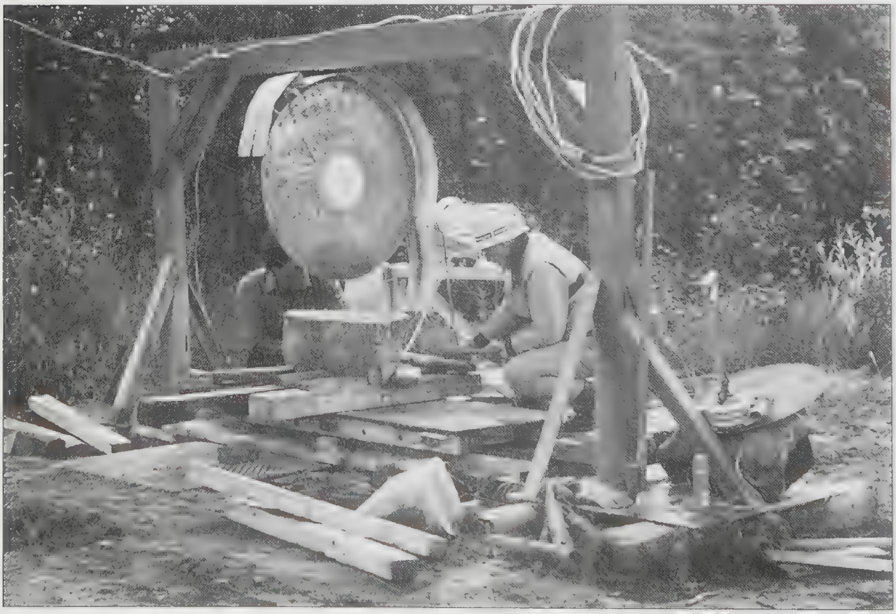

FIGURE 38. The 36-inch diamond saw installed at the Stewart Jade Mine, Dahl Creek, Alaska. *Courtesy Oro R. Stewart.*

FIGURE 39. A 10-foot reciprocating saw used to section very large nephrite boulders of Dahl Creek, Alaska. *Courtesy Oro R. Stewart.*

range of mountains that Anderson (1945, p. 12) calls the Cosmos Hills and sketches upon a map. The Cosmos Hills and the Jade Mountains located to the west-northwest of them are shown on U.S. Geological Survey Alaskan topographic maps *Ambler* and *Shungnak*, scale 1:250,000, and also upon the surficial geologic map of the Central Kobuk River Valley, scale 1:250,000, of Fernald (1964). Stewart's jade mining and processing operation included erection of cabins, workshops, and an electricity-generating plant, the building of roads, and the laying of a pipeline to provide water for jade sawing. Ultimately seven persons were kept at work during each summer season from about May 15 to September 1. Their efforts were supervised by Leslie Williamson, a jade carver from England (Koivula & Kammerling, 1988).

In late 1974 Stewart purchased the William Munz jade claims on Dahl Creek and Promise Creek, which claims and the work upon them were previously described by Munz (1970–1972). Stewart established two camps eventually, about one and one-half miles apart on Dahl Creek, and employed a bulldozer for general groundwork and for uncovering nephrite boulders in alluvia. Various reciprocating and circular saws were set up to section boulders so that only the most saleable material would be shipped out. Some of the saw blades were 36 inches (1 m) in diameter (Proctor 1977). From some of the largest boulders, slabs were cut that would later be finished as tabletops in Anchorage or sold "as is." Shipment was by the air service of the U.S. Postal Service.

The unfortunate and sudden demise of Stewart in 1986 left Mrs. Stewart to carry on the operation alone, which she did for three more years, but when she failed to obtain a patent upon the claimed land from the Bureau of Land Management, U.S. Department of the Interior, the claims were abandoned and "the natives now own the jade claims, and it is my understanding they are not operating them" *(Pers. comm. Ibid.)*. During the Stewart tenure, important quantities of nephrite were mined and processed; for example, 8,000 lbs were sent out in 1987, of which a considerable fraction went to Idar-Oberstein, Germany (Koivula & Kammerling, 1988). The alluvial jade masses ranged in size from mere pebbles to giant boulders as much as 25 tons (22,500 kg). However, many such boulders remain in the mine area because they are simply too large to do anything with. Currently, from her shop in Anchorage, Mrs Stewart sells nephrite in "bookend" quality, with beautiful colors but fissured, some with dendrites in black or red, for from $5 to $10 per pound. Chatoyant jade, a notable feature of Kobuk nephrite, consists of straight-parallel fiber veins penetrating nephrite, and capable of producing very good cat's-eyes in pale grayish/greenish tones. This material sells for $20 to $30 per pound, depending on the extent of chatoyant areas and the quality of the chatoyant portions. Carving nephrite, the best quality overall, is sold for $25 to $40 per pound, depending on color and freedom from defects. As mentioned earlier, in 1993 in Alaskan port towns and cities I saw Alaskan nephrite carvings that were obviously carved by exceptionally skilled artisans, probably in the Orient, with prices ranging from about $50 for a carving of 2 inches (5 cm) to several hundred dollars for pieces up to about 4 inches (10 cm) across, usually in animal forms.

Elsewhere in Alaska, Roy (1986) states that jade was reported from near the junction of Slana-Tok Highway with Mentasta Lake Road at a point about 230 mi (370 km) northeast of Anchorage. In an informational leaflet issued by Stewart's Jewel Jade Claims, jade is said to be found in the Wrangell Mountains, Haines, Afognak Island, Southeast Alaska, and the Mentasta Mountains, but no further details are supplied.

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YUKON TERRITORY. G. M. Dawson (1888) first mentioned jade in the Yukon as fine quality alluvial boulders picked up from the gravels of the Yukon River above its confluence with the Pelly River. The finest specimens were found in the Miles Canyon area. Nephrite-bearing gravels were also noted in the Lewes River region close to the Alaska border. A single nephrite pebble, found in the Sulphur Creek, Klondike area, southeast of Dawson, is in the celebrated Bishop Collection in the Metropolitan Museum of Art, New York.

The most important Yukon deposits are in the Camsell Range-Frances Lake area in the southeastern corner of the province. *In situ* nephrite was found by Earl Sowden in 1969 in serpentine outcrops in the mountains west of Mile 84 on the Campbell Highway. Kindle (1952) reported nephrite in the Klukshu Lake area, but Leaming (1978, p. 39) when he searched the places mentioned, could not find it. Several specific occurrences, however, are noted by Sabina (1973). Jade mining in the Yukon has been sporadic since 1970. In 1976, LEOX Jade took an option on a property (Leaming, *Ibid.*). In 1992, *The San Diego Union-Tribune* (July 18, p. A-21) reported that a United States prospector, Max Rosenquist, found a 577-ton nephrite mass on an unnamed 6,200-ft peak in the Pelly Mountains. Further details on other reported or possible finds in this province are given by Leaming *(Ibid.)*.

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BRITISH COLUMBIA. On April 6, 1969, jade was officially declared to be the mineral emblem of the Province of British Columbia. At nearly the same time, in January, 1968, the provincial government established a Crown Reserve for public jade hunting in the stretch of the Fraser River between Hope and Lillooet (Leaming, 1992). Also by 1992, thirty-seven deposits of jade had been identified, "of which nine have actually produced jade at some point in time," but "only . . . Ogden Mountain, is still producing." Since 1961, Leaming estimates that over 4.5 millions of kilograms of jade have been produced that are worth more than C$18 million. Provincial statistics show that in 1992 alone, 168,047 kilograms of nephrite were produced and valued at C$448,476 *(B.C. Minister of Mines Info. Circ. 1992–13).* These figures give an average value of C$2.80 per kilogram.

Both Leaming (1983) and Ward (1987) comment on the British Columbia jade industry during the 1980s, when most of the nephrite was exported to Taiwan in ton lots for carving and then re-exported as "Taiwan jade," the local supply in Taiwan being unable to satisfy the market by itself. A large variety of objects were carved from the B.C. nephrite, including beads, ring stones, pendant stones, small figures and animals, etc. Ward remarked on the practise of the Tai-

FIGURE 40. A diamond core-drill being used to test a talus block of nephrite on a mountainside in the Dease Lake area, British Columbia. *Courtesy S. F. Leaming, Summerland, B.C.*

wanese of importing low quality nephrite for less than $5 per kilogram. In the 1980s, the Mohawk Oil Company leased jade ground in the Kutcho Creek area (Cry Lake area), north central B.C., and from the nephrite produced they manufactured tiles offered at C$100 per square foot.

An interesting but unfortunately unsuccessful business venture involving B.C. jade was described by Leaming (1983): New World Jade Products, Ltd., was formed in the belief that "they could produce fine quality jade carvings which would turn $20 worth of raw jade into $400 carvings." While many fine carvings were turned out, excelling both in taste and technique, the enormous amount of labor required was not recompensed in sales. If the carvings were sold at a "reasonable" price, as far as the buying public was concerned, the actual pay for labor would be too small to attract anyone to this profession. In this regard I am reminded of a conversation that I had many years ago with Donal Hord, famed San Diego sculptor, who had kept track, with his assistant, of the hours they spent on carving the Wyoming nephrite statue "Thunder" which is now in the Museum of Man in San Diego's Balboa Park. When they finally sold the statue and computed their return, it was concluded that they had worked for something less than one dollar an hour!

The Atlin area is located in the northwest corner of the province just south of the Yukon border. Leaming (1973, p. 51–52) states that nephrite had been found near the town of Atlin, but in his later monograph on jade in Canada (1978) this area is not mentioned as a source of nephrite. It is suggested however, that an area around Atlin Lake and extending to the east-southeast of the lake might possibly be a future source.

The Cassiar district, called by Leaming (1978, p. 19) the Cassiar Segment of the nephrite-bearing belt of ultrabasic rocks that pass through the province in a NNW-ESE direction, or roughly parallel to the axis of the Rocky Mountains, is located in the north central portion of the province, just below the Yukon border. The principal production has been a byproduct of mining for asbestos in the huge opencut of the Cassiar Asbestos Mine. Other deposits in this district are the Dease Lake area south of Cassiar, and Cry Lake to the south and southeast of Cassiar. Mr. Kurt Makepeace of Polar Jade, South Surrey, B.C., (*Pers. comm.* 1/22/96) informs me that his company produced about 50 tons of selected grades of nephrite from a deposit in the Dease Lake area. The material was sawn on the spot and the better grade blocks shipped by surface transport to their headquarters. Some of the nephrite appears to be nearly as hard as quartz, according to Mr. Makepeace, and some contains areas of fine green color of remarkable uniformity and almost invisible texture. Gem grades sell for \$20.00/kg and carving grades for \$10.00/kg, FOB Vancouver. Numerous deposits of alluvial and *in situ* nephrite occur in the Cry Lake area in the Cache Group of rocks that extend from just south of Eaglehead Lake in a southeast direction to Provencher Lake, or over a distance of about 50 km (33 mi). The area includes such famous former sources as Wheaton Creek, Mt. Shea, King Mt., Letain Lake, etc., as shown on Leaming's sketch maps (1978, p. 32-33). Leaming describes many claims, prospects, and mines which were

FIGURE 41. Field camp of nephrite jade miners established to process jade for shipment, Kutcho Creek area, east of Dease Lake, British Columbia. *Courtesy S. F. Leaming.*

FIGURE 42. The late Harry Street pointing toward an exposed vein of nephrite jade near Noel Creek, Bridge River area, British Columbia. The vein is enclosed by cherty sedimentary rock at upper left and serpentine at lower right. *Courtesy S. F. Leaming.*

active during his visits. He also gives production figures. In general, the quality of nephrite is low in many of the deposits and in the large alluvial boulders which must be tested to determine if it is worth doing anything with them. In the center of the area is the Wheaton Creek group of deposits from which much material was obtained in the past. In a visit to this place Leaming (*Ibid.*, p. 32) noted considerable alluvial nephrite and cited one miner's estimate that 2 to 3 thousand tons of jade could be extracted from just one stretch of Wheaton Creek.

Southeast of Wheaton Creek, schistose nephrite occurs on King Mountain. In the extreme southeast part of the area there are many *in situ* showings of nephrite although most production up to 1976 had been from alluvial boulders.

Very large quantities of nephrite have been produced in the Mount Ogden-Fort St. James region, or, as Leaming (1978, p. 19), put it, the Omineca Segment, positioned approximately in the center of the province. In this stretch of the Omineca Mountains numerous ultramafic rock bodies have been found, and a number of nephrite deposits exist in a belt that extends in a north-south direction for about 115 mi (185 km). At the north end, nephrite was found in the southern end of the Axelgold Range in large alluvial boulders. From these boulders about one ton of high quality nephrite was taken, but an estimated reserve of 200 tons was left behind. Further along the belt, the jade workings on Mount Ogden were being operated by Jade West Resources Ltd., who produced a total of 168,047 kg (370,543 lb) of nephrite in 1992 valued at C$448,476, or about C$ 2.60/kg (*B.C. Ministry Energy, Mines, Petrol. Res., Info. Circ.* 1992–13). A news release in 1988 noted that Jade West had acquired the jade mine in 1986, and in one place "found, not a hundred feet from a mined-out area, a lens of jade, the quality of which had not been seen there for 10 years" (*Lapidary J.* 42, 3, 1988, p. 10).

Leaming's Lillooet Segment is in central south British Columbia, generally taking in the region from Yalakom south-southeast to Hope and close to the border with the United States. The Yalakom area is located about 125–150 mi (200–240 km) north-northeast of Vancouver, with the corners of this approximately rectangular area anchored on the Shulaps Range (N), Gold Bridge (SW), Lillooet (SE) and D'Arcy (S). Ultrabasic rocks containing inclusions of serpentine are especially abundant in the Shulaps Range, with smaller masses occurring elsewhere in the area. These relationships appear in the map of Leaming (1978, p. 2) and were briefly described by him in 1973. No less than eight *in situ* deposits are shown extending from just northwest of Lillooet (Anna Creek) to a deposit at the north end of the Shulaps Range, about 36 mi (57 km) northwest of Lillooet. About 9 mi (14 km) directly south of Gold Bridge is the Noel Creek deposit, while a tenth deposit is very close to D'Arcy at the western end of Anderson Lake. Alluvial boulders have been found in many streams in this area. Other deposits in this region were described previously in Volume II.

The Fraser River is now open to private collecting, as previously mentioned, and because of spring floods, the bar gravels are reworked each year to expose a new crop of jade pebbles. In the Lytton area, the Skihist *in situ* deposit lies within a group of ultrabasic rock outcrops in an area located about 15 air miles (24 km) southwest of Lytton. The nephrite is associated with a large body of vesuvianite (Leaming, 1978, p. 21). At least 45 tons of lapidary grade material has been mined.

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FIGURE 43. A two-foot thick vein of nephrite jade exposed in the Lillooet area of southern British Columbia. *Courtesy S. F. Leaming.*

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WILSON, T. (1900) Jade in America. *Proc. Congres Internat. Americanistes de 1900, Sess. 12, Wash., D.C.*, p. 141–187, illust.

YARMACK, W. (1964) Nephrite jade in B.C. *Lapidary J.* 18, 6, p. 696–699, map. Fraser River.

WASHINGTON. Most of the occurrences of nephrite in this state have been described in Volume II and only recent developments are noted here. Leaming (1991, p. 303) points out that the general geological features conducive to the formation of nephrite bodies in British Columbia extend southward across the border into Washington. The principal formation, the Chilliwack Group of Carboniferous and Permian rocks in British Columbia, consisting of graywacke, pelite, andesite and basalt, has its counterpart in Washington where it is called the Darrington schist. Ultramafic intrusions are serpentinized in part where they come in contact with the schist, and in the reaction zones nephrite has formed. Ream (1985, p. 54) notes that the most likely sources of nephrite are therefore along the ultramafic belt of peridotites and serpentinites that extend roughly north to south in the central and northern Cascade Mountains. He states that prospecting gravels and boulders in creek and river beds draining westward from the mountain flanks is most likely to be successful in the broad region north of U.S. Highway 2 to the Canadian border. This region takes in parts of Snohomish and Skagit counties, and possibly a part of Whatcom County. Northeast of Wenatchee, Chelan County, ultramafic rocks also outcrop, and in the Darrington, Snohomish County, vicinity, the Poor Boy Mine, located 8 mi (13 km) west of Darrington, operated by the Washington Gem Jade and Mining Company, yields angular to nodular masses of nephrite that generally weigh between two and twenty pounds, although some masses have been found that weigh as much as 200 lb (90 kg). Waterworn, partly polished nephrite pebbles, locally called "slicks," occur in various stream beds in the area. Farther west, nephrite pebbles also occur in Deer Creek, several miles north of Oso, a small town on the Stillaguamish River, Snohomish County. In the area from Darrington north into Skagit and Snohomish counties, other creeks yield nephrite; these include Day Creek, Finney Creek, Presentin, Mill, Jordan, and Boulder Creeks (Ream, 1985). Cannon (1975) reported green nephrite on Jumbo Mountain, southeast of Darrington.

Cultus Mountain, east of Mount Vernon, Skagit County, also contains nephrite deposits, but so far the only specimens found consist of pebbles from creeks that drain the slopes (Ream, 1985). Gannaway (1993), for example, describes collecting experiences in the gravel floor of Walker Valley, east of Mount Vernon. Ream also found the rare botryoidal form of nephrite at four places in a creek south of Darrington as well as on Cultus Mountain. Such masses seldom exceed three pounds in weight but one large mass measured about 36 inches (1 m) across.

In the Puget Sound region, Ream *(Ibid.)* notes that small nephrite pebbles have been found on Whidbey Island beaches and other islands in the sound west of Mount Vernon. Similar material occurs on beaches of Hood Canal south of Port Townsend. At the southern end of the mainland ultramafic belt of rocks, Ream reports that "at least one deposit of nephrite . . . [exists] at Mt. Stuart . . . located 20 miles [34 km] north of Cle Elum" in Chelan County.

CANNON, B. (1975) *Minerals of Washington.* Mercer Island, WA: Cordilleran, 184 p., illust. Jade p. 37.

GANNAWAY, W. (1993) Walker Valley revisited, Skagit County, Washington. *Mineral News,* Jan. 1993, p. 8–9, map.

GLOVER, S. L. (1949) Origin and occurrence of gemstones in Washington. *State of WA Div. Mines & Geol. Rept. Invest.* 16, 32 p., Discounts early reports of jade.

LEAMING, S. F. (1975) Miscellaneous Investigations. *Geol. Survey Canada Paper* 75-1, Part A, p. 589–591. Skagit County jade.

McLEOD, D. L. (1968) Nephrite jade has been discovered in Washington. *Lapidary J.* 22, 8, p. 1034, 1036, 1037, illust.

ROCKS & MINERALS (1939) Nephrite and jadeite in Washington. Vol. 14, 4, p. 112–116, illust., map.

REAM, L. R. (1974) Washington gem jade. *Lapidary J.* 28, 4, p. 708–711.

_____, (1975) Nephrite in Washington. *Lapidary J.* 29, 9, p. 1748–1757, illust.

_____, (1985) *Gems and Minerals of Washington.* Renton, WA: Jackson Mountain Press, 217 p., illust., maps.

VALENTINE, G. M. & HUNTTING, M. T. (1960) Inventory of Washington Minerals (2nd edit.). Part 1. Nonmetallic minerals. Vol. 1 Text, vol. 2 maps. *State of WA Div. Mines & Geol. Bull.* 37, 175 + 83 p. Gemstones p. 43–46. Discounts early reports of jade.

WASKEY, F. H. (1961) Washington State jade. *Rocks & Minerals* 36, 1, p. 30–31, illust.

ZODAC, P. (1939) Nephrite and jadeite in Washington. *Rocks & Minerals* 14, 4, p. 112–116, map.

OREGON. Leaming (1991), in his review of North American jade occurrences, states that "the first mention of jade in Oregon seems to be that by James Terry [1890] who reported obtaining a 'bowlder' of nephrite weighing 46¼ lb (21 kg) from Southern Oregon. It was found by a gold prospector in a small stream, presumably in the southwestern part of the state." Leaming notes that the rock types and formations in Oregon appear to be favorable for the genesis of jadeite, and states that "it seems safe to predict that both nephrite and jadeite will be found in Oregon as a result of more diligent searches in the appropriate places."

Gaskill (1978) reported a large deposit of white to mottled white and green jade, also green jade, and some "like the jade from British Columbia," quarried from a deposit in the Siskiyou National Forest near China Flats Campground, south of Powers, probably in Curry County. The operator of the quarry, James Wood of Arago, Oregon, discovered the deposit in January, 1976, and sent samples for identification to various laboratories who confirmed the material as nephrite, but, as stated by Gaskill, "it appears that the material there consists of both forms of jade." I have not been able to find more information on this material and note that the deposit is not mentioned by Mitchell (1989).

Elsewhere in the state, Estes (1985) reports discovery of nephrite on the Rogue River, southwest Oregon, about 40 miles (63 km) upstream from Gold Beach. Heflin (1977) mentions jade discovered on Sugar Loaf Mountain, Curry County, near the headwaters of of Pistol River in the Siskiyou National Forest and on the Pacific Ocean shoreline of Lone Ranch Park, 3 mi (4.8 km) north of Brookings, Curry County.

ESTES, W. (1985) The great Oregon jade find. *Rock & Gem* 15, 9, p. 64–65.

GASKILL, L. C. (1978) Oregon jade, *Rock & Gem*, 8, 2, p. 16–20.

HEFLIN, E. (1977) Lone Ranch jade. *Rock & Gem* 7, 5, p. 16–20, 88, 89, map.

LEAMING, S. (1991) Jade in North America. In *Jade*, R. Keverne, ed., London: Anness Publ., p. 303–304.

MITCHELL, J. R. (1989) *Gem Trails of Oregon*. Pico Rivera, CA: Gem Guides Book Co., 119 p., illust., maps.

TERRY, J. (1890) Nephrite boulder from Oregon. *Science* 5, 1890. Not seen; from Leaming (1991).

NEVADA. According to Austin (1991), "in 1989, production began of significant quantities of nephrite jade from a large deposit near Tonopah [Nye County]. The material varies in color from the different shades of green to black." The miners of the jade state that the jade quality ranges from "fine gem to carving grade," with pieces ranging in size from several inches (ca 10 cm) diameter to large boulders with small polished windows. It is said to be like "good-to-fine Wyoming jade." Alvin A. Youngquist of Bergsten Jade Company, Castro Valley, California, examined this material and cut and polished samples, declaring that the best color was the black, and that the jade generally "worked well and took a beautiful polish" (*Pers. comm.*, Youngquist, 12/14/1992).

AUSTIN, G. T. (1991) Nevada's gem value up—thanks to jade. *Colored Stone* 4, 1, p. 20–21.

ARIZONA. In 1982, the *Lapidary Journal* published an article announcing the discovery of black jade in Arizona by Albert Cline at an unspecified place in the northern part of the state (vol. 35, 10, 1982, p. 2102). The jade claims were later sold to Lee Hammons, President of Black Bear Corporation, who intended to market the material. At this time, "about 1½ tons of raw jade have been mined by hand from the area." Youngquist *(see above)* of the Bergsten Jade Company examined specimens of this material that were sent to his company in 1969 but found the material too soft to be nephrite, noting that "it readily scratches with the point of a pocket knife!" He adds that a black rock purporting to be jade, known as "Lash's jade," seems to be more like basalt than jade. Abraham Rosenzweig of Temple Terrace, Florida, with his wife, have intensively studied various North American jades, and informed me that a so-called "black jade" came from a deposit near Sahvaro Lake, northeast of Phoenix, but that when examined in petrographic thin-section it proved to be diabase in metapellite. Another sample of "Old black jade" from Arizona, provenance unknown, examined by him in 1993 was identified as very fine-grained actinolite forming radiate clusters along with interstitial magnetite and probably quartz (*Pers. comm.* 2/94). Robert Poley, Jr., of Prescott, sent me samples of ornamental stone he intends to mine and market, including a black rock which he calls "black jade" (*Pers. comm.* 3/29/1993). However, under the microscope, a fresh fracture surface of this material displays fine lath-like crystals showing very good, reflective cleavage planes, the color and other properties suggesting that it is a very fine-grained hornblendite. The surface clearly lacks the felted structure that is typical of nephrite. In this connection, Crowningshield, *et al* (1994) examined a necklace of polished spherical Arizona "black jadeite" beads, splendidly lustrous, but one bead that was detached and X-rayed showed that the mineral was ferrohornblende, an iron-rich member of the amphibole group, and not jadeite. A "spot" refractometer reading on a bead gave between 1.60 and 1.70, while a specific gravity determination gave a value of 3.36, dark values that could apply to true jadeite. At present, I can find no confirmation of either jadeite or nephrite in Arizona.

CROWNINGSHIELD, G. R., *et al* (1994) Iron-rich hornblende. Gem Trade Lab Notes. *Gems & Gemology* 30, 3, p. 186–187, illust. (col.).

CALIFORNIA. Among the mineral deposits in California to which access is threatened by overzealous and unyielding environmentalists, we can now add the boulders and pebbles of nephrite jade from the seacoast of Monterey County. In 1991, the Monterey Bay National Marine Sanctuary was established for the purpose of preserving a marine habitat rich in animal and vegetable life. However, without soliciting public comment from the very large number of recreational users of California beaches and ocean waters, including mineral and gemstone collectors, the sanctuary limits were extended far beyond the southern edge of Monterey Bay nearly to Morro Bay, a distance of almost 100 mi (160 km), or about three times the shoreline distance originally planned! According to the regulations by which this sanctuary is governed, access to the beaches and waters is virtually prohibited under all circumstances! How the picking up of beach pebbles from the Monterey coastline, or even from the waters, can seriously harm the wildlife has not been explained; apparently environmentalists and their political counterparts believe it better to maintain a completely "hands-off" policy—"look, but don't touch!"

Elsewhere in California, it is still possible to pick up jade without incurring the misplaced alarm of environmentalists. Pemberton (1983), citing a personal communication from R. C. Crippen in 1955, notes that jade from the Chan Jade Mine on Indian Creek, Siskiyou County, better known as the famous vesuvianite "California Jade" locality, contains small specks of native gold; a specimen is included in the California Division of Mines & Geology Collection. In Humboldt County, small nephrite pebbles sometimes of fine quality, are to be found in the Pacific Ocean shingle north of Eureka, and more specifically along the coastline of Patrick's Point–Big Lagoon–Dry Lagoon. Apparently the pebbles are eroding from a conglomerate that forms the shoreline cliffs. Their original source may be far inland!

Some additional details are available on nephrite and jadeite in Mendocino County. O'Brien (1953, p. 360–361) describes nephrite in veinlets and irregular pods in and on the margins of serpentine sills intruding Franciscan graywacke in the Leach Lake Mountain district. Specimens of pale to dark green nephrite were found in the gravels of Williams Creek and in the shallow pits of gold diggers. Several lode and placer claims were filed. This same occurrence was described by Chesterman (1952, p. 1323), and the area earlier called "Covelo"; some older references use that name. In a later contribution, Chesterman (1963) described the local rocks as interbedded graywackes, silt-stones, and cherts, with sills of diabase and serpentinite, plus flows of basalt, all included in the Franciscan formation of Upper Jurassic–Lower Cretaceous age. Pale greenish nephrite occurs in the contact zone between diabase and sepentinite. Diopsidic jadeite is present. The suitability of any of this material for lapidary purposes is not stated by Chesterman.

In Butte County, Hietanen (1973, p. 29) notes "small masses of fibrous tremolite (nephrite) . . . occur at the contact of serpentine and metasedimentary rocks on Mill Creek near Pulga." The suitability of this material for lapidary work is not mentioned.

One of the early, smoothly polished, boulder-sized specimens of nephrite recovered from the waters of Jade Cove, Monterey County, is in a vertical position amid a profusion of ceramic wares in the front yard of The Pottery Shack, a famous landmark in Laguna Beach, California. It is a much-admired attraction, and each year its polish grows in luster as visitors are encouraged to rub their fingers upon its surfaces. The Pottery Shack offers color postcards of this magnificent specimen. The boulder was found in 1958 and weighs 1,307 lbs (593 kg). Its color quality is excellent, comparable in places to fine Wyoming nephrite, and there are large areas that are relatively flawless nephrite.

In 1972, Al Tillman and Paul McCormack recovered a fine nephrite mass of 230 lbs (104 kg) at a depth of 40 ft (12 m) off Jade Cove, and later obtained a 500 lb (227 kg) specimen which was placed on display in the Los Angeles County Natural History Museum. The boulders were recovered by rolling them onto a rope net to which inflatable air bags had been attached, then blowing up the bags to float the specimens to the surface for towing toward shore. At this time (1972) the jades were valued at \$200–\$500 per pound, depending on quality, but in my experience with Monterey jades, I have never seen any that I would appraise at more than a fraction of these values. The continuing recovery of jade boulders from the Jade Cove area by Don Wobber, who published an exciting account of his experiences (1975), is noted by Ward (1987). According to Ward, Wobber stated that he had recovered about fifteen boulders of jade since 1973. However, as noted at the beginning of this California section, further recoveries of jade from this coastal area are now prohibited.

The occurrence of so much nephrite in the Jade Cove area, and elsewhere in the region, led to searches inland for possible *in situ* deposits. Several have been found, and in view of the extremely rugged terrain that makes prospecting very difficult, it is unlikely that all such deposits have been discovered.

Gem quality nephrite of a remarkable dark blue color has been found at an undisclosed place in southern Monterey County, according to Hemrich (1981). The mine is called the Hobbit Blue Jade Mine and is owned and operated by Gary Ozuna of Big Sur, later of Carmel, California (Ozūna, 1984). Tests on this jade gave the following property values: refractive index 1.61–1.63; specific gravity about 2.95; inclusions of gold, also black cubic crystals of magnetite or chromite. The jade is found adjacent to fibrous tremolite, "chalky" talc, smooth and fibrous serpentine, and green-blue granite. The jade also occurs in long flat lenses and as nodules, many with a whitish or grayish rind.

Hemrich (1983) described a chatoyant nephrite which seems to have been found as early as 1970 at a place inland from Jade Cove in rugged terrain. The mine is called the Black Fir Jade Mine and was located by William Nunn, who, with associates, worked the deposit up to 1983 and perhaps somewhat later. Hemrich provides a photograph of a boulder of nephrite at the mine which is "estimated to weigh close to a ton."

During their investigation of marine life along the jade-bearing coastal areas of Monterey County, Wilson & Kennedy (1992) found that the boring clam, a pholedid, in many instances bored for itself sac-like cavities, probably by chemical means, in nephrite cobbles. In some examples, the smooth-surfaced, enlarging recess that formerly protected the clam descended into the jade to a depth of one inch (2.5 cm)!

In San Luis Obispo County, beach pebbles of jadeite, one pound or more in weight, may be found in the shingle of Cayucos Beach, just north of Morro Bay. They apparently weather from the tidal terrace (*Lapidary J.* 33, 6, p. 1444). Pemberton (1983, p. 391) cites S. R. Van Valkenburgh as stating that "pods of jadeite up to several hundred pounds occur in the cliff on the beach at Cayucos."

In San Bernardino County, the black nephrite found near the summit of the Sidewinder Mountains, north-northeast of Victorville, was being mined as late as 1980, according to Perry (1980), who visited the deposit and described the occurrence as "a slash along an actinolite vein some 50 feet in length." A narrow one-person incline followed the nephrite seam. This material is easily recognized because of its feather-like inclusions of black magnetite which provide a semi-metallic luster in contrast to the waxy-glassy luster of the enclosing jade. It has been found that the magnetite can be silver- or gold-plated, producing on finished cabochons a most startling contrast in colors and textures.

ABBOTT, A. L. (1972) *Gem Trails in California.* Anaheim, CA: Abbott & Abbott, 84 p., illust., maps. Jade in Northern CA.

AMES, R. F. (1957) Aquatic rockhounds. *Westways* 49, 5, p. 4–5. Jade Cove.

BERKHOLZ, M. F. (1953) Gems from the sea. *Mineral Notes and News* 193, p. 9–11, illust., maps. Jade Cove.

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BOWEN, O. E. (1964) New jade deposit found by Division. *CA Div. Mines & Geol., Min. Info. Service,* 17, p. 21. Nephrite near. Bagby, Mariposa Co.

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DAKE, H. C. (1950) The jadeite locality. *The Mineralogist* 18, 4, p. 188-190. Clear Creek.

______, (1954) White jade mined. *Ibid.* 22, 10, p. 338. Clear Creek.

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DRAPER, J. W. (1969) Botryoidal jade of the California Coast. *Lapidary J.* 23, 5, p. 682, 684–686.

ELIAS, M. G. (1964) Magnetic jade from California. *Rocks & Minerals* 39, 3–4, p. 132. San Bernardino Co.

EVANS, J. R. (1966) Nephrite jade in Mariposa County. *CA Div. Mines & Geol., Min. Info. Service* 19, 9, p. 135–147, illust, maps.

______, (1970) [Nephrite near. Bagby. Mariposa Co.] *Ibid.* 23, 4,. p. 75.

FERGUSON, R. W. (1980) Variety spices a trip to the Jade Cove area. *Lapidary J.* 34, 4, p. 918–924, illust.

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WARD, F. (1987) Jade—stone of heaven. *Nat. Geogr.* 172, 3, p. 282–315, illust. (col.). Jade Cove p. 309.

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WOBBER, D. (1975) *Jade Beneath the Sea: A Diving Adventure.* Pacific Grove, CA: Boxwood Press, 136 p., illust. (col.). Monterey coast.

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YODER, H. S. & CHESTERMAN, C. W. (1951) Jadeite of San Benito County, California. *CA Div. Mines Spec. Rept.* 10-C, 8 p., illust., map.

MEXICO & CENTRAL AMERICA. Bishop, *et al* (1991, p. 318) introduce the term "social jade" to "describe those objects that are carved in the same form as many styles of jadeite artifacts, but from other stones," these commonly being quartz, serpentine or "even slate." However, true jadeite is estimated to comprise only 20% of the total of such objects. They raise the question of whether or not prehistoric carvers recognized differences among the materials chosen for their works, "especially between jade and quartz." Speaking from practical experience as a lapidary, and I am sure that I will be joined in this opinion by others, it is almost inconceivable that any artisan working in such diverse materials could fail not only to recognize differences in workability, but also to recognize such materials again whenever they appear. So distinct are the abrasive reactions of mineral materials when rubbed against each other that it is often possible to identify a mineral or stone by this behavior alone, especially when the vibrations of rubbing are transmitted directly into the fingertips. There can be little doubt that on the lapidary level terms were developed to identify such materials, but in the case of Middle American prehistoric lapidaries, these terms have not been recorded It has been shown that such vocabularies existed among ancient lapidaries working jade and jade-like stones in New Zealand and China.

Correlating Middle American jades, and other stones such as the "social jades" mentioned above, to deposits remains a serious problem. At present, only the deposits of jadeite in the Motagua Valley of Guatemala are certainly known sources. Bishop, *et al* (1991, p. 324) for example, during field work in Costa Rica, could not establish a source of jadeite which is said to have come from a deposit somewhere on the Santa Elena Peninsula in northwest Costa Rica. However, Reynoard De Ruenes (1993, p. 61-67) suggests that it may have come from an area on the west slope of Costa Rica, as will be described later under that country. The problem of distinguishing jadeite from other mineral look-alikes has been helped to some extent by an instrument, described by Ward (1987, p. 310), which was employed to help recognize Middle American jade-like materials. Called the Portable Instantaneous Display and Analysis Spectrometer (PIDAS), this device works by casting a beam of intense light upon the object's surface and then electronically analyzing the reflected light which has now changed its character because it has interacted with the minerals in the stone's surface. Since the reflections are different for different minerals, it is possible to record such differences on graphs and then compare them to known standard patterns.

An interesting question on sources of jadeites in Middle America has been raised by the studies of Dr. G. E. Harlow of the American Museum of Natural History in New York City, who suggests that the geochemical conditions needed for the formation of jadeite exist only in the Motagua Valley of Guatemala (Harlow, 1993, p. 7–29; Bishop, *et al*, 1991, p. 330). Equally important is the further suggestion that the elements present in such an environment, as well as variable geochemical conditions during formation of jadeite, could produce a large variety of jadeites, from black to nearly white, and including grays, greens, and even the prized apple greens and emerald greens. Implied here is that a careful, systematic search of areas within the Motagua region may ultimately disclose deposits from which the more colorful jadeites came. The "one source" idea of Harlow is discussed in Bishop, *et al* (1991, p. 330–331) and in the various contributions in Lange (1993), with Bishop, *et al (Ibid.)*, noting that "one of the most serious critiques of the single-source hypothesis is that it does not accord with what is known about distribution and trade routes" while admitting at the same time that not enough specimens have been collected from enough finds to substantiate one view or the other. Thus, the controversy concerning source or sources for the jadeites which have been found in many sites separated by great distances remains unsettled.

On the subject of faked jades, Garza-Valdes (1991) states that "thousands of fake jade pieces are in museums and private collections," and the purpose of his studies of such artifacts, real and faked, is to discover the marks and signs of ancient workmanship and the changes produced in the chemical composition of surface layers of the artifacts after prolonged periods of weathering. He therefore studied thousands of fragments or whole objects, using as his principal analytical tool the infrared absorption spectrometer, but also microscopically examining tool marks upon surfaces. Many fakes were identified by the discovery of traces of modern abrasive and polishing agents in grooves and cracks; sometimes these were found in old pieces that had been reworked by a modern lapidary. Garza-Valdes provides valuable photographs of the many types of rocks that pass for jade or "social jade" mentioned above. Special attention was given to the jadeites of Motagua Valley which show wide variations in compositions, noting that in the rocks jadeite is by no means always the principal constituent. According to his studies of the rock types which are called "jades," diopside-albitites comprise almost 80%, while rocks in which jadeite predominates comprise only 7.2% of the total. All of the "jade" rocks were polymineralic, none being composed wholly of jadeite. Among the rocks classed as "social jades" he found aventurine quartzite, a "jasper" of very fine-grained quartzite, amazonite, mica, serpentine, and a "black jade" which is an altered basalt. Garza-Valdes concludes that "a wide variety of green colored rocks were used to make pre-Columbian artifacts generally known as jade," and that by study of the surface alteration products and evidences of lapidary technology, it should be possible to distinguish fakes and genuine pieces that have been reworked in modern times.

As a closing note to this general discussion, I lately found a modern printing of Monardes' 1574 book in which he describes all of the natural substances employed by the natives of Middle America at the time of the Spanish Conquest, that is, John Frampton's translation, London, 1577, Constable & Co., 1925, two volumes, entitled *Joyfull Newes Out Of The Newe Founde Worlde*, etc. This may possibly be the first mention of Central American jade in print. Monardes gives a brief description of jade as an amulet to be worn on one's person to ward off or ameliorate kidney ailments (Vol. I, p. 44–46).

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STIRLING, M. W. (1941) Expedition unearths buried masterpieces. *Nat. Geogr.* 80, 3, p. 277–302, illust. (col.), map.

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STIRLING, M. W. & STIRLING, M. (1942) Finding jewels of jade in a Mexican swamp. *Nat. Geogr.* 82, p. 635–661, illust. (col.).

STRIPP, D. M. (1982) Stolen: a part of the past. $40,000 reward offered for return of Mayan jade artifacts. *Lapidary J.* 36, 9, p. 1526–1531, illust. of many objects (25 in all).

SWEZEY, W. R. (1976) Ancient Maya jade deposits rediscovered. *Lapidary J.* 30, 3, p. 742–744, illust.

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VAILLANT, G. C. (1932) A pre-Columbian jade. *Nat. Hist.,* Nov.-Dec., p. 512–520.

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WARD, F. (1987) Jade: stone of heaven. *Nat. Geogr.* 172, 3, p. 382–315. Includes Meso-American jades.

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WASHINGTON, H. S. (1926) The testimony of the jades. *Scient. Amer.* 135, p. 94–95.

WEST, E. H. (1963) Jade: its character and occurrence. *Expedition* 5, p. 2–11.

GUATEMALA. Much on the geology and mineralogy has already been given above, including numerous references to the occurrence of jadeite in the Motagua River Valley (*see esp.* Bishop, *et al*, 1991, Harlow, 1993 and Lange, 1993). Since the first announcement of *in situ* jadeite by Foshag & Leslie (1955), little has been done to exploit the deposits commercially, largely because of the coarse grain and the rather dull colors exhibited in the specimens that have been described and brought back for examination in the United States. However, a resurrection of a local carving industry was announced by Laberge (1975), who stated that the La Casa De Jade Maya in Guatemala City had been established to process Motagua jadeites into a large variety of small sculptures, beads, plaques, etc., by training local residents in the lapidary arts and using the most modern equipment. In the spring of 1977, Mary and Jay. R. Redinger, citizens of the United States but resident in the city of Antigua, Guatemala, discovered jadeite "in a mountain meadow high above the banks of the Motagua River, only a short distance from Guatemala City, the nation's capital" (Best, 1983). At this time a cottage indus-

FIGURE 44. Jadeite breastplate from a Mayan burial mound near the village of Nebaj, Guatemala. According to Dr. A. V. Kidder, Carnegie Institution of Washington, D.C., it is "the finest single example of Mayan jade carving yet brought to light." The piece was found in 1947 and measures about 6 in. (15 cm) long, 4 in. (10 cm) wide, and 1 in. (2.5 cm) thick. *Courtesy Carnegie Institution.*

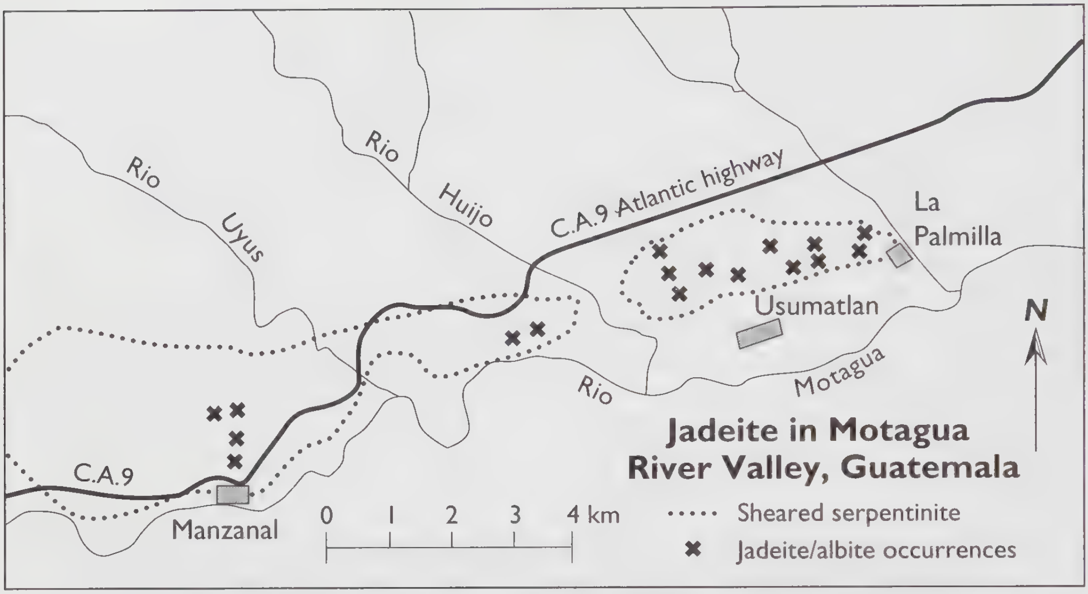

FIGURE 45. Jadeite occurrences in the Motagua River Valley, Guatemala, showing their relationship to the local belt of sheared serpentinous rocks. Geology simplified after a map of G. E. Harlow, in Lange, F.W., 1993.

try for working the jade into various ornaments was set up in Antigua by the Redingers' firm, Jades S. A. Most of the work was done upon the common grayish-greenish granular jadeite, but also worked were jadeites that ranged in color from "bright apple green to jet black." Robert Terzuola, foreman and instructor of the Jades S. A. establishment, is known for having given his name to an ancient carving workplace called the Terzuola Site in the Motagua Valley. He is of the opinion that the only "tool" employed by the ancient lapidaries was a blade-like affair of lignum vitae wood, with the actual removal of jadeite accomplished by grains of pulverized garnet applied to the wood edge and carried along with it to form a sort of file. Holes were bored with crushed garnet applied to the tip of a hollow bamboo core drill. Further remarks on the Redinger enterprise appear in Castro (1979) and Hargett (1990), the latter noting that the Redingers found jadeites in the Rio Pamilla and Rio Huijo. Hargett gives the following property values for the jadeite: refractive indexes between 1.65 and 1.67, and specific gravity between 3.20 and 3.34. Messenger (1976) provided other data, giving the specific gravity range as 2.90–3.16, average 3.10, but calling attention to a high value of 3.30. Thin sections examined microscopically showed that the jade component could be as high as 98%, with the remaining 2% of albite, but most often the jade ranged between 80% and 85% with the remaining minerals being diopside, plagioclase and mica. Messenger noted colors that ranged from light green through all shades of green, and, rarely, the prized apple green and emerald green. A very dark green-black chloromelanite was also found.

A very full study of the jadeitite rocks and related jade-like rocks from the middle Motagua Valley appears in Harlow (1993). He not only shows the distribution of these rocks over large areas but also correlates them to the fault zone that passes through much of northern Guatemala, from the Caribbean Sea shoreline just south of Belize in a west-southwestward direction to the Pacific Ocean shoreline (p. 12). Harlow (p. 10) published a table of "Some Rocks Known as Jade," which is instructive because many of them contain no jadeite whatsoever; yet because of their general appearance and their wide use by prehistoric lapidaries, they are very commonly called "jade" when in artifact form. The rocks shown in this table are jadeitites, altered jadeitites, omphacite rock containing only minor jadeite, and an "emerald-green pyroxenite" which owes its color to chromium but contains no jadeite. Other materials are an altered basalt, several albite-rich rocks, and a green quartzite that locally has been called "Guatemalita," and which is largely colored by fuchsite mica.

Woodward (1987) gives a recent account of the Guatemalan jade industry and estimates that "over 300 Guatemalans today earn their livelihood from the mining, carving, and selling of jade products." He states that jadeite has been obtained from the departments of Izabel, El Progreso, Zacopa, Baja Verapaz, and El Quiche, but that recognizing the boulders of jadeite is made difficult by their being "usually covered with a thick, black-brown or grey rind, which makes it impossible to distinguish jade boulders from normal rocks." Bishop, *et al* (1991, p. 330) depict in color a jadeite boulder with a reddish-brown rind, and note that "boulders sometimes exceeding a diameter of over 3½ feet (1 m) weather out of the surrounding material and move toward the Motagua River" (caption to Fig. 18).

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BEST, D. M. (1983) Green gold. *Lapidary J.* 37, 7, p. 1080–1083, illust.

BISHOP, R. L., LANGE, F. W. & EASBY, E. K. (1991) Jade in Meso-America. In *Jade*, R. Keverne, ed., London: Anness Publ., p. 317–341, illust. (col.).

CASTRO, K. M. & CASTRO, D. (1979) Jade in South America. *Gems & Minerals* 500, p. 10–12, 32–36.

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FOSHAG, W. F. (1954, and other refs.) *See above.*

HARGETT, D. (1990) Jadeite of Guatemala; a contemporary view. *Gems & Gemology* 26, 2, p. 134–141, illust. (col.), map. On-site visits.

HARLOW, G. E. (1993) *See above.*

KIDDER, A. V., JENNINGS, J. D. & SHOOK, E. M. (1946) Excavations at Kaminaljuyu, Guatemala. *Carnegie Inst., Wash., D.C., Publ.* 561, 284 p., illust. maps. Much on carving methods.

KIDDER, A. V. (1947) The artifacts of Uacactuan, Guatemala. *Ibid.* Publ. 576. Many jades illust.

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LABERGE, M. G. (1975) Resurrecting a lost Maya art. *Lapidary J.* 29, 9, p. 1692–1694, illust. Jade carving industry.

LANGE, F. W., ed. (1993) *Precolumbian Jade: New Geological and Cultural Interpretations.* Salt Lake City, UT: Univ. UT Press, 378 p., illust. (col.).

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COSTA RICA. Reynoard De Ruenes (1993) suggests that Costa Rican jadeite is to be found in or near the Reynoard Site, a place whose exact situation is kept secret to "prevent destruction by pothunters." However, the site "includes a small beach and sediments from a small river originating in the Talamanca Valley and flowing south to north from the Limón Basin." This area is on the Atlantic Slope side of Costa Rica. Only determinations of specific gravity were made on numerous samples of "greenstone", and no jadeite was certainly identified. For the most modern information on Costa Rican jadeites see the works below of Easby, Keverne, and Lange.

A handsome descriptive catalog of the collection of jade artifacts preserved in San Jose in the Instituto Nacional de Seguros (1980) shows dozens of carvings in a wide variety of hues and textures in full color on 40 leaves, with text and captions, etc. in English as well as Spanish. An extensive bibliography is provided.

ABEL-VIDOR, S., *et al* (1981) *Between Continents / Between Seas: Pre-Columbian Art of Costa Rica.* NY: Abrams, 240 p., illust. (col.). Articles on jade by Easby, Lange, Bishop, and Van Zelst.

BALSER, C. (1953) *El Jade Precolombiano de Costa Rica.* San Jose, CR: Museo Nacional de Costa Rica.

______, (1974) *El Jade de Costa Rica.* San Jose, CR: priv. publ., 89 p., illust. (col.).

BISHOP, R. L., SAYRE, E. V. & MISHARA, J. (1993) Compositional and structural characterization of Maya and Costa Rican jadeitites. In LANGE (1993) *below*, p. 30–60, illust. (col.), map.

EASBY, E. K. (1968) *Pre-Columbian Jade from Costa Rica.* NY: A. Emmerich, 103 p., illust. (col.).

INSTITUTO NACIONAL DE SEGUROS (1980) *Jade Precolombino De Costa Rica.* San Jose, CR: 130 p., illust. (col.), map.

KEVERNE, R., ed. (1991) *Jade.* London: Anness Publ., 376 p., illust. (col.), maps. Meso-American jades p. 317–337.

LANGE, F. W., ed. (1993) *Precolumbian Jade: New Geological and Cultural Interpretations.* Salt Lake City, UT: Univ. UT Press, 378 p., illust. (col.), maps. Much on Costa Rican jades.

LOTHROP, S. K. (1955) Jade and string sawing in northeastern Costa Rica. *Amer. Antiquity* 21, 1.

LOTHROP, S. K., *et al* (1964) *Essays in Pre-Columbian Art and Archaeology.* Cambridge, NY: Harvard Univ. Press, 507 p., illust. (col.). Includes Easby & Balser on Costa Rican jades.

REYNOARD DE RUENES, M. (1993) A possible source of raw material for the Costa Rican lapidary industry. In LANGE (1993), p. 61–67, illust.

SOTO, Z. (1993) Jades in the Jade Museum, Instituto Nacional de Seguros, San Jose, Costa Rica. In LANGE, (1993), p. 68–72, illust.

CARIBBEAN REGION. Smith (1955) describes and depicts jade artifacts from Puerto Rico which he identified as jadeite by X-ray diffraction, and determined properties as follows: H 7, specific gravity 3.32 average, and upon small chips refractive indexes of 1.662, 1.667, and 1.673, 2V angle of 72 degrees. Also, the "A (110) cleavage was prominent, together with a common (100) twinning. These data strongly suggested that the rock consisted of the jadeite variety of pyroxene, which was subsequently confirmed by an X-ray powder photograph taken by the U.S. Geological Survey." Although he states that the source of the jade is unknown, he furnishes a map showing the areas of Puerto Rico in which serpentinites occur which may include jadeites within them. In this connection, Harlow (1993, p. 15), draws attention to the extension of the fault zones of Central America across the Caribbean Sea to intersect the Antilles. "Jumping to the comparable Oriente Fracture Zone, one might expect to find jadeite-bearing rocks in southern Cuba or on Hispaniola. In fact, jadeite-bearing rocks have recently been described from the Dominican Republic (Grenville Draper and Sorena Sorensen personal communication, 1989), but no jadelike jadeite rocks have been noted so far." See also the general remarks on Caribbean jade artifacts in Easby (1991).

EASBY, E. K. (1991) Jade in South America and the Caribbean, In *Jade*, R. Keverne, ed., London: Anness Publ., p. 338–341, illust. (col.).

HARLOW, G. E. (1993) Middle American jade. In *Precolumbian Jade*, F. W. Lange, ed., Salt Lake City, UT: Univ. UT Press, p. 9–29, maps.

SMITH, R. J. (1955) Jade artifacts of Puerto Rico. *The Mineralogist* 23, 1, p. 37–38, 40, illust., maps.

JET

Zeitner (1968; 1981) provides a number of jet localities in the Eastern and Western United States, among them Maryland, where jet has been found at Loper Hall and Fort Dorsey in Anne Arundel County, and West Virginia, where a specimen has been reported from Randolph County. Jet is also rumored to occur in North Carolina, South Carolina, and Mississippi.

VIRGINIA. Jet of fair jewelry quality was found in a prospect pit on the northeast side of Nyson's Branch, near its junction with Swift Creek, close to a point just north of Otterdale. The latter community is located 5.5 mi (8.6 km) southwest of Midlothian, Chesterfield County. The jet was formed from Araucaroxylon wood, according to Shaler & Woodworth, 1899.

SHALER, N. S. & WOODWORTH, J. B. (1899) Geology of the Richmond Basin, Virginia. *U.S. Geol. Survey 19th Ann. Rept. for 1897–98*, part 2, p. 385–519, maps.

NEW MEXICO. The jet reported from near Acoma, Valencia County in 1874 (Northrop, 1959, p. 314–315) apparently is again being mined as masses of several pounds (ca 1 kg) were being offered for sale at the Tucson Show in February, 1991. Northrop also summarizes other reported occurrences of jet in this state, as in Guadelupe County, in the vicinity of Santa Rosa (Jones, 1904), and in Chaco Canyon excavations, San Juan County.

BREVOORT, E. (1874) *New Mexico: Her Natural Resources*, etc. Santa Fe, NM: 176 p. Mentions jet.

JONES, F. A. (1904) *New Mexico Mines and Minerals* (World's Fair Edition). Santa Fe, NM: 349 p.

NORTHROP, S. A. (1959) *Minerals of New Mexico*. Rev. edit. Albuquerque, NM: Univ. NM Press, 665 p., map.

UTAH. The best account of the important jet deposit in Coaly Basin, Wayne County, is that of Kelly (1942), who also includes a map to aid in reaching the site. The scientific aspects of this material are given in detail by Traverse & Kolvoord (1968). Removals of jet for sale took place in 1925, again in 1956, and recently in 1976 when Jetco Enterprises of Scottsdale, Arizona, offered the jet at $5 per pound in lots less than 500 lbs, with adjustments in price for larger quantities wholesale (*Gems & Minerals Merchandiser*, Feb., 1976).

KELLY, C. (1942) Gem stones found in veins of coal. *Desert Mag.*, Nov., p. 5–7. map.

TRAVERSE, A. & KOLVOORD, R. W. (1968) Utah jet: a vitrinite with aberrant properties. *Science* 159, p. 302–305, illust.

ALASKA. Roy (1986) reports jet in coal seams at the head of Muddy Creek, Mile 94.5, on Glenn Highway, east of Chickaloon, Matanuska Valley.

ROY. S., ed. (1986) *Alaska—A Guidebook for Rockhounds.* Anchorage, AK: Chugach Gem and Mineral Soc., [48] p., maps.

MEXICO. Jet, or *asabache* in Spanish, occurs in amber deposits of Chiapas, where the natives call it "hermano del ambar," or "brother of amber." Like amber, it is also worked up into various ornamental pieces. Apparently jet has been known to Chiapas natives as long as amber, and it has been found incorporated in objects that were found in Precolumbian graves (*see* AMBER, in Chiapas).

MISCELLANEOUS REFERENCES:

GILMORE, E. L. (1963) *A Rockhound's Guide to the Gems & Minerals of Oklahoma.* Tulsa, OK: priv. publ., 77 p., maps. Jet in Marshall County.

PEARL, R. M. (1968) "Whitby" jet from Colorado. *Gems & Minerals* 374, p. 14. Fort Carson area, El Paso County.

TINSLEY, J. C. (1974) Jet from Colorado. *Earth Science* 27, p. 106–108. Fort Carson area, El Paso County.

ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps.

_____, (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps.

_____, (1981) Amber and jet. *Lapidary J.* 35, 1, p. 92–99, *passim*, maps.

KAKORTOKITE

GREENLAND. This is an attractive colored and patterned granular nepheline syenite that occurs at the southern end of the Ilimaussaq intrusion, Kangerdluarssuk Fjord, Julianehaab district, in the extreme southwest of Greenland (Dragsted, 1971). Another attractive nepheline syenite that occurs in the same deposit is named naujaite (which see), and was first described by Ussing (1894) when it attracted interest as a possible source of zirconium, which element is present in the deep red mineral eudialyte. This mineral lends its color to the rock and is accompanied by white nepheline, feldspar, and black arfvedsonite. Dragsted notes that the rock "takes a nice polish" and has been fashioned into "small bowls (which are not ashtrays but models of Eskimo grease lamps) and other objects of art, as well as cabochons for silver ornaments." Dragsted visited the site in 1967 and states that a "mountain" of these decorative rocks is available.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Meddelser om Grønland* 149, 3, p. 245 ff.

DRAGSTED, O. (1971) Kakortokite—and other ornamental eudialyte rocks. *J. Gemm.* 12, 7, p. 312–315, illust. (col.).

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 19–23, illust. (col.), map.

USSING, N. V. (1894) Mineralogisk-petrografiske undersøgelser af Grønlandske nefelinsyeniter og beslaegede bjaergarter. *Med. om Grønl.* 14, p. 109–220, illust.

______, (1911) Geology of the country around Julianehaab, Greenland. Reprint: *Med. om. Grønl.* 38, 367 p., illust., maps.

KONA DOLOMITE, *see* DOLOMITE

KORNERUPINE

GREENLAND. In the summer of 1975, giant crystals of kornerupine were found in the Fiskernaes area of the west coast, south of Godthaab and north of Agdlumersat (Bjørnesund) (Petersen, *et al*, 1980). The crystals occurred in a lenticular rock mass of almost 10 x 30 m (33 x 100 ft) enclosed in anorthosite. Associates were sapphirine, plagioclase, cordierite, mica, enstatite, pargasite, red corundum, spinel, and tourmaline. Kornerupine crystals measured up to 23 cm (9 in) long but only small areas were of sufficient clarity and freedom from flaws to afford small faceted gems of 1.72 and 0.68 ct. Altogether 21 gems were cut from this material, 14 faceted gems and 7 cabochons. The kornerupine is transparent, dark green in color and strongly pleochroic: dark green, reddish-blue, and light blue; specific gravity 3.292–3.306; refractive indexes alpha 1.662, gamma 1.679. None of the gems are completely flawless. In a later reference, Petersen & Secher (1993) give the locality as Fiskenaesset Village, or in modern spelling, Qeqertarsuatsiaat.

PETERSEN, O. V., JOHNSON, O. & JENSEN, A. (1980) Giant crystals of kornerupine. *Min. Rec.* 11, 2, p. 93–96, illust., map.

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 14.

KYANITE

MAINE. Bradshaw (in press) records cabochons cut from kyanite that is found at Dundee Falls, Windham, Cumberland County; the gems have been placed in the collection of the Boston Museum of Science. Details on the locality are given by King & Foord (1994, p. 207).

BRADSHAW, J. J. (*in press*) Gemstones of Maine. In King. V.T., ed., *The Mineralogy of Maine.* Augusta, ME: Geol. Survey ME, excerpt of 21 p.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

NORTH CAROLINA. Large crystals of sapphire-blue kyanite as much as 4 cm (1.6 in) long occur in a pegmatite 90 m (300 ft) west of the Blue Ridge Parkway at a point about 0.8 km (0.5 mi) south-southwest of Walker Knob. This is about

22 km (14 mi) northeast of Asheville (Lesure, *et al*, 1982). Arem (1987) records a faceted gem of 6.57 ct from North Carolina. Kunz (1907) remarks on the occurrence of kyanite and its cut gems, showing same on a color plate in his monograph on the state gem minerals.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, p. 121.

KUNZ, G. F. (1907) History of the gems found in North Carolina. *NC Geol. Econ. Survey Bull.* 12, p. 14–15; plate 13.

LESURE, F. G., *et al* (1982) Mineral resources of the Craggy Mountain Wilderness Study Area and Extension, Buncombe County, North Carolina. *U.S. Geol. Survey Bull.* 1515, 27 p., maps.

PRATT, J. H. (1898) Mineralogical notes on cyanite, zircon and anorthite from North Carolina. *Amer. J. Sci.* 5, p. 126–128. Facet grade kyanite.

IDAHO. Various writers mention that small, facet-grade kyanite crystals occur in the same gravels that produce facet-grade almandine garnets in the Little North Fork and North Fork of the Clearwater River, Idaho County. According to Beckwith (1977, p. 87), the "only important locality . . . of gem quality in Idaho is in Shoshone County."

BECKWITH, J. A. (1977) *Gem Minerals Of Idaho.* Caldwell, ID: The Caxton Printers, 129 p., illust. maps.

"LAHONTANITE,"

see QUARTZ (JASPER)

LAPIS LAZULI

GREENLAND. A small deposit of lapis lazuli rock occurs 60 km (38 mi) east of Sukkertoppen (Manitsoq) village on the west coast at lat. 65°22'N (Petersen & Secher, 1993). The occurrence is within a carbonatite rock in contact with gneiss. The lapis lazuli consists of approximately 80% lazurite and 20% marialite with minor calcite, clinopyroxene and amphibole. It is attractive, "takes a good polish," and has been commercially exploited to a limited extent.

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 15.

BAFFIN ISLAND. Davison (1959) first reported lapis lazuli associated with white diopside in crystalline marble as a place 14 km (9 mi) north-northeast of the settlement of Lake Harbour in the southern end of the island. Hogarth (1971) visited the site, as mentioned in Volume II, and in 1975 gave further details on same as follow. There are two occurrences, both along or near the Soper River. The first, examined in July, 1975, is located at lat. 62°57'54"N and long. 69°47'55"W, at an elevation of 150 ft (50 m) above sea level. It is 10 mi (16 km) northeast of Lake Harbour. Diamond drilling in 1974 indicated that the lapis lazuli zone may extend at least 14 ft (4.3 m) below the surface. A series of exploratory pits were originally dug with Pit No. 5 said to have yielded the best material. "An estimated 300–500 pounds of blocks of lapis lazuli still remain at pit's-edge at the south part of the occurrence and many pieces are of lapidary quality with respect to soundness." However, it was noted that this material did not compare in color quality with that taken from Pit 5. Hogarth remarked that at Frobisher Bay he had seen native work in Pit 5 material and that these cabochons were of good color quality, but the lapis from the southern occurrence was "too drab to be called attractive . . . the pale blue color is better suited to large polished surfaces." He further notes that small carvings made in Clyde showed the color to good advantage.

The second occurrence is about one half mile north of the above, at lat. 62058'38"N, long. 69°46'36"W, at an elevation of 325 ft (96 m) above sea level. This deposit was examined on July 8, 1975. Here *green* lapis lazuli was stockpiled, perhaps about 200 lbs of usable material, but the green amazonite which formerly had been quarried here also had all been taken away. This deposit also provided some transparent facet-grade oligoclase (*see* FELDSPAR) and some gemmy purple to red spinel crystals. Further mineral associations are given by Grice & Gault

(1983), who note the presence of highly metamorphosed sedimentary rocks as the hosts of this mineralization. Associated species include almandine, clinohumite, diopside, forsterite, graphite, hornblende, meionite, oligoclase, phlogopite, spinel and uvite.

It is interesting to note that the green lapis lazuli readily changes color when heated, according to Hogarth (*Ibid.*, p. 13), who heated pale green lazurite at 530°C for one half hour at the end of which it had turned "deep cornflower blue." However, "sparse, randomly distributed, coarse, calcite grains decomposed to chalky CaO during this ignition." Nevertheless "the stone took a good polish with tin oxide powder . . . the lime spots remained chalky but, in their small quantity, did not alter the cohesiveness of the rock." Further experiments with plastic (Araldite) impregnation after heating and before polishing resulted in the rock turning to a "deep navy blue" and, as before, polishing well.

A popular account of this occurrence appears in Grice (1989) along with a color photograph of a polished slab of lapis lazuli and cabochons, the largest, a pendant, being 2 cm (0.8 in) long.

DAVISON, W. L. (1959) Geology, Lake Harbour, Baffin Island, District of Franklin, Northwest Territories. *Geol. Survey Canada Prelim. Geol. Map* 29–1958, with text.

GRICE, J. D. (1989) *Famous Mineral Localities of Canada.* Ottawa, ONT: National Mus. Nat. Sci. & Fitzhugh & Whiteside. Lapis p. 124–130, illust.

GRICE, J. D. & GAULT, R. A. (1983) Lapis lazuli from Lake Harbour, Baffin Island, Canada. *Rocks & Minerals* 58, 1, p. 12–19, illust.

HOGARTH, D. D. (1971) Lapis lazuli near Lake Harbour, southern Baffin Island, *Canada. Canad. J. Earth Sci.* 8, p. 1210–1217.

_____, (1975) Carving stone occurrences in southern Baffin Island. *Report to Dept. Indian Affairs & Northern Development (DIAND), Northwest Terr. Geol. Div.*, 23 p., maps. Lapis p. 12, 13.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Volume I. Yukon, Northwest Territories, etc. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps. Lapis p. 26.

ONTARIO. In 1992, a cobble of gem quality lapis lazuli rock was found in a flower bed of Ottawa General Hospital. The conspicuous blue mineral present in the cobble was soon identified as lazurite by the Canadian Museum of Nature, and it was learned that this stone, along with many others, had come from a local gravel pit. A trip there failed to uncover more material among the glacial till, but it appears that somewhere to the north of the city there is a deposit of gem quality lapis lazuli that needs finding.

ROBINSON, G. W., *et al* (1992) What's new in minerals? *Min. Rec.* 23, 5, p. 428–429.

NEW YORK. The New York State Museum Collection of gemstones contains an oval cabochon of lapis lazuli from Balmat, 16 x 25 mm, and another from Edwards, 22 x 30 mm.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection Catalogue. *Open File Rept.* 8m106, 47 p, p. 23.

COLORADO. The major facts on the Italian Mountain deposits were given in Volume I, but have been brought up to date by Truebe and others as noted below.

The deposits of lapis lazuli on North Italian Mountain and Italian Mountain (4,078 m, 13,378 ft) were carefully described by Truebe (1977), who identifies the two principal occurrences as the Anderson Prospect and "for lack of a better name, the Truebe Prospect." The Anderson deposit is located on North Italian Mountain, but the Truebe Prospect is on Italian Mountain at an elevation of 3,960 m (13,000 ft). There are several occurrences at the Anderson site and "a number of other pits in the vicinity are reported to contain lapis, some of good quality." At this place lazurite is found impregnating a grayish marble bed of about 50 cm (20 in) in thickness. Another nearby occurrence shows lazurite grains of smaller size in nearly white marble.

There are three Truebe occurrences near the summit of Italian Mountain, two of which are similar to those just described, but a third is in a fault zone and contains "some intensely blue lapis."

FIGURE 46. Lapis lazuli mine on North Italian Mountain, Colorado showing the opencut from which lapis lazuli rock has been recovered (as of 1994). *Courtesy Gary Christopher, The Prospectors Cache, Englewood, CO.*

The mineralogy of these deposits essentially consists of lazurite grains in calcite, with pyrite in crystals that range in size from minute individuals to blebs as much as 1 cm (0.5 in) across. Truebe regards the lapis lazuli as "second grade," according to a scale devised by the Gemological Institute of America, and "while some of the lapis produced at the Anderson prospect reaches a royal purple-blue, I remain to be convinced that the deep-colored material makes up a significant amount of the deposit." Truebe also deplores the presence of the gray marble matrix "which tends to kill any 'life' in the stone." In his opinion, the material is not competitive in the world market but can be absorbed locally.

Further remarks on the geology and mineralogy of these deposits appear in Hogarth & Griffin (1980), who also describe in detail the mineral associates and provide analyses of the lazurite. A general paper on the minerals was published by Truebe (1984), who provides excellent photographs of the local scenery and the workings. However, of the several dozen minerals described, by far most occur outside the lapis lazuli zones. Concerning the lazurite itself, Truebe notes that it is typically fine-grained, with grains less than 0.05 mm in diameter, and usually comprises less than 10% of the rock volume.

In 1979, Paul R. Schultz of Gunnison, Colorado, operating on behalf of the Blue Wrinkle Mine company on the Anderson claims, began use of large mechanical excavating equipment (Schultz, 1981). A development plan was filed with the U.S. Forest Service in 1980, and a private road was constructed to the mine site. The new exposures created by him showed lapis lazuli in a calcite vein that averages 3 ft (1 m) in thickness and could be traced laterally over 180 ft (56 m). The vein dips into the mountain at 12°. Mining requires removal of overburden with a bulldozer and backhoe, and as the vein is followed it becomes necessary in places to go underground. The rough is turned over to the House of Art in Gunnison, owned by Nancy & Hugh Pressler, who saw the rough blocks and grade the product (Voynick, 1987). The No. 1 grade, said to be "superb," at the time was priced at $4.75 per gram in slabs or $10 per carat in finished cabochons. The Presslers are of the opinion that their best is equal to the best Afghan lapis. The No. 2 lapis was priced at $2.75 per gram in slabs or $8.00 per carat in cabochons. It differs from the first grade only in containing "tiny bits of calcite matrix and less-than-ideal pyrite distribution." The No. 3 grade was correspondingly priced at $1.00 per gram and $5.00 per carat. Lower grades were priced lower in proportion. Some blocks were sent to Idar-Oberstein, Germany, for carvings, and "a four-inch bluebird, a classic subject for the azure blue of the Blue Wrinkle lapis, is priced at $1,000."

Voynick further notes that mining in 1987 required drilling and blasting to reach the lapis lazuli zones. In 1992, Schultz died and the mining came to a halt, with no further activity taking place since then (*Pers. comm.*, Nancy Pressler, 10/93). However, in 1994, Gary Christopher, proprietor of The Prospectors Cache, Englewood, Colorado, staked four claims covering the lapis lazuli deposit on North Italian Mountain (*Pers. comm.* 12/5/1994) with the intent of commencing mining and recovery of lapis lazuli in the summer season of 1995. Access to the property is via a bulldozed road that is gated below.

DOZIER, O. (1944) Carl Anderson and his lapis lazuli mine in Colorado. *Rocks & Minerals* 19, 1, p. 35–38.

HOGARTH, D. D. & GRIFFIN, W. L. (1980) Contact-metamorphic lapis lazuli: the Italian Mountain deposits, Colorado. *Canad. Min.* 18, 1, p. 59–70, map.

ROSENCRANS, H. I. (1941) Colorado lapis lazuli. *Gems & Gemology* 3, 10, p. 154–155.

SCHULTZ, P. R. (1981) Colorado lapis lazuli from the Blue Wrinkle Mine in Gunnison County. *Lapidary J.* 34, 11, p. 2344, 2346.

SHAW, V. (1946) Notes on Colorado minerals. *Earth Sci. Digest* 1, 2, p. 3. Mentions Italian Mt. material.

TRUEBE, H. A. (1977) Lapis lazuli in the Italian Mountain area of Colorado. *Lapidary J.* 31, 1, p. 54–58, *passim*, 78, 80, maps.

_____, (1984) Minerals of the Italian Mountain area, Colorado. *Min. Rec.* 15, 2, p. 75–88, illust., maps.

VOYNICK, S. (1987) Colorado's Blue Wrinkle Lapis Mine. *Rock & Gem* 17, 4, p. 52–56.

CALIFORNIA. For a brief period, the lapis lazuli deposit in the San Gabriel Mountains, San Bernardino County, was mined by Sam Speerstra who named it the Bighorn Mine (Speerstra, 1979). He notes that it was "officially opened on May 12th of this year" and that "the mine is yielding lapis of the highest quality from what appears to be a vast lode . . . stretching vertically from the top of a ridge 100 yards to the canyon floor below." At this time a crew of three men were employed to mine from 50 to 150 lbs of lapis lazuli rock daily. In an advertisement in the same issue of *Lapidary Journal* in which his article appeared, the lapis lazuli was offered as chunks with some matrix from 1/2 ounce to several pounds in size, for $20.00 per 1/2 pound, $35.00 per pound, but with the best quality being priced at $30.00 per 1/2 pound or $55.00 for a pound. So far as could be ascertained, this deposit has not produced any lapis rock since 1979–1980.

This deposit had been mined prior to 1912 by miners who thought the blue color signified the presence of silver (Surr, 1913), but it was abandoned when assays failed to show any valuable metal in the "ore." Surr's information was given to Sterrett, who published it in his "gems and precious stones" chapter for 1913 (Sterrett, 1914), but Sterrett had earlier (1911) noted that R. M. Wilke, mineral dealer of Palo Alto, had reported that the lapis had been discovered in 1910.

STERRETT, D. B. (1911) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the United States for 1910*, pt. 2, p. 872.

_____, (1914) *Ibid.*, for 1913, p. 674–675.

SURR, G. (1913) Lapis lazuli in Southern California. *Min. and Eng. World*, Dec. 27, 39, p. 1153–1154.

LAPIS NEVADA, *see* THULITE

LARIMAR, *see* PECTOLITE

LAZULITE

VERMONT. Gosse (1963) describes a possible gem grade massive lazulite deposit in Chittenden Township, Rutland County. The material was first found as a mass in the Hinsdale Brook, Berkshire Mountains, just south of the border in Massachusetts, and two years later, it had been found *in situ* at some unidentified place in Chittenden.

GOSSE, R. C. (1963) Vermont's lost lazulite locality. *Lapidary J.* 17, 8, p. 828–829, illust., map.

YUKON. The world's finest lazulite crystals were found sometime in 1974 in the steep walls enclosing Rapid Creek and Bigfish River in the extreme northeastern corner of the territory (Mossman & Robertson, 1979). The crystals are intense dark blue, beautifully formed, with shining faces, but are too soft to be worn if cut into faceted gems. Those that have been cut are collector curiosities. A faceted gem of 0.31 ct is in the Royal Ontario Museum, Toronto, while Wight (1986) records a 0.20 ct faceted gem whose rough came from Cross Cut Creek and yielded a dark blue, green-zoned stone that is now in the Canadian National Gem Collection.

In color, the lazulite ranges from yellow-green to blue-green and pale blue to dark Prussian blue, the last being the predominant color, and so intense that at first glance the crystals appear black. The crystals mostly range in size between one and one and one-half cm in diameter, but exceptional individuals have been found up to 2.5 cm (1 in) in diameter.

In the field, the crystals are found lining cavities and fissures in sedimentary rocks that are mostly phosphatic shales and ironstones. Robinson, *et al* (1992) fill an entire issue of the *Mineralogical Record* on the history, geology, and mineralogy of the several occurrences, with many notes to accompany the fine illustrations of locales and specimens. According to these authors, there are three productive deposits, two on Rapid Creek, roughly lying between Richardson Mountains to the northwest and Mount Davies Gilbert to the southeast. A third site is almost on the border of Yukon Territory/Northwest Territories on the Big Fish River.

GRICE, J. D. (1989) *Famous Mineral Localities of Canada.* Ottawa, ONT: National Mus. Nat. Sci. & Fitzhugh & Whiteside, 190 p., illust. col., p. 33.

MOSSMAN, D. & ROBERTSON, B. T. (1978) Lazulite—our new blue gemstone. *Canad. Geographic* 97, 3, p. 20–25.

_____, (1979) Lazulite—our new blue gemstone. *Canad. Rockhound* 23, 4, p. 4–9, map.

MOSSMAN, D. J. & VAN VELTHUISEN, J. (1979) Lazulite and associated phosphate minerals from the northeastern Yukon. *Rocks and Minerals In Canada* 12, 5, p. 4–8.

ROBINSON, G. W., VAN VELTHUISEN, J., ANSELL, H. G. & STURMAN, B. D. (1992) Mineralogy of the Rapid Creek and Big Fish River area, Yukon Territory. *Min. Rec.* 23, 4, p. 1–72, illust., col., p. 25–27.

MANITOBA. Parsons (1938) reported blue crystals of lazulite, "suitable for ornamental purposes," from near Fort Churchill.

PARSONS, A. L. (1938) Additional semi-precious and ornamental stones of Canada. *Univ. Toronto Studies,* Geol. Ser., 41, p. 45–48.

GEORGIA. The famous deposit of rutile and lazulite crystals in a fine-grained quartzose matrix rock on Graves Mountain, Lincoln County, is sometimes open to collecting, but, so far as I have been able to ascertain, the quartzite with small euhedrons of lazulite, sometimes cut *en masse* as an ornamental material, is not being produced.

HURST, V. J. (1959) The geology and mineralogy of Graves Mountain, Georgia. *Geol. Survey GA Bull.* 68, 33 p., map.

WATSON, T. L. (1921) Lazulite of Graves Mountain, Georgia, with notes on other occurrences in the United States. *Wash. [D.C.] Acad. Sci. J.* 11, 16, p. 386–391.

ZODAC, P. (1939) Graves Mountain, Georgia. *Rocks & Minerals* 14, p. 131–141.

CALIFORNIA. See SCORZALITE.

LEGRANDITE

DURANGO. Arem (1987) reports a 10 ct faceted legrandite from the famous locality of Mina Ojuela, Mapimi.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, p. 124.

DESAUTELS, P. E. & CLARKE, R. S. (1963) Re-examination of legrandite. *Amer. Mineral.* 48, p. 1258–1265, illust.

FINNEY, J. J. (1963) The composition and space group of legrandite. *Amer. Mineral.* 48, p. 1255–1257.

LEIFITE

QUEBEC. This rare mineral, formula $Na_2(Si,Al,Be)_7$, $(O,OH,F)_{14}$, is found only in a few places in the world, and recently, crystallized material from the Mont Saint-Hilaire locality yielded facet grade areas which enabled the cutting of small gems. According to Horvath & Gault (1990), "the finest specimens and larger crystals of leifite found to date are undoubtedly those from Mont Saint-Hilaire." Mandarino & Anderson (1989) provide the following property data: white to colorless (but see below), H 6; there is a distinct cleavage; specific gravity 2.57; hexagonal (trigonal), uniaxial (+); refractive indexes omega 1.515, epsilon 1.519. The information letter of the German Gemmological Association, *Gemmologie Aktuel* (1/94), gives additional data as determined on a transparent, colorless faceted gem of 0.03 ct: omega 1.516 and epsilon 1.520; specific gravity 2.63. More recently, Kammerling, *et al* (1995) examined a faceted light purplish-pink gem of 2.30 cts and found faint pleochroism and indexes of omega 1.517, epsilon 1.522, specific gravity about 2.62; numerous acicular inclusions were noted oriented parallel to the *c*-axis. Among faceted stones are two in the collection of Guy Langelier of Montreal: light lavender, included, 2.82 cts, and light lavender, clean, 1.22 cts. Langelier notes that these gems were cut from long prismatic crystals that formed globular aggregates in specimens found in 1988 (*Pers. comm.* 10/1993).

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont Saint-Hilaire, Quebec. *Min. Rec.* 21, 4. p. 316-317.

KAMMERLING, R. C., *et al* (1995) Faceted sphalerite and other collector stones from Canada. Gem News, *Gems & Gemology* 31, 1, p. 65–67, illust. (col.).

"LEOPARDITE"

NORTH CAROLINA. This most attractive ornamental rock that displays a unique pattern of black manganese oxide plume-like inclusions within a cream-colored, very fine-grained groundmass has not received the attention it merits. It polishes well and, depending on direction of cutting, displays either the plumose figures noted or the "leopard spots" which give this rock its name. The rock itself is actually a quartz porphyry and has been described by Watson (1904), who gives several occurrences in the form of outcrops at Belmont Springs, about 1.5 mi (2.4 km) east of Charlotte, Mecklenburg County. This handsome rock was apparently well-known even in the earlier years of the last century, for it was remarked upon by George William Featherstonehaugh in 1835 when he passed through Charlotte. According to the Berkeleys (1988, p. 149), "he was so fascinated by this rock that he arranged to obtain an eight-hundred-pound specimen of it." It is further described by Van Landingham (1963), who gives very specific localities for the stone which, however, are within the city limits of Charlotte and covered by buildings. However, he does mention other places in the state where the rock can still be obtained. Similar spotted rocks from other states are noted by him, e.g., Wausau, Wisconsin, and near Sheridan and Buffalo, Wyoming. The occurrences in the latter state are noted by Sutherland (1990). A white sandstone with black spots was found in a "gravel

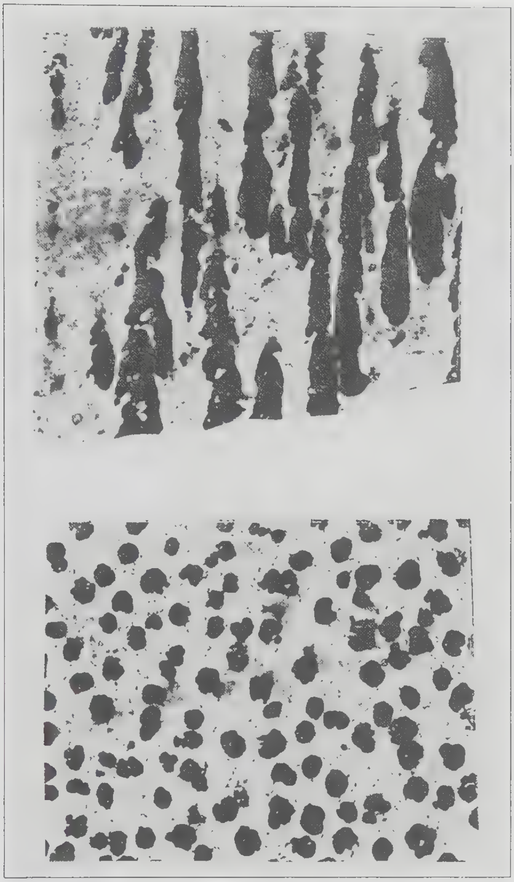

FIGURE 47. "Leopardite" quartz porphyry rock from near Charlotte, Mecklenburg County, North Carolina. Top: the pattern exposed parallel to manganese dendrites; bottom: pattern of dots exposed by cutting across the dendrites. The bottom section is about 2 in. (5 cm) across.

wash" in Larimer County, Colorado, in 1932, according to Pearl (1965).

BERKELEY, E. & BERKELEY, D. S. (1988) *George William Featherstonehaugh: the First U.S. Government Geologist.* Tuscaloosa, AL: Univ. AL Press, p. 149.

HUNTER, C. L. (1853) Notices of the rare minerals and new localities in western North Carolina. *Amer. J. Sci.* 15, p. 373–378.

PEARL, R. M. (1965) Odd rocks of Colorado. *Gems & Minerals* 328, p. 27, 59.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., large localities map.

VAN LANDINGHAM, S. L. (1959) The gem granites. Part 2. *Gems & Minerals* 257, p. 21–27, illust.

_____, (1963) Leopardite and leopard rocks. *Gems & Minerals* 307, p. 26–30, illust., maps.

WATSON, T. L. (1904) The leopardite (quartz-porphyry) of North Carolina. *J. Geol.* 12, p. 215–224.

WATSON, T. L. & LANEY, F. B. (1906) The building and ornamental stones of North Carolina. *NC Geol. Survey Bull.* 2, 283 p., illust., maps.

LEOPARD SKIN STONE,
see OBSIDIAN

LEPIDOLITE

MAINE. Bradshaw (1992) describes several cabochons that were cut from fine-grained massive lepidolite, as well as a polished sphere of 20 cm (8 in) in diameter that was cut from Mt. Mica material. The sphere is in the collection of the Springfield Museum of Science, Springfield, Massachusetts. Another large mass of Mt. Mica lepidolite was fashioned into a vase by the Quincy Granite Company in West Quincy, Massachusetts, and is now in the collection of Perham's of West Paris, Maine. Other places in the state that provided cuttable material include Bowker's Quarry, adjacent to Mt. Mica, and the Tamminen Quarry, Greenwood, Oxford County. Many sources of lepidolite but not all producing suitable lapidary material, are listed by King & Foord (1994, p. 212–215).

BRADSHAW, J. J. (in press) Gemstones of Maine. In King, V.T., ed., *The Mineralogy of Maine.* Augusta, ME: Geol. Survey ME, excerpt of 21 p.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

CALIFORNIA. During a visit in 1993 to Gems of Pala, Blue Sheppard, proprietor and miner in the

Stewart Lithia Mine at Pala, San Diego County, disclosed a large stockpile of the well-known fine-grained lepidolite, some with slender crystals of pink tourmaline imbedded in the rock.

LEUCOPHOSPHITE

SOUTH DAKOTA. According to Dr. E. Fritzsch, of South Dakota School of Mines and Technology (*Pers. comm.* 1/93), a remarkably large leucophosphite crystal measuring approximately 1 x 1 x 0.5 cm (3/8 x 3/8 x 3/16 in) was found in the Tip Top pegmatite mine, Custer County, and was faceted into a gem which displayed strong pleochroism and an alexandrite-like color change. According to Roberts, *et al* (1990, p. 485–486), this pegmatite phosphate "occurs abundantly in superb crystals as much as 1 cm in length, and as lamellar masses several centimeters across, associated with rockbridgeite in altered triphylite nodules at the Tip Top Mine, Custer, South Dakota." Although the hue is not stated, the faceted gem mentioned above is probably of some basic tan to brown color as is typical of this mineral in the Tip Top Mine.

Leucophosphite is a potassium-iron hydrous phosphate, formula $KFe_2 (PO_4)_2 (OH){\cdot}H_2O$, monoclinic, biaxial (+), refractive indexes alpha 1.707, beta 1.721, gamma 1.739, birefringence 0.032; H 3½, G 2.948. The crystals are very brittle. This may be the first record of a gem cut from this species.

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R. (1990) *Encyclopedia of Minerals.* 2nd edit. NY: Van Nostrand Reinhold, 979 p., illust. (col.).

"LLANITE"

TEXAS. This granular igneous rock, made attractive for larger lapidary projects by virtue of its inclusions of opalescent-blue quartz grains, is, according to Iddings (1904), quartz-feldspar-porphyry, or "graniphyro liparose-alaskose," this term, fortunately, falling into disuse soon after coining. According to Girard (1964, p. 71–72), "llanite is a unique rock that is found only in Llano County in central Texas. The rock is sometimes called "opaline granite." Perhaps the best guide to the source is that of Chelf (1961); other recent collecting accounts appear below. See also the geological description of Barnes, *et al* (1947).

BARNES, V. E., DAWSON, R. F. & PARKINSON, G. A. (1947) Building stones of central Texas. *Univ. TX Publ.* 4246, 198 p., illust., maps, p. 71–4.

CARMAN, R. R. (1975) Rockhounding in the Llano Uplift. *Rockhound* 4, 4, p. 12–14, maps.

CHELF, C. R. (1961) The "opaline granite" of Texas. *Gems & Minerals* 281, p. 29–31, map.

GIRARD, R. M. (1964) Texas rocks and minerals: an amateur's guide. *TX Bur. Econ. Geol. Guidebook* 6, 109 p., illust.

GOODALL-ADAMS, G. (1977) Central Texas llanite. *Rockhound* 6, 6, p. 22–23, map.

HUDSON, S. (1988) Texas llanite. *Rock & Gem* 18, 12, p. 68–73, map.

IDDINGS, J. P. (1904) Quartz-feldspar-porphyry. . . . from Llano, Texas. *J. Geol.* 12, p. 225–231.

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps, p. 36.

SIMPSON, B. W. (1958) *Gem Trails of Texas.* Dallas, TX: Newman Stationery & Printing, 88 p., illust., maps, p. 38–39.

STONE, C. M. (1958) Llanite. *Gems & Minerals* 253, p. 54, 56, 58.

VAN LANDINGHAM, S. L. (1959) The gem granites. *Gems & Minerals* 257, p. 21–27, maps.

LUDLAMITE

IDAHO. It is likely that the clear ludlamite faceted gem described by Bank (1983) came from the classic source in the Blackbird Mine, Lemhi County. Bank determined these properties: refractive indexes alpha 1.653, beta 1.673, gamma 1.693, difference 0.040; Hardness 3–4; specific gravity 3.1.

BANK, H. (1983) Grüner, durchsichtiger, geschliffener Ludlamit. *Zs. Dt. Gemmol. Ges.* 32, 1, p. 75.

MAGNESITE

Massive, very fine-grained white to off-white magnesite, magnesium carbonate, formula $MgCO_3$, is now in demand for its usefulness in carving, inlay work, tumbled stones, cabochons, and other ornamental applications. Especially valuable are small cauliflower-like aggregates that remarkably resemble "nuggets" of turquoise after they have been suitably dyed and the dye prevented from bleeding by dipping the nodules into molten wax. Most of the material occurs in the form of slabby masses up to about 1.5 in (3.5 cm) in thickness, sometimes showing faint color bandings. Such material is eminently suitable for carvings which are easily executed with steel tools, files, and sanding papers. Another valuable feature of magnesite is that it can be used in inlays as a substitute for ivory and white marble, being harder than both and thus less likely to present problems in finishing.

The general properties of massive magnesite are: hardness 3.5 to 4; specific gravity 2.69 to 2.78; refractive indexes 1.51 to 1.68. All of these numbers are appreciably lower than those found for magnesite crystals. Magnesite has been offered by dealers under the name "ivoryite" in allusion to its ivory-like texture and color. It has been claimed to come from Arizona, but no deposits exist there which would provide magnesite of this quality, and it is believed that the well-known deposits in Nevada described below are the actual source. In 1993, "ivoryite" was offered in slabs of about 1–1.5 in (2.5–4 cm) thickness and about 6 x 6 in (15 x 15 cm) broad at $1.00 per gram! Some of this slabby material showed faint color banding, indicating its deposition from an aqueous solution.

NEVADA. I am informed by Mr. Herbert Walters of Craftstones, Ramona, California, that the principal source of lapidary grade magnesite is in White Pine and Nye counties of Nevada (*Pers. comm.* 10/1993). These deposits were described in detail by Faust & Callaghan (1948) and later by Vitaliano (1951), who provides maps of the deposits. Exceptional, very fine-grained and uniform-textured magnesite of carving grade occurs in the Currant Creek area about 30 mi (48 km) south-southeast of Ely. The deposits are in the Horse Range, a group of low hills containing magnesite/dolomite beds deposited by hydrothermal activity. The bedded masses are relatively small and occur in Tertiary volcanic tuff. The best material is found as nodules in which the magnesite is almost free of iron and aluminum.

FAUST, G. T. & CALLAGHAN, E. (1948) Mineralogy and petrology of the Currant Creek magnesite deposits and associated rocks of Nevada. *Geol. Soc. Amer. Bull.* 59, p. 11–74, illust., maps.

GALE, H. S. (1914) Late developments of magnesite deposits . . . California and Nevada. *U.S. Geol. Survey Bull.* 540, pt. 1, p. 483–520.

VITALIANO, C. J. (1951) Magnesium-mineral resources of the Currant Creek district, Nevada. *U.S. Geol. Survey Bull.* 978-A, 25 p., illust., maps.

CALIFORNIA. Massive magnesite occurs on the East Fork of Austin Creek and also on Gilliam Creek in serpentinous terrain in Sonoma County (Gale, 1914). The deposits are large, numerous, and many are of "great purity." Other deposits are on Red Mountain in the northeast corner of Santa Clara County; and in Placer County on the upland south of the canyon of the American River "about midway between Iowa Hill and Damascus . . . some material being clear white magnesite with conchoidal fracture."

Numerous deposits occur in the higher elevations of the Diablo Range in San Benito County, especially in serpentinites along Larious Creek about 4 mi (6.3 km) south of Ashurst Ranch. Outcrops of nodular magnesite and loose nodules may be found along the road that leads to the benitoite mine and along Clear Creek Road (Sams, 1974). Almost any excavation for asbestos in this region also yields magnesite in nodular form. Ferguson (1976) describes the occurrence of massive magnesite at the southern end of Anderson Reservoir, reached via road from Morgan Hill which lies to the west in Santa Clara County. The material occurs in large masses and ranges in color from white to dark brown, sometimes with mottled patterns. It is excellent cabochon material and takes a fine polish.

FERGUSON, R. W. (1976) Magnesite at Anderson Reservoir. *Lapidary J.* 30, 4, p. 1030–1036, illust.
GALE, H. S. (1914) Late developments of magnesite deposits in California and Nevada. *U.S. Geol. Survey Bull.* 540, part 1, p. 483–520.
HESS, F. L. (1908) The magnesite deposits of California. *U.S. Geol. Survey Bull.* 355, 67 p., maps.
SAMS, I. K. (1974) Spring tonic—magnesite, jadeite, plasma agate. *Lapidary J.* 28, 8, p. 1230–1234, map.

Baja California Norte. The magnesite deposit not far from El Marmol, south of Ensenada, contains only discolored or yellowish or "ivory" material, according to Mr. Herbert Walters of Craftstones, Ramona, California. Much of it is also excessively porous (*Pers. comm.* 10/93).

MALACHITE

Arizona. Jones (1976) provides an interesting historical account of the famous copper deposits at Bisbee, noting that the final cessation of mining activity occurred in December 1974 when the opencut Lavender Pit was shut down and the opportunities for finding massive, lapidary grade malachite practically eliminated. In early mining it was discovered that "the first major ore body was solid malachite and azurite, measuring sixty feet across and extending four hundred feet underground."

JONES, R. W. (1976) An amazing malachite: an amazing mine. *Lapidary J.* 29, 11, p. 2134–2136, illust.

Nicaragua. An attractive banded malachite has been produced recently from the Rosita Mine, an opencut operation in Zelaya Norte Province, northeast Nicaragua. It is located several km north of the confluence of the Caño Santa Rita and Río Bambana. Solid masses up to 20 x 10 cm (8 x 4 in) have been recovered to furnish excellent cabochon material. The deposit occurs at the contact between alaskite and siliceous skarn. Lapidary grade malachite has also been found at Cinco Piños, Cerro de Granadillo in Cerro El Burro, Chinandega Province, and Cerro De Cobre west of Yalaguina, Ocotal.

MRAZEK, I. (1989) Gemstones of Nicaragua. *Zt. Dt. Gemm. Ges.* 38, 1, p. 17–30, map.

MARBLE, *see* CALCITE

MARIPOSITE

California. Mariposite, provenance unstated but probably from California, was offered in *Lapidary Journal*, July, 1979 at $1.75 per pound by a gem dealer of Palm Springs, California.

KNOPF, A. (1929) The Mother Lode system in California. *U.S. Geol. Survey Prof. Paper* 157, 88 p. Notes occurrences in CA.
MITCHELL, J. R. (1986) *Gem Trails of California.* Baldwin Park, CA: Gem Guides Book Co., p. 118.
PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold. Mariposite p. 426–428.
RIEMAN, H. M. (1972) Mariposite. *Lapidary J.* 26, 8, p. 1186–1191.

MEERSCHAUM (SEPIOLITE)

New Mexico. The potentially valuable meerschaum resources are best described by Northrop (1959), who discusses the occurrences, geology, mineralogy, and economics.

BUSH, F. V. (1915) Meerschaum deposits of New Mexico. *Eng. & Min. J.* 99, p. 941–943.
NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ NM Press, p. 545–548.
PETAR, A. V. (1934) Meerschaum. *U.S. Bur. Mines Info. Circ.* 6780, 6 p.
ROBINSON, M. & ROBINSON, G. (1958) Meerschaum in the Gila Wilderness [NM]. *Lapidary J.* 22, 4, p. 546–549, illust.
STERRETT, D. B. (1908) The discovery of meerschaum in New Mexico. Abstr. *Science* 27, p. 892.
_____, (1908) Meerschaum in New Mexico. *U.S. Geol. Survey Bull.* 340, p. 466–473.

METABASALT WITH COPPER

PENNSYLVANIA. This massive, fine-grained rock is commonly called "cuprite" or "metarhyolite," but the more correct name would be metabasalt, inasmuch as it is metamorphosed basalt whose prevailing greenish color is owing to finely divided epidote and chlorite, according to Geyer, *et al* (1978). Copper is present in the form of small blebs which are surrounded by haloes of orange-red cuprite. In recent years several old mines and dumps have been opened to collectors on a fee basis.

BASCOM, F. (1896) The ancient volcanic rocks of South Mountain, Pennsylvania. *U.S. Geol. Survey Bull.* 136, 124 p., illust., maps.

GEYER, A. R., SMITH, R. C. & BARNES, J. H. (1978) Mineral collecting in Pennsylvania. *PA Topo. Geol. Survey Gen. Geol. Rept.* 33, p. 23–27.

LININGER, J. L. (1978) The native copper and piemontite localities of Adams County, Pennsylvania. *Rocks & Minerals* 53, 3, p. 140–143.

MARTIN, R. G. (1935) Lavas and minerals of Adams County, Pennsylvania, take fine polish. *The Mineralogist* 3, 10, p. 7–8.

STOSE, G. W. (1910) The copper deposits of South Mountain in southern Pennsylvania. *U.S. Geol. Survey Bull.* 430, p. 122–131.

STOSE, G. W. (1932) Geology and mineral resources of Adams County, Pennsylvania. *PA Geol. Survey, 4th Ser., Bull.* C-1, 153 p., maps.

WHERRY, E. T. (1911) The copper deposits of Franklin-Adams Counties, Pa. *Franklin Inst. J.* 171, p. 151–163.

MICROLITE

VIRGINIA. Penick (1992) notes a "flawlessly faceted microlite" from the Rutherford mines near Amelia, Amelia County, in the Smithsonian collection. This is probably the 3.7 carat gem cut by me during the time that the Rutherford Mine No. 2 was being operated by W. D. Baltzley with financial support from me and from another party. Penick also mentions a 0.6 ct gem in the collection of Frank Crayton, and others in the Baltzley collection.

HIDDEN, W. E. (1885) A transparent crystal of microlite. *Amer. J. Sci.* 30, p. 82.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26. Microlite p. 20–21.

SINKANKAS, J. (1968) Geology and mineralogy of the Rutherford pegmatites, Amelia, Virginia. *Amer. Mineral* 53, p. 373–405, illust., maps.

MILARITE

GUANAJUATO. This rare beryllium silicate, formula $K_2Ca_4Be_4Al_2Si_{24}O_{60}\cdot H_2O$, has been found in relatively large, yellow-green crystals in which small clear areas afford faceting material (Arem, 1987). Properties are specific gravity 2.46–2.61, hardness 5.5–6, refractive indexes omega 1.532–1.551, epsilon 1.529–1.548, difference 0.003, uniaxial (-).

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* NY: Van Nostrand Reinhold, 248 p., illust. (col.), p. 130.

MOJAVE STONE

CALIFORNIA. From an unspecified deposit in the Mojave Desert of Southern California, a rock called *Mojave Stone* was produced by a Missouri company in 1979. According to Zeitner (1979) the rock, displaying green and blue colors predominantly, owes its greens to brochantite, antlerite, and some pure albite, while bisbeeite, linarite, covellite and copper silicate minerals contribute to the blue. Some of the material has also been called Mojave Royal Blue, with both names herein copyrighted. The material was cut into cabochons that were set in a line of jewelry manufactured by the company. Rough was not offered for sale.

ZEITNER, J. C. (1979) Mojave Stone, gem of the desert. *Lapidary J.* 33, 9, p. 1896.

MIMETITE

MEXICO. As a curiosity, cabochons have been cut from this bright yellow to orangey-yellow arsenate mineral. Commonly growing in ball-like masses of acicular crystals are compact enough to cut, it is found in mines in Chihuahua but is especially fine in the mines of Mapimi, Durango. It is a member of the apatite group and its formula is $Pb_5(AsO_4)_3Cl$, with the following properties: hardness 3.5–4, specific gravity 7.24, refractive indexes omega 2.147, epsilon 2.128, difference 0.019, biaxial (-). According to Arem (1987, p. 131), the only faceted stones were cut from clear crystals found in Tsumeb, Namibia, many years ago.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 245 p., illust. (col.).

"MOHAWKITE," *see* ALGODONITE

MONTEBRASITE

MAINE. According to Bradshaw (1992, p. 27), "montebrasites from Maine were thought to be amblygonite, but recent analysis shows all reported occurrences are montebrasite with the exception of some of the material from the Mount Rubellite quarries in Hebron." King & Foord (1994, p. 240–244) provide a lengthy discussion of the identification problems and give details on the occurrences of montebrasite in the state. A colorless emerald-cut faceted gem of montebrasite from the Nevel Quarry, Newry, Oxford County, weighing 2.50 ct, is in the collection of the American Museum of Natural History, New York City; another faceted gem of 2.06 ct in the Harvard Mineralogical Museum was presumably cut from Newry material.

BRADSHAW, J .J. (*in press*) Gemstones of Maine. In KING, V. T., ed., *The Mineralogy of Maine.* Augusta, ME: Geol. Survey ME, excerpt of 21 p.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive Mineralogy. Geol. Survey ME, 418 p., illust. (col.).

PALACHE, C., RICHMOND, W. E. & WOLFE, C. W. (1943) On amblygonite. *Amer. Mineral.* 28, p. 39–53.

MORDENITE

NOVA SCOTIA. This zeolite-group mineral is named after its occurrence near Morden, Kings County, Nova Scotia. Its formula is $(Ca,Na_2K_2)(Al_2Si_{10})O_{24}\cdot 7H_2O$. Properties are: hardness 4-5, specific gravity 2.12–2.15; refractive indexes alpha 1.472–1.483, beta 1.475–1.485, gamma 1.477–1.487, difference 0.005; biaxial (+). Mostly occurs in nodular masses or vein fillings in the basalts which are widespread in Nova Scotia. Traill (1983, p. 248) gives several localities from which solid masses, suitable for cabochons, can be collected.

TRAILL, R. J. (1983) Catalogue of Canadian minerals. Rev. 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

MUSCOVITE

NEW MEXICO. A remarkably fine-grained rose-colored muscovite rock is sometimes found in the Harding Mine, Taos County; it has been used for cabochons and small ornamental objects, taking a fair to good polish, according to Jahns & Ewing (1977, p. 120). In some parts of the Harding granitic pegmatite it occurs in masses of considerable size and is of a "somewhat translucent and waxy appearance." The color is said to be due to the presence of lithium and makes it easily mistaken for lepidolite.

HEINRICH,E. W. & LEVINSON, A. A. (1953) Studies in the mica group; mineralogy of rose muscovites. *Amer. Mineral.* 38, p. 25–49.

JAHNS, R. H. & EWING, R. C. (1977) The Harding Mine, Taos County, New Mexico. *Min. Rec.* 8, 2, p. 115–126, illust., map.

RIMAL, D. N. (1962) Mineralogy of rose muscovite and lepidolite from the Harding pegmatite, Taos County, New Mexico. *Univ. NM unpubl. Ph.D. Dissert.*, 94 p.

SCHALLER, W. T. & HENDERSON, E. P. (1926) Purple muscovite from New Mexico. *Amer. Mineral.* 11, p. 5–6.

NARSARSUKITE

QUEBEC. This rare mineral, formula $Na_2(Ti,Fe^{+3})Si_4(O,F)_{11}$, first came to notice from its discovery in the Julianehaab district of southwestern Greenland (Bøggild, 1953, p. 318), where it occurs in considerable abundance but not in gem quality. However, at Mont Saint-Hilaire it has been found in crystals large and clear enough for faceted gems of very small size. Wight & Wight (1989, p. 100) record a 0.14 ct faceted gem in the Canadian National Gem Collection. The crystals are tabular to long prismatic, pale to bright yellow, green, gray, tan, brown, transparent to translucent. Properties are: hardness 6–7, specific gravity 2.64–2.83, uniaxial (+), refractive indexes omega 1.601–1.614, epsilon 1.632–1.647, difference 0.027–0.031 (Mandarino & Anderson, 1989, p. 149). Horvath & Gault (1990, p. 324–325) state that free-growing crystals are those most likely to be clear and occur as individuals of 1–4 mm, "exceptionally up to 2.5 cm" long.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Med. om Grønland* 149, 3, 442 p., illust., map.

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont Saint-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 281–368, illust. (col.).

MANDARINO, J. A. & ANDERSON, V. (1989) *Monteregian Treasures: The Minerals of Mont Saint-Hilaire, Quebec.* Cambridge, NY: Cambridge Univ. Press, 281 p., illust. (col.).

WIGHT, Q. & WIGHT, W. (1989) Art Grant: a cut above the rest. *Canad. Gemm.* 10, 4, p. 98–101, illust.

NATROLITE

QUEBEC. Among the truly remarkable minerals found in the quarries of Mont Saint-Hilaire is natrolite, which forms splendid, long-prismatic colorless to white crystals, some to as much as 15 cm (6 in) long and 1–2 cm (3/8–3/4 in) in diameter (Horvath & Gault, 1990, p. 325). From the clearest crystals flawless faceted gems have been cut that weigh as much as 9.65 carats. However, as E. Fritsch notes, most cut gems are under 5 carats (Koivula, *et al*, 1992). The properties are : hardness 5–5.5, specific gravity 2.25, refractive indexes alpha 1.479, beta 1.485, gamma 1.491, difference 0.012, biaxial (+) (Mandarino & Anderson, 1989, p. 151). This material was also examined by Schlüter (1993), who pictures a round brilliant gem of 4.3 carats and a 4 cm (1.6 in) long clear crystal. He gives properties as follows: H 5.5, G 2.26, RI alpha 1.477, beta 1.481, gamma 1.490, difference 0.013.

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont Saint-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 281–368.

KOIVULA, J. I., *et al* (1992) Rare gemstones from Quebec. Gem News, *Gems & Gemology* 28, 2, p. 134.

MANDARINO, J. A. & ANDERSON, V. (1989) *Monteregian Treasures: The Minerals of Mont Saint-Hilaire, Quebec.* Cambridge, NY: Cambridge Univ. Press, 281 p., Illust. (col.).

SCHLÜTER, J. (1993) Natrolith aus St. Hilaire, Quebec, Kanada. *Zs. Dt. Gemm. Ges.* 42, 1, p. 43–45, illust.

WIGHT, W. (1992) Checklist for rare gemstones—natrolite. *Canad. Gemm.* 13, 1, p. 14–17.

NEW JERSEY. In late 1972, a blast in the Chimney Rock Quarry, Somerset County, exposed more extremely large natrolite crystals in "great abundances," according to Sassen (1978). Some of the crystals were over 18 cm (7 in) long and nearly 3 cm (1.2 in) in diameter. It is estimated that over 5,000 terminated crystals were recovered from a pipe-like cavity, many about 5 cm (2 in) long. In 1993, natrolite rough from this quarry was offered in facet grade at $4 per carat for pieces of 1 to 5 cts, and $6 per carat for pieces of 10–15 cts. Arem (1987, p. 134) notes faceted stones over 20 carats. Dunn (1976) records single prisms of 1.5 x 17 cm (5/8 x 6½ in) and faceted gems in the Smithsonian collection of 9.31 and 7.9 ct.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).

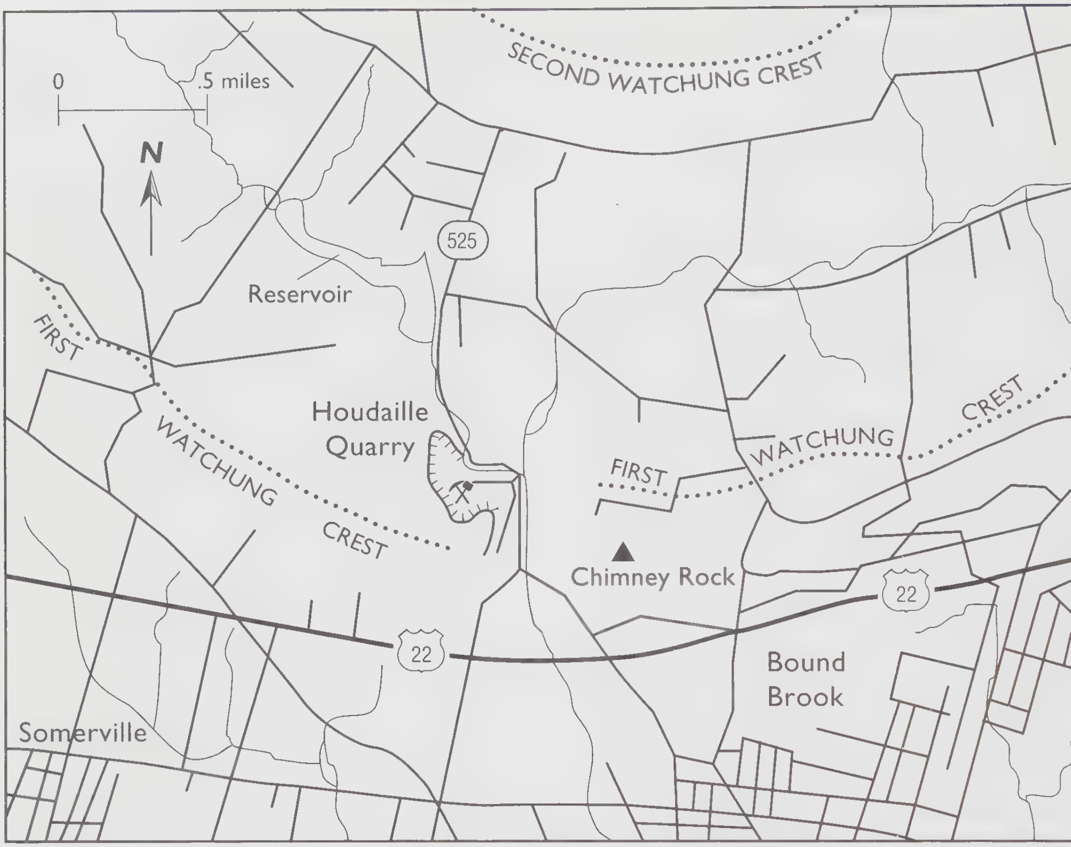

FIGURE 48. Site of the traprock quarry which produced facet-grade natrolite crystals in northern New Jersey.

BLISS, A. & DUFFY, R. (1973) Record-sized natrolite crystals. *Rock & Gem* 3, 5, p. 50–52, illust.

DUNN, P. J. (1976) Gemmological notes. *J. Gemm.* 15, 3, p. 113–118.

SASSEN, R. (1978) Natrolite and associated secondary minerals at Chimney Rock Quarry, Bound Brook, New Jersey. *Min. Rec.* 9, 1, p. 25–31, illust.

SINKANKAS, J. (1961) Natrolite from Houdaille Industries quarry, Bound Brook, Somerset County, New Jersey. *Amer. Mineral.* 46, p. 1195–1197. First report of facet grade natrolite.

BRITISH COLUMBIA. Even if it were allowed, the exhaustion of natrolite and sodalite from its deposit in the Ice River alkaline rock complex, Yoho National Park, southeastern British Columbia, is not likely in view of the rugged alpine terrain. Grice & Gault (1981) of the Canadian Museum of Nature, Ottawa, remark on the difficulties of access when they visited the locality in 1979. Their camp site was at 2,400 m (8,000 ft) altitude! They provide a map and photographs of scenery and show a crystal of colorless natrolite that is about 1.5 cm (3/4 in) long, obviously of facet quality.

ALLAN, J. A. (1914) Geology of Field map-area, B.C. and Alberta. *Geol. Survey Canada Mem.* 55, Geol. Ser. 46, 312 p.

GRICE, J. D. & GAULT, R. A. (1981) Edingtonite and natrolite from Ice River, British Columbia. *Min. Rec.* 12, 4, p. 221–230, illust., map.

PHILLIPS, A. H. (1916) Some new forms of natrolite. *Amer. J. Sci.* 4th. ser., 42, p. 472–474.

NAUJAITE

GREENLAND. Details on the locality furnishing this rock have already been supplied under KAKORTOKITE. According to Dragsted (1971), naujaite, named after the native term for seagull, "is a whitish rock of nepheline and feldspar containing numerous pastel green grains of sodalite and thus has very much the appearance of a seagull's egg. Further there may be dark green aegerine (acmite) and black arfvedsonite included. With red grains of eudialyte the naujaite forms a most attractive decorative rock." Like kakortokite, this rock has been used locally to manufacture cabochons and small ornaments.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Med. om Grønland* 149, 3. Eudialyte-containing rocks p. 245 ff.

DRAGSTED, O. (1971) Kakortokite—and other ornamental eudialyte rocks. *J. Gemm.* 12, 7, p. 312–315, color plate.

USSING, N. V. (1894) Mineralogisk-petrografiske undersøgelser af Grønlandske nefelinsyeniter og beslaegede bjergarter. *Med. om. Grønland* 14, p. 109–220, illust.

_____, (1911) Geology of the country around Julianehaab, Greenland. *Reprint: Med. om. Grønland* 38, 367 p., illust., maps.

NEPHELINE SYENITE,
see KAKORTOKITE, NAUJAITE

NEPHRITE, *see* JADE

NICKELINE, NICCOLITE

ONTARIO. The name niccolite is now superseded by nickeline; this massive silvery arsenide mineral, very handsome when polished, is still to be found in a number of mine dumps, associated with smaltite and safflorite, in the Cobalt area, as detailed by Sabina (1974).

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, p. 136.

HEWITT, D. F. & FREEMAN, E. B. (1972) Rocks and minerals of Ontario. *Ont. Dept. Mines Geol. Circ.* 13, p. 37.

SABINA, A. P. (1974) Rocks and minerals for the collector: Cobalt-Belleterre-Timmins, Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, p. 17–37, map.

TRAILL, R. J. (1983) Catalogue of Canadian minerals. Rev. 1980. *Geol Survey Canada Paper* 80-18. Localities p. 256–257.

NIFONTOVITE

SAN LUIS POTOSI. I am informed by Dr. F. H. Pough (*Pers. comm.* 3/94) that this rare calcium borate, found before only in the Turinsk region of the northern Urals (Roberts, *et al*, 1990, p. 608), has now been found in the Charcas mines as 1+ cm colorless and clear crystals which can be faceted into small gems.

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R. (1990) *Encyclopedia of Minerals.* 2nd edit. NY: Van Nostrand Reinhold, 979 p., illust. (col.).

NOVACULITE

ARKANSAS. No new developments.

GRISWOLD, L. S. (1890) The novaculites of Arkansas. Abstr: *Amer. Assoc. Adv. Sci. Proc.* 39, p. 248–250.

_____, (1892) *Annual Report of the Geological Survey of Arkansas for 1890,* vol. 3, whetstones and novaculite of Arkansas, 443 p., illust.

HOLMES, W. H. (1891) Aboriginal novaculite quarries in Garland County, Arkansas. *Amer. Anthropologist,* Oct., p. 313–316, illust.

JENNEY, W. P. (1891) Ancient novaculite mines near Magnet Cove, Hot Springs County, Arkansas. *Amer. Anthropologist,* Oct., p. 316–318.

REDFIELD, J. S. (1927) Mineral resources in Oklahoma. *OK Geol. Survey Bull.* 42, 130 p., maps. Comparable novaculite sources.

RUTLEY, F. (1894) On the origin of certain novaculites and quartzites. *Geol. Soc. London. Quart. J.* 1, p. 377–392. Includes U.S.A.

NUUMMIT, *see* AMPHIBOLE

OBSIDIAN

There is no foreseeable shortage of the North American lapidary grade obsidians which are being mined from extensive deposits in the western United States and Mexico. From the latter country come rudely carved figurines of mythical Aztec deities which are distributed to souvenir and rock shops everywhere. In contrast, Eduardo Olbés, operating the La Iguana de Oriente lapidary crafts shop in Mexico, takes up modern motifs to create sculptures in Mexican obsidian that are impressive both in size and artistic merit (Olbés, 1991). On the archaeological side of obsidian, Taylor (1976) brings together numerous papers which discuss how studying the surface alteration of obsidian artifacts can lead to their dating, and how the chemistries of various obsidians in the artifacts can possibly relate them to specific obsidian deposits. For purposes of sculpture, obsidian offers an abundance of very uniform material, often in large sizes, and predictable workability, if one does not attempt thin, fragile protuberances which can easily break off in a moment's inattention. Among the interesting developments is the sectioning and polishing of certain obsidians from Mexico and elsewhere which can be cleverly oriented to display the striking lineations of inclusions which give rise to colored bands. These obsidians are often cut into geometric solids as paperweights, bookends, etc. Some general references applicable to North American obsidians are listed below.

CARLE, J. T. (1966) A telescope mirror of obsidian. *Gems & Minerals* 345, p. 25–26.

HEIZER, R. F., WILLIAMS, H. & GRAHAM, J. A. (1965) Notes on Mesoamerican obsidians and their significance in archaeological studies. *Univ. CA Archaeol. Facility, Contrib.* 1, p. 94–103, map.

HOLMES, W. H. (1919) Handbook of aboriginal American antiquities. Part 1, Introductory, the lithic industries. *Smithsonian Inst. Bur. Amer. Ethnol. Bull.* 60, 380 p., illust., maps.

LAUDERMILK, J. (1945) Glittering stone of the Aztecs. *Desert Mag.* 8, 9, p. 13–16. illust.

MASON, J. A. (1927) Mirrors of ancient America. *Univ. PA Mus. J.* 18, p. 201–209.

MEISINGER, A .C. (1985) Perlite. Preprint: *U.S. Bur. Mines Bull.* 675, 7 p.

OLBÉS, E. (1991) Obsessed with obsidian. *Lapidary J.* 45, 5, p. 20–24, illust. (col.).

ROSS, C. S. (1961) Ash-flow tuffs: their origin, geologic relations and identification. *U.S. Geol. Survey Prof. Paper* 366, 81 p., illust. (col.). Includes obsidians.

TAYLOR, R. E., ed. (1976) *Advances in Obsidian Glass Studies: Archaeological and Geochemical Perspectives.* Park Ridge, NJ: Noyes Press, 360 p., illust.

VAN LANDINGHAM, S. L. (1962) Obsidian and other volcanic glasses. *Gems & Minerals* 295, p. 22–25, map.

ZEITNER, J. C. (1990) Obsidian. *Lapidary J.* 43, 12, p. 43–50, illust. (col.).

TEXAS. No new developments.

GIRARD, R. M. (1964) Texas rocks and minerals. *TX Bur. Econ. Geol. Guidebook* 6, 109 p. Big Bend obsidian p. 77.

KING, E. A. (1961) Texas gemstones. *TX Bur. Econ. Geol. Rept. Invest.* 42, 42 p., illust. Obsidian in Presidio Co., p. 24.

WYOMING. No new developments.

FOSHAG, W. F. (1926) The minerals of Obsidian Cliff, Yellowstone National Park and their origin. *U.S. Nat. Mus. Proc.* 68, art. 17, p. 1–18, illust.

HOLMES, W. H. (1878) Notes on an extensive deposit of obsidian in the Yellowstone National Park. *Amer. Naturalist* 13, p. 247–250.

IDDINGS, J. P. (1888) Obsidian Cliff, Yellowstone National Park. *U.S. Geol. 7th. Ann. Rept., for 1885–1886*, p. 249–295, illust.

NEW MEXICO. Apache Tears, very suitable for gem purposes, are found in the area of Bear Springs at the southern end of the Jemez Mountains, Sandoval County, due west of Santa Fe (Mitchell, 1987, p. 36; Murphy, 1966). Murphy particularly draws attention not only to the various types of Apache tears to be found here, but also to interesting hexagonal inclusions which create a cat's-eye effect in cabachons (*Pers. comm.* 11/28/1994). The inclusions are "swarms of tiny, hexagonal plates that are flow oriented in the highly transparent obsidian. These crystals glow blue in good light, but are invisible when back-lighted under a petrographic microscope." Murphy suggests that the inclusions are minute tridymite sixling twin crystals.

Obsidian is also found at many places along Rio Puerco north of the place where it crosses Route 40, about 19 mi (30 km) west of Albuquerque in Bernalillo County. However, the major source for tears is centered just west of Mule Creek in Grant County, on the boundary with Arizona (Mitchell, *Ibid.*, p. 82–3; Kimbler & Narsavage, p. 21). Tears are also reported from the south flank of Grants Ridge, about 9 mi (14 km) east-northeast of Grants, Valencia County. Transparent tears are said to be plentiful south of Las Cruces, Dona Ana County, and at a place about 5 mi (8 km) west of the road leading from Mesilla (Alfredo, 1951).

ALFREDO, D. (1951) Apache tears and other mineral oddities from the Mogollon Mountains, New Mexico. *Rocks & Minerals* 26, 3–4, p. 138–143.

BOYER, W. W. & ROBINSON, P. (1956) Obsidian artifacts of northwestern New Mexico and their correlation with sources material. *El Palacio* 63, p. 333–345, illust.

KIMBLER, F. S. & NARSAVAGE, R. S. (1981) *New Mexico Rocks & Minerals.* Santa Fe, NM: Sunstone Press, 71 p., maps.

McMACKIN, C. E. (1983) Springtime and tears. *Lapidary J.* 37, 9, p. 1304–1308. Mule Creek.

MITCHELL, J. R. (1987) *Gem Trails of New Mexico.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

MURPHY, M. O. (1966) Star studded Jemez. *Lapidary J.* 20, 2, p. 366–368, 370–374, illust., maps.

______, (1966) The reluctant stars. *Ibid.* 20, 7, p. 882-883, illust.

SIMPSON, B. W. (1961) *New Mexico Gem Trails.* Granbury, TX: Gem Trails Publ. Co., 88 p., illust., maps. Rio Puerco & Mule Creek areas.

UTAH. The principal deposits of lapidary grade obsidian (jet black, snowflake, mahogany) in Utah lie in areas located east of Highway 257 in Millard County. Specific directions for reaching them are in Mitchell (1983, 1987). The southernmost deposit, a short distance northeast of Black Rock, is the source of the well-known snowflake obsidian, for which material a brisk demand continues. As late as 1990, snowflake obsidian was being quarried from the large bed near Coyote Springs in the Black Rock area. Some was also being produced from a deposit in Box Elder County.

MITCHELL, J. R. (1983) Apache tears and gem obsidian south of Delta, Utah. *Lapidary J.* 37, 1, p. 118–121, map.

______, (1987) *Gem Trails of Utah.* Baldwin Park, CA: Gem Guides Book Co., 111 p., illust., maps, p. 66–67, map.

SPENDLOVE, E. (1975) Snowflake obsidian. *Rock & Gem* 5, 2, p. 14–18, map.

______, (1987) Black Rock obsidian. *Rock & Gem* 17, 9, p. 8–10, 73, map.

STOWE, C. *et al* (1977) *Collector's Guide to Mineral and Fossil Localities in Utah.* UT Geol. Min. Survey, 112 p., maps, p. 84.

ARIZONA. In addition to localities previously described in this state, Sorenson (1961) gives directions to a collecting area for Apache tears located south of Gila Bend, Maricopa County, via Highway 85 and a side road leading to Black Mesa and Javelina Camp; the area is within a U.S. Air Force gunnery range and prior permission to enter must be obtained.

BUDDHUE, J. D. (1937) Arizona obsidianites. *The Mineralogist* 5, 7, p. 14.

DUKE, A. (1956) *Arizona Gem Fields.* Yuma, AZ: priv. publ., p. 28, 30, 34.

HOUGE, N. L. (1964) Apache agate and tears. *Gems & Minerals* 326, p. 24–25.

KONING, M. (1980) *Prospecting for Gem Stones in Arizona and the Southwest.* Phoenix, AZ: priv. publ., p. 118–121.

MERRIAM, R. (1988) *Arizona Minerals and How to Find Them.* Tucson, AZ: Treasure Chest Publications, p. 34–35, 46, 47.

MOORE, H. R. (1961) Apache tears. *Arizona Highways* 37, 7, p. 8–11, illust.

MORRIS, L. (1960) Apache tears. *Desert Mag.* 23, 3, p. 40-41, illust.

RICHARDS, R. A. (1956) Arizona obsidian notes. *Rocks & Minerals* 31, 11–12, p. 585.

SIMPSON, B. W. & SIMPSON, H. M. (1984) *Gem Trails of Arizona.* Pico Rivera, CA: Gem Guides Book Co., p. 26, 46, Burro Creek.

SORENSON, C. (1961) Sauceda Mountain gem trails. *Desert Mag.* Oct., p. 37–40, maps.

ZEITNER, J. C. (1963) Apache tears plentiful. *Lapidary J.* 16, 10, p. 938–940, illust.

ALASKA. In addition to various deposits of obsidian in the Aleutian Islands, especially on Unalaska Island, it is also found along Mazuma and Glass creeks in the Talkeetna Mountains (Roy, 1986, map 4), located northeast of Anchorage. Schoonover (1964) reported obsidian in a large area in a remote part of Mount McKinley National Park.

ROY, S., ed. (1986) *Alaska, A Guidebook for Rockhounds.* Anchorage, AK: Chugach Gem and Mineral Soc., 32 maps.

SCHOONOVER, M. (1964) Sourdough rockhounding. *Lapidary J.* 18, 1, p. 164–169.

YUKON TERRITORY. Sabina (1965) reports obsidian from several places in the Kaskawalsh and Steele (Wolf) creeks area in the Kluane Lake-Whitehorse district.

SABINA, A. P. (1965) Rock and mineral collecting in Canada: Vol. I. Yukon, Northwest Territories, etc. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps.

WASHINGTON. Basaltic glass, some suited for cabochon work, is reported from a pillow basalt field located about 7 mi (11 km) downstream from Lewiston, Idaho, on the north side of the Snake River (Ream, 1985, p. 65). The material is "black, brown, blue, lavender and white in color, and several colors may be mixed in one specimen . . . most of it is extremely hard and takes an excellent polish."

REAM, L. R. (1985) *Gems and Minerals of Washington.* Renton, WA: Jackson Mountain Press, 217 p., illust., maps.

OREGON. The celebrated Glass Butte, altitude 6,385 ft (1,946 m), essentially a solid mass of obsidian, is located about 12 mi (19 km) southeast of Hampton in the northeast corner of Lake County; it is easily reached via Highway 20. In their varieties and characteristics, the obsidians found here closely resemble the equally famous obsidians of the Davis Creek area of Modoc County, California. Specific collecting sites are minutely described by Foerster (1991), who pinpointed his positions by use of a portable LORAN navigational device, pinpointing his positions in coordinates of latitude and longitude. Here occur such well-known obsidian varieties as flame, gold sheen, mahogany, silver sheen, and numerous mixed-pattern types, all of outstanding lapidary quality. Foerster notes that "there are many more locations at which to collect" and that the obsidian found here and in the Davis Creek area "are the best that can be collected anywhere."

In a different region of the state, Amstutz & Wang (1981) describe a snowflake obsidian from the Cascade Range in the Three Sisters Mountains area, probably the locality mentioned in Volume 2 as Obsidian Ridge, on the crest between North Sister and Middle Sister mountains, Deschutes County, about 25 air miles (40 km) west-northwest of Bend (Williams, 1916). Other important deposits of obsidian in this county occur between Paulina Lake and East Lake; the area is reached from Bend by going 22 mi (35 km) on Highway 87, then turning east on County Road 21 for about 13 mi (21 km) (Mitchell, 1992, p. 44–45). The latter author also mentions obsidian in the mountains around Hines, especially north of this community via minor roads (*Ibid.*, p. 56-57).

ADAMS, D. L. (1953) Obsidian, Oregon's volcanic gem. *Mineral Notes & News* 191, p. 7, 51, map.

AMSTUTZ, G. C. & WANG, N. (1981) Ein "Schneeflocken-Obsidian" aus dem Cascadengebirge von Oregon, Nordamerika. *Zt. Dt. Gemm. Ges.* 30, 3–4, p. 226–229.

FORBES, P. L. (1934) Iridescent obsidian in Oregon. *Rocks & Minerals* 9, 8, p. 112-113.

______, (1935) Iridescent obsidian. *The Gemmologist* 4, p. 306–309.

FOERSTER, R. (1991) Not just a black stone. *Lapidary J.* 45, 5, p. 63–70, maps.

GILLIAM, J. (1976) Glass Buttes obsidian. *Lapidary J.* 30, 5, p. 1320–1323, map.

HEFLIN, E. (1963) Oregon's Glass Buttes . . . prehistoric munitions factories. *Lapidary J.* 17, 8, p. 818–821, map.

_____, (1979) Oregon's incredible Glass Buttes. *Gems & Minerals* 503, p. 72–75, 80–81, 83, map.

MITCHELL, J. R. (1989) Oregon obsidian. *Rock & Gem* 19, 6, p. 22–24, 26, 28, maps.

_____, (1989) *Gem Trails of Oregon.* Pico Rivera, CA: Gem Guides Book Co., 119 p., illust., maps, p. 44, 52.

_____, (1990) Southeast Oregon. *Rock & Gem* 20, 8, p. 60–62, 64–67, map. Includes obsidian.

OREGON MINERALOGIST (1933) Iridescent Oregon obsidian. 1, 3, p. 5.

WILLIAMS, I. A. (1916) Glaciers of the Three Sisters. *Mazama* 5, p. 14–23. Obsidian.

NEVADA. Obsidian in the form of Apache tears is abundant in a number of areas in the state. Mitchell (1991, p. 38–39) describes four sites in the extreme northwestern corner of the state in Humboldt County along the road that leads northeast from Cedarville (in California) to Highway 40. The material is rated as "top quality gem obsidian and Apache tears." Fish Lake Valley is also noted for its abundance of tears, some of facet grade (Weight, 1950; Henry, 1954; Mitchell, 1991, p. 86–87). Strong (1971, p. 7) notes that they range from pea- to tennis-ball-sized, and are of exceptional quality in banded, flow, brown, mahogany and silver sheen varieties. Obsidian is also found to the west of this area near the California border and north of Highway 6 in the southwest corner of Mineral County (Strong, 1971, p. 5). The Montezuma Mountains that lie west-southwest of Tonopah in Esmeralda County furnish Apache tears (Strong, 1972; Ransom, 1962). Another tear collecting site is given as Crow Springs, Esmeralda County, about 25 mi (40 km) west-northwest of Tonopah and reached via Highway 6/95 (Strong, 1974). In Nye County, abundant small but gemmy tears are found in an area about 8 mi (13 km) south of Scotty's Junction on Highway 96 (Mitchell, 1991, p. 105).

BERKHOLZ, M. F. (1961) Montgomery Pass gem fields. *Gems & Minerals* 285, p. 25–26, map.

_____, (1963) Obsidianites of Fish Lake Valley. *Gems & Minerals* 304, p. 20–22, illust., map.

HENRY, D. J. (1953) *The Rock Collector's Nevada and Idaho.* Long Beach, CA: Lowell R. Gordon, 72 p., illust., maps, p. 31, 32.

KLEIN, J. (1983) *Where to Find Gold & Gems in Nevada.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

MITCHELL, J. R. (1981) The Sump. *Gems & Minerals* 529, p. 34–38, map.

_____, (1991) *Gem Trails of Nevada.* Baldwin Park, CA: Gem Guides Book Co., 119 p., illust., maps.

RANSOM, J. E. (1962) Silver and obsidian at Montezuma. *Gems & Minerals* 292, p. 18–19, 55, illust., map.

SHEDENHELM, W. R. C. (1979) Queen Valley obsidian. *Rock & Gem* 9, 2, p. 36, 37, 40.

STRONG, M. F. (1972) Montezuma's treasures. *Desert Mag.* 25, 12, p. 8–11, map.

_____, (1974) Nevada's Crow Springs. *Desert Mag.* Aug., p. 20–23, map.

WEIGHT, H. O. (1950) "Volcanic tears" on Nevada desert. *Desert Mag.* 13, 11, p. 14–18, illust., map.

_____, (1951) Gem hunt on a ghost town trail. *Desert Mag.* 14, 7, p. 13–17, illust., map.

CALIFORNIA. The Mineral Information Service (1951) lists many places in the state where obsidian of lapidary grade is to be found, but by far the most important deposits, perhaps in all of the United States, are those located in Modoc County in the extreme northeastern corner of the state. These are generally located east of Highway 395, about 22 mi (35 km) northeast of Alturas. Here the altitudes range between 5,000 and 7,000 ft (1,525–2,135 m). The best recent account of the diggings is by Foerster (1991), who provides a mileage map to the many localities from which may be collected the sheen obsidians, also those displaying swirled patterns and multicolor bands. The sheens include silvers and golds, the varicolored banded types are called "rainbows," and there are also basic colors such as blue, dark green, and of course dead-black. Some of the obsidian is remarkably transparent and displays alternating bands of pale grayish clear material and dead-black. Flawless blocks of black obsidian can be obtained that commonly weigh about 150 lb (68 kg) and one may even find them weighing as much as 500 lb (225 kg). As in the case of Oregon, much commercial mining of obsidian has taken place here in the past.

In this regard the authorities of Modoc National Forest, Warner Mountain District Ranger Headquarters, Cedarville, California, promulgated rules to provide for orderly collecting by private parties and by commercial collectors (*Lapidary J.* 47, 2, 1993, p. 6). The following collecting sites are posted, and collecting is restricted to them: Rainbow Mine, Pink Lady Mine, Obsidian Needles Area, and Rainbow Obsidian Area. Both Foerster (1991) and Ferguson (1979) provide sketch maps that show these locations. Prior to collecting, permits must be obtained from headquarters in Cedarville, along with a copy of the rules that regulate collecting activity and limit the amounts collected (maximum amount is 500 lb (225 kg) per year). Commercial collectors are required to enter into a contract with the forest authorities, being charged $12 per ton, with a minimum charge of $24 per contract. As in the famous deposits in Oregon, the resources are virtually limitless.

In Lake County, dead-black obsidian is found at Clear Lake, Lower Clear Lake, and on Cole Creek. Hudson (1985) describes occurrences along Bottle Rock Road, beginning at a point about 4 mi (6.3 km) south of Kelseyville. (*See also* directions to these localities in Mitchell, 1986, p. 119). In Napa County an obsidian found on Glass Mountain, several miles northeast of St. Helena, is so intensely black that one cannot see light through a slice only 1 mm (1/25 in) thick! Shedenhelm (1976) reports enormous quantities of obsidian at Obsidian Dome, about 3.5 mi (5.5 km) south of June Lake Junction on Highway 395, or about 52 mi (83 km) north of Bishop in Mono County. Abundant varicolored Apache tears or "obsidianites" occur on the surface in an area southeast of Independence, Inyo County, opposite the Owens River Aqueduct intake (Strong, 1965). Farther south, in the Little Lake area, just east of Highway 395, Obsidian Ridge has furnished much good material, but since it is on the U.S. Naval Ordnance Test Station, permission to collect must be obtained. Among mineral collectors this occurrence is best known for micromount crystals that occur in the ball-like inclusions in the black obsidian (Wright, 1916). Some good lapidary grade obsidian has been found in the area immediately east of Ludlow 1.5 mi (2.4 km), and south of the old highway in San Bernardino County. Another field for Apache tears is located farther east at a place about 3 mi (4.8 km) north-northeast of Bagdad on Highway 66 (Strong, 1971).

BAILEY, E. H., ed. (1966) Geology of Northern California. *CA Div. Mines Geol. Bull.* 190, 508 p., map.

CARLE, J. T. (1966) A telescope mirror of obsidian. *Gems & Minerals* 345, p. 25–26. Glass Mountain.

COLHOUR, O. M. (1967) So this is obsidian? *Lapidary J.* 21, 1, p. 37–39, 41, illust. (col.). Carvings in varicolored Modoc Co. material.

DAVIS, F. F. (1947) Mines and mineral resources of Napa County, California. *CA Div. Mines Geol.* vol. 44, 2, p. 159–188, map.

DEATHERAGE, W. A. (1976) A rainbow that didn't get away. *Lapidary J.* 29, 11, p. 2138–2140.

DUFFIELD, A. (1983) The red & black obsidians of the Warner Mountains. *Gems & Minerals* 550, p. 16–19.

FERGUSON, R. W. (1979) Five-day field trip to Davis Creek. *Lapidary J.* 32, 10, p. 2164–2174, illust. map.

FOERSTER, R. (1991) Not just a black stone. *Lapidary J.* 45, 5, p. 63–70, maps.

GEMS & MINERALS (1966) [Commercial collecting at Royal Purple Mine, Modoc Co.] No. 343, p. 23, map.

HENRY, D. J. (1957) *California Gem Trails.* Long Beach, CA: Lowell R. Gordon, 3rd edit.

HUDSON, S. (1985) Bottle Creek obsidian. *Rock & Gem* 15, 9, p. 48–51, map.

MINERAL INFORMATION NEWS (1951) Obsidian. CA Div. Mines, vol. 4, no. 10, p. 1–4, illust. Localities throughout the state.

MITCHELL, J. R. (1986) *Gem Trails of California.* Baldwin Park, CA: Gem Guides Book Co. Various localities throughout the state.

____, (1987) Gem obsidian & banded rhyolite. *Rock & Gem* 37, 10, p. 64–67, maps.

______, (1991) *Gem Trails of Nevada.* Baldwin Park, CA: Gem Guides Book Co. Includes northeast California obsidian.

PETERS, M. L. (1976) California gemstones: gems and Indians. *Lapidary J.* 30, 1, p. 238–249, illust., maps. Obsidian used by.

REED, B. L. (1965) Where the mountain turned to glass. *Desert Mag.* 28, 7–8, p. 8–9. Glass Mt.

ROBERTSON, D. (1973) Rainbow obsidian in the Warner Mountains. *Rockhound* 2, 1, p. 6–8. illust., map.

SHEDENHELM, W. R. C. (1976) Obsidian Dome. *Rock & Gem* 6, 11, p. 16–18.

STOVER, B. D. (1973) California's obsidian country. *Gems & Minerals* 432, p. 23–34, map.

STRONG, M. F. (1964) Obsidian Ridge in Coso Range. *Gems & Minerals* 320, p. 16–18.

______, (1971) *Desert Gem Trails.* 2nd edit. Mentone, CA: Gembooks, p. 57–60.

______, (1972) Rainbow obsidian. *Desert Mag.* 35, 6, p. 18–21, illust, col., map.

______, (1979) Collecting at Crystal Cove. *Desert Mag.* July, p. 8–11, map. Inyo Mts.

WEIGHT, H. O. (1949) Grey jewels of Bagdad. *Desert Mag.* 13, 1, p. 13–18, illust., map.

WRIGHT, D. G. (1936) New California iridescent obsidian. *The Mineralogist* 4, 1, p. 14.

WRIGHT, F. E. (1916) Note on the lithophysae in a specimen of obsidian from California. *J. Wash. [D.C.] Acad. Sci.* 6, 12, p. 367–369.

MEXICO. Obsidian is truly abundant in many Mexican states, according to Zeitner (1967), who visited many of the localities and described them in her authoritative article in the *Lapidary Journal.* They are to be found in San Luis Potosi, Queretero, Guadalajara, Hidalgo, Veracruz, Jalisco, Michoacan, and Puebla. Active quarrying of the limitless material supplies the market today, as one can readily appreciate from visiting almost any souvenir shop in Mexico and many across the border in the United States.

An important and welcome development in the Mexican crafts industry is the production of "limited edition" works of art and ornaments carved from these obsidians by the company La Iguana de Oriente, based in Tepoztlan, Morelos. The company employs several carvers and subcontracts work to other stone-carving cooperatives. Modern machinery and finishing methods are used to produce such objects as tequila glasses, sake cups, flower vases, and sculptures, some of considerable size. The obsidians are obtained from Hidalgo and Queretaro, which states supply black, gray, and gold sheen types; there is also black obsidian from Cordoba in Veracruz and from Chihuahua and Coahuila (Olbés, 1991). A particularly splendid rainbow obsidian is obtained in Jalisco and is further described below. Olbés mentions that "by the middle of 1990, we had produced 1,500 tequila cups, 500 bamboo vases, 150 each of the cactus, organ, and Gothic vases, plus innumerable other designs produced in quantities of one to six pieces."

In the state of Jalisco, a truly remarkable color-layered obsidian is found which strongly reflects many hues of the rainbow when cut at the proper inclination to the banding. It is said to come from a remote area "that is reached by an eight- to 10-hour drive northwest from the city of Magdalena" (Koivula, *et al*, 1993). This material is being cut and polished into a variety of geometrical shapes whose planar sides are designed to display the surprisingly vivid color effects to their best advantage (McCarthy, 1993). Typical pieces were displayed by their carver, Kevin Lane Smith, at the Tucson Show, February, 1993. Smith estimated at that time that about 30 tons of the obsidian had been recovered, almost all with iridescence, but only about 10% displaying the best color banding.

BRETON, A. (1902) Some obsidian workings in Mexico. *Internat. Congress Americanistes Proc. XIII Sess., N.Y.*, p. 265–268.

BROUGHTON, P. L. (1968) Peanut obsidian from Sonora, Mexico. *J. Gemm.* 11, 1, p. 709, illust.

EDMONS, F. (1835) On specimens of obsidian from the Mountain of Real del Monte, Mexico. *Proc. Geol. Soc. London* 2, p. 686.

HEIZER, R. F., WILLIAMS, H. & GRAHAM, J. A. (1965) Notes on Mesoamerican obsidians and their significance in archeological studies. *Univ. Calif. Archeol. Facility Contrib.* 1, p. 94–103, map.

HESTER, T. R. (1978) *Archaeological studies of Mesoamerican obsidian.* Socorro, NM: Ballena Press, 210 p., illust.

HOLMES, W. H. (1900) The obsidian mines of Hidalgo, Mexico. *American Anthropologist* 2, p. 405–416.

KOIVULA, J. I., *et al*, eds. (1993) Banded iridescent obsidian. Gem News. *Gems & Gemology* 29, 2, p. 133, illust. (col.).
McCARTHY, C. (1993) Chasing rainbows. *Lapidary J.* 47, 5, p. 22–27, illust.
OLBÉS, E. (1991) Obsessed with obsidian. *Lapidary J.* 45, 5, p. 20–24, illust.
ORDOÑEZ, E. (1893) Algunas obsidianas de Mexico. *Soc. Alzate, Mem.* 6, 1892-93, p. 33–45, illust.
RUTLEY, F. (1891) On a spherulitic and perlitic obsidian from Pilas, Mexico. *Geol. Soc. London Quart. J.* 47, p. 530–533, illust.
TAYLOR, R. E., ed. (1976) *Advances in Obsidian Glass Studies: archaeological and geochemical perspectives.* Park Ridge, NJ: Noyes Press, 360 p.
TENNE, C. A. (1885) Ueber Gesteine des Cerro de la Navajas (Messerberg) in Mexico. *Dt. Geol. Ges. Zs.* 37, p. 610–620.
WASHINGTON, H. S. (1921) Obsidian from Copan and Chichen Itza. *Wash. [D.C.] Acad. Sci. J.* 11, 20, p. 481–487.
ZEITNER, J. C. (1967) The obsidians of Mexico. *Lapidary J.* 20, 10, p. 1194–1203, illust.

GUATEMALA. No new developments.

COE, M. D. & FLANNERY, K. V. (1964) The pre-Columbian obsidian industry of El Chayal, Guatemala. *American Antiquity* 30, p. 43–49.
HEIZER, R. F., *et al*, (1965) *See above.*
HESTER, T. R. (1978) *See above.*
WILLIAMS, H., McBURNEY, A. R. & DENGO, G. (1964) Geologic reconnaissance of southeastern Guatemala. *Univ. Calif. Publs. Geol. Sciences* 50. Obsidian occurrences near Ixtepeque volcano.

NICARAGUA. No new developments.

PETERSON, J. (1898) Marekanit-Obsidian aus Nicaragua. *N. Jb. Min.* 2, p. 156–159, illust.

OIL SHALE

COLORADO. Among the more exotic materials that have been used in the lapidary arts is oil shale. This rock has been seriously considered as a source of petroleum; its supplies appear to be inexhaustible. According to Voynick (1989), oil shale "will take a reasonable polish," being very fine-grained and compact. The material can be collected at many places wherever the shale outcrops along Interstate Highway 70 between Grand Junction and Glenwood Springs in Mesa and Garfield counties.

HENDERSON, C. (1976) He cuts oil shale. *Rock & Gem* 6, 9, p. 88–91
VOYNICK, S. (1989) Colorado oil shale. *Rock & Gem* 19, 3, p. 40–43, 45–47, map.

ONYX, CALCITE, *see* CALCITE

OPAL

Precious opal and common opal, the latter usually in the form of wood replacements, continue to be produced in North America, with new finds recorded in British Columbia, Idaho, Nevada, and California (Downing, 1992). An excellent survey of types of opal deposits in the United States was published by Zeitner (1986). Precious opal mining has been resumed in Oregon, and a blue-body-color precious opal has been found in limited quantities in Arizona. A remarkable precious opal filling between grains of a sandstone rock found in Louisiana has recently made its appearance on the market.

Despite claims made from time to time that a method has been found to stabilize precious opal, usually calling for the soaking of the opal rough in some sort of silica-containing solution, the fact remains that nothing appears to halt the cracking of certain opals once they are taken out of the ground and exposed to ordinary surface conditions. Cracking, most likely due to loss of water, is liable to happen in almost any opal, including Australian. Where doubts exist as to the stability of newly mined opal, it is the practice to set such pieces aside for some months or even a year or so to allow them to "adjust" to their new environment. Even better, the opals should be preformed and then allowed to season. Those pieces that are uncracked may be expected to remain uncracked after they have been finished and polished.

The so-called "Arctic opal" that I saw in 1993 for sale in various Alaskan curio shops is actually a massive, plastic-impregnated azurite/malachite mixture! General references to opal in North America appear below.

AITKENS, I. (1931) Opals. *U.S. Geol. Survey Info. Circ.* 6493, 9 p.

DOWNING, P. B. (1986) World opal supply and prices. *Rock & Gem* 16, 9, p. 20, 21, 23.

_____, (1992) *Opal Identification and Value.* Tallahassee, FL: Majestic Press, 210 p., illust. (col.).

_____, (1992) New opal discoveries. *Rock & Gem* 22, 10, p. 42–46, illust. (col.). B.C., ID, NV, CA.

EYLES, W. C. (1964) *The Book of Opals.* Rutland, VT: Charles E. Tuttle, 224 p., illust. (col.).

FOSHAG, W. F. (1933) Opals in the United States National Museum. *Rocks & Minerals* 8, 1, p. 9–10. U.S. & Mexico specimens.

LEECHMAN, F. (1961) *The Opal Book.* Sydney, NSW: Ure Smith, 255 p., illust. (col.).

MINERAL COLLECTOR (1899) American opal mines. Vol. 6, 7, p. 122–123.

_____, (1901) American opals. Vol. 8, 5, p. 76-77.

MITCHELL, R. S. & TUFTS, S. (1973) Wood opal—a tridymite-like mineral. *Amer. Mineral.* 58, p. 717–720.

NORTHWEST MAGAZINE (1901) Opals from the west. Vol. 19, 9, p. 61.

ROCKS & MINERALS MAGAZINE (1933) Special opal number. Vol. 8, l. Includes opals of the U.S.

SINKANKAS, J. (1971) Opal. *Rock & Gem* 1, 1, p. 38–47.

ZEITNER, J. C. (1986) Precious opal in the United States. *Lapidary J.* 40, 3, p. 42–48, illust. NV, ID, CA, OR, NM, TX.

GREENLAND. Bøggild (1953, p. 126) mentions only one locality for precious opal: on Hare Island in the Umanak District, where it occurs at times in hyalite opal seams or cavities in basalt.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Meddelelser om Grønland* Bd. 149, 3, 442 p., map. illust.

NEW JERSEY. Precious opal may occur wherever basalt contains mineralized gas cavities, as in several occurrences in northern New Jersey which were brought to my attention by Rich & Tresa Kosnar of Golden, Colorado, who had collected extensively in New Jersey before settling in the West. Along Highway 46, Pine Brook, Morris County, they record an orange-red, translucent fire opal nodule of 7.5 x 5 x 4.5 cm (3.2 x 2 x 1.75 in), "ostensibly collected by Pat Gross during highway construction." Cabochons of white precious opal of one to three carats were cut from material found in 1942 by Dr. Allen V. Heyl in the Pennington Quarry, Mercer County, "with full spectrum of attractive color flashes" (*Pers. comm.*, R. A. & T. Kosnar, 8/10/1994).

KATO, F. (1891) Some of Bergen Hill's rare minerals. *Mineralogist's Monthly* 6, p. 85–89. Opal in basalt.

SCHALLER, W. T. (1932) The crystal cavities of the New Jersey zeolite region. *U.S. Geol. Survey Bull.* 832, 90 p., illust. Common opal.

INDIANA. According to Erd & Greenberg (1960, p. 44) "opalized wood from the New Albany Shale in Henry County fluoresced with a play of colors. This opalized wood and a few veins in the Tar Springs formation of the Chester Series in Perry County are the only known occurrences of common opal in Indiana. Precious opal is unknown in the State."

ERD, R. C. & GREENBERG, S. S. (1960) Minerals of Indiana. *IN Dept. Conserv. Geol. Survey Bull.* 18, 73 p.

VIRGINIA. Penick (1992) notes that the opalized turritella shells collected from the Aquia Sandstone in Safford County (locality not specified) may exhibit a play of color when broken open.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

GEORGIA. Cook (1978) reports opalized wood in Richmond and Brooks counties. Hudson (1985) states that opalized wood can be found in gravel beds at many places in Muscogee County and especially in the gravels of the Chattahoochee River, which forms the boundary between Georgia and Alabama; the areas surround the city of Columbus in Muscogee and Chattahoochee counties. The opal "tends toward yellows and browns." Further areas recommended for search are given in a later article (Hudson, 1987). Cook also recounts his attempts to track down a deposit of fire opal, reportedly near Chalker, that was originally noted by E. S. Dana in his 1892, 6th edition of *System of Mineralogy*. However, Kunz (1890, p. 143) described this material as "a beautiful fire opal without any opalescence . . . in a small vein about 1/4 inch thick and 2 inches square, from Washington County, Georgia; this locality was first described by Prof. George J. Brush of the Sheffield Scientific School, and he has the finest piece of this opal in his cabinet." Common opal was later found on the Dick Warthen property, about 2 mi (3.2 km) south of Warthen, Washington County, but not the "fire" variety.

COOK, R. B. (1978) Minerals of Georgia. *GA Geol. & Water Resources Div. Bull.* 92, 189 p., p. 158.

HUDSON, S. (1985) Confederate opal. *Rock & Gem* 15, 9, p. 68–72, map.

___, (1987) Opal Dixie. *Rock & Gem* 17, 9, p. 20–22, 64, maps.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scientific Publ. Co., 336 p., illust. (col.).

ALABAMA. Hudson (1985, 1987, *see above*) recommends searching gravels for opalized wood in the broad area that extends from Columbus, Georgia, to Montgomery, Alabama, and sweeping through Mississippi and Louisiana to the border of Texas.

ARKANSAS. According to Howard & Owens (1995), "precious opal occurs as paper-thin, fiery films on slickensided surfaces in fenitized, argillized pyroxenite ore" in the North Wilson Pit of the Wilson Springs vanadium mines near Potash Sulphur Springs, Garland County. Also found here is common opal containing black dendrites in seams up to 2.5 cm (1 in) thick. No statement is made as to the suitability of either variety for lapidary purposes.

HOWARD, J. M. & OWENS, D. R. (1995) Minerals of the Wilson Springs Vanadium Mines, Potash Sulphur Springs, Arkansas. *Rock & Minerals* 70, 3, p. 154–170, illust. (col.), maps.

LOUISIANA. Hudson (1987) particularly notes the occurrence of opalized wood in the Catahoula sandstone in Catahoula Parish, but suggests that all exposures and gravels that can be examined in the broad band mentioned above should be systematically prospected to find more wood. He mentions an opalized log found in the Catahoula formation that measured 16 in (40 cm) in diameter at one end and 30 in (75 cm) at the other end, and was fully 8 ft (2.4 m) long, which when sawn through revealed "attractive red, brown, and cream-colored opalized wood."

Perhaps more exciting than the wood is the discovery of a sandstone in this state whose particles of quartz are so firmly cemented together by precious opal that it can be sawn, lapped, and polished to a fine, glossy finish that shows a yellowish background dotted with minute flashes of precious opal play of color. This material has been processed into attractive spheres, several inches or more in diameter, by the Lemur Trading Co. of San Francisco (*Lapidary Journal* 46, 3, 1992, p. 10). Jones (1989), in writing about a local lapidary in Bastrop, Louisiana, who dug up the opalized sandstone and fashioned various objects therefrom, claims that "records from Tiffany's in New York revealed Louisiana opal was purchased by them in 1911." However, no mention of this opal appears in Kunz's *Gems and Precious Stones of North America*, nor from subsequent articles published in the *Mineral Resources* chapters of the U.S. Geological Survey. In any event, Thomas (1986) claims that the opalized sandstone comes from an unspecified source near Leesville, Vernon Parish, and was obtained by Gary Moore of that town, "the only person to know the location of the Louisiana opal." According to Dunn (1976), a specimen of this opal was sent to the Smithsonian Institution in 1976 and was duly identified. Whether this opal is the same as that said to be "recently" found in Sabine Parish remains to be established (Falster, *et al*, 1993). This opal also "occurs as cement in sandstone and displays vivid fire on generally gray to brown matrix." Falster, *et al* also note that common opal is abundant as a cementing agent in the Miocene Catahoula formation of western Louisiana, and precious opal cements "solid ledges of sandstone of unknown lateral extent occurring in loose, uncemented sand." Such ledges can exceed 6 in (15 cm) in thickness and "colorful opal material may be seen at times throughout the entire thickness of the ledges." The best specimens display various colors in evenly distributed specks but "more commonly, one color—notably blue, green, or purple—tends to be dominant." The possibilities for pure precious opal to exist in seams in this sandstone in various places in this formation are excellent, and indeed, some seams of pure precious opal have been found.

ADAMS, J. (1991) Louisiana opal. *Big Rocks Trader* 4, 2, p. 19.

DUNN, P. J. (1976) Opalescent sandstone from Louisiana. Gem Notes. *Gems & Gemology* 15, 7, p. 201.

FALSTER, A. V., *et al* (1993) Precious opal from Sabine Parish, Louisiana. *Rocks & Minerals* 68, 2, p. 123.

HUDSON, S. (1987) Opal in Dixie. *Rock & Gem* 17, 9, p. 20–22, 64, maps.

JONES, P. J. (1989) *Daily Enterprise,* Bastrop, LA, Feb. 28.

THOMAS, L. H. (1986) Elusive in Louisiana. *Lapidary J.* 40, 3, p. 54–56.

TEXAS. Black and white opalized wood is found in many places on the surface and in gravels in the Rabs Creek area between Leadbetter-Giddings-La Grange in Lee and Fayette counties about 45 mi (72 km) east of Austin (Simpson, 1958, p. 64–65; Mitchell, 1991, p. 76–77). Girard (1964, p. 78) suggests that opalized wood may occur in many places within a belt of Tertiary formations that run approximately parallel to the Gulf Coast but inland about 100 mi (160 km), as shown on his colored geological map (p. 4). Such opalized wood occurrences were mentioned many years ago by Ward (1889), who also suggested that they could be found in the belt of Tertiary formations. Girard *(Ibid.)* also notes the occurrence of opal as the cementing agent in the Catahoula sandstones but does not claim any of the opal to be precious. Colorful common opals occur in the Alpine area of Brewster County, as noted by Sterrett (1914, p. 680), who gave the locality only as "near Alpine." The specimens of opal received from this locality were described as "small patches of white and bluish opal in a dark red rhyolite-like matrix. Some of the opal showed flashes of rich green and bluish fire. The reddish matrix might be cut showing patches of precious opal, if pure gem can not be obtained in larger pieces." This opal may have been found on the Woodward Ranch near Alpine (*see also* King, 1961; French, 1992).

FRENCH, J. D. (1992) An unscheduled field trip. *Lapidary J.* 46, 9, p. 63–66.

GIRARD, R. M. (1964) Texas rocks and minerals. *TX Bur. Econ. Geol. Guidebook* 6, 109 p., illust., map.

KING, E. A. (1961) Texas gemstones. *TX Bur. Econ. Geol. Rept. Invest.* 42, 42 p., illust.

HUDSON, S. (1987) Opal in Dixie. *Rock & Gem* 17, 9, p. 20–22, 64, maps.

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps.

SIMPSON, B. W. (1958) *Gem Trails of Texas.* Dallas, TX: Newman Stationery, 88 p., illust., maps.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1913*, p. 680.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept., 1886–97*, part 2, p. 663–960, map.

NEW MEXICO. No new developments.

KIMBLER, F. S. & NARSAVAGE, R. J. (1981) *New Mexico Rocks & Minerals.* Santa Fe, NM: Sunstone Press, 71 p., maps.

MITCHELL, J. R. (1987) *Gem Trails of New Mexico.* Baldwin Park, CA: Gem Guides Book Co. Opal p. 102–103.

NORTHROP, S. A. (1959) *Minerals of New Mexico.* Albuquerque, NM: Univ. NM Press, 665 p., maps. Opal p. 384–387.

SANDERS, M. B. (1961) New Mexico's opal trail. *Lapidary J.* 15, 5, p. 544–549.

SIMPSON, B. W. (1961) *New Mexico Gem Trails.* Granbury, TX: Gem Trails Publ. Co. Opal p. 28–29, 46–47, 66–67.

WYOMING. In a personal communication (1992) geologist J. D. Love informed me that some specimens of fire opal had been found in the Absaroka Mountains, but no specific place was mentioned. Common opal has been reported from the White River formation in the western part of the Hartville uplift. Clear moss-opal and white common opal were reported from the west side of Pathfinder Reservoir in a white, tuffaceous sandstone of the Miocene Split Rock formation. Common white opal is also reported from the same formation east of the reservoir. These localities are about 8 mi (12 km) north of the Seminoe Dam, Carbon County.

OSTERWALD, F. W., *et al* (1966) Mineral resources of Wyoming. *Geol. Survey WY Bull.* 50, p. 159.

ROOT, F. K. (1977) Minerals and rocks of Wyoming. *Geol. Survey WY Bull.* 56, 84 p.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, 53 p., map. Opal p. 39–41.

COLORADO. No new developments.

CHURCH, A. H. (1889) Note on Colorado hydrophane. *Min. Mag.* 8, p. 181.

HOSKIN, H. Y. (1947) Moss opal from Yuma County, Colorado. *Rocks & Minerals* 22, 2, p. 102.

MINOR, W. C. (1939) Opalized wood of Mesa County, Colorado. *Rocks & Minerals* 14, 12, p. 384–385, illust.

PEARL, R. M. (1965) *Colorado Gem Trails and Mineral Guide.* 2nd edit. Denver, CO: Sage Books, 223 p., illust., maps.

RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: Mineralogist Publ. Co., 80 p., illust., p. 35–39.

SEAMAN, D. M. (1934) Opal found at Specimen Mountain, Colorado. *Oregon Mineralogist* 2, 12, p. 17.

IDAHO. Precious opal is being produced steadily in Idaho from the fee-diggings at the Spencer Mine, and to a lesser extent from other deposits (Waller, 1973). Opalized wood is still being found at a number of places but is not important commercially, the best-known deposit of very handsome opalized oak, at Clover Creek, not having produced any new material in many decades.

In Kootenay County, Shannon (1926, p. 182) remarked on the translucent to almost transparent common opal, some in pieces of large size, in yellow, greenish-yellow to brown, obtained at some unspecified place near Setters in the Spokane Valley between Spokane and Coeur d'Alene.

In Latah County, the famous Gem City and nearby precious opal mines have been thoroughly described historically by Brockett (1974). Shannon (1926, p. 183) reported a very good quality dark gray opalized wood from the canyon of the Potlatch River near Kendrick.

In Valley County, Cater, *et al* (1973) note the occurrence of common opal in certain layers and structures of Tertiary volcanic rocks, as in the Marble Creek and Big Creek districts, but "development has been restricted to a deposit in the Monumental Creek district from which about 200 lb [91 kg] of cobbed yellow opal produced in 1970 sold for $12–$24 a pound. A reserve of 9,600 pounds and a possible resource of 800,000 pounds is estimated to occur at this site."

Early reports of gem quality precious opal from Panther Creek in this county were given by Kunz (1902) and Umpleby (1913) and summarized by Shannon (1926, p. 183-184). These deposits were also mentioned by Beckwith (1977, p. 48). Elsewhere in the county, colorful common opal and some precious opal occur in several places in the wild, mountainous country south of Salmon. Two deposits are owned and operated by John & Carol Cantlin of Ellis, Idaho, who also take collecting parties into their own fee diggings ($125 per person per day). A strongly colored, solid, cuttable common opal occurs at their Sky Blue Opal Mine about 7 mi (11 km) south of Salmon. Here it is found as nodules and seam masses in altered rhyolite, with the deposition of the opal apparently related to a fault which passes through the deposit. Associates are colored agates and jaspers, with the opal itself found in "all shades of blue from pale to very deep blue, pink, orange, and brown, and from opaque to transparent" (*Pers. comm.*, the Cantlins, 1/93). Recently, precious seam opal has been found with play of color in red, yellow, and green, with the green fire most common, and the red least common. The vividness is said to compare favorably with that of precious opal from other deposits, and the pieces are thick enough to cut into cabochons that need no backing or capping. In another deposit in the same general area discovered by the Cantlins in 1964, green common opal occurs near the bottom of a black basalt flow where it fills joints and fissures. The colors range from dark green, "like the finest jadeite," to pale green, and is translucent to opaque.

The premier precious opal deposit in the state is that near Spencer, Lemhi County, as previously described in Volume II. While major attention has been paid to the Stetler Family mine, operated in 1993 by Claudia Haight, daughter of Mr. & Mrs. Stetler, and son-in-law Doyle Haight, attention is drawn by Waller (1975) to a similar deposit next to the Stetler property. It was owned and operated at that time by the Jepperson-Wilson Mining Co., and officially opened for fee digging in 1971. The large area covered by the productive volcanic formations that yield the opal-containing nodules is suggested by a memorandum of Mayerle (1988) to Gordon T. Austin of the U.S. Bureau of Mines, who provided interesting details on the Stetler operation. In 1988, the opencut diggings were open on a fee basis for three days per week in the summer. Attendance ranged from 2,500 to 3,000 visitors per annum, and it was estimated that the total wholesale production value from 1948 to 1988 is about $5 million. By this time experience has shown that the precious opal occurred in 1/16" to 1/4" (1.5–5 mm) thick layers within common opal in the nodules. About 10% of the precious opal layers were thick enough to make into solid opal cabochons, but other layers were so thin that another 10% of the opal went into doublets and 80% into triplets. Further details on the Spencer mining operation were provided by Zicus (1992), who noted that "the largest recorded find was a four-inch-thick [10 cm] plate containing a thin layer of color and having a length of two-and-a-half feet [70 cm] and width of 10 inches [25 cm]." Doyle Haight also found a mass of 27 lbs, [12 kg] about 9" x 6" [22 x 15 cm] broad, in which a 1/2" [1 cm] thick "fireband" was present; this specimen was sold to a private party in Switzerland. Haight estimates that only 25% to 35% of ore has been removed from the deposit and that at the present rate of removal, mining should last for 30 years more. In regard to the stability of the opal, Haight claims that it is less likely to desiccate than much Australian opal. The matrix rock has now been identified as an original obsidian that has been hydrothermally altered to a whitish, easily disintegrated rock. As of September, 1993, fee-diggers were charged $20 per day with an allowance of 5 lbs [2.3 kg] of rough, with excess charged for at the rate of $3.50 per pound.

An entirely new phenomenon in the Spencer precious opal, namely, a cat's-eye effect, and its variation resulting in 6-ray asterism, was studied and explained by Sanders (1976). It will be recalled that Sanders provided the first convincing explanation of the play of color in precious opal some years ago. Sanders attributes the reflections in the Spencer opal to be due to "faults" or misalignments of the minute spheres of siliceous material whose geometrical, orderly arrangement provides the mechanism by which rays of light are selectively reflected as single brilliant and pure hues. However, none of the "streaks" in the Spencer opal are very sharp as in cat's-eye chrysoberyl, for example, but rather are hazy though still distinct (Spendlove, 1981).

In Boise County, the locality on both sides of Moose Creek near Idaho City for precious opal cementing the grains in a sandstone was first reported by Lindgren (1897), reported again by Shannon (1926), and lastly by Beckwith (1977, p. 45). The latter spells the locality name as "More's Creek." Nothing seems to have been done with this material.

Lindgren (1900) reported that fossil bones collected from sandstone near Opaline in Owyhee County, at an elevation of 2,400 ft (730 m), were encrusted with opal, and "some of their cavities contained fire opal. The bones were identified by Prof. O. C. Marsh as *Protohippus of Pliocene age*" (cited in Shannon, 1926, p. 186). In the same county, the Squaw Creek precious opal occurrences were described by Sterrett (1910), who visited the several deposits and noted opal in nodules in basalt. He stated that these occurrences had been previously reported by Lindgren & Drake (1904).

The Tepe blue opal previously reported from a deposit about 10 mi (16 km) west of Marsing is described by Broughton (1974), who gives historical notes, local geology, and mineralogy, with details on the opal and chalcedony varieties that are found in this area. According to Broughton, "about ninety percent of the opal is a beautiful translucent sky blue color, the remainder being periodic finds of amber brown and light green background colors." However, only about 5% to 10% of the blue opal displays enough play of color to be classed as precious and that is "invariably red and green pinfire to broad flashes." The brittleness of the opal is noticeable, and it is recommended that the opal be soaked in water for from 4 to 6 months prior to working. In 1974 fee-digging was allowed through prior arrangement with Tepe Rock Shop in Marsing on the basis of a daily fee of $10 per person for five pounds of rough or fifty pounds of jasper and agate, with a charge of $1 per pound for excess opal and $.15 per pound for excess agate and jasper. Lastly in this county, Ream (1992) reports opalized wood with black cores and white crusts from Coal Mine Basin.

The famous opalized oak wood of Clover Creek, Lincoln County, east of Bliss, has not been worked, probably because of the difficulties involved in its removal from its matrix rock. According to Kunz (1897) and Shannon (1926), logs of oak imbedded in rock were collected by Mr. Otto Uhrlaub of Bliss and sold to noted Philadelphia mineral dealer, Warren E. Foote, who then arranged for worldwide distribution of the polished sections. Kunz notes that the trunks were solidly encased in lava rock and that blasting was needed to remove them.

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BIXBY, M. (1894) Idaho opals. *The Mineral Collector* 1, 6, p. 87–88.

BRADBURY, F. G. (1981) Idaho's sky blue opal. *Gems & Minerals* 525, p. 81, 83, illust.

_____, (1981) A green opal field trip. *Gems & Minerals* 527, p. 106–107.

BROCKETT, R. (1974) *The Moscow Opal Mines 1890 to 1893 (The First Commercial Opal Mines in the United States).* Rangeley, CO: priv. publ., 63 p., illust. Idaho-Washington border area.

BROUGHTON, P. L. (1972) Precious opal mining in the Snake River Plain rhyolites, Idaho. *J. Gemm.* 13, 3, p. 100–104.

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CUTHBERT, D. L. (1969) Precious opal in Idaho. *Lapidary J.* 23, 7, p. 928–930, illust. (col.).

DAKE, H. C. (1962) *Northwest Gem Trails.* Mentone, CA: Gembooks, 95 p., illust., maps.

FALK, V. C. (1970) Here's how I cut Spencer opal. *Gems & Minerals* 393, p. 30–31, illust.

HANSCHILDT, J. (1978) The Spencer, Idaho, opal episode. *Lapidary J.* 32, 2, p. 540–543. Opal cutting instructions.

JOHNSON, B. J. (1973) Digging precious opal at Spencer, Idaho. *Rockhound* 2, 6, p. 39–41, illust., map.

JONES, R. (1989) Idaho blue fire opal. *Rock & Gem* 19, 2, p. 56–59.

KUNZ, G. F. (1893) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1891*, p. 776, Latah Co.

_____, (1893) *Same*, for 1892, p. 698.

_____, (1897) Precious stones. Ch. in *18th Ann. Rept. U.S. Geol. Survey for 1896-1897*, Part V. P. 1209.

_____, (1904) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1902.* Lemhi Co., p. 853.

_____, (1904) *Same*, for 1903. Latah Co., p. 956.

_____, (1912) [Precious opal in Latah Co.] *Ann. NY. Acad. Sci.* 21, p. 214–215.

LINDGREN, W. (1897) The mining district of the Idaho Basin and the Boise Ridge, Idaho. *U.S. Geol. Survey Ann. Rept.* 18, part 3, p. 617–719, maps. Opal p. 665.

_____, (1900) The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. *U.S. Geol. Survey Ann. Rept.* 20, part 3, p. 65–256, maps. Opal p. 99.

LINDGREN. W. & DRAKE, N. F. (1904) The occurrence of opal in the northern end of the Owyhee Range, Owyhee County, Idaho. *U.S. Geol. Survey Folio 104, Silver City, Idaho*, p. 5.

MAYDOLE, H. (1927) Sequoia trunk produces opal and agate "Jureano wood." *Rocks & Minerals* 47, 5, p. 310.

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______, (1892) Opal fields, Snake River, Idaho. 10, 11, p. 42.

______, (1893) Opals in Idaho. Vol. 11, 1, p. 45.

______, (1893) Opals and onyx. Vol. 11, 6, p. 8.

______, (1895) Finest opals in the world. Vol. 13, 11, p. 11.

OLES, F. & OLES, H. (1968) Precious opal in the Bitterroot Mountains. *Gems & Minerals* 373, p. 28–29. Spencer opal.

REAM, L. R. (1992) *The Gem & Mineral Collector's Guide to Idaho*. Coeur d'Alene, ID: L. R. Ream Publ., 34 p., illust., maps, p. 6, 22.

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SELBERT, P. (1993) Opal oasis. *Lapidary J.* 47, 3, p. 65–74, *passim*.

SHANNON, E. V. (1926) The minerals of Idaho. *U.S. Nat. Mus. Bull.* 131, illust. Opal p. 182–186,

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______, (1985) Spencer opal mine. *Ibid.* 15, 9, p. 36–39.

______, (1986) Star opal. *Rock & Gem* 16, 9, p. 36–39.

______, (1991) Idaho opal. *Rock & Gem* 21, 10, p. 32–39.

______, (1993) Spencer opal triplets. *Rock & Gem* 23, 10, p. 8, 10, 12.

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WALKER, D. & WALKER, C. (1991) Idaho's blue heaven, a vacationer's guide to collecting in Idaho. *Lapidary J.* 45, 7, p. 75–76.

WALLER, J. E. (1973) Opal land, U.S.A. *Rock & Gem* 3, 5, p. 76–78.

______, (1974) Idaho blue opal. *Rock & Gem* 4, 4, p. 70–73.

______, (1975) The overlooked opal mine. *Rock & Gem* 5, 5, p. 16–19.

ZICUS, S. A. (1992) The Spencer opal mine. *Rock & Gem* 22, 10, p. 36–40, map.

UTAH. The curious layered opal that is found on the west flank of the Mineral Mountains, Milford County, as described in Volume II, was first noticed by Sterrett (1909), who was sent specimens by James V. Brooks of Milford. It is described as "banded red, brown, yellow, gray, white and colorless opal," with an exterior of "white sintery coating or crust as if deposited by a hot spring or similar agency." Sterrett notes the slab-like structure, about 3/4" to 1" (1.6–2.3 mm) in thickness, and that the opal shows no play of color but is itself "highly colored, resembling the rich colors of jasper," and further, it "takes a good polish and might be used for small ornaments, mosaics, or even curio jewelry. It is not unlike richly colored Mexican onyx or onyx marble in appearance." This is the same opal that was later called "bubble opal" by collectors (*see esp.* Spendlove, *below*).

SPENDLOVE, E. (1974) Utah's fire opal. *Desert Mag.* 37, 5, p. 22–23, illust.

______, (1986) Milford bubble opal. *Rock & Gem* 16, 3, p. 36–39, map.

______, (1993) Utah's bubble opal. *Rock & Gem* 23, 7, p. 70–73, map.

STERRETT, D. B. (1909) Gems and precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1908*, p. 805–859. Opal p. 832.

STOWE, C., *et al* (1977) *Collector's Guide to Mineral and Fossil Localities in Utah*. UT. Geol. & Mineral. Survey, p. 33.

ARIZONA. A blue opal, sometimes displaying play of color, has been found in a welded tuff in a remote area in extreme southern Santa Cruz County. According to the road log of Wight (1984), the site is reached by going south from Tucson on Interstate 19 to the turnoff (west) of Highway 289 that leads to Arivaca. About 15 mi (24 km) along this road, a very poor road leads 3.75 mi (6 km) north to the opal mine. It is an opencut dug by bulldozer, and the exposed rock is examined for masses which contain the opal. The claim was staked by Cheri and James Robert Saunders in 1969; after the demise of the latter in 1973, the venture was converted into a partnership of Mrs. Saunders and Mr. Michael Anderson, and the mine called the Jay-R after the deceased Mr. Saunders. According to Wight, the host volcanic rock contains small geodes with interesting crystals of quartz. The blue opal occurs as seams, mostly thin, although some seams "measured up to 12 inches [30 cm] across" according to Zeitner (1990). Most of the opal is without play of color but solid and easily shaped and polished into cabochons and other small objects. The precious opal is stable, solid, and easy to treat by conventional methods without the need for doubletting or tripletting. Wight (1984) records a cabochon of the blue opal with good play of color of 3.5 carats in the Canadian Museum of Nature.

BERKHOLZ, M. F. (1960) Crystals, opalite and geodes in Arizona. *Gems & Minerals* 278, p. 28–31, maps.

GRIFFITH, J. (1980) Arizona blue opal goes to Europe. *Lapidary J.* 34, 8, p. 1750–1754.

______, (1982) Arizona blue fire opal rests at Annapolis. *Lapidary J.* 36, 6, p. 994–998.

WIGHT, Q. (1984) Arizona blue opal—the Jay-R Mine. *Canad. Gemm.* 4, 1, p. 15–17.

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

WILSON, E. D. (1928) Asbestos deposits of Arizona. *AZ Bur. Mines Bull.* 126, 100 p., illust., maps. Opalized asbestos seams.

ZEITNER, J. C. (1990) Precious and blue. *Lapidary J.* 44, 3, p. 76–80.

ZODAC, P. (1959) Opal pseudo after asbestos from Arizona. *Rocks & Minerals* 34, 3–4, p. 129.

NEVADA. The celebrated mines of precious opal located in Virgin Valley in the northwest corner of the state are as active as ever and as productive of splendid specimen and gem opals. The mines are clustered around Virgin Creek in Humboldt County and generally lie within a square area, 5 mi (8 km) on the sides, whose northeast corner is anchored on the south turnoff to Virgin Valley from Highway 140; this turnoff is about 22.5 mi (36 km) west of Denio.

Among recent writings on the Virgin Valley field is an article by Mitchell (1990) which provides a valuable historical summary, and also the essay by Heylmun (1987). Opal was first noted here by Marsdon Nanson in 1905, and numerous claims were staked by 1908. Flora Loughead (Lockheed), mother of the aircraft engineer/builder, staked a claim of her own in 1918. Interesting firsthand historical notes found in Denton (1949), who as early as 1913 and 1917 visited the diggings and who stated that "as I own an interest in some of the claims, I decided to visit the region, see where they were located, and secure some opal if possible" (p. 146). After a long, harrowing trip from Winnemucca by automobile and horse, Denton arrived at the Virgin Valley camp operated by Mr. & Mrs. George Mathewson and Arthur and Harold Dow. At this time he noted cracking in the opal, which apparently happened so frequently that "Harold Dow has offered ten thousand dollars to any one who will show him how to prevent the cracking of the opals" (p. 158). Thus so early in the game the dehydration/cracking in Virgin Valley opals was noted and passed into the gemological literature. However, recent work on the problem shows that many of the opals survive, and as mentioned earlier, the prudent practise is to let the rough or preforms "season" for at least six months and then proceed to cut the material which shows no signs of cracking. Arthur Grant of New York tells me that he has faceted almost completely transparent and flawless Virgin Valley opal into gems of over 10 carats and these have remained uncracked after a number of years. Heylmun (1987) notes the high water content of the opal, typically 6% to 10%, and as high as 13%, and therefore regards much of the opal as unstable and "apt to crack or craze soon after exposure to atmospheric conditions." Ein (1993, p. 40) provides a detailed scheme for gradually adjusting moisture content in the opal over a period of up to a year with the aim of producing reliable stability. Heylmun *(Ibid.)* notes that "several million dollars worth of precious opal remain in Virgin Valley. Moreover, between 15 and 20 million tons of uraniferous opal remain unmined." While much opal has

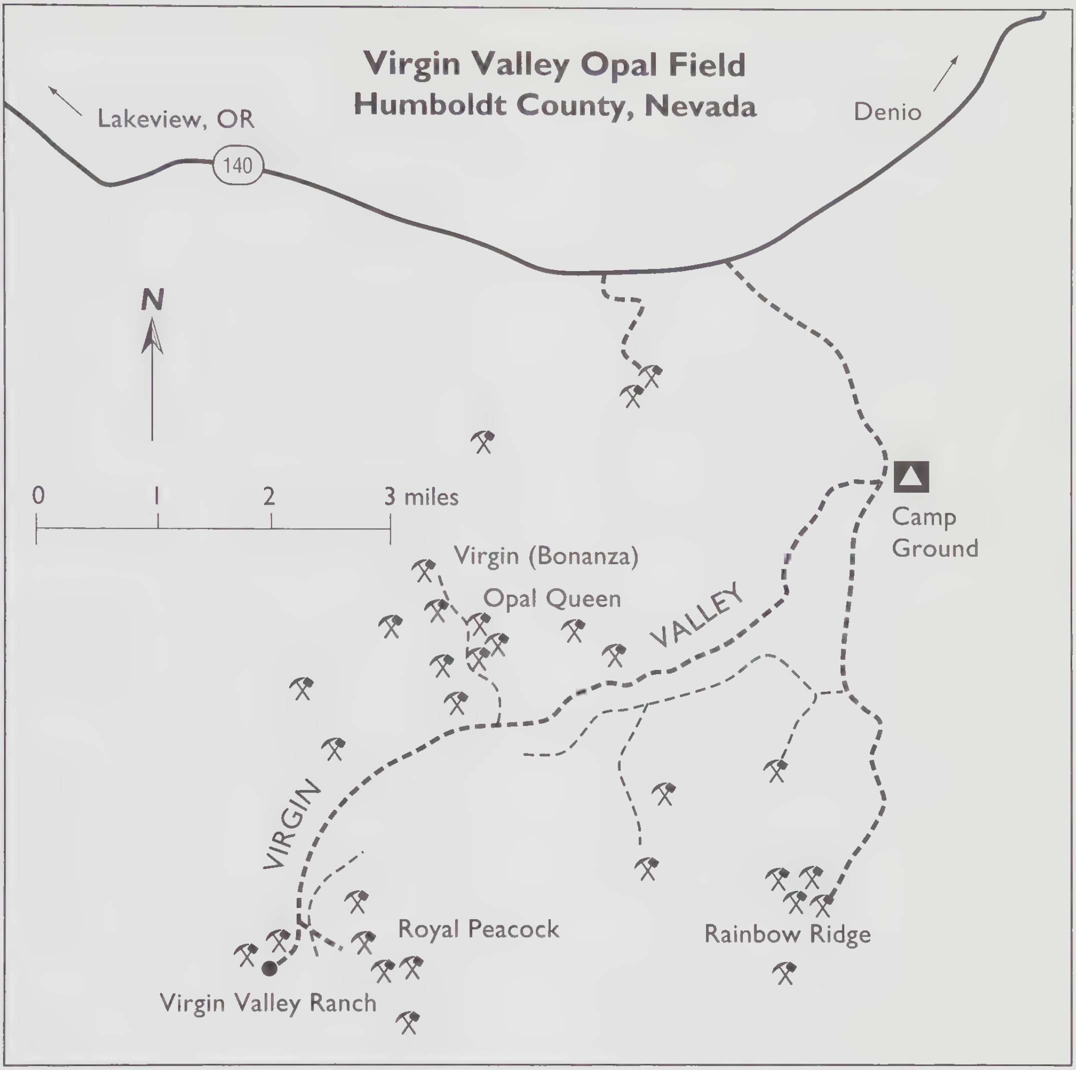

FIGURE 49. Locations of opal mines in Virgin Valley, Humboldt County, Nevada.

been recovered, much more remains, and "each rainstorm uncovers splendid new specimens, both on the ground and on the mine dumps."

The record-size precious opal from Virgin Valley came from the Royal Peacock Mine in June, 1992, when Michael Croxwell of Minneapolis visited the mine to dig opal (Eckert, 1993). Several days after his arrival he struck a huge log of precious opal that after exhumation and cleaning weighed about 30 lbs (13.6 kg) and measured 36 inches (90 cm) long and 16 inches (40 cm) in its greatest diameter. From external appearances it was estimated to contain no less than 30% precious material. Dr. George Munzing, of Sparks, Nevada, who is intensively studying the geology and mineralogy of the Virgin Valley deposits, has identified the wood as gingko, a species which hitherto had not been known here. Other woods commonly replaced by opal are fir, sequoia, and pines, and more rarely chestnut, oak, elm, maple, and others.

In regard to the geology of the Virgin Valley opal occurrence, Munzing identifies the layers as being soft volcanic ash and tuff mixtures of Early Miocene age, probably formed by sedimentation of incandescent volcanic ash which engulfed a forest and thus created the necessary foundation for later replacement of the wood by opal (via *Pers. comm.*, R. Jones, 3/15/94).

At present, fee collecting is permitted at the Rainbow Ridge Mine, owned and operated by Keith and Agnes Hodson of Scottsdale, Arizona, who take up residence at the mine in the summer and spend winters in Arizona. Another nearby fee collecting operation is the Royal Peacock Opal Mine, owned and operated by Walter Wilson and family, of Denio, Nevada.

The Little Jo Opal Mine, formerly owned and operated by Ray Duffield as described in Volume II, was sold in 1984 to David Pooley of Gerlach, who renamed it the Black Rock Opal Mine (Mitchell, 1991, p. 52-53). The generally clear "jelly"-type opal occurs in dark gray andesite and basalt with "occasional pieces being milky white." In the same vicinity, Max and Suzy Berchtold of Laytonsville, California, bought a series of 15 opal claims in 1992, to which they later added four more. The productive mine in this group is called the Royal Rainbow Mine (*Pers. comm.*, S. Berchtold, 11/4/1993 & ltr. dtd. 2/15/93). Their first full season of work took place in 1993, when they began a fee-collecting operation, charging $25 per person per day, which fee rose to $35 in 1994. The mine is essentially an opencut that exposes the opal-bearing basalt whose surface is regularly renewed and debris scraped off by bulldozer. The mine is located 8 mi (13 km) northeast of the Little Jo/Black Rock Mine, along Willow Creek, one mi (1.6 km) north of Soldier Meadow Road. From Gerlach, the following route is recommended: go northeast from Gerlach on Highway 11 for 12 mi (18 km), turn right onto Soldier Meadow Road and proceed 34 mi (54 km) to the mine road entrance on the left; proceed along Willow Creek for one mile (1.6 km).

According to the Berchtolds (*see also* Downing, 1994, a recent visitor), the precious opal occurs as nodules in solid basalt that requires sledging to break down into smaller and smaller fragments until a filled cavity of opal is uncovered. Many body colors are found in this opal: from colorless to all shades of yellowish, brownish, orange, etc., and with a wide variety of hues in the play of color. Most of the opal is highly translucent and even transparent, and in body color and diaphaneity is reminiscent of Mexican opal and the British Columbia opal recently found (*see below*). So far the largest nodular mass of precious opal found weighed 350 carats; after cleaning and polishing it yielded a nodular mass of 174 carats exhibiting fine play of color. Experience thus far has shown that this opal has excellent stability; it is claimed to be better in that respect than the opal found elsewhere in this region.

Farther south, in Nye County, the Starfire Mine (present status unknown) is reached by traveling 13 mi (21 km) north of Gabbs on Highway 23, then taking a turnoff and going another 6 mi (9.7 km) to the mine site (Nichols, 1979). The opal here is of bluish body color, sometimes displaying broad flashes of red, green, blue and lavender. According to Nichols, it shows "no sign of cracking or crazing." Another precious opal deposit, called the Firestone Mine, is located about 31 mi (50 km) by road southeast of McDermitt, Humboldt County. Nichols (1979) dismisses its value.

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BERKHOLZ, M. F. (1957) Steamboat Springs opalite. *Gems & Minerals* 242, p. 58, 60, map.

BOWER, C. E. (1977) Digging for black opals at the Royal Peacock Opal Mine, Virgin Valley, Nevada. *Lapidary J.* 31, 2, p. 526–533, map.

BRAY, J. C. (1915) Opal fields in Nevada. *The Mining American* 72, p. 4; *Mining J.* (1915), May 1 & 15, Dec. 11.

COLE, F. (1973) Virgin Valley? *Lapidary J.* 27, 9, p. 1467–1468, map. Locates deposits of green fluorescent common opal.

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Rocks & Minerals 8, 1, p. 16–18, illust.

_____, (1941) History of Virgin Valley, Nevada. *The Mineralogist* 9, 1, p. 7–8, 22–24.

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DENTON, S. W. (1949) *Pages From a Naturalist's Diary—From the Diaries of Shelley Wright Denton.* Wellesley, MA: priv. publ. Virgin Valley p. 146–169, 170–186.

DOWNING, P. B. (1994) America's outback opal. *Lapidary J.* 48, 3, p. 53–55, 57, illust. (col.).

ECKERT, A. W. (1993) Opal-logue. *Lapidary J.* 47, 3, p. 36–40, illust.

EIN, D. A. (1992) Over the rainbow. *Lapidary J.* 46, 3, p. 79–81, map.

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FRENCH, W. (1980) Virgin Valley venture. *Gems & Minerals* 514, p. 16–19.

GETZ, D. E. (1972) The ravishing opals of Rainbow Ridge. *Rockhound* 1, 2, p. 4–9, illust., map.

GORDON, C. C. (1928) The Virgin Valley, Nevada, opal deposits. *Salt Lake Mining Review* 30, 6, p. 7–8.

HEWITT, C. G. (1977) Adventures with Virgin Valley opals. *Lapidary J.* 31, 9, p. 1994–1998.

HEYLMUN, E. B. (1987) Virgin Valley. *Lapidary J.* 41, 3, p. 33–44, *passim.*

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_____, (1961) Opal mining at Virgin Valley. *Lapidary J.* 15, 5, p. 530–537, *passim*, map.

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JONES, R. (1977) Bonanza opal. *Gems & Minerals* 480, p. 6–7, 77–80, map.

_____, (1994) Das edelste Holz der Welt: feinster Opal vom Virgin Valley. *Lapis:* Extra Lapis No. 7, Versteinertes Holz, p. 12–23, illust. (col.).

KUNZ, G. F. (1912) On the occurrence of opal in northern Nevada and Idaho. *NY Acad. Sci. Ann.* 12, p. 214–215.

LADD, N. B. (1957) A new Nevada opal discovery. *Lapidary J.* 11, 2, p. 208–216, *passim.*

McLEOD, E. (1941) Fluorescent opal in Virgin Valley. *Desert Mag.*, July, p. 30–32, map.

MITCHELL, J. R. (1990) Virgin Valley opal. *Rock & Gem* 20, 9, p. 56–59, 78, 80, illust. (col.), map.

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MONTGOMERY, A. (1934) Digging for opals in Virgin Valley. *Rocks & Minerals* 9, 10, p. 141–145.

MURBARGER, N. (1955) Opal miner of Rainbow Ridge. *Desert Mag.* 18, 8, p. 11–15, illust., map.

_____, (1958) Opalite at the Silver Cloud. *Desert Mag.* 21, 4, p. 15–18. Battle Mt.

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ROBERTSON, D. (1969) Noodling in Virgin Valley. *Desert Mag.* 32, 9, p. 8–10, illust.

_____, (1972) The Duffield's Little Jo Opal Mine—a new place to dig! *Lapidary J.* 26, 7, p. 1096–1101, illust.

_____, (1973) See you at the Little Jo. *Rockhound* 2, 6, p. 17–20.

ROCKS & MINERALS (1942) A report on the Roebling opal. Vol. 17, 1, p. 59. Roebling opal not deteriorating as rumored.

SHEDENHELM, W. R. C. (1973) Little Jo Opal Mine. *Rock & Gem* 3, 11, p. 26–28.

STAATZ, M. H. & BAUER, H. L. (1951) Virgin Valley opal district, Humboldt County, Nevada. *U.S. Geol. Survey Circ.* 142, 7 p., map. Common opal.

STERRETT, D. B. (1909) Gems and precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1908*, 1909, opal p. 831–832.

_____, (1911) *Same*, for 1909, Virgin Valley p. 771.

_____, (1912) *Same*, for 1911, " " p. 1060.

_____, (1914) *Same*, for 1913, " " p. 677–680.

STRONG, M. F. (1966) Wood and wonderstone near Fernley, Nevada. *Gems & Minerals* 346, p. 19–20, illust., map. Opalized wood.

_____, (1973) Lovelock's legacy. *Desert Mag.*, July, p. 8–11.

WALKER, D. & WALKER, C. (1990) Hunting for

opals. *Lapidary J.* 44, 5, p. 97, map. Peacock Opal Mine.
WILSON, J. L. (1977) Royal Peacock opal. *Gems & Minerals* 480, p. 14–15, 83–84, map.

BRITISH COLUMBIA. The first find of precious opal in the province was made near Vernon on October 14, 1991 by Glen, Daryl and Carolyn Grywacheski. A number of pieces of the opal were found that day, "most closely associated with a banded agate and common opal in white and honey colors" (Downing, 1992). Specimens of precious opal were found over an area of at least 100 x 200 meters (ca 300 x 600 ft). The opal occurs as veinlets and fillings in gas cavities in gray basalt, some fillings containing agate, white and orange opal, red opal, and hydrophane. The opal is similar to Mexican opal in that it has a clear, orangey body color, and fire throughout. A second type does not display play of color but has a transparent amber body color and can be cut into excellent faceted stones. The areas are claimed by Glen Grywacheski and Robert Yorke-Hardy. The locality is about 40 km (25 mi) north of Vernon, a city in south-central British Columbia.

According to Downing (1993), the host rock is medium gray basalt that is quite soft and so porous that it is generally not feasible to cut cabochons that incorporate opal in the basalt host rock. It is suggested that plastic impregnation may remedy this weakness. The precious opal appears to be "formed in seams (all vertical so far) and in nodules. Much of the opal near the surface is hydrophane. It loses water as it is exposed to the air, becoming opaque white but still showing bright fire." Much of the precious seam opal is suitable for doublets or triplets and some stones that have been cut for over a year remain solid "so that the instability that plagues Mexican opal does not appear to be a problem here." A local name applied to this material is "Okanogan opal," after the beautiful Okanogan Valley and lake near the mine. The resources of precious opal in this deposit appear promising.

Another precious opal area may exist someplace "near Yellow Lake between Penticton and Keremeos," according to Downing, who also noted a find of white precious opal here years ago but without a precise locality given.

DOWNING, P. B. (1992) New opal discoveries. *Lapidary J.* 22, 10, p. 44–46.
_____, (1993) Okanogan opal. *Ibid.* 46, 11, p. 63–66, illust.
_____, (1994) New fire in British Columbia. *Rock & Gem* 24, 10, p. 42–46, 82, illust. (col.).
LEAMING, S. (1973) Rock and mineral collecting in B.C. *Geol. Survey Canada Paper* 72-53, 138 p., maps.
MOLDOWIN, W. (1967) High country. *Canad. Rockhound* 11, 4, p. 113–116, map. Opalized wood, Barnes Creek.
SABINA, A. P. (1965) Rock and mineral collecting in Canada. Vol. I. Yukon . . . British Columbia, etc. *Geol. Survey Canada Misc. Rept.* 8, 147 p. illust., maps.
TRAILL, R. J. (1983) Catalogue of Canadian minerals. Rev. 1980. *Geol. Survey Canada Paper* 80-18. Opal p. 260.
VERNON, N. (1965) Precious opal? Penticton? Absolutely! *Canad. Rockhound* 9, 4, p. 121, 122.

WASHINGTON. The opal deposits in the area adjacent to Moscow, Idaho, and the history of their exploitation have been described in detail along with the by Brockett (1974). Sterrett (1910) provides notes on the status of those mines at that time.

BROCKETT, R. (1974) *The Moscow Opal Mines 1890 to 1893 (The First Commercial Opal Mines in the United States).* Rangeley, CO: priv. publ., 63 p. illust.
DAKE, H. C. (1962) *Northwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 95 p., illust., maps.
KUNZ, G. F. (1891) On the occurrence of fire opal in the basalt in Washington State. *Geol. Soc. Amer. Bull.* 2, p. 639.
_____, (1893) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1892.* Opal p. 776.
RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: The Mineralogist Publ. Co., 80 p., illust., maps. Opalized woods.
_____, (1955) World's finest opalized woods. *The Mineralogist* 23, 11, p. 387–390.
STERRETT, D. B. (1910) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1909,* part 2, p. 874.

WILLIAMS, O. M. (1973) A good spot for opalized wood. *Rockhound* 2, 6, p. 47–48. Vantage area.

OREGON. The major opal event is the resumption of mining at Opal Butte, on private land in Morrow County, 35 mi (56 km) south of Heppner. The deposit is in volcanic material that lies on the west slope of the butte at 4,700 ft (1,400 m) above sea level in the Blue Mountain Range (Smith, 1988). This deposit has been known since 1892, and as reported by Kunz (1893), it consists of an ash bed in which occur spheroidal nodules or thundereggs "from 1 to 40 per cubic yard. These vary in size from one to several feet. On breaking them open, they are found to obtain [*sic*] some kind of opal, of which one in twenty is a fire opal or a noble opal. It is estimated that some $20,000 worth of specimens have been obtained here during 1892."

The Opal Butte property has been owned by the Kinzua Corporation of loggers since 1953. In 1986, West Coast Gemstones, Inc., Dale E. Huett, vice president, and Kevin Lane Smith, consulting geologist, obtained rights to mine and commenced doing so in 1987 (Smith, 1988). According to Smith, the opal occurs in geodes which are enclosed in a dark green perlite that has locally been altered to a light-colored clay, and "opal-bearing geodes are found exclusively in the clay zones," with the geodes ranging in size from an inch or so to several feet across. Huett (1990) noted that some geodes were dug up that exceeded four feet in diameter (120 cm), and a giant geode was found, oblong in shape, that was "four feet long, three feet wide, and 18 inches thick." Huett notes that the nodules that yield the highest percentage of gem opal "are generally within football size to 18 inches in diameter, though exceptions at both ends of the scale do occur." While a series of volcanic rock flows characterizes the Opal Butte structure, the desirable geodes occur only in one perlitic zone: "nearly all, perhaps 95 percent of all gem quality opal . . . occurs here." In addition to the opal, the geodes also contain stalactitic agate growths, rarely quartz crystals, banded agate, and common opal (Smith, 1988). It is estimated that 70% of the geodes contain no opal, 20% contain common opal, and only 10% contain some gem opal of which less than 1% prominently displays play of color.

The deposit is mined by bulldozer supplemented with a backhoe, and the geodes are picked from the debris as fast as it is produced. Most of the geodes are already cracked and it is a simple matter to split them open to examine their interiors. As is typical of so much opal, Opal Butte material is apt to craze, but methods for selecting stable material and treating opal that is likely to craze are explained by Smith (1988). The greatest inherent stability is found in hydrophane, rainbow, and blue types.

The refractive indexes of this opal range from 1.43 in the hydrophane to 1.47 in the clear material, but generally the values fall within the narrower range of 1.44–1.45. Perhaps the most distinctive feature of the opal is its clarity in large sizes, some specimens providing clear masses of more than 500 grams, especially in the kinds which are almost perfectly transparent and slightly hazy-bluish. The so-called "contra-luz" or literally "against the light" type is well represented, often in large, clean masses of bluish cast which when held to the light display sparks and veils of color play in transmitted light. A prize piece of this kind has been faceted by Kevin Lane Smith into a large thumblike object which weighs 105 carats. Other masses have been cut to 315 carats. Small, conventionally faceted gems have been sold for $40 per carat in 10-carat sizes. The Opal Butte deposit is also remarkable for its production of hydrophane which lives up to its reputation of appearing milky-opaque, then clarifying to almost perfect transparency when soaked in water.

Elsewhere in Oregon, a fine light blue cabochon grade common opal has been found and mined to a limited extent by the Desert Dog Mines, of Bend, Oregon, from claims called the Desert Dog #4 and #3 in the Stockade Mountains. According to V. & L. Kribs of Desert Dog Mines (*Pers. comm.* 10/93), "the opal is in the thundereggs and in veins around the egg pockets. Most of the opal is common but we have found some precious."

AUSTIN, G. T. (1989) Oregon gem production up 155%. *Colored Stone* Fall 1989 Show Guide, 2, 5, p. 28–29.

DAKE, H. C. (1962) *Northwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 95 p., illust., maps.

FERNQUIST, C. O. & DAKE, H. C. (1933) Opal from the Columbia Plateau basalt flows of Washington, Idaho and Oregon. *Rocks & Minerals* 8, 1, p. 30–32.

GAIL, R. W. (1967) Fabulous Stinking Water—Oregon's treasure land. *Lapidary J.* 21, 1, p. 120–131, *passim*, illust. (col.). Opal wood.

HUETT, D. E. (1990) A centennial celebration. *Lapidary J.* 44, 8, p. 22–28, 30, color illust.

KUNZ, G. F. (1889) Mineralogical notes [Prec. opal, Crook Co.]. *Amer. J. Sci.* 38, p. 72–74.

_____, (1893) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1892*, p. 776.

McCARTHY, C. (1992) Renaissance rockhound. *Lapidary J.* 46, 3, p. 28–33, illust. (col.). Carvings in Opal Butte material.

MELHASE, J. (1938) Precious opal in Oregon. *The Mineralogist* 6, 9, p. 5–6, 29. Hart Mt.

MITCHELL, J. R. (1989) *Gem Trails of Oregon.* Pico Rivera, CA: Gem Guides Book Co. Opal p. 54–55, 64–65, 74–75.

NORTHWEST MAGAZINE (1897) Opals found on Burnt River, Oregon. 15, 2, p. 39.

RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: The Mineralogist Publ. Co., 80 p., illust., maps. Much on opalized woods.

RENTON, J. L. (1935) Colored hyalite opal found in large masses at Opal Butte, Oregon. *The Mineralogist* 3, 1, p. 36–37.

SMITH, K. L. (1988) Opal from Opal Butte, Oregon. *Gems & Gemology* 24, 4, p. 229–236, color illust.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1913*, p. 680, Crook Co. opal.

UNDERWOOD, A. H. (1961) Field trip guide, Willow Creek, Oregon. *Gems & Minerals* 285, p. 26, map. Opal wood.

CALIFORNIA. Vivid red to orange-red "myrickite" opal was recently recovered from the opencut workings of the Manhattan mercury mine in 1981, and a stock of specimens and cabochon cutting material was put up for sale at the 1992 Tucson Show. The Manhattan Mine is located in the northern extremity of Napa County adjacent to Lake and Yolo counties. For many years this mine produced cinnabar, the sulfide of mercury (Pemberton, 1983, p. 118, 119). However, it was found that the ground in the vicinity of the mine contained enough disseminated gold to make it economical to mine for that metal alone, with the result that a huge open pit, the McLaughlin Gold Mine, now has completely obliterated all of the Manhattan Mine workings. Fortunately for gem cutters and mineral collectors, some fine lapidary grade opal with many inclusions of cinnabar provides the "myrickite" variety of cuttable opal which is rarely seen these days. This recovery was made possible by prior arrangement with the Homestake Mining Company who operates the mine.

The "myrickite" opal name comes from Francis Marion "Shady" Myrick (1850–1925), a famous desert prospector whose life is treated in detail in the Fraziers' (1992) historical article on this variety of opal. According to them, the opal occurred in the top layers of ground and was recovered before this overburden was stripped away to expose the gold-bearing ore beneath. "The best myrickite from the McLaughlin Mine consists of relatively thin but brilliantly crimson layers or brecciated and recemented opal pigmented with tiny particles of cinnabar. Other layers appear black due to very fine-grained stibnite (antimony sulfide) and other sulfide minerals." Studies of thin sections show that some chalcedony is present as well as other forms of quartz. By the prior arrangement mentioned above, Roberts Minerals of Twain Harte, California, was able to collect the major portion of the best material before all further traces of mineralization were lost by the surface clearing prior to open cutting of the gold mine.

Not far from the above locality, common opal useful for cabochons and small ornamental objects occurs in Sonoma County. Creative Gems of Sonoma marketed the material in 1979, naming it Sonoma Peach Opal in allusion to its predominant color. The land upon which the opal occurs is a sheep ranch, and the deposit is worked only on the surface by bulldozing. The opal occurs in pale tan, peach, and reddish and yellowish tinges, and is found in veins which dip 45° (*Lapidary Journal*, 1978). The company offered mine run material in lumps from "dime to fist size" in 1979 for $10 per pound, or less if bought in large quantity, but better grades sold for as much as $160 per pound.

In Volume II, the Barnett and Nowak-Cowden precious opal mines in Red Rock Canyon, Kern County, were described, but additional historical details are now available. According to Campbell (1983), these mines produce opals that "rival those of Australia and Mexico in fire and stability," as established by a recovery record of over 70 years. "The claim is now split between five owners: Richard and Shirley Barnett own the lower half [while] the upper half of the claim is owned by four couples and is called the Nowak-Cowden Mine." A splendid precious opal, called the "Mojave Flame," was said to have had a value of $50,000 placed on it before it was mounted in a piece of jewelry. The Bennett portion has been open to public collecting since 1977 and the Nowak-Cowden portion since 1946.

Common opal of various types is found on the Snyder Ranch, a fee-digging area, located 2 mi (3.4 km) north of Valley Springs, Calaveras County (Ferguson, 1980).

BERKHOLZ, M. F. (1953) Black Canyon opal. *Gems & Minerals* 195, p. 7–9, illust., map.

______, (1961) Green opal in Black Canyon. *Gems & Minerals* 280, p. 20–21, map.

______, (1961) Collecting at Hackberry Wash. *Gems & Minerals* 282, p. 32, 34, 35, map.

BROMAN, M. (1972) *Gem Trails in California*. Anaheim, CA: Main Street Press, 84 p., illust., maps.

CAMPBELL, D. A. (1983) Fiery opals in Southern California. *Gems & Minerals* 545, p. 37, 62.

DOWNING, P. B. (1992) New opal discoveries. *Rock & Gem* 22, 10, p. 44–46. Opal in Modoc County.

FERGUSON, R. W. (1980) A rock dig at the Snyder Ranch. *Lapidary J.* 34, 9, p. 1948–1958, illust.

FRAZIER, S. & FRAZIER, A. (1992) Shady names. *Lapidary J.* 46, 9, p. 57–60, 94–96, 102, 104, illust. (col.). Myrickite.

HENRY, D. J. (1950) *Gem Trail Journal*. Pomona, CA: priv. publ., 69 p., illust., maps.

______, (1957) *California Gem Trails*. 3rd edit. Long Beach, CA: Lowell R. Gordon, 101 p., illust., maps.

HILTON, J. W. (1939) Opals at Zabriski. *Desert Mag.* 2, 4, p. 9–11, 33.

KUNZ, G. F. (1885) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1883 & 1884*. Calif. opal, p. 760–761.

______, (1898) Precious stones. Ch. in *19th Ann. Rept. U.S. Geol. Survey for 1897-98*, part 6, p. 507.

______, (1905) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1904*. Hinckley, San Bernardino Co., p. 966.

LAPIDARY JOURNAL (1978) New variety of opal found near Sonoma, California. Vol. 32, 3, p. 837–838.

LEWIS, W. S. (1933) Occurrences of opal in California. *Rocks & Minerals* 8, 1, p. 36–37.

MAYO, V. (1973) *American Opal Society Monthly Newsletter*, Sept. 6, 5 p. Red Rock Canyon opal.

MITCHELL, J. R. (1979) Opal near Hinkley. *Rock & Gem* 9, 10, p. 40–43, map.

______, (1984) Opal near Red Rock Canyon. *Rock & Gem* 14, 8, p. 20–22, map. Barnett Opal Mine.

______, (1986) *Gem Trails of California*. Baldwin Park, CA: Gem Guides Book Co., 159 p., illust., maps.

NOWAK, G. (1974) Fire opals in the Mohave Desert. *Lapidary J.* 28, 1, p. 52–54, map.

PEMBERTON, H. E. (1983) *Minerals of California*. NY: Van Nostrand Reinhold. Opal p. 355–356.

PERRY, L. E. (1977) Opalite in the Providence Mountains, a visit to Mid Hills and Hole-In-The-Wall. *Lapidary J.* 31, 7, p. 1586–1590, map. North of Ludlow in Mohave Desert.

SANDERS, J. V. & DIETZ, R. W. (1967) Precious opal from California. *Gems & Minerals* 360, p. 16–19.

SHEDENHELM, W. R. C. (1973) California's opals. *Rock & Gem* 3, 9, p. 8–12, illust.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1913*, p. 675–676.

STRONG, M. F. (1966) *Desert Gem Trails*. Mentone, CA: Gembooks, 81 p., maps.

______, (1968) Opal in Tecopa's Silica Hills. *Gems & Minerals* 364, p. 22–23, map. Inyo County.

______, (1972) Fire opals in the El Paso Mountains. *Desert Mag.* 35, 5, p. 22–23, 50, 51, illust., map. Nowak Opal Mine.

TANSIL, J. (1974) [Opal of Red Rock Canyon, California.] Paper presented to Amer. Opal Soc. *Amer. Opal. Soc. Newsletter*, Feb. 8, p. [1–3].

MEXICO. The precious opals of Mexico were mentioned by mineralogists and geologists at the beginning of the last century, according to Ramirez (1884, p. 238), who noted that the *Gaceta de Mexico* of 12 November 1802 contained remarks on the *ópalo de fuego* of Zimapan, Hidalgo, where it was found in trachyte. Ramirez furnishes other occurrences in Hidalgo, Guerrero, Guanajuato, San Luis Potosi, and Queretaro, with much of the data taken from Barcena's treatise on Mexican opal of 1873. Much later, Salinas (1923) provided many localities and distinguished these varieties of opal: precious opal, common opal, hydrophane, "menilite," wood opal, hyalite, and tripoli. Salinas listed localities for precious opal in Chihuahua, Guanajuato, Hidalgo, Michoacan, Queretaro, and San Luis Potosi. The important deposits in Jalisco were not known at that time. In regard to types of opal, Waite (1969) provides an instructive paper with color illustrations of the various opals, most of which clearly show the typical transparency.

Recent visitors who have provided outstanding accounts of modern opal mining, recovery methods, selling, etc., include Heylmun (1983), Mallory (1969), and Zeitner (1979). Although they mostly confine themselves to classic occurrences in Queretaro, the general geology and mineralogy of the deposits is similar throughout Mexico, as are also the varieties of opal, their mining, preparation, and sale. Today, after many decades of mining, the characteristic feature of many mines is their resemblance to steep-walled open cuts found along railroad rights of way. Mechanized equipment is commonly employed to facilitate the quarrying of opal-bearing volcanic rock and to break down the larger masses into smaller sizes. Nevertheless, the personal intercession of the miner is necessary in the end to detect the presence of opal, evaluate it, and carefully chip away the enclosing rock to expose it. The finest material passes quickly into the cut gem market while opal-studded rhyolite matrix rock fragments are often cut and polished "as is" and are also sold, but at much lower prices. Some such matrix masses are also carved into turtles, frogs, fish, butterflies, and other small objects, according to Zeitner (1987). In regard to prices, a large retail, mail-order firm in the United States offered primarily red and orange body color opals, cabochons and faceted gems, at $20 to $50 per carat for faceted gems ranging in size from less than one carat to about three carats. Cabochons of precious opal, without any attached matrix, sold for $100 to $300 per carat in stones from less than one carat to about 10 carats, with prices adjusted according to the usual factors of beauty, flawlessness, etc.

The stability of Mexican opals, long a controversial matter, received the attention of Zeitner (1987), who disputes the commonly held belief that all Mexican opals will craze sooner or later. Federman (1988) tells of an opal cutter he knows who places his preformed opal gems on a room radiator of about 80°F (26°C) for ten days to test their stability; if at the end of this time they have not cracked, they are considered safe to finish and offer for sale. Some of the specimens also develop a whitish, milky, or hazy appearance in what was previously clear material, indicating instability (excessive loss of water), and constituting grounds for rejection. To this I can add my own experience with Jalisco rough which was preformed and then placed in a drawer for six months to "season." At the end of that time a preformed cabochon had developed whiteness and a clear orange cabochon had developed surface crazing, but about 80% of the rough survived and remained solid and transparent even after a later decade of waiting.

To conclude this short note, it is my opinion that the finest Mexican opals are considerably less abundant than the precious opals from Australia, but that the two really cannot be compared because of their vastly different character; each is endowed with its own merits and any discussion should confine itself to those merits alone.

Jones (1994) described a magnificent piece of sculpture that embodies sterling silver and a curious black basalt rock that is uniformly filled with pinpoints of glittering precious opal. It is a representation of the Aztec god Cuauhtemoc, the face and skull fashioned in the opal basalt and the headdress, base, etc., fashioned in brushed silver with more of the opal basalt laid in as cabochons inset in the silver. The deposit from which the rough came is only vaguely referred to as the "Sierra Madre Occidental Mountains," although the deposit was said to be large and worked to exhaustion. The bust was carved by Taxco artist, Rafael Tapia, who took seven months to complete the 16,875 carats sculpture. The silverwork, weighing 7 lbs (3.2 kg), was executed by Alejandro Gomez and took four months to complete. The finished piece, now in the collection of Kansas Newman College, Wichita, Kansas, is 19 in (48 cm) tall. It is allowed to circulate to various shows and exhibits in the United States.

BARCENA, M. (1873) Los opalos de Mexico. *La Naturaleza* 2, p. 297–302.

BELLET, D. (1898) L'exploitation des opals au Mexique. *La Nature* 29, Jan., p. 131.

COUZEN, T. W. (1953) Opal trails in old Mexico. *The Mineralogist* 21, p. 99–103.

_____, (1956) Mexican fire opal. *Gems & Minerals* 222, p. 16–17.

_____, (1956) Mexican fire opal. *The Gemmologist* 25, p. 182–186.

DAVIES, J. E. (1963) The opals of Mexico. *Lapidary J.* 16, 11, p. 1063–1065.

FEDERMAN, D. (1988) Fire opal: pride of Mexico. *Modern Jeweler*, Oct., p. A26.

FOSHAG, W. F. (1933) Opals in the United States National Museum. *Rocks & Minerals* 8, 1, p. 9–10.

FOSHAG, W. F. (1939) Quest for gems and minerals in Mexico. *Smithson. Inst., Smithsonian Explorations 1939*, 4 p.

_____, (1953) Mexican opal. *Gems & Gemology* 7, 9, p. 278–282.

GUBELIN, E. (1986) Opal from Mexico. *Australian Gemm.* 16, 2, p. 45–51.

HEYLMUN, E. B. (1983) Opal localities in west central Mexico. *Lapidary J.* 37, 4, p. 598–602, map.

_____, (1983) Four opal localities in Mexico. *Lapidary J.* 37, 6, p. 880–882, maps.

_____, (1984) Varieties of Mexican opal. *Lapidary J.* 38, 5, p. 746–747, map, glossary.

JEWELERS' CIRCULAR-KEYSTONE (1937) The Aztec Eagle. Vol. 108, 1, p. 97, 99, 101. Famous carved precious opal.

JOHNSON, P. W. (1965) *Field Guide to the Gems and Minerals of Mexico.* Mentone, CA: Gembooks, 97 p., illust., map.

JONES, R. (1994) A bust of black basaltic opal. *Rock & Gem*, 24, 4, p. 68–70.

KUNZ, G. F. (1902) Gems and precious stones of Mexico. *Trans. AIME* 32, p. 55–93. Opal p. 63.

MacFARLANE, T. M. (1911) Mexican opal mines. *Eng. & Min. J.* 92, p. 842.

MALLORY, L. D. (1969) Opal mining in western Mexico. *Lapidary J.* 23, 3, p. 420–428, *passim*, illust.; 4, p. 570–579, *passim*, illust.

McENELLY, T. (1927) Discovery of an opal mine. *U.S. State Dept. Consular Report, Chihuahua, Mexico,* Nov. 18, 3 p.

PANCZNER, W. D. (1994) Mexican opal, the hummingbird stone. *Rock & Gem* 24, 10, p. 58–62, *passim*, illust. (col.).

RAMIREZ, S. (1884) *Noticia Historica de la Riqueza Minera de Mexico.* Mexico: Oficina Topografica de la Secretaria de Fomento, 768 p.

SALINAS, L. S. (1923) Catalogo sistematico de especies minerales de Mexico y sus aplicaciones industriales. *Inst. Geol. de Mexico Bol.* 40. Opal p. 204–207.

STERRETT, D. B. (1912) Gems and precious stones. *Ch. in U.S. Geol. Survey Mineral Resources of the U.S. for 1911.* Opal p. 1060–1061.

WAITE, G. G. (1969) The unusual opals of Mexico. *Lapidary J.* 23, 9, p. 1220–1222, illust. (col.).

ZEITNER, J. C. (1979) The opal of Queretaro. *Lapidary J.* 33, 4, p. 868–880, illust.

SAN LUIS POTOSI. Before 1965, a new type of hyalite opal was found in the same deposits in which the small colorless to brownish euhedral crystals of topaz occurred. Leiper (1965) briefly described these cauliflower-like growths of transparent opal and noted characteristic spherulitic inclusions in some specimens. Sinkankas (1966) examined the same material, determined the spacing of growth bands, and determined several physical properties. While it was assumed that this material was a form of hyalite opal, it was noted that its measured specific gravity of 2.257 was among the highest values recorded for hyalite. A polished slice gave refractive index 1.4625 ± 0.003, also a very high value for hyalite. Heat treatment at 200°C for 3 hrs 40 min drove off a smoky hue and rendered the material colorless. Dehydration tests showed the material to be virtually water-free, as only 0.001 gm loss of weight was experienced after heating a 1.908 gm specimen. In one experiment, a specimen was brought to red heat without suffering damage! Hänni (1989) investigated this material and found essentially the same properties but also determined the composition. He concludes that the material is not hyalite opal but a kind of natural glass. He notes that hyalite is generally very pure silica, but this glass from San Luis Potosi contains approximately 12 weight percent of foreign elements, as aluminum, potassium, cesium, sodium and iron. As of this date, no specific locality for this curious glass, known for its "iris" reflections from its very fine bandings, is known to me. Hänni knew of this material by 1964 but Leiper's description of 1965 is the earliest account I know of. The material investigated by me was obtained from the late Ronald Olson and the late Harry Miller of San Diego County, who brought back the material from Tepetate, San Luis Potosi.

HÄNNI, H. A. (1989) Irisierendes natürliches Glas aus Mexiko. *Zs. Dt. Gemm. Ges.* 38, 2–3, p. 51–62, illust.

_____, (1989) Iridescent natural glass from Mexico. *J. Gemm.* 21, 8, p. 488–495.

LEIPER, H. (1965) New type of opal with spherulitic inclusions discovered in Mexico. *Lapidary J.* 19, 3, p. 407, illust.

SINKANKAS, J. (1966) Iris opal from Mexico. *J. Gemm.* 10, 3, p. 100–105, illust.

NAYARIT. According to Heylmun (1983), this state is a minor opal-producer with its most important deposits located "4 to 6 kms east and southeast of the village of La Curva, which is 22 km [14 mi], by road, south of Tepic." Other mines are near Jala as described in Volume II. In a later contribution, Heylmun (1983) gave more details on the Jala opal mines and the La Curva district; these are shown on a map.

HEYLMUN, E. B. (1983) Opal localities in west central Mexico. *Lapidary J.* 37, 4, p. 598–602, map.

_____, (1983) Four opal localities in Mexico. *Lapidary J.* 37, 6, p. 880–882, maps.

GUANAJUATO. Heylmun (1983) gives access information to the precious opal district of Huanimaro near the village of San Juan Grande and just northwest of the village of Huanimaro. Another group of mines is located in the Penjamo district, 53 km (33 mi) southwest of the city of Irapuato. Most of the mines are accessible only on foot or on horseback.

HEYLMUN, E. B. (1983) Four opal localities in Mexico. *Lapidary J.* 37, 6, p. 880–882, maps.

JALISCO. The opal mining activity in this state was described in Volume II. Recently, Heylmun (1983) brought matters up to date and provided a sketch map of the localities and the road system to reach them; the deposits are clustered to the northwest, southwest, and south of Magdalena. As mentioned before, few of the deposits can be reached by automobile and eventually one must get to them on foot or horseback. In a later article on the Magdalena district mines, Heylmun (1986) further describes the local geography and geology, and notes the profusion of opal placed on sale in shops and by street vendors in the city of Magdalena. Large scale mining here began in the 1960s and "up to 500 opal mines and prospects have been operated since that time. During the peak of the boom in the late '60s and early '70s, over 4,000 people engaged in mining, cutting, polishing and marketing." Among the major mines, Heylmun mentions La Chela, 8 mi (12.8 km) by road north-northwest of Magdalena and now developed into three large opencuts. Another mine, La Pata de Gallo, is located to the northwest of Magdalena about 7.7 mi (12 km) by road.

HEYLMUN, E. B. (1983) Opal localities in west central Mexico. *Lapidary J.* 37, 4, p. 598–602, maps.

_____, (1986) Opal from Magdalena. *Lapidary J.* 40, 3, p. 49–53, map.

QUERETARO. The famous and much visited precious opal mines and dealers in this state have been the subject of many papers as can be seen in the references below. Among those most useful is the map of localities in Heylmun (1983) and the highly detailed articles by Mallory (1969) and

Zeitner (1979, 1987). A most informative contribution on the gemology of the opals appears in Koivula, *et al* (1983), who particularly notes the modes of opal growth and the variations in composition and internal character of the opals, and describes many fascinating inclusions as needles of black hornblende, some replaced by limonite, also goethite, hematite, fluorite, quartz, cristobalite, kaolinite, and pyrite. More on inclusions is to be found in Gübelin (1985, 1986).

Spencer, *et al* (1992) provides new information on the "fire"-type opals which "are unique among opals because of their unusual orange to red color and translucent to transparent diaphaneity . . . unusually low refractive index (1.42–1.43, to as low as 1.37), and distinctive inclusions." They studied gas-liquid inclusions and interpreted them to be dominantly hydrous silica gel. They believe that such inclusions represent remnants of larger gel masses from which the major portions of the opal grew at relatively low temperatures.

BARBOUR, J. (1964) Black opal at San Juan del Rio. *Gems & Minerals* 325, p. 26–27.

BARBOUR, T. R. & BARBOUR, J. (1964) Queretaro—gem cutting center of Mexico. *Lapidary J.* 17, 10, p. 992–994, 1008, 1009, illust.

BURTON, L. W. (1981) The opals of Queretaro. *Gems & Minerals* 521, p. 6, 21.

CASTRO, K. M. & CASTRO, D. (1979) The opals of Queretaro. *Gems & Minerals* 504, p. 42, 43.

COUSEN, T. W. (1956) Some notes and comments on Mexican opal. *Gems & Minerals* 222, p. 16, 17, 68, 69.

FOOTE, A. E. (1886) The opal mines of Queretaro, Mexico. *Proc. Acad. Nat. Sci. Phila.* 37, p. 278–280.

_____, (1886) The opal mines of Queretaro, Mexico. *Eng. & Min. J.* 42, p. 170.

_____, (1887) The opal mines of Queretaro, Mexico. *Proc. Acad. Nat. Sci. Phila.* 38, p. 278–280.

GÜBELIN, E. (1985) Opale aus Mexiko. *Lapis* 10, 1, p. 23–30.

_____, (1986) Opal from Mexico. *Australian Gemm.* 16, 2, p. 45–51.

HEYLMUN, E. B. (1983) Map of the Queretaro opal mines, Mexico. *Lapidary J.* 37, 2, p. 344–345.

KOIVULA, J. I., FRYER, C. & KELLER, P. C. (1983) Opal from Queretaro, Mexico: occurrence and inclusions. *Gems & Gemology* 19, 2, p. 87–96, illust.

MALLORY, L. D. (1969) Opal mining in western Mexico. *Lapidary J.* 23, 3, part 1, p. 420–428, *passim*, illust.; 4, part 2, p. 570–579, *passim*, illust.

MARSHALL, S. M. (1974) Mexican opals. *Lapidary J.* 28, 3, p. 496–497, illust. (col.).

SHAUB, M. S. (1959) Touring Mexico for minerals. *Desert Mag.*, April, p. 35–39, map. Queretaro visited.

SPENCER, R. J., LEVINSON, A. A. & KOIVULA, J. I. (1992) Opal from Queretaro, Mexico: fluid inclusion study. *Gems & Gemology* 28, 1, p. 28–34, illust. (col.).

WEBSKY, M. (1884) Ueber farbenspielenden Opal von Queretaro. *Zs. Dt. Geol. Ges.* Bd. 36.

ZEITNER, J. C. (1979) The opal of Queretaro. *Lapidary J.* 33, 4, p. 868–880, *passim*, illust.

_____, (1987) Queretaro opals. *Lapidary J.* 41, 3, p. 20–26, *passim*, illust.

HIDALGO. Heylmun (1984) notes that older literature refers to precious opal from Zimapan but recent geological studies, as well as local inquiries, failed to locate such a source. It may be a "lost" locality needing rediscovery, or it may have been erroneously named "Zimapan" but is actually in adjacent Queretaro.

HEYLMUN, E. B. (1984) Zimapan opal, are the mines lost? *Lapidary J.* 38, 6, p. 794–795.

HONDURAS. Precious opal from here was known in the gem trade considerably before Australian opal but production was always minor according to Dabdoub (1993), who provides a valuable update on Honduras opal deposits and production. A kind of opal found at Las Colinas is remarkable for its close resemblance to the classic "Hungarian" opal formerly mined in Czechoslovakia. The potential for substantial future production is good since there are hundreds of mines and prospects in a 50-mile (79 km) radius around the town of Erandique and the deposits have not been exhausted by any means. However, the opals from the deposits are quite dissimilar in regard to color, patterning, etc. The host rocks include basalt, andesite, rhyolite, altered rhyolite, and others, a diversity which partly explains the diversity in opal types mentioned above. Opal occurs in seams, veins, diffused in country rock, and in nodular masses, the latter sometimes found loose in cavities, as has been noted in certain deposits of precious opal in Mexico. The Tablon Mine, just outside Erandique, is noted for its black matrix rock and also for colorful boulder material.

The finest cut gems are valued from $50 to $120 per carat retail in the case of the black matrix type, but seam opal can bring prices up to several hundred dollars per carat for stones of less than one carat to as much as thousands of dollars per carat, matching the prices paid for Queensland opals of comparable size and grade. Another popular opal is the "water opal," noted, as may be divined, for its extreme clarity but with vivid, flashing color flakes suspended within; it is mined from deposits in the San Antonio Mountains near Erandique. However, Dabdoub remarks on its tendency to craze and recommends against buying "solid" gems of this opal, suggesting instead that this type be incorporated in doublet or triplet assembled stones so that the optical effects can be enjoyed even if crazing occurs. He estimates that only 10% of such "solids" remain crack-free. The best of the opals from Las Colinas are prized for their "sky blue tint with excellent color play . . . and are valued slightly higher than the crystal opals."

BARBOUR, T. R. & BARBOUR, J. (1964–1965) Country of Opals . . . Honduras. *Lapidary J. in six parts:* Part 1, 18, 8, p. 948–955, map, illust.; Part 2, 9, p. 1066–1072, map; Part 3, 10, p. 1158–1163, illust.; Part 4, 11, p. 1236–1242, illust.; Part 5, 12, p. 1320–1326, illust.; Part 6, 19, 1, 1965, p. 46–60, *passim*, illust.

BARBOUR, T. R. (1965) A description of Honduras opal with some cutting tips. *Lapidary J.* 19, 1, p. 66–71, *passim*, illust. (col.).

DABDOUB, A. (1993) A cut above. *Lapidary J.* 47, 6, p. 83–88, *passim*.

DURON, J. F. (1965) Opals and opal hunters as a native Honduran sees the scene. *Lapidary J.* 19, 9, p. 1060–1061.

LEIPER, H. (1965) Some notes on the early history of Honduras opal. *Lapidary J.* 19, 1, p. 62, 54. Excerpts G. F. Kunz's *Gems and Precious Stones of North America, 1890.*

LINDHE, H. E. (1961) There is opal in Honduras—I discovered it. *Lapidary J.* 15, 5, p. 500–520, *passim*, illust.

MINING & ENGINEERING JOURNAL (1911) Honduras outlook (opal). Vol. 93. p. 623.

CUBA. According to Kunz (1902), moss opal in pieces larger than a fist, and resembling that found near Hartville, Wyoming, occurs in a bed of white cherty rock on the banks of the Yucatan River at La Cieba, 8 mi (13 km) north of the city of Puerto Principe.

KUNZ, G. F. (1902) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1901*, p. 758.

ORBICULAR GABBRO-DIORITE

NORTH CAROLINA. A strikingly handsome rock composed of dark green nodules of hornblende set in a matrix of white feldspar occurs in the Yadkin River granite area, 10 mi (16 km) west of Lexington and one mi (1.6 km) west of Oaks Ferry on the Yadkin River, Davie County (Watson, 1904; Watson & Laney, 1906). The orbicular inclusions range in diameter from 1/8–1 in (2.5 cm) and sometimes reach 2 in (5 cm) across.

WATSON, T. L. (1904) Orbicular gabbro-diorite from Davie Co., North Carolina. *J. Geol.* 12, p. 294–303.

WATSON, T. L. & LANEY, F. B. (1906) The building and ornamental stones of North Carolina. *NC Geol. Survey Bull.* 2, 783 p., illust., p. 129–133.

ORBICULAR GRANODIORITE

WYOMING. Sutherland (1990) reports a handsome example of this rock from the Ferris Mountains, in the center of the N½ of SW Sec. 30, T27N, R87W, in the northwest corner of Carbon County, southeast of Three Forks.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90–9, p. 43.

ORBICULAR RHYOLITE

QUERETARO. Large flows of this volcanic rock occur over wide areas in this state, and from certain portions is obtained an attractive brownish-reddish compact rock capable of accepting a fair to good polish. It is characterized by nearly circular dots of from 1/2 to 1/4 in (2–5 mm), brown in color, often outlined with fine black lines, imbedded in a groundmass of lighter material. Close examination shows a radial-fibrous structure within the orbicules and sometimes crystalline grains that may be quartz and square white crystals which may be feldspar. Essentially, each orbicule resembles a miniature thunderegg. According to Jack Young of El Paso, Texas (*Pers. comm.* 6/93), the best material comes from an area about 10 mi (16 km) southwest of the city of Queretaro.

PALYGORSKITE (ATTAPULGITE)

MEXICO. This soft, minutely fibrous hydrous aluminum magnesium silicate is principally known for forming flexible, leathery sheets or masses, the so-called "mountain leather," of whitish or pale grayish color. However, it has been found recently in a very dense, solid form of pleasing pale rose-red color, misnamed "angel skin opal," and cut into attractive cabochons and small carvings. It is said to occur in Peru and Mexico but no specific localities have been given. According to Berdesinski, *et al* (1977), the Mexican material's properties are refractive index ca 1.55; pale rose-red to white, associated with calcite; specific gravity 2.10; hardness only 2.5–3.0.

BERDESINSKI, W., SCHMETZER, K. & MÜLLER, E. (1977) Palygorskit aus Peru und Mexiko. *Zt. Dt. Gemm. Ges.* 26, 1, p. 6–8.

PARISITE

MONTANA. Bart Cannon of Seattle, Washington, and C. D. Parsons of Santa Paula, California, inform me that they once owned faceted gems of parisite cut by Parsons from crystals found in the Snowbird Mine, Ravalli County (*Pers. comm.* 11/11/1994). Parisite is is a rare-earth carbonate, formula $(Ce,La)_2Ca\ (CO_3)_3F_2$,H 4.5, SG 4.36 ± 0.03. The Snowbird material is reddish-brown and the less than 1 ct gems are transparent but not free of inclusions.

"PATRICIANITE"

MICHIGAN. Luoma (1945) proposed the above name for a rock composed of chlorite, prehnite, and native copper, but the name received no currency.

LUOMA, H. L. (1945) Patricianite—a new cutting material. *The Mineralogist* 13, p. 309–310.

PEARLS AND SHELL

The best early history of pearls and nacreous shells in the Americas is to be found in the still unsuperseded *The Book of the Pearl* by Kunz and Stevenson (1908). Even before the book's appearance, Kunz had included much information on saltwater and freshwater pearls and shell of North America in his *Gems and Precious Stones of North America* (1890, 2nd edit. 1892, p. 211–257). Kunz then wrote additional treatises in 1894 and 1898, all of which provided the foundation for chapters in *The Book of the Pearl* that deal with American pearls, i.e., p. 235–282; with pearls of Panama, Mexico, and the freshwaters of America; with miscellaneous shellfish such as the conch and the clam; and much on the abalone and its pearls. In addition, this work includes a large and perhaps overly detailed chapter on the aboriginal use of pearls and shell, largely in what is now the United States, and as found in archeological excavations, p. 483–513.

To the above may now be added the remarkable monograph of Holmes (1883), of the Smithsonian Institution, which concerns the aboriginal use of pearl and shell. Holmes noted that "shells were valued chiefly for their utility and beauty, and that fresh water as well as marine varieties were constantly employed (p. 189)." Among the shells esteemed for their beauty were *Unios*, or freshwater mussels, *Haliotis* or abalone, especially *H. californianus*, and, farther north along the Pacific Coast of North America, *H. kamschatkana*, a smaller species but beautiful nevertheless. Certain shells, later employed by Europeans for cameos, namely *Strombus* and *Cassis*, were also used by Indians but mainly as receptacles of various types, sometimes attractively ornamented on the outside by shallow incisions and designs. Among objects of ceremonial or ornamental use were beads made from small pierced shells or bits of shell bored for stringing (wampum). Shell ornaments also included pendants, disks (some of singular beauty), engraved shells, and many variously shaped objects which might have been meant for attachment to clothing. The finds described by Holmes range geographically from the Pacific Northwest through the entire United States and parts of Canada, then into Mexico.

Historical accounts of pearls in the Americas also appear in Streeter (1886, p. 250), and very recently, in an instructive paper by Francis (1985) and as a chapter in Dickinson (1968). Other informative sources of pearl knowledge in the Americas appear in Cattelle (1907) and in Feuchtwanger (1859).

Aside from abalone fishing, primarily in the Pacific Ocean waters off the Baja California coast, virtually no commercial pearl fishing in salt water is attempted on a regular basis in Pacific or Atlantic waters. It is reported that the famous pearling grounds in the Gulf of California are now recovering from the blight which nearly exterminated the oysters, but the grounds are closely controlled and fishing is prohibited to give the oyster colonies an opportunity to reestablish themselves. On the Atlantic side, some conch pearls are found from time to time, but like the abalones of the Pacific waters, this mollusk has been dangerously overfished. In freshwaters, sporadic pearling is carried on by private parties on a largely hobby basis, but some pearls are found as a by-product of the pearl shell fishery which supplies the raw material for the manufacture of culture pearl nuclei. According to John Latendresse of American Pearl Company of Nashville, Tennessee, the recovery of natural freshwater pearls from the waters of the Mississippi River drainage is less than 1% of what it was in 1960, the decline being due primarily to pollution and over-harvesting (*Pers. comm.* 11/30/1993). Studies show that mussels absorb poisons and harmful elements in a cumulative process that eventually causes poor growth and a shorter life span.

Certain colorful freshwater pearl shells are now finding favor for making "stones" for jewelry as in the case of a remarkable pink to slightly purplish-pink species, commonly called the "bluffer" *(Properta purplata)*. However, much more important are the successful attempts to implant and grow blister pearls in freshwater mollusks, as will be discussed below under Tennessee, and the success achieved in growing abalone pearls in British Columbia (*see below*) though so far not on a commercially viable basis.

CATTELLE, W. R. (1907) *The Pearl: Its Story, Its Charm, and Its Value.* Phila., PA: J. B. Lippincott, 376 p., illust., p. 222–253.

DICKINSON, J. Y. (1968) *The Book of Pearls.* NY: Crown Publ., 248 p., illust. Ch. 2, p. 66–91.

FEUCHTWANGER, L. (1859) *A Popular Treatise on Gems.* NY: D. Appleton, 464 p., illust. (col.). p. 400–419.

FRANCIS, P. (1985) Pearls and the discovery of America. *Lapidary J.* 38, 12, p. 1512–1514.

HOLMES, W. H. (1883) Art in shell of the ancient Americans. *Second Ann. Rept. Bur. Ethnol. for 1880–1881*, p. 179–305, illust.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.), p. 211–257.

KUNZ, G. F. & STEVENSON, C. H. (1908) *The Book of the Pearl.* NY: Century Co., 548 p., illust. (col.), p. 235–282.

STREETER, E. W. (1886) *Pearls and Pearling Life.* London: George Bell, 329 p., illust., p. 236–244, 257–272.

SWEANEY, J. L. & LATENDRESSE, J. R. (1984) Freshwater pearls of North America. *Gems & Gemology* 20, 3, p. 125–140, illust. (col.).

ABALONE

Cattelle (1907, p. 92–94) describes the abalone thus: "the exterior is very rough, but the mother-of-pearl interior is one of the most exquisite pieces of color work painted by the hand of nature and to this is added an enlivening iridescence most fascinating." Cattelle, however, cautions that abalone pearls tend to be of coarser and weaker structure than pearls from other shellfish, and that they must therefore be carefully examined for solidity and absence of streaks of black conchiolin which shrinks in time and weakens the bonds between the iridescent nacre layers. Despite such possible faults in the abalone pearl, these "opals of the sea" as remarked by Federman (1989) are receiving a strong revival of interest. Federman provides a splendid color photograph of an irregularly shaped pearl that displays vivid colors of green, blue and pink. That such pearls have been known and appreciated many years before now is evidenced in the magnificent abalone pearl of almost spherical shape, of 175 grains (44 cts), which served as the center drop in the famous necklace owned by Madame Nordica (*pseud.* Lillian Norton, 1857–1914), the celebrated operatic soprano. It is depicted in color in Kunz & Stevenson's *Book of the Pearl* (p. 468). In 1988, the *Lapidary Journal* (41, 11, p. 40–41) published several color photographs of abalone pearls from the collection of Lowell Jones of St. Louis, Missouri, who devoted many years to collecting nearly 3,000 specimens of abalone pearls that had come from Pacific Ocean waters from California to Oregon. The pearls display a considerable variety of hues, from white to greenish and pinkish, and of shapes from nearly round to elongated, discoidal, curved, etc., often reflecting the restraint in growth imposed by the recess in the interior of the shell in which they grew. *Jewelers' Circular-Keystone* (May, 1989, p. 220) reported that Lowell Jones's largest known abalone pearl weighed 349.41 cts but is now owned by Moshe Pereg of California. This pearl, along with others from the collection, was displayed for the first time in the Tucson Show of February 6–14, 1987. According to Jones, the pearl was found by divers off the California coast in 1985. It measures 50 x 50 mm (2 x 2 in) and was valued at $3.5 million. Several years later a number of abalone pearls were offered for sale at the 1992 Tucson Show, including an enormous pearl shaped like a boomerang whose curvature suggested that it had grown snugly against the interior lip of a rather large abalone. It measured 75 mm (3 in) long and about 25 mm (1 in) wide at its midpoint. Today all such pearls of irregular or bizarre shape are much desired for incorporation into modern non-traditional jewelry pieces built around the odd shapes.

FIGURE 50. Objects made from abalone shell by the aborigines of the Pacific Northwest. From W. H. Holmes, 1993, Plate 48.

Dr. Peter V. Fankboner of Simon Fraser University, Burnaby, British Columbia, is attempting to grow cultured abalone pearls with considerable success but is beset by several practical difficulties which are the same as mentioned by Boutan in his monograph, *La Perle*, 1925, p. 298-309 (*Pers. comm.*, P. V. Fankboner, 1992). According to

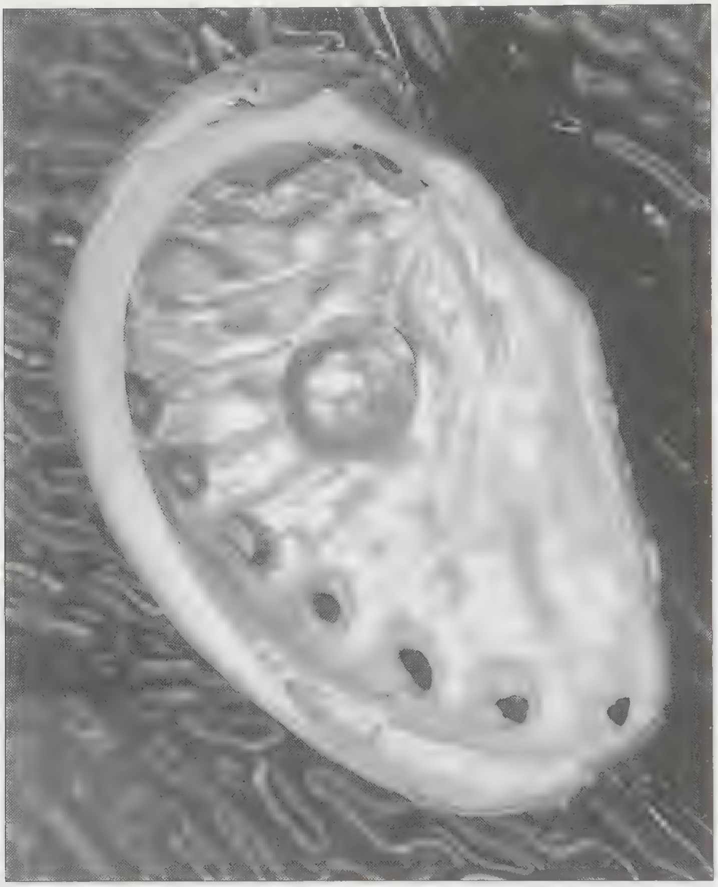

FIGURE 51. Abalone pearl in shell, cultured by Dr. Peter V. Fankboner, Burnaby, British Columbia. *Courtesy Dr. P. V. Fankboner.*

Fankboner, Boutan succeeded in growing abalone pearls late in the 19th century by trepanning the shell of the European abalone *Haliotis tuberculata* and inserting a nucleus around which grew a blister pearl. The beauty of the abalone nacre has not gone unnoticed since then, for in the 1950s methods were developed in Japan for growing abalone blister pearls. Today commercial abalone pearl culture is being pursued in several farms in Korea, Canada, and Australia.

In British Columbia, at the Barnfield Marine Station on Vancouver Island, Fankboner successfully grew gem grade hemispherical pearls to about 17 mm (.75 in) in diameter in *Haliotis kamtschatkana*, a species whose range extends from the Pacific Northwest to Japan. Numerous vexing problems were encountered, including deaths of the animals due to handling and insertion of nuclei, not to mention fatalities caused by natural enemies in the same waters and shocks due to abrupt changes in environmental conditions. Matlins & Bonanno (1991) describe some of the early experimentation of Fankboner on the California species, *Haliotis rufescens.* For the present, reports Fankboner, "success has been excellent from the standpoints of pearl culture time (culture periods usually not longer than one year in contrast to oyster and mussel pearls which typically take 2–3 years) and quality of the abalone nacre." Fankboner guides the activities of Pacific Pearl Culture, Ltd., which owns his patent and the technology developed by him for abalone pearl culture, and another company, The Pearl Doctor, Inc., which concerns itself with abalone pearl technology, sublicensing, training, consultant services, pearl culture supplies, and finishing and marketing of pearls. He also states that he is producing baroque abalone pearls up to 16 x 11 mm (.75 x .5 in), and experimentally, spherical pearls up to 8 mm (.4 in) in diameter.

Because of the alarming depletion of abalones from their natural habitats along the Pacific Coast, and the severe restrictions placed upon their fishing by amateurs and professional skindivers, the demand for abalone meat in restaurants is being met by culturing abalones in tanks or pens. In general, of the several growers who were queried in this regard, it was found that abalones were raised up to about 3 to 5 inches (7.5–12.5 cm) across and then sold to restaurants with no attempts made either to look for pearls or to induce their growth in any manner. All the pearls found by these growers were encountered in large, mature abalones taken from their wild habitat. For example, Kendall W. Smith, of Aqua Ventures of Crescent City, California, found about a dozen pearls over the same number of years, all in wild abalones. In size they ranged from birdshot or about 2 mm in diameter to his largest, a teardrop, measuring about 1 cm long and about 4 mm in cross-section (*Pers. comm.* 1/26/1994). Mr. Smith is intrigued by the prospect of pearl culture in abalones and intends to establish an experimental program. Ray Fields, of Abalone Farm, Inc., of Cayucos, California, located at the north end of Morro Bay, grows restaurant abalones in an efficient tank operation as explained and depicted in an article by G. Smith (1994). He has not found any pearls either in the wild habitat or in his tank-grown animals. Farther south along the coast, John M. Davis of Carlsbad Aqua Farm raises restaurant abalones also but has never found any pearls either in the wild or in his tanks. Michael Cerrito, of Cardiff Sea Farms nearby, reported that he had found only two wild pearls twelve years apart, one shaped like a tooth, and another of irregular shape, both large, 7 gm (35 ct) and 35 gm (175 ct), but neither of high quality; no pearls were ever found in his cultivated stock.

From the above, it is apparent that cultivation of abalones in an artificial environment is a growing business in California and provides the basis for a possible pearl culturing industry that could run concurrently with the growing of abalones for the restaurant trade. However, it appears very unlikely that any pearls will be found in such cultivated abalones without deliberate implantation or trepanning of shells to induce blister growths. The natural scarcity of abalone pearls is also confirmed by these conversations with some of the growers, suggesting that the abalone, a very active feeder, is able to keep his shell cleansed inside; hence the chances for the formation of pearls are drastically reduced.

BLAIR, G. (1977) Abalone: opal of the sea. *Rock & Gem* 7, 11, p. 52–55. Shell used in lapidary work.

BONNOT, P. (1940) California abalones. *California Fish & Game* 26, p. 200–211.

______, (1948) The abalones of California. *Ibid.* 34, p. 141–169.

BOSTWICK, L. P. (1936) Abalones and their pearls. *Nature Magazine* 27, 6, p. 329–332, illust. Attempts to culture pearls.

BOUTAN, L. (1925) *La Perle.* Paris: Libr. Octave Doin, 421 p., illust.

CATTELLE, W. R. (1907) *The Pearl: Its Story, Its Charm, and Its Value.* Phila., PA: J. B. Lippincott, 376 p., illust. Abalone p. 92–94.

COX, K. W. (1962) California abalones, family Haliotidae. *California Dept. Fish & Game Bull.* 118, 133 p., illust. (col.).

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SALTWATER PEARLS

The principal source of information on the pearl resources of the Pacific and Atlantic waters remains Kunz & Stevenson's *The Book of the Pearl,* which has lately been issued in a facsimile paperback edition, thus making this monumental work readily accessible at a reasonable price. Substantial contributions may also be found in Cattelle (1907) whose career as a professional pearl dealer makes his comments permanently valuable. His book contains many references to a number of minor pearl-producing areas in the warm waters of North America.

PANAMA. Pearl oysters of large size have been found in the Bay of Panama, on the Pacific Ocean side of the isthmus, especially around the thirteen small islands that comprise the aptly named Islas Perlas, about 30 to 60 miles (48–96 km) southeast of Panama City. Both Kunz & Stevenson and Cattelle remark upon this source, with the former devoting considerable space to early pearl fisheries and their development. The scattered pearl oyster reefs of these islands extend westward to near the border of Panama with Costa Rica. There appears to be no published data on possible pearl fishing and it must be assumed that no regular production of pearls takes place.

COSTA RICA. Cattelle (p. 369) notes that "pearls [of] good average [size]" have been obtained from the Pacific coastal waters, with "shells, medium size, greenish yellow edge."

BAJA CALIFORNIA SUD. Much early history of pearling in the La Paz area of the Gulf of California appears in Kunz & Stevenson (1908, p. 241–252, and is now augmented by the valuable article published in *Gems & Gemology* by Cariño & Monteforte (1995). These authors also provide details on the early explorations by the Spanish and subsequent attempts to exploit the pearl fishery between 1533 and the present. During the 1600s, called the "Century of Pearl Explorers," large numbers of pearls were recovered by the various expeditions sent from Spain, but by the final years of the 17th century the pearling grounds had become so depleted that Cariño & Monteforte call this "Baja California's first ecological disaster."

From 1697 to 1840 only sporadic pearling occurred but with natural recovery in the beds, intensive fishing took place from 1840 onward to satisfy a vigorous demand from Europe for the splendid mother-of-pearl that the native oyster, *Pinctada Mazatlanica,* supplied. Prosperity prevailed locally for about 75 years from the mid-19th century into the 1920s with profits realized mainly from the sale of shell rather than from the pearls that were incidentally gathered. However, overfishing again resulted in severe depletion of the beds, and attempts were made to repopulate them only in the earliest years of the 20th century when Gaston J. Vives founded Compania Criadors de Concha y Perla de Baja California. He created a highly scientific, biologically sound procedure for the growth of the *P. mazatlanica,* which was preferred over the smaller and thinner-shelled *P. sterna,* using the San Gabriel Bay and inlet on Espirito Santo Island, the latter lying about 32 km (20 mi) due north of the city of La Paz.

La Paz pearls that now reach the market are fished locally on an informal basis from the wild beds in the La Paz Bay area and are found in the two native species mentioned above. The larger of these, *Pinctada mazatlanica*, is by far the more important because of its thick, lustrous mother-of-pearl and because of its potential of producing very large and fine pearls, once the problems of nucleus implantation are solved. At present, the only attempts at pearl oyster cultivation are being made by the Grupo Ostras Perleras, Centro de Investigaciones Biologicos del Noroeste–CIBNOR, based in La Paz, who have succeeded in implanting forms upon which blister pearls form but have not produced pearls grown within the flesh of the oyster. *P. mazatlanica* typically forms bivalves that are almost circular in outline and a mother-of-pearl that is silvery-white to slightly steely bluish-white. The shells are generally about 16 cm (6.5 in) in diameter but larger individuals have been found. This is the shell that found ready acceptance abroad and may still be seen in the handles of silverware and other utensils sold in antique shops. The second native species is the *Pteria sterna*, whose nacre is more colorful, being grayish-silvery to greenish, with overtones of blue, lavender, etc., but so thin-shelled that it has never been used as a source of mother-of-pearl. It is also smaller, being only about half the diameter of *P. mazatlanica*, and displaying wing-like projections upon its hinge such that the shell's outline resembles the Greek capital letter Omega. *P. sterna* has the advantage of being a more prolific producer of natural pearls which are rounder in shape and better suited for jewelry use. As stated by Cariño & Monteforte, "today, approximately 2%–4% of the *Pteria sterna* recovered contain pearls, as compared to less than 0.32% for *P. mazatlanica*, according to interviews with fishermen and personal observations from culturing experiments."

Baja pearls are usually baroque ones from *P. mazatlanica*, many resembling miniature kidneys in form, and with colors that are generally silvery to pale silvery-gray or pale gray-blue with delicate suggestions of blue, lavender and green in their tints. In size they range from about 4 to 16 mm (0.25–0.75 in). The pearls from *P. sterna* are generally smaller, up to about 10 mm (0.5 in), but also darker in tints and more regular in shape. The successful implantations of blister nuclei by CIBNOR resulted in well-shaped blister pearls from 9 mm to 15 mm in diameter after a growth period of 26 months, and development of a nacre thickness of about 2.3 mm. While these experiments are encouraging, the development of a commercially viable pearl culture enterprise in the La Paz area must await massive financing and the importation of personnel skilled in the delicate surgery that is required for production of flesh-grown pearls.

CARIBBEAN SEA. The remarks made above concerning the possible occurrence of pearl oyster beds along Mexican coastlines apply equally to the waters of the Caribbean. The best known source of pearls has been the islands north of Venezuela which have provided pearls since their conquest by Spain in the 16th century. Cattelle (p. 369), for example, mentions that "pearls fine, shells good" came from Haitian waters, which suggests that pearling grounds may be found around all of the islands that border the sea or fall within its boundaries.

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CONCH PEARLS

From time to time, amateur conch fishing in the Florida Keys yields conch pearls, according to the *Lapidary Journal* (1976). Wading on the reefs during low tide, snorkeling, or shallow diving from boats are recommended methods of locating conches. "If a pearl is present, it will generally be found loosely embedded in the meat, somewhere between it and the shell. In some cases the pearl will be found as part of the shell, a deformed 'blister' pearl which generally has little value." However, conch fishing on the keys has been made illegal in order to conserve the dwindling conch resources.

The Gemological Institute of America recently examined a series of conch pearls that weighed 0.67 to 5.10 carats, taken from conches in the waters of St. Christopher and Nevis in the Caribbean Sea's Lesser Antilles chain of islands (Fryer, 1985). The owner of the pearls, a commercial supplier of conch meat, stated that conch pearls were so rare that "in 12 months of shipping over 25,000 lbs [11,340 kg] of conch meat, which represents approximately 54,000 conches, only four large (5–10 ct) and a few dozen smaller 'pearls' were found." The best color, a prized pink, is found in pearls which occur in the outer parts of the shellfish near a hook-like muscle that the conch uses to crawl along the sea floor. Less desirable hues, including opaque brown to yellow, are also found but are discarded as without value. In the color photograph accompanying the article the color ranges from very pale pink to a deep pink verging on red.

A useful summary of facts concerning conch pearls is provided by Federman (1987), who notes that this kind of pearl is best defined as a "calcareous concretion" growing continuously and is not layered as is noted in the structure of nacreous pearls. Citing Susan Hendrickson, a collector of conch pearls, the frequencies of conch pearl occurrences "are the same as in Kunz's day—one in 10,000 to 15,000," here referring to Kunz & Stevenson's *The Book of the Pearl.* The rarity of conch pearls is further reflected in the prices realized for exceptional specimens whenever such are put up for sale, notes Federman, as occurred in an auction battle between a European and Saudi Arabian for a 17 carat symmetrical oval pink pearl that fetched just under $12,000 at a Paris auction in 1984. Normal prices for these pearls fall between $75 and $300 per carat for better to fine grades in sizes up to 12 carats. Federman provides a remarkable colored photograph of a large conch pearl which clearly shows the curious "flame" markings that at once distinguish this pearl from others. This pearl, somewhat ovoid in form, weighs 3.06 carats (9 x 7 x 6.5 mm) and was offered for $500 per carat. Another unusual specimen put up for auction by Sotheby's of Geneva failed to sell, possibly because of its tan color; it weighed 100 carats.

In another detailed and authoritative article, Fritsch & Misiorowski (1987) provide us with the most comprehensive study of conch pearls yet published, exceeding even the information offered in Kunz & Stevenson. The article is especially valuable for its new, firsthand information, and large bibliography. The following notes are taken from same.

The queen conch, *Strombus gigas*, is widely distributed in the Caribbean region as well as in the Florida Keys and Bermuda, wherever suitable shallow waters that meet its life requirements are found. In addition to the large pearl mentioned by Federman above, a 61.41 carat fine, dark pink, unmounted conch "pearl" was sold at auction for US $4,400 at Christie's in London in 1986. Historical conch pearls, as described or mentioned in the literature, include specimens in the former Henry Philip Hope Collection, England, and in the Walters Art Gallery, Baltimore, Maryland, which boasts of a fine pink specimen of 23.5 carats that was purchased from Tiffany's of New York City in about 1900. This pearl is set in a cage of platinum whose enclosing arms are hinged so that the pearl can be removed and examined by itself.

Despite the wide range of the queen conch—the Bermudas, all of the Bahamas, the Antilles, along the north coast of South America, and Caribbean waters of Central America to past Mexico's Yucatan Peninsula—overfishing in many places has drastically reduced the conch population, and protective measures were taken in several countries as in Florida, as mentioned above. The effect of this will be to further reduce the number of pearls that reach the market. The culturing of *S. gigas* pearls has been attempted by La Place Bostwick but without success (Fritsch & Misiorowski, p. 214).

The property determinations below were made by Fritsch & Misiorowski (p. 215 ff), based on examination of more than 150 conch pearls which ranged from 0.2 to 40 carats and from 2 to 22 mm in diameter. Most of the specimens are in the collection of Susan Hendrickson of the Black Hills Institute of Geological Research; she obtained most of them directly from conch fishermen in the Caribbean. Many of the pearls are 2 to 3 mm across and about 0.2 to 0.3 ct and only rarely do they reach diameters large enough to merit mounting in jewelry. The shapes range from nearly round and ellipsoidal (common) to baroque in many shapes. The colors include white, yellow, orangey or salmon, brown in various shades, and of course a wide range of pinks, from those that are barely distinguished from white to those that are fairly strong pink, verging on red. The most desirable pearls are nearly spherical in shape, of a fine purplish pink color, and with a smooth, even, glistening surface of high translucency. However, the pink color tends to fade with exposure to light, especially direct sunlight, to a lighter shade as was noticed many years ago when the shell was extensively employed for cameos, and "there is no known method by which this color can be restored." For this reason it is wise to protect such pearls from exposure to light at all times when they are not being worn.

The physical properties of queen conch pearls are generally: refractive index 1.50–1.53, average 1.51; specific gravity 2.18–2.77 for brown pearls, 2.82-2.87 for white and yellowish pearls, and 2.84-2.87 for pinks.

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KUNZ, G. F. & STEVENSON, C. H. (1908) *The Book of the Pearl.* NY: Century Co., 548 p., illust. (col.). Conch pearls, p. 278–279, color plate.

CLAM PEARLS

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FRESHWATER PEARLS AND SHELLS

Aside from notices of pearls among the aborigines of North America, which are adequately treated by Kunz & Stevenson (1908) and others, the earliest modern notices of United States freshwater pearls appeared about 1857 in metropolitan New York journals, for example *Frank Leslie's Illustrated News* of May, 1857, which carried a story and large wood engravings of pearl shells and pearls, probably from the famous discovery in Notch Brook, Paterson, New Jersey, in that year. The illustrations and story were incorporated in Feuchtwanger's treatise of 1859, and the story subsequently repeated in the gemological literature as in Cattelle (1907, p. 258) and Kunz & Stevenson (1908, p. 259–260). My own visits to Notch Brook took place many years ago but even by that time the paving of large areas with houses, roads, and factories had so reduced the watershed of Notch Brook that it had become no more than a trickle incapable of sustaining a population of mussels.

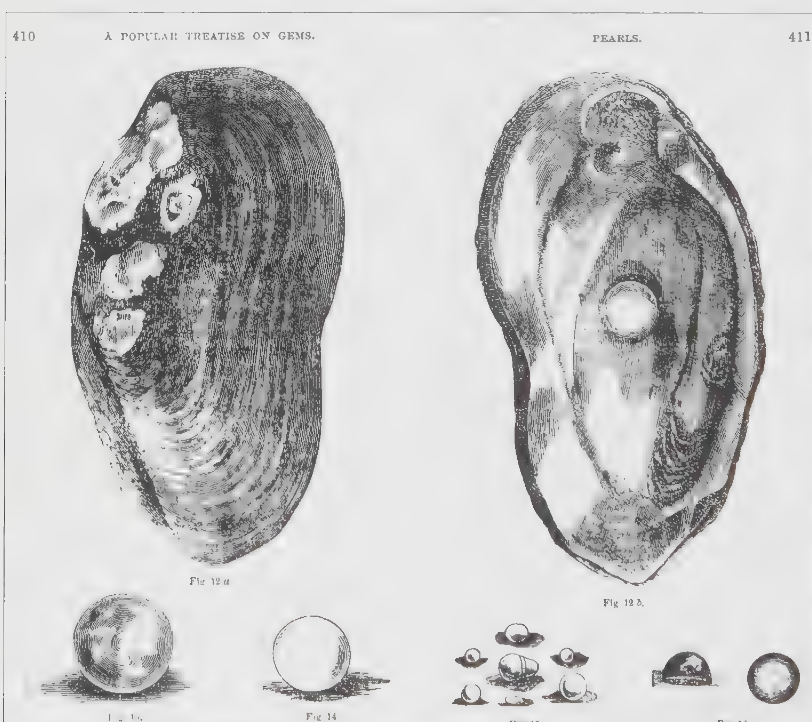


FIGURE 52. United States freshwater pearls and the mussels from which they were obtained. In L. Feuchtwanger, *A Popular Treatise On Gems*, 1859.

NOTABLE FINDS OF AMERICAN NATURAL PEARLS

Compiled by John R. Latendresse, President, American Pearl Creations, Nashville, TN; modified and reproduced by permission.

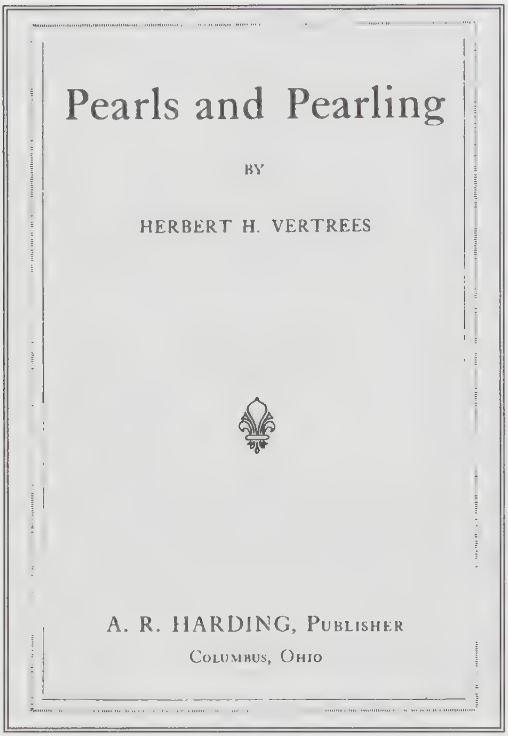
CARATS	LOCALE	YEAR	COLOR	GRADE	SHAPE
63.30	Tennessee R.	Pre-1900	White	Fine	Snail
30.07	"	1963	Purple/bronze	Gem	Snail
29.27	"	1960	White	Fine	
Sharktooth					
27.83	"	1960	White	V. fine	Wing
22.14	"	1960	White	Gem+	Baroque
12.73	"	1960	Pink	Gem	Wing
9.73	"	1940	Rose/lavender	Gem	Bouton
9.54	"	1980	Orchid	Gem	Drop
9.35	"	1980	White	Gem	Baroque
5.46	"	?	White/rose	Gem	Barrel
61.71	Cumberland R.	1905	Multicolor	Gem	Baroque*
38.18	"	1902	Play of color	Gem+	Baroque**
80.46	Wabash R., IN	1920	White	Gem+	Rosebud
21.95	"	1940	White	Gem	Rosebud
9.42	"	1960	Purple, gold, green	Gem	Nugget
8.24	"	?	White/rose	Gem+	Rosebud
15.36	Miami R., OH	1700s?	White	Gem+	Pear
5.80	Rio Grande R., TX	1690?	Purple	Gem+	Bouton

*Found near Nashville, remarkable for its play of color.

**Found near the above; known as "The Pearl of Many Colors"; found downstream from an automobile radiator factory which plates with chromium and nickel.

For many decades, the Mississippi River and its tributaries yielded many thousands of mussels which were fished as raw material for pearl buttons and the occasional pearl. However, the need for shell buttons declined sharply in the 1950s when plastics supplanted nacre, even to the extent of certain plastics cleverly incorporating internal flaws that produced a satisfactory pearly sheen that closely resembles nacre. At present, large quantities of shell are still used for the production of culture pearl nuclei, for which no satisfactory substitute has yet been found. Only North American pearly mussels grow high quality nacreous shells thick enough for the purpose. Insofar as other uses for mussel shells are concerned, some attempts were made in the 1970s to 1980s to use especially colorful shells as cabochon raw material, especially utilizing the pink to purplish pink of the "bluffer" mussel. However, as color photographs used in advertisements indicate, such cabochons commonly display sharp bandings along their edges and thus cannot compare to the uniformity shown by blister pearls. Attempts to locate any companies offering these nacre cabochons failed, and it is assumed that this product is no longer available.

A much different approach to the utilization of freshwater mussels was taken by pearl cultivator John R. Latendresse of Nashville, Tennessee, who after many years of experimentation succeeded in implanting specific shapes of nacre into the mussels which then covered them over with new nacreous growth. These shapes include rounded-corner rectangles and squares, bars, ellipses,


Pearls and Pearling

BY

HERBERT H. VERTREES

A. R. HARDING, PUBLISHER
COLUMBUS, OHIO

FIGURE 53. Vertrees' small but very practical book told all about how to fish for pearly mussels in United States freshwaters. It was published in 1913.

rounds, etc., in various sizes; the pearls thus created are aimed mainly for personal jewelry and thus are limited in size to about 5 mm to no more than about 20 mm across. After a period of several years, the raised parts of the shell are cut out and carefully trimmed for setting in jewelry. Some of the shapes are trimmed next to the protruding part, as in regular blister pearls, but some are trimmed farther away and thus appear as small plaques framing a raised central shape. Details on the Latendresse operations appear below under Tennessee, including remarks on his attempts and successes in growing free cultured pearls.

Some pearls are still obtained incidental to the recovery of shells for nuclei raw material, and some are found from time to time by amateur fishermen. Unfortunately, with the growth of population, industry, and the infrastructure to support same, many waters have been contaminated, and in some cases entire populations of mussels have been destroyed, not to mention the damage done by the installation of many dams that reduce the flow of water that mussels depend upon to bring them their food. However, while the largest rivers are those most likely to be dammed, many smaller rivers contain thriving colonies of mussels. The extent of mussel inhabitation of North American freshwaters is not generally appreciated. A map furnished by Sweaney & Latendresse (1984, p. 131) shows them as being found in every state, and from other sources we learn that they are also to be found in virtually every watershed into Canada and the Arctic and southward into Mexico and Central America. Apparently if waters do not reach extremes of temperature or are reasonably free of pollution, they can and do support a mussel population. Despite this very wide distribution, the most favorable growth conditions occur in the Mississippi River drainage, with especially dense populations in streams and rivers of Minnesota and Wisconsin to the region of Iowa-Illinois-Indiana-Ohio-Kentucky-Tennessee, and down through the Mississippi River Valley to the Gulf of Mexico. There are also large concentrations of mussels in Texas rivers.

In connection with exceptional specimens of American freshwater pearls, Hadley (1992) describes the James L. Peach Collection of natural freshwater pearls, pink, silver, golden, green, blue and black, plus shells and other exhibits, that is housed in the Gem and Mineral Museum of Tennessee in Hermitage. Peach's collection was begun in about 1950. The museum, at 4805 Old Hickory Boulevard, Hermitage, TN 37076, is open to the public.

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_____, (1923) Pearls and the pearl industry. In TRESSLER, D. K. (1923) *Marine Products of Commerce*, NY: The Chemical Catalog Co., p. 146–161, 167–189.

LEA, I. & LEWIS, Dr. (1861) [On the color of the nacre of freshwater pearls]. *Acad. Nat. Sci. Phila. Proc.* 12, p. 88–89.

LEFEVRE, G. & CURTIS, W. C. (1910) Studies on the reproduction and artificial propagation of freshwater mussels. *U.S. Bur. Fisheries Bull.* vol. 30, p. 105–201, illust.

MUSGROVE, M. R. (1962) Freshwater pearls of the Mississippi River Valley. *Lapidary J.* 16, 5, p. 476–479, illust.

ORCUTT, E. (1939) Pearls on purpose. *Sat. Eve. Post*, May 6. Notes Bostwick pearl-growing experiments.

PFUND, A. H. (1917) The colors of mother-of-pearl. *Franklin Inst. J.* vol. 183, p. 453–464.

RAFINESQUE, C. S. (1832) *A Monograph of the Fluviatile Bivalve Shells of the River Ohio.* Phila., PA: 72 p., plate.

REID, W. A. (1927) Pearls in the Americas. *Pan Amer. Union, Commodities of Commerce*, Serial No. 12, 23 p., illust.

ROBERTS, S. G. (1921) America's freshwater pearl-button industry. *Scient. Amer. Monthly*, Sept., p. 200–203.

SHUSTER, W. G. (1988) U.S. cultured pearls: the first full harvest. *Jewelers' Circ.-Keystone* 154, 1, p. 184–186, illust.

SIMMONDS, V. (1899) *Fresh Water Pearls.* Priv. publ., no other data avail. 27 p., 3 plates. How to fish for same in U.S. waters.

SIMPSON, C. T. (1899) The pearly freshwater mussels of the United States: their habits, enemies, and diseases, with suggestions for their protection. *U.S. Fish Comm. Bull.* vol. 18, p. 279–288.

______, (1900) The classification and geographical distribution of the pearly freshwater mussels. *U.S. Nat. Mus. Proc.* 18, p. 295–343.

______, (1900) Synopsis of the Naiades, or pearly freshwater mussels. *U.S. Nat. Mus. Proc.* 22, p. 501–1044.

SMITH, H. M. (1899) The mussel fishery and pearl-button industry of the Mississippi River. *U.S. Fish. Comm. Bull.* vol. 18, p. 289–314, illust.

SPEARS, R. S. (1916) The story of the pearl buyer. *Jewelers' Circ. Weekly*, Feb. 2, p. 97–101. U.S. freshwater pearls.

STEARNS, R. E. C. (1889) On certain parasites, commensals, and domiciliars in the pearl oysters *Meleagrinae. Rept. Smithson. Inst. for 1886*, p. 339–344, illust.

SWEANEY, J. L. & LATENDRESSE, J. R. (1982) American freshwater natural pearls. In D. M. EASH, ed., *Internat. Gem. Symp. Proc.*, Santa Monica, 1982, p. 177–186.

______, (1982) Freshwater pearl culturing in America: a progress report. *Ibid.*, p. 193–199.

______, (1984) Freshwater pearls of North America. *Gems & Gemology* 20, 3, p. 125–140, illust. (col.).

TIFFANY & CO. (1900) *Collection of Pearls and the Shells in which They are Found in the Brooks, Rivers, Lakes and the Coasts of the United States.* U.S. Section, Palais des Forets, Chasse et Peche, Expo. Universelle, Paris, 1900. Separate: NY: Tiffany & Co., [16] p. Lists 95 specimens.

TROYER, B. L. & McREYNOLDS, H. E. (1967) Mussel digging . . . first step in growing cultured pearls. *Modern Jeweler*, Apr., p. 42, 43, 52, 53, illust.

VERTREES, H. H. (1913) *Pearls and Pearling.* NY: Fur News Publ. Co., 203 p., illust. Fishing instructions for U.S. waters.

WARD, F. (1985) The Pearl. *Nat. Geogr.* 168, 2, p. 193–223, illust. (col.). Includes remarks on U.S. pearls and their culture.

WASHBURN, H. E. (1908) *American Pearls.* Ann Arbor, MI: Ann Arbor Press, 48 p., illust.

WILSON, R. H. (1956) The freshwater mussel shell and button industry. U.S. Fish & Wildlife Service, *Fishery Leaflet* (Rev.).

ZEITNER, J. C. (1968) Native freshwater pearls. *Lapidary J.* 22, 1, p. 146, 148–155, illust. Valuable historical notes.

______, (1981) An overview of freshwater pearls in the U.S. *Lapidary J.* 35, 1, p. 4–14, *passim*, illust.

QUEBEC. In the summers of the early 1990s, the waters north of Lac St. Jean in an area centered about the 50th parallel yielded fine *Unio* pearls, the mussels themselves ranging in size from 15 to 20 cm (6–8 in), according to Koivula, *et al* (1993). Six of the pearls, generally well-formed spheroids, smooth and lustrous and displaying white to pinkish colors, ranged in size from 5.5 to 8.5 mm; "the largest Quebec pearls documented thus far are 9.8 and 10.5 mm in diameter [ca 3/8–5/8 in]."

KOIVULA, J. I., *et al* (1993) Natural freshwater pearls from Quebec. In Gem News, *Gems & Gemology* 29, 1, p. 58, col. photo.

MAINE. Bradshaw (1992) notes the occasional find of pearl in the freshwater mussels of Cold River, Crooked River, and Nezinscot River, "to name a few." The Boston Museum of Science owns an Oxford County pearl of 13.2 grains or 3.3. carats, of cream color and of fine luster.

BRADSHAW, J. J. (1992) Gemstones of Maine. In *Mineralogy of Maine*, Maine Geological Survey, *in press.* [21] p.

VIRGINIA. Pink blister pearls, 5 to 20 mm in diameter, have been found recently in several large mussels taken from Snead's Pond, near Schuyler, Nelson County (Penick, 1992).

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 25.

NORTH CAROLINA. In summarizing the gem and mineral collectibles of North Carolina, West (1979) notes that "fresh water mussels occur throughout this state, and pearls can be found in

FIGURE 54. Darryl Markham of American Pearl Company, Nashville, Tennessee, raising a wire-mesh basket which holds the mussels while they develop. These devices are suspended from floating pipes as shown in the background. *Courtesy American Pearl Company.*

many streams and lakes." He found "a number of pearls in mussels from Albemarle Sound near the mouth of the Chowan River," this place being located in the northeast part of the state in Hertford and Chowan counties.

WEST, W. R. (1979) North Carolina and the rockhound. *Lapidary J.* 33, 8, p. 1736–1748 (pearl).

GEORGIA. The streams and rivers of Georgia are all potential sources of mussel pearls, according to C. E. Smith (1970), who describes pearl fishing in the Ocmulgee River near Macon and south-southeast of Atlanta. In the summer of 1969 he found 287 pearls ranging "from seed pearls to two 3-mm blue pearls and baroques measuring up to 7 mm." He discovered that the best places to find mussels are in the eddy portions of river beds where mud is deposited in summer when streams are at their lowest levels. The mussels are found by cautiously wading barefooted and feeling for the slightly protruding gaping shell lips.

SMITH, C. E. (1970) Pearl hunting in Georgia. *Gems & Minerals* 394, p. 27, 46.

ALABAMA. The Chattahoochee River near Dothan yielded a pinkish purple pearl, slightly off-round, about 12 mm (0.5 in) in diameter and weighing about 52 grains (13 ct), according to Fryer (1992).

FRYER, C. W., ed. (1992) Freshwater natural pearl from Alabama. Gem Trade Lab Notes. *Gems & Gemology* 28, 4, p. 264, col. photo.

KENTUCKY. The rivers of this state are noted for

FIGURE 55. Harvesting pearls after the mussels reach maturity. Recovered pearls are shown in small heaps on the table. *Courtesy American Pearl Company.*

their abundance of mussels of various species, from which pearls are taken from time to time. In the late 1980s, the state of Kentucky designated the freshwater pearl as its State Gemstone.

TENNESSEE. The abundance of freshwater mussels in the streams of the western portion of this state and adjoining Kentucky on the north has been known since colonial times, and enormous quantities of these mollusks were fished for the sake of their nacreous shell which was cut up into buttons and many small ornamental items. The demand for shell continues, and even today, according to Austin (1991), Tennessee remains the leading producer among eleven mussel-producing states. During 1990, for example, shell exports, mostly to Japan for the manufacture of cultured-pearl nuclei, reached about 6,000 tons, valued at more than $50 million. While the occasional pearl is found in these mussels, the major development has become the scientific culturing of blister pearls and free pearls in selected species of mussels. The culturing is carried on along the lines of Japanese saltwater pearl culturing practises but modified to suit both the requirements of the mussel itself and the environment in which it grows.

Since 1963, when John R. Latendresse of the American Pearl Company of Nashville, Tennessee, began his systematic research and development of freshwater pearl culture, "periodical success" was obtained "but not enough to be commercial until we had our first major harvest in 1983" (*Pers. comm.*, J. R. Latendresse, 8/10/93). Experimentation was conducted for five to six years in 24 different pearl-bearing mollusks and using a variety of implantation as well as nucleation shapes for blister-type pearls as well as spheres. Since 1983, much success has attended these efforts and the company marketed a large variety of blister shapes, often carefully centered in variously shaped plaques of nacre, and the resulting "blister-cabochon" set in jewelry. The 1993 harvest yielded 700 lbs (318 kg) of loose culture pearls as spheres, drops, flat drops, coin shapes, and others, depending on the location within the mussel where the growth developed (*Pers. comm.* 11/27/93). These pearls ranged in weight from about 5 carats to 20 carats, and developed overgrowths of nacre over the nuclei from 1.3 to 3 mm as compared to the Japanese culture pearl average nacre overgrowth thickness of 0.20 to 0.40 mm.

One of the most difficult problems facing the would-be freshwater pearl culturer in the United States is finding waters that combine suitable chemistry, lack of pollutants, proper temperatures, and a reasonable stability of these environmental factors throughout the year. After investigating about 500 lakes, streams, and rivers, Latendresse found only seven bodies of water that met these requirements, but finally settled upon coves and inlets along the shores of Lake Kentucky for placement of his mussel-culturing rafts. This lake is an exceedingly narrow body of water that was created by the damming of the Tennessee River at a point about 18 miles (28 km) east-southeast of Paducah, Kentucky; the lake extends southward into Tennessee for a total distance of well over 100 miles (160 km). As previously mentioned, Latendresse estimates that the harvest of mussels in the freshwaters of the Mississippi drainage today is only 1% of that recorded in 1960. However, the abundance of potentially favorable waters, once pollution has been brought under control, augers well for the future growth of the freshwater culture pearl industry in North America.

The Latendresse operation begins with fishing and selection of large and healthy specimens of mussels, usually the black-coated "washboard" and "ebony" species taken from rivers in the area. To minimize trauma, the mussels are gathered by hand rather than by dredging, which method also creates as little disturbance of the beds as possible. The mussels are then placed within vertical net frames and suspended in the waters of the culture farm where growth is faster than would be the case if the mussels were allowed to stay in the natural river bed. When the mussels reach a suitable size, they are taken from the frames and nucleated in a process that demands great manual skill to prevent excessive harm to the animal. According to Federman (1992), mussel mortality is only 3.9% as compared to 50%-60% mortality rate in Japanese practise, "because his animals are cared for with antibiotics and then housed in baskets which are not crowded together as they are in Japan." Furthermore, the tranquilizers used dur-

FIGURE 56. Mrs. John Latendresse extracting pearls from the tissue of a mature mussel. Various shapes are shown upon the tablet in the foreground. *Courtesy American Pearl Company.*

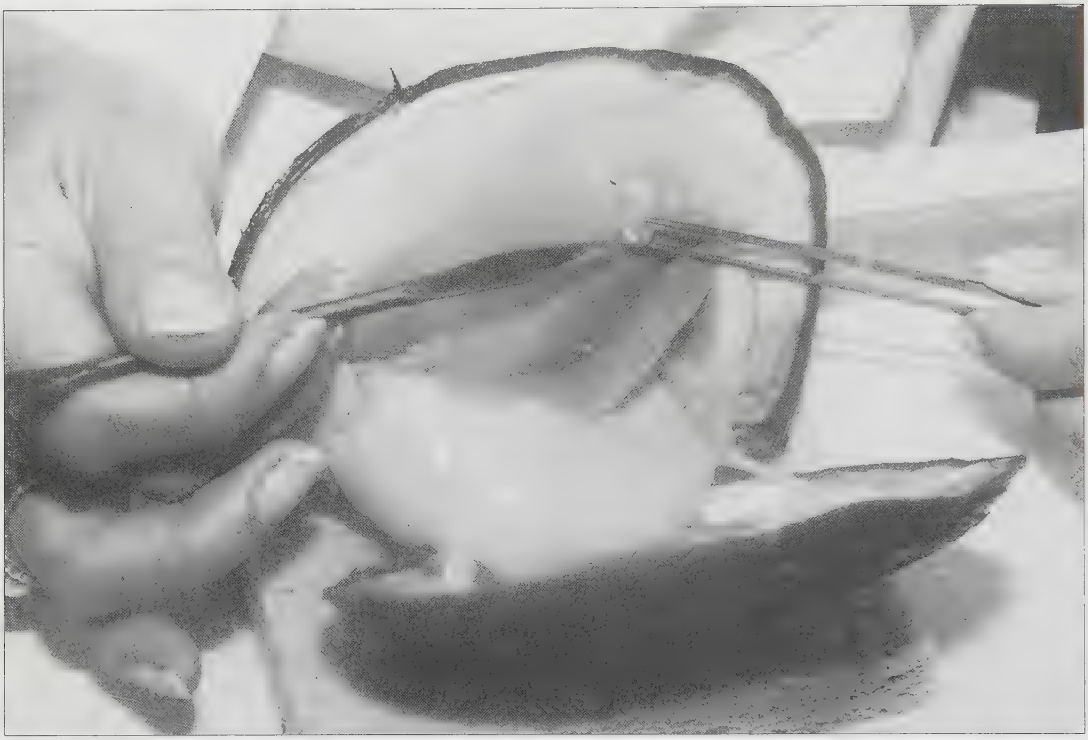


FIGURE 57. Close-up showing a pearl being removed from the mussel tissue with other pearls dimly visible in the flesh. *Courtesy American Pearl Company.*

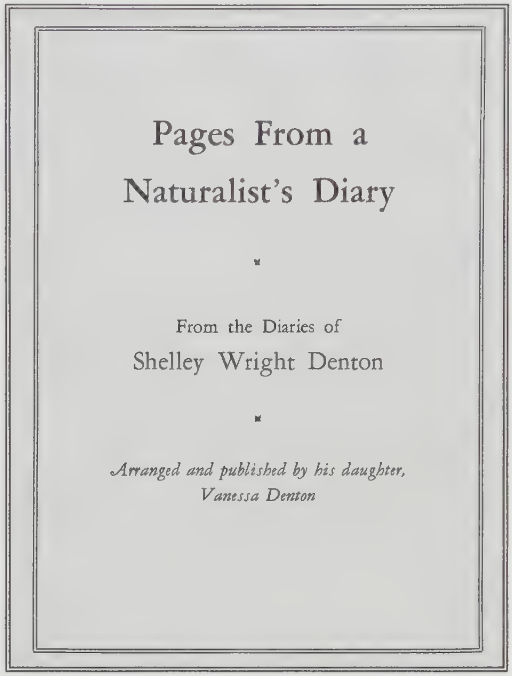
ing the nucleation operation "allows him to insert up to seven mussel-shell nuclei fashioned, by his latest count, into 19 different shapes." Among these, as depicted in brochures supplied by the company, are bar-shapes, drops, pears, disks or "coins," and blister pearls in a variety of shapes. In general, blister pearls develop to useful size and quality in only two years but loose pearls require three years for satisfactory growth. Many freshwater pearls are baroques but since these are now much in demand for modern, non-traditional jewelry, their appearance in the mussels adds to the commercial viability of the culturing business. As to prices, loose pearls range from about one or two dollars per carat for small and lower quality pearls to as much as $20 per carat for the larger and better quality specimens. According to Austin (1991), the iridescent lavender-hued pearls fetched the highest prices, from $15 to $30 per carat and probably more today (1994).

On the more mundane side of the Latendresse operation, his company supplies about 65% of the approximately 6,000 tons of native freshwater mussel shell that are exported to Japan for manufacture into nuclei. Besides the American Pearl Company, there are at least four other suppliers of shell who systematically obtain mussels from a host of individual fishermen in Ohio, Tennessee, Kentucky, and other states in the Mississippi drainage. A small number of strikingly colored shells have been cut up and manufactured into cabochons and other shapes for jewelry purposes.

AUSTIN, G. T. (1991) Tennessee is the pearl of U.S. gem production. *Colored Stone* 4, 3, p. 29–30.

BOEPPLE, J. F. & COKER, R. E. (1912) Mussel resources of the Holston and Clinch rivers of eastern

Tennessee. *U.S. Bur. Fisheries Document* 765, 13 p.
FEDERMAN, D. (1988) *Gem Profile: The First 60.* Shawnee Mission, KS: Modern Jeweler, 131 p., illust. (col.). Freshwater pearl p. 75.
HADLEY, W. D. (1981) Freshwater pearls. *Rock & Gem* 11, 10, p. 48–49, illust. (col.). Examples from the Peach Collection.
______, (1992) The pearls of Nashville. *Rock & Gem* 22, 2, p. 78–82, illust. Peach Collection in Nashville.
SHUSTER, W. G. (1988) U.S. cultured pearls: the first full harvest. *Jewelers' Circular-Keystone* 154, 1, p. 184–185.
SWEANEY, J. L. & LATENDRESSE, J. R. (1982) American freshwater natural pearls. D. M. EASH, ed., *Internat. Gem. Symp. Proc.*, Santa Monica, 1982, p. 177–186.
______, (1982) Freshwater pearl culturing in America: a progress report. *Ibid.*, p. 193–199.
______, (1984) Freshwater pearls of North America. *Gems & Gemology* 20, 3, p. 125–140, illust. (col.).
WARD, F. (1985) The pearl. *Nat. Geogr.* 168, 2, p. 192–223, illust. (col.). Remarks on the American Pearl Company's work.
WILSON, C. B. & CLARK, H. W. (1914) The mussels of the Cumberland River and its tributaries. *U.S. Bur. Fisheries Document* 781, 63 p., illust.


Pages From a
Naturalist's Diary

From the Diaries of
Shelley Wright Denton

Arranged and published by his daughter,
Vanessa Denton

FIGURE 58. Professor Denton's diary extracts relate his mineral and gemstone collecting experiences throughout the United States and contain much on pearling experiences in the Mississippi River drainage. This book was privately published in 1949.

ARKANSAS. Rains (1976) summarized the history of freshwater pearl production in Arkansas, particularly from the White and Black rivers, both famous since 1897 for yielding numbers of fine and large pearls of much value. By 1904, pearls from this state were being regularly sold to buyers from Paris and London, with a total sales figure of $1,271,000. Rains is a collector whose collection of local shells and pearls, along with historical memorabilia, is housed in the Jackson County Courthouse, four miles north of Newport, Arkansas.

BRANN, W. P. (1947) Freshwater mussel shells, the basis for an Arkansas Industry. Fayetteville: *Univ. Arkansas Bur. Research*, Ser. 9.
RAINS, R. D. (1976) White River pearls. *Rockhound* 52, p. 7.

ILLINOIS. A brief but excellent account, based on personal pearling experience in the Kankakee River, in the northeast sector of the state, approximately 50 miles (80 km) southeast of Chicago, is furnished by Geraldine Palmer (1985), whose family members engaged in mussel fishing from 1911 to 1935. The mussels were harvested for sale to pearl button makers but pearls were found from time to time. The scarcity of natural pearls is evident from her report that only about one ounce (28 gm) of pearls were recovered from a ton of shell (2,000 lb or 907 kg). "These shells, along with others bought from fishermen, were sent to the button manufacturing shops in Muscatine, Iowa. Such pearls as were found or purchased were then sold to buyers from the Orient." Among the species of mussels harvested for their shells were muckets, the most valuable because of their very large size, also pig toes, wart backs, elephant ears, three-ridges, paper shell and lady fingers, with the last two not saleable to button makers because of the thinness of shell (paper shell) or pink color (lady finger).

PALMER, G. (1985) 1 ton of shells—1 ounce of pearls. *Gems & Minerals* 574, p. 16, 17, 28, 39, illust.

IOWA. Professor Shelley W. Denton (1949) of Wellesley, Massachusetts, a well-known naturalist, writer, teacher, and purveyor of natural history materials, including minerals and gemstones, wrote entertainingly about his 1898 experiences fishing for pearls in the Cedar River near Waterloo and in the Iowa River near Coralville. He noted that "in all I opened twenty-six thousand seven hundred and twenty-four shells as I keep an account of them. The most in one day was two thousand one hundred and fifteen on the Cedar River August tenth. Although we found no very fine large pearls we did get some very nice small ones and had a fine outing and vacation (p. 134)." On another trip in 1907 he fished the Wapsipinican River near Independence in Iowa and the Scioto River in Ohio, near Kenton, and opened 14,870 shells and "found about seventy-five dollars worth of pearls (p. 144)." This sum translates into about $1,500 of today's dollars.

Much practical advice to would-be pearlers, based on modern fishing practises, is given by Martin (1977), especially for the stretch of the Mississippi River in the vicinity of Muscatine, Iowa.

An interesting account of the now defunct pearl-button industry of Muscatine is given by Barrat (1994), citing David Shayt and Craig Orr of the Smithsonian Institution, who visited the area to collect historical data and artifacts. Originally the buttons were made in what amounted to a cottage industry, but which changed in the decade 1890 to 1900 to a full-blown manufactury "run with complex, automated machinery." The industry died when it was found that pearl buttons "flaked apart" during chemical dry cleaning and electric machine washing, but other factors were also involved, as overfishing and stream pollution.

BARRAT, J. (1994) Buttons highlight vivid chapter in American technological history. *Smithsonian Inst. Research Reports* No. 78, Autumn, p. 3, illust.

DENTON, V., Ed. (1949) *Pages From a Naturalist's Diary.* Wellesley, MA: priv. publ., 375 p.

MARTIN, W. E. (1977) "Pearl" fishing in the Mississippi. *Gems & Minerals* 478, p. 16–18, 20–21, map.

OKLAHOMA. Hower (1962) provides a useful study of freshwater pearls in general, as they occur in the Mississippi River drainage, paying special attention to mussels of Arkansas and Oklahoma. One of the favorite fishing grounds of amateur pearlers is the Verdigris River, from whose mussels mostly seed pearls are removed although some large baroque masses have been found. More on Verdigris River fishing is provided by Buchanan (1981). Initially, fishing was done in a 20-mile (32 km) stretch of the river east of Tulsa "where mussels were found in great abundance," but with changes in the waterways to improve navigation these waters are now too deep. The latest fishing takes place about 60 miles (96 km) north-northeast of Tulsa, above the Port of Caloosa, "where the river is normal and the mussels are plentiful." Other streams in the area also contain populations of mussels but sometimes their bottoms are paved with gravels and the buried mussels are more difficult to detect and extract. Baroque pearls are frequently found, some quite large, but round pearls are rare. The Verdigris River mussels yield mostly white pearls but golden-hued and pink pearls also occur.

BUCHANAN, K. (1981) Freshwater pearls. *Lapidary J.* 35, 1, p. 76, 78, 79.

HOWER, S. G. (1962) Pearl hunting in Oklahoma. *Lapidary J.* 16, 5, p. 480–482, 484–489, illust.

ISELY, F. B. (1924) The freshwater mussel fauna of Eastern Oklahoma. *Proc. Okla. Acad. Sci.* 4, p. 43–118.

RIGGS, C. D. & WEBB, G. R. (1956) The mussel population of an area of loamy sand bottom of Lake Texoma, Oklahoma. *Amer. Midland Naturalist* 56, 1, p. 197–203.

TEXAS. As in Oklahoma, only amateur fishing for mussels takes place, but it sometimes reaches commercial proportions because of the participation of many fishermen, some of whom devote much of their spare time to the avocation. Some fishermen have been successful in their search for pearls as can be judged from a report published in *Gems & Gemology* in 1990 (Fryer, 1990). The Gemological Institute of America, Santa Monica, examined a necklace that contained over 50 graduated Texas freshwater pearls, ranging in diameter from 3.70 to 8.15 mm (1/8"–3/8"), most being quite round and colored brownish to purplish pink, with several pearls being pinkish orange. The pearls were recovered from lakes and rivers in the San Angelo area of west-central Texas, probably from waters of the Concho River drainage. It was stated that the collection was accumulated over a fifteen-year period during which time over 30,000 pearls of all descriptions and qualities had been found, ranging from 2 to 13 mm (3/32"–1/2") in diameter, the average size being 3.5–4 mm (3/16"–7/32").

The range of mussel populations in Texas is given by Strecker (1931). Pearl fisher Portwood (1990) of San Angelo briefly described his fishing experiences in Texas waters and offers a two-hour video entitled "Pearl Fever," which is designed to inspire and guide beginners in the art of fishing for mussels for the sake of the saleable shells. A booklet accompanying the video lists localities in 37 states where mussels may be found.

FRYER, C. W., ed. (1990) Freshwater natural [pearls]. Gem Trade Lab Notes. *Gems & Gemology* 26, 3, p. 223–334, illust. (col.).

PORTWOOD, T. (1990) American freshwater pearls. *Rock & Gem* 20, 8, p. 16–18.

STRECKER, J. K. (1931) The distribution of the Naiades or pearly freshwater mussels of Texas. *Spec. Bull. Baylor Univ. Mus.*, Waco, TX, p. 3–71.

OPIHI SHELL

HAWAII. The endemic limpets of the genus Cellara, locally called "opihi," found only in the Hawaiian Islands, have been cut and polished for use in jewelry (Goldman, 1980). The demand for this nacreous shell accelerated during the late 1970s, both for the sake of the attractive pearly luster and the "eyes" created by selective abrasion of the curved shell, and because of the considerable native folklore attached to the wearing of the shell.

GOLDMAN, R. G. (1980) Hawaiian eyes: the colorful, opalescent opihi shell. *Lapidary J.* 34, 1, p. 196–197, illust.

PECTOLITE

QUEBEC. What must now be considered giant crystals for the species were first found in the famous asbestos open cut Jeffrey Mine at Asbestos, and later at Mont Saint-Hilaire. Hitherto pectolite was always found as radiate fibrous growths, as in the basalt cavities of Paterson, New Jersey, but never as individual crystals large enough to be facetable. According to Arem (1987), pectolite occurs as asbestos in "magnificent prismatic crystals, some facetable, also twinned, up to 5 inches [12.7 cm] long; pale blue-green color, white," and with clear areas that furnished faceted gems up to several carats weight. Recently the Mont Saint-Hilaire locality has provided colorless crystals up to 4 cm (1.5 in) long (Mandarino & Anderson, 1989), and some were faceted into clean gems generally under one carat. However, one gem of 7.31 cts, with inclusions, has been cut, according to Guy Langelier of Montreal (*Pers. comm.* 10/15/93).

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.), p. 147–148.

MANDARINO, J. A. & ANDERSON, V. (1989) *Monteregian Treasures: The Minerals of Mont St.-Hilaire, Quebec.* Cambridge, NY: Cambr. Univ. Press, 281 p., illust. (col.), p. 162.

ALASKA. Extremely fine-fibrous, very tough, compact pectolite has been identified in Eskimo artifacts (Kunz, 1887). In a recent visit to Alaska, I found blue pectolite (*see below*) from the Dominican Republic being offered in souvenir shops as "Arctic Jade!"

KUNZ, G. F. (1887) [Pectolite hammer from Alaska, etc.] *NY Acad. Sci. Trans.* 6, p. 111–112.

DOMINICAN REPUBLIC. A beautiful blue, finely-fibrous, translucent mineral, eventually identified as massive pectolite, although its turquoise-blue color, hitherto unknown in pectolite, suggested otherwise, was found in volcanic rocks of the island in about 1975, according to Woodruff (1986). The first fragments were found as stream-tumbled masses from the bed of the Baoruco River, Barahona Province, in the southwestern corner of the country. Miguel Mendez of Santo Domingo coined the name *larimar* for this pectolite variety, joining parts of *Larissa*, his daughter's name, and *mar*, from the Spanish word for sea in allusion to the fine color. The original deposit was located *in situ* at a place about 10 km (6.3 mi) north of the main road between Barahona and Baharuco. A corporation that included Mendez and the owner of the mine property was formed to exploit the deposit, calling themselves Cooperativa de Extractoses y Procesadores de Larimar. By 1985, bulldozing had begun to expose the decomposed basaltic rocks in which the pectolite formed veins and masses filling openings. The pockets also contained various other minerals, but the pectolite predominated and occurred in all shades of color from white to medium blue. Patterns of varying color intensity mark places where the fibrous growths meet in a "turtle-back" patchwork pattern which is quite attractive. Some material is greenish. Woodruff is of the opinion that tree trunks and branches caught up in the original lava flows were subsequently burnt out to provide spaces for in-filling of pectolite and other minerals.

Schmetzer (1985) examined and identified pectolite-larimar but determined no properties. Woodruff & Fritsch (1989) studied the material further, and gave a very detailed account of the deposit's geology and mineralogy, and specified its location: next to the south bank of the Rio Sitio, 4 km (2.5 mi) due east of the town of Baoruco. Rio Sitio is a south branch of the Rio Baoruco. Typically, the blue pectolite occurs as a hydrothermal mineral in cavities and veins in the basalt, as mentioned before; aside from some sprays of natrolite, no zeolites are found. Colorless calcite, however, is closely associated with the pectolite, and rarely there are small peridot crystals as well as a whitish pumice.

The finest specimens of larimar are quite beautiful, being intense turquoise-blue or sometimes resembling the hue of the best chrysocolla chalcedony. The color is rarely evenly distributed; more often, close examination shows the patchwork pattern referred to above where reflections from differently oriented sprays of natrolite crystals also reflect different intensities of the blue color. In other specimens, the larimar contains brownish-red inclusions ("red plume") of hematite, while still others may include white calcite, natrolite, and bits of the country rock. Most cabochons cut from larimar are less than 25 mm (1 in) across but occasionally some large pieces occur which are suitable for larger stones or for carving into small animal figures generally of about 5 x 5 cm (2 x 2 in) size. Rarely, very small black chalcocite crystals are found, and the presence of this copper mineral suggests that copper is the coloring agent in the larimar.

The properties are: refractive index 1.59–1.63; specific gravity 2.67 for green, up to 2.87 for fine blue (numerous natrolite inclusions bring down the SG to about 2.62); hardness 5–6; tough.

Larimar continues to receive favorable trade notices. No records are available of production but one authority estimated that during the mining season the deposit produced about 300–500 kg per week. The rough is difficult to grade without cutting open the raw masses and it is estimated that only about 20% is cuttable, and only 5% is fine gem quality.

BENTE, K., THUM, R. & WANNEMACHER, J. (1991) Colored pectolites, so-called "Larimar," from Sierra De Baoruco, Barahona Province, southern Dominican Republic. *N. Jb. Min. Monatsh.* 1, p. 14–22.

LIZZADRO, J. (1987) The interesting story of a new blue gem material called Larimar. *Lizzadro Mus.*, Summer/Fall, p. 13–14.

SCHMETZER, K. (1984) Pektolith aus der Dominikanischen Republik. *Zs. Dt. Gemm. Ges.* 33, 1/2, p. 63–64.

WOODRUFF, R. E. (1986) Larimar, beautiful blue and baffling. *Lapidary J.* 30, 10, p. 26–32.

FIGURE 59. View of the Kilbourne Hole peridot locality in New Mexico. Looking south, the diameter of the depression is about one mile (1.6 km). *Courtesy J. D. Lindberg, Las Cruces, New Mexico.*

WOODRUFF, R. E. & FRITSCH, E. (1989) Blue pectolite from the Dominican Republic. *Gems & Gemology* 25, 4, p. 216–225, illust. (col.), map.

PENTLANDITE

ONTARIO. Much of this attractive silvery sulfide ore mineral is still to be found in the Sudbury area (Traill, 1983).

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, p. 265–266.

PERIDOT (OLIVINE)

According to Austin (1993), "the world's largest producer of peridot . . . is the United States," here referring primarily to the single source on the San Carlos Indian Reservation in Arizona. This has been the "basic supply for the colored stone industry since the 1960s. The value of production in 1991 was estimated to be about $1.8 million, according to the U.S. Bureau of Mines." While the San Carlos deposit accounted for an estimated 80 to 95 percent of the world's peridot production, it should be noted that very recent developments elsewhere have introduced important quantities of large-size rough, capable of cutting gems in excess of 100 carats, notably from revived production from a deposit in Myanmar (Burma) and from a newly discovered deposit in Pakistan, both of these also affording very large, clean crystals of fine color. At San Carlos, reservation Indians, who solely are allowed to mine, once sold ungraded lots of raw peridot to local dealers, but are beginning to offer the product directly to consumers and are even contracting for cutting services in order to market faceted gems. Arizona peridot is universally used in jewelry of all types, also in gem trees and other small ornaments where tumbled stones too small to be used for any other purpose find employment. These jewels and trinkets are regularly sold in Hawaiian curio

FIGURE 60. Peridot nodule of about 3 in. (7.5 cm) diameter (outlined), with a facet-grade peridot grain in the center estimated cuttable to about two carats. Kilbourne Hole, New Mexico. *Courtesy J. D. Lindberg.*

and jewelry shops where the peridots are called "Pele's tears," in allusion to a local legend concerning the volcanic goddess Pele. In the Hawaiian Islands themselves, despite their complete volcanic origin, no deposit of peridot has been found as productive as that of Arizona or other peridot-yielding deposits elsewhere in the United States and Mexico. As will be described below under ARIZONA, the importance of the peridot has been recently enhanced by discovery of larger facet grade material.

AUSTIN, G. T. (1993) Cleopatra's "emerald," antiquity's exotic stone, peridot is plentiful in the U.S. *Colored Stone* 6, 3, p. 30, 32.

BRITISH COLUMBIA. No new developments.

CAMPBELL, R. B. (1963) Quesnel Lake (east half) British Columbia. *Geol. Survey Canada Map* 1-1963. Peridot on Takomkane Mtn.

LEAMING, S. (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, 138 p., maps.

LITTLE, H. W. (1957) Kettle River (east half), Similkameen, Kootenay, and Osoyoos districts, British Columbia. *Geol. Survey Canada Map* 6-1957, Lightning Peak peridot locality.

REINECKE, L. (1920) Mineral deposits between Lillooet and Prince George, British Columbia. *Geol. Survey Canada Mem.* 118, 129 p., illust. Peridot on Timothy Mtn.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. 1. Yukon, . . . British Columbia, etc. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18. Gem peridot from Lightning Creek, p. 259.

NEW MEXICO. Recently the Kilbourne Hole gem peridot occurrence was thoroughly investigated and described by Fuhrbach (1992), who mounted a prolonged field trip into this inhospitable desert depression in order to study the geology and nature of the peridot deposits with their associated minerals. The "hole," or in geological terms, a *maar*, is a volcanic explosion crater that has been dated to the Pleistocene period, approximately 180,000 years ago. The altitude of the rim is about 1,300 m (4,300 ft) and the crater is about 3.2 x 2.2 km (2 x 1.4 mi) across. The peridot typically occurs as interlocked grains in nodular segregations or "bombs" whose size ranges from 7 x 5.5 x 4 cm (2.75 x 2.25 x 1.6 in), weighing about 0.25 kg (0.55 lb), to as much as 23 x 23 x 19 cm (8.75 x 8.75 x 7.5 in), weighing about 15.9 kg (35 lb). Fuhrbach, however, notes that the largest nodules generally do not contain the largest single crystal grains of facetable peridot. By far, most clear grains yield faceted gems that are no more than two carats, although Fuhrbach depicts a splendid oval brilliant of excellent color, set in a ring, that weighs 9.58 carats. As is typical of volcanic peridot, here and elsewhere, the Kilbourne Hole material ranges in hue from rich yellowish-green to greenish shades that gradually acquire brownish tones, eventually passing into stones that are so dark brown that they appear to be black. Extra-large facet-grade grains were obtained that weighed 26 and 128 carats. In addition to the peridot which constitutes virtually all of the nodules, minor amounts of augite, diopside, and possibly enstatite and bronzite were found. Inclusions in the peridot have been identified as black hercynite spinel, diopside, and biotite.

From Vol. II it will be recalled that the Kilbourne Hole is located just west of Afton in the southern part of New Mexico. A series of similar maars exists in this region, and others are found across the border in the State of Chihuahua, Mexico. Finds of peridot in the Riley Maar (*see below*) by Lindberg (1984) strongly suggest that all of these volcanic depressions merit thorough investigation for the possibility of peridot gem deposits, especially in Mexico.

FIGURE 61. View of Potrillo Maar, looking south across the fence that marks boundary between New Mexico and adjacent Chihuahua, Mexico. Most of the peridot-productive area is in Mexico. *Courtesy J. D. Lindberg.*

In addition to the Potrillo Maar explored and described by Lindberg (1968) at a place south of Mount Riley in the extreme southern edge of Dona Ana County, Lindberg also explored a similar depression in the same area called the Riley Maar. This depression is located about 15 mi (24 km) southwest of Kilbourne Hole in Dona Ana County, and its position is given as Sec. 31, Tp 237S, R3W, on the USGS Mt. Riley 15-minute quadrangle map. However, Lindberg found facetable peridot and other minerals in large crystals only upon a small hill within the maar called Mineral Ridge. While peridot is found here, only small gems have been cut from the grains and much larger gems can be cut from brown, transparent olivine grains which are far more abundant. Notable among them are crystals that sometimes display good faces and some that are clean enough to facet flawless brown gems of about four carats. The largest crystal, with good though rough crystal faces, weighed 21.3 ct and was of gem quality; it was collected in July 1980. Refractive indices on this material are ca 1.674, 1.692, 1.711. Associates are cleavage fragments of colorless alkali feldspar, some with clear areas large enough to provide faceted gems of very small size. Some feldspar displays chatoyancy and attractive cabochons may be cut from it. Also found are black spinel crystals, sometimes as well-faced octahedra, and octahedral magnetite crystals. A dark green, facet-grade material has been tentatively identified as augite.

DUNHAM, K. C. (1935) The geology of the Organ Mountains, with an account of the geology and mineral resources of Dona Ana County, New Mexico. *NM Bur. Mines Min. Resources Bull.* 11, 272 p., illust. Kilbourne Hole peridot p. 183.

FUHRBACH, J. R. (1992) Kilbourne Hole peridot. *Gems & Gemology* 28, 1, p. 16–27, illust. (col.).

LINDBERG, J. D. (1964) The peridot deposits of Kilbourne Hole, New Mexico. *Lapidary J.* 18, 7, p. 768–771, illust., map.

______, (1968) Potrillo Maar—a new source of peridot. *Lapidary J.* 22, 6, p. 742–744, illust.

______, (1984) Olivine, spinel, feldspar, and other curiosities from Riley Maar, New Mexico. *Lapidary J.* 38, 9, p. 1192–1196, illust.

MITCHELL, J. R. (1991) Collecting a volcano. *Rock & Gem* 21, 2, p. 86–88, 90, illust., map. Kilbourne Hole.

NORTHROP, S. A. (1959) Minerals of New Mexico. Rev. edit. Albuquerque, NM: Univ. NM Press. Olivine p. 380–384.

REEVES, R. C. & DE HON, R. A. (1965) Geology of the Potrillo Maar, New Mexico, and northern Chihuahua, Mexico. *Amer. J. Sci.* 263, p. 401–409.

REICHE, P. (1940) The origin of the Kilbourne Hole, New Mexico. *Amer. J. Sci.* 238, p. 212–225, illust.

WAGNER, L. A. (1994) Kilbourne Hole peridot. *Rock & Gem* 24, 5, p. 48, 49, 70, 71, illust. (col.), map.

ARIZONA. The local geology of the Peridot Mesa on the San Carlos Indian Reservation, Gila County, was studied by Vuich & Moore (1977). The basalt containing the peridot nodular masses seems to be the only flow in the area that contains peridot. It caps the mesa a short distance southwest of the reservation headquarters, and measures 10 to 60 ft (3–15.7 m) in thickness. From the size of current excavations it is estimated that 80% of the peridot-yielding basalt is still available for mining. While no official production figures are kept, Vuich & Moore estimate that from 1,600 to 2,400 lbs (725–1,090 kg) are produced each month. In a later study, Koivula (1981) provides a historical summary of mining, local geology, nodular occurrence of peridot, peridot properties, and inclusions in peridot. The last comprise chromite, chrome spinel, negative crystals, partly developed cleavages, glass blebs, chrome diopside, and biotite.

The production of peridot has not slackened because of the steady demand for this attractive gemstone which is becoming so difficult to obtain from classic sources on St. John's Island in the Red Sea and in Myanmar (Burma). Formerly the small average size of the grains held down the size of faceted gems to several carats although much larger roughs sometimes would be found; for example, a very large grain yielded a 22.9 ct faceted gem that is now in the Smithsonian Institution, and a 34.65 ct faceted gem is reported by Arem (1987) to be in a private collection. According to William Larson, Pala Properties, Inc., of Fallbrook, California, recent mining ap-

FIGURE 62. Scene near the famous peridot quarries on the San Carlos Indian Reservation, Arizona, showing a typical basalt-capped mesa similar to that containing the peridot deposit. *Courtesy Dr. W. Lieber, Heidelberg, Germany.*

pears to have uncovered basalt portions that are providing much larger grains in the nodules, and which also are of fine color, and "at least equal to Burmese in that respect, and in largely clean to fully clean stones" (*Pers. comm.* 7/93). Such large gems regularly exceed ten carats and may run into the twenty- and thirty-carat ranges.

One of the reasons why demand for San Carlos peridot remains steady is the development of ultrasonic drilling machines which drill holes through peridot tumbled stones and beads in a fraction of the time that it formerly took to drill them by hand. It is now financially feasible to market strands of all kinds of drilled gemstones at prices that are astonishingly low as compared to what they were only a few years ago. Thus the overall small-size grains of San Carlos peridot, formerly consigned to "glue-on" applications in jewelry and "gem trees," can now be drilled to make attractive beads out of small tumbled stones. The result has been to maintain mining on the San Carlos site in a profitable status. As mentioned above, Austin (1993) declared that the Peridot Mesa material is the major part of world supply. In 1977, U.S. Bureau of Mines production figures gave a total of 20 tons (9.1 mt) mined to date with a value of $17,000. Production and marketing problems in the 1980s were discussed by Smith (1985) who estimated that San Carlos peridot was supplying 80% to 95% of the world market despite the fact that the majority of the faceted gems were less than five carats. The going price for rough in the 1980s was $5 per lb (0.45 kg), with exceptional rough fetching much higher rates. At this time the Apache Indian residents of the reservation were attempting to organize the industry along the line of rough to cut to jewelry in-house production, but encountered resistance from some tribe members who wished to remain unaccountable to anyone and to mine and sell rough solely at their own discretion. By 1990, monthly production reached an estimated 600 kg (1,323 lb) of cabochon and tumbled stone quality, plus 12–15 kg (26–33 lb) of facet grade material, of which 95% was expected to yield faceted gems of less than five carats. In 1993, widely advertised prices for the faceting rough were $.30 per carat for stones of 3–5 ct to as high as $5 per carat for rough of 30 to 35 carats. Prices up to $6.50 per carat were placed on rough expected to yield the largest and finest grade faceted gems. Among record size rough were those depicted in *Lapidary Journal* (1966) of 1,037.5 cts, said to be a "ceremonial piece" retained in the possession of an Apache medicine man, and other large pieces weighing 382.6, 332.5, and 255 carats, the last said to be "almost all of faceting quality." Depicted also is a round but not clear faceted gem of 75 carats and another of finest quality that weighs 14.5 ct.

In 1994, the television home shopping network QVC devoted Sunday, February 20th, to selling Arizona peridot as the first installment of a proposed series featuring American gems in jewelry (Haley, 1994). The service's phone lines were "flooded" with calls and "about 55,000 pieces" of jewelry set with the Arizona gems were sold, most of the peridot having come from the mining activity of Charles E. H. Vargas, chief executive officer of Apache Gems, and a member of the Apache tribe on the San Carlos Reservation. According to advice from Gordon T. Austin of the U.S. Bureau of Mines, Vargas' family has been allocated 143 mining rights and his mining activity supports 490 employees. Vargas departed from the traditional hand-tool mining methods by introducing power machinery and the use of explosives, both of which led to condemnation by the Apache Tribal Council, which, in 1994, forbade their use (Selwitz, 1994). Vargas exploited levels of peridot-bearing basalt 100 to 200 feet (30–60 m) below the top of Peridot Mesa, from them obtaining peridot grains that ran as high as twenty carats each, of superb medium green color of exceptional purity and freedom from flaws. Such grains sold for as much as $150 to $200 each, depending on the usual quality factors and shape.

BROMFIELD, C. S. & SHRIDE, A. F. (1956) Mineral resources of the San Carlos Indian Reservation, Arizona. *U.S. Geol. Survey Bull.* 1027-N, p. 613–691, maps.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, p. 139.

DUNN, P. J. (1974) Chromian spinel inclusions in American peridots. *Zs. Dt. Gemm. Ges.* 23, 4, p. 304–307.

FOSTER, O. (1972) Peridot Mesa. *Lapidary J.* 26, 7, p. 1108–1109.

FREY, P. S. (1956) Arizona peridot locality. *The Mineralogist* 24, p. 279–280.

HALEY, K. (1994) Peridot hooks QVC on U.S. gems. *Colored Stone* 7, 3, p. 1, 29, 30, illust. (col.).

JACKMAN, G. (1967) Cutting and polishing Arizona peridot. *Gems & Minerals* 353, p. 9–10.

JONES, R. W. (1975) Peridot: Arizona's green gem. *Arizona Highways* 51, 2, p. 6–7, 10, 11, illust.

_____, (1983) Peridot: Arizona's green gemstone. *Rock & Gem* 13, 9, p. 52–55, illust.

KOIVULA, J. I. (1981) San Carlos peridot. *Gems & Gemology* 17, 4, p. 205–214, illust., map.

KOIVULA, J. I. & FRYER, C. W. (1987) Chalcopyrite in peridot: A first observation. *J. Gemm.* 20, 5, p. 272–273. In San Carlos material.

LAPIDARY JOURNAL (1966) Arizona's peridot—America's best. Vol. 20, 9, p. 1060–1061, illust. (col.).

LAUSEN, C. (1927) The occurrence of olivine bombs near Globe, Arizona. *Amer. J. Sci.* 14, p. 293–306. San Carlos material.

MUNDAY, V. F. (1980) Arizona peridots, San Carlos Apache property. *Lapidary J.* 34, 3, p. 796–799, illust.

RABB, D. D. & VUICH, J. S. (1975) San Carlos Indian Reservation peridot mine. *Inspection Report B75-2, AZ Bur. Mines,* Univ. AZ., Tucson.

SELWITZ, R. (1994) Tribal council bans peridot mining. *Colored Stone* 7, 5, p. 120.

SMITH, J. V. (1985) The peridot marketing muddle. *Jewelers' Circular-Keyst.*, Sept., p. 162–164, 166. San Carlos material.

VUICH, J. S & MOORE, R. T. (1977) Bureau studies olivine resources on San Carlos Apache Reservation. *AZ Bur. Mines Field Notes,* 7, 2, p. 1, 6–10, geol. map.

CHIHUAHUA. Light green and light brown peridot occur in the Chavira peridot-olivine mines near Camargo in southeastern Chihuahua, Mexico (Dunn, 1978). The grains form the usual nodular aggregates in basalt along with light brown enstatite, bright green chrome diopside, and chrome spinel. "Stones [of peridot] up to 2 carats can easily be cut from the material." Light green peridot properties are: refractive indexes alpha 1.651, beta 1.669, and gamma 1.684; another tested stone gave 1.652, 1.668, and 1.685 respectively. In contrast, the brown olivine gave alpha 1.655, beta 1.673, and gamma 1.690, all with a difference of ±0.003. Analysis showed the green peridot to contain 8.6% FeO, similar in composition to the San Carlos, Arizona, material, while the brown olivine gave 11.04% FeO. Analysis of the enstatite showed it to be also similar to the San Carlos enstatite but the inclusions of chrome spinel now contain less Cr and more Al than the San Carlos mineral.

BIRCHALL, R. (1966–1967) Peridot on the island of the anguished face. *Lapidary J.* 20, 9, pt. 1, p. 1121–1125; 10, pt. 2, p. 1164, 1166, 1168, 1170, illust., map. Guadelupe Island, Mexico.

DUNN, P. J. (1978) Gem peridot and enstatite with spinel inclusions from Chihuahua, Mexico. *J. Gemm.* 16, 4, p. 236–238.

HAWAII. Olivine nodules containing grains of peridot, plus chrome spinel, diopside, and anorthite, are found in the Lava Flow of 1801 on the northwest part of Hawaii, the "Big Island" (Pemberton, 1964). The flow is most easily reached by traveling north by road 13 miles (21 km) from the town of Kailua; "it is the first flow encountered on this road." The size of the nodules ranges from about one inch (2.5 cm) to about 9 in (22.5 cm) in diameter. Nothing was said in this account as to the suitability of the peridot for gem purposes, but Kunz (1918) does note that faceted gems "weighing from one half carat to one and one half carats each" were cut in Honolulu from peridot grains sifted from volcanic dust from a site somewhere on the island "in a remote part . . . in a bed of black lava sand about an acre in extent . . . they are quite plentiful and many have been sent to Honolulu where they were cut into beautiful yellow and golden-green peridot gems."

KUNZ, G. F. (1918) The production of precious stones for the year 1917. *Mineral Industry* 26, p. 576–601, p. 599–600.

PEMBERTON, H. E. (1964) Olivine nodules on the Kona Coast, Hawaii. *Gems & Minerals* 326, p. 23, map.

PERIDOT IN METEORITES

Meteorites of the pallasite type occasionally contain nodules of olivine large enough to facet small gems, usually less than one carat in size (Sinkankas, *et al*, 1992). The earliest mention of gem material from a pallasite found in the United States is by Kunz (1886) who remarked on the clear material in the Glorieta, New Mexico, pallasite. From this specimen he had obtained "some peridots of 1 carat weight that were transparent and yellowish-green in color" (Kunz, 1890, p. 101). Unfortunately he did not say if faceted gems were indeed cut from this material and it was not until much later that we find an authentic account of a faceted peridot gem from a pallasite, in this case from the Eagle Station, Kentucky, specimen. The gem, noted in the catalogue of gems published by Tiffany & Co., of New York City, to accompany their exhibit at the 1900 Paris Exposition, is now in the collection of the American Museum of Natural History in New York City. It weighs 0.52 carat and is shown in a color photograph in the Sinkankas, *et al* (1992, p. 45) article. The properties of this specimen and other meteorite peridots are remarkably similar to those of terrestrial peridots but the former sometimes contain acicular inclusions, as in the Eagle Mountain pallasite, which are not found (so far) in terrestrial peridots. Another faceted gem was cut from a peridot nodule extracted from the Brenham, Kansas, pallasite for Dr. H. H. Nininger, the famous meteorite expert, but as he ruefully remarks in his book (Nininger, 1972, p. 83–84), the cut gem, entrusted to a jeweler for setting into a ring for Nininger's wife, was broken during its setting.

FRAZIER, S. & FRAZIER, A. (1992) Heavenly peridot. *Lapidary J.* 46, 2, p. 36–40, illust.

KUNZ, G. F. (1886) Further notes on the meteoric iron from Glorieta Mountain, New Mexico. *Amer. J. Sci.* 3rd ser., 32, p. 311–313.

______, (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., p. 101–102.

NININGER, H. H. (1972) *Find a Falling Star*. NY: P. S. Eriksson.

SINKANKAS, J., KOIVULA, J. I. & BECKER, G. (1992) Peridot as an interplanetary gemstone. *Gems & Gemology* 28, 1, p. 43–51, illust. (col.).

PETALITE

MAINE. In 1968, the Tamminen Quarry near Greenwood, Oxford County, produced some clear, colorless petalite that was collected by Rich A. Kosnar of Golden, Colorado, and cut into a flawless round brilliant gem of 3.89 carats. In 1993, more petalite was found, from which were faceted gems of one to two carats, according to Robinson & King (1993), who state that "as far as is known, the Tamminen Quarry has produced the only facetable petalite known from North America."

ROBINSON, G. W. & KING, V. T. (1993) What's new in minerals. *Min. Rec.* 24, 5, p. 382.

PETOSKEY STONE, *see* CALCITE

PHENAKITE

NEW HAMPSHIRE. Colorless crystals of this species, some large and clear enough to afford faceted gems of less than one carat, have been found in cavities in the granites of the Conway and Mount Osceola plutons in the central and north central portions of the state (Samuelson, *et al*, 1990, p. 292). In 1963, Samuelson had found a colorless gemmy crystal measuring 1.8 cm long.

SAMUELSON, P., HOLLMAN, K. & HOLT, C. (1990) Minerals of the Conway and Mount Osceola granites of New Hampshire. *Rocks & Minerals* 65, 4, p. 286–296.

VIRGINIA. W. D. Baltzley, operating the Morefield Mine near Amelia, Amelia County, found small crystals of colorless phenakite that could be cut into fractional-carat gems (*Pers. comm.* 1/93).

COLORADO. Among the species associated with the famous aquamarine of Mount Antero, Teller County, is phenakite which has been found in yellowish to pale pink doubly-terminated twinned crystals up to about one inch (2.5 cm) long and capable of being faceted into clean gems of about 2 carats, according to R. & T. Kosnar (*Pers. comm.* 8/19/94).

PIEMONTITE,
formerly PIEDMONTITE

PENNSYLVANIA. Piemontite is the dark red pigmenting mineral in some of the altered volcanic rocks in Adams County. According to Stose (1932), "excellent specimens . . . were found in considerable abundance in the rhyolite near the greenstone contact at two places on the west side of Buchanan Valley . . . and also on the west side of Piney Mountain. It has also been reported along the Western Maryland Railroad south of Charmian, near the south boundary of the county. The mineral fills thin crevices and gash veins up to one-fourth inch in thickness and several inches in extent. It has deep rich-red color and a fine radiate fibrous structure. It is a hard compact mineral so that it takes a good polish, and since it has a deep red color, it may prove of value as a semiprecious stone as well as for mineral collectors." This resource remains unexploited.

STOSE, G. W. (1932) Geology and mineral resources of Adams County, Pennsylvania. *PA Topogr. Geol. Survey Bull.* Cl., p. 134–135.

PIPESTONE, *see* CATLINITE

POLLUCITE

MAINE. Bradshaw (1992, p. 17) lists a number of faceted pollucite gems cut from Maine material, the largest known being a gem of 8.5 carats now in the U.S. National Museum of Natural History. Others recorded are of a little over one carat to several carats. King & Foord (1994, p. 274–278) give a number of occurrences of pollucite, some of which yielded clear fragments of facet grade material, generally colorless but also faintly pink. Among these are pollucite from the Bennett Quarry and Dudley Ledge (quarry) in Buckfield, and from a place about one-half mile (0.8 km) west of Hebron Academy, Hebron, all in Oxford County.

BRADSHAW, J. J. (In press) Gemstones of Maine. In KING, V. T., ed., *The Mineralogy of Maine.* Augusta, ME: Geol. Survey ME; excerpt of 21 p.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Vol. I: Descriptive Mineralogy. Augusta, ME: Geol. Survey ME, 418 p, illust. (col.).

NEWNHAM, R. E. (1967) Crystal structure and optical properties of pollucite. *Amer. Mineral.* 52, p. 1515–1518.

RICHMOND, W. E. & GONYER, F. A. (1938) On pollucite. *Amer. Mineral.* 23, p. 783–789.

WELLS, H. L. (1891) On the composition of pollucite and its occurrence at Hebron, Maine. *Amer. J. Sci.* 41, p. 213–220.

CONNECTICUT. The Late Gene Vitali of Paterson, New Jersey, described a visit to the Walden Prospect, near Portland, in the early 1950s where he met Mr. Walden, the owner, and was privileged to collect pollucite from large granular masses that had just been exposed after a blast. These masses weighed several hundred pounds, and furnished the facet-grade material for his collection of twelve faceted stones, "one of which is a delicate pink color." The weights were not given but probably none of the gems exceeded several carats.

SEAMAN, D. M. (1963) The Walden gem mine. *Rocks & Minerals* 38, 7–8, p. 355–363.

VITALI, G. (1979) Nostalgia—twenty years of collecting in the Connecticut pegmatites. *Lapidary J.* 33, 7, p. 1598–1610, illust.

PORPHYRY

This term encompasses those rocks in which sharp, blocky crystals, most often a feldspar species of light color, appear suspended in a dark fine-grained groundmass. The crystals, or phenocrysts, range in size from a few millimeters to as much as several centimeters across (1/16"–1"). In some types the crystals are small enough to allow cutting into attractive cabochons, but if the crystals are much larger, the porphyry may be suitable only for large objects such as bookends. Porphyries are common and only a few outstanding sources are given below.

NEWFOUNDLAND. A siliceous rhyolite-porphyry suitable for lapidary work is found in road cuts between St. John's and Channelport aux Basques, according to Sabina (1976). The groundmass is a fine-grained purplish rock which encloses rounded and angular fragments of pink feldspar.

SABINA, A. P. (1976) Rocks and minerals for the collector. The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, p. 65.

ONTARIO. Sabina (1964, 1974) describes porphyry from Bannockburn Township, a short distance north of Rahn Lake, about 19 mi (30 km) west of Matchewan, as a "striking ornamental rock composed of a fine-grained dark grey to almost black matrix enclosing white to reddish and greenish white phenocrysts of plagioclase feldspar."

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. II. Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 8.

______, (1974) Rocks and minerals for the collector: Cobalt-Belleterre-Timmins; Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, p. 106–107.

BRITISH COLUMBIA. A strikingly patterned amygdaloidal porphyry is depicted by Leaming (1980, p. 10) and comes from the Copper River, near Terrace, a town that is inland from Prince Rupert. A handsome porphyry containing phenocrysts which are imagined to be like snowflakes is given the name "snowflake porphyry" accordingly; it is found as an intrusive rock in the Sickler Group rocks of Salt Spring Island at the southeastern end of Vancouver Island, and also on Vancouver Island itself (Leaming, 1973, p. 39). A considerable variety of polishable porphyrys from Vancouver Island are described by the Hutchinsons (1975). More recently, a deposit of lapidary grade porphyry has been located on Texada Island in the Strait of Georgia, and provided commercial quantities of handsome ornamental stone. The rock consists of grayish-white crystals of feldspar set in a black fine-grained gabbro(?) matrix. Because of its patterning it is offered in the trade as "flower rock" (Koivula, *et al*, 1993). Its specific gravity is 2.89. Objects made from this material and sold in curio shops include animal figurines, eggs, tablets, and cabochons.

DANNER, W. R. (1976) Gem materials of British Columbia. *Montana Bur. Mines Geol. Spec. Publ.* 74, p. 157–169, illust.

HUTCHINSON, W. & HUTCHINSON, J. (1975) *Rockhounding & beachcombing on Vancouver Island.* 2nd edit. Victoria, BC: Vaulkhard, p. 25–30, illust.

KOIVULA, J. I., *et al* (1993) Ornamental porphyry from Canada. Gem News. *Gems & Gemology* 29, 2, p. 135.

LEAMING, S. (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, p. 39.

LEAMING, S. & LEAMING, C. (1980) Guide to Rocks & Minerals of the Northwest. Surry, BC: Hancock House, 34 p., illust. (col.).

CALIFORNIA. A variety of porphyry pebbles found in the gravels of the North Fork of the Yuba River above Downieville, Sierra County, yielded excellent cabochon material according to Ferguson (1982). In San Diego County, I have found attractive and polishable porphyry pebbles and boulders in the dry streambeds in many places in the western part of the county.

FERGUSON, R. W. (1982) Leaverites aren't always for leaving. *Lapidary J.* 36, 6, p. 1040–1046, illust.

PREHNITE

NEW JERSEY. Among the many quarries in northern New Jersey that have produced cabochon-grade prehnite is the Millington Quarry, located near that town in Somerset County, from which came ball-like growths of prehnite of yellow-green color, very compact and highly translucent, up to 7 cm (2.8 in) in diameter, according to R. & T. Kosnar of Golden, Colorado (*Pers. comm.* 8/10/1994). Such material was found during 1991 and 1992.

VIRGINIA. In the 1960s, the Fairfax Quarry near Centreville, Fairfax County, supplied excellent light green prehnite as typical incrustations on the walls of fissures in diabase and sometimes covered by handsome apophyllite crystals. According to Penick (1992), in another quarry, that of A. H. Smith in the southern part of Culpeper County near Mitchells, similar material came from a vein in diabase. The solidity and color were excellent, some of the prehnite being fairly dark in hue.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

MICHIGAN. The so-called "thomsonite" nodules weathered from the basalt of Isle Royale are now shown to be fibrous-radiate prehnite with the pink color due to tiny crystals of native copper. The first notice of copper in these nodules is due to Lane (1898), who described the minerals of the island and noted that "the pink prehnite does not appear as such in this section (S. 15651), but S. 15149, which shows copper crystals under the microscope, shows a light flesh pink color to the naked eye." In 1971 and later, Huber (1975, p. 60) gave further proof of the true identity of these nodules and of the fact that the color was due to copper. The nodules are abundant and characteristically pale green to white, but also of the attractive pink hue mentioned. Now it appears that even the nodules from Thomsonite Beach on the north coast of the island are also prehnite and "the pink color . . . is due to internal reflections from finely disseminated native copper inclusions, and the color intensity is related to the distribution, abundance, and grain size of the inclusions."

Elsewhere in Michigan, Heinrich (1976, p. 169–170) notes that similar pink pebbles found on the Lake Superior beaches of Keweenaw Peninsula in the Fort William–Copper Harbor area, some with "eye" patterns, must also be prehnite, as is also the material from the South Range, Houghton County: "the 'thomsonite' from here is actually pink prehnite. Some dealers buy it as prehnite and sell it as thomsonite."

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Div. Bull.* 6, 225 p., illust.

HUBER, N. K. (1971) Pink copper-bearing prehnite from Isle Royale National Park, Michigan. *U.S. Geol. Survey Prof. Paper* 650-D, p. 63–68. Reprint: *Earth Sci.* 24, 1, p. 9–14, illust.

_____, (1975) Pink copper-bearing prehnite from Isle Royale National Park, Michigan. *Lapidary J.* 29, 3, p. 666–673, illust.

_____, (1975) The geologic story of Isle Royale National Park. *U.S. Geol. Survey Bull.* 1309, 66 p., map, illust.

_____, (1983) Pink prehnite from Michigan, a mineral much confused. *Rocks & Minerals* 58, 3, p. 132–134.

LANE, A. C. (1898) Isle Royale. In *Geol. Survey Michigan, Upper Peninsula*, 6, 1893-1897, pt. 1, 281 p., illust., map.

PROSOPITE

UTAH. The first occurrence of possible gem grade prosopite in North America was recorded in Colorado by Cross & Hillebrand (1885) and several years later an analysis was provided by Hillebrand (1889). Kunz (1899) had noted "a beautiful light-green mineral from Utah, which was thought to be probably the same as utahlite, the massive or nodular variscite . . . the exact locality . . . has lately been ascertained and its character has been determined to be quite different [from variscite]." Kunz credits Mr. T. H. Beck of Provo, Utah, with the discovery of the material in the Dugway mining district, Tooele County, "in a low range of hills in a dry desert region, associated with fluorite, native silver, and decomposed auriferous pyrite." The enclosing rock was said to be trachytic, and "slate" was also reported. This material may be prosopite but nothing further developed from the discovery.

CROSS, W. & HILLEBRAND, W. F. (1885) Mineralogy of the Rocky Mountains. *U.S. Geol. Survey Bull.* 20, p. 62–66.

HILLEBRAND, W. F. (1899) Analyses of tysonite, bastnäsite, prosopite, jeffersonite, covellite, etc. *Amer. J. Sci.* 7, p. 53, 54.

ZACATECAS. Very fine-grained blue prosopite, much resembling turquoise, has been found associated with azurite near Santa Rosa as reported in Volume II. New information on this gemstone was given by Dunn & Fryer (1976). The Santa Rosa prosopite properties are: refractive index (mean) 1.50; specific gravity 2.69–2.85; H 4.5. "In summary, blue prosopite from Santa Rosa is an effective turquoise substitute and a very attractive, uniformly colored gem material."

DUNN, P. J. & FRYER, C. W. (1976) Prosopite, an effective turquoise substitute. *Gems & Gemology* 15, 4, p. 205–208.

PYROPHYLLITE

NEWFOUNDLAND. The Foxtrap Mine, located 6 mi (9.6 km) from Manuels, just west of Johnny's Pond, or about 18 mi (27 km) south-southwest of St. John's, furnished good carving-grade pyrophyllite. Most of this fine-textured, soft material is white or cream in hue but also occurs in pinkish, brownish, and purplish tints; some of it contains light blue diaspore and makes an attractive ornamental stone. According to Sabina (1976), it has been used by the Eskimos of the island for their characteristic sculptures.

SABINA, A. P. (1976) Rocks and minerals for the collector: The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, p. 66–67.

CALIFORNIA. A number of deposits of high-grade pyrophyllite that should furnish good carving material occur in Imperial and San Diego counties; commercial production took place in a deposit near Fish Springs, Inyo County.

PEMBERTON, H. E. (1983) *Minerals of California*. NY: Van Nostrand Reinhold, p. 416.

PYROXMANGITE

COLORADO. Much of what has been labeled "rhodonite" from several mines in this state (*see* RHODONITE) is now shown to be pyroxmangite, according to R. A. Kosnar of Golden, Colorado, who "X-rayed at least 30 pieces of 'rhodonite' from Colorado since . . . 1970, and all have proved to be pyroxmangite." This massive material occurs in pink to red hues in the Sunnyside Mine, Gladstone, San Juan County, associated with massive friedelite of reddish-brown color that resembles the friedelite found in the zinc deposits of Franklin, Sussex County, New Jersey; also associated are alleghanyite and tephroite. Similar material occurs in the Idarado Mine, Telluride, San Miguel County, which additionally is accompanied by orangey-pink bustamite and native gold.

According to Arem (1987), pyroxmangite is a manganese-iron silicate, formula $(Mn,Fe)SiO_3$ as compared to rhodonite, formula $MnSiO_3$. Both species commonly contain some calcium, and can occur with the similarly-colored bustamite, formula $(Mn,Ca)Si_3O_9$. When in massive, granular form, these three minerals are easily confused.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones*. 2nd edit. NY: Van Nostrand Reinhold.

PYRITE

PENNSYLVANIA. The use of thin sheets of sparkling, small crystals of pyrite for jewelry is described by Charles (1970), who found his material in the coal mines of central Pennsylvania. A number of applications are shown in his illustrated article.

CHARLES, R. J. (1970) Coal "diamonds"—gems of fire. *Lapidary J.* 24 7, p. 972–974, illust.

QUARTZ

The cryptocrystalline (chalcedonic) varieties of quartz are so abundant that supplies not only have kept up with demand but have increased substantially with the result that the commoner varieties actually fetch lower prices than they did a number of decades ago. However, the finest banded agates of Mexico are becoming scarce because they must be mined rather than merely picked from the surface or from shallow surface diggings. The best grades of chrysocolla quartz have never lost their value; prices for it continue to rise, with the rough often priced by the gram. Amethyst of the finest grades also maintains its value but supplies are uncertain because there are no consistently productive North American deposits. For some years the demand for rock crystal "points" or terminated crystals for use in occult healing practises elevated prices to ridiculous heights, but the fad involving quartz and other minerals thought to have therapeutic value is now subsiding, as are the prices being asked.

QUARTZ NOMENCLATURE. The Fraziers of El Cerrito, California, published a series of lists giving the many names that have been applied to quartz and its varieties (Frazier, 1988, 1989, 1991, 1992, 1993). Each list contains valuable historical information as well as explanatory remarks and references to other authorities and literary sources. Others have also compiled lists on quartz nomenclature, a few earlier ones being Zodac (1936), Dake (1951), Leiper (1961), and Quick (1963), not to mention the various dictionaries of a gemological nature that have been published. The major problem in naming quartz varieties is the almost irresistible urge of finders of "different" material to affix a name ending in the -ite suffix, which professional mineralogists recommend be used only for mineral species and not varieties. Thus we have such names as "mozarkite" for a variety of chert found in Missouri's Ozark Mountains, and "youngite," a variety of chalcedony named after its finder, and a host of other disputed terms as shown in the Frazier lists.

BATES, A. C. (1895) *Quartz and its varieties*. Newark, NJ: Arthur Chamberlain, 56 p., illust. Originally *The Mineral Collector* 2, 4–10, 1895.

DAKE, H. C. (1951) *The Agate Book*. Portland, OR: Mineralogist Publ. Co., 64 p., illust.

FRAZIER, S. & FRAZIER, A. (1988) Name that agate. *Lapidary J.* 42, 1, p. 65–77. Over 500 terms.

_____, (1989) Name that jasper. *Ibid.* 43, 1, p. 75–79, 80–89. Several hundred terms.

_____, (1991-92) Quartz as "diamond." *Ibid.* 45, 1, p. 109–136, *passim;* 46, 1, p. 153–168, *passim.*

_____, (1994) Agate & achates. *Lapidary J.* 48, 8, p. 24–27, 66, 68, 70, 72, illust. (col.). History of terms.

FRAZIER, S., FRAZIER, A. & MUSTART, D. (1993) Thunder showers. *Lapidary J.* 47, 1, p. 149–172, *passim.* Most complete compilation of terms associated with the thunder egg, including types and localities.

LEIPER, H., ed. (1966) *The Agates of North America.* San Diego, CA: Lapidary Journal, 95 p., illust. (col.), maps.

QUICK, L. (1963) *The Book of Agates and Other Quartz Gems.* Philadelphia, PA: Chilton Book Co., 232 p., illust. Glossary p. 30–49.

THRUSH, P. W., ed. (1968) A dictionary of mining, mineral, and related terms. *U.S. Bur. Mines Spec. Publ.*, 1269 p. Includes gemstone terms.

ZEITNER, J. C. (1967) When geodes are gems. *Lapidary J.* 20, 12, p. 1393–1403, 1412, illust. From many localities in North America with names.

ZODAC, P. (1936) Glossary of agate terms. *Rocks & Minerals* Special Agate Number 11, 9, p. 190–192.

THUNDER EGGS, GEODES & NODULES OF AGATE. The curious, roughly spherical chalcedony-cored nodules called *thunder eggs* have been studied for many years, but no mode of origin has yet been agreed upon. A similar difficulty attends the formation of geodes, as those found in sedimentary formations, or those that occur in volcanic rocks as nodules of banded agate. A review of different theories of growth appears in Sinkankas (1966). Just recently, Cook & Cook (1967) revived the idea that sedimentary geodes formed from fossils and their cavities, a concept that was advanced nearly a century ago by Bassler (1908), and the Cooks buttressed their views with considerable supporting evidence. Other recent ideas on chalcedony/agate growth are given by Shaub (1980, 1989), and by Pabian & Zarins (1994) whose study, well-illustrated in color, appears to be the most authoritative thus far. As a result of examining many specimens they believe that "agates are confined to only five lithologies," namely, in rhyolite ash flows, as in Jefferson County, Oregon; in tholeitic basalts as in Brewster County, Texas; in andesite volcanic rocks as at Estacion Moctezuma in Chihuahua; in marine carbonate rocks as in Platte County, Wyoming; and in claystones as in Sioux County, Nebraska. Many references bearing on the problem of origins of chalcedonic quartz are given by them, but the list below presents only a selected few that the reader may wish to consult.

BASSLER, R. S. (1908) The formation of geodes with remarks on the silicification of fossils. *U.S. Nat. Mus. Proc.* 35, p. 133–154, illust.

BROWN, R. W. (1957) Plantlike features in thunder eggs and geodes *Smithson. Inst. Rept.* 1956, p. 329–339, illust.

COOK, K. H. & COOK, W. A. (1967) The origin of geodes. *Gems & Minerals* 357, pt. 1, p. 14–17; 358, pt. 2, p. 18–20, illust.

JONES, R. W. (1992) Agates, geodes, and thunder eggs. *Rock & Gem* 22, 5, p. 48–51, 86–87, illust.

LEIPER, H, ed. (1966) *The Agates of North America.* San Diego, CA: Lapidary Journal, 95 p., illust. (col.). Includes Sinkankas (1961).

LUND, E. H. (1960) Chalcedony and quartz crystals in silicified coral. *Amer. Mineral.* 45, p. 1304–1307. Tampa Bay material.

OREGON DEPT. GEOL. MIN. INDUSTRIES (1989) Oregon's heritage: thunder eggs. *Oregon's Heritage Brochure* 1, 7 columns, illust., map.

PABIAN, R. K. & ZARINS, A. (1994) Banded agates origins and inclusions. *Cons. Survey Div. Univ. NE, Educ. Circ.* 12, Lincoln, NE, 34 p., illust. (col.), map.

RENTON, J. L. (1936) Opal and agate filled "thunder eggs." *The Mineralogist* 4, 1, p. 12–13, 46, 48, 50, 52.

_____, (1951) Some notes on thunder eggs. *Ibid.* 19, p. 171–177.

ROOTS, R. D. (1952) Thunder eggs. *Rocks & Minerals* 27, 5/6, p. 234–236.

ROSS, C. S. (1961) Ash-flow tuffs: their origin, geologic relations and identification. *U.S. Geol. Survey Prof. Paper* 366, 81 p., illust. (col.). Origins of obsidians and thunder eggs.

SHAUB, B. M. (1979) Genesis of thunder eggs, geodes, and agates of igneous origin. *Lapidary J.* part 1, 32, 11, p. 2340–2354, *passim;* part 2, 32, 12, p. 2548–2566, *passim*, illust. (col.).

______, (1980) Genesis of agates, geodes, septaria, and other concretions of sedimentary origin. *Ibid.* part 1, 34, 3, p. 650–679, *passim;* part 2, 34, 4, p. 860–896, *passim*, illust. (col.).

______, (1989) *The Origin of Agates, etc. A New Systematic Theory.* Northampton, MA: The Agate Publ. Co., 105 p., illust. (col.). His previous writings here combined.

SINKANKAS, J. (1961) What do we really know about the formation of agate and chalcedony? *Lapidary J.* 15, 2, p. 242–252.

STAPLES, L. W. (1965) Origin and history of the thunder egg. Oregon Dept. Geol. Min. Industries, *The Ore Bin* 27, 10, p. 195–204.

ZEITNER, J. C. (1967) When geodes are gems. *Lapidary J.* 20, 12, p. 1393–1403, 1412, illust.

______, (1979) A thunder egg review. *Ibid.* 33, 6, p. 1260–1272, *passim*, illust. Localities and types found.

PETRIFIED WOOD. Large quantities of silicified wood, some very attractively colored and patterned, continue to be found throughout the continent. As closer examinations of sedimentary gravel beds in the eastern and southeastern states reveal, much petrified wood is present but it is generally drably colored in tans and browns although much is eminently polishable. These woods are to be found in a broad belt of sedimentary formations that parallel the Appalachians along the Atlantic Seaboard, then curve to the southwest and west into the Gulf states and ultimately into Texas. The more colorful and strikingly patterned woods remain largely products of the western half of the United States.

In Arizona, noted primarily for its Petrified Forest National Park which encompasses a splendid collection of silicified tree trunks, the ranger force is hard pressed to prevent visitors from picking up the many thousands of chips and fist-size fragments of silicified wood that beckon so invitingly along the established pathways throughout the park, this despite the fact that souvenir shops in and around the park sell the wood which is obtained from commercialized private diggings outside the park boundaries. Some of these operations, involving heavy earth-moving equipment, are able to exhume logs of several feet cross-section which are bought by lapidary firms specializing in the production of polished slabs that can be used as small to large table tops; some elongated slabs are also produced by cutting transversely or paralled to the log's axis. In view of the great size of the logs and the difficulties in handling, sawing, lapping, and polishing, such sections may weigh several hundreds of pounds each (100+ kg). For example, at the 1994 Tucson Show, Russell-Zuhl, Inc., of Northampton, Massachusetts, exhibited numerous giant polished slabs of silicified wood, many quite beautiful, with one slab of Arizona wood measuring approximately 2 x 5 ft (40 x 100 cm) offered at $6,000.

The abundance of silicified wood in the past led many to use the material for various building purposes as recorded by Zeitner (1992), who notes slabs of wood used as bathroom tiles, counters, walls, tabletops, and fireplace facings, not to mention a host of other applications in small ornaments.

Special attention is drawn to the superbly color-illustrated special edition of the German mineralogical magazine, *Lapis*, entitled Extra Lapis No. 7, Versteinertes Holz, or "Petrified Wood." This issue is entirely devoted to petrified woods occurring worldwide in all modes of mineralogical replacement, with much on the woods of North America. Particularly valuable features of the issue include a discussion, color-illustrated, of how to identify woods from their fine structure, and proposed explanations of the processes involved in the replacement of wood structures by mineral matter.

ARNOLD, C. A. (1944) Silicified plant remains from the Mesozoic and Tertiary of western North America. *Michigan Acad. Sci. Arts Letters Papers* vol. 30, p. 3–34, illust.

ASH, S. R. & READ, C. B. (1976) North American species of *Tempskya* and their stratigraphic significance. *U.S. Geol. Survey Prof. Paper* 874, 42 p, illust. Numerous U.S. localities plotted.

BROWNEN, G. (1976) Petrified wood. *Lapidary J.* 29, 12, p. 2214–2218, illust. General distribution of, in the U.S.

CHRISTIAN WEISE VERLAG (1994) Versteinertes Holz. Lapis, Muenchen, *Lapis* Extra No. 7, 96 p., col. illust. Magnificent pictures & discussions of petrified woods, many from U.S. sources.

GEMS & MINERALS (1961) Fossils—for the gem cutter. No. 288, p. 20–21, illust.

GREENE, W. D. (1955) Some petrified forest trails. *The Mineralogist* 23, p. 291–295. Northwest U.S.

HOLMES, W. H. (1879) Fossil forest of the volcanic Tertiary formations of Yellowstone National Park. *Bull. U.S. Geol. Geogr. Survey* (Hayden) 5, 1, art. VII, p. 125–132.

McMACKIN, C. E. (1984) Petrified wood from east to west—some we've liked best. *Lapidary J.* 37, 11, p. 1582–1588, illust.

PAGE, V. M. (1969) How to identify petrified wood. *Gems & Minerals* 378, p. 31–34; 379, p. 21–24; 380, p. 31–34, 381, p. 23–24; 384, p. 31–34; 385, p. 33–34; 387, p. 29–30 (conclusion). Illustrated. Formerly publ. in same journal in 1960.

PLATEN, P. (1908) *Untersuchung fossiler Hölzer aus dem Westen der Vereinigten Staaten von Nordamerika.* Univ. Leipzig Inaug.-Dissert; 156 p., illust. Woods from California, Nevada, Arizona, Texas, and Alaska.

QUICK, L. (1963) *The Book of Agates and Other Quartz Gems.* Philadelphia, PA: Chilton Book Co., 233 p., illust.

RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: Mineralogist Publ. Co., 80 p., illust. Covers entire U.S.

READ, C. B. & BROWN, R. W. (1937) American Cretaceous ferns . . . genus *Tempskya. U.S. Geol. Survey Prof. Paper* 186-F, p. 105–129, illust.

READ, C. B. & ASH, S. R. (1962) Stratigraphic significance of the Cretaceous fern *Tempskya* in the western conterminous United States. In *U.S. Geol. Survey Research*, p. D-250–D-254. MT, ID, WY, UT, CO, AZ, NM.

RIEMAN, H. M. (1977) Palms and palm wood. *Lapidary J.* 30, 10, p. 2310–2312.

SCHNITZER, A. (1982) Fossilized trees. *Lapidary J.* 36, 2, p. 418–424, illust.

SPENDLOVE, E. (1990) Bill Bronson's petrified cycads. *Rock & Gem* 20, 12, p. 76–80, illust.

ST. JOHN, R. N. (1927) Replacement vs. impregnation in petrified wood. *Geology* 22, p. 729–739.

STRONG, M. F. (1978) Collecting woods in the Southwest. *Gems & Minerals* 487, p. 16–19, 74, 76, maps (AZ, UT); 488, p. 48–51, maps (NV); 491, p. 46–49, maps (CA); 492, p. 55–56, map (CA).

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept. 1886-'87*, part 2, p. 663–960, map.

WIELAND, G. R. (1906,1916) American fossil cycads. [Vol.I.] *Carnegie Inst., Wash., D.C., Publ.* 34, 296 p., illust; Vol. II. Taxonomy, 277 p., illust.

ZEITNER, J. C. (1963) Our forests of stone. *Lapidary J.* 17, 4, p. 436–447, illust. All major occurrences U.S.

_____, (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. Petrified woods of east.

_____, (1973) Mid-continent petrified wood. *Lapidary J.* 27, 7, p. 1060–1069, illust. ND, SD, NB, KS, OK, TX.

_____, (1992) Petrified. *Lapidary J.* 46, 6, p. 36–39, illust. (col.).

FIRE AGATE. Describing fire agate, Federman (1988) notes that "it has not been easy to light a lasting fire, in terms of public interest, for fire agate." To be sure, fire agate has achieved considerable popularity among amateur lapidaries and collectors, especially in the Southwest, but it has not attained a similar status in the mainstream jewelry trade. However, this appears to be slowly changing in recognition of the fact that the finest, most skillfully cut and polished specimens are truly beautiful by anyone's reckoning. The best pieces display vivid reflections of red, orange, yellow, green, and even blue, but these are rare, and by far most finished fire agates give a first impression of brown color with other colors less vivid and tending to appear in minute pinpoints, somewhat like densely milky opals; a strong light is needed to assure one's self that there is some other color present besides the body color. The cause of the color remains controversial, the most common explanation suggesting that the iridescence arises from a thin layer of minute iron oxide crystals (goethite?) which give rise to interference of light, hence the color(s). A similar iridescence may be noted upon the botryoidal chalcopyrite of

Cornwall, England, especially the specimens from Cook's Kitchen Mine, which material was called by James Sowerby, in his *British Mineralogy*, "blistered sulphuret of copper" and by others simply "blister ore." The colors are similar to those seen in fire agate, but, of course, they are not covered by a translucent layer of chalcedony as is the case in fire agate. A fine colored illustration of the Cornish ore appears as Plate 432, in the fifth volume. Sowerby (p. 53) states that "it may be said to occur of all colours, viz., yellow, red, and blue, in binary varieties, such as orange violet and green; also the ternaries, or all varieties of brown; but this variety of Colour is only superficial." A recent investigation of fire agate color was conducted by Barwood (1982) who found no spheroidal structure in the translucent chalcedony after etching and examination by scanning electron microscopy (SEM). Instead, he found a platelet structure which he likens to that seen in etched ammolite, and thus he is of the opinion that the color arises from interference and not from diffraction. As in the ammolite material, fire agate colors tend to be second-order reds and greens.

Fire agate is a relatively recent newcomer among gemstones but a precise date of first discovery seems unrecorded. However, Watson & Galesi (1993, p. 49) note that while many claim to have discovered fire agate, the Fraziers attribute the first find to Warren Jones. The latter, a vigorous pursuer of minerals and gemstones in the field, claimed to have found fire agate in Arizona as early as 1939 and began working this deposit in 1941. Jones also found a deposit in San Luis Potosi, Mexico, in 1961, from which he mined much material. At present, supplies of fire agate in many color grades are adequate but the finest material remains rare and fetches premium prices. Because of the irregular layering of the basic chalcedony, fire agates cannot be cut into standard cabochon shapes without sacrificing color displays. For this reason, most cabochons tend to be irregular in profile and cross-section and demand a special mounting for each gem. Most stones are rather small, generally from 0.5 to 1 inch (12–25 mm), and as such bring several dollars per carat for the brownish types to as much as $30 per carat for the best stones whose interference colors are both obvious and pure. As pointed out by Federman (1988), the best fire agate gems compare favorably to certain classes of precious opal but cost much less per carat and are far more durable.

BARWOOD, H. L. (1982) The color in fire agates. *Rock & Gem* 12, 8, p. 62–63.

FEDERMAN, D. (1988) Fire agate: Rock shop exclusive. *Modern Jeweler*, Sept., p. 63–64, illust. (col.).

GUMAN, W. J. (1976) Color patterns in fire agate. *Lapidary J.* 29, 11, p. 2131–2133.

HUGHES, W. & SMITH, C. A. (1978) Are fire agates opals? *Rock & Gem* 9, 10, p. 44–45. Detect regular packing structure—like opal?

HUGHES, W. (1980) Looking into fire agate. *Rock & Gem* 10, 7, p. 36–37.

______, (1980) Investing in fire agates. *Ibid.* 10, 11, p. 56–58, 79, 80, illust. (col.).

JONES, R. W. (1992) Fire agate. *Rock & Gem* 22, 1, p. 56–59, 78, 79; 2, p. 40–44, 89, illust.

LOWE, S. (1979) Arizona's own precious gem: The fire agate. *Arizona Highways* 55, 3, p. 10–15, illust. (col.).

RADCLIFFE, D. & PEACOCK, S. (1977) Fire agate: A potent geological delight. *Lapidary J.* 31, 5, p. 1096–1108, *passim*, illust.

WATSON, J. & GALESI, M. J. (1993) Fired up. *Lapidary J.* 47, 3, p. 46–53, illust. (col.).

MISCELLANEOUS QUARTZ REFERENCES.

AUSTIN, G. T. (1993) Chameleon of gems. *Colored Stone* 6, 4, p. 38–39, illust. Chalcedony varieties and distribution in U.S.

BATES, A. C. (1895) *Quartz and Its Varieties.* Newark, NJ: Arthur Chamberlain, 56 p., illust.

CUNNINGHAM, J. L. (1961) Lake Superior agates. *Lapidary J.* 15, 2, p. 220–235, *passim*, illust. Occurrences from Great Lakes south to Missouri.

DAKE, H. C., FLEENER, F. L. & WILSON, B. H. (1938) *Quartz Family Minerals.* NY: McGraw-Hill Book Co., 304 p., illust.

FARRINGTON, P. C. & LAUFER, B. (1927) Agate, physical properties and origin by . . . Farrington . . . Archaeology and folklore by . . . Laufer. Chicago, IL: *Field Mus. Nat. Hist. Geol. Leaflet* 8, 36 p., illust.

FISHER, G. W. (1991) *Gemstones & Chemicals: How to Create Color and Inclusions.* Shelton, WA: priv. publ., 74 p., illust. (col.). Review: NASSAU, K. (1994) *Gems & Gemology* 30, 1, p. 60, advising caution.

GUBELIN, E. J. & KOIVULA, J. I. (1987) Chalcedony and its inclusions. *Lapidary J.* 40, 10, p. 27–29, 32, 34, illust.

KUNZ, G. F. (1885) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1883 & 1884*, p. 748-765, important!

_____, (1890) *Gems and Precious Stones of North America*. NY: Scient. Publ. Co. Quartz: p. 106–146, illust. (col.).

MEEK, J. H. (1981) Flint-knapping: The old hard way. *Lapidary J.* 34, 11, p. 2430–2440, illust.

PABIAN, R. K. (1978) Inclusions in agate and their origins and significance. *Gems & Gemology* 16, 1, p. 16–28, illust. (col). Fundamental study.

ROGERS, A. F. (1924) Mineralogy and petrography of fossil bone. *Geol. Soc. America Bull.* vol. 35, 3, p. 535–556.

SHEPHERD, W. (1972) *Flint, Its Origin, Properties and Uses.* London: Faber and Faber, 255 p., illust.

SIBER, H. J. K. (1987) Nature's pop art: Nordamerikanische und mexikanische Achate und ihre Fundstellen. In: *Achat, das farbige Geheimnis.* Munich: Mineralientage, p. 18–22, illust. (col.). N.A. localities.

SINKANKAS, J. (1961) What do we really know about the formation of agate and chalcedony? *Lapidary J.* 15, 2, p. 242–252, 296.

STEVENS, E. T. (1870) *Flint Chips. A Guide to Pre-Historic Archaeology, etc.* London: Bell and Daldy, 593 p., illust.

SUTTON, R. L. (1964) Bubble crystals and notes on enhydros. *Lapidary J.* 18, 8, p. 924–935, illust. Liquid inclusions in quartz.

WATSON, T. L. & BEARD, R. E. (1917) The color of amethyst, rose and blue varieties of quartz. *U.S. Nat. Mus. Proc.* 53, p. 553–563.

WICKES, W. H. (1910) Beekite. *Proc. Bristol Naturalist's Soc.* 4th ser., 2, 3, p. 9–21, illust.

WILSON, T. (1898) Arrowpoints, spearheads, and knives of prehistoric times. *Rept. U.S. Nat. Mus. for 1897*, p. 811–1021, illust. Flint sources in U.S.

WRIGHT, B. (1894) *Native Silica. A Treatise upon a Series of Specimens of Quartz, etc.* London: Wyman and Sons, 263 p. Includes N.A.

ZEITNER, J. C. (1964) Plume—The regal agate. *Lapidary J.* 18, 1, p. 129–137, illust. From U.S. sources.

ZEITNER, J. C. (1964) Jasper—gem of confusion. *Lapidary J.* 18, 9, p. 980–998, illust. Many types from U.S. sources.

_____, (1969) Chalcedony icicles. *Lapidary J.* 23, 2, p. 342–347, illust. Peculiar rod-like growths from Texas; not fulgurites.

_____, (1970) Feathers, flakes, and fans. *Lapidary J.* 23, 11, p. 1506–1513; 12, p. 1580–1613, *passim*, illust. Reviews many types of inclusions in chalcedonies.

_____, (1973) Fortification agates. *Lapidary J.* 27, 6, p. 868–878, illust.

_____, (1976) Agates, again. *Lapidary J.* 30, 5, p. 1124–1134, *passim*, illust.

_____, (1982) Why agate is my favorite. *Lapidary J.* 36, 5, p. 842–850, *passim*, illust. (col.).

_____, (1988) American classics. *Lapidary J.* 42, 7, p. 36–44, illust. Extra-fine varieties from N.A. deposits illustrated in color.

ZEITNER, J. C. & MILLSON, H. E. (1979) Another look at agates. *Lapidary J.* 33, 2, p. 478–486, *passim;* 3, p. 678–684, *passim*, illust. (col.).

ZODAC, P. (1936) Agates along the Atlantic Coast. *Rocks & Minerals* 11, 1, p. 182–186, 188.

MOGANITE AND LUTECITE. In 1992, Peter J. Heaney and Jeffrey E. Post, of Washington, D.C., published a paper on the widespread distribution of a hitherto unrecognized type of silica which was named *moganite*. It was found to occur abundantly in cryptocrystalline quartzes. They noted that "many scientists may find it surprising to learn that most microcrystalline quartz varieties consist not only of quartz but also of a distinct silica polymorph called moganite."

Moganite was originally identified and described by Flörke, *et al* (1976), from rocks in the Mogan formation on Gran Canaria Island off the northwest coast of Africa in the Atlantic Ocean. A similar type of fibrous quartz, called *lutecite*, was originally described in 1892 from the type locality of Clamart, France, and because of certain properties noted in its microstructure, Healey & Post suggest that "moganite actually is a rediscovery of lutecite, a mineral name abandoned by mineralogists but retained for casual usage among petrologists." The microstructures and properties of all types of cryptocrystalline quartz are discussed by Frondel (1962, p. 195 ff). Among the findings by Heaney & Post on moganite,"more than 10% and as much as 80% of the silica in many samples [more than 150 examined] is actually moganite," while in the case of the well-known silicified coral from Tampa, Florida, more than 20% of moganite was found. On the other hand, no moganite was found in Arkansas novaculite. While Heaney & Post state that "in light of the natural abundance of fine-grained quartz, these results suggest that moganite is a fairly common mineral of the earth's crust," even though it has received no formal species recognition as yet by the International Mineralogical Association. Insofar as gem varieties of cryptocrystalline quartz are concerned, the presence or absence of moganite cannot be determined by any means commonly available to the amateur collector and lapidary, hence moganite's reaction to standard lapidary treatments can't be specified.

FLÖRKE, O. W., JONES, J. B. & SCHMINKE, H. U. (1976) *Zs. Krist.* 143, p. 156.

FRONDEL, C. (1962) *The System of Mineralogy* . . . 7th Edit., Vol. 3, Silica Minerals, 334 p., illust.

HEANEY, P. J. & POST, J. E. (1992) The widespread distribution of a novel silica polymorph in microcrystalline quartz varieties. *Science* 255, p. 441–443, illust.

CANADA. The following references contain information on quartz gemstones in Canada generally. Especially recommended is the series of articles that were written by Canadian gemologist D. S. M. Field for the *Journal of Gemmology* during 1948–1950. His account of the gemstones of the Bay of Fundy area, Nova Scotia, for example, is based on personal observations, "the author having been born in this area and spending many of his boyhood years collecting and studying the Nova Scotian minerals and gemstones." Other authoritative accounts include those by A. P. Sabina and R. J. Traill which appear under the provincial entries. Faceted Canadian gemstones in national collections are listed by Wight (1986).

BOYD, W. F. & WIGHT, W. (1981) Gemstones of Canada. *J. Gemm. Soc. Japan* 8, p. 27–39; also in *J. Gemm.* 18, 6, p. 544–562, 1983.

CHAPMAN, E. J. (1864) *A Popular and Practical Exposition of the Minerals and Geology of Canada.* Toronto, ONT: 236 p.; 2nd edit. 1871, 295 p.; 3rd edit., 1871, 371 p.

COLE, L. H. (1923) Silica in Canada. Part I, Eastern Canada. *Canada Dept. Mines, Mines Br. Rept.* 555; Part II, Western Canada. *Mines Br. Publ.* 686, 59 p., illust.

COSTE, E. (1888) Report on the mining & mineral statistics of Canada for the year 1887. *Geol. Nat. Hist. Survey Canada Part S, Ann. Rept. 1887.* Precious stones by G. F. Kunz, p. 65–80.

DAWSON, J. W. (1855) *Acadian Geology,* etc. Edinburgh: Oliver & Boyd, 388 p., illust., map; 2nd edit. London, 1868; 3rd edit., London, 1878; 4th edit. London 1891. Includes gemstones.

FIELD, D. S. M. (1948) Canadian gems and gem localities. *J. Gemm.* 1, 5, p. 20–30, maps; 6, p. 13–22; 8, p. 21–33; 2, 1, p. 6–15; 5, p. 188–194, 197.

______, (1950) Arctic gems. *Gemmologist* 19, 229, p. 177–179.

______, (1951) Canadian gemstones. *Canadian Mining J.* 72, 11, p. 76–78, illust.

______, (1952) Miscellaneous gemstones in Canada. *Ibid.* 73, 5, p. 78–80.

______, (1952) More Canadian gemstones. *Ibid.* 73, 11, p. 86–88.

______, (1953) List of Canadian gems and ornamental minerals. *Ibid.* 74, 4, p. 82–83.

HOFFMANN, G. C. (1890) Annotated list of the minerals occurring in Canada. *Geol. Survey Canada Ann. Rept.* 4, "T," 67 p. Also: *Roy. Soc. Can. Trans.* 7, sect. 3, p. 65–105, 1890.

JOHNSTON, R. A. A. (1915) A list of Canadian mineral occurrences. *Geol. Survey Canada Mem.* 74, 275 p.

KUNZ, G. F. (1888) Precious stones, gems, and decorative stones in Canada and British America. *Geol. Survey Canada, Dept. Min. Stat. Ann. Rept. 1887,* vol. 3, p. 65–80. Same as E. Coste, 1888, *above.*

______, (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p. Canadian gemstones p. 258–274.

MARSH, O. C. (1863) Catalogue of mineral localities in New Brunswick, Nova Scotia, and Newfoundland. *Amer. J. Sci.* 35, p. 210–218.

PARKS, W. A. (1912–1917) Report on the building and ornamental stones of Canada. *Can. Dept. Mines,*

Mines Br. Vol. I–Vol. V, illust., maps. Includes gem materials.

PARSONS, A. L. (1934) The utilization of the semi-precious and ornamental stones of Canada. *Univ. Toronto Studies*, Geol. Ser. 36, p. 13–21, color plate.

_____, (1938) Additional semi-precious and ornamental stones of Canada. *Ibid.* 41, p. 45–48.

TRAILL, R. J. (1970) A catalogue of Canadian minerals. *Geol. Survey Canada Paper* 69-45, 649 p, map.

_____, (1974) A catalogue . . . Supplement 1. *Geol. Survey Canada Paper* 73-22, 260 p.

WAITE, G. G. (1945) Notes on Canadian gems and ornamental stones. *Univ. Toronto Studies*, Geol. Ser. 49, p. 75–78.

WIGHT, W. (1986) Canadian gems in the National Museum of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

WILLIMOTT, C. W. (1892) Canadian gems and precious stones. *Ottawa Naturalist* 5, p. 117–142.

LABRADOR (QUEBEC). Jasper is reported from Cod Island by Douglas (1953) and by Warren (1964) at Schefferville at the northern end of the railway which leads north from the town of Sept-Iles on the Gulf of St. Lawrence.

DOUGLAS, G. V. (1953) *Geological Survey of Canada Paper* 53-1, p. 45–47.

WARREN, F. J. (1964) Rock collecting in Newfoundland and Labrador. *Lapidary J.* 18, 3, p. 429–431, map.

NEWFOUNDLAND. Gosse (1964) mentions "nicely colored, but fractured specimens" of amethyst found on Silver Fox Island in Bonavista Bay along the northeast coast of Newfoundland. He reports several other occurrences near St. John's. Sabina (1976) enlarges on the Bonavista Bay deposits, noting that crystals of amethyst have been found at two places in cavities and fractures in granite along the north shore of the bay in the Trinity-Wareham-Centreville area about 50 km (32 mi) east-northeast of Gander. The crystals reach 5 cm (2 in) in size and are light to medium violet in color; they are cuttable. Sabina also reports attractive gem grade chert banded in various shades of green, yellow-green, olive, and grayish-green in the White Hills Quarry north of St. John's. Red, brown, dark green, black, and some banded pebbles in a reddish conglomerate make up an attractive decorative rock that occurs on the northeast end of New World Island, 4 mi (6.3 km) southwest of Herring Head on the south side of Goshen (Goldston) Arm to Indian Cove. The island is located about 50 mi (79 km) due north of Gander (Sabina, 1976, p. 102). Banded, mottled and plain red jasper occurs as veins and lenses in volcanic rocks in road cuts along Highway 380, Pilley's Island Road. Pilley's Island is in the south end of Notre Dame Bay (north central Nfld) (Sabina, *Ibid*,. p. 110). Jasper also occurs in volcanic rocks of the shoreline of Harry's Harbour and in road cuts in the vicinity. Harry's Harbour is a small village located upon the peninsula between Green Bay and Western Arm, Notre Dame Bay (Sabina, *Ibid.*, p. 114). Warren (1967) mentions a fine-quality red jasper from near Corner Brook, Port au Port, and Twillingate along the northwest coast. He recommends that more attention be paid to examining gravel beds that occur in many areas of the island as sources of attractive jaspers and cherts of lapidary grade.

GOSSE, R. C. & WARREN, F. J. (1964) The gemstones of Newfoundland. *Lapidary J.* 18, 1, p. 267–269, map.

SABINA, A. P. (1976) Rocks and minerals for the collector: The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, p. 56, 94.

WARREN, F. J. (1967) Rock collecting in Newfoundland. *Canad. Rockhound* 11, 6, p. 187–191.

_____, (198?) *A rockhound's guide: Gemstones of Newfoundland and Labrador.* Newfoundland Dept. Tourism, St. John's, (9) p., map.

MAGDALEN ISLANDS. Chalcedony and jasper reported by Kidzus (1968) and Traill (1983, p. 302).

KIDZUS, M. F. (1968) Les Isles de la Madeline (Magdalen Islands). *Rocks & Minerals* 43, 10, p. 734–737, illust.

TRAILL, R. J. (1983) Catalogue of Canadian minerals Revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

NOVA SCOTIA. One of the earliest and still most interesting accounts of the minerals of Nova Scotia was written by Charles T. Jackson (1805–1880) and Francis Alger and published in the *American Journal of Science* (1828–1829), then revised and reprinted in 1833 (*see below*). These young mineralogists undertook a collecting expedition which uncovered many fine specimens, including amethyst, smoky quartz, and a large variety of chalcedonic quartz varieties as agates and jaspers. Their text is full of references to these gem materials which were almost wholly found along the north coast or the Bay of Fundy shoreline of the province in areas which remain productive today. Collecting accounts for these areas are numerous, as shown in the references below. The geology of the region generally shows volcanic rocks, often with cavities lined by amethyst, smoky quartz, agate, zeolites, etc., forming steep bluffs along the shoreline and with many sections inaccessible except by boat. Especially productive places include Patridge Island, near Parrsboro, Minas Basin, especially noted for its amethyst geodes in amygdaloidal basalt. Jackson and Alger note "that the substance for which this island more than any other spot in the country has been celebrated, and in search of which it is visited by almost every traveller, is amethyst, in crystals of great beauty and brilliancy. They seem first to have drawn the attention of DeMonts, one of the earliest French emigrants to this country, during the reign of Henry IV [1553–1610]. It is said he was so struck with their appearance, that he took several specimens with him to Paris, where he had them appropriately set as jewels, and presented them to the King and Queen as tokens of his loyal attachment [p. 271]."

In regard to large smoky quartz crystals, Jackson & Alger (p. 309) describe such a crystal obtained from granite on Mr. Longley's estate on the banks of the Annapolis River near Bridgetown that weighed "more than one hundred pounds." Other crystals were found here of smaller size, but little is heard from this locality today.

Considerably later, in 1898, Bailey (p. 146–147) described amethysts of "great beauty" from the iron mines of Digby Neck in southeastern Nova Scotia. He also noted fine agates, chalcedonies, and jaspers from trap rocks of North Mountain and Digby Neck, with much attractive material having been obtained from a hillside near the Johnson Mine in Waterford, Digby County. Nearby are agate veins traversing the cliffs overlooking the northern entrance of Petite Passage, between Digby Neck and Long Island. Many more localities for quartz gemstones appear in Sabina (1964) and Traill (1983).

Campbell (1978) notes the occurrence of silicified wood in the Carboniferous belt of rocks that outcrop on Boularderie Island, Cape Breton County, and near Amherst, northeast of Parrsboro. Some of the wood is black and is sufficiently silicified to accept a good polish. It is also found in brown, gray, and beige hues and is abundant at several places on Bow Island. Some log sections were found that weighed several hundred pounds. Campbell believes that Cape Breton "may in time become noted for its silicified wood as more sources are found."

Walter (1994) describes the hazards of being stranded on a beach, and possibly drowning, in the collecting areas around the Bay of Fundy, because of the enormous and swiftly changing tides. His account reminds all collectors that the hazards are real and ever-present.

ACORD, J. P. (1970) Rockhounding fun on Fundy's coves. *Lapidary J.* 24, 9, p. 1202–1208, illust.

BAILEY, L. W. (1898) Report on the geology of southwest Nova Scotia. *Geol. Survey Canada*, No. 628, 154 p., map, illust., p. 146.

BROWNEN, G. (1974) The fossil forests of Joggins. *Lapidary J.* 27, 12, p. 1886–1888.

BURKE, H. L. (1963) Nova Scotia amethyst. *Lapidary J.* 17, 5, p. 538, map.

CAMPBELL, R. H. (1978) Nova Scotia woods. *Lapidary J.* 32, 4, p. 998–1000, map of localities.

CROSBY, D. G. (1962) Wolfville map-area. *Geol. Survey Canada Mem.* 325, p. 47.

DAWSON, J. W. (1855) *Acadian Geology*, etc. Edinburgh: Oliver & Boyd, 388 p. Other edits in 1868, 1878, and 1891.

GESNER, A. (1836) *Remarks on the Geology and Mineralogy of Nova Scotia.* Halifax, NS: 272 p., map, illust.

GILPIN, E. (1880) *The Mines and Mineral Lands of Nova Scotia.* Halifax, NS: Robert E. Murray, 129 p.
______, (1881) The trap minerals of Nova Scotia. *NS Inst. Nat. Sci. Proc. Trans.* 5, p. 283–296.
______, (1882) *The Minerals of Nova Scotia.* Halifax, NS: Comm. Publ. Works & Mines, 14 p. Republ. in 1893 and 1900.
______, (1886) Minerals of Nova Scotia. *NS Dept. Mines Rept. for 1885,* p. 6–23.
______, (1901) *The Minerals of Nova Scotia.* Halifax, NS: Comm. Publ. Works & Mines, 78 p., fold. map. Gemstones p. 70–71.
GOSSE, R. C. (1964) Gemstones of Nova Scotia. *Lapidary J.* 18, 6, p. 706–710, illust., map.
HOW, H. (1869) *Mineralogy of Nova Scotia.* A Report to the Provincial Govt. Halifax. 217 p.
JACKSON, C. T. & ALGER, F. (1833) Remarks on the mineralogy and geology of Nova Scotia. *Acad. Arts & Sci., Memoirs,* ns 1, p. 217–330, scenic views, hand-col.; col. map.
McCULLOCH, T. (1892) List of localities for trap minerals in Nova Scotia. *NS Inst. Nat. Sci. Proc. Trans.* 8, 1, p. 160–166.
PARKS, W. A. (1912) The building and ornamental stones of the Maritime Provinces. *Canada Dept. Mines, Mines Br. Summ. Rept. for 1911,* p. 84–86.
PERSON, R. A. (1977) Rockhounding with the tides near Parrsboro, Nova Scotia. *Lapidary J.* 31, 1, p. 126–136, *passim,* illust., map.
______, (1977) Rainbows of agate in Scots Bay. Nova Scotia. *Ibid.* 31, 2, p. 482–488, map.
______, (1977) Walk to an island for gemstones and crystals. *Ibid.* 31, 3, p. 690–695, *passim,* 712, 714, illust., map.
ROTHSTEIN, J. (1958) Amethyst in the sea. *Rocks & Minerals* 33, 11/12, p. 494–496.
RUMERY, B. (1964) *Handbook of Nova Scotia Mineral Locations.* #1.—Minas Basin area. Cape Elizabeth, ME: priv. publ., [26] p., maps.
SABINA, A. P. (1964) Rocks and minerals for the collector: Bay of Fundy area. *Geol. Survey Canada Paper* 64-10, 96 p., illust.
______, (1964) Rock and mineral collecting in Canada: Vol. III. New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland. *Geol. Survey Canada Misc. Rept.* 8, 103 p., illust., maps.
______, (1965) Rocks and minerals for the collector: Northeast Nova Scotia, Cape Breton, and Prince Edward Island. *Geol. Survey Canada Paper* 65-10, 76 p., illust., maps.
SPRINGER, P. G. (1982) The agates of Nova Scotia. *Lapidary J.* 36, 8, p. 1330–1332, 1338, map.
TAKE, W. F. (1961) Nova Scotia agate. *Lapidary J.* 15, 3, p. 338–339, illust.
TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p. map.
WALTER, M. (1994) Fear kept them alive. *Lapidary J.* 48, 2, p. 51, 52, 54, 56, illust.

PRINCE EDWARD ISLAND. No new developments.

DAWSON, J. W. (1854) On fossil coniferous wood from Prince Edward Island. *Acad. Nat. Sci. Phila. Proc.* 7, p. 62–64. Silicified wood.
SABINA, A. P. (1965) Rocks and minerals for the collector . . . *Geol. Survey Canada Paper* 65-10.

NEW BRUNSWICK. Agate and other chalcedonic varieties of quartz have been reported from many places by the authors cited below, especially in areas containing volcanic rocks flows. Goodwin (1928) noted agate and chalcedony at Dalhousie, Restigouche County; this occurrence was also noted by Traill (1983, p. 298). According to Traill, red and yellow jasper, agate, and carnelian are found on the Washdemoak River, Queen's County. Other occurrences noted at Darling Lake, King's County, and in St. John County, Victoria County, and Gloucester County. Gosse (1904) notes occurrences in Charlotte County and on Deer Island and Campobello Island.

ELLS, R. W. (1881) Report on the geology of northern New Brunswick. *Geol. Nat. Hist. Survey Canada, Rept. Progress, 1879-80,* pt. D, p. 39.
GOODWIN, W. L. (1928) *Geology and Minerals of New Brunswick.* Gardenvale, QUE: Industrial and Educational Publ. Co.
GOSSE, R. C. (1964) Gemstones of New Brunswick, Canada. *Lapidary J.* 18, 1, p. 269, 270, map.
ROHN, K. H. (1986) Agate beds and grasslands. *Gems & Minerals* 581, p. 42–45, map. Areas in northeast corner of the province.
SABINA, A. P. (1964) Rock and mineral collecting in

Canada. Vol. III. New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland. *Geol. Survey Canada Misc. Rept.* 8, 103 p., illust., amps.

_____, (1967) Rocks and minerals for the collector. Eastern Quebec townships and Gaspe, Quebec, and parts of New Brunswick. *Geol. Survey Canada Paper* 66-51, 170 p., illust., maps.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

GRAND MANAN ISLAND. (Located just offshore from the mainland where New Brunswick and Maine meet). Early reports of amethyst and red and yellow jaspers, also other chalcedonic varieties of quartz, appear in Traill (1983) above. Basalt cliffs erode to release the gem materials, as described by Gates (1971) who notes that the island is virtually all basalt and that its amethyst, though relatively common, seldom furnishes good lapidary material. Gates collected agates, jaspers, a fine grade bloodstone, and some non-quartz ornamental rocks such as porphyry and unakite. The bloodstone is found in beach debris at Whale Cove especially.

GATES, C. H. (1971) Beachcombing for gemstones on Grand Manan Island. *Lapidary J.* 24, 12, p. 1620–1624, illust., map.

RUITENBERG, A. A. & McCUTCHEON, S. R. (1983) Bedrock, surficial and environmental geology of North Head, Grand Manan, N.B. *NB Min. Res. Div. Open File* No. 83-1, 10 p. Agate, amethyst.

QUEBEC. No new developments.

CHAPMAN, E. J. (1864) *A Popular and Practical exposition of the Minerals and Geology of Canada.* Toronto, ONT: 236 p.; other edits, 1871, 1888.

FIELD, D. S. M. (1948) Canadian gems and gem localities, part II (cont.). Gems of Quebec and Ontario. *J. Gemm.* 1, 8, quartz p. 30–32.

GOODWIN, W. L. (1929) *Geology and Minerals of Quebec.* Gardenvale, QUE: Industrial and Educational Publ. Co., 346 p., map.

PARKS, W. A. (1913) The building and ornamental stones of Quebec. *Canada Dept. Mines, Mines Br. Summ. Rept. for 1912,* p. 76–79.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. II. Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 8, 252 p., illust., maps.

_____, (1967) Rocks and minerals for the collector. Eastern Quebec townships and Gaspe, Quebec. *Geol. Survey Canada Paper* 66-51, 170 p., illust. maps.

TRAILL, R. J. (1983) *See above.* Quartz p. 302–303.

ONTARIO. As may be expected from the rocks which predominate in this province, most occurrences of agate are confined to the beaches of the north shore of Lake Superior, while jaspers, in many hues and qualities, occur inland at over a dozen places in metamorphic rocks and in the iron formation rocks. However, by far the most important Ontario gemstone is the amethyst which occurs in veins in granite or metamorphic rocks, particularly in the Thunder Bay region of Lake Superior. Although the deposits were already well-known by the late 1880s, with much decorative slab material, studded with glistening amethyst crystal points, sold regularly to tourists locally and elsewhere in the continent (Kunz, 1890), the last few years have seen the production greatly increase from several large deposits described below. Much of the amethyst forms narrow vein-cavity linings with points that range up to one inch (2.5 cm) or more in diameter and thus resemble in many respects the splendid druses that are now being imported in great quantities from Brazilian/Uruguayan deposits, although the latter linings are in cavities in basalt. Differing markedly from the Brazilian/Uruguayan druses, those from Canada are filled with bright red hematite inclusions in layers just beneath the crystal face surfaces. They provide no gem material but are most attractive cabinet specimens. Among the amethyst vein fillings are sometimes found crystals as large as six inches (15 cm) across that may yield clear facet grade material with careful cobbing. Sometimes such material affords a clean faceted gem of fine color of about 25 carats or even more. On May 14, 1975, the Ontario provincial government declared amethyst to be the official mineral of Ontario. The amethyst deposits are specially treated below.

In regard to other gem quartzes, Sabina (1971) describes a very attractive jaspilite rock from the

New Golden Rose (Afton) Mine, located north-northwest of Sturgeon Falls, Nipissing District, near Emerald Lake in the Lake Timagami area (p. 86). Bright crimson to deep brownish-red lapidary grade jaspers are found in an iron formation in the Sherman Mine in the same area. The rock consists of gray quartzite, jasper, chert, chlorite and fine-grained magnetite, and takes a high polish so that it "makes a striking ornamental stone" (Sabina, 1974, p. 9).

ADAMS, F. D. & BARLOW, A. E. (1910) Geology of the Haliburton and Bancroft areas, Province of Ontario. *Geol. Survey Canada Mem.* 6, 419 p., illust., maps.

COCHRANE, H. F. (1972) Quest for quartz. *Gems & Minerals* 414, p. 32–34, 44–45, illust., map. Lyndhurst rock crystal.

FIELD, D. S. M. (1948) Canadian gems and gem localities. Part II (cont.). Gems of Quebec and Ontario. *J. Gemm.* 1, 8. Quartz gems p. 30–32.

_____, (1951) Gem quartz and garnet in Canada. *Canad. Mining J.* 72, 10, p. 81–83, illust.

GOODWIN, W. L. (1929) *See above.*

HARRISON, J. M. & FORTIER, Y. O. (1944) Occurrences of quartz crystals, Leeds County, southeastern Ontario. *Geol. Survey Canada Paper* 44-8, 9 p., maps.

JOHNSTON, R. A. A. (1915) A list of Canadian mineral occurrences. *Geol. Survey Mem.* 74, 275 p.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., p. 258–274.

PARKS, W. A. (1910) Preliminary report on the building and ornamental stones of Ontario, south of Ottawa and French rivers. *Canada Dept. Mines, Mines Br. Summ. Rept. for 1910,* p. 110–114.

PARSONS, A. L. (1916) Iron deposits of Hunter Island with notes on the Gunflint Lake area. *Ontario Bur. Mines Ann. Rept.* 25, pt. 1, p. 163–191, maps.

_____, (1934) The utilization of the semi-precious and ornamental stones of Canada. *Univ. Toronto Studies,* Geol. Ser. 36, p. 13–21, color plate of Quadeville rose quartz.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. II. Ontario and Québec. *Geol. Survey Canada Misc. Rept.* 8, 252 p., illust., maps.

SABINA, A. P. (1968) Rocks and minerals for the collector: Kingston, Ontario, to Lac St.-Jean, Quebec. *Geol. Survey Canada Paper* 67-51, 147 p., illust., maps.

_____, (1969) Rocks and minerals for the collector: Buckingham–Mont-Laurier–Grenville, Quebec; Hawkesbury–Ottawa, Ontario. *Geol. Survey Canada Paper* 68-51, 107 p., maps, illust.

_____, (1971) Rocks and minerals for the collector: Ottawa to North Bay, Ontario; Hull to Waltham, Quebec. *Geol. Survey Paper* 70-50, illust., maps. Quadeville rose quartz p. 39.

_____, (1974) Rocks and minerals for the collector: Kirkland Lake–Noranda–Val d'Or, Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, 172 p., illust., maps. Timagami jasper.

TRAILL, R. J. (1974) A catalogue of Canadian minerals, supplement 1. *Geol. Survey Canada Paper* 73-22, 260 p.

WAITE, G. G. (1945) Notes on Canadian gems and ornamental stones. *Univ. Toronto Studies,* Geol. Ser. 49, p. 75–78. Rose quartz.

THUNDER BAY AMETHYST REGION. As is evident from the large number of articles listed below, the amethyst deposits are now a mecca for tourists, especially when every visitor is assured that he or she will find specimens and perhaps facet grade amethyst of considerable value. Resident Geologist G. C. Patterson of the Ontario government remarks on an account of these deposits given in 1642 by the early traveler P. E. Radisson who noted that the amethyst was used by the local Indians for various purposes. In 1659 the deposits were reported by Jesuit missionaries. Amethyst was later produced as a by-product of silver and lead/zinc mining in the region. However, the first formal mining of amethyst for its sake alone was undertaken by the McEachen brothers who in 1862 "mined about two tons of amethysts." Production continued to the turn of the century when interest in amethyst sharply declined. In the 1950s, interest in the deposits was revived when an amethyst vein was uncovered during local road construction. This led to active exploration and mining. Patterson (1985) recorded seven producers active in that year, as well as others who were active in the past. Garland (1991) briefly described five fee-collecting quarries and pits active at the time as well as several other opera-

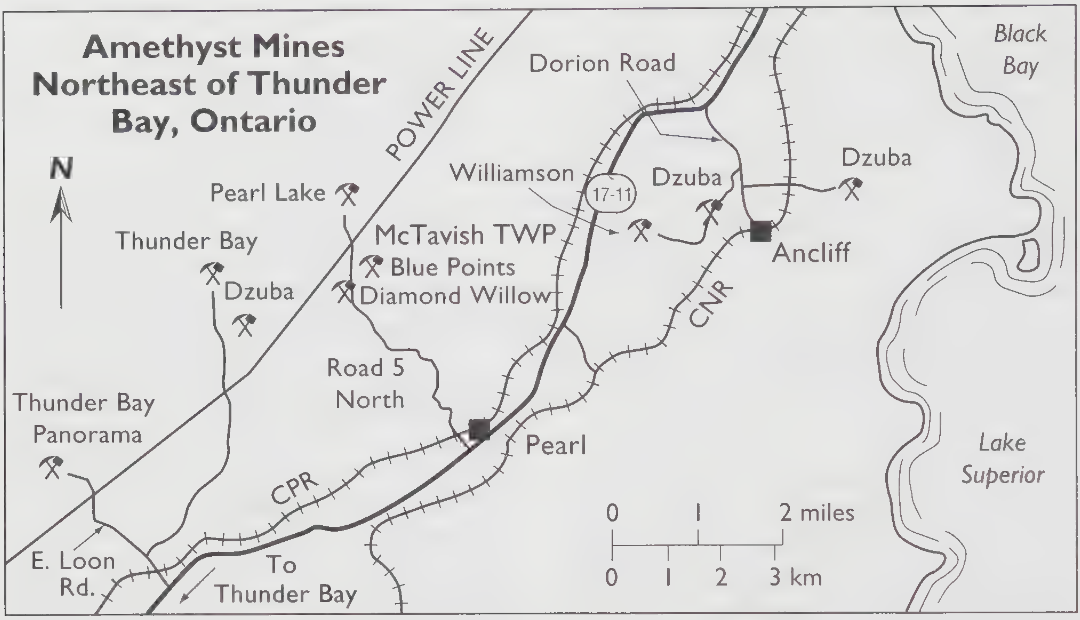


FIGURE 63. Sketch map of amethyst mine locations in the Thunder Bay region of Ontario.

tions closed to fee-collecting. Selbert (1994) presents the latest information on amethyst mining, which information is combined with that from other sources to present the following reviews of properties and their activity.

1. *Diamond Willow Amethyst Mine*, 4 km (2.5 mi) north of Pearl on Road Five; owned by Douglas Noyes on about 160 acres of privately owned ground. Noyes estimated that about 4,000 visitors come each year. As is the case with other amethyst diggings in the region, the mined ground must be restored to its original state once mining is ended. Production: about 20 tons per year.

2. *Pearl Lake Amethyst Mine*, 6 km (3.7 mi) north of Pearl on Road Five, McTavish Township, Conc. III, south half of Lot 3. Philip Castagne, owner. This mine produced 70 tons in 1991.

3. *Ontario Gem Mining Co.*, Peter and Patricia Marino, owners; located off Highway 11/17, McTavish Township, Conc. IV, Lots 10 & 12. This mine was opened in 1976 by Joseph Marino and is now operated by his son. The property includes 400 acres with four pits, but only one is open to fee-collecting. Production is estimated at about 25 tons per year. About 30,000 visitors came in 1994. Associated with the amethyst are green fluorite, pyrite, muscovite, calcite, epidote, and barite.

4. *Mirror Lake Mine*, on Silver Lake, Doris and Henry Hansen, owners of 154 acres of ground. In 1992 the mine was a 12-ft (4 m) deep pit that exposed cavities in basalt.

5. *Blue Points Amethyst Mine*, owner Frances Grann, about 36 mi (57 km) north of Thunder Bay on Road Five, several miles off Highway 11/17. It is near the Diamond Willow Mine, McTavish Twp., Conc. III, Lot 4. Production is about 25 tons per year.

6. *Thunder Bay Amethyst Mine Panorama*, owned by Steve Lukinuk, located about 35 mi (55 km) northeast of Thunder Bay via Highway 11/17, thence along East Loon Road for 4.1 mi (6.5 km); McTavish Twp., Conc. IV, Lots 6 & 7, and Conc. V, Lots 6 & 7. The property contains 2,200 acres on the east shore of Elbow Lake. Amethyst was found here as early as 1955 when a

forestry road uncovered the deposit. Since 1957 "the mine has advanced about one-fourth of a mile east of the lake, and the slope being hosed [washed] on this occasion measures about 35 feet [10.1 m] in height" (Selbert, p. 90). According to Lukinuk, his mine is one of the world's largest amethyst mining operations and produces about 50,000 tons of all classes of amethystine material per year. Facet-grade amethyst, almost always confined to areas just under the crystal points, is relatively abundant but all other authorities state that truly clean, fine color material is rare in all of the Thunder Bay regional deposits (MacFadyen, 1986, p. 37). However, Zeitner (1989, p. 36) notes that true gem quality facetable amethyst has been introduced from the mine and several hundred carats of amethyst have been faceted, with the top grade stone weighing 22 carats and of the prized "Siberian" color.

Another amethyst source in this region is described by Zeitner (1989, p. 42) as the Rocksville amethyst occurrence, 13 mi (21 km) east of Thunder Bay on Highway 11/17. Garland (1991) noted several operations closed to the public: Little Bear Quarry, located just west of Rossport and consisting of two small openings near Kabamivhigama Lake; a large producer known as Blue Star Resources, Ltd., in the north MacGregor area on Magone Lake Road; mines in the Tartan Lake area operated by R. Hietapakka and A. Sitamaki; Gem Mountain Mine deposits in the McGregor Township, owned by M. Grieve; also an amethyst mine in McTavish Twp., owned and operated by G. McLeod and T. Twomey.

FIGURE 64. Thunder Bay Amethyst Mine showing open-cut operations which follow the veins of amethyst (as of 1977). *Courtesy Dr. W. Lieber.*

FIGURE 65. Visitors examining amethyst specimens at the Thunder Bay Amethyst Mine. *Courtesy Dr. W. Lieber.*

In these deposits, amethyst primarily occurs as interlocked stubby crystals that line the walls of cavities and fissures, sometimes solidly filling the openings but often enough presenting terminated crystals which range in size from as thick around as the little finger to many inches across. Much of the amethyst occurs in fine slabs and sheets with uniformly-sized points on one side and matrix rock on the other; they make fine mineral and decorative specimens but rarely provide faceting material of useful size. Of particular interest to collectors are those specimens that contain the red hematite inclusions previously noted, Thunder Bay being one of the few places in the world where this type of amethyst druse occurs. The host rocks are generally granitic (Vos, 1976; Pye, 1969). Where they were disturbed and shattered by faulting, openings formed and were filled with amethyst (Garland, 1991). These crushed zones, filled with breccia, are especially noted and diagrammed by Garland for the major Thunder Bay deposits. In general, the belt in which the deposits occur (or could occur) is about 25 mi (40 km) wide and about 120 mi (195 km) long from east to west, roughly paralleling the north shoreline of Lake Superior. The terrain here is difficult to explore and there is reason to believe that more deposits will be found in the future as more ground is carefully examined.

One of the intriguing features of certain amethyst veins is the presence of "green amethyst," which actually has been found in gem quality sizes large enough to facet gems. Garland (1991) notes green quartz in the amethyst deposits north of the MacGregor area in the Blue Star Quarry, while R. Hietapakka (*Pers. comm.* 1993) states that local lapidaries have cut faceted gems of pale green color up to about 6 mm (1/4 in) across from material found on his (and Siltamaki) claims in the Tartan Lake area. Green amethyst is very rare; aside from this occurrence, it has only been found in the Four Peaks, Arizona, deposit.

Sabina (1971) records very pale to medium intensity amethyst in veins cutting diabase at a place about 22 mi (35 km) northeast of North Bay in the Nipissing district. Wight (1986) records a series of faceted gems from the Thunder Bay district; the two largest, 14.25 and 10.90 carats, are from Nagunagisic Lake, near Nipigon, and the others, ranging from 2.3 ct to 15.20 ct, are from the mines described above.

BROUGHTON, P. L. (1975) The Thunder Bay Amethyst Mine. *Rock & Gem* 5, 7, p. 58–62, 74, map.

BUSH, H. (1968) A new amethyst mine at Port Arthur, Ontario. *Lapidary J.* 22, 8, p. 1076–1079, illust.

CORBETT, J. F. (1940) Amethyst at Thunder Bay. *Rocks & Minerals* 15, 6, p. 187–189.

ELLIOT, D. G. (1982) Amethyst from the Thunder Bay region. *Min. Rec.* 13, 2, p. 67, 70, maps.

GARLAND, M. I. (1991) Amethyst in northwestern Ontario. *Ontario Geol. Survey Misc. Paper* 158, p. 181–194, maps, diagrams.

GRICE, J. D. (1989) *Famous Mineral Localities in Canada.* Ottawa, ONT: National Mus. Nat. Sci. & Fitzhenry & Whiteside, 190 p., p. 68–72 (col. illust.).

HOLDEN, E. F. (1926) Hematite inclusions in Lake Superior amethyst. *MI Acad. Sci. Arts. Ltrs., Papers* 5, p. 283–285.

INGALLS, N. (1992) Thunder Bay amethyst. *Rock & Gem* 22, 10, p. 20–23.

JONES, R. (1985) Thunder Bay amethyst. *Rock & Gem* 15, 11, p. 8–10, 11.

KILE, D. E. (1984) Amethyst deposits of the Thunder Bay area, Ontario, Canada. *Rocks & Minerals* 59, 6, p. 262–271, illust., maps.

LIEBER, W. (1994) *Amethyst.* Munich: Christian Weise Verlag, 188 p., illust. (col.). North America p. 116–145.

MacFAYDEN, D. A. (1985) A study of faceting grade amethyst from the Thunder Bay Amethyst Mine, Ontario. *Canad. Gemm.* 6, 2, p. 50–53; 39, p. 71–77.

______, (1986) More from Thunder Bay. *Lapidary J.* 39, 11, p. 34–37.

PATTERSON, G. C. (1985) Amethyst in the Thunder Bay area. *Resident Geologist's File,* Thunder Bay, Ontario.

______, (1985) Amethyst in the Thunder Bay area of Ontario. *Canad. Gemm.* 6, 4, p. 104–109, 114–116.

PYE, E. G. (1969) Geology and scenery: North Shore of Lake Superior. *Ont. Dept. Mines Guide Book* 2, 148 p., illust., maps. Agate, amethyst.

______, (1968) Geology and scenery: Rainy Lake and east to Lake Superior. *Ont. Dept. Mines Guide Book* 1, 118 p., illust., maps. Amethyst.

ROBINSON, G. (1969) The amethyst of Thunder Bay, Ont., Canada. *Rocks & Minerals* 44, 4, p. 264–266.

ROHN, K. H. (1982) The amethyst mines of Ontario. *Gems & Minerals* 538, p. 34–38, illust., map.

SABINA, A. P. (1963) Rocks and minerals for the collector: Sudbury to Winnipeg. *Geol. Survey Canada Paper* 63-18, 69 p., illust., maps.

______, (1971) Rocks and minerals for the collector: Ottawa–North Bay, Ontario; Hull-Waltham, Quebec. *Geol. Survey Canada Paper* 70-50, 130 p., illust., maps. Amethyst.

______, (1991) Rocks and minerals for the collector: Sudbury to Winnipeg. *Geol. Survey Canada Misc. Rept.* 49, 315 p., illust., maps.

SELBERT, P. (1994) Amethyst. *Lapidary J.* 47, 11, p. 80–92, *passim,* illust.

STEACY, H. R. (1974) Our beautiful, little known gemstones. *Canad. Geogr. J.,* Dec., p. 4–13.

TANTON, T. L. (1931) Fort William and Port Arthur, and Thunder Cape map-areas, Thunder Bay District, Ontario. *Geol. Survey Canada Mem.* 167, 222 p., illust., maps. Amethyst.

THUNDER BAY AMETHYST (1992) [Town brochure advertising the mines, tourist attractions, amethyst producers, etc., 4 p., map.]

VOS, M. A. (1976) Amethyst deposits of Ontario. *Geol.*

Guidebook No. 5, Ont. Div. Mines, Ministry of Nat. Resources, 99 p., illust., maps. A particularly valuable treatise for the visitor; fine color illust.

WATTS, A. M. (1979) Agates, amethyst, and thomsonite. *Lapidary J.* 32, 12, p. 2660–2666, illust., maps. Thunder Bay amethyst.

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

WILLIAMS, M. (1971) Thunder Bay amethyst mine, *Gems & Minerals* 407, p. 20–21, map.

ZARIN, L. E. (1973) On the road to Thunder Bay. *Lapidary J.* 27, 4, p. 606, 609, 610.

ZEITNER, J. C. (1989) Thunder Bay. *Lapidary J.* 43, 8, p. 36–42, *passim*, illust., maps.

NORTHWEST TERRITORIES. Agates from extrusive volcanic rocks occur on north Baffin Island and adjoining Bylot Island, also chalcedony and agate at a place about 40 km (25 mi) north of Lake Hazen in the northeastern region of Ellesmere Island; also on Gale Point on the east coast of Ellesmere Island; jasper and chalcedony are found on Meighan Island, lat. 80°N, long. 99°W (Bell, 1992).

Agate and chalcedony are found on Belanger Island at the entrance to Richmond Gulf, east shore of Hudson Bay (Hoffmann, 1890; Traill 1983, p. 299). Jasper is reported on Princess Royal Island and amethyst in trap rocks in the Dubawnt Lake area; jasper is also found in the Kahochella formation in the northeastern area of Great Slave Lake (Traill, *Ibid.*). Relf (1993) notes an amethyst occurrence at a point 7 km (4.5 mi) due south of Manning Point, 18 km (11 mi) northeast of Bathurst Inlet Lodge, but the amethyst is not of gem quality.

BELL, R. (1992) Report on the compilation of lapidary sites. *Northwest Territories Dept. Energy, Mines & Petrol. Resources, EGS* 1992-14, 157 p., maps.

HOFFMANN, G. R. (1890) Annotated list of the minerals occurring in Canada. *Geol. Survey Canada Ann. Rept.* 4, T., 67 p.

RELF, C. (1993) Report on lapidary occurrences in the Bathurst Inlet area, N.W.T. *Northwest Terr. Geol. Div., EGS* 1993-03, 6 p., maps.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

WALKER, T. L. (1915) Minerals from Baffin Land. *Ottawa Naturalist* vol. 29, p. 63–66. Rose quartz.

MANITOBA. Attractive opalescent rose quartz occurs in a granitic pegmatite north of the east end of Boise Lake, at a point about 2,000 ft (600 m) north of the lake shore and 1,500 ft (450 m) west of the east end of the lake. This deposit is just east of Bernic Lake (Sabina, 1965, p. 125–126). In the same area, at about 3,000 ft (900 m) west of the west end of of Greer Lake, deep pink opalescent rose quartz has been found in the Huron Claim pegmatite and "it is reported to be equal in quality to the best rose quartz from other countries."

In the Souris area, agates, jaspers, and colorful silicified and opalized woods are found in gravel pits. Some wood pieces reach 10 lbs (4.5 kg) in weight and many of the agates and jaspers are colorfully and attractively patterned (Sabina, 1965, p. 120–121; Hotson, 1972).

DAVIES, J. F., *et al* (1962) *Geology and mineral resources of Manitoba.* Manitoba Dept. Mines Nat. Resources, Mines Br., 190 p., illust., maps.

GOODWIN, W. L. (1930) *Geology and minerals of Manitoba.* Gardenvale, QUE: Industrial and Educational Publ. Co., 260 p., illust., map.

HOTSON, R. (1972) "Can this be true?" *Lapidary J.* 26, 7, p. 1044–1048, illust. Souris area collecting.

SABINA, A. P. (1963) Rocks and minerals for the collector: Sudbury to Winnipeg. *Geol. Survey Canada Paper* 63-18, 69 p., maps.

_____, (1965) Rock and mineral collecting in Canada. Vol. I. Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba. *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps.

SPRINGER, G. D. (1950) Mineral deposits of the Cat Lake-Winnipeg River area, Manitoba. *Manitoba Mines Br. Publ.* 49-7. Rose quartz at Birse Lake.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map. Rose quartz p. 298.

SASKATCHEWAN. Ward (1889, p. 839) mentions "silicified wood that was found scattered over the plains" in the Souris River area of extreme southeastern Saskatchewan. At the other lower corner of the province, especially in the Cypress Hills, Furnival (1946) notes silicified wood as does Sabina (1965, p. 110–111). Similar wood is to be found in the gravels of the Wood Mountain area in the extreme south central part of the province close to the border with Montana. The Cypress Hills material occurs as whitish fragments up to 10 in (25 cm) across in lignite/sandstone beds along Boxelder Creek, McShane Creek, and in many other places where these strata are exposed. In 1966, the *Lapidary Journal* (20, 7, p. 907) depicted a silicified tree trunk standing almost 5 feet (1.5 m) tall and weighing about 1,700 lb (770 kg) that had been found near Eastend, just to the east of the Cypress Hills.

FURNIVAL, G. M. (1946) Cypress Lake map-area, Saskatchewan. *Geol. Survey Canada Mem.* 242, 161 p., illust., maps.

RAE, V. E. (1964) Gemstones of Saskatchewan. *Lapidary J.* 18, 6, p. 703–704, illust.

SABINA, A. P. (1965) *See above.*

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept.*, pt. 2, p. 663–960, map.

ALBERTA. In the badlands enclosing the Red Deer River in south central Alberta are numerous occurrences of silicified wood and colorful agate. Localities for wood are given by Sabina (1965) and in more detail by Nutt (1974). The best agate occurs on the Hand Hills just east of Drumheller while woods have been found in the Red Deer Valley as far northwest of Drumheller as Red Deer and as far southeast as Medicine Hat and beyond. Specific collecting sites are Ross Coulee near Levine and near Elbow on the South Saskatchewan River in the Medicine Hat area. Silicified dinosaur bone occurrences in the Red Deer River Valley area around Drumheller and to the northwest of that town are given by Green (1964).

GEMS & MINERALS (1963) Hand Hills agate. No. 313, p. 15.

GREEN, R. (1964) The dinosaur gemstones of Alberta. *Lapidary J.* 18, 6, p. 705, map.

HOFFMANN, G. C. (1890) *See above.*

NUTT, R. G. (1974) Alberta badlands trail. *Lapidary J.* 28, 5, p. 770–776, *passim*, 792–796, illust., map.

SABINA, A. P. (1965) *See above.*

TRAILL, R. J. (1983) *See above.*

LAKE SUPERIOR AGATES. Deserving of a special place among the classic gemstones of North America, these agates here receive a general discussion rather than accounts placed under each state and province in which they occur. They are abundant and perhaps truly deserve to be called "inexhaustible" as they occur in enormous glacial outwash deposits of gravel. Areas covered by these gravels extend from the immediate Lake Superior region southwestward and southward along the Mississippi River Valley to Arkansas, Mississippi, and Louisiana. As may be expected, however, the largest and the most solid nodules are found nearest the basaltic rock formations from which they eroded. Zeitner (1988), for example, considers the northeastern corner of Minnesota, whose state rock is this agate, as the most prolific source of the highest quality and greatest sizes of Lake Superior agate. This area is centered on the towns of Cloquet and Carlton in St. Louis and Carlton counties respectively. Collecting is described by Brockett (1976) and Dahlberg (1976). As one travels southward the nodules usually become smaller and may contain more fractures, or they are broken apart into nodular fragments rather than retaining their original shapes.

Lake Superior agates were mentioned in the early 1820s by geologist Henry Rowe Schoolcraft, according to Pabian (1980), whose historical study is the first to be accorded this native gemstone. Pabian quotes Schoolcraft and also notes the reports on the agates in Douglass Houghton's *Annual Report of the State Geologist, Michigan, for 1841*, wherein are also described other minerals found upon the Keweenaw Peninsula of Michigan. Other early workers include J. W. Foster and J. D. Whitney, J. G. Norwood, N. H. Winchell, L. Hubbard, and A. C. Lane.

In regard to the origin and distribution of the

FIGURE 66. The shores of Lake Superior along Great Sand Bay on the northern side of the Keeweenaw Peninsula, Michigan, with collectors searching for waterworn nodules of agate.

agates, Brummer (1980) describes the geology around Lake Superior and provides a map of the formations, after one prepared by N. K. Huber. This map shows the outcrops of basalt that partially rim Lake Superior and are the source of the agates. In general, the Keweenawan basalts outcrop all along the Keweenaw Peninsula, extend westward into Minnesota, then along that state's Lake Superior shoreline northeast into Ontario. Waite (1961) provides specific collecting areas which were personally investigated as follow: the northern 90% of Isle Royale, the southern shore of Black Bay Peninsula in Ontario, along with its outlying islands, parts of St. Ignace Island, Simpson Island, Salter Island, Wilson Island, Copper Island, Michipicoten Island, Caribou Island, and limited areas around Batchawana Bay, Mamainse, Cape Gargantua, and Cape Chillon, all in Ontario. These last few areas are in the eastern extremity of Lake Superior.

Brummer (1980) also includes a map by N. K. Huber which shows the movement of original glacial debris toward the south, and also movements brought about in later glacial periods which redistributed gravels by outwash flooding as glaciers melted. Wolter (1986), who wrote the first monographic book on Lake Superior agates, devotes much space to the explanation of the geological events which caused the erosion of source rocks and the subsequent scattering of the agates derived from them. Because several distinct glacial periods distributed and redistributed the gravels, certain gravel layers appear richer in agates than others. In Minnesota, for example, collectors have learned to look for the finest agates in a gravel layer that is called the "red drift" after its iron oxide coloration, but this telltale color disappears farther south.

In regard to sizes of Lake Superior agate nodules, the record appears to be a specimen of 108 lb (49 kg) found in Carlton County, Minnesota, in 1979 (Dahlberg, 1979). At an earlier time, Dahlberg (1976) recorded a 49.75 lb (22.6 kg) nodule from this county, and Brummer (1980, p. 2376) conveniently tabulates other record finds, including a 32 lb (14.5 kg) specimen that was remarkable for its place of discovery: Osage, Iowa. Other distant finds are an 11.5 lb (5.2 kg) nodule from Kansas and an 8 lb (3.6 kg) nodule from Strawberry Point, Iowa. Wolter (1986, p. 45) depicts a 21.62 lb (9.9 kg) nodule found at New Haven, Iowa.

The abundance of agates in the gravels in which they occur was studied by Gotsch (1978) who sampled gravels in the Cloquet area, Minnesota, to establish weight-percents of agate contents. Ten samples were taken averaging 16.7 kg (37 lb) of raw gravel, of which 11.3 grams (0.025 lb) proved to be agate, or 0.07%. On the basis of his findings, Gotsch estimates that of the 15,000 cubic meters of gravel processed by the city of Cloquet each year from its municipal gravel pit, there must be about 15,000 kg (33,000 lb) of Lake Superior agates! In his selection process, Gotsch rejected agates smaller than about 6–7 mm (1/4 in). Carrying on this intriguing study, Gotsch also estimated that about half of Minnesota is covered by the "red drift" productive gravel layer, or about 100,000 square km, to a depth of one meter, and "that gives the figure of 100,000,000,000 (one hundred billion) cubic meters of agate-bearing gravel in Minnesota, which contains then one hundred billion kilograms of agate." To this figure must be added estimates for areas outside Minnesota which are covered by similar agate-bearing gravels but have not been studied in similar fashion. It is easy to see that the term "inexhaustible" may not be far off the mark for Lake Superior agates.

Aside from their abundance and ease of collecting, Lake Superior agates offer attractive, contrasting bandings, with many collectors being content to cut and polish windows on the nodules without attempting to process them into cabochons. Several collections of nodules are depicted by Wolter (1986), who also shows a large variety of nodules with unique patterns and inclusions. Among the special types, "eye" agates are sometimes found but are quite rare and much prized. However, taken as a whole, the impressions gained when examining large numbers of "field-run" specimens are that (a) they are finely banded in fortification patterns, sometimes in sharply contrasting hues, and (b) that the predominant colors are browns and brownish-reds, with white bandings. Other colors do occur, as well as differing internal patterns and layerings. The many types that can be found are described by Pabian (1978, 1980), Wolter (1986), and Niemi (1963).

Sukow (1987, 1990) made an extensive and important study of the causes of the reddish coloration in Lake Superior agates and found that much of it was due to very fine particles of native copper! He provides color photographs of copper inclusions which commonly are minute arborescent crystalline growths, and, as he puts it, "penny pink," which is the true color of untarnished native copper. Specimens for this study, begun in 1964, were collected from gravels from Grand Marais, Minnesota, southward to the Duluth area, then approximately along the border region between Minnesota and Wisconsin to as far south as La Crosse. Sukow also identified microscopic inclusions of copper minerals such as bornite, chalcopyrite, cuprite, and others.

ALESSI, A. J. (1936) Hunting agates around Lake Superior. *Rocks & Minerals* 11, 9, p. 139–140.

BROCKETT, B. O. (1976) Minnesota's Lake Superior agate. *Lapidary J.* 30, 1, p. 174–180, illust., map.

BRUMMER, J. J. (1980) Agate collecting around Lake Superior. *Lapidary J.* 33, 11, p. 2368–2379, illust., map.

CUNNINGHAM, J. L. (1954) Lake Superior agates. *Gems & Minerals* 200, p. 14, 16; 201, p. 12–14, 53–58, illust.

______, (1966) Lake Superior agates. In H. Leiper, ed. *The Agates of North America*, p. 70–77, illust., map.

DAHLBERG, J. C. (1976) They are still finding them. *Lapidary J.* 30, 8, p. 1940–1945, illust.

______, (1979) Is this a record? *Lapidary J.* 33, 8, p. 1772, illust.

DUSTIN, F. (1931) The gems of Isle Royale, Michigan.

MI Acad. Sci. Arts & Ltrs. Paper xvi, p. 383–398.
______, (1936) Agates of the Lake Superior region. *Rocks & Minerals* 11, 1, p. 152–155.
GOTSCH, P. (1978) An abundance of agates. *Lapidary J.* 32, 9, p. 2052–2054, illust.
HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Div. Bull.* 6, 225 p., illust., p. 181–183.
HOCKETT, K. (1975) Everybody loves the laminated lakers. *Lapidary J.* 29, 7, p. 1378–1381, illust., map. Collecting in Minnesota.
HUBER, N. K. (1975) The geologic story of Isle Royale National Park. *U.S. Geol. Survey Bull.* 1309, 66 p., illust., maps, p. 60.
LUOMA, H. L. (1945) Description and occurrence of Keweenaw agate. *The Mineralogist* 13, 7, p. 269–271.
______, (1948) *Gems from Keweenaw Beaches.* Ahmeek, MI: Keweenaw Agate Shop, [12] p., illust.
______, (1951) Keweenaw agate. *Lapidary J.* 5, 1, p. 24–30, *passim.*
McATEE, F. (1954) I bought 47 acres of a volcano's graveyard. *Rocks & Minerals* 29, 7/8, p. 367–368, illust. Grand Marais area.
NIEMI, A. A. (1963) Amygdaloidal agates and jaspers. *Lapidary J.* 17, 5, p. 516–521, illust., map.
PABIAN, R. K. (1978) Inclusions in agate and their origins and significance. *Gems & Gemology* 16, 1, p. 16–28, illust. (col.).
______, (1980) Lake Superior agates—a historical review. *Lapidary J.* 34, 1, p. 110–153, *passim*, illust.
______, (1980) Lake Superior agates—characteristic structures and inclusions. *Ibid.* 6, p. 1284–1299, illust.
RAPP, G. R. & WALLACE, D. T. (1966) Guide to mineral collecting in Minnesota. *MN Geol. Survey*, Educ. Ser. 2, 42 p.
ROHN, K. H. (1979) In search of Lake Superior agates. *Gems & Minerals* 503, p. 76–79, map. Duluth to Grand Marais.
ROHN, K. H. (1983) Glacial drift treasures. *Gems & Minerals* 549, p. 24–27, map. Moose Lake-Sturgeon Lake area, MN.
______, (1984) Agates galore. *Ibid.* 564, p. 66–68. Superior, WI, area.
SIDLA, A. A. (1956) Minnesota agates. *Rocks & Minerals* 31, 11/12, p. 599.
STRATTON, C. G. (1943) The older drift of Wisconsin. *Scient. Monthly* 56, p. 45–49.
SUKOW, W. W. (1987) Inside Lake Superior agates. *Lapidary J.* 40, 10, p. 50–56, illust.
______, (1990) Inside Lake Superior agates. Part 2. *Ibid.* 44, 5, p. 81, 84, 86, illust.
VANASSE, T. C. (1947) A study of Lake Superior agate. *Earth Sci. Digest* 2, 1, p. 9–17; 2, p. 9–14, 25–26, illust.
______, (1950) *Lake Superior Agate.* Spring Valley, WI: priv. publ., 63 p., illust.; 2nd rev. edit. 1951, 66 p.
WAITE, G. G. (1961) Gemstones along Lake Superior shores. *Lapidary J.* 15, 4, p. 434–451, illust., map. Ontario localities.
WEYANDT, D. (1972) Agates along the shores of Lake Superior. *Gems & Minerals* 419, p. 28–29, 42, 43, illust., map. French R. area, MN.
WOLTER, S. F. (1986) *The Lake Superior Agate.* Minneapolis, MN: Lake Superior Agate, Inc., 103 p., illust. (col.). maps.
ZEITNER, J. C. (1964) *Midwest Gem Trails.* 3rd edit., rev. Mentone, CA: Gembooks, 80 p., illust., maps.
______, (1988) *Midwest Gem, Fossil and Mineral Trails.* Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps.

MAINE. Cuttable rock crystal, smoky quartz, and rose quartz continue to be found in Maine's granitic pegmatites which are usually mined for more valuable gemstones such as tourmaline and beryl. King (1993) reported a production of "several hundred kilograms of asteriated gem-quality rose quartz" from the Whispering Pines Quarry, Paris, Oxford County, mined in 1992 by Frank Perham of West Paris. This quarry is described by Stevens (1972, p. 97-98) who noted that fine faceted gems as well as star cabachons were cut from this material. Bradshaw (1992) remarks that tons of rose quartz have been taken from this quarry, a mass of which was carved many years ago in China as a representation of a man holding a bird, about 13.5 cm (5.3 in) tall, 8.5 cm (3.3 in) wide and 3.0 cm (1.2 in) thick. It was donated in 1930 by Edward Wigglesworth, the noted gemologist, to the Boston Society of Natural History.

Other occurrences of crystalline quartz varieties are described by Bradshaw *(Ibid.)* who mentions fine faceted citrine gems including a 27.5 ct stone from the Emmons Quarry, Greenfield; a

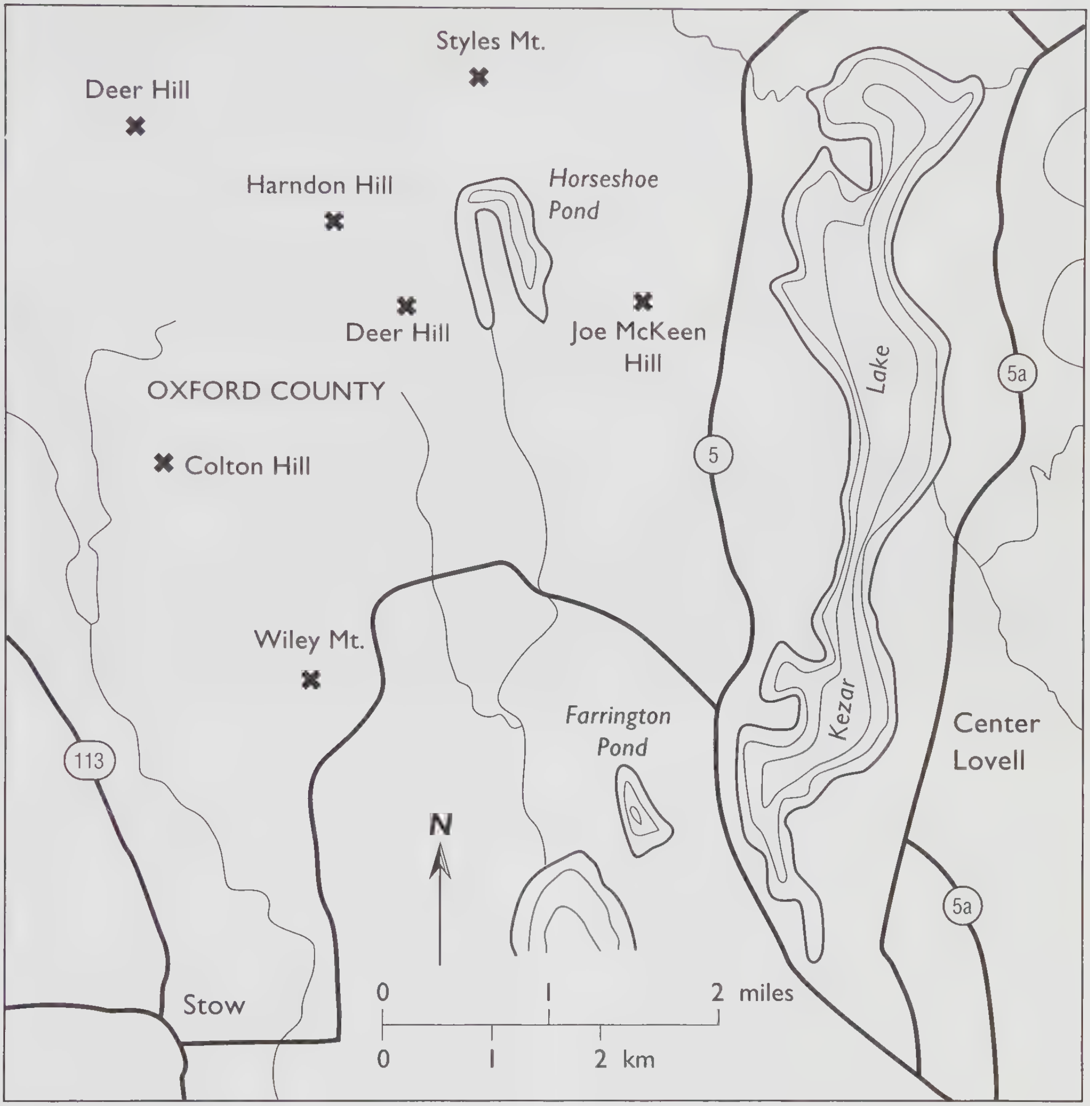


FIGURE 67. Sketch map of the Deer Hill amethyst area in Oxford County, Maine.

39.80 ct gem from Hatch Ledge, Auburn; and from Buckfield, a round brilliant of 57.2 ct. Other faceted gems include a record smoky quartz of 462.40 ct from rough obtained in the Consolidated Quarry, Topsham, Sagadahoc County. Other sources of facet rough are given in Thompson, *et al* (1991). Many occurrences of rose quartz, amethyst, and other varieties of crystalline and chalcedonic quartz are given by King & Foord (1994, p. 289–302).

The most important quartz gem from Maine, however, is the amethyst which was found early in the century in granitic pegmatite on Pleasant Mountain, Denmark, Oxford County, and also

FIGURE 68. Irving Groves and Philip McCrillis opening the amethyst deposit at the Saltman Prospect, Sweden, Oxford County, Maine, in 1989. *Courtesy Woodrow Thompson, Maine Geological Survey.*

upon Deer Hill. Perham (1987) noted that fine gems, usually in the 5-10 ct range, were cut from Pleasant Mountain material and bought by G. F. Kunz for Tiffany's of New York City. At a later time, an exceptional 50-ct faceted gem from this source was cut by local lapidary Knox Bickford of Norway. According to Bradshaw (1992), this gem was later incorporated into a piece of jewelry whose gold in the mounting was panned from the gravels of Swift River, and then ornamented with freshwater pearls obtained from several Maine streams.

In 1956, Deer Hill supplied rough for a 22.90 ct round brilliant and a 13.10 ct oval faceted gem, both in the Smithsonian collections, while an oval brilliant gem of 40.66 ct is in the American Museum of Natural History in New York City. In 1970, a fine crystal provided rough for a triangular faceted gem that weighed 73.15 ct, medium-deep purple with red flashes, acquired by Harvard University in whose Mineralogical Museum it joins other Deer Hill amethyst gems of 34.84, 29.60, 18.58, and 8.23 ct. Another Deer Hill gem of 24.15 ct was sold at auction in 1990 for $600 (Bradshaw, *Ibid.*).

The recent discoveries and mining upon Deer Hill, Stow Township, Oxford County, are described by Thompson (1993, p. 1, 2) and Thompson, *et al* (1992, p. 70, 71). A further account of discovery here is given by Voynick (1994) who reported that on the 4th of July weekend of 1993, Maine collectors Gary Howard, Dennis Creaser, and Jay Windover "opened the largest pocket of gem amethyst ever found east of the Mississippi." In several days of intensive work in clearing out a deep-seated pocket excavation of debris and working farther underground, the trio recovered more than a ton of mine run amethyst as loose crystals and matrix specimens. The pocket was appropriately named "The Fourth of July Pocket." After four weeks of work devoted to stripping it of its contents, the emptied pocket measured 4 ft (1.4 m) tall, and 6 ft (1.6 m) long. One of the faceted gems from this pocket weighs 62 carats and is deep violet in color. More details on this latest discovery of Deer Hill amethyst are to be found in Perham (1994).

Elsewhere, King (1993) reported excellent, facet grade amethyst crystals from Barbour Prospect, Stow, with clear areas estimated cuttable to 15 carats. In 1987, amethyst crystals were uncovered quite by accident in the course of gravel mining upon the property of James Saltman near his family-operated Camp Encore-Coda, a summer music camp, in Sweden Township, Oxford County, close to Stearns Pond. The site is 1/4 mile (0.4 km) from the camp on the North Bridgton Road in the southwest corner of the county. In 1989, the township planning board granted permission to Plumbago Mining Corporation of Rumford, Phillip McCrillis, manager, to mine in an area of about one-half acre (Haynes, 1989; *Bridgton News*, 1989). This is the same deposit described by Berk (1989) and White (1990). Bradshaw (1992) reported that Plumbago Mining Corp. mined the deposit in 1988, 1989, and 1990, by following amethyst-lined fissures in the bedrock, unlike other amethyst occurrences hitherto found in Maine which were all confined to core units of granitic pegmatites. Once the local geology and mineralization are worked out, there may be further finds of similar nature in this region of Maine. Most specimens of amethyst occur as crystals on wall matrix but many loose crystals were also found, many of gem quality but with only small areas of facetable material despite the relatively large size of the crystals. The largest faceted gem was cut to about 12 carats. Most stones of smaller size were sold by Plumbago Mining for about $20 per carat wholesale. The color grade is reported as excellent.

BERK, M. (1989) New from New England. *Lapidary J.* 43, 8, p. 44–48, illust.

BRADSHAW, J. J. (1992) Gemstones of Maine. ME Geol. Survey *Mineralogy of Maine.* In press, [21] p., p. 10–13.

BRIDGTON NEWS (1989) Amethysts found near Camp Encore, Jun. 29.

GOSSE, R. C. (1962) Jasper localities in Maine. *Gems & Minerals* 299, p. 52.

GRAVES, S. B. (1972) A rage for amethyst. *Rock & Gem* 2, 12, p. 68–71, 78, illust. Deer Hill.

HAYNES, W. (1989) Sweden site will be New England's only active amethyst mine. *Portland [ME] Press Herald*, p. 1, 2, map.

KING, V. T. (1993) World news of mineral occurrences. *Rocks & Minerals* 68, 1, p. 49–53.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.)

KUNZ, G. F. (1883) Precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S.*, p. 491. Deer Hill amethyst.

MAINE GEOLOGICAL SURVEY (1957) Maine pegmatite mines and prospects and associated minerals. Augusta: *Mineral Resources Index* No. 1, 43 p., maps. Rose quartz localities.

MORRILL, P. (1969) The Kimball amethyst pocket. *Rocks & Minerals* 44, 1, p. 32–33. Deer Hill.

PERHAM, J. C. (1987) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* West Paris, ME: Quicksilver Publs., 269 p., illust.

______, (1994) Intergalactic amethyst miners. *Lapidary J.* 48, 8, p. 41–44, 64, illust. (col.).

SHAUB, B. M. (1958) The quartz crystal pocket discovered on Deer Hill, Maine, in 1956. *Rocks & Minerals* 33, 8/9, p. 407–410.

SLOCUM, H. W. (1944) A half-mile mistake. *Rocks & Minerals* 19, 8, p. 235–239, map. Lord's Hill locality.

STEVENS, J. P. (1972) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* West Paris, ME: Perham's Maine Mineral Store, 216 p., illust.

THOMPSON, W. B., *et al* (1991) A collector's guide to Maine mineral localities. 2nd edit. *ME Geol. Survey Bull.* 41, 104 p., illust., maps.

THOMPSON, W. B. (1993) A stellar amethyst find at the Intergalactic Pit in Stow, Maine. *Mineral News* 9, 8, p. 1, 4.

______, (1994) Amethyst discovery on Deer Hill, Stow, Oxford County, Maine. *Rocks & Minerals* 69, 1, p. 44–51, illust., map.

VOYNICK, S. (1994) Maine amethyst. *Rock & Gem* 24, 5, p. 42–44, 46, 68, 69, illust. (col.), map. Deer Hill.

WARD, F. M. (1978) Deer Hill amethyst. *Gems & Minerals* 493, p. 54, 55, 59, map.

WHITE, J. S. & COOK, R. B. (1990) Amethyst occur-

rences in the eastern United States. *Min. Rec.* 21, 3, p. 203–213, illust. (col.), map.

NEW HAMPSHIRE. Current prospecting, carried on by enthusiastic amateurs who have learned how to seek signs of pocket mineralization in the enormous granite masses of the state, has increased the number of productive areas and finds in the Moat Mountain, Osceola, and Conway granites of the central portion of the state. Samuelson, *et al* (1990) states that "the Conway granite has unlimited potential as a source of smoky quartz," for example, and "a persistent collector can locate pockets from the Ossipee Mountains to the far northern outcrops in Strafford," or over a distance of about 70 miles (112 km).

Successful collecting in the Moat Mountain granite during 1960 to 1977 produced splendid, lustrous smoky quartz crystals, many of facet grade, and because of the perfection of form and facial quality they remind one of the finest equivalent Swiss smoky quartz crystals. Hurricane Mountain, in the Conway granite, yielded a pocket measuring 2.5 x 2 x 6 m (8.4 x 6.6 x 20 ft), from which were extracted about 100 kg (220 lb) of smoky quartz crystals, largely of gem quality, the largest crystal weighing 32 kg (70 lb) according to Samuelson, *et al (Ibid.)*. In 1988, Samuelson also found a cavity of 2.4 x 1.8 x 2.1 m (8 x 6 x 7 ft) in the Conway granite, Albany Township, from which 1.3 tons of lustrous smoky quartz crystals were taken, the largest single crystal weighing 118 kg (260 lb). Also found was a "spectacular" pocket of amethyst crystals in the same granite near Stark; this pocket provided nine major crystal groups that ranged from 18 to 37 kg (40–80 lb), many crystals being deep rich purple and containing much facet grade material. From other rough, faceted amethysts to 20 carats were cut. Samuelson, *et al* (*Ibid.*, p. 283) also mentions the occasional find of citrine, a quartz variety that is uncommon in New Hampshire. However, broken fragments were collected in 1986 and 1987 from cavities in Conway granite and a 210 ct faceted gem was cut from one

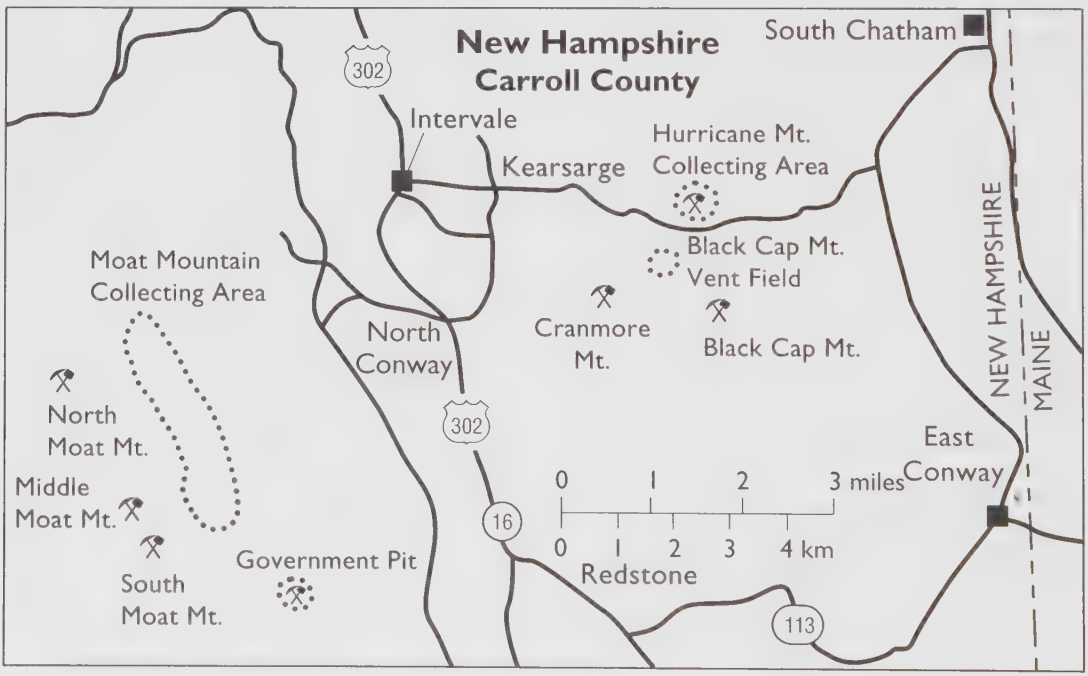


FIGURE 69. Collecting areas of Carroll County, New Hampshire.

FIGURE 70. Digging in a fluorite-quartz "pipe" in the granite bedrock of Black Cap Mountain, Carroll County, New Hampshire. *Courtesy of Jonathan Herndon, Center Ossipee, NH.*

of them. Finds of smoky and amethyst quartz are reported from the Sugarloaf Peaks in Bethlehem Township in the northeastern corner of Grafton County by Whittemore & Janules (1990), while Bearss & Janules (1992) reported fine, clear smoky quartz crystals from the Government Pit, Albany Township.

Amethyst, some facet grade, has been found in a remarkable pipe-like body that vertically pierces enclosing Conway granite on the northwest flank of Black Cap Mountain, about halfway between Cranmore Mountain and Hurricane Mountain, Conway, Carroll County. According to Herndon (1994) the site is a "large vent-like structure that was opened in the mid-sixties by Bill Ross," and in 1983 further explored by Herndon and associates who extracted 90 lb (41 kg) of amethyst crystals; "one of these crystals was the size of a football and deep red/smoky color." Herndon characterises the amethyst as "smoky-amethyst" and the smoky quartz as of the "root-beer" variety (*Pers. comm.* 3/23/94). This curious occurrence is in an area of about 500 ft (150 m) long, "and I believe that it is a large exposure of subterranean vent structures. I have identified over a dozen of these structures, usually by the large milky quartz cap which is the door into the tube." From color photographs supplied by Herndon, the vertical tube is approximately elliptical in cross-section, with remarkably smooth sides as left by the removal of loosely consolidated pipe debris in which are found amethyst/smoky quartz in groups and in crystals, plus fluorite crystals and balls of hematite, all imbedded in variously-colored clays that range from white to brownish red and dark brown. The excavated tube appears to be about 10 x 8 ft (3 x 2.4 m) and has been taken down to over 20 feet (6 m) below the surface. A hoisting rig was installed to remove debris. Insofar as faceting amethyst is concerned, only two stones were cut from the 1984 material, a stepped pear shape of 5.84 ct and a round brilliant of 2 ct.

Bradshaw (1990, p. 303) records several quartz gems from New Hampshire sources, including a remarkable 625 ct colorless quartz sphere which is now in the Smithsonian and which displays asterism. Smoky quartz faceted gems include an 11.57 ct brilliant from Moat Mountain, a 43.32 ct brilliant from Table Mountain, Bartlett, Carroll County, and a 207.75 ct emerald-cut from Rocky Gorge, all of these gems now in the Harvard Mineralogical Museum. Among amethyst gems are faceted stones from Long Mountain, Stark Township, Coos County, and from a find in that area made in 1988 from which the largest recorded faceted amethyst from New Hampshire came, a gem of 20 carats now in a private collection. Bradshaw also notes a cuttable jasper found on Hurricane Mountain, Conway, Carroll County, from which a 91.5 ct cabochon was cut for the Harvard collection.

ARMSTRONG, J. V. (1961) Giant crystals of Hurricane Mountain, N.H. *Rocks & Minerals* 36, 9/10, p. 467, illust.

BEARSS, G. T. & JANULES, R. (1992) Miarolitic cavity minerals of the Government Pit, Albany, New Hampshire. *Rocks & Minerals* 67, 3, p. 158–168, illust., map, p. 165.

BERK, M. (1989) New from New England. *Lapidary J.* 43, 8, p. 44–48, illust.

BRADSHAW, J. J. (1990) Gemstones of New Hampshire. *Rocks & Minerals* 65, 4, p. 300–305, illust., p. 303.

GALLUP, R. W. (1966) New Hampshire treasure. *Rocks & Minerals* 41, 4, p. 249–250. Smoky quartz, Carroll Co.

HERNDON, J. (1994) Black Cap revisited. *Mineral News* 10, 2, p. 4–5, illust.

LAPIDARY JOURNAL (1963) Large smoky quartz crystal found in New Hampshire. Vol. 17, 8, p. 866, illust. 128 lb., Hurricane Mt.

MEYERS, T. R. (1941) *New Hampshire minerals and mines.* Report to N.H. State Planning and Development Comm., 49 p., map.

MEYERS, T. R. & STEWART, G. W. (1956) *The Geology of New Hampshire.* Part III. Minerals and mines. NH State Plan. Dev. Comm., 108 p., map.

MORRILL, P. (1960) *New Hampshire Mines and Mineral Localities.* 2nd edit. Hanover, NH: Dartmouth College Museum, 46 p.

SAMUELSON, P., HOLLMAN, K & HOLT, C. (1990) Minerals of the Conway and Mount Osceola granites of New Hampshire. *Rocks & Minerals* 65, 4, p. 286–296, illust.

VERROW, H. J. (1945) Amethyst–smoky quartz–topaz in northern New Hampshire. *Rocks & Minerals* 20, 6, p. 255–260.

WHITTEMORE, S. & JANULES, R. (1990) Pegmatites and miarolitic cavity minerals of North Sugarloaf Mountain, Bethlehem, New Hampshire. *Rocks & Minerals* 65, 4, p. 338–347, illust. (col.)., map.

WHITE, J. S. & COOK, R. B. (1990) Amethyst occurrences in the eastern United States. *Min. Rec.* 21, 3, p. 203–213, illust. (col.), map.

VERMONT. In a leaflet of 12 pages issued for mineral collectors by the Vermont Agency for Development and Community Affairs, only a few places for quartz gemstones are recommended: the Bristol area for jasper pebbles; blue quartz in a road-cut on the north side of Route 9, 6 mi (9.7 km) east of Bennington (cabochon material); jasper/hematite in the Parrot Jasper Mine, Colchester, 4 mi (6.3 km) west of Route 2, and just south of the bridge over the Lamoille River; smoky quartz crystals at Devil's Den, Mount Tabor, near the picnic area; and agate with serpentine along Adam's Brook, South Newfane. Other localities may be found in the references below.

CHANDLER, H. L. (1942) Jaspilite in Vermont. *Rocks & Minerals* 17, 9, p. 317.

GRANT, R. W. (1968) Mineral collecting in Vermont. *VT Geol. Survey Spec. Publ.* #2, 49 p., maps.

HAYES, A. A. (1851) [Rutilated quartz, Waterbury]. *Boston Soc. Nat. Hist. Proc.* 4, p. 23–24.

MORRILL, P. & CHAFFEE, R. G. (1964) *Vermont Mines and Mineral Localities.* Hanover, NH: Dartmouth Coll. Mus., 57 p., maps.

REX, R. (1947) Jasper near Milton, Vermont. *Rocks & Minerals* 22, 10, p. 910–911.

MASSACHUSETTS. Gosse (1969) prepared lists of gemstones that can be found in this state, including both crystalline and chalcedonic varieties. White & Cook (1990) report that "one of the finest amethysts ever faceted from New England material" is the "Star of Bellingham," a medium purple antique cushion faceted stone of 52.8 ct. The gem was cut from a crystal found by J. H. Marshall, Jr., at a house lot on Rose Street, Bellingham, Norfolk County, in 1976!

GOSSE, R. C. (1969) A catalogue of Massachusetts gemstones. [In 10 parts] *Rocks & Minerals* 44, 1, p. 24–28 to no. 11, p. 758–759.

ROCKS & MINERALS (1951) Petrified wood found in Massachusetts. Vol. 26, 7/8, p. 374.

WHITE, J. S. & COOK, R. B. (1990) Amethyst occurrences in the eastern United States. *Min. Rec.* 21, 3, p. 203–213, illust. (col.), map.

RHODE ISLAND. Winslow (1945) writes about the amethyst formerly found at Bristol Point, Bristol Township, at the place where the Mount Hope Bridge connects the mainland with the township of Portsmouth. "At one time when Bristol was a port for sailing vessels the amethyst was very abundant and was secured for polishing as a gem, to be presented to loved ones, by the seafaring men." Winslow adds that even in his day, good amethysts were scarce, and in recent decades, such that have been found by Metropolis, *et al* (1986) are generally too small and too poor in quality or too unevenly colored to be worth cutting (White & Cook, 1990), although they provide attractive cabinet specimens.

ADAMS, J. (1824) New locality of amethyst [Bristol]. *Amer. J. Sci.* 8, p. 199.

BATTEY, T. J. (1886) The amethyst locality of Burrillville. *Random Notes on Nat. Hist.* 3, p. 90–91.

FLAGG, A. L. (1937) Some old quartz localities in Rhode Island. *Rocks & Minerals* 12, 2, p. 51–52.

MASON, O. (1826) Miscellaneous localities of minerals (Rhode Island). *Amer. J. Sci.* 10, p. 10–11.

METROPOLIS, W. C., RAKOVAN, J. & AVELLA, S. (1986) Amethyst sceptered quartz from Ashaway Village, Hopkinton, Rhode Island. *Rocks & Minerals* 61, 5, p. 247–250, illust. (col.).

MILLER, C. E. (1972) *Minerals of Rhode Island.* Univ. RI, 83 p., illust., maps.

SILLIMAN, B. (1925) [Amethyst in Rhode Island]. *Amer. J. Sci.* 9, p. 49, 401–402.

TAYLOR, S., WEBB, T. H. & ROBINSON, S. (1824) [Localities, Rhode Island minerals]. *Amer. J. Sci.* 8, p. 225–232. Bristol amethyst.

WHITE, J. S. & COOK, R. B. (1990) Amethyst occurrences in the eastern United States. *Min. Rec.* 21, 3, p. 203–213, illust. (col.), map.

WINSLOW, W. S. (1945) Notes on some mineral localities in Rhode Island. *Rocks & Minerals* 20, 10, p. 463–466. Amethyst.

CONNECTICUT. Ward (1889, p. 854) mentions silicified wood in Southbury that was found as early as 1823, and "siliceous petrification of a trunk of a tree eight or ten inches in diameter discovered at Southbury" that was described by Edward Hitchcock. Sohon (1951, p. 64), notes silicified wood at localities such as Lake Zoar, South Britain, Southbury, Washington, and Woodbury. Knowlton (1901) examined more or less perfectly silicified wood which was found in "considerable abundance" in the lowest member of the Newark Formation of South Britain. At the time, a trunk had been found that measured about three feet (1 m) in length and about two feet (60 cm) in diameter and the wood identified as *Araucarioxylon virginianum Knowlton*. No one mentions the suitability of this wood for lapidary purposes, but if it resembles the wood found farther southwestward along the Atlantic coastal plain, some of it will be tan to brown in color and perfectly polishable.

Some agate is still obtainable after diligent search in the Triassic volcanic rocks of the Connecticut River Valley, and rose and smoky quartz suitable for gem purposes have been obtained from granitic pegmatites.

HILLER, J. (1971) *Connecticut mines and minerals.* Shelton, CT: priv. publ., 61 p., maps.

JANUZZI, R. E. (1959) *The Minerals of Western Connecticut and Southeastern New York State.* Danbury, CT: priv. publ., 106 p., maps.

KNOWLTON, F. H. (1901) Report on fossil wood from the Newark formation of South Britain, Connecticut. In HOBBS, W. H., The Newark

System of the Pomperaug Valley, Connecticut. *U.S. Geol. Survey 21st Ann. Rept. for 1899–1900*, Part III, p. 7–162; Knowlton p. 161–162.

SCHAIRER, J. F. (1931) The minerals of Connecticut. *State Geol. Nat. Hist. Survey Bull.* 51, 121 p., illust.

SCHOONER, R. (1961) *The Mineralogy of Connecticut.* Branford, CT: Fluorescent House, 89 p.

SILLIMAN, B. (1819) Localities of mineral and animal remains and acknowledgment of specimens received. *Amer. J. Sci.* 1, p. 237–243. Southbury rose quartz.

SLOAN, E. & SLOAN, B. (1965) *Mineral & Gem Trails.* Mineola, NY: EDSCO, (60) p., maps. Includes CT.

SOHON, J. A. (1951) Connecticut minerals: Their properties and occurrence. *State Geol. Nat. Hist. Survey Bull.* 77, 133 p.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept. for 1886-87*, part 2, p. 663–960.

WHITE, J. S. & COOK, R. B. (1990) *See above.*

NEW YORK. The popularity of digging, or one should say, hard-rock mining for Herkimer "diamonds" remains high despite the strenuous labor now required to expose the cavities in which these splendid rock crystals rest. At some fee-basis operations, actually small quarries in the bedrock sandstone, the owners use heavy mechanical equipment to loosen and break up the sandstone just enough to render the lot of the visitor somewhat easier.

Tuttle (1973) studied the minerals that are found trapped within the rock crystals, noting the common presence of gas-liquid inclusions, and at the same time furnishing a historical account of the study of these inclusions. A characteristic solid inclusion is black *anthraxolite*, a carbonaceous material, to which Tuttle devotes much discussion. Other inclusions are pyrite, sphalerite, calcite, garnet, and dolomite.

In another study of the Herkimer crystals, Ulrich (1973) clearly pictures and describes how one can tell the "handedness" of quartz crystals as revealed by the placement of the small lozenge-shaped faces that fall on the apexes where the terminal faces meet the side, prism faces.

Although two localities for amethyst in New York are listed by White & Cook (1990), neither is available for collecting and so far as is known, neither produced material worthy of cutting.

Zabriskie (1992) reported lapidary grade jasper from along the bank of the Hudson River adjacent to the city of Rensselaer. Ward (1889, p. 859) noted that James Hall had found silicified tree trunks in the Hamilton Group sedimentary rocks, but Ciurca (1962), in a report on petrified woods in the eastern United States, mentions only coalified or unsilicified woods. However, it is probable that the petrified wood mentioned by Sloan (1965, p. 16, map) from Appleby Beach, Garrie's Point, Glen Cove, Long Island, is silicified and thus may be suitable for lapidary work.

Ciurca (1966) reported a very compact, fine-grained ortho-quartzite that displays numerous bandings and which accepts a good polish. It is suitable for making bookends and other larger objects of ornament. This rock, a silicified Grimsby sandstone, was originally found as pebbles and boulders in western New York but *in situ* sources were later found in outcroppings in the Genessee River Gorge in the city of Rochester below the Driving Park Bridge.

AMES, L. *et al* (1984) The big one that didn't get away. *Gems & Minerals* 449, p. 22–24, illust., map. Herkimer quartz.

CIURCA, S. J. (1962) Fossil wood in eastern United States. *Gems & Minerals* 303, p. 26–31, maps.

______, (1963) Agate and opal in New York. *Ibid.* 309, p. 34–36.

______, (1964) Silicified coral at Jaycox Run. *Ibid.* 321, p. 28.

______, (1966) Medina orthoquartzite is a new lapidary stone. *Lapidary J.* 20, 7, p. 909–911.

CUSHING, H. P. (1905) Geology of the vicinity of Little Falls, Herkimer County. *Univ. State NY Bull.* 327; *NY State Mus. Bull.* 77, *Geol.* 6, 95 p., illust., maps. Herkimer quartz.

GOSSE, R. C. (1962) Ornamental stones of Albany, New York area. *Rocks & Minerals* 37, 3/4, p. 165–166.

JANUZZI, R. E. (1959) *See above.*

JENSEN, D. E. (1978) *Minerals of New York State.* Rochester, NY: Upward Press, Ward's Nat. Sci. Establ., 220 p., illust. (col.), map.

KUNZ, G. F. (1885) Precious stones. Ch. in *U.S. Geol. Survey Min. Res. U.S. for 1883-84.* Herkimer quartz p. 748–749.

LABUZ, A. L. (1969) The "Herkimer diamond"

grounds (formerly Schrader property) and related properties. *Rocks & Minerals* 44, 4, p. 243–250, illust.
LISLE, T. O. (1959) Doubly terminated Herkimer "diamonds." *Lapidary J.* 13, 1, p. 90–98, *passim*, illust., map.
LORD, M. & ZIRLIN, S. H. (1981) The "diamonds" of New York. *Gems & Minerals* 525, p. 28–34, maps.
LUQUER, L. M. & RIES, H. (1896) The "augen"—gneiss area, pegmatite veins and diorite dikes at Bedford, N.Y. *Amer. Geologist* 18, p. 239–261, illust. Gem smoky quartz and rose quartz.
MANCHESTER, J. G. (1910) Asteriated rose quartz in New York. *Mining World* 32, p. 1185–1186.
______, (1914) The minerals of Broadway, New York City. *NY Mineral. Club Bull.* 1, 3, p. 25–52, illust., map.
______, (1931) The minerals of New York City and its environs. *Ibid.* 3, 1, 168 p., illust., map.
MASLOWSKI, A. (1986) New York's "diamonds." *Gems & Minerals* 582, p. 10–12, illust.
MOORE, B. S. (1989) *Herkimer diamonds, a complete guide.* Herkimer, NY: Herkimer Diamond Development Corp., 62 p.
MYERS, B. M. (1982) Something for everyone. *Lapidary J.* 36, 1, p. 172–175, illust., map. Herkimer quartz.
NEWLAND, D. H. (1937) Herkimer County quartz crystals. *Rocks & Minerals* 12, 2, p. 36–37.
ROWLEY, E. B. (1951) Crystal collecting at Saratoga Springs, New York. *Rocks & Minerals* 26, 9/10, p. 528–532, map. Includes Herkimer area.
SLOAN, E. & SLOAN, B. (1965) *See above.*
SMITH, C. H. (1950) *Let's Hunt for Herkimer Diamonds.* Geneva, NY: priv. publ., 47 p., illust.
______, (1952) Recent Herkimer "diamond" hunting. *Rocks & Minerals* 27, 5/6, p. 272–275.
TUTTLE, D. L. (1973) Inclusions in Herkimer "diamond," etc. *Lapidary J.* 27, 6, p. 966–976, illust., map.
ULRICH, W. (1973) The recognition of hand and twinning in Herkimer quartz. *Lapidary J.* 27, 8, p. 1236–1241, illust.
______, (1974) Hunting Herkimer diamonds. *Rockhound* 3, 5, p. 4–7, illust., map.
VANDERBILT, H. L. (1985) Herkimer diamonds. *Lapidary J.* 39, 7, p. 45–47.
WALKER, D. & WALKER, C. (1990) Herkimer "diamonds." *Lapidary J.* 44, 4, p. 71–72, illust., maps.
WALTER, M. (1976) The big carbon pocket, a dream come true. *Lapidary J.* 30, 4, p. 918, 920, 922, illust.
WARD, L. F. (1889) *See above.*
WHITE, J. S. & COOK, R. B. (1990) *See above.* Minor occurrences.
ZABRISKIE, D. & ZABRISKIE, C. (1993) *Rockhounding in Eastern New York States and Nearby New England.* Albany, NY: Many Facets, 53 p., maps.
ZENGER, D. H. (1981) Stratigraphy and petrology of the Little Falls dolostone (Upper Cambrian), East-Central New York. *NY State Mus. Map & Chart Service* 34, 138 p., illust., maps. Herkimer deposit geology.

PENNSYLVANIA. White & Cook (1990, p. 208) briefly note the classic amethyst locality of Upper Providence Township, Delaware County, which many years ago provided fine crystal groups and rough for excellent faceted gems, one of which is depicted by them as a "superb 36.2 carat gem." Kunz (1890) also depicted a fine amethyst group from this locality in his color Plate 6. In connection with amethyst, an unverified report states that in 1990, at a construction site near Collegeville, Montgomery County, hydrothermal quartz veins cutting Triassic red sandstone were exposed and from cavities within them were extracted amethyst crystals up to 30 cm (ca 12 in) in diameter in varying degrees of clarity!

BEARD, R. (1993) Pennsylvania agate. *Rock & Gem* 23, 11, p. 46, 49–52, illust., map. Mt. Holly Springs.
EASTER, E. W. (1970) A fossil locality with lapidary potential. *Rocks & Minerals* 45, 1, p. 67. Silicified horn coral, Stroudsburg.
GEMS & MINERALS (1966) Field trip vignette: Pennsylvania. No. 349, p. 10. Vera Cruz.
GENTH, F. A. (1875) Preliminary report on the mineralogy of Pennsylvania. Harrisburg, PA: *Second Geol. Survey PA, 1874,* 206 p., map, p. 55–61.
GEORGE, R. L. (1978) Man and chert in western Pennsylvania. *Rocks & Minerals* 53, 3, p. 104–107.
GEYER, A. R., SMITH, R. C. & BARNES, J. H. (1976) Mineral collecting in Pennsylvania. *PA Topogr. & Geol. Survey Gen. Geol. Rept.* 33, 260 p., illust., maps.
GORDON, S. G. (1922) The mineralogy of Pennsylvania. Phila., PA: *Spec Publ. Acad. Nat. Sci. Phila.,* No. 1, 255 p., illust., p. 47–49.

HAYES, W. H. (1955) A double-interest locale in Pennsylvania. *Rocks & Minerals* 30, 7/8, p. 343–345. Vera Cruz chert.

KING, A. T. (1854) Description of fossil trees in the coal rocks near Greensburgh, Westmoreland County, Pennsylvania. *Acad. Nat. Sci. Phila. Proc.* 7, p. 64–65. "Immense" silicified logs.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.), p. 114–115.

KRAJNAK, M. (1955) Rockhounding in western Pennsylvania. *Lapidary J.* 9, 1, p. 30, 32. Silicified wood.

MERCER, H. C. (1894) Indian jasper mines in the Lehigh Hills. *Amer. Anthropologist* 7, p. 80–92.

______, (1895) Jasper and stalagmite quarried by Indians in Wyandotte Cave. *Amer. Phil. Soc. Proc.* 34, p. 396–400.

MYERS, P. B. (1934) The origin of jaspers in Lehigh and Northampton Counties. Pennsylvania. Phila., PA: *Acad. Sci. Proc.* 8, p. 87–92, illust.

MYERS, R. E. (1940) The Hardyston jasper in the Reading Hills in Pennsylvania. *Rocks & Minerals* 15, 7, p. 219–225.

SCHIEFER, H. V. (1953) New agate find. *The Mineralogist* 21, 6/8, p. 277.

WHERRY, E. T. (1912) Silicified wood from the Triassic of Pennsylvania. *Acad. Nat. Sci. Phila. Proc.* 64, p. 366–372.

WHITE, J. S. & COOK, R. B. (1990) Amethyst occurrences in the eastern United States. *Min. Rec.* 21, 3, p. 203–213, illust. (col.), map.

ZEITNER, J. C. (1968) *Appalachian Minerals & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. PA p. 21 ff.

NEW JERSEY. Virtually no quartz gemstones can be collected in this state because of restrictions placed on visitors to the trap rock quarries in which the occasional amethyst druse and agate nodule may be found. However, a bounty of whitish to colorless, translucent to clear quartz pebbles, the so-called "Cape May diamonds," continue to delight the tourist who seeks them out on the beaches at the extreme southern tip of the state. Voynick (1988) recommends examining the beaches from Sunset Beach to the south and around the tip of the cape. He provides interesting historical anecdotes on collecting in Colonial times and remarks that "European interest in the beach quartz apparently began when a settler, Christopher Leaming, received a gift stone from King Nummy, the last of the Lenni-Lenape chiefs. Leaming sent the stone to Amsterdam where it was cut and polished into a fine gem." Voynick believes that this was the first United States gemstone to be cut and that it probably inspired the term "diamond." Other notes on local lore associated with these quartz pebbles appear in Charles (1963), while Ein (1992) provides a nostalgic essay on Cape May culture as well as on the quartz itself.

By far, most amethyst crystals from the trap rocks of this state average only 1 cm (0.4 in) in diameter and thus, at best, cannot be expected to yield more than fractional-carat faceted gems. However, in the period 1990–1992, Millington Quarry, Somerset County, yielded remarkably large clean facet-grade amethyst that occurred as coarsely granular material in solid seams in the rock, with none of the crystals being euhedrally developed. According to R. A. Kosnar, of Golden, Colorado (*Pers. comm.* 8/10/1994), who obtained a large, clean piece of good color "that would easily cut a 15–20 ct." and owns a faceted gem of this material of 10.08 carats, perhaps much larger gems could be cut "if the clean massive material ever opens up into pockets."

CHARLES, R. J. (1963) Some light on the legends about Cape May "diamonds." *Lapidary J.* 17, 9, p. 968–970, illust.

CONVERY, C. E. (1959) *Field Guide, Gem & Mineral Locations, Northeastern U.S.A.* NY: International Gem Corp., [60] p., illust., maps. Carnelian Brook.

EIN, D. A. (1992) Sunsets & "diamonds." *Lapidary J.* 46, 2, p. 41–46 illust. (col.), map.

HARRIS, P. W. (1979) "Diamond" hunting by the sea. *Gems & Minerals* 497, p. 8.

HEUSSER, G. (1980) Hunting Cape May diamonds. *Lapidary J.* 34, 7, p. 1538–1539, illust.

HUNT, J. H. (1891) A series of quartz pseudomorphs after pectolite and other interesting minerals from Paterson, N.J. *Mineralogists' Monthly* 6, p. 25–29. Agate.

JACKSON, R. & JACKSON, K. (1973) *A Rockhound's*

Guide to Metropolitan New Jersey. Seattle, WA: JAX Products, 50 p., illust., maps, p. 10, 16.

MANCHESTER, J. G. (1931) *See above.*

SLOAN, E. & SLOAN, B. (1965) *See above.* Cape May quartz.

THOMAS, C. A. (1974) Bonus trips in the Cape May, New Jersey area. *Gems & Minerals* 445, p. 28–29, maps.

VOYNICK, S. (1988) "Cape May diamonds." *Rock & Gem* 18, 11, p. 52–55, 78, map.

WHITE, J. S. & COOK, R. B. (1990) *See above.* Minor amethyst.

ZEITNER, J. C. (1968) *See above.* NJ p. 12–20.

ZODAC, P. (1950) New Jersey brook a carnelian locality. *Rocks & Minerals* 25, 9/10, p. 481–483.

DELAWARE. Silicified wood of tan to brown color suitable for polishing has been found in gravel pits and in plowed fields in the Odessa area of Newcastle County and in the Smyrna area of Kent County. It is similar in most respects to the silicified woods found in Maryland and Virginia.

PICKETT, T. & WINDISH, D. (1980) Delaware: Its Rocks, Minerals, and Fossils. *Delaware Geol. Survey,* 18 p., maps.

MARYLAND. Silicified wood, generally in shades of cream, tan, and brown, still to be found in many gravel deposits, was first known in the last century. Ward (1889) notes silicified coniferous wood and remains of cycads in the iron ore clays of the Potomac formation of Cretaceous age. In the vicinity of Baltimore, for example, "lignite is abundant at nearly all points and silicified wood is also found." To the west of Baltimore, such wood was found abundantly in the iron mines and in the railroad cuts between Washington and Baltimore, particularly in Deep Run, near Hanover Station on the Baltimore & Ohio line. Some remarkable cycad trunks have been found in the iron formations also, as on the southern shore of the Middle Branch of Patapsco River opposite South Baltimore and near Beltsville. Ward also mentions "beautifully preserved Sequoia cones in considerable abundance" at Coggin's Engine Mine near Beltsville. Similar woods have been found in the District of Columbia, and in a later contribution Ward (1895) stated that "one of the constant features of the Rappahannock sands [in Maryland] is the presence of silicified wood, large trunks having been exhumed at various points." In the District of Columbia, at an excavation for a new reservoir an enormous silicified log "was visible for a length of 40 feet, and its lower portion still remained covered."

BERNSTEIN, L. R. (1980) Minerals of the Washington, D.C., area. *Maryland Geol. Survey* Educ. Ser. No. 5, 148 p., illust., maps.

KINZER, R. W. (1948) Agates in Maryland. *The Mineralogist,* 16, p. 220, 222, 224.

MORGAN, F. (1945) Petrified wood in the Washington, D.C., area. *Rocks & Minerals* 20, 4, p. 164.

WARD, L. F. (1889) *See above.*

_____, (1895) The Potomac formation. *U.S. Geol. Survey 15th Ann. Rept. for 1893–94,* p. 307–397, illust.

VIRGINIA. The presence of silicified wood, often in logs of considerable size and capable of taking a splendid polish, has been known since Colonial times, but even today this wood fails to evoke much interest among lapidaries because of the generally muted colors in creams, tans, and browns as noted previously. References to this material were made by Knowlton (1889, 1899) and Shaler & Woodworth (1899, p. 435–436, 516) who also noted silicified logs and fragments of *Araucarioxylon* in sandstone near Otterdale, Chesterfield County, at a place about 5.5 mi (9 km) southwest of Midlothian. Some trunks were found in excess of 20 ft (6 m) long. Other trunks were found in the general area near Skinquarter and south of Mosley Junction in the same county. Penick (1992) remarks upon a light to dark brown silicified wood in gravel pits along the Richmond-Petersburg Toll Road, south of Richmond. From personal collecting it can be said that fragments of this wood are severely waterworn and their exteriors bleached to near whiteness, so that they closely resemble pieces of ordinary driftwood.

An unusual pale milky-blue vein quartz, probably colored by minute rutile inclusions as well as reflecting light from numerous closely-spaced fractures, occurs in many places in Albemarle, Floyd, Greene, Madison, and Nelson counties. It has been used by local lapidaries (Zeitner, 1968). Intensely blue quartz of this sort is noted also from Franklin County by Penick *(Ibid.)*.

Rather clear star quartz can be found in the dump debris of the Jefferson Mine No. 9, 4 mi (6.2 km) northeast of Amelia, Amelia County; also in Campbell County, northwest of Altavista near the intersection of State Highways 711 and 712; also in Powhatan County in the White Peak Mines, northeast of Flatrock, and in the Lance and Wheatley Mine in Bedford County (Penick, 1992).

Penick also reports a plume-type agate with black inclusions of a manganese mineral identified as romanechite; it is found in the dumps of old prospect pits on the west flank of Blue Ridge, east of Bentonville, Warren County. It is said to be "excellent cutting material."

Amethyst, one of the best known Virginia gemstones, has been picked up in plowed fields and from quartz outcrops in many places, Dietrich (1990), recording thirty occurrences. In Amherst County, fee-collecting has been permitted on the Schaars Farm near Amherst, where the crystals, many with clear, facetable areas, are found in residual clays weathered from the underlying granite. On a ridge crest of the Donald Plantation, north of U.S. Highway 40, about 4.5 mi (7 km) northwest of Charlotte Courthouse, Charlotte County, amethyst was once mined commercially (Sterrett, 1913). In Louisa County, amethyst crystals, some of gem quality, were once found loose in the soil in an area 4 mi (6.2 km) southwest of Trevillians (Zeitner, 1968). Penick *(Ibid.)* notes gem amethyst in this county northeast of Ferncliff. A fee locality, now closed, was once established on the George Smith Farm, 3 mi (4.8 km) north of Rice in Prince Edward County (Penick, *Ibid.*; Zeitner, *Ibid.*). White & Cook (1990, p. 206) provide a color photograph of a rich purple round brilliant faceted gem cut from Nelson County material and also crystal groups from Amherst County and from near Minnieville, Prince William County. Wight (1984) records a Virginia faceted amethyst of 45.17 ct in the National Museums of Canada collections.

BERNSTEIN, L. R. (1980) *See above.*

BEVAN, A. (1940) Notes on amethyst in Virginia. *Rocks & Minerals* 15, 4, p. 119.

BLAND, R. J., GATLIN, G. A. & JOHNSON, S. S. (1963) Amethyst locality near Ash Lawn [VA]. *Virginia J. Sci.* 14, p. 237.

BLAND, R. J. (1965) Some notes on asteriated quartz in Virginia. *Rocks & Minerals* 40, 11, p. 838–839.

DIETRICH, R. V. (1970) Minerals of Virginia. Blacksburg, VA: *VA Polytech. Inst. Research Div. Bull.* 47, 325 p., illust.

______, (1990) *Minerals of Virginia—1990.* VA Div. Mineral Resources, 424 p., illust.

KNOWLTON, F. H. (1889) Fossil wood and lignite of the Potomac formation. *U.S. Geol. Survey Bull.* 56, 72 p., illust.

______, (1899) Report on some fossil wood from the Richmond Basin, Virginia. *U.S. Geol. Survey 19th Ann. Rept. for 1897–98*, part 2, p. 516–519.

LEWIS, I. F. (1937) Silicified wood from the Patuxent of northeastern Virginia. Abstract *VA Aca. Sci. Proc. 1936–1937*, p. 50–51.

MERTIE, J. B. (1959) Quartz crystal deposits of southwestern Virginia and western North Carolina. *U.S. Geol. Survey Bull.* 1072-D, p. 233–298. Rock crystal.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

SHALER, N. S. & WOODWORTH, J. B. (1899) Geology of the Richmond Basin, Virginia. *U.S. Geol. Survey 19th Ann. Rept. for 1897-98*, part 2, p. 385–519, maps.

STERRETT, D. B. (1913) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources for 1912*, p. 1029–1032, 1045–1048, amethyst.

ULKE, T. (1936) The agates and jaspers of the Atlantic coastal plain. *Rocks & Minerals* 11, 9, p. 174–175.

WATSON, T. L. (1907) *Mineral Resources of Virginia.* Lynchburg, VA: The Virginia Jamestown Expo. Comm., 618 p., illust., maps. Gems p. 385–392.

WHITE, J. S. & COOK, R. B. (1990) *See above.*

WIGHT, W. (1984) The gem collection of the National Museums of Canada. *Canad. Gemm.* 5, 1, p. 2–14.

ZEITNER, J. C. (1968) *See above.*

WEST VIRGINIA. Handsomely patterned silicified coral is abundant at many points in Greenbrier and Pocahontas counties where it occurs in the Hillsdale limestone formation and partly in the rocks of the Greenbrier group. The name of the coral is *Lithostrotionella* (Kirstein, 1982). The coral "heads" sometimes reach 15 lb (6.8 kg), and when cut across show the delicate markings of the coral colony against background colors of light blue, dark blue-gray, pink, and red. After considerable amateur club effort, the coral was officially adopted as the state gemstone for West Virginia (Steelhammer, 1990).

According to Kirstein (1982), carnelian is found in Summers County in the rocks of the Mauch Chunk Group.

KIRSTEIN, D. (1982) Gemstones of West Virginia. WV Geol. Econ. Survey, *Mountain State Geological Magazine*, 1982, p. 34–36, illust.

STEELHAMMER, R. (1990) State's official fossil goes on display. *The Charlestown Gazette*, April 27, Sect. D.

ZEITNER, J. C. (1968) The agatized coral of West Virginia. *Lapidary J.* 22, 8, p. 988–1002, *passim*, illust.

_____, (1968) *Appalachian Mineral and Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust. (col.), maps.

NORTH CAROLINA. As suggested by the numerous references below, the splendid quartz crystals found in the late 1800s drew the attention of mineralogists from all over the world. Excellent crystals continue to be found, especially in the celebrated emerald/hiddenite deposits in Alexander County. In 1990, for example, the *Statesville Record* reported the discovery of a 300 lb (136 kg) smoky quartz crystal of gem grade from an unspecified locality. Among the singular quartz crystals found in the state must be counted those with clay inclusions, water inclusions, and crystals growing in parallel and sometimes with small cappings of late-growth amethyst as described by Taber (1950). The potential for finding more fine crystals is limited only by the obscuration of outcrops by the dense vegetation typical of the Appalachian foothills.

The amethyst deposits of North Carolina have also been known for many years, with recent production due wholly to informal mining by collectors as in the Reel Mine, located about 2.2 mi (3.5 km) northeast of Iron Station, Lincoln County. Here Lucas (1975) reported a large pocket or cavity that yielded 300 lb (136 kg) of amethyst crystals of all grades. Hudson (1980) gave further details on this deposit, including historical notes on the discovery of the amethyst and ownership of the property. At the time, fee-digging was allowed for a "few dollars" per day. This deposit and others in the state are noted by White & Cook (1990) who also depict, in color, crystal specimens from the Reel Mine as well as others from the Goodwin Farm and Leepers Creek near Iron Station; from Vail in Lincoln County (a scepter crystal); from the Minor Lentz Farm near Statesville, Iredell County; and from the Blackwelder Farm near Concord, Cabarrus County. While considerable amethyst has been found in North Carolina, facet grade material of good color is rare and by far most crystals and crystal groups are treasured as handsome cabinet specimens.

In the late 1950s, D. D. Moose of Stony Point, working with E. H. Plyler, owner of the Ellison Beryl Mine, found quantities of reticulated rutile specimens of deep red color in a pegmatite pocket, some of which were completely enclosed in rock crystal. This rutilated quartz when cut made remarkable cabochons (Moose, 1960).

Ward (1889) and Knowlton (1900) remarked on the silicified wood to be found in the state, some of it suitable for lapidary work. In modern times, attention was drawn to the handsomely patterned sections of silicified *Tempskya* that were found mostly in gravel pits, river banks, and bars, and also along Atlantic coastline beaches by West (1968–1978). In his last communication, West (1979) reported finds in Harnett County which included large palm wood sections and smaller masses of *Tempskya.* He provides excellent photographs which clearly show the internal structure.

CONLEY, J. F. (1971) Mineral localities of North Carolina. Rev. 1971 by O. F. Patterson & G. R. Ganis. *NC Div. Min. Resources Circ.* 16, 128 p., illust., maps.

HIDDEN, W. E. (1882) On a phenomenal pocket of fluid-bearing quartz crystals. *NY Acad. Sci. Trans.* 1, p. 131–136.

HUDSON, S. (1980) A Carolina sojourn. The Reel Amethyst Mine. *Lapidary J.* 34, 7, p. 1466–1486, *passim*, map.
KNOWLTON, F. H. (1900) Description of a small collection of fossil wood from the Triassic area of North Carolina. *U.S. Geol. Survey 20th Ann. Rept. for 1898–99*, part 2, p. 272–274.
KUNZ, G. F. (1887) Remarkable occurrence of rock crystal in the United States *Amer Assoc. Adv. Sci. Proc.* 35, p. 229–230.
______, (1888) Precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1887*, p. 560–561.
______, (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co. NC rock crystal p. 108–109.
______, (1907) History of the gems found in North Carolina. *NC Geol. Econ. Survey Bull.* 12, 60 p., illust. (col.).
LUCAS, M. E. (1975) One pocket yields 300 pounds of amethyst. *Lapidary J.* 29, 7, p. 1386–1387.
MERTIE, J. B. (1959) *See above.*
MIERS, H. A. (1893) Quartz from the emerald and hiddenite mine, N.C. *Amer. J. Sci.* 46, p. 420–424.
MOOSE, D. D. (1960) Reticulated rutile, and a rockhound's perfect day! *Lapidary J.* 14, 3, p. 236, 238, 240, illust.
POGUE, J. E. & GOLDSCHMIDT, V. (1912) Quartz from Alexander County, North Carolina. *Amer. J. Sci.* 34, p. 414–420.
ROCKS & MINERALS (1961) Amethyst mine opens in North Carolina. Vol. 36, no. 9/10, p. 458. Near Roberta, Cabarrus Co.
TABER, S. (1950) Quartz crystals with clay and fluid inclusions. *J. Geol.* 58, 1, p. 37–48, illust., map.
WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept. for 1886–7*, part 2, p. 663–960.
WEST, W. R. (1968) Petrified wood in North Carolina. *Tips* 4, p. 14.
______, (1970) *Tempskya* in North Carolina. *Lapidary J.* 23, 11, p. 1552–1556.
______, (1977) [Same]. *Ibid.* 30, 11, p. 2614–2616.
______, (1978) North Carolina *tempskya* update. *Ibid.* 31, 10, p. 2112–2116.
WEST, W. R. (1979) North Carolina and the rockhound. *Lapidary J.* 33, 8, p. 1736–1748, *passim*, illust. (col.).
WHITE, J. S. & COOK, R. B. (1990) *See above.*
WILSON, W. F. & McKENZIE, B. J. (1978) Mineral collecting sites in North Carolina. *NC Geol. Survey Div. Info. Circ.* 24, 122 p., maps, illust.
ZEITNER, J. C. (1967) North Carolina: A fabled land of gems. *Lapidary J.* 21, 1, p. 132–145, *passim*, illust., map.
______, (1968) *Appalachian Minerals and Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps, p. 76 ff.

SOUTH CAROLINA. A splendid amethyst crystal group, measuring 11 x 8 x 7 cm (8.3 x 6.2 x 2.75 in), from the Due West deposit in Abbeville County achieved lasting fame by being portrayed in color on one of a quartet of U.S. Postal Service stamps commemorating our mineralogical heritage issued on February 8, 1974 (White & Cook, 1990, p. 208). The specimen is in the U.S. Museum of Natural History along with another large group, and it is remarkable for the perfection of its crystals. It is probable that some of this amethyst may have been cut into small gems but White & Cook remark that "nearly everything that has been recovered is a good mineral specimen, much too fine to be subjected to faceting." Recent digging for amethyst at the Due West locality is described by Pressey (1981).

Dayvault (1978) provides further details on the diggings for fine smoky quartz crystals in the Liberty Hill area of Kershaw County in the north central part of the state. The diggings are in pegmatitic veins that traverse the granite of the Liberty Hill pluton. The host rock of the pluton is quartz monzonite, and the pluton itself is exposed over an area of about 20–25 km (12.5–15.7 mi) across, centered on the small community which gives it its name. A large, quartz-bearing dike was originally mined for quartz during the 1940s and smoky quartz was discarded on the dumps. Since the 1950s local collectors have consistently recovered handsome terminated prisms of smoky quartz, some of gem quality. Dayvault describes recent pockets that yielded crystals of 10–25 cm (4–10 in) long. He notes that the heavily wooded terrain prevents easy identification of vein outcrops. The wide extent of the quartz monzonite pluton, the remoteness of most

FIGURE 71. Digging for silicified coral in the bed of the Withlacoochee River near Clyattsville, Georgia, during an unusual low-water period. *Courtesy C. E. Doyle, Wewahitchka, Florida.*

of the region, and the tenacious cover of vegetation all guarantee that many fine pockets remain to be discovered.

McCauley (1964) notes that silicified wood is commonly found in the gravels of the PeeDee River Valley in Florence County, especially in the High Hill Creek area.

DAYVAULT, R. (1978) Smoky quartz in the Liberty Hill pegmatite. *Rocks & Minerals* 53, 5, p. 208–213, illust., map.

DONNAN, M. Y. (1964) Some gemstone locations in South Carolina. *Lapidary J.* 18, 2, p. 332–335.

FERGUSON, L. W. (1965) New find of giant amethyst, location—east of Due West, S.C. *Rocks & Minerals* 40, 12, p. 890.

McCAULEY, C. K. (1964) Gem stone resources of South Carolina. *SC Div. Geol. Bull.* 30, 34 p., maps.

PRESSEY, M. R. (1981) Amethyst prospecting in Second Appalachian Range. *Lapidary J.* 34, 12, p. 2528–2544, *passim*, illust., map.

SIMS, F. L. (1960) Petrified wood on Bellyache Creek. *Rocks & Minerals* 35, 5/6, p. 219.

SLOAN, E. (1908) Catalogue of the mineral localities of South Carolina. *SC Geol. Survey Bull.*, 505 p., maps.

WHITE, J. S. & COOK, R. B. (1990) *See above.*

ZEITNER, J. C. (1968) *Appalachian Mineral and Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps, p. 102.

GEORGIA. Cook (1978, p. 154–157) provides the most up-to-date summary of quartz occurrences in Georgia. Pressey (1981) recounts experiences in digging for amethyst vugs in Wilkes County; Cook (*Ibid.*, p. 156) notes that this area has produced fine cutting material. Several specimens of amethyst in the U.S. Museum of Natural History from Wilkes County are depicted in color by White & Cook (1990, p. 211). The most important statement in Pressey's account is that pegmatitic amethyst deposits probably will be found in a narrow belt of metamorphic rocks that extends parallel to the Appalachian Chain for perhaps as much as 300 miles (480 km) from Columbus, Georgia, northeast to Charlotte, North Carolina (Pressey, p. 2530). Experiences in prospecting in this region show the soundness of this concept, and therefore it is anticipated that amateur prospectors (primarily), after studying regional Appalachian geology, will be able to concentrate their efforts on terrains in which the amethyst-vein rocks occur. Much terrain covered by vegetation remains to be closely examined; for all practical purposes it is almost all virgin prospecting ground.

Like most Appalachian amethysts, those from North Carolina are mainly prized as cabinet specimens and not for gem material. However, Cook (1978, p. 156, 157) notes that "superbly faceted stones have been cut from these crystals," and "the finest amethyst crystal yet reported from Georgia was found in a field approximately one mile (1.6 km) north of Tignall on Georgia Highway 17. The crystal was 6 inches (15 cm) in length, 4 inches (10 cm) in diameter, and was flawless gem quality material of a deep royal purple color."

Tower (1978) remarks on the abundance of silicified wood that is found in a "petrified forest" located along the Savannah River and encompassing gravel deposits on both sides of the river in Georgia and South Carolina. Some logs and sections were recovered by diving into the river in the Parrysburg, SC, area! The Savannah River gravels also yield agates just east of Girard, as described by Hudson (1982) who also notes agates from other places in the state, particularly fine lace and fortification agates, some being handsome enough to be mistaken for Mexican varieties, in an area just south of Summerville about 70 mi (112 km) northwest of Atlanta in Chattooga County. Colorful chert is found farther north-northeast of Summerville or just north of Ringgold in Catoosa County. In regard to the petrified woods, Tower identifies them as pine, with fresh sections displaying gray, brown, and white colors. Other silicified wood localities as given by Cook are in Columbus County near Harlem, and in Upatoi Creek near Columbus, Muscogee County, and in Chattahoochee County along Randall Creek south of Columbus. Other sources are in Marion County, in Ben Hill County near Fitzgerald, and in the westernmost portion of Decatur County near the Seminole County line, where the wood is "relatively abundant."

Silicified coral of excellent quality is found in Thomas County according to Cook, but perhaps the most interesting occurrences are in the extreme southern part of the state, adjacent to Florida, where geodes are found in the Withlacoochee River bed and banks. These somewhat resemble the geodes from the famous Tampa, Florida, occurrence but are generally far less colorful and varied. The occurrence is described by Smith (1975) who gives the area as near Clyattville in Lowndes County, south of Valdosta. In the Clyattville area, the river forms the boundary between Brooks County (west) and Lowndes County (east). The corals are part of an ancient Oligocene reef structure, but are exposed only in a narrow strip in the river valley (*Pers. comm.*, C. E. Doyle, 1993). Samples sent to me by Doyle show typical geodal forms with coral shapes on one side, and chalcedony interiors, predominantly white, pale tan, yellowish, or brownish. Most material is recovered simply by wading in the stream during low water in summer. Enhydros, or geodes that are completely sealed but with water inside, are found from time to time.

BROOKSTONE, E. (1979) Perils of a rockhound revisited. *Lapidary J.* 32, 10, p. 2276–2277, illust. Silicified coral, Withlacoochee River.

COOK, R. B. (1978) Minerals of Georgia. *GA Geol. & Water Res. Div. Bull.* 92, 189 p.

FURCRON, A. S. (1945) Amethyst in Georgia. *Rocks & Minerals* 20, 5, p. 210–211.

____, (1948) Amethyst near Hightower Bald, Georgia. *GA Mineral Soc. Newsltr.*, Aug.; reprinted: *Rocks & Minerals* 23, 12, p. 796.

GLEASON, F. F. (1958) Smoky quartz in Georgia. GA Geol. Survey, *GA Mineral Newsletter* 11, p. 132–133.

HUDSON, S. (1976) Summerville agate. *Rock & Gem* 6, 8, p. 70–77, map.

____, (1980) Savannah River agate. *Ibid.* 10, 5, p. 48–51, map.

_____, (1981) Georgia star quartz. *Ibid.* 11, 3, p. 28–32, map.

_____, (1981) Merry Hill jasper. *Ibid.* 11, 12, p. 40–42, 46, 67, map.

_____, (1982) Those Georgia agates. *Lapidary J.* 36, 1, p. 158–162, 164, 165, illust., maps.

_____, (1990) Savannah River agate. *Rock & Gem* 20, 2, p. 18–20, 22, 24, 85, map.

_____, (1990) Summerville agate. *Ibid.* 20, 3, p. 16–20, 22, 23, map .

KUNZ, G. F. (1885) Precious stones. Ch. in *U.S. Geol. Survey Mineral Res. U.S. for 1883–84.* Amethyst p. 750.

_____, (1890) *Gems and Precious Stones of North America.* Quartz p. 106–146.

LESTER, J. G. (1959) Gem minerals of Georgia. *GA Mineral Newsletter* 12, 3, p. 102–104. Orig. *Emory U. Quart.* 15, p. 160–167, 1959.

McCALLIE, S. W. (1926) A preliminary report on the mineral resources of Georgia. Rev. edit. *GA Geol. Survey Bull.* 23, 164 p., illust., maps.

PRESSEY, M. R. (1981) Amethyst prospecting in Second Appalachian Range. *Lapidary J.* 34, 12, p. 2528-2544, *passim*, illust., map.

SMITH, M. B. (1975) Withlacoochee River agate. *Lapidary J.* 29, 8, p. 1590.

STERRETT, D. B. (1911) Gems and precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1910.* GA amethyst p. 852–853.

ST. JOHN, W. F. (1951) Amethyst mine in a Georgia cotton field. *The Mineralogist* 19, p. 286–288.

TOWER, H. B. (1978) The Savannah River's petrified forest. *Gems & Minerals* 494, p. 32, 33, map.

WHITE, J. S. & COOK, R. B. (1990) Amethyst occurrences in the eastern United States. *Min. Rec.* 21, 3, p. 203–213, illust., map.

WIGGINS, S. L. (1964) Agates still found near Augusta, Georgia. *Rocks & Minerals* 39, 11/12, p. 640.

ZEITNER, J. C. (1968) *Appalachian Mineral and Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. GA p. 109 ff.

FLORIDA. Dall (1915) described the silicified corals and mollusks of the Tampa Bay area and reviewed previous geological studies and mentions of this remarkable silica replacement. The first account of record is that by John H. Allen, in the *American Journal of Science* (ser. 2, vol. 1, p. 38–42) for January 1846. Even at this early date, according to Allen, the silicified corals and shells were well known. Weisbord (1973) grants that the replacements were well known but points out that many of the species were little known, a deficiency that he corrects in his paper, wherein he shows that the vestiges of the original external coral structure, retained in silica, are good enough to identify the species. He also provides an excellent historical summary but this is confined to paleontological matters, and nothing is said about the suitability of the material for lapidary or other purposes. Among the informative papers on the corals are those of Millson (1980), who discusses the theories of formation of the geodes and gives results of X-ray diffraction and X-ray fluorescence studies. He found that iron appeared to be the coloring agent in the reddish (carnelian) chalcedony linings. He also discussed fluorescence and phosphorescence, the formation of dendrites, the many colors found in the geode linings, the shapes of same, the occurrence of cachalong (porous opal), the evidence of marine worm borings, and other topics. As associated mineral species he found calcite, drusy quartz, chalcopyrite, aragonite, and barite. In regard to drusy quartz which sometimes coats chalcedony linings as small, sparkling colorless crystals, he tested a sample of 248 lb (112 kg) of unsorted raw coral geodes purchased from three different dealers and found that only three pounds of specimens contained drusy linings, or only 1.2%; 12 lb were good to excellent material (4.8%), 15 lb were good (6%), 130 lb (52%) fair to poor, 56 lb (22.5%) fit only for tumbling, and 32 lb (13%) were discarded as completely unsuited for any application. So far as I can remember, this is the first statistical analysis of Tampa Bay coral in terms of mineral specimen/lapidary usefulness. Excellent photographs are furnished by Millson, some in color.

Other useful, informative articles are by MacFall (1974) and Zeitner (1979), both providing excellent color photographs of sectioned geodes. An interesting archaeological sidelight on the coral is provided by Gallagher (1982), who writes on the exquisite arrowheads made from this material by the prehistoric inhabitants of Florida.

As of 1975, the size record for a Tampa Bay coral geode is held by one that was found by Arthur and Olive Breu of Saginaw, Michigan, at Ballast Point in 1961 (*Lap. J.*, 1961; Breu, 1975). This spherical growth measures 60 x 66 in (152 x 168 cm) in circumference and weighs about 220 lb (100 kg). The interior is visible and is a "red-amber lining of chalcedony covered with the blue-white solid bubble formation and has the botryoidal solid columns in the center and to one side of the head."

According to Dr. S. Upchurch of the University of Southern Florida at Tampa, the corals were originally composed mostly of calcium carbonate in the form of aragonite, but this mineral is unstable at surface conditions and dissolves away to leave cavities behind in the enclosing limestone that exactly take the form of the dissolved coral. The space is now available for infiltration of silica dissolved in water, which eventually is deposited upon the walls of cavities to form the familiar growths that are seen now (Thompson, *Ibid.*, p. 28).

In describing the Tampa Bay corals, Zeitner (1979, p. 468) notes that "they are, in effect, an entire agatized coral reef, including not only dozens of kinds of corals but also many species of mollusks." The shell casts are generally too small to excite much interest insofar as lapidary material is concerned, although some small, exquisitely detailed types are quite suitable for pendants. Most of them pass into the hands of fossil collectors who esteem them highly. The areal extent of these coral reefs is such that many other places in the region provide silicified remains but they are seldom as beautiful and highly colored as those from Tampa Bay. Some solid coral, generally in blue-gray tones, can be found in dredge material at Honeymoon Island off Dunedin and elsewhere wherever channels have been deepened. Good material has been found at Bailey's Point at the extreme west end of Highway 54 in Pasco County just southwest of New Port Richey (Heusser, 1983). Banks (1959) found silicified coral of a jaspery texture on the L. H. Wear Ranch at Kathleen, just north-northwest of Lakeland, Polk County. Lane (1987) depicts a polished log section of silicified wood taken from a phosphate mine pit in southwest Polk County. In the north, Baxter (1979) described silicified coral from the Suwanee River limestone in the White Springs area, near Lake City, Columbia County. Similar material is also found in another ancient coral reef exposed along the bed of the Ecofina River, west of Perry, Taylor County.

Collecting at Ballast Point has been beset by problems arising from the resentment of local residents who have been bothered by the activities of coral collectors (Thompson, 1991). Access to the digging area is still possible but is rigidly controlled, and in order to find any coral, deep digging in the sand at low tide is necessary. Thompson suggests that the best way to find coral is to visit the shops of dealers who handle the material and buy specimens from them.

BANKS, A. C. (1959) Coral and jasper at Kathleen, Florida. *Gems & Minerals* 257, p. 31, map.

BAXTER, H. & BAXTER, S. (1979) Suwanee River coral. *Gems & Minerals* 497, p. 14, 15, 24–27, illust., map.

BREU, O. (1975) Secrets revealed. *Lapidary J.* 28, 12, p. 1934–1935, illust.

CONRAD, T. A. (1846) Observations on the geology of east Florida. *Amer. J. Sci.* 2, p. 36–48. Coral in Tampa Bay.

COOKE, C. W. & MOSSOM, S. (1929) Geology of Florida. *FL State Geol. Survey 20th Ann. Rept.* 227 p. Tampa Bay coral p. 78–84.

DALL, W. H. (1915) Monograph of the molluscan fauna of the *Orthaulax Pugnax* zone of the Oligocene of Tampa, Florida. *U.S. Nat. Mus. Bull.* 90, 173 p., illust. Much on the coral species, Tampa Bay.

HARRIS, C. W. (1970) Sunshine and rocks in Florida. *Gems & Minerals* 388, p. 30–32, maps. Agate.

HEUSSER, G. (1983) Agatized coral at Bailey's Bluff. *Gems & Minerals* 543, p. 44–45, map.

LANE, E. (1987) Guide to rocks and minerals of Florida. *Fl Geol. Survey Spec. Publ.* 8, rev., 61 p., illust., maps.

LAPIDARY JOURNAL (1961) [220 lb coral head, Tampa Bay.] Vol. 15, 5, p. 579. Reprinted in BREU *above*.

LUND, E. H. (1960) Chalcedony and quartz crystals in silicified coral. *Amer. Mineral.* 45, p. 1304–1307. Tampa Bay.

MacFALL, R. P. (1974) Florida coral-treasure from the sea. *Lapidary J.* 28, 3, p. 490–495, 500, map.

MANCHESTER, J. G. (1941) Collecting semi-precious stones in Florida. *Rocks & Minerals* 16, 12, p. 435–454, illust.

MILLSON, H. E. (1980) Ballast Point agatized coral. *Lapidary J.* 33, 11, p. 2332–2344, *passim*, illust. (col.); 12, p. 2524–2544, *passim*.

PURDY, B. A. (1981) *Florida's Prehistoric Stone Technology.* Gainesville, FL: Univ. Florida, 165 p. Chert & flint.

REAVES, D. (1965) Suwanee River agatized coral. *Lapidary J.* 19, 3, p. 420–422, illust.

ROHN, K. H. (1984) Silicified coral and ancient shells. *Gems & Minerals* 555, p. 36–37, illust. Tampa Bay.

THOMPSON, S. E. (1991) Commando collecting. *Lapidary J.* 45, 6, p. 26–32, illust. (col.), map. Tampa Bay.

VAUGHAN, T. W. (1919) Fossil corals from Central America, Cuba, and Porto Rico, with an account of the American Tertiary, Pleistocene and Recent coral reefs. *U.S. Nat. Mus. Bull.* 103, p. 180–524, illust. Includes Tampa Bay.

WEBSTER, R. (1963) Blue-dyed fossil coral (Tampa Bay, Florida). *J. Gemm.* 9, 4, p. 138.

WEISBORD, N. E. (1973) New and little-known corals from the Tampa Formation of Florida. *FL Geol. Survey Bull.* 56, 146 p., illust.

WILLIAMSON, M. & WILLIAMSON, G. (1955) Agatized coral. *Gems & Minerals* 216, p. 16–19, illust., map.

WILLMAN, L. D. (1963) *Gem and Mineral Localities of Southeastern United States.* Jacksonville, AL: priv. publ., Vol. I, 97 p., map.

______, (1970) *Same*, Vol. II, 271 p., maps.

WOLLIN, J. C. (1970) Dig that coral. *Gems & Minerals* 399, p. 24–26, 42–45; 400, p. 28–30, illust. Tampa Bay.

ZEITNER, J. C. (1968) *Appalachian Mineral and Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. Tampa Bay p. 131–132.

______, (1929) Tampa and Florida, gems and more. *Lapidary J.* 33, 1, p. 468–496, *passim*, illust.

ALABAMA. Cook & Smith (1982) conveniently summarize localities for quartz in this state, noting the suitability of certain types for lapidary work. Chert, chalcedony, and agate, often in colorful specimens, occur in many places southeast of Gurley in Madison County. An attractive agate is found over a large area of Jackson County near Pain Rock River and its tributaries on the Cumberland Plateau near the Tennessee state line; agate is also abundant on Jacobs Mountain and Brigham Mountain (Zeitner, 1968, p. 120). Cuttable banded chert is found in many places in De Kalb County. Silicified wood occurs near Brilliant in Marion County. Agate, chert, and carnelian are found in Blount County. Colorful silicified wood occurs northwest of Vernon in Lamar County near the Mississippi state line. It is also found in Tuscaloosa County, along with agate in gravel beds and strip mines in the Brookwood area, also in stream beds near Tuscaloosa.

Chambers County is noted for its rutilated quartz which has been picked up in float fragments along with phantom quartz on the Garrett Farm, 9.7 km (6 mi) due south of Lafayette and just north of Liberty Crossroads. Similar material is found on the Hinkle Farm, 2 km (1.25 mi) northwest of U.S. Highway 431. Gem quality rutilated quartz occurs widely as float pieces in the Lanett area according to Cook & Smith (p. 228). Both Barwood (1966) and Rohrbach (1989) describe the asteriated blue quartz that is found as fragments in topsoil in Chambers County. Rohrbach notes the remarkable display of asterism in some of the material which "exhibits two unusual features: a strong central floating star and another, satellite star that can be seen as one travels down the leg of each ray, making it multistarred."

Silicified wood is found in Perry, Sumter, Elmore, Macon, Choctaw, and Wilcox counties (Kyte, 1961).

BARWOOD, H. (1966) Gemstones of Lee and Chambers counties, Alabama. *Rocks & Minerals* 41, 10, p. 747.

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120, 285 p., map. Quartz p. 227–231.

FAIRBANKS, E. E. (1946) Unique Alabama petrified woods. *The Mineralogist* 14, p. 121–122.
KYTE, K. (1961) Agates of the Central South. *Lapidary J.* 15, 3, p. 320–325.
PRATT, W. L. (1942) Siliceous oolite near Centreville, Alabama. *Rocks & Minerals* 17, 10, p. 345.
ROHRBACH, R. P. (1989) The stars fell on Alabama. *Lapidary J.* 42, 12, p. 20–28, illust.
WILLMAN, L. D. (1963 & 1970) *See above.*
ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. AL p. 119 ff.

MISSISSIPPI. According to Kyte (1961), silicified wood of lapidary grade has been found in gravel deposits of Jefferson, Claiborne, and Copiah counties in the southwestern quadrant of the state. Kyte also notes silicified wood in Stone and Harrison counties in the extreme southern portion. Rohn (1984) described his collecting in Wayne and Jones counties and finding silicified wood, agate, and jasper in many places where gravel beds were exposed as between the towns of Waynesboro and Laurel along U.S. Highway 84. These accounts suggest that almost the entire lower third of the state offers collecting potential for the quartz gemstones named.

Northwest of Jackson, several miles to the southwest of the town of Flora, Madison County, is located the "only petrified forest in the eastern part of the United States and, in addition, it is regarded as one of the country's finest (Mitchell, 1989, p. 41)." R. J. Schabilion and Family obtained the property in the early 1960s and in 1963 established the Mississippi Petrified Forest as a commercial tourist attraction. The generally brownish, tan, or whitish wood, when sawn and polished, provides interesting lapidary material, but the chief attraction in the forest is the natural accumulation of exposed logs, some of enormous size and 3–7 ft (1–2 m) in diameter. These are exposed along a five-city-blocks-long trail. According to Mitchell (p. 42) "the wood itself is primarily fir, birch, sequoia, and maple." It is all driftwood carried here millions of years ago from some place to the north.

James (1994) discusses the possible origins of the agates which are common in the gravels of the southwestern corner of the state; many of the specimens are of the Lake Superior type.

BROWN, C. S. (1913) Petrified forest of Mississippi. *Pop. Sci.* 83, p. 466–470.
DUKE, C. H. (1961) Some Tertiary fossil woods of Louisiana and Mississippi. Louisiana State U. & Agric. & Mech. Coll., Baton Rouge, *Thesis*, 75 p., illust.
JAMES, E. M. (1994) Mississippi agate. *Rock & Gem* 24, 5, p. 72–75, illust, map.
KYTE, K. (1961) Agate of the Central South. *Lapidary J.* 15, 3, p. 320–325.
MITCHELL, J. R. (1989) Mississippi petrified wood. *Lapidary J.* 42, 12, p. 41, 42, illust.
ROHN, K. H. (1984) Petrified wood and agate in Mississippi. *Gems & Minerals* 557, p. 48–50, illust.
WILLMAN, L. D. (1963, 1970) *See above.*

LOUISIANA. Kyte (1961) describes the agate areas in Louisiana as well as those in adjacent parts of Texas and Mississippi. His "Louisiana banded agate" is said to be "translucent, in various pastel shades, strongly banded, usually of highly irregular shape." Other quartz varieties include sard, carnelian, silicified coral in pale cream, yellow, golden brown, and sometimes in red, colors, silicified crinoid, and opalized and silicified woods. The woods were most abundant in the Sabine and Vernon parishes in west central Louisiana. Palm woods occur in Natchitoches Parish as well as in Grant and LaSalle parishes.

In general, wherever gravel deposits are exposed, it may pay to examine them for quartz gemstones and for wood as recommended by Zeitner (1972), who also found quartz gemstones in other places in the state besides those named above, e.g., in Washington, St. Tammany, and Tangipahoa parishes in the extreme southeastern "toe" of the state next to Mississippi. Zeitner (1988) also draws attention to the fine palm woods of Sabine Parish which is found in "large pieces with few flaws" and is "hard, fine-grained, and easy to cut and polish." The log sections occur in the Eocene Jackson formation, and wherever the formation is exposed one is likely to find wood fragments, although complete log sec-

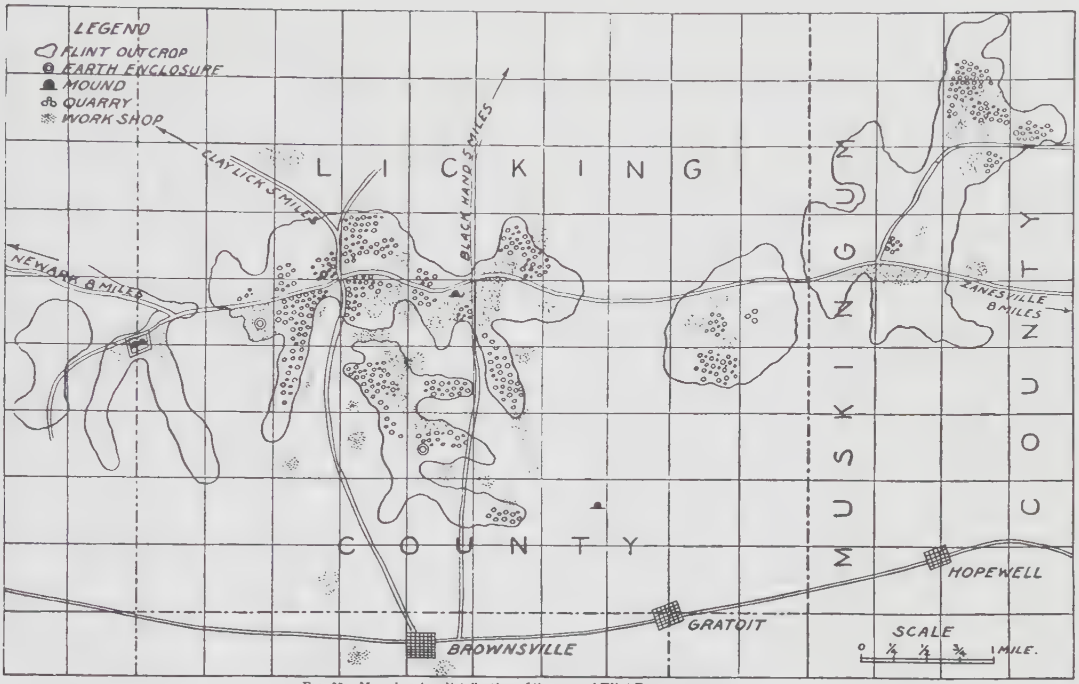


Fig. 56. Map showing distribution of the several Flint Ridge quarry areas.

FIGURE 72. Aboriginal quarries on Flint Ridge. From W. H. Holmes, 1919.

tions which furnish the most attractive specimens when cut and polished are now hard to find and usually call for much digging in likely spots. Zeitner (1988, p. 45) gives high marks to the banded agates found in the same general region as the woods and notes their similarity to Lake Superior agate. Most agates from the southern part of the state are "only pale to colorless" but those from the central and northern regions may be "peach, orange, rust, red, salmon, and brick to charcoal and brown." Locality maps are provided by Zeitner (1972).

COULBOURN, K. (1956) Louisiana full of petrified wood. *Rocks & Minerals* 31, 5/6, p. 238–239, illust.

DUKES, G. H. (1961) *See above.*

KNOWLTON, F. H. (1888) Description of two species of *Palmoxylon,* one new, from Louisiana. *U.S. Nat. Mus. Proc.* 11, p. 89–91, illust.

KYTE, K. (1961) *See above.*

LAPIDARY JOURNAL (1975) Rock hunting in Louisiana. Vol. 29, 3, p. 642.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept. for 1886–87,* part 2, p. 663–960, map. Palm wood, Rapides Parish, p. 881.

WILLMAN, L. D. (1963, 1970) *See above.*

ZEITNER, J. C. (1972) *Southwest Mineral and Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps. LA p. 134 ff.

______, (1988) Louisiana's agatized palm. *Lapidary J.* 42, 4, p. 43–46, illust.

OHIO. In describing the numerous deposits and diggings by Indians for flint on Flint Ridge, Wilson (1898) notes that "this is probably the most extensive and best known of all prehistoric flint quarries in the United States." The ridge lies between Newark, Licking County, and Zanesville, Muskingum County, and extends partly into both counties. Because of its archaeological significance, the Ohio Historical Society established a 525-acre portion of the ridge as the Flint Ridge

State Memorial. In 1968 a museum was built by the society to exhibit the raw material, explain the local geology, and display artifacts made from the flint, with a pamphlet published presenting this information (Ohio, *Educ. Leaflet* No. 6, 1992). According to the sketch map in the leaflet, the Vanport flint formation, yielding most of the useful material, outcrops in many places besides the ridge itself, appearing in isolated patches in nearby Franklin and Hopewell townships of Licking County and toward the east, in very large outcrops in Hopewell Township of Muskingum County.

Elsewhere flint has been quarried in Vinton, Jackson, Coshocton, Hocking, and Perry counties but it is seldom as colorful as the Flint Ridge material. Collecting within the memorial park is forbidden, but Zeitner (1988) shows several places outside the park where good material can be legally collected (p. 87, 88). In addition to the flint, Mitchell (1951) notes occurrences of petrified wood and Bingaman, *et al* (1980) notes quartz varieties as pebbles suitable for tumbling in areas of Lee, Jackson County.

BINGAMAN, A., COPE, D. & BOYER, R. (1980) Rock & mineral collecting sites in Ohio. *Ohio Historical Society, Nat. Hist. Dept., Nat. Hist. Info. Ser.* vol. 5, no. 3, 22 p., maps.

CARLSON, E. H. (1991) Minerals of Ohio. *Ohio Div. of Geol. Survey Bull.* 69, 155 p., illust.

CRAWFORD, B. J. (1973) Flintridge, Ohio. *Lapidary J.* 27, 3, p. 528–532, map.

DELONG, R. M. (1972) Bedrock geology of the Flint Ridge area, Licking and Muskingum counties, Ohio. *OH Div. Geol. Survey Rept. Invest.* 84, map.

HOLMES, W. H. (1919) Handbook of Aboriginal American Antiquities, Part 1, *Bureau of Ethnology Bull.* 60, p. 174.

HUIZING, M. (1977) Every day's a field day at Flint Ridge. *Lapidary J.* 31, 2, p. 574–579, map.

LAPIDARY JOURNAL (1969) Flint: Ohio's official gemstone. Reprint: *Ohio Hist. Soc. Brochure* 23, 4, p. 556–560, col. illust.

MASLOWSKI, A. (1987) Flint in Ohio. *Rock & Gem* 17, 11, p. 22–24, map.

MILLS, W. C. (1921) Flint Ridge. *Ohio Archaeological and Hist. Soc. Quart.* 30, p. 90–161.

MYERS, B. (1977) Stone with character. *Lapidary J.* 30, 12, p. 2720–2722, map.

MITCHELL, R. H. (1951) Petrified wood in Ohio. *Rocks & Minerals* 26, 5/6, p. 253–255, map.

OHIO, DIVISION OF GEOLOGICAL SURVEY (1992) Flint: Ohio's official gemstone. *Educ. Leaflet* No. 6, 3-panel folder, col. illust.

RILEY, M. S. (1947) Flint Ridge, Ohio. *Rocks & Minerals* 22, 8, p. 710–713.

ROBART, V. J. (1957) Gem flint from Ohio. *Lapidary J.* 11, 1, p. 28, 30.

SMITH, C. M. (1885) Sketch of Flint Ridge, Licking County, Ohio. *Smithson. Inst. Ann. Rept. for 1884*, p. 851–873.

STOUT, W. & SCHOENLAUB, R. A. (1945) The occurrence of flint in Ohio. *Geol. Survey OH, 4th Ser. Bull.* 46, 110 p., illust.

WILSON, T. (1899) Arrowpoints, spearheads, and knives of prehistoric times. *U.S. Nat. Mus. Ann. Rept. for 1898*, part 1, p. 868–876.

ZEITNER, J. C. (1988) *Midwest Gem, Fossil, and Mineral Trails: Great Lakes States.* Pico Rivera, CA: Gem Guides Book Co., 96 p., illust. maps.

INDIANA. According to Erd & Greenberg (1960), quartz is abundant in the state but gem material as agate is common only in the geodes of the Edwardsville formation. Zeitner (1964, 1988) mentions occasional finds of agate, chert, etc., in gravel beds.

ERD, R. C. & GREENBERG, S. S. (1960) Minerals of Indiana. *IN Geol. Survey Bull.* 18, 73 p. Quartz p. 47.

ZEITNER, J. C. (1964) *Midwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 80 p., illust., maps.

______, (1988) *See above.*

WEST VIRGINIA. Zeitner (1968) reports many places where quartz varieties are found in this state, some of which, notably the silicified coral of Pocahontas County, provide colorful cabochon material. Localities are also given for silicified wood which is generally found in gravel deposits or stream beds in Wetzel and Kanawha counties.

ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. WV p. 57–62.

KENTUCKY. Colorful banded agate, said to be distinctive in its patterns and coloration, has been found on private lands in undisclosed places in Estill County (Johnson, 1976). Also described is a varved sandstone which when cut across the proper direction displays beautiful curved bands from infiltrated iron oxides (?). This material is found near Mt. Vernon. Settles (1981) recommends searching for agates in creek beds of the Knobs region in Powell, Estill, Jackson, Madison, and Rockcastle counties.

Ward (1889) mentions coniferous petrified wood from Lower Devonian strata near Lebanon, Marion County, where it "is found in very large quantities between Lebanon and the foot of the 'Knobs,' at a distance of about three or four miles from the latter." Rohn (1984) also notes silicified palm wood found in gravels and associated with quartz-lined geodes in the London area of Laurel County. Zeitner (1968) notes petrified wood in Hart, Lyon, and Graves counties.

HELTON, W. L. (1964) Kentucky's rocks and minerals. *KY Geol. Survey Bull.* 9.

JOHNSON, W. S. (1976) Whoever heard of Kentucky agate? *Lapidary J.* 30, 7, p. 1728–1730. Estill County.

RICHARDSON, C. H. (1925) The mineralogy of Kentucky. *KY Geol. Survey*, 6th ser., vol. 27, 127 p.

ROHN, K. H. (1984) Bluegrass geodes. *Gems & Minerals* 559, p. 28–31, illust.

SETTLES, S. (1981) Kentucky agate portfolio. *Rocks & Minerals* 56, 3, p. 128–129.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept. for 1886-87*, part 2, p. 663–960, map.

ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. KY p. 63–67.

TENNESSEE. A considerable variety of agates are found in this state, principally in a broad band of counties that lie between Nashville and Chattanooga. According to Owens (1962), they are (from north to south): Overton, Smith, Putnam, DeKalb, White, Rutherford, Cannon, Warren, Bedford, Coffee, Lincoln, and Franklin. However, Owens (1980) states that the main occurrences are in Bedford County and in the adjacent counties of Rutherford, Williamson, Marshall, Lincoln, Moore, and Coffee. This considerably broadens the region in which agates may be found and one may assume that the entire central one-third of the state is potentially productive, quite aside from the Lake Superior type agates that will be found in the Mississippi Valley gravels of western Tennessee. Details on areas to search are found in Zeitner (1968). Austin (1991) recently summarized national gemstone production noting agates from Hawkins County, agatized oolite from Greene County, carnelian, blue, ivory, pink, faintly-banded, dendritic, moss, iris, and "Fairburn" type agates from Bedford County as well as the Lake Superior type, and agatized shells, corals, and sponges from Shelby County. Owens (1980) has also found petrified wood in the gravels of the Tennessee River from Mississippi to Kentucky. Other specimens have been found in the valleys of the Duck River and Elk River.

AUSTIN, G. T. (1991) Gemstone production in Arizona . . . and Tennessee. *U.S. Bur. Mines Min. Industry Surveys, Advance Summ. Rept.*, 35 p. TN p. 19–21.

OWENS, V. S. (1962) Carnelian and iris bonanza in Tennessee. *Lapidary J.* 16, 1, p. 46, 48–55, illust., map.

_____, (1964) Guide to the agate fields of Bedford Co., Tennessee. *Ibid.* 18, 1, p. 154–162, map.

_____, (1966) Some fossil corals of Tennessee. *Ibid.* 20, 4, p. 514–518, illust.

_____, (1974) Paint Rock agate. *Ibid.* 28, 8, p. 1218–1236, *passim*, illust.

_____, (1976) Calf Killer agate. *Ibid.* 30, 6, p. 1394–1402, *passim*, maps.

_____, (1980) The agates of Tennessee. *Ibid.* 34, 7, p. 1524–1531.

OWENS, W. H. (1978) Elk River agate. *Rock & Gem* 8, 5, p. 44–48.

_____, (1984) Greasy Cove treasures. *Ibid.* 14, 10, p. 32–36.

WILLMAN, L. D. (1963, 1970) *See above.*

ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. TN p. 68–75.

MICHIGAN. The principal agate type found in this state is the Lake Superior agate which has been previously discussed and will be given no further remarks here. Next in importance among quartz gemstones is jaspilite, a metamorphic rock whose vivid red colors are owing to the presence of very finely divided hematite, and whose silver bandings which appear so well in polished sections are owing to more or less solid masses of hematite in the flaky form known as specularite. Polishing to near perfection is usually difficult because the solid streaks and bands of black hematite tend to pluck out and leave behind small cavities. However, when perfectly polished, jaspilite specimens are quite spectacular! Early geological reports on the iron districts of the state sometimes depicted such polished sections as in Van Hise (1896) where Plate 114 shows two fine polished slabs in full color from the best-known occurrence at Jasper Bluff, Ishpeming, Marquette County. This material is likely to be present in many other iron ore deposits in Michigan's Upper Peninsula iron ranges (Zeitner, 1988). Numerous localities are also given by Heinrich (1976).

BROCKETT, B. O. (1973) Rock, gems, and minerals of Michigan's Iron Country. *Lapidary J.* 27, 4, p. 640–648, *passim*, illust., map.

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Bull.* 6, 225 p., illust. Quartz p. 179–183.

KOELNAU, L. A. (1939) Lake Superior jaspers. *The Mineralogist* 7 11, p. 437–438.

LUOMA, H. L. (1947) Chrysocolla in conglomerate, Michigan. *The Mineralogist* 15, p. 286–288.

ROHN, K. H. (1983) Five Mile Rock and beyond. *Gems & Minerals* 551, p. 32–34, illust., map.

VAN GORDER, L. K. (1975) They call them map agates. *Gems & Minerals* 455, p. 65, 76, illust.

VAN HISE, C. R. (1896) Principles of North American Precambrian geology. In *U.S. Geol. Survey 16th Ann. Rept.*, part 1, p. 571–843, illust., map.

VAN HISE, C. R. & LEITH, C. K. (1911) The geology of the Lake Superior region *U.S. Geol. Survey Mono.* 52, 641 p., illust., maps.

ZEITNER, J. C. (1988) *Midwest Gem, Fossil and Mineral Trails, Great Lakes States.* Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps. MI p. 52–69.

MINNESOTA. The Lake Superior agates from this state are discussed in a special section (*see* Lake Superior Agates). Occurrences of silkstone, "binghamite," and other tigereye-like forms of massive quartz are described by Zeitner (1988) and others as shown in the below references. Zeitner draws attention to the jaspilites which are found abundantly in the metamorphic rocks of the Mesabi Range that run in a northeast-southwest direction through the center of St. Louis County and adjoining Itasca County. One of the most vividly colored varieties is called Mary Ellen jasper because it comes from the mine of the same name near Biwabwik, St. Louis County. Judy Owyang of Fossils/Etc. of Venice, California, offers this bright orangey-red jasper that takes a perfect polish as "one of the oldest known rock materials of North America and one of Earth's oldest fossil remains"; it is an algal structure (stromatolite) identified as *Collenia sp.*, originally the blue-green algae Cyanobacteria (*Pers. comm.* 2/94), dated to the Late Precambrian (Proterozoic) period. Another source of Mary Ellen jasper is the Corsica Mine at McKinley. One of the attractive features of this jasper is the delicate banding which is typical of algal growth providing patterns reminiscent of the "peacock" pattern seen in handmade marbled papers but here forever preserved in stone. Zeitner *(Ibid.)* notes other colors in this and other iron formation jaspers.

A coarser but colorful red quartzite of unusual compactness from Pipestone County "is to be highly recommended for ornamental trimming," according to Bowles (1918, p. 203), who deems it to be "one of the most beautiful and durable stones in the state." This material occurs in beds that are only 8–10 in (20–23 cm) thick near Pipestone and Jasper (Dahlberg, 1982; Thiel & Dutton, 1935) but as such it is entirely suitable for plaques, lamp bases, bookends, and the like. This same formation was quarried extensively for ornamental rock just to the west in South Dakota.

BOWLES, O. (1918) The structural and ornamental stones of Minnesota. *U.S. Geol. Survey Bull.* 663, 225 p., illust., maps.

DAHLBERG, J. C. (1975) Silkstone. *Lapidary J.* 29, 1, p. 62, 64, 66.

______, (1977) Hunt rocks in the land of many waters. *Ibid.* 31, 1, p. 432–435, illust.

______, (1982) Take another look at Minnesota's rocks. *Ibid.* 36, 1, p. 66, 67, 70, 72, illust. (col.).

HILL, R. (1978) Tigereye and its kissing cousins. *Gems & Minerals* 493, p. 16–19, 48, 50, 51, 94–96, illust. Includes U.S. types.

INGALLS, N. (1988) Mesabi Range agates. *Rock & Gem* 18, 1, p. 68–71, map.

KAMMERER, J. J. (1989) Binghamite and silkstone. *Lapidary J.* 43, 2, p. 50–53, illust. (col.).

LULLING, R. (1956) Silkstone. *Gems & Minerals* 224, p. 28, 29. Discovery.

McATEE, F. (1954) I bought 42 acres of a volcano's graveyard. *Rocks & Minerals* 29, 7/8, p. 367–367. Grand Marais agate.

RAPP, G. R. & WALLACE, D. T. (1979) Guide to mineral collecting in Minnesota. 2nd edit. *MN Geol. Survey Educ.* Ser. 2, 45 p.

ROHN, K. H. (1980) A Mesabi Range field trip. *Gems & Minerals* 513, p. 36–39.

SIDLA, A. A. (1956) Minnesota agates. *Rocks & Minerals* 31, 11/12, p. 599.

THIEL, G. A. & DUTTON, C. E. (1935) The architectural, structural and monumental stones of Minnesota. *MN Geol. Survey Bull.* 29, 160 p., illust.

WATTS, A. M. (1979) Agates, amethyst, and thomsonite. *Lapidary J.* 32, 12, p. 2660–2666, illust.

ZEITNER, J. C. (1988) *Midwest Gem, Fossil and Mineral Trails. Great Lakes States.* Pico Rivera, CA: Gem Guides Book Co., 96 p., illust., maps.

ILLINOIS. Lake Superior agates have been found in many gravel beds along the Mississippi River from near Galena, East Dubuque, and Blanding in the north, to almost the southern tip of the state (Zeitner, 1988). Agates and silicified coral are found at Pontoon Beach in Madison County, with similar material from near Grand Tower in Jackson County and in Alexander County. Silicified coral has been collected in Hardin County.

ILLOWA GEM & MINERAL SOCIETY (1970) *Field Tripping in Illowa Territory*. Davenport, IA: publ. by the soc., [42 p.], maps.

WATTS, A. M. (1982) Glacial legacy. *Lapidary J.* 35, 10, p. 2056–2063, illust.

ZEITNER, J. C. (1988) *See above.*

IOWA. In earlier times, Iowa was noted for its relative abundance of Lake Superior agates found everywhere in the gravels of the Mississippi River Valley (Muilenberg, 1914; Kennedy, 1948; Zeitner, 1964). These agates are most conveniently collected at gravel mining pits or other places where gravel is being excavated for construction purposes.

In Franklin County, geodes are sometimes filled with white and yellow botryoidal chalcedony, especially from near Chapin and along Bailey's Creek. Beautiful banded agate, often displaying layers of red, orange, white and gray, occurs in geodes in the Lower Keokuk limestone/chert in quarries near Keswick, Ollie, and Harper, Keokuk County (Burry, 1979). This material is called "coldwater agate" locally and is prized because of its fine colors and its ability to take an excellent polish (Menzel & Pratt, 1962, 1968; Broughton, 1972). A similar agate is found in geodes and in chert nodules along the bluffs of Cedar River in northeast Benton County but most of it displays only gray and white bandings. Geode agate is also found in stream beds of the Manchester and Delhi areas of Delaware County.

Carnelian has been found in gravels of the Des Moines River from Des Moines downstream, and in a gravel pit on the west side of Skunk River near Rome. Silicified wood, much of it black, brown, and gray, and sometimes streaked with white, was noted by Ward (1889) in the Keokuk area, also near Estherville, Emmet County, and from the strip coal mine beds in the vicinity of Pella, Marion County. Petrified wood occurs at various places in Palo Alto County.

Cherts of lapidary quality, generally grayish, whitish or brownish, occur in many places in the limestone and dolomite formations of eastern Iowa. An unusual kind of black chert containing white fusulinid fossils is found in the Plattsmouth limestone quarries near Grant and Stennett in Montgomery County and is aptly named "rice agate" in allusion to the color, shape, and size of the fossil inclusions. Another name given to this variety is "protozoa agate." An attractive light to dark gray banded chert, occasionally red-banded, is found in the St. Louis formation near Humboldt and in quarries near Mt. Pleasant, Henry County. The Mt. Pleasant quarries and the beds of Big Creek in southern Henry County, also Cedar Creek in Jefferson County, yield silicified *Lithostrotian* colonial corals which are sometimes handsomely streaked with red and orange patches and nicely display the coralline structure when cut across the growth columns and polished; handsome cabochons have been made from this material (Menzel, 1970).

BROUGHTON, P. L. (1972) Iowa's Kaser Quarry. *Gems & Minerals* 418, p. 30–31, map. Agate.

BURRY, G. A. (1979) Autobiography of an Iowa agate lover. *Lapidary J.* 33, 6, p. 1312–1324, *passim.*

HORICK, P. J. (1974) The minerals of Iowa. *IA Geol. Survey Educ.* Ser. 2, 88 p., illust. (col.).

ILLOWA GEM & MINERAL SOCIETY (1970) *See above.*

KENNEDY, H. (1948) Agate hunting trip to Bellevue, Iowa, August, 1947. *Rocks & Minerals* 23, 9/10, p. 808–809, illust., map.

MENZEL, M. & PRATT, M. (1962) Coldwater agate—new Iowa material. *Lapidary J.* 16, 5, p. 532, 533, illust.

______, (1968) Iowa's Coldwater agate. *Gems & Minerals* 374, p. 25–27, illust., map.

MENZEL, M. (1970) Iowa's pink coral. *Lapidary J.* 24, 9, p. 1192, illust. (col.)

MUILENBERG, G. A. (1914) On the occurrence of precious stones in the drift [of Iowa]. *IA Acad. Sci. Proc.* 21, p. 203–204.

MUSGROVE, J. M. (1962) Gems, minerals, and fossils of Iowa. *Gems & Minerals* 294, p. 24–25, 53–54, illust., map.

MUSGROVE, J. W. & MUSGROVE, M. R. (1962) Iowa fossils as cutting material. *Gems & Minerals* 297, p. 26–27. Silicified corals.

PACHA, R. J. (1966) Iowa has its rock treasures. *Lapidary J.* 20, 9, p. 1050–1058, *passim*, illust.

PRATT, M. & MENZEL, M. (1964) The Coldwater agate of Iowa. *Gems & Minerals* 317, p. 16–17.

______, (1965) Iowa has something for everyone. *Ibid.* 334, p. 14–19, illust., maps.

ROHN, K. H. (1985) Coldwater agate and fossils. *Gems & Minerals* 577, p. 38–43, map.

ROSE, J. N. (1967) The fossils and rocks of eastern Iowa. *IA Geol. Survey*, Educ. Ser. 1, 147 p., illust., maps.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept. for 1886-87*, part 2, p. 663–960, map.

ZEITNER, J. C. (1964) *Midwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 80 p., illust., maps. IA p. 47–53.

______, (1989) *Midwest Gem, Fossil and Mineral Trails: Prairie States.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

MISSOURI. Smith (1977) provides the best description of Missouri's colorful chert, known locally as "mozarkite," a name derived from the name of the state and the Ozark Mountains of central Missouri where the chert abounds. In general, the chert occurs mostly in the cluster of counties that extend from Howard on the north to Dade in the southwest, then eastward to Pulaski County. Chert is also found in Pike and St. Louis counties. However, most finds are concentrated in just a few counties: Lincoln, Benton, and Missouri. Smith *(Ibid.)* states that "mozarkite is more plentiful in the Lincoln area than any other area of the state." A valuable feature of Smith's article is his historical review taken from Colonial times forward to when the rock was named the Official Rock of the state of Missouri by the 74th General Assembly in 1967.

In regard to size of chert masses, Smith *(Ibid.)* notes that it occurs in nodular forms and in geodes as well as in large irregular masses which may weigh up to 500 lb (225 kg) and measure over 2 ft (0.7 m) in diameter.

Another colorful Missouri material is lace agate which occurs in Washington County near Washington State Park where all the creek beds and soil exposures should be examined for the agate masses that weather from the dolomitic rocks of the Upper Potosi and Lower Eminence formations (Smith, 1976, 1982). Most commonly the fine, intricate bandings are whitish or grayish but most specimens show some red banding; other colors are known. Far more colorful than any of the above, and indeed vying for honors as some of the finest agates in the nation, are those that have been found as linings and fillings in cherty nodules that occur in the Union Road area of southern St. Louis County, and are accordingly known as Union Road agate (Smith & Meyer, 1976). The location is in an east-west belt of about 1.5 mi (2.4 km) in length that stretches between Highway I-55 on the east to just beyond Von Talge Road on the west. Unfortunately, the bed containing these beautifully banded colorful agates is "about 35 feet [11 m] below the local terrain," thus making the agates available for collecting only when excavations are initiated. However, as William Thies, a specialist collector of these agates from St. Louis, remarks, "the stones aren't always present, but sometimes when blasting lays bare the bedrock 35 feet or so below the surface, geodes might be sprawled everywhere," (*Lapidary J.*, 1993). The agates are of the fortification type and richly colored with "at least three colors" present in every specimen. The structure of a nodule is typical: an outer layer, sometimes quite thick, of cherty material, then a lining of fortification agate wholly or partially filling the interior. All of it polishes well, especially the agate, and most nodules are saved as cabinet pieces rather than cut up for cabochons.

BROADHEAD, G. C. (1873) Notes on such rocks of Missouri as admit of a fine polish. *MO Geol. Survey, Prelim. Rept., Iron Ores and Coal Fields for 1872*, part 2, p. 414–415.

GILLIAM, J. (1976) Collecting that colorful mozarkite. *Rockhound* 5, 6, p. 19, map.

HALL, R. D. (1963) Agates and jasper in Missouri. *Gems & Minerals* 312, p. 24–26. Crowley's Ridge.

HOVEY, E. O. (1894) Microscopic structure of siliceous oolite. *Geol. Soc. Amer. Bull.* 5, p. 627–629.

______, (1894) A study of the cherts of Missouri. *Amer. J. Sci.* 48, p. 401–409.

KELLER, W. D. (1945) The common rocks and minerals of Missouri. *Univ. Missouri Bull.* 46, 5, 78 p. Rev. edit.: *Bull.* 62, no. 27, *Missouri Handbook* No. 1, 78 p.

KISSICK, R. (1956) A new Missouri locality. *The Mineralogist* 24, p. 216, 218, 220. Agate.

LAPIDARY JOURNAL (1993) Facets. Vol. 47, 8, p. 8.

MORRISON, L. M. (1978) Ohians hunt in Missouri. *Lapidary J.* 32, 5, p. 1136, 1137, illust.

OZMENT, C. M. (1966) Beautiful banded agate found at St. Louis, Missouri. *Lapidary J.* 20, 1, p. 106–107, illust. (col.).

SMITH, W. D. (1976) Missouri's lace agate. *Lapidary J.* 29, 11, p. 2070–2072, illust., map.

SMITH, W. D. & MEYER, E. (1976) Missouri's Union Road agate. *Ibid.* 29, 12, p. 2264–2270, illust., map.

SMITH, W. D. (1977) "Mozarkite"—Missouri's legendary gem. *Lapidary J.* 31, 1, p. 160–168, *passim*, illust., maps.

______, (1982) Missouri lace agate, a colorful agate from Washington County. *Lapidary J.* 36, 1, p. 90, 92, map.

ZEITNER, J. C. (1964, 1989) *See above.*

ARKANSAS. The major quartz gemstone in this state remains the rock crystal which occurs in openings in quartz veins penetrating sandstones (mostly) in Saline, Garland, and Montgomery counties. There are scattered occurrences in Pike, Polk, Howard, and Sevier counties. Taken together, these deposits fall within a broad belt that extends about 135 mi (217 km) from close to Little Rock in the east to near the border with Oklahoma in the west and into that state to near Broken Bow. According to Howard & Stone (1988), the milky quartz veins and associated minerals are hydrothermal deposits within deformed and fractured host rocks of Paleozoic age. Most veins are narrow but some may be as much as 60–100 ft (20–30 m) across. The veins often contain very small amounts of adularia, chlorite, calcite, dickite, rectorite, pyrophyllite, and cookeite. Leiper (1966) described inclusions of some of these species in otherwise clear quartz crystals, sometimes forming attractive phantoms. Howard & Stone *(Ibid.)* mention the enormous size that some crystals and crystal-covered slabs attain, e.g., single crystals up to 5 ft (1.5 m) long and weighing over 400 lb (180 kg), and cavity linings up to 15 ft (4.5 m) long and weighing over 5 tons. However, by far the largest quantity of crystals occur as singles less than 10 in (25 cm) long and 2 in (5 cm) in diameter. Howard & Stone *(Ibid.)* state that "reserves of quartz in the Ouachita Mountains are impossible to calculate, but with the limited area mined to date and the difficulty in prospecting for suitable deposits, it is logical to

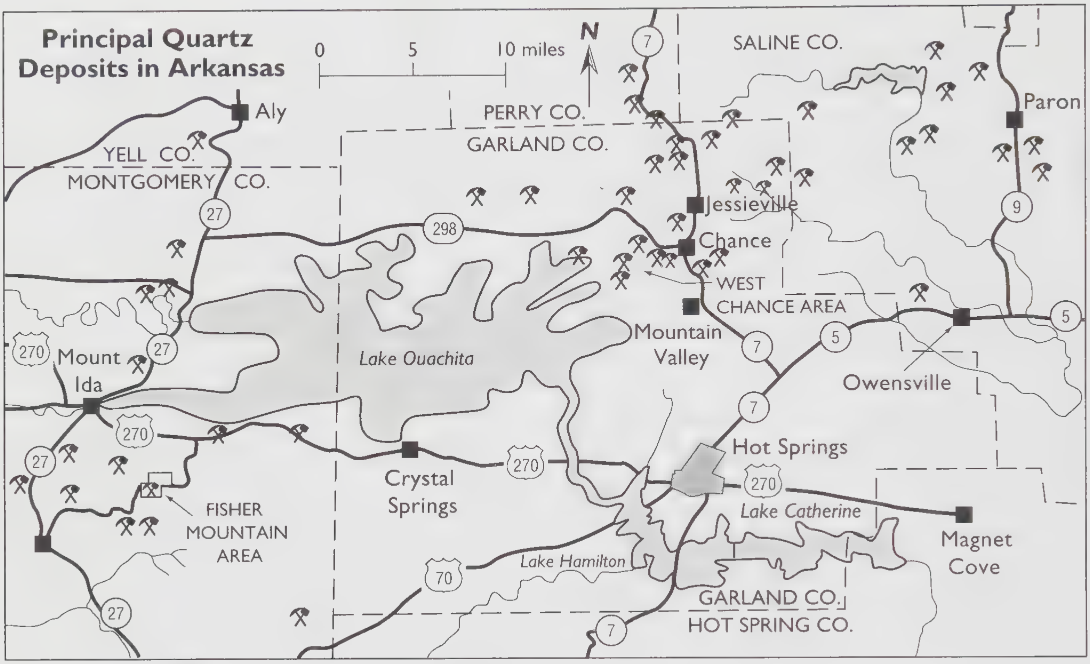


FIGURE 73. Distribution of quartz crystal deposits in Arkansas.

assume that only a small percentage of the potential reserves has yet been mined." In 1967, the Arkansas General Assembly, via Act 128, designated quartz crystal as the Official State Mineral.

The mining and sale of crystals received its greatest impetus in the 1980s when quartz "points" were much in demand for their supposed healing virtues when touched to the body at designated vital intersections or "chakras." At this time, the better terminations, called "jewelry points," of one inch (2.5 cm) or less, bright and clear and sharply-faced, fetched as much as $200/lb ($440/kg). Larger "candle point" crystals, less common by far, with a length-to-width ratio of about 7:1, especially if mined from the Collier Creek and High Peak areas of Garland County, fetched prices into the dozens of dollars per piece and sometimes into the hundreds of dollars if deemed particularly fine! (*Pers. comm.*, Rock Currier, 1993). Undamaged groups of splendid clear crystals sometimes brought prices in the thousands of dollars. In the early 1990s, however, prices generally fell as the "healing" fad lost adherents. Small crystal clusters of 1/4-inch to 4-inch points sold wholesale for $3.00 to $60.00 per pound. Single points, much favored for charms in pendants, and ranging in length from one inch or less to 4 inches, fetched prices from $5.00 to $60.00 per pound wholesale, while the newer irradiated smoky quartz crystals sold for $9.00 to $13.00 per pound wholesale. Single crystals of large size and unusual perfection brought as much as $200.00 per pound wholesale.

In regard to financial success in quartz mining, Howard's 1990 publicity brochure provides a schedule of typical daily fees charged for digging at various properties; these range from $2.00 (Ocus Stanley, Mt. Ida) to $20.00 (Ron Coleman, Jessieville). Most mines also sold quartz crystals and groups, and considerable quartz not suitable for any of the purposes mentioned above was sold as silica raw material (lasca) to chemical and glass industries (Howard & Stone, 1988).

In June 1989, the U.S. Forest Service, supervisors of most of the quartz-bearing land, held the first auction for rights to explore and mine for quartz on certain parcels of land in the Ouachita National Forest (*Paris Express/Progress*, AR, July 12, 1989). Seventy-six bids were received for 46 parcels on 5-year contracts, totaling $18,463.91, as of June 27, 1989. Half of the money from the receipts passes to the state for public works projects within the forest. Rigid control of mining is exercised and all lands must be restored to previous configurations after mining ceases.

Elsewhere in Arkansas, attractive banded chert is found in the Cotter formation in northern Marion County, while in Baxter County chert occurs in fractured nodular masses up to about 8 lb (3.6 kg) in alluvium derived from the weathering of the host sedimentary rocks. This material takes a good polish and has been used for cabochons. Dodson & Dodson (1924) mention chert on Crowley's Ridge around Wynne and Colt, and west of Cushman in Independence County. Holbrook & Stone (1979) delineate areas in the border region of Arkansas/Oklahoma where novaculite is found; some is quite colorful and has been used in larger lapidary objects. Attractive, well-banded translucent amber to dark brown agate occurs as fracture fillings up to 5 cm (2 in) thick in pyroxenitic ores of the East Wilson Pit vanadium mine located near Potash Sulphur Springs, Garland County, at a place about 5 mi (7.8 km) west of Magnet Cove (Howard & Owens, 1995, p. 166). A color photo shows that

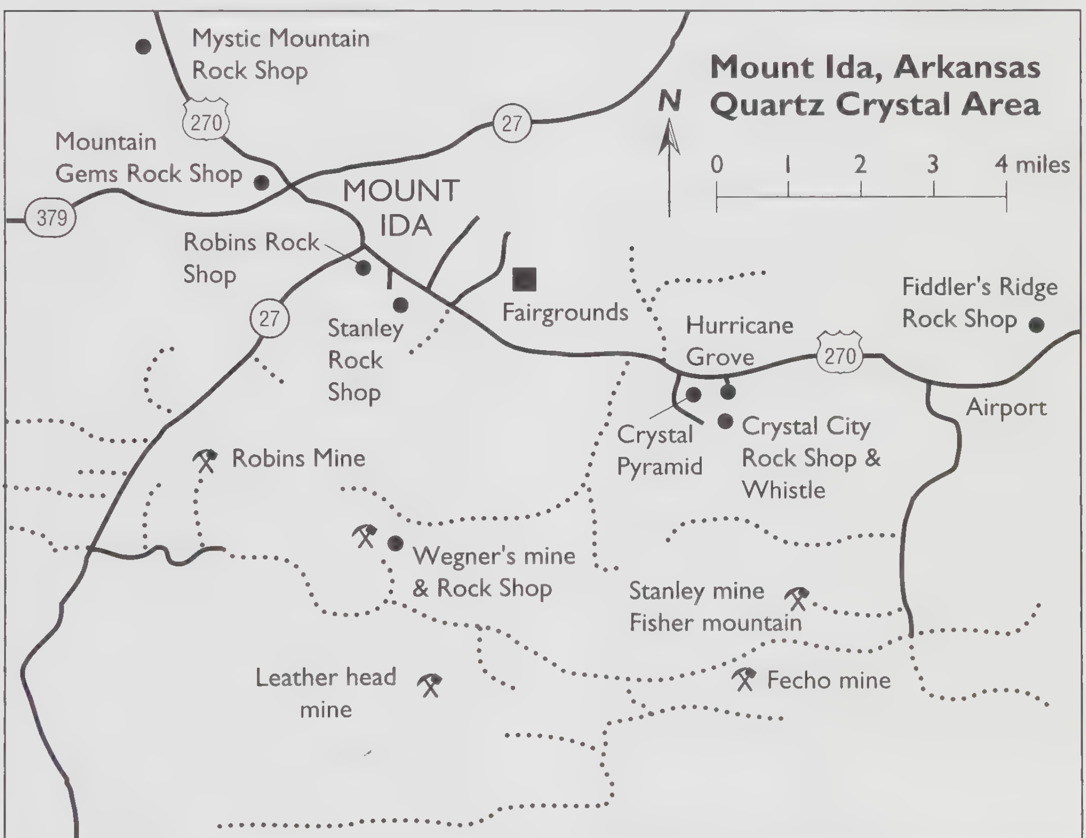


FIGURE 74. Quartz crystal mines and dealer shops in the Mount Ida area of Montgomery County, Arkansas.

the agate is obviously suitable for cabochon work.

BROUGHTON, P. L. (1974) Arkansas' fabulous High Peak quartz clusters. *Gems & Minerals* 440, p. 22–23, illust.

_____, (1974) Rock crystal clusters from Coleman Crystal Mine, near Hot Springs, Arkansas. *Lapidary J.* 28, 4, p. 724–728, illust.

BURROW, D. (1983) Arkansas quartz crystal mining. *Lapidary J.* 36, 10, p. 1758–1760, illust. Written by a mine operator.

CALL, R. E. (1891) The geology of Crowley's Ridge. *Geol. Survey AR Ann. Rept. for 1889*, vol. 2, p. 1–223, maps.

_____, (1891) The Tertiary silicified woods of eastern Arkansas. *Amer. J. Sci.* 42, p. 394–401; *IA Acad. Sci. Proc.* 1, 2, p. 37–43, 1892.

DODSON, D. & DODSON, S. (1974) *Rockhounding in Arkansas.* Little Rock, AR: The Dodsons, 47 p., illust., maps.

ENGEL, A. E. J. (1946) The quartz crystal deposits of western Arkansas. *Econ. Geol.* 41, p. 598–618, illust.

_____, (1952) Quartz crystal deposits of western Arkansas. *U.S. Geol. Survey Bull.* 973-E, 260 p., illust., maps. Definitive work.

GRISWOLD, L. S. (1890) The novaculites of Arkansas. Abstr.: *Amer. Assoc. Adv. Sci. Proc.* 39, p. 248–250.

_____, (1892) Whetstones and the novaculites of Arkansas. In *Ann. Rept. Geol. Survey AR for 1890*, vol. 3, 443 p., illust.

HOLBROOK, D. F. & STONE, C. G. (1979) Arkansas novaculite—a silica resource. AR Geol. Comm., from *OK Geol. Survey Circ.* 79, 1978, 8 p., illust., map.

HOLMES, W. H. (1891) Aboriginal novaculite quarries in Garland County, Arkansas. *Amer. Anthropologist*, Oct., p. 313–316, illust.

_____, (1919) Handbook of aboriginal American antiquities. Part 1, Introductory, the lithic industries. *Smithsonian Inst. Bur. Ethnol. Bull.* 60, 380 p., illust., maps. Arkansas novaculite p. 196–200.

HOWARD, J. M. & OWENS, D. R. (1995) Minerals of the Wilson Springs vanadium mines, Potash Sulphur Springs, Arkansas. *Rocks & Minerals* 70, 3, p. 154–170, illust. (col.), map.

HOWARD, J. M. & STONE, C. G. (1988) Quartz crystal deposits in the Ouachita Mountains, Arkansas and Oklahoma. In *Proc. 22nd Forum on Geol. of Industrial Minerals*, G. W. Colton, ed., 115 p., *AR Geol. Comm. Misc. Publ.* MP-21, p. 63–71.

HOWARD, J. M. (1990) *Arkansas Quartz Crystals.* Brochure of 8 panels, illust., issued by AR Geol. Comm., map.

JENNEY, W. P. (1891) Ancient novaculite mines near Magnet Cover, Hot Springs County, Arkansas. *Amer. Anthropologist*, Oct., p. 316–318.

LEIPER, H. (1966) Arkansas' brilliant rock crystal ranks with the world's finest. *Lapidary J.* 20, 7, p. 804–817, *passim*, illust. (col.).

McCARTHY, C. (1992) Point for point. *Lapidary J.* 46, 6, p. 55–60, illust.

MISER, H. D. & PURDUE, A. H. (1929) Geology of the DeQueen and Caddo Gap quadrangles, Arkansas. *U.S. Geol. Survey Bull.* 808, 195 p., illust., maps. Quartz crystals & novaculite.

MISER, H. D. (1943) Quartz veins in the Ouachita Mountains of Arkansas and Oklahoma. *Econ. Geol.* 38, p. 91–118, illust.

MITCHELL, J. R. (1984) Quartz crystals of Arkansas. *Gems & Minerals* 562, p. 8, 9, 26, 27, map.

RODGERS, F. (1967) Giant Arkansas quartz. *Gems & Minerals* 360, p. 28, 29.

RUTLEY, F. (1894) On the origin of certain novaculites and quartzites. *Geol. Soc. London Quart. J.* 1, p. 377–392. U.S. varieties included.

SELBERT, P. (1993) Hexagon heaven. *Lapidary J.* 47, 5, p. 75–81, illust.

TOWNER, J. M. (1971) Quartz crystal hunting, Crystal Peak, Arkansas. *Lapidary J.* 25, 1, p. 116–120, illust.

_____, (1975) Quartz crystals, Mt. Ida, Arkansas. *Ibid.* 28, 10, p. 1552–1555, illust., maps.

WALKER, D. & WALKER, C. (1989) Digging quartz. *Lapidary J.* 43, 9, p. 89, map.

WILSON, M. M. (1988) Arkansas's other diamonds. *Lapidary J.* 42, 3, p. 69–70, illust.

WRIGHT, C. (1977) Arkansas, land of quartz. *Lapidary J.* 31, 1, p. 188–196, *passim*, illust.

ZEITNER, J. C. (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps. AR p. 114–133.

NORTH DAKOTA. Ward (1889, p. 902–903) noted that explorers before his time had recognized abundant silicified wood found "for a distance of twenty or thirty miles over an open prairie upon the west bank of the Missouri River and a few miles below its junction with the Yellowstone near latitude 48°." This area still produces wood and is now in McKenzie County southwest of Williston in the extreme western part of the state. The gravel bars of the rivers in this area yield Montana-type moss agates and other silica gemstones. However, much of the formerly productive ground is now beneath the water of Lake Garrison (Missouri River).

Much of the central and western portions of the state present collecting opportunities for silicified woods, agates, jaspers, and even agates of the Lake Superior type. Especially recommended are the gravels of the Red River and the Cannonball River (Zeitner, 1964). Other possible sources of material are in gravel deposits which represent the former shorelines of ancient Lake Agassiz. In the Badlands of the west, especially in McKenzie County, wood is found along the Little Missouri River Valley and also is abundant in Hettinger County along the Cannonball River Valley (Kennedy, 1970). In Grant County, fine agatized sequoia cones are found in the Hell Creek formation near the junction of Cannonball River and Cedar Creek. Petrified wood, generally black in color, is found along the lower Sheyenne River in Ransom County, and is notable for containing conspicuous teredo borings whose openings are filled with amber-colored chalcedony. Much of this wood has been collected in the Bismarck-Mandan area and is officially designated the North Dakota State Fossil (Dahlberg, 1977). The latter author also describes pioneer prairie homes whose walls were made of "logs" of petrified wood with the rough exteriors plastered smooth. Near Belfield, Stark County, the North Dakota Highway Department uncovered a petrified log during road construction that measured 120 ft (37 m) long and 6 ft (2 m) in diameter. The log was reburied under the new highway. According to Dahlberg *(Ibid.)*, petrified wood is enormously abundant in the southwest corner of the state, so much so that it is a nuisance to farmers plowing their fields and who would be delighted for collectors to take away the material.

BELL, G. L. (1972) The petrified forests of North Dakota. *Earth Science* 25, p. 11–16.

BUNTING, J. G. (1955) North Dakota worm bored wood. *The Mineralogist* 23, p. 160.

DAHLBERG, J. C. (1977) The woods of North Dakota. *Lapidary J.* 31, 2, p. 606–609, illust.

HUNTER, R. (1982) From Marmarth to Intake: Fiasco to feast. *Lapidary J.* 35, 11, p. 2234–2245, illust. Collecting in west ND to east MT.

INGALLS, N. (1982) Little Missouri gravels. *Rock & Gem* 12, 9, p. 16–19, map.

KENNEDY, M. (1970) Those hard-headed hole makers. *Lapidary J.* 23, 11, p. 1460–1466, *passim*, illust.

ROHN, K. H. (1985) A Red River Valley field trip. *Gems & Minerals* 573, p. 40–42, map.

_____, (1986) Camel Butte. *Ibid.* 580, p. 24–28, map.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept. for 1886-7*, part 2, p. 663–960.

ZEITNER, J. C. (1964) *Midwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 80 p., illust., maps.

_____, (1989) *Midwest Gem, Fossil and Mineral Trails: Prairie States.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

SOUTH DAKOTA. Like its neighbor, North Dakota, this state continues to supply silicified wood from many areas, plus other quartz chalcedonic varieties found in alluvial deposits. Some idea of the enormous existent quantities that exist of this material is gained from Urbanek's (1975) description of Woodland Park in Lemmon, where an eerie landscape of steeply tapered cones made from fragments and logs of petrified wood, estimated by Urbanek to contain 3,700 tons, represents the many years of collecting wood by Ole S. Quammen, a pioneer in the region, who "wanted to preserve the petrified beauty that plagued the farmers around Lemmon." In this area the shallowly buried material severely damaged the plowshares of farmers, who (as in North Dakota) were only too happy to have anyone collect and remove the wood. There are three buildings in the park that are made entirely from petrified wood, one of which serves as a museum.

The famous cycad forest in the Black Hills, so ably described by Wieland (1906, p. 7–10), and earlier by Ward (1898, 1899), is now out of

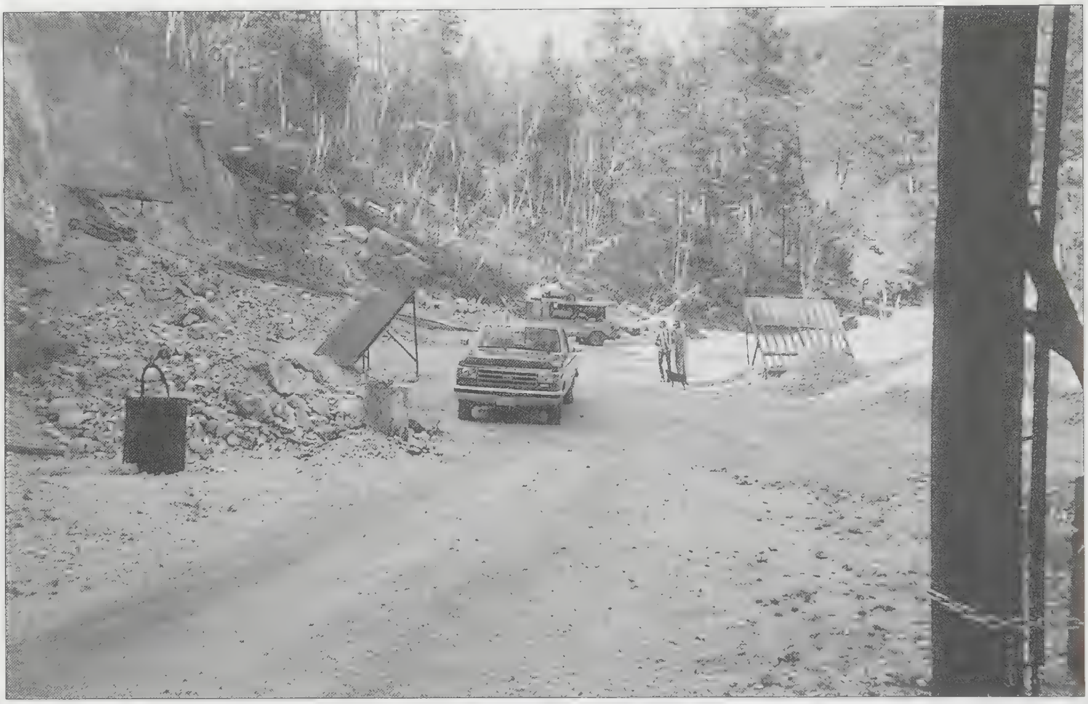


FIGURE 75. The Scott rose quartz quarry in the Black Hills, Custer County, South Dakota. The quarry working face is at the left in the core of an enormous pegmatite body. *Courtesy Scott's Red Rose Quartz, Inc., Custer, South Dakota.*

bounds to collectors, having been given the status of a National Monument (Ransom, 1955). An excellent survey of the silicified cycads appears in Zeitner (1988) who also covers occurrences elsewhere in the United States but notes that the specimens from Fall River County, South Dakota, are especially fine.

In addition to Fairburn whose agates are noted for their fine and colorful bandings, other areas of the state also provide attractive agates, as in the Scenic area (Baler, 1978; Ingalls, 1982). Tepee Canyon agate, a handsome type, is found in an area about 18 mi (29 km) west of Custer on U.S. Highway 16 (Schlough, 1978). Oelrichs agate, another attractive variety, is found just west of the town of that name between Hot Springs and Chadron (Mitchell, 1986), and Custer agate, splendidly banded and colored, is found just a short distance north and west of Custer where it occurs as nodules in limestone (Mitchell, 1990). This material is like the Tepee Canyon agate.

The major gemstone produced in South Dakota remains rose quartz which occurs in core units in granitic pegmatites in the Black Hills. A number of deposits are described by Roberts & Rapp (1965) such as the Big Chief Mine, one half mile (0.8 km) south of Glendale, Pennington County; the Ross (Highland Lode) Mine, 4 mi (6 km) west of Custer, Custer County; and the White Elephant Mine, 2.8 mi (4.6 km) north of Pringle. Large masses of richly colored, slightly lavender-tinged rose quartz have been found in a small pegmatite body of the Wiley Mine, about 1/4 mi (0.4 km) east of Highway 85A, 2 mi (3.2 km) south of Senator. According to Roberts & Rapp, some pieces display remarkable asterism when cut in cabochon or sphere forms, and some other masses contain beautiful dendrites of black psilomelane and make striking cabochons when cut to parallel the markings so that they appear just beneath the surface of the gems. Other rose quartzes include that mined in 1992 from the Fisher pegmatite near Custer, and a peculiar smoky-rose material from the White Elephant Mine (*Pers. comm.*, E. Fritzsch, 1/93).

By far the most important producer of rose quartz on a steady commercial basis is the Scott Red Rose Quartz Mine located 7 mi (11 km) southeast of Custer. The mine was first worked in 1893 by Samuel Scott, mining engineer, surveyor and assayer, and one of the founders of Rapid City. The mine has been in the uninterrupted possession of the Scott family since the year of its discovery. At present it is being actively worked by Carl Scott (*Pers. comm.* 12/12/92). Page, *et al* (1953, p. 3) recorded production from 1879 to 1940 valued at $40,444. Scott, however, states that "it is difficult to estimate the amount of rose quartz that has been shipped from the mine but it would be several thousand tons" and "a recent appraisal . . . indicates a reserve of at least 107,500 tons." In 1972, Scott sold their "premier" grade of mine-run at $2.00/lb or about $5.00/kg, advancing to $5.00 per ounce or about $45/kg for faceting and carving grade material. Prices were set much lower for rose quartz to be used in wall facings, pot fillers, and other mundane applications, for example, "landscape aggregate" sold for only $30.00/ton. Further details on the Scott pegmatite are given in Roberts & Rapp (p. 169) who note that the rose quartz core unit is 6–15 ft (1/5–4.5 m) thick and 10–30 ft (3–9 m) high on the quarry face and is traceable for several hundred feet in length. One large solid mass of 3,300 lb (1,500 kg) measuring 18 x 30 in (45 x 75 cm) was shipped east to be cut up into slabs for tabletops. Another fine large mass was sent to Germany where it was cut into a large bowl that is now in the collection of the Field Museum of Natural History in Chicago.

In late 1991, Dan Neubauer, president of the newly formed International Rose Quartz Mining Company, headquartered in Kansas City, Kansas, began the quarrying of a rose quartz pegmatite in the Custer area (Verbin, 1992). It is estimated that about 80,000 tons of rose quartz are in sight, of which 10% "is likely to be carving grade or better." The company is expanding their market from traditional landscape and amateur employment of the quartz to applications that encompass the manufacture of tiles, bookends, spheres, and other ornamental objects. Some material is selected as faceting grade. Austin (1992) put their early production at "millions of dollars" and thus elevated South Dakota's status as a gemstone producer from 25th to 4th place among states. Rose quartz is South Dakota's Official State Rock.

The Sioux Falls quartzite of lapidary grade mentioned by Kunz (1890, p. 127), and known as Sioux Falls jasper, is also noted by Roberts & Rapp (p. 171) who characterize it as a completely silicified conglomerate composed of brown, red, and yellow rounded pebbles firmly cemented together by interstitial quartz. It occurs in unlimited quantities in the vicinity of the dells of the Sioux River north of Sioux Falls. This material has been extensively quarried in the past for architectural/ornamental stone.

AUSTIN, G. T. (1992) There's more than gold in them thar hills. *Colored Stone* 5, 2, p. 10.

BAIER, E. D. (1978) The Scenic agate beds. *Rockhound* 7, 5, p. 21–24.

CLARK, J. (1985) Fairburn agate. *Rock & Gem* 15, 12, p. 36–38, map.

CONNOLLY, J. P. & O'HARRA, C. C. (1929) The mineral wealth of the Black Hills. *SD School of Mines Bull.* 16, 418 p., illust., maps.

ELSHIRE, A. L. (1942) Hell Canyon agates. *The Mineralogist* 10, p. 111–112.

INGALLS, N. (1982) Scenic black agate. *Rock & Gem* 12, 3, p. 62–64, 66, 67, map.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). Sioux Falls p. 123.

LARSON, P. L. (1975) My cycad. *Lapidary J.* 29, 4, p. 828–829.

LARSON, P. L. & HONERT, J. (1977) Rose quartz of the Black Hills. *Lapidary J.* 31, 2, p. 534–538, illust.

LAWLER, T. B. (1923) On the occurrence of sandstone dikes and chalcedony veins in the White River Oligocene. *Amer. J. Sci.* 5, p. 160–172.

LEE, H. E. (1940) *The Story of Fossil Wood.* Rapid City, SD: Rushmore Museum, 23 p.

LINDE, M. (1972) Chalcedony in South Dakota. *Gems & Minerals* 419, p. 23, 39, 40, map.

_____, (1974) Collecting Fairburn agate. *Ibid.* 439, p. 22–23, map.

MINERALOGIST, THE (1936) Black Hills petrified forest. Vol. 4, 11, p. 7-8.

MITCHELL, J. R. (1986) Oelrichs agates. *Rock & Gem* 36, 6, p. 36–39, map.

_____, (1990) Dakota petrified woods. *Ibid.* 20, 3, p. 52–54, 79, maps.

_____, (1990) Custer agate. *Ibid.* 20, 10, p. 56–59, map.

MUSEUM NEWS (1949) Huge petrified tree found in South Dakota. U. SD, May 1949; reprinted *Rocks & Minerals* 24, p. 502–503, 1949.

PAGE, L. R., *et al* (1953) Pegmatite investigations 1942–1945, Black Hills, South Dakota. *U.S. Geol. Survey Prof. Paper* 247, 228 p., illust., maps.

PUTNAM, G. G. (1953) Fairburn agate. *Mineral Notes & News* No. 187, p. 8, 43.

RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: Mineralogist Publ. Co., 80 p., illust., maps.

ROBERTS, W. L. & RAPP, G. (1965) Mineralogy of the Black Hills. *SD School of Mines & Technol. Bull.* 18, 368 p., illust.

SCHLOUGH, D. J. (1978) My South Dakota dream trip. *Rockhound* 7, 5, p. 36–38. Tepee Canyon agate.

SCIENCE (1936) The Fossil Cycad National Monument. New ser., vol. 84, no. 2182, p. 367–368.

SCOTT, E. M. (1941) Scott rose quartz mine. *Rocks & Minerals* 16, 10, p. 360–363, map.

SHERRILL, G. H. (1948) Fairburn agate. *Rocks & Minerals* 23, 8, p. 713–714.

SPOMER, R. E. (1973) Badlands bonanza. *Rockhound* 2, 6, p. 22–25, map.

URBANEK, M. (1975) The oldest woodland park. *Gems & Minerals* 456, p. 42–43, illust.

VERBIN, E. (1992) Mine pushes South Dakota to #4 in U.S. gem production. *Colored Stone* 5, 5, p. 82, 83, illust.

WARD, L. F. (1898) Descriptions of species of cycadeoidea, or fossil cycadian trunks, thus far determined from the Lower Cretaceous rim of the Black Hills. *Proc. U.S. Nat. Mus.* 21, no. 1141, p. 195–229, illust.

_____, (1899) The Cretaceous formation of the Black Hills as indicated by the fossil plants. *U.S. Geol. Survey 19th Ann. Rept. for 1897–98*, part 2, p. 521–946, illust., map.

WIELAND, G. R. (1906, 1907) American fossil cycads. Wash., DC: *Carnegie Inst. of Wash. Publ.* 34, vols. 1 & 2, 296 & 277 p., illust.

_____, (1934) Fossil cycads, with special reference to *Raumeria Reichenbachiana Goeppert* SP. of the Zwinger of Dresden. *Paleontographica* Bd. 79, Abt. B, p. 85–130, illust.

WIELAND, G. R. (1937) Fossil Cycad National Monument. *Science*, new ser. 85, no. 2203, p. 287–289.

WOODS, C. L. (1979) Badlands collecting. *Gems & Minerals* 501, p. 14, 15, illust., map.

ZAZADIL, J. (1951) The Fairburn agate beds and the Black Hills and badlands of South Dakota. *Lapidary J.* 5, 1, p. 14–16, 18, map.

ZEITNER, J. C. (1954) Story of Fairburn agates. *The Mineralogist* 22, l, p. 6–7.

_____, (1956) South Dakota gem trails. *Ibid.* 24, 5, p. 195–199.

_____, (1959) Where to go in South Dakota. *Lapidary J.* 13, 1, p. 42–54, *passim*, maps.

_____, (1962) South Dakota's new Fair Hills agate. *Ibid.* 16, 4, p. 414–416, illust., map.

_____, (1963) Those beautiful fortification agates. *Ibid.* 17, 9, p. 940–949, illust.

_____, (1964) *Midwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 80 p., illust., maps.

_____, (1968) Gem fossils of the South Dakota Badlands. *Lapidary J.* 22, 7, p. 922–929, illust.

_____, (1970) South Dakota's most popular gem field. *Ibid.* 23, 12, p. 1668–1680, *passim*, illust. Badlands area.

_____, (1973) Facts about Fairburns. *Ibid.* 27, 5, p. 752–755, 772–777, illust. (col.).

_____, (1988) Royal cycads. *Ibid.* 42, 4, p. 35–40. Also cycads from other U.S. localities.

_____, (1989) *Midwest Gem, Fossil and Mineral Trails: Prairie States.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

ZIEGLER, V. (1914) The minerals of the Black Hills. *SD School of Mines Bull.* 10, 255 p., illust., maps.

NEBRASKA. No new developments.

BARBOUR, E. H. (1915) Nebraska green quartzite—an important future industry. *NE Geol. Survey* 4, p. 249-252.

DICKERSON, B. (1978) Hunting the Nebraska blue [agate]. *Rock & Gem* 8, 10, p. 70–71, map. East of Orella.

ELDREDGE, A. G. (1947) Moss agate at Agate, Nebraska. *Rocks & Minerals* 22, 1, p. 30.

HOCKETT, K. (1978) Northeast Nebraska rock. *Lapidary J.* 31, 10, p. 2150–2155, map. Chalcedonic quartzes in gravel beds.

______, (1979) Mecca for rockhounds. *Ibid.* 32, 10, p. 2262–2264, illust., map.

MITCHELL, R. (1946) Bayard, Nebraska, quartz minerals. *Rocks & Minerals* 21, 1, p. 29.

______, (1947) Moss Opal Mine in western Nebraska. *Ibid.* 22, p. 1115.

______, (1950) A description of the quartz minerals found at Bayard, Nebraska. *Ibid.* 25, 1, p. 3–7.

PABIAN, R. K. (1971) The minerals and gemstones of Nebraska. *U. NE Conservation & Survey Div. Educ. Circ.* 2, 80 p., illust. (col.), maps.

______, (1980) Gem collecting in Nebraska. *Lapidary J.* 34, 2, p. 462–476, *passim*, illust. (col.).

______, (1982) Rivers, rockhounds, canoes, and collecting. *Ibid.* 36, 1, p. 76–82, *passim*, illust. (col.).

ROHN, K. H. (1986) Agate beds and grasslands. *Gems & Minerals* 581, p. 42–45, illust., map.

SPOMER, R. E. (1973) Badlands bonanza. *Rockhound* 2, 6, p. 22–25, illust.map.

TRUMP, E. (1973) Rocks and fossils of the Big Blue River. *Rockhound* 2, 6, p. 12–16, illust., map.

ZEITNER, J. C. (1964) *Midwest Gem Trails.* 3rd edit. 80 p., illust., maps.

______, (1974) Converging on Nebraska. *Lapidary J.* 28, 2, p. 348–358, *passim*, illust. (col.).

______, (1989) *Midwest Gem, Fossil and Mineral Trails: Prairie States*, Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

KANSAS. One of the earliest and best guides to quartz variety collecting in Kansas is that of Graffham (1944) who recommends collecting agates of many types in gravel beds along the Smoky Hill River Valley. The river runs between Abilene and Junction City in central Kansas, and "the gem-bearing gravels occur most abundantly in Trego, Gove, Logan, and Wallace counties, but gem materials are found the entire length of the valley in Kansas." The chalcedonic varieties include moss, iris, chalcedony with inclusions, jaspers, and fossil woods. Occasionally facet-grade quartzes are also found. Other productive gravels occur along the Medicine Bow River, Barber County, Cimarron River, Arkansas River, and generally areas in northeastern Kansas. Elias (1931, p. 214) notes that the gravels of the Ogallala and the Pleistocene formations in Wallace County yield pebbles of rock crystal and smoky quartz, from which "fairly good gems have been cut . . . by local citizens." Other quartzes include green and red jaspers, agates, and silicified wood in conglomerate deposits and their debris. Moss agate was first discovered in this county by the first State Geologist of Kansas, B. F. Mudge, at a place south of Fort Wallace.

In regard to Lake Superior agates, Banion (1971) studied the gravels in the northeastern quadrant of the state and provides a map showing river systems that are potential collecting areas distributed over a region that is about 100 mi (160 km) broad from west of Wyandotte on the Missouri River into Wabaunsee County, thence northwestward into Washington County. A general survey of Kansas gemstones is provided by Zeitner (1964, 1989).

BAGROWSKI, B. P. (1943) Kansas minerals and localities. *The Mineralogist* 11, 9, p. 267–270, 287–288. Includes agate and wood.

BANION, E. L. (1971) The glaciers and Lake Superior agates in Kansas. *Lapidary J.* 25, 1, p. 122–127, illust. (col.), map.

BROADHEAD, G. C. (1883) Flint chips. *Kansas City Rev. Sci. & Industry* 7, p. 599–602. Chert beds of the state.

ELIAS, M. K. (1931) The geology of Wallace County, Kansas. *State Geol. Survey of Kansas Bull.* 18, 254 p.. illust., maps.

GRAFFHAM, A. (1944) The gem minerals of Kansas. *The Mineralogist* 12, 7, p. 203–206.

SCHMIDT, M. M. (1920) The common rocks and gem stones of Kansas and how to recognize them. *KS Acad. Sci. Trans.* 29, p. 85–88.

TOLSTED, L. L. & SWINEFORD, A. (1948) *Kansas Rocks and Minerals.* State Geol. Survey KS, 54 p., illust.

ZEITNER, J. C. (1964, 1989) *See above.*

OKLAHOMA. Large regions of this state offer collecting for silicified woods and cycads, agates, jaspers, etc. The Panhandle provides the best collecting ground for woods (Zeitner, 1972; Lovell, 1980 (who describes other areas); Mitchell, 1987; Morrison, 1989). Zasin (1976) describes and pictures an astonishing sight involving Oklahoma's silicified wood: a house with its exterior completely coated with fragments of silicified wood and with silicified wood walls and walkways outside. This is now the Midgeley Museum, in the town of Enid.

GILMORE, R. J. (1959) *A Rockhound's Guide to the Gems and Minerals of Oklahoma.* Tulsa, OK: priv. publ., 77 p., maps.

HAM, W. E. (1942) *Catalog of One Hundred Minerals, Rocks and Fossils from Oklahoma.* OK Geol. Survey, 90 p., illust.

KENNEDY, M. (1964) Petrified wood of Oklahoma. *Lapidary J.* 18, 5, p. 558–563, illust.

______, (1965) Cycads of the Cimarron. *Ibid.* 18, 10, p. 1136–1141, illust.

______, (1966) Oklahoma's forest of stone. *Ibid.* 20, 3, p. 404–413, *passim;* 9, p. 1082, 1084–1089, illust.

______, (1975) Collecting in Kay County, Oklahoma. *Ibid.* 29, 1, p. 356–357.

LOVELL, H. (1980) Petrified wood in Oklahoma. *Gems & Minerals* 514, p. 40–41.

MISER, H. D. (1943) Quartz veins in Ouachita Mountains of Arkansas and Oklahoma. *Econ. Geol.* 38, p. 91–118, illust.

MITCHELL, J. R. (1987) *Gem Trails of New Mexico.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps. OK Panhandle wood.

MORRISON, V. (1989) More than quartz and pine trees. *Lapidary J.* 43, 2, p. 39–41, illust. Petrified wood, McCurtain Co.

REDFIELD, J. S. (1927) Mineral resources in Oklahoma. *OK Geol. Survey Bull.* 42, 130 p., maps. Novaculite, building stones.

REED, F. T. (1947) Some Oklahoma gem trails. *The Mineralogist* 15, 2, p. 64–65, 88, map.

RICE, R. (1971) Rainbow wood in Oklahoma. *Gems & Minerals* 406, p. 13–14.

SLACK, J. N. & KENNEDY, M. (1968) Cycads, agates, and "things" in Oklahoma's Panhandle. *Lapidary J.* 22, 7, p. 898–903, 906, illust. (col.).

ZAZIN, L. E. (1976) We met some gems in Oklahoma. *Lapidary J.* 30, 3, p. 736–741, illust.

ZEITNER, J. C. (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps.

______, (1989) *Midwest Gem, Fossil and Mineral Trails: Prairie States.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust. ,maps.

TEXAS. Mitchell (1991, p. 4) divides Texas into five collecting regions: the Panhandle of the north, the east and west regions, a central region, and one to the south that takes in the "toe" of the state. The Panhandle is noted primarily for its Alibates flint or chert which is found abundantly in the Canadian Breaks area of the Canadian River Valley (Meek, 1983). Similar material is found around Sanford, north-northeast of Amarillo (Towner, 1970). A collection of articles on Alibates flint appears in *Lapidary Journal* (1966) including discussions of the use of the material by prehistoric inhabitants. Mitchell *(Ibid.)* records colorful flint nodules from along the shores of Lake McClellan in Gray County, about 55 mi (88 km) east of Amarillo and north of Highway I-40, but he points out that the National Park Service restricts collecting in the Alibates National Monument north of Amarillo and is considering stopping all collecting. While much of the flint is only faintly colored, some pieces display much stronger hues and therefore are excellent cabochon material as shown in the color photographs of Meek *(Ibid.)*.

One of North America's major sources of silicified wood of lapidary quality, especially palm wood, is the narrow belt of Cretaceous and Tertiary sedimentary formations that extends from Sabine County and the Huntington/Zavalla area near the Louisiana border to south of San Antonio near Falls City, thence toward the Mexican border in the southwest end of the belt. According to Weissenborn & Stenzel (1948, p. 173) "among the Cretaceous sediments, the sands of the Trinity group in Erath and adjoining counties are the richest in silicified wood." Erath County is located in central Texas halfway between Fort Worth and Brownwood. These authors go on to say that "in the Tertiary sediments silicified wood was found principally in the Wilcox Group and

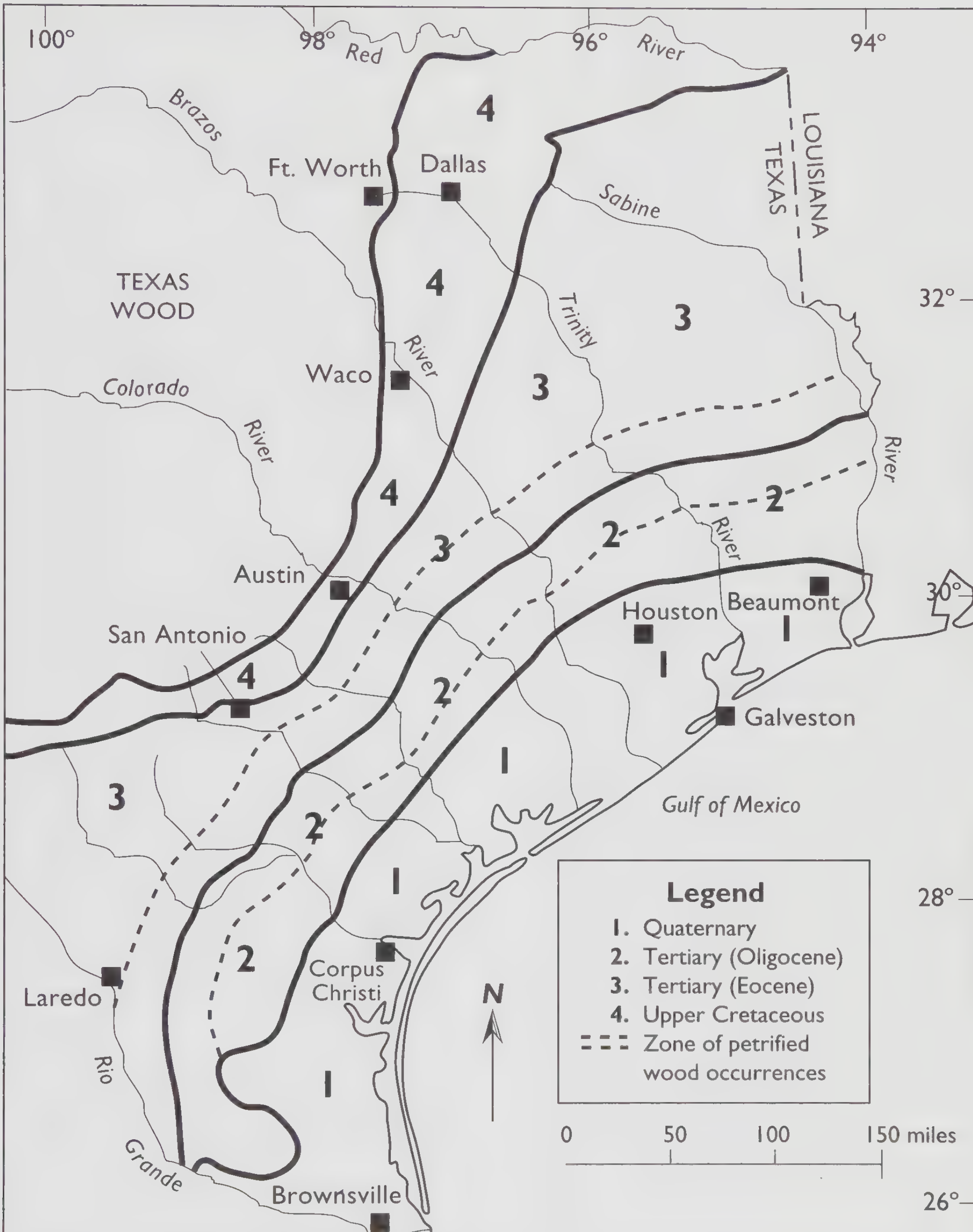


FIGURE 76. Simplified areal geology of Texas showing the zone of petrified wood occurrences. After a map in R. M. Girard, 1964.

the Yegua Formation. The Wilcox outcrops in Robertson, Limestone, Freestone, Leon, Anderson, Navarro, Henderson, Van Zandt, Rains, and other east Texas counties . . . [the] Yegua strata cross Madison, Leon, Houston, Trinity, Angelina, and Nacogdoches counties." On the other hand, Girard (1964) notes that major occurrences of silicified wood are confined to a belt of about 20 mi (32 km) on either side of the boundary between the Tertiary (Eocene) belt on the north and the Tertiary (Oligocene, Miocene, and Pliocene) belt to the south. This relatively narrow band is the Catahoula formation of Leiper (1952) who shows it extending as a southwestward-dipping arc from Louisiana to Mexico; it is further described by Sloat (1981) who gives details on collecting woods in eastern Texas counties. Among specific guides to the collecting areas are Naumann (1984) who deals with numerous sites in Fayette County, northeast of La Grange, and Towner (1969) who describes collecting in the Falls City area southeast of San Antonio. An earlier account by Sloat (1927) discusses the woods of the eastern counties and also occurrences northwest of Jasper in Jasper County. Hudson (1986) describes collecting wood around Lake Sam Rayburn near Zavalla, southeast of Lufkin, and also along the Brazos River next to Highway I-10 west of Houston.

Some idea of the sizes of silicified palm trunks can be gained by viewing photographs of specimens in *Lapidary Journal* (15, 5, 1961, p. 571) where a stump is shown that weighs over 400 lb (180 kg). General descriptions also appear in Zeitner (1964). An outstanding collection of silicified woods, in longitudinal and cross sections, some of enormous size (as a 7 ft [2.2 m] diameter Sequoia section from Oregon) are in the Herbert Zuhl-Joan Russell Collection in the Houston Museum of Natural Science. According to Joel A. Bartsch, curator, the collection of over 100 pieces was acquired in 1993 and includes specimens that range in size from about 8 in (20 cm) in trunk diameter to the mammoth specimen mentioned above. Most are from United States deposits. The collection was to be opened for public viewing in 1995.

In regard to other chalcedonic varieties of quartz, Zeitner (1964, 1972, 1974) indicates that much excellent material can still be found in West Texas and the Big Bend country, while the rugged terrain of the extreme south continually attracts collectors (Zeitner, 1962; Immel, 1963; Robinson, 1966; Towner, 1970; Dalquest, 1974). Collecting on a fee basis continues upon certain West Texas cattle ranches (Ossowski, 1969, 1972; Zeitner, 1974; Walker, 1988). The gravels of the Rio Grande River Valley are also steadily productive of agates and jaspers in large variety; this is an enormous region in which fine material can always be found (Zeitner, 1964, 1972).

DAKE, H. C. (1940) An agate collector's mecca. *The Mineralogist* 8, 12, p. 487, 500, 501. Rio Grande River Valley.

DALQUEST, W. W. (1974) Golden agates of the Big Bend. *Lapidary J.* 28, 7, p. 1140–1147.

DUMBLE, E. T. (1889) Petrified wood. *Texas State Geol. Scient. Assoc. Bull.* 1, 12. Bastrop area wood.

GIRARD, R. M. (1964) Texas rocks and minerals: An amateur's guide. *TX Bur. Econ. Geol. Guidebook* 6, 109 p., illust., col. map.

HUDSON, S. (1982) Brazos River. *Rock & Gem* 12, 6, p. 36–40, maps.

______, (1986) Wood hunt. *Lapidary J.* 40, 1, p. 42–44, 46, 48, map.

IMMEL, E. (1963) Agates of the Big Bend of Texas. *Gems & Minerals* 314, p. 19.

INGERSON, E. (1953) Giant amygdules in andesite from southern Quitman Mountains, Texas. *Amer. Mineral.* 38, p. 1057–1064, maps, col. pl.

KING, E. A. (1961) Texas gemstones. *TX Bur. Econ. Geol. Rept. Invest.* 42, 42 p., illust. Quartzes p. 25–28.

KYTE, K. (1973) Pompon, the aragonite inclusion in agate. *Lapidary J.* 26, 12, p. 1696–1699, 1711–1717, illust. (col.).

LAPIDARY JOURNAL (1961) Big palm stump find in Texas. Vol. 15, 5, p. 571, illust.

LAPIDARY JOURNAL (1966) Texas Alibates flint quarries are declared a national monument. Vol. 19, 10, p. 1114–1131, *passim*, illust., maps.

LEIPER, H. (1952) Gem trails in Texas. *Lapidary J.* 6, 1, p. 10–18, *passim*.

MEEK, J. H. (1983) Gems, minerals, and artifacts in the Panhandle of Texas. *Lapidary J.* 37, 2, p. 316–327, *passim*, illust. (col.).

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps.

NAUMANN, C. R. (1964) Wood replacements of Fayette County, Texas. *Lapidary J.* 18, 1, p. 187–191, illust., map.

OSSOWSKI, J. (1969) Agua Fria Ranch. *Gems & Minerals* 379, p. 18–20, map.

______, (1972) Woodward Ranch, then and now. *Gems & Minerals* 414, p. 22–25, map.

PRESTON, N. E. (1988) A family outing in Southeast Texas. *Lapidary J.* 41, 12, p. 61–62. Livingston Reservoir palm wood.

REINER, T. A. (1942) Beautiful and unique agates from Texas. *Rocks & Minerals* 17, 2, p. 58–59.

ROBINSON, M. & ROBINSON, G. (1966) A fun trip for rare agate. *Lapidary J.* 20, 9, p. 1106–1109, illust. Brewster Co.

SIMPSON, B. W. (1958) *Gem Trails of Texas.* Dallas, TX: Newman Stationery & Printing Co., 88 p., illust., maps.

SLOAT, L. W. (1977) Sam Rayburn Dam. *Rock & Gem* 7, 11, p. 16–18, 20–22, map.

______, (1977) East Texas petrified forest. *Lapidary J.* 30, 10, p. 2326–2331, illust., map.

______, (1978) Agatized wood on Little Tiger Creek. *Gems & Minerals* 487, p. 6, 7, 10, illust., map. Sam Rayburn Lake.

______, (1979) The petrified wood of Long King Creek. *Rock & Gem* 9, 2, p. 24–26, map. Corrigan-Goodrich area.

______, (1981) Hunting the Catahoula in Texas. *Lapidary J.* 34, 12, p. 2640–2644, illust., maps. East Texas wood.

SNYDER, K. (1957) Grab bag of southern Texas. *Gems & Minerals* 235, p. 28, 30, 79, map. Rio Grande River gravels.

______, (1958) Texas palm. *Gems & Minerals* 247, p. 20-22, illust., map.

SPENCE, S. E. (1964) Alibates—the prehistoric treasure. *Desert Mag.* 27, 8, p. 30–31, illust.

STONE, C. M. (1959) Cherts and conglomerates of Texas. *Gems & Minerals* 264, p. 24–27, illust. Cherokee area, San Saba County.

TANNER, O. L. (1970) Agate hunting along the Rio Grande. *Gems & Minerals* 393, p. 24–26, 45, 46, map.

TOWNER, J. M. (1969) The Texas belt of wood and agate—Falls City area. *Lapidary J.* 23, 3, p. 512–519, illust., map.

______, (1970) Flint collecting in the Texas Panhandle. *Gems & Minerals* 391, p. 28–31, illust., map.

______, (1975) Palm wood—Texas. *Lapidary J.* 29, 1, p. 94–108, *passim*, map.

______, (1977) Rockhunting in Texas. *Ibid.* 31, 4, p. 906–920, *passim*, illust., map.

WALKER, D. & WALKER, C. (1988) 4 in Texas. *Lapidary J.* 42, 1, p. 61, 62, 64. Four wood collecting sites.

WEISSENBORN, A. E. & STENZEL, H. B. (1948) Geological resources of the Trinity River tributary area in Oklahoma and Texas. *Univ. TX Publ.* 4824, p. 172–173.

WIELAND, G. R. (1935) The Cerro Cuadrado petrified forest. *Carnegie Inst. of Wash., DC, Publ.* 449, 150 p., illust. Wood of Trinity beds, p. 46–49.

ZEITNER, J. C. (1962) Big Bend country. *Lapidary J.* 16, 5, p. 527–530, illust., map. Needle Peak area, Brewster County.

______, (1964) Gems of the Rio Grande Valley of Texas. *Ibid.* 18, 1, p. 86–90, 92–96, illust.

______, (1964) The gem woods of Texas. *Lapidary J.* 18, 5, p. 565–569, illust.

______, (1972) A Texas gravel pile. *Ibid.* 26, 7, p. 980–988, illust. Rio Grande gravels, Starr County: agates, wood.

______, (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps.

______, (1974) Wonderful West Texas. *Lapidary J.* 27, 10, p. 1534–1542, illust. Brewster & Presidio counties agates.

MONTANA. Field (1983) points out that there is much to be collected in the way of chalcedonic quartzes in the southeastern corner of the state, i.e., the region that lies between the Missouri River (on the north) and the southern border of the state. Much silicified wood, agate, and jasper are to be found in many places simply by searching exposed gravels.

Bleck (1994) describes the occurrence of amethyst scepter overgrowths on smoky quartz crystals in vugs in quartz veins penetrating granite on the Sally Ann Claim, located on Sally Ann Creek, Powell County, just west of the Continental Divide at slightly over 6,000 ft (1,830 m) elevation. The claim was staked by the Helena Mineral Society. One pocket opened by Bleck yielded 300 amethyst-tipped smoky quartz crystals; some of the amethyst is suitable for small faceted gems.

Van Laer (1979, 1985), active in exploring granitic pegmatites of the Boulder Batholith, has found crystal-lined vugs that contain mainly feldspar, smoky quartz, and schorl, much of the smoky quartz being clear, facet grade material. The batholith presents considerable potential for further discoveries of such vugs and is largely unexplored. Its principal rocks are granites which are intruded by pegmatite veins. The batholith roughly extends from Helena southward past Butte for a total length of about 70 mi (118 km). Explorations to date have been confined to areas immediately south, east, and northeast of Butte. Pegmatite swarms in the Pipestone Pass area, 13.5 mi (22 km) south-southeast of Butte, on the Silverbow-Jefferson counties line, and from Toll Mountain to Pole Canyon and Whiskey Gulch, are noted for finds of scepter amethyst upon smoky quartz crystals. At one time enough amethyst was found in the Pohndorf Mine to form the basis of a profitable mining venture. Another similar amethyst source is the Little Gem Mine, located on a ridge about one mi (1.6 km) west of the Pohndorf Amethyst Mine (Sec. 32, T2N, R6W), where two more or less parallel pegmatite veins yielded pockets of feldspar, smoky quartz, and scepter amethyst.

Kunz (1901) located the Pohndorf Mine "about 22 miles [35 km] southeast of that city [Butte] and 16 miles [26 km] from Silver Star, Jefferson County, on the ridge between Little and Big Pipestone creeks." The remarkable minerals found in this pegmatite are colorless, smoky, and amethyst quartz, with the colorless and smoky crystals commonly filled with thread-like black tourmaline crystals, but such are absent in the amethyst which always appears as overgrowths on points and edges of earlier-formed colorless and smoky quartz crystals. Kunz noted these scepter overgrowths, also the zoning within quartz crystals which created phantoms, remarking that "crystals 4 inches or more in diameter, cut across in this way into polished sections, are very beautiful, and equal to anything of this kind ever obtained." The crystals generally occur in cavities filled with very small scales of mica which "in many cases adhere to the sides of the quartz crystals, forming more or less of a coating, and occasionally they are inclosed in the quartz."

In the same general area is the Gem Queen Mine, about 17 mi (27 km) north-northwest of Whitehall, Jefferson County. It is noted for fine though rarely gemmy groups of titanite (sphene) crystals and some gem grade smoky quartz. Near Butte, on Timber Butte, and along the base of East Ridge are more pegmatites that yield smoky quartz and amethyst. At Homestake Pass, 7.8 mi (12.4 km) south-southeast of Butte, a swarm of pegmatites has provided collectors with splendid schorl crystals (Van Laer, 1979). Northward from the pass is Delmoe Lake and the flanks of Goldflint Mountain where many quartz-bearing pegmatite seams occur. Some of the quartz crystals are capped with amethyst. A pegmatite mine, called Beehive #3, contained a very large vug from which 40 smoky quartz crystals were removed. Other pegmatite bodies in the area also yielded pale sherry, pale blue, and colorless topaz crystals, some to 1.5 x 1.5 x 1 in (3.7 x 3.7 x 2.5 cm) in size. A rare find was a brush-like aggregate of slender tourmaline crystals with green terminations, also some purplish and pink, but without areas large enough to facet even small gems. As recently as late 1993, Van Laer (*Pers. comm.* 10/21/93) states that large pockets yielding smoky quartz crystals are still being found.

Regarding another variety of quartz, Koivula, *et al* (1992) describes a handsome, uniformly colored and textured purplish-blue chalcedony that was sent in to the Gemological Institute of America in Santa Monica, California, for examination; it is from an unspecified locality in southwestern Montana. Its properties were consistent with those of chalcedony from other sources. It is depicted in color, and its appearance suggests that it occurs as seam fillings in an igneous rock.

The famous Montana moss agates continue to be found all along the valley and side valley gravels of the Yellowstone River in the southeastern quadrant of Montana. In view of the huge area involved and how little gravel has actually been turned over for examination, these agates will continue to be produced for an indefinite time into the future. An important contribution to the knowledge of these agates is that of Longhurst (1977), who notes similar agates occurring in the extreme southern portion of Saskatchewan and adjacent Manitoba, and discusses the broad geological history of the region from about 50 million years ago, when it is believed that these agates formed, and indicates areas where the gravel beds containing the agates are found.

Another important paper on these agates is by Harmon (1986), the proprietor of a long-established business in Crane, Montana, specializing in the collecting and lapidary treatment of the nodules. Advice is given on how to examine agates and determine the best way to section them to bring out the mossy designs. The photographic illustrations are particularly descriptive, showing the large variety in patterns that have been found in the nodules (*see also* Kehoe, 1961 & Klapmeier, 1970). Articles by Anderson (1973) and Blodgett (1976) describe collecting experiences along the Yellowstone River. As to record sizes of nodules, Field (1983) depicts several giant nodules that average about 20 lb (9 kg) each, with the largest weighing 35 lb (16 kg). In the 1990s, Montana Agate Adventurers of Glendive offered float trips on the Yellowstone River for agate-hunting parties of two to thirty persons, from March to October, on one-day or half-day trips. The attractive feature is the ability to visit gravel bars and other gravel exposures which otherwise could not be reached from land. An early boat trip is described by Young (1973).

Both Prchal (1969) and Field (1983) relate their experiences in collecting silicified wood in the Gallatin petrified forest just north of the extreme northwest corner of Yellowstone National Park but outside its boundaries. At times the wood is as colorful and as attractively patterned as its better-known relative in Arizona. The principal collecting area is the Tom Miner Basin reached via Highway 89, Park County, thence to Miner, then via Tom Miner Creek upstream to near timberline in rugged terrain. Other sites in the area are reached via Rock Creek, Buffalo Horn Creek, and Tepee Creek (Field, *Ibid.*).

The now famous Dryhead fortification agate deposit in the Bighorn Mountains just north of the Wyoming border and reached via Highway 37 from Lovell, Wyoming, north, is only sporadically productive (Myers, 1977). Daggett (1980), proprietor of Santiam Lapidary, Cascadia, Oregon, provides a recent account of the site and its agates, with color photographs that show the fine, vari-colored bandings; the colors and patterns remind one of similar agates from the celebrated deposits in the vicinity of Idar-Oberstein, Germany, or some of the Laguna agates of Chihuahua, Mexico. All factors considered, the Dryhead agates take a place among the best from any world locality. None of the nodules are large, at most reaching up to 6 in (15 cm) in diameter and then sometimes containing central chambers lined with druzy quartz. According to Sutherland (1990, p. 18), Dryhead agates come "from outcrops of the Phosphoria formation near the Bighorn River northeast of Lovell" although "most of these agates are found north of the Wyoming-Montana state line." Dryhead agates predominantly display various tints of pink, reds, also orangey hues and brownish-reds. The usual size run is 2–4 in (5–10 cm).

ANDERSON, J. W. (1973) Along the Yellowstone there's more than agate. *Lapidary J.* 27, 4, p. 616–619, illust., maps.

BLECK, T. (1994) A quartz discovery at the Sally Ann Claim. *Mineral News* 10, 2, p. 8, illust.

BLODGETT, M. M. (1976) Lucky mascot of the Yellowstone. *Lapidary J.* 29, 12, p. 2306–2313, illust.

BRAUN, V. R. (1958) Gem collecting in Montana. *Rocks & Minerals* 33, 1, p. 12–14. Silicified wood, Frying Pan Basin, NW of Dillon.

DAGGETT, J. (1980) Dryhead! *Lapidary J.* 34, 9, p. 1930–1934, 1946, illust. (col.).

FELDMAN, R. (1985) *The Rockhound's Guide to Montana.* Helena, MT: Falcon Press, 154 p., illust., maps.

FIELD, L. G. (1983) Southeastern Montana: The neglected area. *Lapidary J.* 36, 12, p. 1992–1997, illust., map.

______, (1983) The Gallatin Petrified Forest. *Ibid.* 37, 8, p. 1218–1223, map.

FISK, L. H. (1976) The Gallatin "Petrified Forest": A review. In *MT Bur. Mines & Geol. Spec. Publ.* 73, "Guidebook—The Tobacco Root Geol. Soc. 1976 Field Conference," p. 53–72, illust., map.

FRY, P. (1972) *Meanderings of a Montana Rockhound.* Miles City, MT: Fry's Gemshop, 32 p., map. Collecting Yellowstone River agates.

HARMON, T. (1986) How to get the most from Montana agate. *Gems & Minerals* 583, p. 14–19, illust. (col.).

HARSTAD, A. J. (1938) The Montana agate. *Rocks & Minerals* 13, 11, p. 323–328.

HEINRICH, E. W. (1949) Pegmatite mineral deposits in Montana. *MT Bur. Mines & Geol. Mem.* 28, 56 p., maps. Pohndorf amethyst,

______, (1949) Pegmatites of Montana. *Econ. Geol.* 44, p. 307–335.

HOWARD, J. W. (1936) The mystery of the moss agate. *Nature Mag.* 28, 3, p. 143–144, illust.

HUDSON, S. (1985) Montana plume agate. *Rock & Gem* 15, 3, p. 52–59, maps.

HUNTER, R. (1982) From Marmarth to Intake: Fiasco to feast. *Lapidary J.* 35, 11, p. 2234–2245, illust. Collecting in eastern MT.

JACKSON, M. W. (1972) The petrified forest of Gallatin. *Rock & Gem* 2, 4, p. 62–65. Tom Miner Basin.

JOHNSON, R. N. (1969) *Northwest Gem Fields and Ghost Town Atlas.* Susanville, CA: Cy Johnson, 48 p., maps.

KEHOE, J. J. (1961) About Montana agate. *Lapidary J.* 15, 2, p. 255–257, illust., map.

KLAPMEIER, E. (1970) Collecting and cutting Montana agate. *Gems & Minerals* 389, p. 28–29, illust.

KNOWLTON, F. H. (1914) A forest of stone. *Amer. Forestry* 20, p. 709–718. Gallatin Petrified Forest.

KOIVULA, J. I., *et al* (1992) Gem news. *Gems & Gemology* 28, 3, p. 200, illust.

KUNZ, G. F. (1901) Precious stones. Ch. in *U.S. Geol. Survey Ann. Rept. for 1900*, p. 36.

LONGHURST, R. A. (1977) Geologic history of Montana agate. *Lapidary J.* 31, 6, p. 1404–1412, maps.

MORELL, F. (1929) Stone forests of the Gallatin. *Nature Mag.* 13, p. 105.

MYERS, B. M. (1977) In pursuit of Dryhead agates, a delight for all. *Lapidary J.* 31, 8, p. 1822–1828, illust., map.

NORTHWEST MAGAZINE (1894) Amethyst, Montana. Vol. 12, 3, p. 36. Pohndorf.

PRCHAL, M. (1969) A petrified forest above the timberline. *Lapidary J.* 23, 6, p. 804–807, illust. (col.).

RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: Mineralogist Publ. Co., 80 p., illust. MT forests p. 52–53.

______, (1956) Montana's Dryhead agate, a new locality. *The Mineralogist*, 24, p. 56–58, 60.

REAM, L. R. (1992) *The Gem, Mineral & Fossil Collector's Guide to Montana.* Vol. I. Coeur d'Alene, ID: L. R. Ream Publ. Co., 40 p., illust., maps.

REINER, T. A. (1941) Agates of the Yellowstone River valley, Montana. *Rocks & Minerals* 16, 9, p. 319–325, map.

ROHN, K. H. (1981) A Yellowstone field trip. *Gems & Minerals* 527, p. 94–96, map.

______, (1986) Big Sky country. *Ibid.* 583, p. 30–34, map.

SPENDLOVE, E. (1981) Dryhead agate. *Rock & Gem* 11, 12, p. 52–55, 65, map.

SUTHERLAND, W. M. (1990) Gemstones, lapidary materials, and geologic collectibles in Wyoming. *Geol. Survey WY Open File Rept.* 90-9, 53 p., maps.

VAN LAER, W. C. (1979) Tourmalines of the Homestake Pass. *Lapidary J.* 33, 1, p. 58, 60, 64, illust.

VAN LAER, W. C. (1985) Boulder Batholith pegmatites. *Lapidary J.* 39, 2, p. 242–247, illust.

VAN LANDINGHAM, S. L., ed. (1985) *Geology of world gem deposits.* NY: Van Nostrand Reinhold, 406 p., illust. R. A. Longhurst on Montana agate, p. 159–164.

VOYNICK, S. (1989) Montana moss agate. *Rock & Gem* 19, 5, p. 40, 41, 45–47, 70, map.

WILSON, M. M. (1988) Montana moss agates. *Lapidary J.* 42, 7, p. 58–61, illust., map.

WOODS, C. L. (1980) Montana's Dryhead agate. *Gems & Minerals* 514, p. 6, 22, 23, map.

YOUNG, P. A. (1940) Gallatin Petrified Forest. *Torrey Botanical Club Bull.* 67, 2, p. 121–123, illust.

WYOMING. This state remains noted for its production of a wide variety of chalcedonic quartzes, almost entirely dug by amateur collectors. In the most recent summary of gemstone resources, Sutherland (1990, p. 13–17) collects and condenses much scattered information on Wyoming quartz and lists no less than 44 kinds, ranging from "angel agate" to "zebra flint." Many of these varietal names refer to some special pattern within the material. Petrified wood is especially widespread but much of it is poorly or only partially silicified, therefore it is unsuitable for lapidary purposes.

The fossil forests are extensive and reckoned among the most important in the world. In the northwest corner of the state, in the Yellowstone Park region, and extending into Montana to the north, the Gallatin petrified forest is perhaps the largest and best preserved. Its trunks, especially those in the park, have been pictured for nearly a century. Recent descriptions of the forest appear in Sanborn (1972), Fisk (1976), Field (1983) and Smedes & Prostka (1972). The most thorough treatment is by Fisk, who furnishes numerous illustrations in addition to providing a geological background to the evolution of the several forests within the region. These are shown upon a sketch map with forests in Montana (*see above*) and also south of Immigrant Peak (Cedar Creek headwaters) just east of Tom Miner Basin in Montana, then a group of forests just above the northwest corner of Wyoming at the heads of Daly and Specimen creeks. There are several forests scattered along the boundary between Montana and Wyoming west of Cooke, but by far the most numerous exposures are in the northeast quadrant of Yellowstone Park; these, of course, are not open to collecting. The forests extend eastward beyond the park boundary.

A most valuable feature of Fisk's study is his detailed, descriptive chronology of human events connected with these forests beginning with the reports of early explorers in the last century. No scientific studies took place until Dr. F. V. Hayden led exploration parties into the Yellowstone Plateau in 1871 and in subsequent years (Fisk, p. 57). However, "it was actually W. H. Holmes, a geologist and artist with the Hayden Survey of 1878, who first brought the forests of petrified stumps to scientific attention with his report on the geologic reconnaissance of Amethyst Mountain and vicinity in the northeastern corner of the Park (Holmes, 1878)."

Following Sutherland (1990) and using his map which locates gemstone deposits, the summary below touches the most important sources, details of which may be found in the references listed.

In Crook County: agates in Mineral Hills area, 15 mi (24 km) east of Sundance; jasperoid about 9.5 mi (15 km) south of Sundance. Park County: jasperoid about 14 mi (23 km) northwest of Cody. Big Horn County: petrified wood abundant in an area about 3 mi (4 km) north of Shell; also agates, chert about 15 mi (24 km) east-southeast of Shell (Mitchell, 1983; Walker & Walker, 1990, p. 83). Also in Big Horn County, chert, agate, jasper in many places along the west flank of the Bighorn Mountains. Johnson County: silicified wood in the Dry Creek petrified forest centered about 7 mi (11 km) due east of Buffalo, and Crazy Woman petrified forest area extending in an arc from a point about 16 mi (26 km) east-northeast of Buffalo, then passing southward and curving west to terminate at a point about 17.5 mi (28 km) almost directly south of Buffalo.

One of the best known forests and also a source of agates and other chalcedonic varieties is the Wiggins Fork area which begins about 12 mi (21 km) northwest of Dubois, Fremont County, and extends (with interruptions) to a point about 24 mi (39 km) northeast of Dubois. From here, and farther north, petrified wood pieces have been transported as stream pebbles from sources within the Yellowstone National Park. All such gravel beds are potential sources of wood. Articles on collecting in this area appear in Nesheim (1961), Zeitner (1971), Dickinson & Dickinson (1972), Spendlove (1978) and Greta (1984). Love (1970, p. C38) describes uranium-bearing agatized logs from the south side of Crooks Mountain about 4 mi (6.2 km) south of Happy Springs Oil Field.

In Hot Springs County, agate and other forms of chalcedony are found on the northern flanks of the Owl Creek Mountains and in a field located about 7 mi (11 km) north of Anchor. In Washakie County, agate, along with chalcedony limb casts, is found in the area that parallels the highway from Colter toward the southwest to just below Kirby in the valley of the Bighorn River.

In Fremont County, agate, jasper, and silicified wood occur in a field that stretches from Wilderness to Burris and somewhat beyond along the Wind River Valley, also in an area just to the southeast of Lenore, and in areas between Kinnear and Riverton. About 15 mi (24 km) west and slightly south of Riverton, moss agate occurs over a large field, with an even larger field beginning at Arapahoe (southwest of Riverton) and extending for about 23 mi (30 km) in a south-southeast direction. Petrified wood and agate are also found in an area centered about 4.5 mi (7 km) north-northeast of Moneta. Similar material is also found in a large field centered about 16 mi (26 km) south and slightly east of Lander. Elsewhere in Fremont County, chalcedonic varieties occur in many places near Sweetwater Junction and extending northeast to areas north of Jeffrey City and Split Rock. Petrified wood and silicified algae occur about 21 mi (33.5 km) south-southwest of Sweetwater Junction, almost on the line between Fremont and Sweetwater counties (Love, 1970, p. C58). Agate is also found 10 mi (16 km) almost directly south of Jeffrey City. Extensive agate fields also occur beginning about 5 mi (8 km) north of Split Rock and extending northeast into Natrona County. The famous, small, smoothly rounded translucent grayish chalcedony pebbles containing black moss inclusions, and known as "Sweetwater agates," are described by Love (1970, p. C75, C139–140) as occurring in a hard gray arkosic conglomerate and sandstone as nodules 1–4 in (2.5–10 cm) in diameter; they are slightly radioactive and fluoresce a brilliant yellow because of a low content of uranium. Such pebbles found in place are usually covered with a brownish "bark" but most of those found in the past have been naturally sandblasted and are therefore quite clean. These moss agates were first noticed in the literature by F. M. Endlich who judged them "very fine north of the Sweetwater [River] at Agate Lakes" (Endlich, 1879). Love notes that these agates are exposed adjacent to about 50 square miles of dip slopes in the north-central part of the Granite Mountains area.

In Natrona County, a belt of agate occurrences lies about 21 mi (33 km) directly west of Casper. The so-called "angel agates" of Wyoming are found 7 mi (11.5 km) east of Split Rock, just north of the border with Carbon County. These agates are described by Love (1970, p. C79–80) as nodules in sandstone of attractive, pale greenish-gray color and brilliant greenish-yellow fluorescence under UV because of a minute content of uranium. The locality is in the southwest corner of Natrona County, almost due north of Muddy Gap 4.7 mi (8.3 km).

In Converse County, chalcedony is found 9.5 mi (16 km) southeast of Glenrock and also in an area 14 mi (23 km) east-southeast of Douglas. "Youngite" agate comes from a place 9 mi (15 km) west-southwest of Lusk in Niobrara County. Several fields of agate and jasper are located about 7 mi (11.5 km) west-northwest of Flattop, and another area lies about the same distance northeast of Glendo in northern Platte County. "Youngite" and other varieties of agate are found in an area about 10 mi (16 km) southeast of Glendo (Anstey, 1959). In northern Albany County, many collecting areas for chalcedonic quartzes lie along an axis that parallels the west slope of the Laramie Mountains beginning at Specimen Hill near Little Medicine, thence southeastward, with interruptions, for about 40 mi (55 km).

In Carbon County, a very broad petrified wood field is centered about 13 mi (20 km) west-southwest of Little Medicine in the northeast corner of the county. Banded iron-jasper (jaspilite) occurs in an area about 9 mi (13 km) west-northwest of Seminoe Dam. The famous Eden Valley petrified woods, also agates, occur in a wide area that extends about 13 mi (20 km) north-northwest of Farson and partly into Sublette and Sweetwater counties, extending eastward for about 13 mi (20 km), thence southeastward to a point about 19 mi (30 km) almost due east of Farson (Pluard, 1978; Spendlove, 1992). Oolitic agate and silicified algae occur in an area about 33 mi (52 km) east-northeast of Farson. Another agate field lies 21 mi (33 km) north of Thayer Junction in Sweetwater County. Also in this county is the famous Blue

Forest of petrified wood, jasper, and agate, centered about 7.5 mi (14 km) east-northeast of Fontenelle. Spendlove (1991) describes collecting in this area where limb and trunk sections of the wood must be dug up from a featureless sagebrush plain. Most of the limb sections or logs are about 5–6 in (12.5–15 cm) in diameter, usually white-encrusted with caliche, light tan to black, and sometimes laced with blue chalcedony crack-fillings. Spendlove experimented with dipping limb sections into dilute hydrochloric (muriatic) acid to dissolve the adhering caliche, with success. In this same general region, another petrified wood field lies 15 mi (24 km) east-southeast of Fontenelle; other areas are 13 mi (20 km) south-southeast of Fontenelle, and 16 mi (25 km) southwest of same but now in Lincoln County.

In Albany County, agate, jasper, and other chalcedonic varieties are found 8 mi (12 km) northeast of Laramie; another area is 9 mi (14 km) south-southeast of Woods Landing near the Colorado border. Amethyst is reported in an area about 8 mi (13 km) north-northeast of this place in the Sheep Mountains.

In southern Carbon County, an agate-wood field is centered 8 mi (13 km) north of Saratoga. In the western portion, wood is found in an area lying just to the east of the road that connects Wamsutter to Baggs, or about 14 mi (22 km) south of Wamsutter.

In southern Sweetwater County, occurs the well-known *goniobasis* ("turritella") agate, also oolitic agate, silicified wood, and silicified algae. These are found within a broad field that is about 20 mi (36 km) along an east-west axis south of Tipton, commencing 4 mi (5 km) south of that town and continuing south for a distance of about 19 mi (31 km). Farther west in this county goniobasis agate is found in a field of about 27 mi (44 km) that lies between Granger and Green River. Other collecting areas in Sweetwater County are described by Mitchell (1982). Kirkby (1962) provided an early description of the so-called "turritella agate," by which name it continues to be known among lapidaries. Then in 1969, the *Lapidary Journal* (23, 6, p. 887) drew attention to the fact that the popular name was a misnomer since the spiral agatized shells are actually *Goniobasis*, genus *Oxytrema*. A map of the collecting area appears in Gregory (1969), and another in a note on fossils in Wyoming in *Gems & Minerals* (No. 426, p. 20–23). A recent article on this material is by Dolenc (1979), who tells of his collecting experiences and notes that "there are millions of tons of agate and there is absolutely no digging [needed]." Dolenc updated this report in 1981, and used photographs to show the enormous outcrops of this material. Despite its abundance, "turritella agate" is used only sparingly in tumbled stones because its sole attractive feature is the patterning of the whitish shells when cut through and polished, but the brown matrix is dull and, frankly, unattractive.

Elsewhere in Sweetwater County, an agate and wood field lies 15 mi (24 km) almost due north of Granger, and between that town and west nearly 14 mi (23 km) lies another agate field centered on Nutria. About 12 mi (18 km) south-southwest of Kemmerer is another agate-wood field. Agate and jasper also occur in several smaller areas centered about 14 mi (22 km) north of McKinnon in Lincoln County.

In Uinta County, silicified algae and silicified mudstone are found in an area 7 mi (11 km) east-southeast of Mountain View, and silicified shell material in an area 3 mi (5 km) northwest of Lone Tree. Mitchell (1983) describes several agate-collecting places around Carter and north of Fort Bridger.

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COLORADO. The recent paper on Colorado quartzes by Kile, *et al* (1991) and another by Muntyan & Muntyan (1985) are the first to adequately describe occurrences on a state-wide basis and without neglecting the gem varieties. A considerably earlier work by Ransom (1955, p. 35–39) devotes much space to the fossil forests, including opalized wood and the famous Florissant petrified forest. Kile, *et al* documents so many localities for silicified wood in the eastern Great Plains portion of the state that it strongly suggests that further finds will be made wherever erosion has exposed the alluvial beds in which the wood is found. Occurrences are reported all the way from Julesburg in the extreme northeastern corner to south of Lamar over a N-S distance of about 250 mi (420 km). Finds made in the vicinity of Denver, south to Colorado Springs, further suggest that the belt is approximately 140 mi (225 km) broad. Further occurrences of wood in the adjacent Oklahoma Panhandle/Nebraska region have been mentioned above. Kile, *et al* notes that "petrified wood in eastern Colorado is generally well silicified and locally abundant in gullies, road cuts, or isolated outcrops; it ranges in size from tumbling chips to enormous logs" and "lapidary material from this widespread area is often underappreciated; colors range from subdued brown to dark brown and black and occasionally to a distinct red."

Some outstanding silicified wood areas are Cherry Creek, southeast of Denver, Arapahoe County; the Parker-Franktown-Elbert area in Douglas and Elbert counties; the Calhan-Payton area in El Paso County; the La Junta-Lamar areas; and south, in Otero, Bent, and Prowers counties. Some of the best silicified wood is found in a small area about midway between the towns of Lake City and Gunnison, Gunnison County. In the extreme southeast of the state, Mitchell (1987) notes petrified wood in an area in Baca County where Colorado, Oklahoma, and Kansas meet. Much wood also occurs along a nearly 100 mi (160 km) stretch of Highway 141 from Whitewater in the north in Mesa County south to Naturita in Montrose County.

Colorado, however, is far better known domestically and internationally for its splendid smoky quartz crystals that occur with feldspar (amazonite) in granitic pegmatites in the central region of the state. These are still being found as local collectors learn to interpret surface signs that may lead below to hidden veins and cavities (Muntyan & Muntyan, 1985; Kile, *et al*, 1991). Many crystals are faceting grade but their abundance insures that only the occasional crystal is cut up for gems. Sometimes the quantity of crystals found in a single pocket goes into the hundreds of pounds and Muntyan & Muntyan record individual crystals weighing more than 100 lb (45 kg) and reaching lengths of 12 in (30 cm) or more. Interesting accounts of collecting experiences are provided by Close (1969), Hantla (1969), Swindle (1976), and Vaughan (1979). On the peaks of Antero, White, and Shavano, smoky quartz is found in the pockets which are principally sought for their aquamarine crystals (*see* BERYL). Some of these crystals are 18 in (45 cm) long and 6 in (15 cm) in diameter but most are considerably smaller and clearer.

Overgrowths of amethyst and of bladed goethite on smoky quartz crystals of the Pikes Peak granite are described by Swindle (1982), who notes that some of the amethyst contains bright yellow goethite inclusions in an amethyst variety that has been called "onegite" after its occurrence on an island in Lake Onega in Russia's Karelia. Unfortunately, nothing was said as to the suitability of this material for lapidary work.

Michalski (1984) and Kile, *et al* (1991) summarize occurrences of gem amethyst in Colorado. The northernmost site is in the Red Feather Lakes area of Larimer County, northeast of Fort Collins via State Highway 10. This deposit was discovered in 1923 by R. C. Coffin of Fort Collins and has been worked sporadically ever since. Originally, it was called the Pennoyer Amethyst Mine, and recently, the Rainbow Lode. The amethyst crystals occur in clay-filled cavities within quartz veins that cut Precambrian granite. The *Montrose Daily Press* of September 10, 1987, announced a new discovery of amethyst by Nick Fennell, a partner in the mining venture exploiting the deposit. The owners, Nick Fennell and B. Dunbar recovered about 2,000 lb (900 kg) of unsorted material, from which about 990 lb (450 kg) of single crystals were sorted out (Koivula, 1987). The facet material is medium to dark purple but flawless gems of only one to nine carats can be cut as a rule.

Marginal gem quality amethyst is reported from Glen Cove on the north side of Pikes Peak, Teller County, and it is said that considerable material was produced in the early 1900s, probably from quartz veins in granite. Fine crystals, but again only marginally useful for faceted gems, were once found in Poverty Gulch, Cripple Creek, Teller County.

From Goethite Hill, near Lake George, Park County, comes a very dark hued amethyst as core material in otherwise colorless quartz crystals which according to R. & T. Kosnar (*Pers. comm.* 8/10/1994), "will cut clean stones up to 2 cts." Rough found by Rich Kosnar in 1975 at Crystal Creek nearby yielded a 5.60 ct round brilliant flawless faceted gem of "finest color amethyst."

In the early 1900s, deep purple tumbling quality amethyst from quartz veins in Precambrian granite was found in Fremont County near Howard, east of Salida, along Little Badger Creek. Kile, *et al* (1991) mentions amethyst from the Endicott Mine, an occurrence first published by Sterrett (1908, 1909). In Saguache County, the Crystal Hill Tertiary volcanic breccia pipe near Beidell Creek, northwest of the town of La Garita, furnished amethyst crystals up to 3 to 5 in (7.5–12.5 cm) but only small areas were clear enough to cut faceted gems (Michalski, 1984).

The mine dumps in the Creede area, Mineral County, still furnish the typically banded vug linings that consist of pale amethyst, milky quartz, chalcedony, and minor sulfides. Collecting experiences and guides to the collecting sites are given by Towner (1969), Dickerson (1970), and Harringer (1974). In Mesa County, some "Siberian quality" amethyst of facet grade has been mined from the Amethyst Queen Mine in Unaweep Canyon, south of Grand Junction (Kile, *et al*, 1991). Specimen crystals, sometimes of large size, and cutting material were recovered in the late 1970s and early 1980s, while some was found as late as the early 1990s. In 1976, Rich Kosnar of Golden, Colorado, mined rough from this deposit which furnished a faceted flawless gem of "fairly dark purple" color of 41.40 cts. The deposit is remarkable for its amethyst crystals occurring in calcite veins that cut Precambrian and Mesozoic rocks. Small faceted gems can also be cut from amethyst found in the Discovery Ore Shoot, Camp Bird Mine, Ouray County, and from the Argentine Vein, Idarado Mine, Telluride, San Miguel County, according to Kosnar *(Ibid.)*.

Rose quartz of lapidary grade has been found in the Devil's Hole Mine, east of Salida, Fremont County, in a granitic pegmatite (Hodgson, 1993). This body lies in the Texas Creek pegmatite field located about 25 mi (40 km) west of Cañon City on Highway 50. According to Hodgson, "several thousand tons of excellent grade have been removed and many thousand more tons are available," but it is noted that much is shattered because of the use of explosives in the quarry. Some masses of rose quartz measured 2 ft (0.6 m) across. Rose quartz also occurs in the Crystal Silica Mine near the summit of Crystal Mountain.

In one of the earliest accounts of Colorado gemstones, Hollister (1867) stated that moss agates are abundant in Colorado "but the best are from Middle Park." He also mentions aventurine quartz "from Elk Creek, five miles above the Old St. Louis Ranch," and chalcedonic quartzes as "very beautiful specimens from the South Park, five miles from the Salt Works," also silicified wood in "Middle Park, South Park, Cherry Creek, near Denver, Kiowa Creek, and the Plains generally, from Julesburg to Cañon City."

Jones (1992) draws attention to the large variety of chalcedonic quartzes that were found recently in a single volcanic basalt sill in Grand County. The occurrence is in one of a series of basalt flows in which chalcedony fills fissures, forms replacements and pseudomorphs, and is found lining geodes. The most important gemstone is bloodstone, first found here in 1991 by Kathy Faulkner. According to Jones, "the quality of the material equals that from India." A yellow and red streaked material found here in 1986 has been called "firestone" because of its flame-like color patterns.

Kile, *et al* (1991) describes a colorful "flower" or "garden agate" that occurs in the Morrison formation rocks near the town of Ninaview in Bent County where it forms ledges up to 6 in (15 cm) thick and traceable laterally for 100 ft (30.5 m). Voynick (1991) mentions gem chrysoprase as occurring in the gangue minerals at the Creede mines, best known for their amethyst (*see above*). He writes that "some of the gem-quality, deeply colored chrysoprase has been cut and polished;

the color was sometimes so intense that the cabochons were mistaken for—and sold as—turquoise."

In Saguache County, plume and moss agate, "as fine as any in the world, occur near the Twin Mountains area, northwest of the town of Del Norte," where it is found in thunder eggs in Tertiary rhyolite of the Conejos formation; it is also found in thunder eggs near Houselog Creek, southwest of Saguache.

At the Tucson Show of 1992, a dealer offered gold in quartz of cabochon grade that came from the Sunnyside Mine, Eureka Gulch, Gladstone, San Juan County. The cabochons were 1–1.5 in (3–4 cm) in diameter, showing obvious specks of gold in a fine-grained quartzite matrix of slightly grayish color. One remarkable cabochon with an excellent display of native gold measured 2.5 in (6 cm) across. Mitchell (1976) reported a turquoise-like mixture of chalcedony and celadonite from the Blue Sky Mine, near Rainbow Trout Lodge, Conejos Canyon, Conejos County.

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HARRINGER, R. (1974) Minerals of the San Juan mining region, Colorado. *Lapidary J.* 28, 4, p. 656–662, illust., maps. Creede amethyst.

HODGSON, K. (1993) The Devil's Hole Mine. *Rock & Gem* 23, 12, p. 58–59, 61, 88.

HOLLISTER, O. J. (1867) *The Mines of Colorado.* Springfield, MA: Samuel Bowley & Co., 450 p. Colorado minerals p. 396–415 by J. Alden Smith.

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KILE, P. E., MODRESKI, P. J. & KILE, D. L. (1991) Colorado quartz: Occurrences and discovery. *Rocks & Minerals* 66, 5, p. 374–406, illust., map.

KOIVULA, J. I., ed. (1987) Gem news: Colorado amethyst find. *Gems & Gemology* 23, 4, p. 240

LAKES, A. (1896) Quartz. *Colliery Engineer,* Scranton, PA, 17, p. 307. Amethyst: Creede and Cripple Creek.

LONGYEAR, B. O. (1939) Collecting amethyst in Colorado. *The Mineralogist* 7, 7, p. 270–271. Red Feather Lakes.

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MICHALSKI, T. C. (1984) Colorado amethyst. *Rocks & Minerals* 59, 1, p. 6–12, illust.

MITCHELL, R. S. (1976) A turquoise-like mixture of chalcedony and celadonite from Conejos County, Colorado. *Rocks & Minerals* 51, 8, p. 394–395.

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REITSCH, C. W. (1939) Smoky quartz and amazonstone at Pine Creek, Colorado. *Rocks & Minerals* 14, 9, p. 270–271.

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STEIN, J. F. (1956) Rockhounding along the South Platte River. *Lapidary J.* 10, l, p. 34–36, map.

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_____, (1909) Same, *Ibid.* for 1908, pt. 2., p. 805–809.

SWINDLE, L. J. (1976) A surprising find. *Lapidary J.* 29, 11, p. 2128–2130, illust. Smoky quartz pocket, Pikes Peak area.

_____, (1982) Amethyst quartz with goethite inclusions. *Ibid.* 36, 1, p. 144–157, passim, illust.

TOWNER, J. M. (1969) Rockhounding at Creede, Colorado. *Lapidary J.* 23, 9, p. 1286–1291, illust., map. Amethyst.

TROUT, P. W. (1974) Colorado's orphan gemstone-sowbelly agate. *Lapidary J.* 28, 5, p. 798–802, illust. Banded agate at Grand Mesa.

VAUGHN, H, (1979) She was a good old pocket. *Lapidary J.* 32, 11, p. 2460–2464, illust. Smoky quartz, Crystal Peak area.

VOYNICK, S. (1991) Creede, Colorado. *Rock & Gem* 21, 12, p. 68–75, map.

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WAHLSTROM, E. E. (1941) Hydrothermal deposits in the Specimen Mountain volcanics, Rocky Mountain National Park, Colorado. *Amer. Mineral.* 26, p. 551–561. Chalcedonies.

WEIGHT, H. O. (1950) Ridge of the terrible lizards. *Desert Mag.* 13, 6, p. 10–15, illust. Silicified dinosaur bone.

WHITE, G. M. (1935) The Crystal Peak region near Florissant, Colorado. *Rocks & Minerals* 10, 12, p. 184–187. Smoky quartz.

NEW MEXICO. The silicified wood of this state drew the attention of early explorers and travelers as told by Knowlton (1888) and Ward (1889), the latter noting that from what is now McKinley County came "one of the huge logs that now lies in front of the U.S. National Museum [in Washington, D.C.]" and which "was obtained by Col. P. T. Swaine, U.S. Army, from a mesa two miles north of Fort Wingate." A fine account of early discoveries of silicified wood in this region is given by Ash (1969) concerning the logs found in the Chinle formation which outcrops in other places in the Four Corners region of the Southwest. Ash notes the use of Triassic wood by the American Indians not only for arrowheads and other small objects but for "large blocks as building stones in their houses in the Petrified Forest National Park in northeastern Arizona." One such hut whose walls are entirely silicified wood is shown in his Figure 3 (p. D4) while Figure 4 (p. D6) shows a group of explorers using a huge log as a convenient resting bench; "this is the first illustration of Triassic plant remains from what is now southwestern United States to be published." The original engraving was published in the Whipple Expedition account of 1854, p. 74 (*see under* ARIZONA).

In regard to other sources of wood, see the still useful account of Ransom (1955), Northrop (1959, p. 429 ff), Berkholz (1960, 1961), Simpson (1961), Spendlove (1977), Kimbler & Narsavage (1981), and the recent accounts by Mitchell (1983, 1987). The wood of the Four Corners region is also described by Kappele (1994).

ASH, S. R. (1969) Ferns from the Chinle formation (Upper Triassic) in the Fort Wingate area, New Mexico. *U.S. Geol. Survey Prof. Paper* 613-D, 52 p., plates, figures.

BERKHOLZ, M. F. (1960) Petrified wood on the Rio

Puerco. *Gems & Minerals* 276, p. 33–34, map. West of Las Lunas.

BRUES, C. T. (1936) Evidences of insect activity preserved in fossil wood. *J. Paleont.* 10, p. 637–643. San Juan County.

CLAYTON, N. (1980) Abiquiu agate. *Gems & Minerals* 515, p. 42–45, maps.

DICKERSON, B. (1974) Hunting Laguna. *Gems & Minerals* 438, p. 31, 41, map. Apache National Forest northwest of Luna.

_____, (1978) Hunting Luna agate. *Rockhound* 7, 5, p. 27–28.

ELLERMEIER, G. B. (1936) Some New Mexico agates. *Rocks & Minerals* 11, 9, p. 167.

HAMLEY, T. (1978) Adventures on a Deming rock trip. *Lapidary J.* 31, 12, p. 2526, 2527, maps.

HARRINGTON, E. R. (1939) Forests turned to stone. *New Mexico Mag.* 17, 4, p. 16–17.

HILTON, T. (1972) Prospecting in New Mexico. *Lapidary J.* 25, 10, p. 1391–1393, illust. Cimarron River agate.

HOUGE, N. L. (1964) Agate near Luna, New Mexico. *Gems & Minerals* 323, p. 24, map.

_____, (1964) Apache agate and tears. *Ibid.* 326, p. 24, 25, maps.

KAPPELE, W. A. (1994) The fossil wood of La Plata road. *Rock & Gem* 24, 5, p. 60–62, 64, 76, 77, illust. (col.), map.

KIMBLER, F. S. & NARSAVAGE, R. J. (1981) *New Mexico Rocks & Minerals: The Collecting Guide.* Santa Fe, NM: Sunstone Press, 71 p., illust. (col.), maps.

KNOWLTON, F. H. (1888) New species of fossil wood (Araucaroxylon arizonicum) from Arizona and New Mexico. *U.S. Nat. Mus. Proc.* 1888, vol. 11, p. 1–4.

MANNING, C. L. (1941) Jornada Valley agates. *The Mineralogist* 9, p. 207.

McCANN, F. T. (1940) A new source for agate artifacts in central New Mexico. *Science* 92, p. 259.

McMACKIN, C. E. (1974) White chalcedony and bacon agate neglected material. *Lapidary J.* 28, 5, p. 855–857.

_____, (1977) Collecting "candy rock" and agate nodules in the Deming, New Mexico, area. *Ibid.* 31, 4, p. 986–991, illust.

MITCHELL, J. R. (1983) The Bisti Badlands. *Rock & Gem* 13, 5, p. 40–41, map. Areas south of Farmington.

MITCHELL, J. R. (1987) *Gem Trails of New Mexico.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

_____, (1990) Albuquerque agate. *Rock & Gem* 20, 8, p. 24–27, map.

MURPHY, M. O. (1955) Gem hunting along the Rio Puerco. *Gems & Minerals* 211, p. 20–22, map.

_____, (1961) Agate, jasper and wood in the Land of Enchantment. *Lapidary J.* 15, 2, p. 266–270, illust.

_____, (1970) Red is for Rio Puerco. *Ibid.* 24, 8, p. 1062–1067, *passim*, maps.

NEELY, L. M. (1946) Two agate fields in New Mexico. *Rocks & Minerals* 21, 3, p. 139–140.

_____, (1946) Jeffers agate field in New Mexico. *Ibid.* 21, 7, p. 430–431.

NORTHROP, S. A. & POPEJOY, T. L. (1931) Going places and seeing things. *Univ. NM, NM Alumnus* 4, 9, p. 10–12. Petrified wood near Cerillos.

NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ. New Mexico Press, 665 p., map.

PERSON, R. A. (1976) Agate on Flaking Stone Mountain. *Gems & Minerals* 462, p. 10–11, 71–73, map. Approx. 5 mi SE of Youngsville.

RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: Mineralogist Publ. Co., 80 p., illust. NM p. 33.

SIMPSON, B. W. (1961) *New Mexico Gem Trails.* Granbury, TX: Gem Trails Publ. Co., 88 p., illust., maps.

SPENDLOVE, E. (1977) Chaco Canyon chalcedony. *Rock & Gem* 7, 3, p. 36–40, map.

TRUMBO, T. M. (1951) Carnelian is where you find it. *Mineral Notes & News* 166, p. 7, 23. NE of Deming about 14 mi.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey, 8th Ann. Rept*, part 2, p. 663–960, map.

WOODS, B. (1947) Trees of stone. *New Mexico Mag.* 25, 4, p. 13–14.

ZEITNER, J. C. (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps. NM p. 10–52.

IDAHO. Gem-grade smoky quartz crystals are being produced from pockets in granitic rocks in the state but few are cut into gems; most by far are preserved as handsome cabinet specimens. Ream (1989, p. 52–94) devotes much space to describing occurrences in the Sawtooth Mountains of central Idaho, and in an earlier treatise (1972) he describes the well-known occurrences in the Dismal Swamp area. A recent account of collecting smoky quartz in geological circumstances similar to those found in the Sawtooth Mountains is given by Maggart (1983) for finds in the Bitterroot Mountains but without specific localities.

Far more important than the above are the chalcedonic quartz varieties that continue to be mined at many points in the state. Preeminent among these is the now famous Bruneau jasper that is found as nodular masses in a dense gray rhyolite in the canyon of the west fork of the Bruneau River in Owhyee County approximately 14 mi (22 km) east-southeast of Grasmere, or about 28 mi (46 km) almost due south of Bruneau Hot Springs. According to Walton (1978), who visited the site, the jasper was known as early as 1958, but since no road led to the deposit, collecting was sporadic. However, by the time of his visit, a difficultly traversed four-wheel drive road led to a quarry site located about 500 ft (152 m) above the river. At this time Gene Anthis of Twin Falls, Idaho, was working the deposit, using explosives to break up the rock, then bulldozing to turn it over and allow examination of the blasting debris. Sometimes the nodules fell free of matrix but more often they had to be separated by hammering. In 1988, it was reported that the property was owned and operated by Lowell Fields (Mayerle, 1988), with the site located at an altitude of 4,800 ft (1,460 m), in lat. 42°20'15"N and long. 115° 39'W. According to Mayerle, the Bruneau jasper is prized "because it occurs in tan, brown, green and red colors in patterns of enclosed circles or adjoining semicircles that have been likened to stylized clouds." Further, "the jasper occurs in veins or vugs in a rhyolite where it was deposited by hydrothermal waters." The esteem in which this handsome material is held can be seen in the praise given to it by Roger Caillois (1985) whose fascinating color-illustrated book deals with natural patterns in all manner of stones, with Bruneau jasper represented in a double-page photograph (p. 72–73). Another specimen appears on p. 76.

A similar jasper, occurring predominantly in light to dark chocolate browns and showing banding or overlapping circular areas, is being mined on Willow Creek, about 20 mi (32 km) northwest of Boise, Ada County. According to Beckwith (1977, p. 34), "the best gem quality material came from a small area on the north side of the west end of Eagle Box Canyon." Here it occurs as nodular masses and veins in rhyolite and is "delicately colored in tints of yellow, purple, pink, and green." However, at the Tucson Show of 1994, Willow Creek jasper was being offered in rough and cut forms by B+C Mining of Minneapolis, Minnesota, but in the restricted color range noted previously. The cabochons display a fine, glassy polish which indicates that the material is extremely fine-grained and compact in structure.

Numerous localities for quartz gemstones in Idaho may be found in Beckwith (1977), Ream (1992), and Ransom (1962), the last dealing primarily with petrified wood.

ANDREWS, H. N. & JERN, E. M. (1947) The Idaho *Tempskyas* and associated fossil plants. *Missouri Botan. Garden Annals* 34, 2, p. 110–183–186, illust.

BECKWITH, J. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: Caxton Printers, 129 p., illust., maps.

BRADBURY, F. (1977) A miniature mountain of agate. *Gems & Minerals* 480, p. 49, 50, 55, 56, map. Spar Canyon, S of Challis.

BURRESS, R. (1975) Search for Sage Creek gemstones. *Gems & Minerals* 454, p. 64–65, map. Agate, opal near Midvale.

CALLOIS, R. (1985) *The Writing of Stones.* Charlottesville, VA: Univ. Press of Virginia, 108 p., illust. (col.).

DAKE, H. C. (1938) Manns Creek petrified forest. *The Mineralogist* 6, p. 9–10.

_____, (1942) Latah petrified forests. *Ibid.* 13, p. 339–340, 352–353.

_____, (1962) *Northwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 95 p., illust., maps.

FERNQUIST, C. O. (1934) Gem minerals of Idaho. *Oregon Mineralogist* 2, 2, p. 6, 14–16.

_____, (1947) The gem minerals of Idaho. *The Mineralogist* 15, p. 510–513.

HANSON, L. (1956) Gems of Idaho. *Lapidary J.* 10, 1, p. 56–61, maps.

HENRY, D. J. (1953) *The Rock Collector's Nevada and Idaho.* Long Beach, CA: Lowell R. Gordon, 72 p., maps.

JACKSON, M. W. (1972) Good pickings in the deserts of Idaho. *Rock & Gem* 2, 5, p. 22–25, illust., map. Bruneau wood, Owhyee Co.

JOHNSON, R. N. (1972) N.W. *Gem Fields and Ghost Town Atlas.* 3rd edit. Susanville, CA: Cy Johnson & Son, 48 p., maps.

MAGGART, H. (1983) Smoky quartz crystals in the Bitterroots. *Lapidary J.* 36, 11, p. 1906–1907, illust.

MAYDOLE, H. (1972) Sequoia trunk produces opal and agate "Jureano wood." *Rocks & Minerals* 47, 5, p. 310, illust.

MAYERLE, R. T. (1988) *Memorandum to Gordon T. Austin,* U.S. Bur. Mines, Wash., DC, on gemstones of Idaho (prelim. rept.), Oct. 14; enclosure.

MITCHELL, J. R. (1982) North of Weiser. *Rock & Gem* 12, 5, p. 28–31, map.

______, (1982) Agate, jasper, and opalized wood between Homedale, Idaho, and the Oregon border. *Lapidary J.* 35, 12, p. 2438–2442, illust., map.

______, (1983) Boise wood and jasper. *Rock & Gem* 13, 10, p. 70–73.

OLSON, B. (1938) Gem minerals of the region around Orofino, Idaho. *Rocks & Minerals* 13, 5, p. 148–149.

REAM, L. R. (1992) *Idaho Minerals.* Coeur d'Alene, ID: L. R. Ream Publ. Co., 329 p., illust., maps.

______, (1992) *The Gem & Mineral Collector's Guide to Idaho.* Vol. 1. *Ibid.* 34 p., illust., maps.

RODGERS, J. (1969) A visit to Succor Creek. *Lapidary J.* 23, 2, p. 324–328, illust., map. Thunder eggs in SW Idaho.

ROOT, J. V. (1971) Bruneau wood. *Gems & Minerals* 409, p. 36–37.

SELDE, V. (1984) Idaho earthquake agate. *Rock & Gem* 14, 11, p. 36–39, map. Salmon River Valley from Stanley to Salmon.

SHANNON, E. V. (1926) The minerals of Idaho. *U.S. Nat. Mus. Bull.* 131, 483 p., illust. Quartz p. 177–181.

SPENDLOVE, E. (1992) Bruneau jasper. *Rock & Gem* 22, 11, p. 44–50, *passim,* illust. (col.).

______, (1994) Cutting cabs of [Bruneau] jasper. *Ibid.* 24, 5, p. 37–41, illust. (col.).

WALTON, M. (1978) Bruneau jasper, a rare gemstone. *Gems & Minerals* 493, p. 72–74.

UTAH. The attractive, bright red silicified horn coral of the Riley Canyon area, east of Francis in Summit County, was described by Simpson (1975, p. 30) and later by Mitchell (1987, p. 34–35), and also by Stowe, *et al* (1977, p. 96). The latter states that the coral occurs as "sections generally 4 inches long" and "gray with some red agatized sections," but Bushman, who collected at the locality while it was under a fee-basis, gave a maximum size of 8 in (20 cm). The shape resembled that of a cow's horn. The deposit apparently extends over a considerable area in limestone and is centered about 7 mi (11 km) east of Francis and northeast of Woodland in the Wasatch National Forest (Spendlove, 1979, 1992). Spendlove identifies the coral as *Caninia contorta.* Hard digging in the underlying rock is required to find the specimens. Lapidary treatment calls for slicing across the stem to expose the radiate growth pattern when the slices are shaped into cabochons. The red color appears to be confined to the agatized portions while the intervening areas are filled with grayish calcite which is much softer than the agate and requires care in sanding and polishing of cabochons and cross-sections to prevent undercutting. According to Spendlove (1979), the color ranges from pure red to carnelian-red and pink. Bushman (1981) notes that "the coral will fluoresce a light green" and "the deeper the red coloring the more it will fluoresce."

Over a broad area in Utah, dinosaur bone, replaced more or less completely by silica, has been collected for many years and fragments sawn into cross-sections and polished to show the cellular bone structure, with some better material made into cabochons (Talbot, 1978). The area extends generally from Vernal in Uintah County southward to Moab in Grand County. Some of the bone is quite colorful and attractive, and rarely dendrites may be found in cores that have been completely replaced by chalcedony and which then resemble the moss agates of Montana.

In Utah, the most abundant chalcedonic quartz is found in silicified wood, agates, and jaspers, and numerous localities are known for same. Some smoky quartz of facet grade has been found in quartz pegmatite cavities in granite around Rock

Corral in the Mineral Mountains of Beaver County (Stowe, *et al*, 1977; Stowe & Perry, 1979). Specific sites and directions for reaching all types of quartz collecting sites are found in Simpson (1975) and in Mitchell (1987). As can be seen from the numerous references below, virtually every county in southern Utah was visited by collectors for the sake of chalcedonic quartz varieties, especially silicified wood.

BERKHOLZ, M. F. (1959) Petrified wood near Silver Reef. *Gems & Minerals* 262, p. 19–20, 87, illust., maps. S of Leeds.

_____, (1959) Nevada's fantastic sump. *Ibid.* 265, p. 32–34, illust., map. Fish Lake Valley.

_____, (1960) Flower agate in the Red Sand Dunes. *Ibid.* 275, p. 65–68, map. SSW of Hurricane.

_____, (1963) Flame agate in Utah's Chinle. *Gems & Minerals* 310, p. 24–25, map.

BIXBY, M. (1894) Precious and ornamental stones [of Utah]. *Mineral Collector* 1, 1, p. 8–10.

_____, (1916) *A Catalog of Utah Minerals and Locations.* 4th edit. Salt Lake City, UT: priv. publ.; reprinted by UT Geol. Min. Survey, No. 60, 32 + 10 p.

BODTCHER, J. D. (1971) The Clay Point agate field in eastern Utah. *Lapidary J.* 25, 5, p. 704–709, illust.

BULLOCK, K. C., *et al* (1960) *Minerals and Mineral Localities in Utah.* Provo, UT: priv. publ., 170 p.

BULLOCK, K. C. (1967) Minerals of Utah. *UT Geol. Min. Survey Bull.* 76, 237 p., illust., maps.

BUSHMAN, J. (1981) People, places, and plunder: Oregonians visit Utah. *Lapidary J.* 34, 10, p. 2220–2226, illust., maps.

CHATWIN, S. (1965) Horn coral, new Utah gem. *Desert Mag.* 28, p. 54.

EVELETH, J. & EVELETH, C. (1981) An abundance of cutting materials near Utah's Sundial Butte. *Lapidary J.* 35, 4, p. 960–962, illust., map.

GILMORE, R. J. (1959) Smoky quartz crystals. *Gems & Minerals* 261, p. 31–33, illust.

GRETA, L. M. (1981) Along the Red Rock trails—a lesson learned in timing. *Lapidary J.* 35, 3, p. 766–774, illust., map. E of Kanab, Kane Co.

HAYES, J. J. (1944) The agate field of Jericho, Utah. *UT Mineralogical Soc. News Bull.* 5, 2, p. 25–31.

HILTON, J. W. (1940) On the trail of gem rock in Utah. *Desert Mag.* 3, 8, p. 7–9, illust., map.

HUBERT, A. L. (1953) Rock hunting in Utah. *Lapidary J.* 7, 1, p. 36–42, *passim.*

INGALLS, N. (1988) Nephi palm wood. *Rock & Gem* 18, 2, p. 16–19, map.

JOHNSON, R. N. (1983) *Nevada-Utah Gem Atlas.* Susanville, CA: Cy Johnson & Son, 48 p., maps.

JONES, W. R. (1952) Black agate in Milky Wash. *Desert Mag.* 15, 8, p. 11–13, illust., map.

KAPPELLE, W. A. (1992) The backside of Bryce Canyon. *Rock & Gem* 22, 11, p. 60–65, 81, 82, illust. (col.).

KELLY, C. (1948) Rock hunters' wonderland. *Desert Mag.* 11, 8, p. 21–23, illust., map.

McMACKIN, C. E. (1978) Our Cedar Canyon collecting adventure. *Lapidary J.* 32, 5, p. 1316–1321, map. SE of Cedar City agate.

MINOR, W. C. (1937) Rambling round Cisco, Utah. *Rocks & Minerals* 12, 10, p. 302–304.

MITCHELL, J. R. (1983) Agate near Beaver, Utah. *Gems & Minerals* 546, p. 8, 10, 11, map.

_____, (1983) Gem materials in Southern Utah. *Ibid.* 552, p. 16, 17, 26, map. Between Escalante and Boulder.

_____, (1984) Agate, jasper, and opalite near Eureka, Nevada [sic]. *Lapidary J.* 37, 12, p. 1734–1737, illust., map. Actually in Utah.

_____, (1987) *Gem Trails of Utah.* Baldwin Park, CA: Gem Guides Book Co., 111 p., illust., maps.

_____, (1990) West of Hanksville. *Rock & Gem* 20, 1, p. 56–59.

_____, (1991) The gifts of Gabbs. *Ibid.* 21, 3, p. 48–51, map.

NOBES, B. (1970) The wood of Escalante. *Rocks & Minerals* 45, 1, p. 10–13, 15, illust.

OSBORNE, G. C. (1957) Agates of southwestern Utah. *Lapidary J.* 11, 1, p. 38–46, *passim.*

RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: Mineralogist Publ. Co., 80 p., illust.

SIMPSON, B. W. (1975) *Utah Gem Trails.* Glen Rose, TX: Gem Trail Publs., 88 p., illust., maps.

SPENDLOVE, E. (1975) Wolverine petrified wood. *Rock & Gem* 5, 4, p. 70–73, map. SE of Boulder, Circle Cliffs region.

_____, (1976) Wood in the gulch. *Ibid.* 6, 5, p. 40–44, map. Near Boulder.

_____, (1977) Green River nodules. *Ibid.* 7, 5, p. 60–63, map. Floy.

_____, (1977) Utah's pigeon blood agate. *Ibid.* 7, 8, p. 48–51. Floy.

______, (1977) Utah's Cisco agate. *Ibid.* 7, 11, p. 56–61, map.

______, (1978) Plume agate & chalcedony roses. *Ibid.* 8, 3, p. 52–55, map. SE of Beaver.

______, (1980) Fremont River agate. *Ibid.* 10, 7, p. 56, 57, 59, map.

______, (1980) Clay Canyon agate. *Ibid.* 10, 10, p. 36–39, 42, 81, maps.

______, (1981) Sand Creek wood. *Ibid.* 11, 11, p. 52–55, map. N of Torrey.

______, (1985) Silver Creek wood. *Ibid.* 15, 6, p. 40–42, map.

______, (1986) Jericho agate. *Ibid.* 16, 11, p. 36–38, map.

______, (1986) Hansen Creek wood. *Ibid.* 16, 12, p. 36–39, map. Henry Mts.

______, (1989) Petrified wood in the Circle Cliffs. *Ibid.* 19, 11, p. 18–20, 22, 87, map.

______, (1992) Red horn coral. *Ibid.* 22, 2, p. 52–54, 84–87, map.

STEWART, K. (1960) Gem localities in Utah. *Lapidary J.* 14, 1, p. 20.

STOWE, C. H., *et al* (1977) *Collector's Guide to Mineral and Fossil Localities in Utah.* UT Geol. Min. Survey, 112 p., maps (col., pocket).

STOWE, C. H. & PERRY, L. I. (1979) Rockhound guide to mineral and fossil localities in Utah. *UT Geol. Min. Survey Circ.* 63, 79 p., maps.

STRONG, M. F. (1978) Collecting woods in the Southwest. *Gems & Minerals* 487, p. 17–19, 74, 76, illust., maps. Little Creek Mnts.; Leeds.

______, (1984) Brianhead agate at Cedar Breaks. *Ibid.* 562, p. 10, 11, 28, 29, 31, map.

TALBOT, V. (1978) Beauty and the beast. *Lapidary J.* 32, 6, p. 1260–1266, *passim*, illust. (col.).

TROUT, P. W. (1979) Utah's amazing plateau. *Rock & Gem* 9, 6, p. 44–48, 62, 63, map. Agate, etc., between Hanksville-Capitol Reef.

WARD, L. F. (1889) The geographical distribution of fossil plants. *U.S. Geol. Survey 8th Ann. Rept.*, part 2, p. 663–960.

WEIGHT, H. O. (1947) They call it "Petrified Hollow." *Desert Mag.* 10, 6, p. 5–9, illust. Wood near Kanab.

______, (1950) Black wood in Utah's White Canyon. *Ibid.* 13, 5, p. 14–19, illust., map.

______, (1950) Rocks where the rivers meet. *Ibid.* 13, 9, p. 9–13, illust., map.

______, (1951) Rocks of the ages—in Utah. *Ibid.* 14, 8, p. 11–15, illust., map. Chalcedonies near Green River.

NEVADA. Remarkable limb casts in pink, highly translucent chalcedony that is completely textureless and which resembles nothing more than a pink wax are found in the Texas Spring area of Elko County about 10 mi (16 km) by road southwest of San Jacinto or about 4 air mi (6.3 km) due east of Contact on Highway 93. Also found here are nodules of "snakeskin" agate, so called because the surfaces of the nodular masses are uniformly crackled in patterns reminiscent of snakeskin scales. These too consist of translucent pink chalcedony (Dickerson, 1975; Spendlove 1978). This material strongly resembles the Oregon snakeskin agate which is known to readily accept chemical dyes, and it too may be able to do so, although nothing has been published to support this possibility.

Mr. Christopher W. Ralph of Reno informs me of his experiences collecting amethyst in the mines of Virginia City (Comstock Lode) during the early 1980s when he worked as a mining engineer for a gold-silver mining company (*Pers. comm.* 5/28/93). He notes that "during that time I collected about two ounces of facet grade material and a few pounds of carving grade and specimen material. The color is a good medium purple and the facet material is suitable for cutting clean stones of up to about 2 carats." Apparently amethyst occurs in a number of mines on the lode "but is not common or abundant at any location. Only a few of the many dumps contain enough amethyst material to make hunting worthwhile."

Johnson (1977, p. 86) provides a note on the occurrence of a rare quartz gem material that is colored by numerous fibrous inclusions of pink dumortierite in the open pit of the Champion Mine, 5.2 mi (8.3 km) east of Oreana, Sacramento District, Pershing County. This material has been previously noted in the earlier volumes of this work.

The term "lahontanite" has been applied to a kind of jasper that occurs in boulders at some unspecified place in the vicinity of Fallon, Churchill County. According to Schneider

(1977), "the material will have a base color of cream, pink, green or lavender. This in turn is shot through with runners or fingers of darker green or red or other colors." The material is exceptionally compact and takes a fine polish. For guides to numerous localities in the state, *see* Klein (1983) and Mitchell (1991).

One of the best places in the West to obtain scepter quartz crystals, also rock crystal, smoky quartz, and some amethyst of facet grade, is popularly known as Hallelujah Junction, after the nearby intersection of Highways 70 & 395 in Plumas County, California. However, the collecting site is actually just across the border in Nevada and is reached from the junction by traveling north about 6 mi (9.4 km) and then turning east about a mile to the southern slopes and summit of Hallelujah or Peterson Mountain. The exact place is now in the extreme western edge of Washoe County, Nevada (Ferguson, 1981; Ream, 1992; *Pers. comm.*, R. W. Ralph, 4/28/93). According to Ream, the cavities containing crystals are vugs within quartz veins that traverse partly decomposed granodiorite. The rock is sufficiently friable so that a backhoe, used by the mine owners/operators, Mr. Foster Hallman of Reno, Nevada and Mr. Robert Jackson of Renton, Washington, is used to dig into the granodiorite to follow veins of quartz. In addition to facetable rock crystal, smoky quartz, and amethyst, some pale citrine of cutting grade has been found. Ralph notes that some of the smoky quartz is too dark for cutting faceted gems more than two carats in weight. The rare green color phase of quartz, suitable for small faceted gems, was found here in 1979 by Paradise (1982) who examined "pebbly talus below steep basalt-andesite cliffs approximately one-half kilometer to the east of Interstate Highway 395, 33 km (19 mi) north of Reno, Nevada." Specimens of amethyst, citrine, and green quartz were found in detritus at the cliff base with indications that the quartz had formed in the inaccessible basalt-andesite cliffs. Paradise provides colored photographs of faceted green quartz (4.99 ct), citrine (5.74 ct), light amethyst (19.30 ct) and a faceted dark amethyst of 3.77 ct. It is suggested that the conversion of amethyst to citrine and green quartz in this deposit was due to heating by igneous rock intrusions in the area. It is possible that this area is in Plumas County, California, rather than in Nevada, as its exact position has not been established.

BERKHOLZ, M. F. (1957) Petrified wood in the Broken Hills. *Gems & Minerals* 240, p. 26–28, map. S of Fernley.

______, (1957) Petrified wood in the Broken Hills. *Ibid.* 241, p. 38, 40, 42, map. Churchill Co.

______, (1961) Goldfield gem claim. *Ibid.* 287, p. 24–25, illust., map.

______, (1963) Wood in the Volcanic Hills. *Ibid.* 311, p. 16–19, map.

CONROTTO, E. L. (1959) Gem banks on the shores of Lake Mead. *Desert Mag.*, March, p. 36–39, map.

GREULICH, F. G. (1937) Reno club observes annual field trip. *Rocks & Minerals* 12, 10, p. 291–296. Dumortierite quartz, Pershing County.

MITCHELL, J. R. (1981) The Sump. *Gems & Minerals* 529, p. 34–38, map.

______, (1981) A wide variety of cutting materials between Coaldale and Gilbert, Nevada. *Lapidary J.* 35, 2, p. 440–442, illust. (col.), map.

______, (1984) Agate, jasper, and opalite near Eureka, Nevada. *Ibid.* 37, 12, p. 1734–1736, illust., map.

______, (1991) *Gem Trails of Nevada.* Baldwin Park, CA: Gem Guides Book Co., 119 p., illust., maps.

______, (1991) West of Tonopah. *Rock & Gem* 21, 8, p. 52–55, 70, maps.

______, (1992) Las Vegas jackpot. *Ibid.* 22, 2, p. 18–20, 22, map.

MURBARGER, N. (1951) On Black Rock Desert trails. *Desert Mag.* 14, 9, p. 15–20. Silicified wood near Gerlach.

______, (1955) Rock hunting along pioneer trails. *Ibid.* 18, 7, p. 16–20, illust., map. Near Lovelock.

______, (1957) Gemstone trails in the Pancake Range. *Ibid.* 20, 12, p. 8–12, illust., map.

NACHMAN, F. L. (1977) Chalcedony in Nevada. *Rock & Gem* 7, 6, p. 82–85, map. SSW of Tonopah.

NAPIER, C. E. (1959) Five gem and mineral field trips in the Hoover Dam area. *Desert Mag.*, August, p. 36–37, map.

PARADISE, T. R. (1982) The natural formation and occurrence of green quartz. *Gems & Gemology* 18, 1, p. 39–42, illust. (col.), map.

PIERCE, M. L. (1970) *The Nevada Rock Finder.* Carson City, NV: Brittain Print., 41 p., maps.
RANSOM, J. E. (1955) *Petrified Forest Trails.* Portland, OR: Mineralogist Publ. Co., 80 p., illust.
REAM, L. R. (1992) Collecting quartz at Peterson Mtn., Nevada. *Mineral News* 8, 7, p. 1, 4, 5.
ROBERTSON, D. (1975) Tuledad agate. *Rock & Gem* 5, 2, p. 36–40. West of Duck Lake.
______, (1981) Tonopah wood & agate. *Ibid.* 11, 7, p. 22–25, map.
SASSER, C. W. (1985) Rockhounding in wild horse country. *Lapidary J.* 39, 4, p. 31–37, illust. North of Tonopah.
SCHNEIDER, J. (1977) "Lahontanite"—what is it? *Lapidary J.* 31, 9, p. 2032–2033, illust. Near Fallon, Churchill Co.
STRONG, M. F. (1966) *Desert Gem Trails.* Mentone, CA: Gembooks, 81 p., maps.
______, (1966) Nevada's western Lyons County. *Gems & Minerals* 344, p. 14–16, map.
______, (1967) Tonopah's gem fields. *Ibid.* 356, p. 24–27.
______, (1967) Gems along Nevada's pioneer trails. *Ibid.* 357, p. 18–21, map. Area SW of Carlin and Tuscarora Mts.
______, (1967) Gems in Nevada's Trinity Range. *Ibid.* 360, p. 20–22, map. NW of Lovelock, Pershing Co.
______, (1968) Petrified wood near Stonewall Pass. *Ibid.* 367, p. 3–33, map. SW of Lida Jct., Esmeralda Co.
______, (1970) Agate Cove. *Desert Mag.* 33, 12, p. 6–7, illust., map.
______, (1971) Gem fields in the San Antonios. *Ibid.* 34, 5, p. 14–16, illust., map. E & NE of Tonopah.
______, (1972) Wood in Broken Hills. *Ibid.* 35, 9, p. 28–31, illust., map. N of Gabbs but in Churchill Co.
______, (1972) Montezuma's treasures. *Ibid.* 35, 12, p. 8–11, illust., map. Near Goldfield.
______, (1973) Lovelock's legacy. *Ibid.*, July, p. 8–11, map.
______, (1973) The Sump. *Ibid.*, April, p. 28–32, illust., map.
______, (1973) Collecting on Nevada's Stonewall Flat. *Gems & Minerals* 431, p. 10–12, map.
______, (1982) Montezuma country. *Ibid.* 541, p. 40–43, maps.
______, (1985) Unexpected Sodaville. *Gems & Minerals* 569, p. 34–38, map.
______, (1985) Summit Peak in the Trinity Range. *Ibid.* 575, p. 16, 17, 24–28, maps. Lovelock region.
TSCHABOLD, E. L. (1963) Agate at Jarbidge. *Gems & Minerals* 311, p. 24–25, map.
WALKER, P. (1936) Fossil redwood from Nevada. *The Mineralogist* 4, 6, p. 7–8.
WEIGHT, H. O. (1947) He staked a claim for the rockhounds. *Desert Mag.* 11, 1, p . 26–29, map. Cedar Mt. NE of Mina, Mineral Co .
______, (1951) Fossil wood in Nevada. *Ibid.* 14, 4, p. 11–15, illust., map. Near Yerington.
______, (1951) Agate trail in Nevada. *Ibid.* 14, 11, p. 15–19, illust., map.
______, (1952) We explored an old Nevada lake bed. *Ibid.* 15, 12, p. 4–8, illust., map. Silicified wood SW of Coaldale, Esmeralda Co.
______, (1955) Gems of Monte Cristo. *Ibid.* 18, 3, p. 12–16, illust., map.

ALASKA. Readily accessible quartz collecting localities are scattered about the population centers of mainland Alaska, especially around Anchorage where it may be assumed that most collectors live. These localities are described by Roy (1986) and include sources of jasper and bloodstone along the north shore of Eklutna Lake, about 35 mi (56 km) north-northeast of Anchorage, and of agate, jasper, thunder eggs, and petrified wood along the Chickaloon River just north-northeast of Chickaloon at the head of Matanuska Valley; quartzes are also found at the head of Muddy Creek, Mile 94.5 on the Glenn Highway, east of Chickaloon. Chalcedony varieties are found farther east along Matanuska Valley at the east end of Anthracite Ridge and also in the upper reaches of Boulder Creek, Hicks Creek area, and along Caribou Creek close to Mile 107 on the Glenn Highway. In an area just northeast of Mt. McKinley Denali National Park, there is jasper near Ferry, and "beautiful moss agate and chalcedony on Moose Creek, some as large as 100 pounds" (Roy, map 25). Carnelian and bloodstone are reported from Eva Creek.

Southwest of Anchorage, the shores of Cook Inlet furnish agates and jaspers among the beach pebbles, especially between Birch Hill to the northeast of Kenai and extending southwestward to Cohoe, south of Kenai (Cox, map 30).

On the Alaskan Peninsula, Detterman & Reed (1980, p. B81) describe agate in cavities in Tertiary volcanic rubble flows at many points and mention that "gem-quality orange agate is found along the north shore of Nonvianuk Lake," and "white, gray and blue agate is present in the Narrow Cove area, Intricate Bay, and many of the islands in Iliamna Lake." Furthermore, "many large unfractured pieces can be found at these localities." Waskey (1960) had mentioned Nunainuk Lake as a locality but added that petrified wood was found here also, and that wood was to be had at Kujulik Bay on the peninsula, and agate pebbles were found in beach gravels of Hagemeister Spit, north shore of Bristol Bay.

Eakins (1970) described a silicified wood forest of considerable extent that boasted large, well-preserved logs and stumps on the northeast shoreline of Unga Island in the Shumagin Islands group on the south side of the Alaska Peninsula near its western terminus. Most of this material, as in many other occurrences of petrified wood, is poorly silicified, nondescript in color, and generally unsuited for lapidary work. Another similar forest is located on Anchor Point, on the northeast shore of Kenai Peninsula, approximately 117 mi (190 km) southwest of Anchorage, according to Goff and Albanese (1985), who assembled and summarized 26 occurrences of petrified wood throughout Alaska from the Arctic Slope to the Alaska Peninsula, also on the mainland, and including a forest on Kuiu Island in southeast Alaska. Presumably some of the material is silicified, but they furnished no information on lapidary suitability.

Detterman & Reed (1980, p. B81) noted that a "pale-blue to violet dumortierite is found as glacial erratics along the north shore of Iliamna Lake and on the Pile River." No source for this material is known and it is presumed that the authors refer to a massive granular quartzite colored by dumortierite inclusions rather than to a pure form of this easily cleavable mineral.

All of the volcanic islands in the Aleutian Chain are potential sources of chalcedonic quartzes; for example, Donald B. Hoover (*Pers. comm.* 9/1976) found some agates and jaspers of poor lapidary quality on Adak Island but others who had made a visit across Adak Bay to Great Sitkin Island found "agate and jasper beach pebbles that showed promise."

ALBANESE, M. D. & GOFF, K. M. (1987) Petrified wood occurrences in Alaska. *AK Div. Geol. Geogr. Surveys, Public Data File* 87-26, 10 p., illust.

ALLEN, R. (1966) Thunder eggs of the Talkeetna Mountains. *Gems & Minerals* 350, p. 22–25.

DETTERMAN, R. L. & REED, B. L. (1980) Stratigraphy, structure, and economic geology of the Iliamna Quadrangle, Alaska. *U.S. Geol. Survey Bull.* 1368-B, 86 p., illust.

EAKINS, G. R. (1970) A petrified forest on Unga Island, Alaska. *AK Div. Mines & Geol. Spec. Rept.* 3, 19 p., illust., maps.

GEMS & MINERALS (1960) Alaskan gem materials. No. 268, p. 2023, illust.

GOFF, K. M. & ALBANESE, M. D. (1985) A petrified forest on the Kenai Peninsula, Alaska. *AK Div. Geol. Geophys. Surveys, Public Data File* 85-24, 3 p.

GOSSE, R. C. (1964) Gemstones on the islands of Alaska. *Lapidary J.* 18, 4, p. 514–517, illust., maps.

MINERALOGIST, THE (1940) Alaska agates. Vol. 8, 6, p. 292.

MITCHELL, J. R. (1982) A rockhound trip to Alaska's Matanuska Valley. *Lapidary J.* 36, 1, p. 14, 16, 18, 19, map.

MITCHELL, J. R. (1982) North of Juneau. *Rock & Gem* 12, 11, p. 66–69, map.

_____, (1983) A rockhounding trip to Valdez, Alaska. *Lapidary J.* 36, 10, p. 1664, 1666, 1668, illust. (col.), map.

_____, (1983) Rockhounding north of Fairbanks. *Ibid.* 27, 5, p. 710–715, illust., map.

_____, (1983) Collecting minerals near Paxon, Alaska. *Ibid.* 37, 6, p. 834, 836–838, illust. (col.), map.

NELSON, L. (1970) Alaska's Agony Beach. *Gems & Minerals* 394, p. 30–31. Near Wrangell.

ROY, S. ed. (1986) *Alaska—A Guidebook for Rockhounds.* Anchorage, AK: Chugach Gem and Mineral Soc., (48) p., maps.

SCHOONOVER, M. (1964) Sourdough rockhounding. *Lapidary J.* 18, 1, p. 164–169.

SOELDNER, M. (1974) Minerals and fossils in Southeast Alaska. *Lapidary J.* 28, 5, p. 871–875.

WASKEY, F. H. (1960) Gemstones of Alaska. *Lapidary J.* 14, 1, p. 16, 18, map.

YUKON TERRITORY. Very little has been published on quartz gemstones in this large and very sparsely populated province. The principal references are Sabina (1973) and Traill (1983); both authorities list only a few places where jasper and agate are to be found, none of it outstanding.

SABINA, A. P. (1973) Rocks and minerals for the collector. The Alaska Highway; Dawson Creek, British Columbia to Yukon/Alaska border. *Geol. Survey Canada Paper* 72-32, 146 p., illust., map.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

BRITISH COLUMBIA. Most quartzes so far found in this province are mainly agates and jaspers derived from volcanic rock weathering. Leaming (1973) provides excellent prospecting guides to possible collecting areas by delineating upon his maps Tertiary rock exposures that are likely to contain cavities filled with agate and chalcedony. His maps of the Princeton, Penticton, Vernon, Kamloops, Cache Creek, and other areas take in most of the south-central region of the province which has been covered by volcanic rock flows (Leaming, p. 17–33). Numerous localities for chalcedonic quartzes are conveniently summarized by Traill (*see above*), and other guides include Sabina (1965) and the Hutchinsons (1975) for Vancouver Island. For all practical purposes, British Columbia is virtually unexplored for most gemstones, including quartz.

AITKEN, J. D. (1959) Atlin map-area. *Geol. Survey Canada Mem.* 307, 89 p., map.

BAKER, S. G. (1960) B.C. gem trails. *The Mineralogist* 28, 4–5, p. 66–68.

BELL, A. (1961) The Omineca agate story. *Canad. Rockhound* 5, 2, p. 2–4.

______, (1961) Rockhounding in the Prince George area. *Lapidary J.* 15, 3, p. 340–343.

BROUGHTON, P. (1975) Collecting beach agates on the Queen Charlotte Islands. *Gems & Minerals* 454, p. 42–43, 60, map.

______, (1975) Collecting in British Columbia. *Rocks & Minerals* 50, 5, p. 289–299, map; 6, p. 355–363.

CANADIAN ROCKHOUND (1966) Princeton fossil wood. Vol. 10, p. 126–127.

______, (1967) Rockhounding in B.C. Vol. 11, p. 167–169.

DANNER, W. R. (1976) Gem materials of British Columbia. *Montana Bur. Mines Geol. Spec. Publ.* 74, p. 157–169, illust.

DAWSON, J. W. (1874) Note on fossil woods from British Columbia collected by Mr. Richardson. *Amer. J. Science* 3rd ser. 7, p. 47–51.

______, (1889) *The Mineral Wealth of B.C. With an Annotated List of Localities.* Geol. Nat. Hist. Survey Canada, Montreal, 163 p., p. 110.

______, (1894) *Geological Survey of Canada Annual Report* 7. Quartz gemstones mentioned.

DRYSDALE, C. W. (1914) Geology of the Thompson River Valley below Kamloops Lake, B.C. *Geol. Survey Canada Rept. for 1912, Sess. Paper* No. 26. p. 115–150, col. geol. map. Agate localities.

FIELD, D. S. M. (1949) Canadian gems and gem localities: Part III, gems of British Columbia. *J. Gemm.* 2, 1, p. 6–15.

FRY, W. L. (1958) Petrified logs of *Cupressinoxylon* from the west shore of Chilko Lake, British Columbia. *Geol. Survey Canada Bull.* 48, p. 10–14, illust.

HUTCHINSON, J. & HUTCHINSON, W. (1967) Rockhounding in big British Columbia. *Lapidary J.* 21, 1, p. 244–251, illust., map.

______, (1968) Rockhounding in British Columbia. *Ibid.* 22, 7, p. 956–958, illust. Beach pebble collecting.

______, (1969) Rockhounding in British Columbia. *Ibid.* 23, 9, p. 1242–1243, illust., map. Agates of Shaw Springs.

HUTCHINSON, W. & HUTCHINSON, J. (1971) *Rockhounding and Beachcombing on Vancouver Island.* Rev. edit. Victoria, BC: Tom and George Vaulkhard, 59 p., illust., maps; 2nd edit. 1975, 74 p., illust., map.

JOHNSTONE, R. A. A. (1915) A list of Canadian mineral occurrences. *Geol. Survey Canada Mem.* 74, 275 p.

LEAMING, S. F. (1965) Gemstones and lapidary materials of Western Canada. *Lapidary J.* 19, 1, p. 175–181, illust., map.

______, (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, 138 p., illust., maps.

LEAMING, S. & LEAMING, C. (1980) *Guide to Rocks & Minerals of the Northwest.* Surrey, BC: Hancock House Publs., 33 p., illust. (col.).

McDOUGALL, H. J. (1974) Trout Lake gemstones. *Rockhound* 3, 1, p. 13, map.

NICHOLSON, H. A. (1873) Nature of a silicified forest in the Rocky Mountains with an account of a supposed fossil chip. *British Assoc. Advancem. Sci.* Rept. 42, Sec. 192.

NICHOLSON, H. A. & ELLIS, W. H. (1875) On a remarkable fragment of silicified wood from the Rocky Mountains. *Canad. J.* 14, p. 148–153, illust.

PARKS, W. A. (1917) Building and ornamental stones of British Columbia. *Canada Dept. Mines, Mines Br., Summ. Rept. for 1916*, p. 59–60.

PEARSONS, H. L. (1964) *More B.C. Gem Trails.* Monte Lake, BC: Monte Lake Rock Shop, 38 p., maps.

______, (1968) *Ibid.*, 3rd edition with maps. 30 ff., maps.

PERSON, R. A. (1975) Crazy lace near Francis Lake, British Columbia. *Lapidary J.* 29, 9, p. 1730–1736, map.

RICHARDSON, P. (1973) Shaw Springs agate. *Canad. Rockhound* 17, 5, p. 4–5.

SABINA, A. P. (1965) Rock and mineral collecting in Canada. Vol. 1. Yukon, Northwest Territories, British Columbia, etc. *Geol Survey Canada Misc. Rept.* 8, 147 p., illust., maps.

SACKETT, E. L. (1958) The Kamloops Forest. *The Mineralogist* 26, p. 304, 306.

SMITH, C. (1974) Fraser River bar locations. *Canad. Rockhound* 18, 1, p. 29–31.

SUTHERLAND, M. L. (1955) Rock hunting in British Columbia. *Lapidary J.* 9, 1, p. 62, 64–65.

TRAILL, R. J. (1983) *See above.*

WELLS, D. J. (1961) Another chapter in the Omineca agate story. *Canad. Rockhound* 5, 3, p. 16–17.

WASHINGTON. The state of Washington, in January 1975, adopted petrified wood as its official gemstone, and a most appropriate choice it is, considering the abundance and variety of woods that are still found in dozens of places in the state. Pattie (1991) furnishes a list of 97 collecting sites for agate, silicified woods, and jasper in Washington, showing them by number upon an index map and giving general remarks on the several regions where specific varieties are to be found. By far most occurrences lie in the western half of the state with the densest concentration of sites in Kittitas County which lies almost in the exact geographical center of the state. Edmundson (1991) notes that petrified wood occurs in almost every county and that "the highly agatized, colorful material from east of the Cascades crest is both beautiful and plentiful." He provides a geological sketch of the formations in which the wood occurs and discusses theories of wood replacement by silica, offers remarks on the problem of wood identification, and lastly furnishes a list of references which could be helpful to the collector desiring to identify his finds.

Among the references given below, the collector should consult the Jackson & Jackson (1974–1978) booklets and the later publications by Cannon (1975) and Ream (1985), the last emphasizing quartz gemstones.

BATEMAN, E. S. (1947) A rockhound in the petrified forests. *The Mineralogist* 15, p. 395–401, 426, 428, 430.

______, (1949) The famous petrified wood Russell forests of Washington. *Rocks & Minerals* 24, 1, p. 18–23.

BECK, G. F. (1936) [A series of articles describing the wood species found in the petrified forests of Washington; illust.] *The Mineralogist* 4, 12, p. 7–8; 5, 2, p. 9–10; 3, p. 7–8; 4, p. 7–8; 6, p. 7–8; 10, p. 7–8; 6, 1, p. 13–14; 7, p. 3, 4, 29, 30.

______, (1945) Ancient forest trees in the sagebrush area in central Washington. *J. Forestry* 43, 5, p. 334–338, illust., map.

______, (1955–1956) Fossil woods of the West. *Mineral News* 9, p. 12–15; 10, p. 10–22; 11, p. 16–19; 12, p. 12–14; 14, p. 19–20.

BLOOD, B. (1953) Petrified woods of Washington State. *Lapidary J.* 7, 1, p. 26–34, *passim.*

BROCKMAN, C. F. (1952) *The Story of the Petrified Forest; Gingko State Park, Washington.* Tacoma, WA: North Pacific Bank Note Co. 16 p., illust.

CANNON, B. (1975) *Minerals of Washington.* Mercer Island, WA: Cordilleran, 184 p., illust., maps.

CATTS, C. O. (1982) Lyre River agate. *Rock & Gem* 12, 3, p. 29–32, map.

CHURCH, C. C. (1959) Cloverdale, Washington locality. *The Mineralogist* 27, p. 107–108, map.

CLINESMITH, C. N. (1936) Blue agate in Washington. *Rocks & Minerals* 11, 9, p. 136.

COFFMAN, R. (1979) Nature's Saddle Mountain fire sale. *Lapidary J.* 32, 11, p. 2504–2507.

CUNNINGHAM, J. L. (1959) Redtop Mountain blue agate. *Gems & Minerals* 263, p. 14–17, illust., map.

DAKE, H. C. (1937) A day in the Gingko forest. *The Mineralogist* 5, 9, p. 7–8.

______, (1942) Latah petrified forests. *Ibid.* 10, p. 339–340, 352–353.

______, (1958) A day in the Horse Heaven Hills. *Ibid.* 26, p. 246–247.

______, (1962) *Northwest Gem Trails.* 3rd edit. Mentone, CA: Gembooks, 95 p., illust., maps.

DRAFT, A. H. (1956) A new Washington locality. *The Mineralogist* 24, 4, p. 158, 160, 162. Redtop Mt.

______, (1956) Washington gem trails. *Ibid.* 24, 12, p. 448–460, *passim.*

EDMONDSON, L. S. (1991) Petrified wood from Washington. *Rocks & Minerals* 66, 4, p. 321–325, illust. (col.).

FERNQUIST, C. O. (1934) Gemstones of Washington described for first time. *Oregon Mineralogist* 2, 1, p. 12, 26–27.

______, (1940) The gem minerals of Washington. *Ibid.* 8, 10, p. 393–396, 437–439.

FORAKER, D. (1972) Collecting Ellensburg's rare agates and petrified wood. *Gems & Minerals* 422, p. 46–47, 65–66, map.

FORSBERG, E. (1960) A field trip guide Washington. *Gems & Minerals* 279, p. 53, map. Ellensburg blue agate.

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GLOVER, S. L. (1949) Origin and occurrence of gem stones in Washington. *WA Div. Mines Geol. Rept. Invest.* 16, 32 p.

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OREGON. One of the most popular states for collecting chalcedonic varieties of quartz is Oregon, with federal, state, and local governments and agencies actively encouraging collecting upon public and private lands. Oregon acknowledged the abundance of thunder eggs, which are found at many places in the state varieties and quantities unmatched elsewhere, by officially naming the thunder egg the Oregon State Rock in 1965. While most thunder eggs are fist-size, a record nodule was found in Deschutes Canyon in central Oregon by Elliott Parkes of Bend, that measures 5 ft (1.52 m) long and 4 ft (1.21 m) in diameter and weighs 3,500 lb (1,590 kg) (Brogan, 1968). Appropriately enough, it is now placed in front of the state capitol in Salem and it is not likely to be stolen.

Information on thunder egg collecting sites is available from the Prineville Chamber of Commerce who maintains 12 collecting claims for agates, thunder eggs, jaspers, silicified woods, and obsidians. A brochure is issued by the Oregon Department of Geology and Mineral Resources giving general guidance to visitors wishing to collect gems and minerals in Oregon (Lawson, 1989). One of the best-known fee-digging places that has steadily produced thunder eggs is the Priday Ranch-Kennedy agate beds operated by Richardson's Recreational Ranch, 11 mi (18 km) northeast of Madras on U.S. Highway 97 (Birdsall, 1981; Walker & Walker, 1990; Zeitner, 1987). Lawson *(Ibid.)* lists other fee-digging operations. Some excellent color photographs of sectioned and polished thunder eggs and agates from Oregon appear in Shaub (1979, 1989). A remarkable thunder egg variety which consists of dark brownish-red spherical cores surrounded by yellowish-greenish rims that are minutely fractured and recemented with reddish silica is called "red thunder egg"; according to Shaub (1979), it comes from Coyote Springs. However, according to Virginia and Larry Kribs, Desert Dog Mines, of Bend, these (or similar) thunder eggs are mined at their Desert Dog #3 Mine, 35 mi (56 km) south of Harper in Malheur County. This material is also called "spiderweb" in allusion to the network of fine cracks mentioned above. The nodules range in size from 6 in to 30 in (15–75 cm).

Gail (1972) and Rodgers (1969) describe the curious, very uniformly colored and textured worm-like masses of chalcedony that are commonly called "snakeskin agate" in allusion to the crinkled surface that resembles the patterns of serpent scales. This material is found about 40 mi (63 km) west of Jordan Valley on Highway 95, and 6 mi (9.6 km) east of Burns Junction, Malheur County. Gail places another deposit on the east slope of Dog Mountain just west of Highway 205, about 8 mi (13 km) south of Burns, Harney County. These chalcedonies rarely go over several inches across and are most remarkable for their extremely uniform translucency and texture that resembles so much congealed wax or lard. According to Si Frazier (*Pers. comm.* 5/3/1995), "In thin section this material does not show typical chalcedony structure but rather a peculiar micro-granular one. It is thought by some that they are formed in an alkaline lake, from a

Magadi-type chert," here referring to an occurrence in south Kenya, Africa. Perhaps it is this structure which enables this material to accept chemical dyes, especially the black formed after first impregnating with sugar solution and then treating with concentrated sulphuric acid. Other colors such as green and blue have also been used.

The material popularly known as "kinradite," a spherulitic/orbicular jasper, is found as pebbles on the beaches of the Pacific Ocean from California northward to Oregon; the jasper was named after a San Francisco lapidary (Brown, 1953).

The late Dr. Benjamin M. Shaub (1893–1993) studied the many types of nodular growths as typified in thunder eggs and agates, and attempted to account for their special features in his treatise on the subject (1979). For nodules in igneous rocks, e.g., thunder eggs, agates, and jaspers of the Bruneau type, he postulates accumulations of colloidal silica from an as-yet-uncongealed igneous rock in the form of spherical masses which later are transformed into the nodular structures that we find now. Essentially this same theory was offered in Germany in the last century but never received support.

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CALIFORNIA. Peters (1976) summarizes the gemstones of California that were used by Indians before the coming of Europeans. The article essentially covers the same ground as and uses many illustrations from the large, more detailed monograph of Heizer & Treganza (1944). Quartz gemstones are included.

Among older occurrences may be mentioned the famous but now mostly inaccessible locality of Nipomo "bean field" agate in San Luis Obispo County: pale grayish or bluish translucent chalcedony with flower-like inclusions of marcasite. When carefully polished, the marcasite assumes a brilliant metallic luster. Morris (1974) describes an enormous mass of this material that measured about 5 ft (1.5 m) long and 3.5 ft (1.1 m) wide, and from 16–20 in (40–50 cm) thick. It weighed over 2,000 lb (ca 900 kg); its disposition was not stated.

Speaking of large agate masses, Cutler (1940) describes an enormous thunder egg that compares in size with the record specimen found in Oregon (*see above*). This approximately spherical mass measured 42 in (1.1 m) in diameter and weighed 2,070 lb (939 kg); it and was found by D. P. Leonard of Orange, California, in the Little Mule Mountains, "about 40 miles southwest of Blythe," in Imperial County.

Psilomelane inclusions in translucent chalcedony, sometimes called "crown of silver" in allusion to the semimetallic luster of the manganese mineral when polished, or "black malachite" in allusion to its bandings, have not been positively identified, and several manganese oxides may be present in this chalcedony. A comment appended to Hemrich (1913) states that "psilomelane" is a misnomer but does not offer alternative names! Lately this material has been collected by Mulkey (1992) who found it in the McCoy Mountains, about 18 mi (29 km) air distance northwest of Blythe, Riverside County. The occurrence is in the Arlington Manganese Mine and surrounding quarries and dumps. Both Hemrich and Mulkey give cutting and polishing instructions for this handsome and neglected gemstone. Mulkey (1994) also describes collecting this material in the Thumb Butte area of Imperial County.

"Chapinite," a silica gem material originally found on Cape Irwin Military Reservation, about 2.5 mi (4 km) west of Tiefort Village, via Goldstone Road, San Bernardino County, is defined by Berkholz (1959) as "colorful agate fragments floating in agate," thus a kind of breccia in which earlier jasper was shattered and then infused with chalcedony to form a solid material. It was named after Dr. Roy E. Chapin who first found the material.

The famous petrified forest that lies south of Mt. St. Helena in Sonoma County and whose trunks lie scattered over a very large area of nearly 30 mi (48 km) long from the St. Helena volcano south to just beyond Petaluma, is briefly but adequately described by Ransom (1955, p. 75–76). The forest was discovered in 1871, and according to Ransom, "with respect to the great number of fossil trees, and their enormous size, the California 'stone forest' surpasses anything found in Arizona's Petrified Forest, or for that matter, anywhere else in the world." The individual trees have been partly unearthed and given names such as "Queen of the Forest," a tree that is 80 ft (24 m) long and 12 ft (3.6 m) in diameter, and "Giant," 56 ft (17 m) long and 8 ft (2.4 m) in diameter. These trees were buried in the ashes of an ancient eruption of Mt. St. Helena. While collecting in the park that preserves these trees is forbidden, Daugherty (1976) notes many places where the wood can be found, especially between Santa Rosa and Calistoga, south of the forest. Recently, Ferguson (1981) visited the area and found wood suitable for making large objects such as bookends, but also material that was suitable for cabochons, some of which was quite attractively patterned in blacks, tans, pale and dark browns, or mixtures thereof. While Ransom compares this forest with that of Arizona in regard to sizes of trees, there can be no comparison in terms of color and patterning, both these features being vastly superior in the Arizona wood.

At the Tucson Show in the Spring of 1994, the Coogan Gold Company of Turlock, California, offered for sale polished slabs and cabochons of native gold in dense, fine-grained milky quartz from the Gold Country of the state. Purchases of rough are made from miners in Mariposa County, but because of the demand for this material, the cost often approximates that of bullion even though the rough consists mostly of quartz! While gold in quartz is fairly common, the best rough must be exceptionally compact, without voids, and the quartz must be pure milk-white with the gold veinlets distributed in aesthetically pleasing patterns. Cabochons offered at the show were priced at $10 to $22 per carat, depending on the amount of gold, its distribution, size of cabochon, etc. In this connection it is interesting to note the remarks made by Kunz (1890, p. 117) about the value of California gold quartz: "when clear, compact, white quartz contains veins, or streaks, or spots of fine gold [sic], it is worked into jewelry and souvenirs on a considerable scale in San Francisco, and to a less extent in many large towns in the mining regions," and "the gold found in California quartz is worth about $16.50 an ounce but jewelers willingly give from $20 to $30 for each ounce of gold contained in material that they can use." The amount of gold that is present in a mixture of gold and quartz is determined by referring to a set of tables known as "Price's tables," wherein one enters the specific gravity of the entire gold/quartz mass and its weight, and then reads off the weight of gold. Kunz notes that "the white gold quartz of California is mainly supplied from the counties of Butte, Calaveras, El Dorado, Mariposa, Nevada, Placer, Sierra, Tuolumne, and Yuba." In 1994, the Original Sixteen to One Mine of Alleghany, Nevada County, announced that they possessed "a large selection of fine gold and quartz slab, which has been stabilized and readied for cabochon cutting," such stabilization perhaps being brought about by pressure-impregnation of plastic to fill pores in the rough. Various small gold-in-quartz jewelry items were offered as earrings, pendants, rings, etc., at prices ranging from $165 to $695. More information on gold quartz can be found in Kunz's work on the gems and precious stones of North America, either the 1890 or 1892 editions.

In the Mother Lode country of the Sierra Nevada foothills, a new source of moss agate, jaspers, and petrified woods has been located in an area around Valley Springs in Calaveras County (Lodato, 1975). The presence of quartz on the Snyder Hereford Ranch, 2 mi (3.2 km) north of Valley Springs, has been known since 1965 at least, and fee-digging has been allowed. Ferguson (1982) states that the ranch is now closed to collecting but that collecting is allowed on the Hale Place, a four-acre tract about 2 mi (3.2 km) east of Valley Springs. Another relatively new locality for agate was found in the 1970s at the Anderson Reservoir near Morgan Hill, Santa Clara County (Ferguson, 1976). Attractive jasper has been found at Black Butte Reservoir on the south shore of the western arm of Black Butte Reservoir near Burris Creek (Ferguson, 1982). This area is west of Orland in Glenn County but the actual site is just over the border into Tehama County.

Along the Pacific coast, Neer (1984) briefly notes that agates are to be found on the beach at Trinidad's Patrick Point State Park, north of Eureka, Humboldt County. Farther south, lapidary grade chert pebbles are found on the beach south of Half Moon Bay in the San Francisco area (Ferguson, 1980). Foerster (1990) describes chert pebbles that are found on a beach near Ventura, Ventura County; he also describes a source of moss agate on Gem Hill, northwest of Rosamund in Kern County. Also in Kern County, Mitchell (1981) obtained agate and jasper from a remote area north of Randsburg, and Kirkland (1963) told how to reach an agate collecting site on Rainbow Ridge in the El Paso Mountains. In these same mountains, the Rapparlies (1981) provide a guide to agate, chert, and jasper in the Red Rock Canyon area, west of Johannesburg. Similar materials are found south of Randsburg, according to Mitchell (1987), and also around California City, an area that lies northeast of Mohave (Mitchell, 1988).

Agates and jaspers are found north of the Hinkley turnoff from Highway 58 (west of Barstow), then north to Black Mountain in San Bernardino County (Oglesbee, 1980). Similar material is found in the Cady Mountains located just north of Highway I-40 and east of Barstow in the same county (Foerster, 1991), while farther to the southeast, agate and jasper are found in the Bristol Mountains north of Bagdad (Perry, 1978).

In Riverside County, Mulkey (1992) and Selbert (1993) describe visits to Nancy Hill's Fire Agate Mine on Opal Hill, located southwest of Blythe in the Coon Hollow area, Mule Mountains, 9 mi (14 km) west of Palo Verde village. According to Mulkey, "the fire agate found at Opal Hill is believed by many to be the finest in California." Other collecting sites in this extreme southeast corner of the state are Palo Verde Mountains, visited by Mitchell (1983), and Wiley Well, visited by Perry (1984). Many more collecting sites are given in Mitchell's compilation of 1986.

The dark blue dumortierite quartz found near the southern end of the Chocolate Mountains in southeastern Imperial County is actually a very fine-grained quartzite in which minute fibrous crystals of dumortierite impart the color, the intensity varying according to the amount of dumortierite. Morton (1977) notes that this material occurs as boulders in older alluvium in an area about 12 mi (20 km) north of Ogilby and south of Indian Pass, and "the source area of these boulders has never been determined." Mitchell (1986, p. 18–19) shows the collecting area on a map and notes that these boulders are now scarce.

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ARIZONA. It is safe to say that of all the quartzes found in Arizona, the first to come to mind are the justly celebrated silicified woods that eroded from the Chinle sediments many thousands of years ago. These are most conveniently and spectacularly displayed as nature left them in the Petrified Forest National Park that extends east and northeast of Holbrook and straddles in a north-south direction the boundary between Navajo and Apache counties. From north to south the park is 30 mi (48 km) long, and within this rather irregular strip lies the finest collection of silicified trunks to be seen anywhere. The best historical summary of the discovery, exploration, and final legal maneuvering that brought the park into existence, including as well a discourse on the trees found outside the park boundaries and their geological circumstances, is in Ash (1969).

In regard to the early history of the park, Ward (1889, p. 916–7) suggests that the first European to see the logs was Baldwin Möllhausen who found a "forest" in a ravine in the area on December 2, 1853. However, it is now certain that the honor of first discovery must go to Lt. James H. Simpson who found the logs during his explorations in 1849, and published his report in 1852, at the time providing the first published illustration of a log section which "exhibits its various tints by a colorful lithograph" according to Whipple & Blake (1854, p. 43). These authors also mentioned explorers who covered the same area and especially noted the abundance of the silicified logs along a wash which they aptly named Lithodendron Creek (Vol. 3). Whipple and Blake depict typical log sections in quaint engravings. Of course it should be said that these logs were known by the Indians for untold centuries before the advent of Europeans, and Ash (p. D4) provides a photograph of a square pueblo, now called "Agate House," whose walls are made entirely of neatly fitted sections of silicified logs, built by the prehistoric inhabitants about 600 years ago.

Ash's historical summary not only discusses the many military and other explorations in the Petrified Forest area but also devotes much space to George F. Kunz (p. D9) because of the

FIGURE 77. This comical sketch may be one of the earliest published illustrations of the silicified tree trunks in what is now the Petrified Forest National Park in Arizona. From Whipple & Blake, 1854.

publicity he gave to the forest. Ash also summarizes some scientific studies of the woods and describes some aspects of their commercialization, of which more will be said below. Another valuable scientific account appears in Stewart, *et al* (1972) who describe the plant remains, including the fossil woods (p. 83–86); like Ash, they also include a list of many references.

For a general appreciation of the silicified woods of Arizona, especially those in the Petrified Forest National Park, the reader is referred to the handsomely color-illustrated articles that appeared in many issues of *Arizona Highways* and the illustrated booklet by Ash & May (1969). More recent articles are by Smith (1963), White (1968), Richard (1977), and Blair (1981).

In regard to the personal collecting and commercial exploitation of wood, the private properties surrounding the park have been opened at times to fee-collecting and also fairly large-scale earth excavation to dig up buried logs of precisely the same colorful grades as those found in the park. Fee-collecting was noted by Feilen & Feilen (1968) upon the Milky Ranch, southeast of Holbrook. A commercial mining venture calling itself the Petrified Forest Wood Company was described in *Arizona Highways* (1975, p. 33) as having "mineral rights to huge tracts of land adjoining the Petrified Forest, and [as having] discovered an extensive deposit on these lands of the precious stone. Sufficient quantities have already been mined to develop and serve a world market." In October 1976, the company took out a fullpage advertisement in color in *Lapidary Journal* showing a series of Buddhas, 70–110 mm (4–4.3 in) tall and weighing from 150 to 370 grams, to be sold at $400 each. They also offered "crystal woods" in 5 and 10 lb (2.25–4.5 kg) lots from $15.95 to $18.50 postpaid. Richard (1977) also comments on the products of this company and on the Dobell Curio Shop near the south entrance to the park which sold objects and specimens of petrified wood, and noted the exhibits, including carvings made in Germany, in the park museum. The Petrified Forest Wood Company is no longer in existence.

Another collecting area open to the public was described by Walkers (1990) at the Patton and Sons Ranch, 19 mi (30 km) east of Holbrook on the U.S. Highway 180 turnoff to the park.

In addition to the color photographs mentioned above that appeared in *Arizona Highways*, particularly fine and varied color photographs appear in articles by Connell (1974), one of these showing a fine blue specimen of wood from Arizona and another showing a remarkable specimen containing veinlets of native silver! See also illustrations in Barnes (1975). In about 1975, a celadon-green silicified wood was found in the Chinle that was identified as the Triassic tree *Araucarioxylon;* this material was sold in small fragments at the Tucson Show in 1992.

One of the most important publications yet to appear on the petrified woods of the world, with much on those of Arizona, is the special publication of Christian Weise Verlag of Munich, Germany, entitled *Versteinertes Holz*, extra Lapis No. 7, published in 1994. It consists of 96 pages filled with splendid color illustrations and includes discussions of opalized wood, as from Virgin Valley, as well as silicified wood. An especially valuable feature is the discussion of how wood becomes replaced by mineral matter.

Fire agate continues to be produced in important quantities from several deposits as in Greenlee County, north of Metcalf in the Eagle Creek area (Dimick, 1962), and the Castle Dome area, south of Quartzsite, Yuma County (Brauer, 1964). Other sources are noted by Cantou (1977) who also discusses quality features of the various productions. However, the deposit that has been mined most extensively and consistently on a commercial basis is located at Deer Creek on the north slopes of the Galiuro Mountains, at about

FIGURE 78. Scene in the Petrified Forest National Park of a gully filled with eroded log segments. *Courtesy Dr. W. Lieber, Heidelberg, Germany.*

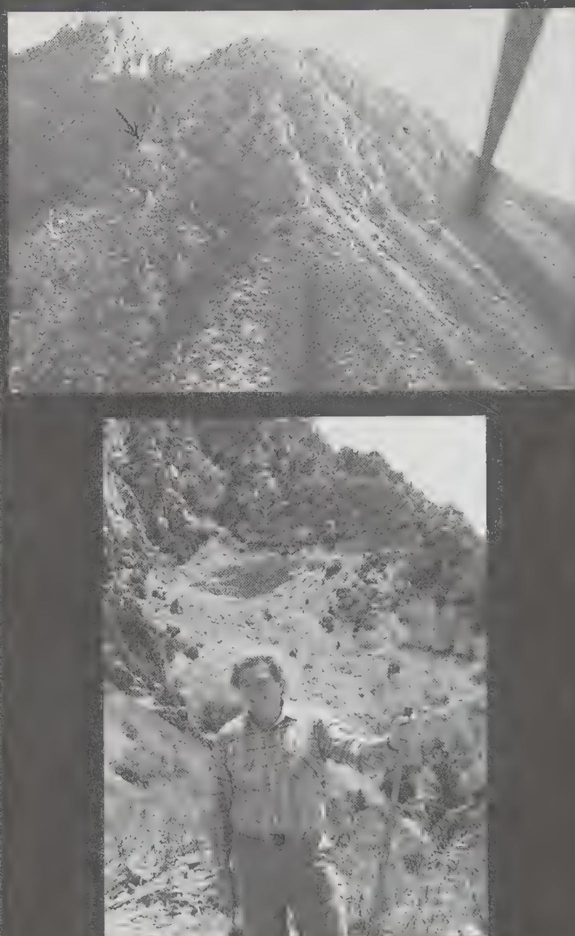

FIGURE 79. The Four Peaks, Arizona, amethyst locality. Top: view of mountain from helicopter; the arrow points to the very small helicopter landing pad, the mine opening is to the right. Bottom: mine owner Joe Hyman, with mine workings in background. *Courtesy Jack Lowell, Colorado Gem and Mineral Company, Tempe, Arizona*

5,500 ft (1,675 m), about 40 mi (64 km) west of Safford, Graham County (Sweaney, 1979; Stripp, 1984). Sweaney not only furnishes a historical summary of mining and ownership but also discusses the mining methods, occurrence and origin of the material, its processing, and the criteria used to classify and grade the stones; he also provides many fine color photographs. Stripp, too, provides color photographs as well as views of mining activity. There are five mining claims of 720 acres altogether being mined, in 1984, by David and Lana Penney of Pima, Arizona, using heavy equipment to open up the volcanic rock beds that contain the fire agate-lined voids. The material displays violet, blue, green, and orange or red colors when properly thinned down to expose the iridescent layers and then polished to a high gloss. Some stones which display strong reds and greens together are locally called "Christmas tree" fire agates, according to Stripp. The origin of colors is discussed by Sweaney (1979) and Jones (1992), the latter noting recent research on fire agates which suggests that the colors are due to interference phenomena in thin platelets of quartz in the chalcedony host and not to the presence of any iron compound. However, this theory is not accepted by everyone and the best that one can say at this time is that a convincing explanation is lacking.

A remarkable application of fire agate which takes advantage of the selfsame curved surfaces which make it difficult to produce good cabochon stones is the carving of small sculptures from suitable pieces of rough. Dale (1981) carved a number of pieces representing animals and birds, and describes the steps he takes to produce these handsome miniature carvings. His technique calls for grinding away selected spots to expose the colored layers that add so much to the final appearance of each piece. Another article on carvings made from Oatman as well as Deer Creek material describes the techniques employed by Joseph and Debbie Intili in carving a dragon, porpoise, bird of paradise, and a cobra, as depicted in color in the article by Goodman (1987). Unfortunately neither of the carving essays gives dimensions of the carvings, but they probably do not exceed several inches across.

Lowe (1974) gives the price range for fire agate cabochon stones as $1 to $3 per carat for average gems, rising to $8 to $10 per carat for higher grades, and to as much as $40 per carat for the finest, most vividly colored gems. Jones (1992) cites retail prices asked by the Rincon Mineral Company for rough as $5 to $100 per lb, according to potential, and for cabochon gems, good to "museum" grade, as from $4 to $30 per carat. However, especially fine pieces of rough, on which "windows" had been cut and polished, sometimes brought $10 to $200 per carat!

The valuable blue-green chalcedony colored by copper compounds and generally referred to as "chrysocolla" or "chrysocolla chalcedony," long produced from Arizona openpit copper mines, received useful reviews by Jones (1979) and Haag (1993). According to Jones, "the world's greatest deposit of gem silica chrysocolla is the Cobre Valley [Copper Valley], Arizona," which includes the mining towns of Miami and Globe in Gila County, and their local mine pits. John Mediz, of the Copper City Rock Shop of Globe, obtained collecting rights from the Inspiration Consolidated Copper Company to remove chrysocolla and other specimen or lapidary minerals from their mines. Jones cites as an example of the benefits of this arrangement the discovery by Mediz of splendid large masses of chrysocolla chalcedony at the base of Red Hill in the Live Oak Pit: "one huge mass of gem 'chrys' and good chrysocolla was recovered which weighed over 150 pounds [68 kg]." This specimen was never cut and remains on exhibit in the lobby of the Copper Hills Hotel on the highway between Globe and Miami. Aside from the uniformly colored and textured cabochon and carving material, some chrysocolla chalcedony forms thin cavity linings which are covered with very small, sparkling, colorless quartz crystals. These linings can be cut into small plaques and mounted in jewelry as pendants and bolas. I have been informed (1993) that some dealers in Arizona ask as much as $4,000 per lb ($8,800/kg) for the very finest grades of chrysocolla chalcedony.

A remarkable color phase of chalcedony, called "damsonite" in allusion to its fancied resemblance to the color of the damson plum, is actually light reddish purple in color, reminiscent of charoite. It was first found by a hunter in 1980 but the locality was not specified (*Gems & Minerals*, 1984). The properties of this material are essentially those of ordinary chalcedony. At the time, the deposit was to be mined by the Royal Edge Mining Association, Inc., of Boulder City, Nevada.

Because of its inaccessibility, mining at the Four Peaks amethyst deposit in the Mazatzal Mountains, Maricopa County, continues only sporadically. Jaeger (1985) describes his visit to the site, which is in steep, rocky terrain at an altitude of 7,200 ft (2,195 m) and accessible either by foot trail or by helicopter for which a very narrow pad was cut into the rock near the mine. The geology and mineralogy of the deposit were described by Lowell & Rybicki (1976). The amethyst crystals line vugs in quartz veins and in quartz fillings of other voids in a brecciated zone of Precambrian Mazatzal quartzite. Several episodes of mineralization took place subsequent to the first rupturing of the enclosing rock, with the last episode being a hydrothermal event that caused much etching of the amethyst crystals and subsequent overgrowths of smoky quartz crystals plus deposition of minute apatite and hematite crystals upon amethyst crystal faces. According to Lowell (*Pers. comm.* 11/24/92), Joseph Hyman of Phoenix, Arizona, was the owner of the patented claim but "has not actively mined it for a decade as he has another business and currently the property (20 acres of patented land) is for sale." Lowell also notes that the mine is regularly checked by helicopter to prevent unauthorized mining, because "there is a tremendous amount of very fine material at the site still to be mined." He also notes that he has cut splendid faceted gems from this amethyst, exhibiting "red flashes" and weighing up to 40 carats.

Clear rock crystals, some with phantoms and interesting inclusions, and some, rarer still, with silky inclusions that give rise to the cat's-eye effect, are still being found at the well-trampled Crystal Hill locality just southeast of Quartzsite, Yuma County (Perry, 1985). An interesting article on giant chalcedony roses by Brauer (1964) provides photographs which shed light on how these curled, drusy quartz-coated chalcedony shapes form. They occur as partial fillings or linings in spheroidal gas cavities in rhyolite, many being loose and simply lifted from the openings, while others are attached to the cavity walls and are "cleaned" by nipping away the adhering matrix rhyolite. The locality, the so-called "Porter Bed," is southeast of Quartzsite, Yuma County, about 9 mi (14 km) south of the town via Highway 95; a turnoff is made to the east for about 20 mi (32 km) on a dirt road to a point north of the hill where the diggings are located.

Among recent guidebooks to gemstone deposits in Arizona are Simpson (1984), Koning (1980), Merriam (1988), and Blair (1992). An excellent survey of the state's gemstones, enhanced by many color illustrations, appears in Jones (1977).

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MEXICO. The "strawberry quartz" previously described in Volume 2 has almost disappeared from the market (Sinkankas, 1962). According to Jack Young of El Paso (*Pers. comm.* 6/93), this quartz came from a deposit in the Barranca de Cobre area in southwest Chihuahua. The celebrated colorful banded agates of northern Mexico are now difficult to obtain (Lyons & Young, 1961; Johnson, 1963; *Lapidary Journal*, 1964; Zeitner,

FIGURE 80. Mrs. J. B. Carillo (center) of Gem Center, USA, El Paso, Texas, at the company geode mine on the Mesteno Ranch, Chihuahua, Mexico. *Courtesy Gem Center, USA.*

1969). All surface and shallow-depth diggings are mostly depleted and if further material is to be obtained, digging to considerable depth and possibly formal hard-rock mining may have to be engaged in. While it is certain that much of this splendid agate remains in place, the cattle ranches upon which most of it has been found refuse to put up with the inconvenience of mining and the dangers posed to wandering cattle which may be maimed by falling into pits.

The famous "coconut geodes" of the Carrillo Ranch and the Mesteno Ranch in Chihuahua are being mined by Gem Center, U.S.A. of El Paso, Texas. The locality is about 120 km (75 mi) north of Ciudad, Chihuahua, and about 35 km (22 mi) east of Laguna Encinillas at the south end of Sierra Gallego (Keller, 1979). Keller provides a map which shows other occurrences, especially of the agates for which Chihuahua is famed. The geodes, almost perfectly spherical in shape, range in diameter from a few centimeters (1 in) to 30 cm (12 in), but by far most are less than 15 cm (6 in) in diameter. Many of the geodes are "solids" and are used for ornamental objects or sliced and polished into bookends. Much more desirable are the hollow geodes, because these are relatively thin-walled and lined with glittering crystals of smoky quartz. In some, interesting associated minerals occur as described by Finkleman (1974). Mrs. Jeannette B. Carillo of Gem Center, U.S.A. (*Pers. comm.* 12/3/93) provided me with several color photographs showing her coconut diggings which by now are completely underground. The low-relief terrain is marked by piles of waste from many pits that have been dug into the friable volcanic rock beneath. The geodes when brought to the surface appear white from the clinging fragments of the ash-like volcanic material in which they were imbedded. They are simply and effectively sorted into "solids" and "hollows" by "hefting" to judge their weight, that is, their specific gravity. Some slip-ups are possible and for this reason the hollows are sold wholesale at $400 per 100 lb (45 kg) with a guarantee of 90% hollow. These measure from 7–11 cm (2.75–4.5 in) in diameter, with solids of comparable size fetching only $45 per 100 lb (45 kg) (as of 1992/1993). Very large hollows, 12+ cm (4.75+ in), brought $450 per 100 lb (45 kg). Some geodes contain amethyst linings but by far most are smoky quartz. Polished halves brought $62 for 4 to 6 pieces of jumbo size, and when amethyst was present, somewhat more.

The Chihuahua fields continue to yield other types of quartz and agate geodes and nodules in bewildering variety, as indicated in the extensive glossary of terms assembled by Johnson (1965, p. 11–14), and needless to say, many other descriptive terms could now be added.

A most attractive quartz variety, vividly colored red by exceedingly slender needles of chalcotrichite, the fibrous form of cuprite, or copper oxide, has lately been found in the walls of a copper open pit mine in Zacatecas (Koivula, *et al*, 1993). A color photograph shows a faceted gem of several carats of slightly brownish, red color, and a rough specimen that appears to be a section of a quartz crystal-lined vug.

Shedenhelm (1980, p. 33–34) noted that "prime chrysocolla" was being sold in the El Arco area of Baja California Sur. At the Guerrero amethyst mines, very large tapered dark purple amethyst crystals sometimes yield splendid faceted gems to 200 carats! It is rumored that one pocket of these crystals yielded one-half million dollars in rough.

Mallory (1974) provided a large and informative article on the Calvillo fire agate mines, of which seven are located near the remote village of El Terrero north of Guadalajara, Jalisco. Mining is laboriously done with hand tools to break up the volcanic rock in which occur the cavities lined with the curled growths of chalcedony.

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JONES, W. (1962) New fire agate find at Tula Hill. *Lapidary J.* 16, 1, p. 113, map. San Luis Potosi.

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KOIVULA, J. I., *et al* (1993) Red quartz from Mexico. Gem News, *Gems & Gemology* 29, 1, p. 59–60, illust. (col.).

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). Rock crystal skulls p. 284–287.

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LAPIDARY JOURNAL (1964) The glory of colorful Mexican agates. Vol. 18, 4, p. 472, color pl. Erle Collins collection.

LEIPER, H., ed. (1966) *The Agates of North America.* San Diego, CA: Lapidary Journal, 95 p., illust. (col.), maps. Mexico p. 78–79.

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MALLORY, L. D. (1974) The fire agate mines of Calvillo. *Lapidary J.* 27, 10, p. 1500–1530, *passim*, illust. (col.).

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SHEDENHELM, W. R. C. (1978) Sierra Pinta jasper. *Rock & Gem* 8, 6, p. 40–42, map. Near Mexicali.

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ZEITNER, J. C. (1969) Lament for Laguna. *Lapidary J.* 23, 6, p. 788–798, *passim*, illust. Laguna agates.

PUERTO RICO. Ray (1941, p. 357–358) mentions various crystalline and cryptocrystalline quartzes as having been found on this island but nothing was outstanding in his opinion.

RAY, H. C. (1941) Minerals of Porto Rico. *Rocks & Minerals* 16, 10, p. 355–359, map.

ANTIGUA. The only quartz variety mentioned in the literature appears to be silicified wood.

BROWN, A. P. (1914) Notes on the geology of Antigua. *Acad. Nat. Sci. Phila. Proc.* 65, p. 584–616, illust.

FELIX, J. P. (1883) Die fossilen Hölzer Westindiens. *Sammlung Palaeont. Abhandl.* Ser. 1, H.1, 2, 2, 28, 12 p., illust.

MARTINIQUE. Chalcedony, silicified wood.

LACROIX, A. (1903) Sur le gisement de la calcédoine et des bois silicifés de la Martinique. *Soc. Franc. Mineral. Bull.* 26, p. 150–152.

BELIZE (BRITISH HONDURAS, FORMERLY) One of the most remarkable examples of lapidary art attributed to Central American prehistoric cultures is the famous rock crystal skull acquired in Belize by British explorer-adventurer F. A. Mitchell-Hedges. However, in his autobiography (1954), he refers to this magnificent object in only a few words, calling it the "Skull of Doom," and stating that "how it came into my possession I have reason for not revealing" (p. 243). Mitchell-Hedges claimed that the skull must have taken over a century to manufacture and that "it is at least 3,600 years old and according to legend was used by the High Priest of the Maya when performing esoteric rites." Eventually the skull passed into the hands of his adopted daughter, Anna Le Guillon, who allowed the skull to appear publicly at a gem show held in 1967 (*Lapidary Journal*, 1967; *Gems & Minerals*, 1967). Information supplied with the exhibit stated that the skull was fitted with an articulating jawbone and that both sets of upper and lower teeth were fitted "as precisely as a skilled dental technician could do the job today." The rock crystal is remarkable for its freedom from inclusions and weighs 11 lbs 7 oz (5.3 kg). Morrill (1972) examined the story behind the skull and voiced his opinion that the mysterious disappearance of Ambrose Bierce in Mexico in 1913 was somehow related to the appearance of the crystal skull in 1920. Another rock crystal skull, among others described by Kunz (1890, p. 284), was recovered from a prehistoric grave in Mexico but a precise locality is not given. The largest crystal skull from the Americas, very rudely fashioned as compared to the elegant sculpture and finish of the Mitchell-Hedges specimen, was in the possession of H. Sisson of New York City, but, as noted by Kunz (1902), it found its way into the collections of the British Museum in London. The weight of this piece is given as 39.6 lbs (17.96 kg) and its dimensions (corrected from earlier 1890 figures) are 21 cm (8.3 in) long, 13.6 cm (7.3 in) wide, and 14.8 cm (7.8 in) tall.

GEMS & MINERALS (1967) Mystery surrounds crystal skull. No. 353, p. 14, illust.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.).

_____, (1902) Gems and precious stones of Mexico. *Trans. Amer. Inst. Mining Eng.* 32, p. 55–93.

LAPIDARY JOURNAL (1967) Crystal carving features Castro Valley Show. Vol. 20, 11, p. 1351, illust.

MITCHELL-HEDGES, F. A. (1954) *Danger My Ally.* London: ELEK Books, 255 p., illust.

MORRILL, S. S. (1972) *Ambrose Bierce, F. A. Mitchell-Hedges, and the Crystal Skull.* San Francisco, CA: Cadleon Press, 83 p., illust.

HONDURAS. No new developments.

YOUNG, V. (1961) Rockhounding in Honduras. *Rocks & Minerals* 36, 5–6, p. 229–232. Agate, jasper, silicified wood.

NICARAGUA. Mrazek (1989) describes numerous varieties of chalcedonic quartz, e.g., agate, chalcedony, and silicified wood, in a series of occurrences along northwest-southeast belts in the western portion of the country. Localities include El Espinoso in Cerro Miraflores, Esteli Province in basalts and trachytes; in Venecia and Cerro Grande areas; gray and white banded agates at San Juan de Limay to Mata Platanos; also in the Cano Lakes area near the Bocay River. Alluvial material has been found in the Rio El Chaque about 8.5 km (5.4 mi) southeast of Leon.

MRAZEK, I. (1989) Gemstones of Nicaragua. *Zs. Dt. Gemm. Ges.* 38, 1, p. 17–30, illust.

COSTA RICA. As long ago as 1941, *Rocks & Minerals* noted that "very fine grayish-blue agates were found recently in the Province of Lemon . . . about 8 miles from the port of Lemon on the Caribbean Sea," and "the agates occur as water-worn pebbles and small boulders and are of excellent gem quality." The place name "Lemon" actually is *Limon.*

Ralls (1972) visited several areas in which he found chalcedonic quartzes, sometimes in considerable abundance. The varieties include agate, chalcedony, jasper, and silicified wood. The most prolific sources were found in the extreme northwestern corner of Costa Rica in Guanacaste Province where specimens were found in the gravel beds of many streams that drain into the Pacific Ocean. Especially productive were the Rio Barranco and Rio Canamazo. Farther south, Ralls also collected material at Punta Coralillo and Punta Catedral in the Quepos area of the west coast, almost directly south of the capital city of San José. Much wood, agates, etc., were found in the Mata de Limon area of the Gulf of Nicoya.

From the above accounts of chalcedonic quartz occurrences in Nicaragua, Costa Rica, and as previously given in an earlier volume of this treatise, in Panama, it is likely that prospecting along the western slopes of the volcanic mountains throughout Central America should unearth many more deposits of quartz gemstones.

RALLS, R. H. (1972) Rockhounding in Costa Rica. *Gems & Minerals* 422, p. 36–38, 55–57; no. 423, p. 34–40.

ROCKS & MINERALS (1941) Agates found recently in Costa Rica. Vol. 16, 9, p. 325.

PANAMA. No new developments.

BARBOUR, T. R. & BARBOUR, J. (1965) A rockhound's look at Panama through a camera. *Lapidary J.* 19, 8, p. 924–929, illust.

FREEHAN, P. A. (1936) Agates in the Canal Zone. *Rocks & Minerals* 11, 9, p. 170–171.

HERSHEY, O. H. (1901) The geology of the central portion of the Isthmus of Panama. *Univ. Calif. Bull. Dept. Geol.* 2, 8, p. 231–267, map.

SINKANKAS, J. (1954) Collecting in the Big Ditch. *Rocks & Minerals* 29, 1, p. 13–16, map.

STEWART, R. H. (1967) The quartz minerals of Panama and the Canal Zone. *Lapidary J.* 21, 1, p. 185–190, 324–333, *passim*, illust.

HAWAII. Despite the volcanic origin of the islands, no important source of quartz gemstones is known.

OKAMURA, R. T. & FORBES, J. C. (1961) Occurrence of silicified wood in Hawaii. *Amer. J. Sci.* 259, p. 229–230.

REMONDITE

QUEBEC. The beautiful hexagonal prisms of yellowish remondite found in the celebrated Mont St.-Hilaire locality and previously identified as

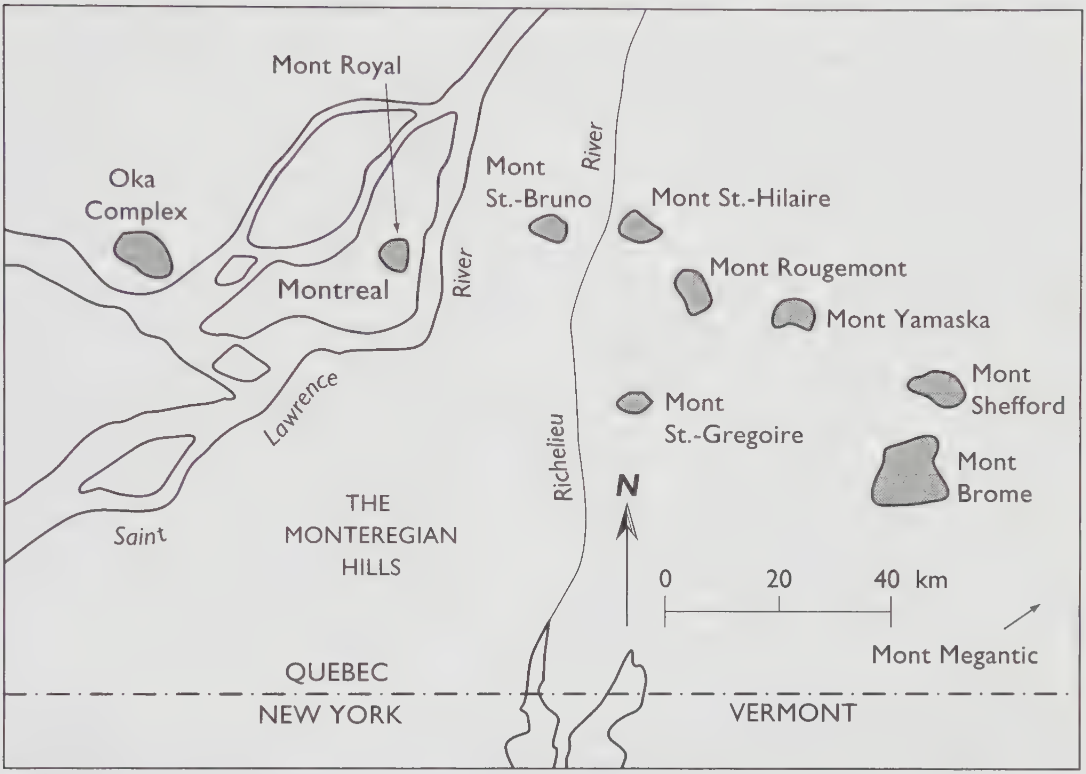


FIGURE 81. The Monteregian Hills of alkaline intrusive rocks which stand above the plain from Montreal eastward to Mont St.-Hilaire in Quebec.

burbankite are now shown to be a new species according to Robinson, *et al* (1992). While remondite is related to burbankite, microprobe analyses at the Canadian Museum of Nature demonstrated the difference. Further confirmation of the distinction is contained in Koivula, *et al* (1992) who investigated the properties of a cut gem of 3.18 ct from the Poudrette Quarry on Mont St.-Hilaire. The most striking feature of remondite is change in color from a greenish-yellow in daylight to a strong yellowish-orange under tungsten light, as shown in a pair of color photographs that accompany the article. The refractive indexes are 1.630 and 1.632, only 0.002 difference, "which is exceptionally low for a carbonate and also quite different from the published values for burbankite of 1.615 and 1.627. The stone showed no significant pleochroism, and the optic figure was pseudo-uniaxial. The specific gravity, determined by averaging three hydrostatic measurements, was 3.53 (as compared to 3.50 for burbankite)." According to Art Grant, who faceted the gem, not all remondites display the color change, and it was therefore suggested that in this instance it is due to the presence of neodymium^{3+}, and that remondites that do not show a color change lack this element. Descriptions of remondite appear under burbankite in Mandarino & Anderson (1989, p. 47) and in Horvath & Gault (1990, p. 300–301), but both give property data based on published burbankite data.

Mr. Guy Langelier of Montreal informs me that he owns a 6.59 ct "burbankite" which dis-

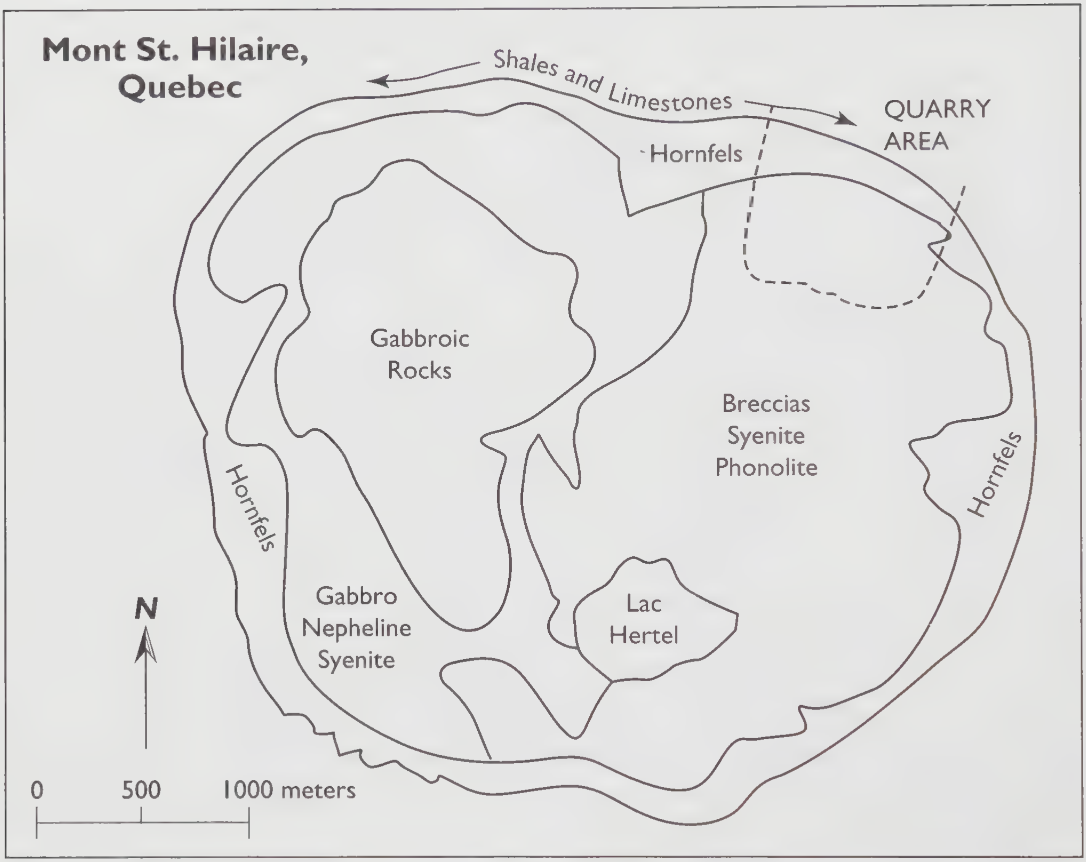


FIGURE 82. Approximate areas of the several rock types exposed on Mont Saint-Hilaire, Quebec, all of which are upthrust through the local limestones.

plays a color change from green to brown, and he knows of only five stones of this species that exceed one carat (*Pers. comm.* 10/15/93).

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont St.-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 300–301.

KOIVULA, J. I., *et al* (1992) Gem news: Color-change burbankite-related mineral from Mont St.-Hilaire, Quebec. *Gems & Gemology* 28, 4, p. 270–271.

MANDARINO, J. A. & ANDERSON, V. (1989) Monteregian Treasures: The Minerals of Mont St.-Hilaire, Quebec. Cambridge, NY: Cambridge Univ. Press, 281, p. illust. (col.).

ROBINSON, G. W., *et al* (1992) What's new in minerals? *Min. Rec.* 23, 5, p. 429.

RHODOCHROSITE

QUEBEC. Among the bewildering number of species yielded by the quarries upon Mont St.-Hilaire, even rhodochrosite has been found in crystals large and clear enough to afford a few faceted gems; one of 1.16 ct is in the Canadian National Gem Collection (Wight & Wight, 1989).

WIGHT, Q. & WIGHT, W. (1989) Art Grant: A cut above the rest, *Canad. Gemm.* 10, 4, p. 98–101.

COLORADO. The Sweet Home Mine, Alma, Park County, known worldwide for its unmatched crystals of transparent, vivid red rhodochrosite, sometimes reaching astonishing size, recently produced many additional specimens of all grades as well as numerous pieces of rough from which beautiful faceted gems were cut. The mine was worked intermittently by private venturers in the early 1960s to the late 1970s (Kosnar, 1979). The mine is located on the south flank of Mt. Bross, 3.8 mi (6 km) northwest of the town of Alma. These mining operations, sometimes conducted under difficult conditions, nevertheless produced "phenomenal" results and "probably the best rhodochrosite crystals ever recovered from this mine were taken out during this period." In 1977, Richard A. Kosnar and John Saul, owners of Intercontinental Mining Corporation, obtained a five-year lease on the property and began mining in the summer of 1977 with considerable success, obtaining many fine mineral specimens as well as facetable crystals and crystal sections of the rhodochrosite. From the Colorado Vein in the mine, Kosnar had the following faceted gems cut: 17.50 cts emerald cut, with a small flaw, "blood-red" color; 15.50 cts Portuguese cut, flawless; 9.13 cts, similar cut, flawless; and "dozens of smaller, flawless, mixed-cut gemstones," and a piece of "flawless rough measuring 23 mm x 12 mm x 9 mm" that remains uncut (*Pers. comm.* 8/10/1994).

In about 1990, the mining rights were acquired by Bryan and Kathryn Lees of Collector's Edge, a specimen mineral house based in Golden, Colorado, who produced a number of specimens in 1991 from a series of cavities in the sulfide ore body. These were sold mostly to visitors to the Denver Gem and Mineral Show of that year (Cook, 1993). Providentially, in the fall of 1992, two larger pockets were found that yielded extremely fine and large rhodochrosite crystals of classic form and color. The largest cavity measured about 6 x 4 x 0.5 ft (1.6 x 1.4 x 0.17 m) and produced several hundred specimens. According to Jones (1993), the costly mining operation was financed by "two dozen investors including the

FIGURE 83. The Poudrette Quarry on Mont Saint-Hilaire showing a party of mineral collectors examining the debris near a working face in August, 1993. *Courtesy W. Wight, Ottawa, Ontario.*

mine owners," who formed a company named Sweet Home Rhodochrosite, Inc. During the February 1993 Tucson Gem and Mineral Show, Collector's Edge exhibited two gargantuan crystallized matrix specimens as the featured exhibit in the main hall, each being slabs of cavity wall rock, studded with numerous small prisms of colorless quartz crystals, over which grew, in the case of one slab of 18 in (46 cm), numerous vivid red translucent to transparent rhodochrosite rhombohedra. Another slab, almost of the same size, boasted only one crystal of rhodochrosite, but this measured about 5 in (12.5 cm) in diameter! Also exhibited at the same time were a series of splendid faceted gems which appeared to range from about 5/8 in (1.5 cm) to a step-cut gem of about 1 x 3/4 in (2.5 x 2 cm). Unfortunately, carat weights were not included in the label data, but Michael Gray, of Missoula, Montana, who cut some of the material, informs me that he cut excellent faceted gems of 51.58 cts, a cushion-cut of 33.39 ct, a rectangular brilliant, and a 21.51 ct round brilliant (*Pers. comm.* 3/94). In his opinion, these are slightly lighter in color than previous Colorado rhodochrosites but appear to be cleaner and more brilliant. Gray mentioned that the large single crystal noted above measures on its edges 10.5 x 10.5 x 6.0 cm (4.25 x 4.25 x 2.5 in).

An excellent historical account of the mine, especially of its recent activity, appears in *Compressed Air* magazine and although anonymously published, is actually from the pen of Steve Voynick of Leadville, Colorado. Its colored photographs show all phases of mining as well as specimens and cut gems.

Elsewhere in the state, Kosnar records the following sources of facetable rhodochrosite: Moose Mine, Pleasant Valley, Gilpin County, crystals of 4.5 x 3.5 x 3 cm "dark blood-red (as good as Sweet Home Mine color) . . . will cut flawless, blood-red stones up to 3 cts"; from between the 7th and 8th levels in the Mickey Breen Mine, Uncompahgre Gorge, Ouray County, similar material from which was faceted a 2.10 ct "flawless, bright, lively blood-red color round Portuguese-cut gemstone"; and from the Smuggler Vein, Marshall Basin, Telluride County, crystals "up to 1" [2.5 cm] rose-red color with gem areas which will cut small stones."

COOK, R. B. (1993) Rhodochrosite, Alma, Park County, Colorado. *Rocks & Minerals* 68, 1, p. 40–43, illust. (col.).

COMPRESSED AIR (1994) Specimen mining. Vol. 99, 1, p. 6–13, illust. (col.).

ECKEL, E. B. (1961) Minerals of Colorado, a 100-year record. *U.S. Geol. Survey Bull.* 1114, 399 p.

HILL, R. (1979) The Colorado reds. *Gems & Minerals* 501, p. 9, 44, 49, map.

JONES, R. W. (1993) Colorado's rhodochrosite. *Rock & Gem* 23, 2, p. 42–46, *passim*, illust. (col.).

______, (1994) Sweet red rhodochrosite. *Rock & Gem* 24, 11, p. 48–51, 77, illust. (col.).

JUD, W. F. (1971) The Sunnyside Mine. *Earth Science* 24, p. 236–241.

KOSNAR, R. A. (1979) What's new in Colorado minerals. *Min. Rec.* 10, 6, p. 329–332; also The Home Sweet Home Mine, p. 333–338, illust. (col.), map.

KUNZ, G. F. (1887) Mineralogical notes. *Amer. J. Sci.* 34, p. 477–480. Includes John Reed Mine, Colorado rhodochrosite.

MARSHALL, J. H. (1968) Rhodochrosite—1968. *Rocks & Minerals* 43, 10, p. 748–749.

MILLER, H. W. (1971) Rhodochrosite crystal localities in the West. *Min. Rec.* 2, 3, p. 105–110, 143, illust.

ROOTS, R. D. (1951) Rhodochrosite in Colorado. *Rocks & Minerals* 26, p. 170.

WHERRY, E. T. & LARSEN, E. S. (1917) The Indices of refraction of analyzed rhodochrosite and siderite. *Wash. Acad. Sci. J.* 7, 12, p. 365–368. John Reed Mine material.

RHODONITE

ALASKA. Gem quality rhodonite is found on the banks of Jack River in an area about 3.5. mi (8.8 km) southeast of Cantville, Denali Highway (Roy, 1986).

ROY, S., edit. (1986) *Alaska—A Guidebook for Rockhounds.* Anchorage, AK: Chugach Gem and Mineral Soc., (48) p., maps. p. 26.

YUKON TERRITORY. A potentially valuable source of massive, fine-grained rhodonite has been discovered at a place about 25 km (16.1 mi) north of Johnson's Crossing, Km 1346, Alaska Highway in south-central Yukon. The rhodonite was discovered in 1986 during exploration for silver ore. Test drilling suggests that a minimum of 4,700 tons is available. The material is 60% fine-grained pink and about 20% very high quality dark raspberry red veined with black. The rock is taken by road to Skagway, Alaska, and shipped south to Vancouver, British Columbia, where it is processed into carvings and other ornaments (*Pers. comm.*, ANORAQ Resources Corp., 8/9/91). In 1992, the *Mineralogical Record* (vol. 23, p. 428) reported this material to be of excellent quality but it was being produced by Osiris Enterprises of Port Coquitlan, British Columbia.

BRITISH COLUMBIA. Recently a very fine-grained and richly colored rhodonite has been marketed by the Sea Rose Mines, Tony Karup and Frank Ayres, partners, the former from Bella Coola and the latter from Anahim Lake, where workshops are established for working the material. According to O'Neill (1986), the deposit has been known for at least thirty years, but earnest work did not begin until 1984. The deposit contains all grades of rhodonite, from pink to rich red material, and also some with typical black manganese dendrites. The rock is quarried at a remote, unspecified place and taken by small boat to Bella Coola where it is trucked to Anahim Lake for slabbing and further processing into cabochons, ornamental objects, carvings, and jewelry stones. The proprietors believe that the deposit is large enough to provide rhodonite tiles, much like those that have been manufactured from B.C. nephrite.

In 1990, it was reported that Rhode West, Ltd., was producing rhodonite from a property at Arthur Point on the west coast, north of the northern tip of Vancouver Island.

ARMSTRONG, J. E. (1949) Fort St. James map-area, Cassiar and coast districts, British Columbia. *Geol. Survey Canada Mem.* 252, 210 p., illust., maps.

DANNER, W. R. (1976) Gem materials of British Columbia. *MT Bur. Mines & Geol. Spec. Publ.* 74, p. 157–169, illust.

FIGURE 84. Fred Hollings standing atop a huge vein section of rhodonite on his property in Saltspring Island, British Columbia. *Courtesy S. F. Leaming, Summerland, B.C.*

FYLES, J. T. (1955) Geology of the Cowichan Lake area, Vancouver Island, British Columbia. *B.C. Dept. Mines Petrol. Res. Bull.* 37, 72 p., illust., maps.

HANSON, G. (1932) Manganese deposits of Canada. *Geol. Survey Canada, Econ. Geol. Series* 12, 120 p., illust.

HERRMANN, R. C. (1965) New discovery of gem quality rhodonite in British Columbia. *Lapidary J.* 19, 7, illust., map.

HILL, R. (1964) Cinnabar and rhodonite at Red Lake, B.C. *Canad. Rockhound* 8, 3, p. 16–17.

LEAMING, S. F. (1966) Rhodonite in British Columbia. *Canad. Rockhound* 10, 1, p. 5–11.

______, (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, 138 p., illust., maps, p. 54–62.

O'NEILL, K. (1986) Roses of the sea. *Lapidary J.* 40, 5, p. 49–52, illust.

SABINA, A. P. (1965) Rock and mineral collecting in Canada. Vol. I. Yukon, Northwest Territories, British Columbia, etc. *Geol. Survey Canada Misc. Rept.* 147 p., illust., maps.

MASSACHUSETTS. The latest and best account of the long-known rhodonite of Betts Farm, near Plainfield, about 24 mi (39 km) northwest of Northampton, Hampshire County, is that of Dunn (1976). He notes that "the Plainfield rhodonite is associated with quartz, rhodochrosite, kutnahorite, secondary manganese oxides (chiefly pyrolusite), and minor amounts of pyrite and galena." As is typical of most granular rhodonite found near the surface, black veinings and dendrites occur along fractures and create interesting patterns. Dunn identifies this black material as "oxidized rhodonite" which "gives an X-ray powder pattern of rhodonite with no extraneous lines." In addition to the usual range of pinks, a more rarely met orangey material is also found but is not colored by spessartine garnet grains as may otherwise be expected. White areas in some specimens have been identified as kutnahorite, $Ca(Mn,Mg,Fe)(CO_3)_2$. As of June 29, 1979, rhodonite was officially declared to be the Massachusetts State Gem (*Lapidary J.* 33, 7, 1979, p. 1632).

ANDERSON, J. (1962) Mineral collecting in the Springfield, Massachusetts, area. *Rocks & Minerals* 37, 3–4, p. 145–146.

DUNN, P. J. (1976) On gem rhodonite from Massachusetts. *J. Gemm.* 15, 2, p. 76–80.

EMERSON, B. K. (1895) A mineralogical lexicon of Franklin, Hampshire, and Hampton counties, Massachusetts. *U.S. Geol. Survey Bull.* 126, 180 p.

_____, (1898) Holyoke folio, No. 50. *U.S. Geol. Survey Geol. Atlas U.S.*

HITCHCOCK, E. (1825) Localities for minerals in Massachusetts. *Amer. J. Sci.* ser. 1, 9, p. 22.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient Publ. Co., 336 p., illust. (col.), p. 151–152.

ZABRISKIE, D. & ZABRISKIE, C. (1992) *Rockhounding in Eastern New York State and Nearby New England.* Albany, NY: Many Facets, (100) p., maps.

VIRGINIA. Penick (1992) briefly describes the old rhodonite locality in Fluvanna County, north of Kidd's Store in the western part of the county, and also rhodonite from several manganese prospects on both sides of the Smith Fork of Cunningham Creek. Collecting is allowed on a fee basis.

DIETRICH, R. V. (1970) Minerals of Virginia. Blacksburg, VA: *VA Polytech. Inst. Research Div. Bull.* 47, 325 p., illust., maps, p. 242.

PENICK, D. A. (1992) Gemstone and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26.

SMITH, J. W., *et al* (1964) Geology and mineral resources of Fluvanna County. *VA Div. Min. Resources Bull.* 79, 62 p.

NORTH CAROLINA.

ROSS, C. S. & KERR, P. F. (1932) The manganese minerals in a vein near Bald Knob, North Carolina. *Amer. Mineral.* 17, p. 1–18, illust.

SIMMONS, W. B. *et al* (1981) Manganese minerals of Bald Knob, North Carolina. *Min. Rec.* 12, 3, p. 167–171, map.

COLORADO. According to Rosemeyer (1988), citing as his authority Casadevall (1973), all of the so-called "rhodonite" mined in large quantities from various silver mines in the Ouray-Silverton region is actually the closely related species pyroxmangite. Similar remarks are made by R. A. Kosnar under that mineral. In the Sunnyside Mine, located 7 air miles (11 km) northeast of Silverton, San Juan County, the tabular bodies of this pink rock occur with quartz and sulfides, more or less parallel to the ore veins. Tons of this handsome ornamental rock were thrown into the dumps where it is still being recovered by amateur lapidaries (Hill, 1979; McMackin, 1980). The properties of rhodonite and pyroxmangite are similar and without careful testing it is very difficult to distinguish them. However, the refractive indexes of rhodonite are slightly lower as also is its specific gravity. In terms of chemical composition, rhodonite is $(Mn,Ca,Fe)SiO_3$ while pyroxmangite is $(Mn,Fe)SiO_3$, the presence of calcium in rhodonite slightly lowering its properties.

In the Silverton area, Kappele (1987) described gem quality material from the dumps of the Gold Prince Mine, near the ghost town of Animas Forks, several miles north of Eureka.

BURBANK, W. S. (1933) The manganese minerals of the Sunnyside veins, Eureka Gulch, Colorado. *Amer. Mineral.* 18, p. 513–527.

CASADEVALL, T. (1973) Gold mineralization in the Sunnyside Mine, Eureka mining district, San Juan County, Colorado. *PA. State Univ. M.S. Thesis*, unpubl.

GREGORY, G. E. (1969) Mineral collecting at picturesque Silverton. *Gems & Minerals* 381, p. 20–22, map.

HARRINGER, R. (1976) Rocking around Silverton, Colorado. *Lapidary J.* 30, 2, p. 624–640, illust., maps.

HILL, R. (1979) The Colorado reds. *Gems & Minerals* 501, p. 9, 44, 49, map.

KAPPELE, W. A. (1987) Rhodonite at the Gold Prince Mine. *Rock & Gem* 17, 1, p. 36–38.

_____, (1992) 4 WD beyond this point. *Rock & Gem* 22, 2, p. 56–59, 75–77, illust.

McMACKIN, C. E. (1980) We sought rhodonite and discovered Colorado. *Lapidary J.* 34, 1, p. 198–201, illust.

PEARL, R. M. (1965) *Colorado Gem Trails and Mineral Guide.* 2nd edit. Denver, CO: Sage Books, 223 p., illust., maps, p. 47–49.

ROSEMEYER, T. (1988) The Sunnyside Mine, Eureka Mining District, San Juan County, Colorado. *Rocks & Minerals* 63, 5, p. 366–384, illust. (col.), maps.

MONTANA. No new developments.

SMITH, P. A. (1941) Minerals of the Butte district, Montana. *Rocks & Minerals* 16, 7, p. 241–247.

IDAHO. No new developments.

BECKWITH, J. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: The Caxton Printers, 129 p., illust., maps.

NEW MEXICO. Northrop (1959), citing Jones (1919, p. 51), notes fine gem grade rhodonite from the Comstock and Lady Franklin mines in the Kingston district of Sierra County. Jones states that "fractures in beautiful pink rhodonite are filled with manganese oxides, which also extend in fernlike growths into the rhodonite."

JONES, E. L. (1919) Deposits of manganese ore in New Mexico. *U.S. Geol. Survey Bull.* 710, p. 37–60, map.

NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ. NM Press, p. 440.

WASHINGTON. Jackson & Jackson (1975, 1992) record occurrences of massive gem-grade rhodonite from the Mt. Higgins area, located northeast of Oso, Skagit County, and from Big Lake in the same county.

JACKSON, R. & JACKSON, K. (1975) *The Rockhound's Guide to Washington.* Vol. II. Renton, WA: Jax Products, 45 p., illust., maps.

_____, (1992) *Ibid.*, vol. 4. Renton, WA: Jackson Mountain Press, 23 p. + 21 maps., illust.

CALIFORNIA. Numerous localities for massive granular rhodonite appear in the guidebooks referenced below; others are listed in Pemberton (1983) but he does not mention suitability for lapidary work. Very few deposits are worked except intermittently by amateurs.

ABBOTT, A. L. (1972) *Gem Trails in California.* Anaheim, CA: priv. publ., 84 p., illust., maps. Localities in northern California.

BERKHOLZ, M. F. (1954) Rhodonite at Jacumba. *Gems & Minerals* 207, p. 26, 28, map. San Diego County.

BROMAN, M. (1978) *Gem Trails in California.* Anaheim, CA: Main Street Press, rev. reissue of ABBOTT, 1972.

BURROWS, D. (1970) *Go to—Northern California Gem and Mineral Collecting Areas.* Sonoma, CA: Studio Press, 44 p., maps.

BUSHMAN, J. (1982) People, places, and plunder, Oregonians visit Northern California. *Lapidary J.* 35, 12, p. 2358–2364, illust.

GEMS & MINERALS (1962) Rhodonite. No. 294, p. 18–20, illust. Tejon Ranch near Rosamund; Crafton Hill south of Redlands.

JOHNSON, C. & SON (1992) *Western Gem Hunters Atlas.* 25th edit., 80 p., maps.

MITCHELL, J. R. (1986) Happy Camp jade. *Rock & Gem* 16, 9, p. 52–55, map. Includes occurrences of rhodonite.

_____, (1986) *Gem Trails of California.* Baldwin Park, CA: Gem Guides Book Co., 159 p., illust., maps. Happy Camp p. 143–145.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold Co., 591 p., illust., maps, p. 410–414.

RANSOM, J. E. (1963) Siskiyou—a collector's treasure house. *Gems & Minerals* 310, p. 18–22, maps.

SCHWEITZER, C. G. (1957) Tejon Ranch rhodonite locality. *The Mineralogist* 25, p. 103–104.

RHYOLITE

According to Thrush (1968, p. 923), rhyolite is "the general name for fine-grained igneous rocks having a similar chemical composition to granite, commonly occurring as lava flows." Most rhyolites are therefore light in color and often so fine-grained that one cannot clearly see the individual feldspar and quartz grains without using a lens. Many types are also porous, as can be divined from their failure to assume an unbroken glassy polish no matter how carefully the polishing process is pursued. This porosity sometimes results in rhyolites absorbing minerals in solution with resulting fern-like deposits of manganese and iron oxides, or in bandings, such as those seen in wonderstones (*which see*). Rhyolites are widespread and only a few of the better types can be described below.

NEWFOUNDLAND. Sabina (1976) mentions a silicified rhyolite suitable for lapidary work that is found on the Burin Peninsula.

SABINA, A. P. (1976) Rocks and minerals for the collector. The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75–36, p. 89, 91.

QUEBEC. A buff-colored porphyritic rhyolite suitable for lapidary work is found on the dumps of Aldermac Mine, Rouyn area (Sabina, 1974). The rock contains lathlike crystals of oligoclase in a fine-grained matrix of feldspar, quartz, and sericite.

SABINA, A. P. (1974) Rocks and minerals for the collector. Kirkland Lake-Noranda-Val d'Or, Ontario, and Quebec. *Geol. Survey Canada Paper* 73-30, p. 41.

NEW HAMPSHIRE. A fine-grained rhyolite, locally called "Hurricane Mountain jasper," occurs in a dike in the Conway granite, Conway Township, Coos County. Some contains black dendrites while other kinds display brown bandings. It has been cut into attractive cabochon gems (Samuelson, *et al*, 1990).

SAMUELSON, P., HOLLMAN, K. & HOLT, C. (1990) Minerals of the Conway and Mount Osceola granites of New Hampshire. *Rocks & Minerals* 65, 4, p. 286–296, illust.

UTAH. Spheroid-patterned fine-grained rhyolite, useful for larger lapidary projects, is found in an area east of Birdseye, Utah County, south of Provo. A similar material in the form of weathered-out nodular masses occurs in the hills to the west of Yuba Lake, reached via Interstate Highway 15, southwest of Levon, Juab County. A very fine-grained, cream to brownish rhyolite whose fractures contain attractive, complexly formed black dendrites, locally called "mountain fern," occurs in the Tushar Mountains which form the border between Beaver and Piute counties in south central Utah. In 1993, this stone was being quarried by Robert Stober for commercial monumental building purposes, including interior decoration. The deposit was discovered and claimed in 1987. It has been identified as part of the Mount Baldy extrusion of the Belknap caldera (*Gem Faire Quart.*, 1993, Spring, p. 31).

CALIFORNIA. An orbicular rhyolite, some of which is useful for larger lapidary projects, is found on the southern end of the East Ord Mountains, between Barstow and Lucerne Valley in San Bernardino County (Strong, 1965). The rock groundmass is light colored with round nodular "eye" inclusions. Numerous quarries furnishing building (but not lapidary) grade rhyolite are described in Aubury (1906).

AUBURY, L. E., ed. (1906) The structural and industrial materials of California. *CA State Mining Bur. Bull.* 38, 412 p., illust., p. 154–164.

STRONG, M. F. (1965) Ord Mountain rhyolite. *Gems & Minerals* 338, p. 16–17, map.

ROCKBRIDGEITE

VIRGINIA. Lapidary material has been found on the dumps of the Dixie Iron Mine, 1.5 mi (2.4 km) east of Vesuvius, Rockbridge County (after which place the mineral was named). It is fibrous, massive, greenish-black, and sometimes cut by amateur lapidaries into cabochons which take on "a brilliant luster which resembles black jade. Attractive jewelry has been made with this material" (Penick, 1992).

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 23.

RODINGITE

MARYLAND. No new developments.

BERNSTEIN, L. R. (1980) Minerals of the Washington, D.C. area. *Maryland Geol. Survey Educ. Series* No. 5, 148 p., illust., map.

BROUGHTON, P. L. (1972) Mineralization of a serpentinite quarry at Hunting Hill, Montgomery County, Maryland. *Earth Sci.* 25, p. 298–301.

LARRABEE, D. M. (1968) Serpentinite and rodingite in Hunting Hill Quarry, Montgomery County, Maryland. *U.S. Geol. Survey Bull.* 600-D, p. 195–196.

RUTILE

ALABAMA. In describing a source of gem-grade star quartz, Rohrbach (1989) mentions that he found "quartz, hematite, and fine quality rutile crystals [that] are dispersed in the red clay . . . a high percentage of the rutile crystals are of sufficient clarity to be faceted," but "only small stones can be cut from these crystals . . . due to their intense color." No locality is given but it may be in Chambers County.

ROHRBACH, R. P. (1989) The stars fell in Alabama. *Lapidary J.* 42, 12, p. 20–22, 24–26, 28, illust.

SCAPOLITE GROUP

QUEBEC & ONTARIO. Some fibrous, chatoyant scapolite, at times mauve in color, has been found in the Hadley Mine, south of Old Chelsea in Quebec, and from it some attractive chatoyant cabochons have been cut. Numerous localities for members of this group are given in the Sabina guides listed below but few deposits furnish any type of gem material.

SABINA, A. P. (1971) Rocks and minerals for the collector. Ottawa to North Bay, Ontario; Hull to Waltham, Quebec. *Geol. Survey Canada Paper* 70–50, 130 p., illust., maps.

______, (1987) *Ibid.* Hull-Maniwaki, Quebec, Ottawa-Peterborough, Ontario. *Ibid. Misc. Rept.* 41, 141 p., illust., maps.

THOMAS, W. B. S. (1947) Chatoyant wernerite from Canada. *Rocks & Minerals* 22, p. 339. Bancroft, Ontario.

NEW YORK. The New York State Museum in Albany includes in its gem collection a 1.25 ct colorless round brilliant faceted scapolite from Minerva and a 0.30 ct blue baguette faceted gem from Olmstedville, both in Essex County.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection Catalogue. *Open File Report* 8m106, Albany, 47 p.

SCHEELITE

YUKON TERRITORY. Arem (1987, p. 168) lists an 8.55 ct intense orange step-cut faceted gem from Emerald Lake, but I have not been able to find a corroboration of the locality.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 245 p., illust. (col.).

ARIZONA. Arem *(Ibid.)* notes an 8.70 ct orange gem from the Cohen Tungsten Mine in the Cabezas Mountains, 10 mi (16 km) east of Willcox, Cochise County, that is in the Devonian Group collection, Calgary, Alberta.

FIGURE 85. Collectors examining the contents of a huge cavity exposed in the wall of the Poudrette Quarry, Mont Saint-Hilaire, Quebec. The pocket was noted for its abundance of splendidly-crystallized serandite. View taken in May 1988. *Courtesy W. Wight, Ottawa, Ontario.*

CALIFORNIA. Arem *(Ibid.)* lists a 14.0 ct colorless faceted gem that is in the collection of the Royal Ontario Museum and a 20.65 ct colorless faceted gem "from near Bishop, California," presumably from the Greenhorn Mountains source in Kern County; the latter stone is in the collection of the American Museum of Natural History in New York City. Arem also notes that "California gems may reach 70 carats . . . but an orange Mexican stone [Sonora?] over 100 carats has been cut."

BERKHOLZ, M. F. (1954) The Greenhorn Mountains. *Gems & Minerals* 204, p. 10–12, 60, 61, illust., maps.
TROXEL, B. W. & MORTON, P. K. (1962) Mines and mineral resources of Kern County, California. *CA Div. Mines Geol. County Rept.* 1, 370 p., illust., maps. Scheelite p. 294–326.

BAJA CALIFORNIA. No new developments.

FRIES, C. & SCHMITTER, E. (1945) Scheelite deposits in the northern part of the Sierra de Juarez, Northern Territory, Lower California. *U.S. Geol. Survey Bull.* 946-C, p. 73–101, maps.

SCORZALITE

CALIFORNIA. The attractive, deep blue nodular masses of "lazulite" from the Champion Andalusite Mine on White Mountain, Mono County, are now shown to be scorzalite. Lazulite from here was originally described by Pecora & Fahey (1950) while the newer work of Smerud & McDonald (1956) corrects the identity.

GROSS, E. B. & PARWEL, A. (1968) Rutile mineralization at the White Mountain andalusite deposit, California. *Arkiv f. Mineralogi och Geologi* Bd. 4, no. 29, p. 493–497.

PECORA, W. T. & FAHEY, J. J. (1950) The lazulite-scorzalite isomorphous series. *Amer. Mineral.* 35, p. 1–18, illust.

SMERUD, A. K. & McDONALD, W. H. (1956) Scorzalite and lazulite. *Gems & Minerals* 224, p. 20–21, 86.

WISE, W. S. (1977) Mineralogy of the Champion Mine, White Mountains, California. *Min. Rec.* 8, 6, p. 478–486, illust., map.

WOODHOUSE, C. D. (1951) The Mono County andalusite mine. *Rocks & Minerals* 26, 9–10. p. 486–493, illust.

SEPIOLITE, *see* MEERSCHAUM

SERANDITE

QUEBEC. The vivid orange to salmon-pink crystals of serandite from the Poudrette Quarry on Mont St.-Hilaire, 32 km (20 mi) east of Montreal, continue to be found to the delight of mineral collectors and a few collectors of unusual faceted gems who have been able to obtain the rare bits of rough that are sufficiently clear for this purpose. Serandite is a complex silicate, formula Na $(Mn^{+2},Ca)_2Si_3O_8(OH)$, triclinic, occuring commonly in squarish prismatic crystals that range up to 20 cm (8 in) long and 7 cm (2.75 in) wide. Properties: refractive indexes alpha = 1.660, beta = 1.664, gamma = 1.688, difference 0.028, biaxial (+); H 4.5–5, SG 3.32 (Arem, 1987, p. 169). Roberts, *et al* (1990, p. 779) gives these optical constants: 1.674, 1.677, 1.710, diff. 0.036, SG 3.41, while Kammerling, *et al* (1995) examined a very bright orange faceted gem of 0.79 carat, very clean, and found approximate indexes of 1.679, 1.680 to 1.681, and 1.711, diff. 0.032; SG 3.47.

Serandite was once deemed rare, but the finds here led Horvath & Gault (1990, p. 335) to declare that it is the preeminent mineral for which Mont St.-Hilaire has become famous. They record rectangular emerald-cut gems of "intense pinkish orange" of 1.65 and 0.95 ct. Wight (1986) records four faceted gems rarely exceeding a fraction of a carat in weight. Guy Langelier of Montreal informs me that he owns an orange gem of 14.62 ct but with inclusions (*Pers. comm.* 10/15/1993). In 1993, a published price list of rare gems offered a faceted 1.2 ct serandite, bright orange, for $750/carat.

AREM, J. E. (1987) *See above.*

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont St.-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 338, illust. (col.), map.

KAMMERLING, R. C., *et al* (1995) Faceted sphalerite and other collector stones from Canada. *Gems & Gemology* 31, 1, p. 65–67, illust. (col.).

MANDARINO, J. A. & ANDERSON, V. (1989) *Montereglan Treasures: The Minerals of Mont St.-Hilaire, Quebec.* Cambridge, NY: Cambridge Univ. Press, 281 p., illust. (col.), p. 183.

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R., Jr. (1990) *Encyclopedia of Minerals.* 2nd edit. NY: Van Nostrand Reinhold, 979 p., illust. (col.).

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

______, (1991) Checklist for rare gemstones—serandite. *Ibid.* 12, 2, p. 46–49.

SERENDIBITE

NEW YORK. This rare mineral, formula $Ca_2 (Mg,Al)_6 (Si,Al,B)_6O_{21}$, has been reported only in granular form in various shades of blue or blue-gray. Properties: refractive indexes alpha 1.701, beta 1.703, gamma 1.706, difference 0.005; biaxial; specific gravity 3.41; H 6½–7 (Roberts, *et al* 1990, p. 780). According to these authors, serendibite occurs at the contact between Grenville marble and intrusive granite at a place several miles west of Johnsburg, Warren County. A 21.5 ct blue cabochon of this material is in the New York State Museum collection (Schimmrich & Campbell, 1990, p. 34).

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R. (1990) *Encyclopedia of Minerals.* 2nd edit. NY: Van Nostrand Reinhold, 979 p., illust. (col.).

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum gem collection catalogue. Albany, *Open File Rept.* 8m106, 47 p.

SERPENTINE

Serpentinites, or rocks comprised mostly of serpentine group minerals, are widespread in New England, the Middle Atlantic states, the South, and California, as summarized by Merrill (1897). However, only a few deposits contain material suitable for lapidary purposes. The gem varieties are ably described by Webster (1967) while the mineralogical properties are treated by Faust & Fahey (1962).

BURNHAM, S. M. (1883) *History and Uses of Limestone and Marbles.* Boston, MA: S. E. Cassino and Co., 392 p., color plates. Includes serpentines.

FAUST, G. T. & FAHEY, J. J. (1962) The serpentine-group minerals. *U.S. Geol. Survey Prof. Paper* 384-A, 92 p., illust.

MERRILL, G. P. (1987) *Stones for Building and Decoration.* 2nd edit. NY: John Wiley & Sons, 506 p., illust. Serpentine p. 53–72.

NAGY, B. & FAUST, G. T. (1956) Serpentines: Natural mixtures of chrysotile and antigorite. *Amer. Mineral.* 41, p. 817–838.

SELFRIDGE, G. C. (1936) An X-ray and optical investigation of the serpentine minerals. *Amer. Mineral.* 21, 8, p. 463–503, illust.

SMITH, J. L. & BRUSH, G. J. (1853) Reexamination of American minerals. *Amer. J. Sci.* 15, p. 207–215. Bowenite and williamsite are serpentine.

WEBSTER, R. (1967) Ornamental serpentine. *Lapidary J.* 21, 1, p. 98, 100, 102–109, illust.

NORTHWEST TERRITORIES. Hogarth (1975), Gibbins (1987, 1988), and McDermott (1992) use the word "carvingstone" as a convenient categorical term for a variety of rocks that are employed by the Inuit of northern Canada for creating their unique folk carvings. Gibbins particularly examines the economics of this now-important income-producing native carving industry which depends on supplies of territorial rocks for its viability. Serpentine is a favorite material because it carves readily and assumes a good polish. Information on sources appears in the references below. The most important deposits are few, namely near Mary River, near Milne Inlet in North Baffin Island, and in the Markham Bay and Aberdeen Bay areas to the south of the island.

GIBBINS, W. A. (1987) Carvingstone and Inuit carvings: Unique northern Canadian resources. *NWT Geol. Div.*, EGS 1987-7, Yellowknife, 22 p.

______, (1988) Carvingstone, the foundation of a northern economy. *Inuit Art Quart.*, Fall, p. 4–8, illust.

HOGARTH, D. D. (1975) Carvingstone occurrences in Southern Baffin Island. *NWT Geol. Div. Rept.*, 23 p., maps.

McDERMOTT, G. (1992) Carvingstone occurrences of the Northwest Territories. *NWT Geol. Div.*, EGS 1992-15, Yellowknife, 185 p.

QUEBEC. Sabina (1974, p. 80) notes that in the Lac Malarctic area the dark green to almost black serpentinite "is extracted from an open cut and shipped to various points in the Arctic for use as a sculpturing stone by the Eskimo." The deposit is located near the Marbridge Mine, several miles northwest of Lac Kergus. Other sources of lapidary grade serpentine in Quebec and Ontario appear in the other work of Sabina below.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. II. Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 8, 252 p., illust., maps.

_____, (1969) Rocks and minerals for the collector: Buckingham-Mont Laurier-Grenville, Quebec; Hawkesbury-Ottawa, Ontario. *Geol. Survey Canada Paper* 68-51, 107 p., illust., maps.

VERMONT. According to Gosse (1962), serpentine is abundant in the Williams River and Middle Branch River beds near Chester, Windsor County, although only a small percentage is suitable for lapidary work, and "a little translucent green serpentine of the williamsite variety occurs sparingly, and more rarely, a prized pebble of the chatoyant or fibrous variety which furnishes a beautiful cat's-eye gem is also found."

ADAMS, C. B. (1845) *First Annual Report of the Geology of the State of Vermont*, Burlington, VT: Chauncey Goodrich, 92 p. Serpentine p. 38–39.

GOSSE, R. C. (1962) Mineral collecting in Chester, Vermont. *Lapidary J.* 16, 9, p. 858–861, illust., map.

HAYES, A. A. (1855–1856) [On the so-called verd-antique marble from Roxbury, Vermont.] *Boston Soc. Nat. Hist. Proc.* 5, p. 260–263, 339–341.

MERRILL, G. P. (1897) *See above.*

MORRILL, P. & CHAFFEE, R. G. (1964) *Vermont Mines and Minerals Localities.* Hanover, NH: Dartmouth College Museum, 57 p. Many mentions.

RHODE ISLAND. Bowenite serpentine is still found in the quarries near Limerock, about 5 mi (8 km) north of North Providence (Mitchell, 1984). Here the Conklin Quarry is worked primarily for its impure marble which is crushed and used for agricultural applications.

MITCHELL, J. R. (1984) Conklin Quarry. *Gems & Minerals* 563, p. 122–124.

NEW YORK. The principle occurrence of lapidary grade serpentine is in an asbestos quarry located about 0.75 mi (1.2 km) southeast of the town of Thurman, Warren County, originally described by Merrill (1889) and later by Gosse (1964), Zirlin (1979), and Zabriskie (1992). Gosse notes that the serpentine is retinalite, and gem quality material is to be found on the dumps, and while some is cracked, "much of it is equal to the best from any North American locality, if not better."

GOSSE, R. C. (1964) An occurrence of precious serpentine in New York. *Lapidary J.* 17, 12, p. 1232–1234, illust., map.

MERRILL, G. P. (1889) On the ophiolite of Thurman, Warren Co., N.Y. *Amer. J. Sci.* 37, p. 189–191.

NEWLAND, D. H. (1901) The serpentines of Manhattan Island and vicinity and their accompanying minerals. *Columbia Univ. School of Mines Quart.* 22, p. 307–317, 399–410.

ZABRISKIE, D. & ZABRISKIE, C. (1992) *Rockhounding in Eastern New York State and Nearby New England.* Albany, NY: Many Facets, 49 p., maps, p. 34.

ZIRLIN, S. H. (1979) Rediscovering Thurman: An old serpentine location in New York State. *Lapidary J.* 33, 8, p. 1818–1820, map.

NEW JERSEY. The classic locality at Franklin, Sussex County, is now extinct, the mine workings abandoned and flooded, and the Buckwheat Pit, the source of gem quality reddish-brown manganiferous serpentine, is a pond. The Montville locality is still visited and yields gem serpentine.

BERKHOLZ, M. F. (1958) The Royal Green Quarry. *Gems & Minerals* 248, p. 38–39, map. Phillipsburg, near Easton, PA, gem serpentine.

JACKSON, R. & JACKSON, K. (1973) *A Rockhound's Guide to Metropolitan New Jersey.* Seattle, WA: JAX Products, 50 p., illust., maps, p. 10, 35.

KOENIG, G. A. (1887) Manganese zinc serpentine from Franklin, N.J. *Acad. Sci. Phila. Proc.* 38, p. 350–351.

MANCHESTER, J. G. (1931) The minerals of New York City and its environs. *NY Mineralogical Club Bull.* 3, 1, 168 p., illust., map, p. 31.

MERRILL, G. P. (1889) On the serpentine of Montville, New Jersey. *U.S. Nat. Mus. Proc.* 11, p. 105–111, illust.

PALACHE, C. (1935) The minerals of Franklin and Sterling Hill, Sussex County, New Jersey. *U.S. Geol. Survey Prof. Paper* 180, 135 p., illust., map. Serpentine p. 117.

SHANNON, E. V. (1927) The serpentine locality of Montville, New Jersey. *Amer. Mineral.* 12, p. 53–55.

PENNSYLVANIA-MARYLAND. The fine, translucent green "williamsite" serpentine found in its finest quality in the debris surrounding the Line Pit chrome mine located squarely upon the line between Pennsylvania and Maryland is now only occasionally found by collectors, especially if they take the trouble to dig among the roots of the scrub vegetation characteristic of such "serpentine barrens." The most complete information on this deposit and others like it, is to be found in Foord, *et al* (1981), who describes the local geology, the mining history, the deposits, and the mineralogy. They classify williamsite as an antigorite, formula $(Mg,Fe^{+2})_3Si_2O_5(OH)_4$. The attractive bluish-green color has been attributed to the presence of iron, but in their opinion it is more likely due to nickel, with or without chromium. *See also* previous studies of this deposit and its minerals, especially Pearre, *et al* (1960).

BROUGHTON, P. L. (1965) Mineralogy of Southeastern Pennsylvania. *Gems & Minerals* 338, p. 26–28, maps.

CHESTER, F. D. (1888) The State Line serpentine and associated rocks; a preliminary notice of the serpentines of southeastern Pennsylvania. *Amer. Assoc. Adv. Sci. Proc.* 36, p. 224 (abstract).

______, (1889) *Ibid. PA Geol. Survey Ann. Rept.* 1887, p. 93–105.

DUERSMITH, L. J. (1951) Wood's chrome mine, Lancaster County, Penn. *Rocks & Minerals* 26, 5–6, p. 243–247, map.

FOORD, E. E., HEYL, A. V. & CONKLIN, N. M. (1981) Chromium minerals at the Line Pit, State Line chromite district, Pennsylvania and Maryland. *Min. Rec.* 12, 3, p. 149–156, maps.

GEYER, A. R., SMITH, R. C. & BARNES, J. H. (1976) Mineral collecting in Pennsylvania. *PA Topo. Geol. Survey Gen Geol. Rept.* 33, 260 p., illust., maps.

GLASS, J. J., VLISIDIS, A. C. & PEARRE, N. C. (1959) Chromian antigorite from the Wood's mine, Lancaster County, Pennsylvania. *Amer. Mineral.* 44, p. 651–656. Williamsite.

GORDON, S. G. (1921) Texas, Lancaster County, Pennsylvania. *Amer. Mineral.* 6, p. 112–117.

JACKSON, R. & JACKSON, K. (1973). *See above.* Line Pits p. 21.

LAPHAM, D. M. (1958) Preliminary report on the chromite occurrence at the Wood Mine, Pennsylvania. *PA Geol. Survey 4th Ser. Progress Rept.* 153, 11 p.

LARRABEE, D. M. (1969) Serpentinite and rodingite in the Hunting Hill Quarry, Montgomery County, Maryland. *U.S. Geol. Survey Bull.* 1283, 34 p., illust. (col.), maps.

PEARRE, N. C. & HEYL, A. V. (1959) The history of chromite mining in Pennsylvania and Maryland. *PA Bur. Topo. Geol. Survey, Info. Circ.* 14, 27 p.

______, (1960) Chromite and other mineral deposits in serpentine rocks of the Piedmont upland, Maryland, Pennsylvania, and Delaware. *U.S. Geol. Survey Bull.* 1082-K, p. 707–833, illust.

TRAPP, F. W. (1971) Gemstones and ornamental rocks, the serpentine belt of Maryland, Pennsylvania, and Delaware. *Lapidary J.* 25, 1, p. 48–58, *passim*, 82–88, *passim*, illust., maps.

MONTANA. Prchal (1970) describes large deposits of serpentine in the Beartooth Mountains on Hellroaring Plateau and on Rock Creek nearby, Carbon County, that were originally opened for chromite. Some of the serpentine is gem quality, "vivid green . . . highly translucent," and from it were made cabochons that closely resembled nephrite jade. No specific locality is given but the area is generally southwest of Red Lodge.

PRCHAL, M. (1970) Jade hunting in Montana. *Lapidary J.* 23, 11, p. 1476–1478, illust. (col.).

NEW MEXICO. The handsome, banded serpentine known as "ricolite" occurs only in Ricolite Gulch (Ash Creek), about 6 mi (9.5 km) north, slightly east, of Red Rock, Grant County. Merrill (1897, p. 64) first published information on this rock which was subsequently amplified by Northrop (1959, p. 460–462) who additionally provides historical notes. Northrop states that the ricolite was already well-known by 1890 and that by the end of the century it was being quarried as decorative panels for interior use. Two veins of ricolite are present at the site, 15–20 ft (4.6–6 m) wide, and large boulders of the ricolite, up to two tons each, are found in the gulch. The colors are green, yellow, blue, and black. About 0.5 mi (0.08 km) to the northeast of the ricolite quarry is a quarry where fine yellow serpentine is available, according to Van Landingham (1962). He states that "a common misconception is that ricolite is a variety of serpentine, a mineral. Ricolite is more than a mineral. At least two distinct minerals, talc and serpentine, are present in ricolite. Often there are more than two." Van Landingham also notes that the commonest color combination is dark green with yellow and yellow-green, "but buff, red, yellow, blue, and brown are also common."

JONES, F. A. (1904) *New Mexico Mines and Minerals (World's Fair Edition, 1904).* Santa Fe, 349 p., illust.

KIMBLER, F. S. & NARSAVAGE, R. J. (1981) *New Mexico Rocks & Minerals. The Collecting Guide.* Santa Fe, NM: Sunstone Press, 71 p., illust. (col.), maps. Ricolite p. 12.

McMACKIN, C. E. (1979) Memories of Ricolite Gulch. *Lapidary J.* 33, 5, p. 1184–1190, map.

MERRILL, G. P. (1897) *See above,.* p. 64.

NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ. NM Press, 665 p. Ricolite p. 460–462.

SIMPSON, B. W. (1961) *New Mexico Gem Trails.* Granbury, TX: Gem Trails Publ. Co., 88 p., illust., maps. Ricolite p. 78–79.

VAN LANDINGHAM, S. L. (1962) The gem rocks. Part 6. Ricolite. *Gems & Minerals* 301, p. 24–25, map.

BRITISH COLUMBIA. Although not specifically mentioned as suitable for lapidary work, the serpentines that accompany the nephrites of this province may be useful for carving. Leaming (1973) mentions a serpentinite called "yalakomite" that is described as "boulders of altered brecciated serpentine cut by magnesite veins" which "takes a good polish and makes attractive slabs, bookends, and pen stands." These rocks occur in the Yalakom River Valley northwest of Lillooet (p. 74).

LEAMING, S. (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, 138 p., illust., maps.

______, (1978) Jade in Canada. *Geol. Survey Canada Paper* 78-19, 59 p., illust., maps.

CALIFORNIA. In addition to providing valuable remarks on California serpentines useful for lapidary purposes, Ferguson (1977) also gives advice on how to recognize serpentine in the field and describes the several varieties that he has examined. Many of the occurrences listed below are from his paper.

Siskiyou County: pebbles and boulders in many streams in the vicinity of Happy Camp; in a quarry just east of Slater Butte, northwest of Happy Camp about 10 mi (16 km) via Highway 96 (Mitchell, 1986, p. 141–142). Aubury (1906, p. 148) notes that "a belt of it [serpentine] runs along a part of the main ridge of the Cottonwood Mountains . . . it takes a fine polish."

Humboldt County: pebbles and boulders in stream beds around Willow Creek, especially about 4–5 mi (6.3–7.5 km) west of Willow Creek village on Highway 2999 (Mitchell, 1986, p. 135–136); attractive green material, along with jaspers, in stream gravels about 10 mi (16 km) southeast of Alderpoint on the road to Kettenham; similar material about 15 mi (24 km) south of Kettenham (Mitchell, 1986, p. 132–133).

Butte County: lapidary grade serpentine about 1 mi (1.6 km) north of Pulga; also about the same distance south of Pulga on the west side of Pulga Road (Mitchell, 1986, p. 148).

Amador County: yellowish-green to dark olive-green material has been quarried 2 mi (3.2 km) west of Plymouth; also a beautiful mottled variety was quarried 1.5 mi (2.4 km) west of Sugar Loaf (Aubury, 1906, p. 147).

Lake County: cuttable serpentine in roadcuts in the general area of Kelseyville and in local creek beds (Ferguson, 1977).

Calaveras County: dark green serpentine containing flecks of chalcopyrite which show up well in polished cabochons is found in the Copperopolis area; north of Copperopolis near Jackson a light green ophiolite with small dark green specks affords attractive cabochon material; a "bird's-eye" serpentine has been found near Murphys and has proved to be excellent carving material (Ferguson, 1977).

Alameda County: carving and cabochon grade serpentine occurs in Del Puerto Canyon, reached by Mine Road south from Livermore (Ferguson, 1977). This very attractive material displays a breccia-like pattern of brownish serpentine against dark green serpentine. Ferguson likens it to the pattern of a giraffe's neck.

San Benito County: fine carving grade antigorite of grayish-green color with streaks of yellow-green occurs on San Benito Mountain in the Clear Creek–New Idria area, south of Hollister (Ferguson, 1977).

Monterey County: the Jade Cove area, presently off-limits to collectors, contains large quantities of lapidary grade serpentines which have been largely ignored in the pursuit of jade.

Tulare County: "satelite," a fibrous, chatoyant grayish serpentine, capable of being cut into feeble cat's-eyes, occurs on Venice Hill, 8 mi (12.7 km) east of Visalia (Ferguson, 1977).

San Luis Obispo County: light and dark green serpentine of cutting grade occurs on the hill just behind (west of) the famous Madonna Inn on Highway 101, just south of San Luis Obispo (Ferguson, 1977).

Santa Barbara County: a mottled green and white serpentine of cabochon grade is found near Solvang.

Santa Catalina Island: serpentine-marble has been commercially quarried on this island (Ferguson, 1977; Aubury, 1906, p. 147).

San Bernardino County: handsome verde antique marble-serpentine, "probably as fine as any in the United States," was quarried many years ago in the Verde Antique Marble Quarry (also known as the Gem Quarry or the Kimball Mine) about 16 mi (25 km) north 25° east of Victorville (Aubury, 1906, p. 147). Butler (1994) found an attractive green lapidary grade serpentine in the open cut of the Kaiser Steel Company's mine located between the Pinto Basin and the Chuckawalla Mountains.

AUBURY, L. E., ed. (1906) The structural and industrial minerals of California. *CA State Min. Bur. Bull.* 38, 412 p., illust.

BUTLER, G. A. (1994) Eagle Mountain Mine minerals. *Rock & Gem* 24, 10, p. 50, 51, 83–85, illust. (col.), map.

FERGUSON, R. W. (1977) California's cuttable serpentines. *Lapidary J.* 31, 1, p. 174–180, *passim*, illust.

MITCHELL, J. R. (1986) *Gem Trails of California*. Baldwin Park, CA: Gem Guides Book Co., 155 p., illust., maps.

ARIZONA. No new developments.

RANSOM, J. E. (1956) Serpentine miners of Salt Creek Canyon. *Desert Mag.* 19, 4, p. 13–16, illust., map.

STEWART, L. A. (1956) Chrysotile asbestos deposits of Arizona. *U.S. Bur. Mines Info. Circ.* 7745, 41 p., illust., maps.

SHALE *see* OIL SHALE

SHATTUCKITE

ARIZONA. Massive, fine-granular material is sometimes cut into cabochons as a cabinet curiosity.

EVANS, H. T. & MROSE, M. E. (1966) Shattuckite and plancheite: A crystal chemical study. *Science* 154, p. 506–507.

NEWBERG, D. W. (1964) X-ray study of shattuckite. *Amer. Mineral.* 49, p. 1234–1239.

SCHALLER, W. T. (1919) Plancheite and shattuckite, copper silicates, are not the same mineral. Wash., DC. *Acad. Sci. J.* 9, p. 131–134.

SHORTITE

QUEBEC. Another facetable rarity from Mont St.-Hilaire is shortite, formula $Na_2Ca_2(CO_3)_3$, a carbonate that occurs as short prismatic crystals of yellow to greenish-yellow color. According to Horvath & Gault (1990), such crystals are small, generally less than one millimeter, but larger ones must have been found later to supply the rough for the cut gems. Guy Langelier of Montreal (*Pers. comm.* 10/15/1993) includes a faceted "canary yellow" gem of 3.52 ct in his collection but notes that the average size of gems is less than one carat and the usual color yellowish-green. A faceted peridot-green gem of 2.35 ct was cut by Art Grant (*Pers. comm.* 2/93), and in 1993, a gem dealer offered a rich yellow stone of 0.57 ct for $550, or $950/ct. Arem (1987) mentions cut gems of less than one carat but from crystals found in oil well clays in Wyoming and Utah (p. 171). He gives the following properties: refractive indexes, alpha 1.531, beta 1.555, and gamma 1.570, difference 0.034; biaxial; orthorhombic; hardness 3; specific gravity 2.60. A transparent yellow faceted gem of 0.44 ct was examined at the German Gemological Institute (1994) and gave the following properties: refractive indexes, alpha 1.530, beta 1.551, and gamma 1.569, difference 0.039, biaxial negative; specific gravity 2.61.

Kammerling, *et al* (1995) records a very large (for the species) cut gem of 3.52 carats which appears to be the largest example known. They examined another gem of 0.23 carats and found pleochroic colors of slightly greenish-yellow, very light yellow, and colorless; refractive indexes alpha 1.530, beta & gamma close to 1.568, difference ca 0.038; specific gravity 2.58.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.).

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont St.-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 281–368.

KAMMERLING, R. C., *et al* (1995) Gem News. Faceted sphalerite and other collector stones from Canada. *Gems & Gemology* 31, 1, p. 65–67, illust. (col.).

ZEITSCHRIFT d. DEUTSCHEN GEMM. GES. (1994) Gemmologie Aktuell.

SIDERITE

QUEBEC. Among the spectacularly large and fine crystallizations found in the quarries on Mont St.-Hilaire is the iron carbonate siderite, formula $FeCO_3$. It forms mostly simple rhombohedra, sometimes to 25 cm (10 in) on edge although the usual size range is 1–2 cm (ca 0.75 in). The tan to brown crystals are sometimes paler in color on their exteriors than inside (Horvath & Gault, 1990, p. 338). The properties of world siderites, according to Arem (1987, p. 171–172) are refractive indexes omega 1.873, epsilon 1.633, difference 0.240; uniaxial negative; H 3.5–4.5; SG 3.83–3.96. A specimen of the Mont St.-Hilaire siderite measured by Mandarino & Anderson (1989, p. 49) gave SG 3.92. Despite the former abundance of many large crystals, very little material was found to have facet gem potential, and Wight (1986, p. 52) records only two small faceted gems in the Canadian National Gem Collection, namely light brown brilliants of 2.60 and 2.25 ct, both acquired in 1984.

AREM, J. E. (1987) *See above.*

HORVATH, L. & GAULT, R. A. (1990) *See above.*

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 24–45, 50–55.

_____, (1992) Checklist for rare gemstones—siderite. *Canad. Gemm.* 13, 3, p. 78–81.

SILLIMANITE

VIRGINIA. Penick (1992) reports that fibrous gem quality sillimanite has been found northeast of Altavista in Campbell County, near the crossing of state routes 711 and 712. It occurs as "extremely fine-grained fibrous masses known as the variety fibrolite . . . polished cabochons display an attractive cat's-eye effect or chatoyancy and have been used in jewelry."

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust., p. 23.

SOUTH CAROLINA. The gem quality chatoyant sillimanite previously described from near Seneca, Oconee County, has been cut into cat's-eye stones; a black 5.9 ct gem is in the Smithsonian collection. This material has been described in Volume 2.

IDAHO. No new developments.

BECKWITH, J. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: The Caxton Printers, 129 p., maps. Sillimanite p. 90.

BLALOCK, J. L. (1956) Gem sillimanite from Idaho. *Rocks & Minerals* 31, 5–6, p. 240.

GRIGSBY, J. (1956) Gem stones of Idaho. *Gems & Minerals* 230, p. 20, 69–70.

HANSON, L. (1956) Sillimanite—the world's newest gem. *Lapidary J.* 10, 4, p. 294, 296, 298.

_____, (1957) Sillimanite. *Gemmologist* 26, p. 23–25.

SILVER

ONTARIO. Native silver, forming complex dendritic crystal growths in white, massive calcite, alone or with such nickel-cobalt minerals as nickeline (niccolite), smaltite, and safflorite, occurs in carbonate veins in Archean volcanic rocks and others in the Cobalt area of east-central Ontario (Sabina, 1974, p. 17). From time to time, slabs or masses of this calcite rock are offered for sale from which attractive polished flats or even cabochons can be cut and polished. Some care must be employed in the process to prevent undercutting because of the differences in hardness of the several minerals present.

SABINA, A. P. (1974) Rocks and minerals for the collector: Cobalt-Belleterre-Timmins, Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, 199 p., illust., maps.

SKUTTERUDITE (SMALTITE)

ONTARIO. No new developments.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones*, 2nd edit. NY: Van Nostrand Reinhold, 248 p., illust. (col.), p. 173 as "smaltite."

HEWITT, D. F. & FREEMAN, E. B. (1972) Rocks and Minerals of Ontario. *Ontario Dept. Mines Geol. Circ.* 13, 135 p., illust.

SABINA, A. P. (1974). *See above.*

SMITHSONITE

ARKANSAS. The classic yellow "turkey fat" smithsonite from the Rush Creek mines in southeast Marion County is well described by Howard (1989) who gives the history of mining, local geography, and the geology and mineralogy of the zinc ore deposits. Most of the smithsonite is grayish where it formed in openings as rounded, layered masses or as stalactitic growths, and the colored varieties are considerably less common. While smithsonite occurs in a variety of physical forms, the greatest interest is in the stalactitic growth which "commonly exhibits color zoning; from the interior outward, the normal sequence is coarse to finely banded yellow smithsonite, followed by a thin layer of red smithsonite, gray smithsonite, and finally an outer layer that may be creamy white. Other colors noted are orange-pink, brown, greenish, and a peculiar orange-brown."

Richards (1993) provides a fine history of mining for zinc ores in the Rush Creek area, supplemented with old photographs, maps, and discussions of geology and mineralogy. He notes the confusing variety to be found in smithsonites and, accordingly, the adoption of descriptive terms such as "sealing wax," "eggshell," and "honeycomb" in addition to the more commonly applied term "turkey-fat," which alludes to the characteristic yellow color. The better specimens of turkey-fat ore, according to him, "were spared from the mill crusher and sold for ornamental purposes at $5 per pound."

BAIN, H. F., VAN HISE, C. R. & ADAMS, G. I. (1901) Preliminary report on the lead and zinc deposits of the Ozark region. *U.S. Geol. Survey 22nd Ann. Rept.*, part 2, p. 23–227, illust., maps.

DODSON, D. & DODSON, S. (1974) *Rockhounding in Arkansas.* Little Rock, AR: The Dodsons, 47 p., illust., maps, p. 5–7.

HOWARD, J. M. (1989) Rush Creek mining district, Marion County, Arkansas. *Rocks & Minerals* 64, 4, p. 284–292, illust., map.

RICHARDS, D. A. (1993) The Rush Creek district, Marion County, Arkansas. *Min. Rec.* 24, 4, p. 285–299, illust., map.

RIDDLE, R. (1976) Zinc mining in Arkansas. *Lapidary J.* 30, 1, p. 8, 10, 12.

NEW MEXICO. The famous Kelly locality, Magdalena district, Socorro County, is occasionally worked to obtain the splendid green to blue-green smithsonite for which it is noted. Its scarcity upon the market results in high prices being asked for lapidary grade material: in 1993, from $25 to $150 per pound, and hundreds of dollars for fist-size specimens of cabinet grade. One of the earliest writers to appreciate the beauty of the smithsonite is Sterrett (1908) who writes: "translucent, apple-green smithsonite, not only furnishing beautiful cabinet specimens but cutting pretty gems, has been found in large masses in the Magdalena mining district, New Mexico. This smithsonite occurs in the Kelly Mine, which is being developed by the Tri-Bullion Smelting and Development Company. It was found in a zinc vein in a cavity or vug several feet wide and 25 feet long, which is lined and partly filled with odd-shaped masses. The surface of the smithsonite masses has a mammillary structure which is drusy with the edges of many small projecting crystals. The mineral assumes odd shapes and sometimes nearly a globular form. One specimen, seen in the New York office of the Tri-Bullion Company, was roughly the size and shape of the head and bust of a man. It had a beautiful light-green color and was covered with drusy mammillary lumps an inch or two across." Sterrett then goes on to describe the layered structure and coloration of the material and notes that "it is being cut and sold as a gem in some of the western states. It yields handsome cabochon stones similar to chrysoprase, though of course not so hard and therefore less valuable than that mineral. Mr. Hart, of Manitou, Colorado, reports that the rough mineral for gem purposes brought from $2 to $5 per pound at Magdalena."

In his discussion of smithsonite, Northrop (1959, p. 474–5) employs the term "herrerite" as synonymous with "bonamite," and both terms referring to gem-grade smithsonite. Apparently "herrerite" was first applied to a cuprian variety of smithsonite ("herrerita") by Manuel Del Rio (*American J. Science*, 1830, 18, p. 193) as given in Dana *7th System*, vol. 2, p. 179. Panczner (1987, p. 348) states that this term was applied to smithsonite from the El Leon Mine, Municipio de Casas Grandes, State of Chihuahua, Mexico, "which proved not to be smithsonite," but gives no amplification of this statement. In Dana (p. 179) "herrerite" is a cuprian variety which "contains Cu in substitution for Zn up to at least Cu:Zn-1:9.3 . . . color apple-green to dark green and bluish-green."

ARGALL, P. B. (1908) The ore deposits of Magdalena, New Mexico. *Eng. Mining J.* 86, p. 366–370.

BLAZEK, M. C. & MOLSBEE, R. N. (1977) Kelly, New Mexico. *Gems & Minerals* 477, p. 8–9, 24–29, 61, illust. (col.)., maps.

GIBBS, R. B. (1989) Famous mineral localities, the Magdalena district, Kelly, New Mexico. *Min. Rec.* 20, 1, p. 13–24, illust. (col.), map.

HEADDEN, W. P. (1925) Smithsonite; Kelley [sic] Mine, Magdalena Mountains, New Mexico. *Amer. Mineral.* 10, p. 18.

KEYES, C. R. (1905) Zinc carbonate ores of the Magdalena Mountains. *Mining Mag.* 12, p. 109–114.

KIMBLER, F. S. & NARSAVAGE, R. J. (1981) *New Mexico Rocks & Minerals.* Santa Fe, NM: Sunstone Press, 71 p., illust. (col.), maps, p. 30, 59.

LASKY, S. G. (1932) The ore deposits of Socorro County, New Mexico. *NM Bur. Mines Min. Resources Bull.* 8, 139 p., illust.

LOUGHLIN, G. F. & KOSCHMANN, A. H. (1942) Geology and ore deposits of the Magdalena mining district, New Mexico. *U.S. Geol. Survey Prof. Paper* 200, 168 p., illust., maps.

MEYER, J. P. (1985) Smithsonite at Kelly. *Gems & Minerals* 567, p. 56, 57, 68, map.

MITCHELL, J. R. (1987) *Gem Trails of New Mexico.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps, p. 16–17.

MURPHY, M. O. (1962) Kelly blue-green gem. *Lapidary J.* 16, 2, p. 224–226, illust.

NORTHROP, S. A. (1959) *Minerals of New Mexico.* Albuquerque, NM: Univ. NM Press, 665 p., p. 472–476.

PANCZNER, W. D. (1987) *Minerals of Mexico.* NY: Van Nostrand Reinhold Co., 459 p., illust. (col.), maps.

SIMPSON, B. W. (1961) *New Mexico Gem Trails.* Granbury, TX: Gem Trails Publ. Co., 88 p., illust., maps, p. 8–9.

STERRETT, D. B. (1908) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the United States for 1907*, p. 825.

STRONG, M. B. (1964) Kelly, New Mexico. *Gems & Minerals* 321, p. 20–21, map.

ZEITNER, J. C. (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps, p. 29–30.

CHIHUAHUA. Panczner (1987, p. 348) notes that "in the early 1980s, large masses of botryoidal smithsonite were uncovered here ranging in shades of color from gray, green, yellow, orange, and rose red," referring to a discovery of massive smithsonite in the 5th level of the San Antonio Mine, San Antonio el Grande. Elsewhere, the original "herrerita" apparently came from the El Leon Mine, as mentioned above, but "proved not to be smithsonite."

PANCZNER, W. D. (1987) *See above.*

SINALOA. In the early 1970s, in the Municipio de Choix, "large masses of botryoidal smithsonite ranging in shades of gray, blue, pink, and violet" were found here according to Panczner (*Ibid.*, p. 349).

SODALITE

GREENLAND. Bøggild's locality for sodalite in nepheline-syenite rock at Grønnedal (1953, p. 390) is affirmed by Peterson & Secher (1993, p. 47) who describe lapidary-grade massive sodalite of intense ultramarine blue whose "specimens are popular with local collectors. The blue sodalite is rather well suited for polishing."

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Meddelelser om Grønland* 149, 3, p. 389–393

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 1–65.

QUEBEC. The curious color change characteristic of the hackmanite variety of sodalite has never appeared to better advantage than in the clear, facet-grade specimens found in 1988 at Mont St.-Hilaire, especially in the Poudrette Quarry (Horvath & Gault, 1990, p. 339). Sodalite is abundant and in places "was commonly encountered in extensive zones as nearly pure, blue masses, in the upper (now mined out) levels of the Poudrette Quarry." However, the sodalite was heavily stained and pale in color and as such was unsuited for lapidary work. On the other hand, a much more remarkable discovery, made in 1988 was of large clear crystals of sodalite of yellow color from which were faceted gems ranging in weight from 3.23 to 15.33 ct.! The larger gem is in the possession of Guy Langelier of Montreal (*Pers. comm.* 10/15/93) who states that it is "light yellow . . . included." He also owns a clean light yellow gem of 6.35 ct and a "natural pink" gem of 0.24 ct.

Quite aside from the extraordinarily large dodecahedral crystals of sodalite found here (the mineral is rarely found in euhedral crystals to begin with) the luminescent phenomena are remarkable: the normally near-colorless to pale yellow sodalite turns pink when exposed to ultraviolet light, which hue, however, fades to its original color within minutes in daylight or incandescent light after the UV light is withdrawn. This is the hackmanite variety referred to. Pough (1992) discusses hackmanite and gives its formula as $Na_4Al_3(SiO_4)_3(Cl,S)$; it is cubic, refractive index 1.48, H 5½–6, and SG 2.25. Under long-wave UV the fluorescence is pink, while under short-wave UV it is bright orange, with bright blue phosphorescence. Henn & Bank (1991) investigated ten faceted stones ranging from 0.27 ct to 1.31 ct and found the refractive index to be 1.485–1.487, SG 2.30–2.32. The remarkable color change is well shown in two before-and-after color photographs of a 3.32 ct shield-shape faceted gem of normal light straw-yellow color which changes to a deep pink under UV (Koivula & Kammerling, 1989, p. 113).

HENN, U. & BANK, H. (1991) Geschliffener, klar durchsichtiger Hackmanit von Mont St.-Hilaire in Kanada. *Zs. Dt. Gemm. Ges.* 40, 2/3, p. 93–97.

KOIVULA, J. I. & KAMMERLING, R. C. (1989) Hackmanite, a remarkable variety of sodalite. Gem news. *Gems & Gemology* 25, 2, p. 110–118, illust. (col.).

POUGH, F. H. (1992) Hackmanite. *Lapidary J.* 46, 8, p. 16, 19, 21, illust. (col.).

WIGHT, W. (1989) Round and about. *Canad. Gemm.* 10, 3, p. 93–94. Hackmanite.

ONTARIO. The Princess Quarry sodalite of Dungannon Township, Hastings County, was memorialized upon a Canadian C$0.42 postage stamp that shows a polished slab of blue sodalite with typical white veinings of natrolite. Annerstein & Hassib (1979) attribute the blue color to colloidal particles of metallic sodium.

ADAMS, F. D. & BARLOW, A. E. (1908) The nepheline and associated alkali syenites of eastern Ontario. *Trans. Roy. Soc. Canada* 2, 4, p. 3–76, illust., map.

____, (1910) Geology of the Haliburton and Bancroft areas, Province of Ontario. *Geol. Survey Canada Mem.* 6, 419 p., illust., maps.

ANNERSTEIN, H. & HASSIB, A. (1979) Blue sodalite. *Canad. Mineral.* 17, p. 39–46.

BOSIAK, C. P. (1963) *Rocks & Minerals at Bancroft & Madoc.* Campbellford, ONT: Pen-Reid Publs., 61 p., maps.

FIELD, D. S. M. (1951) Sodalite and apatite in Canada. *Canad. Mining J.* 72, 9, p. 82–83, illust.

FOYE, W. G. (1915) Nephelite syenites of Haliburton County, Ontario. *Amer. J. Science* 40, p. 413–436.

HOGARTH, D. D., *et al* (1983) Classic mineral collecting localities in Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 37, 79 p., maps, p. 56–57.

JOHNSON, L. P. (1982) Collecting in the Bancroft area. *Gems & Minerals* 536, p. 16–22, illust. (col.).

PARKS, W. A. (1910) Preliminary report on the building and ornamental stones of Ontario, south of the Ottawa and French rivers. *Canada Dept. Mines, Mines Br., Summ. Rept. for 1910*, p. 110–114.

PETCH, H. E. (1964) Sodalite—Ontario's mineral emblem. *Lapidary J.* 18, 6, p. 711, map.

THOMSON, J. E. (1943) Mineral occurrences in the North Hastings area. *Ont. Dept. Mines, 52nd Ann. Rept.*, vol. 52, pt. 3, 80 p., illust., map, p. 66–67.

MAINE. The elusive sodalite of Litchfield, Kennebec County, may now be easier to find if the instructions of Thompson, *et al* (1991) are followed. In general, the sites where the sodalite-in-syenite boulders have been found are on Dennis Hill and also just north of the hill, with the "streak" intersecting Highways 9 and 126. Further details on this locality can be found in King & Foord (1994, p. 324–325).

BAYLEY, W. S. (1892) Eleolite-syenite of Litchfield, Me., and Hawe's hornblende syenite from Red Hill, N.H. *Geol. Soc. Amer. Bull.* 3, p. 231–252, map.

BRADSHAW, J. J. (1992) Gemstones of Maine. ME Geol. Survey: *Mineralogy of Maine*, (*in press*), 21 p.

CLARKE, F. W. (1886) The minerals of Litchfield, Maine. *Amer. J. Science* 31, p. 262–272; also in *U.S. Geol. Survey Bull.* 42, p. 28–38.

HAVEN, M. W. (1930) Litchfieldite. *Rocks & Minerals* 5, 1, p. 41–43.

KIMBALL, J. P. (1860) On sodalite and elaeolite occurring together at Litchfield, Maine, and Salem, Massachusetts. *Amer. J. Science* 29, p. 66.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy, Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

THOMPSON, W. B., *et al* (1991) A collector's guide to Maine mineral localities. *ME Geol. Survey Bull.* 41, 2nd edit., 104 p., illust., maps.

NORTHWEST TERRITORIES. No new developments.

BELL, R. (1992) Report on the compilation of lapidary sites. *NWT Dept. Energy, Mines & Petrol. Resources, EGS* 1992-14, 157 p., maps. Sodalite: Report No. 042.

LORD, C. S. (1942) Snare River and Ingray Lake map-areas, Northwest Territories. *Geol. Survey Canada Mem.* 235, 55 p. Sodalite p. 34.

BRITISH COLUMBIA. In the latest recorded visit to the sodalite locality at Ice River, Yoho National Park, Grice & Gault (1981) found sodalite in seams of 5 cm (2 in) thickness, "commonly . . . deep blue but grades through sky-blue to white (rare)." Green sodalite has been reported. Collecting within the park is prohibited but it is pointed out that a deposit outside the park boundaries is located in Moose Creek Valley, but is very difficult to reach because of the rugged terrain.

ALLAN, J. A. (1914) Geology of the Field map-area, British Columbia and Alberta. *Geol. Survey Canada Mem.* 55, 312 p., map.

ANNERSTEIN, H.& HASSIB, A. (1979) Blue sodalite. *Canad. Mineral.* 17, p. 39–46.

BARLOW, A. E. (1902) On the nepheline rocks of the Ice River, British Columbia. *Ottawa Naturalist* 16, p. 70–76.

CURRIE, K. L. (1975) The geology and petrology of the Ice River alkaline complex, British Columbia. *Geol. Survey Canada Bull.* 245, 68 p.

DAWSON, G. M. (1886) Preliminary report on the physical and geological features of that portion of the Rocky Mountains between 49° and 51°30'. *Geol. Survey Canada Ann. Rept.*, pt. B., 169 p., map.

GRICE, J. D. & GAULT, R. A. (1981) Edingtonite and natrolite from Ice River, British Columbia. *Min. Rec.* 12, 4, p. 221–230, map.

LEAMING, S. (1973) Rock and mineral collecting in British Columbia. *Geol. Survey Canada Paper* 72-53, 138 p., illust., maps, p. 37.

PARKS, W. A. (1917) Building and ornamental stones of British Columbia. *Canada Dept. Mines, Mines Br. Summ. Rept. 1916*, p. 59–60.

ARKANSAS. Sodalite was reported from the Magnet Cove area of Hot Spring County in Volume 1 (p. 202) but recent advice indicates that the locality is upon private land and collecting is not allowed. The sodalite fills seams that are ordinarily no more than 0.75 cm thick and only several centimeters in diameter.

SPHALERITE

QUEBEC. Mont St.-Hilaire has lately produced superb crystals of transparent sphalerite, pale enough in color to provide faceted gems of much brilliance in colors of light yellow, yellowish-green, or olive green. Other hues are noted as red, orange, brown, black and even colorless (Horvath & Gault, 1990, p. 339). Of the pale-hued stones, E. Fritsch remarks that "some smaller, paler faceted stones resemble some yellowish-green diamonds" (Koivula, *et al*, 1992). Fritsch especially remarked upon a 55.62 ct oval of olive green color, truly a splendid gem for this species. Arem (1987, p. 176) records a 24.8 ct gray-green faceted gem in a private collection cut from Mont St.-Hilaire material. Art Grant of Hannibal, New York, cut an exceptional very pale grayish-green gem of 42.16 ct which very much resembles the gems faceted from the celebrated Franklin, New Jersey, cleiophane. According to Wight (1986), the collection of the Canadian National Museums includes four faceted Mont St.-Hilaire sphalerites, including a superb, lively gem of 24.74 cts of "intense yellowish green" color, Cat. No. 22212.

Another remarkable faceted sphalerite from Mont St.-Hilaire is described by Kammerling, *et al* (1995) as a 3.98 ct gem whose color is unlike that of any recorded sphalerite, being a "saturated, medium bluish-green, devoid of any yellow overtones." This beautiful, flawless (?) gem, shown in color in their article, measured 4.10 in SG but its refractive index was beyond the scale of the gemological refractometer. The absorption bands, established by UV-visible spectroscopy, indicated that the unique color was due to cobalt.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* NY: Van Nostrand Reinhold Co., 2nd edit., 248 p., illust. (col.), p. 176.

HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont St.-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 339, illust. (col.).

KAMMERLING, T. C., *et al* (1995) Faceted sphalerite and other collector stones from Canada. Gem news. *Gems & Gemology* 31, 1, p. 54–67.

KOIVULA, J. I., *et al* (1992) Rare gemstones from Quebec. Gem News. *Gems & Gemology* 28, 2, p. 134.

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

NEW YORK. The Balmat Zinc Mine, located 3 mi (4.7 km) southwest of Emeryville in St. Lawrence County, has produced some facet-grade sphalerite, from which Art Grant has cut a 1.60 ct round brilliant that is almost colorless and which resembles the Franklin, New Jersey, cleiophane (*Pers. comm.* 2/93). He also cut three other Balmat gems for the New York State Museum gem collection, two yellows of 1.45 and 2.80 ct, and a brown gem of 6.40 ct. (Schimmrich & Campbell, 1990 p. 35).

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection Catalogue. Albany, *Open file Report* 8m106, 47 p.

NEW JERSEY. According to Arem (1987) the Smithsonian gem collection includes a 59.5 yellow-green faceted sphalerite cleiophane from Franklin, Sussex County.

AREM, J. E. (1987) *See above.*

HENRY, T. H. (1851) On the white blende of New Jersey. *Phil. Mag.* 1, p. 23.

PENNSYLVANIA. In the Thomasville Stone and Lime Company's Quarry No. 1, about 10 mi (16 km) west of York, York County, mineral collectors B. Brookmyer and S. Myers in March 1992 found a cavity in the rock from which they took out over 100 specimens of beautiful peridot-green sphalerite crystals. Most were single crystals less than one inch (2 cm) across but some were larger clusters of crystals. A round brilliant of 3.5 ct was cut from this material by Art Grant which was considered to be the finest sphalerite faceted gem from Pennsylvania on the basis of its clarity, brilliance and rare color (Koivula, *et al*, 1992).

KOIVULA, J. I., *et al* (1992) Pennsylvania sphalerite, Gem News, *Gems & Gemology* 28, 3, p. 204, col. illust.

VIRGINIA. Penick (1992, p. 23) reports cabochon quality sphalerite from the Bowers-Campbell Zinc Mine near Timberville, Rockingham County.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

TENNESSEE. Austin (1991, p. 20) notes that Tennessee leads all other states in the production of zinc ores, and "therefore it is not surprising that gem-quality yellow sphalerite can be found at many different locations in the state. Cutting-grade yellow sphalerite has been found . . . in the Moshein anticline in Green Co.; in the Gulf Fork area of Cocke Co., and in the Bullard barite mine in Monroe Co." These counties are all in the extreme eastern part of the state. Some of these deposits were mentioned earlier by Zeitner (1968) who gave directions to some of the mines as well as references to geological reports on the state and its mines.

AUSTIN, G. T. (1991) Gemstone production in Arizona . . . and Tennessee. *U.S. Bur. Mines Mineral Industry Surveys, Adv. Summ. Rept.*, May 6, 1991, 35 p., maps.

ZEITNER, J. C. (1968) *Appalachian Mineral and Gem Trails*. San Diego, CA: Lapidary Journal, 134 p., illust., maps.

UTAH. Arem (1987, p. 176) records two large faceted sphalerite gems, 73.3 and 68.9 cts, from this state but without locality.

AREM, J. E. (1987) *See above.*

ARIZONA. In March 1987, splendid transparent oil-green sphalerite crystals, many twinned, and perched on matrix, were found in the Iron Cap Mine, located in the SW¼ of the SE¼ of the SE¼ of Sec. 19, T5S, R20E, near the head of Arizona Gulch, Graham County (Wilson, 1988). The color photographs indicate that the crystals are of gem quality. Other crystals occurred in various shades of green and yellow-green to brown or even black. In size they range from 1/5 cm (0.75 in) to as much as 5 cm (2 in) but the larger crystals are darker in hue. Cut stones were not reported.

WILSON, W. E. (1988) The Iron Cap Mine, Graham County, Arizona. *Min. Rec.* 19, 2, p. 81–87, illust. (col.).

SONORA. No new developments.

LEONARD, R. J. (1929) Green sphalerite from Sonora, Mexico. *Amer. Mineral.* 14, 4, p. 161. Cananea.

SPHENE (TITANITE)

ONTARIO. Wight (1986) records only one faceted sphene from this province, a 0.40 ct brown gem with many inclusions, cut by G. G. Waite, and from a deposit on Martin's Farm, Westport, Leeds County.

PRINCE, A. T. (1938) A study of Canadian sphene. *Univ. Toronto Studies*, Geol. Series no. 41, p. 59–66, illust.

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

NEW YORK. Januzzi (1959, 1966) provides authoritative accounts of the occurrence of gem quality sphene crystals in the Tilly Foster Mine at Brewster, Putnam County, and notes (1966) that the American Museum of Natural History in New York owns two faceted gems that weigh 1.5 and 1 ct.

JANUZZI, R. E. (1959) *The Minerals of Western Connecticut and Southeastern New York State.* Danbury, CT: The Mineralogical Press, 106 p. , maps.
______, (1966) *A Field Mineralogy of the Tilly Foster Iron Mine at Tilly Foster, Brewster, New York.* Danbury, CT: The Mineralogical Press, 161 p., illust.

PENNSYLVANIA. Kunz (1890, p. 194–195) noted fine sphene crystals from the eastern counties of this state, especially those from Bridgewater, Bucks County, which sometimes were "one inch long, and very transparent in parts . . . rich greenish-yellow and vitreous golden shades, equaling in color the finest from Tyrol, and would afford gems weighing from 10 to 20 carats each, that would show a play of color rather adamantine than opalescent." Crystals from Bridgewater found their way into the cabinets of such eminent American collectors as Clarence S. Bement, William S. Vaux, and others. The latest tracing of their disposition was undertaken by Carter Rich (1994) who took the considerable trouble to locate the crystals in their present repositories and to illustrate them with photographs, including one in color. Rich also includes a photograph of a mixed cut faceted gem of 4.3 carats that is in the collection of the U.S. National Museum of Natural History. However, according to his table of specimens located, only one faceted gem is listed, the same as the one above.

FORWOOD, W. H. (1876) On sphenes from Delaware County, Pa. *Acad. Nat. Sci. Phila. Proc.* 28, p. 176.
GORDON, S. G. (1922) The mineralogy of Pennsylvania. Philadelphia, PA: *Spec. Publ. 1, Acad. Nat. Sci. Phila.*, 255 p., illust., p. 129–130.
KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.).
RICH, C. (1994) A search for Bridgewater Station titanites. *Matrix* 3, 3–4, p. 3–8, illust. (col.), map.

CALIFORNIA. The sphene locality in San Diego County described by Horensky & Horensky (1971) has now been obliterated by a new housing development. The vague report of a sphene-bearing pegmatite dike located somewhere in the Laguna Mountains of eastern San Diego County has not been amplified nor confirmed.

HORENSKY, L. & HORENSKY, M. (1971) A new find of sphene in San Diego County, California. *Lapidary J.* 25, 5, p. 748, illust.
LEIPER, H. (1963) Gem sphene discovered in San Diego County, Calif. *Lapidary J.* 17, 3, p. 448, illust.

BAJA CALIFORNIA NORTE. Nothing has been reported on the sphene deposits of this state for over a decade.

LEIPER, H. (1958) Spectacular find of sphene made in Mexico. *Lapidary J.* 12, 4, p. 466–472, *passim*, illust.
SINKANKAS, J. (1963) Chromian sphene—a new find in Baja. *Lapidary J.* 17, 1, p. 4, 5, illust.

SPINEL

NORTHWEST TERRITORIES. Grice, *et al* (1982) reports the discovery of excellent octahedral crystals of blue to purple spinel on Glencoe Island, lat. 63°04'N, long. 71°29'W, off the southeast coast of Baffin Island. The spinel is almost the pure magnesian end-member, formula $MgAl_2O_4$, and found associated with graphite, phlogopite, and pargasitic hornblende in marble. The crystals range in size from several millimeters to some as much as 5 cm (2 in) along the four-fold axis, but only the smaller crystals are gemmy and offer promise as facet material. Another possible source of facet material is in a similar spinel occurrence about 1.5–2 km north of Lake Harbour on a peninsula on the southeast shore of Soper Lake.

GRICE, J. D., GAULT, R. A. & WALLER, R. (1982) Spinel from Glencoe Island, Northwest Territories, Canada. *Rocks & Minerals* 57, 4, p. 155–157, illust.

NEW JERSEY. In regard to spinel from metamorphic marble occurrences in this state, Kunz (1893, p. 762) states that "a few specimens of a smoky blue or velvety green, and a dark-tinted claret color, weighing about 2 carats each, have been found near Hamburg, Sussex County, New Jersey." However, there seems to be no record of gems cut from this material, except indirectly, as given by R. A. Kosnar of Golden, Colorado, who found "gemmy, reddish to pinkish-brown color crystals" in June, 1968 in the Limecrest Quarry, Sussex County, from which clear areas afforded "fairly clean stones less than 1 ct" faceted by a friend (*Pers. comm.* 8/10/1994). Kosnar also acquired "three, clean, cut spinels (2 cts or less each) from the Pat Gross Collection in June of 1990," said to have been originally sold by Kunz as cut from crystals found at Hamburg, Sussex County. Since a similar marble environment yields gem grade corundums and spinels in Burma, among other places, it is possible that cuttable material can be found in the New Jersey marble belts from time to time.

KUNZ, G. F. (1893) Precious stones. Ch. in *U.S. Geol. Survey Min. Resources of the U.S. for 1892*, p. 762.

VIRGINIA. Dietrich (1990) reported dead-black hercynite spinel from diabase on Mole Hill, west of Harrisonburg, Rockingham County. Penick (1992), citing Dietrich, notes that the spinel is "dark, clear, greenish-black gem quality" and "at least one stone from this site has been cut for gem purposes." The latter was faceted for Dietrich by Art Grant as a stepcut measuring about 5 x 3 mm (*Pers. comm.*, R. V. Dietrich, 3/25/95).

DIETRICH, R. V. (1990) *Minerals of Virginia*, 1990. VA Div. Mineral Resources, Charlottesville, 474 p., illust.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

NEW MEXICO-ARIZONA. The peridot deposits in these states commonly furnish black spinel crystals which are sometimes cut into faceted, though opaque gems of several carats weight. *See* PERIDOT.

NAYARIT. Similar black spinel crystals are found in this state according to Heylmun (1984), who describes the spinel as "black and of very good quality, with few flaws." Localities have been kept secret by the natives who collect the crystals as waterworn pebbles from stream gravels. Larger specimens, up to 2 in (5 cm) or more in diameter have been found but appear to have had all traces of crystal faces removed. A possible area for this material is suggested as the tributaries of Rio Ameca near the villages of Barranca del Oro, Estancia los Lopez, and Amatlan de Canas, south of the town of Ahuacatlan in the southeastern part of Nayarit.

HEYLMUN, E. B. (1984) Gem-quality spinel in Nayarit, Mexico. *Lapidary J.* 38, 9, p. 1232.

SPODUMENE

MAINE. According to King & Foord (1994, p. 329–332), spodumene is very common in certain pegmatites of Maine, especially those on Plumbago Mountain, Newry, Oxford County. In some deposits the slabby, greenish-white translucent crystals were so abundant that they were mined as lithium ore. Most of the crystals, however, were firmly frozen in quartz or quartz/feldspar and thus escaped the attack of later hydrothermal solutions that coursed through the central units of the pegmatites, thus accounting for the very minor quantities of facetable spodumene that were found in these bodies. In contrast, the pegmatites of San Diego County, California, had most of their spodumene contents destroyed by late hydrothermal activity which commonly left only striated impressions of former enormous spodumene crystals upon quartz and feldspar masses and crystals. In the few pegmatites where some spodumene remained, it consisted of only the most sound (hence "gemmy") crystal remnants, mostly of kunzite. Such fragments appeared in large masses of clays, quartz crystals and shards, and fragments of feldspar crystals, with the spodumene ranging from slender glittering spicules to slab-like masses, and, rarely, deeply etched crystals showing only the general morphology of former sharply-faced individuals.

Bradshaw (1992) noted a white, oval, cat's-eye cabochon of 35.33 ct in the U.S. National Museum, but the only facetable material he has seen is in the Harvard Mineralogical Museum in the form of colorless transparent rough from Newry. In his opinion, flawless gems can be cut from this material up to about 15 carats. If this were done, then such gems would establish the size record for spodumene from Maine. In connection with the cat's eye material noted above, I recall collecting slabby greenish-white spodumene crystals from the same locality many years ago and preparing therefrom cat's-eye cabochons of no great merit save for the fact that they were spodumene, a gem species that ordinarily lacks the inclusions necessary for sharp chatoyancy.

BRADSHAW, J. J. (in press) Gemstones of Maine. In KING, V. T., edit., *The Mineralogy of Maine*, Augusta, ME: Maine Geological Survey.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine*. Volume I: Descriptive Mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

NEW HAMPSHIRE. The only faceted spodumene from this state is a 1.62 ct emerald cut, containing inclusions, from the Parker Mountain Mine, Center Strafford, Strafford County (Bradshaw, 1990, p. 303). This pegmatite mine is described by Cameron, *et al* (1954) and Page & Larrabee (1962).

BRADSHAW, J. J. (1990) Gemstones of New Hampshire. *Rocks & Minerals* 65, 4, p. 300–305, illust.

CAMERON, E. N., *et al* (1954) Pegmatite investigations, 1942–45, in New England. *U.S. Geol. Survey Prof. Paper* 255, illust., maps, p. 270–273.

PAGE, J. J. & LARRABEE, D. M. (1962) Beryl resources of New Hampshire. *U.S. Geol. Survey Prof. Paper* 353, p. 44–45.

NORTH CAROLINA. The trials and tribulations attending the hard-rock mining for North Carolina's famous hiddenite crystals are told by William B. Colburn, who reopened the Stony Point Mine in 1926 and operated it for one year (Colburn, 1992). The mine was leased by his brother, banker Burnham S. Colburn of Asheville, at the suggestion of former North Carolina State Geologist Joseph H. Pratt. William Colburn was persuaded by his brother to take charge of the venture, an occupation that kept him busy for eleven months, during which time he found pockets with spodumene crystals and other minerals. From one pocket were removed numerous slender hiddenite crystals ranging in weight from 3.82 to 59.40 ct. Additional remarks on hiddenite history appear in Pough (1993).

In an article in *Matrix* (vol. 2, no. 5, 1992, p. 70), Lawrence H. Conklin notes that the large hiddenite crystal depicted in Plate 5 of Kunz (1890) is erroneously stated by that author (p. 148) to be in the Bement Collection when actually it passed into the James A. Garland Collection, thence into the collection of the Harvard Mineralogical Museum in Cambridge, Massachusetts. This crystal was described by Kunz as "the finest crystal of lithia-emerald ever found . . . it measures 2⅔ inches (68 millimeters) by 1/2 inch (14 millimeters) by 1/3 inch (8 millimeters). One end is of very fine color, and would afford the largest gem yet cut from this mineral, weighing perhaps 5½ carats." Bancroft (1973, p. 82–83) describes and depicts a splendid hiddenite crystal of green and yellow color that is in the collection of the Cranbrook Institute of Science, Bloomfield Hills, Michigan. It measures 4.5 x 0.96 cm (1.5 x 0.4 in) but its weight is not stated. Also among the better-known specimens of North Carolina hiddenites is the crystal depicted in color in Plate III of Kunz's *History of the Gems Found in North Carolina* (1907). The text of this work did not indicate the disposition of this crystal but it eventually found its way into the collection of the American Museum of Natural History in New York City, from which it was exchanged to Mr. William Larson of Pala International, Fallbrook, California, sometime in the early 1980s (*Pers. comm.* 6/21/95). When examined by me the crystal was found to fit exactly over the color drawing mentioned above, evidently drawn in full-size from the crystal itself, matching it in all essential respects as shape, size, markings, faces, etc. The crystal weighs 21.75 carats and is essentiallly flawless. It measures 50 x 11 x 4 mm (2$^{15}/_{16}$ x 7/16 x 3/16 in), with one end terminated with a set of faces giving it the typical spear-shape of most of the Hiddenite spodumenes. The best color is concentrated toward this termination and it is estimated that a somewhat flattish, flawless gem of about 5 carats could be cut from same.

ALLEN, F. M. (1958) Hiddenite, a North Carolina gemstone. *Rocks & Minerals* 33, 7–8, p. 310–311, illust.

BANCROFT, P. (1973) *The World's Finest Minerals and Crystals.* NY: Viking Press, 176 p., illust. (col.), p. 82.

______, (1984) *Gem & Crystal Treasures.* Fallbrook, CA: Western Enterprises/Min. Rec., 488 p., illust. (col.). Hiddenite p. 25–28.

BERNHEIM, L. C. (1883) Hidden and hiddenite: A sketch of the life and labors of Prof. Wm. Earl Hidden, discoverer of the famous new gem—"hiddenite." *At Home and Abroad,* Charlotte, NC, 5, 1, p. 1–10, portr.

CLAFFY, E. W. (1953) Composition, tenebrescence, and luminescence of spodumene minerals. *Amer. Mineral.* 38, p. 919–931.

COLBURN, B. S. (1935) Stony Point hiddenite deposits. *The Mineralogist* 3, 11, p. 9–11.

COLBURN, W. B. (1992) Rambles of an amateur mineralogist. Part one. *Matrix* 2, 5, p. 65–71, illust.

DANA, E. S. (1881) On the emerald-green spodumene from Alexander County, North Carolina. *Amer. J. Science* 22, p. 179–182.

DAVIDSON, S. C. (1927) The hiddenite occurrence in North Carolina. *Amer. Mineral.* 12, p. 305–307.

FOSTER, J. W. (1992) Hiddenite: North Carolina's Emerald Hollow Mine is a rare treat. *Rock & Gem* 22, 1, p. 67–69, illust.

HIDDEN, W. E. (1883) Hiddenite—the new emerald-green gem. In G. F. KUNZ, Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1882,* p. 502–503.

______, (1886) North Carolina mineral localities. *Amer. J. Science* 32, p. 204–208.

HODGES, K. (1974) William Hidden's gems. *Lapidary J.* 27, 11, p. 1749–1751, illust. Historical notes on hiddenite.

KUNZ, G. F. (1907) *History of the Gems Found in North Carolina. NC Geol. Econ. Survey Bull.* 12, 60 p., illust. (col.).

PALACHE, C., DAVIDSON, S. C. & GORANSON, E. A. (1930) The hiddenite deposit in Alexander County, North Carolina. *Amer. Mineral.* 15, p. 280–302, illust.

POUGH, F. H. (1993) Some Hiddenite history. *Lapidary J.* 46, 11, p. 14, 112–114, illust.

PRATT, J. H. (1928) Hiddenite—a rare mineral. *Manufacturers Record* 94, 14, p. 68.

SMITH, J. L. (1881) Hiddenite, an emerald-green variety of spodumene. *Amer. J. Science* 21, p. 128–130.

ALABAMA. Cook & Smith (1982) record a find of "a grass green gem quality spodumene crystal 2 cm in length" from a farm in the valley of Finikochika Creek near its confluence with Weogufka Creek, Coosa County. Despite a careful local search the crystal could not be traced to any source and it was therefore suggested that it "may have been transported by Indians to this site [from North Carolina?] and subsequently lost."

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120. 285 p., illust., map, p. 225.

SOUTH DAKOTA. No new developments.

MONTGOMERY, H. (1900) A large spodumene crystal. *Pop. Science* 34, 10, p. 199.

ROBERTS, W. L. & RAPP, G. (1965) Mineralogy of the Black Hills. *SD School of Mines & Technol. Bull.* 18, 368 p., illust., p. 190–193.

STAATZ, M. H., *et al* (1963) Exploration for beryllium at the Helen Beryl, Elkhorn, and Tin Mountain pegmatites, Custer County, South Dakota. *U.S. Geol. Survey Prof. Paper* 297-C, p. 129–197, illust., maps.

CALIFORNIA. The gem spodumene discovery previously reported from the north flank of Tule Mountain, southeastern San Diego County, led to other claims being filed on adjacent areas as described elsewhere in the present volume under BERYL. The discoverer of the spodumene, Loren D. Beebe, then a resident of the county, came upon the surface signs of a "spilled" pocket quite by accident while prospecting in the area in company with his wife (*Pers. comm.* 6/24/93). The first pocket opened by him yielded mostly quartz crystals and feldspar crystals and only one specimen of spodumene (kunzite). The signs being promising, Beebe filed a claim on the property and named it the Beebe Hole. He then commenced intermittently to dig in the pegmatite and in the course of several years excavated seven pockets, from which he estimates that he obtained 125 lb (57 kg) of various grades and colors of gemmy spodumene. None of the spodumene, however, provided clear areas capable of furnishing gems of more than several carats. The largest flawless gem that he cut from this material weighed only 7.5 ct. The largest single crystal, much corroded as usual, weighed about 5.5 lb (2.5 kg) and measured about 7 inches long, 4 inches wide, and 1–1.5 inches thick (17.5 x 10 x 2.5–4 cm). When first extracted it was dark blue but in time faded to residual colors of violet, green, and blue. This crystal is being retained by Mr. Beebe. Associated with the spodumene were rather large but only fair to poor quality quartz crystals and a few pieces of aquamarine of no cutting value. It was later reported by local collectors that visitors to the now abandoned claim found facetable fragments of morganite on the dumps.

BANCROFT, P. (1984) *Gem and Crystal Treasures.* Fallbrook, CA: Western Enterprises/Min. Rec., 488 p., illust. (col.). Historical notes on San Diego spodumene, p. 102–105.

BASKERVILLE, C. (1903) Kunzite: A new gem. *Amer. J. Science* 18, p. 303–304.

BASKERVILLE, C. & KUNZ, G. F. (1904) Kunzite and its unique properties. *Amer. J. Science* 18, p. 25–28. Pala material.

BURANEK, A. (1935) Kunzite. *Pacific Mineralogist* 2, 1, p. 8, 13.

CONKLIN, L. H. (1987) Historical notes on mineralogy: On Kunz and kunzite. *Min. Rec.* 18, 5, p. 369–372, illust.

FLETCHER, C. R. (1905) California precious stones. *Los Angeles Mining Rev.*, Jan. 7, 3 p. History of kunzite discovery.

GROSS, W. B. (1905) Kunzite the precious. *Sunset Mag.*, Oct., p. 556–560, illust. of gems & mine, also portr. G. F. Kunz.

KUNZ, G. F. (1903) On a new lilac-colored transparent spodumene, *Science* 18, p. 280.

______, (1903) On a new lilac-colored spodumene from Pala, California. *Amer. J. Science* 16, p. 264–267, color plate.

LAPIDARY JOURNAL (1965) The Dawsons purchase Vanderberg Mine—Pala. Vol. 19, 9, p. 1074–1075, illust.

LEIPER, H. (1959) Kunzite strike at reopened California mine. *Lapidary J.* 13, 2, p. 348–351, illust.

LIND, S. C. & BARDWELL, D. C. (1923) The coloring and thermophosphorescence produced in transparent minerals and gems by radiation. *Franklin Inst. J.* 196, p. 375–390. Includes experiments on California kunzite.

MINERAL COLLECTOR (1904) How kunzite was discovered. Vol. 11, 1, p. 1–4.

MINERAL NOTES & NEWS (1951) [Report of George Ashley's discovery of kunzite in Vanderberg Mine, Pala.] Sept., no. 168, p. 11.

MINING JOURNAL (1904) Kunzite as a gem stone from California. Vol. 76, p. 621.

ORDWAY, A. C. (1967) The Pala Chief awakened. *Lapidary J.* 21, 8, p. 970–975, *passim*, illust. (col.).

SCHALLER, W. T. (1903) Spodumene from San Diego Co., California. *Univ. Calif. Dept. Geol. Bull.* 3, 4, p. 265–275, illust.

SINKANKAS, J. (1955) Naming California's spodumene. *Gems & Minerals* 218, p. 50–52. Valiant of Rutgers, first to identify San Diego spodumene.

VALIANT, W. S. (1906) Addenda and corrigenda. *Mineral Collector* 13, 2, p. 17–20. First to identify San Diego County spodumene.

WEBER, F. H. (1963) Geology and mineral resources of San Diego County, California. *CA Div. Mines County Rept.* 3, 309 p., illust., maps.

STAUROLITE

NOVA SCOTIA. No new developments.

SABINA, A. P. (1964) Rocks and minerals for the collector: Bay of Fundy area. *Geol. Survey Canada Paper* 64-10, 90 p., illust.

______, (1965) Rocks and minerals for the collector: Northeastern Nova Scotia, Cape Breton, and Prince Edward Island. *Geol. Survey Canada Paper* 65-10.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map. Staurolite p. 350–351.

ONTARIO. Several localities for twinned staurolites are given by Hewitt (1964, p. 23; 1972, p. 24) at Fernleigh, Clarendon Township, Frontenac County, and at Nipigon, Nipigon Township, Thunder Bay District. Other localities are given by Traill (1983, p. 351) who notes "beautiful, large twinned staurolite crystals . . . in dark coloured medium-grained rock on the northwest shore of Albert Lake, Gzowski Township, in the Kowkash gold area."

HEWITT, D. F. (1964) Rocks and Minerals of Ontario. *Ontario Dept. Mines Geol. Circ.* 13, 108 p., illust.
______, (1972) *Ibid.*, rev. edit. *Ont. Dept. Mines & Northern Affairs Geol. Circ.* 13, 135 p., illust.
TRAILL, R. J. (1983) *See above.*

MANITOBA. Among a number of localities for staurolite in this province, Traill (1983, p. 350) remarks upon potential facet-grade material based on advice from the well-known mining expert and mineral collector, the late M. H. Frohberg, as follows: "large, untwinned crystals of long prismatic habit, up to 2.5 cm wide and 18 cm long occur on the north bank of Snow Creek, approximately 30 m below the outlet of Snow Lake. The dark, reddish brown crystals, some of gem quality, occur in random orientation in a banded metamorphosed arkosic greywacke." Sabina (1972) also notes localities in the Snow Creek area located about 40 mi (63 km) north of Wekusko or about 75 air miles (120 km) east-northeast of Flin Flon. If the material can produce faceted gems it would be a "first" for Canada as well as North America inasmuch as I can find no record of any faceted clear staurolite from a North American source.

SABINA, A. P. (1972) Rocks and minerals for the collector: La Ronge-Creighton, Saskatchewan; Flin-Flon-Thompson, Manitoba. *Geol. Survey Canada* 71-27, 100 p., illust., maps.
TRAILL, R. J. (1983) *See above.*

MAINE. Several localities for fine crystals of staurolite, including twins, are given in King & Foord (1994, p. 332–334).

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

NEW HAMPSHIRE. No new developments.

MORRILL, P. (1960) *New Hampshire Mines and Minerals Localities.* 2nd edit. Hanover, NH: Dartmouth College Museum, 46 p.
VERROW, H. J. (1942) Franconia iron mine, Lisbon, New Hampshire. *Rocks & Minerals* 17, 4, p. 136–139, map.

VIRGINIA. No new developments.

EDMISTON, R. L. (1963) Quest of the fairy cross. *Lapidary J.* 16, 12, p. 1114–1115, illust.
HERBERT, H. J. (1937) Crystal tears of the Blue Ridge. *Nature* 29, 2, p. 77–78, illust.
HUDSON, S. (1985) Staurolite in Virginia. *Rock & Gem* 15, 5, p. 8–11, map.
MOORE, C. H. (1937) The staurolite area in Patrick and Henry counties, Virginia. *Amer. Mineral.* 22, p. 990–996.
ROBERTS, J. K. (1934) Virginia staurolites as gems. *Amer. Mineral.* 19, p. 549–552.
WESTWOOD, V. (1979) Virginia's fairy crosses. *Gems & Minerals* 506, p. 28–29, map.

GEORGIA. Several outstanding sources of staurolite crystals are noted by Cook (1978), namely in Hart County where crystals occur up to 1.5 in (3.8 cm) in soil in the vicinity of Gold Mine, and fine crystals with deep blue kyanite in soil on the Dolly Cherry property, 3.5 mi (5.6 km) southwest of Thomaston in Upson County. Some of the crystals reach 3.5 in (8.5 cm) in length; they are mostly singles but some 60° twins are also found. Recent visits to several staurolite collecting sites are described by Hudson (1978, 1988) and Minge (1987).

COLE, J. F. (1970) "Fairy crosses"—Georgia's staurolites. *Lapidary J.* 24, 2, p. 314–323, *passim*, illust. (col.).
COOK, R. B. (1978) Minerals of Georgia. *GA Geol. Water Resources Div. Bull.* 92, 189 p.
FURCRON, A. S. (1949) Staurolite and its occurrence in Georgia. *Earth Sci. Digest* 3, 7, p. 7–12, illust.
HUDSON, S. (1978) Rock crosses. *Rock & Gem* 8, 3, p. 84–89, maps.
______, (1988) North Georgia's fairy crosses. *Lapidary J.* 41, 11, p. 55–59, map.
MINGE, C. (1987) Georgia staurolite. *Rock & Gem* 17, 2, p. 48–51, maps.
SCROGGS, F. O. (1946) Collecting staurolite crystals in North Carolina and Georgia. *The Mineralogist* 14, p. 61–62.

MINNESOTA. No new developments.

HOLLER, A. C. (1956) Minnesota staurolites. *Rocks & Minerals* 31, 2, p. 120–121.

ROHN, K. H. (1983) Minnesota pixy crosses. *Gems & Minerals* 554, p. 46–49, map.
SLOAN, R. The Royalton staurolite outcrop. *Rocks & Minerals* 57, 3, p. 123.

SOUTH DAKOTA. No new developments.

ROBERTS, W. L. & RAPP, G. (1965) Mineralogy of the Black Hills. *SD School Mines & Technol. Bull.* 18, 268 p. Staurolite p. 194.

MONTANA. No new developments.

PARKER, M. C. (1941) Staurolite in Montana. *The Mineralogist* 9, 2, p. 43–44.

IDAHO. Shannon (1926, p. 344–345) describes staurolite twins from Shoshone County as "strikingly developed in some of the metamorphosed rocks of the Belt series in the southern part of the Avery quadrangle in southern Shoshone County," and notes that "the crystals, which reach an extreme length of 10 cm [4 in] are either twinned or cruciform or are simple and well-developed prisms." Shannon depicts several in-matrix pieces showing staurolite crystals.

BECKWITH, J. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: Caxton Printers, 129 p. illust., p. 91–92.
REAM, L. R. (1989) *Idaho Minerals.* Coeur d'Alene, ID: L. R. Ream Publ., 329 p., illust., maps, p. 284–285, also additional localities.
SHANNON, E. V. (1926) *The Minerals of Idaho.* U.S. Nat. Mus. Bull. 131, 483 p., illust.

NEW MEXICO. In confirming a commercial staurolite source, supposedly in this state, I found that the twin crystals being offered as from New Mexico actually were from France. An interesting discussion of staurolite crystals and the lore surrounding them appears in Northrop (1959, p. 487–489).

BRANSON, O. T. (1944) Staurolite of New Mexico. *The Mineralogist* 12, p. 141–143, 154, map.
KIMBLER, F. S. & NARSAVAGE, R. J. (1981) *New Mexico Rocks & Minerals: The Collecting Guide.* Santa Fe, NM: Sunstone Press, 71 p., maps, p. 31.
MITCHELL, J. R. (1987) *Gem Trails of New Mexico.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps, p. 52–53.
NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ. NM Press, 665 p., map.
SIMPSON, B. W. (1961) *New Mexico Gem Trails.* Granbury, TX: Gem Trails Publ. Co., 88 p., illust., maps, p. 38–39.
SMITH, I. (1964) Staurolites of the Picuris Range, New Mexico. *Lapidary J.* 18, 1, p. 213–218, illust., map.
SMITH, W. M. (1940) Stones where the fairies danced. *Desert Mag.* 3, 7, p. 11–13, map.

STEATITE (SOAPSTONE)

According to Spence (1940, p. 9–11), the narrow mineralogical definition of *steatite* is "massive, compact, cryptocrystalline talc, without visible grain and usually of a pale yellow or cream colour." In contrast, the term *soapstone* is more loosely defined, most commonly used "to denote any soft and compact talcose rock that can be fairly readily sawn and worked." Spence also notes that such a rock "may contain little or no talc, being a fine-grained chlorite or mica schist, a soft slate, or a basic igneous rock that has undergone sufficient alteration to render it soft without advancing to the point where sufficient talc has been formed to justify the rock being classed as a true soapstone."

The obvious difficulties in providing precise definitions for such soft rocks suitable for carving with steel tools led to the adoption of the term "carvingstone" by Canadian geologists as remarked under SERPENTINE. For purposes of this section, fairly pure talcose rock is meant for most occurrences cited below, hence the choice of the term "steatite" as primary.

Spence also provides an excellent review of all the uses to which steatite has been put, including its fashioning by primitive man "all manner of domestic utensils, pots, dishes, lamps, etc., using it also for the carving of ornamental objects, images, beads, and so forth . . . and in the Orient, particularly in China, India, and Japan, the carving of such articles from soapstone (including also steatite) is an industry of considerable importance." In addition, Spence's treatise provides information on many commercial steatite sources in Canada and the United States.

NORTHWEST TERRITORIES. Bell (1973) reported on soapstone in the Belcher Islands group in the southeastern portion of Hudson Bay above James Bay. He examined fifteen deposits and reported on the suitability of the stone for carving purposes and on potentials for production. Gibbins (1982) examined deposits on Baffin Island, including sites in the Pangnirtung area, Broughton Island, and Pond Inlet–Mary River. Some of these occurrences had been quarried by Inuit inhabitants for raw carving material. In his attempts to obtain reliable information on deposits, Gibbins devised a several-pages form to be filled out by finders of soapstone deposits.

BELL, R. T. (1973) *Report on Soapstone in the Belcher Islands, N.W.T.* Brock Univ. Dept. Geol. Sciences, St. Catherine's, Ontario, 8 p.

GIBBINS, W. (1982) *DIAND-GNWT-COOP-Soapstone project Baffin Island 1981.* Geol. Sect. DIAND, Yellowknife, N.W.T., 8 p.

ONTARIO. Sabina (1974, p. 144–145) describes carving grade steatite found in the Canadian Magnesite quarry in Deloro Township, District of Cochrane, about 7 mi (11 km) south-southwest of Timmins. Steatite used by the Indians to make smoking pipes occurs 1.75 mi (2.8 km) southwest of French Portage, Lake of the Woods area (Wilson, 1926, p. 56).

SABINA, A. P. (1974) Rocks and minerals for the collector: Cobalt-Belleterre-Timmins; Ontario and Quebec. *Geol. Survey Canada Paper* 73-13, 199 p., maps.

WILSON, M. E. (1926) Talc deposits of Canada. *Geol. Survey Canada Econ.* Geol. Series 2, 149 p., illust., maps.

SASKATCHEWAN. Carving grade soapstone occurs along the south shore of Wapawekha Lake, at 54°56' N, 104°14' W and on some of the adjacent Pipestone Islands (Sabina, 1972, p. 15).

SABINA, A. P. (1972) Rocks and minerals for the collector: LaRonge Creighton, Saskatchewan; Flin-Flon-Thompson, Manitoba. *Geol Survey Canada Paper* 71-27, 100 p., illust.

UNITED STATES. Merrill (1897) summarizes occurrences of soapstone in Maine, Vermont (many deposits commercially worked), New Hampshire (several very large commercial quarries), Massachusetts (Lynnfield, North Dana), New York (at Fowler and Edwards, St. Lawrence Co.), Pennsylvania (Montgomery Co.), Maryland, Virginia (many commercial deposits, *see* Watson, 1907, p. 291–296), North Carolina (many occurrences, *see also* Conley, 1958 and Wilson & McKenzie, 1978), South Carolina and Alabama (many small deposits, *see* Cook & Smith, 1982).

CONLEY, J. F. (1958) Mineral localities of North Carolina. Rev. edit. *NC Dept. Nat. & Econ. Resources Info. Circ.* 16, 128 p., illust., maps.

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120, 285 p., illust., map.

MERRILL, G. P. (1987) *Stones for Building and Decoration.* 2nd rev. edit. NY: John Wiley & Sons, 506 p., illust.

SCHRADER, F. C., STONE, R. W. & SANFORD, S. (1916) Useful minerals of the United States. *U.S. Geol. Survey Bull.* 624, 412 p.

WATSON, T. L. (1907) *Mineral Resources of Virginia.* Lynchburg, VA: J. P. Bell Co., 618 p., illust., maps.

WATSON, T. L. & LANEY, F. B. (1906) Building and ornamental stones of North Carolina. *NC Geol. Survey Bull.* 2, 283 p., illust., maps.

WILSON, W. F. & McKENZIE, B. J. (1978) Mineral collecting sites in North Carolina. *NC Geol. Survey Sect. Info. Circ.* 24, 122 p., illust., maps.

MONTANA. Duane L. Johnson of Butte, operating as Rocky Mountain Soapstone, produces an attractive pale yellow to greenish or grayish massive talcose rock of extremely uniform fine texture. This texture makes it eminently suitable for carvings while an added feature in some of the material is the presence of finely detailed black dendritic markings. It is quarried in the Yellowstone Mine at Cameron, near Ennis, Madison County. While the workings here are devoted almost entirely to the production of industrial talc, the dendritic phases, locally called "lava talc," are saved out for sale as an ornamental stone. Sculptor Clarence P. Cameron of Madison, Wisconsin, noted for his carvings of birds, uses the Montana material with excellent effect, finishing off the pieces with a coat of carnauba wax (Advert. brochure, 1993). In souvenir shops in southeastern Alaska, I saw this same material in native carvings in 1993, advertised as "Glacier Fern," and in other shops as "dendritic soapstone (talc)." The source of "Glacier Fern" was not stated but the objects carved from this stone were by natives of Gamble, St. Lawrence Island. The locality for this material is given as Johnny Gulch, near Ennis, by Feldman.

FELDMAN, R. (1985) *The Rockhound's Guide to Montana.* Helena, MT: Falcon Press, 154 p., illust., maps, p. 106.

OREGON. Steatite of Southern Oregon, Inc., John H. Pugh, president, of Grants Pass, recovers large amounts of uniformly textured soapstone from fifteen claims on 300 acres at a site on the Oregon/California border, 25 mi (40 km) due west of Highway I-5 in Klamath County, Oregon (*Pers. comm.* 10/93). This stone is eminently suited for carvings and considerable quantities have been shipped to many states and to foreign users, and "large volumes to Alaska." The stone occurs in green, browns, and mixtures of same, and solid pieces are available from "1 lb to several tons each." On the average, the stone weighs 175 lbs (79 kg) per cubic foot. Both this stone and the similar material from Montana are much favored for carving because of their uniformity, solidity, and predictable behavior when being worked.

CALIFORNIA. Many large and important commercially mined steatite/soapstone deposits are described by Aubury (1906, p. 350–353); the sources and uses of soapstone quarried by early Indians of California are given in Heizer & Treganza (1944, p. 306–308); *see also* localities in Pemberton (1983, p. 416–420).

AUBURY, L. E., ed. (1906) The structural and industrial materials of California. *CA State Min. Bur. Bull.* 38, 412 p., illust.

HEIZER, R. F. & TREGANZA, A. E. (1944) Mines and quarries of the Indians of California. *CA J. Mines and Geol.* 40, 3, p. 291–359, illust., maps.

HUDSON, S. (1985) Cleaning up at Soapstone Hill. *Gems & Minerals* 572 p. 16–20, illust. (col.), map. East of Los Olivos, Santa Barbara Co.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold Co., 591 p., illust., maps.

STIBIOTANTALITE

CALIFORNIA. During the 1988–1989 mining season at the Himalaya Mine, Mesa Grande, San Diego County, a number of splendid stibiotantalite crystals were found in pockets that contained gem tourmaline. Two of the finest examples are doubly-terminated, lath-like crystals of deep reddish brown color, almost rectangular in profile, and with the broad faces striated as is usual in these crystals. They measured 4.5 x 2.1 cm (1.75 x 0.75 in) and 5.8 x 2.1 cm (2.25 x 0.75 in). Associated species included polychrome tourmaline, stilbite, and rarely white hambergite and deep pink apatite, plus the usual quartz, feldspar, and muscovite/lepidolite. These specimens are in the collection of William Larson, mine owner, who informed me that his company, Pala International, had cut eight faceted gems from fragments of clear stibiotantalite. The largest gem, about 3 carats, sold for $200/ct. He estimates from sales of rough that about 100 faceted gems have been cut by various parties, most of which are less than one carat in weight (*Pers. comm.* 12/21/93). The most thorough study of the geology and mineralogy of the Himalaya Mine pegmatites and those nearby appears in Foord (1977).

FOORD, E. E. (1977) The Himalaya dike system, Mesa Grande district, San Diego County, California. *Min. Rec.* 8, 6, p. 461–474, illust. (col.), map.

PENFIELD, S. L. & FORD, W. E. (1906) On stibiotantalite. *Amer. J. Science* 22, p. 61–77.

SUGILITE

QUEBEC. Kammerling, *et al* (1995) describes large crystals of sugilite that have been found at Mont St.-Hilaire in 1994 and from which very small clear faceted gems could be cut. The crystals range in

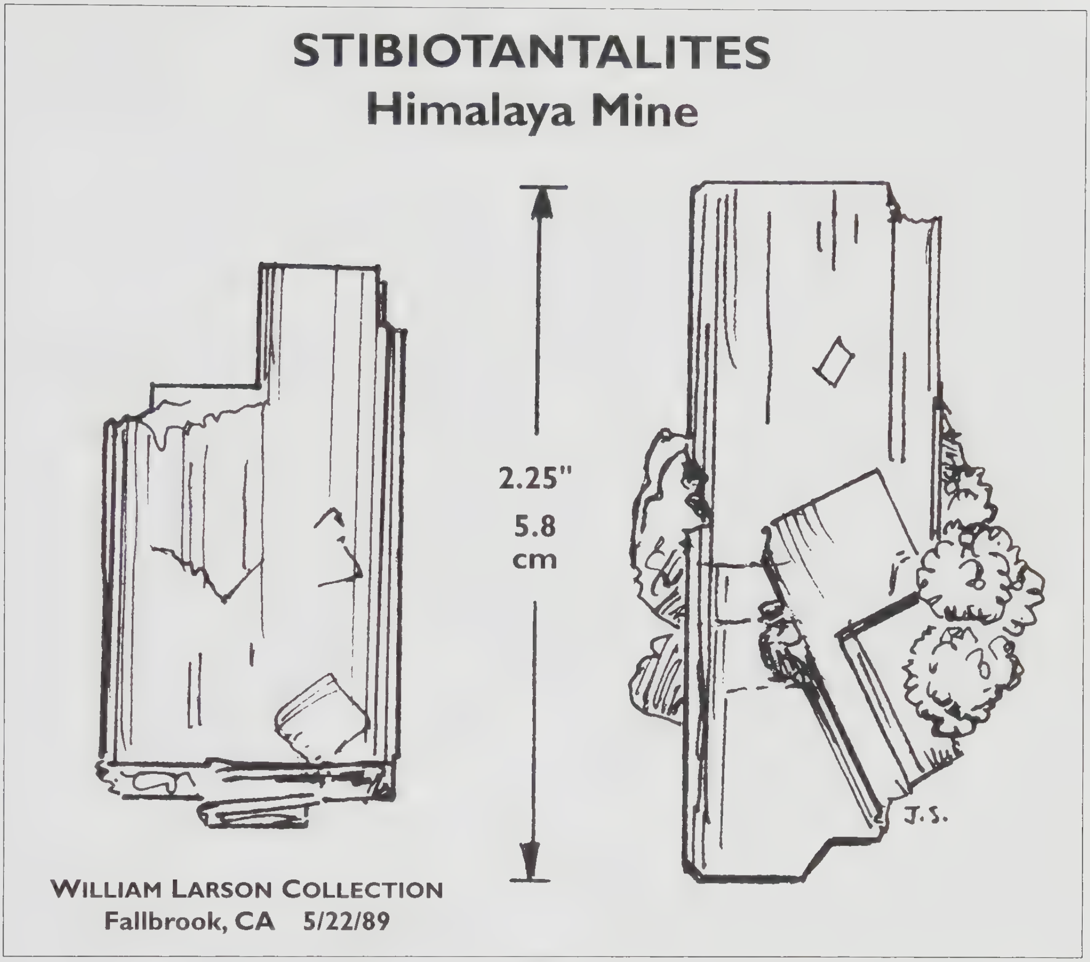


FIGURE 86. Lath-like, striated crystals of stibiotantalite from tourmaline pockets in the Himalaya Mine, Mesa Grande, San Diego County, California. Sketched from specimens in the Pala International collection, Fallbrook, California.

size from several millimeters to as much as 2 cm (0.8 in), with the larger individuals containing the clear, facetable portions. Sugilite is a complex lithium-bearing silicate, formula $KNa_2 (Fe^{+3}, Mn^{+2}, Al)_2Li_3Si_{12}O_{30}$; hexagonal, uniaxial (-), refractive indexes omega = 1.610, epsilon = 1.607, difference 0.003; H 6–6½; SG 2.74 (Roberts, *et al*, 1990, p. 831). The crystals display only a weak dichroism as slight changes in their basic purplish hue.

KAMMERLING, R. C., *et al* (1995) Faceted sphalerite and other collector stones from Canada. Gem news, *Gems & Gemology* 31, p. 65–67, illust. (col.).

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R., Jr. (1990) *Encyclopedia of Minerals.* NY: Van Nostrand Reinhold, 979 p., illust. (col.).

TACHARANITE

VIRGINIA. This rare white, porcelain-like mineral, formula $Ca_{12}Al_2Si_{18}O_5 \cdot 18H_2O$, has been reported in cabochon cutting quality by Penick

(1992, p. 24). It occurs as amygdule fillings in dark basalt dikes that cut limestone country rock on Virginia State Road 620 near Doe Hill, Highland County. The occurrence was first described by Mitchell & Giannini (1987). Penick states that "matrix specimens of the white tacharanite on dark basalt give the appearance of snowflake obsidian. Attractive cabochons have been cut from this material. One mass of tacharanite was large enough to cut into a pure white cabochon without matrix." The species has been validated only recently (Roberts, *et al*, 1990, p. 843).

MITCHELL, R. S. & GIANNINI, W. F. (1987) Tacharanite in an amygdaloidal basalt, Highland County, Virginia. *Mineral Mag.* 51, p. 467–468.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R. (1990) *Encylopedia of Minerals.* 2nd edit. NY: Van Nostrand Reinhold Co., 979 p., illust. (col.).

TALC, *see* STEATITE

TEKTITES

The following references include material on North American tektites.

BARNES, V. E. (1940) North American tektites. *Univ. TX Publ. 3945, Contrib. Geol. 1939*, part 2, p. 477–582, plates, figs.

______, (1956) Tektite localities in southern United States. Abstr: *XX Internat. Geol. Congress, Mexico, D. F.*, p. 274.

______, (1962) On the origin of tektites. *Gems & Minerals* 299, p. 16–21, illust., map.

______, (1962) A worldwide geological investigation of tektites. *Lapidary J.* 16, 1, p. 132–138, illust.

______, (1972) Worldwide investigation of tektites continued. *Lapidary J.* 26, 1, p. 18–26, 38–50, illust.

BARNES, V. E. & BARNES, M. A., eds. (1973) *Tektites.* Stroudsburg, PA: Dowden, Hutchinson & Ross, Inc., 445 p., illust.

CLARKE, R. S. & CARRON, M. K. (1961) Comparison of tektite specimens from Empire, Georgia, and Martha's Vineyard, Massachusetts. *Smithson. Misc. Coll.* 143, 4, 18 p., 6 plates.

CUTTITA, F., *et al* (1966) Martha's Vineyard and selected Georgia tektites: New chemical data, a preliminary report. *Unpubl.*, supplied by the authors.

FUTRELL, D. (1970) Some notes on tektites. *Gems & Minerals* 394, p. 22–25, 44–46, illust.

O'KEEFE, J. A., ed. (1963) *Tektites.* Chicago, IL: Univ. Chicago Press, 228 p., illust.

MASSACHUSETTS. No new developments.

KAYE, C. A., *et al* (1961) A tektite from Martha's Vineyard, Massachusetts. *Geol. Soc. Amer. Bull.* 72, p. 339–340.

GEORGIA. No new developments.

BARNES, V. E. & BRUCE, G. A. (1959) Tektites in Georgia. *GeoTimes* 3, 7, p. 18.

BRUCE, G. A. (1959) Tektites in Georgia. *Gems & Minerals* 264, p. 22–23, 65–69.

CARSON, X. (1977) Tektites, their origin, and where they may be found. *Gems & Minerals* 459 [in error, recte 470], p. 46–47, 50–54.

CLARKE, R. S. & HENDERSON, E. P. (1961) Georgia tektites and related glasses. *Geol. Survey GA, GA Mineral Newsletter* 14, 4, p. 90–114, illust.

COHEN, A. J. (1959) Moldavites and similar tektites from Georgia, U.S.A. *Geochim. Cosmochim. Acta* 17, p. 150–153.

FURCRON, A. S. (1961) Geologic age of the tektite shower and its associated rocks of the Georgia coastal plain. *GA Mineral Newsletter* 14, p. 115–119.

KING, E. A. (1962) Field investigation of Georgia tektites and description of new specimens. *GA Mineral Newsletter* 15, p. 84–89, illust.

______, (1964) New data on Georgia tektites. *Geochim. Cosmochim. Acta* 28, p. 915–919.

___, (1966) Major element composition of Georgia tektites. *Nature* 210, 5038, p. 828–829.

MINGE, C. (1989) Georgia tektites. *Rock & Gem* 19, 12, p. 26–28.

WISCONSIN. A spherical golden-colored glass object was found in 1974 by Robert L. Gorjance in the northeastern part of Racine, on Wind Point, and it has been suggested that it is a tektite, but this has not been established. This so-called

"G" Tektite is about 24 mm (1 in) in diameter and weighs 8.05 gm; SG 2.49, refractive index 1.51 (Buchanan, 1978).

BUCHANAN, K. (1978) The "G" Tektite. *Lapidary J.* 32, 7, p. 1450–1460, *passim.*

TEXAS. No new developments.

CAREY, M. (1958) Texas tektites (bediasites). *Gems & Minerals* 255, p. 26–31, illust., maps.

CARSON, X. (1977) *See above.*

KING, E. A. (1961) Texas gemstones. *TX Bur. Econ. Geol. Rept. Invest.* 42, 42 p., illust., p. 28.

______, (1964) An aerodynamically sculptured bediasite. *J. Geophys. Research* 69, p. 4731–4733, illust.

MITCHELL, J. R. (1991) *Gem Trails of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps, p. 84.

SIMPSON, B. W. (1958) *Gem Trails of Texas.* Dallas, TX: Newman Stationery, 88 p., illust., maps, p. 70–71.

TOWNER, J. M. (1978) A tektite hunt in Texas. *Lapidary J.* 32, 6, p. 1300–1304, illust.

WRIGHT, R. (1962) Tektites from Texas. *Rocks & Minerals* 37, p. 569–571.

THOMSONITE

ONTARIO. No new developments.

WAITE, G. G. (1945) Notes on Canadian gems and ornamental stones. *Univ. Toronto Studies,* Geol. Ser. 49, p. 75–78. Michipicoten Island.

MICHIGAN. The so-called "thomsonite" nodules found on Isle Royale are now shown to be finely fibrous prehnite colored pink by inclusions of native copper (*see* PREHNITE). Other localities are given in Heinrich (1976, p. 204). Attractive, mostly pink thomsonite nodules in basalt may be found on Thomsonite Hill, located about midway between Eagle Harbor and Delaware, and along Owl's Creek about midway between Eagle Harbor and Central, all on the Keweenaw Peninsula, Keweenaw County (Brockett, 1975).

BROCKETT, B. O. (1975) Thomsonite Hill and Owl's Creek. *Lapidary J.* 29, 7, p. 1350–1356, illust., map.

HEINRICH, E. W. (1976) The mineralogy of Michigan. *MI Geol. Survey Div. Bull.* 6, 225 p., illust. (col.), p. 204.

MINNESOTA. The principal fee-collecting localities for the most colorful and the most highly prized thomsonite nodules are three in number: Thomsonite Beach at Grand Marais; at Lutzen; and at Good Harbor Bay at Cutface Creek, Cook County. Virtually no loose nodules can be found now; almost all are obtained by quarrying the basalt in which they formed and then breaking down the basalt masses to expose the nodules. Attempts have been made to find nodules in the waters of Lake Superior as recounted by Dukes (1976), while Muszynski (1978) gives advice on how to extract nodules from basalt and how to process them as well as processing matrices in which the nodules and basalt are smoothed and polished together. An exceptionally large specimen of almost solid thomsonite consisting of many dozens of "eyes" that were closely packed together was collected in 1978 by Harold and Bea Schmidt (1979). This specimen measured 3.5 by 7.25 in (8.7 x 18.3 cm) and weighed 13 ounces (370 gm). In an excellent general article on the thomsonite, Almquist (1987) advances the opinion that "thomsonite is the most unusual and desirable opaque colored stone in North America," but adds that "lovers of jasper or turquoise will disagree." For excellent color photographs of polished thomsonite nodules, *see* Shaub (1976).

Dahlberg (1976) provides a welcome historical article on the "lintonite" variety of thomsonite whose grayish-green translucent pebbles, reminiscent of some nephrite jades, were once found among the beach pebbles of regular thomsonite localities. The material was named to honor Dr. Laura A. Linton (1853–1915), a graduate of the University of Minnesota who later also took her doctorate in medicine there. Dahlberg depicts a number of interesting cabochons made from lintonite as well as offering photographs of persons in the Linton family.

ALMQUIST, A. (1987) Minnesota's thomsonite. *Lapidary J.* 41, 1, p. 58, 60–62, illust.

DAHLBERG, J. C. (1976) A woman to remember. *Lapidary J.* 30, 7, p. 1732–1736, illust.

_____, (1977) Hunt rocks in the Land of Many Waters. *Lapidary J.* 31, 1, p. 432–435, illust.

DUKES, J. W. (1976) Scuba diving for thomsonites. *Lapidary J.* 30, 7, p. 1662–1663.

EDWARD, W. (1980) Thomsonite mine reopens to public following six years of dormancy. *Lapidary J.* 34, 3, p. 726–728.

HALL, C. W. & PECKHAM, S. F. (1880) On lintonite and other forms of thomsonite . . . Grand Marais, Cook County, Minnesota. *MN Geol. Nat. Hist. Survey 8, Append. A.* Also: *Amer. J. Science* 19, p. 122–130.

HANLEY, F. B. (1939) Minnesota's Thomsonite Beach. *Rocks & Minerals* 14, 12, p. 371–376, illust., map.

_____, (1939) New accessibility of Thomsonite Beach, Minn. *Amer. Mineral.* 24, 11, p. 726–727.

INGALLS, N. (1992) The gemstone eyes are watching you! *Rock & Gem* 22, 5, p. 23, 24, 26, illust.

KOENIG, G. A. (1878) Thomsonite from Grand Marais, Lake Co., Minnesota. *Naturalists Leisure Hour* no. 8.

KURRASCH, V. (1956) Minnesota gem thomsonite. *The Mineralogist* 24, p. 296–299.

MUSZYNSKI, D. (1978) Thomsonites and thomsonite removal. *Lapidary J.* 32, 5, p. 1106–1112.

PECKHAM, S. F. & HALL, C. W. (1880) On lintonite and other forms of thomsonite . . . Grand Marais, Cook County, Minnesota. *Amer. J. Science* 19, p. 122–130, also *MN Geol. Survey Ann. Rept.* 19, p. 166–172 (1880).

SCHMIDT, H., *et al* (1979) Hunting the elusive thomsonite. *Lapidary J.* 33, 6, p. 1336–1338, illust.

SHAUB, B. M. (1976) Thomsonite. *Mineral Digest* 8, p. 24–30, illust. (col.).

WATTS, A. M. (1979) Agates, amethyst, and thomsonite. *Lapidary J.* 32, 12, p. 2660–2666, illust., maps.

WINCHELL, N. H. (1898) Thomsonite and lintonite from the north shore of Lake Superior. *Amer. Geologist* 22, p. 347–349.

CALIFORNIA. Pea-size to lemon-size nodules of thomsonite occur in basalt on the east flank of Black Mountain, directly north of Hinkley about 24 mi (38 km) via road. Hinkley is located on Highway 58, about 8 mi (13 km) west of Barstow, San Bernardino County. The colors are yellow, brown, green, gray, blue, red, and white, but the polished nodules and cabochons do not display the handsome ringed patterns of the Minnesota specimens (Strong, 1964; Robertson, 1976).

ROBERTSON, D. (1976) Thomsonite and jasp-agate. *Rock & Gem* 6, 11, p. 86–89, map.

STRONG, M. F. (1964) Thomsonite at Black Mt. *Gems & Minerals* 326, p. 30–32, map.

THULITE (ZOISITE)

GREENLAND. Bøggild (1953, p. 211–212) described a thulite that occurs in lenses in gneiss at the head of Franz Joseph's Fjord in East Greenland, calling the lenses "very striking because of their rosy colour." The very pure thulite crumbles when rubbed but the thulite-impregnated rock, composed of about half thulite and half quartz, albite, calcite and other minerals, is firm enough to be used for lapidary work.

BØGGILD, O. B. (1953) The mineralogy of Greenland. *Meddelelser om Grønland* 149, 3, 442 p., illust., map.

CONNECTICUT. Schairer (1931, p. 71) notes the occurrence of thulite on top of Walkley Hill, Haddam, as pink crystals with epidote but does not mention if the rock is suitable for lapidary work.

FOYE, W. G. (1926) The occurrence of thulite at Haddam, Connecticut. *Amer. Mineral.* 11, p. 210–213, map.

SCHAIRER, J. F. (1931) The minerals of Connecticut. *CT State Geol. Nat. Hist. Survey Bull.* 51, 121 p.

SCHALLER, W. T. & GLASS, J. J. (1942) Occurrence of pink zoisite (thulite) in the United States. *Amer. Mineral.* 27, p. 519–524.

VIRGINIA. Penick (1992) reports pink, fibrous thulite with feldspar, furnishing cabochon material, from the Wheatley Pegmatite Mine, east of Moneta, Bedford County.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust.

NEVADA. Since 1955, David C. Smith and Barbara T. Smith of Castro Valley, California,

FIGURE 87. The Lapis Nevada Quarry in the Pine Mountains, Douglas County, Nevada. *Courtesy Four Clover Mine, Castro Valley, California.*

have been quarrying a handsome rock in which pink thulite is a prominent constituent. Technically the rock is called a thulite-diopside skarn, or a very compact rock formed from the hydrothermal alteration of what is believed to have been a granite originally. However, to make the rock more acceptable commercially, the Smiths named it *Lapis Nevada,* by which name it is offered in the market (*Pers. comm.* 2/27/1989, 12/28/1994). According to an examination by geologist Michael R. Smith, the rock "is composed of at least ten distinct minerals including: thulite, diopside, clinozoisite (locally Mn-rich), microcline, sericite, titanite, epidote, plagioclase, scapolite, actinolite, and quartz." The pink color is due to both the thulite and the manganese-rich clinozoisite, the green due to diopside, and a cream color due to Mn-poor clinozoisite, microcline and scapolite. The rock is extremely compact, almost void-free, and thanks to the silica-rich nature of its constituent minerals, capable of producing an excellent, uniform surface polish. The rock is also tough and thus lends itself to the preparation of small, detailed carvings. Typical finished products include cabochons, plaques, bookends, carvings, beads, and bracelets. Many of these items are sold by the Four Clover Mine but manufactured by outside firms under contract. Rough, depending on color, and other factors, sold in 1994 for $1.00 to $8.00 per pound, while carving grades brought $10.00 to $15.00 per pound. In large, mine-run lots, the rock was available for $250.00 per ton.

GIANELLA, V. P. (1936) Occurrences—thulite in Nevada. *The Mineralogist* 4, 12, p. 5–6.

ZEITNER, J. C. (1992) A gem of a rock. *Lapidary J.* 46, 5, p. 47–51.

NEW MEXICO. No new developments.

NORTHROP, S. A. (1935) Thulite in New Mexico. *Amer. Mineral.* 20, p. 805–807.

_____, (1959) *Minerals of New Mexico.* Albuquerque, NM: Univ. NM Press, 665 p. Thulite p. 566.

TOPAZ

A useful short survey of topaz occurrences in North America appears in Leiper (1964). Gem quality colorless, light blue, and sherry-colored topaz crystals continue to be found in miarolitic cavities in the granites of New Hampshire, and from such crystals some fine gems have been cut. An astonishingly large prism of colorless topaz was found in Amelia County, Virginia, as described below, but the value of the specimen is in its crystal form and not in its cuttability and for this reason it is being preserved in its natural state. Major finds of beautiful light blue crystals of topaz were made on the Little Three Mine property near Ramona, California, and these were sold almost exclusively as mineral specimens. Some facet material was found and cut but once cut the gems are quite pale and indistinguishable from thousands of others cut from Brazilian material.

The first book devoted exclusively to topaz has been written by Dr. Donald B. Hoover and published in 1992 by Butterworth-Heinemann of Oxford, England. The following information has been taken from his work.

The formula for topaz, an aluminum fluorosilicate, is written as $Al_2SiO_4F_{2-x}(OH)_x$, indicating the variable content of fluorine and hydroxyl. Analyses of record show that "there are now two distinct types of topaz; a high RI-low density yellow and orange, and low RI-high density blue and colourless type, as often stated in the gemmological literature" (Hoover, p. xii). Furthermore, in regard to refractive indices, Hoover states that the values "vary directly as OH substitutes for F with high F topaz having lower indices." The ranges of indices are given below, with the birefringence which Hoover believes to be uniform for all topazes:

n_x=1.609 - 1.630
n_y=1.612 - 1.632
n_z=1.618 - 1.639. Birefringence = 0.009.

The hues of topaz are due to color centers in brown, blue, and brown-blue crystals and/or Cr^{+3} in pink, red, and violet crystals, but these last three varieties are not known to occur in North America. The density varies between 3.56 (high F) and 3.51 (low F). In regard to localities, only brief notes on North American sources are provided by Hoover.

Christiansen, *et al* (1983) studied topaz-bearing rhyolites of the western United States and found that the fluorine-rich rhyolites were chemically and mineralogically distinct from other rhyolites. The fluorine-rich types are noted for cavities containing fine crystals of topaz, garnet, and beryl, some of the last being of the prized red spinel color, e.g., in Utah. *See also* Hoover (1992, p. 127 ff).

In the past decade the world gemstone market has been flooded with irradiated topazes of beautiful blue color which far surpass in quality and intensity anything that unassisted nature has been able to produce. The color quality often exceeds that of the finest aquamarines. Some North American topazes may be susceptible to this color change but those who have experimented on them with success have not made us privy to their findings (Hoover, *Ibid.*, p. 73–78; Nassau, 1994, p. 187–194).

AITKENS, I. (1931) Topaz. *U.S. Bur. Mines Info. Circ.* IC 6502, 11 p.

CHRISTIANSEN, E. W., *et al* (1983) The petrogenesis of topaz rhyolites from the Western United States. Contributions to Mineralogy and Petrology, vol. 83, no. 1/2, p. 16–30. NY: Springer International.

EAKLE, A. S. (1899) Topaz crystals in the mineral collection of the U.S. National Museum. *U.S. Nat. Mus. Proc.* 21, p. 361–369, illust.

HOOVER, D. B. (1992) *Topaz.* Oxford: Butterworth-Heinemann, 207 p., illust. (col.), maps.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). Topaz p. 68–70.

LEIPER, H. (1964) Occurrence of gem topaz in North America. *Lapidary J.* 18, 8, p. 956–959, illust.

NASSAU, K. (1984) *Gemstone Enhancement.* Oxford: Butterworth-Heinemann, 252 p., illust. (col.). 2nd edition.

MAINE. In October 1968, the Bell Minerals Company of West Paris opened a pocket in their Lord Hill, Stoneham Township, Oxford County, pegmatite quarry and found a large topaz crystal,

FIGURE 88. Mineral collectors at the Lord Hill pegmatite quarry, Stoneham, Oxford County, Maine, in 1989. *Courtesy Woodrow Thompson, Maine Geological Survey.*

part blue-green, part grayish-white, that measured 9 x 11 x 3 in (23 x 28 x 7.5 cm) and weighed 54 lbs (24.5 kg) (Stevens, 1972, p. 32). This crystal was sold to Harvard University. In April 1967, Frank Perham and Richard Robinson found a 140 lb (63.5 kg) crystal of milky white color, mottled with green, that measured 21 x 15 x 9 in (51.5 x 38 x 23 cm). This specimen was sold to Dartmouth College Museum. While these very large crystals contained faceting material, by far most faceted topazes were cut from much smaller crystals of far greater clarity. According to Bradshaw (1992, p. 18), the largest cut topaz from this locality is a 31.50 cts colorless round brilliant in the collection of the late Benjamin Shaub of Northampton, Massachusetts. A much smaller colorless gem of only 2.90 cts is in the collection of the Smithsonian Institution.

Stevens (*Ibid.*, p. 147) describes mining operations in the Keith Quarry, Mount Apatite, area, Androscoggin County, where a blue topaz specimen was discovered by John Towne early in the century; this topaz furnished a blue faceted gem that weighed 43.75 cts which is now in the Smithsonian also. Additional localities and historical notes on topaz finds and type specimens from Maine are contained in King & Foord (1994, p. 349–351).

BRADSHAW, J. J. (1992) Gemstones of Maine. In *Mineralogy of Maine*, Maine Geol. Survey, 21 p. *In press.*

BURBANK, W. S. (1934) Topaz and herderite at Topsham, Maine. *Rocks & Minerals* 9, 9, p. 125–130.

CLARKE, F. W. & DILLER, J. S. (1885) On topaz from Stoneham, Maine. *Amer. J. Science* 29, p. 378–384.

CLARKE, F. W. (1886) Topaz from Stoneham, ME. *U.S. Geol. Survey Bull.* 27, p. 539–545.

GENTH, F. A. (1885) Description of topaz from Stoneham, Maine. *Amer. Phil. Soc. Proc.* 23, p. 43.

GREGORY, G. (1966) Lord Hill Mine. *Gems & Minerals* 347, p. 24–25, map.
KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Vol. I: Descriptive Mineralogy. Geol. Survey ME, 418 p., illust. (col.).
KUNZ, G. F. (1883) On the discovery of topaz at Stoneham, Maine. *Amer. J. Science* 25, p. 161.
_____, (1884) Topaz and associated minerals from Stoneham, Oxford County, Maine. *Amer. J. Science* 27, p. 212–216.
MORRILL, P. (1956?) *Maine Mines and Mineral Locations.* Naples, ME: Dillingham Natural History Museum, 47 p., maps.
_____, (1958) *Maine Mines and Minerals.* Vol. 1. Western Maine. Winthrop, ME: Winthrop Mineral Shop, 80 p., maps.
NEVEL, W. D. (1929) Large topaz crystal from Maine. *Amer. Mineral.* 14, p. 75. Mt. Apatite crystal that cut a gem of 43.75 cts.
PALACHE, C. (1934) A topaz deposit in Topsham, Maine. *Amer. J. Science* 27, p. 37–48, illust.
STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1913*, p. 682, Stoneham.
STEVENS, J. P. (1972) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* Trap Corner, ME: Perham's Maine Mineral Store, 216 p., illust. maps.
THOMPSON, W. B., JOYNER, D. L., WOODMAN, R. G. & KING, V. T. (1991) A collector's guide to Maine mineral localities. *ME Geol. Survey Bull.* 41, 2nd edit., 104 p., illust., maps.

NEW HAMPSHIRE. The topaz crystals of New Hampshire, of remarkable perfection of form and luster, rank with those from Colorado and California. They largely occur in miarolitic cavities in the large granite masses that characterize the mountainous regions of this state. These occurrences were noted at the end of the last century by Kunz (1893, p. 765) who stated that "during 1888 nearly 100 crystals associated with phenacite were found on Bald Mountain, New Hampshire. They were colorless, light green or sherry colored on the outer sides, and colorless in the center. The largest one measured 1½ inches in height and the same in thickness." Sterrett (1914) visited the locality to examine pockets and their contents and made careful notes on the occurrence and its minerals. In regard to the topaz, he noted that it "occurs in crystals of minute size up to those more than an inch thick. The majority of them are translucent, or transparent only in places, but some perfectly transparent crystals are found. Some of the topaz is suitable for cutting into gems but most of it is worth more as specimens because of the perfection of the crystals."

As can be seen from the many references below, interest in topaz and its associates persisted in the intervening years, with Shaub's papers ushering in the modern era of collecting reportage. Hollmann (1987) reported the discovery and removal of a large pocket containing gemmy topaz crystals in the Conway granite on October 19, 1986 by P. B. Samuelson of Conway. One hundred twenty-five crystals were found weighing together 8.2 kg (18 lbs), of rich sherry color, also some blue and some bicolor. The largest crystal, blue in color, weighed 1,975 grams. Associated species included smoky quartz, citrine, siderite, microcline, and muscovite. Later on, Samuelson (1990) described the two large granite outcrops that contain cavities: the Conway granite and the Osceola granite. The topaz crystals from one of the localities, South Baldface Mountain, generally average 1 cm (3/8 in) in size, with a 5 cm (2 in) crystal considered large. As observed elsewhere, especially in Colorado topazes from similar deposits, New Hampshire brown and sherry crystals lose this color upon exposure to light, becoming either colorless or blue, the latter hue often present to begin with but masked by the brown/sherry color. At Hales location, Middle Moat Mountain, Carroll County, hundreds of crystals were found, and near Stark, Coos County, Samuelson found in 1986 a pocket from which he extracted a large crystal that measured 13.5 x 11.7 x 8.5 cm (5.4 x 4.4 x 3.4 in), weighing 1,975 gm (4.34 lb). This blue crystal is now in the collection of the Harvard Mineralogical Museum; however, "the very finest crystal found" measured 9.6 x 7.3 x 6.4 cm (3.75 x 2.8 x 2.5 in) and was estimated to contain about one thousand carats of gem material of a medium blue color but with a yellow zone which combines with blue to impart a greenish tinge to the basal portion of the crystal.

In another highly interesting account of the gem minerals of this state, Bradshaw (1990) records a number of faceted topazes in sherry and blue colors, also some colorless, the largest being a 58 cts pale blue cushion-cut from the Stark find mentioned above, and "currently the largest cut New Hampshire topaz on record." Another gem from this find is a 13.50 cts golden brown square cushion-cut. Ownership of these gems is not mentioned but presumably they belonged at the time to Peter Samuelson, the finder. Other cut gems include a 24.40 cts blue stone and a 13.40 cts colorless stone, both in the Smithsonian collection. A flawless light blue emerald-cut of 10.93 cts is in the Harvard Mineralogical Museum.

A very detailed article by Bearss & Janules (1992) describes the local geology, pockets, and pocket minerals of the Government [gravel] Pit area, White Mountains National Forest, Albany Township, Carroll County. This pit was worked for road paving gravel, actually the granular debris of decomposed granite that was so soft it could be excavated with an ordinary mineral pick, as I had discovered many years ago. The pit was steadily worked up to 1986 but in 1987 it was filled in, graded, seeded, and obliterated as far as mineral collectors are concerned. A pity!

BEARSS, G. T. & JANULES, R. (1992) Miarolitic cavity minerals of the Government Pit, Albany, New Hampshire. *Rocks & Minerals* 67, 3, p. 158–168, illust.

BILLINGS, M. P. (1927) Topaz and phenacite from Baldface Mountain, Chatham, New Hampshire. *Amer. Mineral.* 12, p. 173–179.

BRADSHAW, J. J. (1990) Gemstones of New Hampshire. *Rocks & Minerals* 65, 4, p. 300–305, illust.

BUCKLEY, B. W. (1974) Miarolitic minerals of the Conway granite. *Rocks & Minerals* 49, 3, p. 164–166, illust.

CHANDLER, M. H. (1937) Topaz on Baldface Mountain, N.H. *Rocks & Minerals* 12, 3, p. 72–73.

______, (1939) Topaz on Baldface Mountain. *The Mineralogist* 7, 2, p. 45–46.

GILLSON, J. L. (1927) The granite of Conway, New Hampshire, and its druse minerals. *Amer. Mineral.* 12, p. 307–319.

HOLLMANN, K. (1987) New Hampshire—remarkable topaz discovery. *Mineral News* 3, 8, p. 1–2.

KUNZ, G. F. (1893) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1892*, p. 756–781.

MEYERS, T. R. & STEWART, G. W. (1956) *The geology of New Hampshire.* Part III—Minerals and mines. Concord, ME: State Plann. & Develop. Comm., 105 p., large map. Topaz p. 58.

MORRILL, P. (1960) *New Hampshire Mines and Minerals Localities.* 2nd edit. Hanover, ME: Dartmouth College Museum, 46 p., maps.

SAMUELSON, P. B., HOLLMANN, K. H. & HOLT, C. L. (1990) Minerals of the Conway and Mount Osceola granites of New Hampshire. *Rocks & Minerals* 65, 4, p. 286–296, illust.

SHAUB, B. M. (1955) Recent discoveries of topaz. *Gemmologist* 24, p. 124–127.

______, (1955) A new discovery of topaz crystals near Conway, New Hampshire. *Rocks & Minerals* 30, 5–6, p. 227–235, illust., map.

______, (1981) Notes on New Hampshire gem pockets. *Gems & Minerals* 520, p. 44–47, 58, 59.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1913.* Baldface Mtn., p. 683–684.

CONNECTICUT. I have not been able to find any statement as to the lapidary suitability of the topaz from the famous Long Hill, Trumbull Township, Fairfield County, occurrence (Hobbs, 1901; Shannon, 1920, 1921). However, Schairer (1931, p. 67) states that "clear blue topaz of gem quality has been found here." The only faceted topaz from this state that is on record is a two carats gem cut from Gillette Quarry material (Scovil, 1992).

HOBBS, W. H. (1901) The old tungsten mine at Trumbull, Connecticut. *U.S. Geol. Survey Ann. Rept.* 22, part 2, p. 7–22, maps.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). Topaz p. 67.

SCOVIL, J. A. (1992) The Gillette Quarry, Haddam Neck, Connecticut. *Min. Rec.* 23, 1, p. 19–28, 80, illust. (col.), maps.

SCHAIRER, J. F. (1931) The minerals of Connecticut. *CT State Geol. Nat. Hist. Survey Bull.* 51, 121 p.

SHANNON, E. V. (1920) Some minerals from the old tungsten mine at Long Hill in Trumbull, Connecticut. *U.S. Nat. Mus. Proc.* 58, 2348, p. 469–482.

______, (1921) The old tungsten mine in Trumbull, Connecticut. *Amer. Mineral.* 6, 8, p. 126–128.

SHELTON, W. & WEBSTER, B. (1979) *Mineral Collector's Field Guide the Northeast.* Wallingford, CT: Mineralogy, 137 p., illust., maps. Trumbull p. 37–38.

SOHON, J. A. (1951) Connecticut minerals, their properties and occurrence. *CT State Geol. Nat. Hist. Survey Bull.* 77, 133 p.

WEBSTER, B. (1978) *Mineral Collector's Field Guide Connecticut.* Wallingford, CT, priv. publ., 40 p., maps. Long Hill p. 26–7.

VIRGINIA. The reopened Morefield Mine near Amelia, Amelia County, has produced short, stubby crystals of gemmy topaz but they are rarely over an inch (2.5 cm) in diameter. According to mine owner and operator, William D. Baltzley (*Pers. comm.* 6/93), they occur in small vugs in the granitic pegmatite body which is being mined mainly for the sake of its amazonite and rare minerals. Baltzley's collection contains a faceted, clean light blue gem from here that weighs 13.10 cts. Some sherry-color crystals have been found (Kearns, 1993).

In a nearby pegmatite, the Herbb #2 Mine, 3.6 mi (5.7 km) northeast of Flat Rock, Powhatan County, the occurrence of topaz upon the dumps had been noted years earlier by Dietric (1970, p. 278), but it was not until McCrery (1983) systematically worked the outcrop that the most important discovery of topaz in Virginia took place. On September 15, 1982, a long prismatic pale blue topaz crystal was found that was terminated at one end and displayed the common basal cleavage on the other end. It is lozenge-shaped in cross-section, and according to McCrery's drawing it displays only two sets of prism faces and a pair of terminal dipyramid faces. It measures 10.95 inches (27.8 cm) long and 2.12 x 2.65 in (7.9 x 9.3 cm) in cross-section and weighs 8.95 lbs (4 kg). Most of the interior contains inclusions and is not suited for cutting but McCrery noted that one crystal section found in the mine, possibly belonging originally to the large crystal, "weighs exactly one pound [0.4536 kg] and could afford a marquise, pseudomarquise, or oval of about 1,000 carats."

DIETRICH, R. V. (1970) Minerals of Virginia. *VA Polytech. Inst. Research Div. Bull.* 47, 325 p., illust. Topaz p. 278.

GLASS, J. J. (1935) The pegmatite minerals from near Amelia, Virginia. *Amer. Mineral.* 20, 11, p. 741–768.

KEARNS, L. F. (1993) Minerals of the Morefield pegmatite, Amelia County, Virginia. *Rocks & Minerals* 68, 4, p. 232–242, illust. (col.).

McCRERY, P. A. (1983) That magic moment, a veteran collector's Virginia experience. *Lapidary J.* 37; 4, p. 586–594, illust.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust., p. 24–25.

RICHARDSON, D. (1985) Herbb #2 Mine update. *Lapidary J.* 39, 2, p. 286–287.

GEORGIA. Sterrett (1914, p. 682) received two cut gems, said to be topazes found in the Williams Mica Mine, about 9.5 mi (15 km) north-northwest of Dahlonega, Lumpkin County, but upon examination one proved to be ordinary quartz and the other a true, colorless topaz. The latter was said to have come from a cavity in a large crystal of mica. Cook (1978, p. 112) states that the topaz gem was placed on exhibit in the museum of the Georgia State Capitol, and also reported that "at least one large topaz was found prior to 1871 in a gold placer along the Etowah River above Palmer's Mill." This specimen weighed about 2 lbs (0.9 kg) and eventually was cut up, one half preserved in its original state and other half made into gems. Another occurrence is given as a portion of a clear topaz crystal found on Kennesaw Mountain in 1952 (Cook, *Ibid.*).

COOK, R. R. (1978) Minerals of Georgia: Their properties and occurrence. *GA Geol. Water Resources Div. Bull.* 92, 189 p.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1913*, p. 682.

TEXAS. Interest in Texas topaz continues unabated, and recent visitors to several fee-collecting localities still find crystals, sometimes large

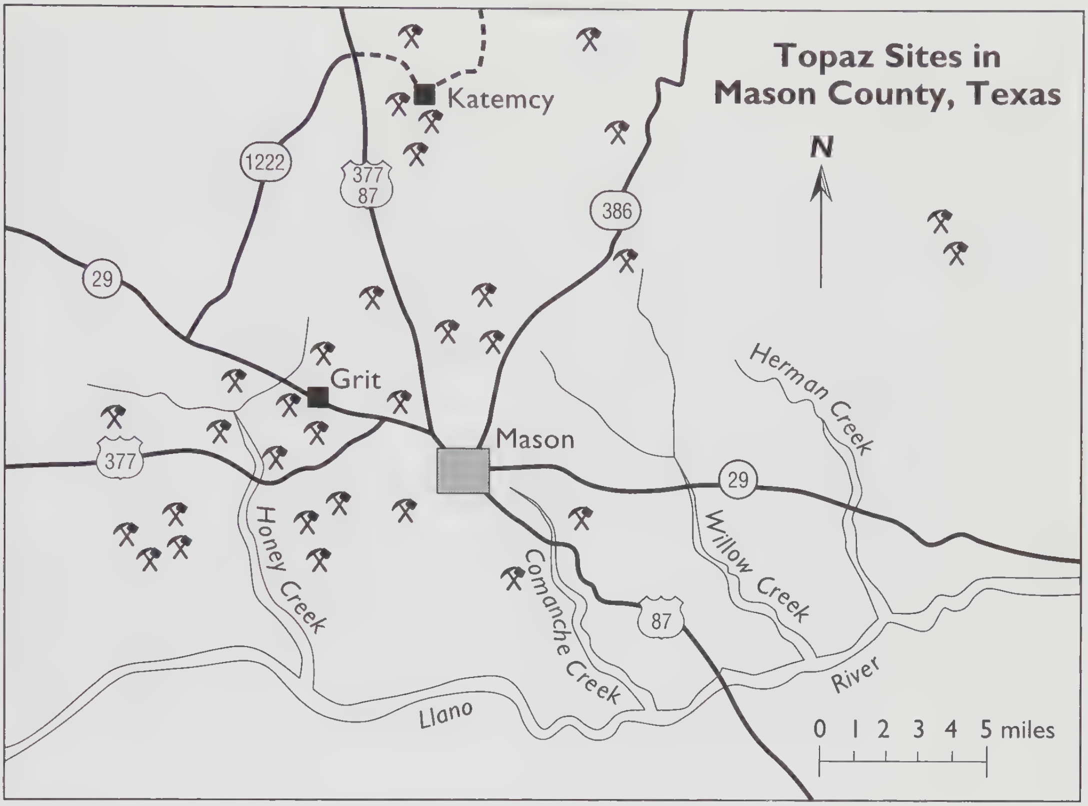


FIGURE 89. Sketch map of the Mason County, Texas, topaz collecting areas.

and clear enough to cut a handsome gem. Mitchell (1991, p. 30–35) notes occurrences of topaz in many creek beds in northern Mason County but believes that the best hunting is along Katemcy Creek and its tributaries in the area enclosed by Highway 87 on the west, the San Saba River on the north, Highway 71 on the east, and north of Mason. Much topaz has been collected upon the Hoffman Ranch just northwest of Mason, and also upon the Sequist's Honey Creek Ranch about 6 mi (9.7 km) west of Mason.

Among the large Texas topaz crystals from the area just described is a 1,296 grams specimen in the U.S. National Museum of Natural History. The largest faceted gem, a light blue step-cut of 333.5 cts, known as the Porter Rankin topaz, was stolen from the Rockhound Museum, Weatherford, Texas, on September 24, 1965 and remains unrecovered. A Mason County faceted topaz of 48.35 cts is in the Canadian National Collection. The Royal Ontario Museum in Toronto owns a medium blue faceted gem of 117.65 cts, and a pale blue faceted gem of 146.4 cts is in the Smithsonian collection.

BROUGHTON, P. L. (1973) Precious topaz deposits of the Llano Uplift area, central Texas. *Rocks & Minerals* 48, 3, p. 147–156, illust., maps.

BROWNE, V. (1982) Topaz in the Lone Star State. *Gems & Minerals* 531, p. 16–18, map.

FECHENBACH, M. F. (1984) Trapping the crafty topaz. *Gems & Minerals* 558, p. 55–57, maps.

GIRARD, R. M. (1964) Texas rocks and minerals, an amateur's guide. *TX Bur. Econ. Geol. Guidebook* 6, 109 p., illust. Topaz p. 94.

FIGURE 90. View on the Sequist Ranch, Mason County, where digging in the stream beds often produces gemmy topaz crystals. *Courtesy P. L. Broughton.*

KING, E. A. (1961) Texas gemstones. *TX Bur. Econ. Geol. Rept. Invest.* 42, 42 p., illust. Topaz p. 29–30.

KUNZ, G. F. (1893) [Notes on topaz from Texas.] *NY Acad. Sci. Trans.* 12, p. 96.

______, (1894) Topaz from Texas. *Amer. J. Science* 47, p. 403–404.

______, (1894) Mineralogical notes. *NY Acad. Sci. Trans.* 13, p. 144–145.

LANGSETH, H. (1976) Topaz of the Sequist Ranch. *Rockhound* 5, 6, p. 8, 10, 11.

LAPIDARY JOURNAL (1965) 333.5 Carat "Porter Rankin" Texas blue topaz stolen . . . Vol. 19, 8, p. 959, illust.

LEIPER, H. (1951) Texas blue topaz. *Lapidary J.* 5, 1, p. 98–102, illust.

MEYER, H. C. (1913) Topaz and stream tin in Mason County, Texas. *Eng. & Mining J.* 95, p. 511–512.

MITCHELL, J. R. (1991) *Gemstones of Texas.* Baldwin Park, CA: Gem Guides Book Co., 104 p., illust., maps. Topaz p. 30–35.

RENEAU, R. R. (1992) Texas topaz. *Rock & Gem* 22, 11, p. 26–28, 30.

SIMPSON, B. W. (1958) A trip to a Texas blue topaz location. *Lapidary J.* 12, 1, p. 44, 46, 48, map.

______, (1958) *Gem Trails of Texas.* Dallas, TX: Newman Stationery, 88 p., illust., maps. Topaz p. 29, 32–35.

SPARKS, D. (1968) The Texas topaz fields. *Gems & Minerals* 367, p. 20–22, 34, map.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Min Resources U.S. for 1913,* p. 684–688.

TOWNER, J. M. (1968) A topaz hunt in Mason County, Texas. *Lapidary J.* 22, 6, p. 780–782, 784, 785, illust.

______, (1969) A return trip to the topaz fields of Texas. *Ibid.* 22, 11, p. 1396–1398, illust. (col.).

_____, (1969) Bigger and better topaz in Mason County, Texas. *Ibid.* 23, 5, p. 700–705, illust.

_____, (1970) Just for the fun of it . . . *Ibid.* 24, 9, p. 1194, 1196–1198, illust.

_____, (1971) Topaz time in Texas. *Ibid.* 24, 11, p. 1504–1412, *passim*, illust.

_____, (1973) Digging for Texas topaz. *Ibid.* 27, 1, p. 48–67, *passim*, maps.

_____, (1979) Topaz joker. *Ibid.* 33, 2, p. 610–612, illust.

ZEITNER, J. C. (1972) *Southwest Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 146 p., illust., maps. Topaz p. 65–68.

MANITOBA. No new developments.

WRIGHT, J. F. (1932) Geology and mineral deposits of a part of southeastern Manitoba. *Geol. Survey Canada Mem.* 169, 150 p., illust., map. Reports pegmatite topaz—of unknown quality.

ALBERTA. No new developments.

HOFFMANN, G. C. (1896) *Annual report of the Geological Survey of Canada*, 9, p. 18R. Topaz near Jasper House, Jasper National Park.

YUKON. Grice & Gault (1985) report an occurrence of gem quality crystals of topaz from vugs in graphic granite pods associated with cream-colored orthoclase crystals. The crystals reach 2 cm (0.75 in) across and occur on matrix with smoky quartz crystals that are up to 10 cm (4 in) long. The authors depict a transparent, gem quality pale blue topaz of typical square cross-section terminated with a wedge of prism faces; it measures 3.7 cm (1.5 in) tall. The specimen is in the National Museum of Natural Sciences in Ottawa, museum number NMNS 45777. The occurrence is within monzonite (orthoclase-quartz-biotite) in the southern part of the Seagull Batholith located about 8 km (5 mi) north of the border with British Columbia, approximately 120 km (75 mi) west of Walker Lake on the Alaska Highway. It is noted that "the topaz is clear and ranges from colorless through shades of pale blue and, more rarely, pale orange . . . a few stones of poor quality have been cut from this material, the largest being 12.5 carats." The authors do not consider this to be a "profitable gem deposit." This locality appears to be the same that is given in Traill (1980, p. 381) who places the occurrence on the north face of a 1,800 m (5,900 ft) mountain on the east side of Seagull Creek, about 7 km (4.4 mi) north of Swift River, Km 1180 on the Alaska Highway, or at lat. 64°04'N, long. 131°08.5'W.

GRICE, J. D. & GAULT, R. A. (1985) Jade, gold, and topaz from the Cassiar Mountains, British Columbia/Yukon Territory, Canada. *Rocks & Minerals* 60, 1, p. 9–13, illust., map.

SABINA, A. P. (1965) Rock and mineral collecting in Canada. Vol. 1. Yukon, Northwest Territories . . . *Geol. Survey Canada Misc. Rept.* 8, 147 p., illust., maps. Topaz, Watson Lake, p. 19.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80–18, 432 p., map.

MONTANA. A promising area for discovery of gem-bearing granitic pegmatites is being explored to the north-northwest of Butte, Jefferson County, in the Boulder Batholith (Van Laer, 1985). Topaz crystals have been found that measure up to 1.5 x 1.5 x 1 in (3.7 x 3.7 x 2.5 cm); they are light sherry, pale blue, and colorless, and many contain cuttable areas.

VAN LAER, W. C. (1985) Boulder Batholith pegmatites. *Lapidary J.* 39, 2, p. 242–247, illust.

IDAHO. Perhaps the earliest mention of topaz in Idaho was made by Kunz (1897) as follows: "Mr. G. F. Moore, of Roseberry, Boise County, Idaho, who has for some years worked gold-gravel mines about 100 miles north of Boise, has found in the gravel a large waterworn crystal of topaz identical in habit with those from the Alabaschka locality in the Urals. The crystal is of greenish color, weighs 1,110 carats, and measures 50 millimeters in-length and 46 millimeters at its greatest breadth."

The current interest in prospecting for topaz is centered in the Sawtooth Batholith where it straddles the convergence of Custer, Boise, and Elmore counties in the central portion of Idaho's lower half. Ream (1989, p. 88–91) has been collecting in this area and devotes much discussion to the geology, mineralogy, and miarolitic cavities which produce large numbers of splendid smoky quartz crystals as well as aquamarines and topazes. *See also* the remarks of Van Laer and others under BERYL above.

Sawtooth topaz crystals, many with clear, facetable areas, usually form stubby prisms, sometimes several times as long as they are wide, and mostly colorless to sherry color. However, other colors are found, namely pale yellow to yellow, brown, and rarely with pale blue color zoning which at times is quite distinct. Ream *(Ibid.)* notes that consistent with experience elsewhere, Sawtooth sherry topaz bleaches when exposed to daylight, and "apparently an original sherry color will become light yellow or colorless." Crystals range in size from pinheads to 12 cm (4.75 in) long but the average is only 0.5 to 2 cm (up to 0.75 in). While some cutting material can be obtained, by far the greatest value of the topazes is as cabinet specimens, especially when on matrix, associated with quartz and feldspar.

Other topaz occurrences in the state are noted by Ream and others, but few such occurrences are significant producers of facet material, except perhaps the alluvial deposit in the Dismal Swamp area located 9.5 mi (15 km) northeast of Rocky Bar on the headwaters of Buck Creek in Elmore County (Beckwith, 1977; Ogden, 1977; Ream, 1989, 1992).

BECKWITH, J. A. (1977) *Gem Minerals of Idaho.* Caldwell, ID: The Caxton Printers, 129 p., illust., maps, p. 74–77.

KUNZ, G. F. (1897) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1896–7*, p. 1183–1217, p. 1203.

OGDEN, G. (1977) Where to find topaz in Idaho. *Lapidary J.* 31, 8, p. 1760.

REAM, L. R. (1989) *Idaho Minerals.* Coeur d'Alene, ID: L. R. Ream Publ. Co., 329 p., illust., p. 88–89, 295–296.

______, (1992) *The Gem & Mineral Collector's Guide to Idaho.* Vol. 1 *Ibid.*, 34 p., illust., maps, p. 1.

SHANNON, E. V. (1926) The minerals of Idaho. *U.S. Nat. Mus. Bull.* 131, 483 p., illust., p. 319–321.

COLORADO. Topaz in Colorado is almost exclusively the product of pockets within small, flat-lying pegmatite bodies, associated with smoky quartz, feldspars, mica, and sometimes fluorite and rare minerals. According to Michalski (1986) such pegmatites most often occur within the outer zones of potassic granitic plutons or within the Pikes Peak granite next to such plutons. Since the area of potential mineralization is vast, it is not surprising that pockets continue to be found, some of which yield handsome topaz crystals that are clear enough to afford faceted gems. However, not much value can be attached to such gems, except for their locality interest, because market prices for colorless and very pale blue gems are very low. While the sherry-colored varieties are far more attractive, they suffer from rapid fading of color when exposed to light. Blue crystals, even of only fair color intensity, are very rare.

An excellent survey of the minerals of the Pikes Peak granite batholith, including much on topaz and its occurrences, is to be found in Muntyan & Muntyan (1985). This information is elaborated in Michalski's paper noted above. The first area of topaz interest, Devil's Head, is located in the northern portion of the batholith in Douglas County along the Rampart Range Road between Deckers and Woodland Park. The first study of topaz crystals from this area appeared in Peacock (1935) who furnished crystal drawings and was careful to show the etched areas that typically in topaz occur upon the terminations rather than upon the prism sides. As is also common elsewhere, these crystals are often very severely corroded, but such crystals are most likely to contain flawless cutting areas.

Unlike other topaz deposits in Colorado, that at the Topaz Mountain Gem Mine, operated by Mr. Walt Riebeck of Colorado Springs, is an alluvial or detrital deposit, whose debris is believed by Voynick (1990, p. 43) to come from the decay of a pegmatite dike above the deposit. The "gravel" of the deposit is "composed almost entirely of reddish, clayey, tightly compacted, decomposed granite," and is exploited by power digging machines. The mine is located to the east of the road linking Lake George and Tarryall in Park County, and is reached from this road by taking a

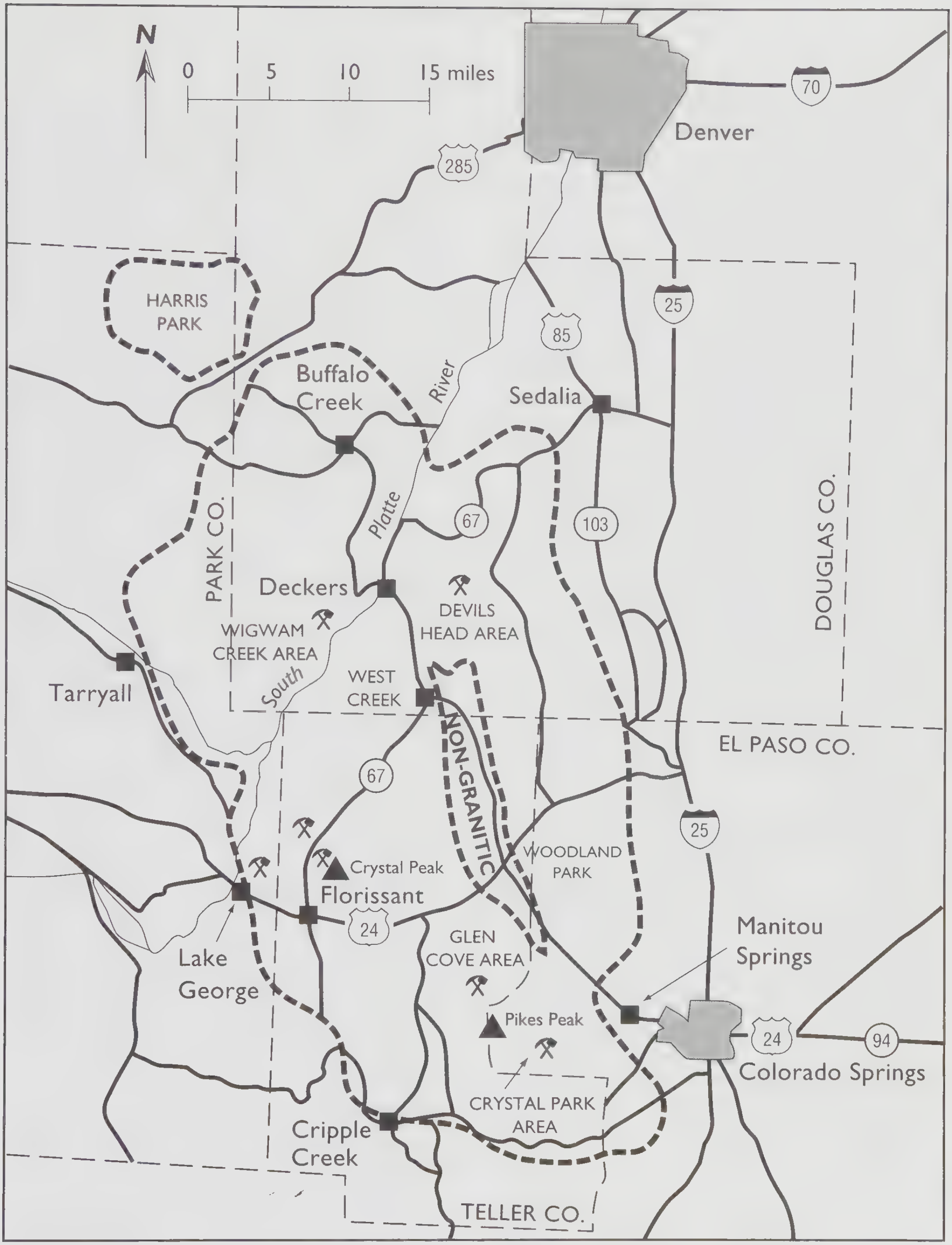


FIGURE 91. Sketch map of the Pikes Peak Batholith within which many finds are still being made of pegmatite pocket minerals including topaz. The granite intrusives are shown in heavy black dashed outline.

turnoff called the Matukat Road, which then leads to the mine. Visiting collectors are charged $10 per 5-gallon bucket of gravel and are entitled to whatever they find therein (as of 1993, *pers. comm.*, 1/23/93). No one is allowed to dig *in situ* because of the high cost of insurance. Topaz crystals are typically short, stubby, squarish prisms, many showing slight face/edge wear, and many of fine facet grade, sometimes with remarkable blue-sherry color zoning. Smoky quartz crystals are also found. An unusual inclusion in the topaz is phenakite. Mr. Riebeck believes that his deposit may be as much as 25 to 30 ft (7.5–9 m) thick and "at the present rate there should be between 50 and 75 years left." In 1992, he found a strongly bicolored crystal, 1 inch wide and 2 inches long (2.4 x 9 cm), which contained a phenakite inclusion, and also a large piece of facet-grade rough which weighed 220 carats. As to the yield from the buckets of gravel sold at the mine, Voynick (p. 44) noted that each bucket, containing about 50 lbs (22.7 kg), on the average provides from one to four pieces of topaz with a total weight of perhaps 20 carats. About one-third of the crystals are cuttable, the sherry crystals being the cleanest and yielding faceted gems of "not less than three carats."

In the Wigwam Creek Trailhead area, located west of Deckers in Jefferson County, at the eastern edge of the Tarryall Mountains, many collecting sites are controlled through claims filed by the Denver Gem and Mineral Guild (Muntyan & Muntyan, p. 221). From pegmatites therein came amazonite, smoky quartz, topaz, and other minerals. According to Kile, *et al* (1991, p. 384), "some of Colorado's best topaz, ranging from pale blue to brown, has recently been collected near the Wigwam Creek Trailhead," and "further exploration in this region should yield more quartz and other gemstone occurrences."

Another area that produces fine topaz crystals, many of gem grade, is reached from the Spruce Grove Campground, Park County, and is located on the road that connects Jefferson and Lake George, the area is approximately 13 mi (21 km) north-northwest of Lake George (Nelson, 1968). Here the Pikes Peak granite has been intruded by the Redskin Stock and the topaz-bearing pockets commonly occur in small pegmatite bodies along the contact between the two rock types and near the cliffs at the southern end of the Tarryall Mountains (Muntyan & Muntyan, p. 221). Many fine crystals came from the rugged pinnacles locally called "The Spires," which are located directly east of the Spruce Grove Campground. Other collecting areas are located immediately east and southeast of the campground as delineated upon a map provided by Nelson, who gives an exciting account of his discovery of pockets and extraction of crystals. From one pocket, for example, he obtained his largest crystal, one that weighed 50.27 grams. About half of the crystals were terminated. According to Michalski (1986) these crystals may be colorless, pale blue or amber, and the largest reach 3 in (5 cm) tall.

The Crystal Peak area, Park and Teller counties, embraces much ground near the community of Lake George and has been the scene of collecting activity since the 1870s (Kile, *et al*, 1991, p. 383–384). According to Muntyan & Muntyan (p. 219), the area lies generally north of the towns of Florissant and Lake George and extends for about 5 km (3.1 mi) in an east-west direction and 3 km (1.9 mi) north to south; it straddles the county line between Park and Teller counties. The topaz here, however, is far overshadowed by the superb smoky quartz and amazonite for which this area is world-famous. Although similar in name, Crystal Park is located in the Pikes Peak Batholith along the base of Cameron Cone, southeast of Pikes Peak in El Paso County. Michalski *(Ibid.)* notes topaz crystals from this area that can measure 1.5 in (3.5 cm) tall but are rarely found in this size.

Glen Cove, Teller County, is located on the north side of Pikes Peak and is noted for "outstanding quality gem topaz" (Muntyan & Muntyan, p. 221). During the late 1940s and early 1950s, "sky-blue gem topaz were recovered from a number of pockets," and in my first volume I provided a photograph showing a virtually flawless blue faceted pear-shape gem of 368.5 cts cut by me for the Smithsonian collection from material collected at Glen Cove by the late Edwin

Over, the noted Colorado mineral collector.

In his monograph on the Mount Antero aquamarines (*see* BERYL), Jacobson (1993, p. 115–116) treats topaz as one of the "moderately rare" minerals found in the pockets of this famous locality in Chaffee County. Nevertheless, fine crystals, fully formed and nearly perfect, as well as etched ones, have been found in brown, sherry, and yellowish hues, and some measure up to 3 in (7.5 cm) long. A number of such crystals were found recently in an area on the southern knob of Mount Antero, and from a sherry crystal was cut a faceted gem of 15.65 cts. Some topaz has also been found on adjacent White Mountain, but none of gem quality.

BIXBY, M. (1894) A collector in Colorado. *Mineral Collector* 1, 9, p. 131–3.

CROSS, C. W. & HILLEBRAND, W. F. (1882) Notes on some interesting minerals occurring near Pike's Peak, Colorado. *Amer. J. Science* 24, p. 281–286.

______, (1885) Contributions to the mineralogy of the Rocky Mountains. *U.S. Geol. Survey Bull.* 20, 114 p., illust.

CROSS, C. W. (1885) A list of specially noteworthy minerals of Colorado. *Colorado Scient. Soc. Proc.* 1, p. 134–144.

______, (1886) On the occurrence of topaz and garnet in lithophyses of rhyolite. *Amer. J. Science* 31, p. 432–438. Also: *CO Scient. Soc. Proc.* 2, p. 61–70. Nathrop locality.

CROSS, R. T. (1883) Notes on a new topaz locality. *Amer. J. Science* 26, p. 484–485.

DICKERSON, B. (1972) Topaz and quartz at Devil's Head. *Gems & Minerals* 418, p. 26–27, map.

HANTLA, J. P. (1971) Topaz from Colorado's Tarryall spires. *Lapidary J.* 25, 8, p. 1048–1060, *passim.*

JACOBSON, M. I. (1993) *Antero Aquamarines. Minerals from the Mount Antero-White Mountain Region, Chaffee County, Colorado.* Coeur d'Alene, ID: L. R. Ream Publ., 126 p., illust. (col.) Topaz p. 115–116.

KILE, D. E. (1986) Pegmatite cavities in the Lake George area, Colorado. In *Colorado Pegmatites:* abstracts, short papers, and field guides from the Colorado Pegmatite Symposium, May 30–June 2, 1986, Denver, p. 131–134.

KUNZ, G. F. (1886) Notes on some minerals from the West . . . 2. Topaz and spessartite from Nathrop, Chaffee Co., Colorado. *NY Acad. Science Trans.* 5, p. 213–214.

______, (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). CO topaz p. 68–70.

MICHALSKI, T. C. (1986) Topaz in the Pikes Peak batholith. In *Colorado Pegmatites* . . . Colorado Pegmatite Symposium . . . Denver, p. 70–71.

MODRESKI, P. J., ed. (1986) *Colorado Pegmatites* . . . Colorado Pegmatite Symposium. Denver, CO: Friends of Mineralogy, 161 p., illust., maps.

MUNTYAN, B. L. & MUNTYAN, J. R. (1985) Minerals of the Pikes Peak granite. *Min. Rec.* 16, 3, p. 217–230, illust., map.

NELSON, K. E. (1968) Tarryall topaz from Colorado. *Lapidary J.* 22, 1, p. 138–143.

PEACOCK, M. A. (1935) Topaz from Devil's Head, Colorado. *Amer. Mineral.* 20, p. 254–363, illust.

PEARL, R. M. (1941) Topaz at Devil's Head, Colorado. *The Mineralogist* 9, p. 416, 418, 419.

______, (1963) Topaz in Colorado. *Gems & Minerals* 309, p. 16–19, map.

______, (1965) Colorado *Gem Trails and Mineral Guide.* 2nd edit. Denver, CO: Sage Books, 223 p., illust., maps.

______, (1974) Minerals of the Pikes Peak granite. *Min. Rec.* 5, 4, p. 183–189.

PENFIELD, S. L. & SMITH, W. B. (1887) Phenacite from Colorado . . . with notes on the locality of Topaz Butte. *Amer. J. Science* 33, p. 130–135. Also: *CO Scient. Soc. Proc.* 2, p. 141–146, 1887.

SMITH, W. B. (1885) Notes on the occurrence of topaz at Devil's Head Mountain. *U.S. Geol. Survey Bull.* 20, p. 73–74.

______, (1887) Notes on the crystal beds of Topaz Butte. *Colorado Scient. Soc. Proc.* 2, p. 108–115. Abstract: *Amer. J. Sci.* 33, p. 134–135.

SWINDLE, L. J. (1975) Digging for pegmatite pockets in the Pikes Peak region of Colorado. *Lapidary J.* 29, 3, p. 682–684, 702, illust.

VOYNICK, S. (1990) Finds on Topaz Mountain. *Rock & Gem* 20, 11, p. 40–44, 85–86, illust.

WRIGHT, R. V. (1977) Colorado gem materials. *Lapidary J.* 31, 2, p. 610– 614, illust.

WULFF, W. W. (1934) Topaz in the Tarryall Mountains of Colorado. *Rocks & Minerals* 9, 1, p. 45–47.

UTAH. The well-known and well-trodden locality of Topaz Mountain in Juab County, located at the southern end of the Thomas Mountains, remains a favorite and productive collecting area. Of course the thousands of loose crystals that once littered the ground have been picked up long ago and it is now necessary to excavate the rhyolite rock in which the crystal-lined cavities occur. Despite such intensive collecting, the size of the productive area as shown on the geological map of Staatz & Carr (1964) ensures that the supply of crystals for those willing to work for them will not run out in the foreseeable future. By far most crystals are collected for their mineralogical value rather than for gem purposes, although some collectors utilize the small, glittering prisms as pendant stones in necklaces and in decorative objects (Spendlove, 1993).

As mentioned in previous volumes, sherry color topazes are commonly found in vugs but quickly fade when exposed to sunlight. However, the possibility that true pink topazes may occur was brought up by Montgomery (1934) who claimed that he had found some and that they were stable in color: "a few small, transparent crystals were found to be rose-tinted throughout," such being found associated with pseudobrookite, leading Montgomery to speculate that titanium was the cause of color. However, in 1990, Hoover (1992, p. 200) submitted specimens to E. E. Foord of the U.S. Geological Survey in Denver, who failed to detect the presence of titanium. I have not been able to find any other reference to a stable pink color in Topaz Mountain topaz crystals. Among other properties, Staatz & Carr *(Ibid.)* found refractive indexes of alpha 1.605–1.608, and gamma 1.618–1.6185.

In a recent issue of *Mineralogical Record*, Robinson (23, 5, p. 428) records the mining activity upon Topaz Mountain by John Holfert of Bountiful, Utah, and Steve Allred of Erda, Utah, who operate the Holfert-Allred Claim from which they obtain "numerous exceptionally fine sherry-brown topaz crystals. Some are of faceting quality and are up to 5 cm [2 in] long." Associates are small, translucent red beryl crystals and exceptionally large tridymite crystals.

Stowe, *et al* (1977, p. 65) and Stowe (1979, p. 36) notes small topaz crystals, similar to those of the Thomas Mountains, at a place in Iron County, about 12 mi (19 km) northwest of Lund. Here they occur in a gray to dark brownish-red rhyolite in small vugs.

ALLING, A. N. (1887) On the topaz from the Thomas Range, Utah. *Amer. J. Science* 33, p. 146–147.

ALLRED, C. W. (1980) Three days on the Brooks Range. *Lapidary J.* 34, 5, p. 1182–1193. Topaz Mtn.

BIXBY, M. (1895) A description of topaz crystals, their localities and occurrence in Utah. *Mineral Collector* 2, 9, p. 141–143.

_____, (1897) A trip to the Utah desert. *Ibid.* 4, p. 121–123. Topaz Mtn.

_____, (1959) A catalogue of Utah minerals and localities. *UT Geol. Mineralogical Survey Reprint* 60, 35 p. First edit. 1916.

BROCK, D. & BROCK, R. (1954) Utah's Topaz Mountain. *Gems & Minerals* 202, p. 40–41.

BULLOCK, K. C. (1967) Minerals of Utah. *UT Geol. Mineral. Survey Bull.* 76, 237 p., maps.

BURANEK, A. M. (1941) Notes on topaz and associated minerals of Topaz Mountain and adjacent areas, Utah. *Dana Mag.* 6, 1–3, p. 7–17.

_____, (1947) *Same. Mineral. Soc. Utah Bull.* 7, 1, p. 36–43, illust.

DICKERSON, P. & DICKERSON, F. (1973) Thumbnails from Utah's treasure chest. *Lapidary J.* 27, 1, p. 4–10, *passim*, illust.

_____, (1974) A commentary from Utah's treasure chest. *Ibid.* 28, 8, p. 1326–1332, illust.

_____, (1974) Topaz Mountain West. *Gems & Minerals* 444, p. 30–32, 43–47, map.

ENGELMANN, H. (1863) Topaz in Utah. *Acad. Sci. St. Louis Trans.* 2, p. 114.

FOERSTER, R. (1992) Tee off at Topaz Mountain. *Lapidary J.* 46, 5, p. 52–59, *passim*, map.

HOLFERT, J. (1978) *A Field Guide to Topaz and Associated Minerals of Topaz Mountain, Utah.* Rev. edit. Bountiful, UT: priv. publ., 67 p., illust.

HOOVER, D. B. (1992) *Topaz.* Oxford: Butterworth-Heinemann, 207 p., illust. (col.).

IVES, R. L. (1947) Topaz areas of the Thomas Range, Utah. *Rocks & Minerals* 22, 11, p. 1003–1010, maps.

JENKINS, J. E. (1981) The minerals of Topaz Mountain. *Gems & Minerals* 522, p. 8, 26, 27, map.

JONES, A. J. (1895) Topaz crystals of Thomas Mountains, Utah. *Iowa Acad Science Proc.* 2, p. 175–177.

KENNEDY, M. (1969) Topaz Mountain—Utah's treasure chest. *Lapidary J.* 23, 2, p. 317–319, illust.

MITCHELL, J. R. (1987) *Gem Trails of Utah.* Baldwin Park, CA: Gem Guides Book Co., 111 p., illust., maps. Topaz Mtn. p. 20–21, map.

MONTGOMERY, A. (1934) A recent find of bixbyite and associated minerals in the Thomas Range, Utah. *Amer. Mineral.* 19, 2, p. 82–87, illust.

_____, (1935) Minerals of the Thomas Range, Utah. *Rocks & Minerals* 12, 7, p. 195–208, illust., maps.

PABST, A. (1938) Orientation of bixbyite on topaz. *Amer. Mineral* 23, 5, p. 342–347, illust.

PALACHE, C. (1934) Minerals from Topaz Mountain, Utah. *Amer. Mineral.* 19, 1, p. 14–15.

PATTON, H. B. (1908) Topaz-bearing rhyolites of the Thomas Range, Utah. *Geol. Soc. Amer. Bull.* 19, p. 177–192, illust.

PENFIELD, S. L. & FOOTE, H. W. (1897) On bixbyite, a new mineral, and notes on the associated topaz. *Amer. J. Science* 4, p. 105–108.

REAM, L. R. (1978) There's still good collecting at Topaz Mountain. *Rockhound* 7, 3, p. 4–7, map.

_____, (1979) Topaz collecting in Western Utah. *Rockhound* 8, 1, p. 23–35, maps.

_____, (1979) Famous mineral localities: The Thomas Range, Wah Wah Mountains, and vicinity, Western Utah. *Min. Rec.* 10, 5, p. 261–278.

ROBINSON, G. W., *et al* (1992) What's new in minerals? *Min. Rec.* 23, 5, p. 428. UT topaz.

SIMPSON, B. W. (1975) *Utah Gem Trails.* Rev. edit. Glen Rose, TX: Gem Trails Publs., 88 p., illust., maps, p. 18–19.

SPENDLOVE, E. (1968) Topaz Mountain. *Desert Mag.* 31, 10, p. 28–29, map.

_____, (1993) Topaz Mountain. *Rock & Gem* 23, 2, p. 76–81.

SPRUNGER, M. R. (1974) Collecting at Topaz Mountain. *Lapidary J.* 28, 2, p. 402–406.

STAATZ, M. H. & CARR, W. J. (1964) Geology and mineral deposits of the Thomas and Dugway ranges, Juab and Tooele counties, Utah. *U.S. Geol. Survey Prof. Paper* 415, 188 p., illust., maps.

STERRETT, D. B. (1909) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. For 1908*, p. 805–859. UT topaz p. 840–842.

STOWE, C., *et al* (1977) *Collector's Guide to Mineral and Fossil Localities in Utah.* UT Geol. & Min. Survey, 112 p., maps. Topaz Mtn. p. 74.

STOWE, C. H. (1979) Rockhound guide to mineral and fossil localities in Utah. Rev. *UT Geol. & Min. Survey Circ.* 63, 79 p., illust., maps.

VOYNICK, S. (1990) Finds on Topaz Mountain. *Rock & Gem* 20, 11, p. 40–44, 85, 86, map.

WEIGHT, H. O. (1947) Field day for topaz hunters. *Desert Mag.* 10, 12, p. 19–24, illust., map.

NEVADA. Christopher W. Ralph of Reno informs me that cuttable crystals of topaz are being found, with amazonite, in Harvey Gordon's Zapot Claim in the Gillis Range, northeast of Hawthorne, Mineral County (*Pers. comm.* 5/10/93). This seems to be the first record of topaz for the state of Nevada and is confirmed by Mr. Gordon (*Pers. comm.* 7/93). The topaz crystals are typical squarish prisms with wedge-shaped terminal faces, colorless to faintly blue, but when irradiated they assume a vivid blue color. The largest crystal measures about 2 x 2 x 2 in (5 x 5 x 5 cm), but the finest specimen, acquired by Mr. William Larson of Fallbrook, California, measures about 2 x 2 x 1.25 in (5 x 5 x 3 cm) and is faintly greenish in color and virtually free of etching (*Pers. comm.* 1/4/94). Portions of this crystal are clear gem material. As is so often the case, the crystals are found loose in the pockets because of having broken off along the perfect and easily developed basal cleavage plane. Associated species include amazonite and smoky quartz crystals, also cleavelandite, mica, very small dark green tourmaline (non-gem grade), fluorite, hematite, and sometimes gemmy spessartine. This granitic pegmatite deposit has been known since 1978 but serious development work did not commence until 1989–1990. Mr. Gordon owns a flawless, faceted, colorless topaz from his mine that weighs 12.67 carats. *See also* FELDSPAR.

NEW MEXICO. Mitchell (1987, p. 6) records topaz crystals, some large enough to facet small gems, probably of less than two carats, in cavities in rhyolite at a place about 9 mi (14 km) east-northeast of Grants, Valencia County. The area is reached via the Lobo Canyon Road (Highway 547) and lies on the south flank of Grants Ridge.

MITCHELL, J. R. (1987) *Gem Trails of New Mexico.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

ARIZONA. Anthony, *et al* (1977, p. 190), citing Heinrich (1960), mentions the occurrence of euhedral topaz crystals up to 2.5 in (6 cm) long in pegmatites of the Aquarius Range, Mohave County, south of the Rare Metals Mine. Elsewhere, a typical gray rhyolite cavity occurrence of topaz crystals of small size, associated with quartz, bixbyite, spessartine, and pseudobrookite, hence very much like the Topaz Mountain occurrence in Utah, is located on Ash Creek, near Hayden, Pinal County. According to White (1992) "they are classic rhyolite topaz crystals . . . virtually indistinguishable from the famed Thomas Mountains, Utah, crystals." This may be the same locality given by Anthony, *et al (Ibid.)* as "near Saddle Mountain, Winkelman area, in rhyolite with pseudobrookite, spessartine, and bixbyite," citing a personal communication from collector Richard L. Jones.

ANTHONY, J. W., WILLIAMS, S. A. & BIDEAUX, R. A. (1977) *Mineralogy of Arizona.* Tucson, AZ: Univ. Arizona Press, 241 p., illust. (col.), maps, p. 190.

HEINRICH, E. W. (1960) Some rare-earth mineral deposits in Mohave County, Arizona. *AZ Bur. Mines Bull.* 167, 22 p., map.

WHITE, J. S. (1992) An occurrence of bixbyite, spessartine, topaz, and pseudobrookite from Ash Creek near Hayden, Arizona. *Min. Rec.* 23, 6, p. 487–492, illust. (col.).

CALIFORNIA. In San Bernardino County, Robert Reynolds, of Redlands, California, has placed a claim on a property containing granitic pegmatites from which came amazonite and topaz (*Pers. comm.* 6/93). The occurrence is in the New York Mountains east of Baker. The few topaz crystals that have been found are non-gem quality. (*See also* FELDSPAR.)

The "Blue Chihuahua" pegmatite mine located north of Palomar Mountain upon the border between Riverside County (north) and San Diego County (south) is noted among mineral collectors for its fine terminated herderite crystals which are among the best of their kind for any locality. Some blocky colorless topaz crystals were found in the same pockets, along with cleavelandite, microcline, quartz, schorl, muscovite, beryl, and, rarely, cassiterite and tantalite. The topaz crystals are clear and suitable for faceting but all are better preserved as mineral specimens. After a brief period of exploration by A. C. Ordway and others in 1968, no further work has been done on this claim. The pegmatite itself was a remarkably thin sheet-like body, only about 18 in (46 cm) wide, and is one of a local swarm of similar bodies in the neighborhood (Ordway, 1968).

In San Diego County, additional details on the history and productions of the famous Ware "emeralite" mine, noted for its fine blue-green tourmaline crystals and light blue topaz crystals, have been gleaned from the brief historical notes compiled by Mabel Ware Mullineaux of San Diego, daughter of the mine owner, developer, and San Diego jeweler, John W. Ware (1866–1946). Ware claimed the property atop Aguanga Mountain at an elevation of 5,100 ft (1,555 m) in 1913. Aguanga Mountain is 13 mi (21 km) northwest of Warners Hot Springs. Ware's first discovery occurred during a prospecting trip when he stumbled upon the glistening contents of an eroded gem pocket. Altogether the mine property covers 20.66 acres and ultimately the flat-lying pegmatite body was honeycombed by 3,800 ft (1,160 m) of tunnels. Mining was conducted each year from 1913 through 1945, although much of the later work was done solely to keep rights to the claim as required by law. Two to three miners were continuously employed. The claim was sold recently to a Miss Wiesendanger, and later leased by her to Norman E. Dawson, of Escondido, who did some work but found little material. According to a note in the *Lapidary Journal* (37, 5, 1983, p. 779), the Ware Mine was reopened by Pala Mining Company, with Pala Wholesalers of Pala, California, acting as marketing agents for the anticipated production; the present status of this activity is unknown. The 17 carats blue pendeloque topaz cut from

Ware Mine material, and long claimed to be the finest California blue topaz, was presented to the Smithsonian in 1961 by Ethelmae Ware, widow of J. W. Ware (*Lapidary J.* 15, 4, 1961, p. 467).

On the opposite or western side of the ridge, not far from the Ware Mine, is the Maple Lode Mine, patented in the 1980s by Roland Reed of El Cajon, California, who worked the pegmatite for its fine blue topaz crystals and the remarkable, pale blue to pink gemmy elbaite tourmaline crystals, some of which yielded faceted gems of several carats. The largest topaz crystal found by Reed is lozenge-shaped in cross-section and terminated by a broad *c*-face and small bipyramidal faces. It is pale blue, unsuited for gems, but provides an excellent cabinet specimen. Its dimensions are 2.5 x 2 x 0.75 in (6 x 5 x 1.7 cm), while other crystals generally range from 0.75 to 1.0 in (1.7–2.3 cm) in size. The smaller crystals are much clearer but so pale in color that gems cut from them would have little value save that imparted by their source. Some crystals are very strongly etched to the point where all original faces are obliterated. In the generally very small pockets, no more than several inches across, the topaz is associated with elbaite, cleavelandite, quartz and lepidolite. This mine was subsequently leased to Oscar Nukka of Oceanside, California, who accomplished considerable development work in the summer of 1993 (*Pers. comm.*, R. Reed, 3/93).

Topaz is rare in the Mesa Grande pegmatites but Foord (1977, p. 471), citing an unpublished study by R. H. Jahns and J. B. Hanley, states that crystals have been found in the Himalaya pegmatites "as large as 3 inches [7.5 cm] in maximum dimension and are colorless to very pale blue, distinctly paler than much of the topaz from other pegmatites in San Diego County." Pemberton (1983, p. 454) cites these authors but also Carnahan (1960, p. 57) who notes only that "small, transparent topaz [crystals] . . . accent the matrix specimens or appear as single crystals." Mr. William Larson, owner of the Himalaya Mine, obtained several 1 to 2 in (2.3–5 cm) colorless crystals during the 1990s, all with good prism faces but severely etched on their terminations to the point that they became rounded from their original wedge shape. These crystals were found in the workings that are reached via a tunnel from the east slope of Gem Hill. A fine 2-in (5 cm) crystal is almost perfectly clean and would cut into a flawless faceted gem of about 75 carats but it is being preserved as a cabinet piece (*Pers. comm.*, W. Larson, 1/4/94).

The classic topaz locality of California remains the Little Three Mine pegmatite swarm located east of Ramona, San Diego County. Recent papers devoted to the geology and mineralogy of these deposits include Stern, *et al* (1986) and Foord (1989, 1991). All recent finds of topaz, along with the dark green elbaite tourmalines, spessartines, and other minerals, have been mined by the Spaulding family of Ramona. The late Louis B. Spaulding acquired the Little Three patented claim in 1951, and worked it until his death in 1973; his son, Louis, Jr., has worked it from then to the present. The details of the mine history, local geology and mineralogy, and the plots of claims in the district are given in Foord, *et al* (1989), which paper also furnishes much information on the topazes themselves (p. 118–119). In 1976, near the west end of the Little Three opencut, a large pocket, dubbed the "New Spaulding Pocket," produced "more than 28 kilograms [63 lbs] of Topaz . . . in the form of about 75 nearly complete and additional fragmented crystals" (Foord, *et al*, 1989). Further pockets and topaz crystals were recovered in 1985, while the smaller pegmatite, called the "Sinkankas Pegmatite," parallel and downslope from the main Little Three pegmatite, yielded small colorless, etched crystals along with the typical dark green elbaite tourmaline crystals mentioned above.

In the main pegmatite pockets, two crystal types of topaz were noted. One was blocky, almost cube-like in habit due to the development of a very large *c*-face; in the second type crystals were terminated with a pair of broad faces forming a blunt wedge. Most of the larger crystals from recent finds weighed as much as 450 gm (1 lb). Foord (1991, p. 137) recounts a story told to him by Louis B. Spaulding, Jr., concerning a 70 kg (154 lb) topaz-tourmaline matrix specimen that was mined from the Little Three Mine in 1905 and placed on display for many years in the San Diego Chamber of Commerce. It was then moved to the newly opened Natural History Museum in Balboa Park, but during World War II, "the Navy took over the museum and the displays were crated and stored for the duration. The specimen was never seen again, and it is probable that it was hauled to sea in a barge full of junk and dumped." Some fine matrix specimens from recent mining met better fates and are now carefully preserved in various public and private collections.

The color of Little Three topazes is mostly pale blue but Foord, *et al* (1989, p. 119) mentions the unusual tendency for such color to deepen after the crystals are removed from the ground, noting that "crystals excavated in 1976 were very pale blue and have darkened noticeably since then, without exposure to direct sunlight."

During the most recent pocket excavation in early 1992, about 20 lb (9 kg) of topaz crystals were recovered, almost all of specimen grade and including one handsome matrix specimen. One large crystal measured 4 in (10 cm) tall and 3 in (7.5 cm) across, but most crystals fell into the size range of 1–2 in (2.3–5 cm) (*Pers. comm.*, L. B. Spaulding, Jr., 6/93). Spaulding owns a flawless, light blue faceted gem of 18.66 cts and a colorless flawless gem of 38 cts.

CARNAHAN, V. (1960) The treasure of the Himalaya Mine. *Gems & Minerals* 278, p. 21–25, 55–57.

FOORD, E. E. (1977) Famous mineral localities: The Himalaya dike system. *Min. Rec.* 8, 6, p. 461–474, illust., map.

FOORD, E. E., *et al* (1989) Mineralogy and paragenesis of the Little Three Mine pegmatites, Ramona district, San Diego County, California. *Min. Rec.* 20, 2, p. 101–127, illust., map.

FOORD, E. E., *et al* (1991) Gem-bearing pegmatites of San Diego County, California. In WALLAWENDER, M. J. & HANAN, B. B., eds. (1991) Geological excursions in Southern California and Mexico. *Guidebook, 1991 Ann. Mtg. Geol. Soc. Amer., San Diego, CA, Oct. 21–24, 1991*, p. 128–146, illust.

ORDWAY, A. C. (1968) Herderite in a California pegmatite. *Gems & Minerals* 375, p. 40, 42–47.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps. Topaz p. 454.

SIMPSON, D. R. (1965) Geology of the central part of the Ramona pegmatite district, San Diego County, California. *CA Div. Mines & Geol. Spec. Rept.* 86, p. 3–23, illust., map.

SNYDER, D. (1962) Wonderful world of pegmatite minerals. *Gems & Minerals* 293, p. 24–26, illust.

_____, (1962) Blue topaz from San Diego County. *Ibid.* 297, p. 32.

STERN, L. A., *et al* (1986) Mineralogy and geochemical evolution of the Little Three pegmatite-aplite layered intrusive; Ramona, CA. *Amer. Mineral.* 71, 3–4, p. 406–427, illust.

WEBER, F. H. (1963) Geology and mineral resources of San Diego County, California. *CA Div. Mines & Geol. County Rept.* 3, 309 p., illust., maps.

San Luis Potosi. Although many localities for topaz are listed by various authorities, by far most occurrences produce only small crystals, seldom large enough to bother faceting. In only two areas of rhyolitic rocks in this state, topaz crystals of significant size occur that are capable of being faceted into gems of several carats. However, most crystals are not gem quality and are sold as single-crystal mineral specimens. The two areas are delineated on a sketch map by Heylmun (1983, p. 38). One area is located on the southeast flank of Cerro Silva (2,615 m), 5 air miles (8 km) almost due north of Tepetate, and is reached via road from Tepetate to San Miguelito, thence by trail to the mining site. Tepetate is located on Highway 70, about 25 mi (41 km) southwest of the city of San Luis Potosi. The second area is about 42 air miles (70 km) almost due south of San Luis Potosi and is reached via Highway 57, then turning off to the southwest on Highway 37 to Villa De Reyes, thence west to a south turnoff to La Ventilla. Heylmun points out the need to make local inquiries, or, better, to arrange for a guide to be sure of reaching the sites. A useful account of experiences in mining topaz in the Tepetate area is given by Barbour (1964). The reddish inclusions in many crystals may be goethite instead of rutile as commonly supposed (*Gems & Minerals*, 1972).

In the references below, most of the earlier entries refer to the crystallography of the topaz, particularly those individuals found in alluvial deposits. Kunz (1902), for example, states that none of the crystals were regularly used for gem purposes.

BARBOUR, J. (1964) Mexican topaz and where it comes from. *Gems & Minerals* 316, p. 22–23, 61–63.

BÜCKING, H. (1887) Topas von San Luis Potosi und von Durango in Mexico. *Zs. Krist.* 12, p. 242–434, 451–452.

CHAPMAN, E. J. (1893) On the Mexican type in the crystallization of topaz. *Roy. Soc. Canada Proc. & Trans.* 10, 3, p. 25–28.

DESCLOIZEAUX, A. (1886) Note sur quelques formes nouvelles observées sur des cristaux de topaze de Durango, Mexique. *Soc. Franc. Min. et Crist. Bull* 9, p. 135–138.

GEMS & MINERALS (1972) Rutile inclusions in topaz? No. 413, p. 35, illust.

HEYLMUN, E. B. (1983) Topaz in San Luis Potosi. *Gems & Minerals* 554, p. 38–40, map.

HOOVER, D. B. (1992) *Topaz.* Oxford: Butterworth-Heinemann, 207 p., illust. Mexican topaz p. 180–182.

KUNZ, G. F. (1902) Gems and precious stones of Mexico. *Trans. Amer. Inst. Mining Eng.* 32, p. 55–93. Topaz p. 58–59.

PANCZNER, W. D. (1987) *Mineralogy of Mexico.* NY: Van Nostrand Reinhold, 459 p., illust. (col.), maps. Topaz p. 380–381.

WITTICH, E. & PASTOR Y GIRAUD, A. (1913) Resena acerca de los topacios de Mexico. *Soc. Geol. Mex. Bol.* 8, p. x–xi, 53–59.

WITTICH, E. & KRATZERT, J. (1921) Contribuciones a la mineralogia Mexicana. *Soc. Cient. "Antonio Alzate," Mem. y Rev.* 39, 9–12, p. 651–661.

TOURMALINE GROUP

The latest compilation of data on the members of the tourmaline group has been published by V. T. King, *et al* (1995) who provides a general formula for the group:

$$XY_3Z_6(BO_3)_3Si_6O_{18}(OH,O)_3(OH,F).$$

As can be seen from the above, tourmaline is basically a silicate mineral with borate, hydroxyl, and hydroxyl-fluorine. The variable elements that enter into the compositions of the species and which give them their distinctive characters are shown by the capital letters X, Y, and Z. The letter "X" represents calcium or sodium, "Y" represents iron, aluminum, lithium and magnesium in various combinations, while "Z" represents aluminum, iron, magnesium, and sometimes chromium in various combinations. The colors generally reflect the absence or presence of iron; if there is much iron the colors may be brown, brownish-green, or black. Also, generally, when iron is absent, the colors may be vivid in a variety of hues, and from crystals of this sort may be cut the gems for which tourmaline is so well known.

The table below summarizes a few features of each of the eleven species that now have been accepted as members of the group:

FOITITE—Iron-aluminum tourmaline that lacks alkali elements; recently named after F. F. Foit, Jr., in 1993. Found as dark blue to purplish blue crystals in White Queen Mine, Pala, San Diego County, California, but not stated if gem quality. A similar gem quality tourmaline was mined from the Esmeralda Mine, Mesa Grande, San Diego Co., by John Sinkankas and has been cut into gems of about 3–5 cts.

LIDDICOATITE—Calcium-lithium-aluminum tourmaline, most splendidly represented by the colorful zoned crystals of Madagascar.

UVITE—Calcium-magnesium-aluminum tourmaline, often dark brown, dark brownish-green, etc., and best known from Uva Province, Sri Lanka. Some of the "schorl" from Pierrepont, New York, may be this species.

FERUVITE—Like the above but with calcium-iron-aluminum; black non-gem crystals from Cuvier Island, New Zealand.

BUERGERITE—Sodium-iron-aluminum tourmaline; brownish, non-gem crystals from San Luis Potosi, Mexico.

POVONDRAITE—Sodium-iron tourmaline, recently named after P. Povondra of Prague; non-gem crystals from Department of Cochabamba, Bolivia.

OLENITE—Sodium-aluminum-lithium tourmaline, pale rose red color, possibly confused with elbaite; originally from Olenek River area, northern Siberia, also from Black Mt. Quarry, Rumford, Oxford Co., Maine, and from Island of Elba, Italy.

ELBAITE—Sodium-lithium-aluminum tourmaline; the colorful species that provides by far the most gem material.

DRAVITE—Sodium-magnesium-aluminum tourmaline, generally brown to black and much resembling uvite; mostly found in marbles and schists.

SCHORL—Sodium-iron-aluminum tourmaline, the most abundant species of all and common as black crystals in granitic pegmatites.

CHROMDRAVITE—Sodium-magnesium-chromium/iron tourmaline, non-gem, dark green to black; from Karelia, Russia.

Because of the complexity of the chemical composition, Dietrich (1985) recommends that any tourmaline should be called simply "tourmaline" until its composition has been determined satisfactorily. He recommends avoiding the use of color-based name such as "rubellite," "verdelite" "indicolite," and "achroite," noting that "rubellite," for an example, "connotes pink elbaite for most people, for others it includes other pink or red species, including pink or red liddicoatite and red dravite." However, as to the species most likely to be met, "experience indicates that schorl, elbaite, dravite and uvite are much more likely to be encountered than the other species." Of North American tourmalines, by far most are elbaites, but others, less common, are now known to be uvites rather than dravites as will be noted in appropriate places below. The establishment of uvite as a distinct tourmaline species is a recent event and according to Dunn (1977), this species is "not distinguishable from dravite by standard gemmological techniques."

Insofar as North American production is concerned, gem tourmaline continues to be found and marketed in small amounts from sporadic finds in Maine, but by far the major and most consistent production of all grades of elbaite is from the Himalaya Mine, Mesa Grande, San Diego County, California. Under the direction of Mr. William Larson of Pala International, Inc., of Fallbrook, California, underground tunneling and stoping pursue a single richly mineralized sheet-like body of pegmatite which contains tourmaline-filled pockets. On the average, most of the crystals are pink, many are pink with green zones, and some are mostly green. Much of the tourmaline occurs in broken and sometimes rehealed sections, a lesser amount in doubly-terminated crystals, and relatively rarely matrix specimens with terminated tourmaline crystals perched on quartz-microcline-lepidolite matrixes are extracted. These are highly prized and very valuable cabinet pieces. Much of the broken or otherwise unsuitable tourmaline is saved for small carvings and cabochon work, and only a very small percent, perhaps less than 3%, can be classed as fine faceting material. The most remarkable faceting material is the bicolor crystal consisting of a green portion more or less sharply separated from the adjacent, slightly brownish, red portion. The resulting faceted gems are easily the best of their kind, worldwide.

Some of the larger pieces of the celebrated gem tourmaline find at the Dunton Mine, Newry Mountain, Oxford County, Maine, have been carved into splendid sculptures. The enormous quantity of gemmy tourmaline found here some years ago is being gradually released to the market but large stocks remain and should last for some years to come. In 1993, a very large mail-order firm in the United States offered faceted pink tourmaline at prices ranging from $50 per carat to as much as $500 per carat, depending on color, freedom from flaws, and size. Rubellites could go as high as $1,500 per carat. Small, fully carved figurines or other representations in pink tourmaline, generally not over about 2 inches (5 cm) in maximum dimension, fetched as much as $1,300 per piece, depending on complexity, artistic achievement, etc. On the other hand, small leaf, flower, and geometric carvings of about 10–25 carats sold for about $5 per carat. While the raw material for these stones came from worldwide sources, it is thought that much of the pink rough came from the Himalaya Mine.

BENESCH, F. & WÖHRMANN, B. (1985) Toramalli, a short history of the tourmaline group. *Min. Rec.* 16, 5, p. 331–338, illust.

BENESCH, F. (1990) *Der Turmaline: Eine Monographie.* Zeit, Holland: Uitg. Christofoor, 380 p., illust. (col.). Splendid, lavish work.

DIETRICH, R. V. (1985) *The Tourmaline Group.* NY: Van Nostrand Reinhold, 300 p., illust. (col.).

______, (1985) The tourmaline group: A resume. *Min. Rec.* 16, 5, p. 339–351, illust.

______, (1987) The tourmaline group. *Lapidary J.* 40, 11, p. 22.

DUNN, P. J., *et al* (1977) Uvite, a new (old) common member of the tourmaline group and its implication for collectors. *Min. Rec.* 8, 2, p. 100–108.

DUNN, P. J. (1977) Uvite, a newly classified gem tourmaline. *J. Gemm.* 15, 6, p. 300–307, illust.

GRATACAP, L. P. (1917) Gem mining in the United States: Tourmaline and turquoise. *Amer. Mus. Nat. Hist. NY, J.* 17, 1, p. 64–69.

HAMLIN, A. C. (1873) *The Tourmaline.* Boston, MA: J. R. Osgood, 107 p., illust.

HAÜY, R. J. (1817) Observations sur les tourmalines, particulierement sur celles qui se trouvent dans les États Unis. Paris: *Mem. Mus. Hist. Nat.* 2, p. 1–9.

KING, V. T., FOORD, E. E. & GAINES, R. V. (1995) Die Turmalin-Gruppe. In *Turmalin, extra-Lapis* No. 6, Munich, p. t-13, illus. (col.).

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.). Tourmaline p. 70–77.

LEIDY, J. (1882) On tourmalines. *Acad. Nat. Sci. Phila. Proc.* p. 71–73.

POUGH, F. H. (1967) Tourmaline. *Lapidary J.* 21, 2, p. 282–291, *passim*, illust.

______, (1987) Tourmalines! *Ibid.* 40, 11, p. 21–32, *passim*, illust.

SINKANKAS, J. (1971) Tourmaline. *Rock & Gem* 1, 2, p. 38–45, illust.

SPOTSWOOD, A. (1911) Occurrence and uses of American tourmalines. *Mining World* 35, p. 280.

NORTHWEST TERRITORIES. An area of complex granitic pegmatites that lie generally north of Yellowknife attracted prospectors to several that were beryl-rich and to others because of the promise of gem tourmaline. According to Bell (1992), the Lily and Riber pegmatites, "located about 8 km [5 mi] north of the most northerly bay on Prelude Lake, 27 km [17 mi] northeast of Yellowknife," at lat. 62°38' N, long. 113°57'30"W, are accessible only by aircraft; they were the object of gemological study in 1978–1979, and then showed "very good potential" as a source of gem tourmaline. Some green beryl and red tourmaline were found. At another site, some blue-green tourmaline, possibly of gem quality, has been found in pegmatite on the south shore of Sproul Lake, about 55 km [35 mi] northwest of Yellowknife at lat. 62°44', long. 113°29' W. This place is also inaccessible save by aircraft.

BELL, R. (1992) Compilation of lapidary sites of the Northwest Territories. *NWT Geol. Div.—NAP, EGS* 1992-14, 157 p.

ONTARIO. Dark green and crimson tourmalines have been found at Wilberforce, Monmouth Township, Haliburton County (Traill, 1983, p. 382). This deposit produced the rough for a mixed cut faceted gem of 0.80 ct of "very dark reddish brown" color, Museum No. 21024 (Wight, 1986). In Renfrew County, the Jamieson Quarry, located 3.2 km [2 mi] south of Renfrew, contains transparent brown tourmalines in marble; the crystals are of good size but "they are generally too fractured to be used for lapidary purposes" (Sabina, 1971, p. 13). Traill (*Ibid.*, p. 383) mentions "much coarse pink tourmaline, appreciable quantities of spodumene and lepidolite and some fluorite" in pegmatites that outcrop just north of Lily Pad Lakes in the Fort Hope area but nothing is said about the gem potential. Fort Hope is located north of the north end of Lake Nipigon at lat. 50°50'N, long. 88°03'W. Wight (*Ibid.*, p. 53) also includes a golden brown faceted tourmaline, Museum No. 21025, of 1.22 cts from the Burn's Farm, Enterprise, Sheffield Township.

SABINA, A. P. (1971) Rocks and minerals for the collector: Ottawa to North Bay, Ontario; Hull to Waltham, Quebec. *Geol. Survey Canada Paper* 70-50, 130 p., illust., maps.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., map.

WIGHT, W. (1986) Canadian gems in the national museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55. Tourmaline p. 53.

QUEBEC. Hogarth, *et al* (1983, p. 29) notes that "green and pink tourmaline are fairly abundant, though seldom of gem quality" in the Leduc Quarry, located on the east half of Lot 25, Range VII, Pierre de Wakefield Township, Gatineau County. Traill (1983, p. 383) remarks that this is the "only mine ever worked in Canada with the idea of producing gem tourmaline." Apparently the tourmaline was abundant in crystals as much as 5 cm (2 in) in diameter but because they were "frozen" in the enclosing pegmatite, they were far too fractured to yield more than small gemmy fragments as indicated by two faceted gems of only 3.85 cts, blue-green, semi-transparent, and 1.27 cts, medium dark green, recorded by Wight *(see above)*.

HOGARTH, D. D., *et al* (1983) Classic mineral collecting localities in Ontario and Quebec. *Geol. Survey Canada Misc. Paper* 37, 79 p., maps.

MAINE. As noted in the following, prospecting and mining of gem tourmaline continues in the pegmatites of the state, sometimes yielding rich rewards. The stockpile of gem tourmaline from the famous find in the Dunton Quarry on Plumbago Mountain, Oxford County, remains large and is being carefully released to the market to sustain values. Mount Mica is being worked again, but because of the thickness of the gneissic rock that overlies the pegmatite sheet, and the expense of its stripping to gain access to the pegmatite, not much actual pegmatite mining has taken place.

In regard to the literature dealing with Maine tourmaline, the reader should consult these comprehensive works: Stevens (1972), Thompson, *et al* (1991), and King & Foord (1994), the last being now the most complete summary of Maine elbaite tourmaline, which species provided the gem and mineral specimens for which this state's pegmatite mines are justly famed. Furthermore, this treatise provides much historical detail as well as describes the types of crystals that have been found in the gem-bearing pegmatites, especially in Oxford County. The paper by Bradshaw (in press) is not available at this writing but is expected to appear soon, perhaps in 1995.

The Maine State Museum in Augusta became a worthy stop for the mineral enthusiast when it began exhibiting Maine gemstones and jewels incorporating Maine tourmaline gems, notably the famous Admiral Peary necklace, described below, and one of the largest gemmy crystals found in the Dunton Quarry, Newry, Oxford County.

ACORD, J. P. (1977) Tourmaline. *Lapidary J.* 31, 1, p. 216–229, *passim*, illust.; 2, p. 512–524, *passim*, illust.

AUSTIN, G. T. (1990) The Maine attraction: Tourmaline. *Colored Stone* 3, 6, p. 21–22.

BANCROFT, P. (1984) *Gem & Crystal Treasures.* Fallbrook, CA: Western Enterprises, 488 p., illust. (col.).

BASTIN, E. S. (1911) Geology of the pegmatites and associated rocks of Maine. *U.S. Geol. Survey Bull.* 445, 152 p., illust., map.

BLAKEMORE, J. (1952) *Treasure Hunting in Maine.* Boothbay Harbor, ME: The Smiling Cow Shop, 118 p.

_____, (1976) *We Walk on Jewels: Treasure Hunting in Maine for Gems and Minerals.* Rockland, ME: Courier of Maine Books, 175 p., illust., maps.

BRADSHAW, J. J. (1992) Gemstones of Maine. In *Mineralogy of Maine*, in press; Maine Geol. Survey, p. 1–21.

EARTH SCIENCE (1987) Maine's tourmaline gems. Winter, p. 14–16, illust.

FEDERATION OF MAINE MINERAL AND GEM CLUBS (1983) *Guidebook I.* To Mineral collecting in the Maine pegmatite belt. Priv. publ., 22 p.

FRANGIS, C. A. (1985) Maine tourmaline. *Min. Rec.* 16, 5, p. 365–388, illust.

HAMLIN, A. C. (1873) *The Tourmaline.* Boston, MA: J. R. Osgood & Co., 107 p., illust.

KING, V. T. (1993) World news of mineral occurrences. *Rocks & Minerals* 68, 1, p. 49–53, illust. Maine tourmalines included.

KING, V. T. & FOORD, E. E. (1994) *The Mineralogy of Maine.* Volume I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p., illust. (col.).

KUNZ, G. F. (1883) Colored tourmalines and lepidolite

crystals from a new American locality. *Amer. Assoc. Advancement Sci. Proc.* 32, p. 274–275.
______, (1886) The tourmaline locality at Rumford, Oxford County, Maine. *Ibid.* 34, p. 242–243.
______, (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.), p. 70–77.
______, (1885–1905) Precious stones. Chapters in *U.S. Geol. Survey Mineral Resources of the U.S.:* CY 1883 & 1884, 1885, p. 723, 724, 743–745; CY 1886, 1887, p. 595; CY 1891, 1893, p. 546–7; CY 1892, 1893, p. 765; CY 1893, 1894, p. 695–6; CY 1895–96, 1896, in 17th Ann. Rept., p. 910; CY 1898–99, 1899, 20th Ann. Rept., p. 577–579; CY 1904, 1905, p. 65–68.
LANDES, K. K. (1925) The paragenesis of the granite pegmatites of central Maine. *Amer. Mineral.* 10, 11, p. 355–411, illust.
LAPIDARY JOURNAL (1960) An authoritative and official guide describing gemstone and mineral localities in Maine. Vol. 14, 3, p. 264–266, 268–278, maps.
MORRILL, P. (1956?) *Maine Mines and Mineral Locations.* 2nd print., new maps. Naples, ME: Dillingham Nat. Hist. Mus., 47 p.
______, (1958) *Maine Mines and Minerals.* Vol. I. Western Maine. Winthrop, ME: Winthrop Mineral Shop, 80 p., maps.
______, (1963) *Mineral Guide to New England.* Intervale, NH: House of Color, 40 p., maps.
MOULTON, W. B. (1930) Some personal observations on colored tourmalines as found in the state of Maine. *Rocks & Minerals* 5, 1, p. 50–51.
PERHAM, J. (1980) New adventures in Maine tourmaline. *Lapidary J.* 33, 10, p. 2114–2118, 2142–2152, *passim*, illust. (col.).
SHAUB, B. M. (1955) Recent discovery of fine gem tourmalines in Maine. *Gems & Gemology* 8, 5, p. 131–136, illust.
SHEPARD, C. U. (1830) Mineralogical journey in the northern parts of New England. *Amer. J. Science* 18, p. 289–303.
STERRETT, D. B. (1909) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1908*, p. 842–844.
______, (1914) *Ibid.* for 1913, p. 688–692.
STEVENS, J. P. (1972) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* West Paris, ME: Perham's Maine Mineral Store, 216 p., illust.
______, (1974) Maine tourmaline. *Rock & Gem* 4, 8, p. 56–63.
THOMPSON, W. B., *et al* (1991) A collector's guide to Maine mineral localities. *Maine Geol. Survey Bull.* 41, 2nd edit., 104 p., illust. (col.), map.

In Oxford County, the Dunton Mine on Plumbago Mountain, Newry, remains dormant. Much of the large crystal stock provides material uniquely suited for carvings, for which there is a lively demand. Most of the tourmaline is sent to Idar-Oberstein in Germany where it is exquisitely carved into colorful bird and animal figurines as depicted by Stevens (1979). Other types of gem material were also employed in some carvings with the various separately carved sections carefully fitted to each other in the manner employed in the celebrated "mosaic" carvings of Fabergé in Russia. In an appendix to her general article on Maine gemstones, Stevens (1980, p. 2148–2152) describes a matching set of five cameos engraved by the firm of Friedrich August Becker of Idar-Oberstein from Dunton green tourmaline. These elliptical gems, called the Gerhard Becker Cameos, were cut from cross-sections taken from a single large crystal which weighed about 2.2 lb (1 kg). The crystal was remarkable for its uniformity of color "which extended throughout the entire crystal," and hence made it eminently suitable for this project. The figures carved on the cameos were taken from Greek mythology, each being exquisitely carved in low relief. The final dimensions of each are 80 x 60 mm (3.25 x 2.5 in) and each weighs about 375 carats. They are individually inset into a rock crystal rectangular plaque.

Dunton tourmaline is also featured in the official Maine Tourmaline Necklace, manufactured for the Maine Retail Jewelers Association for presentation to the people of Maine and preserved in the State Museum in Augusta. The major gem, a central faceted pendant of red tourmaline, weighs 24.58 cts and was donated by the Plumbago Mining Corporation who owns the Dunton Mine and produced its tourmaline. Twenty smaller faceted gems of various colored tourmalines form double rows leading upward from the central stone and the latter is surmounted by three other faceted gems. Maine alluvial gold was used in the mountings.

Another necklace featuring Dunton tourmaline gems is called the "Maine Phoenix" and was redesigned and remanufactured from a previous necklace that was deemed unsatisfactory by its owner (Frazier & Frazier, 1990). It is a large bird-like pendant formed of a basic gold frame overlaid by colored tourmaline polished sections, some of watermelon type, and surmounted by a carved rubellite bird's head. It is suspended from a chain whose links are studded with cabochons of green and red tourmaline.

According to Bradshaw (1992, p. 6), "the largest faceted tourmaline from the Dunton find was a clean red stone of 78 carats, cut by a Toronto lapidary . . . and sold by the Plumbago Mining Corporation to a private collector for about $100 per carat." Among green gems, the finest of record is a flawless, 45 ct stone. Many bicolor gems were also cut from Dunton material, the best being a 40 ct stone "showing a distinct pink and green color combination . . . nearly flawless . . . a quality rarely seen in bi-color tourmalines." Dunton gems are in various museums, among them a 21.95 cts pink, pear shape, in the American Museum of Natural History, New York, and two octagonal stepcuts of 27.43 cts (pink) and 29.67 cts (green) in the Maine State Museum, Augusta, as well as an emerald-cut tricolor of 20.01 cts. The Smithsonian collection includes a 35.19 cts rectangular faceted gem and another of 30.49 cts cut as a rectangular cushion shape. The Harvard University Museum owns the second largest Dunton faceted tourmaline, a 60.05 cts flawless round brilliant which was "heat-treated to a dark violet-pink." In this regard, heat treatment experiments on Dunton material were directed toward removal of brownish tones in red stones, and Dietrich (1985, p. 194) cites a personal communication from Dean McCrillis of the Plumbago Mining Corporation (1983) noting that "brownish burgundy colored stones are heated slowly to 500°C, held there for 10 minutes, and slowly cooled to produce rose-colored stones; or, they may be heated to 505°C, held there for 15 minutes, and slowly cooled to produce pink stones."

The properties of Dunton tourmalines were investigated by Beesley (1975) who matched natural colors against refractive indexes and found very little variation among specimens which ranged in color from pale pink through various reddish tints to greens and dark blue. The indexes ranged from epsilon 1.619 to 1.621, and omega 1.634 to 1.641; SG 3.04–3.09. Dunn (1975, a, b) also investigated these properties and especially remarked upon the color zoning in the crystals and furnished diagrams of same. Most crystals are red, overgrown by a thin, crackled skin of green, but "this fracturing does not continue into the rubellite core, however, and only serves to give the beautiful red gem material a crackled green coat!" Based on examination of several hundred faceted gems, Dunn (1975a) listed dichroic colors for the red to pink stones, which, as expected, exhibited light and dark variations of the basic red hue, but a light pink stone gave colorless for epsilon and light pink for omega. Greens ranged from yellowish to bluish greens, to light green and blue green dichroic colors in stones that were apparently greenish blue. For refractive indexes, Dunn found epsilon from 1.612 to 1.626, and omega from 1.629 to 1.644, but the most common values were epsilon 1.620–1.621, and omega 1.636–1.638. Discarding a single set of suspect readings, Dunton tourmalines will generally measure epsilon 1.620, omega 1.638, difference, 0.018, and SG 3.04 to 3.09, with the higher values appearing in the darkest stones.

In another area of Newry Township, some gem blue ("indicolite") tourmaline was produced from the Martin Prospect pegmatite quarry in 1993, "including a flawless crystal with an etched termination of 1,150+ carats and a 10-cm, 155-carat well-terminated crystal" (Robinson & King, 1993; King, 1994).

BEESLEY, C. R. (1975) Dunton Mine tourmaline: An analysis. *Gems & Gemology* 15, 1, p. 19–24, illust., map.

DUNN, P. J. (1975a) On gem elbaite from Newry, Maine, U.S.A. *J. Gemm.* 14, 8, p. 357–368, illust.

______, (1975b) Elbaite from Newry, Maine. *Min. Rec.* 6, 1, p. 22–25, illust.

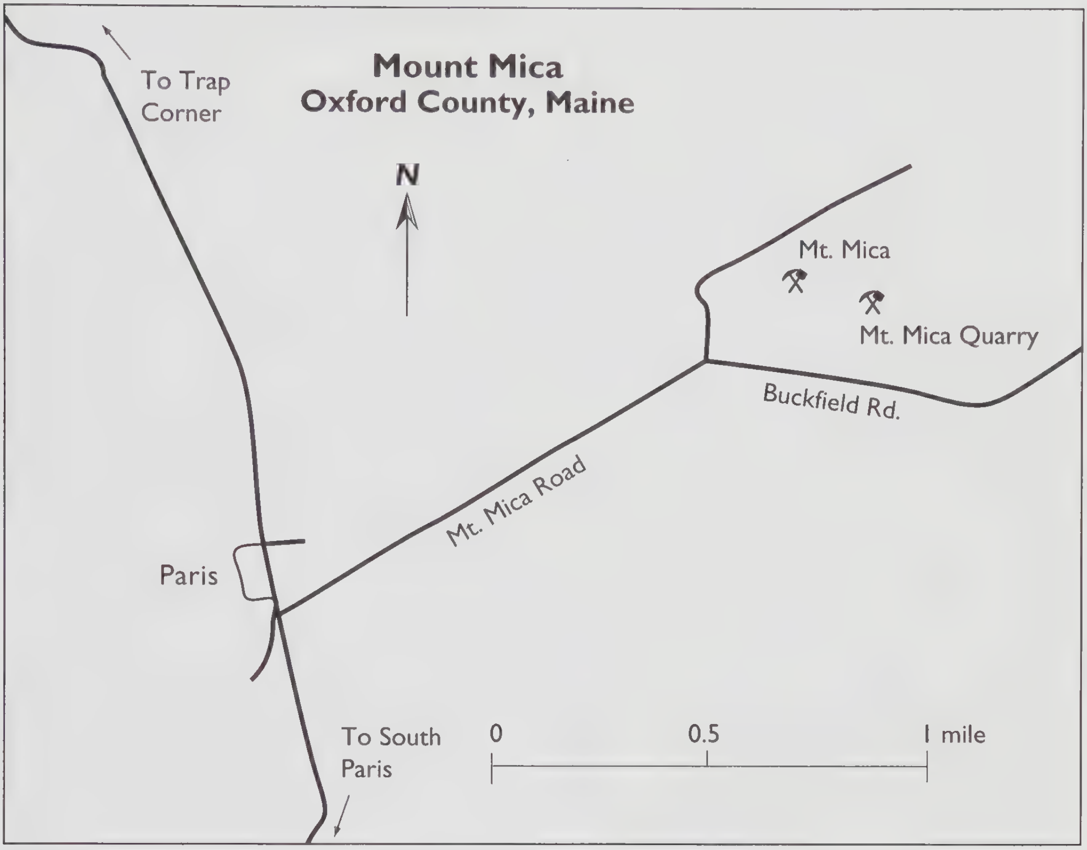


FIGURE 92. Sketch map of the Mount Mica locality in Paris, Oxford County, Maine.

FERRISS, L. (1981) Maine soil yields dazzling crystals. *Maine Sunday Telegram*, p. 21A–22A. Dunton find.

FRASER, H. J. (1930) Paragenesis of the Newry pegmatite, Maine. *Amer. Mineral.* 15, 8, p. 349–364.

FRAZIER, S. & FRAZIER, A. (1990) Phoenix: The Maine Phoenix, an American Jewel . . . *Lapidary J.* 44, 9, p. 38–57, *passim*, illust. (col.).

KING, V. T. (1994) Mineralogy of the Martin Prospect, Crooker pegmatite, Newry, Maine. *Rocks & Minerals* 69, 2, p. 135–136.

MacFALL, R. P. (1975) The story beyond the story of the great tourmaline discovery. *Lapidary J.* 29, 5, p. 994–1001. Dunton find.

McCRILLIS, D. A. (1975) Gem tourmaline rediscovered at Newry. *Min. Rec.* 6, 1, p. 14–21, illust.

PERHAM, J. (1980) New adventures in Maine tourmaline. *Lapidary J.* 33, 10, p. 2114–2118, 2142–2152, *passim*, illust. (col.).

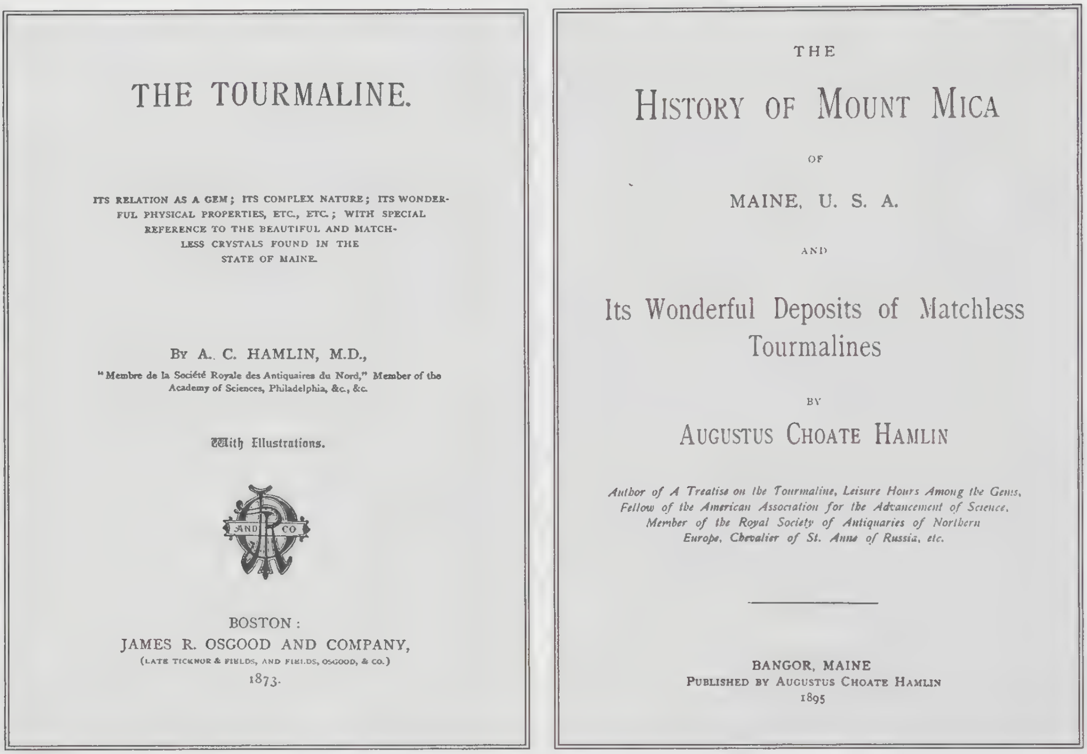
ROBINSON, G. W. & KING, V. T. (1993) What's new in minerals? *Min. Rec.* 24, 5, p. 382.

SHAININ, V. E. & DELLWIG, L. F. (1955) Pegmatites and associated rocks in the Newry Hill area, Oxford County, Maine. *ME Geol. Survey Bull.* 5, 58 p., maps. Dunton Mine.

SHAUB, B. M. (1974) Dunton Gem Mine and its remarkable tourmalines. *Min. Digest* 6, p. 20–28, illust. (col.).

STEVENS, J. P. (1973) The treasure of tourmalines at Newry. *Rocks & Minerals* 48, 4, p. 219–224.

______, (1979) The Gerhard Becker miniatures in Maine tourmaline. *Lapidary J.* 32, 10, p. 2122–2160, *passim*, illust. (col.).


THE TOURMALINE.

ITS RELATION AS A GEM; ITS COMPLEX NATURE; ITS WONDERFUL PHYSICAL PROPERTIES, ETC., ETC.; WITH SPECIAL REFERENCE TO THE BEAUTIFUL AND MATCHLESS CRYSTALS FOUND IN THE STATE OF MAINE.

BY A. C. HAMLIN, M.D.,

"Membre de la Société Royale des Antiquaires du Nord," Member of the Academy of Sciences, Philadelphia, &c., &c.

With Illustrations.

BOSTON:
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(LATE TICKNOR & FIELDS, AND FIELDS, OSGOOD, & CO.)
1873.

THE
HISTORY OF MOUNT MICA
OF
MAINE, U. S. A.
AND
Its Wonderful Deposits of Matchless Tourmalines
BY
AUGUSTUS CHOATE HAMLIN

Author of A Treatise on the Tourmaline, Leisure Hours Among the Gems, Fellow of the American Association for the Advancement of Science, Member of the Royal Society of Antiquaries of Northern Europe, Chevalier of St. Anne of Russia, etc.

BANGOR, MAINE
PUBLISHED BY AUGUSTUS CHOATE HAMLIN
1895

FIGURE 93. Title page of Augustus C. Hamlin's treatises on Mount Mica and its tourmalines, and his general study of tourmaline which deals mostly with Mt. Mica specimens.

WHITE, J. S. (1973) What's new in minerals? *Min. Rec.* 4, 2, p. 54, 55, 77, 78. Dunton tourmaline.

In the town of Greenwood, Oxford County, King (1993) reported the discovery of fine green tourmaline crystals in the Gross Prospect pegmatite on Noyes Mountain in 1992 but the crystals were so flawed that clean faceted gems of only several carats could be cut from them.

KING, V. T. (1993) World news of mineral occurrences. *Rocks & Minerals* 68, 1, p. 49, illust.

The Bennett Quarry in Buckfield, Oxford County, is presently best known for its morganite beryl crystals as previously described (*see* BERYL). According to Holden (1990), who provides a lively account of the reopening and exploration of the long dormant quarry in 1989, gem tourmaline commonly occurred in the pockets but seldom in large crystals. He and his associates found green crystals of excellent color but rarely in crystals or fragments capable of cutting flawless gems larger than several carats. Watermelon, "cucumber," and bicolor crystals were also found, among them pink-bicolor prisms up to about 1.6 in (3.8 cm) long and 0.3 in (1 cm) thick. In some pockets, hundreds of small green crystals were found, "some as long as 2.7 inches [6.5 cm] and up to 0.6 inch [1.3 cm] thick." Other tourmalines were found of blue color, some colorless, and rarely, some that were purple. King (1993) reported that "Ron and Dennis Holden continued mining at the Bennett Quarry . . . that resulted in several pockets of green tourmaline crystals."

HOLDEN, R. E. (1990) Mining at the Bennett Quarry,

Buckfield, Maine. *Rocks & Minerals* 65, 6, p. 498–504, illust. (col.), maps.

KING, V. T. (1993) World news of mineral occurrences. *Rocks & Minerals* 68, 1, p. 49–53, p. 50.

An excellent, thorough discussion of Maine elbaite tourmalines, including varieties of same, appears in King & Foord (1995, p. 114–135), with an extended treatment of the Mount Mica deposit (p. 127–132) embracing considerable quotation from past visitors to the mine.

The famous pegmatite quarry at Mount Mica, Paris, Oxford County, was reopened in the 1990s with some success by a group of investors, including the Plumbago Mining Corporation and a small number of private parties. The modern history of this deposit and its mining is summarized by Bradshaw (1992, p. 3–5) and begins with the purchase of the property in 1926 from the General Electric Company by Howard Irish of Buckfield. The General Electric Company had purchased the property from the Hamlin heirs in the same year but accomplished no work. The next owner/operator was Frank C. Perham, who leased the mine from Howard Irish's widow and by 1965 had opened several new pockets (Stevens 1972; Perham, 1980, 1987). The property was purchased in 1973 by the Mount Mica Land Company, a subsidiary of Plumbago Mining Corporation, and was worked on behalf of the company by Rene Dagenais who found a splendid tourmaline crystal in 1978 which weighed 433 carats, and from which Mr. Arthur Grant cut a rectangular emerald-cut faceted gem of 256 carats of fine bluish-green color. According to Bradshaw *(Ibid.)*, "it remains in the United States today in a private collection as Maine's largest and finest faceted tourmaline." Francis (1985) gives an excellent history of Mount Mica in the "Hamlin period," roughly from 1868 to 1889, and the fol-

FIGURE 94. New work in the Mount Mica Quarry begun in 1990 by the Plumbago Mining Corporation. *Courtesy Woodrow Thompson, Maine Geological Survey.*

lowing "Merrill period," from 1890 to 1915, after which the mine was mostly dormant up to the 1926 date noted above. Francis is of the opinion "that of all of Maine's pegmatites, [Mount Mica] has the greatest potential for additional production of crystals and gemstock but now lies idle because of the economic uncertainties of mining [p. 372]." Nevertheless, in 1990, the investor group noted above set miners to work to strip off the gneiss rock that overlies the sheetlike pegmatite body in order to mine the latter for pockets. Bradshaw (*Ibid.*, p. 5) states that the "1991 season was fairly productive with a substantial production of blue as well as green tourmaline." In view of the considerable thickness of the overlying rock, it would seem more economical to exploit the pegmatite by inclines and lateral tunnels, for which no internal supports need be erected. A gridwork of inclines and laterals should insure that no significant pocket is overlooked.

Wise (1992) described recent mining at Mount Mica with the observation that "this past year [1991] only three large nodules [of tourmaline] weighing 60, 35, and 25 carats were found. The largest cut to an 18 carat flawless gem, the second to a 9.48 carat flawless mint green, and the third is yet to be cut." In comparing color qualities of Mount Mica tourmalines to those from other places, notably from Afghanistan and Nigeria, the fine Maine stones are set at 30 percent higher in price than Afghan material and almost 70 percent higher than identical quality material from Nigeria, with at least some of the price differential being due to the local esteem in which the Maine gems are held. Wise notes that "clean, well-made, better to fine Maine goods (medium toned green) is $125–$150 per carat; pink $200 – $300 per carat, and mint to blue-green (indicolite) of the finest grade for as much as $300 per carat." According to Wise, the current mining campaign is scheduled for a term of five years and should finish at the end of the summer/fall season of 1995.

The Hamlin Necklace, a famous assemblage of faceted, variously colored Mount Mica tourmalines, is described by a number of authorities, including Dietrich (1985, p. 199) who gives the text of a Lewiston, Maine, newspaper article that describes the necklace in glowing terms. A more detailed account, including a drawing of the necklace and identification of each stone, appears in *Earth Science* (1987). Bradshaw (1992, p. 3–4) states that the necklace was made for Augustus C. Hamlin, owner of Mount Mica, prior to 1890 and was exhibited in the Tiffany Pavilion at the 1893 World's Fair. The necklace itself, a rather plain affair obviously meant to display the gems primarily, consists of a series of cylindrical gold links from which hang a series of mostly round or oval faceted tourmalines, many surrounded by smaller stones. There are eighteen large gems, all from Mount Mica with the exception of "the large pink tourmaline to the left of center . . . the only stone used in the necklace which is not from Mount Mica . . . it was cut from material mined . . . from Mount Rubellite in Hebron" (Bradshaw, p. 3). The largest gem, the central pendant, is a 34.25 ct oval step cut of rich blue-green color mined in 1886. Other colors represented in the necklace are colorless, pale green, yellowish-green, pink, red, yellow, and brown. The necklace is on view at the Harvard University Mineralogical Museum, Cambridge, Massachusetts. A good color photograph of it appears in Perham (1987, p. 423).

BASTIN, E. S. (1911) Geology of the pegmatites and associated rocks of Maine. *U.S. Geol. Survey Bull.* 445. Mt. Mica p. 81–93, illust.

BRADSHAW, J. J. (1992) Gemstones of Maine. In *Mineralogy of Maine*, ME Geol. Survey, *in press*, p. 3–4.

COURTER, E. W. (1970) Mt. Mica' s fabulous treasure trove. *Lapidary J.* 24, 5, p. 754–759.

DIETRICH, R. V. (1985) *The Tourmaline Group*. NY: Van Nostrand Reinhold, 300 p., illust. (col.).

EARTH SCIENCE (1987) Maine's tourmaline gems. Winter, p. 14–16, illust.

GRAVES, S. B. (1967) A tourmaline bonanza at old Mt. Mica, Maine location. *Lapidary J.* 21, l, p. 10–17, *passim*.

HAMLIN, A. C. (1873) *The Tourmaline*. Boston, MA: J. R. Osgood, 107 p., illust. (col.).

______, (1895) *The History of Mount Mica*. Bangor, ME: A. C. Hamlin, 72 p., 43 color plates.

_____, (1899) Output of the Mt. Mica mine during 1898. *Mineral Collector* 6, 1, p. 13.

KING, V. T. & FOORD, E. E. (1995) *The Mineralogy of Maine.* Vol. I: Descriptive mineralogy. Augusta, ME: Geol. Survey ME, 418 p.

KUNZ, G. F. (1881) On colored tourmaline, Mt. Mica, Paris, Maine. *New York Acad Sci. Trans.*, October 3.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. (col.), p. 71–75.

_____, (1899) Precious stones. Ch. in *U.S. Geol. Survey 20th Ann. Rept. for 1898–99.* Mt. Mica p. 577.

MINERAL COLLECTOR (1897) Explorations at Mt. Mica during the summer of 1896. Vol. 4, 1, p. 6–7.

PERHAM, J. (1980) New adventures in Maine tourmaline. *Lapidary J.* 33, 10, p. 2114–2118, 2142–2152, *passim*, illust.

PERHAM, J. C. (1987) Some notable Maine gemstones. *Rocks & Minerals* 62, 6, p. 420–427.

POUGH, F. H. (1967) Tourmaline. Part Two. *Lapidary J.* 21, 3, p. 420–427, illust.

RAYMOND, J. (1987) Down in the dumps. *Lapidary J.* 40, 11, p. 65–70, illust.

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1913.* Mt. Mica p. 688–689.

STEVENS, J. P. (1972) *Maine's Treasure Chest: Gems and Minerals of Oxford County.* West Paris, ME: Perham's Maine Mineral Store. Mt. Mica p. 108–126.

WISE, R. W. (1992) Oldest mine in U.S. reopens. *Colored Stone* 5, 4, p. 1, 8, 9, illust.

The BB #7 Quarry, Norway, Oxford County, produced a rich gem pocket that was called the "Friday the Thirteenth Pocket," having been opened on that day in August, 1954 (Perham, 1987, p. 81). It yielded between 8,000 and 10,000 carats of gem tourmaline crystals (some pink, but not gem quality), many terminated, and ranging in size from "small crystals to one finger-size crystal nearly three inches [7.3 cm] long." Many were about 3/8 in (7–8 mm) in diameter and up to 2 in (5 cm) long. The largest gem crystal was found in two sections which together weighed 137.47 cts and yielded two rectangular step-cut faceted gems of 23.67 and 10.91 cts.

PERHAM, J. C. (1987) *See above.*

In the Auburn area of Androscoggin County, there are many pegmatite quarries and prospects on Mount Apatite, the most important being the Pulsifer, noted for its purple apatite crystals, some of which have been faceted into gems. Other important quarries are the Keith, Wade, Greenlaw, and Maine Feldspar. From these quarries came the tourmaline crystals which were used to create two notable necklaces: the Coombs Necklace which utilized slices of watermelon crystals set in sterling silver, and the famous Peary necklace, commissioned by Admiral Robert E. Peary, U.S.N. (1856–1920), the Arctic explorer, which utilized a series of faceted gems. Admiral Peary wanted a jewel made entirely of Maine gemstones and native gold, and for this purpose obtained nine faceted Keith Quarry green tourmalines, weighing from a little over one carat to eight carats. One half ounce of native gold was panned from Maine's Swift River for the setting (Bradshaw, 1992, p. 7). A photograph of this necklace appears in Kley (1987, p. 418). The necklace was presented to the Maine State Museum in Augusta in 1964 by Admiral Peary's daughter, Mrs. William Kuhne of Brunswick.

BERMAN, H. & GONYER, F. A. (1930) Pegmatite minerals of Poland, ME. *Amer. Mineral.* 15, p. 375–387.

BRADSHAW, J. J. (1992) Gemstones of Maine. In *Mineralogy of Maine*, Maine Geological Survey, *in press*, p. 1–21.

HIDDEN, W. E. (1884) On tourmaline and other minerals from Auburn, Maine. *Amer. J. Science* 27, p. 154–155.

KLEY, R. (1987) The Maine State Museum. *Rocks & Minerals* 62, 6, p. 417–419, illust.

KUNZ, G. F. (1884) On the tourmaline and associated minerals of Auburn, Maine. *Amer. J. Science* 27, p. 303–305.

SZENICS, T. (1968) Emerald-green tourmaline found at Pulsifer Quarry, Mt. Apatite, Auburn, Maine. *Lapidary J.* 22, 1, p. 96–98, 100–102 illust.

VOYNICK, S. (1991) Turnpike tourmaline. *Rock & Gem* 21, 6, p. 40–44, map. Mt. Apatite.

WILSON, W. E. (1977) The Pulsifer Quarry. *Min. Rec.* 8, 2, p. 72–77, illust.

In recent years, a little work in a small pegmatite about 100 meters east of the Consolidated Feldspar Quarry, about 1.85 mi (3 km) south of the village of Georgetown, Sagadahoc County, yielded a pocket from which came etched sections of gemmy colored tourmaline. This locality is reached via Bay Point Road from Highway 127 and lies roughly 10 mi (15 km) south of Bath (Francis, 1985, p. 378–379).

FRANCIS, C. A. (1985) Maine tourmaline. *Min. Rec.* 16, 5, p. 365–388, illust. (col.).

MASSACHUSETTS. No new developments.

BILLINGS, M. P. (1941) Pegmatites of Massachusetts, *MA Dept. Public Works & U.S. Geol. Survey Cooperative Geol. Project Bull.* 5, 22 p., maps.

GIBBS, G. (1819) On the tourmaline and other minerals found at Chesterfield and Goshen, Massachusetts. *Amer. J. Science* 1, p. 346–351.

HITCHIN, C. S. (1935) The pegmatites of Fitchburg, Mass. *Amer. Mineral.* 20, 1, p. 1–24, illust.

CONNECTICUT. The most significant gem tourmaline deposit in the state is the granitic pegmatite of the Gillette Quarry, located on the east bank of the Connecticut River about 5 mi (8 km) south-southeast of Middle Haddam, Haddam Township, Middlesex County. One of the most complete accounts of its early history is given by Davis (1901) who noted that the quarry was originally opened in the fall of 1895 for the sake of its feldspar by its owner, Mr. M. P. Gillette. The first pockets containing tourmaline were found in December of 1895 and at that time, and in the next several years, yielded mostly green tourmaline crystals, in light to dark shades, but also pink, yellow, white and blue crystals. "The largest crystal found was pale green, of uniform color, and about ten inches long, 1 inch thick at the base, tapering to about three-quarters of an inch. A few crystals have been found nearly two inches in diameter, and from that size down to the diameter of a hair. One crystal was green, eight inches long, doubly terminated, and yellow at one end. Another green, six inches long, doubly terminated, and 1½ inches thick. Another three inches long, 1 inches thick half its length green and the other terminated end a deep pink. One seven inches long, less than 1/8 inch thick (about like a darning needle), of clear light green color. Several good-sized green crystals, with both terminations pink, and also several yellow at one end and blue at the other. One crystal showed five colors, white, pink, yellow, green and blue. Crystals observed of single or combined colors were: white; white and pink; green, yellow, blue-green; green with terminations of pink; green and white (one crystal having both terminations white); pink; pink with termination of white; green with dark blue termination."

Davis goes on to say that "a glance at the crystals would lead one to think that quite large gems might be cut from them," but as it turned out "they have not been able to get any perfect gems over one carat in weight." However, some pieces cut in cabochon provided "perfect" cat's-eyes, "equal to the famous chrysoberyl cat's-eye from Ceylon." In the pockets, the tourmalines were associated with colorless to dark smoky quartz, cleavelandite, microcline, muscovite, lepidolite, cookeite as coatings, beryl (colorless, pale green, pale rose), apatite, and rarely microlite. "One large rose-beryl crystal, weighing about twenty pounds, was presented to the American Museum of Natural History of New York City by Mr. Ernest Schernikow."

For more details on the history, geology, and mineralogy of the Gillette Quarry, one must refer to the article by Mr. J. A. Scovil (1992), who also refers to the large tourmaline crystals mentioned above in Davis' account. Perhaps the most recent and systematic informal miner of the Gillette pegmatite was the late Mr. Gino Vitali of Haledon, New Jersey, an unusually skilled and knowledgeable collector of minerals, especially of Northern New Jersey zeolites, who spent much time visiting pegmatite deposits in Connecticut, including the Gillette Quarry. My examination of his collection in his home many years ago showed that he was remarkably successful, his suite of pocket species from the Gillette Quarry probably being the best in existence outside of museums. In his account of his explorations (1979) he gives details on the Gillette Quarry pegmatite, the finds, and the contents and characters of the minerals found in pockets. Another interesting collecting account is given by Stearns (1980), who especially remarks on finding golden beryl in the Gillette pegmatite.

In regard to cut gems of Gillette tourmaline, Scovil *(Ibid.)* also notes their paucity despite the large number of crystals that were found. For example, the Smithsonian collections include only two step-cut faceted green gems of 6.14 and 5.14 carats.

BOWMAN, H. L. (1902) On the occurrence of minerals at Haddam Neck, Connecticut, U.S.A. *Mineral. Mag.* 13, 60, p. 97–122.

CAMERON, E. N. & SHAININ, V. E. (1947) The beryl resources of Connecticut. *Econ. Geol.* 42, p. 353–367, illust., maps.

CAMERON, E. N., ROWE, R. B. & WEISS, P. L. (1954) Pegmatite investigations 1942–45 New England. *U.S. Geol. Survey Prof. Paper* 255, 352 p. Gillette Quarry p. 318–321.

DAVIS, J. W. (1901) The minerals of Haddam, Conn. Pt. II. *Mineral Collector* 8, 5, p. 65–70, p. 68–70.

FOYE, W. G. (1922) Mineral localities in the vicinity of Middletown, Connecticut. *Amer. Mineral.* 7, p. 4–12, map.

GILLETTE, S. G. (1937) Some minerals of the Gillette Quarry, Haddam Neck, Conn. *Rocks & Minerals* 12, 11, p. 333.

KUNZ, G. F. (1896) Precious stones. Ch. in *17th Ann. Rept. U.S. Geol. Survey for 1895–96*, p. 910.

_____, (1897) Same. *18th Ann. Rept. 1896–97*, p. 1204.

_____, (1898) " *19th* " " *1897–98*, p. 505.

_____, (1899) " *20th* " " *1898–99*, p. 577–79; col. plate of Gillette Quarry 25 cm green tourmaline crystal.

LONDON, D. (1985) Pegmatites of the Middletown district, Connecticut. *77th Ann. Mtg., New England Intercollegiate Geol. Conf. Yale. U.; CT Geol. & Nat. Hist. Survey Guidebook* 6, p. 509–533.

SCHAIRER, J. F. (1931) The minerals of Connecticut. *CT State Geol. & Nat. Hist. Survey Bull.* 51, 121 p.

SCHOONER, R. (1961) *The Mineralogy of Connecticut.* Branford, CT: Fluorescent House, 90 p.

SCOVIL, J. A. (1992) The Gillette Quarry, Haddam Neck, Connecticut. *Min. Rec.* 23, 1, p. 19–28, 80, illust., maps.

SOHON, J. A. (1951) Connecticut minerals, their properties and occurrence. *CT State Geol. & Nat. Hist. Survey Bull.* 77, 133 p.

STEARNS, H. T. (1980) The Connecticut pegmatites in their heyday. *Lapidary J.* 33, 10, p. 2266–2268.

STERRETT, D. B. (1916) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1914*, pt. 2, p. 328–331.

STOBBE, H. (1949) The Gillette Quarry, Haddam Neck, Connecticut. *Rocks & Minerals* 24, 9/10, p. 496–502, maps.

STUGARD, F. (1958) Pegmatites of the Middletown area, Connecticut. *U.S. Geol. Survey Bull.* 1042-Q, p. 613–683, illust., maps.

VITALI, G. (1979) Nostalgia—twenty years of collecting in the Connecticut pegmatites. *Lapidary J.* 33, 7, p. 1598–1610, illust.

NEW YORK. One of the earliest accounts of gem quality tourmaline from New York was by Dr. Leidy (1882) who remarked that "recently, good-sized crystals [of colorless tourmaline] . . . had been found at De Kalb, St. Lawrence Co., New York." From a broken crystal Leidy had cut a faceted brilliant gem, "transparent, flawless, and nearly colorless, or with only the faintest yellowish tint, like that of a so-called 'off-color' diamond." This gem weighed 398 milligrams or 1.99 carats. Leidy also mentions "fine brown tourmalines, often of large size and frequently doubly terminated . . . have been found in abundance in late years, at Gouverneur, St. Lawrence Co., N.Y." Similar material, or gem dravite, is also recorded by Agar (1923) who states that the dravite "can also be found in clear, amber-colored crystals several inches long."

The New York State Museum collection, Albany, New York, contains a series of variously colored faceted tourmalines from the state: brown from Brant Lake, 1.85 ct; brown from Newcomb, a round brilliant, 12.65 cts; and a 1.05 cts brown brilliant from Minerva. Only the Minerva stone is identified as dravite (Schimmrich & Campbell, 1990, p. 38). Dunn, *et al* (1977) established uvite as the calcium analog of dravite (magnesian) tourmaline and hence a new species. Their investigations show that the so-called brown "dravites" of

New York, specifically from Gouverneur and the colorless and light brown crystals from De Kalb, are actually uvites. Even the black glossy crystals much prized by mineral collectors from the well-known source at Pierrepont are now identified as uvite.

AGAR, W. M. (1921) The minerals of St. Lawrence, Jefferson, and Lewis counties, New York. *Amer. Mineral.* 6, p. 148–153, map.

_____, (1923) Contact metamorphism in the Western Adirondacks. *Proc. Amer. Phil. Soc.* 62, 3, p. 95–174, illust.

BLAKE, W. P. (1908) Tourmaline of Crown Point, New York. *Amer. J. Science* 25, p. 123. Gem material.

DUNN, P. J., APPLEMAN, D., NELEN, J. A. & NORBERG, J. (1977) Uvite, a new (old) common member of the tourmaline group and its implication for collectors. *Min. Rec.* 8, 2, p. 100–108, illust.

GOSSE, R. (1962) A fabulous find of gem tourmaline. *Lapidary J.* 16, 7, p. 680–682, illust. Dravite in NY.

LEIDY, J. (1882) On tourmalines. *Proc. Acad. Nat. Sci. Phila.*, p. 1, p. 71–73.

ROWLEY, E. B. (1955) Brown tourmaline, a new American locality. *Rocks & Minerals* 30, 9/10, p. 461–463. Brant Lake locality.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum Gem Collection Catalogue. Albany, *Open File Rept.* 8m106, 47 p.

SOUTH DAKOTA. In the Bob Ingersoll Mine, 2 mi (3.2 km) northwest of Keystone, Pennington County, Roberts & Rapp (1965) report, "fine pink to deep red rubellite . . . in part gemmy, in crystals as much as 1 inch [2.5 cm] in diameter and several inches in length occur imbedded in lavender lepidolite, cleavelandite, and light-tinted smoky quartz, the most gemmy crystals being found in the latter." They also note "slender prismatic crystals of green to blue green color, in part gem quality, as much as 1/4 inch [0.5 cm] in diameter and 6 inches [15 cm] in length, occur sparingly in books of muscovite."

ROBERTS, W. L. & RAPP, G. (1965) Mineralogy of the Black Hills. *South Dakota School of Mines and Technol. Bull.* 18, 268 p., illust.

COLORADO. No new developments.

STERRETT, D. B. (1909) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1908*, p. 844, Royal Gorge gem tourmaline.

MONTANA. W. C. Van Laer and others are actively exploring pegmatites in the Boulder Batholith in an area east of Butte in Jefferson County and they have discovered fine schorl crystals (Van Laer, 1979). Further investigations turned up colored tourmaline from a pegmatite in an area north-northeast of Butte (Van Laer, 1985). The tourmaline occurs as groups of small prismatic crystals with green terminations and some crystals were purple or pink. None contained clear areas large enough to cut faceted gems but the outlook for finds of tourmaline, perhaps of gem grade, as well as for other pocket minerals, is promising. As noted before, excellent gem quality smoky quartz and some topaz have been found and cut from these pegmatites.

VAN LAER, W. C. (1979) Tourmalines of the Homestake Pass. *Lapidary J.* 33, 1, p. 58, 60, 64, illust.

_____, (1985) Boulder Batholith pegmatites. *Ibid.* 39, 2, p. 242–247, illust.

CALIFORNIA. For all practical purposes, the only steady supply of gem and specimen tourmaline in all of California comes from a single source, the Himalaya Mine at Gem Hill, Mesa Grande, San Diego County. Some scratching about in other pegmatites occasionally turns up a crystal or two, but the great finds of large pink crystals from pegmatites on Tourmaline Queen Mountain, Pala, San Diego County, appear to be over. The following are general references on California tourmaline.

BANCROFT, P. (1984) *Gem & Crystal Treasures.* Fallbrook, CA: Western Enterprises. Pala and Mesa Grande p. 98–110, illust. (col.).

BERKHOLZ, M. F. (1953) Magic gems in San Diego County. *Mineral Notes & News* 189, p. 12–13.

COWAN, J. L. (1910) Tourmaline in California. *Mining & Scientific Press* 100, p. 864–865.

DAWSON, N. E. (1948) Gem minerals of San Diego County, California. *Lapidary J.* 2, 4, p. 208–215, illust.

FAIRBANKS, H. W. (1893) Notes on the occurrence of

Bulletin No. 37. San Francisco, June, 1905.

Gems, Jewelers' Materials, and Ornamental Stones of California

BY

GEORGE FREDERICK KUNZ, Ph.D.

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1905.

FIGURE 95. Title page of G. F. Kunz's description of gem deposits of California, especially those yielding gem tourmaline in San Diego County.

rubellite and lepidolite in Southern California. *Science* 21, p. 35–36.

GRIEGER, J. M. (1934) San Diego County, California, gem mines not exhausted. *Oregon Mineralogist* 2, 10, p. 7–8.

_____, (1935) Good tourmaline specimens can be collected at Mesa Grande, California. *The Mineralogist* 3, 4, p. 11–12.

JAHNS, R. H. (1948) Gem deposits of Southern California. *Gems & Gemology* 6, 1, p. 6–9, 28, 30.

JOHNSON, P. W. (1969) Gemstones of San Diego County. *Lapidary J.* 23, 7, p. 998–1014, *passim*, illust., map.

KEPNER, R. M. (1969) A brief history of gem mining in San Diego County. *Gems & Minerals* 378, p. 26, 44, 45.

KUNZ, G. F. (1894) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1853.* CA tourmaline p. 695–696.

_____, (1901) *Same, for 1900.* Mesa Grande p. 33–34.

_____, (1902) " " *1901.* " " p. 748.

_____, (1905) " " *1904.* Gem minerals of CA.

_____, (1905) Gems, jewelers' materials, and ornamental stones of California. *CA State Min. Bur. Bull.* 37, 171 p., illust. (col.), map.

MURDOCH, J. & WEBB, R. W. (1956) Minerals of California. *CA Div. Mines Bull.* 173, 452 p., illust. (col.). Pegmatite gem area p. 25–27; 330–332.

_____, (1966) Minerals of California: Centennial Volume (1866–1966). *CA Div. Mines & Geol. Bull.* 189, 559 p., illust. Peg. area p. 46–49; p. 369–372.

ORCUTT, C. R. (1898) Note on the occurrence of tourmalines in California. *Amer. Geol.* 22, p. 265; *Science* 8, p. 505.

_____, (1901) Tourmaline. *West. Amer. Scientist* 12, 7, p. 114–115.

PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps, p. 502–505.

RYNERSON, F. (1967) *Exploring and Mining for Gems and Gold in the West.* Healdsburg, CA: Naturegraph Co., 204 p., illust.

SANBORN, W. B. (1976) Tourmaline—the mineral with charisma. *Gems & Minerals* 469, p. 16–30, *passim*, 94, illust.

SCHALLER, W. T. (1904) The tourmaline localities of southern California. *Science* 19, p. 266–268.

SINKANKAS, J. (1955) Tourmaline by the case. *Rocks & Minerals* 30, 9/10, p. 458–460.

_____, (1962) San Diego's gem studded tiara. *Lapidary J.* 16, 3, p. 300–323, *passim*, illust.

SNYDER, D. (1962) Wonderful world of pegmatite minerals. Part 1. *Gems & Minerals* 293, p. 24–26; Part 2, 294, p. 26–29; Part 3, 294, p. 16–17; all parts illust. Excellent overview of San Diego gem mines.

STERRETT, D. B. (1904) Tourmaline from San Diego County, California. *Amer. J. Science* 17, p. 459–465, illust.

_____, (1908) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1907.* S. CA gemstones p. 833–838.

VAN AMRINGE, E. V. (1935) World's best tourmaline collection. *The Mineralogist* 3, 3, p. 24–25. T. W. Warner Collection, Pasadena, CA.

WEBER, F. H. (1963) Geology and mineral resources of San Diego County, California. *CA Div. Mines & Geol. County Rept.* 3, 309 p., illust., maps.

WRIGHT, W. G. (1894) Rubellite in California. *Mineral Collector* 1, 2, p. 18–20.

To the north of the Southern California pegmatite gem fields, Bradley (1916, p. 439) noted that "red and green tourmaline are found in quartz on the White Divide, south of Mt. Goddard, at an elevation of about 12,000 feet [3,660 m]. A few stones from here have been cut for gems." Another Fresno County locality for gem tourmaline is given as upon Spanish Peak, in Sec. 1, T12S, R28E, at an elevation of 9,700 feet [2,960 m] in a ledge of white quartz. Neither of these occurrences has been confirmed so far as I can tell.

BRADLEY, W. W. (1916) Fresno and Kings counties. *CA Mining Bur. Rept.* 14, p. 429–470, 525–530.

Farther south, some desultory work has been done in recent years in Riverside County pegmatites and some gem beryl has been recovered but no gem tourmaline worthy of notice. In northern San Diego County, the Ware Mine, described under TOPAZ, which *see*, was reopened for exploration in 1983 by the Pala Mining Company (*Lapidary J.* 37, 5, 1993, p. 779). This mine was highly touted by its original owner, John W. Ware of San Diego, whose laudatory poem "composed and copyrighted 1923" is taken from an undated advertising brochure, probably written about 1915:

"A repository of radiant gems,
In these ledges are displayed,
Brought to light by ardent labor,
With the shovel, pick and spade.
There are Kunzite, Beryl and Garnets,
The finest ever seen,
With Emeralite, Quartz and Topaz,
And the beautiful Tourmaline."

In the Mesa Grande district, only Mr. William Larson's Himalaya Mine continues to produce its typical short to long prismatic crystals, predominantly pink, with some green and some bicolor crystals. The property is now wholly owned by Larson and his company, Pala International of Fallbrook, California. Larson bought all outstanding shares to the property save for one share held out by Josephine L. Scripps, recently deceased, who willed her share to Larson, thus making his ownership complete. However, at an earlier date, Pala International leased the mine from the consortium of shareholders with a production-sharing agreement, once the mine was reopened. Because of difficulties with poor ground on the western side of Gem Hill, where all previous penetrations had been made during Potter's mining campaigns, Larson decided to intersect the gem-bearing pegmatite at a low level by driving a tunnel westward from the east or opposite side of Gem Hill. The first 75 ft (22.5 m) of tunnel passed through soft, crumbling saprolite and was carefully lagged to prevent slumping; thereafter the tunnel entered unaltered solid rock to a total distance of about 750 ft (236 m) at which point the pegmatite was intersected and laterals could be driven to seek pockets. By 1985, it was estimated that over 2,250 ft (680 m) of tunnels and stopes had been completed.

Pockets encountered were of the same type that had been found in earlier workings by Potter, but notable finds were made of elegant, slender bicolor tourmaline crystals, green and pink; from some of these thick enough that beautiful bicolor stepcut gems were fashioned. Flawless gems of this sort were cut to 40 carats and surely they remain the best bicolor gems of tourmaline known.

Because tunneling now exposed pockets far removed from surface infiltration by contaminated water, pocket contents were found in their pristine state without trace of the reddish clay which was the invariable filling and staining agent in pockets close to the surface, especially in those reached from the west side of Gem Hill. Here, at last, miners could observe the contents as they were left in the final mineralizing stages millions of years ago! Outstanding mineral specimens, aside from the tourmaline, lepidolite, feldspars, and quartz, included splendid glistening tabular crystals of deep brownish-red stibiotantalite, several inches (ca 5–6 cm) in length, sometimes in matrix associated with colored tourmaline, apatite, and cleavelandite. Smaller fragments of stibiotantalite provided rough for garnet-like faceted gems of one or two carats. The most recent pockets produced stibiotantalites far larger and of greater cabinet interest than any found in the workings reached from the west side of Gem Hill. Some hambergite was also found, usually as white prismatic crystals, sometimes with very small clear areas from which faceted gems of less than a carat can be cut. A few hambergite crystals reached a length of 1.5 in (3.5 cm) but are poorly formed. Fine clusters of typical white to cream "wheat sheaf" stilbites were found in some pockets, some matrix pieces being fist-size and very attractive in their sculpturing. A few specimens displayed stilbite whose extremities were tipped in brown. Laumontite crystals are common as very small, rarely over 0.75 in (1.8 cm) prismatic crystals with typical diagonally-cut terminal faces. Calcite appeared in remarkable clusters of "nailhead spar" habit, but with the rhombohedral faces so low that the crystals became thin, circular knife-edged disks of white to cream color, often stacked atop each other. Other calcite crystals grew on edge and resembled cleavelandite. In addition to these species, apatite crystals were found that ranged in habit from short prisms of pink or pale blue (rarely) to some that were as much as one inch (2.5 cm) in diameter and more than an inch long. A surprising rarity in these pockets is topaz, which only occurs as partly etched colorless stubby prisms of blocky habit. Another rarity of an otherwise common pocket species is beryl, which has been found only as several severely etched glassy colorless masses, not over an inch (2.5 cm) across. No morganite has been found in the workings tapped by the east side tunnel.

In May 1989, Pala International found one of the largest recorded pockets, from which about 1,100 lbs (500 kg) of tourmaline crystals were removed, of which half was classed as carving/cabochon grade, and less than one percent classed as facet grade. The remaining crystals were mineral specimens ranging from relatively inexpensive single crystals to some matrix pieces of top grade that fetched thousands of dollars wholesale. The tabular pocket measured about 2 x 3 x 11 ft (0.7 x 1 x 3.7 m). Perhaps the most extraordinary tourmaline crystals found in this pocket were a series of exceedingly slender, flawless, bicolor crystals, terminated at one end, that measured as much as 8 in (20 cm) long and were only about 1/4 inch (0.5 cm) in diameter.

The richness in tourmaline of Himalaya Mine pockets has often been noted in the literature but no quantitative measure had been recorded until May 1991 when a "small" pocket of about 15 kg of all types of pocket material was saved in toto. When this material was thoroughly washed to remove clays, it was found that tourmaline of all grades, sizes, and chips came to 33% of the total weight.

The geology and mineralogy of the pegmatites of Gem Hill has been described in several recent papers, the principal one is by Foord (1977) and another important one is by Marcusson (1985). Foord provides a drawing of a dike cross-section that shows the relationships of pocket mineral crystals to walls and floors of the cavities. He notes the presence of three tourmaline species, namely schorl, elbaite, and dravite, but observes that the latter occurs only in altered norite wall rock in non-gem prismatic crystals. In relating the chemical composition of tourmaline crystals to their color, from the black schorl root in the pocket wall to the emergence of colored sections into the pocket openings, Foord notes that, "The principal changes are in contents of Mn, Fe, Al and Ca, which evidently increased at the expense of Fe with continued development (crystallization) of the pocket crystals." The corresponding sequence of colors, from black schorl root to prism termination "as typically observed in singly terminated pocket zone crystals, is black - blue - blue-green - green - yellow - colorless - pink." However, as I and others have observed, the yellow and colorless zones are often so small that they defy detection, and may be absent altogether. Actually, by far most crystals are simply all pink, or green and pink, or, more rarely, all green.

The Marcusson paper reports mining events and describes notable finds made in the early 1980s, with diagrams of workings that show those made after 1977. He also provides brief descriptions of species associated with tourmaline in the pockets, i.e., apatite, hambergite, malayaite (a Ca-Sn silicate), stibio- and columbotantalite, and stilbite.

As of the summer of 1993, Larson *(Pers. comm.)* estimated that his campaign had driven just under 7,000 ft (2,135 m) of tunnels, stopes, etc., since 1980. Production of all grades of rough and mineral specimens totaled close to $2 million since 1981, but profits have been very small since hard-rock mining is expensive and since the operation was required to adhere strictly to all the rules established by the state and federal governments to promote healthy and safe working conditions. In general, the most consistently profitable tourmaline is the bright pink broken crystals which are suitable for high-grade cabochons and small carvings. Facet material remains rare, and represents probably less than one percent of all rough mined, and very little of that is capable of providing faceted gems of more than several carats. Standard faceted pinks fetch wholesale $100 to $200 per carat, and standard pink cabochons bring in $20 to $40 per carat. The superb bicolor pink/green step-cut gems, carefully faceted upon their ends to suppress infusion of brown due to admixing of pink and green, fetch wholesale $100 to $200 per carat for stones under 10 carats, but prices rise steeply for larger gems which bring

$200 to $400 per carat. The bicolors and special pinks are cut on the premises in Fallbrook, California. The largest bicolor step-cut faceted gem, owned by the company, weighs 75 carats and is flawless.

Recent mining (1993–1994) yielded tourmaline crystals of a record size, some measuring 2–3 in (5–7.5 cm) in diameter and about twice as long. Almost always, such crystals offer superb carving stock but no faceting material. The latest mining extended underground workings to the north where promising pegmatite has been encountered. As an interesting sidelight, Dr. Jonas Salk of polio vaccine fame, of the Salk Institute in La Jolla, California, was presented with a 1,185 ct bicolor tourmaline crystal from the Himalaya Mine by the March of Dimes on the 30th anniversary (1985) of the announcement of the vaccine (*Lapidary J.* 39, 6, 1985, p. 9).

BANCROFT, P. (1984) *Gem & Crystal Treasures.* Fallbrook, CA: Western Enterprises, 488 p., illust. (col.). Mesa Grande p. 98–101.

______, (1991) Command performance. *Lapidary J.* 45, 3, p. 50–56, illust. China's purchases and mining of Mesa Grande tourmaline.

CARNAHAN, V. (1960) The treasure of the Himalaya Mine. *Gems & Minerals* 278, p. 21–25, 55–57, illust.

COWAN, J. L. (1911) How the world's great gem mines were discovered. *Pacific Monthly,* Nov., p. 545–556, illust. Includes Himalaya Mine.

______, (1912) Tourmaline mining in California. *Keystone,* Oct. 15, p. 2149.

DONNELLY, M. G. (1935) The lithia pegmatites of Pala and Mesa Grande, San Diego County, California. *Unpubl. Ph.D. dissert., Calif. Inst. Technol.*

EIDAHL, D. (1977) Footnote: The reopening of the Himalaya Mine. *Min. Rec.* 8, 6, p. 475.

FOORD, E. E. (1976) Mineralogy and petrogenesis of layered pegmatite-aplite dikes in the Mesa Grande district, San Diego County, California. *Unpubl. Ph.D. Thesis, Stanford Univ.,* 326 p., illust., maps.

______, (1977) The Himalaya dike system, Mesa Grande district, San Diego County, California. *Min. Rec.* 8, 6, p. 461–474, illust.

FOORD, E. E., *et al* (1991) Gem-bearing pegmatites of San Diego County, California. In *Geol. Excursions in S. Calif. & Mexico, Guidebook, 1991 Ann. Mtg. Geol. Soc. Amer., San Diego,* 1991, p. 128–146, illust.

JAHNS, R. H. (1979) Gem-bearing pegmatites in San Diego County, California. In *Mesozoic Crystalline Rocks: Peninsular Ranges batholith and pegmatites, Point Sal ophiolite.* P. L. Abbott & V. R. Todd, eds., Geol. Soc. Amer. Ann. Mtg., San Diego, 1979, p. 3–38, illust. Mesa Grande.

MARCUSSON, C. R. (1985) Recent work at the Himalaya Mine. *Min. Rec.* 16, 5, p. 419–424, illust.

MARTIN, J. G. M. (1958) Historical Himalaya tourmaline mine resumes production. *Gems & Gemology* 9, 6, p. 163–173, illust.

RICHARDS, G. (1949) The New York tourmaline mystery. *The Mineralogist* 17, p. 379–380, 382. Missing tourmaline from Mesa Grande.

SINKANKAS, J. (1958) Largest American gem find in 42 years. *Lapidary J.* 12, 3, p. 340–352, *passim,* illust. Mesa Grande.

SNYDER, D. (1962) Wonderful world of pegmatite minerals. *Gems & Minerals* 294, p. 26–29, illust. Mesa Grande.

WEBER, F. H. (1963) Geology and mineral resources of San Diego County, California. *CA Div. Mines & Geol. County Rept.* 3, 309 p., illust., maps.

WEIGHT, H. O. (1953) Fabulous jewels of old Pala and Mesa Grande. *Calico Print* 9, 4, p. 3–5, 23–25, illust.

In the Pala district of San Diego County, mining continues from time to time in the Stewart Lithia Mine, at the southeastern base of Tourmaline Queen Mountain, by J. B. Sheppard of Gems of Pala, headquartered on McGee Road, Pala. Sheppard (*Pers. comm.* 10/93) states that the property was acquired from a German syndicate in 1990. In an earlier period, the mine was operated by Pala International, Inc., a partnership of Edward Swoboda of Los Angeles and William Larson of Fallbrook, for a period of twelve years, during which time Larson estimates that specimen and gem grade pink tourmaline realized sales of about $500,000 (*Pers comm.,* W. Larson, 1/14/94). The present operator, Gems of Pala, produces typical pink tourmaline in small crystals and sells specimens and faceted stones; the latter, in pink colors, fetch $300 per carat wholesale for gems of over two carats. The rough, in 5-gram pieces and over, brings $100 per gram. In addition to tourmaline, pale pinkish morganite is found but mostly in lumpy forms with only a few well-developed faces and with clear areas rarely large enough to cut gems of over several carats. Other pocket associates are small, nearly colorless etched kunzite crystal slivers, apatite crystals, and columbite-tantalite crystals. In 1988, a blue-coated pink tourmaline crystal was found that measured about 2.5 in (6 cm) in diameter and about 4 in (10 cm) in length; it strongly resembles the large colored tourmaline crystals found above the Stewart Mine in the Tourmaline Queen Mine.

Recently, legal problems have beset miners in this district because of contentions by the local Pala Indians that the mines were unjustly carved out from reservation land in the early part of this century, and thus belong by rights to them. So long as these mining claims were refiled annually, as required by law, they continued to be held as valid claims. However, in the case of the White Queen Mine on Hiriart Hill, operated by the Dawson Family of Escondido for the sake of its morganite for nearly 40 years, the claim was deemed "abandoned" by the Federal Bureau of Land Management when Robert Dawson, son of the late Norman E. Dawson, failed to file a notice of improvement in 1992, with the result that rights to the claim were lost and the property reverted to the Pala Indian Reservation (Smith, 1992). Smith also notes that "in the early 1980s they [BLM] instigated a review of mining claims on reservation land . . . that . . . resulted in dozens of mines being declared invalid because they were officially registered after the land was set aside for the reservation in 1903." A related problem is the refusal of the Pala Indians to permit access across reservation land to the mines on Tourmaline Queen Mountain, thus forcing operators of the Tourmaline Queen and Tourmaline King mines to utilize a steep bulldozer road on the north side of the mountain on federal land.

In the Tourmaline Queen Mine, located near the summit of the mountain of the same name, some facts on the campaign of Pala International are now available (*Pers comm.*, W. Larson, 1/14/94). The mining period extended from 1972 to 1978, and resulted in the discovery of a series of pockets which yielded the now-famous fine large pink crystals, many on matrix, that were described in a previous volume. Larson estimated that during their campaign they realized about $1 million from sales of specimen crystals and groups, and cut and rough gem tourmaline. The quality of the tourmaline from this mine is superb; its color is a rich pink with a distinctive bluish overtone. Pala International still retains two faceted gems of 120 and 132 carats, and some time ago sold an even larger faceted gem. Marshall (1980) describes and illustrates carvings made in Idar-Oberstein, Germany, by Gerhard Becker from pink Tourmaline Queen material. An especially fine piece is a cameo of a mother and child cut in the blue termination of a large crystal in such a way that the figures appear in blue against a lighter pink background. This engraved gem measures about 2 in (5 cm) across and keeps the typical rounded triangular tourmaline prism cross-section. This piece is retained by Becker.

The latest work upon the Tourmaline Queen Mine has been expended by Roland Reed of El Cajon, California, who worked the Elizabeth R. Mine on Pala Chief Mountain for many years as described in the previous volume. According to Reed (*Pers. comm.* 1/30/94), he leased the Tourmaline Queen from its owner, Edward Swoboda, for a period of ten years. With others, he is attacking the very large ledge-like pegmatite from about 100 yards south of the the main adit with the intention of working through a tunnel toward the downward extension of the pocket zone. Serious work was commenced in the spring of 1993; the mine is reached via the north slope road mentioned above. Adjacent to the Queen is the Tourmaline King Mine, which has been closely examined by various parties but signs for further pockets are so poor that no one has attempted serious mining.

BANCROFT, P. (1984) *See above.* Pala mines p. 102–110, illust.

BARTSCH, R. W. (1970) Gem pockets of the Stewart Mine. *Lapidary J.* 24, 3, p. 428, 430.

BERKHOLZ, M. F. (1953) Magic gems, a San Diego County field trip. *Gems & Minerals* 189, p. 12, 13, 49. Stewart Mine.

DONNELLY, M. G. (1935) The lithia pegmatites of Pala and Mesa Grande, San Diego County, California. *CA Inst. Technol., unpubl. Ph.D. thesis.*

______, (1936) Notes on the lithium pegmatites of Pala. *Pacific Mineralogist* 3, p. 8–12.

FAIRBANKS, H. W. (1893) Notes on the occurrence of rubellite and lepidolite in Southern California. *Science* 21, no. 520, p. 35–35.

FOORD, E. E., *et al* (1991) *See above*, p. 128–146, illust.

JAHNS, R. H. (1947) Internal structure of the Pala pegmatites, San Diego County, California. *Geol. Soc. Amer. Bull.* 58, p. 1254.

______, (1948) Gem deposits of Southern California. *Gems & Gemology* 6, 1, p. 6–9, 28, 30. Also: *CA Inst. Technol. Eng. & Sci. Monthly* 11, 2, p. 6–9.

JAHNS, R. H. & WRIGHT, L. A. (1951) Gem- and lithium-bearing pegmatites of the Pala district, San Diego County, California. *CA Div. Mines Spec. Rept.* 7-A, 72 p., illust. (col.), maps.

KUNZ, G. F. (1905) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1904*, p. 941–987. CA gem mines.

______, (1905) Gems, jewelers' materials, and ornamental stones of California. *CA State Min. Bur. Bull.* 37, 171 p., illust. (col.).

LARSON, W. (1972) The "Queen" reigns again. *Lapidary J.* 26, 7, p. 1002, 1004–1006, 1028–1032, illust. (col.). Giant Queen crystals.

MARSHALL, S. M. (1980) Washington International to star first public showing of new Gerhard Becker mini-masterpieces. *Lapidary J.* 34, 2, p. 450–451, 478, illust.

PEPPER, S. J. (1981) Pala gem mine, an update. *Lapidary J.* 35, 2, p. 476–477, maps. Stewart Mine.

PFEFER, J. (1977) Pala—a "jewel" of a name. *Lapidary J.* 31, 1, p. 202–210, illust.

SINKANKAS, J. (1957) Recent gem mining at Pala, San Diego County, California. *Gems & Gemology* 9, 3, p. 80–87, 95.

SMITH, G. (1992) Gem of a dispute. Indians, miners dig in for battle over claims. *San Diego Union-Tribune.* Sunday, Aug. 30, p. D1–D2, illust., map.

SNYDER, D. (1962) Wonderful world of pegmatite minerals. *Gems & Minerals* 295, p. 16–17, illust. Pala area.

STERRETT, D. B. (1904) Tourmaline from San Diego County, California. *Amer. J. Science* 4th ser., 17, p. 459–465.

SZENICS, T. (1970) The special magic of pink tourmaline. *Lapidary J.* 24, 8, p. 1042–1050, *passim*, illust. (col.). Stewart Mine.

WARING, G. A. (1905) The pegmatite veins of Pala, San Diego County. *Amer. Geologist* 35, p. 356–369.

WEBER, F. H. (1963) *See above.*

WEIGHT, H. O. (1953) *See above.*

ZEITNER, J. C. (1987) Tourmalines of Pala. *Lapidary J.* 40, 11, p. 34–41, illust., map.

In the Ramona district of San Diego County, the pegmatites of the Little Three Mine property have been exploited mainly for spessartine and topaz, which *see*. Tourmaline has been found in the same pockets with topaz but only schorl occurs with the spessartine. The topaz-pocket tourmaline crystals are squat, rounded prisms with a single broad terminal face and only a thin layer underneath this face contains clear material that can be faceted into brownish-green gems of one or two carats that are quite unattractive. In recent topaz mining, Louis B. Spaulding, Jr., owner of the Little Three property, collected about 200 lbs (90 kg) of typical dark green stubby crystals from the large topaz pocket found in 1993 (*Pers. comm.* 10/93).

FOORD, E. E., *et al* (1989) Mineralogy and paragenesis of the Little Three Mine pegmatites, Ramona district, San Diego County, California. *Min. Rec.* 20, 2, p. 101–127, illust., map.

FOORD, E. E., *et al* (1991) *See above.*

SIMPSON, D. R. (1965) Geology of the central part of the Ramona pegmatite district, San Diego County, California. *CA Div. Mines & Geol. Spec. Rept.* 86, p. 3–23, illust., maps.

SINKANKAS, J. (1956) Recent gem mining at Ramona, San Diego County, California. *Gems & Gemology* 8, 12, p. 367–373.

SNYDER, D. (1962) Wonderful world of pegmatite minerals. *Gems & Minerals* 293, p. 24–27, illust. Little Three Mine.

STERN, L. A., *et al* (1986) Mineralogy and geochemical evolution of the Little Three pegmatite-aplite layered intrusive, Ramona, CA. *Amer. Mineral.* 71, p. 406–427, maps.

WEBER, F. H. (1963) *See above.*

BAJA CALIFORNIA. Interest in prospecting and mineral collecting by residents of the United States dropped off to virtually zero in the past several decades and no production of any gemstone has been reported.

BOSE, E. & WITTICH, E. (1913) Informe relativo a la exploracion de la region norte de la costa occidental de la Baja California. *Inst. Geol. Mexico, Parergones*, T. 4, 1912–13, p. 307–533, illust., map.

GASTIL, R. G., PHILLIPS, R. P. & ALLISON, E. C. (1974) Reconnaissance geologic map of the state of Baja California. *Geol. Soc. Amer. Mem.* 140.

SHEDENHELM, W. R. C. (1980) *Rockhounding in Baja.* Glendale, CA: La Siesta Press, 48 p., maps.

SINKANKAS, J. (1964) Gemstones and minerals of Baja California—an annotated directory. *Lapidary J.* 18, 1, p. 48–63, *passim.*

WITTICH, E. (1914) Ueber Edelsteinfunde auf der Halbinsel Nieder-Kalifornien. *Centralbl. f. Min.* p. 449–456.

_____, (1916) Estudio sobre las piedras preciosas en el territorio de la Baja California. Mexico, D. F.: *Dept. de Minas de la Dir. de Minas y Petroleo, Bol. Minero* 1, p. 69–74.

SONORA. The velvety-surfaced black tourmaline associated with facet-grade scheelite as previously reported in Volume 2, from the mountains near Santa Cruz in the extreme northern part of the state, is further described by Culp (1977). The deposit is mined by Manuel Dominguez from his Mina Guadalupana in the Sierra del Chivato, Culp noting that the tourmaline "polishes very well and some gem cutters as well as myself have had success making chatoyant cabochons from the satin material."

CULP, C. H. (1977) La turmelina de Senor Dominguez. *Gems & Minerals* 482, p. 46–47, 82–84, illust.

TREMOLITE

ONTARIO. A number of faceted and cabochon gems of tremolite are preserved in Canada's National Gem Collection (Wight, 1986, p. 53–54). These are a dark blue-green marquise brilliant of 0.65 ct from near Wilberforce, Haliburton County; a dark green stepcut of 1.35 cts from Bruceton, Renfrew County; and a yellowish-green stepcut of 0.50 ct from Hastings County. Two cabochons are recorded: an opaque dark blue gem of 4.55 cts from near Wilberforce and an opaque dark brown gem of 12.55 cts from the Desert Lake occurrence in Loughborough Township, Frontenac County.

WIGHT, W. (1986) Canadian gems in the national museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

NEW YORK. The State Museum collection in Albany includes three tremolite gems: two gray oval cabochons from Gouverneur (15 x 20 mm) and from DeKalb (7 x 9 mm), and also from DeKalb a white, emerald-cut facet gem of 1.05 cts (Schimmrich & Campbell, 1990, p. 39).

Far more attractive are the small faceted gems that have been cut from the lilac tremolite, or "hexagonite," from the classic New York State sources. The State Museum collection includes two purple faceted gems, one from Balmat of 1.65 cts and one from Talcville of 1.20 cts (Schimmrich & Campbell, *Ibid.*). Particularly interesting are two purplish-pink cat's-eye gems which were examined by the Gemological Institute of America and which weighed 1.86 and 2.72 carats, from Fowler, St. Lawrence County. Determination of properties gave refractive indexes of 1.60–1.62 (spot method), birefringence ca 0.02, SG ca 3.00 (in heavy liquids) trichroism of weak orangey-pink, purplish-pink, and purple (Fryer, 1985). An earlier determination by Bank (1975) gave RI 1.602–1.630, birefringence 0.028 and SG 3.03. A recent visitor to the localities reported that specimens were still to be found (Zirlin, 1983).

BANK, H. (1975) Durchsichtiger violetter Tremolit von Fowler/USA. *Zs. Dt. Gemm. Ges.* 24, 4, p. 248–249.

FRYER, C. W., ed. (1985) Gem trade lab notes. Hexagonite, cat's-eye. *Gems & Gemology* 21, 2, p. 110, col. illust.

GOLDSMITH, E. (1877) On hexagonite, a new mineral. *Acad. Nat. Sci. Phila. Proc.* 1876, p. 170–161.

GOSSE, R. C. (1963) Hexagonite—New York's lavender gem rarity. *Lapidary J.* 16, 10, p. 964–967, illust., map.

KOENIG, G. A. (1876) Hexagonite, Goldsmith, a variety of tremolite. *Acad. Nat. Sci. Phila. Proc.* 28, p. 180–181.

______, (1902) Hexagonite, a magnesium-bearing variety of tremolite. *The Mineral Collector* 8, 11, p. 170–172.

SCHIMMRICH, S. H. & CAMPBELL, J. E. (1990) New York State Museum gem collection catalogue. Albany, NY: *Open File Rept.* 8m106, 47 p.

ZIRLIN, S. H. (1983) Hexagonite: New York State's purple tremolite. *Lapidary J.* 36, 11, p. 1864–1867, illust., map.

"TRINITITE"

NEW MEXICO. The atomic bomb test conducted near Alamogordo, Otero County, at the Trinity Site on July 16, 1945, resulted in a crater of about 800 yards (725 m) in diameter whose surface was covered by a green glass formed by the fusion of the ground beneath the explosion. According to Ratkevich (1981), "trinitite, the glassy remnant at Trinity, is now a very rare mineral in any collection," since the site was buried to cover the radioactivity, and collecting the material was strictly forbidden afterward. "Chemical tests on trinitite have confirmed the obvious, that it is nearly pure melted silica with traces of olivine, feldspar, and other minerals which comprise the sand." From time to time some of this glass appears on the gem market and has even been cut into cabochons and faceted gems.

RATKEVICH, R. (1981) Trinitite: The origin of a rare atomic mineral. *Lapidary J.* 34, 10, p. 2276–2278, illust.

TROLLEITE

VIRGINIA. The rare hydrous aluminum phosphate, trolleite, formula $Al_4(PO_4)_3(OH)_3$, is found in only two places in the United States, one of which is the Willis Mountain Quarry of the Kyanite Mining Corporation, Buckingham County, Virginia. A small amount of cabochon material has been found here at the crest of a ridge 3.9 mi (6 km) south of Dillwyn and 0.5 mi (0.8 km) east of U.S. Highway 15. The occurrence is in a kyanite-bearing quartzite. The mineral is granular-massive, pale green, and surprisingly hard, H 8.5! (Giannini, *et al*, 1986; *Pers. comm.*, D. Woolley, 2/24/93). Penick (1992, p. 25) notes that "a few small cabochons were cut from this material which resembles light green jade."

GIANNINI, W. F., PENICK, D. A. & FORDHAM, O. M. (1986) Mineral update—Virginia (trolleite). *Virginia Minerals* 32, 1, p. 11.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26.

TUGTUPITE

GREENLAND. The rare sodalite-related silicate, tugtupite, is now given the formula $Na_4AlBeSi_4O_{12}Cl$ by Petersen & Secher (1993, p. 26–27). As a result of personal visits to the locality they place the occurrences upon the coastal cliffs of Tugtup Agtakorfia in the Tunugdliarfik (Tunugliarfik) Fjord in the extreme southwest of Greenland and northeast of the village of Julianehaab (Qaqortoq). The entire deposit is very small but other occurrences were found nearby. The best material is deep-red, compact, and suitable for cabochons. Very rarely, clear areas afford faceted gems in the range 0.5–2.0 cts. The color fades when stones are kept in the dark but quickly returns when they are exposed to daylight or ultraviolet light. A detailed description of its fluorescent properties is given by Newsome (1982). Jensen & Petersen (1982) gave the following properties for tugtupite: refractive indexes 1.502 + 0.002, 1.495 + 0.001, positive, with polished cabochon faces usually giving 1.495 and 1.499. Another color phase, light blue, gave omega 1.495, epsilon 1.499. Specific gravity is 2.33 + 0.01; some cabochons tested gave between 2.27 and 2.44 SG, presumably reflecting porosity. SG for the light blue phase is 2.33–2.36.

Tugtupite occurs in hydrothermal veins in an augite-syenite rock, the veins consisting mostly of albite with minor aegerine, epistolite, sphalerite, pyrochlore, neptunite, and chkalovite.

BANK, H. (1972) Roter durchsichtiger Tugtupit aus Grönland. *Zs. Dt. Gemm. Ges.* 21, p. 7–8.

DANØ, M. (1966) The crystal structure of tugtupite—a new mineral. *Acta Crystallographica* 20, p. 812–816.

DRAGSTED, O. (1970) Tugtupite. *J. Gemm.* 12, p. 10–11, color plate.

JENSEN, A. & PETERSEN, O. V. (1982) Tugtupite: A new gemstone from Greenland. *Gems & Gemology* 18, 2, p. 90–91, illust.

NEWSOME, D. (1976) Tugtupite, an unusual fluorescent. *Lapidary J.* 29, 10, p. 1945–1946.

PETERSEN, O. V. & SECHER, K. (1993) The minerals of Greenland. *Min. Rec.* 24, 2, p. 1–65, illust. (col.).

USSING, N. V. (1911) Geology of the country around Julianehaab, Greenland. *Meddelelser om Grønland* 38, xi, 367 p., illust., maps.

TURQUOISE

After reaching a faddish peak in about 1980, the demand for turquoise dropped off sharply in the following decade but in the early 1990s has begun to climb once more. Partly this is due to the modernization of designs of Indian turquoise/silver jewelry. Here although traditional motifs are sometimes retained, the design in some pieces departs so radically from the usual standards that the pieces could be mistaken for the productions of sophisticated design centers in large cities rather than the manufactures of small home workshops upon Indian reservations. However, most pieces are recognizable as Indian and now fall into the style class known as "Southwestern jewelry." Such jewelry now appeals to a far larger audience and hence more production of turquoise is needed to satisfy the demand. United States production has been accelerated for another reason: satisfying the demand for "Persian" turquoise in non-Indian jewelry, which, as Federmann points out in *Modern Jeweler* (Mar. 1987, p. 42), is actually Southwestern turquoise because "mining activity in Iran is negligible at best."

In 1976 and 1977, top years of turquoise production in the United States, principally from mines in Arizona, Nevada, and Colorado, the *U.S. Bureau of Mines Minerals Yearbook for 1976* reported production of 221 tons of all grades of turquoise valued at $3.9 million, and for 1977, a sharp drop in production to 44 tons, but apparently of much higher grade since the estimated value was $4.5 million. In 1977 only about 10% of the production could be classed as gem grade, that is, ready to fashion into cabochons, small carvings, etc., and selling for about $10 to $100 per carat, and in the rough, fetching about $200 per pound. Low grade material suitable for resin impregnation sold for about $35 per pound. As to the mines themselves, Bureau of Mines records show that in 1976 fourteen mines reported production: nine in Nevada, three in Arizona, and two in Colorado. In the ensuing years from 1977 to about 1989, production slumped because the demand for Indian-style jewelry decreased but small quantities of top-grade turquoise were absorbed in the market for the non-Indian-type jewelry mentioned above. In 1990, Bureau of Mines reported an all-states production of $1.105 million of mine-run, with Arizona now leading other states, surpassing even Nevada which had held the lead up to that time. It was noted that the all-years combined turquoise production from Nevada mines was estimated at between $40 and $50 million.

A directory of gemstone and pearl producers issued by the U.S. Bureau of Mines for 1989 showed that twenty-six turquoise mines reported production, eleven in Nevada, eight in Arizona, three in New Mexico, and two each in California and Colorado. It is to be noted that the increased production in Arizona is almost entirely due to the authorized collecting activity by dealers within the large opencut copper mines where potential turquoise-vein ground is laid bare daily.

In 1963 and 1967, Ronzio and Salmon, using nondestructive x-ray fluorescence equipment, determined compositions of numerous samples of turquoise from mines in the southwestern United States and Mexico to establish the correlation between color and the content of copper/iron. They found that higher values of copper produced the most intense blue color. In a second trial (1967), they analyzed specimens for trace elements and found them only from certain deposits, and by their presence, or absence, suggested that analyses of turquoise could be used to determine the deposit from which the specimens came.

"Stabilized" turquoise, that is, originally porous turquoise, partly or wholly impregnated with resin, continues to be produced in large quantities. Most of it now is found as tumbled "nugget" stones much employed in necklaces, with colors that are good to excellent and giving the buyer a durable, attractive turquoise product at a price much lower than that asked for untreated material of the same color grade. When properly impregnated, the treated turquoise is readily cut and polished (Blair, 1967). Further information on treatment methods appears in Jones (1976) and Nassau (1994). Webster (1975) describes techniques for detecting impregnated material, the simplest of which merely calls for scratching some obscure spot on a cabochon under magnification and noting whether the scratching produces a flexible peel of colorless plastic. Also effective is the "hot-wire" test, by which any convenient metal wire, an unfolded paperclip for example, is heated, and its tip applied to the back side of the stone, and the fumes issuing at this point smelled. If the odor is flowery, the plastic is probably an acrylic resin, the kind most commonly used for impregnation. Windham (1976) describes a method he developed for shallow impregnation of turquoise with epoxy, using a resin followed by a catalyst to harden the resin layer. Hemrich (1975) hardened "chalk" turquoise by soaking the material in a water solution of sodium silicate, or waterglass, but notes that "so far the most effective commercial method of treating turquoise is to grind it to a powder, then bond it with a plastic resin," the resulting mass then being called "reconstructed turquoise." Hemrich also discusses other turquoise simulants and their probable compositions.

Nye (1982), speaking from the viewpoint of the turquoise dealer, notes the very high cost of top grade material, with prices ranging from $2,000 to $4,000 per pound and up, but "good virgin material below the top 10% will average between $250.00 to $800.00 a pound—some higher." In a wholesale price list, the L. W. Hardy Company of Kingman, Arizona, who contracted for turquoise collecting rights in the Duval open pit copper mine near Kingman and the Castle Dome open pit copper mine near Miami, recently offered natural turquoise from Kingman at $100 to $125 per pound for low-grade mine run material and $175 to $200 per pound for high-grade mine run. In contrast, various types of "treated" and "stabilized" turquoise sell as low as $10 per pound to as high as $100 per pound depending on color, quality, and size. Other prices for treated turquoise are given by Nye who makes a strong case for the acceptance of this material in the market in lieu of paying very high prices for untreated turquoise.

In 1979, Arizona State University at Tempe established its Turquoise Research Project in the Chemistry Department, offering to test and provide certification of turquoise samples for a fee of $20.00 each. By use of the electron microprobe device and other laboratory equipment they identify and characterize such samples with a unique compositional "fingerprint" which assists in tracing turquoise samples to specific deposits and in detecting adulterations (*Ariz. Highways* 55, 4, 1979, p. 46; *Lapidary J.* 31, 2, 1977, p. 594–596).

In Volume 2 (p. 139–140), turquoise pseudomorphs after distinctly-formed but as yet unidentified mineral crystals were recorded from California and from Nevada. A new occurrence in California, in the classic Toltec/Himalaya mine group in San Bernardino County, is described below.

Lawrence Favorite of Stokesdale, North Carolina has taken ironwood *(Olneya tesota)* from the Sonora Desert to make various sculptured objects and containers decorated with inlays of turquoise; the results are intriguing and beautiful. Turquoise from China is beginning to appear in the market as carvings and someday may displace much American turquoise because of its good quality and relative inexpensiveness. The following are general references to North American turquoise followed by references on cultural aspects. The single largest collection of references on turquoise is to be found in J. E. Pogue's *The Turquoise*, listed below.

AITKENS, I. (1931) Turquoise. *U.S. Bur. Mines Info. Circ.* 6491, 17 p.

ARIZONA HIGHWAYS (1974) [Much on Southwest U.S. turquoise.] Vol. 50, no. 1, 48 p., color photos.

AUSTIN, G. T. (1990) Directory of principal gem stone producers in the United States in 1989. *U.S. Bur. Mines Min. Industry Surveys*, 37 p.

BALL, S. H. (1941) Mining of gems and ornamental stones by American Indians. *Smithson. Inst. Bur. Ethnol. Bull.* 128. Turquoise p. 142.

BLAIR, G. (1967) A ton of turquoise at Kingman, Arizona. *Lapidary J.* 21, 8, p. 992–995, illust.

BLAZEK, M. C. (1983) Color changes in turquoise. *Gems & Minerals* 554, p. 32–33. Natural and induced.

BRANSON, O. T. & BRANSON, E. (1974) *Turquoise the Gem of the Centuries.* Santa Fe, NM: Treasure Chest Publ., 62 p., col. illust.

BROMAN, M. G. (1975) *Blue Gold—The Turquoise Story.* Anaheim, CA: Main Street Press, 84 p., illust. (col.); 2nd edit., 1976, 101 p.

COWAN, J. L. (1911) American gem mines and mining. *Mines and Minerals* 32, p. 103–105.

FEDERMAN, D. (1987) Turquoise: Bum rap for a blue beauty. *Modern Jeweler*, Mar., p. 42, col. photo.

HAMMONS, L. (1973) *Southwestern Turquoise, the Indians' Sky Stone.* Glendale, AZ: Arizona Maps and Books, 24 p., illust. (col.), maps.

INTERNATIONAL TURQUOISE ANNUAL (1976, 1977). [Two volumes.] Reno, NV: Internat. Turquoise Assoc., 79, 112 p., illust. (col.).

JACKA, J. D. & HAMMACK, N. S. (1975) *Indian jewelry of the Prehistoric Southwest.* Tucson, AZ: Univ. Arizona Press, 48 p., col. illust.

JONES, F. A. (1909) History of mining turquoise in the Southwest. *Mining World* 31, p. 1251–1252.

_____, (1909) Notes on turquoise in the Southwest. *South-Western Mines*, l, 12, p. 1–2.

JONES, R. W. (1974) Turquoise. *Rock & Gem* 4, 6, p. 40–47, 70, illust.

_____, (1976) Treating turquoise. *Ibid.* 6, 12, p. 68–70, 72–75, 90–93.

KUNZ, G. F. (1883) Precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1882*, p. 493–495. NM, AZ, NV.

_____, (1885) *Same*, for 1883–84, p. 767–768.

_____, (1893) " " 1892, p. 763–764.

_____, (1894) " " 1893, p. 693–694.

_____, (1896) " " 1895–96, p. 910.

_____, (1901) " " 1900, p. 41–43.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., p. 54–65, illust., color plate.

LIEBER, W. (1977) Western Turquoise. *Lapis* 2, 2, p. 10–13, illust. (col.) .

NASSAU, K. (1994) *Gemstone Enhancement.* 2nd edit. Oxford: Butterworth-Heinemann, 252 p., illust. (col.); 1st edit., 1984.

NAZELROD, E. (1985) Turquoise—inside and out. Part 1, 1 38, 9, p. 1152–1190, *passim;* Part 2, 10, p. 1304–1319, illust.

NORTHROP, S. A., NEUMANN, D. L. & SNOW, D. H. (1973) *Turquoise.* Reprinted from *El Palacio*, Santa Fe, NM: 79, 1, 51 p., illust. (col.).

NYE, N. C. (1982) Spiderweb turquoise. *Gems & Minerals* 542, p. 8–9, 25–26, illust. (col.).

_____, (1982) Turquoise—the abominably treated. *Ibid.*, p. 48–50.

PEARL, R. M. (1976) *Turquoise.* Colorado Springs, CO: Earth Science Publ. Co., 32 p., illust.

POGUE, J. E. (1914) The technology of turquoise. *Mining & Scient. Press* 108, p. 285–287.

_____, (1915) *The Turquoise. A study . . .* Wash., DC: *Nat. Acad. Sci. Mem.* 12, pt. 2, 3rd memoir, 207 p., illust. (col.). Reprinted with addit. material, illust., Glorieta, NM: Rio Grande Press, 1972.

RONZIO, A. R. & SALMON, M. L. (1963) The correlation of chemical composition and color of turquoise. *Gems & Minerals* 309, p. 39, 54.

_____, (1967) Relation between the source and the composition of turquoise. *Ibid.* 353, p. 26–27.

ROWE, R. C. (1967) Turquoise, gem of antiquity. *Gems & Minerals* 363, p. 16–17, 45–47.

ROZNEK, C. & STACEY, J. (1976) *Skystone and Silver.* Englewood Cliffs, NJ: Prentice Hall, 166 p., illust. (col.).

SMITH, H. M. (1939) Turquoise. *Arizona Highways* 15, p. 23.

SMITH, I. (1962) Turquoise of the Southwest. *Lapidary J.* 16, 8, p. 786–793.

SMITH, S. I. (1994) Turquoise: True or tampered? *Rock & Gem* 24, 9, p. 50–52, 54, illust. (col.).

STERRETT, D. B. (1907) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources U.S. for 1906*, p. 1908–1912.

______, (1909) *Same*, for 1908, p. 805–859, NM, NV, AZ, CA.

______, (1911) " " 1909, p. 778–795, AZ, CA, CO, NV, NM.

______, (1911) " " 1910, p. 885–886, NV.

______, (1912) " " 1911, p. 1065–1073, NM, CA.

______, (1914) " " 1913, p. 693–704, AZ, CA, NV, NM, TX.

WEBSTER, R. (1962) Turquoise—natural, treated, synthetic, and simulated. *Lapidary J.* 16, 8, p. 758–777, 806, illust. Large bibliography.

______, (1975) More notes on turquoise. *Ibid.* 29, 8, p. 1428, 1456.

WINDHAM, J. A. (1976) Treating turquoise with epoxy. *Lapidary J.* 30, 8, p. 1960–1962, illust.

WOODS, B. (1941) They learned about turquoise. *Desert Mag.* 4, 9, p. 20–22.

ZEITNER, J. C. (1975) The legend and lore of turquoise. *Lapidary J.* 29, 8, p. 1430–1454, *passim*, illust. (col.).

______, (1990) Eternal sky. *Ibid.* 43, 11, p. 49–57, *passim*, map.

The following are selected references concerning the cultural aspects of North American turquoise.

ADAIR, J. (1944) *The Navajo and Pueblo Silversmiths.* Norman, OK: Univ. Oklahoma Press, 220 p., illust.

ARIZONA HIGHWAYS (1974) [Special turquoise issue.] 45, 1, 48 p., illust. (col.).

______, (1974) [Turquoise & jewelry.] 50, 1, 50 p., illust. (col.).

______, (1974) [Indian jewelry.] 50, 8, 50 p., illust. (col.).

______, (1975) [" "] 51, 3, 48 p., illust. (col.).

______, (1975) *Turquoise Blue Book and Indian Jewelry Digest.* Joseph Stacey, ed. Hardcover, 95 p., illust. (col.).

______, (1979) [Contemporary Indian jewelry.] 55, 4, 50 p., illust. (col.).

ARMER, L. A. (1960) Because I wore the turquoise. *Desert Mag.*, Apr., p. 14–16.

BENNETT, E. M. (1966) *Turquoise and the Indian.* Denver, CO: Sage Books, 152 p., illust. (col.).

BENNETT, E. M. & BENNETT, J. F. (1973) *Turquoise Jewelry of the Indians of the Southwest.* Colorado Springs, CO: Turquoise Books, 148 p., illust. (col.).

BLAKE, W. P. (1858) The chalchihuitl of the ancient Mexicans: Its locality and association, and its identity with turquoise. *Amer. J. Science* 25, p. 227–232.

______, (1883) New locality of the green turquoise known as chalchuite, and on the identity of turquoise with the callais or callaina of Pliny. *Ibid.* 25, p. 197–200.

______, (1900) Mosaics of chalchihuitl. *Amer. Antiquarian & Oriental J.* 22, p. 108–110.

CARMICHAEL, E. (1970) *Turquoise mosaics from Mexico.* London: Trustees of the Brit. Mus., 41 p., illust. (col.).

COCANOWER, N. (1982) *Turquoise: American Indian Legends About the Origin and Use of the Sky Blue Stone.* Cincinnati, OH: Mosaic Press, 64 p., illust.

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HARRINGTON, E. R. (1940) Chalchihuitl—a story of early turquoise mining in the Southwest. *Eng. & Mining J.* 141, p. 57–58.

HILL, G. F. (1938) Turquoise, its history and significance in the Southwest. *Master's Thesis, Univ. AZ.*, Tucson, unpubl., 210 p., map.

______, (1938) The use of turquoise among the Navajo. *The Kiva* 4, 3, p. 11–14.

HODGE, F. W. (1921) *Turquoise work of Hawikuh, New Mexico.* New York: Mus. Amer. Indian, Heye Foundation leaflet, 30 p., color plate.

HUNT, W. B. (1952) *Indian Silversmithing.* Milwaukee, WI: Bruce Publ. Co., 160 p., illust.

ICHIKAWA, S. (1931) The Maya of Middle America. Part 3—Restoration of the turquoise mosaic plaque. *Carnegie Inst. Washington, News Service Bull.* 11, 19, p. 129–132, plate.

JACKA, J. & GILL, S. (1975) *Turquoise Treasures: The Splendor of Southwest Indian Art.* Portland, OR: Graphic Arts Center Publ. Co., [96] p., illust, (col.).

JERNIGAN, E. W. (1978) *Jewelry of the prehistoric Southwest.* Albuquerque, NM: Univ. New Mexico Press, 260 p., illust. (col.).

JUDD, N. M. (1954) Archeological investigations at Pueblo Bonito, New Mexico. *Smithson. Inst., Misc. Collect.* 77, part 2.

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______, (1907) Altmexikanische Mosaiken in Kgl. Museum, für Völkerkunde zu Berlin. *Congres Internat. Americanistes, xv Sess., Quebec,* 2, p. 339–349, illust.
MANSELL, T. N. (1975) And they caught a piece of the sky. *Lapidary J.* 29, 8, p. 1438–1450, *passim*, illust. (col.).
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MATTHEWS, G. W. (1882) Navajo silversmiths. *Smithson. Inst. Bur. Amer. Ethnol. Ann. Rept. 2 for 1881*, p. 167–178, illust.
MAYERS, D. E. (1947) Turquoise from the reservation. *Jewelers' Circ.-Keystone*, May, p. 250–252, 304–306, 315.
MERA, H. P. (1960) *Indian Silverwork of the Southwest* Illustrated. Vol. 1. Globe, AZ: Dale Stuart King, 122 p., illust.
OPPEL, A. (1896) Die altmexikanishen Mosaiken. *Globus* 70, 1, p. 4–12, illust.
PEPPER, G. H. (1905) Ceremonial objects and ornaments from Pueblo Bonito, New Mexico. *Amer. Anthropologist* 7, 2, p. 183–197, illust.
POGUE, J. E. (1912) The aboriginal use of turquoise in North America. *Amer. Anthropologist* 14, p. 437–466. *See also* 1915 *above.*
READ, C. H. (1895) On an ancient Mexican headpiece, coated with mosaic. *Archaeologica* 54, p. 383–398, illust.
SAVILLE, M. H. (1922) Turquois mosaic art in ancient Mexico. New York: *Mus. Amer. Indian, Heye Foundation, Contrib.* 6, 110 p., illust. (col.).
ZACHARY, R. A. (1975) Myths of the Turkey-stone. *Lapidary J.* 29, 8, p. 1524–1531, illust.

NEW JERSEY. No new developments.

KUNZ, G. F. (1905) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1904*, p. 957, in copper mine, Somerville, Somerset Co.

ALABAMA. Kunz (1904) reported turquoise "at several points near Idaho, Clay County, about 95 miles [160 km] due east of Birmingham, in the region of the Talladega Mountains." The principal deposit was located by tracing a fragment found on the surface but there was no sign of aboriginal workings nor has turquoise been found in Indian graves or among their artifacts. The turquoise occurred in compact veins of yellowish-green material from 1/8–3/4 in (3 mm–1.9 cm) thick while another type of fine blue color that "more distinctly resembles that of the Persian material" was also found. Kunz probably obtained his information from geologist E. A. Smith as suggested by Cook & Smith (1982, p. 263) quoting from Smith as the first to mention the Clay County turquoise, and who give the following remarks. "Turquoise of rather fine quality has been obtained in small amounts from a prospect pit along the old Idaho Gold Mine trend in the NW¼, Sec. 3, T20S, RTE." It occurs as thin seams in sericite-graphite schist. Two other occurrences are given by Cook & Smith, one in Cleburne County and the other in Coosa County but neither provides gem material.

COOK, R. B. & SMITH, W. E. (1982) Mineralogy of Alabama. *Geol. Survey AL Bull.* 120, 285 p., map.
KUNZ, G. F. (1904) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1902*, p. 856–857.

ARKANSAS. Some commercial production of turquoise was obtained from a deposit located near the summit of Little Porter Mountain, Polk County, in the NE¼, Sec. 23, T4SM R30W. This property has been variously called the McBride, Newton Company, McBroom, Blue Bird, and Mona Lisa. Rumor has it that turquoise was first found while prospecting for copper in the 1920s. There appears to be no evidence that the turquoise was known to the aboriginal inhabitants. The site was visited in 1974 by members of the Arkansas Geological Commission and U.S. Bureau of Mines when mining was being conducted by the Newton Company, Inc., of Denver, Colorado. Turquoise was found as fracture fillings in Arkansas novaculite along with iron and manganese oxides. Good to fair quality filling material reached up to 1/4 inch (6 mm) thick and as much as 3 inches (7.5 cm) wide. Much of it was porous and of the kind that can only be used if impregnated with plastic. At this time about 200 lbs (90 kg) of fair to good material had been produced, of which about 10 lbs (4.5 kg) was sold for $1,000. D. Smith, writing in the *Arkansas Gazette*, Little Rock, Nov. 29, 1981, interviewed Mr. Charles Mayfield who had claimed the McBride property in the mid 1970s, calling it the Mona Lisa Mine; over a period of several years this mine produced several thousand pounds of all grades of turquoise. At one time Mayfield contracted with a company in Terrell, Texas, to ship them his production which would then be processed by them and sold in the market. In an advertisement in the *Lapidary Journal* in 1980, however, Mona Lisa Mines offered the turquoise as natural, untreated material, and offered hard, "dark blue" at $20.00 per ounce (25.7 gm) or $250.00 per pound (0.45 kg); light blue was offered at $12.00/oz or $150.00/lb, while "hard green" stock was offered at $6.00/oz or $75.00/lb. F. Fellone, writing in the *Arkansas Gazette* of June 12, 1983, provided further information on Mayfield and his mining endeavors, noting that Mayfield claimed "15 tons were mined in the first year of production, 1981," presumably of all grades. Mayfield also claimed to have mined "the world's largest nugget," which was then in storage in Terrell, Texas. A less optimistic picture of the deposit and possible reserves is painted by Erickson, *et al* (1983) who notes that in November 1978 the workings consisted of a caved shaft and adit, and that at this time "the total turquoise produced was probably not more than 600 lb." Turquoise was seen at several places on the McBride property as "veins, fillings of irregular vugs, and impregnating material in weathered Arkansas novaculite," and, "the occurrences are small and the possibilities of finding larger or higher grade deposits in the area are poor." Turquoise veinlets, "not more than a millimeter in maximum thickness" and not of commercial grade, were noted elsewhere in the area in Sec. 12, T4S, R30W and Sec. 30, T4S, R38W, in the Caney Creek Wilderness.

ERICKSEN, G. E., PATTERSON, S. H., DUNN, M. L. & HARRISON, D. K. (1983) Mineral resources of the Caney Creek Wilderness, Polk County, Arkansas. *U.S. Geol. Survey Bull.* 1551, p. 39–40.

TEXAS. Pogue (1915, p. 58) mentions turquoise obtained in 1884 from a locality north of El Paso and notes that in "about 1910 a small quantity of greenish material, obtained from near Van Horn, in El Paso County, was cut into matrix stones." The latter deposit was briefly described by King (1961, p. 31) as furnishing turquoise only in seams about 1 millimeter thick in joints in fine-grained rocks. King also mentions that "small amounts . . . have been reported near El Paso, El Paso County, and also in volcanic rocks near the Jeff Davis-Brewster County line, north of Alpine." Further, "a small amount . . . has been mined from several localities a few miles southwest of Sierra Blanca in the Sierra Blanca Mountains of Hudspeth County."

Sterrett (1914) provides further information on the Culbertson County deposit located about 5 mi (8 km) west of Van Horn which was worked intermittently from about 1909 to 1913 by the Texas Turquoise Company of El Paso. The mine is located in small hills on the northeastern flank of the Carrizo Mountains about one mile (1.6 km) south of the Texas and Pacific Railway. The workings then consisted of two small opencuts in the Carrizo formation of Algonkian rocks which are quartz-mica schist, quartzites, slates, and some igneous rocks. The turquoise is found in a "hard light-gray to pink rock in which feldspar and quartz are prominent constituents." Sterrett noted that "no real dark-blue turquoise was obtained, but some of that from the seams has a very pretty light-blue color" and "the turquoise has a hard dense texture necessary for good gems." There are also attractive matrix gems and greenish material to be had, and a little turquoise was also found in a silver/copper prospect about one mile (1.6 km) southwest of the above deposit but only a small prospect pit had been opened.

KING, E. A. (1961) Texas gemstones. *TX Bur. Econ. Geol. Rept. Invest.* 42, 42 p., illust.

POGUE, J. E. (1915) *See above.*

STERRETT, D. B. (1914) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1913*, p. 703–704, Texas.

COLORADO. Recent mining produced important quantities of gem turquoise. Carson (1977) describes the Turquoise Chief Mine within a group of turquoise mines located about 7 mi (11 km) west of Leadville, Lake County. The mine is on a mountain slope several miles north of Turquoise Lake and in 1977 was open to public fee-collecting in its opencut. Voynick (1993) also wrote about this mine, giving its location as 6 mi (9.8 km) west of Leadville and noting that it was discovered by two Navajo miners in 1935 who staked claims and proceeded to mine opencut and underground, from which workings they obtained about 1,000 lbs (455 kg) of hand-cobbed rough. There are three other turquoise prospects nearby which include the Josie May and Poor Boy mines, but neither was in operation at the time of Voynick's visit. The Turquoise Chief was worked from time to time in the 1950s and opened to fee-collecting in the 1970s, but this arrangement was halted in 1980 and the mine closed. Voynick notes that turquoise occurs as veinlets and occasional nodular masses in pale-colored Precambrian granite which is readily friable.

At Cripple Creek, Teller County, a mining venture called Bad Boys of Cripple Creek Mining Company began producing very good to fine turquoise, in blue to green colors, including nuggets, one of which weighed about 3 lbs (1.36 kg). According to Taylor (1991), the owners of the property in 1991 were Harriet Snare and David Graham of Cripple Creek. At that time fee-collecting was permitted. Much of the material is high grade, hard, and capable of taking a splendid polish. According to their advertisement in *Lapidary Journal*, April, 1992, they offered material in the color-range of "jade green to brilliant blue-matrix running brown/black/white" with "some lace available." In 1993, mine run material sold for $160.00 per pound (0.45 kg), and calibrated cabochons for $1.00 per carat in sizes from 10 to 30 mm diameter. In an earlier description, Lucian (1979) provides a map of the city and alludes to finding turquoise in the soil of certain streets!

CARSON, X. (1977) Turquoise Chief Mine. *Rock & Gem* 7, 3, p. 24–28, 30–31.

HARVEY, Mr. J. R. & HARVEY, Mrs. J. R. (1938) Turquoise among the Indians and a Colorado turquoise mine. *Colorado Mag.* 15, 5, p. 186–192.

KUNZ, G. F. (1902) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1901*, p. 760–761.

LUCIAN, A. C. (1979) Turquoise in the streets. *Rock & Gem* 9, 9, p. 70–72, map.

PEARL, R. M. (1941) Colorado turquoise localities. *The Mineralogist* 9, p. 3–4, 24–27, map.

_____, (1941) Turquoise deposits of Colorado. *Econ. Geol.* 36, p. 335–344.

PEARL, R. M. (1947) Largest turquoise nugget: A Colorado find. *Mineralogist* 15, p. 283–285. King Mine, Conejos Co.

_____, (1953) *Colorado Gem Trails.* 3rd edit. Colorado Springs, CO: Mineral Book Co. Turquoise p. 40.

POGUE, J. E. (1915) *See above.* Colorado p. 47–48.

STEIN, J. F. (1976) A quest for turquoise. *Lapidary J.* 30, 9, p. 2210–2212, maps.

STERRETT, D. B. (1909) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1908*, p. 845–853.

_____, (1911) Same, for 1909, p. 778–795.

TAYLOR, S. (1991) Turquoise and Bad Boys. *Lapidary J.* 45, 9, p. 65–66, illust.

VOYNICK, S. (1993) The Turquoise Chief Mine. *Rock & Gem* 23, 2, p. 48, 49, 91–93.

NEW MEXICO. For decades during the late 1880s into the early 1900s, New Mexico held first place in the production of turquoise but by the time that Northrop (1959) wrote about this gemstone, production had virtually ceased and has not been resumed since. Emphasizing the lack of reliable records, Northrop (p. 528) ventures estimates of production of about $9 million for the Cerillos district mines and about $5 million for the Burro Mountains mines for a possible total of $14 million for both districts. When the recent fad for turquoise was gaining momentum in the late 1960s, the demand was largely supplied by production from Arizona and Nevada mines.

Stripp (1985) describes the famous turquoise carving of an Indian pueblo formerly in the possession of Rainbow Traders of Albuquerque but now owned by Turquoise Traders of Tucson, Arizona. The rough for this enormous carving, a chalky mass originally weighing about 160 lbs (73 kg) when extracted from a mine in the Hachita Mountains, was found in 1926 by J. D. Ingraham. A section of 35 lbs (16 kg) was broken off during transport. In 1978 or 1979 the mass was "stabilized" by use of clear, colorless resin to which no coloring agent was added, the process taking one month to complete. It was then decided to send the mass to Cebu Island in the Philippines for carving, which task eventually took over a thousand hours by five native carvers. In its finished state, the mountain-shaped carving depicts a pueblo with its occupants, and a forest scene on the other side. The weight is 121 lbs (55 kg), and the color is a good blue with attractive patches of brown scattered about. The owner issued a color postcard showing the carving both from a distance and in close-up detail.

The long, distinguished history of turquoise mining in New Mexico is reflected in the many references listed below but special attention should be paid to the contributions of Pogue (1915) and Northrop (1959, 1975).

ANDERSON, E. R. (1972) Look for turquoise in the Guadelupes. *Rockhound* 1, 1, p. 24–27, illust., map. Eddy Co., NM.

BALL, S. H. (1941) The mining of gems and ornamental stones by the American Indians. *Smithson. Inst. Bur. Ethnol. Bull.* 128. NM p. 22–25.

BLAKE, W. P. (1858) The chalchihuitl of the ancient Mexicans, etc. *Amer. J. Science* ser. 2, 25, p. 227–232.

______, (1883) New locality for the green turquoise known as chalchihuite, etc. *Ibid.* ser. 3, 25, p. 197–200.

______, (1899) Aboriginal turquoise mining in Arizona and New Mexico. *Amer. Antiquity* 21, p. 183.

CARNOT, A. (1895) Sur la composition chimique des turquoises. *Soc. Fr. Mineral Bull.* 18, p. 119–123. Burro Mtns.

CLARKE, F. W. & DILLER, J. S. (1886) Turquoise from New Mexico. *Amer. J. Science* 32, p. 211–217. Also: *U.S. Geol. Survey Bull.* 42, 1886, p. 29–44.

COWAN, J. L. (1907) Turquoise mining of New Mexico. *Great Southwest Mag.*, May, p. 5.

______, (1908) The turquoise mines of New Mexico. *Mineral Collector* 15, p. 110–112.

DINSMORE, C. A. (1910) Azure turquoise mine, New Mexico. *Mining World* 33, p. 660.

DISBROW, A. E. & STOLL, W. C. (1957) Geology of the Cerillos area, Santa Fe County, New Mexico. *NM Bur. Mines & Min. Resources Bull.* 48, 73 p., illust.

FENDERSON, W. C. (1897) Turquoise mining in New Mexico. *Mining & Scient. Press* 74, p. 192.

GENTH, F. A. (1890) Contributions to mineralogy, no. 48: 4. Gold in turquoise from Los Cerillos, New Mexico. *Amer. J. Science* 40, p. 115–116.

GUSTAFSON, W. G. (1915) Geology of copper-lead-zinc-turquoise deposits, southern part of the Cerillos mining district, Santa Fe County, New Mexico. *Unpubl. master's thesis, Univ. NM,* 58 p.

HARRINGTON, E. R. (1939) Digging for turquoise in America's first mine. *New Mexico Mag.* 17, 7, p. 12–13, 45–46, map.

______, (1940) Chalchihuitl—a story of early turquoise mining in the Southwest. *Eng. & Mining J.* 141, 6, p. 57–58, illust.

HIDDEN, W. E. (1893) Two new localities for turquoise. *Amer. J. Science* 46, p. 400–402.

HYDE, D. C. (1885, ca.) *Mount Chalchihuitl; description of property and mines of the Turquoise Gold & Silver Mining Company, Los Cerrillos, Santa Fe County, New Mexico.* Promotional brochure, 15 p.

JOHNSON, D. W. (1902–1903) The geology of the Cerrillos Hills, New Mexico. *Columbia School Mines Quart.* 24, p. 173–246, 303–350, 456–500; 25, p. 69–98. Also: *Univ. NM Bull. 28,* Geol. Ser., 2, pt. 2, 1903.

JONES, F. A. (1909) Notes on turquoise in the Southwest. *South-Western Mines* 1, 12, p. 1–2, illust.

______, (1909) History and mining of turquoise in the Southwest. *Mining World* 31, p. 1251–1252.

______, (1915) The mineral resources of New Mexico. *NM School of Mines Mineral Resources Bull.* 1, 77 p., map.

KNAUS, C. L. (1948) Sky stones. *New Mexico Mag.* 26, 3, p. 22–23, 39–41.

KUNZ, G. F. (1883) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1882,* p. 493–495.

______, (1885) *Ibid.* for 1883–84, p. 767–768.

______, (1893) " " 1891, p. 544–546.

______, (1894) " " 1893, p. 693–695.

______, (1901) " " 1900, p. 41–43.

______, (1902) " " 1901, p. 760–761.

_____, (1904) " " 1903, p. 951–955.
_____, (1905) " " 1904, p. 957.
KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* NY: Scient. Publ. Co., 336 p., illust. Turquoise p. 54–65.
LAKES, A. (1901) The turquoise mines of the Cerillos Mountains in New Mexico. *Mines & Minerals* 21, p. 395–396.
LINDGREN, W., GRATON, L. C. & GORDON, C. H. (1910) The ore deposits of New Mexico. *U.S. Geol. Survey Prof. Paper* 68, 361 p., illust., maps.
MURPHY, M. O. (1962) Turquoise in the Cerrillos Hills. *Lapidary J.* 16, p. 720–740, *passim*, illust., map.
NORTHROP, S. A. (1959) *Minerals of New Mexico.* Rev. edit. Albuquerque, NM: Univ. NM Press, 665 p., map. Turquoise p. 520–535.
_____, (1975) *Turquoise and Spanish Mines in New Mexico. Ibid.*, 86 p., illust.
PAIGE, S. (1912) The origin of turquoise in the Burro Mountains, New Mexico. *Econ. Geol.* 7, 4, p. 382–392.
POGUE, J. E. (1915) The Turquois. *Memoirs, Nat. Acad. Sci.* 12, 3, 206 p., illust. (col.). NM p. 52–58.
REID, G. D. (1903) The Burro Mountains turquoise district. *Eng. & Mining J.* 75, p. 786.
SILLIMAN, B. (1858) W. P. Blake's visit to Cerrillos. *Amer. J. Science* 25, p. 227.
_____, (1880) The turquoise of New Mexico. *Science* 1, p. 289.
_____, (1881) The turquoise of New Mexico. *Amer. J. Science* ser. 3, 22, p. 67–71.
_____, (1881) Turquoise of New Mexico. *Amer. Assoc. Advancement Science Proc.* 29, p. 431–435. Cerrillos.
SIMPSON, B. W. (1961) *New Mexico Gem Trails.* Granbury, TX: Gem Trails Publ. Co., 88 p., illust., maps. Cerrillos p. 18–19.
SNOW, C. H. (1891) Turquois in southwestern New Mexico. *Amer. J. Science* 41, p. 511–512.
STERRETT, D. B. (1908) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1907*, p. 827–832.
_____, (1909) *Ibid.* for 1908, p. 845–853.
_____, (1911) " " 1909, p. 788–795.
_____, (1912) " " 1911, p. 1066–1071.
_____, (1913) " " 1912, p. 1055–1056.
_____, (1914) " " 1914, p. 699–703.
_____, (1916) " " 1914, p. 334.
STRIPP, D. M. (1985) "Million Dollar" turquoise carving. *Lapidary J.* 39, 3, p. 12, 14, 16, illust.
TALMADGE, S. B. & WOOTTON, T. P. (1937) The non-metallic mineral resources of New Mexico and their economic features (exclusive of fuels). *NM Bur. Mines & Min. Resources Bull.* 12, 159 p., illust. (maps).
ZALINSKI, E. R. (1907) Turquoise in the Burro Mountains, New Mexico. *Econ. Geol.* 2, p. 464–492.
_____, (1908) Turquoise mining, Burro Mountains, New Mexico. *Eng. & Mining J.* 86, p. 843–846.

UTAH. Very little has been published on the turquoise from the Kennecott Copper Company mine in Bingham Canyon, Salt Lake County, other than a mention in Bullock (1967, p. 48). However, in 1981, the *Lapidary Journal* (vol. 35, no. 2) placed a color photograph on its front cover of a large, gem-grade blue turquoise mass of about 16.5 lbs (7.5 kg) that was found in the Bingham open pit in March 1976. Turquoise-set jewelry is shown with the rough and is obviously of very good color. Bullock notes other localities for turquoise are in the Erickson district of Tooele County.

BULLOCK, K. C. (1967) Minerals of Utah. *UT Geol. & Mineralogical Survey Bull.* 76, 237 p., maps.

ARIZONA. In his report on Arizona gemstone production, Austin (1991, p. 2) ranked turquoise first in value and noted that "nearly all important deposits . . . are located near copper occurrences or in copper deposits in arid desert regions of the world" and "the world famous turquoise deposits associated with certain of the large Arizona copper deposits were to be expected." Most of the turquoise is hand-picked from broken rock exposures along the working benches in the open pit mines. Austin further notes that the increased acceptance of turquoise in the gem market resulted in a demand that could not be satisfied by *au naturel* material and hence "an industry emerged—the business of turquoise stabilization, reconstitution, and the manufacture of synthetic and simulated turquoise." In most instances, honest descriptions of such materials prevails, although from a practical viewpoint no buyer should expect bargains in natural turquoise, con-

FIGURE 96. Randy and Wayne Brown collecting turquoise from a freshly blasted shelf in the open-pit Morenci Copper Mine in Arizona. *Courtesy Brown Brothers Lapidary, Safford, Arizona.*

sidering that top grade natural material fetches in the rough as much as $1,000 per pound or $2,200 per kilogram.

In recent years, copper mines in Gila County furnished exceptionally fine turquoise, especially from the Sleeping Beauty Mine near Miami. Substantial quantities of fine material were also found in open pit mines at Castle Dome and Copper Cities. Collecting activities are described by Jackson (1955) who noted that during overburden stripping to expose profitable copper-bearing porphyry, hundreds of pounds of turquoise were collected, with much of it going to the German lapidary industry in Idar-Oberstein. In 1992, at the Tucson Show, light-colored, porous but treatable material from the Sleeping Beauty Mine (also known as the Pinto Valley Mine) sold for $25 per pound but prices rose steeply to $325 per pound for top-quality rough. An advertisement in 1993 for Sleeping Beauty material offered all-natural "lovely robin's-egg blue" at $1.25 per gram or about $400 per pound in pieces as much as 20 to 90 grams each. William Larson of Pala Properties International of Fallbrook, California, likens the seam turquoise to the finest Persian material and noted that some seams were found that were as much as one inch (2.5 cm) thick. From such seams splendid cabochons have been cut to 50 mm across without flaw. Much material of this quality has been sold to China, and Larson estimates that sales in the past few years may have been in the millions of dollars (*Pers. comm.* 10/93).

In Greenlee County, Wayne O. Brown, of Brown Brothers Lapidary, Safford, Arizona, provided the following interesting facts on turquoise obtained in the Phelps-Dodge open pit copper mine at Morenci (*Pers. comm.* 7/93). Brown states that his parents, William O. and Berniece Brown, received a contract to mine turquoise in the pit beginning in 1955, and continued to do so to 1984, the year of Mr. Brown's demise. However, the operation was continued by his son, Wayne. According to Brown, "Morenci Mine produces a very beautiful medium to dark blue gem turquoise," and also handsome matrix material in which pyrite is characteristically present in addition to light brown veining. About 70% of the material is medium to high grade, 20% is chalky, but treatable, and 10% is categorized as "specimen" grade. Brown notes that "over 100 tons have been mined," presumably in all grades, and that forms or shapes taken by the rough are about 70% sheet-like and 30% in nuggets or nodules. Rough prices ranged from $35 to $50 per pound for treatable chalk, $80 to $200 for medium gem grade, and from $250 to $600 per pound for high grade. Cabochons fetched from $.35 to $2.50 per carat. Wayne A. Thompson, a turquoise specialist of Phoenix, ranks Morenci material very highly but notes increasing competition from recent Chinese sources which now produce very high grade turquoise in large sizes and who are able to sell fine cabochons for as little as $1.00 per carat (*Pers. comm.* 6/93). Moolick & Durek (1966) note that in the Morenci open pit, the turquoise is closely associated with a diabase dike system that crosses the porphyry ore body.

In Graham County, in the Lone Star district of the Gila Mountains, turquoise is intimately associated with jarosite and alunite in the oxidized zone of the Safford porphyry copper deposit (Robinson & Cook, 1966).

Although it was reported in volume two that one of the turquoise mines on Turquoise Ridge, northwest of Courtland, Cochise County, had been operated in 1972, Heylmun (1986), a recent visitor, indicates that mining is at a standstill. He describes the turquoise from several mines and prospects and states that "considerable gem-quality turquoise remains undiscovered in the area," suggesting that prospecting be especially concentrated upon all outcrops of quartzite, the host rock for turquoise in this area. Sterrett (1914, p. 693–694) described these mines when they were active.

Also in Cochise County, the turquoise found in the copper mines of Bisbee is declared by Graeme (1981) to be "perhaps . . . the world's finest turquoise," referring to material recently recovered from the Lavender open pit mine. Graeme, however, notes that the turquoise has been mined commercially only in the past few years, the first lot having been found in 1953. In grade, it occurs in large sizes of exceptional compactness, uniformity of texture, and uniform blue color.

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BLAIR, G. (1967) A ton of turquoise at Kingman, Arizona. *Lapidary J.* 21, p. 992–995.

_____, (1992) *The Rockhound's Guide to Arizona.* Helena, MT: Falcon Press, 165 p., illust. (col.). Maricopa Co. p. 119.

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_____, (1899) Aboriginal turquoise mining in Arizona and New Mexico. *Amer. Antiquity* 22, p. 278–284.

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FRENZEL, A. B. (1898) A turquoise deposit in Mohave County, Arizona. *Eng. & Mining J.* 66, p. 697.

GRAEME, R. W. (1981) Famous mineral localities: Bisbee, Arizona. *Min. Rec.* 12, 5, p. 259–319, illust. (col.).

GUILD, F. N. (1910) *The Mineralogy of Arizona.* Easton, PA: Chemical Publ. Co., 103 p.

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JACKSON, D. (1955) Turquoise in eastern Arizona. *Gems & Minerals* 212, p. 52–53.

JOHNSTON, B. (1964) A newly discovered turquoise mine of prehistory, Mohave County, Arizona. *Kiva* 29, 3, p. 76–83. Ithaca Peak.

_____, (1966) Ancient turquoise mine and tunnel with tools rediscovered near Kingman, Arizona, *Lapidary J.* 20, 2, p. 309–315, *passim,* illust.

JONES, R. W. (1975) Arizona turquoise. *Rock & Gem* 5, 9, p. 54–59, illust. Morristown, Maricopa Co.

KUNZ, G. F. (1883) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1882,* p. 493–495. Cochise Co.

______, (1890) *Same,* for 1889, p. 60, Mineral Park, Mohave Co.

______, (1899) Precious stones. Ch. in *20th Ann. Rept. U.S. Geol. Survey for 1898–99,* p. 581, Kingman.

______, (1902) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1901,* p. 761, Mohave Co.

______, (1904) *Same,* for 1902, p. 857–858, archeology of.

MINING & SCIENTIFIC PRESS (1902) Turquoise mining in Arizona and New Mexico. Vol. 85, 8, p. 102–103, illust.

MOOLICK, R. T. & DUREK, J. J. (1966) The Morenci district, in *Geology of the Porphyry Copper Deposits, Southeastern North America.* Tucson, AZ: Univ. AZ Press, p. 221–231.

MOORE, R. T. (1968) Mineral deposits of the Fort Apache Indian Reservation, Arizona. *AZ Bur. Mines Bull.* 177, 84 p., maps.

PETERSON, N. P., GILBERT, C. M. & QUICK, G. L. (1946) Hydrothermal alteration in the Castle Dome copper deposit, Arizona. *Econ. Geol.* 41, 8, p. 820–840, illust. (maps).

PETERSON, N. P. (1947) Phosphate minerals in the Castle Dome copper deposit, Arizona. *Amer. Mineral.* 32, 9–10, p. 574–582. Gem turquoise.

PETERSON, N. P., *et al* (1951) Geology and ore deposits of the Castle Dome area, Gila County. *U.S. Geol. Survey Bull.* 971, 134 p., illust. (maps.).

PETERSON, N. P. (1962) Geology and ore deposits of the Globe-Miami district, Arizona. *U.S. Geol. Survey Prof. Paper* 342, 151 p., illust. (maps).

POGUE, J. E. (1915) The Turquoise. *Memoirs Nat. Acad. Science* 12, 3, p. 44–46, Cochise and Mohave counties.

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ROBINSON, R. F. & COOK, A. (1966) The Safford copper deposit, Lone Star mining district, Graham County, Arizona. In *Geology of the Porphyry Copper Deposits, Southwestern North America.* Tucson, AZ: Univ. AZ Press, p. 251–266.

SAYRE, J. (1966) Turquois. *Gems & Minerals* 343, p. 22–23. Mineral Park.

SCHRADER, F. C. (1907) The mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona. *U.S. Geol. Survey Bull.* 340, p. 53–83.

SIMMONS, W. W. & FOWELLS, J. E. (1966) Geology of the Copper Cities mine. In *Geology of the Porphyry Copper Deposits, Southwestern North America.* Tucson, AZ: Univ. AZ Press, p. 151–156.

SMITH, H. M. (1939) Turquoise in Arizona. *The Mineralogist* 7, p. 295–296, 314–317.

STERRETT, D. B. (1909) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1908,* p. 847–852, Mohave Co.

VAN VALKENBURGH, R. (1947) Trail to turquoise. *Desert Mag.* 10, 4, p. 5–8, illust., map. Courtland.

WILSON, E. D. (1927) Geology and ore deposits of the Courtland-Gleeson region, Arizona. *Univ. AZ Bull. 123,* Geol. Ser. 5, 79 p., illust.

NEVADA. According to Austin (1991), "Nevada has been a major producer of turquoise since the 1930s, and until the early 1980s, the state was the largest producer in the United States." About 75–100 mines and prospects produced turquoise and a rough estimate of the total production up to 1991 falls between $40 and $50 million. In an earlier paper, Morrissey (1968) estimated production at about $30 million for rough but much more in terms of cut stones. Morrissey's paper remains the fullest account of the many mines and prospects in the state up to the date of publication. However, Nevada production has been steadily declining and the top producer is now Arizona. In 1990, the U.S. Bureau of Mines directory of principal gemstone producers in the United States as of 1989 listed only twelve turquoise mining ventures in the state. In a recent collector's guidebook by Klein (1983), directions are given for reaching deposits in Elko, Eureka, Lander, Douglas, Lyon, Mineral, Nye, Esmeralda, and Clark counties.

AUSTIN, G. T. (1991) Gemstone production in Arizona . . . etc. *U.S. Bur. Mines Mineral Industry Surveys, Ann. Advance Summ.,* 35 p., maps.

______, (1991) Gemstone production in Nevada. *Colored Stone Mag.,* Jan./Feb., p. 20–21.

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CARSON, X. (1975) Turquoise in Nevada. *Rockhound* 4, 4, p. 4–7.

DAKE, H. C. (1932) Turquoise in Nevada. *Rocks & Minerals* 7, 3, p. 94–97.

EAKLE, A. S. (1912) The minerals of Tonopah, Nevada. *Univ. CA Dept. Geol. Bull.* 7, p. 1–20. Turquoise p. 17.

ENGINEERING & MINING JOURNAL (1897) Turquoise in Nevada. Vol. 64, 16, p. 456.

HOFFMANN, W. J. (1878) On the mineralogy of Nevada. In *U.S. Geol. & Geogr. Survey of the Territories (Hayden), vol. 4, Bull.* 3, p. 740. Columbus.

KLEIN, J. (1983) *Where to Find Gold & Gems in Nevada.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

KUNZ, G. F. (1883) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1882*, p. 493.

______, (1898) *Ibid.* for 1897–1898, p. 504.

______, (1899) Precious stones. Ch. in *20th Ann. Rept. U.S. Geol. Survey for 1898–99*, p. 580, Simmons Mine.

______, (1902) Precious stones. Ch. in *U.S. Geol. Survey Mineral resources of the U.S. for 1901*, p. 760–761, Nye Co.

MORRISSEY, F. R. (1968) Turquoise deposits of Nevada. *NV Bur. Mines Rept.* 17, 30 p., map.

MURBARGER, N. (1953) Turquoise miner in Nevada. *Desert Mag.* 16, 1, p. 4–9. Battle Mountain.

NYE, N. C. (1982) The Number Eight Mine. *Lapidary J.* 35, 10, p. 2124.

POGUE, J. E. (1915) The Turquois. *Memoirs Nat. Acad. Science* 12, 3. NV p. 48–51.

STERRETT, D. B. (1909) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1908*, NV p. 846.

______, (1911) *Ibid.* for 1909, NV p. 781–788.

______, (1911) " " 1910, NV p. 885–887.

______, (1914) " " 1913, NV p. 697–699.

STEWART, J. H., McKEE, E. H. & STAGER, H. K. (1977) Geology and mineral deposits of Lander County, Nevada. *NV Bur. Mines & Geol. Bull.* 88, 106 p., illust., maps. Turquoise p. 75, 78, 79, 95.

STRONG, M. F. (1974) Nevada's Crow Springs. *Desert Mag.*, Aug., p. 20–23, map.

WEIGHT, H. O. (1948) Ghost town miners. *Desert Mag.*, May, p. 17–20. Columbus.

CALIFORNIA. In San Benito County, Pemberton (1983, p. 322) notes a hitherto unrecorded turquoise deposit on the basis of a personal message from C. W. Chesterman. The turquoise occurs as "narrow veins . . . cutting glaucophane schist . . . about 4.5 miles [7.2 km] north of Llanada (Sec. 33, T14S, R10E, M.D.M.), in the Panoche Valley." It is mentioned by Mrose, *et al* (1967), but neither Pemberton nor Mrose, *et al* mention its suitability for gems.

In San Bernardino County, Pemberton (1964) reexamined early reports of the turquoise mines in the area located a few miles northwest and northeast of Halloran Spring off Highway I-15, the latter turnoff located about 12 mi (19 km) east-northeast of Baker. He noted that the famous Himalaya and Toltec mines were reversed in location because of an error in a map drawn by M. J. Rogers (1929). As shown in Figure 97, the Himalaya Mine group, including Nazelrod's Apache Canyon Mines, is correctly placed at the west extremity of the area (West Camp mines), and the Stone Hammer Mine in the center of the deposit belt, which runs nearly due east. The mines are located thus: Himalaya Mine, about 5 mi (8 km) northwest of Halloran Spring; Stone Hammer Mine, about 3.5 mi (5.6 km) north-northwest of Halloran Spring and about 2.3 mi (3.7 km) due east of the Himalaya Mine. The Toltec Mine is about 2.6 mi (4.1 km) northwest of Halloran Summit or about 8 mi (13 km) due east of the Himalaya Mine. All area roads are dirt-surfaced except for a paved road that leads to the summit of Turquoise Mountain, atop which is a microwave relay tower. These positions have been confirmed by Edward Nazelrod, owner and operator of the West Camp mines group. The turquoise mines are not included in the recently established East Mohave National Park.

In 1977, I received a letter from Robert and Mary Paoli of Fort Bragg, California, giving an account of their finding of turquoise pseudomorphs after an unknown crystallized mineral, with the turquoise reproducing fairly well the angles and flat planes of the original crystals. The locality for this material is given as on the Silurian Mountain, about 16 mi (25 km) northeast of

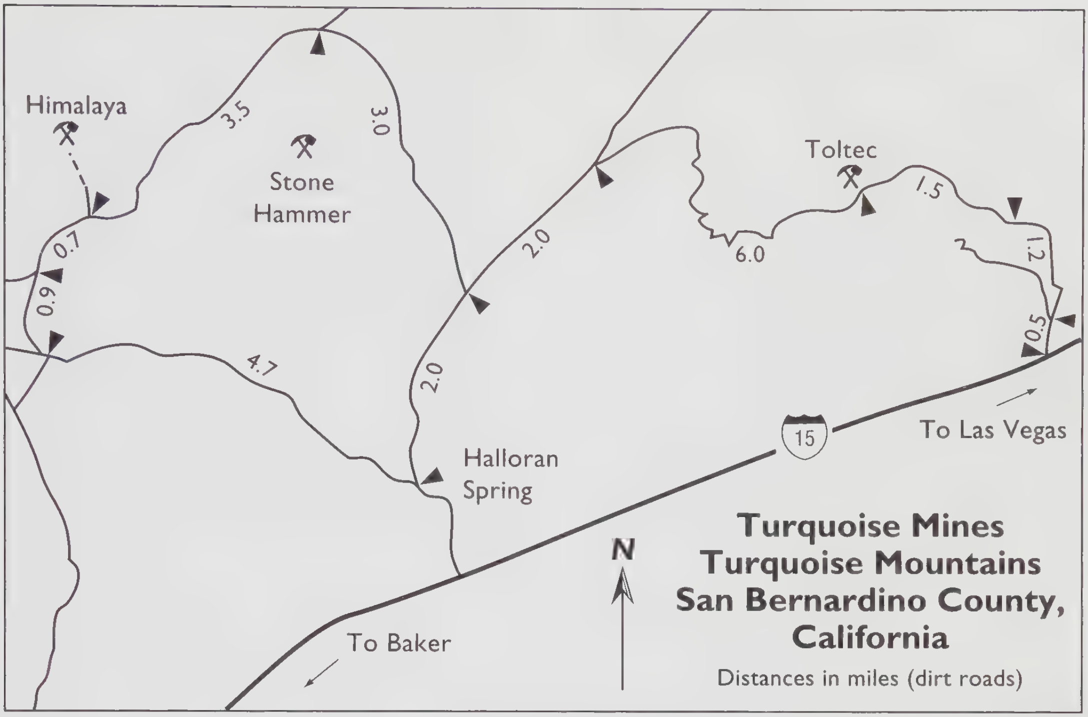

FIGURE 97. Sketch map of the turquoise mines in San Bernardino County, California, from information supplied by H. E. Pemberton and E. Nazelrod of Apache Canyon Mines, Baker, California.

Baker and "just northwest" of the Toltec Mine. At this time the Paolis owned three 20-acre claims "along with our partner Ed Nazelrod." They began mining turquoise in 1972 and after chancing upon the account of crystallized turquoise from Virginia (Pogue, 1915), they looked for and found "crystals" of turquoise which proved to be pseudomorphs rather than true crystals of the species. In 1975, Mrs. Paoli found a turquoise mass of simple matchbox shape, which, according to her sketch, measures about 1.7 in (4 cm) long, somewhat less in depth, and still less in thickness. As its significance was not recognized at the time, this record-size pseudomorph was sliced up to make cabochons! Color transparencies received from the Paolis depict other matrix specimens with partly imbedded "crystals." The matrixes are quartz, feldspar, and clays. The light blue pseudomorphs are distinctly "blocky," suggesting a former orthorhombic species, in contrast to other turquoise pseudomorph "crystals" found by the late Edward McGinnis in Nevada in 1971 and described in Vol. II. (p. 139–140). A drawing of another California turquoise pseudomorph appears in Kunz (1890, p. 61); morphologically it resembles apatite as do the specimens found by McGinnis. It appears that turquoise is capable of occupying the space left by chemical removal of a number of species but the mode by which this is accomplished is not clear, especially when no remnants of former mineral crystals have been found to confirm the identity of the mineral replaced. In this regard, the Paolis consulted Dr. C. W. Chesterman, who was of the opinion that the mineral replaced was barite. Further information on this most interesting occurrence is given by Mr.

Edward Nazelrod, owner of the Apache Mining Company of Baker, California (*Pers. comm.* 4/28/85; *see also* his articles of 1977 and 1985).

Nazelrod notes the presence of many filled-in excavations for turquoise in the mining area, possibly numbering as many as two hundred, from small to large pits and even deeper mines. About 17 diggings were tested on four lode claims in the West Camp area; collectively these are called the Apache Canyon Mines group, and are owned jointly by the Paolis and Nazelrod. Current production is from the Renee Blue Mine, noted for spiderweb material and yielding the largest nugget so far found of good quality, weighing 3 lb 1 oz (1,390 gm); the El Producto Mine, jointly owned with the Paolis; the New Himalaya Mine, discovered only in 1990 and producing excellent fine blue nuggets from pegmatitic zones and within "silvery" (micaceous?) clay fissure fillings, and deemed to be the most important mine in the group; and the Upper Himalaya Mine, discovered on New Year's Day of 1987 at a place just above the Main Himalaya Mine. This last mine produces turquoise in all colors and qualities.

A good review of the turquoise pseudomorph problem is also furnished by Nazelrod (1984) who notes that the first mention of the Fresno County specimens was made by J. D. Whitney in 1864, and that these were later studied by Moore & Zepharovich (1885) who deemed them to be replacements of apatite. Nazelrod found pseudomorphs in his Apache Canyon Mines in 1974 at the same time as the Paoli discoveries in the latter's Cube Mine in the same area.

FIGURE 98. Turquoise pseudomorphs. LEFT: Fresno County, California, as redrawn from G. F. Kunz's *Gems and Precious Stones of North America*. RIGHT: small crystal on clayey matrix, Mineral County, Nevada (0.75 in., 1.8 cm tall).

In an advertising leaflet issued by the Nazelrod, his best grade of turquoise is called "turquoise of the old rock," which material is stated to be so dense that its color will remain unchanged. The specific gravity is 2.77 to 2.8 and the hardness, enough to scratch glass, is Mohs 6.5. In 1993, he offered pseudomorphs for sale also, noting that "these pseudomorphs are generally small, from about 1/8th inch up to 1/2 inch, and occasionally larger, the largest known is 7/8ths of an inch," and asking $5 to $10 for smalls, up to $15 to $35 for mediums, and $40 to $100 for those up to one- half inch "according to color and excellence of shape." Cabochons were offered at $1.50 to $3.00 per carat, while rough sold from $35 to $200 per ounce, but lesser quality turquoise, somewhat porous, sold in cabochons for $.50 to $2.00 per carat, and the rough for $7 to $35 per ounce.

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BERKHOLZ, M. F. (1952) Turquoise of the desert Mohaves. *Mineral Notes & News* 183, p. 7, 44, map. Toltec Mine.

______, (1953) A guide to the Toltec Mine. *Ibid.* 186, p. 7.

EISEN, G. (1898) Long lost mines of precious gems are found: The prehistoric turquoise mines of California . . . *San Francisco Call*, Mar. 18, p. 2; Mar. 19, p. 6; Mar. 27, p. 17.

GAMBLE, R. C. (1960) Turquoise in the Last Chance Range. *Gems & Minerals* 276, p. 52, 54, illust. Inyo Co.

HEIZER, R. F. & TREGANZA, A. E. (1944) Mines and quarries of the Indians of California. *CA Div. Mines & Geol., Rept. State Mineralogist* 40, 3, p. 291–359.

HENRY, D. J. (1957) *California Gem Trails.* 3rd edit. Long Beach, CA: Lowell R. Gordon, 101 p., p. 66.

HILTON, J. W. (1938) Turquoise on the Mohave. *Desert Mag.* 1, 11, p. 9–11.

HORD, D. (1962) The prehistoric turquoise mines of California. *Lapidary J.* 16, 8, p. 785, map. San Bernardino Co.

INGALLS, D. (1949) Turquoise hunters have field day. *Desert Mag.* 12, 5, p. 13–15. Lone Pine, Inyo Co.

KUNZ, G. F. (1890) *Gems and Precious Stones of North America.* New York: Scient. Publ. Co. Turquoise pseudomorphs p. 61.

______, (1898) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1897–98*, p. 504.

______, (1899) *Ibid.* for 1898, p. 582–583.

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______, (1905) Gems, jeweler's materials, and ornamental stones of California. *CA State Mining Bur. Bull.* 37, 171 p., illust., map. San Bernardino Co. p. 12–13, 107–110.

LAWBAUGH, A. L. (1951) Where turquoise was mined by the ancients. *Desert Mag.*, Aug., p. 9–12.

MINERAL COLLECTOR (1898) A turquoise mine in Death Valley, California. Vol. 5, 1, p. 14–15.

______, (1898) Turquoise beds in the West. Vol. 5, 5, p. 80.

MITCHELL, J. R. (1979) Turquoise and talc. *Rockbound* 8, 2, p. 24–27, map.

______, (1986) *Gem Trails of California.* Baldwin Park, CA: Gem Guides Book Co. Toltec Mine p. 72, map.

MOORE, G. E. & ZEPHAROVICH, V. V. (1885) Kallait pseudomorph nach Apatit aus Californien. *Zs. Krist.* 10, p. 240–251.

MORTON, P. K. (1977) Geology and mineral resources of Imperial County. *CA Div. Mines & Geol.County Rept.* 7, 104 p., illust., map. Possible turquoise source in Chocolate Mtns.

MROSE, M. E., *et al* (1967) Nissonite . . . a new hydrous copper phosphate mineral from the Panoche Valley, California. *Amer. Mineral.* 52, 5/6, p. 927.

MURDOCH, J. & WEBB, R. W. (1966) Minerals of California. Centennial Volume (1866–1966). *CA Div. Mines & Geol. Bull.* 189, p. 375–376.

NAZELROD, E. (1977) Recent developments in the Turquoise Mountains of California. *Lapidary J.* 31, 9, p. 1982–1989.

______, (1984–1985) Turquoise—inside and out. *Lapidary J.* 38, 9, p. 1152–1190, *passim*, illust.; 10, p. 1304–1319.

PEMBERTON, H. E. (1964) Place names in the Turquoise Mountains. *The Mineralogist* 32, p. 10–13, maps.

______, (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps, p. 322.

PERRY, L. E. (1986) Turquoise, amethystine and "ros-

alite" at the Clark Mountains. *Gems & Minerals* 578, p. 6, 7, 24, 26, map.
POGUE, J. E. (1915) The Turquois. *Mem. Nat. Acad. Sci.* 12, 3. CA p. 46–47.
ROBERTSON, D. (1970) From collecting to creating. *Desert Mag.*, April, p. 30, 31. Toltec Mine.
STERRETT, D. B. (1911) Gems and precious stones. Ch. in *U.S. Geol. Survey Min. Resources U.S. for 1909*, p. 778–795.
_____, (1912) *Ibid.* for 1911, p. 1065–1073.
_____, (1914) " " 1913, p. 694–697, Turquoise Mtns.
STRONG, M. F. (1963) The Toltec revisited. *Gems & Minerals* 312, p. 20–22, map.
_____, (1971) *Desert Gem Trails.* Rev. edit. Mentone, CA: Gembooks, 80 p., maps. Toltec Mine p. 31–32, map.
_____, (1977) Mojave Desert turquoise. *Desert Mag.* 40, 4, p. 32–35, map. Toltec Mine.

SONORA. As may be expected, the open pit porphyry copper mines in this state also produce turquoise, most of it coming from the large mine at Nacozari, and some from Cananea. Much of the so-called "green turquoise" comes from Cananea. Panczner (1987, p. 383) characterizes the Cananea material as "extremely pure and considered 'chalk,' but will treat [impregnate] very well." Similarly, turquoise from the La Caridad Mine in Nacozari also yields chalk turquoise in nodules, some to 15 in (28 cm) in diameter! Panczner also mentions turquoise from the La Barranca Mine in the Municipio de Onavas. Because of similar geological conditions, porphyry copper deposits south of the U.S. border should yield much fine turquoise as they are exploited in the future.

BLAKE, W. P. (1858) Chalchihuitl of the ancient Mexicans. *Amer. J. Science* ser. 1, 25, p. 227.
CASO, A. (1965) Lapidary work, goldwork, and copperwork from Oaxaca. *Handbook of Middle American Indians*, vol. 3, Archaeology of southern Mesoamerica, part 2, Austin, TX: Univ. Texas Press.
CROSS, C. (1971) *Baja California, Mexico.* 1970–1971 Edition. N. Palm Springs, CA: Cliff Cross Guidebooks, 170 p., illust., maps. Several turquoise mines located.
ENGINEERING & MINING JOURNAL (1901) [Report on two deposits of turquoise found by J. Owen in volcanic rock, La Barranca copper mining district, Sonora.] Vol. 71, p. 347.
KUNZ, G. F. (1902) Gems and precious stones of Mexico. *Trans. Amer. Inst. Mining Eng.* 32, p. 55–93. "Turquoise is not known to-day as occurring in Mexico." p. 92.
_____, (1904) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1903.* Turquoise in Zacatecas p. 951–955.
MINERAL COLLECTOR (1904) Discovery of Mexican turquoise mine. Vol. 11, 5, p. 80. Santa Rosa district, near Bonanza, Zacatecas.
MURRAY, H. (1963) Mine for sale. *Desert Mag.* 26, 6, p. 5. Baja California turquoise mine.
PANCZNER, W. D. (1987) *Minerals of Mexico.* NY: Van Nostrand Reinhold, 459 p., illust. (col.), maps, p. 383.
SALINAS, L. S. (1923) Catalogo sistematico de especies minerales de Mexico y sus aplicaciones industriales. Mexico, D. F.: *Inst. Geol. Mexico Bol.* 40, 290 p.

ULEXITE

CALIFORNIA. Fibrous polished seam pieces of fibrous ulexite, forming the so-called "television stone," continue to be sold in shops and shows. They are from material obtained mostly from the Mohave Desert deposits.

BAUR, G., *et al* (1957) Image projection by fibrous materials. *Amer. Mineral.* 42, p. 697–699. Ulexite included.
DIETZ, R. W. (1957) "Television" ulexite. *Gems & Minerals* 232, p. 16–17.
MITCHELL, J. R. (1985) The minerals of Boron. *Gems & Minerals* 568, p. 64–67, map.
_____, (1986) *Gem Trails of California.* Baldwin Park, CA: Gem Guides Book Co. Ulexite p. 90, map.
PEMBERTON, H. E., ed. (1960) *The Minerals of Boron, California.* Montebello, CA.: The Mineral Research Soc. CA, 40 p., illust.
PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps, p. 256–259.
PUFFER, J. H. (1975) The Kramer borate mineral

assemblage. *Min. Rec.* 6, 2, p. 84–91.

SCHALLER, W. T. (1930) Borate minerals from the Kramer district, Mohave Desert, California. *U.S. Geol. Survey Prof. Paper* 158-I, p. 137–170, illust.

STRONG, M. F. (1966) *Desert Gem Trails.* Mentone, CA: Gembooks, p. 45, map.

VONSEN, M. (1951) Borates of California. *Rocks & Minerals* 26, p. 494–503, illust., map.

UNAKITE

According to the American Geological Institute's *Glossary of Geological Terms* (1957), unakite is a "metamorphosed granitic igneous rock composed of abundant [green] epidote and pink orthoclase, oxides, apatite, and zircon." The lesser-known species are generally inconspicuous, so that at first glance unakite seems composed entirely of an angular patchwork of yellowish green epidote and pink to brownish-pink feldspar. Because of its compactness, ease of tumbling, and ability to accept of a very good polish, unakite is now a standard ornamental stone much used in cabochons, beads, small carvings, and the like. While its name was derived from the Unaka Mountains in the Appalachian Chain, many similar-appearing rocks are given the same name as a matter of marketing convenience, especially if they present a patchwork of green and pink blotches. For more information on this material, the works of Van Landingham listed below are most useful.

BRADLEY, F. H. (1874) On unakite, an epidotic rock from the Unaka Range, on the borders of Tennessee and North Carolina. *Amer. J. Science* 3rd ser., 7, p. 519–520.

OWENS, V. S. (1977) Unakite. *Lapidary J.* 31, 1, p. 182, 184, illust.

VAN LANDINGHAM, S. L. (1959) The gem granites. *Gems & Minerals* 256, p. 24–29, 88, maps; 257, p. 21–27, maps.

_____, (1962) Unakite. *Ibid.* 297, p. 28–31, maps.

WATSON, T. L. (1910) Granites of the Southeastern Atlantic States. *U.S. Geol. Survey Bull.* 426, p. 73, 77, 78, 111–112, 157–159.

ZEITNER, J. C. (1968) *Appalachian Mineral & Gem Trails.* San Diego, CA: Lapidary Journal, 134 p., illust., maps. Many localities in VA, TN, NC.

QUEBEC. Sabina (1974, p. 45) describes an ornamental rock that takes a good polish which resembles unakite inasmuch as it displays grains of green epidote within a red to pink granite. Specimens are found on the dumps of the Eldrich Mines near the northwest end of Lac Flavrian, Abitibi County, about 14.4 km (9 mi) by road northwest of Evain.

ONTARIO. Sabina (*Ibid.*, p. 31) also notes "an epidote-quartz-feldspar rock suitable for polishing" at the Argonaut (Huronia) Mine, located along the west shore of Beaverhouse Lake, Gauthier Township in the Larder Lake area.

SABINA, A. P. (1974) Rocks and minerals for the collector: Kirkland Lake-Noranda-Val d'Or, Ontario and Quebec. *Geol. Survey Canada Paper* 73-30, 162 p., illust., maps.

NEW JERSEY. No new developments.

LEWIS, J. V. (1909) Building stones of New Jersey. *Geol. Survey NJ Ann. Rept. State Geologist for 1908*, p. 53–124, col. illust.

VIRGINIA. No new developments.

JONES, W. H. (1951) Unakite—where to get it and how to cut it. *Lapidary J.* 5, 1, p. 4–6, map.

_____, (1954) Old Dominion minerals, Virginia unakite. *The Mineralogist* 22, p. 3–5.

LIVINGSTON, J. J. (1954) In the Blue Ridge Mountains of Virginia. *Lapidary J.* 8, 1, p. 4–6, 8, map.

PENICK, D. A. (1992) Gemstones and decorative-ornamental stones of Virginia. *Virginia Minerals* 38, 3, p. 17–26, illust. p. 26.

PHALEN, W. C. (1904) A new occurrence of unakite—a preliminary paper. *Smithson. Inst. Misc. Coll.* 45, p. 306–316, illust.

VAN LANDINGHAM, S. L. (1962) *See above.*

WATSON, T. L. (1907) *Mineral Resources of Virginia.* VA Jamestown Expo. Comm., Lynchburg, VA: J. P. Bell Co., 618 p., maps, p. 30–31.

_____, (1906) Occurrence of unakite in a new locality in Virginia. *Amer. J. Science* 22, p. 248.

TENNESSEE. Austin (1991, p. 20) notes that unakite is available in "large quantities and good grade" in the Unaka Mountains of Unicoi County, the Roan Mountains in Carter County, along the North Carolina border in Cocke County, and on Bluffton Mountain, Rag Mountain, and in the Great Smokies in Sevier County.

AUSTIN, G. T. (1991) Gemstone production in AZ, CO, ID, MT, NC, OR, ME, UT, NV and TN. *U.S. Bur. Mines Mineral Industry Surveys*, 35 p., maps.

ROCKS & MINERALS (1945) Unakite in Tennessee. Vol. 20, p. 217.

GEORGIA. Cook (1978, p. 117) cites Hurst & Crawford (1964, p. 114) on epidote as follows: "unusually attractive unakite . . . found as float along Sutton Mill Creek near Bethlehem Church, approximately 2 miles (3.2 km) northwest of Clarkesville," in Habersham County.

COOK, R. B. (1978) Minerals of Georgia. *GA Geol. and Water Resources Div. Bull.* 92, 189 p.

HURST, V. J. & CRAWFORD, T. J. (1964) Exploration of mineral deposits in Habersham County, Georgia. Wash., DC: *U.S. Dept. Commerce Area Development Admin.*, 180 p.

WISCONSIN. Van Landingham (1962, p. 29) suggests that "although epidotization has not developed to a great extent, the Waupaca red granite of Waupaca County can be termed unakite." A colored illustration of this stone in Buckley (1898, p. 126) depicts a primarily rose-colored material composed of large roundish red feldspar grains, about 0.75 in (2 cm) in diameter, rimmed in part by yellow-green epidote and with spaces between the grains filled by grayish quartz and other dark minerals. The grain size is much larger than the usual run of unakites from the Appalachian states and possibly the material would be better suited for large ornamental objects than for cabochons or beads.

BUCKLEY, E. R. (1898) On the building and ornamental stones of Wisconsin. *WI Geol. & Nat. Hist. Survey Bull. 4*, Econ. Ser. 2, 544 p, illust. (col.).

VAN LANDINGHAM, S. L. (1962) *See above.*

VARISCITE

Some excellent compact carving-grade variscite was mined in the 1980s in Lander County, Nevada, (*see below*) but apparently very little production occurred elsewhere and the beautifully patterned nodules of the Fairfield (Clay Canyon) deposit are objects of the past. The latter are rarely offered and fine, complete nodule sections of 5 or 6 inches (12–15 cm) in diameter fetch many hundreds of dollars. However, in 1990, according to Austin (1991, p. 9), some variscite was mined from the Lucin, Box Elder County, deposit. At the Tucson Show in 1994, Lucin variscite was offered in intricate carvings executed in Indonesia.

UTAH. Thomssen (1991) reviews the history of mining for the celebrated variscite nodules from the Clay Canyon, Fairfield, Utah, deposit, noting that there is no current commercial production. He describes the local geology, the nature of the deposit, and the mineralogy, discussing the origin of the nodules and giving details on the habits, associates, and properties of the numerous minerals that are found in the nodules. Confirmed species are variscite, crandallite, goyazite, wardite, millisite, gordonite, montgomeryite, overite, englishite, kolbeckite, carbonate-fluorapatite, and alunite, calcite, and quartz in the argillitic limestone matrix. Discredited species are deltaite, dernite, lewistonite, davisonite, and lehiite. The color of the variscite is attributed to about 0.53 weight percent of vanadium plus 0.069% chromium. Thomssen supplies a long list of references that are mainly of interest to mineralogists who wish to sort out the numerous minerals within the nodules. Doelling (1976) provides excellent histories of the three variscite deposits in Utah, namely the Clay Canyon deposit, just noted, the Lucin deposit, and the Amatrice Hill deposit which will be discussed below.

The well-known variscite deposit on Amatrice Hill, Tooele County, consists of nodular masses of variscite in a large variety of sizes and shapes and with various internal patterns, as shown in Doelling's illustrations; the nodules occur in brecciated zones in limestone. The deposit is located on a small knoll about 8–9 mi (13–14.5 km) east of Stockton or 9–10 mi (14.5–16 km) south of

Grantsville, in Sec. 22, T4S, R6W, on the east flank of the Stansbury Mountains. The site is reached via a dirt road that connects with the Grantsville-St. Johns road.

In the deposit, two brecciated zones in the limestone contain variscite nodules, while within the limestone are found chert nodules which are often colorful, handsomely-banded, and polishable, making them attractive as gem rough in their own way. Examples are shown in Doelling's illustrations. The variscite nodules range in size from as small as peas to as much as two feet (60 cm) across, and many of the larger masses are actually composed of several to numerous nodules cemented together, Doelling noting that "one nodule containing a "clump" of variscite bodies weighed 200 pounds [90 kg]." Internal patterns can be unbroken, solid in texture and color, or fractured and brecciated, such being cemented together with additional mineralizations. Terms such as "spiderweb" and "apple blossom" describe internal patterns, the apple blossom type being "perhaps the most common of the new material . . . is exemplified by nodules with white centers and green edges (white blossoms on a green background)."

The variscite nodules are recovered from shallow pits dug into the brecciated limestone zones by bulldozer, backhoe, and the use of explosives where necessary. According to Doelling, "in 1972 after nearly twenty years of inactivity the property was leased and subsequently purchased by James, Atkin, and Jones of Tooele, Utah, who soon discovered a remarkable find of nodules containing several tons of material," and "the development has barely proceeded into the hill [as of 1976]."

The vexing problem of making a certain distinction between variscites and similar-appearing turquoises has led to suggestions that if one cannot tell them apart the material should be called "variquoise," which term would reflect not only the colors and texture of the material, but also such similarities as veinings and occurrences in characteristic deposits (Spendlove, 1991). This problem was raised again by recent mining of such material by Nathan Bullock of Ogden, Utah, on the west side of Hansel Valley, about 15 mi (24 km) southeast of Snowville in the extreme northern edge of Box Elder County just below the Idaho border. Bullock excavated "a hard, grey, shaley clay" in which he found seams and nodular masses of variscite which range in color from very pale green to good medium-green of slightly bluish-green cast as compared to the yellowish-green of Clay Canyon variscite. A color photograph on the cover of *Rock & Gem* for September 1991 shows a considerable variety of hues in this material, as well as "spiderweb" patterns and small nodular masses enclosed in brownish, grayish, or black matrix. Most of the material takes a fine, glassy polish, including the black material, but in masses where brownish or grayish matrix is present, the polish is good only on the variscite areas.

According to Spendlove (1978) this material was known perhaps as early as the turn of the century when the deposit was prospected as a possible copper ore deposit, but it has been investigated more fully only in the 1980s. Bullock, owner and operator of the mine, found evidence of Indian mining and suggests that the variscite was used by prehistoric inhabitants much like turquoise from other places in the Southwest. Ball (1941, p. 45) noted that variscite was used by the ancient Pueblo peoples of the region that is now Utah.

As to the identity of this material, a heat-treatment test tried upon typical specimens from this deposit failed to produce the lavender color that so typically appears when Clay Canyon variscite is strongly heated. I know of no definitive chemical analysis of this material and therefore have used the term "variscite" only until the identity is confirmed or denied.

Because of difficulties in operating the mine properly, the claim and the working rights were transferred to Carl Cobia of Snowville, Utah, who now calls the mine "The Blue Lady." At the time Spendlove wrote his report (1991) the deposit was covered over by dump material and lay dormant.

AUSTIN, G. T. (1991) Gemstone production in AZ, etc. *U.S. Bur. Mines Mineral Industry Surveys*, 35 p., maps.

BALL, S. H. (1941) The mining of gem and ornamental stones by American Indians. *Smithson. Bur. Ethnol. Bull. 128, Anthropol. Papers* 13, 77 p., illust., maps.

BIXBY, M. (1912) Gem minerals of Utah. *Salt Lake Mining Review* 14, March 30, p. 19–20.

______, (1959) A catalogue of Utah minerals and localities. *UT Geol. Mineral. Survey Reprint* 60, 36 p.

BRIGGS, H. E. (1932) Amatrice. *Rocks & Minerals* 7, 1, p. 97

BULLOCK, K. C. (1967) Minerals of Utah. *UT Geol. Mineral. Survey Bull.* 76, p. 176.

DICKERSON, P. (1971) New notes from Utah's treasure chest. *Lapidary J.* 25, 6, p. 830–841. Clay Canyon.

DICKERSON, P. & DICKERSON, F. (1974) Exciting notes from Utah's treasure chest. *Ibid.* 29, 12, p. 1828–1833, illust. Amatrice Hill.

DOELLING, H. H. (1973) Amatrice Hill variscite deposit, Tooele County, Utah. *UT Geol. Mineral. Survey Rept. Invest.* 74, 2 p.

______, (1976) Amatrice Hill variscite deposit, Tooele County, Utah. *Utah Geology* 3, 1, p. 13–22, illust., maps.

GILLULY, J. (1932) Geology and ore deposits of the Stockton and Fairfield quadrangles, Utah. *U.S. Geol. Survey Prof. Paper* 173, 171 p., illust., maps.

HAYES, J. J. (1944) Variscite and phosphates in Utah. *UT Mineral. Soc. Bull.* 5, 1, p. 33–47.

HEMRICH, G. (1963) Variscite—an American gemstone. *Gems & Minerals* 311, p. 14–17.

JONES, R. W. (1974) Variscite. *Rock & Gem* 4, 12, p. 52–59, 80–81, illust.

KUNZ, G. F. (1895) Precious stones. Ch. in *U.S. Geol. Survey 16th Ann. Rept.*, part 4, p. 602–603.

LARSEN, E. S. & SHANNON, E. V. (1930) The minerals of the phosphate nodules near Fairfield, Utah. *Amer. Mineral.* 15, p. 307–337, illust.

LARSEN, E. S. (1942) The mineralogy and paragenesis of the variscite nodules from near Fairfield, Utah. *Amer. Mineral.* 27, p. 281–300, 350–372, 441–451.

MONTGOMERY, A. (1970) The phosphate minerals of Fairfield, Utah. *Rocks & Minerals* 45, p. 667–674, 739–745; 46, p. 3–9, 75–80.

PACKARD, K. L. (1894) Variscite from Utah. *Amer. J. Science* 47, p. 297–298.

PALMER, C. (1975) Rare and beautiful gem, variscite, mined in Stansbury Mountains. *Salt Lake Tribune*, Feb. 6.

PEPPERBERG, L. J. (1911) Variscite near Lucin, Utah. *Mining & Scientific Press* 103, p. 233–234.

RIGBY, J. K., ed. (1958) Geology of the Stansbury Mountains, Tooele County, Utah. *UT Geol. Soc. Guidebook* 13, p. 34–51.

SCHALLER, W. T. (1912) The crystallography of variscite. *Wash. D.C. Acad. Science J.* 2, p. 143.

______, (1912) Crystallized variscite from Utah. *U.S. Nat. Mus. Proc.* 41, p. 413–430, illust.

______, (1912) Mineralogical notes, series 2. *U.S. Geol. Survey Bull.* 509, p. 48–65.

______, (1916) Mineralogical notes, series 3. *U.S. Geol. Survey Bull.* 610, p. 56–80. Lucinite = variscite.

SPENDLOVE, E. (1978) Variquoise? *Rock & Gem* 8, 5, p. 60–63.

STERRETT, D. B. (1909) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1908*, part 2, p. 853–856.

______, (1911) *Ibid.* for 1910, part 2, p. 894.

STOWE, C. H. (1979) Rockhound guide to mineral and fossil localities in Utah. *UT Geol. Mineral. Survey Circ.* 63, p. 61, Amatrice Hill.

THOMSSEN, R. W. (1991) Forgotten phosphates of Fairfield. *Lapidary J.* 45, 49 p. 46–56, *passim*, illust. (col.).

ZALINSKI, E. R. (1909) Amatrice, a new gemstone of Utah. *Eng. & Mining Journal* 87, p. 1038–1039.

ZEITNER, J. C. (1987) Four American beauties. *Lapidary J.* 41, 4, p. 34–41, illust. (col.). Includes variscite of Utah.

NEVADA. In about 1975, James Puckett of Boise, Idaho, discovered a deposit of variscite in Lander County, Nevada, which is so close in appearance to the material from Lucin, Box Elder County, Utah, noted above that one is hard pressed to see any difference between them (Jones, 1978). The find was made in Lander County near the community of Crescent Valley in Eureka County. As in the Utah occurrence, the variscite ranges in color from very pale green to medium green, but is especially remarkable for the preponderance of delicately black-veined "spiderweb" material. According to Jones, the variscite, occurring in veins and nodular masses, is found partly in a dense gray shale or in tan clayey streaks within shale. In a later description of the deposit, Novak (1982) depicts in color some fine examples of carvings executed in this material whose fine details show how well it is suited for this purpose in addition to the usual applications in cabochons and other ornaments. Novak noted that the deposit was being mined under lease and that the variscite was being marketed by Anthony Jones of California Rock and Mineral of Duarte, California. Some of the grades were sold as "verde web," a term expressive of the fine black veining. Novak confirms that the variscite "occurs as both nuggets and vein fillings within or near a shear zone . . . on the flank of an Ordovician shale upwarped into a north-plunging syncline." He noted that unlike other deposits of variscite, no limestone or jasper is present although some of the shale contains enough silica to be called chert. The most productive zone is overlain by a gray-black shale that is stripped away by bulldozer. The quality of material improves with depth. In size, the nuggets range from 0.25 in (5 mm) to 24 in (60 cm) across, while vein material reaches about 2 in (5 cm) in thickness. While most of the material polishes well, porous types can be plastic-impregnated, according to Novak, in those places where variscite is not present. He also notes that some similar material is being sold under the term "chalcosiderite" but the variscite herein described has been tested by X-ray diffraction and atomic absorption spectroscopy and is shown to be "pure end-member variscite," aside from containing 0.5 weight percent iron and less than 0.001% copper.

JONES, R. (1978) New find in Nevada. *Rock & Gem* 8, 11, p. 44–48.

NOVAK, G. A. (1982) Verde web variscite from Lander County, Nevada. *Lapidary J.* 36, 3, p. 544–552, *passim*, illust. (col.).

CALIFORNIA. No new developments.

INGALLS, D. (1949) Green rock in the Last Chance Range. *Desert Mag.* 12, 3, p. 28–29, maps. Variscite in Inyo County.

VESUVIANITE (IDOCRASE)

QUEBEC. A detailed study of vesuvianite gems from Canadian localities appears in Wight & Grice (1983). The brownish-yellow "laurelite" faceted gems from near Laurel, Argentuil County, are represented in the Canadian National Gem Collection by five examples ranging from 0.54 to 3.15 cts (Wight, 1986; Boyd & Wight, 1981). The Laurel stones are yellowish-brown, dark orange-brown, and greenish-brown; refractive indexes are epsilon 1.70, 1.706, and 1.725 (for the greenish-brown specimen), and omega 1.709 and 1.711, birefringence 0.007–0.005. The dichroism is strong: usually deep green and orange or orange-brown.

The vesuvianite from the Jeffrey Mine, Asbestos, which locality has been previously described under GARNET, occurs in various colors as green, brown, mauve, pale red, and brownish-yellow but Wight & Grice record only cut gems of green; Wight (1986) records three faceted gems in the Canadian National Gem Collection from the Jeffrey Mine, Asbestos, Shipton Township, Richmond County: 0.54, 0.82, and 0.87 ct, "medium green, slightly yellowish." Mr. Guy Langelier of Montreal owns six faceted gems from the Jeffrey Mine, two of "apple-green," of 4.15 and 21.10 carats, but the large gem with inclusions; a chrome green gem of 0.40 ct; a mauve of 1.60 cts; a colorless of 1.02 cts; and a 6.66 mauve gem with inclusions (*Pers. comm.* 10/15/93). Langelier also stated that he had "pink, red, and bicolor of the above and light cat's-eye, star cabochons."

Wight & Grice (1983) measured refractive indexes for the several color varieties and found a range from a low epsilon of 1.703 to a high value of 1.717, and omega from 1.704 to 1.721. Koivula & Kammerling (1991) described transparent faceted gems of purple and green vesuvianite from the Jeffrey Mine including three purple gems, two greens, and two bicolors (green and light pink). Their weights ranged from 0.48 to 2.79 cts. The purple color is due to manganese and the vivid green hues to chromium; some nickel was also detected in the analysis but its possible contribution to coloration could not be determined.

BOYD, W. F. & WIGHT, W. (1981) Gemstones of Canada. *J. Gemm. Soc. Japan* 8, 14, p. 27–39. Republished in *J. Gemm.* 18, 6, 1983, p. 544–562, maps.

CHAMBERLAIN, S. C. (1980) The Jeffrey Mine, in Asbestos, Quebec, Canada. *Rocks & Minerals* 55, 5, p. 188–191, illust.

FRITSCH, E. (1992) Rare gemstones from Quebec. Gem news. *Gems & Gemology* 28, 2, p. 134.

GRICE, J. D. & WILLIAMS, R. (1979) The Jeffrey Mine, Asbestos, Quebec. *Min. Rec.* 10, 2, p. 68–80, illust., maps.

GRICE, J. D. & WIGHT, W. (1986) Correlation of colour and chemistry in grossular and vesuvianite from the Jeffrey Mine, Quebec, Canada. In *Proc. IMA, XIII General Mtg., Varna, 1982*, p. 433–440.

KOIVULA, J. I. & KAMMERLING, R. C. (1991) Purple and "chrome" green vesuvianite from Quebec. Gem news. *Gems & Gemology* 27, 3, p. 185.

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

WIGHT, W. & GRICE, J. D. (1981) Colourless grossular and green vesuvianite from the Jeffrey Mine, Asbestos, Quebec. *Canad. Gemm.* 3, 2, p. 2–6.

______, (1983) Canadian vesuvianite gems. *J. Gemm.* 18, 8, p. 738–745.

VERMONT. R. A. Kosnar of Golden, Colorado, informs me that he collected gemmy, light to dark olive-green crystals of vesuvianite, 2–2.5 cm long, in July 1969 in the Eden Mills Quarry, Lamoille County (*Pers. comm.* 8/10/1994). The crystals were said to be of "good peridot color" and he estimated that faceted gems of from one to two carats could be cut from them.

NEW JERSEY. No new developments.

LEWIS, J. V. & BAUER, L. H. (1922) Cyprine and associated minerals from the zinc mine at Franklin, New Jersey. *Amer. J. Science* 204, p. 249–251.

SHANNON, E. V. (1922) Note on the cyprine from Franklin, New Jersey. *Amer. Mineral.* 7, p. 140–142.

MARYLAND. No new developments.

SINKANKAS, J. (1958) Idocrase from Rockville, Maryland. *Rocks & Minerals* 33, p. 490–491.

COLORADO. According to R. A. Kosnar of Golden, Colorado, vesuvianite crystals were found on Italian Mountain, Gunnison County, that measured up to 5 cm (2 in) long were of yellowish-brown color and had "gem areas [that] will cut clean stones up to 1 ct." (*Pers. comm.* 8/10/1994).

NEVADA. In 1983, Spectrum Commercial Lapidaries, Inc., of Boulder, Colorado, announced discovery of a new "californite" deposit at an unnamed site in the state (*Lapidary J.* 37, 7, 1983, p. 998). It was said that "the material from the new mine location in Nevada will cut average sized cabochons as large as 12 x 16 mm, rarely cabochons of 30 x 40 mm." It was also stated that the deposit potentially could supply the lapidary industry for a long time.

CALIFORNIA. Native copper inclusions were found in a faceted gem of vesuvianite of 1.38 carats cut from material found at Pulga, Plumas County, according to John I. Koivula of the Gemological Institute of America (Koivula, 1994).

AVERILL, C. V. (1935) Mines and mineral resources of Siskiyou County. *CA Div. Mines Rept.* 31, p. 255–338, p. 291.

BRADLEY, W. W. (1916) Fresno and Kings counties. *CA Min. Bur. Rept.* 14, p. 429–470, 525–530. Watts Valley "Jade Mine" p. 439.

BROWN, G. C. (1915) Mines and mineral resources of Shasta County, Siskiyou County, Trinity County. *CA State Min. Bur. Rept.* 14, p. 745–925.

CLARKE, F. W. & STEIGER, G. (1905) On "californite." *U.S. Geol. Survey Bull.* 262, p. 72–74.

CRAW, J. (1966) Feather River country's jade, gold, and crystals. *Gems & Minerals* 348, p. 16–19, maps.

ESSELINK, J. H. (1938) The story of californite. *The Mineralogist* 6, 3, p. 3–4, 26–27, 29–30, illust.

HEMRICH, G. I. (1964) Idocrase. *Gems & Minerals* 323, p. 25.

HIETANEN, A. (1973) Geology of the Pulga and Bucks Lake quadrangles, Butte and Plumas counties, California. *U.S. Geol. Survey Prof. Paper* 731, 66 p., illust., maps.

KOIVULA, J. I. (1994) Copper in vesuvianite. *Lapidary*

J. 48, 8, p. 14, illust. (col.).
KUNZ, G. F. (1902) Precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1901*, p. 729–771, p. 747–748.
_____, (1903) Californite (vesuvianite); a new ornamental stone. *Amer. J. Science* 16, p. 397–398.
MELHASE, J. (1935) Some garnet localities in California. *The Mineralogist* 3, 11, p. 7–8, 22–24.
MITCHELL, J. R. (1986) *Gem Trails of California.* Baldwin Park, CA: Gem Guides Book Co., 159 p., illust., maps. Pulga p. 147–148.
MURDOCH, J. & WEBB, R. E. (1956) Minerals of California. *CA Div. Mines Bull.* 173, 452 p., illust. (col.), p. 340–342.
_____, (1966) *Ibid.*, Centennial Volume (1866–1966). *CA Div. Mines & Geol. Bull.* 189, 559 p., illust., p. 224–226.
PABST, A. (1936) Vesuvianite from Georgetown, California. *Amer. Mineral.* 21, p. 1–10, illust.
PEMBERTON, H. E. (1983) *Minerals of California.* NY: Van Nostrand Reinhold, 591 p., illust., maps, p. 500–502.
STERRETT, D. B. (1911) Gems and precious stones. Ch. in *U.S. Geol. Survey Mineral Resources of the U.S. for 1910*, pt. 2, p. 847–900. Pulga.

VESZELYITE

MONTANA. A copper-zinc hydrous phosphate, formula $(Ca,Zn)_3(PO_4)(OH)_3 \cdot 2H_2O$, occurs in facetable crystals only in the Black Pine Mine, Philipsburg, Granite County, Montana. It is reported that clear sections have been cut into faceted gems of one-third to one carat (Roberts, *et al*, 1990).

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R. (1990) *Encyclopedia of Minerals.* 2nd edit. NY: Van Nostrand Reinhold, 979 p., illust. (col.), p. 919.

VILLIAUMITE

QUEBEC. Among the astonishing rarities found at Mont St.-Hilaire, one must now include the rare sodium fluoride, formula NaF, which occurs in cubic crystals, some large and clear enough to afford faceted gems. The species is isometric and its crystals form cubes and cube-octahedra, generally of small size, but cleavage masses have been found up to 5 cm (2 in) across. According to Arem (1987), Mandarino & Anderson (1989), and Horvath & Gault (1990), villiaumite occurs in pink, red, and orange colors, while Koivula, *et al* (1992) note a brownish-red color that "sometimes exhibits two or three tones within a single gem and was seen in sizes up to 5 ct, with larger pieces generally being quite dark." The single refractive index is quite low, 1.327, the luster is glassy and the hardness is only 2–2¼. The specific gravity is 2.78–2.79, the last value obtained by Mandarino & Anderson upon a specimen in the Royal Ontario Museum. Being a fluoride, villiaumite rapidly dissolves in water but lapidaries have successfully cut faceted gems by the simple expedient of using petroleum derivatives for lubrication and suspension of polishing agents. Guy Langelier of Montreal possesses a faceted red gem of 7.50 carats but notes that most cut gems are much smaller, averaging one carat or less (*Pers. comm.* 10/15/1993). Horvath & Gault mention a fine, bicolor red to colorless emerald cut gem of 5.01 carats. Because of its solubility in water, all villiaumite gems must be preserved in containers in which a drying agent is present to absorb moisture.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, p. 199.
HORVATH, L. & GAULT, R. A. (1990) The mineralogy of Mont St.-Hilaire, Quebec. *Min. Rec.* 21, 4, p. 345.
KOIVULA, J. I., KAMMERLING, R. C. & FRITSCH, E. (1992) Gem news. *Gems & Gemology* 28, 2, p. 134.
MANDARINO, J. A. & ANDERSON, V. (1989) *Monteregian Treasures: The Minerals of Mont St.-Hilaire, Quebec.* Cambridge, NY: Cambridge University Press, p. 209.
WILSON, W. E. (1989) What's new in minerals? *Min. Rec.* 20, 3, p. 236.
WIGHT, W. (1992) Checklist for rare gemstones—villiaumite. *Canad. Gemm.* 13, 4, p. 110–113.

VLASOVITE

QUEBEC. According to Wight (1993), this rare sodium zirconium silicate, formula $Na_2ZrSi_4O_{11}$, formerly found only on the Kola Peninsula of Russia and Ascension Island in the Atlantic Ocean, is now reported in facet grade rough from the Kipawa Complex of alkaline rocks located next to Sheffield Lake, Villedieu Township, Temiscamingue County. The vlasovite occurs in pods and lenses of pegmatite "composed of exceptionally coarse eudialyte, feldspar, nepheline, agrellite, wöhlerite group minerals, vlasovite, britholite, and other species." Traill (1983, p. 403) gives the locality as lat. 46°47'49" N, long. 78°29'31" W, and notes that vlasovite occurs as "subrounded grains up to 2 cm across surrounded by eudialyte, and as crystals up to 15 cm long in potash feldspar and eudialyte." Properties given by Roberts, *et al* (1990, p. 924) are based on Kola material and not that from Quebec: crystal system monoclinic, optically biaxial (-), alpha 1.607, beta 1.623, gamma 1.628, birefringence 0.021; H 6, SG 2.97. There is a distinct cleavage. Clear Kipawa sections gave a faceted gem of 1.43 ct in the Canadian National Collection (Wight & Wight, 1989; Wight, 1993) and a fine pale straw yellow faceted gem of 0.38 ct cut by Arthur Grant; also Guy Langelier of Montreal has cut a "champagne" color faceted gem of 0.27 ct (*Pers. comm.* 10/15/1993). This last gem is described by Fritsch (1993) who found refractive indexes of about 1.609–1.624, birefringence 0.015, SG 2.90–3.26.

FRITSCH, E. (1993) Rare gemstones from Quebec. Gem Trade Notes. *Gems & Gemology* 29, 4, p. 287, 288.

ROBERTS, W. L., CAMPBELL, T. J. & RAPP, G. R. (1990) *Encyclopedia of Minerals.* 2nd edit. NY: Van Nostrand Reinhold.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18.

WIGHT, Q. & WIGHT, W. (1989) Art Grant: A cut above the rest. *Canad. Gemm.* 10, 4, p. 98–101.

WIGHT, W. (1993) Checklist for rare gemstones—vlasovite. *Canad. Gemm.* 14, 4, p. 110–113, illust.

WARDITE

YUKON TERRITORY. Up to several years ago, the only wardite faceted gems, very small, were cut from Brazilian material, but now additional facet rough has been obtained from crystals found in the astonishing phosphate mineral occurrences in the Yukon (Grice, 1989, p. 38; Robinson, *et al*, 1992, p. 31). Wardite is a hydrous sodium-aluminum phosphate, formula $NaAl_3(PO_4)_2(OH)_4 \cdot 2H_2O$; tetragonal, optically uniaxial (+), refractive indexes epsilon 1.607, omega 1.597; H 5, SG 2.76. There is a perfect basal cleavage. Wardite is mostly colorless, white, or pale green to pale bluish-green, and commonly occurs in pyramidal crystals of glassy luster. According to Robinson, *et al* some Yukon crystals reach 3 cm (1.25 in) across but most are much smaller, one cm or less. Wight & Wight (1989) record a 0.22 ct faceted gem in the Canadian National Collection.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, p. 200.

GRICE, J. D. (1989) *Famous Mineral Localities of Canada.* Ottawa, ONT: National Museum of Nat. Sci. & Fitzhenry & Whiteside, 190 p., illust. (col.), p. 38.

ROBERTS, W. L., *et al* (1990) *See above,* p. 933–934.

ROBINSON, G. W., VAN VELTHUISEN, J., ANSELL, H. G. & STURMAN, B. D. (1992) Mineralogy of the Rapid Creek and Big Fish River area, Yukon Territory. *Min. Rec.* 23, 4, p. 1–72, illust. (col.), maps. P. 31.

WIGHT, Q. & WIGHT, W. (1989) *See above,* p. 101.

WELOGANITE

QUEBEC. This hydrous strontium-sodium-zirconium carbonate, formula $Sr_3Na_2Zr(CO_3)_6 \cdot 3H_2O$, uniquely occurs associated with an igneous sill intruded into limestone in the Francon Quarry, Saint-Michel, within the city limits of Montreal (Grice, 1898, p. 109). It is a very rare species whose chief hallmark is its formation of groups of small, pale grayish-yellow crystals that appear to be tapering hexagonal prisms but actually are triclinic in crystallization. From an occasional clear area within such crystals, very small faceted gems have been cut. Weloganite is optically biaxial (-), refractive indexes alpha 1.558, beta 1.646, gamma 1.64, birefringence 0.088; H 5, SG 3.22. There is a perfect basal cleavage. The color ranges from white to lemon-yellow to a somewhat brownish-yellow and color zoning may be present (Roberts, *et al*, 1990, p. 939–940; Arem, 1987, p. 201). Wight (1986, p. 55) records three faceted gems in the Canadian National Collection: a light yellow stone of 0.74 ct., a light grayish-yellow of 4.27 cts, and a light yellow of 0.52 ct.

AREM, J. E. (1987); GRICE, J. D. (1989); ROBERTS, W. L., *et al* (1990) *See above.*

WIGHT, W. (1986) Canadian gems in the National Museums of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55.

WHEWELLITE

SOUTH DAKOTA. This rarity among faceted gemstones cut for collectors of the unusual is a calcium oxalate, formula $Ca(C_2O_4)\cdot H_2O$, forming mostly white or colorless crystals, or crystalline masses in various types of deposits (Arem, 1987, p. 201; Roberts, *et al*, 1990, p. 942–943). It is monoclinic, biaxial (+), refractive indexes alpha 1.489, beta 1.553, gamma 1.649, birefringence 0.016; H 2.5–3, SG 2.21–2.23. It is brittle, and a good cleavage is present. Arem states that in the Elk Creek area of Meade County, there occur "fine crystals up to 6 cm [2.4 in] in length . . . among the finest in the world." According to E. Fritzsch of the South Dakota School of Mines & Technology, several small faceted gems were cut from crystals found near Elm Springs, Meade County (*Pers. comm.* 1/1993). Whewellite is insoluble in water and is cut and polished with ordinary agents.

AREM, J. E. (1987); ROBERTS, W. L., *et al* (1990) *See above.*

WILLEMITE

QUEBEC. Aquamarine-blue, etched prismatic crystals of transparent willemite were found many years ago in one of the quarries on Mont St.-Hilaire, Rouville County. They are described by Horvath & Gault (1990, p. 346) as "several superb, gemmy blue crystals up to 2.5 x 1.5 cm"; these authors add that "from crystal fragments a few fine quality, pale blue gems up to 1.01 carats in weight have been cut." These specimens were found before 1972 and apparently no more have turned up since. Several faceted gems are preserved in the Canadian National Collection, according to Wight (1986, p. 55), namely a light blue emerald stepcut of 6.75 cts and a very light blue emerald cut with "fancy pavilion" of 0.30 ct. Bank (1975) determined properties on this willemite as follow: refractive indexes omega 1.690, epsilon 1.723; SG 3.99.

BANK, H. (1975) Durchsichtiger schleifwürdiger blauer Willemit vom Mont St.-Hilaire in Kanada. *Zs. Dt. Gemm. Ges.* 24, 4, p. 250.

HORVATH, L. & GAULT, R. A. (1990) *See above.*

POUGH, F. H. (1974) Willemite, an uncommon gemstone. *Zs. Dt. Gemm. Ges.* 23, 2, p. 128–130. Mont St.-Hilaire material.

WIGHT, W. (1986, 1991) *See above.*

NEW JERSEY. The famous source of facet and cabochon grade willemite at Franklin, Sussex County, has now been permanently shut down and all underground workings allowed to fill with water. Graziani (1978) describes red bands in cabochon-grade willemite from Franklin and attributes the chatoyancy noted in some specimens to streaks of minute, flake-like crystals of hematite which impart the red color. Arem (1987, p. 202) notes that the Smithsonian collections include faceted yellow-orange gems of 11.7 and 11.1 cts, and a 6.75 cts gem is in the Canadian National Collection. A considerable number of smaller stones are held by private collectors, among them Rich A. Kosnar of Golden, Colorado, who obtained a broken willemite crystal from the Lazard Cahn Collection, from which he had cut a 7.03 cts flawless, modified emerald-cut faceted gem of the same color as the imperial topaz from Brazil.

AREM, J. E. (1987) *See above.*

GRAZIANI, G. (1978) Rote Bänder in Willemit von Franklin Furnace, N.J., USA. *Zs. Dt. Gemm. Ges.* 27, 4, p. 201–204, illust. (col.).

PALACHE, C. (1935) The minerals of Franklin and Sterling Hill, Sussex County, New Jersey. *U.S. Geol. Survey Prof. Paper* 180, 135 p., illust., map, p. 82–90.

WOLLASTONITE

QUEBEC. Colorless, translucent to transparent tabular and lath-like crystals of wollastonite have been found in the Jeffrey Mine at Asbestos, associated with vesuvianite; from some of the material very small faceted gems have been cut (Wight, 1983). The Canadian National Gem Collection includes one remarkable crystal which is 6 cm long but only 5 mm across and 2 mm thick (2.4 x 0.25 x 0.08 in). Faceted gems were prepared by Arthur Grant of Hannibal, New York, weighing 0.8 and 4.05 cts, the latter, acquired for the Canadian National Collection, measuring 27.0 x 5.1 x 3.9 mm; it is perfectly colorless and transparent. This stone does not fluoresce under UV. The refractive indexes are alpha 1.619 and gamma 1.634. Because of the perfect, indeed nearly unavoidable cleavage, faceting any wollastonite is a remarkable lapidary achievement! Additional property data appear in Arem (1987, p. 203): triclinic, biaxial (-), indexes alpha 1.616–1.640, beta 1.628–1.650, gamma 1.631–1.653, birefringence 0.015; H 4.5–5, SG 2.8–3.09. When fibrous cabochon material is tested a "shadow edge" appears at 1.63 in the refractometer. Arem records a 1.22 cts faceted gem in the Smithsonian Institution collection.

AREM, J. E. (1987) *See above.*

CHAMBERLAIN, S. C. (1980) Wollastonite, vesuvianite, native copper, and diopside from the Jeffrey Mine in Asbestos, Quebec, Canada. *Rocks & Minerals* 55, 5, p. 188–191, illust.

WIGHT, W. (1983) Faceted wollastonite from the Jeffrey Mine, Asbestos, Quebec. *J. Gemm.* 17, 6, p. 406–415; also in *Canad. Gemm.* 4, 1, 1983, p. 13–15.

NEVADA. Koivula & Kammerling (1989, p. 49) report a carving-grade massive, white to light greenish-gray wollastonite that occurs in the White Caps wollastonite deposit in the Viola Mining District, 50 mi (79 km) east of Caliente, Lincoln County. At the time, the material was being marketed for carving purposes by Gorman Boen Enterprises of Las Vegas, Nevada. The wollastonite is found in a contact zone between volcanic rocks and limestone where it forms very compact and tough masses associated with diopside, vesuvianite, hydrogrossular, and nephrite, but the nephrite apparently has no lapidary value.

KOIVULA, J. I. & KAMMERLING, R. C. (1989) Gem news. *Gems & Gemology* 25, 1, p. 49.

WONDERSTONE

Van Landingham (1962) states that "wonderstone is a rather loose term that is often applied to a group of silica-rich rocks of igneous or sedimentary origin, which have secondary banding." The banding develops after the rock has solidified yet retains sufficient porosity to allow impregnation by water solutions carrying trace amounts of iron and manganese compounds via networks of cracks, from which the foreign coloring matter passes into seemingly solid rock. Commonly the host rock is light-colored, fine-grained rhyolite or sedimentary rock. Sometimes the impregnation carries silica in solution as well as coloring matter and the result is a rock that is nearly pure silica, commonly called jasper. The host rock often fractures into angular blocks that range from fist-size to melon-size or somewhat larger. The banding conforms to the original exterior shape of the block near its margins but as the coloring proceeds inward, the bandings approach circles in outline. Because of the predominance of iron compounds, most rhyolite wonderstones contain bandings of rich red-brown, brown, tan, blackish-brown, and sometimes purplish-red or purplish-brown. Depending on the amount of silica introduced, the stone may assume only a dull, slightly pitted surface finish, or a brilliant flawless surface where the stone is heavily impregnated with silica.

Much of the source information below is derived from Van Landingham's excellent survey of wonderstone deposits in the western states, published in *Gems & Minerals*, 1962, no. 300, p. 26–28, maps.

MONTANA. A very "attractive, highly polishable material," locally called "Montana onyx," is found 20 mi (32 km) southwest of Virginia City, Madison County, in Sec. 9, T9S, R5W.

VAN LANDINGHAM, S. L. (1962) Wonderstone. *Gems & Minerals* 300, p. 26–28, maps.

OREGON. Mitchell (1992, p. 60–61) locates a wonderstone deposit in Harney County, northeast of Buchanan and north of Highway 20, noting that "the best is filled with bands and swirls, some of which is solid enough to take a fairly good polish." A scenic type of wonderstone with complex patterns that differ considerably from other varieties is found in the hills about 18 mi (28 km) west-northwest of McDermitt in Malheur County. McDermitt is just south of the Oregon–Nevada border but the locality itself is just inside Oregon. *See also* Mitchell's guide to Nevada below (p. 26–27).

MITCHELL, J. R. (1989) *Gem Trails of Oregon.* Pico Rivera, CA: Gem Guides Book Co., 119 p., illust., maps.

NEVADA. Wonderstone is abundant in this state and it has been used sparingly for monumental purposes, e.g., for a historical road plaque just outside Austin that is mounted on a mass of the stone. Strong (1975) summarizes occurrences and gives sources in the Trinity Range west of Lovelock, Pershing County, several sites about 10 mi (16 km) southeast of Fernley in Lyon County (*see also* Strong, 1966), and two sites yielding "exceptionally good" material near Tonopah, Nye County, while Klein (1983) gives directions to a collecting area on Little Antelope Summit, about 40 mi (63 km) west of Ely, White Pine County, along Highway 50. However, the prime source is an apparently inexhaustible deposit in the Fallon, Churchill County, area, more specifically, upon a prominence appropriately called Wonderstone Mountain. Directions to these sites are given by Mitchell (1991, 1992). Generally, they are reached by going southeast of Fallon on Highway 50 for 10 mi (16 km) to Grimes Point, then turning east on a dirt road that leads in about 5 mi (8 km) to a north trail up the west side of Wonderstone Mountain. Much of the material found here is sharply and colorfully banded in reds, yellows, pinks, purplish-reds, and browns. Much of it, however, only assumes the typical high gloss rather than a glassy polish.

BERKHOLZ, M. F. (1958) Nevada wonderstone. *Gems & Minerals* 251, p. 36–27, map.

FERGUSON, R. W. (1982) Wonderstone near Fallon, Nevada. *Lapidary J.* 36, 1, p. 108–124, *passim*, illust. (col.), map.

_____, (1984) Wonderstone, moss agate, and mosquitos. *Ibid.* 38, 1, p. 84–97, illust. Fallon area.

KLEIN, J. (1983) *Where to Find Gold & Gems in Nevada.* Baldwin Park, CA: Gem Guides Book Co., 110 p., illust., maps.

MITCHELL, J. R. (1991) *Gem Trails of Nevada.* Baldwin Park, CA: Gem Guides Book Co., 118 p., illust., maps.

_____, (1992) Fallon wonderstone. *Rock & Gem* 22, 5, p. 56–59, map.

SPENDLOVE, E. (1978) Snakeskin agate & wonderstone. *Rock & Gem* 8, 6, p. 74–75, illust., map. Elko County.

STRONG, M. F. (1966) Wood and wonderstone near Fernley, Nevada. *Gems & Minerals* 346, p. 19–20, illust., map. Lyon County.

_____, (1975) Wonderful wonderstone. *Desert Mag.*, Jan., p. 8–11, map.

WEIGHT, H. O. (1950) Wonder pebbles of Lake Lahontan. *Desert Mag.* 13, 7, p. 19–24, illust., map. Fallon area.

UTAH. In Tooele County, Stowe, *et al* (1977, p. 101) refers to a siltstone as "wonderstone" and also as "picture stone," suggesting a hardened sedimentary rock rather than one of igneous origin. The material exhibits "concentric patterns" and is light gray and pink to maroon in color. The deposit is located in southern Rush Valley, north of Dunbar Station; it appears to be the same as described by Mitchell (1987, p. 30-31) who shows it in the hills north of Highway 36, about 4.6 mi (7.3 km) southeast of Vernon. The stone is colorfully and sharply banded but much is so porous that it takes only a fair polish.

The other major wonderstone collecting area in Utah is in Salina Canyon, Sevier County, in hills that lie about 5 mi (8 km) south-southeast of Salina past Soldier Dam. Salina is located on Highway 89. According to Mitchell (1987, p. 70–71), one is able to find "top-quality, fine-grained material, much of which will take a polish." The colors include maroon, red, yellow, and dark brown. Van Landingham (1962) notes a collecting area in Washington County "along the upper part of Beaver Dam Wash at the western edge of the canyon" and "scenic sandstone" near St. George and Washington.

MITCHELL, J. R. (1983) Utah wonderstone. *Rock & Gem* 13, 9, p. 24–26, map.

_____, (1987) *Gem Trails of Utah.* Baldwin Park, CA: Gem Guides Book Co., 111 p., illust., maps.

SPENDLOVE, E. (1980) Salina Canyon wonderstone. *Rock & Gem* 10, 12, p. 36–38, 80, 92, illust.

_____, (1984) Vernon wonderstone. *Ibid.* 14, 1, p. 56–60, map.

_____, (1991) Salina wonderstone. *Ibid.* 21, 7, p. 52–55, map.

STOWE, C., *et al* (1977) *Collector's Guide to Mineral and Fossil Localities in Utah.* UT Geol. & Min. Survey, 112 p., illust., maps.

VAN LANDINGHAM, S. L. (1962) Wonderstone. *Gems & Minerals* 300, p. 26–28, maps.

NEW MEXICO. No new developments.

McMACKIN, C. E. (1976) In search of New Mexico's rocky rainbow wonderstone and "rainbow marble." *Lapidary J.* 30, 9, p. 2080–2090, *passim,* illust.

BAJA CALIFORNIA NORTE. An attractive, finely-banded wonderstone in the form of nodular masses up to 6 in (15 cm) in diameter, and capable of being polished, occurs in the petrified wood area of Cerro Pinto, just south of the border with California. The colors are predominantly browns but reddish, purplish, and tan hues also occur. This material has been described in Volume 2.

"WYOMINGITE"

WYOMING. Soulenc (1985) notes that a rock called "wyomingite" has recently been collected in Sweetwater County and found to be capable of taking a polish, thus becoming a suitable lapidary material for large objects such as bookends, plaques, and the like. However, care must be taken in orienting the rough to realize the greatest number of attractive reflections which emanate from the enclosed mica. According to Thrush (1968, p. 1246), this rock is defined as "an extrusive rock containing leucite, phlogopite, and diopside (pyroxene) in a glassy groundmass." The occurrence is upon the Zerkel Mesa in the Leucite Hills area where a quarry exposes unlimited quantities of the rock. The Leucite Hills are centered about 22 mi (35 km) north-northeast of Rock Springs.

THRUSH, P. W. (1968) *A Dictonary of Mining, Mineral, and Related Terms.* Washington, DC: Bureau of Mines, 1269 p.

XONOTLITE

NEWFOUNDLAND. Xonotlite is a calcium silicate, formula $Ca_6Si_6O_{17}(OH)_2$. It is monoclinic, biaxial (+), refractive indexes alpha = beta = 1.583, gamma 1.593; H 6, SG 2.71 (Arem, 1987, p. 205). It is rarely found in forms useful for lapidary work but some compact, felted, fine-fibrous material has been found in this province as described by Gosse (1963) who cited Smith's (1958) paper on the local geology and mineralogy of the Bay of Islands area. Gosse notes that pink seam material, "though light in hue, has sufficient merit to qualify as a collector's gem," and further, that it is very tough and in the Bay of Islands deposits occurs in "veins up to 3 inches [7.5 cm] in thickness . . . slightly translucent and of a solid rose-pink color." It is also found mottled and veined in white, and much takes a polish. Warren (1967) reported pink and white material, resembling pink jade, and taking a fine polish, from the Bonne Bay area near Corner Brook on the west side of Newfoundland. This is probably the same occurrence noted in Sabina (1976, p. 148–149) at a place on the south slope of North Arm Mountain near its extreme northeastern end, about 18 mi (28.5 km) almost due north of Corner Brook. The occurrence is within serpentinite. Gosse's source of gem material is located 2.5 mi (4 km) directly west of Shoal Brook, a village on the west shore of the South Arm (western side of the Great Northern Peninsula) or about 37 mi (58 km) north of Corner Brook (Sabina, p. 127–131). Here the xonotlite forms finely-fibrous aggregates in veins that cut altered shale. Sabina repeats the description of Gosse but additionally notes that the material "takes a high polish which brings out an attractive pink and white mottled effect and is used locally for cabochon-cut jewelry."

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold.

GOSSE, R. C. (1963) Xonotlite, a new gemstone from Newfoundland. *Lapidary J.* 16, 12, p. 1132.

SABINA, A. P. (1976) Rocks and minerals for the collector: The Magdalen Islands, Quebec, and the Island of Newfoundland. *Geol. Survey Canada Paper* 75-36, 199 p., illust., maps.

SMITH, C. H. (1958) Bay of Islands igneous complex Western Newfoundland. *Geol. Survey Canada Mem.* 290, 132 p., illust.

_____, (1954) On the occurrence and origin of xonotlite. *Amer. Mineral.* 39, 5/6, p. 531–532.

WARREN, F. J. (1967) Rock collecting in Newfoundland. *Canad. Rockhound* 11, 6, p. 187–191.

ZEKTSERITE

WASHINGTON. This rare lithium-sodium-zirconium silicate, with formula $NaLi(Zr,Ti,Hf)Si_6O_{15}$, was first found in 1966 by Bart Cannon but not recognized as a new mineral, but later, when additional crystals were collected, it was evident that this hexagonal-appearing mineral was not beryl as originally thought, but something new. Specimens were then sent to the Smithsonian Institution whose mineralogists confirmed it as a new species and named it after Jack Zektser, mineral collector of Washington, who first recognized its individuality (Gait, 1991). Its crystals are found in small miarolitic cavities in arfvedsonite granite that forms part of the Golden Horn batholith, located in the vicinity of Washington Pass (elev. 5,250 ft, 1,600 m) on the divide between Chelan County to the east and Okanogan County to the west (Dunn, *et al*, 1977). The area is centered at lat. 48°32'N, long. 120°35'W.

The orthorhombic crystals are colorless to pink, optically biaxial (-), refractive indexes alpha 1.582, beta 1.584, gamma 1.584, birefringence 0.002; H ca 6, SG 2.79. It has two perfect cleavages on planes of 100 and 010. There is blue fluorescence under UV that resembles that seen in scheelite. Zektserite was found in "less than fifty miarolitic cavities" which were only 2 to 10 cm (0.75–4 in) across and free of clay, with the crystals ranging in size from small to as much as 37 mm (1.5 in) in diameter. Associates were fine smoky quartz crystals and feldspar crystals, also astrophyllite, polylithionite, sogdianite, arfvedsonite, and zircon. A few of the larger, clear fragments were faceted into what must be counted as among the rarest of all gems—in weight only up to about two carats.

DUNN, P. J., ROUSE, R. C., CANNON, B. & NELEN, J. A. (1977) Zektserite: A new lithium sodium zirconium silicate related to tuhualite and the osumilite group. *Amer. Mineral.* 62, 5/6, p. 416–420, illust.

DUNN, P. J. (1978) Gemmological notes. *J. Gemm.* 16, 2, p. 90–93.

GAIT, R. I. (1991) Who's who in mineral names. *Rocks & Minerals* 66, 4, p. 282.

ZINCITE

NEW JERSEY. With the closure and final flooding of the zinc mines at Franklin and Ogdensburg, Sussex County, it is now certain that such rare faceting materials as willemite and zincite from these deposits will only be obtained from existing collections. Arem (1987) gives weights of record sizes for faceted gems of zincite in several major collections. The largest gem is 20.1 cts and was cut by J. Sinkankas for the Smithsonian collection, which also contains a 12.3 cts gem. A fine 16.27 cts gem is in the American Museum of Natural History collection in New York and a 12.7 cts example is in the Philadelphia Academy of Natural Sciences. The rarity of cut zincite is reflected in the price asked by a dealer in 1993 who offered a 0.55 ct stone for $435 or $790 per carat.

AREM, J. E. (1987) *Color Encyclopedia of Gemstones.* 2nd edit. NY: Van Nostrand Reinhold, p. 207–208.

BERMAN, H. (1927) The optical properties of zincite from Franklin, New Jersey. *Amer. Mineral.* 12, p. 168–169.

PALACHE, C. (1935) The minerals of Franklin and Sterling Hill, Sussex County, New Jersey. *U.S. Geol. Survey Prof. Paper* 180, illust., map. Zincite p. 37–40.

TRUMPER, L. C. (1959) Zincite, a rare gemstone. *Gemmologist* 28, p. 81–83.

ZIRCON

ONTARIO. Wight (1986) records two dark brownish-red faceted zircons from the Kuehl Lake occurrence in Brudenell Township, Renfrew County. This locality was described by Sabina (1964). The stones are a lozenge mixed cut of 2.24 cts and a square mixed cut of 1.09 cts.

FIELD, D. S. M. (1950) Giant zircons from Canada. *Gemmologist* 19, 228, p. 139–141; reprinted: *The Mineralogist* 19, 3, 1951, p. 134.

______, (1952) Miscellaneous gemstones in Canada. *Canad. Mining J.* 73, 5, p. 78–80, illust.

PALACHE, C. & ELLSWORTH, H. V. (1928) Zircon from North Burgess, Ontario. *Amer. Mineral.* 13, p. 384.

SABINA, A. P. (1964) Rock and mineral collecting in Canada. Vol. II. Ontario and Quebec. *Geol. Survey Canada Misc. Rept.* 8, 252 p., illust.

TRAILL, R. J. (1983) Catalogue of Canadian minerals revised 1980. *Geol. Survey Canada Paper* 80-18, 432 p., p. 411–413.

WIGHT, W. (1986) Canadian gems in the National Museum of Canada. *Canad. Gemm.* 7, 2, p. 34–45, 50–55, p. 55.

NEW JERSEY. Zircon crystals have been found in some of the rocks associated with magnetite ore deposits of northern New Jersey, and R. A. Kosnar of Golden, Colorado, owns a "highly modified, gem/gemmy, brownish-red color crystal [that] will cut a 2 ct. flawless stone." The crystal measures 1.5 x 1.4 x 1.5 cm (0.65 x 0.6 x 0.065 in) and it was found at Ironia, Morris County, but is considered to be an isolated find.

COLORADO. Zircon crystals have been known for many years from St. Peter's Dome, El Paso County, but R. A. Kosnar for the first time offers proof that some faceting material is to be found in some of the crystals. In his collection is a 2.05 cts round brilliant faceted gem, flawless, of dark reddish-brown color, which was cut from a damaged crystal that had been collected by two commercial miners of Manitou Springs in 1971 (*Pers. comm.* 8/10/1994).

Appendix

The following entries are selections from a considerably larger list compiled by Patricia A. S. Gray of Missoula, Montana, from her search of the gemological literature. Her list contains details on owners, where known, as well as other information which it has not been practicable to include here. Her help in making this list available to readers is gratefully acknowledged and it is hoped that when the master list is completed it will be published for the benefit of all interested in North American gemstones.

Table of Largest Cut Gems from North American Localities

SPECIES	COLOR	WEIGHT	LOCALITY
Actinolite	gray	16.15	Balmat, New York
Adamite	pink	4.38	Mina Ojuela, Mapimi, Mexico
Analcime	colorless	3.11	Mont Saint-Hilaire, Quebec
Andalusite	—	1.50	Smalls Point, Phippsburg, Maine
Anglesite	colorless	2.43	Pennsylvania
Anhydrite	pink	7.75	Bancroft, Ontario
Apatite	green	65.52	Monmouth Twp, Haliburton Co., Ontario
Apatite	purple	14.12	Pulsifer Quarry, Maine
Apatite	pink	6.60	Himalaya Mine, California
Apatite	yellow	60.85	Cerro Mercado, Durango, Mexico
Axinite	brown	23.6	Mina La Olivia, Baja California
Barite	light yellow	42.60	Rock Candy Mine, British Columbia
Barite	light grayish	207.3	Otero County, Colorado
Barite	golden brown	109.95	Meade County, South Dakota
Benitoite	blue	15.42	San Benito County, California
Beryl	light green	40.40	Roebling Mine, Litchfield Co., Connecticut
Beryl	blue	11.17	Mount Antero, Chaffee Co., Colorado
Beryl	blue	111.5	Idaho
Beryl	blue	63.45	Royalston, Massachusetts
Beryl	blue	137.16	Stoneham, Oxford Co., Maine
Beryl, emerald	green	15.465	Alexander County, North Carolina
Beryl	colorless	39.00	New Hampshire
Beryl	yellow	23.01	Topsham, Sagadahoc Co., Maine
Beryl	yellow-green	39.6	Ray's Mica Mine, Yancy Co., North Carolina

Table of Largest Cut Gems from North American Localities
(continued)

SPECIES	COLOR	WEIGHT	LOCALITY
Beryl	pink	400.0	San Pedro Mine, San Diego Co., California
Beryllonite	colorless	24.96	Stoneham, Oxford County, Maine
Brucite	blue	4.04	Madoc, Ontario
Burbankite	orange	6.62	Mont Saint-Hilaire, Quebec
Calcite	colorless	4620.00	Balmat, New York
Calcite	yellow	201.60	Montclair, New Jersey
Calcite	brown-orange	170.00	Rosarita Beach, Baja California
Carletonite	blue	1.48	Mont Saint-Hilaire, Quebec
Cassiterite	yellow	24.17	Baffin Island, NWT
Catapleiite	colorless	2.48	Mont Saint-Hilaire, Quebec
Celestite	light blue	3.85	Chittenango, New York
Chambersite	purple	0.62	Venice Salt Mine, Louisiana
Chondrodite	red	3.52	Tilly Foster, New York
Chrysoberyl	green-yellow	1.00	Hedgehog Hill, Oxford Co., Maine
Cinnabar	red	2.97	Nevada
Clinozoisite	brown-green	20.+	Baja California, Mexico
Clinozoisite	orange	1.63	Eden Mills, Vermont
Colemanite	colorless	26.50	Boron, Kern Co., California
Corundum	red-violet	2.16	Montana
Corundum	red	1.52	Corundum Hill, Macon Co., North Carolina
Corundum	dark blue-green	3.86	Corundum Hill, North Carolina
Corundum	blue-green	13.72	El Dorado Bar, Montana
Corundum	blue	10.2	Yogo Gulch, Montana
Creedite	purple	1.77	Santa Eulalia, Mexico
Cryolite	colorless	2.25	Mont Saint-Hilaire, Quebec
Cuprite	very dark red	5.48	Arizona
Danburite	colorless	38.67	Charcas, San Luis Potosi, Mexico
Datolite	colorless	13.21	Lane Quarry, Westfield, Massachusetts
Diamond	light pink	12.42	Murfreesboro, Arkansas
Diamond	brownish yellow	5.39	Kelsey Lake Mine, Colorado
Diopside	green	38.0	St. Lawrence Co., New York
Dolomite	light pink	23.06	Baffin Island, NWT
Enstatite	dark green	10.83	Arizona
Epidote	brown	15.40	Jensen Quarry, Riverside Co., California
Feldspar	colorless	1.77	Cleavelandite; Maine
Feldspar	colorless	2.24	Adularia; Black Mt., New Mexico
Feldspar	yellow	209.0	Plush, Oregon
Feldspar	yellow	153.0	Chihuahua, Mexico
Fluorite	light green	143.00	Madoc, Ontario
Fluorite	green	416.00	Westmoreland, New Hampshire
Fluorite	dark blue	3965.35	Cave-In-Rock, Illinois
Fluorite	yellow	535.80	Elmwood, Tennessee

Table of Largest Cut Gems from North American Localities *(continued)*

SPECIES	COLOR	WEIGHT	LOCALITY
Friedelite	red-brown	11.8	Franklin, New Jersey
Garnet	brown-orange	23.94	grossular; Shipton Township, Quebec
Garnet	red-brown	48.13	Garnet Queen Mine, Idaho
Garnet	red	8.39	Pyrope; Arizona
Garnet	pink	13.36	Rhodolite; Macon Co., North Carolina
Garnet	orange	39.65	Spessartine; Ramona, California
Garnet	orange	96.06	Spessartine; Amelia, Virginia
Gaylussite	colorless	3.44	California
Hambergite	colorless	3.49	Ramona, California
Haüynite	blue	0.82	St. Lawrence Co., New York
Hemimorphite	colorless	2.5	Santa Eulalia, Mexico
Hodgkinsonite	pink	3.34	Franklin, New Jersey
Hornblende	brown	5.47	Pargasite; Baffin Island, NWT
Iolite	blue	8.82	Asbestos, Quebec
Kernite	colorless	2.00	Searles Lake, California
Kyanite	blue & colorless	9.58	Balsam Gap, North Carolina
Lazulite	dark blue	2.06	Rapid Creek, Yukon Territory
Legrandite	yellow	2.13	Mapimi, Durango, Mexico
Leifite	yellow	2.82	Mont Saint-Hilaire, Quebec
Leucophanite	yellow	1.67	Mont Saint-Hilaire, Quebec
Linarite	blue	2.55	Grand Reef Mine, New Mexico
Lithiophosphite	colorless	5.26	Bernic Lake, Manitoba
Ludlamite	green	0.47	Mexico
Manganotantalite	yellow	1.47	Mont Saint-Hilaire, Quebec
Manganotichite	light brown/yellow	0.66	Mont Saint-Hilaire, Quebec
Microlite	brown	3.7	Amelia, Virginia
Monazite	brown	0.63	Riverside, California
Montebrasite	light yellow	3.94	Riverside Co., California
Narasarsukite	yellow	0.31	Mont Saint-Hilaire, Quebec
Natrolite	colorless	15.55	Ice River, British Columbia
Opal	red	93.12	Mexico
Opal	colorless	71.84	Nevada
Pectolite	colorless	0.85	Mont Saint-Hilaire, Quebec
Peridot	yellow-green	100.–	San Carlos, Arizona
Petalite	colorless	1.85	Harvard Quarry, Oxford Co., Maine
Phenakite	colorless	2.5	Colorado
Pollucite	colorless	8.99	Connecticut
Quartz	purple	202.47	Statesville, North Carolina
Quartz	yellow	143.32	Florissant, Colorado
Quartz	colorless	580.00	Acushnet, Massachusetts
Quartz	pink	181.00	Bumpus Quarry, Maine

TABLE OF LARGEST CUT GEMS FROM NORTH AMERICAN LOCALITIES *(continued)*

SPECIES	COLOR	WEIGHT	LOCALITY
Realgar	red	0.65	State of Washington
Remondite	orange	1.70	Mont Saint-Hilaire, Quebec
Rhodochrosite	red	61.0	Sweet Home Mine, Colorado
Rutile	very dark brown	3.84	Franklin, New Jersey
Scapolite	yellow	2.75	Dudley Twp., Ontario
Scheelite	colorless		Greenhorn Mts., California
Serandite	orange	5.40	Mont Saint-Hilaire, Quebec
Shortite	yellow-green	3.52	Mont Saint-Hilaire, Quebec
Siderite	light brown	2.60	Mont Saint-Hilaire, Quebec
Sodalite	yellow	32.60	Mont Saint-Hilaire, Quebec
Sphalerite	light yellow-green	59.5	New Jersey
Sphalerite	yellow brown	133.40	Utah
Sphene	brownish-green	17.99	Camp Bird, Ouray Co., Colorado
Sphene	green-yellow	14.60	Baja California
Spinel	dark green-black	2.43	Groves Quarry, Maine
Spodumene	green	9.29	Sharpes Twp., Alexander Co., North Carolina
Spodumene	light purple	191.83	Pala Chief Mine, California
Staurolite	red	1.05	Georgia
Stibiotantalite	yellow-brown	3.15	Himalaya Mine, Mesa Grande, California
Topaz	light blue	333.50	Mason County, Texas
Topaz	light blue	368.5	Glen Cove, Colorado
Tourmaline	red-brown	15.38	Dravite (?); St. Lawrence Co., New York
Tourmaline	light brown-red	42.25	Mt. Mica, Maine
Tourmaline	bicolor	40.00	Dunton Quarry, Maine
Tourmaline	green	27.75	Mt. Rubellite, Maine
Tourmaline	dark pink	509.0	Tourmaline Queen Mine, California
Tremolite	green	2.20	Minden Ontario
Vesuvianite	green	4.39	Shipton Twp., Quebec
Villiaumite	red	22.00	Mont Saint-Hilaire, Quebec
Vlasovite	light yellow	1.65	Kipawa, Quebec
Weloganite	light yellow	4.27	Francon Quarry, Quebec
Willemite	orange	29.66	Franklin, New Jersey
Witherite	colorless	21.90	Illinois
Wollastonite	colorless	5.00	Quebec
Wulfenite	orange	9.03	Los Lamentos, Chihuahua
Zektzerite	colorless	1.25	Okanogan Co., Washington
Zincite	dark red	20.05	Franklin, New Jersey
Zircon	brown-red	2.24	Brudenell Twp., Ontario

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The author collecting tourmaline on the dumps of the Himalaya Mine, Mesa Grande, California. *Courtesy David Federman.*

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