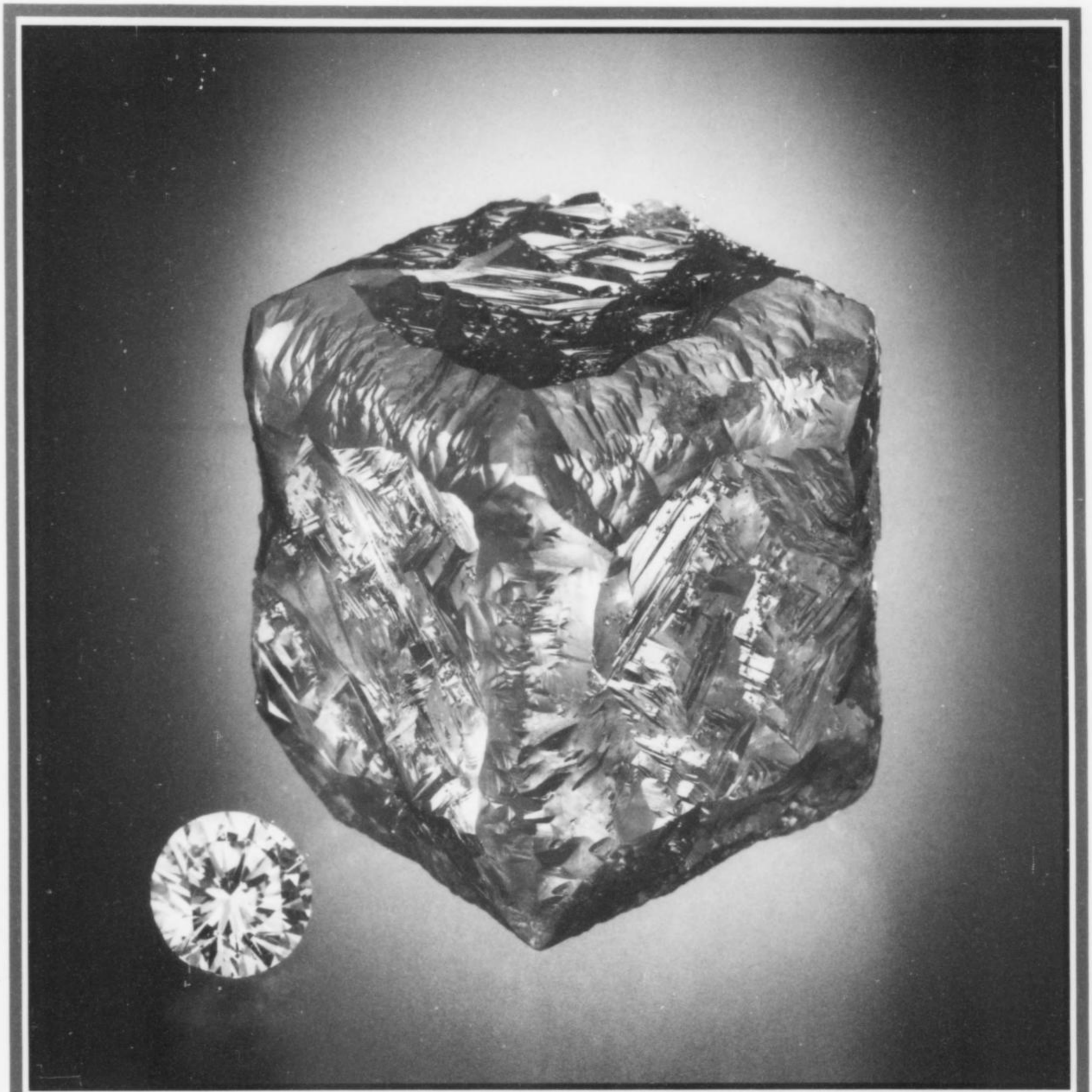
Diamonds & Gold!



The Mineralogical Record

January - February 2004 - Volume 35 Number 1 - 815

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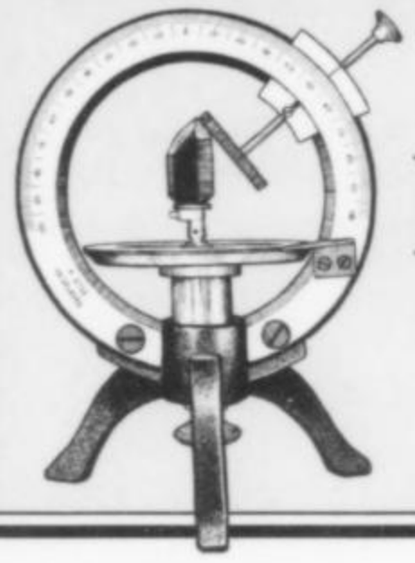

THE MINERALOGICAL RECORD

January–February Volume Thirty-five, Number One

Articles

Columns

COVER: DIAMOND crystal, 2.5 cm (156 carats) from Ghana. Michael Scott collection; photo byHarold & Erica Van Pelt.

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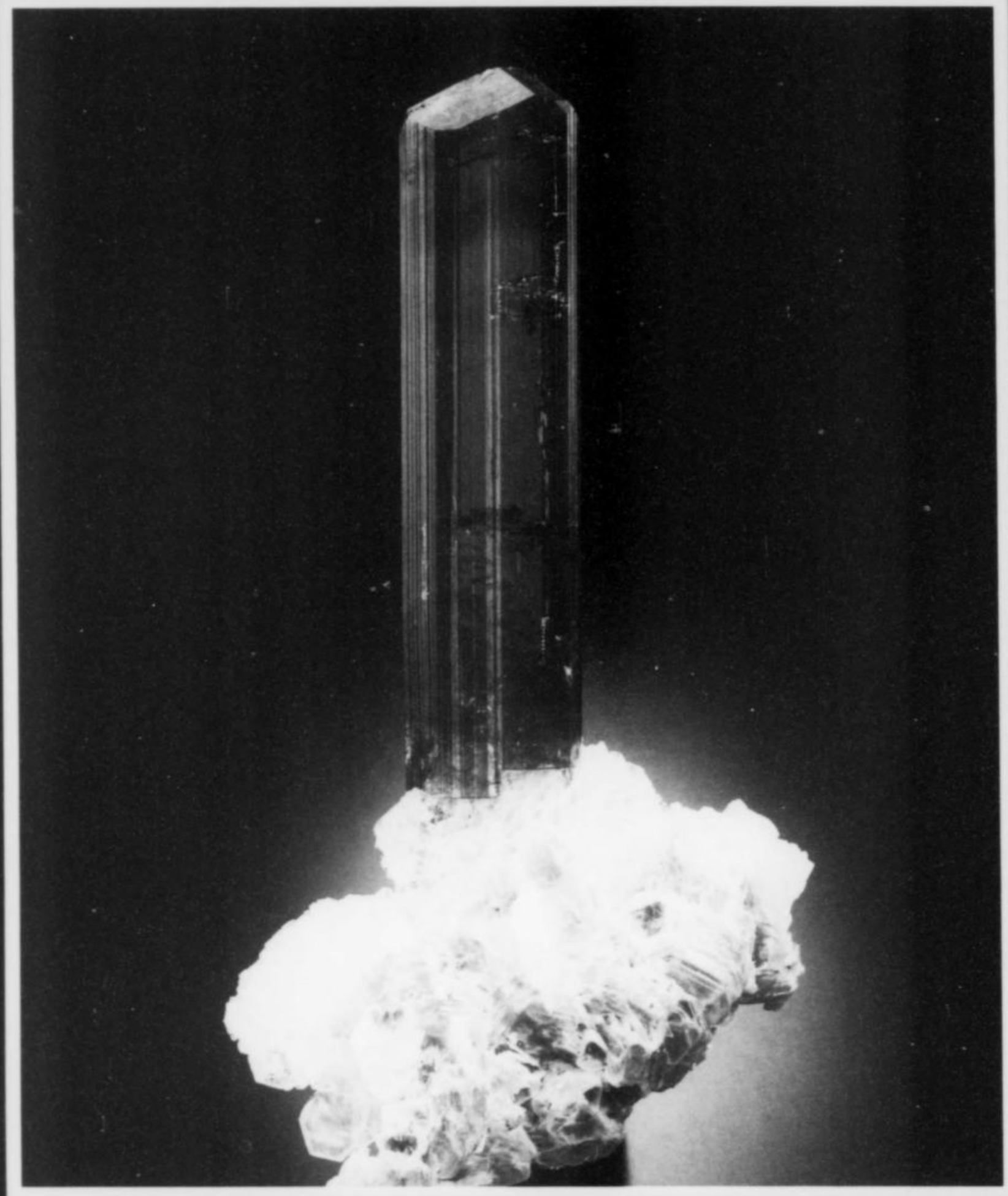


PHOTO: JEFF SCOVIL

Elbaite with Lepidolite, 9.1 cm. Jonas mine, Itatiaia, M. G., Brázil

Sandor P. Fuss

Collector

SandorFuss@aol.com

notes from the EDITORS

The Microscope Monograph

As all of our readers know by now, the November–December Issue was accompanied by our first separately bound supplement, Dan Kile's monographic masterpiece on the history and development of the petrographic microscope. This *tour de force* started out two or three years ago as a bare-bones six-page article, but ultimately the exceedingly complex and historically rich story grew to over 90 pages, illustrated by more than 100 color photos.

In the course of this inexorable expansion (as Dan's research progressed), it became clear to us that this work was approaching full-issue size. However, we were not looking forward to a repeat of the controversy that had greeted our previous issue on the history of the crystallographic goniometer. In that instance our normally agreeable readership split into two warring camps over the question of whether a subject essentially devoid of any actual mineral specimens was appropriate fare for the *Mineralogical Record*. Those who had no interest in the subject felt they had been cheated out of one of their six issues for that year. Those of a more technical and historical bent thought it was both fascinating and soul-satisfying to see something which contributed so much to their understanding of mineralogy as a science. There was no resolving the two points of view, and although we expect readers to understand that not every issue can be of interest to every subscriber, we decided it was best not to go that far afield again. And yet the history of mineralogical instrumentation provides fundamental background for any involvement in mineralogy and mineral collecting, so we did not want to abandon Dan's increasingly erudite and significant work either.

Consequently the decision was made that, if we were to publish the microscope monograph, it would have to be outside the context of the year's normal six issues. That meant that it would have to be produced entirely through donations, so we began to seek donors. Bill and Carol Smith took the task upon themselves to contact many potential donors on our behalf, and we also presented a grant proposal to the Friends of Mineralogy, both the Colorado Chapter and the National governing board, which (to our everlasting gratitude) both came through for us. The total raised was still insufficient, however, so we prevailed upon our graphics company in Maryland (Capitol Communications) and our scanning company in Tucson (Hollis Photo-imaging) to provide their services for this project at half their normal rate, and they both graciously agreed. This finally brought us close enough to break-even, and we were able to go ahead with publication.

So, for the first time in our history, our readers received seven issues for the year, and we hope that at least some of them will find value and interest in the extra issue. For those of our subscribers who are not interested in keeping the microscope monograph, I might urge you to donate it to a local university or college mineralogy department. We also have a few copies available to sell individually, so if you want to keep your own subscription copy and would like to buy one for your old alma mater we will send it to the recipient of your choice with a gift card in your name. It never hurts to stimulate interest in descriptive mineralogy at the college level . . . too many geology departments are neglecting the study of classical mineralogy these days.

I would like to take this opportunity to thank once again those people and organizations who contributed in order to make the publication of the microscope monograph possible, and especially to author Dan Kile himself for making what I consider to be a major contribution to the literature on the history of mineralogy.

The Friends of Mineralogy

Every mineral collector, at least those who read the *Mineralogical Record*, knows about the existence of the *Friends of Mineralogy*, an organization consisting of mineralogists, mineral collectors, mineral curators and mineral dealers. It was founded through the efforts of the late Arthur Montgomery, as a purely altruistic organization whose mission it is to foster the appreciation of minerals, to support the preservation and dissemination of mineralogical knowledge (especially among the collector community), and to support the responsible conservation of mineral specimens and mineral localities for posterity.

FM consists of a national governing body and also of various regional chapters. The national and regional organizations have been involved in many worthwhile projects, including the preparation and publication of regional locality indexes, the preservation of specific famous mineral localities, the sponsorship of symposia, lectures and awards, and the dissemination of instructional materials, teachers' guides, technical publications and other educational documents that benefit the science and the public.

Perhaps it has been a while, however, since most readers have actually considered becoming a member. There is no better time than the present to address this question! What are the personal benefits of membership? The personal satisfaction of helping to promote mineralogy, and the fun of working with like-minded people who are passionate about minerals (and, of course, you get the organizational newsletter). FM does not exist to benefit its small membership, but rather as a vehicle through which its members can effectively be of service in many organized ways to mineralogical science and the mineralogical community. Your dues support mineralogical symposia, mineralogical publications and awards, and educational programs. You may also volunteer your time, if you wish, to assist with various worthwhile and often quite interesting projects. You may join a regional chapter, or you may join the national organization directly if there is no regional chapter operating where you live.

Getting involved helps to increase the amount of enjoyment and satisfaction that the hobby of mineral collecting provides so abundantly. Go for it! Be a part of the synergy! Check the FM page in this issue to see if a regional chapter is active in your area, or check out the organization's website at www.friendsofmineralogy.org. You can join the national Friends of Mineralogy as an at-large member (and receive their newsletter) by sending $10.00/year dues to Jim Hurlbut, 2240 S. Adams St., Denver, CO 80210-4912. Phone 303-757-0283. Prospective members of a chapter may submit their applications directly to the chapter contacts, and will then be billed for the chapter and national dues, since the dues vary with individual chapters.

Internet Directory

The Internet is a wonderful thing, and brings almost the entire mineral world to your desktop. Unfortunately, we have too much of a good thing now, and it is becoming ever more difficult to find what we want amidst the countless thousands of websites. Search engines now become hopelessly overloaded. For example, using Google, a search on the words "mineral specimens" turns up 222,000 hits. Even if you get really restrictive and search on the exact phrase "mineral specimens for sale," you get over 1,300 hits, and will still

probably miss many good dealers who don't use that exact phrase on their website. "Mineral collector" yields 5,240 hits. "Mineral museum" yields over 12,000 hits. Unless you are looking for something very specific ("Ojuela wulfenite," 232 hits), a search engine will inundate you with far more sites than you would ever want to check.

The *Mineralogical Record* offers a service to circumvent this problem: our Internet Directory. Here, for just $200 a year, dealers, collectors and museums can place their website prominently before the mineral world and not be lost in the crush of countless search engine hits. If a site is listed in the *Record*, it is surely worth a look.

The Internet Directory may appear to be full at present, but we will be pleased to add a second page if demand warrants. Listings for any mineral-related site are accepted, whether by a mineral dealer, a dealer in mineral books, a collector with a personal site to show off his collection, a museum with a website, an educational mineralogical website, or anything else that would interest our readers. Each entry consists of four pieces of information: (1) business or personal name, (2) a description of what the site offers, in 40 characters or less, (3) website address, and (4) e-mail address.

A new listing can be started at any time. Simply e-mail the editor at minrec@earthlink.net and provide the text for your listing. VISA or MC charges by e-mail are easiest, but a check can also be sent.

In the meantime, go check out the sites listed there now. You will find some wonderful things that you probably could not have come across any other way.

Marcelle Weber (1918–2003)

Died, Marcelle Weber, 84

Marcelle Juanita Horn Weber, amateur mineralogist, well-known micromounter and long-time resident of Guilford, Connecticut, died at home on Tuesday, July 8, 2003 after a brief illness. Marcelle was born on September 19, 1918 in Randolph County, Indiana. She is survived by her daughters, Ruth Weber Hoffman and Martha Jane Weber; and her son, Charles H. Weber, III.

Marcelle earned an A.B. in Business Administration from Indiana University in 1940. After graduating, she returned to Fairfield to work at Remington Arms, and subsequently served as private secretary in her husband's business as a manufacturer's representative. Over many years, she was actively involved in national, state and local chapters of some dozen lineage societies such as the Daughters of the American Revolution, Women Descendants of the Ancient and Honorable Artillery Company, etc.

A nearly lifelong passion for mineralogy led to Marcelle's recognition as one of the most knowledgeable and respected amateur mineralogists in the U.S. and Canada. She had a remarkable ability to sight identify minerals, especially from her favorite locality, the Poudrette quarry, Mont St-Hilaire, Québec. Her memory was phenomenal, allowing her to give year and month for any important find or trip to Hilaire. Marcelle and Charlie first visited the Poudrette quarry in 1968, ultimately returning some 240 times, and traveling a total of approximately 180,000 miles to do so. Their diligence at collecting there, and Marcelle's reluctance to throw any specimen away, are attested to by the mountains of specimen-filled beer flats crowding everything else from their cellar, and leaving only a six inch gap between the tops of the stacks and the ceiling! As a result of her work, she was named to the Micromounters Hall of Fame. And in the early 1990's Marcelle and Charlie discovered and supplied the type material for a new Mont St-Hilaire mineral species that was subsequently named *charmarite-2H* in their honor.

Marcelle was an avid mineral photomicrographer, lecturer and author, taking her message to micromount symposia and conferences throughout North America. She and Charlie also represented the *Mineralogical Record* at Eastern mineral shows, particularly the Springfield Show, and often helped out at the subscription table at the Tucson Show. Over the years, she inspired many people to become interested in mineral collecting, especially the study of micromounts, to subscribe to the *Mineralogical Record*, and to join the fraternity of advanced collectors at Mont St-Hilaire. She was an active member of the Friends of Mineralogy (Secretary), the Micromounters of New England, the Tucson Gem and Mineral Society, the Mineralogical Association of Canada, the Baltimore Mineral Society, the New Haven Mineral Club (President), and the Stamford Mineral Club (President).

Specimens of charmarite-2H and others from Marcelle and Charlie's extensive collection are held by the Smithsonian Institution, the Canadian Museum of Nature, and other institutions. Donations in Marcelle's memory may be sent the Canadian Museum of Nature, P.O. Box 3443 Station D, ATTN Mr. Robert Gault—Confidential, Ottawa, Ontario K1P 6P4, Canada.

William A. Henderson, Jr.

Died, Charles H. Weber Jr., 85

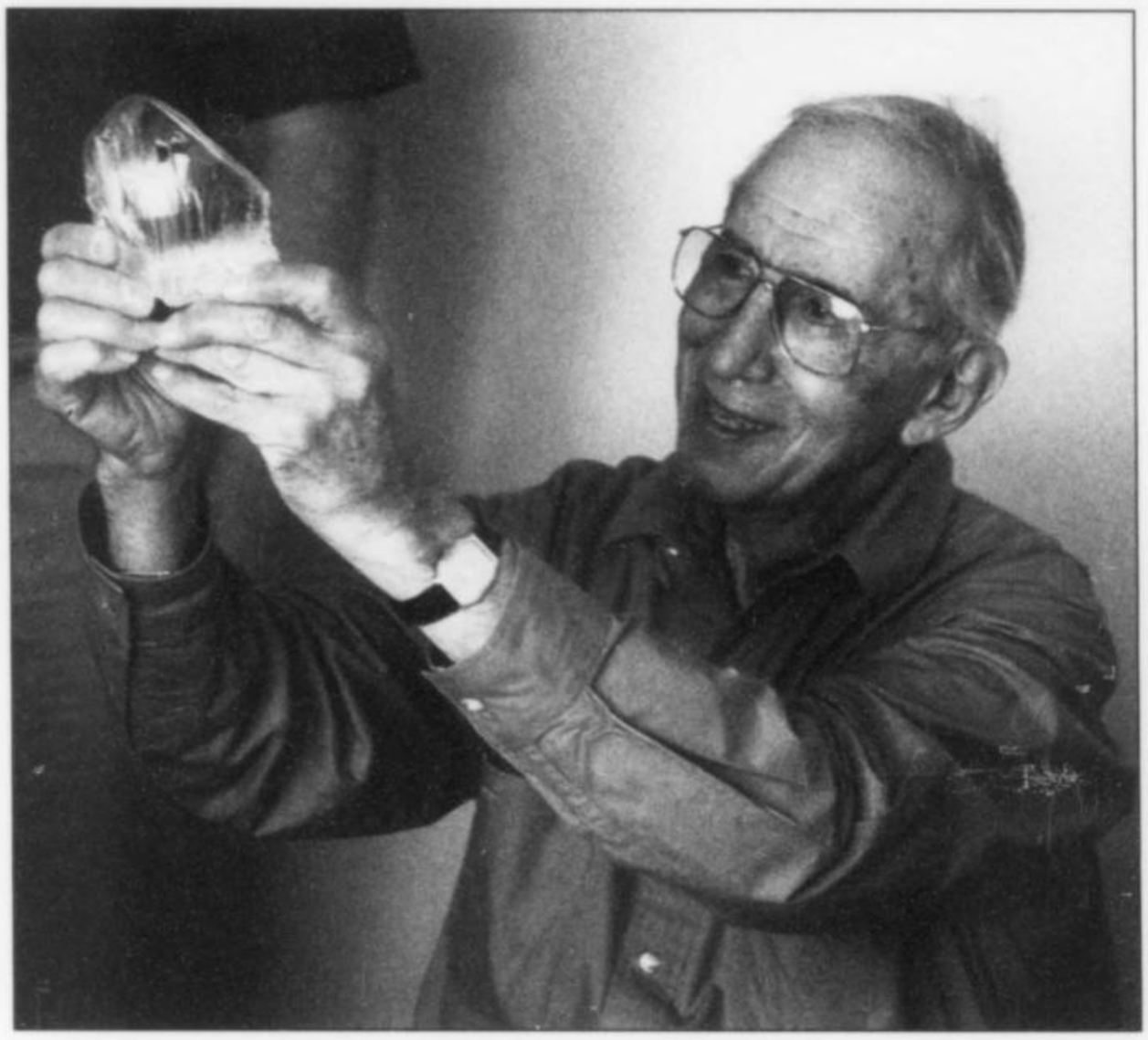
The death of Charles Henry Weber Jr. on November 16, 2003, following that of his wife and life partner Marcelle in July, marked the end of a long saga in the world of mineral collecting in general and micromounting in particular.

Charlie and Marcelle were a team in the truest sense of the word. The name *charmarite* for the new mineral they discovered in Mont Saint-Hilaire, Québec, in 1971, epitomizes their closeness, and Charlie's intense support of Marcelle's mineral endeavors. She found the minerals, but he broke the rocks for her.

Born in Nutley, New Jersey, on December 22, 1917, the son of Charles Henry Weber and Marie Frances Sipple Weber, Charlie paid his way through Newark College of Engineering by spending his weekends in hotel ballrooms playing the violin as leader of a string quartet. His talents as a musician and his love of music were unknown to many, but they were strong, and he made sure that they were passed to his children and grandchildren.

On graduating as a chemical engineer, Charlie began working for E. I. Dupont. Throughout World War II, he was first assigned to the Remington Arms Division in Bridgeport, Connecticut, then

Charles H. Weber Jr. (1917–2003)



Hyman Savinar (1916–2003)

faced subsequent moves to Wilmington, Delaware, and Baton Rouge, Louisiana. He subsequently joined Rolock Company in Fairfield, Connecticut, as chief engineer. Ultimately he established his own sales business as a Manufacturer's Representative, residing in Fairfield until his move to Guilford upon his retirement. A 50-year member of the Masons, Charlie was currently active in St. Albans Lodge No. 38 of Guilford.

Marcelle may have had higher billing in mineral matters, but that was only because Charlie was right there holding up the signs. A man of quiet mien, but firm integrity, and subtle humor, he was often the one who manned the booth or the hotel room at mineral shows, selling subscriptions to the prestigious mineral journals they both supported so strongly, while Marcelle was scouting the dealers for minerals.

He loved nature, the outdoors, and fishing, but he loved Marcelle the most. Together, their influence on mineral collecting and micromounting was enormous. It was Charlie who supplied ultrasonic cleaners to many micromounters, and it was Charlie who knew suppliers and where to buy things. For mineral questions, one went to Marcelle, but for most other things, one went to Charlie.

I once attended a retirement dinner for two senior military officers. One stood up and harangued us for half an hour about his illustrious career and great achievements. When he had finished, the other stood and said: "Ladies and gentlemen, throughout my career I have learned one thing: it's nice to be important, but it's more important to be nice." Then he sat down.

Charlie was a nice man.

Donations in his memory may be sent to the Canadian Museum of Nature, P.O. Box 3443 Station D, Ottawa, ON K1P 6P4, Canada ATTN Mr. Robert Gault—Confidential; or to The Connecticut Hospice, 100 Double Beach Road, Branford, CT 06405.

Quintin Wight

Died, Hyman Savinar, 86

Hyman Savinar, mineral collector, businessman and museum patron, passed away on June 15, 2003 after a short illness. He made donations to several mineral museums as well as to the Gemological Institute of America, but his primary focus for philanthropy and support was the Mineral Sciences Department of the Natural History Museum of Los Angeles County. Over the past 20 years he donated many fine mineral and gem specimens to the collection. When the museum established its Gem & Mineral Council support group in 1985, Hyman joined its board of directors. As a dedicated and influential board member, he served for many years as chair of the council's ways and means committee, helping to develop and promote fund-raising initiatives such as the Adopt-a-Mineral program. The exceptional personal collection of minerals and gems which Hyman and his wife built has been willed to the museum; it includes the superb Peruvian rhodonite pictured on the cover of vol. 21, number 2.

Hyman was born on 7 August 1916 in Los Angeles, California. He showed an early proficiency and love for music and developed into a concert-caliber pianist. In 1941 he married Beverly Chapman, and they remained happily married for sixty-two years. As a young man, Hyman joined the family business, H. Savinar Luggage Company, which his father had started in 1916. After serving four years in the Pacific during World War II, Hyman began to assume an increasing share of the responsibilities of running the business. After his father's death in 1972, Hyman became president and, together with his son Lewis, and brother Harold, managed the business with dedication, hard work, business acumen, and integrity.

Hyman's interest in gems and minerals sprouted in the early 1970's. He and his wife took an extension course in gemology at UCLA, followed by four trips to Minas Gerais, Brazil, where they became acquainted with such notable gem dealers as Jules Sauer, Agenor Tavares, and Kahlil Elawar. On a trip to Namibia around 1984, they became close friends with world-renowned mineral dealer Sid Pieters and his wife, Val. Savinar spoke with Sid regularly until Sid's death in March of 2003. Such was Hyman's personality that friendships often arose from business transactions.

All who met Hy were immediately taken by his kind, gracious, and caring personality. He was a gentle, unpretentious, and genuine man, who was valued as a friend by many in the gem and mineral community.

Anthony R. Kampf

Jerry Hurianek (1919–2003)

Died, Jerry Hurianek, 84

Jerome (Jerry) W. Hurianek, a longtime collector in the Crystal Peak area of Colorado, passed away in Casa Grande, Arizona on August 23, 2003. Born in Jaroso, Colorado in 1919, Jerry acquired an early interest in minerals, and apprenticed in his teens with Albert Whitmore at the Crystal Peak Gem Mines in 1934. There he learned techniques for collecting in pegmatite cavities. In 1938 he wrote an article for *Rocks & Minerals* on "Smoky quartz at Crystal Peak, Colorado," wherein he mentions Whitmore, his claims in the area, and his mineral shop.

Jerry made a career in the U.S. Army, retiring in 1966, after which he resumed his mineralogical activities. Following a brief stint with *Missouri Minerals*, he settled in the early 1970's on a 40-acre property in the Florissant area, Colorado where he established a mineral business under the name of *Florissant Gems and Minerals*. He and his wife Thelma opened up a series of amazonite and smoky quartz pockets on land they had purchased just north of Crystal Peak, and removed many fine specimens. He offered mineral specimens for sale through his shop, and also allowed visitors to collect minerals on a fee basis, patiently guiding less-experienced collectors (including myself in 1972) in the techniques of prospecting and excavating gem pegmatites, as he had learned them from Albert Whitmore nearly 40 years earlier.

Jerry maintained a longstanding presence at the Desert Inn during the annual Tucson Gem and Mineral Show, where he marketed some of the world's finest amazonite, smoky quartz, and other associated pegmatite minerals. Among his finest pieces was a spectacular large-cabinet specimen of amazonite, smoky quartz, albite (cleavelandite) and goethite which he had collected in December of 1979. Jerry was instrumental in providing the amazonite and smoky quartz specimens that are prominently displayed in a cavity reconstruction in the Coors Mineral Hall in the Denver Museum of Nature and Science. This cavity reconstruction is illustrated in Peter Bancroft's *Gem and Crystal Treasures* (1984), along with another of Jerry's spectacular finds (a 13 x 19-cm amazonite and smoky quartz specimen), and a photo of Jerry in 1935 drilling holes for explosives on the Whitmore property.

After deeding most of his mining claims to local rock clubs, Jerry moved to Casa Grande, Arizona, where he was often seen at the Tucson Show. He is survived by his second wife, Alice (his first wife, Thelma, died in 1989), and four children. His warm sense of humor and generosity will be missed.

Daniel E. Kile

Died, Dan Belsher, 46

On April 5, 2003, the mineral community lost one of its most well-liked and enthusiastic supporters with the untimely passing of Dan Belsher following a prolonged illness. As proprietor of Denver Box Company and Blue Sky Minerals, a major retail/wholesale operation, Dan was instrumental in the development and discovery of many Mexican and Peruvian localities for minerals and lapidary material.

Dan was born on April 13, 1956, and was exposed to minerals from the beginning: Dan's father, Don Belsher, a prominent Colorado mineral collector and dealer, recalls Dan being at Creede, Colorado in his rocker, and his selling self-collected pyritized fossils at age five. In 1986, after attending the University of Colorado, Dan joined with his brother Dennis in starting a business for the importation of Peruvian minerals. Fine native silvers, raspberry-colored fluorites, and later the classic rhodonites were among the minerals these brothers brought out of Peru. Later, Dan did much exploration work in northern Mexico; he made several new wulfenite discoveries, and he imported schorl stalagmites, smithsonite, amethyst, numerous Santa Eulalia minerals, and more. To complement the mineral business, Dan opened Denver Box Company in 1990, and thereafter supplied large quantities of boxes to the jewelry, mineral and fossil trades.

His parents, his brother and his 15-year-old daughter survive Dan. He was a friend to many and will be sorely missed.

Chris Cowan

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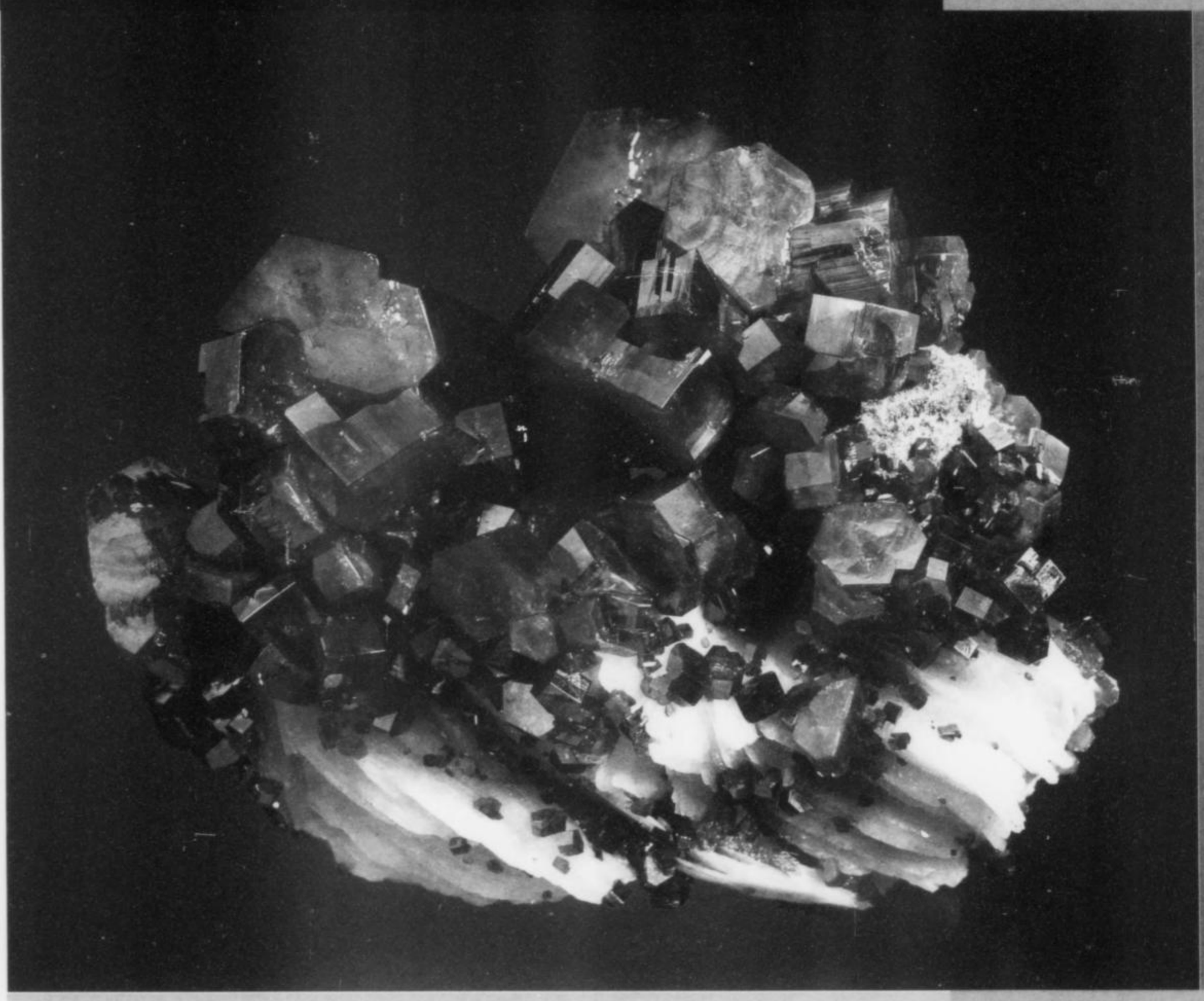

Vanadinite on Barite, 4 inches wide, from Mibladen, Morocco. Jeff Scovil photo.

Rhodochrosite; Quartz and Tetrahedrite, Porcelain Pocket, Sweet Home Mine, Alma, Colorado. Come see the spectacular collection of Sweet Home Mine specimens displayed at the new Colorado School of Mines—Geology museum, Golden, Colorado. Photo by Jeff Scovil

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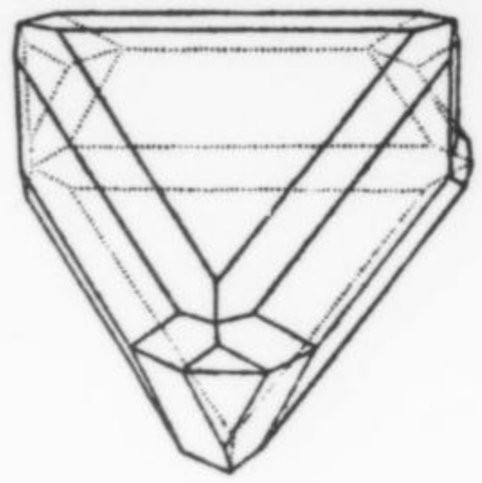


A Collection of

DIAMOND CRYSTALS

with

Notes on the Science, History, and Worldwide Localities of Diamonds

Thomas Moore
5755 East River Road, #1317
Tucson, AZ 85750

Natural diamond crystals are among the most elegant and charismatic of mineralogical collectibles, but they are relatively rare in collections because of their high value as gemstones, their typically rather small size and their limited availability outside of the gem trade. They also represent a rich and extensive cultural history, a broad geographical distribution, and a fascinating geological history still being puzzled out by researchers.

INTRODUCTION

Diamonds have been found on every continent in the world, with the possible exception of Antarctica, and have been mined from hundreds of deposits worldwide since at least 800 B.C. Enormous stockpiles are held in reserve by DeBeers, the preeminent clearing-house for world diamonds, and by the Russian Diamond Fund. Diamond can hardly be said to be a rare mineral, despite its traditionally high market value. Despite this seeming abundance of diamonds over the centuries, and the presence of at least token crystals in many 18th and 19th-century mineral collections (some of which are illustrated here for comparison), relatively few collectors, especially in recent times, have ever attempted to specialize in the species. One of the early diamond specialists was the British collector Sir Abraham Hume (1749–1838), whose fine collection of 107 diamond crystals was cataloged by Count de Bournon in 1815. Another early British collector, Charles Hampden Turner (whose mineral collection was assembled for him by the mineral dealer Henry Heuland), possessed 109 examples of diamond. Armand Levy, who prepared Turner's published collection catalog in 1838, remarked that it was impossible to identify the locality for any given diamond crystal based on its habit alone, and so localities were generally not cited in the catalog, but Levy guessed that most of Turner's diamond crystals were probably from Brazil. The extrava-

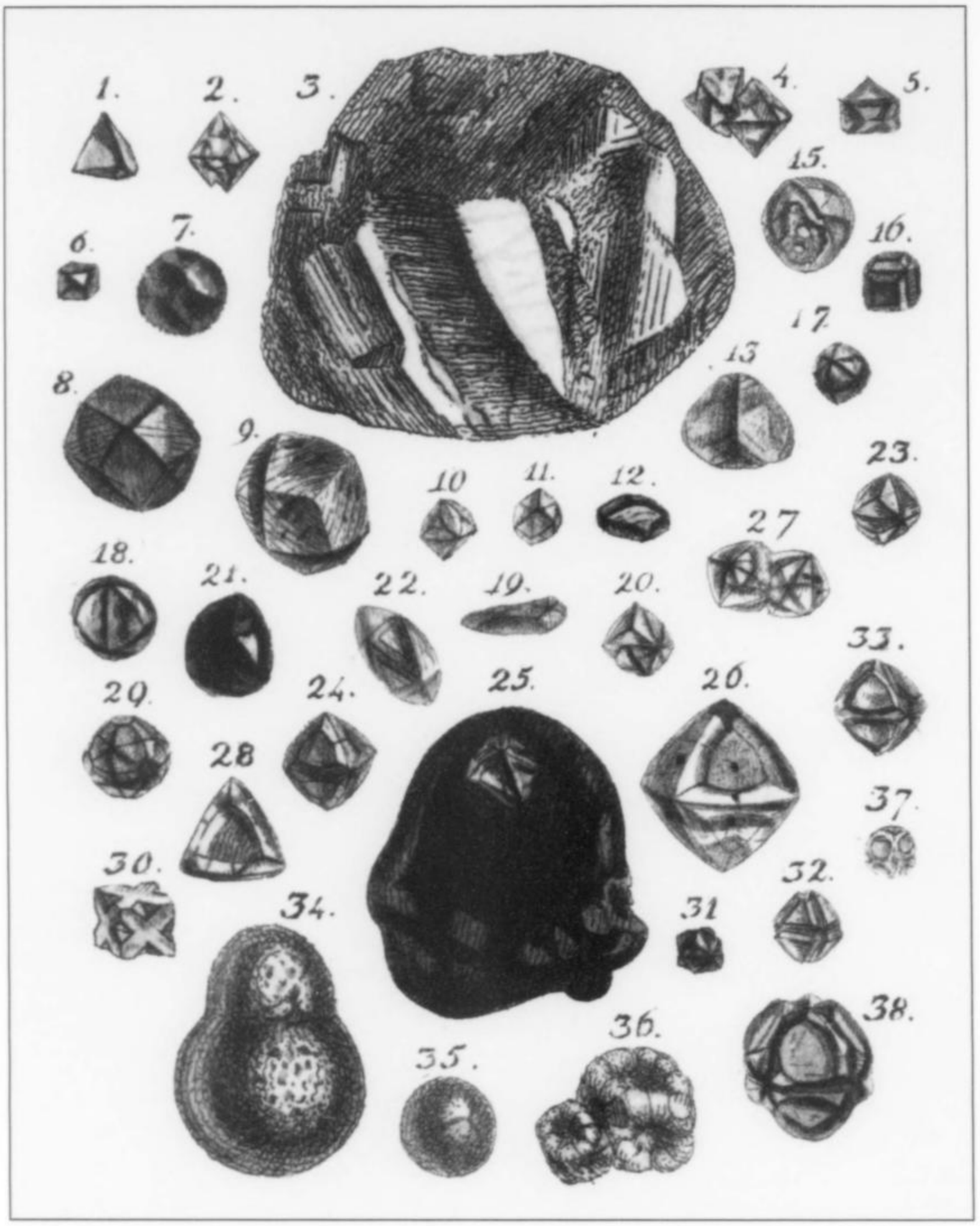


Figure 1. **Diamond crystals illustrated in Sowerby's *Exotic Mineralogy* (1817), borrowed by him from Rundell & Bridges (no. 3), the Charles Greville collection at the British Museum (no. 6, 36, 38), John Mawe (no. 30), Sarah Mawe (no. 7, 13, 21, 28, 29, 32, 37), John Heuland (no. 8, 9, 22, 25, 26, 27, 34, 35), and the British Museum (no. 15). Sowerby does not provide localities, but states that "Of late years an immense number of diamonds has been obtained from the Brazils, particularly from the bed of the river Jigitonhonha" [=Jequitinhonha]. Mineralogical Record Library.**

gant Ecuadorean collector in Paris, Don Pedro Davilla (ca. 1710–1775), had a mere 16 diamond crystals in his enormous collection of over 8,000 total specimens. The Austrian banker and businessman Jacob Friedrich von der Null, whose huge mineral collection, curated by the prominent mineralogist Friedrich Mohs, was considered to be the best in Vienna, owned 36 diamond crystals (Mohs, 1804). Also in Austria, Ignaz von Born assembled a suite of nine crystals for Mlle. Eleanore de Raab in 1791. In the 20th century, Paul Seel (1904–1982) assembled a collection of several hundred diamond crystals, each of which "illustrated some morphological fact" (Desautels, 1970). It was considered by Paul Desautels to be the finest and largest collection of diamond crystals then in existence—and considering his authoritative knowledge of collections worldwide, we can safely accept his judgment.

Such collections remain rare today, both because of the high unit cost of good specimens and because the international diamond market is not set up for the distribution of collector-quality uncut crystals. Rough gem-quality diamonds are normally sold only in parcels which cannot be cherry-picked for individual pieces. These parcels are always purchased (usually in Amsterdam) by commercial cutters or by dealers in abrasives, who have no interest in or awareness of diamond crystals as specimens. Therefore the acquisition of collector-quality crystals normally requires the help of someone who is either involved in the commercial end of the diamond trade or who has especially good personal connections in Amsterdam, or both.

Recently the *Mineralogical Record* was given access to a remarkable private collection of diamond crystals. The specimens

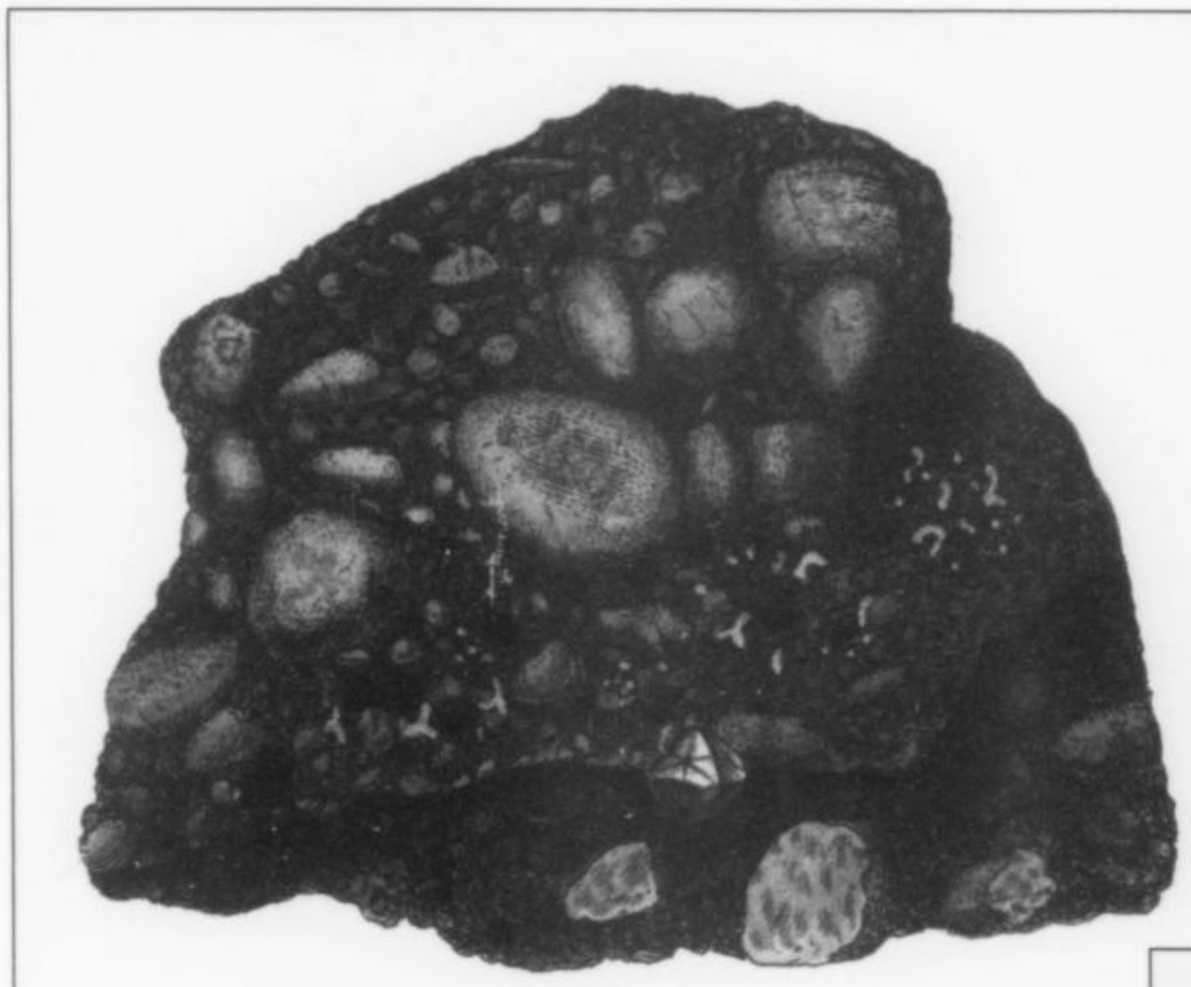
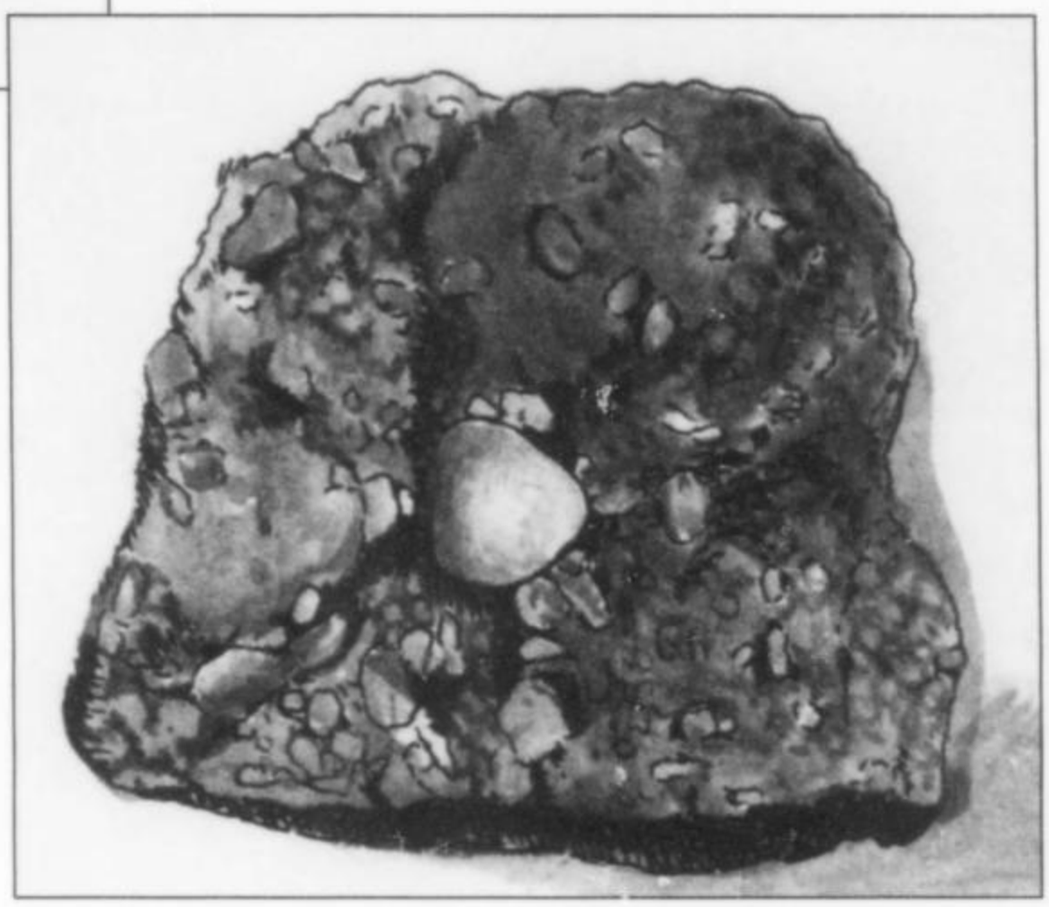


Figure 2. **A diamond crystal in matrix collected in Brazil (probably in the Jequitinhonha River area) by the British mineral dealer John Mawe and illustrated in his *Travels in the Interior of Brazil* (1812). Mineralogical Record Library.**

Figure 3. **A diamond in matrix from Golconda (India or Brazil?), "of a fine water and well rounded; remarkably preserved in its original matrix, a variegated mass not unlike an iron-stone." From the collection of Christian Stieglitz of Leipzig, illustrated in his rare collection catalog of 1769. Mineralogical Record Library.**



were acquired by dealers Jack Greenspan and David New over the last 20 years or so. Jack filtered his specimens out of commercial lots purchased for his business in abrasives and saw blades; Dave got his through personal connections with diamond merchants in Amsterdam, who were willing to set aside for him a particularly nice single crystal every once in a while. The private collector who acquired the specimens from these gentlemen was thereby able to assemble an extraordinary diamond collection. Since such a collection is so unusual, we thought that *Mineralogical Record* readers would like an opportunity to see the specimens and learn something about the geology, cultural contexts and mining histories of the localities represented.

The crystal forms of the diamonds cover a familiar range: there are simple octahedrons, cubes and dodecahedrons, and there are combinations of these; there are single crystals and clusters of crystals, and there are the characteristic, flattened triangular shapes of "macle" spinel-law twins. Some of the crystal faces are convex to varying degrees, some are slightly rough, and inspection with a loupe reveals growth trigons on some. A few crystals are highly lustrous and gemmy while others are duller; inclusions may or may not be naked-eye visible.

The physical appearance of diamonds, even large ones, is predictable in many ways, and yet their historical/cultural and even geological histories always have a special fascination. We are talking, after all, about diamonds: *adamas* was the Greek root word, always carrying connotations of magic powers, invincible strength and the workings of strong, brazen gods.

Before looking specifically at the localities for the 52 diamonds pictured here from the collection, a brief historical overview of diamond mining and a summary of the exotic geological "story" that all localities have in common is in order.

SOME HISTORY

Very few modern mineral collections can boast diamond crystals from India, and yet the roots of diamond romance and diamond commerce lie unmistakably there. The world's "first" diamonds were taken from Indian riverbeds as long ago, perhaps, as 800 B.C. (www.diamondcutters.com); a Sanskrit manuscript, the *Artha-Sastra*, mentions a king of the Maurya dynasty (320–298 B.C.) who regulated an active local diamond trade (Maillard, 1980). Legends associated with the invasion of India by Alexander the Great speak of a "Valley of Diamonds," narrow and deep but laden with gems: men would kill and flay sheep, cast quarters of raw flesh into the chasm, let birds of prey eat the flesh, then kill the birds when they soared out of the chasm, collecting the diamonds which had adhered to the feathers. Variations of this core story spread to China, and later into the Persian and Arab worlds, reaching Europe in 1298, when Marco Polo repeated it in his *Book of Marvels*. Other early legends claimed that Indian diamonds had the power to neutralize magnetism, and that the most precious diamonds are those which float in water (this one is puzzling, given the high specific gravity of the mineral). Four general grades of Indian diamonds were associated in various ways with the four castes into which classical Hinduism divides humankind. Diamonds could either poison or heal, bring bad luck or good. A myth repeated by Pliny claimed that the diamond's "invincible force" can be "broken" only by applying to the stone the blood of a he-goat: the myth was later allegorized in Christian terms, the diamond being identified with Christ, the he-goat with Satanic powers (Maillard, 1980).

The ancient Romans loved Indian diamonds, and traded for them with native merchants around the "Gulf of Cambay" (today, the Gulf of Khambat, above Mumbai). From the days of the Roman Republic, through the centuries of the Empire, the medieval period, and into the Renaissance, diamonds were brought from India to Europe via two main trade arteries: an overland route, passing through Persia and Byzantium to Rome or Venice, and a southern

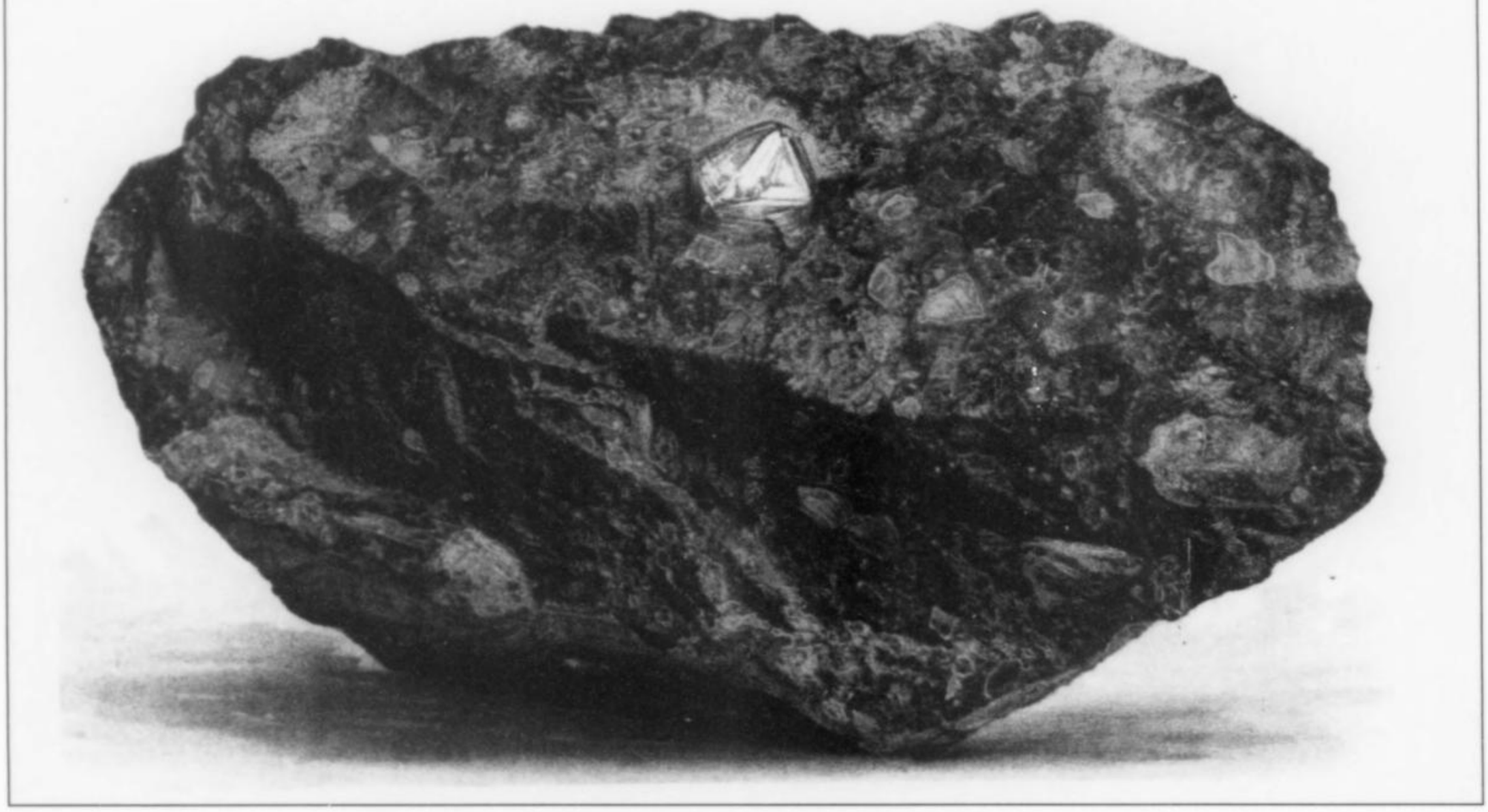


Figure 4. **A diamond crystal in "blue ground" from South Africa, probably from the collection of Gardner and Alpheus Williams (illustrated in both of their books, published in 1905 and 1832). Mineralogical Record Library.**

route, traversing the Indian Ocean and running up through Arabia to Alexandria, and thence to Italy. In the 17th century, the French traveler Jean-Baptiste Tavernier visited some of the Indian diamond mines and brought back much valuable information—including legends, already richly textured, about the fabulous Koh-i-Noor ("Mountain of Light") diamond. This, the first of the world's major named diamonds, reportedly weighed 600 carats originally, and is now to be seen, facet-cut, in the crown of the English Queen Mother. The great blue "Hope" diamond, now in the Smithsonian, was also found in India, and is likewise couched about with ancient mythic tales, mostly involving the bad luck it brought to its owners.

Most Indian diamonds were harvested from alluvial deposits in the gravels of stream beds, possibly very far from the primary kimberlite pipes. However, some also were probably found in loose eluvium just above a pipe or in colluvial ground adjacent to it. One Greek account of about 120 B.C. speaks tantalizingly of underground diamond mines with deep galleries (Maillard, 1980); these were probably not mines in kimberlite but deep diggings in diamond-bearing conglomerates, called "the pits of Panna" by Williams (1905).

Five areas in India produced diamonds, and one, the largest and richest, became famous under the name "Golconda mines," or "the Kingdom of Golconda," since the town of Golconda was its capital and the center of a large diamond trade (Williams, 1905; Harlow, 1998). All that remains of the opulent "Kingdom" today is a ruined fort near Hyderabad, and the only modern producing diamond mine in India exploits the Majhgawan lamproite pipe near Panna, producing annually about 20,000 carats—0.2% of world output (Levinson *et al.*, 1992).

During the European Renaissance, Dutch and Portuguese traders competed for Indian diamonds, while at the same time the Portuguese, from their infant colonies on the African coasts, attempted to penetrate the African interior. The Portuguese hoped to find the wealth of "Ophir," the legendary home of the biblical Queen of Sheba and of King Solomon's mines, whence had supposedly come the diamonds (?) on the breastplate of the High Priest of ancient Jerusalem. Nothing came of these early African quests, but Indian diamonds meanwhile poured into Europe along the main internal trade routes running at first from Venice to Antwerp, and then later from Lisbon to Amsterdam. Around 1464 the "Sancy" diamond from India, then owned by Charles the Bold, Duke of Burgundy, was refashioned as a fine facet-cut gem by "the true artist Louis de Berquem of Bruges," in modern Belgium (Williams, 1905), and by the early 16th century a diamond-cutting industry was beginning to flourish in Antwerp. Between the 16th and 18th centuries, first Amsterdam, then London, became the capital of the diamond world. Although Dutch merchants kept investing heavily in the Indian diamond trade, the English by the early 18th century had acquired near-monopoly control of Indian diamonds, and had supplanted the Dutch—by which time, however, the discovery of Brazilian diamonds brought Portugal once more into the game. For a full account of these early-capitalistic maneuvers involving diamonds, and their entwinements with European power politics, see Maillard (1980).

The era of Indian diamonds ended in 1725, when some shiny stones found by Brazilian *garimpeiros* in an alluvial gold deposit near the town of Tejuco (now Diamantina), in Minas Gerais, proved to be diamonds. The Brazilian era continued until the South African discoveries of the 1860's, and South African diamond production monopolized the field until the first decades of the 20th century. South Africa is still a significant producer, but since about 1920 Zaire (now the Congo Republic), Angola, Botswana, Russia and Australia, in that chronological order, have all surpassed it in annual output.

Zaire produces mainly industrial diamonds, and has been doing so since the First World War, when the country was known as the Belgian Congo. Zaire's diamondiferous region lies near the Angolan border, where crystals are found in alluvial gravels and mined from a large kimberlite pipe at Mbuji-Mayi. This country has been so prolific since about 1920 that, surprisingly, it *leads* the world in total production, as measured by carat weight, for the entire period from antiquity to 1990. Zaire's total all-time figure is 718,117,000 carats, and South Africa, with 446,856,000 carats, comes in second (Levinson *et al.*, 1992).

Kimberlite pipes were first prospected in the Yakutia Craton of northeastern Siberia, Russia, after World War II. There are three major diamond-producing fields here: the adjacent Daldyn and Alakit fields and, about 400 km to the south, the Malaya Botuobiya field. In the summer of 1955, within ten days of each other, the Udachnaya ("success") kimberlite was discovered in Daldyn, and the Mir ("peace") kimberlite was discovered in Malaya-Butuobiya. These occurrences have become fairly well known to mineral collectors, as small numbers of their matrix specimens of diamond crystals in kimberlite have reached western collector markets (Sullivan, 1978; Moore, 1995). The mine at Mir is now idle and flooded, but Udachnaya continues to produce diamonds, as does a very large pipe called Jubilileynaya ("Jubilee"). The Yakutia Craton is now the world's second most productive geological province for gem-quality diamonds, after the Kalahari Craton in southern Africa (Harlow, 1998).

Diamonds from the United States have been nothing more than small sideshows on the world scene. The "Crater of Diamonds" at Murfreesboro, Arkansas remains a popular site for tourist diggers in loose "dry ground"; diamonds were first found there in 1906, above what was first called a kimberlite, but is now known to be a lamproite diatreme (Kidwell, 1990). In the early 1960's, some kimberlite diatremes in Laramie County, Colorado and adjacent parts of Wyoming were found to be diamondiferous (Collins, 1982), and 327 carats' worth of small octahedral crystals were recovered in the early 1990's (Moore, 1997). California also hosts at least one primary deposit, at Leek Springs near Jamestown. Vastly more promising for the future are the diamonds of Canada—a country which bestrides the enormous North American cratonic region, and where, given the vastness of the potential ground, exploration still must be said to be in its early stages. Kimberlite swarms have been located in Saskatchewan and Alberta, but the real excitement during the late 1990's was occasioned by the discovery of diamondiferous diatremes lying around and under Lac de Gras, in the Arctic wilderness of the central Northwest Territories: see Kevin Krajick's recent book *Barren Lands* (2001) for an exciting account of events leading to the opening of the Ekati diamond mine there, in 1998.

Presently Venezuela, Guyana, Indonesia, Liberia, Ivory Coast, Lesotho and Swaziland all produce some diamonds; and alluvial mining in the northwestern part of Hunan Province, China has recently yielded a beautiful 1.2-cm macle twin which appeared in Tucson around ten years ago (Moore, 1993).

THE ORIGIN OF DIAMONDS

Before the latter half of the 19th century, all diamonds were mined from alluvium: the antique crystals from India and Brazil had been found in sediments, loose or lithified, and science had no idea of how the mineral formed in its native rock, or indeed what that rock might be. But the great South African diamond discover-

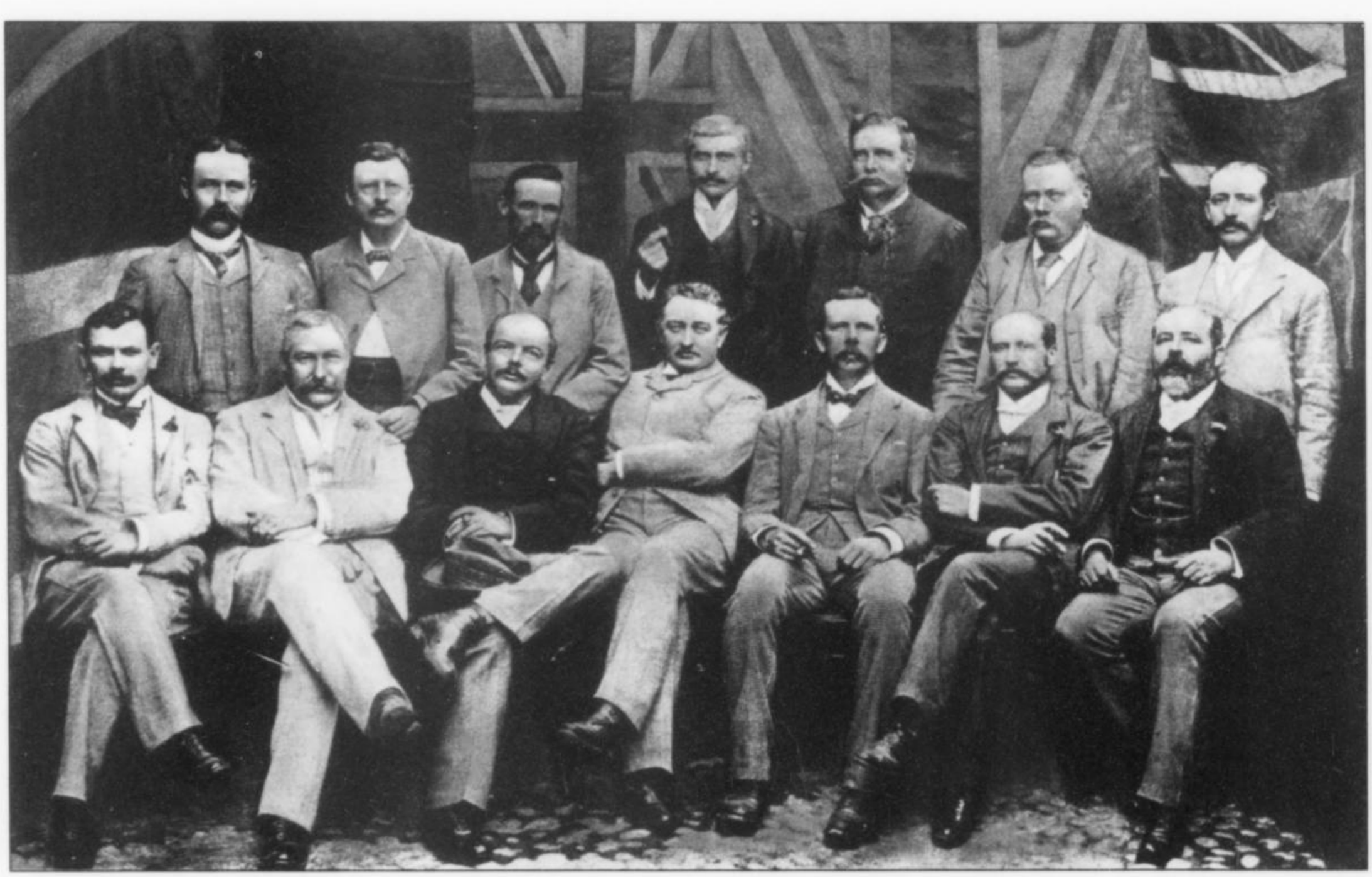


Figure 5. **A group of De Beers Directors, Officials and prominent South Africans in 1894. At front row-center sits Cecil Rhodes, and to the right of the man behind him is Gardner F. Williams (Williams, 1905). Mineralogical Record Library.**

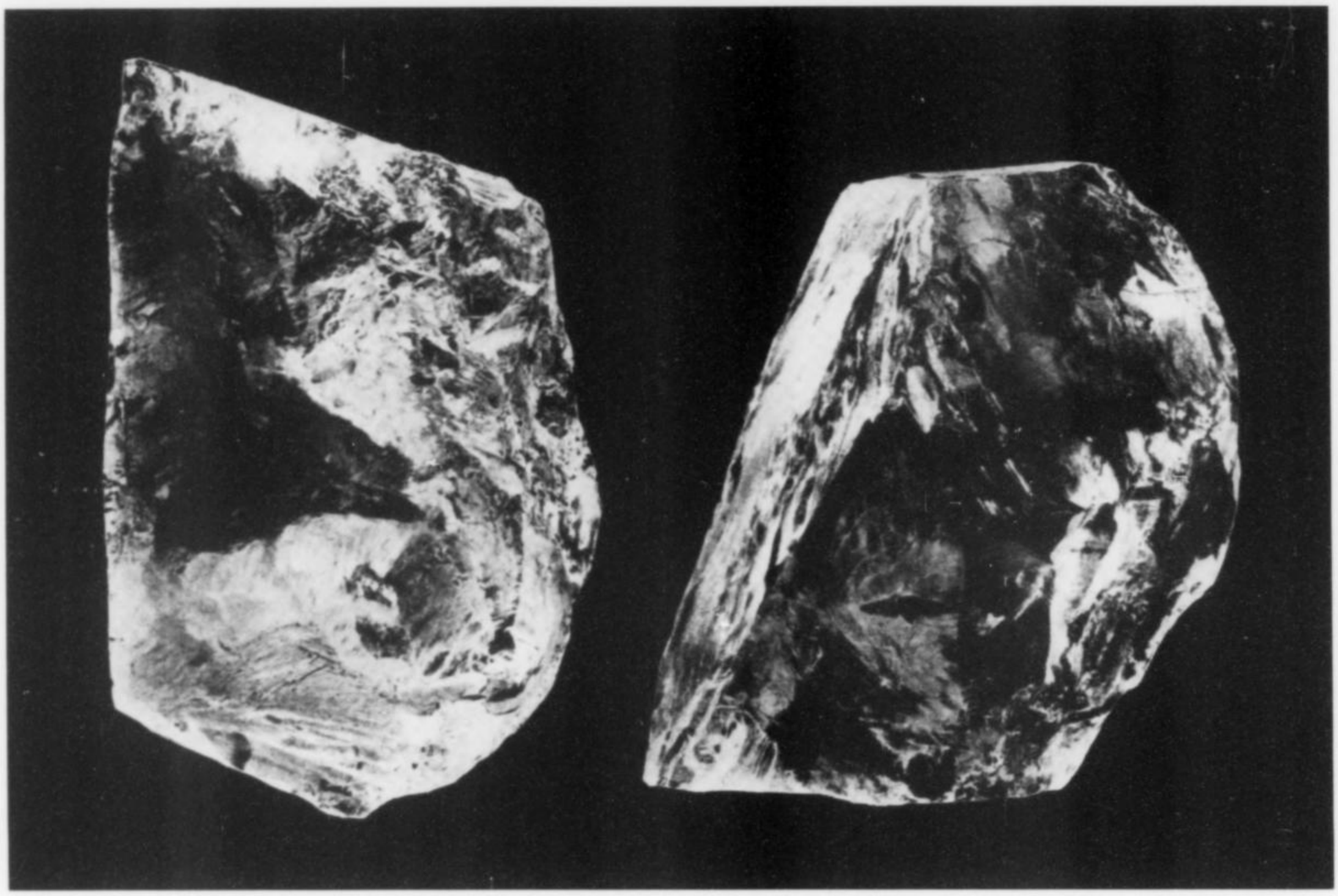


Figure 6. **The Cullinan Diamond before cutting, shown actual size. It was found on January 25, 1905 at the Premier mine, Transvaal, and weighed 3025.75 carats or about 1½ pounds. Although it is the largest gem-quality diamond ever found, it is clear from the morphology that it is the smaller portion of a cleaved octahedron, the larger part of which has never been found but must exist somewhere! (Williams, 1932) Mineralogical Record Library.**

ies in the 1860's revealed the rare rock type *kimberlite* to be the true home of diamonds. The first gem crystals were found loose in the so-called "yellow ground" of weathered kimberlite, and soon the unaltered "blue ground" below was found to contain riches too.

Kimberlite is typically a greenish gray, chowdery-looking igneous rock formed from a magna very rich in volatiles (chiefly CO_2 and H_2O). The rock is composed of large, irregularly shaped fragments chaotically mixed in a fine-grained groundmass. Whether these "fragments" are phenocrysts crystallized directly from the kimberlite melt or xenolithic inclusions of other rock types was a question which went unresolved for some decades.

Kirkley *et al.* (1991) define kimberlite as follows:

> A hybrid, volatile-rich, potassic, ultramafic igneous rock derived from deep in the earth (>150 km below the surface) which occurs near the surface as small volcanic pipes, dikes and sills [the latter two structures are very rare]. It is composed principally of olivine . . . with lesser amounts of phlogopite, diopside, serpentine, calcite, garnet, ilmenite, spinel, and/or other minerals; diamond is only a rare constituent.

Research eventually established that diamonds come from the included bodies in kimberlite, not from the groundmass; that these bodies are xenoliths, not phenocrysts; and that the xenoliths (and, therefore, the diamonds) are much older than the kimberlite which carried them to the surface.

A deep-seated origin for kimberlite was suspected by early investigators, not only because of its composition, but also because it was found in South Africa as great, carrot-shaped "pipes," the point of the carrot connecting with a system of "feeder" fissures reaching to unknown depths. Of the South African kimberlites exploited by the first mines, some were much more deeply weathered than others, but the general shape of these peculiar structures soon became apparent by comparing what could be seen in the various workings.

Three general zones of a typical kimberlite pipe have been distinguished. (1) **The root zone,** from the point of the carrot two or three kilometers down and below, generally marks the lower limit of economically profitable mining (even when erosion has brought the root near the surface, the volume of ore is scant). But the pinch-out of the structure is never quite complete; the feeder system is now believed to reach to depths of at least 150 km, i.e. well into the upper mantle. (2) **The main body** of the pipe widens upwards, and is composed of highly brecciated kimberlite and other rock types. The breccia fragments come from the country rocks through which the pipe has passed, and from earlier pulses of the kimberlite which hardened before later pulses shattered it during the explosive release of gases. At the top of the pipe, (3) **the crater zone** originally consisted of a low-relief crater called a *maar.* This crater area, if it still exists, may be water-filled and may contain substantial amounts of weathered kimberlite "yellow ground." Around the shallow *maar* craters on the surface there was originally a ring of volcanoclastic debris, called a "tuff ring," about

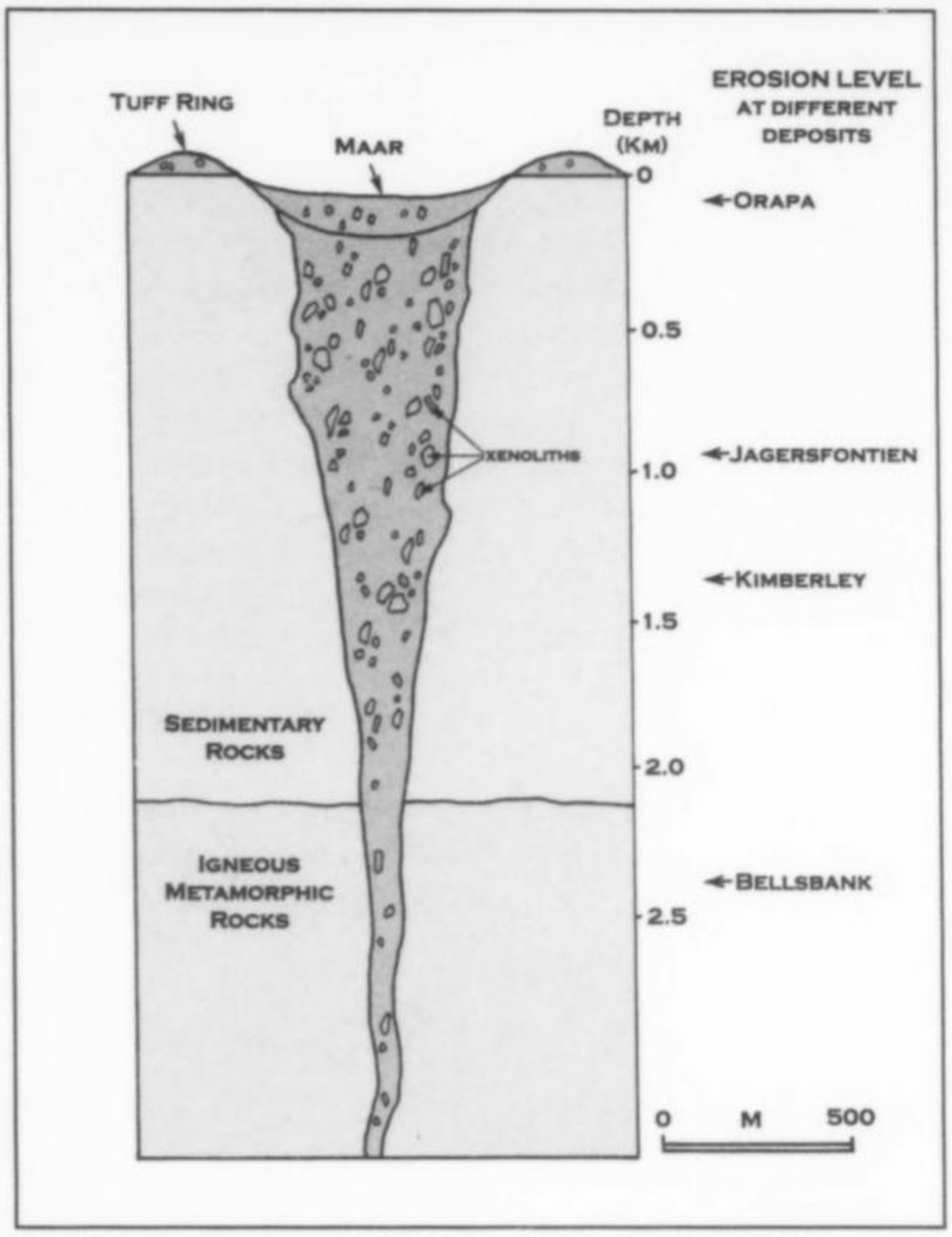


Figure 7. **Idealized model of a kimberlite pipe; diamonds are carried up in the xenoliths from peridotite and eclogite bodies at depth. Deposits in South Africa have been eroded down to various levels in the structure, as indicated at right (adapted from Hawthorne, 1975).**

50 meters high. In most deposits this ring is now gone—it has been observed only in a few places in Tanzania and Botswana—because the deposits are of great age and the clastic debris weathers away very quickly. In fact, kimberlite rock generally weathers quickly: hence the considerable thickness of many yellow-ground beds where the "dry diggings" of South Africa's early diamond rushes took place.

The ascent of kimberlite through overlying rocks is classified broadly as a volcanic event, although kimberlite magma clearly originates at much greater depths than do the more common basaltic and granitic magmas. Because these types of bodies are so different from ordinary volcanic pipes they have been given a different name: *diatremes*.

Since no kimberlite diatremes have been observed in the process of eruption during man's time on earth (the youngest ones known, in Namibia and Tanzania, date from the Eocene, i.e. at about 55 million years ago), it was a challenge to the imaginations of early investigators to try to picture the eruptive events. With self-conscious vagueness Alpheus Williams (1932) wrote that the kimberlite extrusions "never existed as volcanoes as we understand true volcanoes, but . . . they existed, at all stages, as eruptive fissures." The currently accepted picture is that kimberlite is emplaced as a slurry of brecciated, gas-rich material which, though originally molten at depth, rises explosively through the pipe as a "cold" solid, with multiple pulses of new material shattering already solidified material above. The overall speed of ascent is a fantastic (geologically speaking) 10 to 30 km per hour. At the point in the main body of the diatreme where pressure drops enough to allow the dissolved volatiles to come out of solution, the slurry becomes effectively jet-propelled, rising at velocities of several hundred kilometers per hour during the final few hundred meters (Kirkley *et al.*, 1991). Thus the diamonds transported from where they had rested in "storage" for perhaps 3 billion years at the bases of continental cratons (see later) reach the surface in an ascent that takes only four to fifteen *hours* (Kirkley *et al.*, 1991). The eruption climaxes in near-surface explosions of expanding gases and spewings of volcanoclastic debris that any observers present would have found extremely dramatic.

That the kimberlite which fills the upper parts of the pipe arrives "cold," rather than as lava, is shown by the fact that there are no indications of thermal effects, such as contact metamorphism, along the walls of the pipe. Furthermore, in some diamond deposits described by Williams (1932), unburned tree trunks and other organic material that collapsed into the crater and became embedded in the kimberlite as it surged up and down have been encountered at considerable depths.

It is interesting to note that diamonds which reach the surface via the kimberlite fast-express are metastable (which is to say that *all* diamonds we have are metastable): they only remain diamonds, instead of disintegrating or pseudomorphing to graphite, because their rate of ascent was too fast to allow re-equilibration. A small kimberlite pipe at Beni Bouchera, Morocco has yielded fairly sharp, multi-centimeter-sized octahedral "crystals" of graphite paramorphic after diamond: presumably the rate of ascent in this particular pipe was slow enough to allow the crystallographic reorganization to take place (Bob Downs, personal communication, 2002).

A second rock type, *lamproite*, which likewise erupts from great depths to form pipes, can also be diamondiferous. Lamproite is less gas-rich than kimberlite and its eruptions are less violent; the near-surface configurations of lamproite pipes tend to be wider (champagne-glass-shaped) than those of kimberlite (Harlow, 1998). Lamproite is also somewhat different mineralogically (see the later discussion of the Argyle mine in Australia), although the diamonds in the two rock types do not seem to differ in any important way. Lamproites, like kimberlites, occur in the continental cratons, or on their margins, and, also like kimberlites, range very widely in age: the Argyle lamproite pipe is about 1,200 million years old, but the Ellendale lamproite pipe, only 400 km from the Argyle, was intruded in the Miocene, only 20 million years ago (Kirkley *et al.*, 1991).

But where and how do the diamonds originate? This was the mystery which a great number of theorists began trying to solve as soon as the South African kimberlite pipes were discovered. When, in 1905, De Beers general manager Gardner F. Williams published the two volumes of *The Diamond Mines of South Africa*, little headway had yet been made on the question of how and where diamonds form, but by 1932, when his son, Alpheus F. Williams, published his own two-volume work, *The Genesis of the Diamond*, three broad classes of theories had evolved. Some geologists argued that the diamonds crystallized *in situ* out of kimberlite magma during the time when the (presumed) magma was solidifying in the pipe. Other geologists also thought that diamonds crystallized out of kimberlite, but argued that they did so at depth, before the ascent of the pipe. A third school held that the diamonds formed at depth in ultramafic rocks *other* than kimberlite, and were later caught up in the kimberlite melt, as constituents of xenoliths (Williams, 1932). The first of these theories was a casualty of the realization that near-surface kimberlite is emplaced as a cold solid, not as a magma. The other two theories remained for several more decades in active contention, being called informally the "pheno-

cryst school" and the "xenolith school" (Kirkley *et al.*, 1991). Alpheus Williams himself adhered to the phenocryst school, presenting at great, careful length in his book the argument that the large included fragments in kimberlite are of essentially the same composition as the fine-grained groundmass, i.e. that the fragments are cognate, not xenolithic. However, the debate is now settled: the fragments are indeed xenoliths, and diamond crystals are *not* products of the kimberlite but, as components of xenoliths, are mere passengers on the kimberlite fast-express to the surface. This triumph of the xenolith school is a product of two basic lines of mid to late 20th-century research: (1) petrological study of the xenoliths themselves, as correlated with evolving knowledge of the earth's mantle and of plate-tectonic processes, and (2) modern analytical studies utilizing sophisticated instruments for the investigation of the mineral components of the inclusions in diamonds, and of the ages of these inclusions.

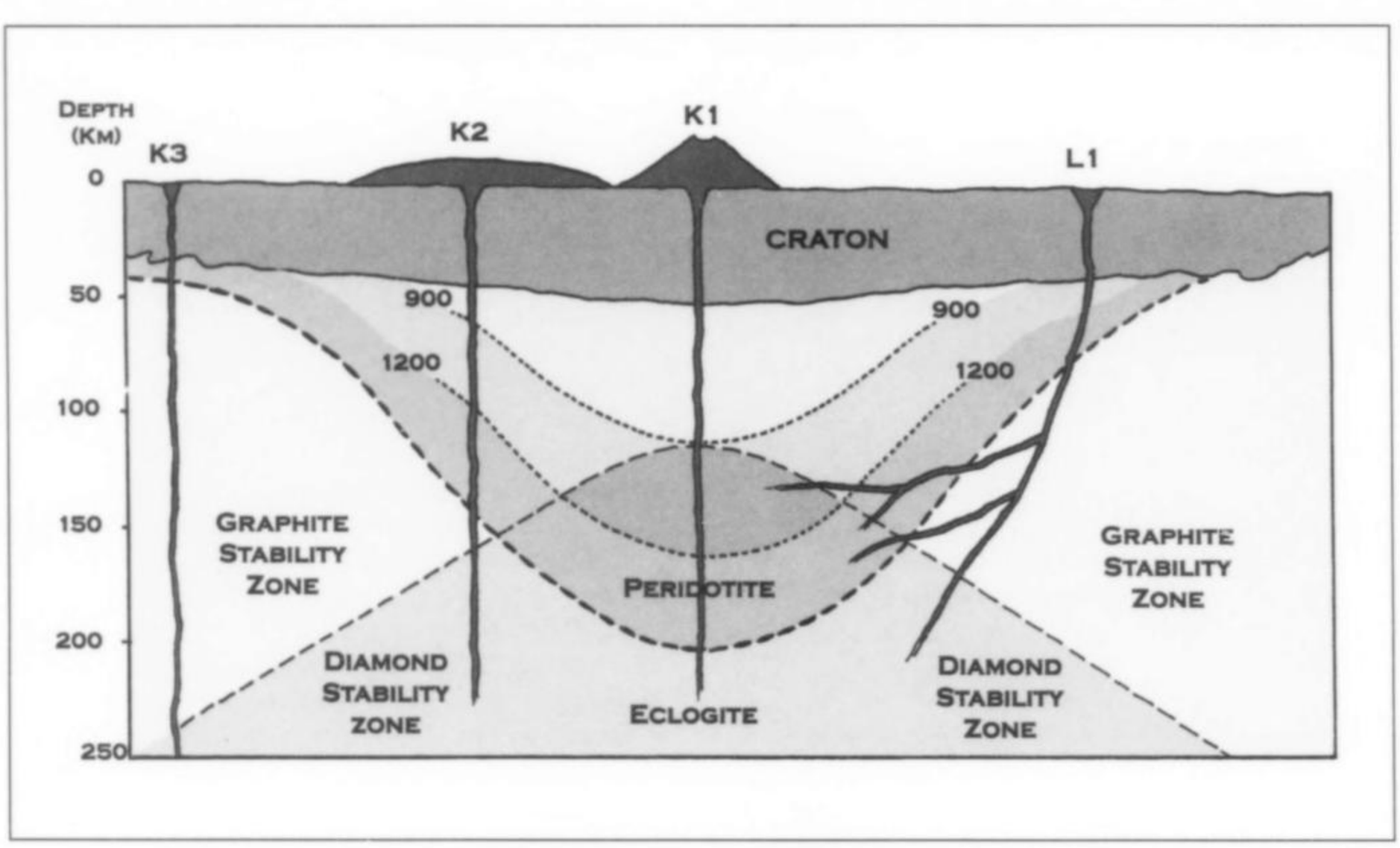


Figure 8. **A model illustrating the deep source areas for diamonds in eclogite (E-type) and peridotite (P-type) xenoliths in kimberlite. The isotherms and the subcratonic (peridotitic) basement rock or cratonic "keel" are concave downward whereas the diamond stability zone is convex upward. Where they overlap, diamonds in peridotite are theorized to exist. Kimberlite pipes such as K3 do not pass through the diamond stability zone and so are liable to be barren of diamonds; the K2 kimberlite will contain only eclogitic E-type xenoliths and diamonds carried up from below; K1 will contain primarily peridotitic P-type xenoliths and diamonds brought up from below; and the lamproite diatreme L1 may contain both types (after Kirkley *et al.*, 1991).**

The xenoliths found in kimberlite (and lamproite) are of two rock types, both known to be common in the upper mantle around and under the continental plates: **eclogite**, and a more broadly defined type generally called **peridotite**. Eclogite is a coarse-grained, attractively colored red-and-green rock consisting of about 50% garnet (almandine-pyrope) and 50% clinopyroxene, with minor rutile, kyanite, corundum and coesite; it is thought to result from profound metamorphism of subducted basalt under tectonically active margins of continental plates (basalt and eclogite are identical in their bulk chemistry—Kirkley *et al.*, 1991). By contrast, the xenoliths classed as "peridotite" average about 50% olivine (forsterite), 40% pyroxene, and 10% garnet. Diamonds are known to occur in three peridotite subtypes: **dunite** (90% olivine), **harzburgite** (40–90% olivine, the rest orthopyroxene and garnet), and **lherzolite** (at least 40% olivine, with orthopyroxene and clinopyroxene in a wide range of proportions, and minor garnet). Peridotite of these varying types, as found just beneath the crust in the stable interior zones of continents (cratons), probably is primordial upper-mantle material, having remained little changed since the first differentiation of crust from mantle in the very early earth (see later).

Diamonds which have been brought to the surface in eclogite or peridotite xenoliths have come to be called respectively "E-type" and "P-type" diamonds. Either may be found still embedded within the host xenoliths or floating in the kimberlite groundmass after the fragmentation of xenoliths during the violent events of ascent. Eclogite, being the tougher of the two rock types, is found much more commonly as intact xenoliths in kimberlite at the surface. Eclogite xenoliths are commonly fresh-looking, whereas the much rarer peridotite xenoliths are usually crumbly and/or altered around their rims. Studies of inclusions in diamonds have shown that P-type diamonds are much more common than E-type diamonds, even though the greater survival rate of eclogite matrix fragments would seem to suggest the reverse. This is one illustration of how the study of the xenoliths alone can be misleading unless supplemented by diamond-inclusion studies.

Research on inclusions in diamonds began to yield hard results in the 1970's, with the attainment of required levels of sophistication in X-ray diffraction techniques, electron and ion microprobe analyses, and the dating of trace isotopes (Meyer, 1985; Kirkley *et al.*, 1991). These minute inclusions (mostly around 1 μm, or 0.001 mm), having been shielded from later changes by the

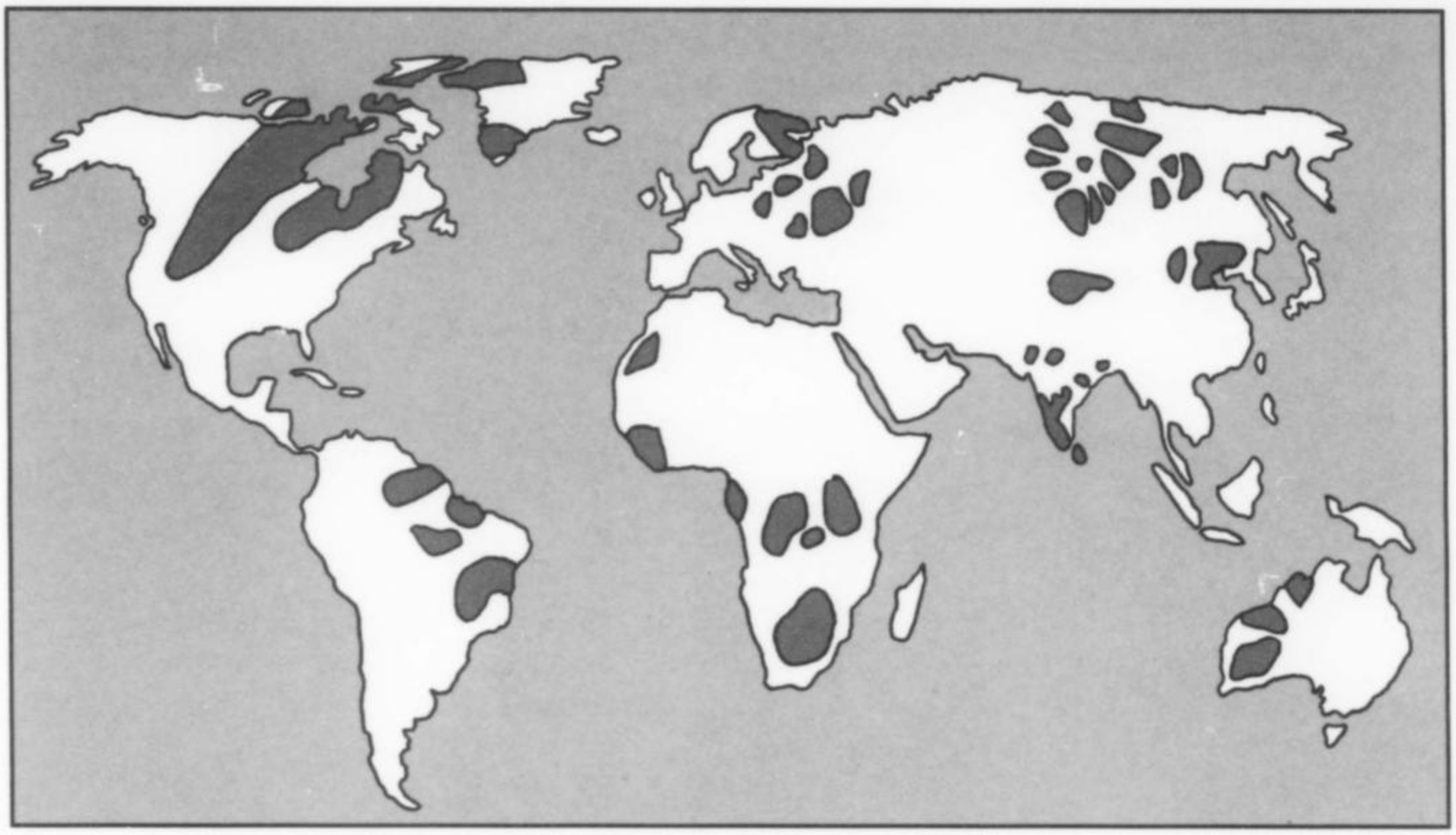


Figure 9. **Only the oldest portions (called archons, defined as being at least 2.5 billion years old; shown here in purple) of the ancient cratonic areas of the continents are known to host diamond-bearing kimberlite pipes (after Janse, 1992).**

enclosing diamond, represent our best and most pristine samples of mineral suites from upper mantle rocks. Although most diamonds show inclusions of only one mineral species, polymineralic inclusions are (fortunately) also found. Thus far, 22 mineral species (including diamond itself) have been identified as inclusions in diamonds, and although six of these may be found either in eclogite or peridotite, detailed analyses have revealed two mutually exclusive assemblages of included minerals, making it possible to assign 98% of all included diamonds to either the E (eclogite) or the P (peridotite) categories (Meyer, 1985).

It has also been possible to draw some inferences about the temperature and pressure conditions, and therefore the depths of diamond formation, in these two rock types. Correlating with these results are the isotopic age-dating studies of the tiny inclusions, which have led to the approximate dating of the formation of the host rocks, and therefore the ages of their diamonds (it is not yet possible to age-date diamonds directly).

Both of these lines of research indicate that upper-mantle eclogites and peridotites formed at different times and by different processes in the deep earth, and that kimberlite melts at depth may have taken up diamond-bearing xenoliths from either environment (or from both), for transport to the surface. It remains to consider the nature of these two environments, and to summarize current thinking which seeks to correlate the distribution of diamondiferous diatremes with plate-tectonic processes.

Geothermal and geobarometric studies of E-type diamonds have shown that these diamonds have a higher temperature of crystallization, and form at greater depths, than P-type diamonds (Meyer, 1985; Kirkley *et al.*, 1991). Eclogite, as already mentioned, is characteristic of very deep parts of subduction zones, well within the upper mantle below continental platforms, where the subducted basalt of the former sea floor metaphorphoses to eclogite. P-type diamonds, on the other hand, are believed to form in peridotites of the shallower upper mantle; they come from depths in the range of 150–200 km below the surface, whereas E-type diamonds from one South African mine, for example, have been assigned depths of formation of more than 300 km. Radiometric dating of trace isotopes of Rb-Sr, Sm-Nd, and U-Pb in the inclusions has revealed that *all* of the diamonds occurring in the peridotite xenoliths are around 3 billion years old. This theme of immense age was also sounded quite early in the modern history of diamond studies, for it was realized early that most of the earth's swarms of kimberlite-pipe intrusions occur in stable continental cratons of Archaean age.

The now-favored model of the genesis of P-type diamonds involves the insight that "in Archaean times there was a unique process accompanying crustal formation: a combination of melt extraction, fluid interaction, and diamond crystallization that sometimes left a relatively cool, rigid, deep keel beneath a continental plate" (Harlow, 1998). From the plausible hypothesis that these isothermally defined "keels" below the cratons have remained constant through all geologic time since the Archaean, it is inferred that P-type diamonds were formed no later than about 3 billion years ago, and at depths of 150–200 kilometers.

The question of the source(s) of the carbon in diamond has also been considered. In carbon-isotope studies of diamonds, the term $\delta^{13}C$ denotes the ratio of the carbon isotopes C^{12} and C^{13}; these studies have found stark differences between the carbon in P-type and E-type diamonds. In the former, there is a very tight clustering of $\delta^{13}C$ values within a narrow range, whereas in the latter there is a much wider $\delta^{13}C$ distribution across a broad range. This is to say that the carbon in P-type diamonds had a uniform and stable source in the upper mantle: it is thought to be "primitive" carbon which accumulated in a stable convective zone perhaps 4.5 billion years ago, at the time when the first continental cratons were forming. (One intriguing modern theory suggests also that some of this "primitive" carbon may have come from convection cells transporting liquid metallic C to the upper mantle from the *lower* mantle—Meyer, 1985.)

By contrast, the carbon in eclogitic (E-type) diamonds is thought to have been transported to deep levels with the basalt of the subducted sea-floor plates, such that when the basalt turned to eclogite, the carbon turned to diamonds. In this case, the sources of carbon might have included both carbonaceous crustal sediments (e.g. limestones from geosynclinal trenches) and organic remains

on the ancient seafloors. The differences between the carbon of P-type and E-type diamonds correlate well with the derived ages of diamonds of the two types. All P-type diamonds have been found to be very old, at least 3 billion years, whereas some E-type crystals are well under 1 billion years old—suggesting that E-type diamonds may be the byproducts of different tectonic cycles of differing ages. (These age-dates for the diamonds themselves are not to be confused, of course, with the dates of intrusion of the kimberlite pipes, which range, for known pipes, between 1,600 and 50 million years ago).

Since the discovery of the first African kimberlites, the world-wide hunt for more such structures has revealed a definite pattern of distribution: kimberlite and lamproite diatremes are almost always found within the innermost, stable parts of continental shields—the original and most ancient, cratonic nuclei of continents. The diagram shown here illustrates the most favored current theory explaining how these cratonic diatremes can contain both E-type and P-type diamonds. P-type diamonds repose in the cooler thermal "keel" of very old upper-mantle peridotite under the craton, wherein they formed during very early times. E-type diamonds occur in the eclogite below this keel, which has been subducted (originally as sea-floor basalt), perhaps at a much later time. A kimberlite diatreme such as K1 on the diagram, having passed through both regions, will contain diamonds of both types, with those of the P-type probably predominating. A diatreme such as K2 will have "sampled" only the eclogite region and thus will contain only E-type diamonds. A diatreme, like K3, situated out too far from the cratonic center, will have "sampled" neither region and thus will be barren of diamonds. L1 represents a lamproite diatreme of the Argyle, Australia type, situated near a cratonic margin and containing both E-type and P-type diamonds, perhaps because of a complex system of interconnecting fractures at depth (Kirkley *et al.*, 1991).

Although the general picture sketched above would seem to account very well for the great bulk of the world's diamonds, one anomalous occurrence in New South Wales, Australia has recently given rise to an alternate model of diamond formation which may sometimes apply. About two million diamond crystals, with an aggregate weight of about 500,000 carats, have been found in alluvium in the Copeton-Bingara area, in eastern New South Wales. Despite intensive exploration, no kimberlite or lamproite diatremes have been found in the area, and the nearest cratonic block (west of Broken Hill) is about 1,000 km away. If a nearby source for the diamonds is posited, another theory of their formation and/or transport to the surface is needed, and such a theory was published in 1996 by Barron *et al.* Very briefly, these authors propose that the diamonds were formed in subducted oceanic plates along the eastern margins of Australia, at only about half the depth thought typical for diamond formation in the subducted eclogites of the "standard" model outlined above. When this oceanic crust plunged under the continental plate, the authors argue, it remained much cooler than its surroundings; the combination of rapidly increasing pressure and relatively low temperature opened a "window" into the stability field of diamond. Subduction then stopped, preserving the diamonds which had formed, and later these were transported to the surface by non-kimberlitic magmas such as leucitite, melilitite, nephelinite, and basanite—"diamonds have been found in several diatremes and dikes with these compositions in eastern Australia" (Barron *et al.*, 1996). The authors correlate various characteristics of the Copeton diamonds—nitrogen content, color, carbon isotopic composition and others—with several rock types that presumably existed in the original oceanic plates, and they propose that, depending on the rock type, the carbon was either of "primitive" origin or existed as limestone or

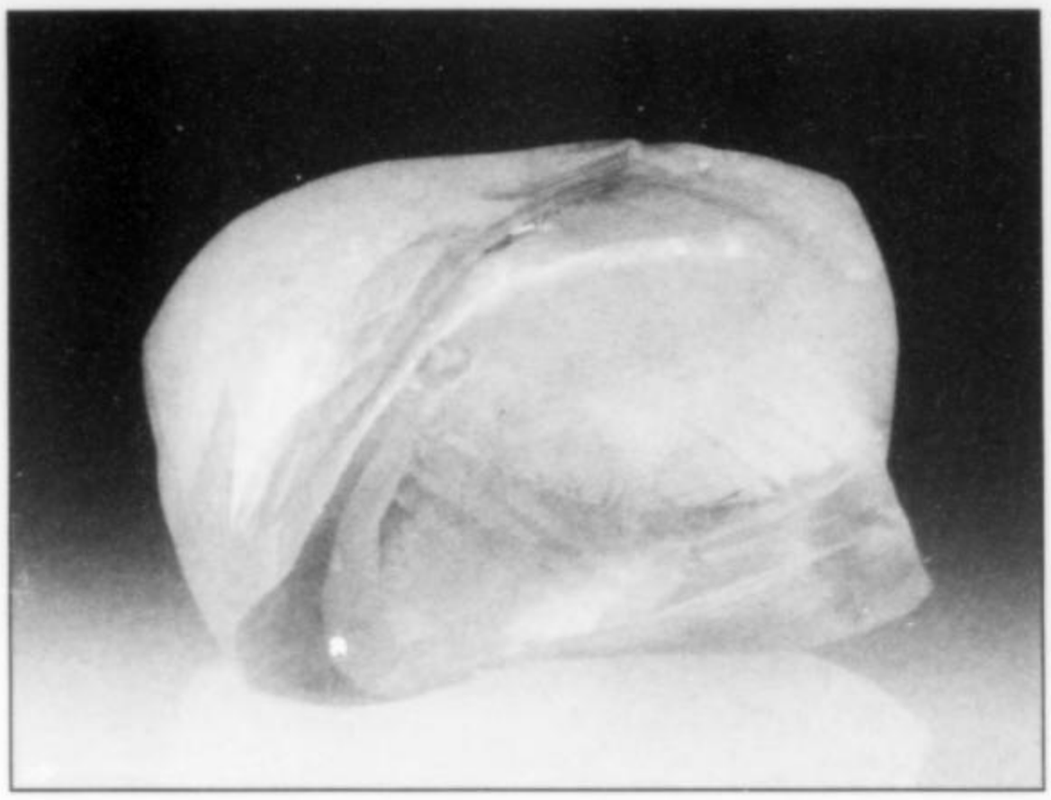


Figure 10. **Diamond crystal, irregular and frosty-surfaced, from Estralla do Sol, Matto Grosso, Brazil; 1.3 cm, 11 carats. Wendell Wilson photo.**

organic remains in trench sediments. Some diamond formation, they suggest, may even have been catalyzed by natural fullerene carbon molecules. Once formed, the diamonds rested in "cold storage" in their static, partially subducted rock slabs, whose temperatures remained low, for up to 100 million years before transport to the surface.

Obviously, the whole question of diamond formation is still dynamically open, and there are many remaining uncertainties even in the "standard" picture. What, for example, is the detailed nature of the processes which accumulate carbon in the primordial peridotites? How much of the carbon in E-type diamonds is organic in origin, and how young might the E-types conceivably be? Why do kimberlite melts form at depth, and what propels them so rapidly to the surface? The sense of romance that clings like an aura around diamonds arises not only from their beauty, their gemstone value, and their rich historical lore, but also from the unsolved mysteries which still persist in the shadowy, remote reaches of deep-earth science.

LOCALITIES OF THE PICTURED DIAMONDS

Estralla do Sol, Mato Grosso Province, Brazil

According to one story, Brazilian diamonds were first noticed by a Portuguese, Sebastino Leme do Prado, when he saw gold prospectors using them as chips in card games, around 1725 (Maillard, 1980). Another version of the story, recounted by Williams (1905), says that it was black slaves who conducted the card games. From 1728, when the Portuguese government learned of the stones, until the blossoming of South Africa around 1870, Brazil reigned supreme in the world for diamonds. Cassedanne (1989) estimates that 13 million carats, or 2 metric tons, of diamonds were produced from Brazilian fields over roughly a century. During the 1730's, just after the first discoveries, Europe's supply of diamonds quadrupled, and diamond prices plummeted, partly because of the mistaken feeling that the new source of supply would prove inexhaustible. All Brazilian diamonds were declared to be the property of the Portuguese state, and all diamond mining declared to be a Crown monopoly. This simple policy, based on simple state greed, ensured that the industry would remain static, without achieving major advances in mining tech-

niques or in economic development of the diamond market (Williams, 1905).

Mid-20th-century prospecting revealed hundreds of kimberlite outcrops in Brazil, but all mining during the period 1725–1865 took place in alluvial, eluvial or colluvial deposits. Some lithified "bedrock alluvial" sites were worked by benched quarries, and matrix specimens of diamond crystals in coarse conglomerate were sometimes found. Miners to this day may try to sell visitors fake specimens of this type, with the crystals glued onto the matrix (Cassedanne, 1989).

In the early days, mining was done by slaves under the whips of the Portuguese. After Brazilian independence there was much freelance prospecting, and *garimpeiros* often formed co-operative organizations, the miners sharing the work and dividing the profits among themselves and with financial backers, as well as with owners (if any) of the lands hosting successful prospects.

Diamond fields speckle most of the southern half of the country, but the richest sites, and the earliest found, stretch along the Jequitinhonha River for many tens of kilometers north of the town of Tejuco (Diamantina). Diamonds there are found in *gupiaras* (coluvial terraces high above the streambeds), *gorgulho* (eluvial plateau deposits), and *cascalho* (gravel deposits in the streams). In the *cascalho* deposits, the most important type, gravels were (and are) washed and sorted in complex systems of hoses, pumps, sluices, and washing crates, while women and children comb adjacent parts of the drainages for diamonds. A mechanized dredging operation in the Jequitinhonha River, 80 km downstream from Diamantina, is the only contemporary Brazilian diamond "mine," producing 1 carat of diamond and 1 gram of gold for each 100 cubic meters of gravel (Maillard, 1980; Cassedanne, 1989).

The featured collection's only Brazilian diamond is a typically frosty and somewhat irregular crystal measuring 1.3 cm and weighing a little over 11 carats. It comes not from Diamantina, Minas Gerais, but from "Estralla do Sol, Mato Grosso." The province of Mato Grosso is in west-central Brazil, bordering Goiás Province on the east and Bolivia and Paraguay on the west; its capital is the town of Diamantin*o*, near which the chief diamond field of the province is located. Prospecting for diamonds (and gold) in this remote region has never been as intense as in the other fields to the east. According to Cassedanne (1989), "A period of excitement and wealth was short-lived, ending in 1847 with the decline in gold production. In the year of 1852 the Mato Grosso Mining Society went bankrupt [and] the Diamantino prospect was abandoned."

In recent years, however, diamond mining activity has picked up in the province. Near Diamantino and north of the city of Cuiaba, a 63,000-hectare claim block now known as the Mato Grosso Diamond Project was host to a large-scale diamond rush in the 1960's, when alluvial diamonds were first discovered in the Morro Vermelho Formation. The proliferation of high-quality diamonds being found by prospectors in the area attracted several major diamond mining companies, and more than 50 kimberlite pipes were discovered. Diamonds collected from the property exhibit pristine or near-pristine surfaces, suggesting a local source for the significant number of alluvial diamonds found on the claims. Eclogitic garnets have also been found in two of the initial heavy mineral samples collected. Iciena Ventures, Inc. is part owner in the project, and recently announced the acquisition of 47 prime diamond exploration permits covering 438,000 hectares in the states of Mato Grosso and Rondonia, Brazil (www.iciena.com).

An area in the southern tip of the state of Rondônia and the northwestern part of the state of Mato Grosso also has large reserves of diamonds. Mining is forbidden there because it is in the protected homeland of the Cinta Larga Indigenous People; however, nearly 3000 garimpieros and miners entered the area illegally to mine diamonds in 1999, and eventually had to be evicted by government troops. The Federal Police estimates that gems amounting to 50 million dollars were smuggled from the region to Belgium last year.

Figure 11. **Diamond crystal from the Argyle mine, Western Australia; 1.1 cm, 4.4 carats. Wendell Wilson photo.**

Figure 12. **Diamond crystal from Argyle, Western Australia; 6 mm. Wendell Wilson photo.**

In the Juina Diamond Province, Mato Grosso, the Diagem International Resources Corporation currently has 130,000 hectares of mineral claims. The Province has vast deposits of alluvial diamonds as well as 7 identified diamondiferous kimberlite pipes on which basic exploration is complete. Over 130,000 carats of diamonds were recovered during the evaluation phase, including large stones up to 450 carats, and a 100-carat pink crystal. Production began in 1996 (www.diagem.com).

Argyle mine, Western Australia, Australia

No diamonds from Australia reached the world market until 1981, but by 1995 the country had assumed first place in annual diamond production worldwide. Most of this ballooning output has come from the Argyle mine, in the East Kimberley diamond

Figure 13. **Diamond crystals to 1.2 cm, the center one showing penetration twinning, from the Orapa mine, Botswana. Wendell Wilson photo.**

Figure 14. **Pink diamond crystals to 5 mm, from the Orapa mine, Botswana. The larger crystal is a tetrahexahedron. Wendell Wilson photo.**

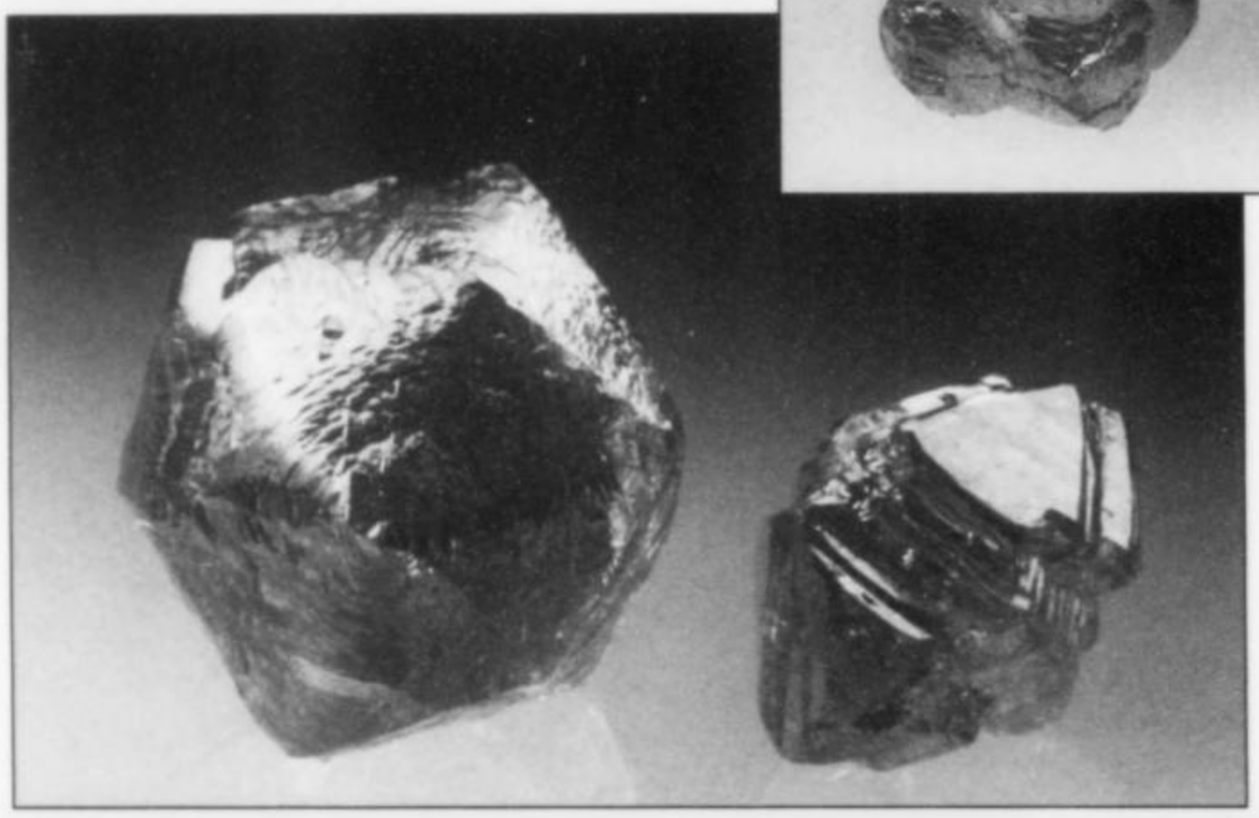
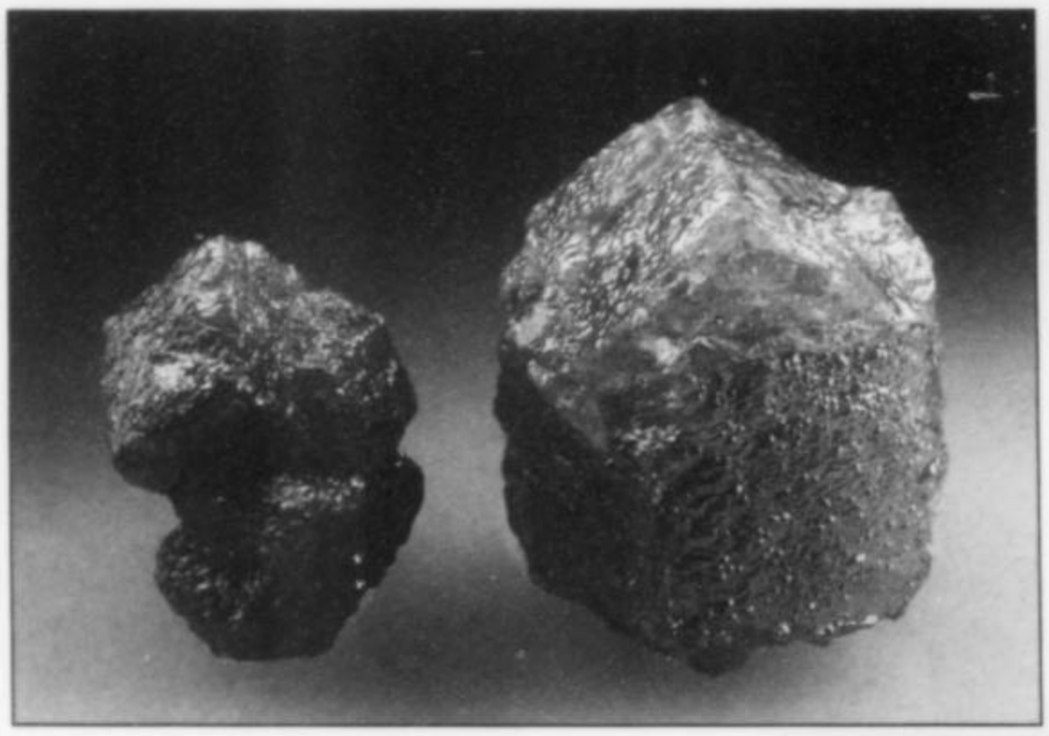


Figure 15. **Diamond crystals to 2 cm from the Orapa mine Botswana. The crystal on the left is a penetration twin. Wendell Wilson photo.**



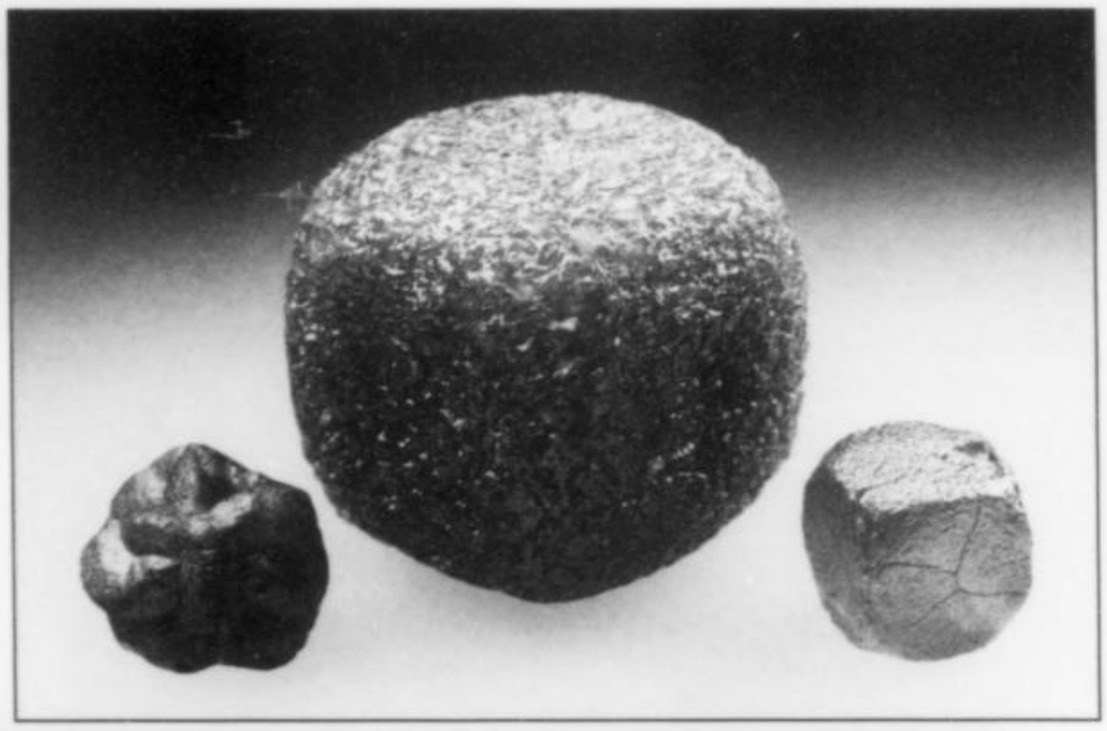


Figure 16. **Intergrown diamond crystals to 2.2 cm from the Orapa mine, Botswana. Wendell Wilson photo.**

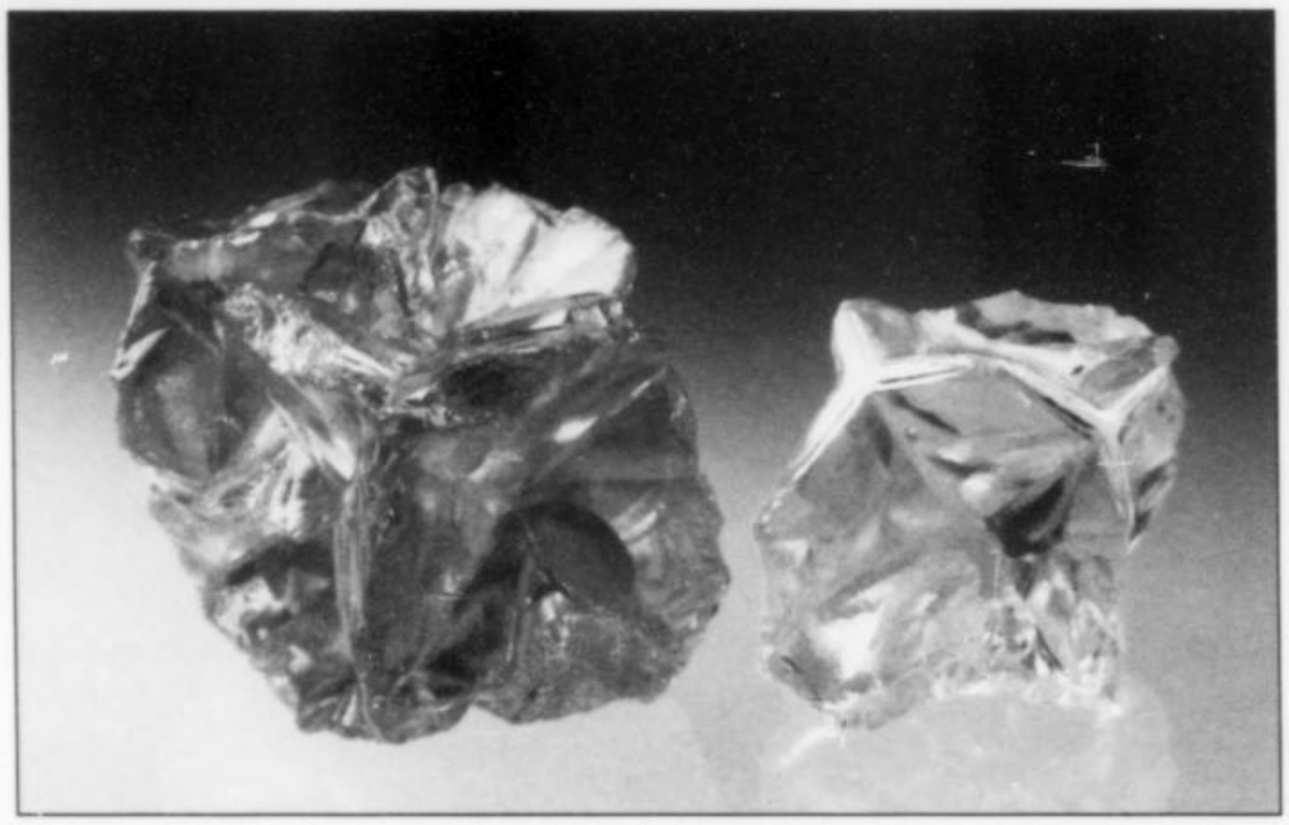


Figure 17. **Skeletal yellow diamond crystals to 6 mm from the Orapa mine, Botswana; the three-pointed-star forms are octahedron faces. Wendell Wilson photo.**

Figure 18. **Cubic diamond crystals to 5 mm from the Orapa mine, Botswana; the crystal at right is a penetration twin. Wendell Wilson photo.**

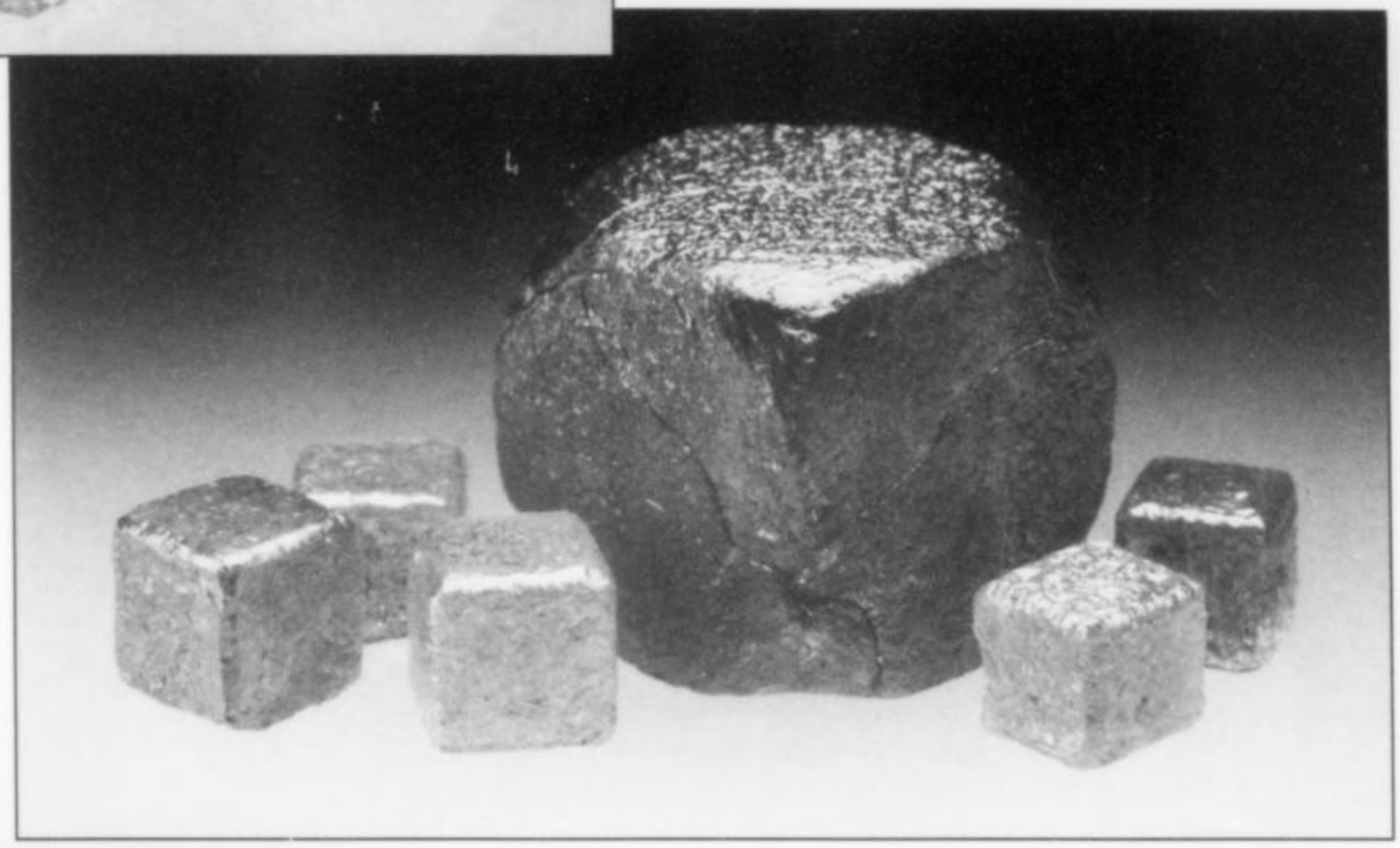
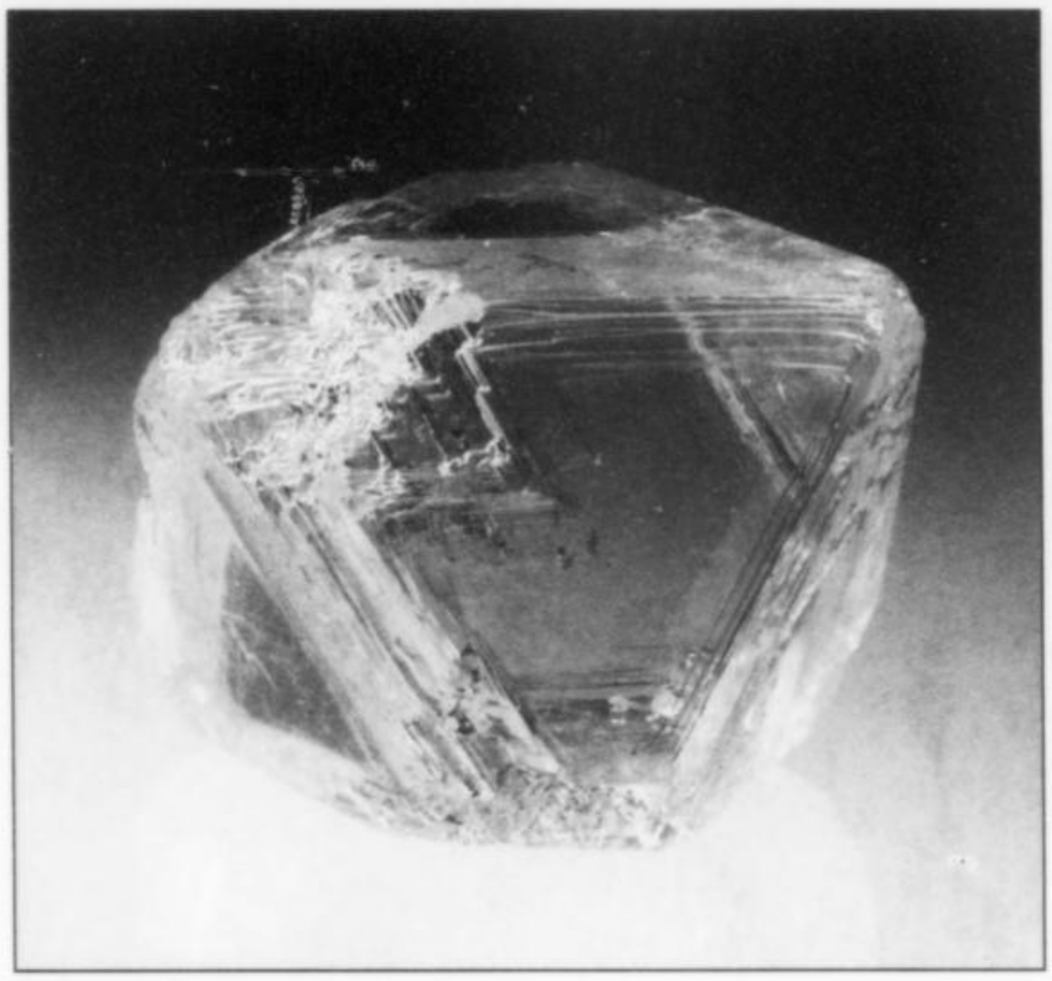


Figure 19. **Modified cubic diamond crystals to 8 mm, from the Orapa mine, Botswana. Wendell Wilson photo.**

Figure 20. **Pale yellow octahedral diamond crystal, 1.6 cm (12.6 carats), from the Letlhakane mine, Botswana. Wendell Wilson photo.**



province, situated in the northeastern part of Western Australia. The workings consist of a huge open-pit mine in a lamproite pipe. It is somehow satisfying, though merely coincidental, that this Australian "Kimberley" region was named (in 1880) after the same Earl of Kimberley, then British Secretary of State for the Colonies, after whom the great De Beers New Rush diamond mine in South Africa had been renamed the Kimberley mine in 1873 (Grice and Boxer, 1990).

Australian diamonds were first found in New South Wales in 1851, in alluvium being washed for gold, and New South Wales produced modest quantities of diamonds for a few decades thereafter. In Western Australia, although a few alluvial diamonds were found near Nullagine in 1895, major prospecting did not begin until the late 1960's. A few kimberlites and a few diamond-bearing alluvial deposits were found in the Ellendale and Noonkanbah areas in the early 1970's, but the real bonanza followed the discovery, in 1979, that Smoke Creek was full of diamonds. Prospectors following an easy trail of these alluvial deposits upstream for about 20 km came to the primary source—the Argyle (AK1) lamproite pipe.

This was only the second (Murfreesboro was the first) primary diamond deposit found anywhere in any rock other than kimberlite—and there are now known to be at least 100 other lamproites in the Kimberley area, many of which contain diamonds (Harlow, 1998). Though similar in its origins to kimberlite, lamproite is finer-grained and lighter-colored (typically it is gray to greenish gray, and mottled), and differs somewhat in its mineralogy. The major component species are forsterite, phlogopite, diopside, richterite, chromite and pyrite, and some of the lamproites of the Kimberley area also contain some very rare species, including priderite, jeppeite and wadeite (Grice and Boxer, 1990). However, diamonds from lamproites do not seem to differ in any important way from those found in kimberlites. Argyle mine diamonds show a wide range of crystal forms, colors and twinning habits, but such a range is also commonly seen in kimberlite diamonds.

Argyle mine crystals average only 0.1 carat in weight. The largest found up to 1998 weighs 41.7 carats. Only about 5% of the crystals are of gem quality. In 1995 the mine produced 38% of the world's diamonds as measured by weight, but just 6% as measured by value (Harlow, 1998). About 75% of the stones have dark inclusions, rendering them brown, yellow, or (in cases of larger, "bort" diamonds) steel-gray. However, a few rare stones are green or colorless, and pale pink ones are something of a specialty of the mine, making lovely and very valuable gems (see a dramatic photograph of a swarm of pink crystals in Grice and Boxer, 1990). The Argyle diamond crystals in the collection featured here are a lovely, gemmy brown, 1.1-cm octahedron weighing about 4.4 carats, and a smaller but sharper, purplish brown octahedron measuring 6 mm.

Production at the Argyle mine began to fall off in 1999, and the deposit is expected to be largely exhausted, and the mine to close, by 2006. However, Ashton Mining, the company which operates the mine, should recoup any loss of income, as it is also 100% owner of Australia's only other hard-rock diamond operation, at Merlin in the Northern Territory. This mine, which began production in 2000, exploits a number of small kimberlite pipes with much higher gem-quality diamond content than Argyle's, and it is expected to remain productive for a long time to come (www.mbendi.co.za).

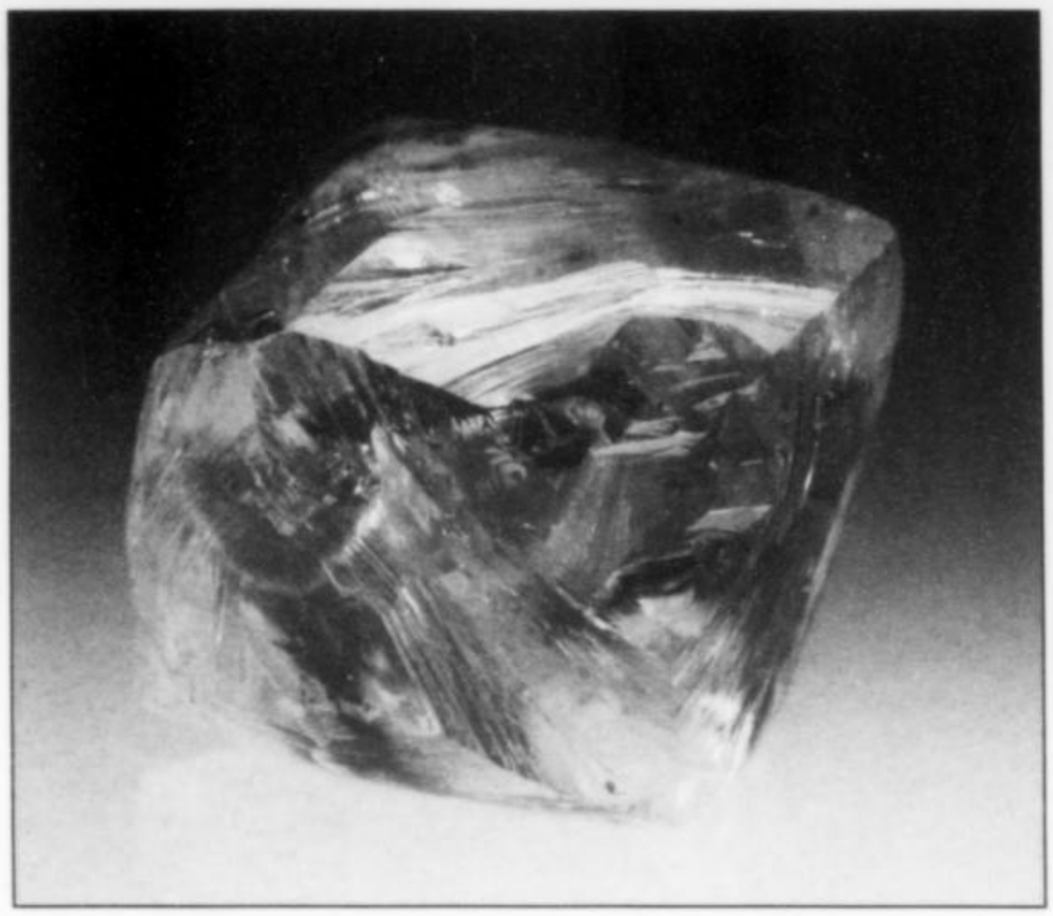


Figure 21. **Modified octahedral diamond crystal, 1.4 cm (11.3 carats), from the Kimberley district, South Africa. Wendell Wilson photo.**

Orapa mine and Letlhakane mine, Botswana

Between 1967 and 1973, DeBeers geologists located three richly diamondiferous kimberlite pipes in Botswana (formerly British Bechuanaland), with the eventual result that this poor, underpopulated nation in the Kalahari Desert (and right over the center of the Kalahari Craton) is now third in the world in diamond production as measured by carat weight, behind only Zaire and Australia. Moreover, since there is a very high ratio of gem-quality to industrial quality diamonds here, Botswana since the early 1990's has *led* the world in diamond production as measured by value. Many kimberlites occur in the country besides the main three (Orapa, Letlhakane, Jwaneng), and many smaller mines are now working. Nearly all diamond production is controlled by the Debswana Diamond Company, a joint venture firm of which 50% is owned by De Beers and 50% by the government of Botswana (www.mbendi.co.za).

The Orapa kimberlite pipe, discovered in 1967, is exploited by the second largest pipe mine in the world, surpassed in size only by the Williamson mine in Tanzania (Webster, 1983). The outcrop of the Orapa pipe—the only known kimberlite pipe in Botswana not overlain by sand—covers 263 acres; production commenced in 1970 (Harlow, 1998) or 1971 (Webster, 1983). The Orapa kimberlite is remarkably well preserved, having suffered less erosion than any other known major kimberlite pipe. Only the topmost few meters are missing, and the great bulk of the diatreme remains intact and awaiting exploitation (Kirkley *et al.*, 1991). As of 2000, after a major expansion of the open-pit mine, the Debswana Diamond Company planned to shift to an underground operation, working through twin vertical shafts to reach the lower sections of the kimberlite. The life expectancy of the mine has been estimated at another 30 years (www.mbendi.co.za).

Illustrated here is a truly extraordinary suite of 21 Orapa mine diamonds, most of them in various shades of yellow, but also including two large multiple-crystal clusters to 2.2 cm and two lovely, gemmy pink crystals to 5 mm (one of them a tetrahexahedron). Several of the yellow crystals show cubic penetration twins, and two have an odd skeletal habit that is probably the result of twinning.

Near the town of Letlhakane, 48 km northwest of the Orapa pipe, two smaller pipes, Letlhakane 1 and Letlhakane 2, were discovered in 1968. The mines here came into production in 1976; nearly 40% of the diamonds found in them are of gem quality (Webster, 1983). The specimen shown here is a very gemmy, faintly yellow, 1.6-cm crystal weighing about 12.6 carats.

The third and greatest of the diamondiferous kimberlite pipes in Botswana (not represented in the collection featured here) is the Jwaneng, much farther south than the Orapa and Letlhakane. This is the second most productive single diamond mine in the world, after the Argyle mine in Australia, in terms of carat-weight, and the world's most productive in terms of value (since, again, the percentage of gem crystals is very high). The pipe is hidden under 165 feet of sand; its discovery in 1973 was the result of a rigorous search program directed by Dr. Gavin Lamont of De Beers (Maillard, 1980).

Kimberley district, Cape Province, Republic of South Africa

"Kimberley district" is unfortunately a vague term for the purposes of a label, since several kimberlite pipes near the town of Kimberley have produced diamonds in huge numbers—not to speak of the comparably huge numbers of alluvial diamonds found in the area before (and since) their primary sources became known. This is certainly the most famous of all the world's diamond regions, whose history has been written in many places. Offered here are only a few points of "color"; for a really full story told by an upclose observer/participant, see Gardner F. Williams' *The Diamond Mines of South Africa* (1905).

The history begins in late 1866 or early 1867, when some children of a Boer (Dutch-descended) farming family named Jacobs found a transparent, 21-carat diamond on the south bank of the Orange River—some say that the finder specifically was 15-year-old Erasmus Jacobs, others favor a daughter named Fredrika, and other candidates for the honor also exist (Janse, 1995). Mrs. Jacobs showed the pretty stone to a neighbor named Schalk van Niekerk, telling him that if he liked it he could keep it; she was accustomed to seeing piles of such pretty stones (only smaller) that the children built in the fields. After several more casual changes of hands the plaything ended up with Lorenzo Boyes, who was either acting Civil Commissioner of the British Cape Colony (Williams, 1905) or the town clerk of Colesberg (Janse, 1995), and Boyes,

having the stone tested, found that his suspicion had been correct: it was a diamond. Frenzied rushes of diggers to the gravel beds of the Orange and nearby Vaal Rivers followed (see later), and then came the rushes to nearby "dry digging" sites, where diamonds were being picked from loose deposits of yellow, calcareous dry mud on farmers' lands.

At first, and despite the dryness and heat of the work sites, this mud—"yellow ground"—in which the diamonds occurred was thought to be some kind of water-deposited sediment; after all, the searchers had just recently been finding alluvial diamonds in riverbeds. When, at some sites, they neared the bottom of the dry, yellow mud, revealing a hard bluish-gray rock beneath, some diggers gave up and sold their claims, believing that the diamondiferous ore had run out. But those optimists who kept working, hacking into the "blue ground," were delighted to find that diamonds continued to appear. Noting how easily the mysterious rock weathered, they broke it up and spread it out in the sun in wide "floors," so that after six months or so it would turn, in effect, to yellow ground which could be sieved to recover the diamonds (Janse, 1995). In 1872 the German mineralogist Emil Cohen became the first to propose that the dark cylindrical columns of rock, as uncovered below the weathered zone, were in fact volcanic pipes. During the rest of the decade the idea that diamonds come from these igneous pipes won general assent, and in 1887 the American mineralogist Henry Carvill Lewis proposed the name *kimberlite* for the rock.

By this time the great diamond mines in the blue ground had already been initiated in quick succession. Four of the deposits fall within a circle 5 km in diameter, which includes also the city of Kimberley. In order of their discovery they are **Bultfontein** (September 1869), **Dutoitspan** (October 1869), De Beers Old Rush, later simply **De Beers** (May 1871), and De Beers New Rush, later **Kimberley** (July 1871). Two more pipes, **Koffiefontein** and **Jagersfontein**, lie 90 and 150 km respectively to the southeast. In 1890 another huge pipe, **Wesselton**, was found only 3 km from Bultfontein and Dutoitspan.

The De Beers mine was begun on a farm, called Vooruitzigt, owned by two Boers, the De Beers brothers. They sold the land for a sum that anyone more sophisticated would have thought negligible, then couldn't think what to do with the windfall except perhaps buy a new wagon and some ox yokes (Krajick, 2001). But, because the mine named after them ultimately became so famous, their name eventually became attached to the great diamond cartel called De Beers, still one of the wealthiest and most powerful business concerns in the world.

As already mentioned, the first Kimberley diamonds were found in the loose yellow earth of shallow "pans," as dry ponds were called by the Boers—"Dutoitspan" literally is the "pan" on the land of a farmer named Du Toit. The news of these thrilling new kinds of diamond fields reached the alluvial diamond-digging communities on the Orange and Vaal rivers very quickly, of course; and soon the taciturn, pious Boers who owned and farmed the lands found themselves overwhelmed by fame, although, for the most part, not by any instant wealth. Makeshift leasing and royalty arrangements were insufficient to cope with the numbers of people and volumes of potential profit involved, and the Boer government of the new, tiny, precarious Orange Free State was out of its depth. It tried to restrict the allotment of claims on the farm lands to all but citizens of the Free State, but since the claimants in reality came from every part of the world and every moral terrain of the soul, the Free State government soon lapsed into passivity.

Besides, the regional politics were complicated and tricky. Some indigenous tribes still asserted a vague kind of claim to some of the diamondiferous lands. The Orange Free State, of course, also asserted a claim; and in Capetown there was the increasingly aggressive authority of the British Cape Colony under its new High Commissioner, Sir Henry Barkly. In 1871 Sir Henry concluded an arrangement, subject to (routine) ratification by Her Majesty's government, for the transfer to Great Britain of the claims of the native African chiefs. After some legal maneuvers which had the effect of locking out all claims of the Orange Free State, British sovereignty over the new Crown Colony of Griqualand West, which included the diamond fields, was proclaimed. The imperial gesture probably helped ensure that the diamond fields would be exploited with maximum profitability, and was in any case surely in tune with the times. A voice clearly speaking from the mind-set of those times (that of G. Williams, 1905) rhapsodizes that ". . . this settlement was greatly contributory to the extraordinary advance of diamond mining . . . as well as to the uplifting and development of the Colonies, and to the push of civilization into the heart of the dark continent."

No one better personifies this Imperial spirit than Cecil John Rhodes, who, in the rhetoric of Williams (1905) again, sought "to reach ends of Imperial scope, to throw the searchlights of civilization into every cranny of the Dark Continent, to lift the prodigious dead weight of unnumbered bygone ages of barbarism . . . to create a Greater Britain . . . and stretch the hand of his Queen over a realm transcending the farthest sweep of the Macedonian or the Roman." By the time of his death in 1902, Rhodes indeed had done more than anyone else to make southern Africa British, as far north as Kenya and Uganda—working from a power base secured by diamonds and by his mighty creation, the De Beers corporation.

When Rhodes came to Africa in 1870 to seek diamonds, he was merely the sickly 17-year-old son of a Hertfordshire clergyman. It was his ambition, imagination, and financial daring which finally gave him the victory, after years of capitalistic battle, over another ambitious adventurer, a Jewish shopkeeper from London named Barnett Isaacs, also known as "Barney Barnato." Barnato had come to work as a "kopje wallower" (amateur diamond buyer) in the Great White Camps of the diamond fields in 1873, joining his older brother Henry. With an equally inexperienced partner, Louis Cohen, Barnato soon began buying up claims, and founded a diamond company—thus moving into direct competition with Rhodes, who was doing the same sort of thing. The two entrepeneurs' rivalry did not end until 1887, when Rhodes bought out Barnato and incorporated their combined holdings as the De Beers Consolidated Mines Limited. Rhodes' other great creation, the British African Empire, is now gone, but the De Beers cartel is supreme to this day in the (now worldwide) diamond trade.

One dramatic episode in the early history of Kimberley deserves mention. In 1899 the Boer War broke out, itself a perfect artifact of British imperialism, as the British victory ended all Boer, not to speak of native African, aspirations to independence. Between October 1899 and February 1900 the Kimberley mine, and Kimberley town, came under military siege. An ill-organized but well-armed force of angry Boers surrounded the town/mine complex and bombarded it with long-range artillery; fortifications around the town and mine were erected, and small engagements were fought between British patrols and the besieging forces. In advance of the siege Rhodes had sent from Capetown a small but stout British force and ample supplies; food was rationed during the siege, and some diamond mining even continued. During one period of especially fierce bombardment, several hundred women and children took refuge for several days in the mine's deep tunnels. By the time a British relief column finally arrived, nine people had been killed in Kimberley, and many houses destroyed, but the brave defense had solidified local pride, and no permanent damage had been done to the mine.

Figure 22. **Extraordinary 1.3-cm cluster of octahedral diamond crystals on a matrix of bort (non-transparent diamond), from the Premier mine, Transvaal. Wendell Wilson photo.**

Figure 23. **Dark gray octahedral diamond crystal, 1.3 cm, from the Premier mine, Transvaal. Wendell Wilson photo.**

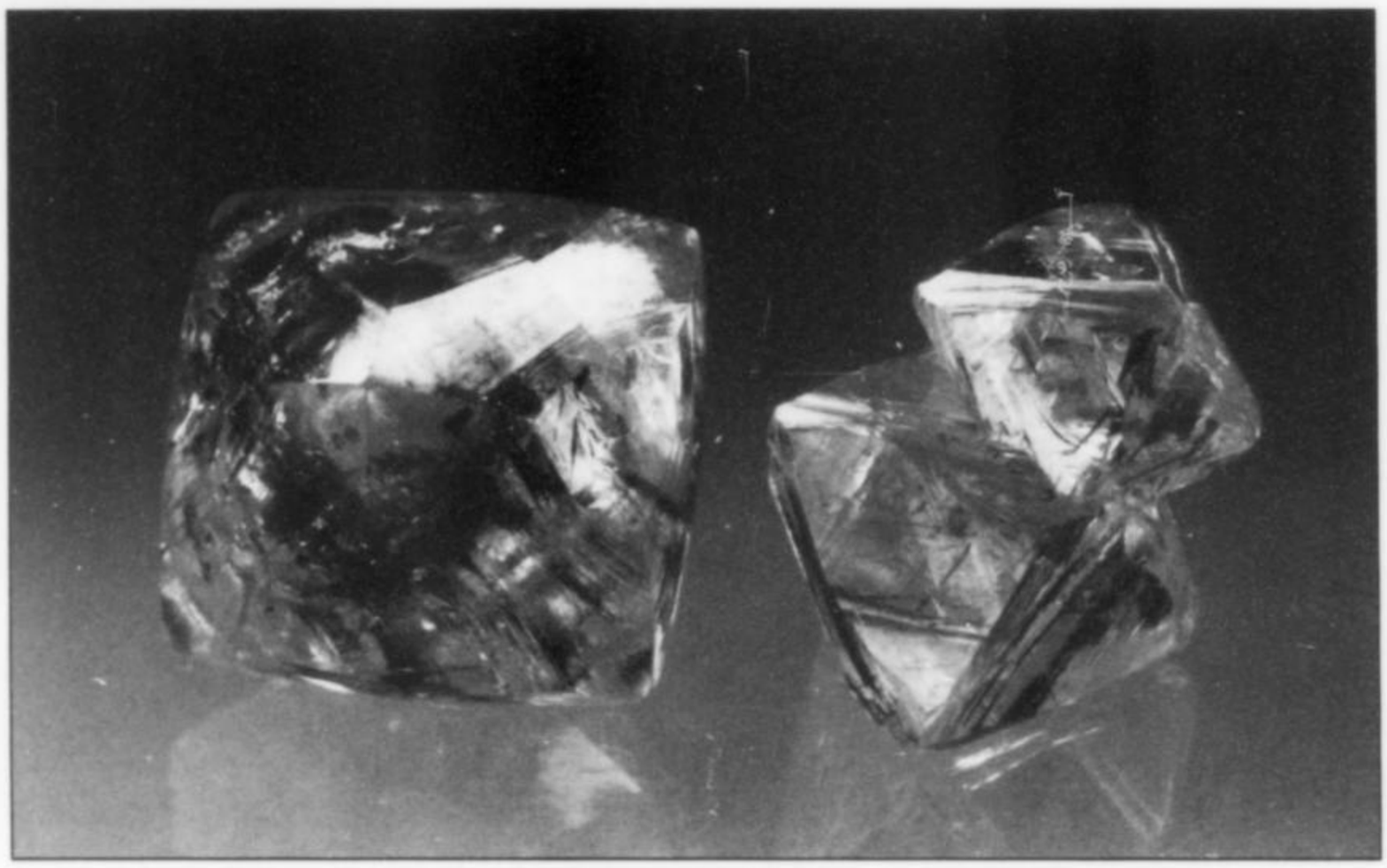


Figure 24. **Colorless diamond crystals to 9 mm, from the Premier mine, Transvaal. Wendell Wilson photo.**

In 1914 the Kimberley mine closed, having been worked to a depth of 1,098 meters; its site is presently marked by the famous "Big Hole," the deepest manmade excavation on earth. Four of the giant original mines are still active today: Bultfontein, Dutoitspan, Wesselton and Koffiefontein. Their combined production during the 1990's averaged only about 700,000 carats of diamonds annually, accounting for 0.7% of world production. The mines are close to the bottoms of their reserves of kimberlite ore, and all may be closed permanently by 2010 (Harlow, 1998).

The Kimberley diamond crystal illustrated here is a very gemmy, interestingly modified 1.4-cm octahedron weighing 11.3 carats.

Premier mine, Transvaal, Republic of South Africa

Up until 1903 the mines around Kimberley had supplied all of South Africa's (and the world's) kimberlite diamonds. But in that year a large diamondiferous pipe 20 miles from Pretoria, in the province of Transvaal, went into production as the Premier mine. Diamonds had been found abundantly in the soil there, especially around the Elandsfontein farm, as far back as 1897, but apparently some South Africans were reluctant to think that this new kimberlite deposit could possibly rival the already world-famous mines at Kimberley, almost 500 km to the southwest. In an official report in June, 1903—after the "Cullinan" diamond had been found in the Premier mine—a mining engineer employed by the Transvaal government noted that although the soil of this region was indeed full of diamonds, the blue ground below would probably prove unprofitable; others in the Transvaal Bureau of Mines shared this view (Williams, 1932).

But according to a report issued on October 31, 1903 by the Premier Diamond Mining Company, the Premier mine had already produced almost 100,000 carats of diamonds, valued at £137,435, during the first few months of its start-up year. Ten years later the company reported that the Premier mine had yielded 2,107,983 carats of diamonds worth £2,336,828 in the year ending October 31, 1913 (Williams, 1932).

The mine achieved its highest average annual production of diamonds during the 11-year period between its opening and the temporary suspension of mining at the outbreak of World War I in 1914. Work resumed in 1917, and by 1932, when the open pit had reached a depth of 610 feet, there was still almost no decrease in the diameter of the kimberlite pipe (Williams, 1932). But soon thereafter the miners encountered a sill of gabbro intersecting the pipe (Bancroft, 1984), and because of this barren ground the old open-pit Premier mine closed in 1936. In 1946 it re-opened, this time as an underground mine exploiting kimberlite below the gabbro, and as of today, one year past the mine's centennial, diamond production still continues. The deposit enjoys record longevity in another sense too: it is geologically the oldest of the major known kimberlite intrusions, dating between 1,100 and 1,200 million years (Bancroft, 1984; Kirkley *et al.*, 1991).

On the popular level, the story of the Premier mine is the story of Thomas Cullinan, and of the "Cullinan" diamond. Thomas Cullinan, born in the British Cape Colony, inherited a prosperous construction business, but before the turn of the 20th century he sold off most of his assets and moved north, into the Witwatersrand area near Johannesburg, Transvaal, where he devoted himself to prospecting for diamonds. Knowing that they occurred in the soil near the farm called Elandsfontein, he offered to buy the farm from its owner, Joachim Prinsloo, who responded by threatening to shoot Cullinan and any other prospectors who might trespass on his land. The Boer War put a halt to most prospecting anyway, and Prinsloo died before the war ended. In November 1902, the persistent Cullinan was finally able to purchase the farm from the Prinsloo heirs for £52,000.

In January 1903, diamondiferous kimberlite began to show up in the prospect pits, and a De Beers geologist came for a look. Apparently sharing the general skepticism about the viability of any kimberlites outside of Kimberley, he reported to his superiors that this new mine would be "a flash in the pan" (Janse, 1995). On Janauary 25, a gigantic diamond was found less than a meter below the surface, and mine manager Frederick Wells dug it out of the ground with his penknife (Bancroft, 1984). It was, of course, the fist-sized, 3,106-carat "Cullinan" diamond, by far the largest gem-quality diamond ever found anywhere in the world. Bancroft (1984) tantalizingly points out that the overall shape of the "Cullinan" indicates that it was actually the smaller half of an enormous, cleaved octahedron, and *somewhere* the still-buried larger half of the same crystal must certainly still exist.

The Cullinan diamond was presented to King Edward VII, and of the 105 separate gemstones cut from it, the largest two, the Great Star of Africa and the Lesser Star of Africa, at 530.2 and 317.4 carats respectively, are the largest faceted diamond gems in the world. Today they are seen by the thousands of tourists who visit the display of the British Crown Jewels in the Tower of London each week.

As the production figures cited earlier show, the Premier mine during its amazing first years provided strong competition for the mines of the De Beers monopoly at Kimberley. De Beers, moving quickly to rectify its earlier error in judgment, reached an "understanding" with the board of directors of Thomas Cullinan's Premier Diamond Mining Company in 1920, and by 1922 De Beers had acquired all shares in the Premier mine (Janse, 1995). Cullinan was knighted by Edward VII, and went on to a successful career as a South African politician; he died in Johannesburg in 1936.

The four Premier mine crystals illustrated here include a gemmy, modified, 9-mm octahedron, an interesting pair of gemmy and colorless octahedral crystals attached to each other in parallel, a 1.3-cm octahedron darkened by many blackish inclusions, and an extraordinary 1.3-cm crystal *cluster* consisting of at least seven

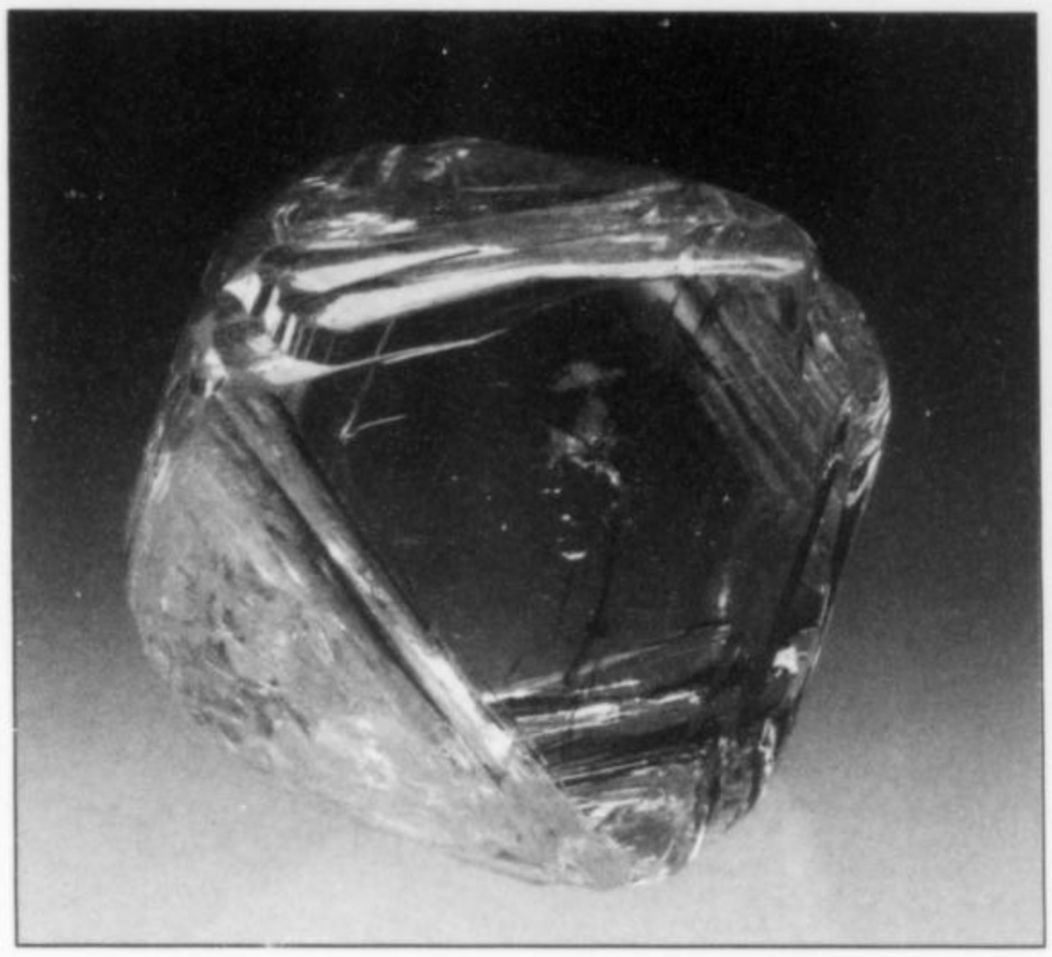


Figure 25. **Pale yellow octahedral diamond, 1.4 cm (12.5 carats), from the Vaal River District, Cape Province. Wendell Wilson photo.**

gemmy, octahedral individuals growing on a matrix lump of opaque diamond "bort."

Vaal River district, Cape Province, Republic of South Africa

The Vaal River, rich in alluvial diamonds, passes through the "Kimberley district" of kimberlite-pipe mines (see above); in fact, a bend of the river passes within two km of the Kimberley mine. This description, therefore, is to some extent redundant with the description of the Kimberley district, inasmuch as the diamonds have a common source.

The part of the Vaal River which has historically been most productive of diamonds runs northeast for about 150 km, from Pniel and Kimberley to the town of Bloemhof—although the very first finds came from points farther south. About 100 km southwest of Kimberley, just below the point at which the Vaal River joins the Orange, lies the site of the De Kalk farm, where in 1867 the Jacobs children found the large crystal that started the whole South African diamond excitement; in 1869 the 83.5-carat "Star of South Africa" was found on the Zandfontein farm, also very near the junction of the Orange and the Vaal. After some early prospecting in this area, though, the early diggers moved north, to Pniel on the Vaal, developing extensive diggings at a place called Klipdrift, later Barkly West, where the gravel beds yielded many of the finest South African diamonds ever found (Williams, 1932).

As early as 1869, about 4000 diggers were at work in the Vaal and Orange Rivers (Webster, 1983). The swarming tent camps took in "a motley throng of fortune-hunters" (Williams, 1905) from the neighboring Boer lands, from the British Cape Colony, from other parts of Africa, and from abroad:

> Black grandsons of Guinea coast slaves and natives of every dusky shade . . . butchers, bakers, sailors, tailors, lawyers, blacksmiths, doctors, carpenters, clerks, gamblers, sextons, laborers, loafers . . . fell into line in a straggling procession to the Diamond Fields. Army officers begged furloughs to join the motley troop, schoolboys ran away from school, and women even of good families could not be held back from joining their husbands and brothers in the long and wearisome journey to the banks of the Vaal (Williams, 1905).

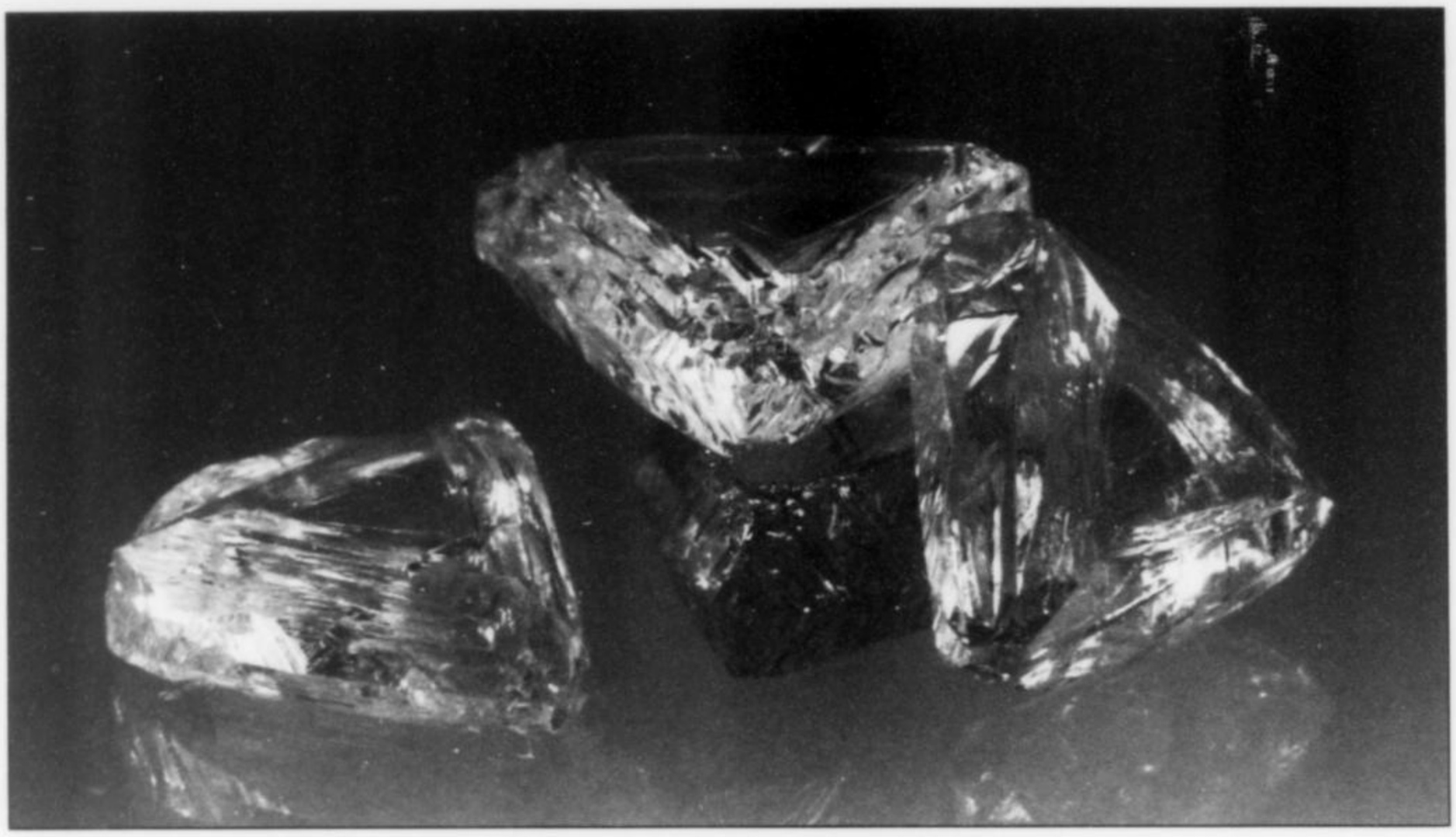


Figure 26. **Suite of four spinel-law diamond twins ("macles") to 6 mm, from the Finsch mine, Orange Free State. Wendell Wilson photo.**

Figure 27. **Suite of nine diamonds in different colors and habits, to 5 mm, from the Finsch mine, Orange Free State. Wendell Wilson photo.**

Soon, of course, the kimberlite mines overshadowed the alluvial workings, but the latter continued in action nevertheless, being concentrated at points progressively farther upstream on the Vaal, i.e. to the northeast. In 1926, enormous alluvial deposits were found in high plateau country near Lichtenburg, 175 km north of Bloemhof, and 10,000 prospectors joined a first rush (Harlow, 1998). In the next year there was an "organized" rush near Grasfontein in the Lichtenburg field. A Transvaal government official standing up on a cart proclaimed the opening of a farm tract for digging, and at the drop of a flag 25,000 people rushed forward to plant their claims. The output of alluvial diamonds from the Vaal River region kept increasing well into the 20th century, with a new surge from the Lichtenberg fields after 1926, and production continues today.

From the start, Vaal River diamonds enjoyed a reputation for being unusually clear, bright, and free of fractures. Some are lightly tinged yellow, and deep orange, pale blue, brown and pink hues are found very rarely, but a large percentage of the stones are perfectly white. The commonest crystal forms are the octahedron and dodecahedron (Williams, 1905) The crystals illustrated here (a beautifully gemmy, near colorless 1.4-cm octahedron weighing 12.5 carats, and a 1.8-cm macle weighing 13.2 carats), having no doubt been found rather recently, are probably from the northern part of the Kimberley district, since, as mentioned, the general historical trend was that the alluvial workings moved northeastwards along the Vaal from the old Barkly West area near Pniel.

Finsch mine, Orange Free State, Republic of South Africa

The Orange Free State, briefly an autonomous Boer state just before the turn of the 20th century, is now a province of the Republic of South Africa. The kimberlite pipe exploited by the Finsch mine was discovered in 1960. The mine, located on the Brits Farm near Limeacre, 160 km west of Kimberley, is a major producer of gem crystals—about 25% of its diamonds are of gem quality (Webster, 1983). The discoverers of the pipe, Alister Fincham and Ernest Schwabel, had been working a claim there for asbestos, but when they found garnets in the soil they suspected the presence of underlying kimberlite (pyrope being a major "indicator" mineral). When the relevant mining law changed in their favor in 1960, they began mining diamonds.

In 1963 the entire capital of the Finsch Diamonds Company was purchased by De Beers, and two years later the mine began full-scale production. As a large open-pit mine with many benches, the Finsch produced 95,000 carats of diamonds in 1965, with production steadily increasing to 3,500,000 carats in 1985 (Maillard, 1980). The pit had reached a depth of 430 meters before underground mining commenced (Harlow 1998), and ultramodern block-caving methods of gathering kimberlite ensure the continued importance of the Finsch mine today.

The collection illustrated here features a superb suite of 13 Finsch mine diamonds in a gorgeous array of colors including canary-yellow, orange, pink, reddish brown, colorless and black. The habits range from modified cubic to octahedral to triangular macle twins up to 6 mm in size.

Williamson mine, Mwadui, Tanzania

The Williamson mine is the largest kimberlite mine in Africa, with a main pipe eight times larger than that of the Premier mine. It has yielded diamond crystals to 240 carats; a gorgeous pink 54-carat stone was cut to a gem of 23.6 carats and presented to Princess (now Queen) Elizabeth on the occasion of her marriage in 1947.

Mwadui village lies in an area of diamondiferous gravels between Shinyanga and the southern shore of Lake Victoria; some claims were pegged as early as 1910, and limited mining began in 1925 (Webster, 1983; Janse, 1996). In 1934, Dr. John Williamson, a geologist from Quebec, came to prospect in Tanzania (then British Tanganyika), and one of the last star-stories about an individual diamond entrepeneur commenced: "Every geologist dreams of discovering an important diamond mine," wrote G. J. Du Toit in an unpublished manuscript called *The Williamson Story*, "[and] everybody wants to own one outright. Only one man, Dr. John Thorburn Williamson . . . the discoverer and founder of the now-famous Mwadui diamond mine . . . has ever achieved both ambitions" (quoted in Maillard, 1980).

In 1940 Williamson had worked in three small, unprofitable diamond mines in Tanganyika, and had discovered a few small

Figure 28. **Octahedral diamond crystal, 1.3 cm (7.9 carats), from the Williamson mine, Tanzania. Wendell Wilson photo.**

kimberlite pipes, but was nonetheless down to his last £100 and thinking of joining the army. But on the evening of March 6, 1940, his assistant brought him a soil sample from an abandoned survey trench near Mwadui; processing it, the two men found not only abundant grains of the indicator mineral ilmenite but also a beautiful 2-carat diamond octahedron (other versions of the discovery-story exist, as we might expect—see Janse, 1996). Soon Williamson's systematic work at the site had revealed a massive kimberlite pipe and associated diamondiferous gravels, and the Williamson mine was born. He was able to bootstrap the mine's growth from profits, and built a huge processing plant, a power station, and a township for several thousand employees. After Williamson's death in 1956, his heirs sold the mine to De Beers, and continued economic success followed Tanzanian independence in 1961, and the mine's nationalization (Maillard, 1980).

According to the present owner, Tan Range Exploration Corporation, the Williamson mine is still operating, but on a much smaller scale than previously. Through various modern exploration technologies, e.g. airborne magnetic-anomaly surveys, the company has identified several new, although small, kimberlite pipes in the area and elsewhere in Tanzania. These might be expected to compensate, at least partially, for the expected closing of the Williamson mine sometime in the fairly near future (www.tanzam 2000.com).

The Williamson mine specimen illustrated here is an attractive, nearly colorless 1.3-cm octahedron weighing 7.9 carats.

Kenema, Eastern Province, Sierra Leone

The diamond fields of Sierra Leone lie in hilly terrain north of the town of Kenema. Bounded on the west by the Sewa River and on the east by the borders of Liberia and Guinea, the region measures about 80 x 100 km and accounts for about one-third of the total land area of the tiny country. Alluvial diamonds were first found in Gboboro Stream in January 1930 by N. R. Junner and J. D. Pollett of the Sierra Leone Geological Survey (Janse, 1996), and there was small-scale prospecting and mining until the end of British colonial rule in 1961. A company called Consolidated African Selection Trust (CAST), through its wholly owned subsidiary Sierra Leone Selection Trust (SLST), acquired a diamond-prospecting lease over the whole country, and annual production

Figure 29. **Three spinel-law diamond twins ("macles"). From left: Kenema, Sierra Leone (1.1 cm; 4.6 carats), Vaal River District, Cape Province, South Africa (1.8 cm; 13.9 carats), Oranjemund District, Namibia (1.2 cm; 4.1 carats). Wendell Wilson photo.**

Figure 30. **Modified octahedral diamond crystal, 1.3 cm (7.5 carats), from Kenema, Sierra Leone. Wendell Wilson photo.**

reached one million carats by 1937 (Janse, 1996). Even during this period, as a harbinger of the chaos to come, more diamonds probably left the country illicitly than were sold by the mining company (Webster, 1983).

Sierra Leone diamonds are all alluvial, being found by time-honored methods of scouring and processing gravels in the Sewa, Gboboro, Male and other small rivers, and mining on terraces along these rivers. This is a deeply weathered terrain, with coarse-grained granitic rocks underlying the valleys and more resistant schists forming the uplands, all overlain by thick soil cover and dense vegetation. The remnants of the original kimberlite pipes crop out in only a few spots, now showing only their once deep-seated roots. They must once have been large and richly diamondiferous, for even after most of the diamonds have washed out to sea, rich alluvial deposits, including many on high banks and ledges which represent ancient drainages, are still widespread.

Quite early on in the region's history, Sierra Leone diamonds acquired the reputation for being of highest gem quality at their best, as well as very well crystallized. Many crystals, called "glasses," are sharp, lustrous octahedrons of pellucid transparency, colorless in most cases but rarely also bottle-green. The "Star of Sierra Leone," found at Yengema in 1972 and weighing 969.8 carats, is the largest alluvial diamond of gem quality ever discovered anywhere.

During the last years of British rule the villagers of the region, having learned about how to find diamonds and about their extremely high value, began illicitly collecting and selling them on a large scale, with fortune-seekers from neighboring Guinea and Liberia often joining in too. These are among Africa's poorest countries—Sierra Leone is *the* poorest—so the diamond mania was not surprising, but it soon threatened the overall economy of the colony. "Farmers neglected their crops and livestock to such an extent that the government had to import commodities like rice, which in normal times Sierra Leone exported. Instead of enriching the country, diamonds were threatening to ruin it. In the region of the diggings there was a severe shortage of food, and prices rose to dizzying heights" (Maillard, 1980).

The British, by issuing diamond-collecting licenses and by encouraging the villagers to dig for the official company SLST, attempted to get control of the situation. But large-scale illegal trading still went on, especially after large numbers of Lebanese merchants moved in to seize control of smuggling activities close to the border of Liberia, in whose capital, Monrovia, diamond dealers and cutters from Antwerp and elsewhere waited to buy smuggled gems at very low prices.

In 1955 the British, in co-operation with DeBeers, countered by authorizing the Diamond Corporation of Sierra Leone (DCSL) to set up a buying office in Freetown, the capital city, with smaller outposts in villages near the sources. "Miners" then could individually bring diamonds to sell at fair prices, and without risk to themselves, and the diamonds could be taxed by the government, then channeled into established international markets. The single

SLST concession for all of Sierra Leone was split into two lease areas, called Yengema and Tongo (Janse, 1996).

But since Sierra Leonean independence in 1961, and especially after the country became a republic in 1971, the story of diamonds there has been largely one of civil war, mayhem, deepening poverty, cruelty, and death—one of the world's worst and least noticed "news" stories of recent decades. A series of government coups and counter-coups, these supported or undermined variously by the governments of major powers and by the forces on different sides of the civil conflict going on in neighboring Liberia, have cost tens of thousands of Sierra Leonean lives. Government and rebel forces have both typically formed their armies from underfed children and from alcohol and drug-addled young men, and all sides have employed mercenaries from the U.S., Russia and Europe to "lead" them. In one rebel offensive against Freetown between December 1998 and February 1999, at least 7,000 people died, and, in the overheated (but not necessarily inaccurate) language of one website, "Women and young girls were raped systematically . . . The population was routinely used as human shields. . . . Entire compounds of families have been emptied, the villagers lined up while the rebels jokingly decide which ones to shoot and which to let go . . ." (www.comebackalive.com). Mutilations, especially the chopping-off of arms and legs, have been practiced on a large scale, foreigners have been executed, villages have been starved, and reports of cannibalism persist.

Clearly the most common motive for all this violence is greed for the diamonds which are Sierra Leone's only significant source of wealth and accessible symbol of power. "The diamond mines were the first targets for repossession, as one of the would-be dictators hired [mercenaries] on credit, with a promise of US $500,000 a month payment in diamonds" (www.comeback alive.com). Such are the facts which lurk behind the vaguely, often glibly used term "conflict diamond"—one may or may not choose to bear them in mind while contemplating the two crystals illustrated here, a colorless, modified 1.3-cm octahedron (with a smaller "side-car crystal") weighing 7.5 carats, and a colorless triangular 1.1-cm macle weighing 4.6 carats.

Between 1960 and 1996, "official" diamond production from Sierra Leone fell from 2 million to 400,000 carats per year; however, in 1996 a Canadian company was thinking of mining a small kimberlite pipe where gem-quality diamonds seem to comprise an extraordinary 60% of the total yield (Janse, 1996).

Oranjemund district, Orange River, Namibia

Oranjemund lies, as its name specifies, at the mouth ("Mund") of the Orange River, where this river empties into the South Atlantic. Since the Orange River forms the border between Namibia and the Republic of South Africa, Oranjemund is at the southernmost point of Namibia (formerly the South African protectorate known as South-West Africa, and before World War I the German colony of Deutsch Südwest Afrika). At Oranjemund, the Namdeb Diamond Corporation Limited (owned jointly by the Namibian government and De Beers) maintains a fleet of earth-moving equipment "nearly as large as that owned by the United States army" (Maillard, 1980), and uses it to conduct a mammoth beach-mining operation for diamonds.

"Beach" diamonds were first detected along this coast in 1908, near Lüderitz, where a railroad worker found a few small crystals in the sand dunes. Soon, discrete beach deposits were being found along a 60-mile stretch north of the mouth of the Orange, and the Germans were mining considerable numbers of small but high-quality diamonds. When South Africa took control after World War I, the deposits were sold to Consolidated Diamond Mines (CDM), which was transferred to DeBeers in 1929; the present Namdeb Corporation was organized in 1994. Its current operations include beach-mining, terrace-mining, and seabed-mining—all flourishing nicely, and imparting a new sense to the old term "alluvial diamonds."

For a while geologists wondered whether these marine diamonds had come from kimberlites on the sea floor, or whether they had been transported oceanwards from the great kimberlite swarms of the inland Kalahari Craton. But it is now quite certain that kimberlites do not occur in the ocean basins, only in continental cratons, and moreover a mere glance at a stream-drainage map of southern Africa makes it clear that huge numbers of diamonds from inland kimberlites *must* have been transported to the sea by the Orange River system (including tributaries such as the Vaal); further, it has been noted that the sizes of the marine diamonds diminish regularly as the distance from the mouth of the Orange increases. Presently it is estimated that over the past 100 million years, up to 1,400 meters have been eroded from the land surface of South Africa and Namibia, and that of all of the diamonds released to the streams by the weathering of the kimberlites, only 10% stayed behind in inland alluvial deposits, the remaining 90% having been carried to, and out into, the ocean. And since the ocean waves shatter the poorer-quality diamonds, 90–95% of marine diamonds are of gem quality (www.amnh.org/exhibitions/diamonds).

Terrace mining for diamonds at Oranjemund takes place well above the high-water level and up to 3 km inland, and seabed mining, carried out by suction-dredging from huge offshore barges, operates more than a mile out from the mouth of the Orange. More important than either of these is beach mining. In the first stage of this process, massive earth-moving equipment removes loose beach-sand overburdens to depths of up to 80 feet, exposing ancient beach terraces as much as 65 feet below present high-water levels. The terraces are broken up and bulldozed into rubble-piles until the tough, irregularly configured bedrock schists are laid bare: this is the level most avidly sought, since the gravels left in the potholes and crevices here have concentrated most of the diamonds.

Backtrenchers with digging buckets gouge out some of the gullies, but mining from this point is largely a matter of hand work: miners known as bedrock cleaners dig, shovel, and sort the highly diamondiferous residual gravels, until the whole schist floor is swept clean (Maillard, 1980). The technology is efficient, and potential yields from the "Oranjemund district" are vast—in 1995 alone, such beach deposits produced 1,300,000 carats of diamond crystals (www.amnh.org/exhibitions/diamonds).

Similar beach deposits have been located in Namaqualand, South Africa, south of the mouth of the Orange, as well as much farther north, on the "Skeleton Coast" of Namibia (Webster, 1983). It is most likely, however, that the specimen illustrated here (a gemmy triangular macle twin 1.3 cm across, weighing 4.1 carats) came from somewhere not too far north of Oranjemund—and that the working from which it came has long since been buried again by tide-borne sands.

Bangui region, Central African Republic.

Although only a tiny fraction of the world's diamonds comes from the Central African Republic, diamonds are this poor, landlocked former French colony's principal resource. The colony (which is partially underlain by a small craton), was once known as Ubangi-Chari; it lies just north of Zaire, the latter also known as the Congo Republic. Neither state should be confused with the former French Congo, now the People's Republic of Congo, lying just to the west of Zaire (devotees of dioptase will be familiar with these confusions). The Ubangi (or Oubangui) River marks the border between Zaire and the Central African Republic, and Bangui is a town on the river's north bank. The "Bangui region" (source of the

Figure 31. **Modified cubic diamond crystal, 1 cm (13.5 carats), from the Bangui Region, Central African Republic. Wendell Wilson photo.**

crystal illustrated here, a 1-cm yellow cube weighing 4.1 carats) corresponds to a diamond-producing area between Bangui and Berberati, in the southwestern part of the country (Maillard, 1980; Webster, 1983).

Here, diamonds are recovered by clearing heavy forest and jungle vegetation, then removing a thick bed of topsoil to reach diamond-bearing alluvial gravel; there is also some mechanized dredging in beds of the region's numerous rivers and streams. Further diamond-related developments may follow when the parent kimberlite or lamproite pipes (if they still exist) are finally located in the Central African Republic.

Northern Lunda Province, Cuango River area, Angola

Angola produced 1.8% of the world's diamonds in 1996 (www.amnh.org/exhibitions/diamonds), and a high proportion are of gem quality. Counterbalancing these upbeat observations, though, is the fact that civil wars and insurgencies have intermittently troubled Angola ever since independence from Portugal was declared in 1975. Consequently, as in the case of Sierra Leone, diamonds known to be from Angola may be "conflict diamonds." At least half of all diamonds found in the country are gathered and sold illicitly (Janse, 1996). Even when there is no fighting, demobilized soldiers generally prefer to dig gems rather than return to bare-subsistence farming.

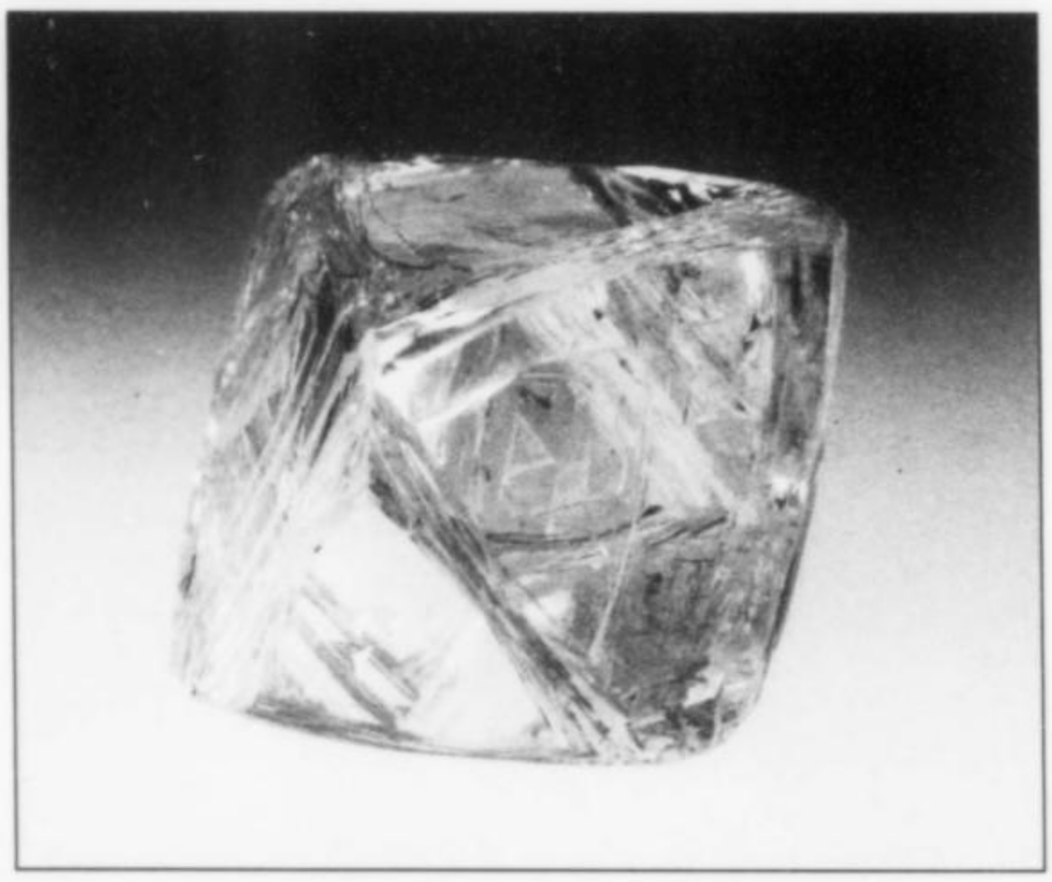


Figure 32. **Canary-yellow octahedral diamond crystal, 1 cm (6.4 carats), from the Cuango River area, Angola. Wendell Wilson photo.**

The Angolan diamond regions are all in the northern part of Lunda Province, in the country's northeastern corner, adjoining Zaire. In fact, the first discoveries of alluvial diamonds, in 1911/1912, were byproducts of exploratory surveys just to the north, in what was then the Belgian Congo. A series of parallel rivers run from south to north through Lunda Province before passing into Zaire, and diamonds have been found in many of them. The Cuanga River, forming the border between Lunda Province and Malanje Province to its west, is the largest of these rivers, and had produced about 80% of Angola's diamonds as of 1998 (Harlow, 1998). It is possible, however, that the stated source of the lovely 1-cm yellow crystal illustrated here,"Cuango (or Kwombo) River," is merely a geographically convenient term, and that the diamond was found in one of the region's smaller rivers (candidates include the Chicapa, Luachimo, Chiumbe, Luana and Lembe).

Creative geological fieldwork by R. Delville in the early 1950's succeeded in establishing that diamondiferous gravels and conglomerates were concentrated along two parallel faults in a buried fault-graben structure in Lunda Province, and inferences could then be drawn concerning where the original kimberlite sources lay concealed in the forested wilderness of the province. The first of the kimberlite pipes was found near the Chicapa River in 1952; it is now known to be one of the largest in the world (Maillard, 1980), and one of about 600 pipes in northern Lunda (Harlow, 1998). Ongoing mining and prospecting is in the hands of a consortium, Consorcio Mineiro de Diamantes (Condiama), whose members include De Beers, the government of Angola, and an earlier company called Diameng (Companhia de Diamantes do Angola), which had begun to look for diamonds during Portuguese colonial times.

Ghana

Although Ghana is not represented by any of the diamonds in the collection featured here, it is the locality for the large and amazingly modified cube shown on the cover of this issue, from the collection of Mike Scott. In 1911, British prospectors found small numbers of alluvial diamonds in what was then the colony called the Gold Coast—more famous in history both for its gold and for its infamous slave-trading ports—on the Gulf of Guinea. As of 1980, 3 million carats of diamonds were being produced annually, 85% of the output being merely of industrial grade (Maillard, 1980). In 1996 the country accounted for 0.7% of world diamond production (www.amnh/exhibitions/diamonds).

Alluvial diamond deposits in Ghana are concentrated in the Birim valley, in the Akwatia region midway between the capital city of Accra and the town of Kumasi (Maillard, 1980)—this is the likely provenance of the cover crystal.

THE FUTURE OF DIAMOND MINING

Levinson *et al.* (1992) estimate that the *total world production* of diamonds, both gem and industrial, between remotest antiquity and the year 1990 was 2,213,875,000 carats, equivalent to 450 metric tons weight. This is, they say, a conservative estimate, since it rounds up only slightly from official figures to take into account unreported, illicit production. As mineral species go, even gem-

(continued on page 53)

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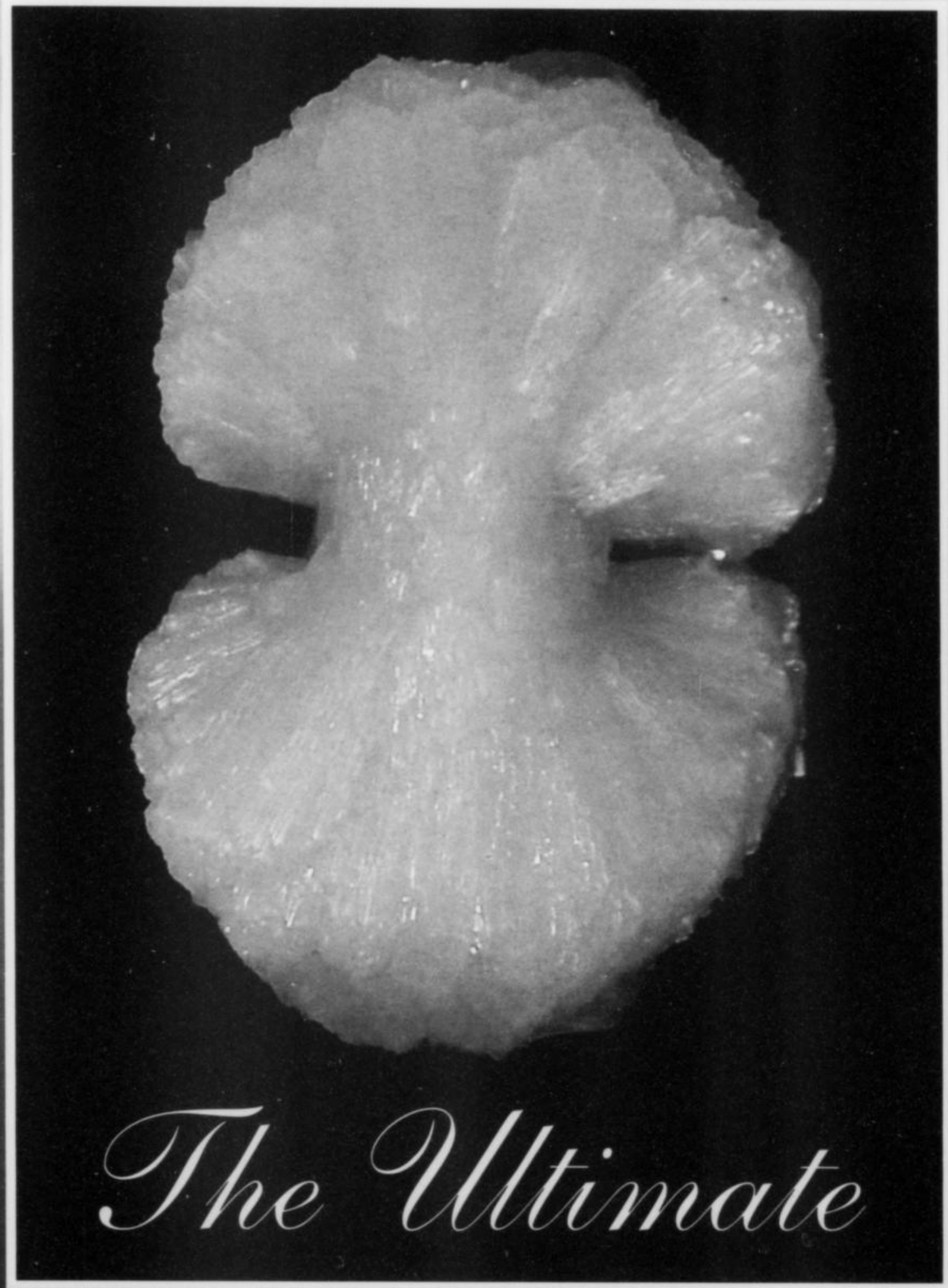

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SILVER with Galena crystals, Kongsberg, Norway; 10 cm. From Stuart Wilensky, May 2002; Schvetholm collection, to Helmut Brückner, to Wilensky.

Clara and Steve Smale

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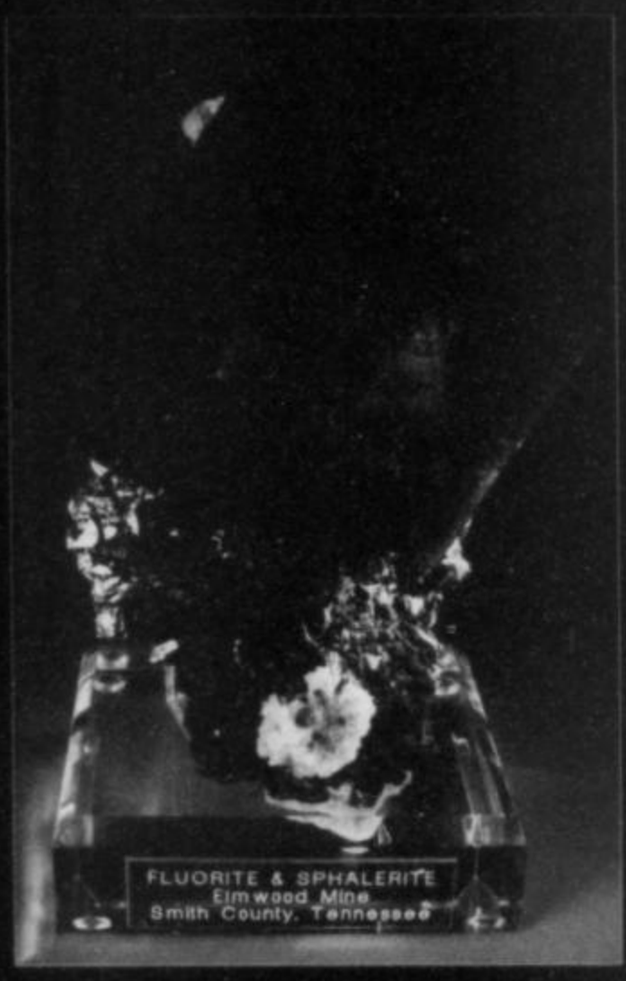

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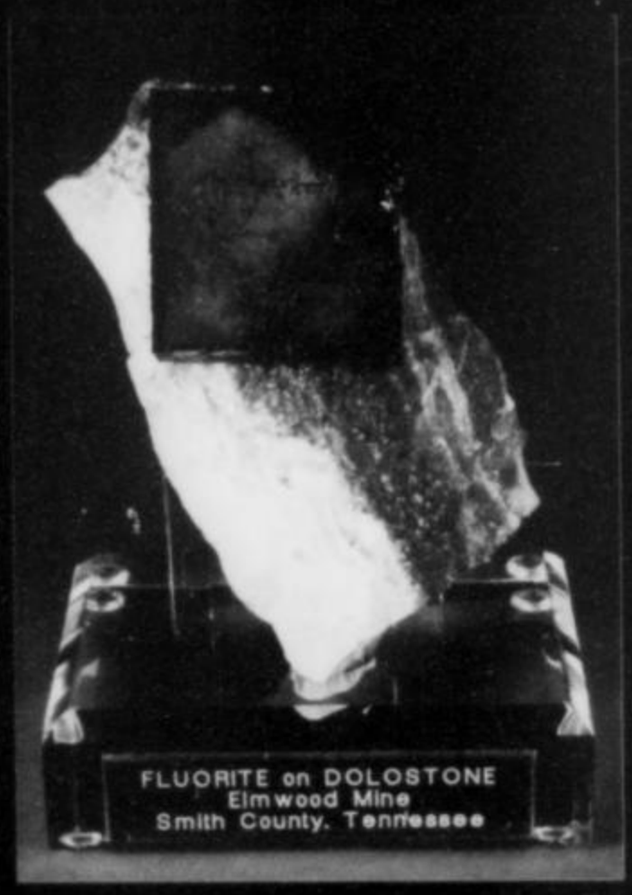

CALIFORNIA GOLD

from the Wreck of the S. S. Central America

Q. David Bowers
P. O. Box 539
Wolfeboro Falls, New Hampshire 03896

A treasure ship laden with gold coins, ingots and specimen gold fresh from the California Gold Rush was on its way to the bank vaults of New York City when it sank in a hurricane off the coast of North Carolina—in over 7,000 feet of water. It sat undisturbed on the deep ocean floor for 130 years before being discovered and salvaged, a unique time capsule of the gold rush that has been distributed by dealers and auction houses to the collector community.

INTRODUCTION

By 1857 the California gold rush was in its mature era, the output of precious metal having peaked in 1853. Coins from the San Francisco Mint (which had opened in 1854) and from several private coiners, along with many gold bars, were shipped regularly from California to the East, particularly to New York City, from which point the gold went to banks, the United States Assay Office, and to the Philadelphia Mint, among other destinations, including transshipment to London, the center of the world gold market.

The typical itinerary for such gold was by sidewheel steamer from San Francisco, then southward via the Pacific Ocean to Panama, at which point the treasure was transferred to the 48-mile-long Panama Railroad for its journey across the isthmus. On the Atlantic side a connection was made with another steamer at the newly built town of Aspinwall (later renamed Colon) for transport to New York City or another port. By 1856 over $330 million in California gold had been exported via this route.

One such Atlantic-side steamer was the *S. S. George Law*, which had recently been renamed the *S. S. Central America*. Her fateful voyage in September 1857 was her 44th transit. She had picked up passengers and cargo from the *S. S. Sonora*, a ship plying the Pacific side from San Francisco down to Panama. She carried a $1.6-million time capsule of gold coins, ingots, nuggets, natural gold crystal specimens, and gold dust fresh from the gold fields of the Mother Lode in California. Consignors and consignees included Wells Fargo & Company, the American Exchange Bank, and the Duncan & Sherman Company; and there was also a

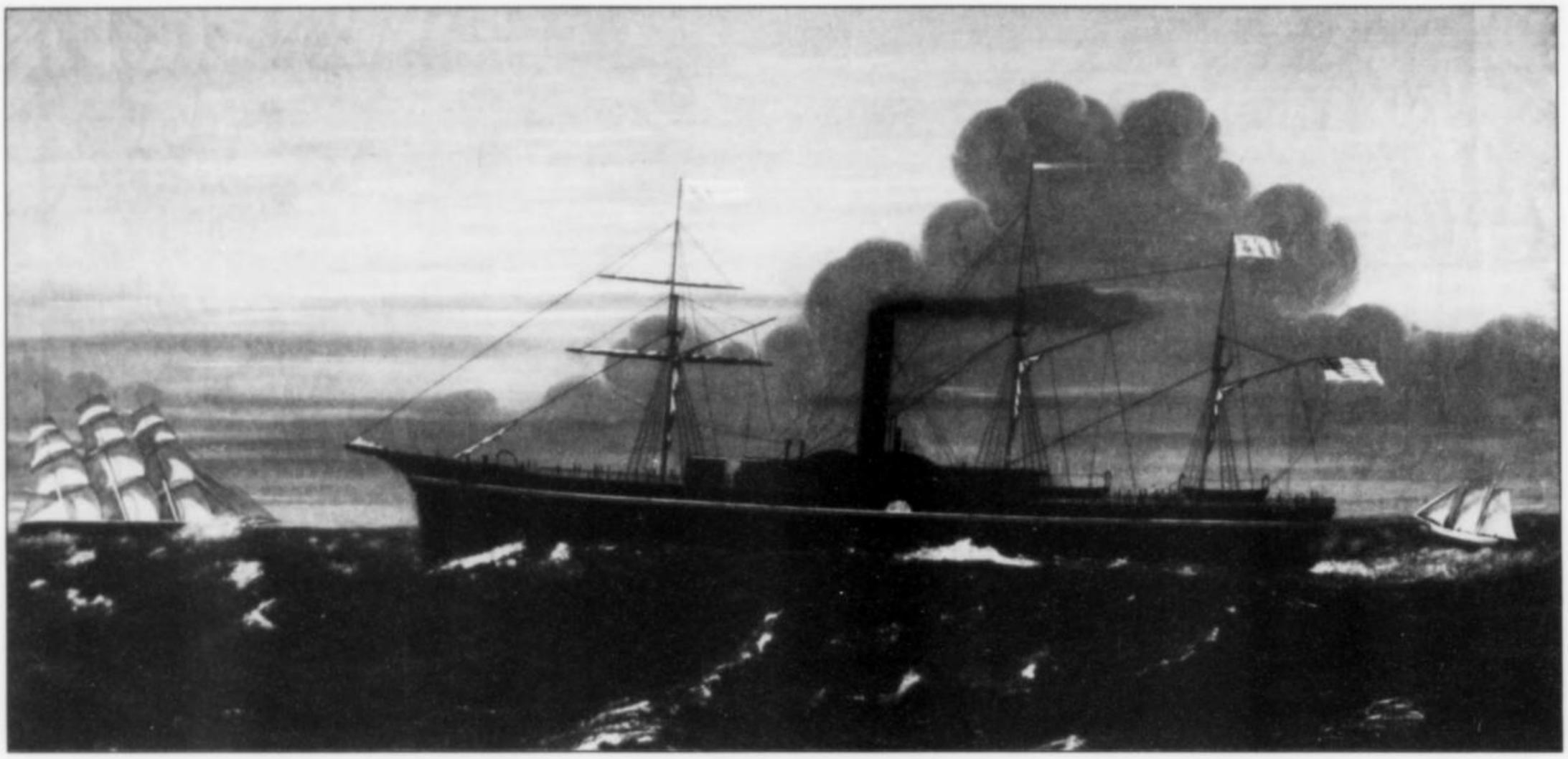

Figure 1. **In September of 1857, passengers and cargo from the California Gold Rush boarded the *S. S. Sonora* at San Francisco, and steamed south to Panama. There they debarked and crossed the isthmus via the 48-mile long Panama Railroad, then boarded the *S. S. Central America* (shown above in an anonymous oil painting now in the Mariner's Museum, Newport News, Virginia) which was to take them to New York City.**

substantial amount of "passenger gold" carried in trunks, satchels, packing crates and other containers.

On her way from Panama to New York City the *S. S. Central America* encountered an unexpected hurricane. After being tossed by mountainous seas for several days, on the night of September 12 the 278-foot, 2,141-ton vessel slipped beneath the waves. Carried to their grave in 7,200 feet of cold water 200 miles off the coast of North Carolina were about 425 men. Only 153 people were rescued, among whom were all of the women and all but one of the children on the ship. (The exception was a boy who did not want to go into a lifeboat unless his adult brother could accompany him, and his request was denied.) It was the worst maritime disaster in peacetime in the history of the United States.

At the time there was a financial crisis already in progress (later to be known as the Panic of 1857), caused primarily by unfavorable foreign trade and bad banking practices. The crisis was exacerbated by news of the sinking of the *S. S. Central America* with its massive cargo of California gold. It was California gold that had been fueling the nation's economy. But the recent failure of the New York branch of the Ohio Life Insurance and Trust Company had left massive banking debts in its wake, and nervous depositors were staging a run on the banks. With their gold reserves dwindling, the New York bankers had been looking forward to the fresh infusion being brought by the *Central America*. Fortunately the cargo was heavily insured, and the underwriters paid out the claims immediately to calm the fears of the financial community.

Fast-forward to 1986, when a group of daring modern-day scientists and adventurers, organized in Columbus, Ohio as the Columbus-America Discovery Group, mounted an academic study combined with a sea-floor search and located the long-lost "ship of gold." The discovery played out in a set of fascinating circumstances, culminating in 2000 with the first sale of gold coins, bars and mineral specimens recovered from the ship. Dwight Manley and his California Gold Marketing Group were instrumental in bringing the hoard to market and seeing it distributed to collectors and museums far and wide.

During the 15 years following the discovery of the ship and its fabulous treasure, a number of books have appeared on the subject. The first was *Story of an American Tragedy; Survivors' Accounts of the Sinking of the Steamship Central America* (Conrad, 1988). Then came *The Final Voyage of the Central America 1857* (Klare, 1992), a volume that can be considered definitive with regard to the ship itself. The third was *Ship of Gold in the Deep Blue Sea* (Kinder, 1998), which made the best-seller lists and concentrated upon the successful efforts of the Columbus-America Discovery Group in recovering the treasure from the sea bottom. The fourth, *America's Lost Treasure: A Pictorial Chronicle of the Sinking and Recovery of the United States Mail Steamship Central America* (Thompson, 1998) brought to print many photographs from the gold rush era and the early days of the ship, plus scenes of the recovery, accompanied by a fascinating narrative.

In 1999 the Columbus-America Discovery Group transferred much of its interest in the treasure to the California Gold Marketing Group headed by Dwight Manley. I was tapped to write a comprehensive book on the find, in the context of the Western era that produced it: *A California Gold Rush History, featuring the Treasure from the S. S. Central America* (Bowers, 2002), and my firm, Bowers and Merena Galleries, created much of the printed information used in the distribution of numismatic items and specimen material from the ship—a process that continues.

The discovery of coins, bars and crystalline gold from the wreck of the *S. S. Central America* was, and is, almost unbelievable. It was like traveling in a time machine back to 1857 and viewing (and being able to buy!) freshly minted gold coins, assayer-stamped gold bars and recently dug nuggets and crystal gold in white quartz—perhaps as much as $100 million dollars' worth in today's valuation. We are fortunate that the finding of the *Central America* treasure took place in our lifetime. I will always consider my slight involvement to be a highlight of my career.

GOLD IN CALIFORNIA

Gold had been found in California since early times, but the earliest Philadelphia Mint deposit of California gold appears to have been shipped in 1837 and received by the mint on January 30, 1838. This shipment is of great historical importance, and has not been recorded in other histories nor is it widely known among scholars even today. The shipment consisted of 851 ounces, noted on the Mint's bullion ledger simply as being "from California," in the form of "native grains," that is, placer gold.

In 1841 or 1842 there was a flurry of excitement at San Francisquito (also known as San Feliciano) Canyon about 35 miles northwest of the small pueblo of Los Angeles. Francisco Lopez had been digging wild onions and pulled up gold dust clinging to the roots. Before long the canyon was thronged with fortune-seekers, some of whom were successful in finding gold. By 1843 the Los Angeles placers were being worked over a distance of about 30 miles and had produced a total of about 2,000 ounces, but by 1844 the field had been exhausted and mostly abandoned.

The key find which started the great gold rush of 1849 took place in January of 1848 along the Sacramento River, inland from San Francisco by a journey of several days. Sutter's Fort was a central depot for ranching, farming and trading in the area. In charge was John A. Sutter, a Swiss immigrant who had come to the district in 1839 and had named it Nueva Helvetia ("New Switzerland"). In time the city of Sacramento would be built nearby, but in the 1840's the land was grassy and open, with few inhabitants. The fort was constructed around 1841. Sutter eventually sent out exploration parties to locate sites along rivers where a sawmill might be constructed. The scouting party included James W. Marshall, a craftsman and carpenter from New Jersey. They settled upon a site on the American River about 50 miles from the fort by horse trail. Marshall entered into a partnership with Sutter, agreeing to construct the mill while Sutter provided provisions, teams, tools and part of the men's wages. They put up log houses and then dug the foundation for the mill, cutting some distance into the soft granite, and by mid-January 1848 the mill had been completed. On the morning of January 24, Marshall took his usual walk along the mill race after shutting off the water. In Marshall's own words:

> My eye was caught with the glimpse of something shining in the bottom of the ditch. There was about a foot of water running then. I reached my hand down and picked it up; it made my heart thump, for I was certain it was gold. The piece was about half the size, and of the shape of a pea. Then I saw another piece in the water. After taking it out I sat down and began to think right hard. I thought it was gold, and yet it did not seem to be of the right color. All the gold coin I had seen was of a reddish tinge; this looked more like brass. I recalled to mind all the metals I had ever seen or heard of, but I could find none that resembled this. Suddenly the idea flashed across my mind that it might be iron pyrites. This question could soon be determined. Putting one of the pieces on a hard river stone, I took another and commenced hammering it. It was soft and didn't break: it therefore must be gold, but largely mixed with some other metal, very likely silver; for pure gold, I thought, would certainly have a brighter color. While we were working in the race after this discovery we always kept a sharp lookout, and in the course of three or four days we had picked up about three ounces—our work [on the mill] still progressing as lively as ever, for none of us imagined at that time that the whole country was sowed with gold.

Figure 2. **The *Central America* encountered an unexpected hurricane 200 miles off the coast of North Carolina, and sunk on September 12, 1857, taking 425 people and $1.6 million in gold nuggets, crystals, dust, bars and freshly minted coins to the deep ocean floor 7200 feet below. Only 153 people were rescued. (Contemporary lithograph published by J. Childs of Philadelphia.)**

Figure 3. **Nuggets and gold dust were mined from alluvial workings, but crystalline gold in quartz came only from vein mines such as the one depicted above in a *Harper's New Monthly Magazine* article entitled "How We Get Gold in California" (April 1860; Mineralogical Record Library).**

Marshall eventually showed the gold to Sutter, and workers at the mill site soon spread the word. By May there were 2,000 men panning gold in the area. The *California* newspaper in San Francisco had to shut down publication because all of its employees had left for the gold fields. Hundreds of ounces of gold were regularly being brought into San Francisco, and new discoveries were being made constantly over a large area of land along the rivers. By June of 1848 San Francisco was the city of gold. The few who remained did little but talk about gold and trade in it. Business was expanding rapidly, and an unprecedented quantity of goods was arriving by ships from the East and elsewhere. Gold dust, flakes and nuggets were everywhere—and were traded actively—but the rules of the U.S. Treasury Department did not provide for customs duties to be paid in anything but government-issued coins, and there were not enough coins in circulation to support the transactions. The Collector of the Port had to establish a new policy of taking gold dust on deposit at $10 an ounce, which could be redeemed for coin within 60 days. Most of this gold collected for duties was not redeemed and had to be sold at auction for $6 to $10 an ounce, the price being so low because no one had coins with which to pay for it. Some merchants shipped their gold dust all the way to the U.S. Mint in Philadelphia, where it was valued at $18 to $20 an ounce and was rendered into coins (although this involved over two months of waiting and the expenses of shipping and insurance). Some of the Mormon miners took their gold back to Salt Lake City where it was privately coined beginning in December 1848. Gold Spanish-American doubloons were among the available coinage in San Francisco. By 1849 thousands of Easterners were arriving regularly in San Francisco and heading for the gold fields, and raw gold was accumulating in alarming quantities.

CALIFORNIA ASSAYERS AND COINERS

Assayers performed a vital function during the gold rush, not just testing gold for purity but also melting it down from the dust, nuggets and crystals they were given and casting it into clearly marked, conveniently transportable shapes that could be used like money—primarily in the gambling parlors. The ingots, once cast, would have a small corner or two removed which was carefully weighed, refined to pure gold, and then weighed again. This established the purity of that particular bar, measured in fineness (parts of gold per thousand). The purity was stamped on the bar, along with its precise weight, and these two numbers multiplied together were then multiplied by the price of pure gold to establish a dollar value, which was then also stamped on the bar. Oddly enough, the arithmetic was not always correct. Then the assayer stamped his own company name on the bar as his personal guarantee of accuracy. Assayers who produced unreliable analyses found that their ingots traded at a discount or were refused outright as payments and bank deposits. A good assay office promised to turn dust and nuggets into bars within 24 hours, and some, such as Blake & Company, claimed to produce bars within six hours (as opposed to the nearly 14 days required by the U.S. Mint's assaying office).

Among the contenders for the first California coiner is the partnership of Norris, Gregg & Norris, New York City plumbing contractors who left their business and sailed for California, presumably bringing ready-made dies and coin presses with them. In May they began striking $5 coins at Benicia City, a port on San Francisco Bay. Several hundred survive today, most showing slight wear from use in the gambling halls. Another early coiner was Joseph Haskins Bowie of Washington, D.C., who is believed to

Figures 4 and 5 (above). **Tons of gold flowed from the California gold fields into Sacramento and San Francisco in the 1850's, but for many years there was no mint there. Local assayers melted down the gold dust, nuggets and crystals brought in by the miners and cast the gold into carefully analyzed, weighed and stamped bars which could be used in transactions. The above bar (recovered from the *Central America* wreck) and period advertisement are from one such assaying company, that of Harvey Harris and Desire Marchand in San Francisco. Photo by Milt Butterworth.**

Figures 6 and 7. **Gold ingot and contemporary advertisement from the assaying firm of Henry Hentsch in San Francisco. Gold bars such as this one, bearing his stamp, were recovered from the wreck of the *Central America*. Sotheby's photo (sale catalog 7578).**

have produced at least a few 1849-dated $5 gold coins marked "CAL. GOLD" and "J. H. BOWIE."

Of the various private mints established in the gold rush country, none surpassed the scope of Moffat & Company, who produced coins and bars from 1849 through 1853. John Little Moffat had operated a gold mine in North Carolina, so the lure of the precious metal was in his blood. He and his partners arrived in San Francisco in 1849 and were a success from the start; their $16 ingot was the most popular, but surviving ingots with their stamp range from $9.43 to $264. They soon began producing a $10 eagle and a $5 half-eagle coin as well. The charge for converting an ounce of gold dust or nuggets into a coin or bar that could pass as legal tender (except for the payment of customs duties) was typically 50 cents to one dollar.

Another coiner of 1849 was the "Pacific Company," almost

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—AND—

COINERS,

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J. G. KELLOGG.

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DUNCAN, SHERMAN & Co.,
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BEEBEE & CO.
VAN VLECK, READ & DREXEL.
B. BEREND.
AUG. BELMONT, (*pr. Pro.*)
Ch. Christmas, E. A. Mathiesen.
SCHUCHARD & GEBHARD.

NEW YORK, August, 1855.

Figures 8 and 9. **The assayers John Kellogg and Augustus Humbert teamed up for a time in San Francisco, producing countless large and small gold bars bearing their stamp, including the ones shown above from the *Central America* wreck. At left is one of their advertisements. Milt Butterworth photo.**

certainly the assaying company formed by David C. Broderick and Frederick D. Kohler. They produced $1, $5 and $10 coins and $50 ingot "slugs." Yet another was the firm of Wright & Company, bankers and exchange brokers, who opened the Miner's Bank in San Francisco in 1849. They produced not only gold coins but for a short time issued their own paper currency as well. And a Pennsylvanian named Dr. J. S. Ormsby settled in Sacramento in 1849 and opened an assaying, refining and coining business that minted $5 and $10 coins. Numerous other individuals and companies made plans to open mints as well, some producing only a few test coins or "patterns."

The gold coins and bars of the 49ers occupy a special place in

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☞ We guarantee our Assays, and will pay all differences arising from the same with any of the U. S. Mints. Bars discounted at San Francisco rates.

Figure 10. **Ad for the assaying company of Gorham Blake in Sacramento. Many gold bars carrying his stamp were recovered from the *Central America* wreck.**

Figures 11 and 12. **Another prominent San Francisco assaying firm during the Gold Rush was the company of Emil Justh and Solomon Hunter, founded in 1855. Many bars stamped with their names, such as those shown above, were recovered from the *Central America* wreck. At right is one of their advertisements. Milt Butterworth photo.**

the annals of the gold rush. These are the incunabula of Western numismatics, the coins of the beginning, made from hard-won gold nuggets, dust and, yes, crystals pried from the white quartz veins of the Mother Lode. Each has its own story, in most cases a still mysterious one. The early gold coins and smaller bars were spent primarily in the gambling halls, bordellos, and stores—where they served well in the absence of federal coins in quantity. The heavier ingots weighing several ounces or more were mostly used in large transactions or for shipping to distant places.

In 1850 nearly 400 citizens sent a petition to the California State Legislature, asking for the creation of the office of state assayer, such facility to refine gold dust and nuggets and issue ingots with appropriate stamps indicating fineness, weight and value. A few days later another petition was sent to the governor, asking that Frederick D. Kohler (a highly regarded private assayer) be appointed state assayer. Their petitions were granted and a state assay office was opened in San Francisco; it was an immediate success, receiving nearly 5,000 ounces on the first day, and increasing amounts daily thereafter. Although this was a boon to miners it was a thorn in the side of local bankers, who were active in the gold dust trade, and who wanted to keep the value of raw gold lower and thus their profit margin higher. By refusing to accept the state assayer's bars they forced the state assay office to close.

In 1850 California gold coins in $5 and $10 denominations were being produced by Theodore Dubosq, a jeweler from Philadelphia, and by Baldwin & Company, the successor to Kohler. And in 1851 the United States Assay Office of Gold in San Francisco, under

E. JUSTH, S. HILLEN HUNTER.

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ASSAYERS.

No. 188 Montgomery Street, 2d door South of Jackson Street,

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of every description, are now fully prepared to execute all business entrusted to them, at the shortest notice, and on the most favorable terms.

MR. E. JUSTH, the Senior Partner, late Assistant Assayer in the United States Mint of this City, possesses great practical knowledge and experience in the business, and we feel confident in promising all who may employ us, the most satisfactory results.

We further guarantee the correctness of our assays, and bind ourselves to pay all differences arising from the same with any of the United States Mints. All Bars assayed at our office are taken by all the Bankers of this City, and can be cashed at any time at the current rate of discount. Returns made in from 12 to 24 hours, in Coin or Bars.

We refer to the annexed Certificate.

JUSTH & HUNTER,
No. 188 Montgomery steet, 2d door south of Jackson st.,
SAN FRANCISCO.

We hereby ceretify that MR. E. JUSTH was Assistant Assayer in the United States Branch Mint, from April, 1854, to this date, during which time he performed his duties most faithfully and intelligently, and we take pleasure in recommending him to the public, as a competent and faithful Assayer.

A. HARASZTHY,
U. S. Assayer.
LOUIS AIKEN BIRDSALL,
Supt. U. S. Branch Mint.

SAN FRANCISCO, May 10th, 1855.

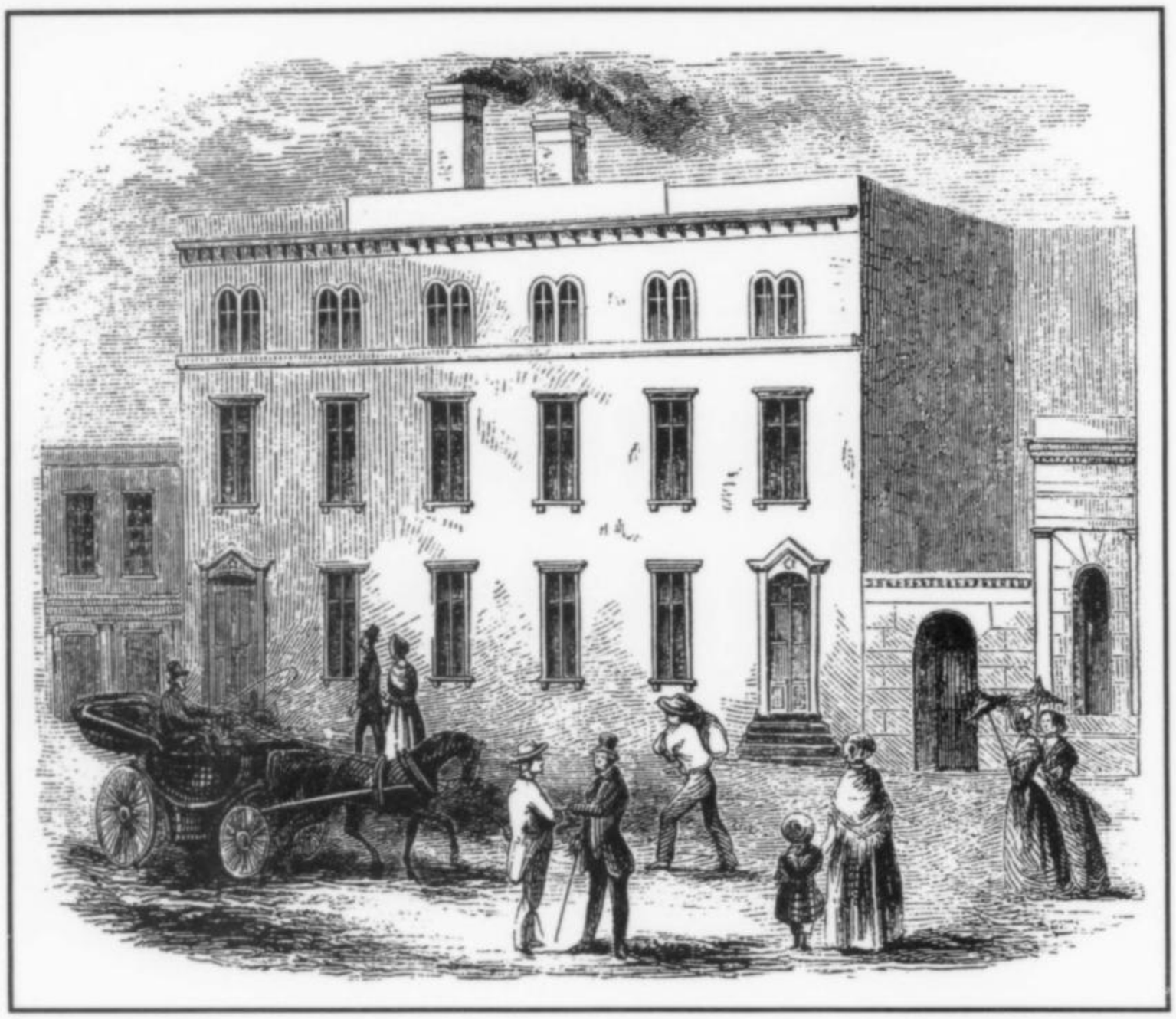


Figure 13. **The San Francisco Mint opened for business in the spring of 1854, turning miners' gold into assayed bars and official United States coinage. Thousands of mint-fresh coins were recovered from the *Central America* wreck.**

Augustus Humbert, began issuing octagonal $50 slugs from gold assayed by Moffat & Company. The recently formed Wass, Molitor Company also began producing ingots, and Schultz & Company produced their own coins. In 1852 Moffat & Company issued $10 coins, Augustus Humbert issued $10, $20 and $50 coins, and Wass, Molitor & Company issued $5 and $10 denominations.

In 1853 the Crystal Palace was built in New York City for the Exhibition of the Industry of All Nations. It was patterned after the wildly successful 1851 Crystal Palace Exhibition in London, which had attracted international attention and garnered much new business for exhibitors. The new Crystal Palace enclosed 206,000 square feet in what looked like a giant greenhouse. Exhibitors from the United States and about two dozen countries set up about 4,800 cases and displays. Some of these were devoted to minerals, including many gold specimens from California displayed by private individuals and companies such as Julius May of San Francisco, Adams & Company of New York, Mrs. Butler of Brooklyn, John Perry of San Francisco, L. M. Arnold of Poughkeepsie, Stearns & Jackson of New York City and F. Bekhart, also of New York. The Adams & Company exhibit must have been particularly spectacular, including crystallized gold, nuggets from California and Australia, specimens of gold from 200 different diggings, plus gold ingots from the major assayers and "California coins" from the private mints.

A federal mint for California had been proposed as early as 1848. On July 3, 1852, after many false starts and dashed hopes, Congress finally approved the idea of establishing a branch mint in San Francisco. A tiny facility just 40 x 60 feet was set up in the renovated Moffat & Company building. Meanwhile yet another private coinage company opened its doors, Kellogg & Company, owned by John Glover Kellogg; Kellogg was also then a partner with Augustus Humbert in the assaying firm of Kellogg & Humbert. Finally the San Francisco Mint also opened for business in the spring of 1854. It was said to be capable of coining $100 million dollars per year. The first gold coins produced included $1, $2.50,

Figure 14. **Foundrymen at an assay office in San Francisco are shown here pouring molten gold into ingot molds, after which the bars were cleaned, weighed, assayed and stamped before being returned to the miner or bank who brought in the gold.**

$5, $10 and $20 denominations. Nearly all depositors preferred the larger values, because there was no paper money in circulation to support large transactions, so the mintages of eagles and double eagles predominated. Private assay offices continued to produce ingots during 1854, including the companies of Curtis & Perry,

Figure 15. **Thousands of beautifully preserved gold coins, mostly from the San Francisco Mint but a few also from private coiners, were recovered from the *Central America* wreck. These amazing numismatic treasures look as fresh and lustrous as the day they were struck. Milt Butterworth photo.**

Augustus Humbert, Kellogg & Company, Kellogg & Hewston, Kellogg & Richter, Kellogg & Ringel, James J. Ott, Wass, Molitor & Company, and Dr. A. S. Wright's Miners' Exchange and Savings Bank and Assay Office. Some of these were very small operations.

In the following year, Wass, Molitor produced a round $50 coin, the only round-format slug to circulate in gold rush commerce; a fine example was recovered from the wreck of the *S. S. Central America*. Assayers in 1855 included Blake & Company of Sacramento, Blake & Agrell, E. Ford of San Francisco, Harris & Marchand Company of Sacramento & Marysville, Justh & Hunter of San Francisco, Kellogg & Company, Kellogg & Hewston, Kellogg & Humbert, Kellogg & Ringel, James J. Ott's assay office in Nevada City, California, F. Schotte in Nevada City, Dr. A. S. Wright's Miners' Exchange, and the Wass, Molitor Company in San Francisco (not all necessarily operating simultaneously, but simply shifting partnerships with time). Blake & Agrell and its successor, Blake & Company, were founded by Gorham Blake, at first with his partner Johan Agrell. They processed several hundred thousand ounces of gold, the finest of which came from the Michigan Bluff district (which has been productive of fine crystal specimens in recent decades). The firm was one of the principal assayers in that area, and shipped many bars of gold to San Francisco where they were transshipped to the East. A large number of Blake & Company bars were loaded aboard the *S. S. Sonora* for transport to Panama and transfer to the *Central America*. The Henry Hentsch Company also produced many of the ingots recovered from the *Central America*.

In 1856 the California Metallurgical Works was established in San Francisco, Henry Hentsch opened his office there in February, and the firm of Wass, Uznay & Company (operators of the California Metallurgical Works at a different location) also opened for business. It was at this time, up until August of 1857, that most of the many gold bars and coins recovered from the *Central America* were made.

THE TREASURE

As near as can be determined, the following is a comprehensive inventory of the gold recovered from the *S. S. Central America*:

$20 ("double eagle") gold U.S. coins:	7,490
$10 ("gold eagle") gold U.S. coins:	115
$5 ("half eagle") gold U.S. coins:	88
$3 gold U.S. coins:	3
$2.50 ("quarter eagle") gold U.S. coins:	30
$1 gold U.S. coins:	1
$50 privately minted gold coins ("slugs"):	16
$20 privately minted gold coins:	9
$10 privately minted gold coins:	320
$5 privately minted gold coins:	1
Gold ingots, assayer-stamped, various weights:	485
Natural gold dust, nuggets and crystals:	251 ounces

[Sotheby's catalog 7415]

The gold coins recovered from the *Central America* are dominated by the most popular of all gold denominations, the $20 gold piece or "double eagle." About two-thirds of the double eagles are of the 1857-S variety, produced by the San Francisco Mint, no doubt representing transfers of funds by various banks, express companies and merchants. Most of the gold coins in other denominations were probably part of the passengers' personal property and private parcels placed with the ship's purser. Smaller denominations are probably somewhat underrepresented because they were more difficult to find amid the sediment of the sea floor. The most extraordinary aspect of most of these coins is their incredibly fine condition, looking virtually fresh from the mint, as indeed they were when they were plunged into the cold and quiet environment of the deep sea bottom in 1857.

Among the privately minted gold coins recovered there is, oddly enough, a predominance of $10 gold pieces. The $20 denomina-

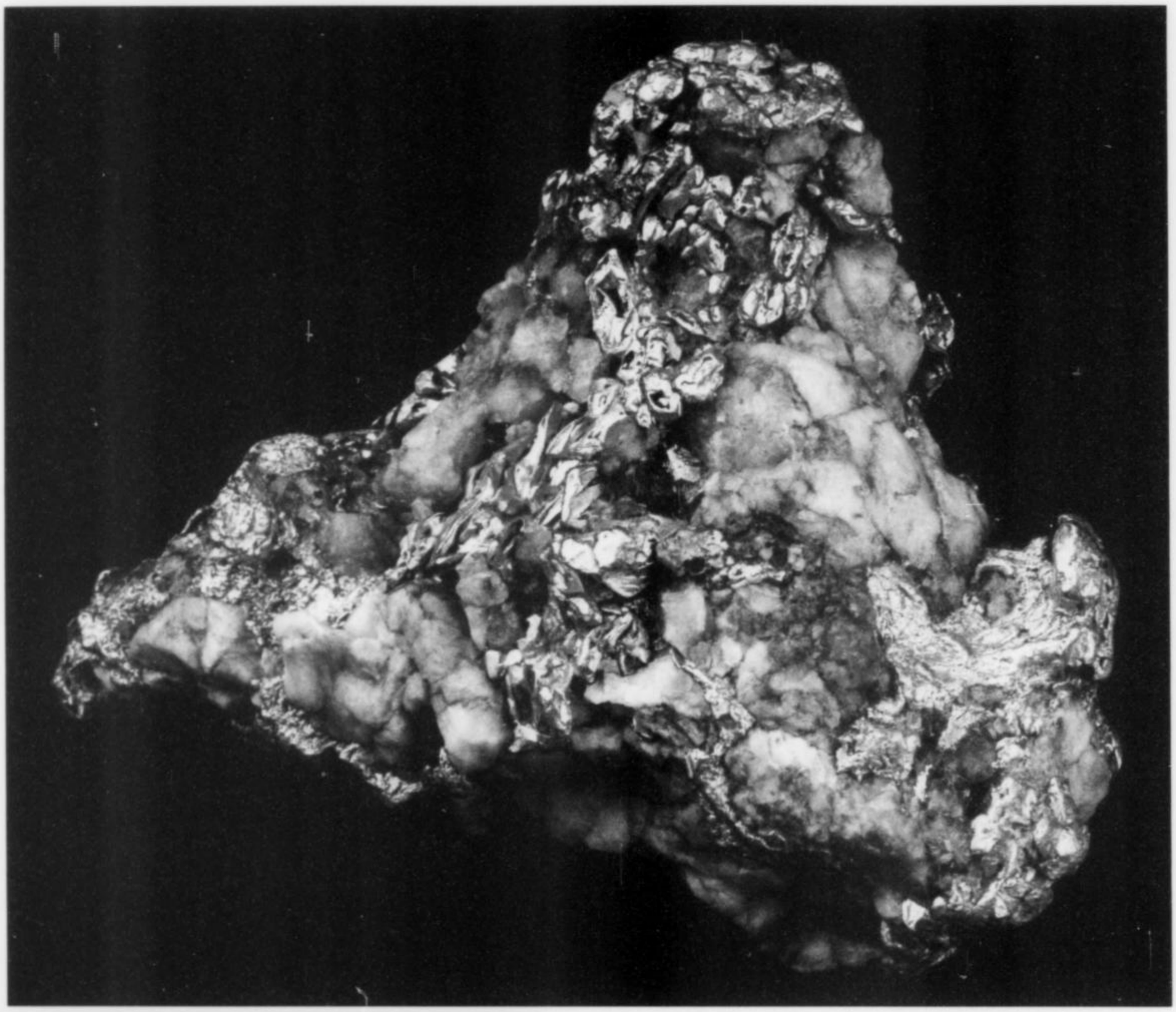


Figure 16. **The most remarkable specimen recovered from the *Central America* wreck, from a mineralogical point of view, is this 9.4-cm example of weight vein quartz riddled with over 13 ounces of gold crystals prominently exposed on both sides. Milt Butterworth photo.**

Figure 17. **This 4.8-cm nugget, recovered from the *Central America* wreck, weighs 2.89 ounces. Milt Butterworth photo.**

tion, produced in San Francisco by the U.S. Assay Office, was in far greater circulation at the time but none at all were found with the wreck. Perhaps a cache of $10 coins was being shipped east to be melted down, or as part of an effort to recall them from circulation. The octagonal $50 coins of Augustus Humbert and the U.S. Assay Office were still in active circulation in California in 1857, but were not nearly as plentiful as they had been a few years earlier. Historical records suggest that such pieces were often included in deposits sent to the Philadelphia Mint for re-coining, perhaps the intention of the shippers in this case. However, some were no doubt also part of the "passenger gold" on board, as such pieces were staples in California coinage of the time.

Perhaps the most historically significant and unique aspect of the treasure is the large number of assayer-stamped gold bars. Al-

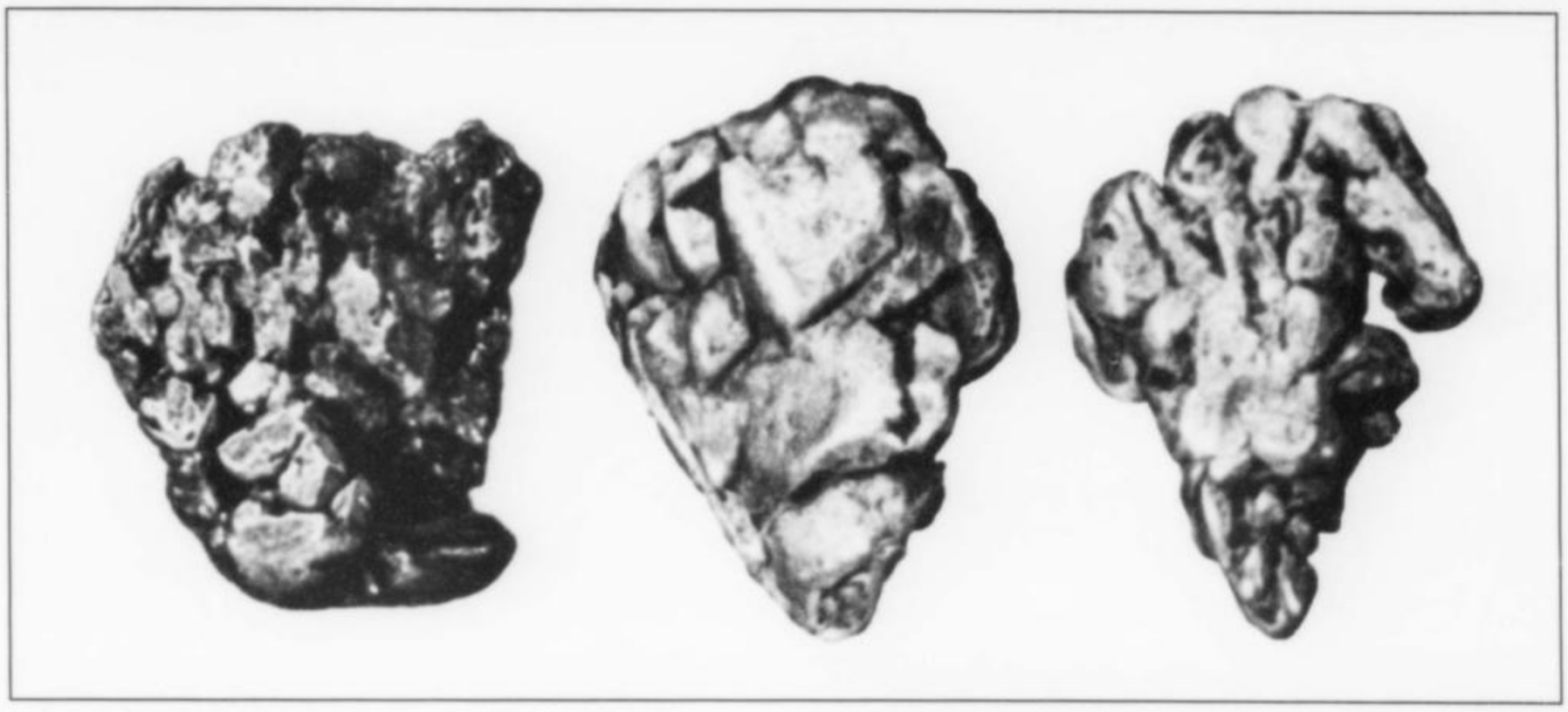


Figure 18. **Thumbnail-size gold specimens (from left: 2.25, 2.9 and 2.7 cm) showing crystal forms. Sotheby's photos (sale catalog 7415).**

though the assayers' names had been known before this find, based on their old advertisements and other historical documents, in many cases not a single ingot stamped with their names had been known to survive. Gold bars were normally a rather short-lived transitional form between the raw gold dust and nuggets melted down by the assayer, and the finished gold coins produced by the mints. Consequently relatively few assayer bars have survived to the present day, and the remaining examples are nearly all of small size, a few ounces or less in weight. The dollar values stamped on the bars recovered from the *S. S. Central America* are based on a mint value for pure gold at $20.67 per ounce. An overview of the research potential of the ingots has been published by Gilkes (2000):

> The 485 assay bars in the California Gold Marketing Group's holdings range in size from 4.95 ounces to 933.94 ounces, with 19 bars by Blake & Company of Sacramento; 27 from the Swiss banker and San Francisco assayer Henry Hentsch; 32 produced by Harris Marchand & Company of Sacramento and Marysvale; 77 produced by Justh & Hunter in San Francisco and Marysville; and 330 ingots from the dominant assaying firm of the day, Kellogg & Humbert of San Francisco, including the largest bar, dubbed the "Eureka."

Regardless of the size or shape of the bars, each is stamped with the same five pieces of information (albeit not always in the same location): the maker/assayer, the serial number, the weight in fine troy ounces, the purity in parts per thousand, and the dollar value. The bars range in fineness from .580 to .973 (1.000 being pure gold). The deeper the golden color of the bar, the higher the purity; the lower the fineness, the paler yellow the color. Because the fineness of the gold varied from mining camp to mining camp, it is possible to link the bars to their most likely source.

Even on a county-wide basis there were significant differences in the range of fineness of the gold being recovered. Bancroft's *History of California* cites the following parameters by county:

Butte	.900 – .990 [highest in the State]
Calaveras	.850 – .960
Del Norte	.875 – .950
Fresno	.760
Humboldt	.726 – .940
Kern	.600 – .660 [lowest in the State]
Mariposa	.800+
Mokelumne	.900–
Placer	.784 – .960
Plumas	.846 – .936
Shasta	.885
Siskiyou	.749 – .950
Stanislaus	.920
Trinity	.875 – .927
Tuolumne	.900 – .950
Yuba	.900 – .950

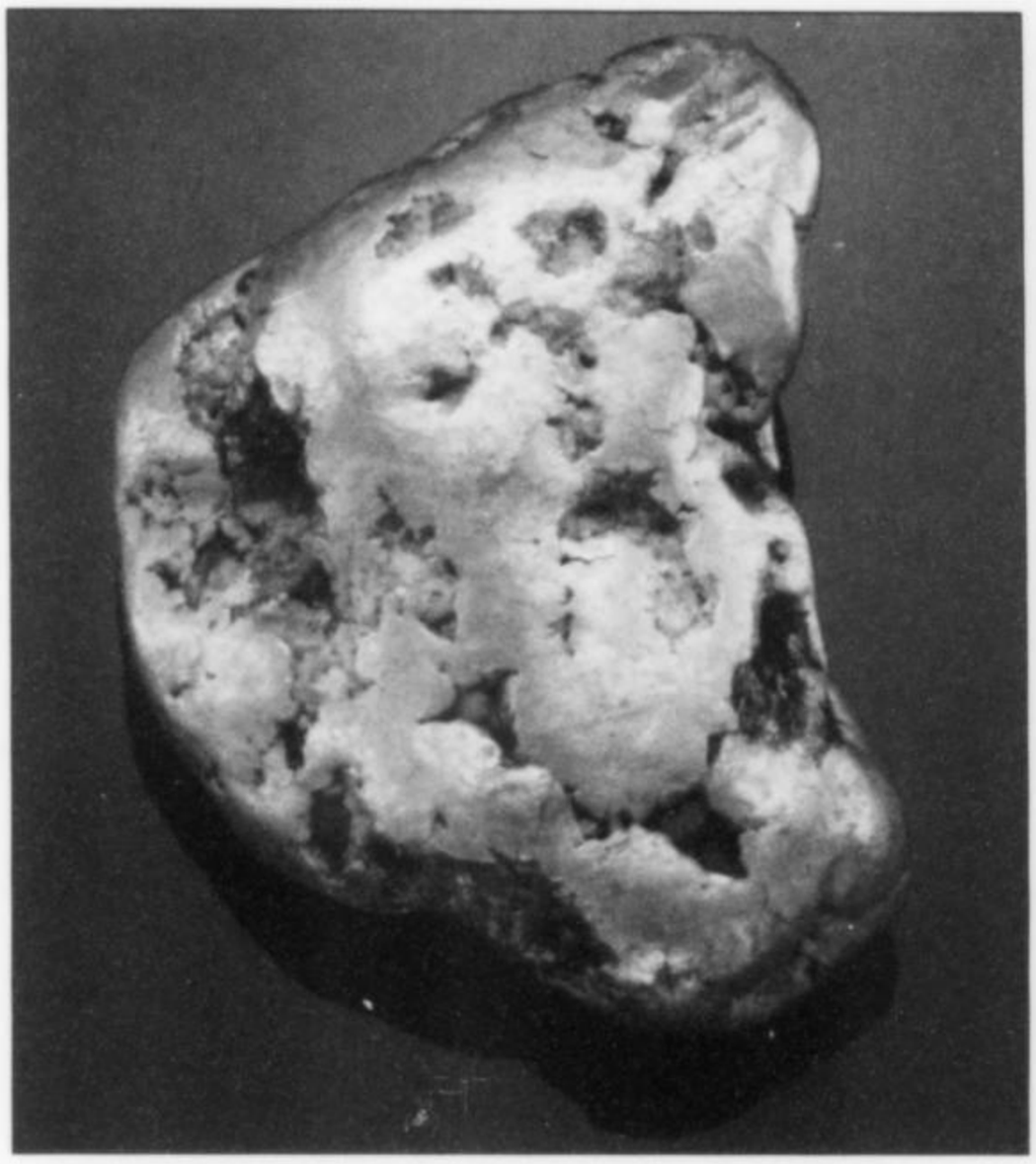


Figure 19. **Among the largest nuggets recovered from the *Central America* is this 8.9-cm example, weighing 20.3 ounces and showing a small amount of included white vein quartz. Sotheby's photo (sale catalog 7415).**

THE MINERAL SPECIMENS

Because of the enormous numismatic value of the coins and the unprecedented value of the gold bars to collectors of Western memorabilia, very little attention has been paid thus far to the comparatively few examples of specimen gold recovered from the wreck. A fair amount of the specimen gold is in the form of gold nuggets and gold dust, probably as part of the personal cache of various passengers, most likely the miners on board. It seems highly unlikely that non-miners would purposely acquire raw, unassayed, unprocessed gold to carry with them on the long trip home when they could more conveniently carry coins and bars that could be easily spent if necessary. And, since the opening of the San Francisco Mint, there was no longer any financial advantage to shipping raw gold to the Philadelphia Mint. Only someone who had personally mined it would be likely to carry it with him on such a trip.

This is particularly true of the small number of specimens of crystalline gold in white quartz. These amounted to first-class mining souvenirs, rather than specimens for the mineral collector. Chances are that they were acquired at the mine, in the course of mining by the owners, and were kept as treasured mementos of their gold rush success. And the person would certainly have had to be successful simply to be able to afford to keep such an intrinsically valuable specimen rather than selling it for bullion. Therefore the best guess (and it is only that) is that the best specimen golds were probably owned by a miner traveling in first cabin accommodations, perhaps John Fell or James Foster (see below). This is the conclusion arrived at by Wendell Wilson (personal communication), and it seems reasonable to me as well.

The premier crystal specimen recovered from the wreck is a 9.4-cm chunk of white, vuggy vein quartz with minor iron staining, thoroughly shot through with attractive, coarsely crystalline pocket gold showing good crystal forms. It weighs 17.41 ounces, including the quartz. The locality is, as yet, undetermined (as is currently the case with all of the gold specimens) but it might very well be possible to deduce the probable locality on the basis of a few chemical tests. If this can be done, a comparison with the gold districts known to have been worked by the various miner passengers might then suggest a connection. The specimen sold at the original Sotheby's auction for $122,000, then was later reconsigned and sold for $66,000.

Another fine example is a large (7.9-cm) waterworn nugget containing white quartz. Although not a good crystal specimen it is attractive for what it is: a superb historical specimen weighing in at 20.31 ounces (almost all of which is gold).

A substantial number of smaller nuggets were recovered in the 1 to 3-cm range. Many of these show crystal forms, and are barely waterworn, constituting attractive thumbnails. There were also substantial quantities of particulate gold ranging from fine dust to nuggets 5–10 mm in size.

Several gold amalgam balls were also discovered, which are the artifacts of the crude process used in the field for extracting and concentrating fine gold dust through the admixture of liquid mercury.

A number of interesting specimens were found that amount to cemented masses of gold dust, perhaps bonded together by the deposition of organic calcium carbonate during the many years on the sea floor. Some of these concretions reach 7 or 8 cm across, and some contain relict fragments of the wooden boxes in which they had been packed. One 10.5-cm specimen contains a fairly large piece of wooden board. Another 8.9-cm mass consists of gold dust cemented together with ocean sediment. The largest example measures 18.4 cm and contains a mixture of various types of placer gold including flour gold, gold dust, gold nuggets (the largest exceeding 2 ounces), grains, flakes and even a gold amalgam ball, all cemented together with some sea sediment and a deteriorated panel of wood on the bottom side; it weighs 79.43 ounces, most of which is probably gold (it sold at auction for $27,500). Sotheby's auction catalog 7415 depicts the 8% of the total find which was successfully claimed by the insurers. It lists primarily coins and ingots; but it also depicts 43 lots of gold dust, grains and nuggets containing over 200 ounces, plus the 17.41-ounce crystal gold and the big 20.31-ounce nugget.

PASSENGERS

A fairly complete list of the passengers and crew has been compiled, and it is an interesting exercise to speculate upon who might have been the owner of the superb crystallized gold specimens. There were people of all occupations, including the postmaster of a gold rush town called Hell-Out-For-Noon, a star stage performer in the San Francisco Minstrels, the owner of the Croton Hotel in New York, a former associate editor of the *San Francisco Chronicle*, physicians, merchants, attorneys, judges, gamblers, diplomats, booksellers, bakers and machinists, along with their wives and children. Although it could have been anyone, the odds are that it was a miner who had perhaps saved the gold specimens from his own workings, as beautiful souvenirs of his success in the Mother Lode country. Examining the list of passengers offers the following possibilities:

John Fell

John Fell, originally from Iowa, had mined gold at McAdam's Bar in Siskiyou County, California and was traveling with his family. He is said to have saved $6,000 from his mining activities, perhaps including the crystalline gold specimens. He perished in the sinking but his wife and two children were saved.

James A. Forster

James A. Forster, age 35, was originally from Harrisburg, Pennsylvania. He had been mining for gold at Murphy's Bar in Calaveras County, and was carrying about $9,000 in gold (including the specimens?) with which he planned to purchase stock in the East. He was rescued by the bark *Ellen*.

The above two are the leading candidates, not only because of being miners but because they were traveling in first cabin accommodations, the most expensive ($300), and were financially the most successful. However, there was also the following man traveling in second cabin, and another 13 miners traveling in steerage ($150) who must be considered among the possibilities. At $150 for a ticket, even the steerage passengers had to be fairly well funded.

John O. Stevens

John Stevens, age 32, was originally from New Jersey. He had worked in California for eight years as a miner, trader, vintner and orchardist. He had traveled with the artist and naturalist John Woodhouse Audubon (son of the famous ornithologist and artist John James Audubon), and was bringing 200 of his sketches to New York. He and the drawings were lost in the sinking.

Daniel Beaver

Daniel Beaver, age 56, was originally from Hamilton, Ohio. He had been among the original 49ers, engaged in gold mining in California since 1849. At one time he had been active at Mameluke Hill in El Dorado County. By 1857 he had made enough money to go home to his wife and 12 children in Ohio. He perished in the sinking.

Figure 20. **When the wreck site of the *Central America* was discovered, the camera of a robotic explorer returned this view of the ocean floor covered with exposed gold coins and rotting wooden chests of gold dust and nuggets! Searchers dubbed it the "Garden of Gold." Photo courtesy of the Columbus-America Discovery Group.**

Joseph Capello and friends

Joseph Capello, Gaitano Festu, Thomas Ravenna and Domecio Casta, all from a town about 25 miles from Genoa, Italy, had engaged in mining together and were on their way back to Italy.

William Chase

William Chase, originally from Washtenaw County, Michigan, had been a gold miner in Nevada County, California since 1852. Chase survived the sinking and later reported that he could have picked up tens of thousands of dollars in gold which had been thrown away and lay strewn about the decks, but he did not think his chances of surviving to use it were sufficient to make it worth the trouble. Heavy gold was a distinct liability to anyone who hoped to stay afloat in the water!

Jacob Brown Clark

Maj. Jacob Clark, age 46, came originally from Missouri. At one time he had served as sheriff of Sutter County, and was later a gold miner in Colusa County. He was rescued by the bark *Ellen*, and lived to be 87.

Ede Williams

Ede Williams, age 30 or 31, had been born in Sussex, England and worked as a gold miner at Howland Flat in Sierra County, in 1850. He was traveling to Wisconsin to get married, having brought $1500 in gold with him which went down with the ship. He, however, was among the 49 men rescued by the bark *Ellen*.

Oliver Perry Manlove

Oliver Manlove, age 25 or 26, was from Grant County, Wisconsin. He had come to the gold rush rather late, in 1854, taking the overland route; this was his first trip by sea. For some time he had worked in sluicing and hydraulic mining at Gopher Hill in Plumas County. He was among those rescued by the bark *Ellen*.

Barney M. Lee

Barney Lee, age 27 or 28, had been a miner since 1852 and had worked with his uncle in Nevada City. He clung to a floating plank for several hours, suffering immensely from the cold, until being picked up by the bark *Ellen*.

Henry W. Rummell

Henry Rummell was a German, born in Hesse Darmstadt, who had mined gold at Irish Flat for three years. He was en route to Illinois to visit his brother.

Samuel B. Swan

Samuel Swan, age 35, was a Pennsylvanian who had worked as a miner in Rough and Ready, California. He was traveling with his wife and infant daughter, both of whom were saved, but he was lost.

Richard Wilton

Richard Wilton, age 31, was from Quincy, Illinois and had worked as a miner in El Dorado County since 1852.

THE RECOVERY PROJECT

The story of the recovery of the *S. S. Central America* treasure begins with Tommy Thompson. Thompson studied ocean engineering at Ohio State University where, in 1977, he began to research historic deep ocean wrecks, first investigating the methods and technologies used in finding ships lost in shallow water and then studying the record of ships lost in the deep ocean. He learned that in the deep ocean no currents exist to disturb shipwreck sites; the ships and their cargoes could be intact, though perhaps deteriorated or oxidized. Thompson continued his study of shipwrecks after graduation, while working as a research engineer in the ocean engineering section of Battelle Memorial Institute in

Figure 21. **At first glance thought to be bricks, piles of large gold ingots were found covering the ocean floor at the site of the *Central America* wreck. Gold dust and nuggets are also visible, at lower right. Photo courtesy of the Columbus-America Discovery Group.**

Columbus, Ohio. As he compiled a list of ocean shipwrecks that might be recoverable, one well-documented deep-water shipwreck stood out, though its exact location was unknown: the *S. S. Central America*. In 1981 he resolved to attempt to locate and recover its cargo of gold.

In 1983 Thompson was joined by a geologist, Bob Evans, and during the next three years they worked together at compiling computer analyses of historical records to map out probable sites for the wreck. In 1984 Thompson took a leave of absence from the Battelle Institute to develop the needed systems and technologies. Evans and Thompson compiled the known passenger and crew information from historical accounts, including 33 stories taken mainly from 1857 newspaper accounts, with reports by survivors and eye-witnesses to the sinking. The resulting "data correlation matrix" provided clues to the location of the ship. The matrix also included data on the weather, the progress of the hurricane, and the physical deterioration of the steamship.

They took this compilation of information to Lawrence D. Stone, a leading expert in search theory (a method using probability and statistical analysis to locate objects, particularly in the ocean). No one had ever applied search theory to a historical database. Stone was able to generate thousands of computerized models of possible sinking scenarios based on variables including the ship's last known position, the probable wind speed, the direction of the hurricane, and the ocean currents prevailing at that place and time. From these models and the data matrix Stone and his associates were able to construct a probability map covering 1,400 square miles of sea floor, a rectangular area less than 40 miles on a side.

Thompson shared the details of his project with his mentor and former professor at Ohio State University, Donald Glower, Dean of the College of Engineering. Glower put Thompson in touch with leaders of the Columbus business community who in time became the primary financial backers of the project. The Columbus-America Discovery Group was formed, growing to a total of 161 partners and providing $12.7 million to fund the search and recovery operation.

In 1986 the partnership hired a crew and chartered an old Louisiana mud boat, the *Pine River*, for a 40-day sonar search covering the target area. During this stage they used a new technology, Sea MARC side-scanning sonar, which they modified to sweep the search grid in 3-mile-wide strips. The Sea MARC was towed behind the ship while sending out strong pulses of sound waves that would reflect off of objects on the ocean floor. A computer aboard the ship processed the signals and painted an image of the sea bed. After one sweep the vessel would change course 180 degrees and scan another 3-mile-wide strip slightly overlapping the previous one. (The deep-ocean explorers called the process "mowing the lawn."). After locating several promising sites they left the area, planning to return during the next window of good weather and calm seas beginning in June.

During the winter of 1986–1987 the group worked in Columbus, analyzing the sonar images and developing the technology that they had envisioned: a submersible, remotely-piloted robot that could do complex work in the depths of the ocean. What was needed was a device that could excavate historic shipwrecks under the crushing deep-ocean pressure of 4,000 pounds per square inch. Thompson was a purist, wanting to recover delicate items of historical value without damaging them. After assembling a team of scientists and engineers, some from the Battelle Institute, they succeeded in building the world's first undersea robot capable of working in the deep ocean. Technically it was a computer-guided modular remotely operated vehicle, but since the acronym of that long name wasn't especially memorable they decided to name it *Nemo,* after the explorer hero of Jules Verne's *20,000 Leagues Under the Sea*. *Nemo* weighed 4 tons and measured about 8 x 15 feet, with an open-frame construction and spider-like arms carrying prosthetic modules, lights, cameras and manipulators. It could be lowered into the water by an on-board winch system on the deck of the recovery ship and remain on the ocean floor for up to 100 hours at a time. Using a joy-stick, the operators could maneuver the robot with dexterity and surgical precision, lifting delicate objects like small coins and also moving 1000-pound loads.

In 1987 Thompson returned to the search area with *Nemo* on a retrofitted work boat, the *Nicor Navigator*. Early in the season *Nemo*'s cameras discovered an array of mid-19th century objects resting on the ocean floor about 160 miles off the South Carolina coast, at a depth of 7,200 feet. China, pitchers, washbowls and children's toys were arrayed about a rotting wooden hull. Now they needed to physically retrieve some item from the wreck site to prove that they had been present on, and were legally in control of, the shipwreck. In order to avoid disturbing artifacts they brought up a piece of anthracite coal. Competitors were closing in, so time was critical. Heavy seas made it impossible for the Columbus-America seaplane to land, so they taped the lump of coal to a rope strung from the ship's mast, and the seaplane swooped over and snatched the line and package with a grappling hook. The specimen was flown to Norfolk, Virginia in under four hours and was presented in Federal District Court. It was the first time that a salvage claim had been made on a shipwreck touched only by robotic hands; but sending a human to that depth was technologically impossible. A few days later the historic decision was handed down, granting Columbus-America permanent recovery rights to the site. The ruling set a precedent in international maritime law because the injunction was granted on the basis of a new legal concept called *telepresence*, the real-time imaging and mechanical manipulating of objects on the site; the court deemed this as good as an actual human presence at the site.

This was just the beginning of Columbus-America's struggle to establish title to the wreck site and its treasure. The legal battle took more than a decade and was appealed all the way up to the U.S. Supreme Court before being decided more or less in Columbus-America's favor. And, as it happened, the original insurance companies and their successors (American and British) were still around 130 years later to assert their valid claims on a portion of the recovered cargo.

During the winter of 1987–1988 Thompson and his associates purchased a 30-year-old Canadian icebreaker built with armor plate left over from World War II. The sturdy vessel was known as the *Arctic Discoverer*, and was retrofitted with state-of-the-art navigational, GPS (global positioning system), communications and electronics systems. *Nemo* could be spooled out on 14,000 feet of cable while being controlled from the operations center, a tiny room under the main deck fitted with 18 computers and 12 monitors. One monitor even provided the controllers with stereoscopic images visible using special glasses. In August the ship with its crew of 25 steamed out of Wilmington Harbor in North Carolina and made its way to the recovery site. Bob Evans had been giving further study to the detailed sonar records and had identified one other interesting site that he planned to investigate; he reasoned that a closer look at this second site would be good experience and would provide an opportunity to further test *Nemo* as well as the new equipment installed in the *Arctic Discoverer*.

On September 11, 1988 they lowered the robot over the second site and began exploring while carefully watching the monitors. Suddenly an image came into view, a rusting sidewheel distinctive to ships like the *Central America*. This evidence was only circumstantial, and it was not until the ship's bell was found (clearly

marked "MORGAN IRON WORKS—NEW YORK—1853") that definitive proof was obtained. The *Central America*'s engine and iron works had been installed at the Morgan Iron Works in 1853.

By this time the October weather was closing in, and it was nearly time to leave the site until the following season. With just days to go, *Nemo* made a spectacular discovery. A series of automated photographs had revealed an unusual yellowish color at one location on the wreck site, and so the robot was directed there again for a closer look. The camera revealed an odd scene, with what appeared to be bricks strewn across the ocean floor. Lighting was adjusted and it became clear that the bricks were actually gold ingots!

The gold was stacked on the ocean floor like brownies and loaves of bread—spectacular gold bridges of gold ingots piled on top of timbers. Further along they found thousands of gold coins spread amid the wreckage, heaped in piles and neat stacks and spilling into what looked like a frozen waterfall. The camera saw one towering stack of 300 "double eagle" $20 gold pieces. The treasure looked otherworldly in its splendor, a "Garden of Gold," as they later called it. The sheer quantity of gold was amazing, and the condition of the coins and bars was astonishing. When the camera moved in for a close-up it was even possible to read the dates off the coins, looking as clear and bright as if they had just been minted.

Several methods were used to recover objects. A small sea-vac sucked up gold dust and other small, loose material. The robot also had padded fingers at the end of a flexible arm, and could pick up objects as small as a tiny gold dollar. Some of the coin stacks had become bonded together, so they were covered in silicone foam which hardened around them and allowed them to be raised as a block. One block retrieved a neat group of coins that had been packed in a now-rotted-away box: 15 stacks of 30 double eagles, three stacks wide and five long. More than 6,000 ounces of ingots were recovered. It was the largest treasure in American history.

Nemo also located and retrieved thousands of artifacts including personal effects as varied as miners' tools, pottery and cuff links. The debris field surrounding the wreck was the size of a football stadium, and intriguing items were found all about. In one instance a steamer trunk was found resting on the ocean floor as if it had just settled there. It was retrieved and proved to contain a man's shirts and a woman's petticoats, a man's socks and a woman's stockings, nightshirts and nightgowns, long johns and bloomers, dueling pistols, jewelry, a readable issue of the *New York News*, and, finally, a dress shirt embroidered with the name "A. Ives Easton," identifying the owners of the trunk as passengers Ansel and Addie Easton. Another trunk recovered proved to contain the property of John Dement. These and other historical artifacts have provided a fascinating complement to the many gold objects that were the primary focus of the search and recovery operation.

DISPOSITION OF THE TREASURE

The insurers of the *Central America* and its cargo were awarded approximately 8% of the total treasure, including *all* of the raw gold dust, nuggets and crystal specimens. These were sold at auction by Sotheby's in June 2000 [Catalog 7415], December 2000 [Catalog 7578] and (for much of the gold dust) via Sothebys' online auctions (www.sothebys.com). Dwight Manley's group obtained the other 92%, of which they have by now sold all of the coins and 95% of the bars they acquired, with about 25 bars remaining in their stock. In total the *Central America* treasure has brought in over $100 million.

An impressive selection of items was also donated by Dwight Manley's group to institutions including the California Historical Society, the New York Historical Society, the Byron Reed Western Heritage Museum in Omaha, the American Numismatic Association (Colorado Springs) and the American Numismatic Society (New York), among others. In addition, a traveling exhibit, "The Ship of Gold," was presented in several venues across the country, and Bob Evans and the author gave several theater-style presentations on the treasure.

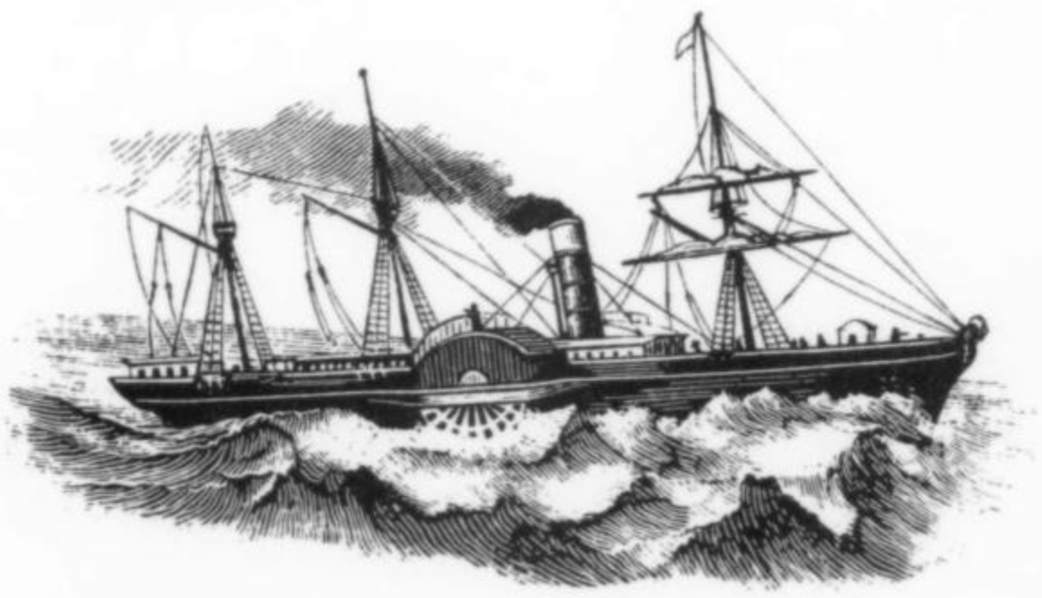
CONCLUSION

In total, the thousands of items recovered from the *S. S. Central America* constitute an enormous historical archive that will be studied and treasured by historians and collectors for decades to come. We can optimistically hope that the new technologies developed for the recovery operation will, in due time, yield further historical treasures and information from other formerly inaccessible wreck sites on the deep ocean floor. In fact, the recent discovery of a British treasure ship called the *Sussex*, which sank in deep water off the North African coast in 1694, taking 3 million pounds sterling in silver and 6 tons of gold with it, will probably provide the next opportunity. No mineral specimens will be found in that one, however; the *Central America* will forever remain unique as to the size and extent of its Gold Rush treasure, since no other American ship with similar contents was ever lost at sea during that seminal era in history.

The treasure of the *S. S. Central America* is a time capsule, providing a colorful window on the California gold rush. The extraordinarily well preserved coins, the rare and unique assayers' ingots, and the natural gold nuggets and crystal specimens each appeal to a different segment of the collector community, but I think most collectors of any specialty feel the fascination and lure that all of these items provide. All are evocative of an exciting and pivotal time in American history, a time when the frantically intense search by thousands of determined men for a single mineral species dominated world attention and fed the American dream.

ACKNOWLEDGMENTS

I am indebted to David E. Tripp (author of Sotheby's catalog 7415 offering certain of the recovered items from the *Central America* treasure), to Dwight Manley and other members of the California Gold Marketing Group, to treasure finders Bob Evans and Tommy Thompson, and to photographer Milt Butterworth for their kind cooperation.



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Diamonds *(continued from page 30)*

potential species, diamond is not really rare—how many tons of jeremejevite or sinhalite do you suppose have been found?—but its enduring appeal, not to speak of its many industrial uses, makes the securing of further supplies a pressing concern.

Since 1870, Africa has spoiled us: in that year, as mining was just beginning at Kimberley and on the Vaal River, only 300,000 carats of diamonds were produced worldwide, but in 1920, 3,000,000 carats were produced, the tenfold increase being entirely due to new production from African sources. Although the classic African kimberlite mines are now in decline (and some are closed), new African mines, Russian mines, and most recently the Argyle mine in Australia have so far kept worldwide production growing rapidly: 42,000,000 carats were produced in 1970, and more than 100,000,000 in 1990 (Levinson *et al.*, 1992). But now several Russian mines, the Williamson mine in Tanzania, and even the Argyle mine are well past their primes—if we keep up the present rate of consumption, where are diamonds to come from in future decades (aside from the vast stockpiles held by the Russian Diamond Fund)?

One plausible speculation is that more and more of them will come from the sea. Marine diamond mining off the Atlantic coasts of South Africa and Namibia was pioneered by two small companies in 1954. Then, in the early 1960's, a Texas oilman named Sam Collins founded a company called the Marine Diamond Corporation, now in the capable, high-tech hands of De Beers Marine (Pty) Ltd. This company currently dominates the available offshore lease areas, which extend up to 5 km out from the shore (Gurney *et al.*, 1991). There are several positive indications about this diamond source: for one thing, a conservative estimate of reserves in the African marine deposits is 1.5 billion carats—almost three-quarters of total world production since antiquity—and, for another thing, 90–95% of the diamonds are of gem quality, natural "sorting" having destroyed the inferior stones along the way between the original drainages of the kimberlites and final deposition on the continental shelf. To put it in terms of another statistic, these deposits contain at least 100 times as many gem diamonds (by weight) as are presently being used each year in jewelry (Levinson, *et al.*, 1992). However, diamonds recovered by relatively simple suction equipment, and by divers, in shallower waters are vastly outnumbered by deeper-water diamonds, and these are difficult and expensive to find and retrieve. Much technical progress is being made, but deep-marine diamond mining is still only marginally profitable. It may also be true that the South African/Namibian marine diamond deposits are an anomaly in the world, since they result from the uniquely favorable combination of a rich inland diamondiferous craton, deep weathering of the craton, and

stable drainage over a very long time to a nearby ocean. Prospectors have eyed the Arctic waters north of the Siberian and Canadian cratons, and some sites in the Gulf of Guinea, but climatic as well as geological factors would seem to preclude mining in these areas, even if they should prove to hold diamonds.

Although they acknowledge the importance of the southern African marine fields, and although they regard some inland alluvial diamond deposits, particularly in Angola, as promising, Levinson *et al.* (1992) predict that the most significant new diamond sources of the 21st century will be newly discovered kimberlite pipes in Siberia and northern Canada. Economically viable kimberlites, they point out, are amenable to large-scale mining and discouraging to illicit "pirates": two-thirds of world diamond production in 1990 came from just eight large kimberlite mines. The Russian and Canadian cratons are vast, and huge swarms of diatremes may well lurk under the glacial cover in under-explored or unexplored regions (the very rich diatreme now being exploited by the Ekati mine remained successfully camouflaged for a long time under the glacial meltwater of Lac de Gras).

Levinson *et al.* also point to the geological favorability of Antarctica, where a large craton lurks under the ice cover. Perhaps by the end of this century some technology will have evolved for getting at diatremes there. And Janse (1996) suggests that Africa may not only continue to be a major diamond producer, but may again become *the* major producing diamond province of the world, perhaps thanks to technological breakthroughs at the marine deposits, or perhaps also to new kimberlite discoveries in central and western Africa, where alluvial mining so far has been the only important kind.

As a mineral collector, one might wistfully regret that almost all of the people who customarily seek or mine or study or write about diamonds are interested in them solely for their industrial or gemstone uses, or as objects of scientific research. It would be interesting (though probably depressing) to know exactly how many euhedral, uncut crystals of diamond are preserved today, from throughout the course of the long history of human obsession which has been sketched here. The fine crystals in the private collection illustrated here provide a wonderful glimpse of a unique species in its original state.

ACKNOWLEDGMENTS

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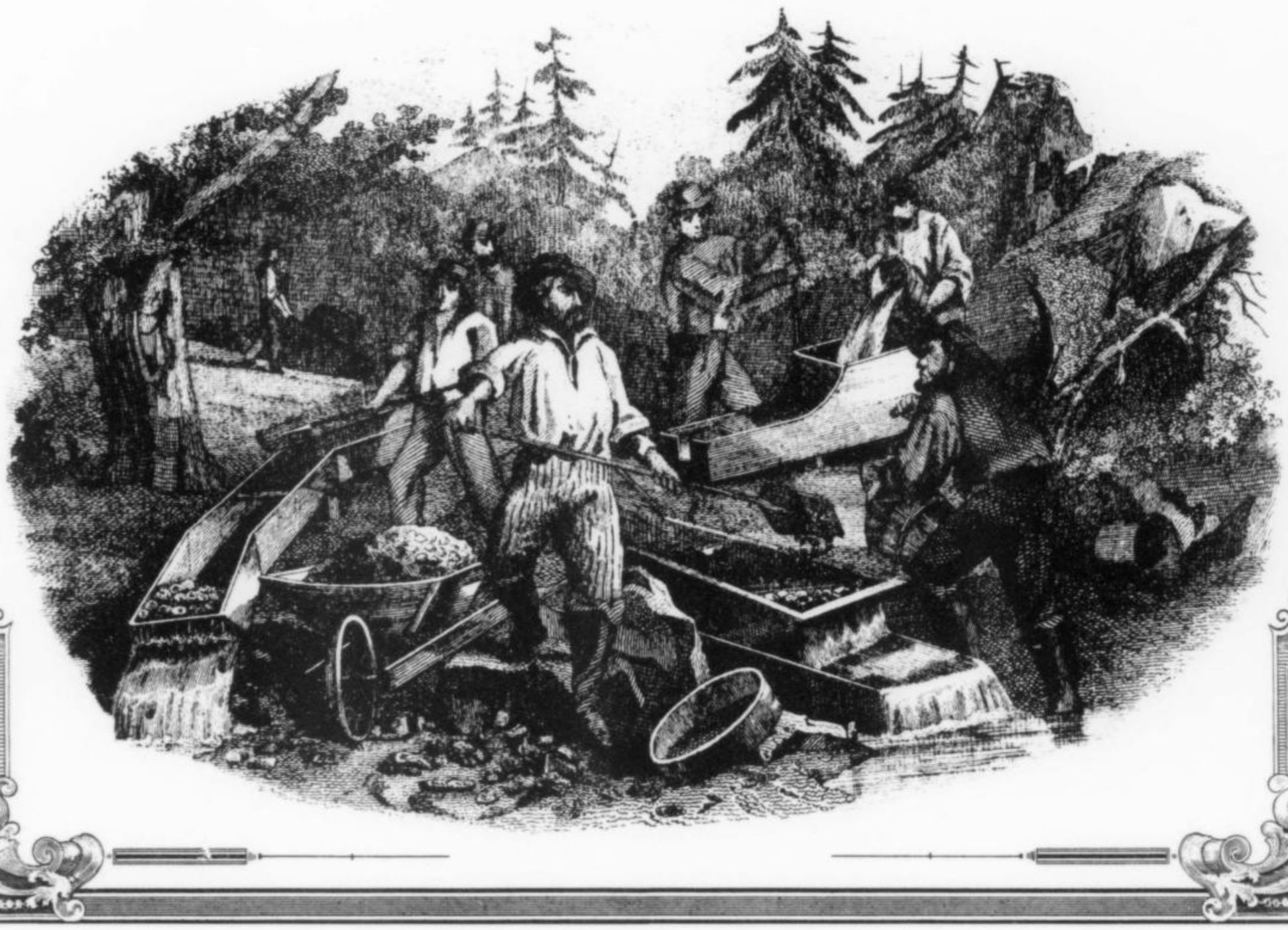
(continued on page 63)

ABSTRACTS
of the 25th Annual
TUCSON MINERALOGICAL SYMPOSIUM



GOLD!

INTRODUCTION

Robert B. Cook & Susan Eriksson, Chairpersons

The 25th Annual Mineralogical Symposium, sponsored by the Mineralogical Society of America, Friends of Mineralogy, and the Tucson Gem and Mineral Society, will be held on Saturday, February 14, 2004, at the Tucson Convention Center. Admission is free and everyone is welcome. The event marks the 50th anniversary of the Tucson Gem and Mineral Show, and in keeping with this most significant milestone, the theme of both the Show and the symposium is ***Gold.***

In the early years of the Tucson show, the price of gold was governmentally established at $35/troy ounce, and while gold no longer officially backed American currency, it was nevertheless used as an international medium of exchange and it was retained *en masse* to varying extents by governments of larger countries. Few gold mines operated in the United States during these years; most earlier mines had failed to reopen after their forced closure during World War II. The active mines were for the most part underground operations whose relatively high operating costs had to be balanced against the fixed price of gold, and profits consequently were low. There were universally strict policies against high-grading at the mines. For these reasons, good gold specimens were not readily available in those first Tucson years.

Interestingly, things began to change in the world of gold during

PROGRAM SCHEDULE

Saturday, February 14, 2004

NOTE: Each presentation is allotted 15 minutes plus a 5 minute question and answer period at the end, for a total of 20 minutes.

[10:00 am to 10:20]
The Crystal Forms of Gold
Carl A. Francis

[10:20 to 10:40]
The Systematic Study of Regolith Gold
Rob Bowell

[10:40 to 11:00]
The Harvard Mineralogical Museum's Gold Collection
Carl A. Francis & Robert B. Cook

[11:00 to 11:20]
Russian Gold: A Review
Michael Leybov

[11:20 to 11:40]
The World's Greatest Gold Deposit: The Witwatersrand Goldfield, South Africa
Bruce Cairncross

[11:40 to Noon]
An Island of Gold: An Overview of Specimen Gold from Papua New Guinea
Lawrence D. Queen

LUNCH BREAK

[1:00 pm to 1:20]
Recent Specimen Gold Activities in Australia
Mark I. Jacobson

[1:20 to 1:40]
Canadian Gold: A Review of Gold-Specimen Producing Localities Past and Present
Mark Mauthner

[1:40 to 2:00]
Gold in the Southeastern United States
Julian C. Gray & Travis A. Paris

[2:00 to 2:20]
Geology, Mining, and Gold Recovery History of the Olinghouse District, Washoe County, Nevada
Scott Kleine

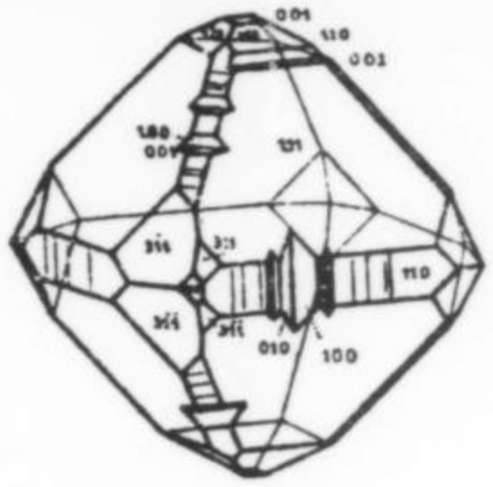
[2:20 to 2:40]
The Gold Tellurides of Colorado
Ed Raines

[2:40 to 3:00]
The Round Mountain Gold Mine, Nye County, Nevada
R. Scott Werschky

the 1970's. The price of gold was released to float on the world market, and it quickly rose, peaking briefly at over $800 an ounce some ten years later. This phenomenal increase inspired rapid exploration for large, bulk-mineable deposits that could be developed profitably by the then-new heap-leach technology, an inexpensive way of recovering extremely fine-grained gold from very low-grade ores. In addition, smaller new deposits of relatively high grade were found while searching for the larger, lower-grade "elephants," and even venerable old mines that had survived the war years were given new life as the value of their ores increased faster than the cost of operations. Many new potential specimen sources emerged as mines sprang up in traditional areas such as the mineralized belts of California, Nevada, northern Mexico, Western Australia and Ontario, as well as such unlikely places as South Carolina and Papua New Guinea. Although not all of these regions produced specimens, some did, and a few did so to a remarkable degree.

As the gold mining industry thrived in this new economic environment, other developments also increased the availability of gold specimens. The Russian government made bulk lots of Siberian gold nuggets available, and these lots quickly appeared at the Tucson and other shows during the late 1980's and early 1990's. At the same time, gold-specific metal detectors were developed and a new breed of electronic prospector began to revisit long abandoned, formerly productive areas of the American West, northern Mexico, and Australia. Suddenly new supplies of gold specimens and nuggets began to punctuate some dealers' stocks, and several new companies evolved which specialized in gold, most of it found by the proprietors. If this were not enough, several California mines, including the Eagle's Nest and the Colorado Quartz mines, were successfully operated exclusively for specimens. Operators of several commercial gold mines, such as those at Round Mountain, Nevada; Balmertown and Porcupine, Ontario; and Mt. Kare, Papua New Guinea realized the value of specimen gold and made selected material from their mines available to the collector market. Consequently, the past two decades have been characterized by relatively abundant gold specimens from a variety of traditional as well as new localities.

Clearly, the papers in this year's symposium reflect various aspects of the remarkable place of gold in science and commerce. They include descriptions of gold crystallography and chemistry, locality descriptions, and collection overviews given by professional geologists and engineers, academics, mineral dealers, and curators. The traditional international flavor of the yearly Tucson symposium will be reflected by speakers from South Africa and Europe as well as the United States, with papers representing African, Australian, North American and European gold occurrences. Each will be illustrated with specimen and locality photographs, most of which have not been used in previous publications and talks. There is much to be learned from the presentations at this year's symposium, and we encourage audience interaction during the question-and-answer sessions between papers and during breaks.



The Crystal Forms of Gold

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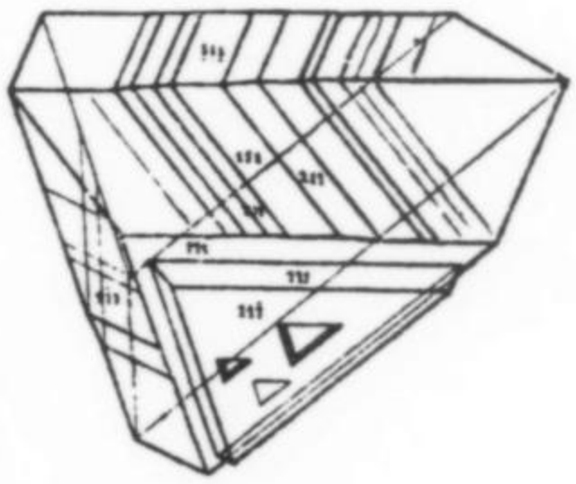
The morphology of gold was investigated by studying the suite of ~1,200 specimens of gold in the Harvard mineral collection and by reviewing the literature, especially Goldschmidt's *Atlas der Krystallformen*. Leaves, wires, and branching arborescent forms commonly comprise the most magnificent specimens of crystallized gold. Individual crystals that resemble the ideal drawings in textbooks are surprisingly rare and small. Crystals exceeding one centimeter should be considered notable. Only 2–3% of the Harvard specimens display "good" crystal forms. Sixteen different crystal forms are reported in the literature, but only five are common. The octahedron {111} is by far the most common crystal form observed, particularly if skeletal and distorted forms (leaves and wires) are included. The cube {001} is more common than the dodecahedron {011}. Of the four tetrahexahedra reported, only *e*{012} is common. Of the five trapezohedra reported only *m*{113} is common. No trisoctahedra {*hll*} have been reported. Four hexoctahedra have been reported as modifying forms on complex crystals. The hexoctahedra *t*{124} and *x*{1.10.18} occur on specimens from California localities such as the Colorado Quartz mine near Mariposa.



The Systematic Study of Regolith Gold

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Gold grains from regolith and supergene zones have been a popular form of gold for many collectors because of their excellent crystalline nature and unusual morphologies. Additionally, the understanding of the morphology and chemistry of such regolith gold provides useful information both for academic studies and for exploration, mining and optimization of ore processing. This paper presents the main morphological features of primary and secondary gold as reflections of different weathering conditions.

In weathering profiles, gold can be particularly mobile at two dissolution fronts:

(i) the ferruginous zone at the top of a deposit, and

(ii) the oxidation front, typically associated with oxidizing sulfides.

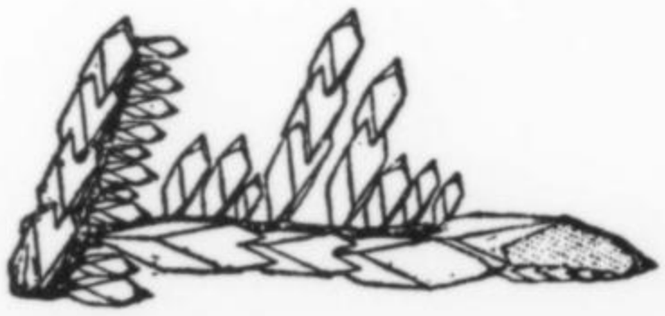
Independently of these two dissolution fronts, gold also can be intensively remobilized in highly saline environments.

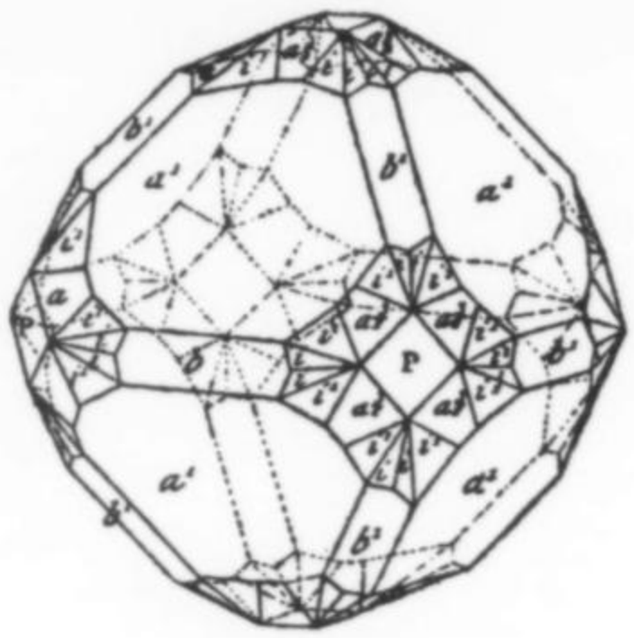
Several types of gold remobilization occur in weathering profiles, depending strongly on the present-day and palaeo-climatic situations. Where gold is liberated by oxidation of sulfides or tellurides, mossy aggregates and dendritic gold forms are commonly observed. On rare occasions gold has been found psuedomorphing casts of primary minerals and/or mantling regolith phases such as goethite, kaolinite and gibbsite.

The remobilization process of gold in savannah systems and particularly in duricrust profiles occurs over different lengths of time and under differing hydrologic and physico-chemical conditions than in more humid climates. Secondary gold reprecipitates at the base of the duricrust or in the mottled zone where conditions are less oxidizing, preferentially on Fe-oxides, probably because gold has a better adsorption capacity on goethite than on kaolinite. Secondary gold in savannah systems is micro-sized, in part because the vadose environments do not allow large crystalline growth, but favor spherical or irregular secondary shapes.

Under more humid conditions, such as in latosols or stone line profiles, gold remobilization is a very active process, even in recent soils, and corrosion is often uniform on the grain surface. Gold in latosols tends to concentrate either as adsorbed gold on organic matter in humic horizons or as secondary gold in deeper horizons. As in duricrust, secondary shapes are mostly micro-sized spherules, but bigger automorphic crystals or irregular aggregates can develop, probably because the B-horizon of these soils is seasonally saturated. Organic matter in humid tropics plays an important role in gold chelation. In Western Australian supergene deposits, gold is strongly dissolved and re-precipitated within the saprolite, in response to the highly saline conditions. This process develops independently of the classical dissolution fronts of gold in active lateritic profiles. In this case, both gold corrosion and dissolution occur in water-saturated environments, and the gold is widely dispersed. Corrosion is of uniform type; secondary particles are predominant and can exceed several hundreds of microns.

The study of gold morphologies requires a statistical approach to be significant, particularly if the importance and nature of corrosion processes are to be estimated. Corrosion features of primary gold are dependent on the Au dissolution conditions in, for example, vadose or saturated environments. Secondary gold particles are usually easy to distinguish from primary grains by their shape, appearance and chemical composition. However, secondary shapes seem not to be dependent on specific weathering environments. Automorphic crystals, spherical shapes, or irregular aggregates can be found in most of the different weathering profiles; pseudo-hexagonal plates, however, are characteristic of highly saline environments.





The Harvard Mineralogical Museum's Gold Collection

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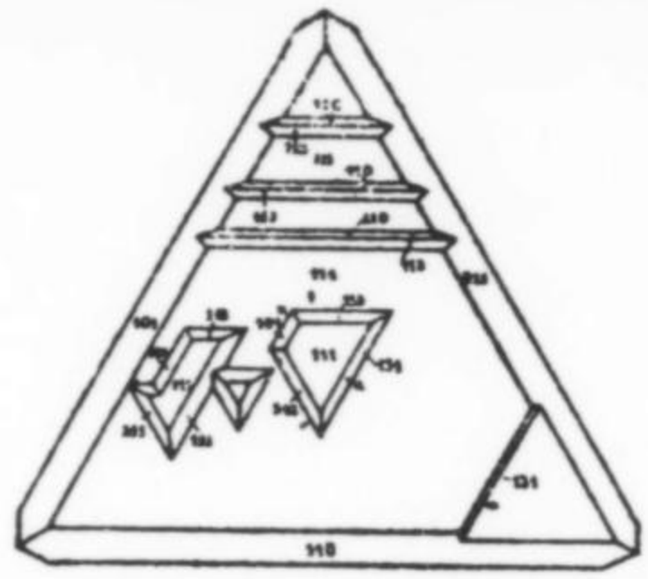
The Harvard Mineralogical Museum is well known for its suite of display-quality gold specimens, many of which have been exhibited nationally through loan arrangements with other museums and at major mineral events. Not so well known is the extraordinary representation of gold in the systematic mineral collection: about 1200 specimens (plus 200 micromounts) from a wide variety of historically important localities, most of which were productive in the latter half of the 19th century and the early 20th century. Approximately 450 distinct occurrences are represented.

The United States is disproportionately represented by about 600 (half) of the specimens. Sixty of these can be called Appalachian gold, as they are from occurrences in the eastern states stretching from Maine to Alabama. With the exception of one Michigan specimen, all of the rest are from western states and can be called Cordilleran gold. California and Colorado are very strongly represented by about 250 and about 130 specimens respectively. Nine other states are represented by 40 or fewer pieces each.

The collection holds gold specimens from 51 other countries. The rest of North America is represented by Canada (30), Mexico (38) and seven other countries with fewer than 10 each. Half of the 153 South American specimens are from Chile (42) and Colombia (33). Of the 203 specimens from Europe, 120 are from Romania, and thirteen other countries, especially Portugal, are represented. Asian specimens (55) are mostly Russian (45); specimens from Australia and New Zealand (56) exceed those from Africa (38).

The majority of the systematic suites are from the Albert C. Burrage collection, which was acquired by bequest in 1948. That collection contained the important gold collection (526 specimens) of George de la Bouglise, a Parisian mining engineer, and the smaller yet important William P. Blake collection, noted for its early crystallized California golds. More than 300 additional locality specimens have accumulated since 1948. The preparation of a monograph to document and promote use of this extensive collection is being considered.



Russian Gold: A Review

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Historical gold prospecting and mining in Russia began more than 250 years ago. In the mid-19th Century, Russia was a world leader, accounting for 41% of all gold produced. However, discoveries of gold in California, Australia and South Africa caused a decrease in Russia's share of world gold production, from 41% in 1840 to 13% in 1855 (Sher, 1999). At present, Russia produces about 140 tonnes of gold annually and is sixth among world gold producers (Bennevolskii, 2002).

In 1714 Ivan Mokeyev, a master fire assayer, invented a way to extract byproduct gold from silver ore mined at Nerchinsk, Transbaikalia. The next major recovery of gold occurred in the Altai Mountains, where A. Demidov was mining copper from sulfide-rich base metal ore. Analyses performed by order of the Chief Mining Supervisor, Wilhelm I. Gennin, proved that the ore at Altai, like that from Nerchinsk, contained gold and silver. Soon Altai became the major gold-producing area in Russia, but it was exhausted by the end of the 18th century.

Uralian gold fills the next page in Russian gold history. While in most districts the initial discovery was of placer gold, the first gold found in the Urals was lode in character. It was found by a peasant, Yerofey Markov, on May 21, 1745, in the Beryozovsk district 50 miles from Ekaterinburg. Five small gold leaves on quartz led to the ultimate discovery of 150 lode zones stretching for ten miles and extending for more than a mile downdip. The Beryozovsk gold field has been mined for more than 250 years and is a classic example of quartz-gold lode deposits (Konstantinov *et al.,* 2000).

Seven decades later, in 1814, placer gold was found in the Urals by Lev I. Brusnitsyn, a mining engineer from the Beryozovsk district. His discovery opened the epoch of placer mining in Russia, and rampant gold fever led to the search for placers throughout the Urals and eastern Siberia. Hundreds of placers were found near the towns of Tomsk, Krasnoyarsk, Minusinsk, and Achinsk, and later in the Yenisey River basin. Gold production increased dramatically; about 20 tonnes of gold were mined during the summer of 1847 alone. Ultimately the gold rush reached the Lena River basin, with its world famous Spassky and Voscresenskii districts, and placers in the remote Vitim River basin. In 1870, diggers reached the vicinity of the Pacific Ocean and found the rich placers of the Amur River basin. Today the center of East Siberian gold mining is at Bodaibo and Bodaibocan.

A total of 2,800 tonnes of gold were produced in Russia between 1712 and 1917, about 12.5% of the world production for that period (Danilevskii, 1959). From 1928 to 1990 the gold mining industry developed steadily. Huge new gold districts and gold deposits were discovered, e.g. the Kolyma district in northeastern

Siberia (1930s) and the Murun-tay, Kubaka, Sukhoi Log, and Deputatskoye deposits (1950's–1970's). Gold production declined after 1990, reaching a low of 113 tonnes in 1999, but then increasing again; it was 140 tonnes in 2000 (Benevoiskii, 2002).

Today, eighteen gold provinces covering huge areas in both the European and Asian parts of Russia are known. Three of them are in Europe and 12 in Siberia and the Far East (*Mineral Wealth of Russia*, 2001). Known reserves are 10,000–12,000 tonnes, with additional estimated reserves of more than 55,000 tonnes (Benevoiskii, 2002).

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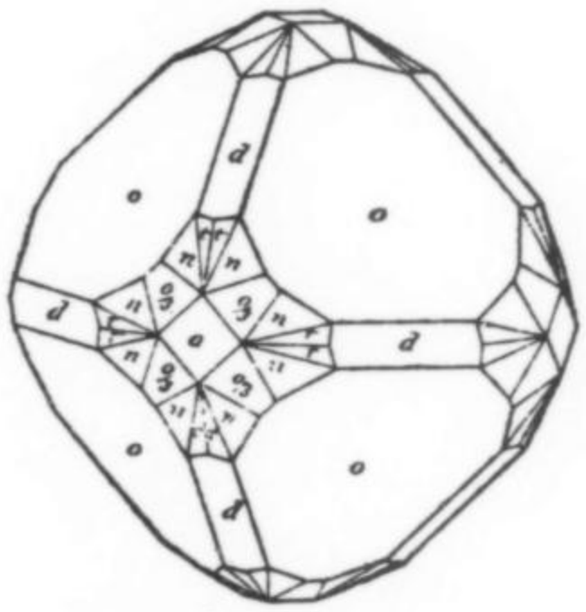

The World's Greatest Gold Deposit: The Witwatersrand Goldfield, South Africa

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South Africa is the largest producer of gold in the world, even though production declined somewhat during the closing stages of the 20th century. During 2001, South Africa produced 394.8 tons of gold, the lowest production figure in 50 years. However, South Africa still leads the world's other major producers of gold—the United States of America, Australia, Canada and China. South Africa possesses 46% of the world's gold reserves. Although the country's gold deposits occur in a variety of geological settings, it is the sedimentary conglomerates of the Witwatersrand goldfield that dominate South Africa's gold mining statistics: 98% of the country's production comes from this deposit.

The Witwatersrand goldfield has produced ten times more gold than all the rest of the world's gold mines combined, and although 50,000 tons of gold had already been mined by 2002, about 36,000 tons are still waiting to be exploited. The gold occurs in conglomerates that are between 3,000 million and 2,700 million years old. The entire sedimentary sequence is approximately 10,000 meters thick and consists of quartzites, shales, conglomerates and minor volcanic lava and banded-iron formations. The gold-bearing conglomerates form only a fraction of this thick sedimentary pile, with the greatest concentration of gold reefs being located in the upper half of the deposit. The source of the gold is still hotly debated, the following theories having been proposed:

[1] Erosion from ancient, pre-existing gold deposits in Greenstone belts (placer, syn-depositional)—gold and clastic sediment was eroded from surrounding greenstone belt terrains and deposited simultaneously in the basin.

[2] Exhalative volcanic activity (syngenetic)—"black smokers" erupted gold-bearing fluids that precipitated in the sediments.

[3] Hydrothermal precipitation of gold after sediment deposition (epigenetic)—late-stage hydrothermal fluids permeated the sequence and precipitated the gold in the lithified sedimentary sequence.

[4] "HAGS"—**H**ydrothermally **A**ltered **G**ranite**S**—granite emplacement on the edge of the basin was coeval with the deposition of the sediments, and gold and clastic sediment were eroded and deposited together.

[5] Modified placer theory whereby original placer gold is remobilized—gold was originally eroded from a hinterland source and was deposited with the sediment, and later epigenetic processes remobilized and concentrated the gold.

Mineralogical, sedimentological and structural data exist to support all of the above theories, although the "modified placer" theory is the most popular. This theory is widely favored because the sedimentary pile has undergone low-grade metamorphism, been penetrated by numerous dykes and sills, has a thick pile of younger volcanics overlying it, and was subjected to the Proterozoic Vredefort meteorite impact event that provided major heat and hydrothermal fluids.

The gold occurs primarily as microscopic grains dispersed in the conglomerate or within pyrite. Pyrite is ubiquitous in all the gold-bearing conglomerates, either as well-rounded "buckshot" detrital grains, or as euhedral, recrystallized crystals. Kerogen (carbon) is also an important component in some conglomerates. Where gold and kerogen are found together, the gold grades are highly enriched. The mines operating on the western margins of the basin produce significant quantities of uranium, primarily from uraninite associated with the gold-bearing reefs. The average current ore grade in the Witwatersrand mines is 5–6 grams of gold per ton.

Gold specimens from the Witwatersrand mines are rare, but some excellent specimens do exist. The placer origin of the Witwatersrand gold accounts for the scarcity of fine specimens, but where the sedimentary rocks have been hydrothermally altered, or invaded by dykes, the fine-grained gold may recrystallize into macro specimens. Beautiful "seaweed"-type gold is found on joints and fault planes associated with dykes. Euhedral gold crystals are very rare. Other secondary minerals are occasionally found; barite, calcite, dolomite, epidote, fluorapophyllite, galena, pyrite, pyrrhotite, quartz, sphalerite and uraninite are sometimes found as collectible specimens. These minerals are vein- and vug-associated species that crystallized during post-depositional metamorphic and hydrothermal alteration of the deposit. Some exceptional mineral specimens worth noting include a unique skeletal octahedral gold crystal from the Van Dyks mine; the finest pyrrhotite and cubanite from southern Africa, collected at the Mponeng mine during 2002–2003; the largest barite crystals in the world, found at the Elandsrand gold mine; and a host of outstanding quartz specimens from several of the Witwatersrand mines.

An Island of Gold: An Overview of Specimen Gold from Papua New Guinea

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In 1527, Don Alvaro de Saavedra, a Spanish merchant returning from the Moluccas with a load of cloves, sailed along an uncharted coast to the east of the Spice Islands. Bringing theory and hope equally to bear, he called the new land "Isle del Oro," the island of gold. Saavedra never saw any gold from his Isle del Oro, but later explorers would find the island, now called New Guinea, to be blessed with the precious metal.

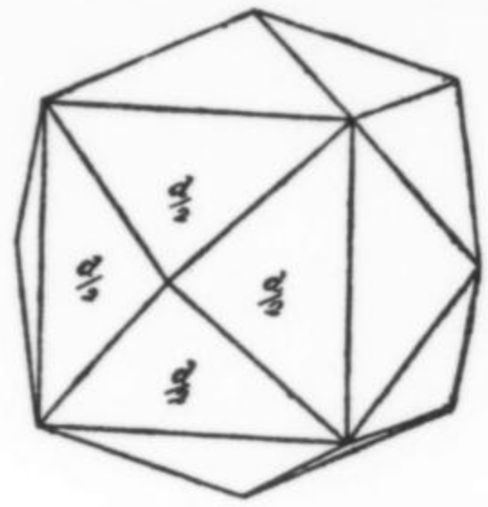
No gold was documented from New Guinea or the surrounding islands until 1873, when Capt. John Moresby of the *HMS Basilisk* reported finding gold in a potsherd made of clay from the Laloki River. This unusual sample set off a long series of discoveries of gold mines, nuggets, and the occasional specimen.

Although Papua New Guinea (PNG) boasts some of the world's greatest gold fields (Porgera, Lihir, Ok Tedi, Wau-Bulolo), very few specimens came to the attention of collectors until gold was discovered at Mt. Kare in 1988, sparking a modern gold rush into the cold, high-altitude swamps around that mountain. At the peak of the rush, some 5000 to 8000 native miners were working the ground. Using only hand tools, the miners produced between 100,000 and 500,000 ounces of gold in less than three years.

Unusually for gold from an alluvial deposit, many Mt. Kare nuggets show some degree of crystalline form. However, most of the nuggets found in the early days of the rush showed varying degrees of abrasion or folding of the flattened crystals. Gold from Mt. Kare ranges in fineness from 710 to 960, averaging around 790. Specimen gold has been recovered from the alluvial and colluvial material as well as the deeply weathered bedrock.

Besides Mt. Kare, PNG has several other localities that have produced either large, attractive nuggets (Simbai and Amenab) or crystalline gold specimens (Edie Creek, Porgera, Tolukuma and Wapolu). Simbai and Amenab are noted for producing high fineness (>950) gold nuggets weighing up to several ounces. Prior to the discovery of Mt. Kare, these two areas were the source of most of the jewelry nuggets from PNG.

Of the crystalline gold localities, only Edie Creek and Porgera have produced specimens larger than micromounts. The giant Porgera deposit (>15 Moz of Au) has produced crystallline specimens very similar to the material from the nearby and geologically related Mt. Kare. Edie Creek in the Wau District is noted for masses of tiny crystalline gold wires of low fineness (500–600 fine).



Recent Specimen Gold Activities in Australia

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The discovery of gold in 1851 near Bathurst, New South Wales and the subsequent development of gold mining fueled the growth of Australia and its major cities. The mining of visible (and sometimes invisible) gold has been a powerful drive for fossickers—pursued for pleasure, wealth and even lifestyle enhancement. The introduction of affordable metal detectors *circa* 1980 launched a new gold rush throughout Australia, the participants including both recreational fossickers and traditional miners searching for coarse, visible gold near the surface. Today, after more than 20 years of metal detector use, such near-surface gold is still being found, as is the less common kind of specimen gold which comes from hardrock mines. It should be appreciated that in Australia there is at least a 100-to-1 ratio of gold fossickers using metal detectors to mineral collectors.

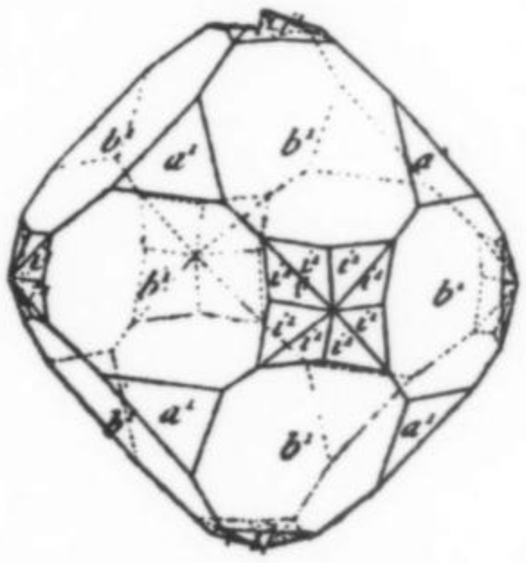
Almost all gold specimens in Australia are now found with metal detectors; they are nuggets, leaf gold, crystalline (mostly dendritic) masses, or gold forming veinlets and lumps in quartz matrix. Material from these sources can be obtained from local fossickers in Australia, shops in the mining towns, or remotely via websites. Finders.com.au, jaysgoldnuggets.com, janetsgoldnuggets.com, treasureenterprises.com, and goldnuggetexchange.com are just a few of the sites that sell Australian specimen gold. Only a small number of gold specimens are recovered via hardrock mining. Gympiegold.com.au is a company known for its gold in quartz specimens from Gympie, Queensland.

Most of the historic gold mining districts still yield specimen gold to those using metal detectors. In Queensland, fossickers still recover coarse gold from many of the abandoned camps west of Cooktown and Cairns. This area is attractive because of its high degree of tropical weathering and because there is little competition from other fossickers. The goldfields north of Brisbane remain active for mining and fossicking. The goldfields north of Melbourne in Victoria remain active and popular for metal-detecting, with some successes reported in various Australian magazines or in publications of gold fossicking groups. In Western Australia, all the traditional areas around Coolgardie-Kalgoorlie, Laverton, Wiluna, Menzies, Paynes Find, Fields Find, Mt. Magnet, Cue, Pilbara, and Kimberleys are still detected with some success. Each fossicker may specialize in a certain environment or area: some favor the alluvia of dry (or almost dry) salt lakes, while others prefer the areas around abandoned gold fields. Many fossickers stop to prospect anywhere they happen to be traveling.

Reports of large gold masses are an entrenched tradition in Australia. Some of the earliest discoveries were the Burrandong nugget from near Orange, New South Wales in 1851 (2200 ozs),

the Welcome nugget from Ballarat, Victoria in 1858 (2217 ozs), the Welcome Stranger nugget from Mt. Moliagul, Victoria in 1869 (2315 ozs), the Poseidon nugget from Tarnagulla, Victoria in 1906 (953 oz) and the Golden Eagle nugget from Larkinville, Western Australia in 1931 (1135 oz). In addition to large alluvial masses of gold, matrix gold specimens have been discovered; two famous examples are a mass known as Kerr's Hundredweight found at Hargraves, New South Wales in 1851 (106 pounds), and the Beyers and Holtermann's matrix mass found at Hill End, Victoria in 1872 (630 pounds).

Gold specimens located by metal detectors range in weight from less than a gram to more than 100 ounces. Two to ten-gram specimens are common, with a handful of specimens available for purchase in the 200-300 gram range. Some of the larger recent discoveries have been the Hand of Faith at Kingower, Victoria in 1980 (876 oz); the Pride of Australia at Mosquito Gully, Victoria in 1981 (256 oz); the Jewel of the Desert in 1982 (173 oz); Snapping Duck at Ashburton, Western Australia in 2001 (20 oz); and the Golden Aussie nugget near Kalgoorlie in 1980 (267.5 oz). Metal detecting by avid fossickers will continue to uncover additional specimens for purchase.



Canadian Gold: A Review of Gold-Specimen Producing Localities Past and Present

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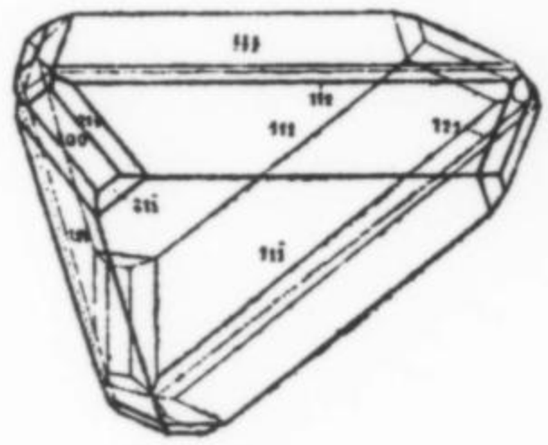
For most of the 20th century, Canada was among the five leading gold producers in the world. The Klondike gold rush of 1898 brought Canadian gold to world prominence, despite earlier significant production in British Columbia, Ontario, Québec and Nova Scotia. The Porcupine gold camp in northern Ontario, discovered a decade later than the gold fields of the Klondike and never as celebrated, was nevertheless what put Canada solidly on the gold-producing map, and northern Ontario today continues to be a leading producer of gold.

Quartz vein material rich in "free" or visible gold has come from many mining areas in Canada, notably the South Porcupine/ Timmins camp and the Kirkland Lake-Val d'Or belt in Ontario and Québec, the Bralorne-Pioneer camp in British Columbia, and the Slave geologic province near Yellowknife in the Northwest Territories. The placer deposits of British Columbia and the Yukon Territory have provided quantities of interesting, unusual, and even fairly large nuggets.

More rare in Canada, as is the case world-wide, are localities that produce well-crystallized gold specimens. Gold crystals are known from quite a number of Canadian localities, but only one produced specimens fairly regularly—the Klondike gold field, which has been producing good gold crystals since they were first reported during the gold rush. Unfortunately, few early crystals were kept. However, miners today are more aware of the interests of collectors, and several are making efforts to preserve the gold crystals from the smelter. For slightly more than a decade now, specimens from several creeks have been made available on the collector market. Notable sources are Hunker Creek and some of its tributaries and benches such as Last Chance Creek and Dago Hill; Victoria Gulch on Bonanza Creek; and Eldorado Creek and its tributaries, Oro Grande Gulch and Irish Gulch.

In recent years, two major gold mines have embarked on programs to preserve collector gold. As a result, rich specimens showing massive, spongy and leaf gold have been made available from the Sigma Mine in Québec and the Red Lake Mine in Ontario (the latter is currently one of the highest-grade gold mines in the world).

In 1997–1998, a remarkable discovery of well-crystallized leaf and wire gold was made in the Nugget Pond Mine in Newfoundland. Unfortunately, the material was being smuggled out of the mine and became the subject of a police investigation. Most of the smuggled material was recovered and is currently being stored by the company, which plans to market it when this mine and a neighboring one (also operated by the company) close.



Gold in the Southeastern United States

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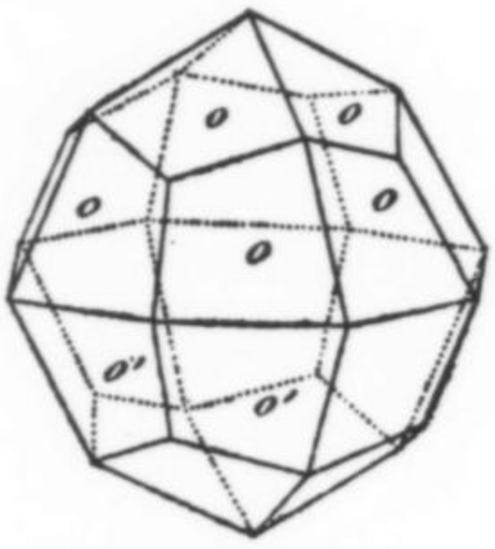
The original discovery of gold in the southeastern U.S. is veiled in the mist of history. Early expeditions such as that of DeSoto failed to find a new Eldorado. There is some evidence of gold mining by later expeditions in northern Georgia and western North Carolina, and there was some colonial or post-colonial mining in central North Carolina, and there was the well-publicized 17-pennyweight Rappahannock nugget reported by Thomas Jefferson in 1782. In 1799, a young boy accidentally discovered a 17-pound gold nugget in Little Meadow Creek in Cabarrus County, North Carolina, at what would become the Reed Mine. Although it took three years to confirm that the boy's cabin doorstop was gold, the hunt was on after that. In rapid succession other deposits were found in North Carolina, which for 24 years was the only source of gold in the U.S. As gold discoveries and mining expanded outwards from central North Carolina, gold was quickly discovered in adjoining states: Tennessee in 1827, South Carolina in 1827, Georgia in 1828, Virginia in 1829, and Alabama in 1830.

Gold from mining operations before the Civil War went predominantly into commerce—jewelry, and private and government coinage. U.S. Mints were established in Dahlonega, Georgia and Charlotte, North Carolina. Other than some nuggets saved as keepsakes or used for ornamentation (watch fobs and hat and stick pins), only minor examples were saved as specimens. Most specimens in museum and private collections post-date the Civil War, coming from mining in the 1880–1918 period and during the 1930's, after the increase in gold price.

Through the cooperation of a number of sources we are able to bring together a display of many specimens, most of them normally kept unseen in museum vaults and private collections, to illustrate the range in size and form of surviving gold specimens from each of the southeastern states.

Examples of southeastern gold are available from time to time to the collector as placer sand concentrate, placer nuggets, crystalline gold, and gold in quartz. The most common localities for placer gold are the Loud mine, Dukes Creek placers, Nacoochee placers, placers in the Dahlonega area, the Magruder mine, and the Creighton mine of Georgia; Vein Mountain/South Mountain area, Albemarle area, and Georgeville areas in North Carolina; Cherokee County, and the Haile mine and Dorn mine of South Carolina; the Chulafinne and Arbacoochee placer areas of Alabama; and the Coker Creek placers of Tennessee. Crystalline gold is notable from the Hercules mine, Caldwell County, North Carolina. Gold on quartz is commonly available from the Crisson mine and less commonly from the Battle Branch mine, Magruder mine, and Parks mines of Georgia; and from the Cotton Patch mine and Georgeville area mines of North Carolina. Small specks of native gold on magnetite come from Carroll County, Maryland.



Geology, Mining, and Gold Recovery History of the Olinghouse District, Washoe County, Nevada

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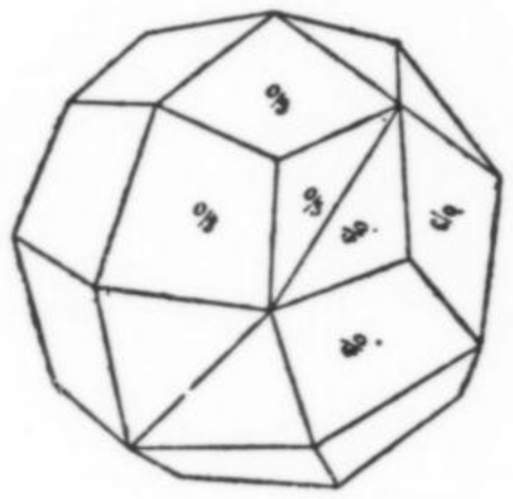
The Olinghouse district, located 45 minutes east of Reno, was first discovered in the 1860's, most likely by Comstock prospectors. Underground mining peaked in the early 1900's and then dropped off by the 1930's. From 1997 to 2000, renewed interest in bulk, heap-leach, open-pit mining by Alta Gold Co. reactivated the district, and specimen gold was recovered during this time. District gold production totaled around 100,000 ounces. The district currently sits dormant.

Gold deposition at Olinghouse occurred about 10–11 million years ago when pre-existing faults and related fractures were intruded by stockwork dikes of granodiorite porphyries. Later, crosscutting fault displacement of these dikes and earlier faults allowed mineral-rich fluids to rise from deep-seated igneous intrusives and concentrate at structural intercepts, creating high-grade gold ore shoots in the now propylitized andesite host rock.

The gold at Olinghouse ranges in purity down to 60% gold and 40% silver, making at least some of it electrum. This district's gold specimens occurred as two major types, both forming in calcite-filled voids in host rock breccia cavities. The Green Hill pit produced about 180 specimens consisting of freestanding gold wires measuring from 2.5 mm to 7 cm growing off plates of quartz crystal-coated green andesite. Some of this quartz is amethystine. The more typical specimens came from the 813 pit and consisted of nest-like, finely crystalline wires; dendrites; and leaves of gold occurring in patches and masses ranging up to 20 cm across. One specimen contains a unique 8.4-cm freestanding wire. This pit produced approximately 920 gold specimens, more than half being thumbnails. Clinozoisite, epidote, galena, heulandite, laumontite, quartz, and scheelite have been observed in direct association with gold in specimens from the 813 pit.



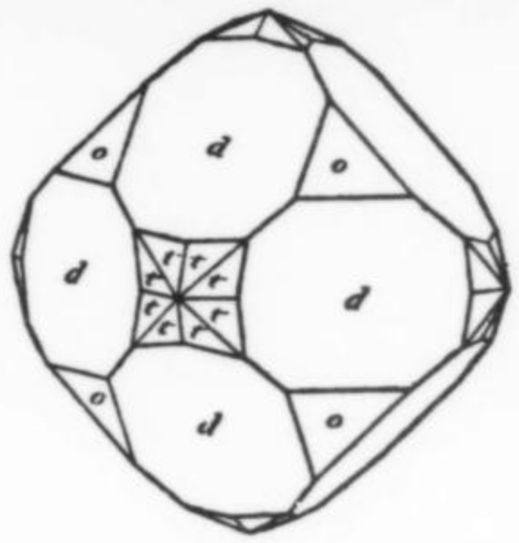
The Gold Tellurides of Colorado

Ed Raines
Ward, Colorado 80481

More than forty tellurium-bearing mineral species have been identified in Colorado over the years, and seven of these species also contain gold. They are calaverite—$AuTe_2$; krennerite—$AuTe_2$; sylvanite—$(Au,Ag)_2Te_4$; petzite—Ag_3AuTe_2; buckhornite—$AuPb_2BiTe_2S_3$; kostovite—$CuAuTe_4$; and nagyágite—$Pb_5Au(Te,Sb)_4S_{5-8}$. Additionally, native gold has been reported as a pseudomorph after several telluride minerals.

Gold tellurides are reported from Cripple Creek in Teller Co.; Gold Hill, Magnolia, Central, Sugar Loaf, and Eldora in Boulder Co.; Lake City in Hinsdale Co.; Telluride in San Miguel Co.; Eureka in San Juan Co.; Buckeye Gulch in Lake Co.; La Plata in Montezuma Co.; Gilman in Eagle Co.; Central City in Gilpin Co.; Chicago Creek and Idaho Springs in Clear Creek Co.; Vulcan in Gunnison Co.; and Sneffels in Ouray Co. Ores from the Cripple Creek district, the La Plata district, and the various Boulder County districts yielded much of their gold production from the telluride minerals.

Mines in the Cripple Creek, LaPlata, and Boulder districts have all produced specimens in both micro and macro sizes. As a general rule the crystals are small, but even small specimens of gold tellurides can be world-class.



The Round Mountain Gold Mine, Nye County, Nevada

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The Round Mountain Mine is one of the largest gold producers in central Nevada, having yielded over 7 million ounces to date. Although the mine mainly exploits very low-grade ore, spectacular crystallized gold is periodically recovered. The mine is located at the foot of the Toquima Range in Nye County, central Nevada, the heart of the Basin and Range Physiographic Province. Its total reserves are currently estimated at 192,000,000 tons of ore grading 0.020 ounce of gold per ton, for a total of 3.75 million ounces. Gold occurs as very fine-grained disseminations in felsic volcanics associated with a 26.5 million year-old caldera system. The gold is typically not visible to the unaided eye. In fact, the typical ore is a bland, white, sericitically altered tuffaceous volcanic that is remarkable only in that it economically yields gold! The mine is worked as a 2500 x 1500-meter open pit elongated in a NW-SE direction. Gold extraction occurs by cyanide leaching on a rotating reusable leach pad as well as on dedicated leach pads.

Round Mountain was discovered by Louis Gordon in 1906—generally the time of discovery of many other famous mining districts of west-central Nevada, e.g. Goldfield, Tonopah, and Rawhide. Mining boomed until the 1930's, after which time the district saw only sporadic production. In the late 1960's it was acquired by the Ordrich Group, and the current mine was put into production in 1975. Following a series of mergers and buyouts, the mine is now a 50:50 joint venture between Barrick Gold Corp. and the operator, Kinross Gold Corp. Annual production is approximately 720,000 ounces of gold at a cash cost of about $210/ounce. Mining is scheduled to end in 2006.

In the late 1980's, there was a surprising discovery of a narrow, high-grade vein structure along the western pit wall. This sericitically altered quartz-adularia-gold vein trends N30W, and dips 30 degrees to the southwest. It has produced several thousand ounces of coarse, crystallized gold. Most of this gold occurs as small leafy and crystalline pieces weighing from a few grams to several ounces. Large pieces have been encountered, the largest weighing 5785 grams. The vein can only be accessed during pit enlargement operations and is quickly mined through, usually producing gold for only a few weeks each year. The mine management, realizing the value of such a rare find of crystallized gold, opted to make specimens available for employees to purchase once a year as what might be considered a Christmas bonus.

Diamonds *(continued from page 54)*

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The Eagle's Nest Mine

Placer County
California

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Since 1982, the Eagle's Nest mine has been a more or less consistent source of fine crystallized gold specimens, with the exception of recent years during which legal challenges have diverted financial resources to litigation instead of production. At present, the mine is in full production with the expectation that it will produce additional fine specimens of crystallized gold in the future.

INTRODUCTION

Specimens of crystallized gold from what is now known as the Eagle's Nest mine first came to the attention of the mineral collecting community in a brief article in the *Mineralogical Record*'s, "What's New in Minerals" column (Leicht, 1982). At that time, specimens were simply labeled as coming from the Michigan Bluff Mining District in Placer County. Since that time, substantial numbers of beautiful gold specimens have reached the market. The present owner/operator has purchased and leased other claims in the immediate area and has consolidated them under one name: the "Eagle's Nest mine." Consolidation of many claims under one name is not unprecedented in California. The 16 to 1 mine in Sierra County, the Red Ledge mine in Nevada County (8 claims), and the Sonora mine in Tuolumne County all encompass numerous claims.

EARLY HISTORY

Historically most of the mining in Placer County has been placer, both from recent stream deposits as well as from old

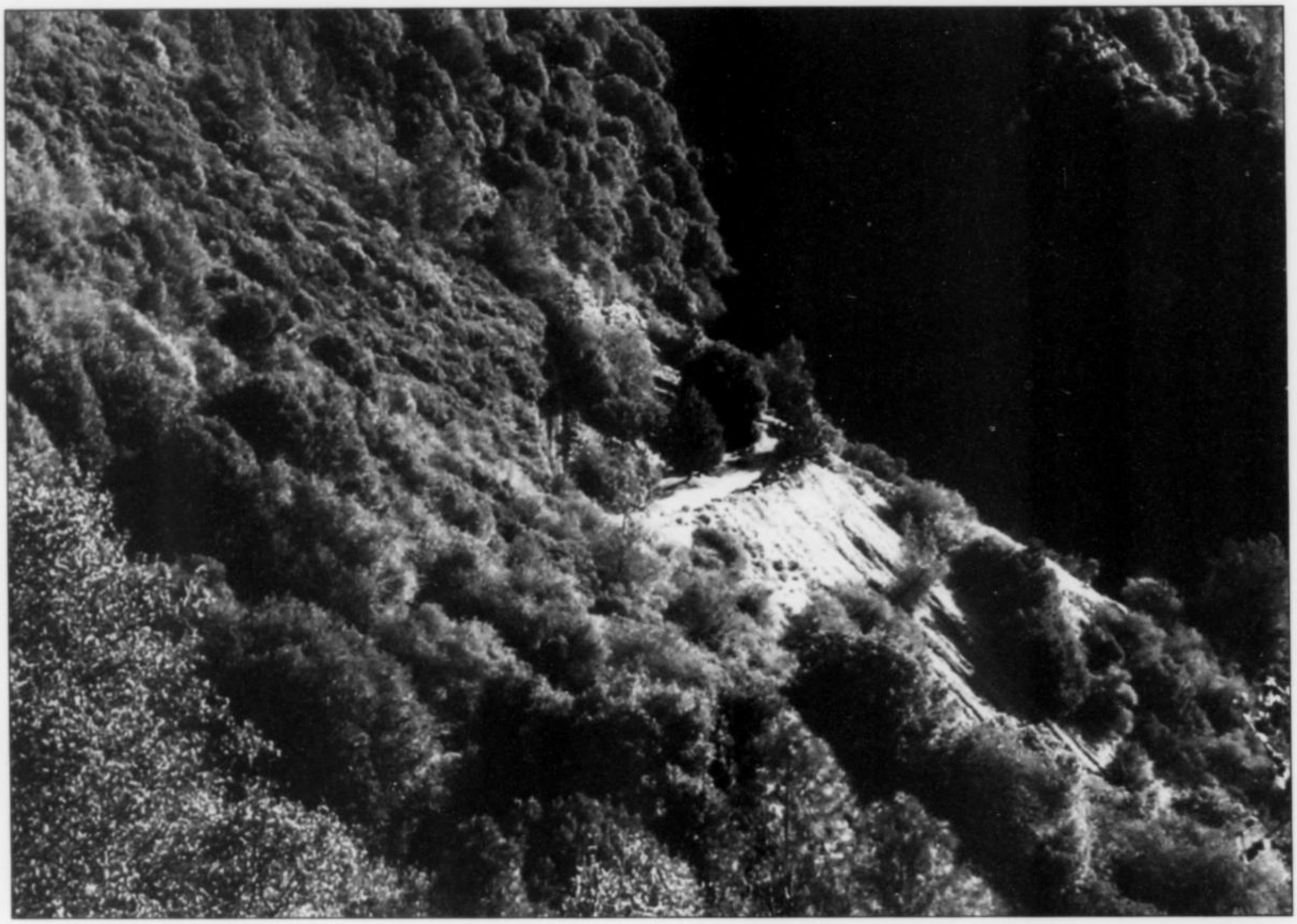


Figure 1. **The Eagle's Nest mine is well-named, perched on a steep hillside high above a valley. Robert Cook photo.**

Tertiary channels which bisect the County. Placer and drift mines (a "drift mine" is an underground mine exploiting ancient river gravel) were particularly rich and were mined intermittently since the early 1850's. Lode mining in the Michigan Bluff District began shortly after the discovery of gold in California but was never as important as the alluvial deposits. The site of the original discovery of gold at Coloma in El Dorado County is less than 20 miles from the Eagle's Nest mine. One of the earliest reports of lode mining near Foresthill can be found in the *American Journal of Science and Arts,* written by William F. Blake (1855); he states that ". . . interesting octahedral crystals have been found in the claims of the Messrs. Diedesheimer . . . 2,500 feet above the level of the river." From his description it appears that these crystals of gold must have been found in either the Michigan Bluff District or the adjacent Foresthill District.

During the California gold rush, Michigan Bluff was a booming town of several thousand citizens. It was originally settled by immigrants from the State of Michigan and was simply called "Michigan" until the town was physically moved to a higher bluff when gold was discovered beneath the townsite. It is now better known as the town where Leland Stanford started his career as a lowly store merchant in 1853. He became part of the "Big Four," which included C. Crocker, C. P. Huntington and M. Hopkins, and together they financed the Central Pacific Railroad. Later he became Governor of California and founded Stanford University.

Early lode mining in the County was obviously overshadowed by the extensive placer, drift, and hydraulic mining in the area.

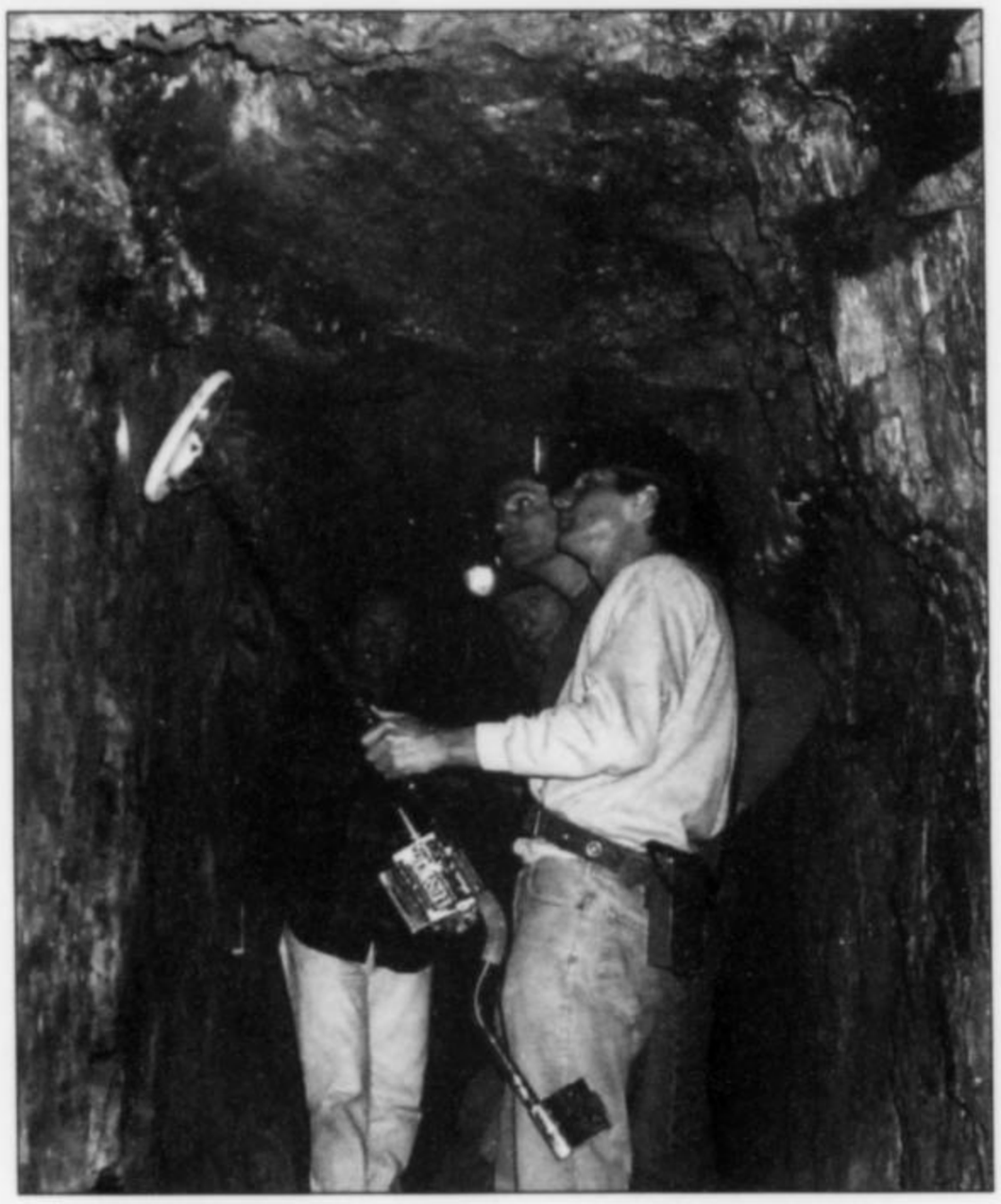


Figure 2. **Using a metal detector to search for gold veinlets in the adit walls, Eagle's Nest mine. Robert Cook photo.**

Figure 3. **Adit entrance to the Eagle's Nest mine. Robert Cook photo.**

There were never any rich deep mines like those in Mariposa, Tuolumne, Calaveras, Nevada, Sierra, or even the tiny County of Amador. Almost all the lode mines in the Michigan Bluff District were small "pocket" mines where the gold was found in narrow stringers near the surface. Often pocket mines do not produce enough gold to be commercially profitable from the sale of bullion alone, but if the gold is crystallized it can be sold at several times its bullion value to collectors. Other pocket mines in the Michigan Bluff District include Ford's mine (inactive) and the Golden Sheaf mine (mined briefly at the turn of the century). In the past, Placer County has been the source of some of the finest crystallized gold ever found in California, from mines on both sides of the Foresthill Divide which bisects the County, separating the North and Middle forks of the American River. The famous Golden Bear Nugget was thought to have been found at the George Hill mine near the town of Yankee Jim's, Placer County, some 10 miles from the town of Foresthill (Bradley, 1922). Some of the claims which make up the Eagle's Nest mine were located shortly after the turn of the century and in the early literature were referred to as the Garbe and deMaria mine (correctly written as DeMaria). At that time the mine was operated by Mr. Louis Garbe and Mr. Clement DeMaria, as partners. Around 1921, Mr. John (Jack) Greenwood joined the mining venture. Jack Greenwood was a relative of Louis Garbe and also of the family after which the town of Greenwood in El Dorado County is named. He is also the grandfather of the present owner's late wife. Jack Greenwood had a long history of successfully operating gold mines in both El Dorado and Placer Counties. When Jack was associated with the mine several large pockets of gold were found.

After Clement's death, his son, John R. DeMaria, assumed the family's interest in the mine. Records of production during this period are sketchy, but the *Thirty Second Report of the State Mineralogist*, published in 1936, states that for "many years this mine has been noted for occasional 'pockets' of coarse crystallized gold." It also states that the present operators (presumably John R.) "professed to be at a loss to recognize any sure sign of 'pay.'" Obviously John R. was not the miner his father was; his wife stated that during the period from 1938 until he ceased active mining operations he found only "colors" (traces of gold)! She later stated that her husband had personally mined less than one ounce of gold on their claims in 40 years! Obviously the DeMaria family relied upon others to do their mining and were content to collect royalties from their claims.

Just before the State Mineralogist's Report of 1936 was published, Charles "Bud" Greenwood, Jack Greenwood's son, and father of the present mine owner's wife, joined John R. in the mining operation. Bud, like his father, Jack, was a hard-working, industrious miner who learned how to read the signs of pocket mining from his father. When Bud was associated with the claims owned by the DeMaria family, again, many fine specimens were found. He also located two additional claims, the Hope and the Wildcat, and worked them independently of the DeMaria operation. The DeMaria family had no financial interest in these claims. Many of the largest gold specimens found in the district came from the Hope claim during the period from 1900 to 1939, at which time Bud left for military service. Specimens on display at the Placer County Courthouse in Auburn, California, came from the Hope Claim and were sold to the county in the early 1920's by Louis Garbe. The Hope claim is often referred to as the Frenchman's Adit, in reference to a Frenchman named "Frenchy" LaBarr who illegally worked the claim in the late 1920's and early 1930's. Even though the adits for the various claims are separated by some distance, recent geological studies indicated that all of the claims are in the same geological setting with the gold deposited in the same mineralogical event. There is some indication that the Hope and the Wild Cat are potentially richer than the five DeMaria family claims. The mine owner has, in the past, concentrated his efforts on the DeMaria family claims and has left the Hope and

Figure 4. **Narrow, rich, horizontal quartz vein mid-way up support pillar, half of which has been removed to access a pocket; Eagle's Nest mine. Robert Cook photo.**

Figure 5. **Milky quartz/gold vein in situ in the mine. Chris McGown photo.**

Wildcat for development at a later date. However, several large specimens have been found on these claims recently, through the use of advanced metal detectors capable of detecting gold at greater depth than earlier models could.

During the war years very little development, apart from the required assessment work, was done by John R. on his claims. Shortly after Greenwood's discharge from the military in 1945, he was stricken with polio and retired from any mining activity. Bud's previous work on the Hope and Wildcat produced several large plates of quartz containing large amounts of gold. These were passed on to Bud's daughter, Denise, after Bud's death in 1984. When one of us (WCL) asked Bud in 1982, shortly before he passed away, why he saved these pieces he simply stated that he did not know how to prepare them properly for market even though he believed they contained several ounces of crystallized gold. One specimen, which was as large as a dinner plate, he estimated to contain only 10 ounces of gold, but it actually contained much more! This specimen was prepared and sold, and the money was used to help finance future development of the mine. Bud further indicated that most of the gold he mined was sold for little more than bullion value, but he always believed that the price of gold would go up in the future and the specimens he saved would increase in value.

In 1965 Bud's son-in-law, the present mine operator, became involved in the mining operation. Although confined to a wheelchair, Bud taught his son-in-law the telltale signs for finding gold in pocket mines, even though neither had any formal training in geology or mining. At that time, apart from keeping up the assessment work on their claims, the DeMaria's were not actively mining on their claims. John R. undoubtedly felt that his claims were "played out" and decided to lease two of his claims to Bud's son-in-law.

Figure 6. **Rough piece of vein quartz containing gold (removed from the area shown in Fig. 5). Chris McGown photo.**

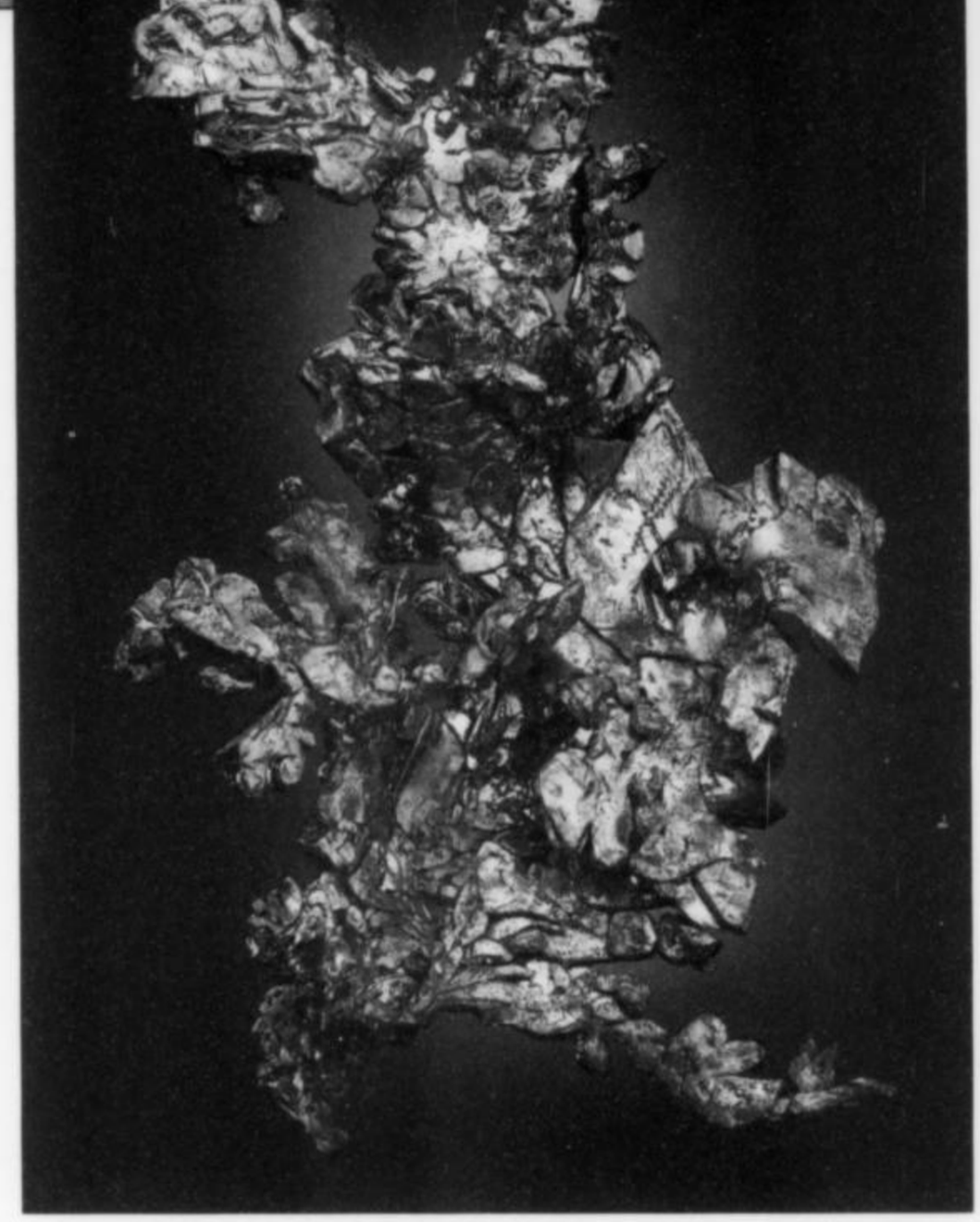


Figure 7. **Gold, 4 inches, from the Hope claim, Eagle's Nest mine. Van Pelt photo.**

THE MINE

Presently the Eagle's Nest mine consists of over seven unpatented claims of approximately 20 acres each, located approximately 4 miles from the small town of Foresthill in Placer County, California. Five of the claims, the Big Seam, the Red Ink Maid, the Dandy, the Louise and the Moonshine, are contiguous claims. Two other claims, the Hope and the Wild Cat, are located northwest of the main portal and across a county road. Other lode and placer claims in the area have also been located by the mine owner but are not being worked at the present time.

The Eagle's Nest mine was initially developed by a series of short adits that accessed somewhat chaotic workings along the narrow, gently dipping quartz veins. Today, however, a much better planned and developed mine exists that exploits what are referred to as the 300, 350, 400 and 500 veins. Older, upper workings that do not connect with the current operations are on what are designated as the 100 and 200 levels. The deeper levels are accessed by inclines from the 350 level, with the deepest current workings on the 400 vein; the 500 vein area is currently temporarily flooded. Ventilation and emergency exits are provided by drifts to the surface from the main 300 and 400 vein workings, and there are several equipment/supply raises and winces. In total, the workings encompass several thousand linear feet, underlying a surprisingly small area that is about 400 x 250 feet exclusive of the main adit and the ventilation shaft.

Stopes are open rooms that vary from about 6 to 10 feet in height, generally opened with the quartz vein on the floor. Pillars are left at somewhat random intervals and supply the only needed support in the mine. Blast holes are drilled with a small compressed-air jackhammer and all rock loading and haulage is carried out with a rubber-tired scoop tram. Mining is carefully controlled and quite selective; pockets are located with the aid of metal detectors and are then worked out by hand. There is no operative mill at the mine, and gold-bearing, non-specimen-grade ore is carried off site for processing. A guard animal patrols the mine at night and during periods of inactivity.

GEOLOGY

The mine is located within the complex Foothills Metamorphic Belt at a position approximately 15 kilometers upstroke (north) of the generally accepted terminus of the great Mother Lode Belt (Ransome, 1900; Logan, 1935). The geology of the Mother Lode proper, as well as similar outlying districts, such as Grass Valley and Allegheny, for example, have been discussed at depth in the technical literature for over a century (Lindgren, 1895; Knopf, 1929; Johnston, 1944; Ferguson and Gannett, 1932).

The Foresthill and Michigan Bluff districts have been described by Chandra (1961), who gives the only relatively detailed, modern account of the mine area geology in his description of the Colfax and Foresthill quadrangles.

The Foothills Metamorphic Belt is composed of a series of multiply deformed, accreted blocks. In the mine area, the rocks comprising the host block are moderately metamorphosed Upper Paleozoic sediments and intercalated volcanic rocks of the Calaveras Group that are locally cut by dikes and multigenerational quartz veins. A complex mass of Upper Jurassic serpentinite lies north and west of the metasedimentary-metavolcanic mine-area sequence

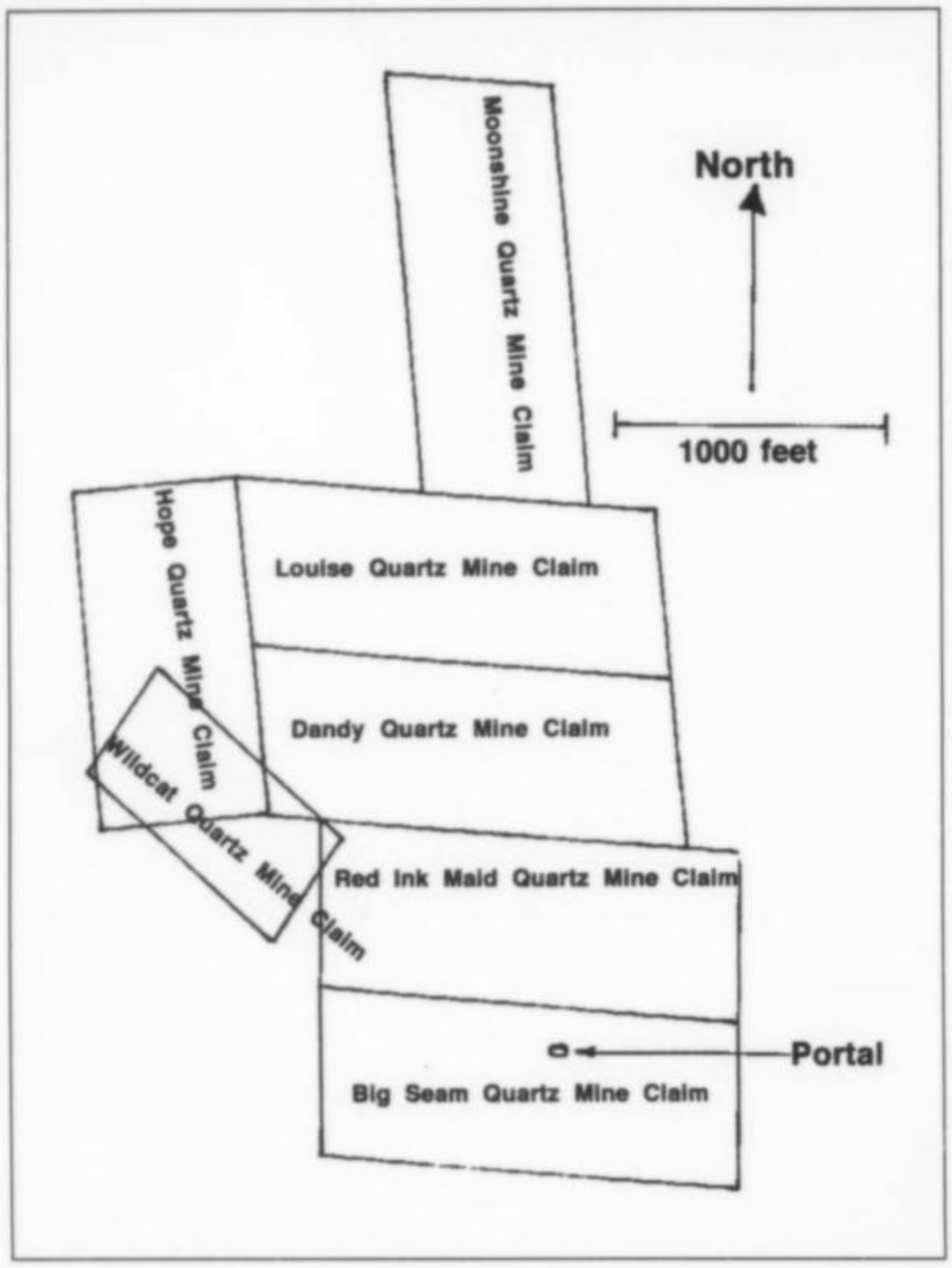


Figure 8. **Map showing the relationship between the various adjacent claims.**

and is separated from it by the Volcano Canyon thrust fault. Tertiary flows and tuffs crop out approximately 2 km northeast of the mine, obscuring the gold-bearing sequence.

Rock units within the immediate mine area most likely correlate with the Blue Canyon Formation and consist of variably graphitic and pyritic slate, metaconglomerate, gritty quartzite, and metagraywacke. Minor amounts of the Tightner Formation have also been mapped near the mine and consist of distinctive intermediate to mafic metavolcanics including amphibolite and amphibole schist. The thickness of individual units or "beds" is quite variable and progressive changes in unit thickness within the mine suggest the presence of one or more isoclinal folds. Steeply dipping, variably altered lamprophyre dikes up to 1.5 meters thick cut units of both formations and are obvious throughout the mine workings. Dominant east-west-striking and north-south-striking dikes intersect within the mine and have been used for location reference on all levels. Petrographic and geochemical examinations of major rock unit samples collected from within the mine indicate that alteration includes silicification of dramatically variable intensity and pervasive though generally less intense carbonate alteration proximal to quartz veins. Local bands of mylonitic recrystallization are common, particularly near boundaries between units of differing competencies. All major rock units, with the exception of dikes, are foliated at some scale, although the more equigranular grits retain a somewhat massive bedded appearance in outcrop. Foliations most commonly strike steeply to the north and exhibit a variable though typically steep dip. Graded bedding is locally preserved.

The structural setting is somewhat complex. The Blue Canyon and Tightner formations are folded together into relatively tight north-northeast-trending, northwest-vergent antiforms and synforms. Chandra (1961) has mapped a dominant open, northeast-plunging antiform across the southeast portion of the claim block, implying that the majority of the mine workings lie within its west limb. East of this fold, a north-striking, very steeply dipping fault of unknown displacement has carried rocks of the Blue Canyon Formation west of the fault upward against what is interpreted to be a structurally higher part of the Blue Canyon-Tightner stratigraphy. Within the mine proper, the productive workings appear to terminate to the west against a fault of unknown displacement. Elsewhere, very minor normal and reverse displacement is exhibited along widely spaced faults that appear to represent joints along which sporadic local movement has taken place.

Gold occurs within small, very irregularly distributed zones in a set of narrow, subparallel, gently dipping quartz veins. This vein set typically strikes north-northwesterly and dips gently to the northeast. At least four productive veins, separated from each other by several tens of meters, have been identified, along with numerous similar though barren veins. Veins are typically quite thin, averaging about 5 cm in thickness. Although they are generally persistent throughout the workings, they can be seen to pinch and swell locally and in some places have thinned to the point of disappearing completely. Although gone, their traces are marked by joint-like seams which continue on in structural continuity and which gradually become quartz-filled again down dip or along strike. Joints that contain no quartz veins but are subparallel with

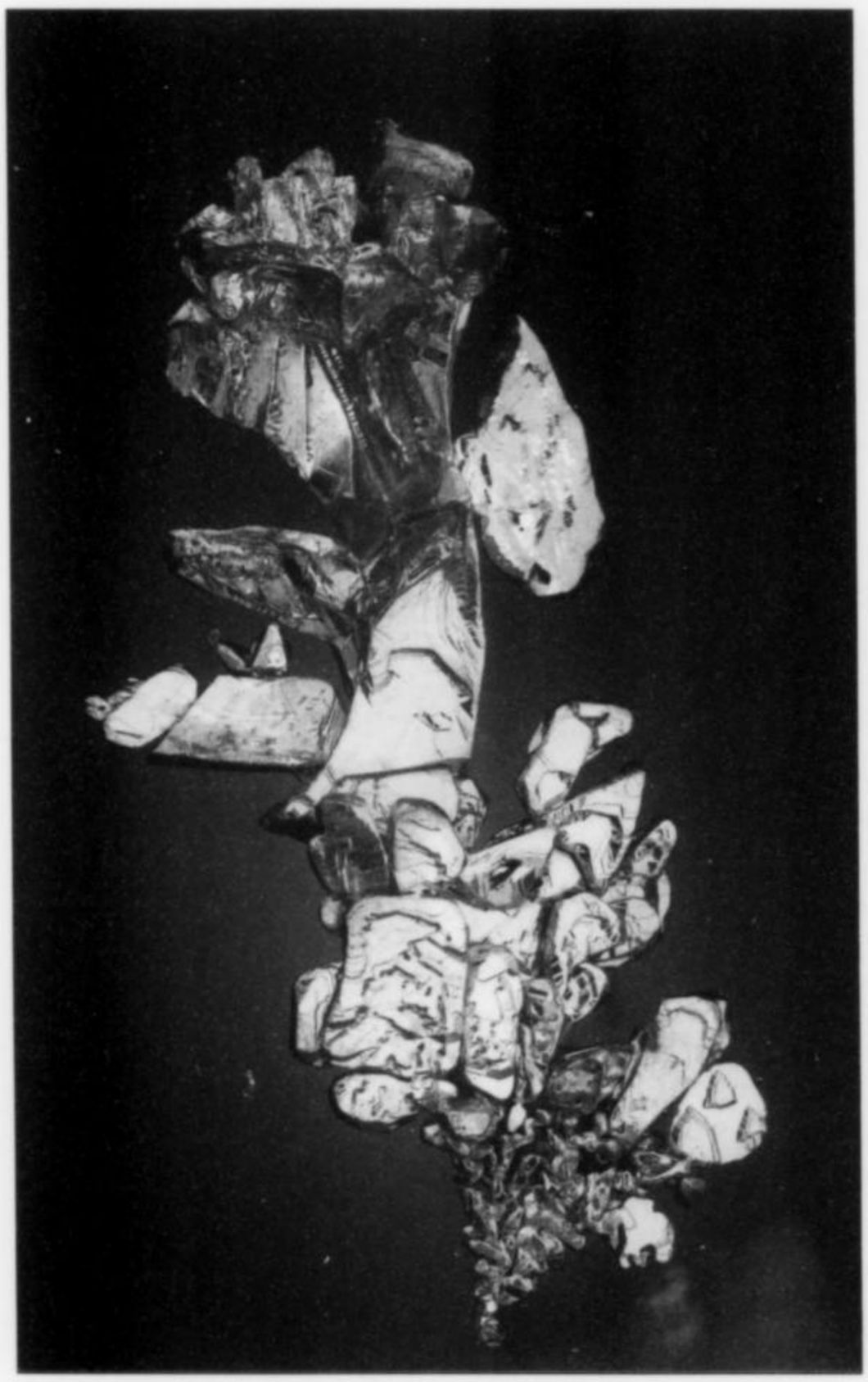


Figure 9. **Gold crystals, 2.5 inches tall, from the Eagle's Nest mine. Van Pelt photo.**

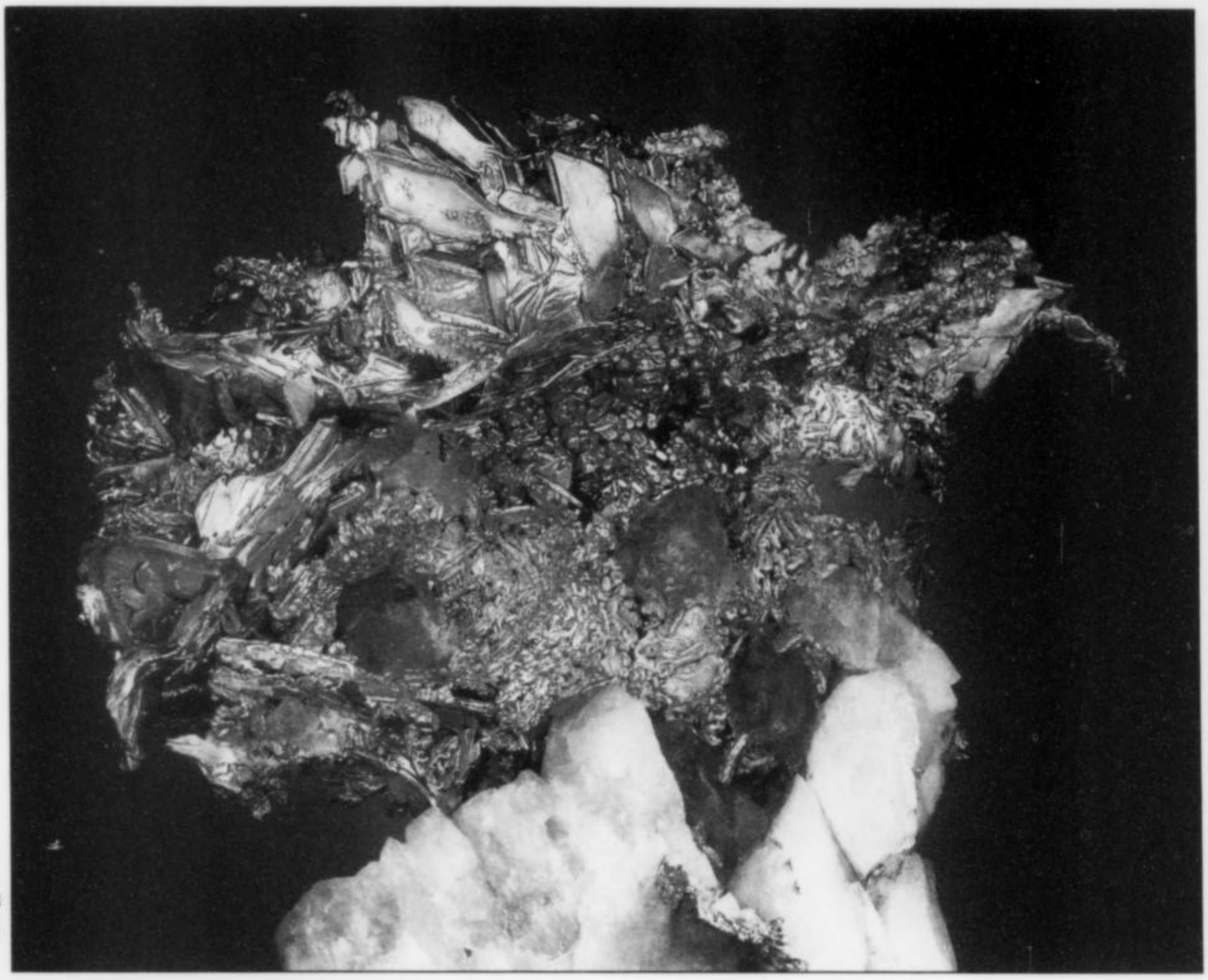
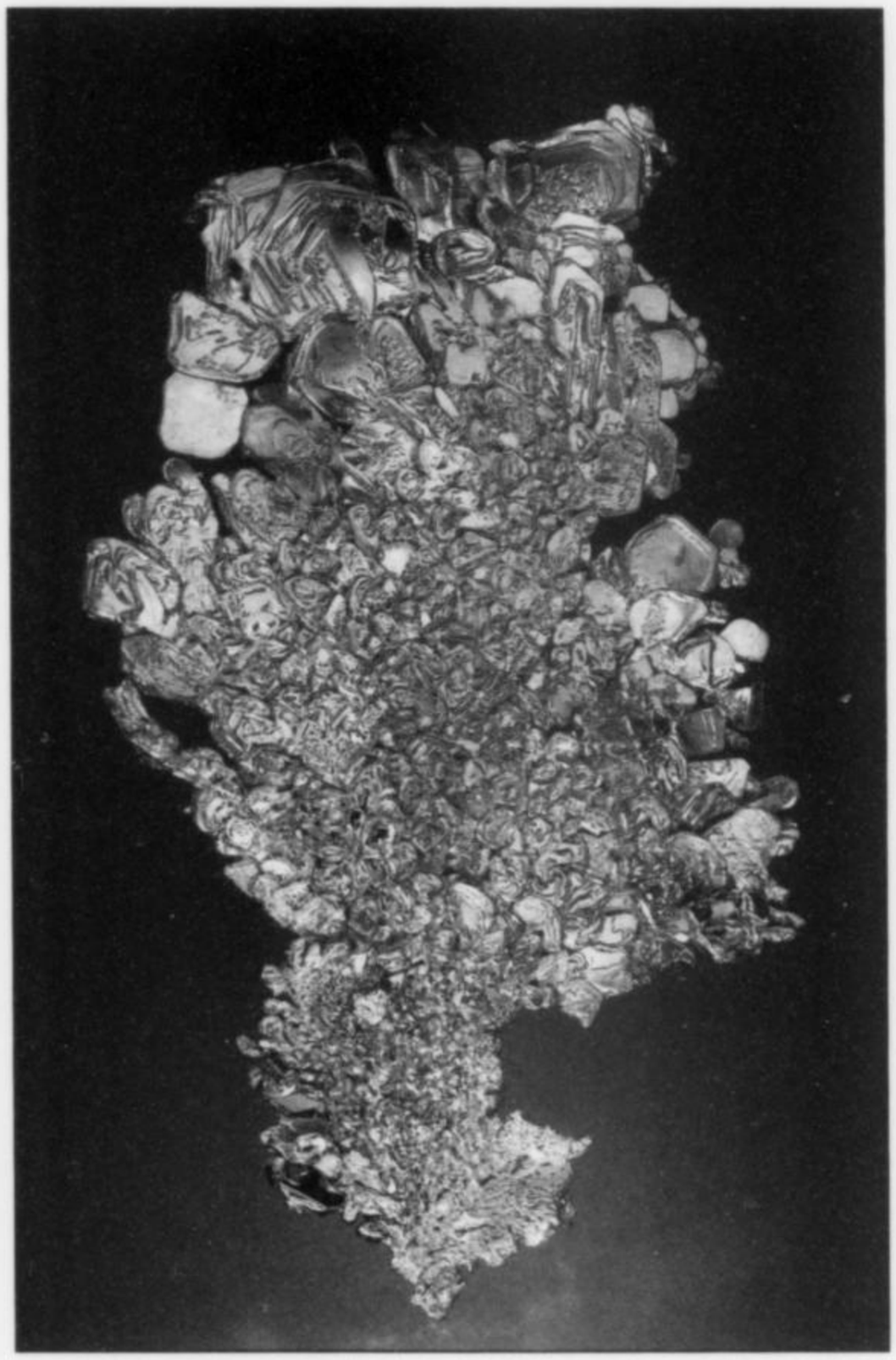


Figure 10. **Gold crystals emerging from milky quartz, 3 inches across, from the Eagle's Nest mine. Van Pelt photo.**

Figure 11. **A sheet of gold crystals, 3 inches tall, from the Eagle's Nest mine. Van Pelt photo.**



those serving as the locus of auriferous veins are common throughout the mine.

The specimen-gold-bearing veins are generally featureless and massive, although ankerite occurs locally, intergrown with quartz near vein margins; thin seams of carbonate locally mark vein walls. Small quartz-crystal-lined pockets have been encountered, but only rarely, and these are typically barren of other minerals. The productive (auriferous) quartz veins are surprisingly free of sulfide minerals, and the system as a whole is generally sulfur-poor, the highest sulfur content being within pyrite-bearing lamprophyre dikes, where it reaches almost 3%. Trace metal analyses of veins and immediately adjacent wall rock reflect low Cu, Pb, Zn, Te, Sb and As contents.

The host rocks are also cut by generally steeply dipping veins and lenses of quartz of an apparently different generation from that which produced the specimen-bearing veins. Many of these appear to be sweat-outs contemporaneous with peak regional metamorphism. Pyrite is locally associated although its gold content is almost invariably low, and these veins have not produced gold specimens.

GOLD

By far the most common habit of crystallized gold from the Eagle's Nest mine is flattened octahedrons which commonly extend into thin dendritic plates. Solid plates with sharp edges are less common. Recently several specimens were found on the Hope claim which are in the form of solid plates. Well-formed equant octahedrons are found only rarely. Almost always they exhibit some degree of "hoppered" growth, especially in the larger crystals. Only one or two wires have been found in the over 20 years of my association with the Eagle's Nest mine.

The composition of the gold from all of the claims is remarkably consistent in terms of the fineness and trace element profiles, suggesting that the gold was deposited during the same mineralogi-

cal event. The fineness is almost always between 870 and 880, with silver being the dominant impurity.

SPECIMEN PREPARATION

Eagle's Nest mine gold specimens are particularly easy to prepare. The gold usually lies within narrow seams of quartz which are generally 1 to 2.5 cm thick. No sulfides or tellurides are associated with the gold. The area where the gold is best crystallized is usually obvious because the quartz tends to be brecciated in that area, or is associated with carbonate-rich rock. In cases where it is not obvious where quartz needs to be removed, an X-ray of the specimen might be required. Based on the X-ray I can decide where quartz needs to be removed and where the quartz should be retained to form a natural base. I experimented with several X-ray techniques, one of which (though expensive) proved to give the best results; that technique remains proprietary and will not be described here. However, readers thinking that perhaps they can run to the nearest doctor's office for a quick X-ray of a specimen will be disappointed. Medical X-ray equipment will not do the job!

From the X-ray photograph I can usually tell how well the gold is crystallized and whether it will "hold together" during preparation. The only difficulty occurs when the gold lies in more than one layer, one on top of the other. The X-ray shows only the shadow of all superimposed layers on the film plane, and side-view X-rays are even more difficult to take and interpret.

Normally the removal of quartz requires the use of hydrofluoric acid (HF) but more recently I have been using only mechanical vibrating tools with carbide tips to spall the brittle quartz from the more ductile gold. This is especially true of specimens which I plan to market in Europe. Europeans are often adverse to acid-etching of gold specimens, even though they may already own benitoites, silvers and other specimens which have been etched from the matrix. The rules seem to change when it comes to gold!

THE FUTURE

The outlook for continued production from the Eagle's Nest mine seems promising. The current owner/operator of the mine along with his two sons have become accomplished miners and seem to be able to "read the signs" of a pocket mine even better than their grandfather and great grandfather. Currently mining is concentrated on the two claims partially owned and leased, with plans for further development on the Hope and Wildcat at a later date. However, several significant specimens have been found on these claims using recent improvements in metal detectors, even though the old workings can only be worked with a wheelbarrow and hand tools. In the future the Hope and the Wildcat will likely provide some of the best specimens from the claims which make up the Eagle's Nest mine.

ACKNOWLEDGMENTS

The energy, passion and commitment of the current operators of the mine are inspiring. A man, his wife and his two sons and their young families have been through the best of times and the worst of times. The recent death of the miner's wife has left all of us who know this family deeply saddened.

Thanks are also due Harold and Erica Van Pelt and Jeff Scovil for their unique talents in photography. And thanks to special friends like Dick Thomssen, Bob Jones, Bill and Roberta McCarty, Richard Bideaux and to all of our supporters. And a special thanks is owed to Stephanie Andrews for always "being there" when needed.

And yes, there is indeed a woman behind the man [WCL]: my wife of 39 years, Dona, has been a willing partner through ups and downs of a somewhat crazy business.

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The Early History

of the

Mineralogical Record

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The Mineralogical Record has been a cornerstone of the mineral collecting world for over a third of a century, and many people today take its existence for granted. In the beginning, however, its survival was anything but assured. The first years were precarious and challenging for its founder, then a young curator with no editorial, publishing or business experience. The support of donors, authors, advisors and volunteers helped it survive those early years, just as they have continued to help it flourish every year since then. Here is the story of how it all began.

PROLOGUE

When I was asked to write an article about the early days and years of the *Mineralogical Record*, it struck me as an intriguing idea and a story that I would like to tell, but I was reluctant because I feared that I would not be able to remember enough of the details to make much of a story of it. Fortunately, I located lecture notes from an early Rochester Symposium, which proved to be detailed enough to encourage me to begin. I also found in my files a folder full of letters exchanged between Richard Bideaux and me, and another rich with my correspondence with Peter Embrey, then with the British Museum (Natural History). Mary Lynn Michela (of whom more later) sent me copies of letters from and to Arthur Montgomery; these also contain details which are critical to the story.

WHY IT ALL BEGAN

Most simply put, the *Mineralogical Record* was born as the result of two circumstances that fortunately came together: (1) my desire to start a new publication for mineral collectors, and (2) the financial support of the late Arthur Montgomery. A third key was my position on the staff of the Mineral Sciences Department of the Smithsonian Institution. This affiliation lent immediate credibility to my name and thus to my efforts, and it assured the enthusiastic support of the esteemed Paul Desautels who was, at that time, my supervisor and mentor.

But we are jumping ahead of the story, which began back in the late sixties. My frustration then with the inadequacy of the literature of the hobby was such that I felt compelled to do something about the situation. I strongly believed that the mineral hobbyist deserved something much better than what was available. *Rocks & Minerals*, perhaps the only existing potential candidate for possible redemption (this was before Marie Huizing became editor), was then at a low point. Unfortunately, the publishers of *Rocks & Minerals* were not interested in letting me assume any sort of role which might have resulted in improving its content. James and Winifred Bourne, who took over the journal when Peter Zodac died in 1967, appeared quite content with the level to which both Zodac and they had successively allowed *R&M* to descend. By the time the Bournes finally decided to unload *Rocks & Minerals* (it was purchased by the Heldref Foundation in 1974), *The Mineralogical Record* was already four years old.

I decided that I had no option but to consider starting my own journal, and so I looked around for support, as I had neither the experience nor financial wherewithal to embark upon such a course alone. Sometime around 1967 I had rather wistfully discussed with my dear friend Kent C. "Casey" Brannock of Kingsport, Tennessee, the idea of actually starting a journal on my own. Casey offered strong encouragement and good counsel right up until his tragic death in 1973. Other friends were supportive as well. I recall

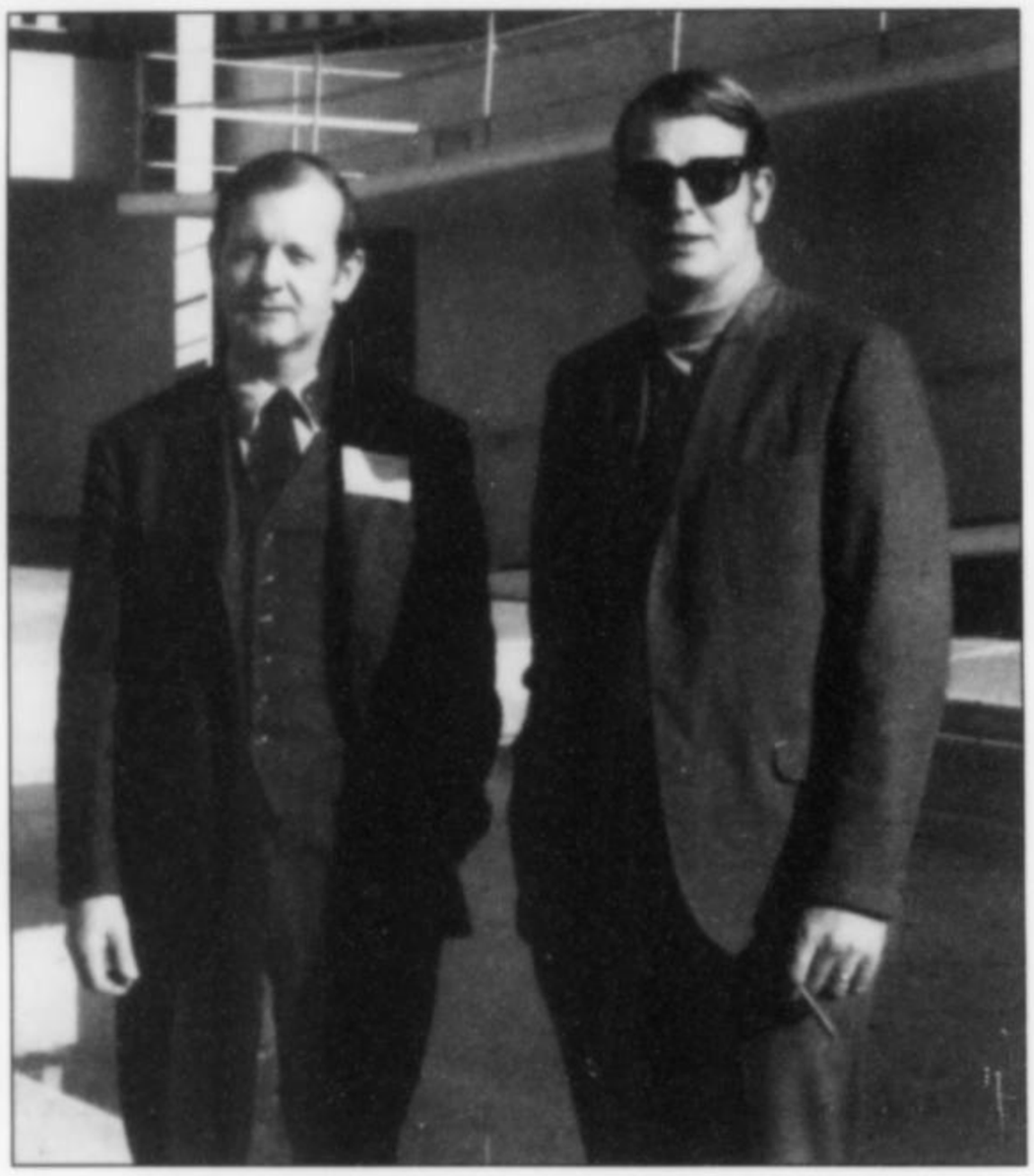


Figure 1. **Smithsonian Curator Paul Desautels and his protégé, John White, ca. 1970.**

sitting on the porch of Jack Hanahan's mountain cabin in western North Carolina where Jack, Bob (Robert B.) Cook and I used to talk through the many challenges associated with beginning a mineralogical journal, not the least of which was attracting enough good articles. In the fall of 1969 I began collecting some manuscripts and preparing a list of potential articles in anticipation of getting started. I would have been willing to begin with just a few mimeographed pages stapled together, or something quite modest along the lines of Lanny Ream's excellent *Mineral News*, if necessary. By the end of the year I had lined up perhaps a half-dozen potential backers willing to lend about $1,000 each, so I decided that I could go ahead and publish something in early 1970.

That January, however, I received the first advertisement for *Mineral Digest* and was terribly depressed for I felt that someone had pre-empted me. Its promotional material made it sound very much like the magazine I had envisioned *and* they were offering to pay authors $100 per article! Additionally, they claimed substantial financial backing, and promised a bigger, flashier product which appeared primed to completely usurp my market; they had even pre-empted my choice for the journal's name. *Mineral Digest* ultimately proved to be a flash-in-the-pan lasting only eight issues, a glossy promise unfulfilled, and merely a blatant advertising vehicle for Julio Tanjeloff, then the world's largest seller of mineral "doorstops." But the appearance of the new journal was a crushing blow at the time. Although I felt seriously threatened, I was nevertheless still committed and decided to go forward, somewhat encouraged by the fact that as the days passed there was no sign of the first issue of *Mineral Digest*.

An early exchange of letters with Arthur Montgomery, whose financial support I considered vital, was not encouraging. It was generally known that he had long lamented the absence of a respectable journal bridging the huge gap between *The American Mineralogist* and other publications purporting to serve mineral collectors so, on October 20, 1969, I wrote to him of my plans, hoping that he might consider providing financial support. In his response he stressed the importance of a new magazine attaining financial independence:

> I would gladly help any good-quality mineral magazine. But to help produce one that would have very slight chance of becoming self-supporting, would do nothing useful for anyone or for mineralogy.

Perhaps my reply, wherein I confidently developed the reasons why I felt that this effort could succeed financially, was too strong, for it elicited the following from Montgomery:

> As I read the intent of your proposition, it would very much be a one-man operation, with financial success more important than magazine content, and with a minimum of cooperative participation by others. If we ever get together any kind of group under the guise of something like a Mineral Preservation Society, one of the aims would be to put out a journal of high-class content appealing both to amateurs and professionals. But as I imagine its beginnings, its operation, philosophy and purpose would be the antithesis of your proposed project. I surely want to wish you well, for I am powerfully for anything that can aid in raising the standard of amateur mineralogy. But I am in no position to help. Sorry!

Montgomery was actively pushing for the formation of a national organization of mineral collectors, and in my view he envisioned a new journal as little more than a newsletter for this organization. I was dreaming of something much grander, a journal over which I would exercise more or less complete control, and one that would carry a far greater range of material than what I perceived he wanted. Nonetheless, in late January I was urged by Richard Bideaux to visit Tucson during the mineral show there in order to meet with a small group of collectors and scientists desirous of forming a "society for the preservation of minerals." I believe that Bideaux also succeeded in convincing Montgomery that he had misinterpreted my intentions, for Montgomery wrote to me on January 22, 1970, with an offer to pay my air fare to Tucson.

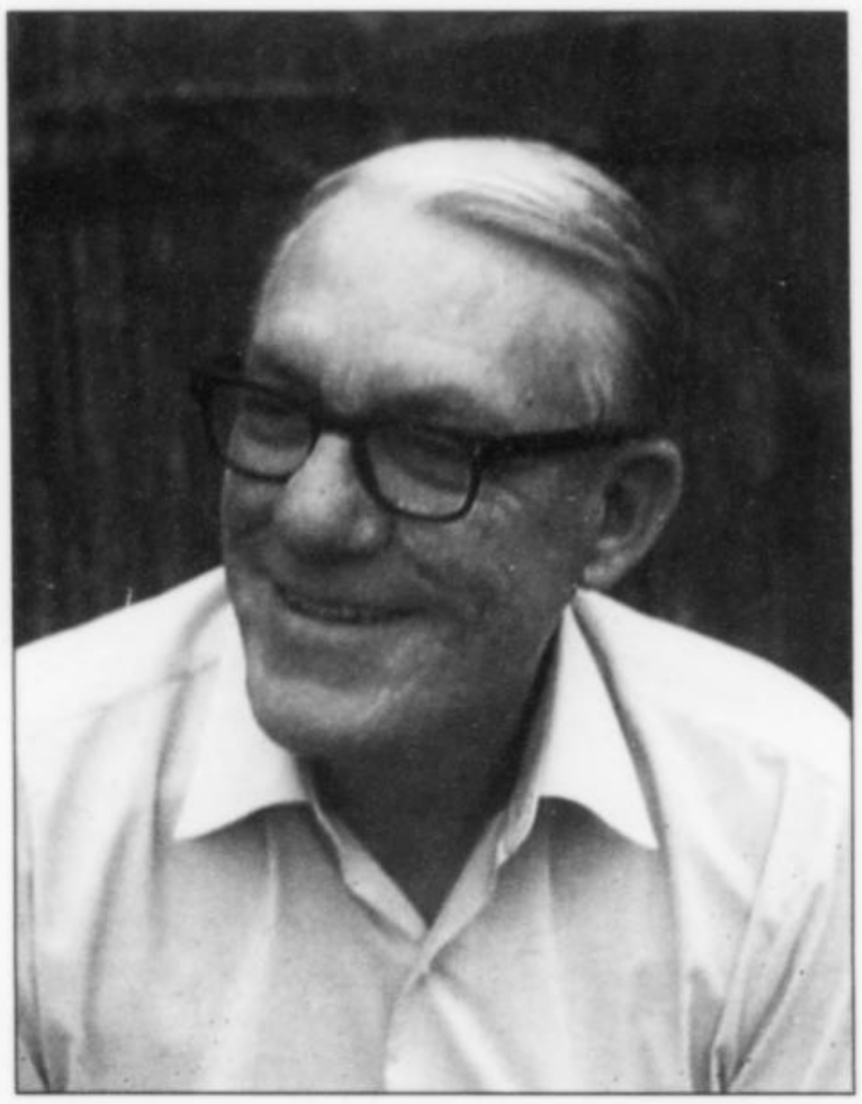


Figure 2. **Friend and supporter of the initial concept for the *Mineralogical Record* in 1967, Kent C. "Casey" Brannock.**

Thus, I was given an opportunity to present my conception of what a proper mineral journal should be. As a result of the meeting, not only was Friends of Mineralogy (FM) born, but funds were generated with which I was able to proceed with my plans to launch the journal. Montgomery, who was present, decided that he could support what I outlined as long as I agreed to provide within the journal a forum for news notes and articles generated through FM. The title page was to identify the magazine's affiliation with FM. To quote from page 4 of the maiden issue of *The Mineralogical Record* (Spring, 1970):

> *The Mineralogical Record* has agreed to an affiliation with FM whereby it will publish its written material and news of its activities. FM will support the *Record*, since the aims of both are similarly educational and directed toward better coordination of the interests and efforts of amateurs and professionals throughout the world.

This affiliation and mutual support has continued to the present day. The agreement with FM was formalized by the following document, which Montgomery drafted and I quite willingly signed, even though we both were aware that it had no legal strength:

Understanding between Friends of Mineralogy and John White's Journal

1. We in FM will help to finance the early issues - most of the funds coming from private donors among FM members, but in behalf of the group collectively. Those funds are not to be returned, but to be regarded as a means of advancing the aims and activities of FM. If and when the Journal becomes self-supporting, we will continue to contribute to it on a smaller scale to insure its financial stability and independence and a regular modest salary for its editor.

2. In return, the Journal will maintain an affiliation with FM—not so much in the spelling-out of this, as in the sense of agreeing in principle with its aims and acting as the vehicle to carry and publicize its activities. The Journal agrees to allow FM as much space per issue as needed (within reason, such as up to 10 pages of a 40-page issue), with the understanding that the published material from the FM membership will both advance FM aims and also strengthen the educational-scientific stature and reader-appeal interest of the Journal. If any disagreements occur as to publication of FM material or any other matter in the FM-Journal relationship, these will be resolved in fairness to both sides through discussion between the editors of the Journal and the regional committee representing FM.

Although much of this preliminary agreement did not actually become reality exactly as written (such as the regular, significant financial contributions by FM and the allotment of 25% of the magazine pages to FM matters) I now at least had an agreement with Montgomery. But having an agreement was one thing, and producing a journal was quite another. At least I had the prospect of potentially more substantial financial support—a critical matter, as I had no resources of my own to invest in the project and I had known of no one else that I could count on until Montgomery came into the picture. This was not a loan, but a grant, yet the structure of the financial support from Montgomery did place on me the burden of trying make the effort financially self-supporting as swiftly as possible, for he agreed to advance up to $10,000 the first year, but only $5,000 the second year and just $2,500 per year in the third, fourth and fifth years.

It is important to record that Montgomery (who is now deceased) was an exceedingly modest man. Although no one but him made financial contributions on behalf of FM during those formative years, he always insisted that we not identify his role in making possible the creation of the new journal:

> Please try to keep my name out of things as far as possible. I want the FM group to feel pride in your journal and their part in supporting it without any personalities blocking the way to strong voluntary contributions for the good of the cause. This strengthens the work of the group and gives the members a deeper interest in helping your journal to succeed.
>
> (Montgomery letter: April 3, 1970)

I was uneasy over Montgomery's reaction to publishing this story but I felt that in the interest of historical accuracy in recording the birth of the *Mineralogical Record*, he would not object to this explanation of how essential his participation had been. My fears were put to rest when I received a letter from him following the initial publication of an earlier draft of this account in *Matrix* in 1995 (vol. 4, no. 4):

> The way you dealt with my part in the enterprise, so kindly & generously, I appreciate very much indeed. I like above all how you bring out the vision we both had, the same, of wanting to uplift mineralogy to a higher level somewhere between the too rigid restraints of the science and the too popular approach of the hobby side which can water down harmfully the real stature of minerals and mineralogy. (February 11, 1997)

Actually money wasn't all that I lacked. I must confess that I had zero experience in managing such a venture, I knew nothing about editing, I had no knowledge of putting a journal together, and I didn't even know where or how to begin, let alone what I actually wanted. Making matters worse was the fact that I had an absolutely terrible lack of business and accounting skills. I did, however, have good contacts and this turned out to be invaluable for I considered it essential that the magazine attract prominent people to write feature articles for the first issue so that professional mineralogists would take the effort seriously. Drs. Brian Mason (Smithsonian), Clifford Frondel (Harvard), George Ericksen, Mary Mrose and Joseph Fahey (U.S.G.S.) all readily agreed to provide articles. Neal Yedlin (Mr. Micromount!) and Paul Desautels were not only willing but eager to help. I cannot recall my reaction to a postscript in a March 13, 1970, letter from Montgomery (he was famous for adding postscripts to his letters, often two or three, across the bottom, along the sides and then across the top if necessary):

> P.S. I can't help noting that the day we founded FM was Friday the 13th and today when I send you this check, is another Friday, the 13th!

HOW IT BEGAN

Now all I needed was paper and printing and, obviously, a *name* for the new publication. Fortune smiled on me with respect to some of these early details. A colleague at the museum, Roy Clarke, introduced me to his brother-in-law who was then a salesman for Graphic Arts (which became Kaufmann-Graphics Inc. before the first issue was published), and I did not look further. He, in turn, recommended James O'Leary to assist with typesetting, layout and design—a true blessing for these processes were as alien to me as the controls in the cockpit of an airplane are to most of its passengers. It was O'Leary who was responsible for the original design of the magazine, as well as the creation of the logo. And it was also O'Leary who immediately saw an opportunity to create a publication as revolutionary in its makeup and appearance as I

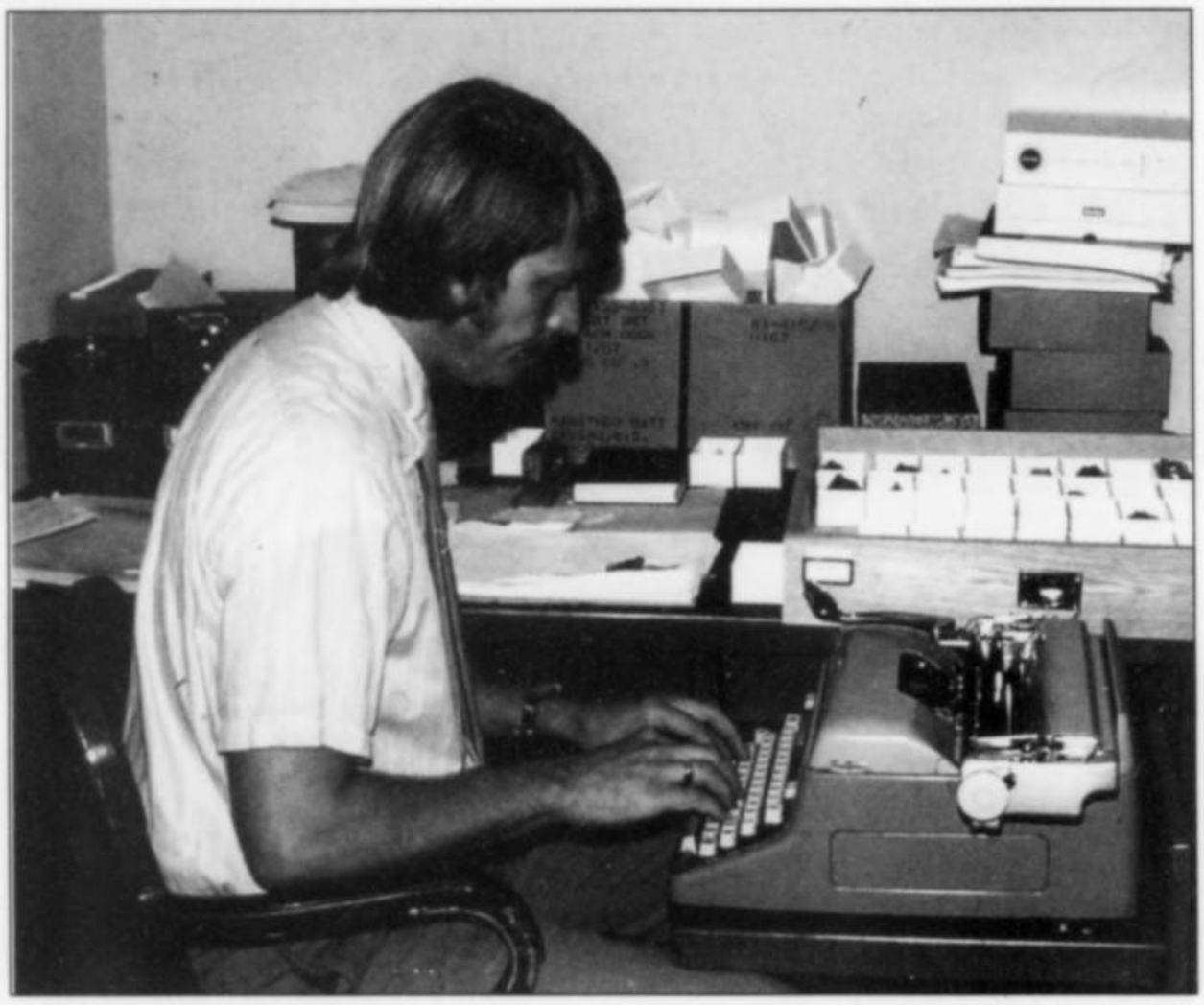


Figure 3. **The author and fledgling editor/publisher in his Smithsonian office, ca. 1969.**

intended it to be in its coverage of the science and hobby. His visions far exceeded my expectations.

But back to the matter of a name. Since my favorite name, *Mineral Digest*, had already been taken, I decided that I would call my new magazine *The Mineralogical Journal*, so a corporation in this name was established. I then called Bill Holser, editor of *The American Mineralogist*, who reminded me of the Japanese publication in English called *The Mineralogical Journal.* Paul Desautels and I, in a mild state of panic, rushed to Webster's dictionary to search for other possible names and we hit upon "record," with which I was quite happy, preferring it, in fact, to "journal." We were in Washington D.C., and the name *The Mineralogical Record* seemed to conjure up distinguished connotations of *The Congressional Record* (the official journal of the U.S. Congress), even though, on the negative side, it would prove to be a bit of a tongue-twister for some people.

At this point, on the advice of a then-prominent local lawyer who was also keenly interested in the lapidary arts, I arranged a trademark search using a Washington D.C. patent attorney recommended by that lawyer. Inasmuch as the lawyer was fully aware of the bare bones nature of the venture, it came as quite a shock when I later received the patent attorney's bill for this routine bit of assistance; he was not inexpensive. And he was also unsympathetic when I complained about the charge, reminding me that "there are no free lunches." I felt that I had been ill-used by both of these sterling representatives of the legal community. Far too much of our meager capital had been eaten up early on by this naively arrived at decision. Was this to be the way everything would proceed? I was devastated!

A complication that had to be worked out early on was finding time to get together with representatives from the graphics company without impinging on my work schedule at the museum. Happily, we found it was sometimes possible for them to bring materials to my home in the evening or meet with me over lunch. In the latter case this usually involved my speeding off in my car at noon, grabbing a snack at a fast food place along the way, munching my lunch over the layouts and blue lines in the office of the graphics company, and then racing back so as to return within an hour. Fortunately their office was no more than a few miles from mine. Color separations for the covers (which constituted the one and only color photo in each issue) were usually passed to me in the parking lot of the museum, where I could stash them in the trunk of my car to study them later at home. My evenings and weekends were totally consumed with soliciting articles, editing manuscripts, proofing copy, and handling a great variety of correspondence, especially with regard to advertising.

So, now we had a name, a corporation, manuscripts, a printer and a layout/design expert, plus one relatively unpublished editor-owner who had never worked on even a school newspaper before. But we still had no subscribers, and how to tackle that? With the help of Jim O'Leary, the first fliers were designed and printed in March and these were sent in batches to mineral clubs, mostly, because I believed then that the best market would be the members of the clubs associated with various federations. Subscriptions began to trickle in.

Problems arose almost daily. There were interminable delays for everything, and frustrating failures of people to meet their promised deadlines (something that anyone in the publishing business has to learn to live with, but I was new at the game). It took, for example, 5 days to get the fliers delivered to me in Bowie, Maryland, from Arlington, Virginia, a distance of about 22 miles. I wanted a post office box in Washington, D.C., for the prestige value, but needed one in a hurry in order to have an address for the flier, so settled (fortunately) for one in Bowie. The typesetting, originally done in Baltimore by Colonial Composition, took so long that I didn't have time to send galleys to the authors for proofreading. I hand-carried a draft of a paper by Mary Mrose to her office at the U.S. Geological Survey, then delivered it back to Baltimore only to learn at five minutes past closing time that the typesetters were not prepared to handle the various special symbols used for mineralogical data. The authors of the articles for the first issue supplied very few graphics, so Jim O'Leary and I took some photographs ourselves, and managed to obtain some from NASA, and a historical society in Boston came through in record time with the engraving of Colonial collector John Winthrop for Clifford Frondel's article on early New England mineral collectors.

We figured the magazine needed a logo of some kind, so we borrowed a goniometer off the shelf at the Smithsonian and Jim photographed it. We didn't think of it as a deep philosophical symbol of "taking the measure of the mineral world," it was just handy at the time. That goniometer has appeared in almost every issue since then. (Some years ago the Smithsonian, recognizing the

importance of the goniometer as a symbol of the magazine, graciously traded it to the Mineralogical Record in exchange for a similar one, so the magazine could have permanent ownership of the original model for its logo.)

Making arbitrary decisions became the order of the day, for there was no rational basis available to me upon which to make educated ones. For example, what should we charge for the magazine? Believe it or not, I agonized over setting the subscription price as high as six dollars a year (of course, a dollar was worth a lot more over a third of a century ago!). Were the graphics and printing charges that I had to pay reasonable? I had no time to scout around for a better deal.

What about advertising rates? One could only guess, and I did. Clifford Frondel at Harvard had urged that the advertising rates be set "rather high to scare off the cheapies." The response to my first special solicitation for large ads was poor, and I discovered that it was very time-consuming (on a per-page basis) to deal with a lot of very small ones. My very good friend Martin Ehrmann, a class act in every way, purchased a full page ad in the first issue, the only such in all of volume one. The absence of ads forced me to run a short article on the inside-back cover of number one, the only instance where that was done. Recognizing a good thing for them when they saw it, Si & Ann Frazier weighed in with a regular half-page inside-cover ad beginning with issue number two.

How many copies to print? I decided on about 5,000 although Montgomery had been pushing for as few as 1500. I am glad that we printed the larger number, and in fact we later had to go back and print 600 more copies of that first issue to satisfy demand (the reprinted copies can be easily recognized because they were printed in dark blue rather than black ink). Adding to my anxiety was having an anxious, albeit generous, benefactor looking over my shoulder, as witnessed by this Feb. 28, 1970, letter from Montgomery:

> I feel worried . . . that you are moving too fast to get out the first issue with resultant quick decisions and arrangements to be made without sufficient investigation and consultation. It is surely better to start not too ambitiously; depending on the quality of the printed material rather than the trappings and show; and to build a gradually-increasing number of subscribers rather than trying to reach too many at first with free copies. This is why the costly affair of the *Mineral Digest* probably won't last too long. A cost of $5,000 per issue sounds terrifically expensive to me, although you were figuring on 5,000 copies of course. I would like to see you check with some people who have been getting out journals of somewhat similar character in order to compare costs of printing in various places and various circumstances. . . .
>
> It is also important for you to have time to talk to Frondel and others not too close by. He definitely wants to help and has excellent ideas to discuss with you. The more he can be encouraged to participate, the better for all of us.

Memorial Day arrived and still the first (Spring, 1970) issue was not ready. The binder didn't show up for work following the long weekend. We began receiving complaints from those who had signed on early. In the meantime there was a multitude of other details requiring attention and problems needing resolution.

Second-class mailing privileges had to be obtained from the Post Office but, fortunately, we were allowed to proceed by printing in the magazine that the application for these privileges had been filed. Adding to our woes was the fact that the addresser rejected many of our address cards (this was in the pre-computer era, remember!). One of the trade-offs with second-class mailing is that the magazines have to be sorted by zip code and bundled accordingly. Guess whose job this turned out to be? Eventually we had neighbors who would show up at mailing time to lend a hand, and it was my former wife Mary Lynn (who is still Circulation Manager today) who usually won the privilege of hauling the magazines off to the post office during the day for mailing. This was, of course, not the only support she provided. Apart from always being very encouraging, she was willing from the start to assume responsibility for managing the mailing lists and the active subscribers list, a large part of which involved sending out renewal notices, then processing the renewals when received.

Which brought up another question that had to be arbitrarily answered: how long to carry non-renewers before giving up on them? Since so little cost was involved at the outset and we desperately needed readers, we tended to grant great leniency before dropping a subscriber. We had so few that we were very reluctant to reduce our circulation at this point, so we stuck much longer by those who did not wish to continue than we probably should have.

Perseverance and patience paid off, for we were finally able to ship the magazines to subscribers by the first Thursday of June, 1970. Not too bad, really, for what was designated as the Spring issue, but that left only six months in which to produce three more issues. Only four were planned for the first year, but it was announced editorially in the third issue of the first year that *The Mineralogical Record* would become a bimonthly in 1971, and it has been so ever since. Following the first mailing we sent copies, some 2000 in all, to various clubs and geoscience departments of many universities and colleges across the country, a move that was largely futile in terms of winning new subscribers, and horribly time-consuming, for all of the labels had to be prepared by hand.

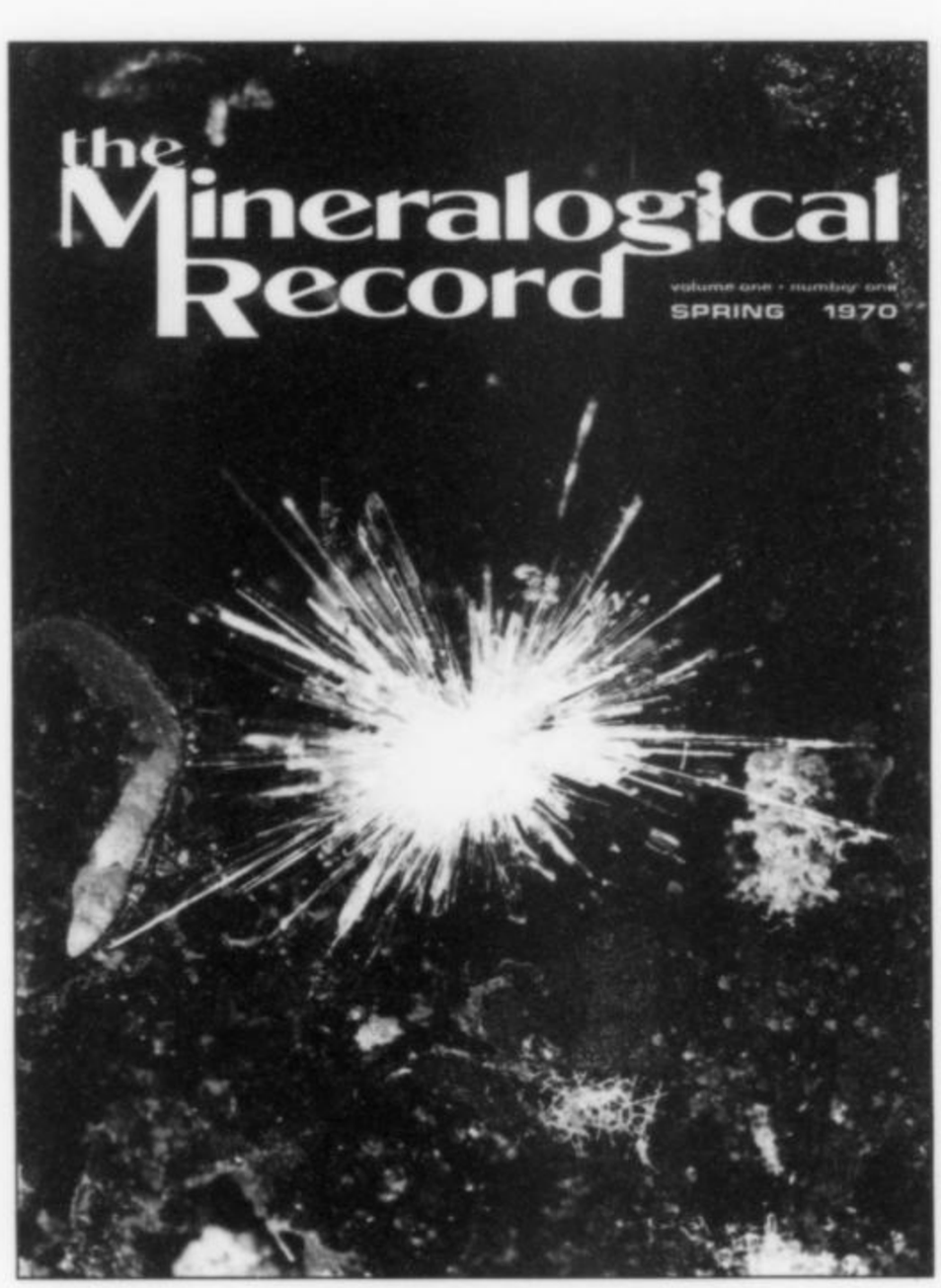


Figure 4. **The first issue of the *Mineralogical Record*, Spring 1970. The gypsum microcrystals (USNM specimen) from the Cornwall iron mine in Pennsylvania were photographed by Jack Kath.**

Figure 5. **Mary Lynn White (now Mary Lynn Michela) was the editor's wife and the original Circulation Manager; she still serves in that position today.**

Sadly, the mortality rate of our mailings was very high. Initially we used white paper envelopes but we soon learned that they tore easily, addresses became separated from issues, and those that did arrive were often so damaged that they had to be replaced.

Reaction to the first issue was generally favorable, especially with respect to the content. I found out early on that I could count on at least two of my editorial board members, Peter Embrey (then curator of minerals at the British Museum) and Richard Bideaux, to write very candidly of their reactions. First a letter from Embrey arrived dated 5 June 1970, with appended comments echoing Embrey's remarks, written in longhand by his colleague Max H. Hey:

> I like the contents — the right sort of level, on the whole, except for mirabilite. On the other hand, I don't care for the size — slightly larger than *Min. Abstracts*, and that's bad enough for a standard bookshelf — nor for the layout which I can only describe as 'orrible!!!! Even the *Scientific American*, which has lots of advertisers as an excuse for fragmenting articles, doesn't descend to the "Woman's Own" trick of continuing articles backwards! *Geotimes* leaves something to be desired in its layout, particularly the bad habit — for a journal that may need binding — of having plates running off the page, but it's at least 200% better than the *Min. Record*!! John, I don't mean to be unkind in this but I think you've been very badly advised by some layout man who's only interested in arty-crafty rubbish and cares nothing for the content. This is not supposed to be an ephemeral publication but something to be kept for reference. In short, sack him! I'd go further and say it might almost be worth running a revised reprint! . . . Enough of this! I only hope you'll take these comments in the constructive way they're intended. Max and I are fiddling with the article on types — you'll have it fairly soon.

My response, dated August 18, 1970, reads (in part):

> Sorry about the long period of no writing. It wasn't that I took your remarks personally, although I was at least temporarily stung by them. After I got over the shock of your reaction and took stock I found that you were the ONLY ONE (or two, including Max) who felt that way of all the people from all positions in the spectrum who have taken the trouble to express to me their reaction to the magazine [Bideaux's letter didn't arrive until much later]. On that basis I decided that your reaction, although interesting, should not be taken too seriously. There were, of course, minor things which needed to be changed and are being changed. Most, if not all, can be attributed to my inexperience and the haste with which issue number 1 was put together.

Richard Bideaux also weighed in with his share of constructive comments on the first issue, and these were truly an eye-opener for me, for they identified problems that I hadn't even considered.

> Typographic errors [are] a little too numerous. Implies to me that someone other than you should check the galley proofs — by then you have read them 20 times & will not see errors . . . should be someone who has read the copy no more than say once or twice prior to checking galley proofs. Page 10, NLY column — first two paragraphs show "white rivers" — improper line justification; later (paragraphs) are ok. Sometimes extra vertical spaces appear unnecessarily — example p. 25, Cole reference, above & below it. Some symbols are not in your typeset, accent mark noticeably put in by hand. Errata which probably must be corrected, p. 31, Turner is past president; J.R. Goldsmith is VP. I see nothing else that demands correction. Other errors of fact not requiring retraction: p. 31, Sorbonne's new exhibit hall is not in Jardin des Plantes; p. 11, Yedlin, Tucson was Rocky Mtn show only, not American Federation. . . . Don't take the above personally - the mag is nearly 100% excellent, but needs error rate cut to 1/2 or less present, shouldn't be too hard to do.

About a year later, this from Bideaux:

> Mag looks good as ever, no typos on first reading. Saw Dave Wilber, he wants an ad but had no idea of rates-I told him $30-$35 for little one, says all he needs, will send in; also Bideaux Minerals preparing new copy I hear.

The work load was extreme. Apart from the routine editorial chores, I was obliged to write an editorial for each issue. As there were no letters to the editor at the outset I made up some, beginning in issue number two, in order to illustrate just what kind of forum I hoped to provide in the journal. I also prepared the abstracts of new species for "Minerals Notes" and wrote the "What's New in Minerals" column for the earliest issues. The lack of ads and the thinness of the first issues necessitated certain unfortunate juggling such that some articles beginning in the middle of the magazine had to be continued to an earlier page. We remedied this by the second volume when we had more things to use for partial pages of text and thus had more flexibility. I patched together an editorial board but in the early years the members really were of very little

utility, for I found that I seldom had time to send manuscripts out for review.

Even under those difficult circumstances, the *Mineralogical Record* received remarkable support and input from Peter Embrey and Richard Bideaux, both very important participants in many stages of the development of the journal. Embrey minimized the mail delay problem on his own initiative: "If you will be kind enough to send my personal copies of the Record by air, so that I know what's in it etc., I will not charge the Record for any postage that I incur at this end. Is that a fair deal? If not, say so!" Bideaux was responsible for organizing the meeting which brought Art Montgomery and me together, a meeting that was also attended by Bideaux, John Anthony (U. of Arizona), Desautels, Peter Embrey, Joseph Finney (Colorado School of Mines), Richard V. Gaines, Mike Groben, Jack Hanahan, Russ Honea, Louis Moyd, Julius Rosenberg, John and Marge Sinkankas, Sid Williams, Neal Yedlin, Paul Seel and Paul B. Moore (U. of Chicago). Bideaux also solicited numerous articles on behalf of the journal at the very beginning when it was so important to attract good ones, and he contributed some excellent pieces himself. Throughout the first year he continued to pull articles, good ones mostly, out of people and he promptly reviewed the manuscripts that I was able to send to him. He carried on an active correspondence with Montgomery and was in frequent communication with John Anthony over the journal and its proposed contents. In reporting discussions with Anthony to Montgomery, Bideaux had the following to say:

> John (Anthony) suggests that the editorial (from a grammatical and style point of view) must be maintained at a high level as well - he would like to think of it as the American Mineralogist, part B; containing a higher proportion of articles that could otherwise appear in Am. Miner. but more oriented towards new occurrences, locality descriptions, and classical descriptive mineralogical contributions, etc. (Too bad that it can't literally be the Am. Miner., part B; or is there any possibility that it could be?)

Bideaux also grappled with one of our many concerns, that of whether or not the *Mineralogical Record* should publish original descriptions of new mineral species. He had this to say, in a letter to Montgomery.

> It seems to me that a central question is whether new mineral descriptions should appear in the proposed Journal. Certainly these are the essence of classical descriptive mineralogy. Also, even though they are given first billing in Am. Miner. [author's note: not any more!!] they are a little out of place there compared to the bulk of the contents. Certainly their inclusion would go a long way towards professional acceptance of the Journal, guarantee abstracting of its contents and a wider circulation to Libraries, etc.

In a letter to me dated Feb. 29, 1970, some few weeks after the fateful meeting in Tucson, Bideaux wrote that "some sort of editorial style book should be adopted." Great idea, but who was to do that? This was not something that I felt competent to tackle, and there certainly was no time available for the diversion. He later sent a copy of *Gems and Minerals*' instructions to authors. A subsequent letter found Bideaux offering his time and computer "perhaps at cost" in order to develop an index after the first five years, an offer that I regret never having accepted. And he had the nerve to request a "projected budget" for the magazine — as if I had one! — that he might show around in the course of soliciting financial backing. What he didn't understand then, but probably does today, is that I am constitutionally incapable of developing a budget! So, he didn't get his proposed budget. All through this frantic gestation period Arthur Montgomery was as nervous as a cat, raising questions about this and doubts about that, to the point of real distraction. Richard was reassuring: "I think that most of his fears will vanish when you have demonstrated by the first issue what you can do."

Figure 6. **The second issue, with a cover painting by Mrs. Ingeborg Vass. The amazonite and smoky quartz (USNM specimen) is from the Pike's Peak region, Colorado.**

At this particular time Bideaux was very much on the show circuit so he took advantage of opportunities to plug the magazine while lecturing at such venues as Pasadena and Detroit. In Pasadena (November, 1970) he deflected the mounting public perception in the West that the *Mineralogical Record* was "an East Coast-Smithsonian magazine," as former L.A. County Museum curator Bernard Fuller had recently asserted. He took it upon himself to determine what rates other magazines were paying for advertising in journals he felt the *Record* should advertise in, such as *Science Teacher*, and persistently urged that I advertise in a variety of publications, and that I produce an ad "striking enough to capture attention!" Great idea, but thwarted by weak resources, meaning no time and no money.

Bideaux also allowed me to persuade him to write a regular column, "The Collector," beginning with volume 2, number 4. I had proposed something like "The Thumbnail Collector" but he informed me that he hated the term thumbnail. In any case, there was a conflict with Bob Jones, who had already volunteered a column for the *Record.* About this Bideaux wrote in May 1971:

> Have written Bob Jones, talked to him on phone, letter today confirms, no problem, he relinquishes prior claim to such a column. Seemingly no problem in this that I could detect—he has one column already!

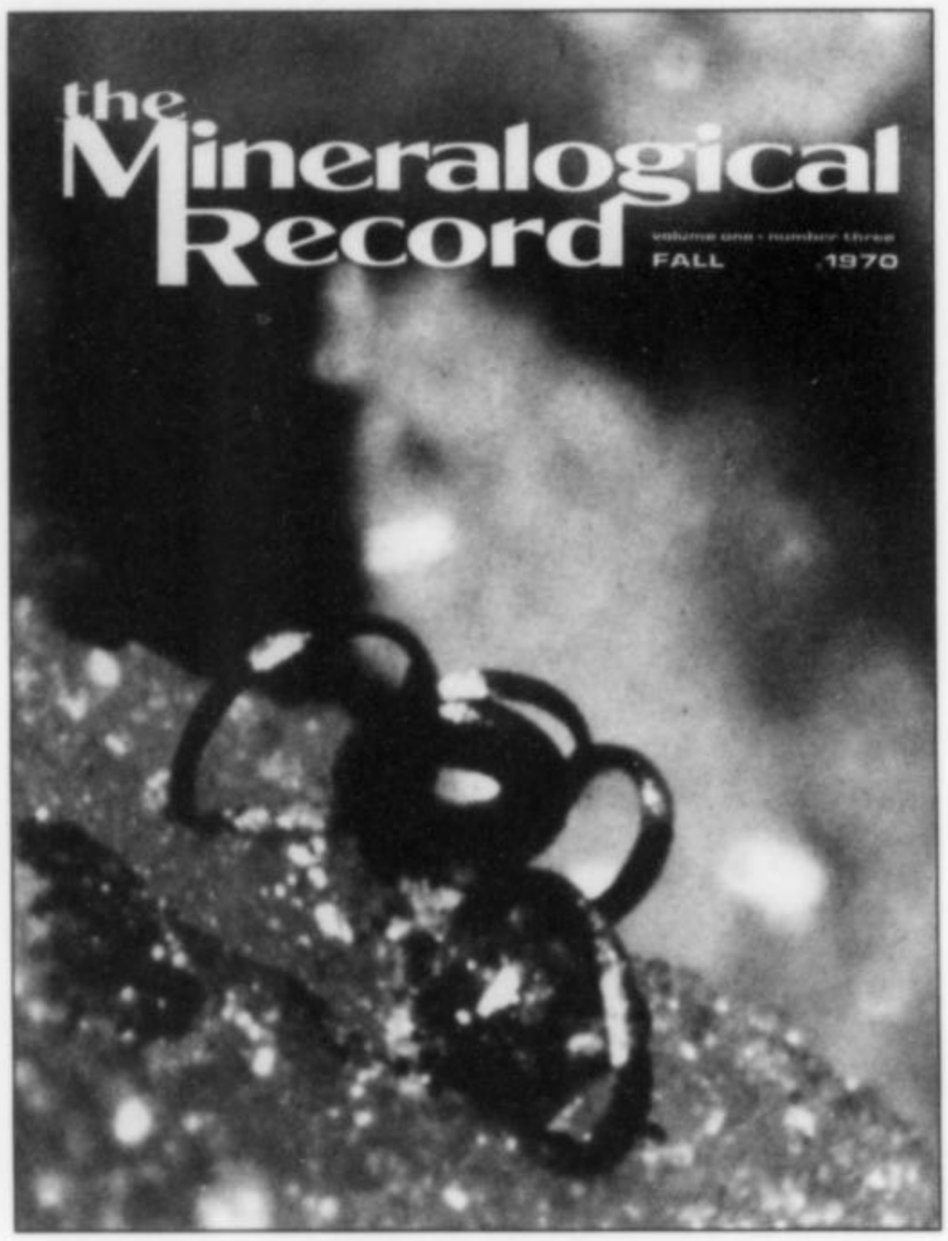


Figure 7. **The third issue, with a cover photo of pyrite rings from Hall's Gap, Kentucky by Ben Kinkead; collection of Lee Wood.**

Although being pretty damned quick to offer "constructive" criticism, Peter Embrey was nevertheless supportive and active in many other ways. He wrote and collaborated on writing early articles, and he solicited more from other authors in Great Britain. More indicative of his willingness to work hard to ensure the success of the *Record*, however, was that he offered to push subscriptions in Great Britain., to sell back issues and Fleischer's *Glossary,* and to handle the payments for us there:

> I am sorry to be a bit rough on you, but I must demand some action from you on Glossaries, for which orders are slowly piling up. I've done my best to overcome my natural inertia over communication with you, and the least you can do is to return the compliment. I can't act as the British agent without your cooperation, and will have to give it up if I don't get it. The other thing is that, whether you like it or not, I shall be letting you have about $400 (or just under) in the next couple of months; if I don't I shall have an unwanted and unnecessary hassle with the Bank of England over exchange control problems.

Joel E. Arem, too, turned out to be an important resource in a way that I could not have anticipated. At the time of the establishment of the *Mineralogical Record*, Joel had just been awarded his Ph.D. and had been hired as a curator at the Smithsonian. He contributed several articles for the first two volumes and innumerable book reviews in what became his own column, "The Record Bookshelf," until multiple reviewers were used beginning with the last issue of volume 3. More importantly, however, he was also just beginning to develop his skill as a mineral photographer, and so he became very helpful in providing desperately needed photographs for color covers, and for articles, columns (What's New in Minerals?) and even advertisements that appeared in the early issues, even if this shortly turned out to be a little awkward in some ways. Richard Bideaux, who might appropriately be tagged "the conscience of the *Record*" during the first years, wrote (Sept. 4, 1971) that "I had had a comment on the 14 times Joel's name appeared in this last issue, and had written him saying this was a bit too much. His reply back already—claims that he must insist on having his name on each individual photo that is 'original' with him—whatever that means." Joel was placed on the editorial board starting with volume 1, number 3 and served until volume 4, number 3.

It must be remembered that while all this was occurring I still had a full-time position at the museum, a job that was in itself very demanding. Furthermore, I had three young and very precious daughters and I was not willing to block them out of my life. I tried my best to be a good father to them during all of this. I am grateful that they appear to bear no resentment about the special time that they didn't receive with me because of my involvement with the *Record*.

VOLUNTEERS AND CONTRIBUTORS

To a large extent the story of the *Mineralogical Record* is a story of volunteerism and generosity, without which the journal surely could not have survived. At the outset it became obvious that the *Record* had struck a responsive chord with many of those I hoped to serve, even if the circulation was disappointingly slow to grow. Several mineral dealers ran notices about the new publication in the price lists that they circulated. Mineral clubs began to buy gift subscriptions for speakers and young members new to the hobby. Some speakers at club meetings even contributed their honoraria to the magazine (my notes mention Si Frazier, Neal Yedlin and Carl Krotki, but there were no doubt many others).

It was, I believe, Arthur Montgomery who first proposed that there be an auction to raise money for the journal at the time of the Tucson Show every year, and he donated specimens from his

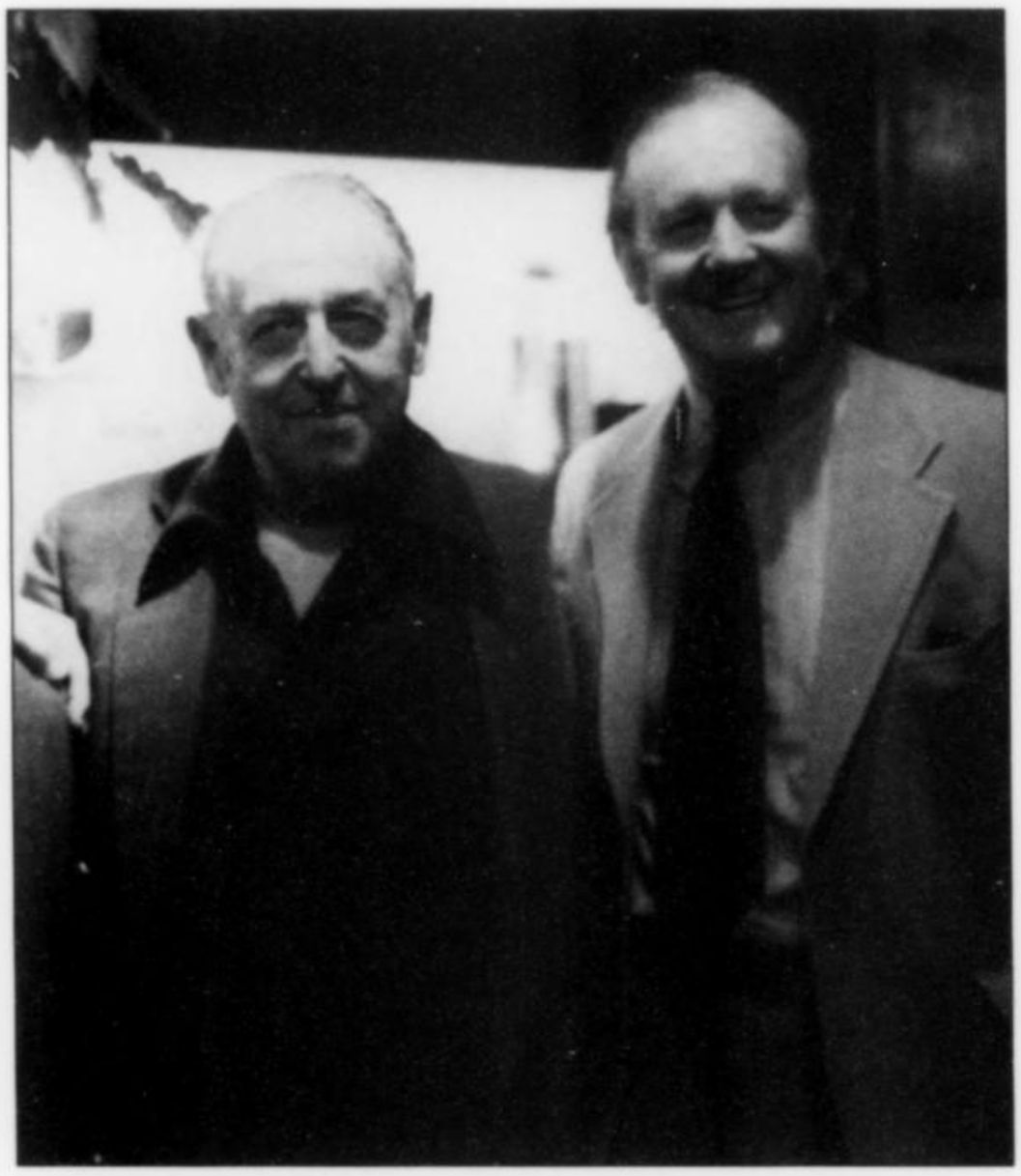


Figure 8. **Micromounting columnist and collector Neal Yedlin (left) with Paul Desautels (Kent England photo).**

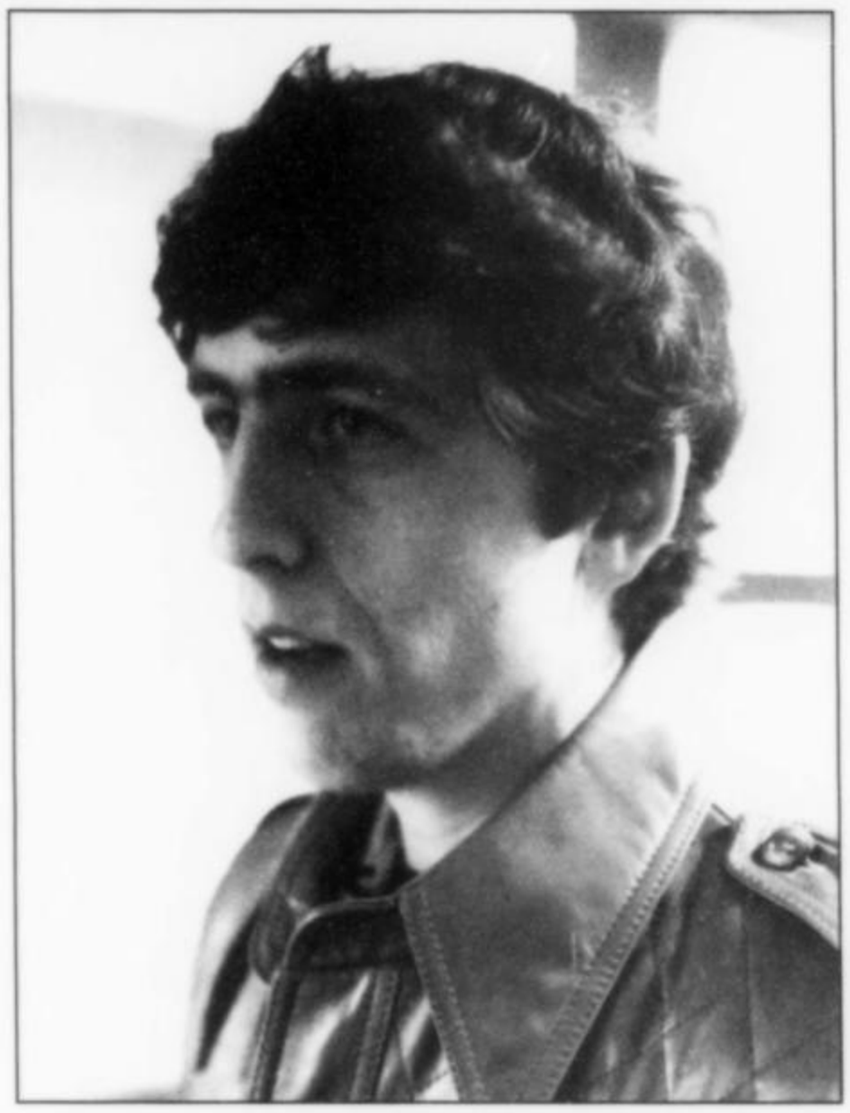


Figure 9. **Joel Arem, author, columnist, associate editor and mineral photographer during the early years (Kent England photo).**

private collection to be sold at the first auction. Mineral dealers began to donate specimens for subsequent auctions and in no time at all there were up to 140 dealers contributing. Most of the top dealers always attended the auction, which had become a popular social event, and could be counted on to bid in a spirited fashion on just about everything that was offered. Clifford Frondel donated a suite of gold specimens and a wonderful Japanese stibnite from the Harvard University collection for the auction, an amazing demonstration of how strongly he believed in the importance of the *Mineralogical Record*. I hasten to point out here that all of the specimens that came from various supporters were spontaneous donations, for I had neither the time nor the inclination to go to dealers with my hand out asking for contributions, and I had little help. Following the first auction I did manage to send letters to most of the prominent dealers asking them to support upcoming auctions. It was all I could do to organize the contributed materials, and the event itself, including finding volunteers (again) to assist with everything from auctioneering to spotting and keeping sales records. I tried to be present at the *Mineralogical Record* subscription table as much as possible, because I looked forward to chatting with the many subscribers who stopped by. Yet I was, after all, in Tucson representing the Smithsonian and my first responsibility was to serve my employer while there. The first auctioneers, in order of service, were Neal Yedlin, John Sinkankas, Al McGuinness and Clarence Maier. In publishing, there is never any shortage of complaints. The auctioneers, for example, were found wanting by some who expressed their displeasure to me. What was I to do? The auctioneers were volunteers and I couldn't afford to pay a professional. Actually, Clarence Maier had professional experience, but he didn't know minerals very well so he was perhaps less effective than his predecessors who did. John Patrick, too, helped in various ways at the auctions, and Gary Hansen, the best auctioneer the *Record* ever had, came somewhat later.

Clifford Frondel found yet another way in which to help: he actually paid for a full-page advertisement for the *Record* in *The American Mineralogist*. The ad appeared in their July-August 1971 issue and stated "At last, a journal to fill the long-standing void in mineralogical literature between the very technical journals and the hobbyists' magazines. The Mineralogical Record is devoted to minerals, providing informative reading in all phases of the science and hobby." This was followed by a list of 12 very prominent mineralogists lending their endorsement.

The Tucson Gem and Mineral Society could not have been more gracious. Not only did they allow the *Record* to have a promotional table at the show itself, but they provided a room and public address system for the auction. Other shows around the country granted space for promotion of the journal, and people often volunteered to man the table and take subscriptions.

A rapidly developing problem was the handling of foreign subscriptions, especially with different currencies and incredibly long delivery times. In this matter we were blessed with volunteer subscription agents who recorded renewals and collected funds in local currency, eventually converting them to dollars and passing them to us. The earliest were Cynthia Peat (in Canada; now deceased), Roger Harker (in England) and Horst Windisch (in South Africa). Cynthia was the only one whom I knew personally; the others just offered their services and I accepted their help without even knowing anything about them. On the domestic front, a good friend and Smithsonian colleague, Florence Ruhoff (now Florence A. LaBruzza), volunteered to handle *Glossary* sales through her post office box in Bethesda, Maryland. Florence received payments for the *Glossary,* deposited them in an account, and mailed the books to the purchasers. Actually her participation started earlier for she could always be counted on, along with my dear friend Arthur Roe (a former Smithsonian volunteer, now deceased), for emergency proofreading of manuscripts when time

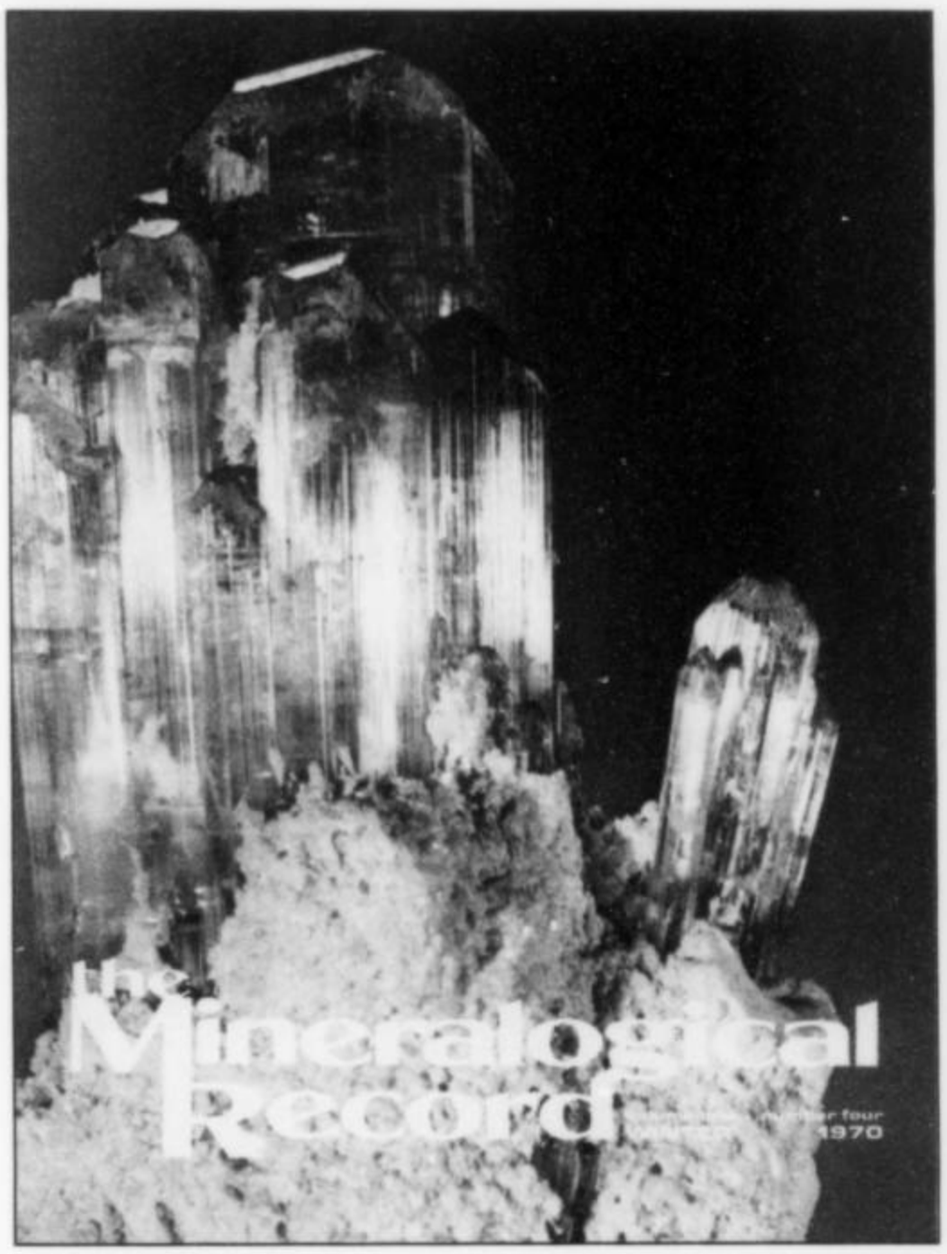


Figure 10. **The fourth issue, completing the first year (1970), the only year in which the magazine was a quarterly. The Brazilian tourmaline (USNM specimen) was photographed by Lee Boltin.**

constraints precluded sending them out to members of the editorial board. At least I got someone besides myself to look at them. Florence also helped with retyping some of the pages of the *Glossary* manuscript. Later and also on the local level there was another friend who helped mightily with the *Glossary*. G. Edwin ("Ed") Maccubbin, Jr., then a commander in the U.S. Navy with an office in the Pentagon, offered to handle the packaging, addressing and mailing of bulk orders of the *Glossary of Mineral Species 1975*, destined for dealers ("over-the-counter sales") as well as billing the recipients. All we had to do was provide him with boxes of books and he did the rest. They were at times transferred in Bowie in the evening when Ed would drive out from his home in Alexandria, Virginia, and at other times in the parking lot of the Museum. On some occasions, however, it proved necessary to make the "drop" in the parking lot of the Pentagon and when this occurred I couldn't help but wonder if the C.I.A. or some such agency wasn't watching with more than casual interest. Ed, with help from his wife Donna, provided this valuable service until near the end of 1978 when the effort had to be transferred to Bowie because Ed was assigned for a year's naval duty on the island of Diego Garcia, far too remote a location to allow him to continue mailing books on our behalf. Today he tells me that he felt privileged to have been able to make that contribution to the effort.

Authors were, of course, unpaid. Paul Seel translated a couple of German manuscripts for us without compensation. I have already mentioned the neighbors who assisted with mailing the issues. Their help was vital for, surprisingly (in retrospect), the number of paid subscribers had reached 2000 by issue #4 of the second year. That meant 2000 copies to put into envelopes by hand, sorted by zip code, then bundled with string every other month. I am reminded of one day when, after I had hauled the magazines to the post office, my back was so sore that I couldn't even bend over to tie my shoe laces. It was shortly after that when Mary Lynn and I decided to have the magazine professionally mailed rather than risk losing all of our friends or my being permanently disabled with back problems. Even my two older daughters were pressed into service. One of them, Kendahl, recently reminded me of the evening they spent with scissors trimming thousands of renewal notices because we had printed them on cards that were larger than the second-class postage regulations allowed. Countless other friends and supporters assisted in various ways, and I apologize for not being able to mention you all, but memory fails. In a very real sense, both Mary Lynn and I were volunteers for we took nothing out of the effort for ourselves for the first several years. It wasn't until January 1972 that I began to pay Mary Lynn the very modest salary of $100 per month for her work. My first compensation, we believe, did not occur until eight years into the effort (1977), when I claimed $3200 for myself, upon Mary Lynn's insistence.

As more dedicated readers are fully aware, the first 15 issues contained no color inside, as the budget simply would not allow it. This changed dramatically in 1972, however, when a good friend from the Baltimore Mineral Society, Randolph Rothschild, made his first contribution of funds to support the printing of color in two articles about the minerals of Arizona's 79 mine. Randy made much-needed cash contributions toward color expenses every year thereafter, until his death just recently. The other regular donor, who came on board around 1977, is Philip Rust. Philip has made generous and substantial donations every year since then, and is historically our most important donor by far. His support has truly been essential to the continued survival and success of the magazine.

There were countless other friends and collectors who participated in one way or another and whose efforts I was not aware of. Some of those who toiled extra hard that I knew about included Marcelle Weber, Carl Krotki, Pat Gross, Herb Corbett, D. Vincent Manson, Richard V. Gaines (all now deceased), and Dona and Wayne Leicht.

THE CONTENTS

Much of what I initially planned for the new journal was fairly standard stuff: editorials (including more than a few controversial ones), reports of new mineral discoveries, locality and mineralogy articles of all kinds (both contemporary and historically oriented), columns, abstracts of new species descriptions, news notes from museums and other institutions, personality sketches, memorials, show news, book reviews, and letters. I wanted very much to personalize the journal and had intended to introduce brief biographical sketches of new authors, possibly even with their photographs. To a degree I envisioned being somewhat of a crusader, but several of my early editorial-writing efforts met with less than inspiring receptions. One of the issues I took on was the subject of the so-called "uniform rules" for display of specimens adopted by the federations. The net effect of that effort, as nearly as I could judge, is that I lost some subscribers and hardened the resistance of others to change. I tried to persuade the same people to apply some intelligence to the use of varietal names of minerals, and I also poked some fun at "rock shops," a term I suggested was usually synonymous with "rock junk."

Early on I decided to conduct an experiment to test the widely held theory that if experienced dealers and collectors would appraise the same set of fine mineral specimens, their results would be remarkably consistent. Through the resources of the Smithsonian I devised the test using a set of ten specimens from the National Collection. The first appraisals were gathered in 1972, then the same specimens were reappraised five years later. As far as I know, this is the only such experiment ever conducted using mineral specimens as the subject, and the reader is invited to read the subsequent article which appeared in January-February 1977. I am grateful to Wendell Wilson, for if he hadn't participated and taken the photographs, the article may never have been written.

Occasionally I gave in to the urge to have a little fun, as with the Prosper Williams ad. Prosper was an excellent and much admired mineral dealer, and also an artist of considerable skill. As he was a native South African, he embellished his ad with one of his own drawings depicting an antelope-like animal called a springbok. Knowing he wouldn't be upset, I began to shift the springbok to the left a little in each successive issue (as if it was running out of the ad in super-slow-motion), until it was off the margin; then it reappeared on the opposite side. Prosper was amused when he finally noticed what was happening. On another occasion, Bill Larson of Pala Properties (now Pala International) provided me with a photograph of a nearly nude woman wearing only boots and a hardhat pushing a wheelbarrow into (and another of the same woman pushing a wheelbarrow out of) his tourmaline mine. I don't think he believed that I would run it with his ad, but I did. At the last moment, however, I became a little uneasy about it and had the graphic artist place a diagonal black bar across her backside. What was perhaps my most infamous hoax was composed in conjunction with Rick Smith, a dealer at the time. While he and I were on a trip together in Europe, we collaborated on composing an ad for him which declared the following: "Minerals expertly repaired, Suitable matrix supplied for loose crystals, Old labels faithfully copied, Broken crystals artfully reterminated, pornographic and scatological specimens," and more (volume 5, number 2, p. 91). We received some 30 letters from outraged readers, including a few subscription cancellations. In fairness, there were others who greatly enjoyed it and one wrote that it was "the finest piece of satire ever to appear about mineral collecting," and that was, of course, just what it was

Figure 11. **A convivial group photographed at the Rochester Mineralogical Symposium ca. 1979 (all of whom had minerals named after them), which includes many people involved in the early years of the *Mineralogical Record*: (back row from left) Richard Bideaux, Paul Desautels, Joseph Mandarino, Lou Perloff, John Jago Trelawney, Robert Whitmore, Robert Gait; (middle row from left) Richard Gaines, John White, William Pinch, Charles Key, Hatfield Goudey; (front row from left) Prosper Williams, Paul Moore, Peter Embrey.**

intended to be. Peter Embrey weighed in with the following comment:

> As for Rick's advert in the Record, we all thought it hilarious and the best - almost the only - bit of fun for ages. If your average readers are so stuffily starch-shirted they can't see the joke then it's high time they climbed into a cabinet, closed the doors, and threw away the key!

There is much of what was done in the early years that made me feel it was all worthwhile. In an early editorial (volume 2, number 2) I advocated that mineral shows adopt a "Best in Show" award for the best specimen of a single species at that show. I believe that the Tucson Show was the first to try it out and it has been successful. Other shows have adopted the feature as well. The Cincinnati Show set up an identification table in response to the suggestion in an editorial. The Detroit group adopted another editorial suggestion and produced handouts for their shows explaining what mineral collecting is, where it occurs, where clubs meet, and so on. That Michael Fleischer would have proposed that the *Record* publish his *Glossary of Mineral Species* had to be one of the highlights of my career. It was exceedingly flattering, I felt (and still do), that he believed enough in me to entrust me with this task. When I look back and reflect that we were able to bring out the first edition of the *Glossary* in 1971, only the second year of the magazine's publication and the one in which we changed it from a quarterly to a bimonthly, I quite frankly don't know how we managed it. I do know that Bideaux's willingness to manually type the whole thing for us, with the assistance of his secretary, was critically important in making it possible. Even more remarkable, however, is that it was offered to subscribers for only $1 ($2 to non-subscribers). That the *Glossary* (now about to appear in its ninth edition!) has turned out to be "the bible" for collectors, unsurpassed in its usefulness, has been for me the source of immense satisfaction, and a great tribute to the remarkable dedication to the science of this highly regarded man. I take great pride, too, in the fact that the list of authors contributing articles and other materials for the early issues reads like a *Who's Who* in contemporary mineralogy: Clifford Frondel, Brian Mason, Paul Desautels, Paul Moore, Joel Arem, Michael Fleischer and many others with the U.S. Geological Survey, Cornelius Hurlbut, Richard Bideaux, Neal Yedlin and John Sinkankas (John even donated specimens for the earliest auctions). Later the list grew to include Kurt Nassau, Peter

Embrey, Max Weibel, Arthur Montgomery, Richard Dietrich, and Richard Mitchell. I can even claim the distinction of rejecting an article by my very good friend Fred Pough.

In the last issue of 1975, I reflected editorially over the first five years of publishing the *Record*. I made the point that great efforts had been extended to blunt the criticism that the magazine was too technical for many readers. I stressed that we actively tried to attract articles from amateurs, that we worked very hard to upgrade these, and that we almost never rejected manuscripts submitted by them; by contrast, we rejected "far more articles submitted by professional mineralogists." This editorial also noted that, finally, we had arrived at a point wherein there was sufficient lead-time to allow for sending galley proofs to authors for reviewing prior to publication. A major breakthrough! Also announced was our hiring of a professional mailing service for the magazines, and the computerization of the list of subscribers (can anyone today imagine publishing a magazine for five years without computerizing the subscriber list?).

Among the many sources of personal satisfaction is the fact that there remains to this day a very active market for back issues of the *Mineralogical Record*, with at least one individual issue fetching as much as $175! I have been told by a book dealer friend that the *Record* is virtually unique in this respect, that back issues of all of the other popular mineral journals are difficult even to give away. I discovered the truth of this recently when I was unsuccessful in selling old issues of *The Mineralogist*. I am also very proud of the fact that in just six years the paid circulation grew to a very respectable 3980 subscribers.

There were few true disappointments arising from this enterprise, but at least three are worth mentioning. One was the fact that the circulation never took off and grew at the rate, or to the extent, that I had once anticipated. At the time, *Lapidary Journal* claimed a circulation of nearly 50,000. That number had given me false hope, for I felt that we could expect to reach 25,000 within five years. Needless to say, the *Record* has never come close to that figure, even after 34 years. Another surprise was that the "Museum News" column did not draw more support from museum curators. I thought that this would be one of the most popular columns, that it would attract regular contributions from the world's curators eager to share the news of new acquisitions, personnel hirings, and the openings of new exhibits. Instead there was practically no such response. And what I thought was one of my best ideas never even got off the ground. I had urged that researchers in mineralogy use the *Record* as a means of advertising their need for specific minerals for their studies. It was appalling to me that so many researchers did not appear to realize that the Smithsonian's vast collection, for example, was there for that purpose, and that there were many other such collections available to the scientific community around the world. Instead of requesting the free and often previously analyzed materials in these institutions, researchers would repeatedly write to mineral retailers such as Ward's Natural Science Establishment asking if the species needed were available for purchase. I had hoped that the journal could form a bridge between these needs and potential suppliers, but the service was never utilized.

FINE IRONY

When I was first hired by the Smithsonian as a museum technician in 1963, it was generally understood that Natural History Museum policy precluded promoting non-Ph.D.'s to curatorial positions. This policy troubled me, for I felt that it was completely unreasonable, yet I felt privileged to have been given the opportunity to work with what many consider the finest mineral and gem collection in the world. Furthermore, I was moderately confident that I could override the policy somehow, as Paul Desautels (who also lacked a Ph.D.) had managed to. I had in mind taking more graduate courses locally in order to earn my Ph.D. while still employed at the museum. In time, however, it was made abundantly clear to me that this strategy probably would fail for, even if I acquired a Ph.D., I would have to apply for a curatorial position after one had been created and advertised, and I would have to compete with all other applicants. After some time I began to see that one simply couldn't advance from museum specialist (a "subprofessional" position) to curator.

In starting a new mineralogical journal, therefore, I was always mindful that it could provide for me a way out of this dilemma. If the journal proved successful—and I was quite confident that it would—I anticipated leaving the museum to devote full time and energy to it, while deriving a good salary as publisher and editor. Imagine my surprise, just three years after the birth of the *Mineralogical Record*, when the magazine itself became the vehicle that I rode into a curatorship. I learned that the director of the museum, Dr. Richard Cowan (a botanist), was so favorably impressed with what I had produced with the journal that he led a successful effort to have me promoted to curator. I was told that he showed the journal at a meeting of the museum's curators and asked why other departments were not producing similar journals. What fine irony, then, that the publication that was to provide me with a means to leave the museum because I had no hope of becoming a curator, became the key to my becoming a curator with the Smithsonian, which was what I most wanted.

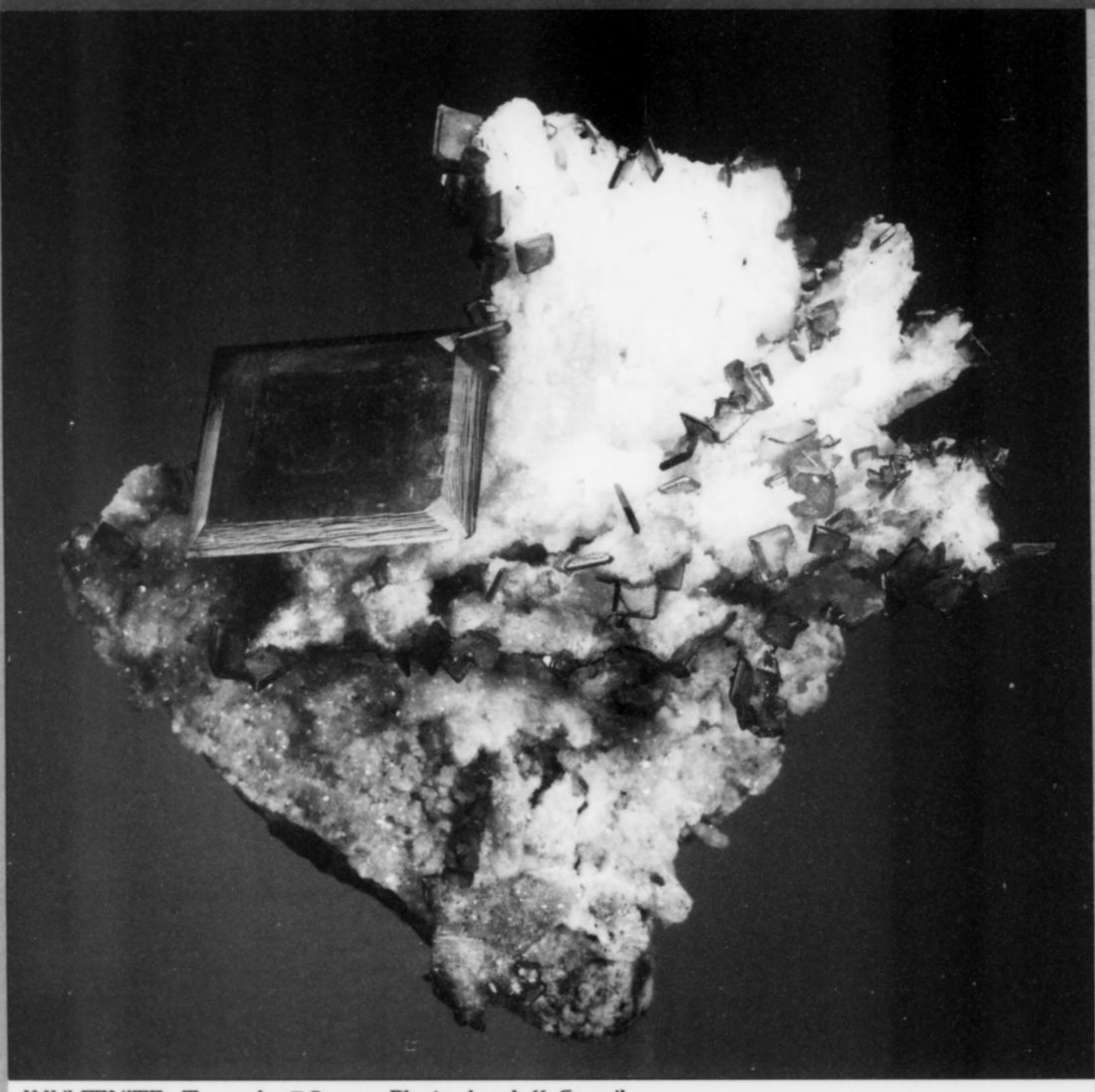
The irony doesn't end there. When I made the decision to remain with the museum I recognized that I could not much longer continue to serve as editor of the journal, as the demands of two full-time occupations were too much. When the opportunity presented itself, I began to involve Wendell Wilson more and more in the production effort. Wendell, who at that time was still a graduate student, had desired a more serious involvement at least as early as 1972 (volume 3), when he contributed two articles, a book review and original art for the cover of issue number 6 (his first-ever mineral painting). In the following year (volume 4) he began writing the column "The Photographic Record" and was added to the editorial board. This arrangement continued until volume 7 (1976), when he was awarded his Ph.D. in Mineralogy from the University of Minnesota. He had been thinking of seeking a curatorial position at a major mineral museum after graduation, but none were open at that time, so I offered him the chance to take over for me as Editor of the *Record*, and he immediately accepted. He was taking a risk in doing so, because the magazine had only enough money to pay his very modest salary for one year. If he proved unable to raise circulation enough to cover his own salary in the following year, he'd be back looking for a curator position. And so, whereas in the January-February issue I had identified myself as Publisher & Editor on the masthead, in the following issue I became Publisher & Editor-in-Chief with Wendell as the new Managing Editor. After a few months' break-in period the changeover was completed in the July-August issue, wherein I was listed simply as Publisher and Wendell as Editor. And I am happy to say that he did, in fact, manage to raise the circulation sufficiently during his first year and a half, in part by creating attractive special issues such as the first Colorado Issue and the Tsumeb Issue which generated excitement and new subscribers.

I remained Publisher until a major debacle occurred at the Smithsonian in 1981 which precipitated Paul Desautels' abrupt departure the following year. The administrative climate that ensued was definitely unfriendly. Everyone in the mineralogy section of the department was having their activities very closely scrutinized for any conceivable appearance of wrongdoing. Smithsonian auditors now determined that my association with the

Mineralogical Record (an association formerly so laudable as to merit my promotion) placed me in a position where the possibility of a conflict-of-interest was too great for their comfort, and so they forced me to sever my relationship with the journal. Thus, beginning with volume 14, number 4 (1983), my name had to be removed altogether from the title page, reappearing a few years later simply as "founder." Wendell has since then taken on the duties of both Editor and Publisher, lately with the assistance of Tom Moore.

A final bit of irony with which to close this tale: *Rocks & Minerals*, the journal that refused to allow my participation and in so doing forced the creation of my own publication, has recently invited me to become one of its consulting editors, and I have jumped at the chance!

Tsumeb Minerals Wanted!



WULFENITE, Tsumeb, 7.8 cm. Photo by Jeff Scovil.

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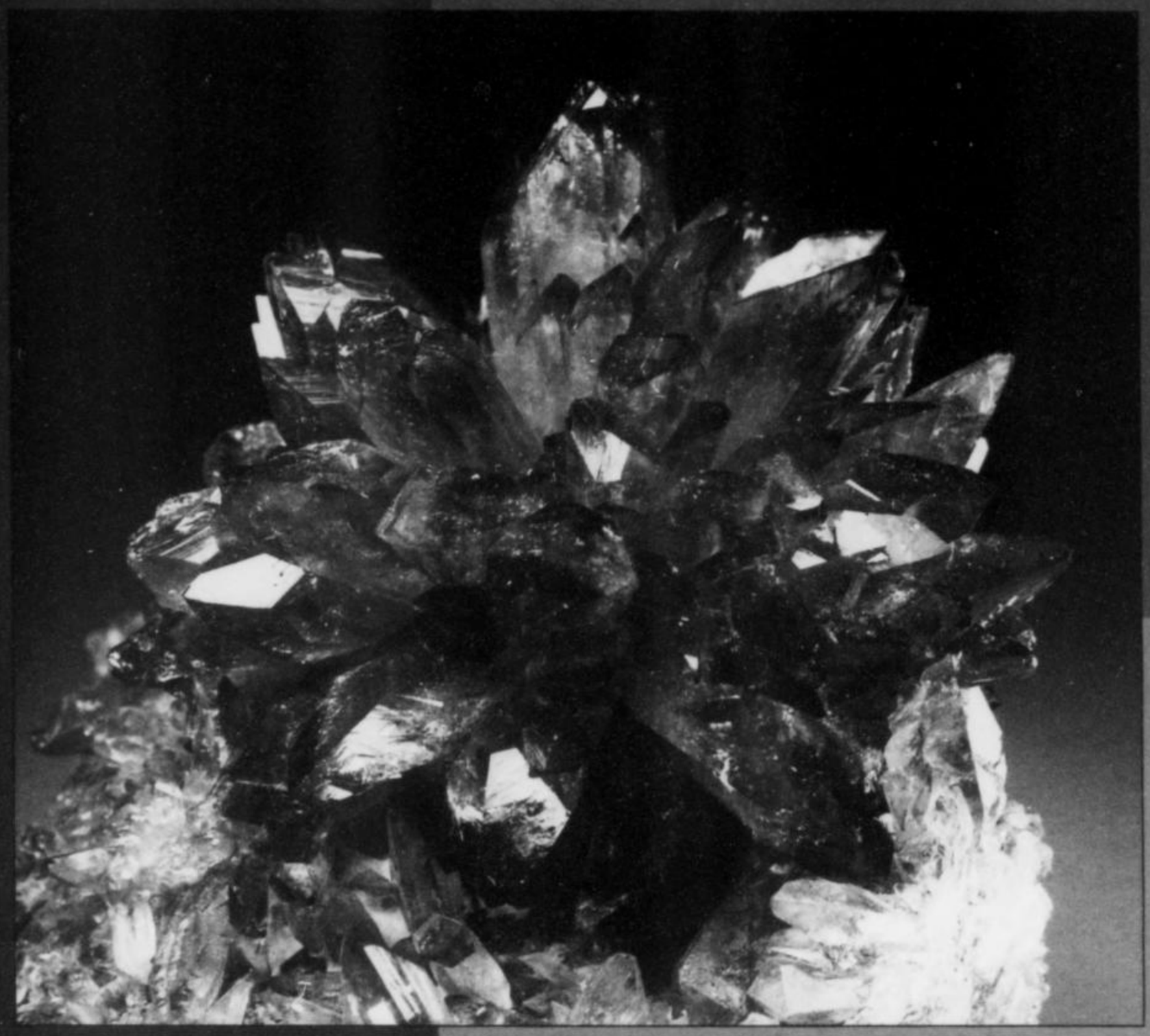

Creedite, 5.2 cm, from Akchatau, Kazakhstan.
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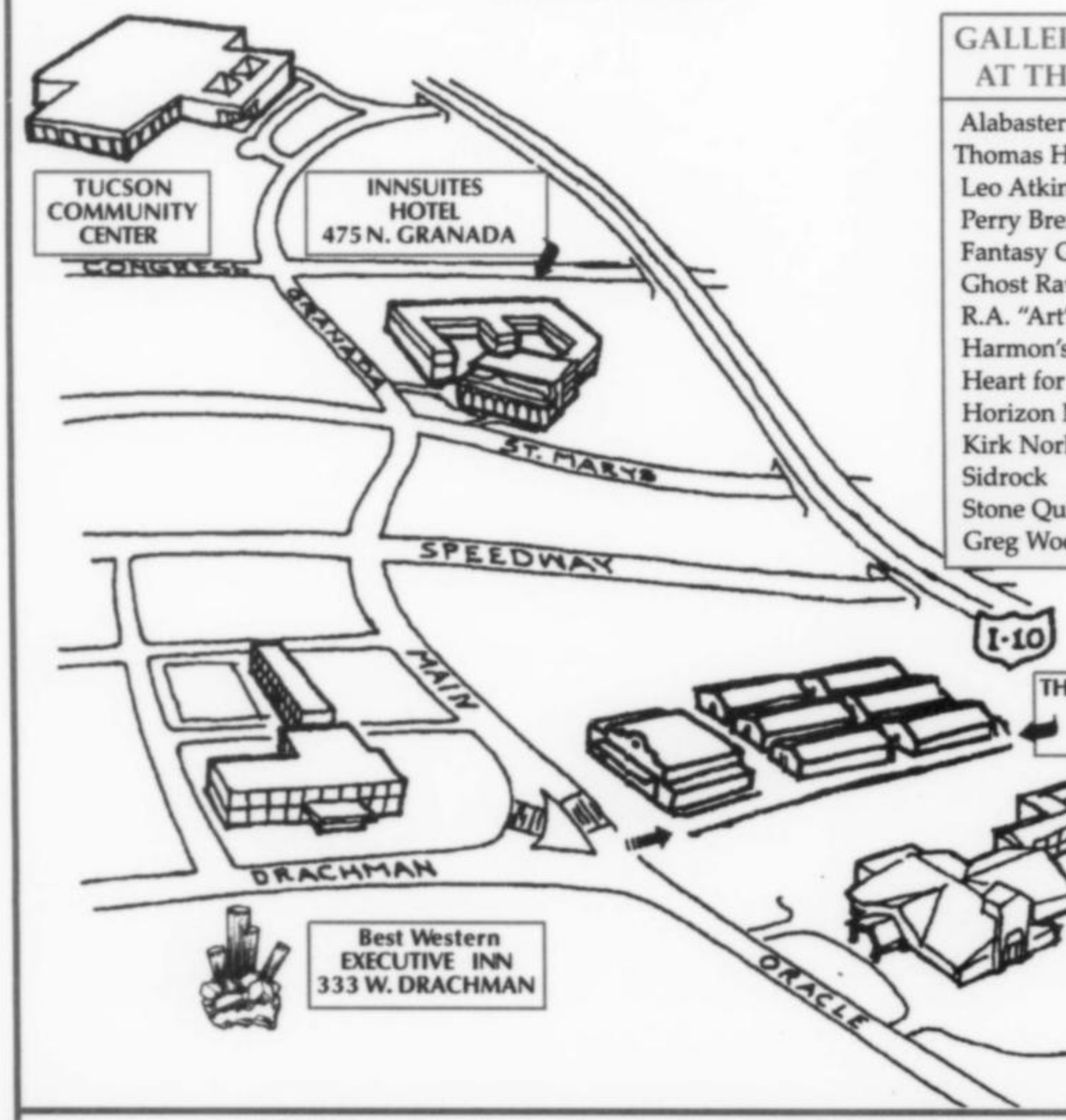

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Letters

200th Issue of M.R.!

I would like to congratulate the *Mineralogical Record* on its the 200th issue (July-August 2003). I had expected that the achievement of reaching 200 issues would have been mentioned somewhere in that issue, or that there would have been a special issue to mark the occasion.

I have been a regular subscriber for a number of years and was recently able to complete my collection of *Mineralogical Record* back issues. The collection provides a very valuable and reliable resource. The high standards and high quality that the magazine has maintained over the years are impressive. I have just sent in my subscription renewal for the next two years, and expect to remain a subscriber to the *Mineralogical Record* for many years to come. Should I someday not renew my subscription, it will no doubt be due to an unfortunate circumstance such as befell the group of 250 subscribers that you tracked.

Your editorial describing the state of subscriptions seems to mirror the state of mineral collecting in general. It is difficult to attract people to mineral collecting, especially teenagers and young adults. The interest is there but can quickly be displaced by other pursuits. The lower subscription rate for first time subscribers is a good idea, but the long-term success of the *Mineralogical Record* will require an expansion of mineral collecting itself.

Once again, I would like to congratulate you on reaching 200 issues and I hope to still be a subscriber when you reach issue 400 (issue November–December 2036, Volume 67 #6, I believe).

Doug Miller
Saskatoon, Canada

Thanks for pointing out our 200th issue—we hadn't been counting, and didn't realize it! *Eds.*

Ojuela Issue

Just two hours ago we received your recent Ojuela Issue and found it highly fascinating. This is a work that really needed doing! Congratulations on this issue, which is not only a "pioneering work" on this world-class locality but also a modern and comprehensive description that has long been lacking, not only for the mineralogy but also for the geology and history as well. Being eager collectors of phosphates and arsenates, we were especially fascinated by the excellent mine maps and the "lugar" site maps. Now we are finally able to imagine where some of our specimens have come from!

Stefan Weiss and **Christian Weise**
Lapis Magazine
Munich, Germany

The reception of the Ojuela Issue in Mexico has been phenomenal. I gave copies to the Minister of Mines, Head of the Natural Resources Council, General Director of Mines, and the top four people at the Peñoles Mining Company. The latter liked the issue so much they have asked for a full box (which I'm lugging down there soon). The Peñoles people had absolutely no idea that such wonderful things came from their mine.

There are two errors I've found that should be corrected:

(1) I should not be credited with the old Ojuela Bridge photo (frontispiece photo, page 4). It should instead be credited to Kameron Searl, Houston, Texas. He is a descendent of Carlos Patoni, who was the mine manager at Ojuela in the early 1900's and who either took the photo himself or had it taken. The Patoni family were important in both the political and mining fields in the state of Durango with at least one governor coming from the family. Carlos Patoni also worked at the famous Guanacevi gold district.

(2) The only other possible error I've found in the issue is the attribution of the botryoidal mimetite from Kerith Graeber's collection (Fig. 114, p. 77). In my opinion this specimen probably came instead from the Bilbao mine in Panfilo Natera, Zacatecas. The Bilbao mine is a little-known locality that has produced huge volumes of orange-yellow-cream-colored mimetite. Some show outer cream-colored layers of hedyphane and a very few are partially dusted with plattnerite. The mine also produced some exquisite wulfenite crystals to 5 cm in the late 1800's. All apparently went to Europe and some still survive in museums in Germany.

Peter Megaw
Tucson, AZ

I have read the Ojuela Issue with great delight, however, there is an error in the caption to Figure 48 (page 40), the outstanding cuprian adamite specimen. Although the photograph is indeed mine, the specimen itself belongs to Consie Prince of Houston, Texas, who kindly let me photograph it many years ago for the slide competition at the Tucson Show.

Stephen C. Blyskal
Houston, TX

Los Lamentos

When I opened my new MR and saw an article on Los Lamentos I was a little disappointed because I thought that I had read enough about the place, but was I wrong! The first night I read up to the mineral part and I was so captivated I couldn't get to sleep. You did a fantastic job of arranging the whole story, and the pictures and diagrams are great. After reading it I felt I had been there. The mineral photos are also a treat.

I learned two things that I have always wondered about. First, I learned why many of the engineers including Rickard never mentioned the wulfenite in the mine. The other goes back to my own experiences. In the 1970's I accumulated from the local flea markets here in Houston numerous miniature to small-cabinet wulfenites with just "Chihuahua" as a point of origin. I learned to recognize the classic tabular and pseudo-cubic Los Lamentos specimens, but as to the others I had no idea where in Chihuahua they had come from. Unfortunately for me, I decided I would never find that out, so in the 1980's I traded them off to European collectors via mail. They didn't seem concerned about the generalized location. After seeing your photos and reading your mineral descriptions, I am convinced that most if not all of those specimens were from Los Lamentos. Too bad for me. Thanks for a wonderful article.

Art Smith
Houston, TX

Magazine Shelf Boxes

For years I have been buying from Highsmith Company the nice labeled storage boxes for my MR issues. Unfortunately they now tell me that they no longer sell these boxes and cannot find a manufacturer. I'm curious if you or any readers have found a similar product elsewhere.

John Jaszczak
Houghton, MI

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The Friends of Mineralogy (FM), formed at Tucson, Arizona on February 13, 1970, is a national organization which also supports local chapters where they are viable. It is open to membership by all. FM's objective is to promote, support, protect and expand the collection of mineral specimens and to further the recognition of the scientific, economic and aesthetic value of minerals and collecting mineral specimens.

FM helps produce locality indexes for specimen mineral localities and is co-sponsor, with the Tucson Gem & Mineral Society (TGMS) and the Mineralogical Society of America (MSA), of the annual Tucson Mineralogical Symposia. It also sponsors awards for best articles each calendar year in *The Mineralogical Record*, *Rocks & Minerals* and *ExtraLapis International* gives special recognition at the February Tucson Gem and Mineral Show for cases which help explain an aspect of mineralogy.

The Friends of Mineralogy is affiliated with the *American Geological Institute*, the *Mineralogical Society of America* and *The Mineralogical Record*, which provides FM space and publishes news of its activities from time-to-time. FM in turn supports *The Mineralogical Record* in various endeavors.

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For Chapter information contact Nelson Shaffer, President, 530 Cabot Ct., Bloomington, IN 47408; Tel: 812-339-6623 or 812-855-2687; E-mail: shaffern@indiana.edu

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Visit our website at www.mineralsocal.org/scfm.

FM Awards

The Friends of Mineralogy annually presents various awards at the Tucson Gem and Mineral Show. The awards are presented at the Saturday night banquet. The winners in 2003 were:

Best Article 2002, *The Mineralogical Record*, Jesse Fisher

Best Article 2002, *Rocks & Minerals*, Dan Kile

Best Educational Case, TGMS, 2003—**Individual**, Georg Gebhard

Best Educational Case, TGMS, 2003—**Institutional**, Virginia Tech

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In conjunction with the awards for Best Article, FM presents a check for $200 to *Rocks & Minerals* and to *The Mineralogical Record*.

Educational Cases at the Tucson Gem and Mineral Show

The Friends of Mineralogy sponsors non-monetary recognition at the Tucson Gem and Mineral Show (TGMS) for cases which help explain an aspect of mineralogy. There is no restriction on the theme, but the case should have some special instructive feature. In keeping with the high standards of the TGMS, the case should be aesthetically pleasing and contain specimens worthy of the show. Two certificates are awarded, one for private collections and one for institutions, and the winners are honored at the Saturday night banquet and on a plaque in the FM case. Instructive cases help the hobby grow and underline its scientific basis. Exhibitors at Tucson, both individuals and institutions, are asked to consider seriously such a feature for their cases.

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Tel: 518-486-2011
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Albany, NY 12230-0001
Website: www.nysm.nysed.gov
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email: wmmicurator@aol.com
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Fax: (719) 488-9261
www.wmmi.org
1025 North Gate Road
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The Gillespie Museum of Minerals, Stetson University

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Hours: 9–4:30 M–F
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Los Angeles, CA 90007
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Tel: (209) 742-7625
Fax: (209) 966-3597
e-mail: mineralcurator@sierratel.com
5005 Fairgrounds Rd.
Mariposa, CA 95338
Mailing Address:
P.O. Box 1192
Mariposa, CA 95338
Hours: 10–6 Daily (May–Sept.)
10–4 Wý¥.–Mon. (Oct–Apr.)
Specialties: Gold, California minerals, California mining

Arizona Mining & Mineral Museum

Department Director: Doug Sawyer
Curator: Sue Celestian
Tel: (602) 255-3795
1502 W. Washington Avenue
Phoenix, AZ 85007
Hours: 8–5 M–F, 11–4 Sat., closed Sun. & holidays
Specialty: Arizona minerals

Carnegie Museum of Natural History

Collection Manager: Marc L. Wilson
Tel: (412) 622-3391
4400 Forbes Avenue
Pittsburgh, PA 15213
Hours: 10–5 Tues.–Sat., 10–9 F, 1–5 Sun., closed Mon. & holidays
Specialty: Worldwide minerals & gems

Museum of Geology

Curator: Thomas J. Campbell
Tel: (605) 718-2288
South Dakota School of Mines & Technology
501 E. St. Joseph St.
Rapid City, SD 57701-3995

New Mexico Bureau of Mines & Mineral Resources—Mineral Museum

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Associate Curator: Robert Eveleth
Tel: (505) 835-5325
E-mail: beveleth@gis.nmt.edu
New Mexico Tech,
801 Leroy Place
Socorro, NM 87801
Hours: 8–5 M–F, 10–3 Sat., Sun
Specialties: New Mexico minerals, mining artifacts, worldwide minerals

Penn State Earth & Mineral Sciences Museum

Curator: Dr. Andrew Sicree, PhD
Tel: (814) 865-6427
E-mail: sicree@geosc.psu.edu
Steidle Building
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State College, PA 16802
Hours: 9–5 M–F & by Appt. (closed holidays)
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Gargoti Mineral Museum

Director: K. C. Pandey
Tel: ++91 2551 230528
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D-59 MIDC, Malegaon, **Sinnar**, Nashik 422 103 India
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Arizona-Sonora Desert Museum

Fax: (520) 883-2500
Website: http://www.desertmuseum.org
Curator, Mineralogy: Anna M. Domitrovic
Tel: (520) 883-3033
E-mail: adomitrovic@desertmuseum.org
2021 N. Kinney Road
Tucson, AZ 85743-8918
Hours: 8:30-5 Daily (Oct.-Feb.)
7:30-5 Daily (Mar.-Sept.)
Specialty: Arizona minerals

Pacific Museum of the Earth

Curator: Kirsten Parker
Tel: (604) 822-6992
E-mail: kparker@ubc.ca
Dept. of Earth and Ocean Sciences
Univ. of British Columbia
6339 Stores Rd.
Vancouver, BC, Canada V6T 1Z4
Hours: 9–4, M–F
Specialties: BC–Yukon–Pacific NW, Worldwide Gold & Silver

U.S. National Museum of Natural History (Smithsonian Institution)

Curator: Dr. Jeffrey E. Post
e-mail: minerals@nmnh.si.edu
Collection Managers: Paul Pohwat and Russell Feather
(Dept. of Mineral Sciences)
Washington, DC 20560-0119
Hours: 10 am–5:30 pm daily
Specialties: Worldwide minerals, gems, research specimens

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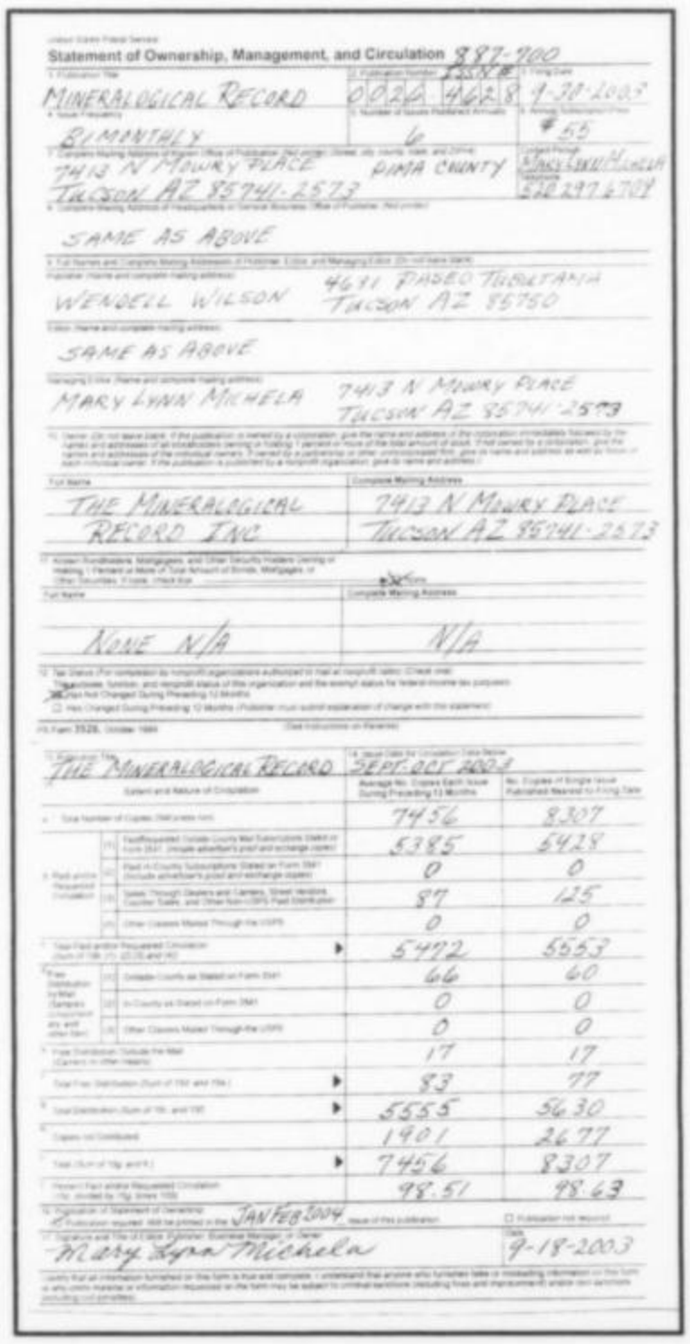

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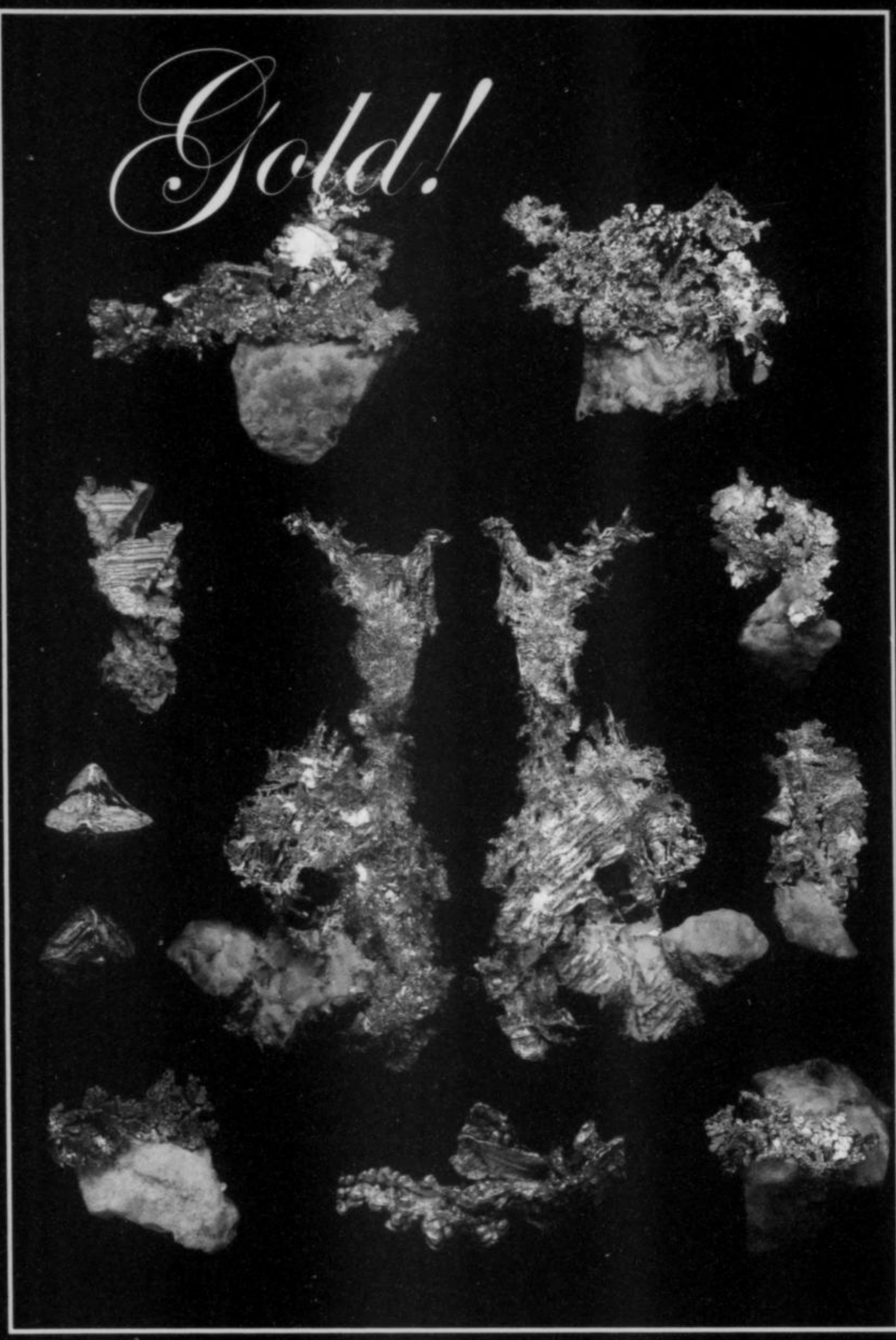

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They brought me rubies from the mine,
And held them to the sun;
I said, They are drops of frozen wine
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Ralph Waldo Emerson
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