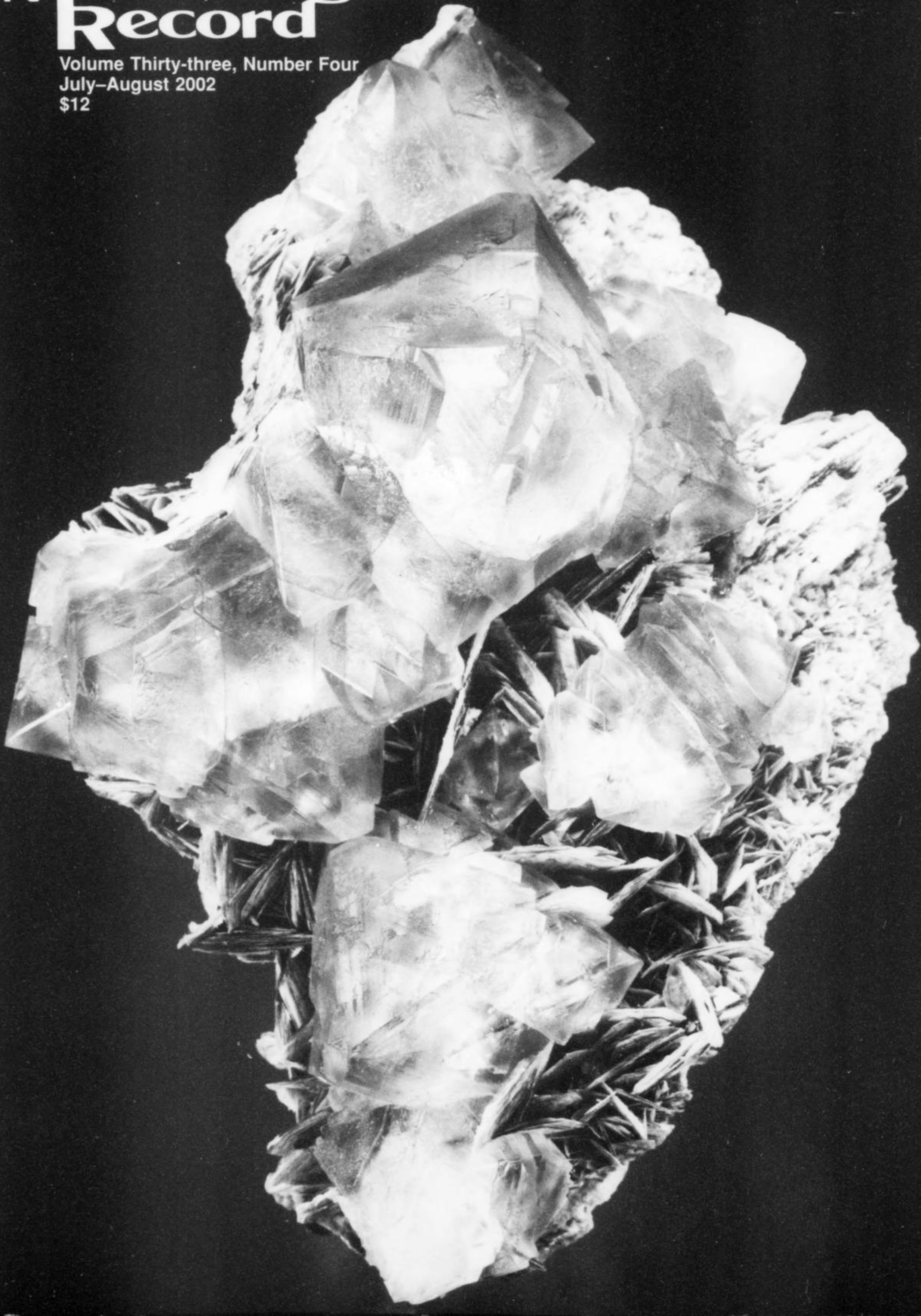
the Mineralogical Record

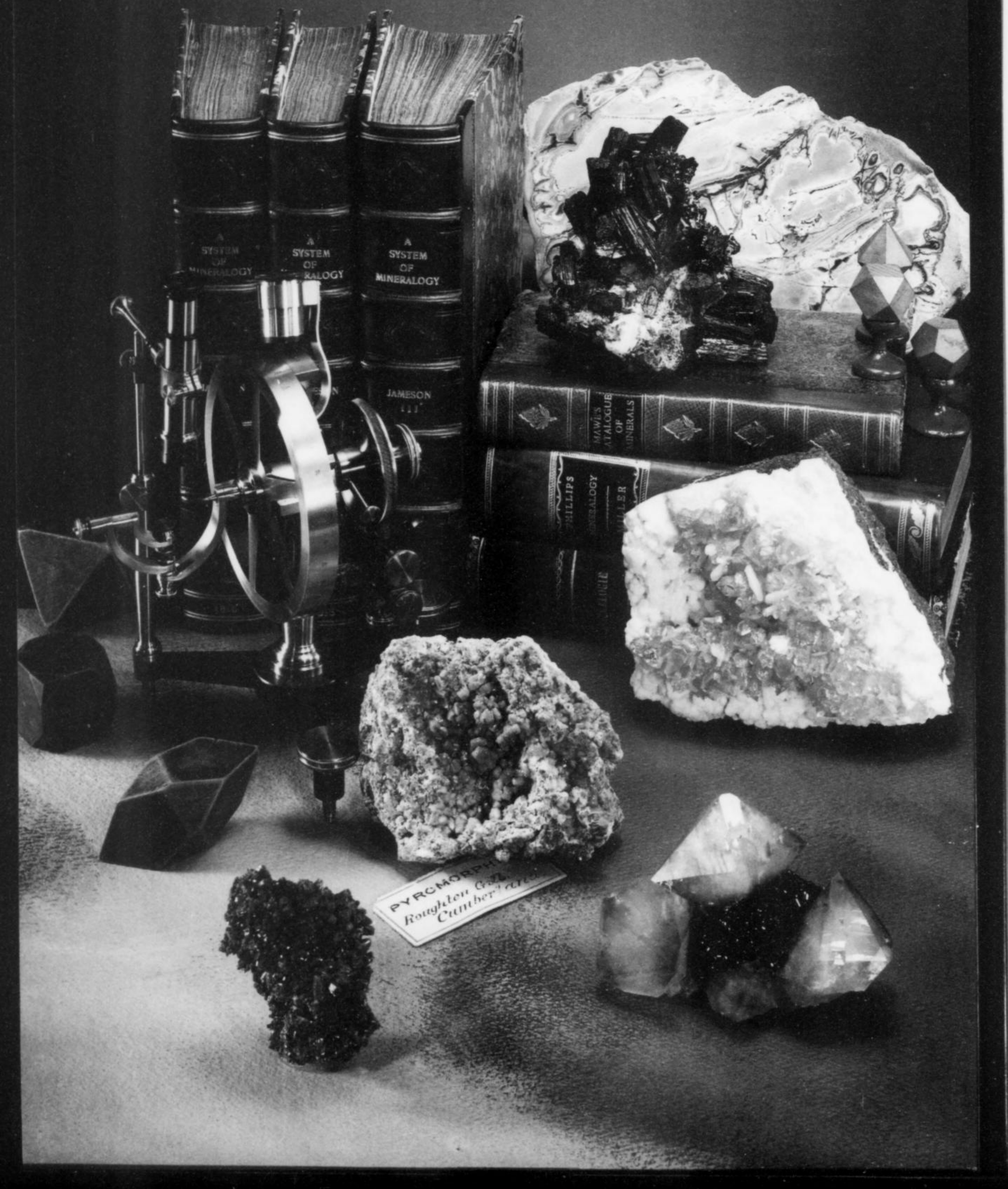
Volume Thirty-three, Number Four
July–August 2002
$12



KRISTALLE

Wayne & Dona Leicht, 875 North Pacific Coast Highway, Laguna Beach, CA 92651
(949) 494-7695 . . . 494-5155 . . . FAX (949) 494-0402
Open Tues.-Sat. 10-5. (Closed Sun.-Mon.) Photo by Harold and Erica Van Pelt, Los Angles

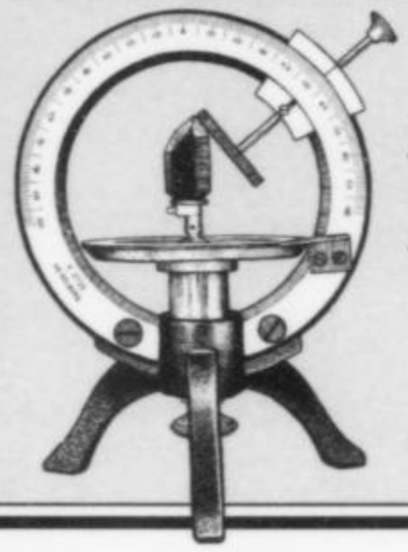
Note: Please call ahead for our travel schedule, to be sure we'll be here when you plan your visit!
WEB: http//www.kristalle.com • E-mail: leicht@kristalle.com



Editing, advertising
4631 Paseo Tubutama
Tucson, AZ 85750
520-299-5274 • FAX: 520-299-5702
E-mail: minrec@earthlink.net

Subscriptions
(Subscriptions, back issues, reprints, book sales, shows)
P.O. Box 35565
Tucson, Arizona 85740
520-297-6709 • FAX: 520-544-0815
E-mail: minrec@aol.com

- **Individuals (U.S.):** $51 for one year; $96 for two years. (First-class mailing available; write to circulation manager for rates.)
- **Individuals (outside the U.S.):** $55 for one year, $99 for two years. (Airmail mailing available; write to circulation manager for rates.)
- **Libraries, Companies and Institutions (worldwide):** $150 for one year.



THE MINERALOGICAL RECORD

July–August Volume Thirty-three, Number Four

Articles

Columns

COVER: FLUORITE on muscovite, 14 cm, from Nagar, Hunza Valley, Northern Areas, Pakistan. Wally Mann collection; Jeff Scovil photo.

Visit
our Website:
www.MINREC.org

The Mineralogical Record
(ISSN 0026-4628) is published bi-monthly for $51 per year (U.S.) by Mineralogical Record, Inc., a non-profit organization, 7413 N. Mowry Place, Tucson, AZ 85741. Periodicals postage paid at Tucson, Arizona and additional mailing offices. POSTMASTER: Send address changes to: The Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740.

*Continued on p. 359

notes from the EDITORS

John Sinkankas (1915–2002) at the Pala Properties Mine Bash, 1977. Van Pelt photo.

NOTICE

Died, John Sinkankas, 87. Everyone in the mineral world knew John Sinkankas, through his achievements as an author, artist, mineralogist, bibliophile, bookseller, field collector, lapidarist and gemologist.

Born in Paterson, New Jersey on May 15, 1915, John Sinkankas (the name is Lithuanian) began his nature studies as a young boy, collecting botanical specimens. His first exposure to minerals came during a chance visit to the Lower New Street quarry immediately following a blast; prehnite-filled cavities were everywhere, along with calcite, apophyllite, and stilbite—all of which he found "irresistibly fascinating." Following graduation from high school he attended New Jersey State Teachers College in Paterson (where he met his future wife, Marge), graduating in 1936.

Sinkankas then enlisted in the Naval Aviation Reserve and became a qualified pilot, serving in many locations around the world and taking time to do a little mineral collecting at places like Ivigtut, Greenland as opportunities arose. (He once told me that he had "seen" Saint John's Island, Egypt, the famous olivine locality, but "only on radar" as his ship passed the island at night.) After the war he took the full sequence of gemology courses from the Gemological Institute of America (GIA) and the American Gem Society (AGS), and focused his attention on gemology and lapidary. In 1948 he began writing a regular lapidary column for *Rocks & Minerals* magazine, and over the next eight years he wrote 33 installments on various gemological/mineralogical topics. He also began building a book collection which would one day become the finest private collection of gemological works in the U. S.

In 1955 Van Nostrand published the first of John's many books: *Gem Cutting—A Lapidary's Manual*, followed by his *Gemstones of North America* vol. 1 in 1959 (two more volumes would later follow). In 1960, now a Captain in the Navy, he was elected a Fellow of the Mineralogical Society of America, and in 1961 retired from the Navy after 25 years of service. He soon published *Gemstones and Minerals—How and Where to Find Them* (1961), the first of a dozen such textbooks.

John and Marge retired to their first permanent home, in San Diego, California. He wrote articles regularly for *Lapidary Journal*, worked part-time as a Research Assistant in mineralogy at the Scripps Institute of Oceanography, and studied mathematics and languages as a "special student" at the University of California. He also spent much time field collecting in the San Diego County localities. He published *Mineralogy for Amateurs* (still a commonly used book among mineral collectors) in 1964, and *Mineralogy: A First Course* in 1967.

As their book collection grew to over 3,000 volumes, John and Marge formed Peri Lithon Books to market the excess titles coming in, and to help spread mineralogical literature. Meanwhile John poured extensive hours of research into one of his most admired books, *Emerald and Other Beryls*, published in 1981.

Honors poured in during his later years. In 1982 he was awarded an honorary Doctor of Humane letters degree from William Paterson University in New Jersey. The American Federation of Mineralogical Societies presented him with their Scholarship Foundation Award in 1983. The new mineral *sinkankasite* was named in his honor in 1984. And in 1991 he was given the prestigious Carnegie Mineralogical Award.

In 1988 John and Marge turned over their incredible 14,000-volume library to the GIA, where it now forms the core of the GIA's Richard T. Liddicoat Library.

John never slowed down. At an age when most men would be satisfied to rest on such considerable laurels, John finished researching his long-time project, the monumental three-volume *Gemology: An Annotated Bibliography,* and saw it published in 1993 . . . 1179 pages of concentrated scholarly information.

Only a sampling of his more important publications and achievements can be given here (for more information see the references below). John Sinkankas was an extraordinary and influential individual, a true Renaissance man, who in many ways helped to shape the modern world of mineral collecting and mineralogical literature studies as we know it.

Wendell E. Wilson

(See especially J. L. Lininger (2000) "Highlights from the life and times of John Sinkankas. *Matrix*, **8** (4), 179–195. Also R. S. Mitchell (1986) "Who's who in minerals: John Sinkankas." *Rocks & Minerals*, **61** (1), 28–31; and D. Leicht (1971) "Personality sketch: John Sinkankas." *Mineralogical Record*, **2** (3), 103–104.)

Mineralogical Record BACK ISSUES!

Pay us now . . . or pay a rare book dealer later!

v.1/#4 Columbian Emerald, Natrolite (OR), Benstonite (IL), Långban (Sweden) **$30**	**v.8/#5** Characterization of New Species, Twinning, Axinite (Brazil), Green River (WY) **$12**	**v.8/#6 California Issue** Benitoite, Gold L.A. County Museum, Himalaya mine **$12**	**v.9/#3** Kalahari rhodochrosite, Paterson (NJ), Brumado district (Brazil), Bosch Collection **$12**	**v.9/#4** Elmwood (TN), Chester (MA), Pyrite XL Forms **$12**
v.9/#5 Turkish Kämmererite, Afghan pegmatites, Chuquicamata (Chile) **$12**	**v.9/#6** Libethenite (Zambia), Quartz & Pyrite (WA), Hydroboracite (CA) **$12**	**v.10/#1** Hydroxylherderite (Brazil), Bookson U.S. minerals **$12**	**v.10/#2** Jeffrey mine (Quebec), Alpine Rodingites, Fluorite (Germany) **$12**	**v.10/#3** Taewha mine (Korea) Japan Twins (Quartz), Bancroft (Ont.), Franklin **$12**
v.10/#5 Thomas & Wah Wah Ranges (Utah) (famous for Topaz, Red Beryl. etc) **$12**	**v.11/#1** Toxic Minerals Barite from Hartsel (CO), Cassirer Memoirs (part II) **$12**	**v.11/#5** Los Lamentos (Mex.), Chromates (Iran), Nealite, Sperrylite, Mullica Hill **$12**	**v.11/#6** Brok… Cruz… Interv… Qtz. **$12** SOLD OUT	**v.12/#1** Iceland… Zeoli… Zeolit… **$12** SOLD OUT
v.12/#3 Pribram (Czecho.), Bald Knob (NC), Line Pit (PA-MD), Mcguinnessite **$12**	**v.12/#4** Mineral Fakes, Mineral Fraud, Leadhills-Wanlockhead (England) **$12**	**v.13/#4** Diamond (CO), Quartz (MT), Jeanbandyite. Bancroft (Ont.) **$12**	**v.14/#1** Celestite (IN), Derbyshire (England), Lotharmeyerite (Mapimi) **$12**	**v.14/#6** Chuquicamata (Chile), Univ. of Delaware Mineral Museum **$12**
v.15/#1 Darwin (CA), Pereta Mine (Italy), Cetine Mine (Italy) **$12**	**v.15/#5** Jacupiranga mine (Brazil), Jensen quarry (CA), Cunha Baixa mine, Paulkerrite **$12**	**v.15/#6** Bad Ems (Germany), Touissit Vanadinite, Hawleyite (IN), Fluorapatite (SD) **$12**	**v.16/#1** New… stoc… Maju… White Caps **$12** SOLD OUT	**v.16/#3** Colorado-III Issue! Leadville, Rico, Cresson Vug, Pikes Peak, CSM Museum **$12**
v.16/#4 Kingsgate mines (Australia), Mauldin Mountain Phosphates (AL) **$12**	**v.16/#5 Tourmaline Issue!** (ll2 p.) Elba, Maine, Pakistan, Nepal, California, etc. **$12**	**v.16/#6** Graves Mtn. (GA), Gardiner Complex (Greenland), Canaphite Hutchinsonite **$12**	**v.17/#2** J. C. Holmes claim (AZ), Austrian Minerals, Marsturite, Franklin (NJ) **$12**	**v.17/#3** Knappenwand (Austria). Laurium (Greece), Senaite (Brazil), Chalcophyllite (New Zealand) **$12**
v.17/#4 National Belle mine (CO), Tip Top mine (SD), Stoneham Barite (CO) **$12**	**v.17/#5** Black Hills type localities, Urucum (Brazil), Kalkar quarry (CA), Kremsmünster **$12**	**v.17/#6** Bleiberg (Austria), Brochantite (OK), Arsenopyrite (Ont.) Author's Guide **$12**	**v.18/#1 Gold-II Issue!** Australia, Calif., Breckenridge, Hopes Nose (England), etc. **$12**	**v.18/#2** Elk Creek (SD), Teyler's Museum, Ramsbeckite, Neotocite, Phosphosiderite **$12**
v.18/#3 Uranium minerals (Sardinia), Garnet Hill (NV), Photographer's Guide, Library Guide **$12**	**v.18/#4** Carrara Marble (Italy), Marburg Museum (Germany) **$12**	**v.18/#5** Hale Creek Inesite (CA), Vanadium Minerals Review, Peking Museum **$12**	**v.19/#1 Mineral Museums of Eastern Europe** Full-color 72-page book-issue **$12**	**v.19/#3** Table Mtn. Zeolites (CO), Tonopah-Belmont mine (AZ), Parker Cleaveland **$12**
v.19/#4 Ichinokawa mine (Japan), Bandora mine (CO), Chernikovite. Getchell arsenates (NV) **$12**	**v.19/#5** Almaden (Spain), IMA, J. Berzelius, Probertite, Osarizawaite **$12**	**v.19/#6 Australia Issue!** 152 pages and much color photography! **$12**	**v.20/#1 New Mexico Issue!** 96 pages and much color photography! **$12**	**v.20/#3** Ouro Preto (Brazil), Anjanabonoina (Madagascar), Port Radium Silver (Canada) **$12**
v.20/#4 Katanga Uranium Issue! Shaba (Zaire) deposits, much color photography! **$12**	**v.20/#5** Brazilian Diamonds, Leveäniemi mine Phosphates (Sweden), Phoenixville (PA) **$12**	**v.20/#6** Spanish Pyrite, Pint's quarry (IA), Beaverdell (Br. Col.), Hollister (CA), Blue Ball (AZ) **$12**	**v.21/#1 Special 20th Anniv. Issue!** Roebling, Canfield, Bement. Paris Exp., Transylvania **$12**	**v.21/#2** Thornberry Axinites (CA). El Dragón mine (Bolivia), Silver District (AZ), Goldschmidt **$12**
v.21/#3 American Amethyst Localities, Terlingua, Davis Hill, Edgarbaileyite, Faden Qtz. **$12**	**v.21/#4 Mont Saint-Hilaire Issue!** 112 pages and much color photography! **$12**	**v.21/#5** Rose qtz. (Brazil), green Apatite (Brazil), stereo photogr., Carnegie Museum Catalog **$12**	**Carnegie Museum Catalog** Magnificent 32-page, full-color catalog **free** in each v.21/#5.	**v.21/#6** Nanisivik mine (Canada). De Kalb (NY), Murfreesboro (AR) Australian Diamonds **$12**
v.22/#1 Mashamba mine (Zaire), Fat Jack mine (AZ), Monitor-Mogul (NV), azurite, Scandinavia **$12**	**v.22/#2** Mezica mine (Yugoslavia), Caldbeck Fells (England), SEM, Eugui quarries (Spain) **$12**	**v.22/#3** Messina mines (So. Afr.), Idria mines (Yugoslavia), Outlaw mine (NV), Pribram (Czech.) **$12**	**v.22/#4** Kalahari update (So. Afr.), Seriphos (Greece), Lake George mine (New Bruns), Wattersite **$12**	**v.22/#5** Smokey Bear qtz. (NM), Taaffeite, Sterling Hill (NJ), Grew's *Mus. Reg. Soc.* (1681) **$12**
v.22/#6 Wagholi cavansite (India), Kombat mine (Namibia), Madan mines (Bulg.),Beltana mine **$12**	**v.23/#1** Dohrmann Gold collection, Gillette quarry (CT), Spanish fluorite **$12**	**v.23/#2 Michigan Copper Country Issue!** Spectacular, 104-pg. book issue. One of our best! **$15**	**v.23/#3** African gold, IA calcite, Hiendelaencina (Spain), Freiberg Acad.; Tucson & Paris shows **$12**	**v.23/#4** Yukon Phosphates Issue! The only complete review of these famous occurrences **$12**
v.23/#5 Matlock (Eng.), Prenteg (Wales), Stephen Smale Collection, Mineral Stories **$12**	**v.23/#6** Black Pine mine (MT), Bixbyite (AZ), Pd-Pt (Brazil), Franklinphilite (NJ) **$12**	**v.24/#3** Majuba Hill mine (NV), Sawtooth Batholith (ID), Ashburton Downs (Australia) **$12**	**v.24/#4** Cornwall's Famous Mines, Rush Creek (AR), Clinomimetite, Inclusions in Microcrystals **$12**	**v.24/#5** The Geysers (CA), Sanford deposit (ME), Wessels mine (So. Af.), Parker mine (Que.) **$12**
v.25/#1 Jamest… (CA), Hor… a dist. (Ma… (England) **$12** SOLD OUT	**v.25/#2** Quasicrystals, Sterling Hill (NJ), French Creek (PA), Burra Burra (Australia) **$12**	**v.25/#3** Jacupiranga mine (Brazil), Bennett quarry (ME), Rose mine (NM), Prospect Intrusion **$12**	**v.25/#4** Blowpipe Analysis, Arno Valley (Italy), Widgiemooltha (Australia), Laurium (Greece) **$12**	**v.25/#5** Orford nickel mine (Que.), Martin Ehrmann, Topeka-Kentucky Giant & Indiana veins (CO) **$12**
v.25/#6 The History of Mineral Collecting 1530–1799 Full-color 264-pages **$24**	**v.26/#1 Topaz Issue!** Gorgeous full-color issue, 80-pages, many illustr. **$12**	**v.26/#5** Finch… …ld Qua… …view 1993… …overies **$12** SOLD OUT	**v.26/#6** Guide to Soviet Mineral Localities, Morefield peg. (VA), Mineral Stories **$12**	**v.27/#1** Fluorescence in Minerals, Billie mine (CA), Seravezza Marble (Italy) **$12**
v.27/#2 Onganja mine (Namibia), Lac Nicolet mine (Quebec), Afghanite **$12**	**v.27/#3** Boulby mine (Engl.), Picos de Europa (Spain), Elmwood (TN), J.G. Lenz **$12**	**v.27/#4** Rio Tinto (Spain), Mendip Hills (England), Calcioaravaipaite **$12**	**v.27/#5** Hyalophane (Bosnia), Red Cloud mine wulfenite, N. Geronimo mine (AZ) **$12**	**v.27/#6** Alva mine (Scotland), Kruisrivier mine (So. Afr.), Silvana mine (Br. Col.) **$12**
v.28/#1 Illinois …uorite Distr… Issue **$12** SOLD OUT	**v.28/#2** Platinum (Russia), Otavi Mtn. Land (Namibia), Repair & Restoration **$12**	**v.28/#3** Western Union mine (AZ), Utahite, Pakistan Locality Guide! **$12**	**v.28/#4 Mines and Minerals of Peru.** Special 120-pg. issue **$15**	**LIMITED HARDBOUND EDITION** Mines and Minerals of Peru **$49**
v.28/#5 Hall's Gap (KY), Szenicsite (Chile), Glossary Additions **$12**	**v.28/#6** Kingsbridge Q. (NY), Ed Swoboda, Ernstite (Brazil, Emerald (Spain) **$12**	**v.29/#1 Mexico-I Issue** All about the Boléo District, Baja Calif. **$12**	**v.29/#2** Saint-Amable, Que.; Denver Show; Munich Show; Pomona Show **$12**	**v.29/#3** Annaberg, Type Locality for Wulfenite; Namibite; Philolithite; Boqueirãozinho **$12**
v.29/#4 The Sweet Home Mine! 192 pages, 180 color photos! Spectacular! **$30**	**v.29/#5** Castle Dome Dist. (AZ), Bushveld Complex, IDing micromounts, French Torbernite **$12**	**v.29/#6** Monograph on the Crystallographic Goniometer, 39 color illustrations **$12**	**v.30/#1** Potosí, Bolivia & phosphophyllite, Zeolite Group, mineral show reviews **$12**	**v.30/#2** Flambeau mine (WI), Silvermines Dist. (Ireland), Peabody Museum at Yale **$12**

Order From: Circulation Manager • Mineralogical Record • P.O. Box 35565 • Tucson, Arizona 85740

[Postage $1 per copy–Order 10 copies or more and **we pay all postage.**]

FAX YOUR **VISA** *or* **MasterCard** *CREDIT CARD ORDERS! 520-544-0815* Supplies are Limited

The Friends of Mineralogy, Inc.

Visit the national Friends of Mineralogy website at www.indiana.edu/~minerals/fm.html

Who We Are:

Vol 1, No 1, Mineralogical Record, Spring 1970
The *Friends of Mineralogy* was founded in Tucson, Arizona, on February 13, 1970. Its objectives were to promote better mineral appreciation, education and preservation. The chief aims and activities of *FM* include:

* Compiling and publishing information on mineral localities, and important mineral collections.
* Encouraging improved educational use of mineral specimens, collections, and localities.
* Support a semi-professional journal of high excellence and interest designed to appeal to mineral amateurs and professionals, through which *FM* activities may be circulated.
* Operating informally in behalf of minerals, mineral collecting, and descriptive mineralogy, with voluntary support by members.

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

Co-Sponsor, with the Tucson Gem & Mineral Society and the Mineralogical Society of America, of the Annual Tucson Mineralogical Symposia.

Werner Lieber Photo Contest and Traveling Museum Exhibit

Sponsored by Friends of Mineralogy

A traveling Museum exhibit will be created from the best photographs submitted for the contest

Categories: Juniors, Amateur Adults—(a) Micro and (b) Macro Minerals, Professionals, and Digital/Computer-Enhanced Photography

Contest Rules:

1. Matted 8″ x 10″ print. Mat must be 11″ x 14″.
2. The photo must be related to the contest theme: Minerals of the Andes.
3. Each photo must have a caption with locality, bar scale or description of crystal size, photographer, category, and other information submitter deems relevant. Caption should be attached to back of mat.
4. Photos will be displayed at the 2003 Tucson Gem and Mineral Show. Photos will be judged by the FM board of directors during the annual board meeting. Winners will be announced at the FM annual meeting and awards presented at the TGMS Saturday night awards banquet.
5. All photos become the property of FM. Copyright will be retained by author, but FM has royalty free use.
6. A non-monetary award will be presented to the winners.
7. Contest deadline: November 1, 2002.
8. Mail submittals to Dr. Karen Wenrich, P.O. Box 5054, Golden, CO 80401—(303) 278-1218 (phone & fax); email: CrystalsUL@aol.com.

2002 National Officers

President
Susan Eriksson, Virginia Tech, 1013 Draper Road, Blacksburg, VA 24060
540 231-5360, E-mail: seriksn@vt.edu

Vice-President
Bill Dameron, 1609 NW 79th Circle, Vancouver, WA 98665
360 546-1267, E-mail baritebill@aol.com

Secretary
Virgil Lueth, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801
505 835-5140, E-mail vwlueth@nmt.edu

Treasurer
Jim Hurlbut, 2240 South Adams St., Denver, CO 80210
303 757-0283 or 303 279-7796, E-mail jfhu@vanion.com

Newsletter Editor
Andrew Sicree, Penn State University, 122 Steidle Building, University Park, PA 16802
814 867-6263 or 814 865-6427, E-mail sicree@geosc.psu.edu

Chapter News

Colorado Chapter
Order now!! *Minerals of Colorado*
Order from: Friends of Mineralogy—Colorado Chapter
P.O. Box 11005, Denver, CO 80211-0005
$150 + $3 p.&h. (Colo. residents add 7.3%)
For Chapter information, contact Peter Modreski, President, 3555 Miller St., Wheat Ridge, CO 80033; Tel: 303 425-9549 or 303 236-5639, E-mail pmodresk@usgs.gov

Midwest Chapter
Visit our website at www.indiana.edu/~minerals
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

Mississippi Valley Chapter
For Chapter information, contact Mark Sherwood, President, P.O. Box 436, Oak Grove, MO 64075, Tel: 816 690-8226, E-mail msherwod@swbell.net

Pennsylvania Chapter
Order now!! *Reminiscences of a Mineralogist* by Arthur Montgomery. $20 plus $3 p.&h. Order from: Arnold Mogel, PA Treasurer, 15 Oak Rd., Schuykill, PA 17972
For Chapter information, contact Roland Bounds, President, 315 Stamford Dr., Newark, DE 19711, Tel: 302 731-8407, E-Mail 25628@udel.edu

Pacific Northwest Chapter
The 28th Annual symposium will be held in Longview, WA, Sept. 28-29, 2002. Featured topic is "The Inside Story-Inclusions" with guest speakers John Koivula and John S. White. Contact Sharleen Harvey at bill-sharleenharvey@att.net for additional information.
For Chapter information, contact Jim Etzwiler, President, 3935 Interlake Ave. N, Seattle, WA 98103, Tel: 206 633-1512, E-mail kd7bat@arrl.net

Southeast Chapter
Visit our website at http://members.cox.net/fomse01/
For Chapter information, contact David J. Babulski, President, 2677 Colony Circle, Snellville, GA 30078, Tel: 770 985-1772 or 678 584-6004, E-mail dbabulski@lanier.com

Southern California Chapter
Visit our website at www.mineralsocal.org/scfm
For Chapter information, contact Robert E. Reynolds, President, 220 S. Buena Vista St., Redlands, CA 92373, Tel: 909 792-3548 or 909 798-8570, E-mail jreynold@empirenet.com

INTERNET DIRECTORY

Bookmark these Great Websites and Check Them Regularly!

Alpine Mineral Company
Fine Alpine and Gem Pegmatite Minerals
www.alpineminerals.com
e-mail: kevin@alpineminerals.com

ARCH Minerals
Established Internet Mineral Pioneer
www.archminerals.com
e-mail: rhoek@archminerals.com

Argentum Auctions & Appraisers
Auctioneers of Minerals, Gems, Fossils & Mining Memorabilia
www.argentumauctions.com
e-mail: silver@argentumauctions.com

Attard's Minerals
Fine Worldwide Minerals, Equipmt., Services
www.attminerals.com
e-mail: attard@attminerals.com

Bob's Rockshop
Content & connectivity for rockhounds
www.rockhounds.com
www.tucsonshow.com

British Lapidary & Mineral Dealers Association
Member Directory, UK Mineral Fair Dates
www.blmda.com
e-mail: mansemins@btopenworld.com

Broadstone Minerals
Quality British & Worldwide Minerals
www.broadstoneminerals.com
mike@broadstoneminerals.com

CK Minerals
Cyril Kovac
www.ckminerals.com.au
minerals@netlink.com.au

Colorado Gem & Mineral
Fine Minerals, Gems, & Collectibles
www.coloradogem.com
jacklowell@earthlink.net

The Crystal Hopper
Australian and Worldwide Minerals
www.crystalhopper.com.au
e-mail: goodgame@vianet.net.au

Crystal Showcase
Collector-Quality Mineral Specimens
www.crystalspecimens.com
mineralspecimens@hotmail.com

Cyberocks
Worldwide Minerals, Fossils, Fluorescents
www.cyberocks.com
e-mail: steven@cyberocks.com

Dakota Matrix Minerals
Cab. To MM, Rare, Fine, Weekly Specials
www.dakotamatrix.com
e-mail: dakotamatrix@rushmore.com

Douglass Minerals
Quality Worldwide Affordable Minerals
www.douglassminerals.com
e-mail: douglassminerals@aol.com

Excalibur Mineral Company
Rare Minerals & Analytical Services
www.excaliburmineral.com
e-mail: info@excaliburmineral.com

Fabre Minerals
High-Quality Worldwide Minerals
www.fabreminerals.com
enquiry@fabreminerals.com

H&P Minerals and Gems
Thumbnail and Miniature-size Minerals
www.hpminerals.com
e-mail: halprior@louisacomm.net

Jewel Tunnel Imports
Indian & Worldwide Minerals Wholesale
www.jeweltunnel.com
rockcurrier@compuserve.com

Key's Mineral Collection
Kiyoshi & Eriko Kiikuni
www.keysminerals.com
keys@keysminerals.com

Martin Zinn Expositions
Tucson, Denver, Springfield and Costa Mesa Shows!
www.mzexpos.com
e-mail: mz0955@aol.com

Mineralogy Database
On-line User-Frndly, Up-to-date Mineral Data
http://webmineral.com
e-mail: dbarthelmy@webmineral.com

Mineral Shop
Worldwide Classics & Rarities
www.minservice.com
info@mail.minservice.com

Mineralsweb
Brice & Christophe Gobin
www.mineralsweb.com
gobin@club-internet.fr

North Star Minerals
So. Illinois & Eastern European Minerals
www.northstarminerals.com
northstarminerals@comcast.net

Pala International
Best in Worldwide Gems & Collector Minerals
www.palagems.com
john@palagems.com

Penn Minerals
Classic Pennsylvania Minerals our Specialty
www.pennminerals.com
e-mail: SteveCarter@pennminerals.com

Pequa Rare Minerals
Rare, unique and new minerals
www.pequarareminerals.com
e-mail: josef1@optonline.net

Pickens Minerals
Fine Worldwide Minerals, Acrylic Stands/Mounts
www.pickensminerals.com
e-mail: reo@pickensminerals.com

SIBER+SIBER Ltd.
High-quality minerals since 1964
www.siber-siber.ch
e-mail: siber-siber@bluewin.ch

Simkev Micromounts
Finest quality minerals since 1979
http://www.simkevmicromounts.com
e-mail: simkev@kos.net

Spheres to You
More than 5,000 Beautiful Mineral Spheres
www.spherestoyou.com
e-mail: spheres@iswest.com

The Sunnywood Collection
Bill and Elsie Stone
www.sunnywood.com
minerals@sunnywood.com

Trafford-Flynn Minerals
Affordable Worldwide Quality Minerals
www.trafford-flynn.com
e-mail: info@trafford-flynn.com

UV Systems, Inc.
SuperBright and TripleBright UV lights
www.uvsystems.com
e-mail uvsystems@aol.com

The Webmineralshop
Specializing in Fine Italian Minerals
www.webmineralshop.com
e-mail:webminerals@libero.it

Western Minerals
Finest Quality Worldwide Minerals
www.wmtucson.com
e-mail: schlepp@wmtucson.com

Wright's Rock Shop
Fine Worldwide Minerals
www.wrightsrockshop.com
wrightsr@ipa.net

**List your internet site here! Contact the editor at minrec@earthlink.net*

THE MUSEUM DIRECTORY

New York State Museum

Curator (Geol.): Dr. William Kelly
Tel: 518-474-7559
Collections Mgr. (Geol.):
Michael Hawkins
Tel: 518-486-2011
Fax: 518-486-3696
3140 Cultural Education Ctr.
Albany, NY 12230-0001
Website: www.nysm.nysed.gov
Hours: 10–5 daily (closed Thanksgiving, Christmas, New Years)
Specialty: New York & worldwide minerals
Support Org.: NY State Acad. of Mineralogy (www.nysm.nysed.gov/nysam)

Geology and Meteorite Museums University of New Mexico

Curators: Barry Kues (Geology), Rhian Jones (Meteorites)
Tel: (505) 277-4204
Dept. of Earth & Planetary Sciences
Northrop Hall, Univ. of New Mexico
Albuquerque, NM 87131
Hours: 8–12, 1–4 M–F (closed on school holidays)
Specialties: Worldwide minerals and meteorites, New Mexico fossils, Harding Pegmatite Mine Collection

Colburn Gem & Mineral Museum

Curator of Collections: Christian Richart G.G. (GIA)
Tel: (828) 254-7162
Fax: (828) 257-4505
Website: www.main.nc.us/colburn
Pack Place Education, Arts & Science Center
2 South Pack Square
Asheville, NC 28801
Hours: 10–5 Tues.–Sat.
1–5 Sun.
Closed Mondays and holidays
Specialties: North Carolina and worldwide minerals and gems
Accessible to persons with disabilities

Montana Tech Mineral Museum

Curator: Dr. Richard Berg
Tel: 406-496-4172
Fax: 406-496-4451
e-mail:dberg@mtech.edu
Program Director: Ginette Abdo
Tel: 406-496-4414
e-mail:gabdo@mtech.edu
Website: www.mbmg.mtech.edu/museumm.htm
Montana Bureau of Mines & Geology
Montana Tech of UM,
1300 W. Park Street
Butte, Montana 59701
Hours: Mem/Day to Labor Day 9-6 daily; Rest of year M-F 9-4; Open Sat & Sun May, Sept & Oct 1-5 pm
Specialties: Butte and Montana minerals, worldwide classics

Harvard Mineralogical Museum

Curators: Dr. Carl A. Francis
William Metropolis
Tel: (617) 495-4758
24 Oxford Street
Cambridge, Mass. 02138
Hours: 9–4:30 M–Sat.; 1–4:30 Sun.
Specialties: Systematic Mineral Coll'n

Western Museum of Mining & Industry

Curator: Terry A. Girouard
Tel: (719) 495-2182
email: curatewmmi@juno.com
Dir. of Educ.: Gary Renville
Tel: (719) 488-0880
Fax: (719) 488-9261
www.wmmi.org
1025 North Gate Road
Colorado Springs, CO 80921
Hours: 9–4 M-Sat., (12-4 Sun., June–Sept. only), closed holidays
Specialties: Colorado minerals & ores, Western mining memorabilia, 14,000-vol. research library

The Gillespie Museum of Minerals, Stetson University

Curator: Dr. Bruce Bradford
Tel: (904) 822-7331
E-mail: bbradfor@stetson.edu
Assistant Director: Holli M. Vanater
Tel: (904) 822-7330
E-mail: hvanater@stetson.edu
Fax: (904) 822-7328
234 E. Michigan Avenue
DeLand, Florida
Mailing: 421 N. Woodland Blvd., Unit 8403, DeLand, FL 32720-3757
Hours: 9–noon, 1–4 M–F when university is in session (closed on holidays, university breaks & in the summer)
Specialties: Worldwide comprehensive collection of rocks & minerals; Florida rocks, minerals & fossils; large historic fluorescent collection

The Denver Museum of Nature and Science

Curator of Geology: Jack A. Murphy
Tel: (303) 370-6445
Dept. of Earth Sciences
20001 Colorado Blvd.
Denver, CO 80205
Hours: 9–5 daily
Specialties: Colorado minerals

Geology Museum Colorado School of Mines

Curator: Paul J. Bartos
Tel: (303) 273-3823
Golden, Colorado 80401
Hours: 9–4 M–Sat., 1–4 Sun. (closed on school holidays & Sundays in the summer)
Specialties: Worldwide minerals; Colorado mining & minerals

A. E. Seaman Mineralogical Museum

Director: Stan Dyl
Curator (mineralogy): George W. Robinson
Adjunct Curator: Dr. John A. Jaszczak
Tel: (906) 487-2572
Michigan Technological Univ.
Houghton, Michigan 49931
Hours: 9–4:30 M–F
Specialty: Michigan minerals, copper minerals & worldwide minerals

Additional listings welcome!
Send vital information, as shown, to the editor. There is a modest annual fee (lower than our regular advertising rates).

Museums listed alphabetically by city

THE MUSEUM DIRECTORY

Houston Museum of Natural Science

Curator (mineralogy): Joel Bartsch
Tel: (713) 639-4673
Fax: (713) 523-4125
1 Herman Circle Drive
Houston, Texas 77030
Hours: 9–6 M–Sat., 12–6 Sun.
Specialty: Finest or near-finest known specimens

Natural History Museum of Los Angeles County

Fax: (213) 749-4107
Website: http://nhm.org/minsci
Curator (Mineral Sciences):
Dr. Anthony R. Kampf
Tel: (213) 763-3328
e-mail: akampf@nhm.org
Collections Manager:
Dorothy L. Ettensohn
Tel: (213) 763-3327
e-mail: dettenso@nhm.org
900 Exposition Blvd.
Los Angeles, CA 90007
Hours: 9:30–5:00 Daily
Specialties: Calif. & worldwide minerals, gold, gem crystals, colored gemstones
Support organization:
The Gem and Mineral Council

California State Mining and Mineral Museum

Website: http//parks.ca.gov/parkpages/park_page.asp?lvl_id=227
Curator: Peggy Ronning
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 Wÿ¥.–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

Director: Dr. Virgil W. Lueth
Tel: (505) 835-5140
E-Mail: vwlueth@nmt.edu
Fax: (505) 835-6333
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
University Park
State College, PA 16802
Hours: 9–5 M–F & by Appt. (closed holidays)
Specialties: Mineral properties exhibits; "velvet" malachite; old Penna. minerals, mining art

Arizona-SonoraDesert 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.)
7:30-6 Daily (Mar.-Sept.)
Specialty: Arizona minerals

Pacific Mineral Museum

Director/Curator: Mark Mauthner
Tel: (604) 689-8700
E-Mail: markm@pacificmineralmuseum.org
848 West Hastings Street
Vancouver, B.C., Canada V6C 1C8
Hours: M–F 10–5, Weekends 10–6 (Closed Mondays in winter)
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

William Weinman Mineral Museum

Asst. Curator: Doug Gravely
Tel: (770) 386-0576
51 Mineral Museum Dr.
White, GA 30184
Hours: 10–4:30 Tues.–Sat., 2–4:30 Sun.
Specialty: Georgia & worldwide minerals & fossils

Europe

Museo Civico di Storia Naturale

Curator: Dr. Federico Pezzotta
Tel: +39 02 8846 3326
Fax: +39 02 8846 3281
E-Mail: fpezzotta@yahoo.com
Associate Curator: Alessandro Guastoni
Department of Mineralogy and Petrography
Corso Venezia, 55
I-20121 **Milano,** Italy
Hours: 9 am–6 pm daily
Specialties: Italian minerals, pegmatite minerals

2002 EAST COAST
GEM • MINERAL • FOSSIL SHOW

Better Living Center • EASTERN STATES EXPOSITION • 1305 Memorial Ave.

WEST SPRINGFIELD, MA

AUG. 9 - 10 - 11, 2002

Show Hours:
Fri. & Sat. 10 AM to 7 PM • Sun. 10 AM to 5 PM
Admission: Adults - $6.00 • Students & Seniors - $5.00

Guest Speakers are:

• *Bob Jones* • *Gonzalo Jara*
• *Les Presmyk*

• Minerals • Fossils • Gemstones •
• Meteorites • Beads • Jewelry •

• AIR CONDITIONED HALL •

Special Memorial Exhibit . . .

Only Public Showing of the

James & Dawn Minette Collection

• *Enter Via Gate #9 From Memorial Drive* •

200 TOP QUALITY
Dealers From Around the World !

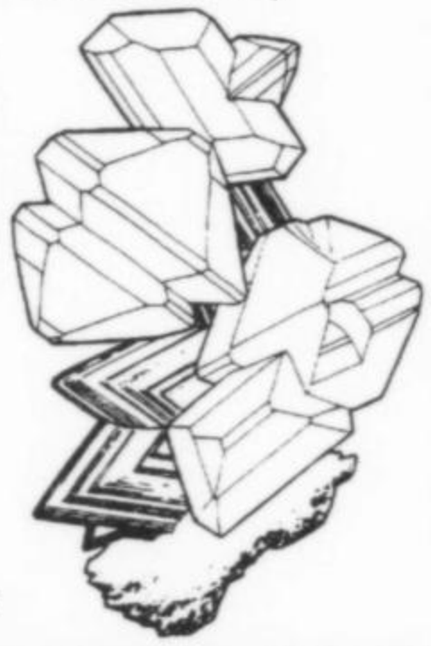
DENVER

COLORADO
MINERAL & FOSSIL SHOW

Holiday Inn - Denver North • 4849 Bannock Street • (where I-25 meets I-70)

SEPT. 11 - 15, 2002

Show Hours:
Wed. thru Sat. 10 - 7
Sun. 10 - 5



★ Wholesale & Retail ★ Dealers on **3** floors of the Hotel ★

★ ***FREE*** Admission ★ Open to the Public ★

★ ***FREE*** shuttle bus to the Merchandise Mart Shows ★

★ ***225 TOP*** *Quality Dealers From All Over the World* ★

COLORADO FOSSIL EXPO

Denver Merchandise Mart ◆ Plaza Annex ◆ 58th Ave. & Washington St. ◆ **(North side of Mart)**

SEPT. 13 - 15, 2002

Show Hours:
Fri. 9 - 6 ◆ Sat. 10 - 6
Sun. 10 -5

Outstanding Paleontological Specimens From All Over The World!

◆ ***SEE MR. BONES CRUISE BOTH SHOWS!!*** ◆ **Park On the North Side of the Mart** ◆

Held in conjunction with the Denver Gem & Mineral Show!

(Admission of $5.00 includes both shows)

FOSSILS ★ METEORITES ★ PETRIFIED WOOD

Martin Zinn Expositions, L.L.C. • P.O. Box 999 • Evergreen, CO 80437-0999 • Fax (303) 674-2384 • E-mail: mz0955@aol.com • website: http://mzexpos.com

JEREMEJEVITE

from

NAMIBIA

Wendell E. Wilson
Mineralogical Record
4631 Paseo Tubutama
Tucson, Arizona 85750

Christopher L. Johnston
Johnson Namibia C. C.
P.O. Box 354
Omaruru, Namibia

Edward R. Swoboda
1004 N. Rexford Drive
Beverley Hills, California 90210

Jeremejevite is among the rarest of gem minerals. Some of the best crystals, water-clear and cornflower-blue, have come from a small oceanside occurrence in Namibia discovered in 1973. The site was reworked for specimens in 1999, but yielded only colorless to pale yellow crystals; the first-found examples remain the best from the occurrence. A new locality for blue jeremejevite was discovered in the Erongo Mountains in 2001, and has produced some fine, lustrous crystals

INTRODUCTION

Jeremejevite,* $Al_6B_5O_{15}(F,OH)_3$, was originally described by Damour (1883), the type specimens consisting of a few colorless, prismatic crystals to several centimeters from a pegmatite situated on Mt. Soktuy (a northern extension of the Adun-Chilon Range), Chitinskaya Oblast, in the Nerchinsk district of Transbaikal, Russia. The name is for Pavel Jeremejev (1830–1899), a Russian mineralogist and engineer.

A second occurrence of jeremejevite, this time as deep blue crystals found near Mile 72, on the Cape Cross Sheet (see Fig. 1) north of Swakopmund, Namibia in 1973, is the subject of this review, inspired by recently renewed collecting activity at the site.

Since the Mile 72 discovery, occurrences have been found in Germany in the Eifel district (in prismatic blue crystals rarely exceeding 1 mm, and in yellowish crystals in tiny spherical aggregates) at Wannenköpfen bei Ochtendung and Emmelberg (Hochleitner and Weiss, 2000), and also in the eastern and southwestern Pamirs, Tajikistan (Zolotarev *et al.*, 2000).

*Spelling variants include jeremeiewit, jeremejewite, jeremejeffite, eremeyevite and yeremeyevite, the last of these being closest to a phonetically accurate representation of the currently accepted pronunciation, based on the Russian pronunciation of the name Jeremejev (Yeremeyev).

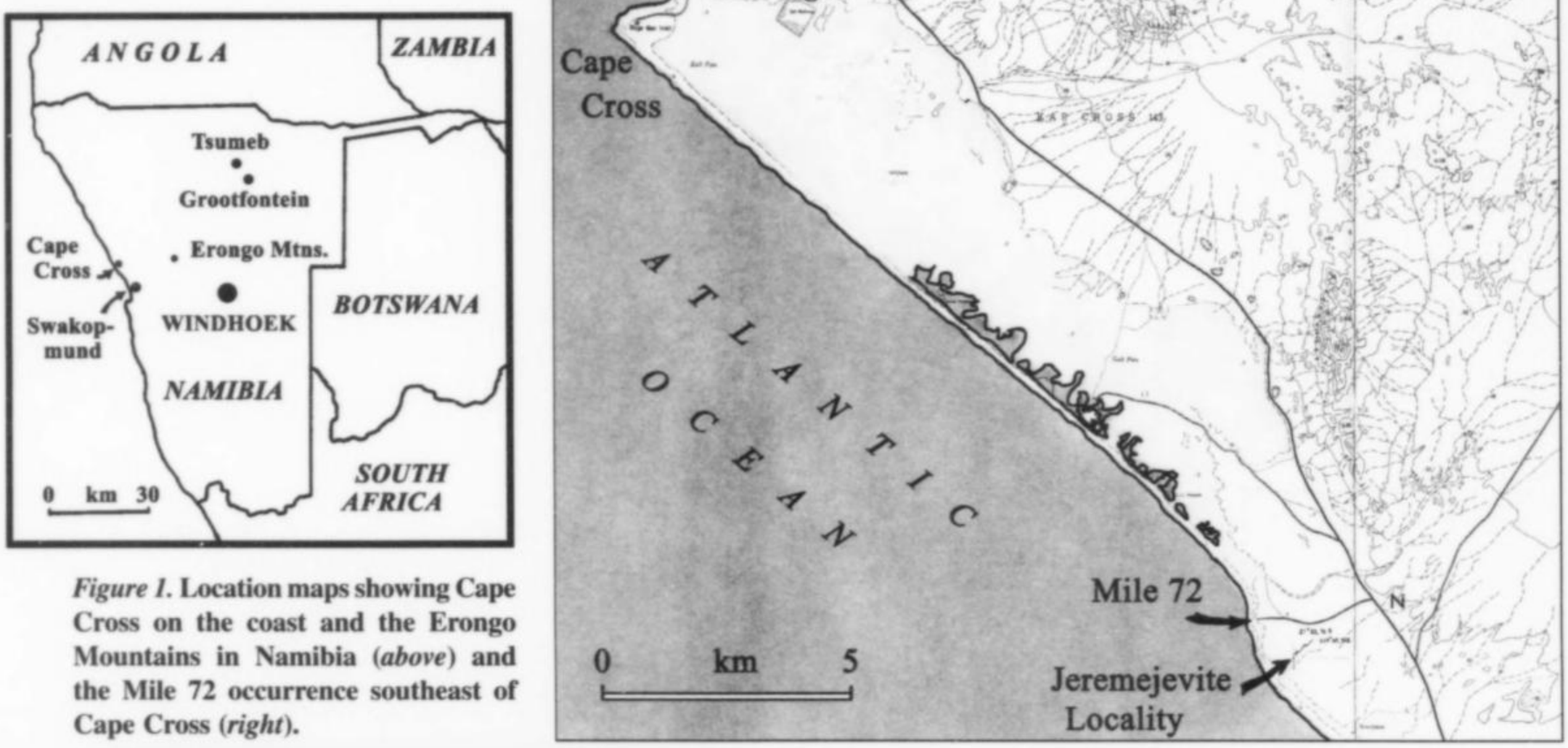


Figure 1. **Location maps showing Cape Cross on the coast and the Erongo Mountains in Namibia (*above*) and the Mile 72 occurrence southeast of Cape Cross (*right*).**

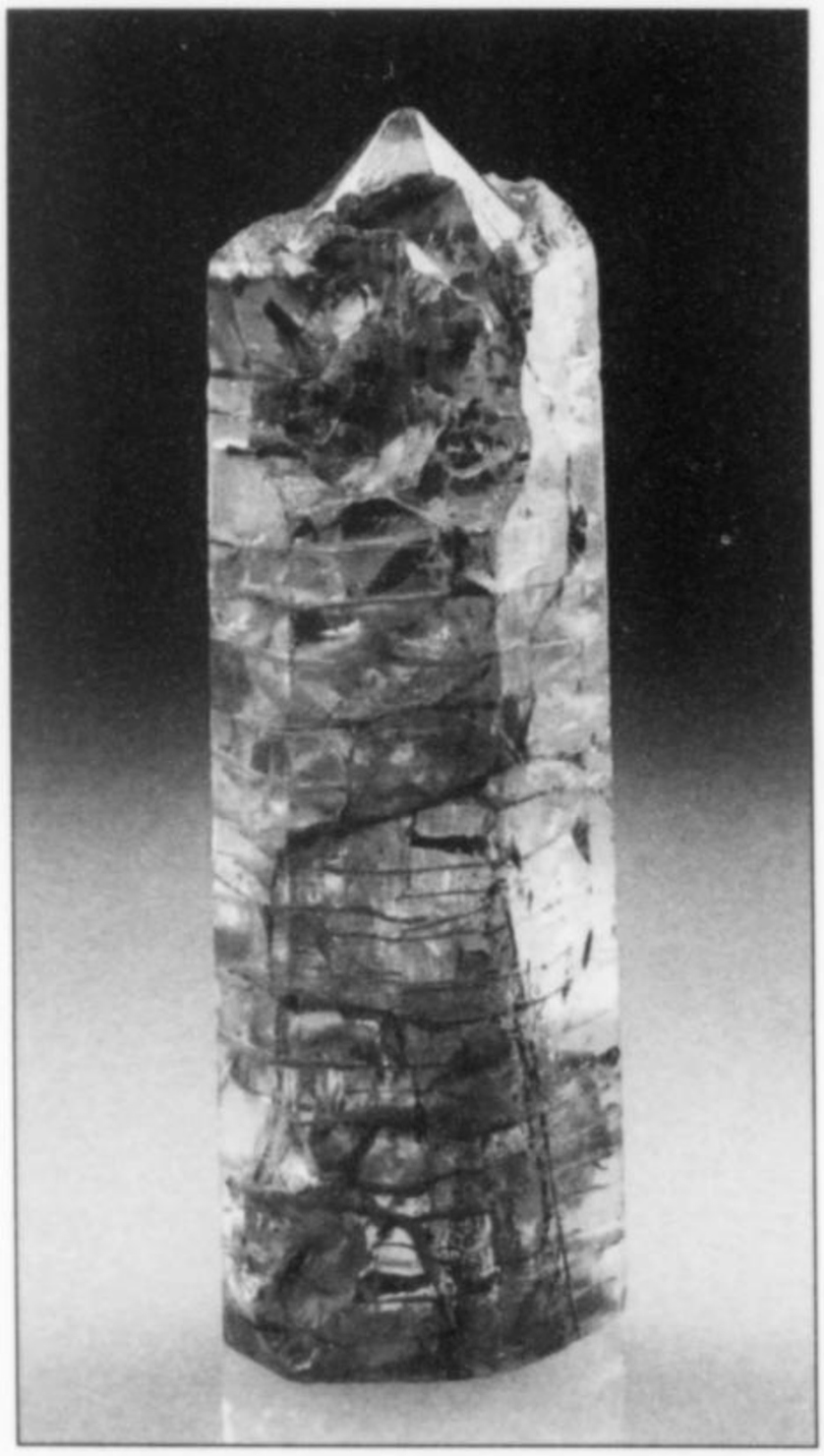


Figure 2. **Jeremejevite crystal, 3.4 cm, from the original discovery on Mount Soktuy, Transbaikalia, Russia. Harvard collection; Wendell Wilson photo.**

Most recently, in March of 2001, a second Namibian occurrence was found in the Erongo Mountains.

The Mile 72 Occurrence

SID PIETERS' OPERATION

Discovery

The Mile 72 occurrence is in a wind-blown flat surface of hard, ocean-weathered granite protruding from a sandy stretch of beach about 750 meters back from the shoreline, where the breakers lap the Namib Desert. It is close to milepost 72, that is, 72 miles by road north of Swakopmund. One kilometer to the northwest of the mining area is the nearest settlement, a government-run fishing camp well known in Southern Africa as "Mile 72."

The initial discovery was made by a woman known as "Tannie Klippie" (literally, "Aunty Little Rock"), who was the wife of John Marais. Mr. Marais was employed by the state as a road-grader operator, and his wife frequently spent her days walking behind her husband's grader collecting pretty rocks. In 1973 the road leading to the Mile 72 fishing camp road was angled at approximately 45 degrees southward to the coast road from its current location. Consequently Mr. Marais' grader turned over a few jeremejevite crystals that had weathered out into the sand, and Tannie Klippie was there to pick them up. These specimens eventually made their way to the sharp eye of Usakos/Windhoek gem and mineral dealer Sid Pieters. At first glance Pieters thought them to be aquamarine, but an analysis identified them as jeremejevite. This was confirmed by a gemological analysis, performed by the Gemological Institute of America (Liddicoat, 1973), of a cut gem supplied by one of the authors (ERS).

Mining

Always quick to recognize a potentially economic mineral discovery, Mr. Pieters quickly filed three 300 x 600-meter claims covering the area. (Tannie Klippie apparently never benefited substantially from her important discovery.) Once Mr. Pieters had secured a land position he brought in a compressor and hired a local miner, Peter Kitler, to begin drilling. Periodically Pieters also brought in his tourmaline miner, Jan Coetzee, from Usakos to blast. They decided to opencut the granite beginning on the eastern end

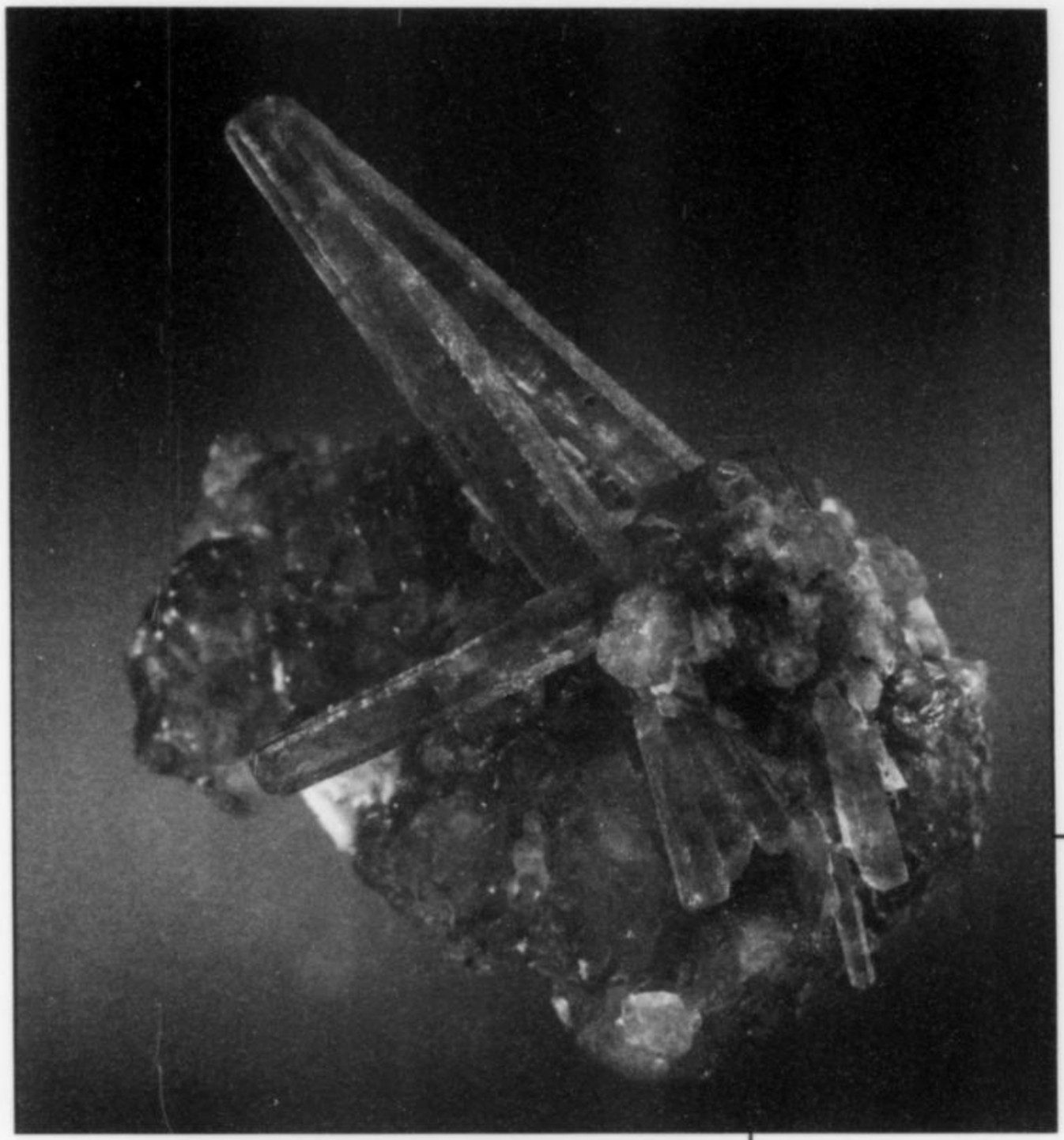
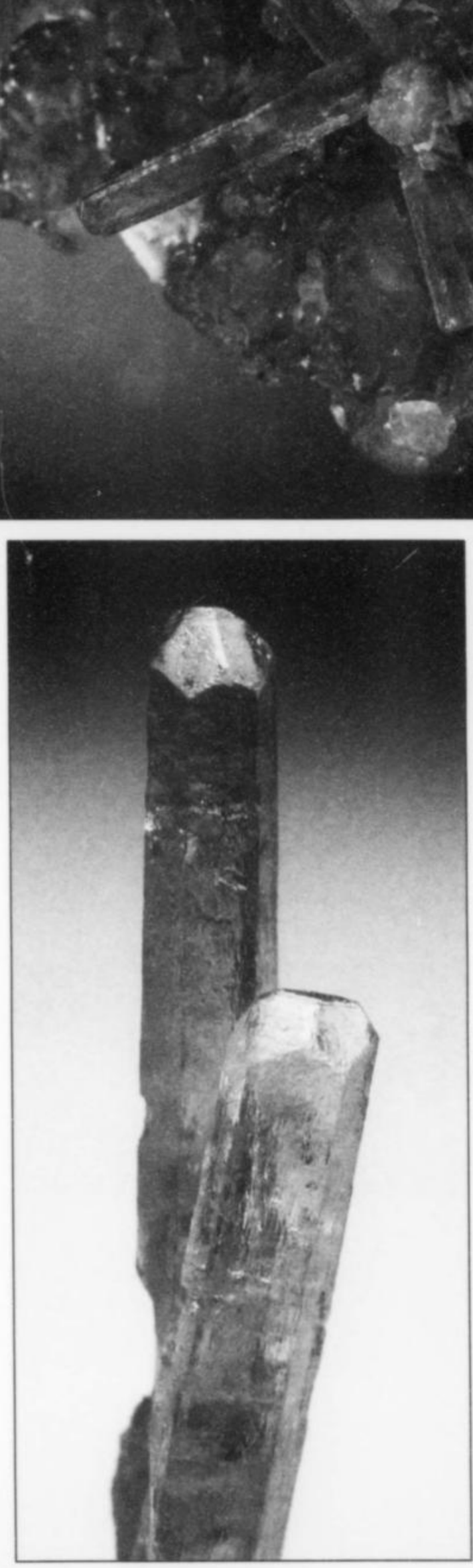


Figure 3. (left) **Jeremejevite crystals on matrix, 5.5 cm, from Mile 72. Ed Swoboda specimen now in the Houston Museum of Natural Science collection; Harold and Erica Van Pelt photo.**

Figure 4. (below left) **Jeremejevite crystal pair, 3.7 cm, from Mile 72. Canadian Museum of Nature collection (formerly William Pinch collection); George Robinson photo.**

Figure 5 (below). **Jeremejevite crystal on feldspar matrix, 2.5 cm, from Mile 72. Geoscience Museum of Pretoria collection; Rainer Jäckle photo.**



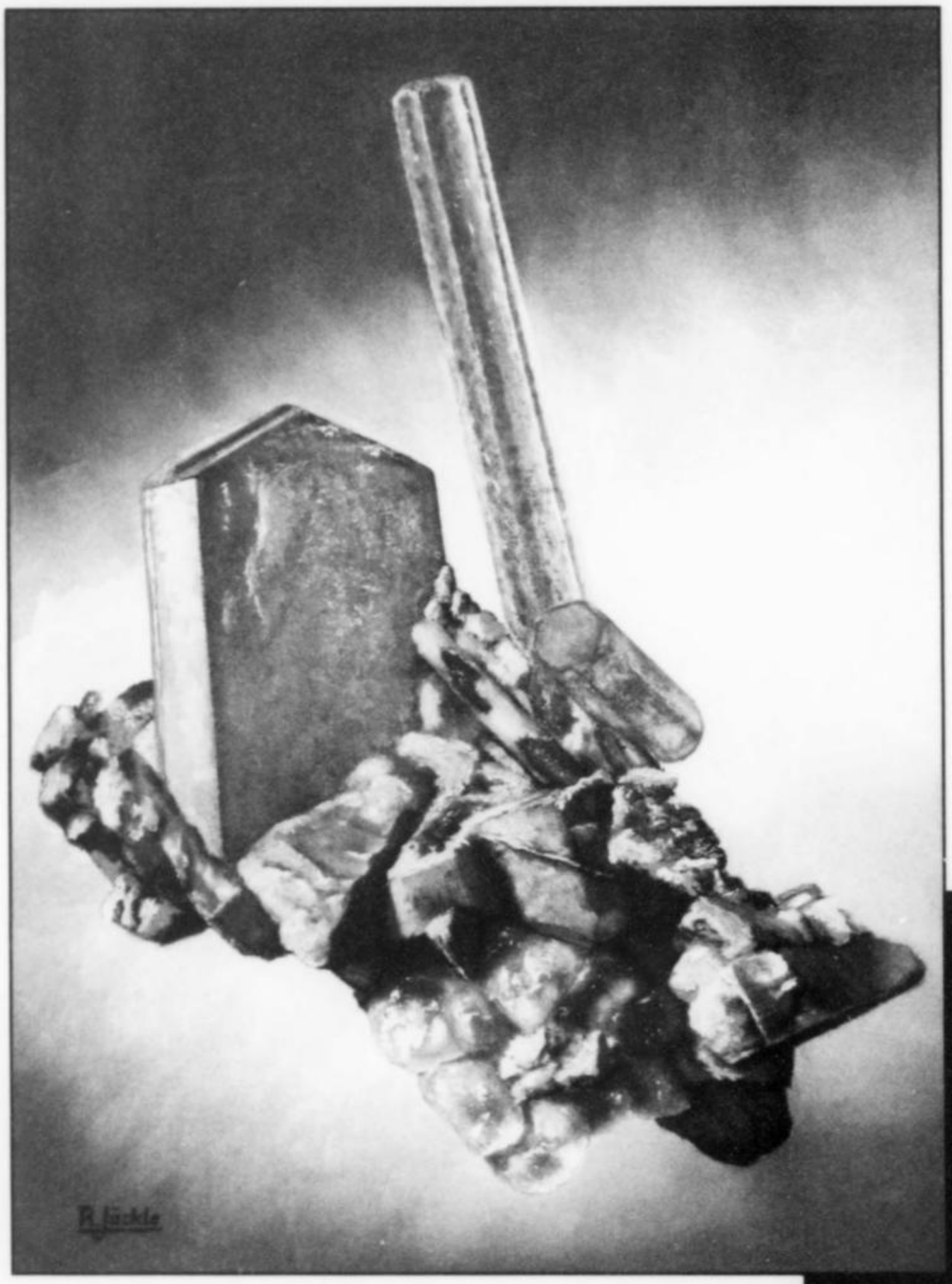
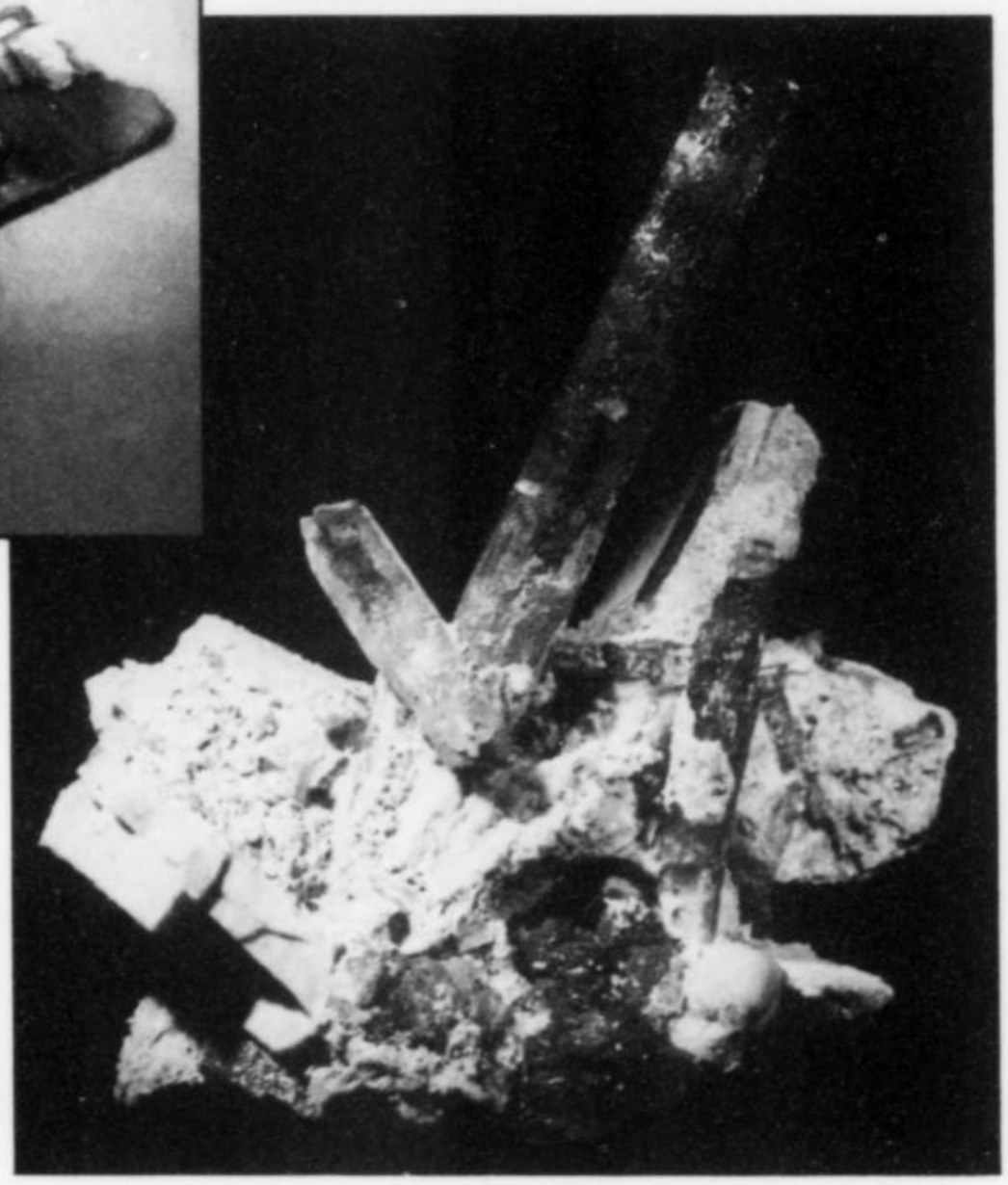


Figure 6. **Painting of jeremejevite crystals on matrix with feldspar crystals, 6.5 cm overall, from Mile 72. Specimen in the Geoscience Museum of Pretoria collection; painting by Rainer Jäckle.**

Figure 7. (below) **Jeremejevite crystals to 3.7 cm on feldspar matrix from Mile 72. Geological Survey of South Africa collection.**



and drive a trench westward perpendicular to the vertical vein containing the jeremejevite pockets. Conveniently, a zone of altered granite bordering the eastern rim of the outcrop was easy to excavate, and a little ramp was soon established there, extending down into the cut.

The first pocket found was in the altered granite. It yielded a number of gemmy but colorless, hexagonal-prismatic crystals to 7.6 cm. The trench was continued through 5 or 6 meters of hard granite, maintaining a depth of 1.5 meters. This work netted just a meager handful of loose, colorless crystals from small pockets along the vein.

A small, narrow, vertical zone of gray to black, medium-grained quartzite was found to intersect the main vein at about 90°. Here, at the junction of the veins, is the only place where *blue* jeremejevite crystals were found. Associations include pegmatitic albite, quartz, lepidolite, apatite, schorl, partially resorbed blebs of brown tourmaline, and gypsum (White, 1975). What subtle physiochemical difference existed at this intersection which allowed the crystallization of blue instead of colorless jeremejevite is unknown.

Work proceeded for a time along the newly found vein, extending both north and south from its point of intersection with the main vein. The largest pockets containing the best blue crystals were all found within a meter of the vein intersection. These pockets rarely exceeded 10 cm across. Later mining efforts followed the vein system to a depth of 3 meters, showing the dike itself to be consistently at least 20 cm in width over that distance.

Only a few colorless crystals of smaller size and lower quality were found as a result. Mining was therefore halted. At the time Pieters stopped his mining effort the "opencast" was approximately 5 meters wide (North-South) and 12 to 15 meters long (East-West), with a maximum depth of 1.5 meters.

According to Herting and Strunz (1978), a second discovery approximately 100 meters to the east took place in August 1976, when careful drilling and blasting yielded approximately 100 well-formed blue crystals from small size up to 5 cm long. However,

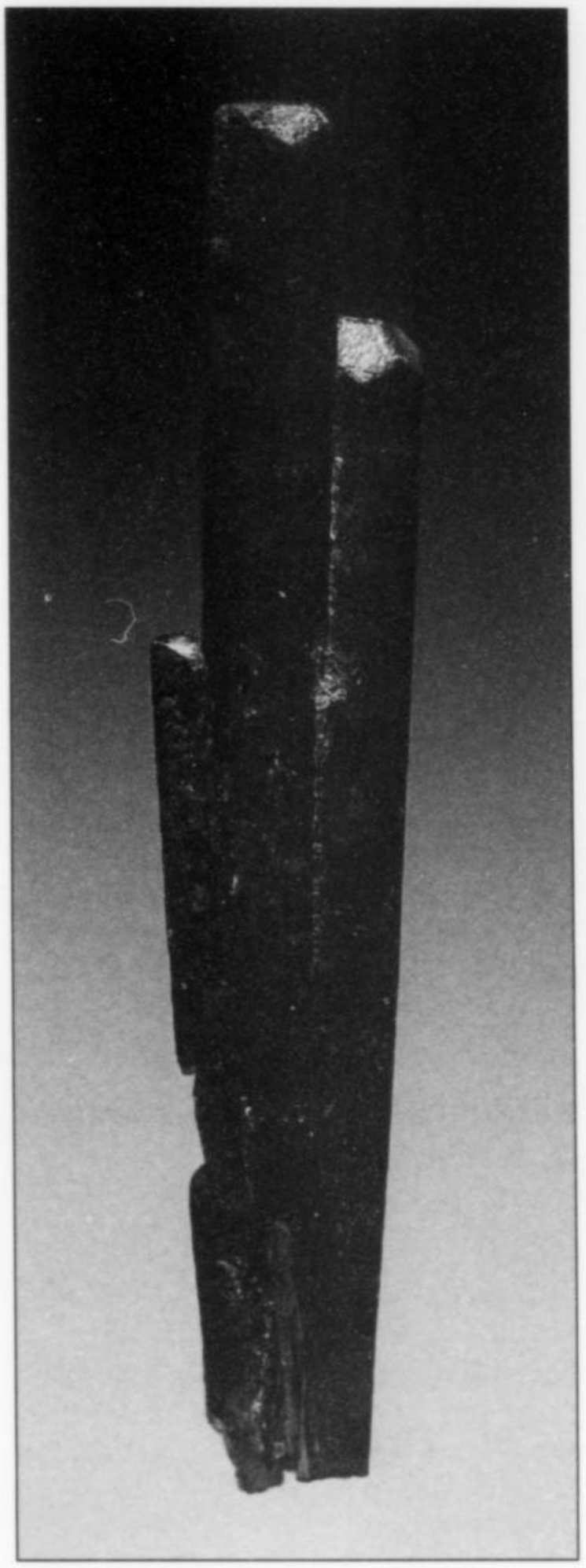


Figure 8. (left) **Jeremejevite crystal cluster, 5.7 cm, from Mile 72. Pacific Mineral Museum collection (formerly Charles Key collection); Mark Mauthner photo.**

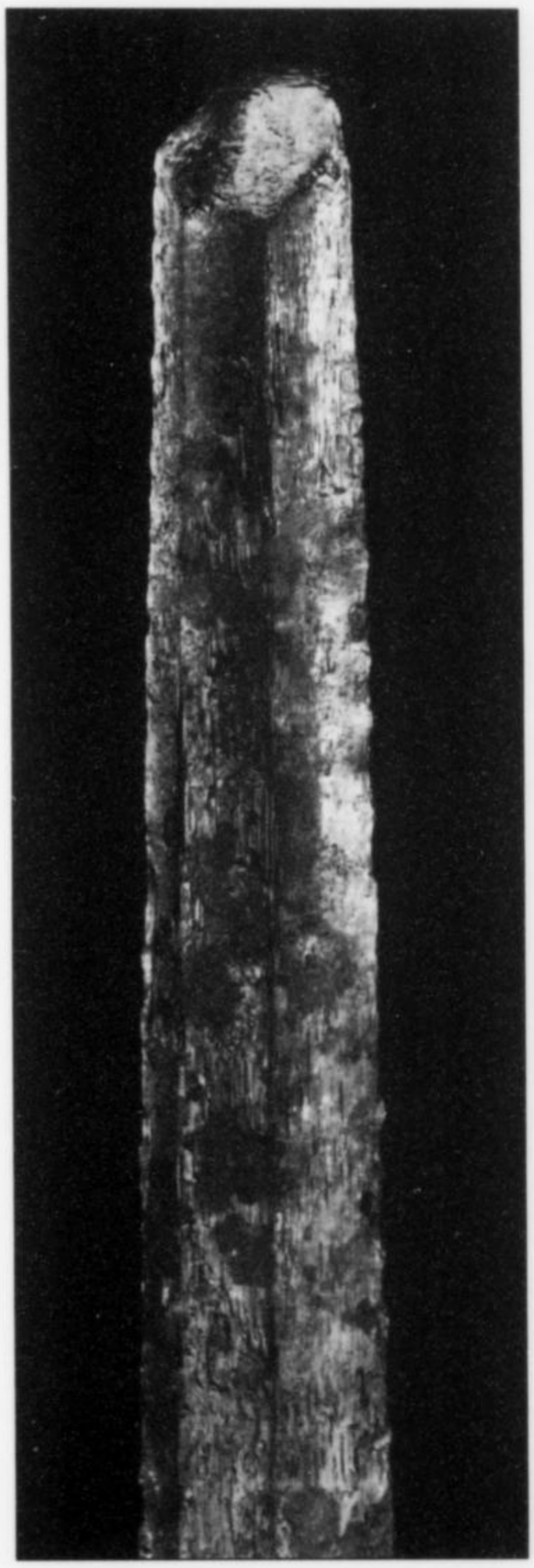


Figure 9. (right) **Part of the main jeremejevite crystal in the well-known, 5.6-cm two-crystal cluster from Mile 72, now in the Steve and Clara Smale collection (formerly John Barlow collection). Jeff Scovil photo.**

these crystals ranges from colorless to gray, faintly blue, greenish blue, and (the ultimate) deep cornflower-blue. Most of the crystals are small, 1 to 2 cm, with a few notable exceptions running up to 7 or 8 cm. Most of the terminations, where present at all, are rather corroded and indistinct. However, many broken crystal sections qualified as excellent gem rough, and a number of them were later faceted into gemstones.

Key passed through London on his way home from Namibia. He showed the crystals to Peter Embrey, curator of minerals at the British Museum (Natural History), who confirmed their identity with the help of a gemologist at the nearby Geological Survey.

Key's big sale came at the 1977 Tucson Gem and Mineral Show. He took a motel room adjacent to the Convention Center; word quickly spread about the jeremejevites (see Pinch, 1977), and he soon had a line of people waiting to get into his room. Among the first was one of the authors (ERS), who quickly selected a matrix piece with one attached crystal and two broken stumps where other crystals had once been attached. A careful search of the loose crystals eventually turned up the two that fit perfectly. The reassembled specimen (now in the collection of the Houston

according to Mr. Kitler and Mr. Coetzee, this pocket contained only relict, heavily altered crystals.

Specimen Sales

Small numbers of jeremejevite crystals began to reach the specimen market almost immediately after the discovery in 1973. Richard T. Liddicoat (1973) of the Gemological Institute of America made mention of the find that same year, and Strunz and Wilk (1974) described specimens a year later in the journal of the German Gemological Society. The Smithsonian Institution in Washington also acquired specimens in 1974 (White, 1975).

Shortly after the 1976 pocket had been worked out, the American mineral dealer Charles Key arrived in Namibia on a buying trip. Being a good friend of Sid's, he was offered and took most of the jeremejevite specimens, except for some which Pieters had already sold to South African mineral dealer Prosper Williams, or set aside for himself. Williams introduced his specimens to the American mineral market at the 1976 Detroit Show (Wilson, 1977). Key's lot amounted to around 150 specimens in two small flats. There were only two or three matrix specimens, the rest being loose crystals, crystal fragments and prism sections. The color of

Figure 10. **Excavation created at the Mile 72 site in 1999 by Khan River Mining and Exploration (Pty) Ltd., in partnership with *Collector's Edge Minerals*. The flat desolation of the area is visible in the background. Chris Johnston photo.**

Museum of Natural Science) is the finest matrix miniature recovered. Some of the best single crystals ultimately were acquired by the Smithsonian Institution and by William Pinch, (whose collection is now owned by the Canadian Museum of Nature in Ottawa); a similar crystal was obtained by the Museum in 1982 from Rod Tyson. Key retained a large pair of crystals in parallel growth, finally selling it not long ago to the Pacific Mineral Museum in Vancouver. Of the five or six specimens taken by Swoboda, one was faceted and presented to the Gemological Institute of America, along with two small crystals. One of the crystals obtained by the Smithsonian Institution has also been faceted. A large pair of attached crystals obtained by John Barlow (illustrated on page 37 of the Freilich Issue, January-February 2000) is now in the Steve and Clara Smale collection.

KHAN RIVER MINING AND EXPLORATION (PTY) LTD. OPERATION

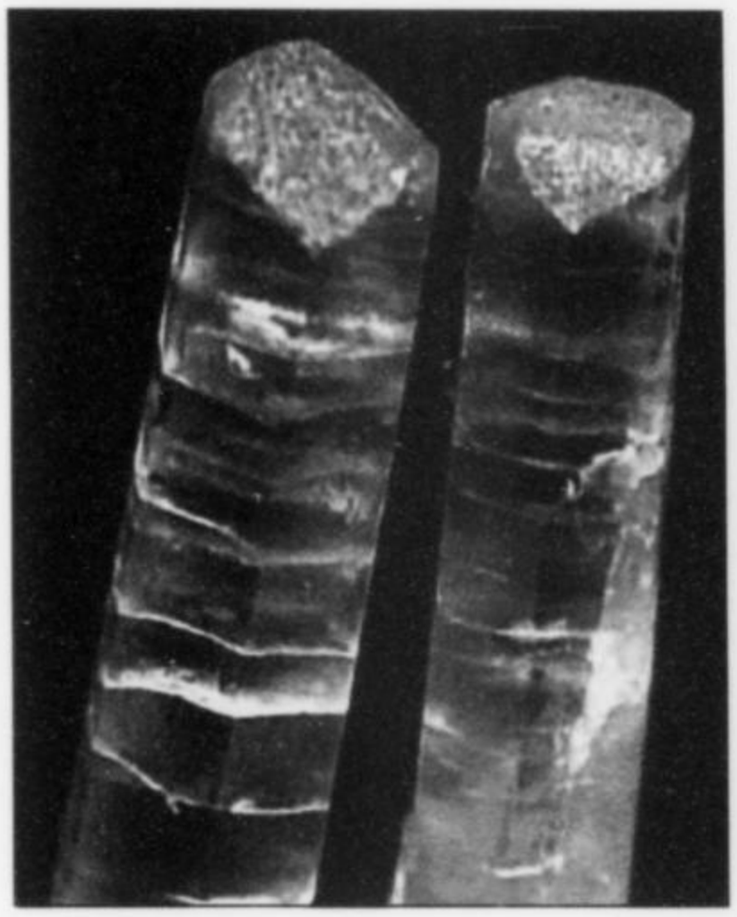
Exploration

In mid-1998, Brian Lees of *Collector's Edge Minerals* in Golden, Colorado teamed up with one of the authors (CLJ), an American mining geologist/gem and mineral dealer based in Omaruru, Namibia, to form *Khan River Mining (Pty) Ltd.* Their intention was to excavate further along the pegmatite veins in hopes of finding more jeremejevite. Acquiring the mining rights from Mrs. David Mansfield, (Rochelle Pieters Mansfield, daughter of Sidney Pieters), securing the necessary explosives licenses, locating and purchasing the required heavy equipment, and importing specialized specimen-extraction equipment from Golden consumed about 6 months. The new mining operation commenced in early January 1999.

During a reconnaissance visit in June of 1998 Mr. Lees and Mr. Johnston determined that the original intermittent mining efforts had removed less than 100 tons from the original discovery pit at coordinates 21° 52′ 76″ S and 14° 04′ 51″ E, and that there existed a substantial, visibly mineralized zone to the north of the discovery pit. This area measured approximately 20 square meters and extended to unknown depth, but clearly involved a minimum of 800 tons of rock to be initially mined; it was therefore chosen as Khan River Mining's primary target area. Upon cleaning out the "Kitler pit" the first truly mechanized mining effort at Mile 72 commenced.

Mining

As predicted, the presence of seawater at a depth of 1 meter created an extremely difficult mining environment requiring constant pumping. In spite of this difficulty, over the course of 6 months the Khan River crew (consisting of Mr. Ryno van der Smit, Mr. Alfeus "microchip" Hamutenya and Mr. Johnston) were able to mine an estimated 2700 tons of rock from the alteration zone. With the advantage of heavy equipment, Khan River Mining (Pty) Ltd. was able to mine more rock in the first two weeks of operation than was mined during the entire Sid Pieters effort in 1973–1976. Within the first week, directly below the area where the best material had been found by Kittler in 1973, a coarse-grained granitic pegmatite was encountered which produced approximately 300 single, colorless to pale straw-yellow, dull-lustered, water-clear jeremejevite crystals up to 5 cm in length and one lonely pale blue crystal. A small number were removed still attached to the



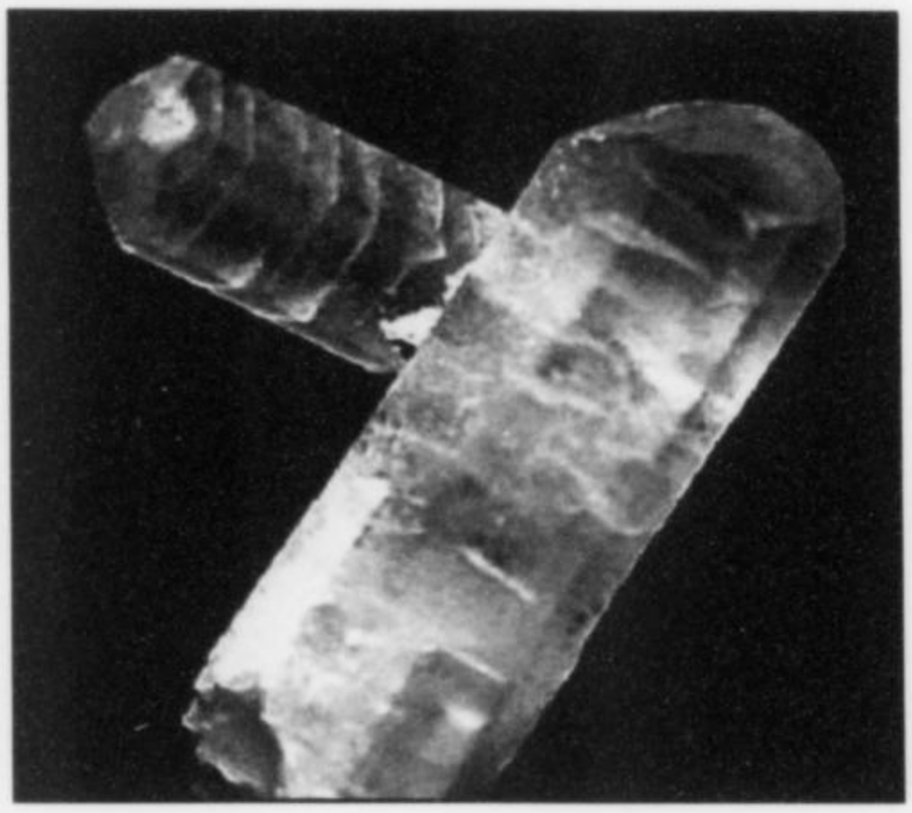


Figure 11. **A 1.5-cm pair of connected, relatively colorless jeremejevite crystals collected at Mile 72 during the 1999 operations. Rob Lavinsky (*The Arkenstone*) specimen and photo.**

Figure 12. (above) **Two terminated but relatively colorless jeremejevite crystals to 1.9 cm collected at the Mile 72 site in 1999. Rob Lavinsky (*The Arkenstone*) specimens and photo.**

Figure 13. (right) **Preparing an area at the Mile 72 site for blasting, 1999. Chris Johnston photo.**

matrix pegmatite, but unfortunately the dike rock was heavily weathered.

Over the next 12 months an additional 14 target areas were identified, and an estimated 2300 tons of rock mined. In addition to these targets a total of 15 trenches were excavated across various structures. While this effort produced some interesting specimens of feldspar, apatite, quartz and schorl, no further jeremejevite was found.

Namibia is one of the few countries in the world that constitutionally guarantee the protection of the environment. The mining area at Mile 72 is wholly contained within the Skeleton Coast Marine Conservation Area and consequently the company's mining activities were strictly regulated and controlled to minimize environmental impact. Eighty-five percent of the claim block is covered by a veneer of drifted sand, so there are few actual outcrops. Exploration could only be conducted over the portions of the claim block where bedrock was exposed and structures were visible. Environmental regulations prevented the company from removing the sand veneer from large areas that might conceivably still contain jeremejevite-bearing pegmatites. Consequently it is highly unlikely that any further mining for jeremejevite will take place at Mile 72.

Specimen Sales

All specimens from the 1999 operation were shipped to Colorado and sold by *Collector's Edge Minerals* in Golden; some specimens found their way through wholesale channels to other dealers.

GEOLOGY

The geology of the Mile 72 area is surprisingly complex, covering 425 million years of geologic history from roughly 560 to 135 million years ago. The area is directly adjacent to the marine trench formed during the breakup of Gondwanaland (where the African continent separated from South America), and the associated inundation with turbidite deposits (Amis Formation of the Zerissene Group). Post-spreading Damara-age granites (Salem Formation) are present within the region, as are the much younger (135 m.y.) granites of the Cape Cross Complex (Etendeka Group). The country rock into which the granites and pegmatite veins

(including those bearing jeremejevite) have been injected is the Precambrian Swakop facies of the Damara System, consisting of strongly metamorphosed quartzites, limestones, schists and granitized sedimentary rocks.

There are three distinct sets of pegmatites present at the location. There is an east-west-trending set that is presumed to be equivalent with the Uis Tin-Tantalite belt, and thus Damaran in age; there is a north-south-trending set which is presumed to be related to the Cape Cross Complex; and there are isolated secretion-type metamorphic pegmatite bodies of unknown age. Some of the pegmatites are probably the result of anatexis of the basement rocks, formed by metamorphic secretion, diffusion and replacement (Haughton, 1969). (Complex pegmatites of metamorphic origin were frequently encountered during Khan River Mining's efforts to recover jeremejevite.) The pegmatites may take the form of large, complex, lithium-rich bodies, or of thin veins in a spider-web distribution as at Mile 72. Although the Mile 72 pegmatites have not been dated specifically, Haughton (1969) reports a general age of 510 ± 60 m.y., i.e. Cambrian to Ordovician, for all of the post-tectonic pegmatites in the Swakopmund district and nearby districts.

Because there has never been any significant age-dating research or geochemical analyses conducted at Mile 72, the true identity and relationships of the various geologic components remain to be established with certainty. Field observations suggest that there was a pre-existing pegmatite body—either Uis Tin-Tantalite-equivalent or a metamorphic pegmatite—which was cut by a much younger Cape Cross Complex-equivalent dike, and in the resulting remobilization of the pre-existing constituents jeremejevite was precipitated. It must be stressed that this is only one of a number of possible explanations for the origin of this single occurrence. Unfortunately, any theory regarding the genesis of the deposit is now difficult to substantiate since much of the essential physical evidence was removed during the Pieters mining effort without keeping geological records.

The Uis Tin-Tantalite pegmatites are part of a regionally extensive belt which is responsible for much of the economic mineralization in central and west-central Namibia. These pegmatites were a primary source of tin for the German Empire during the colonial period. Production of tin continued until the discovery of the Malaysian beach deposits, which rendered the Namibian hard-rock occurrences comparatively uneconomical to mine. In recent years (Post, 1960) these deposits have yielded a modest but steady production of fine-quality gem materials, most notably gem tourmaline and aquamarine. During recent years there was a resurgence of mining activity for the production of tantalite in the Uis belt, driven by high demand from the electronics industry prior to the collapse of market in 2000.

Notable localities associated with the Uis Tin-Tantalite Belt include: Brandberg West, Uis, the Arandis-Rössing district (70 km southeast of Swakopmund), the Erongo district (120 km east) and the Karibib district (150 km southeast). The Khan pegmatite near the Rössing mine is one of the few known copper-bearing pegmatites in the world.

MINERALOGY

The first specimens of Mile 72 jeremejevite were identified primarily on the basis of index of refraction. When the Smithsonian Institution in Washington acquired a pale blue, 2.2-cm crystal in 1975, Pete Dunn performed the standard mineralogical tests and provided the following data, reported by White (1975): $\alpha = 1.641$, b = 1.652; uniaxial to weakly biaxial; sp. gr. 3.29; hardness 6½.

Jeremejevite is crystallographically interesting because of its anomalous optical characteristics: most crystals have a uniaxial zone and a biaxial zone, though no difference in crystal structure can be detected by X-ray crystallographic analyses (Golovastikov *et al.*, 1955). The Siberian crystals have a biaxial core surrounded by a uniaxial rim, whereas the Namibian crystals show a uniaxial core and biaxial rim (Foord *et al.*, 1981). The Siberian crystals from the two zones even show a difference in external morphology, visible at the terminations where the core zone is exposed.

The morphology of the Mile 72 crystals is difficult to establish precisely with confidence because of the somewhat corroded crystal surfaces. Herting and Strunz (1978) reported the obvious major forms, a hexagonal prism $\{11\bar{2}0\}$, second-order hexagonal pyramid $\{10\bar{1}1\}$, and pinacoid {0001}. They also noted a minor lower-angle pyramid $\{00\bar{1}3\}$ and a narrow second-order hexagonal prism {1010}. The largest and best-formed crystals also show signs of one and possibly two first-order hexagonal pyramids $\{11\bar{2}2\}$, $\{22\bar{4}3\}$. The slight tapering of some of the largest crystals also suggests an extremely high-angle first-order pyramid approaching the planes of the first-order prism. Most of these forms should be considered provisional until crystals more suitable for precision goniometry are discovered.

Foord *et al.* (1981) and Rodellas and García-Blanco (1983) determined that the crystals are hexagonal and centrosymmetric, with space group $P6_3/m$ and cell measurements of a = 8.556 to 8.558 and b = 8.175 to 8.183Å. There is some variability in the F/(OH) ratio; the cell volume increases slightly with increases in (OH), the expansion being slightly larger in the *c*-direction. They determined the hardness to be 7½ (higher than Dunn's 6½) and the specific gravity to be 3.294 ± 0.01 (in good agreement with Dunn). No response to longwave or shortwave ultraviolet radiation was reported. Indices of refraction determined by Foord *et al.* (1981) are $\alpha = 1.637$, b = 1.644, ?? = 1.645.

The chemical analyses of Mile 72 jeremejevite reported by Foord *et al.* (1981) and by Herting and Strunz (1978) vary somewhat (see Table 1). The Foord *et al.* analyses yield a calculated formula of $Al_6Fe_{0.01}B_{4.97}Si_{0.01}O_{15}F_{2.76}(OH)_{0.24}$.

The color variations in Mile 72 jeremejevite have not been satisfactorily explained. Foord *et al.* (1981) speculated that the blue color might be due to trapped cations such as Fe, but the chemical evidence for this is weak; inorganic-radical-trapped electrons (BO_3) or lattice vacancies were also postulated but the analytical tests were inconclusive.

Table 1. **Chemical analyses of Mile 72 jeremejevite (in weight-percent). (Foord *et al.*, 1981) (Herting and Strunz, 1978)**

Al_2O_3	59.12 – 59.79	57.80
B_2O_3	34.09 – 33.81	40.27
Fe_2O_3	0.02 – 0.14	1.35
SiO_2	0.01 – 0.17	(n.d.)
F	9.26 – 10.23	(n.d.)
Na_2O	(n.d.)	0.28
K_2O	(n.d.)	0.16

The Erongo Mountains Occurrence

DISCOVERY

In 1998 pegmatites discovered in the Erongo Mountains first began producing interesting schorl crystals on microcline. Since then an increasing diversity of species and morphologies has been recovered; in some cases the specimens are among the finest ever produced in Namibia. The species list now includes aquamarine beryl, topaz, fluorite, cassiterite, tantalite, hyalite, dolomite, sider-

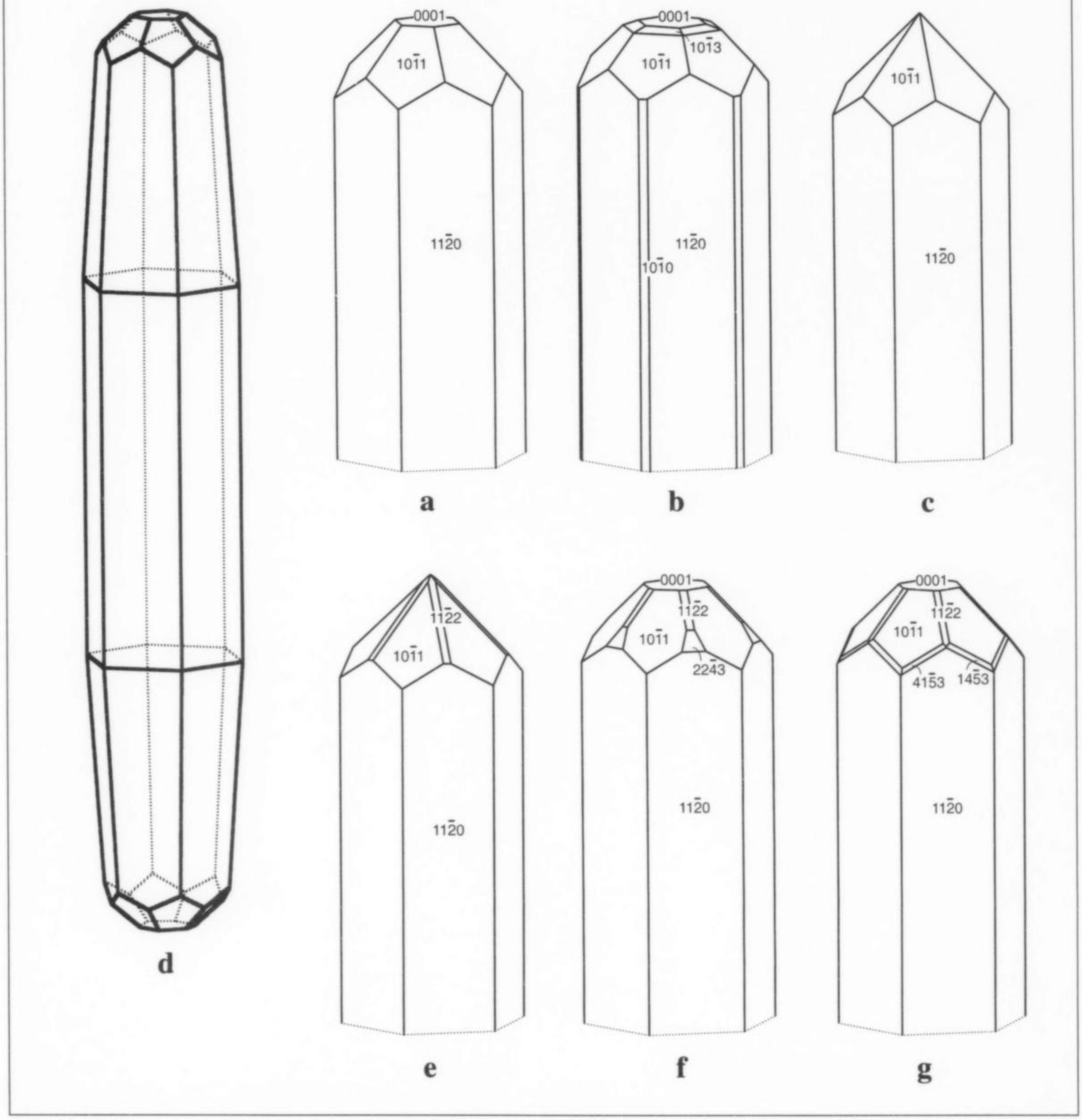


Figure 14. **Crystal drawings showing habits and forms of Mile 72 jeremejevite: (a, b, c) after Herting and Strunz, 1978; (d, e, f,) from recent studies of Mile 72 crystals; (g) Pamir Mountains habit (after Zolotarev *et al.*,2000); drawings courtesy of R. Peter Richards.**

ite, goshenite beryl, zinnwaldite, smoky quartz and amethyst, plus the finest specimens known of a new tourmaline-group mineral, foitite. In March of 2001, pegmatites containing jeremejevite were discovered near the summit of an isolated inselberg on Farm Ameib near the border with Farm Davib-Ost, halfway between the Village of Tubussis and the Town of Usakos on the south side of the Erongo Mountains. As at Mile 72, the first intense-blue crystals found were thought to be aquamarine beryls, and caused little excitement. However, once their identity had been correctly established, the local miners were sent back to search for more. A few thousand crystals have since been recovered.

The workings are restricted to a 100-square-meter area on a steeply sloping spalling surface near the top of the inselberg at map coordinates: 21° 45′ 27″ S, 15° 35′ 00″ E. on the Usakos North Sheet. The jeremejevite occurs in a series of pockets in pegmatitic pipes penetrating granite within a localized zone just below the summit.

Figure 15. **Best available transportation for supplies en route to the Erongo Mountains site (in the distance). Georg Gebhard photo.**

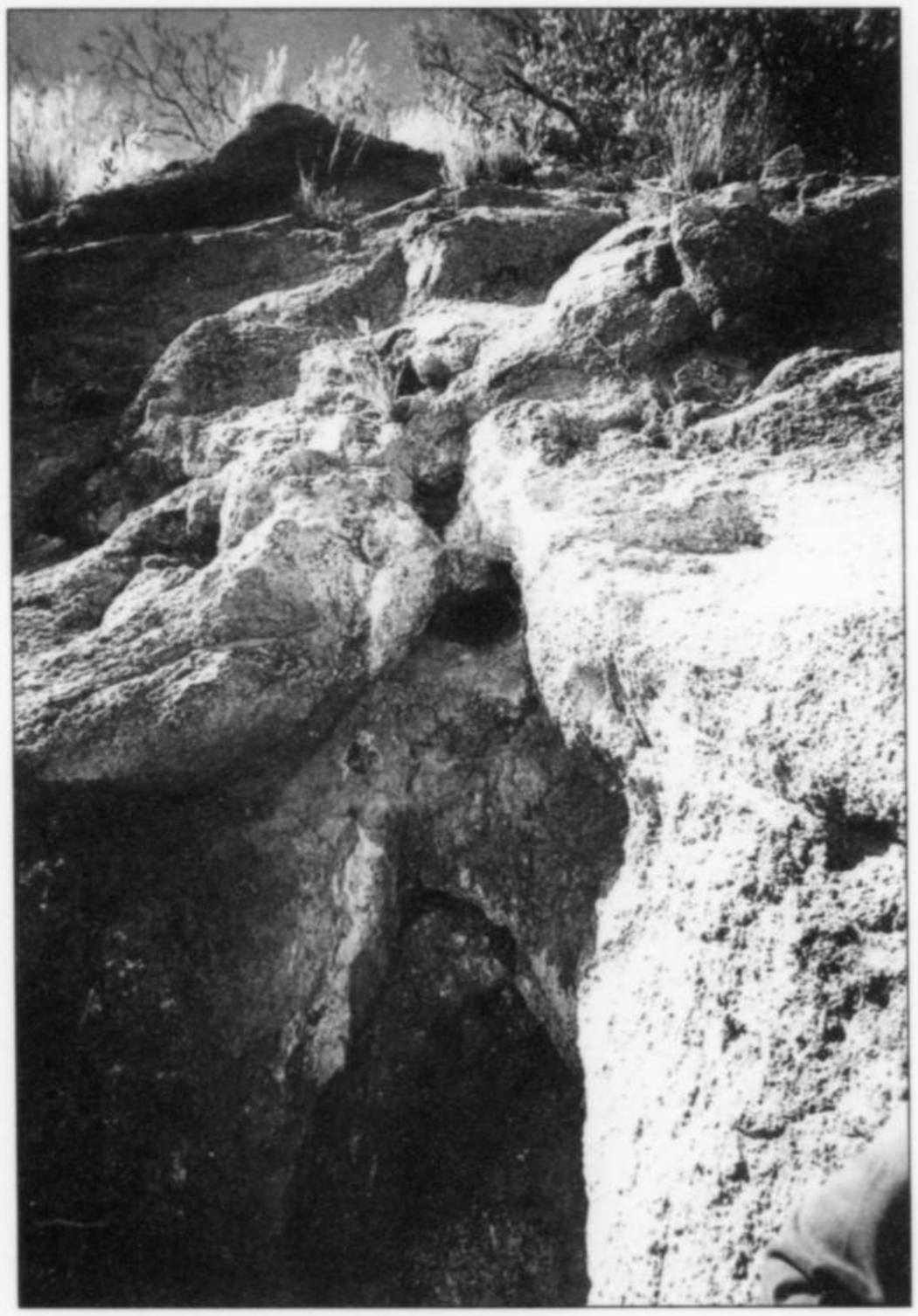


Figure 16. **Remains of a small pegmatite pipe exposed on a rock slope, Erongo Montains. Georg Gebhard photo.**

MINING

Unlike the Khan River Mining and Exploration project at Mile 72, specimen mining in the Erongo Mountains is a simple brute force manual labor affair. The local landowners, who still cling to pre-independence attitudes, restrict access. The diggers must walk 14 kilometers from the Government gravel road to reach the base of the inselberg. It is then a very hard climb of nearly 500 meters to reach the top. There is no water on the inselberg, so the diggers must carry their own water in addition to their modest equipment. In spite of these difficulties, numerous industrious diggers have formed informal "companies" and secured the use of small 4-kilowatt gasoline-powered generators and heavy-duty Bosch rotary-impact drills which they use to drill out pockets. The majority of the diggers, who have numbered up to 150, have nothing more than a hammer, chisel and shovel with which to attack the granite. Some of the excavations now exceed 6 meters in depth. These miners exhibit extraordinary strength and determination.

Although the restricted access is a problem, of far greater concern is the chronic lack of water. Consequently mining activity is largely restricted to the rainy season and two or three months following while the catchment potholes still hold water.

The intensity of mining activity in the Erongo Mountains tends to fluctuate; at its peak there were in excess of 1,000 diggers spread out on the west and south sides of the range. Currently (January 2002) activity is at a low ebb, with an estimated 300 to 500 diggers working.

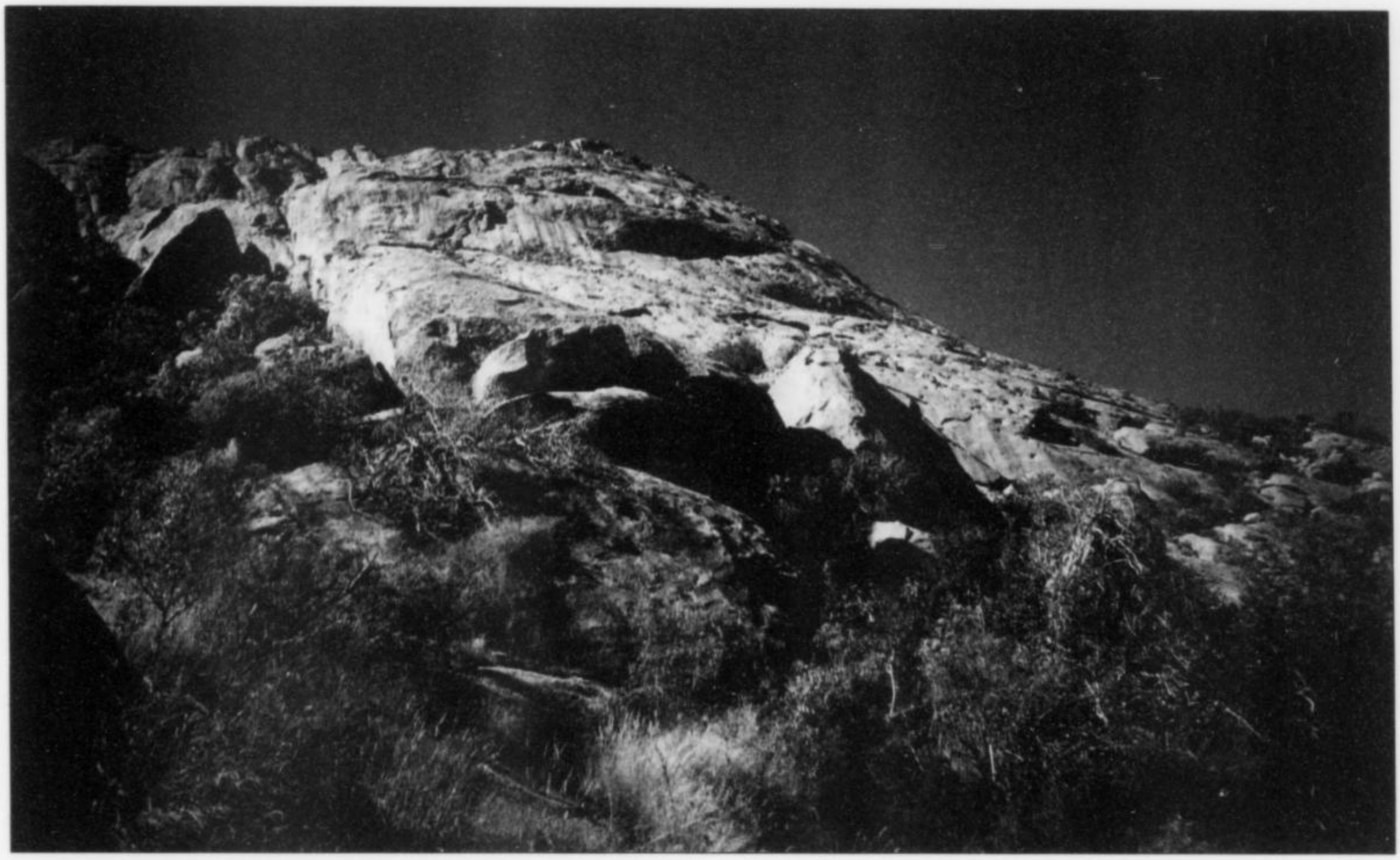


Figure 17. **Looking up at the rock slope in the Erongo Mountains where many of the jeremejevite-containing pegmatite pipes were found. Georg Gebhard photo.**

Figure 18. **Surface opening of a vertical pegmatite pipe a few inches across in the Erongo Mountains area which yielded jeremejevite crystals. Georg Gebhard photo.**

MINERALOGY

The majority of the Erongo Mountain jeremejevite crystals are under 2.5 cm in size, but a respectable number of larger crystals (over 200) range up to 5 cm in length and 1 cm wide. There have been unverified reports of crystal sections in excess of 8 cm. In addition, a significant number of water-clear microcrystals have also been found (Gebhard and Brunner, 2001). A small but steady stream of specimens continues to be recovered there but high-quality examples remain extreme rarities. The color ranges from deep cornflower-blue (rare) to predominantly pale to medium blue in color, with a small percentage being distinctly lavender, blue-green, or colorless to tan.

In stark contrast to the etched crystals from the Mile 72 occurrence, Erongo jeremejevite crystals tend to have smooth, highly lustrous faces, in some cases including sharp terminal faces. Oddly, most of the colorless to pale blue crystals are found with terminations intact whereas few of the deep blue crystals exhibit termination forms. Some crystals are more deeply colored on the end which had been attached to matrix, and grade to colorless on the terminal end. The habit varies from short and stubby to very thin and elongated, tapering toward the terminal end. Only a few clusters have been recovered.

The pockets also contain a fibrous habit of blue to green tourmaline, and larger crystals of smoky quartz and orthoclase feldspar to which all jeremejevite crystals were presumably once attached; only a few specimens of jeremejevite crystals still on their quartz or feldspar matrix have been recovered. The majority of the crystals found thus far at the Erongo location are damaged, generally lacking terminations. An inspection of the pockets themselves by Gebhard and Brunner (2001) suggests that the damage is the result of an explosive decompression phase of the kind typical of many pegmatites, rather than mining damage or crystal growth extending to contact the opposite wall of the pocket.

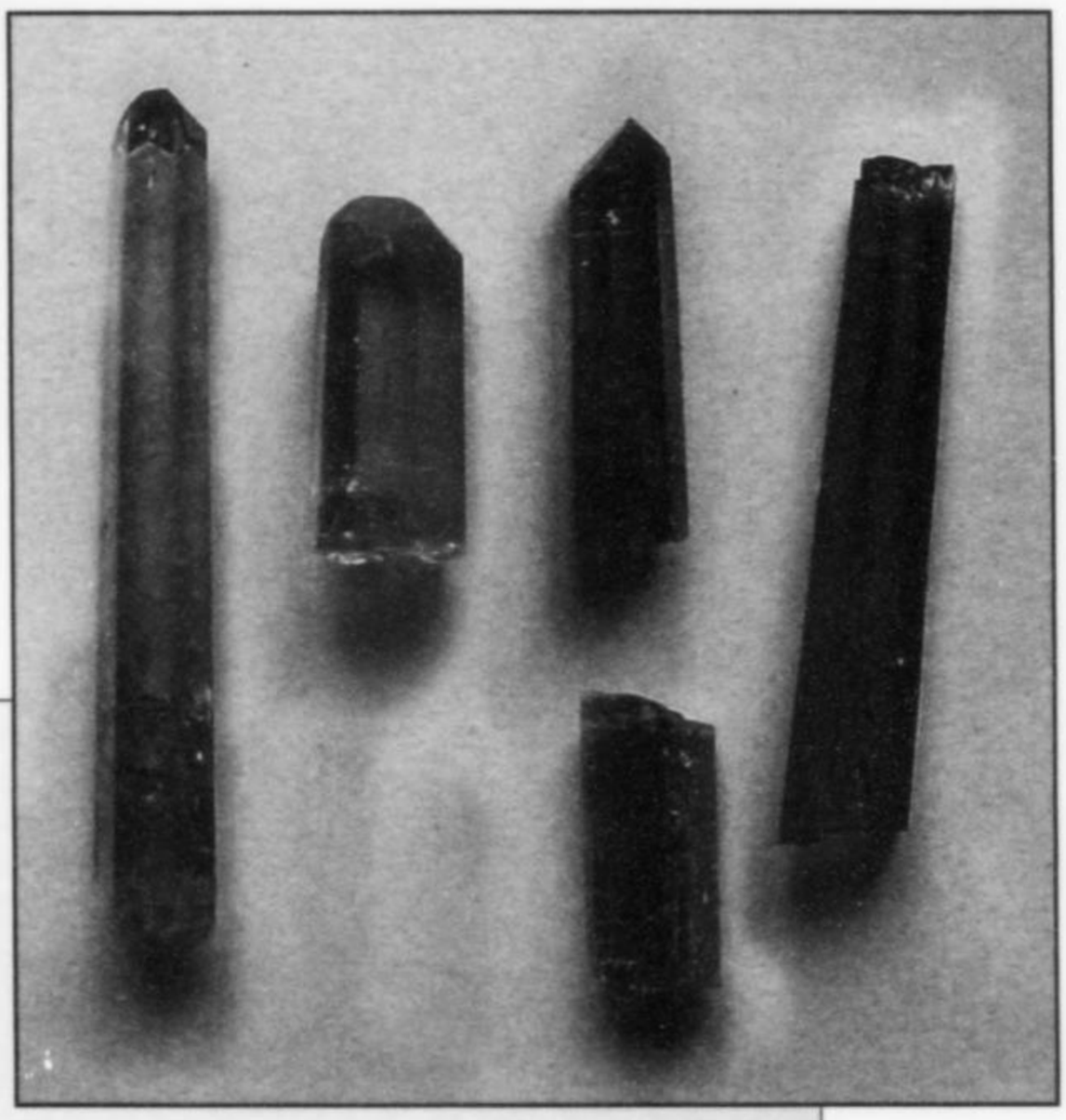
ERONGO SPECIMEN SALES

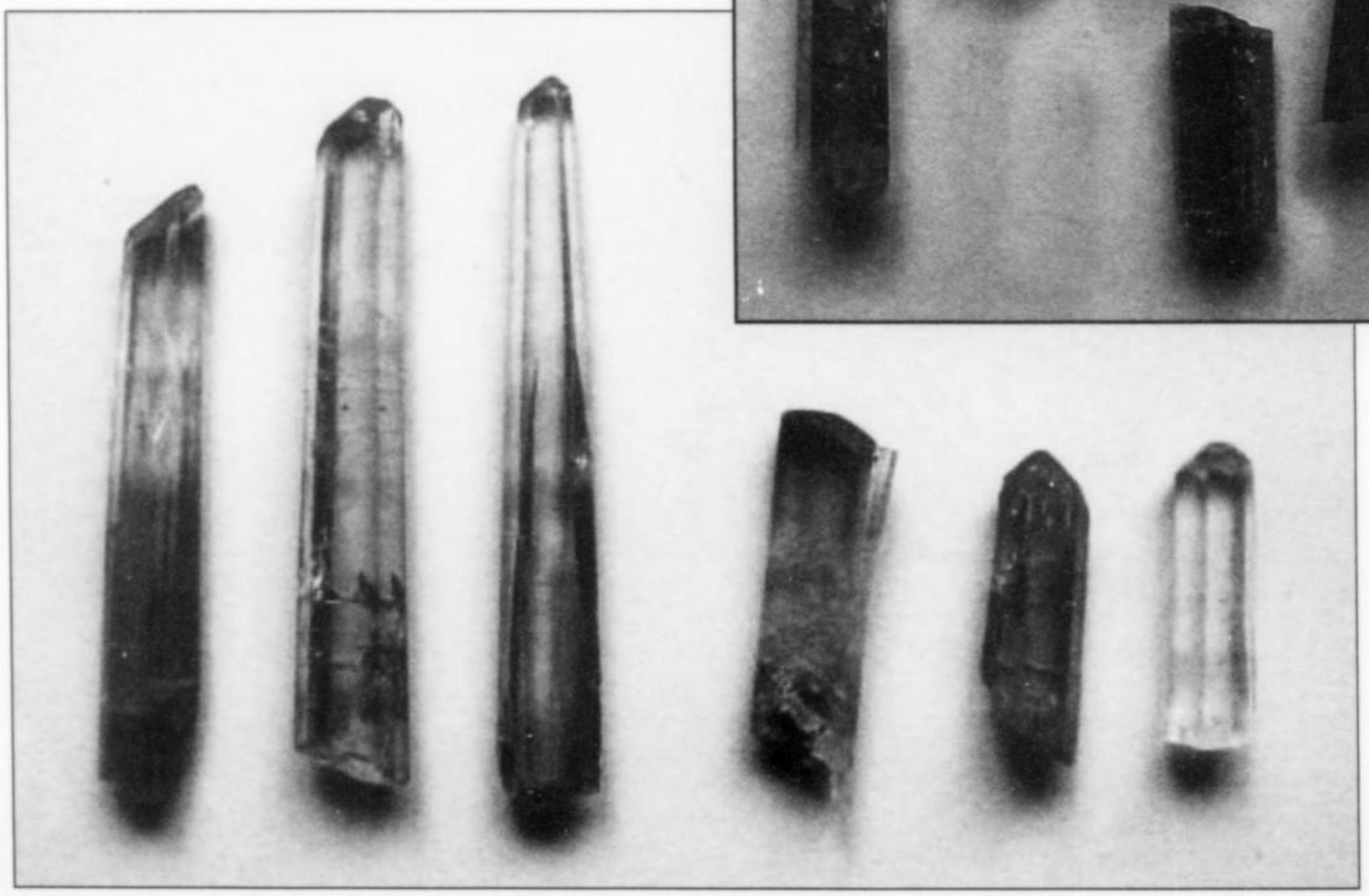
Virtually all jeremejevite specimen production went through the hands of local mineral dealers, Horst Bachran, Marta Rousseau, Johannes Brunner, Cornelius and Johann McDonald and Herbert Naegele. In turn many of the finer pieces immediately found their way into private collections predominantly in Europe. German

dealer Georg Gebhard has sold many of the remaining pieces, though a number have been distributed wholesale to other dealers. Wayne and Dona Leicht (*Kristalle*) offered a number of fine specimens at the 2001 Tucson Show. Two of the finest matrix pieces were sold by one of the authors (CLJ). Prices for single crystals have varied widely, whereas the prices asked for rare matrix specimens have remained consistently high.

Figure 19. (left) **A rare 2.5-cm, doubly terminated jeremejevite crystal, perched on a quartz crystal as matrix, from the Erongo Mountains area. Brendan Laurs specimen and photo.**

Figuure 20 (below). **Two photos showing 11 Erongo Mountains jeremejevite crystals to 3.8 cm, illustrating a range of color variations and zoning. Georg Gebhard photo.**





CONCLUSIONS

It is probably safe to say that the possibility of finding additional blue crystals of jeremejevite at Mile 72 is nil, and that for all practical purposes the locality is extinct. The crystals currently preserved in collections are likely to be the only ones that will ever be known from this fascinating occurrence. Collectors and curators should value and protect them accordingly, and should especially make every effort to prevent any more crystals from being faceted into gemstones. It is likely, however, that more specimens will continue to be found in the Erongo Mountains.

ACKNOWLEDGMENTS

Our thanks to Paul Pohwat and Chip Clark of the Smithsonian Institution, Robert Gault of the Canadian Museum of Nature, Mark Mauthner of the Pacific Mineral Museum, Joel Bartsch of the Houston Museum of Natural Science, Anthony Kampf of the Natural History Museum of Los Angeles County and Steve Smale for specimen photography, Charles L. Key and Prof. Dr. H. Pöllmann for kindly providing background information; R. Peter Richards for the crystal drawings; and Bruce Cairncross and Abraham Rosenzweig for reviewing the manuscript.

REFERENCES

DAMOUR, A. (1883) Note sur un borate d'alumine cristallisé, de la Sibérie. Nouvelle espèce minérale. *Bulletin de la Societe française de Minéralogie*, **6**, 20–23; *Compte rendu Academie Sci. Paris*, **96**, 675–677.

FOORD, E. E., ERD, R. C., and HUNT, G. R. (1981) New data for jeremejevite. *Canadian Mineralogist*, **19**, 303–310.

GEBHARD, G., and BRUNNER, J. (2001) Jeremejevite from Ameib, Erongo, Namibia: A new and probably the best find ever made. Website article published at www.mineralnews.de.

GOLOVASTIKOV, N. I., BELOVA, E. N., and BELOV, N. V. (1955) Crystal structure of eremejevite. *Zapiski vserossiyskogo. Mineralogicheskogo Obschestva*, **84**, 405–414 [in Russian].

HAUGHTON, S. H. (1969) *Geological History of Southern Africa*. Geological Society of South Africa, Cape Town, 535 p.

HERTING, S., and STRUNZ, H. (1978) Jeremejewit von Mile 72 in SW-Afrika. *Aufschluss*, **29**, 45–53.

HOCHLEITNER, R., and WEISS, S. (2000) Steckbrief Jeremejewit. *Lapis*, **25** (2), 9–10.

LIDDICOAT, R. T. (1973) One of the great rarities; *in* Developments and highlights of GIA's lab in Los Angeles. *Gems & Gemology*, **14**(6), 184-–185.

PINCH, W. W. (1977) Rare minerals report. *Mineralogical Record*, **8**, 391.

RODELLAS, C., and GARCÍA-BLANCO, S. (1983) Crystal structure refinement of jeremejevite ($Al_6B_5F_3OH_{15}$). *Zeitschrift für Kristallographie*, **165**, 255–260.

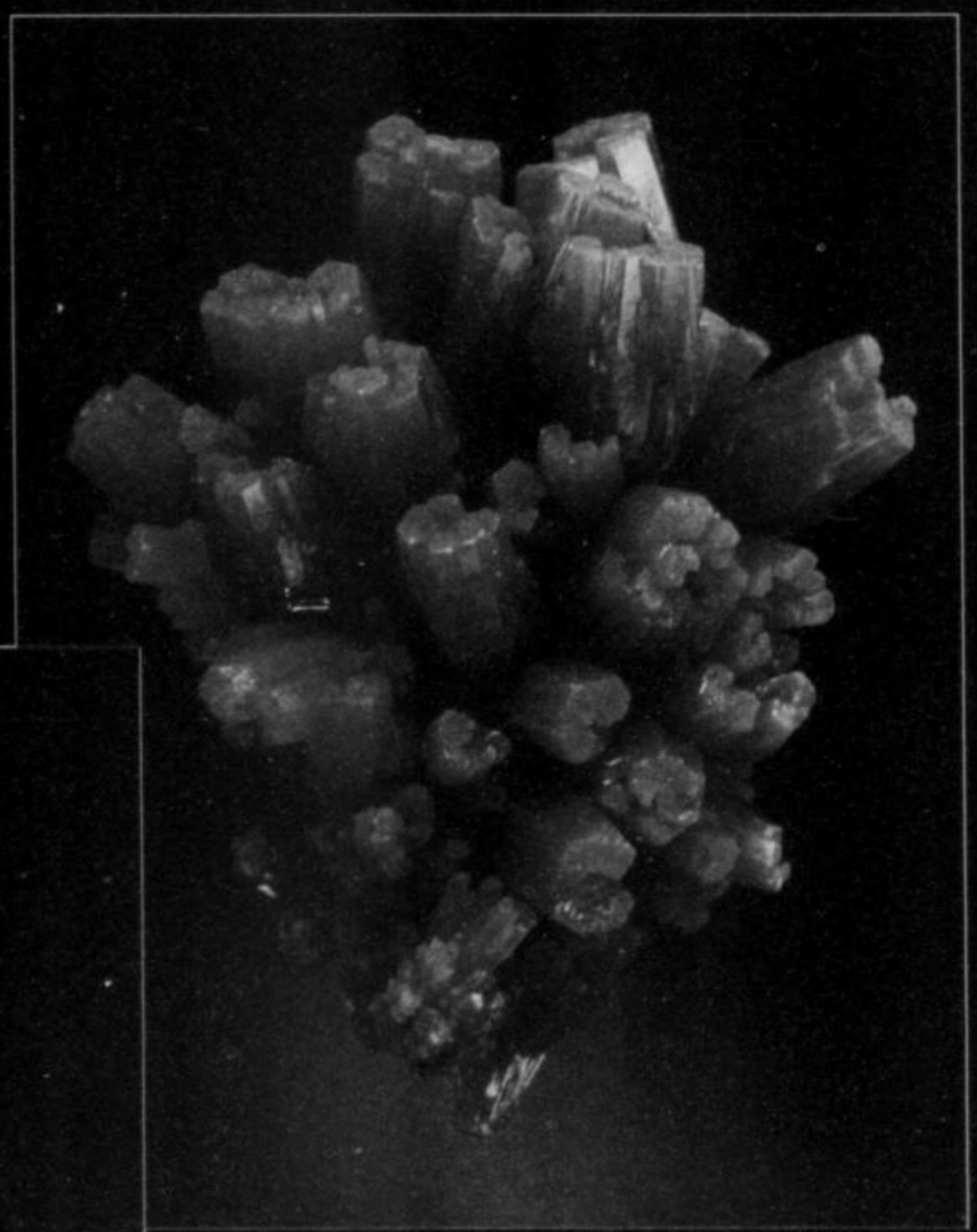
STRUNZ, H., and WILK, H. (1974) Jeremejewit als Edelstein aus SW-Afrika. *Z. Deut. Gemmol. Gesellschaft*, **23**, 142–150.

WEBSKY, M. (1884) Über Jeremejewit und Eichwaldit vom Berge Soktuj in Daurien. *Neues Jahrbuch für Mineralogie, Monatshefte*, 1–17.

WHITE, J. S. (1975) Jeremejevite from Southwest Africa, *in* What's new in minerals? *Mineralogical Record*, **6**, 38.

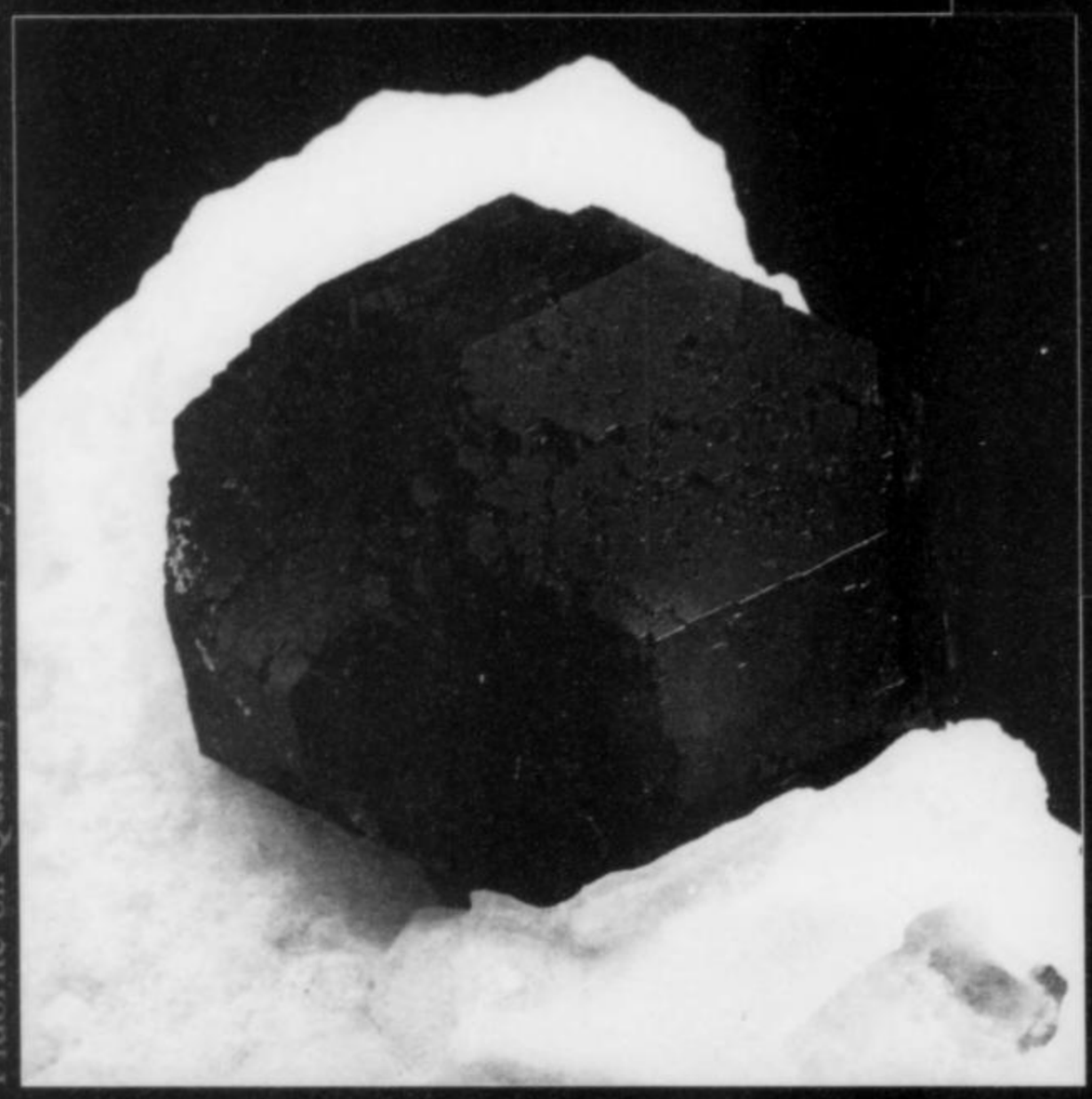
WILSON, W. E. (1977) Rare minerals report. *Mineralogical Record*, **8**, 391.

ZOLOTAREV, A. A., DZHURAEV, Z. T., PEKOV, I. V., and MIKHAILOVA, K. V. (2000) Jeremejevite from pegmatite veins of the Eastern Pamirs. *Zapiski vserossiyskogo Mineralogicheskogo Obschestva*, **129** (2), 64–70. [In Russian with English abstract.]



JEFF SCOVIL

Pyromorphite, Daoping
Lead-Zinc Mine, China, 4 cm



JEFF SCOVIL

Fluorite on Quartz, China, Crystal Size, 3.3 cm

The Collector's Edge has developed excellent contacts in China. Since the spring of 1999, we have been acquiring the finest specimens available. Please contact us with your wants!

The Collector's Edge Minerals, Inc.

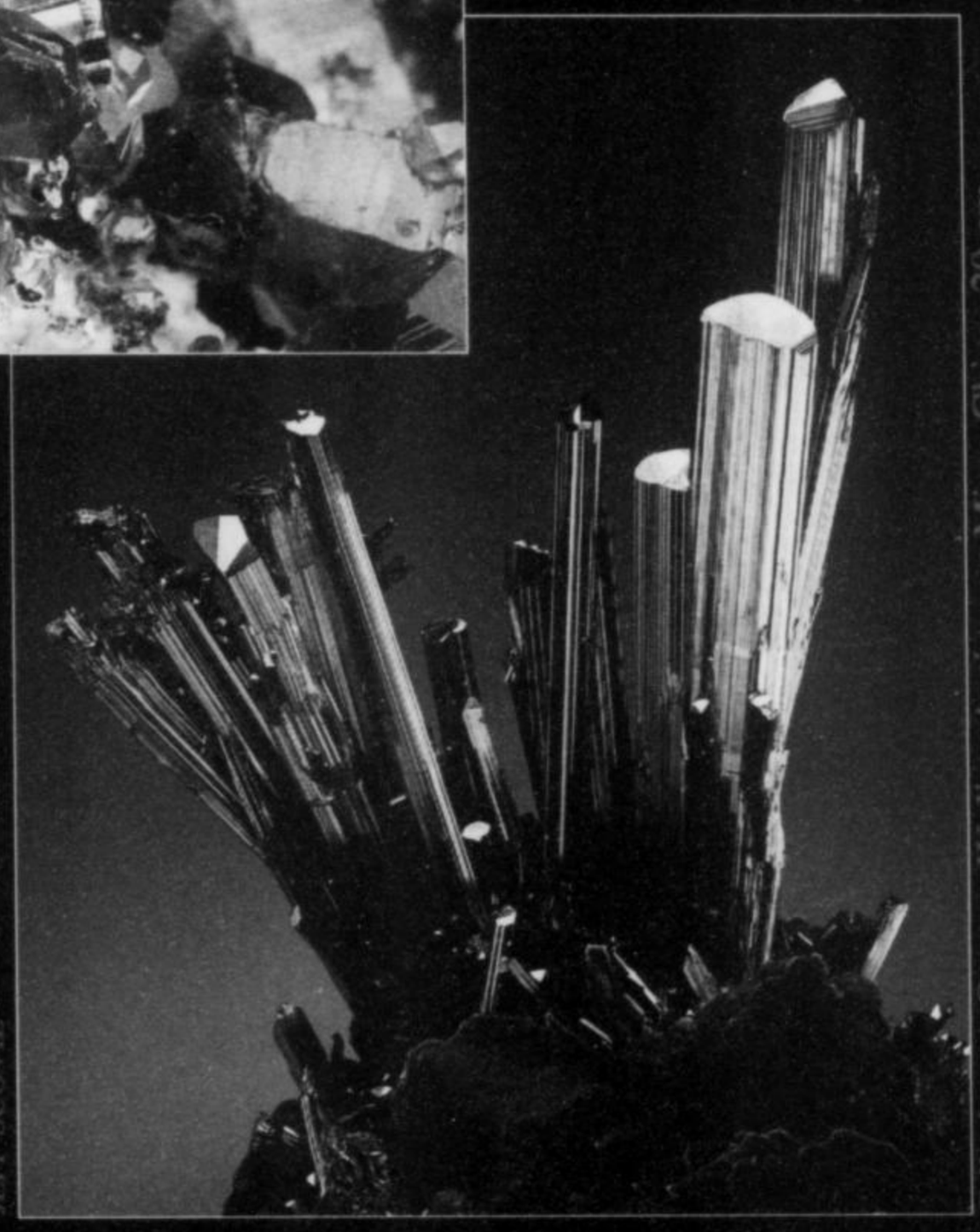
Premium Prices Paid for Superb Specimens!

We Buy Collections!

Internet Website Currently Under Development—Stay Tuned for Details!

JEFF SCOVIL

Spessartine, Tongbei area,
China, Crystal Size 1.5 cm



JEFF SCOVIL

Stibnite on Quartz, Waling Antimony Mine, China, 20 cm

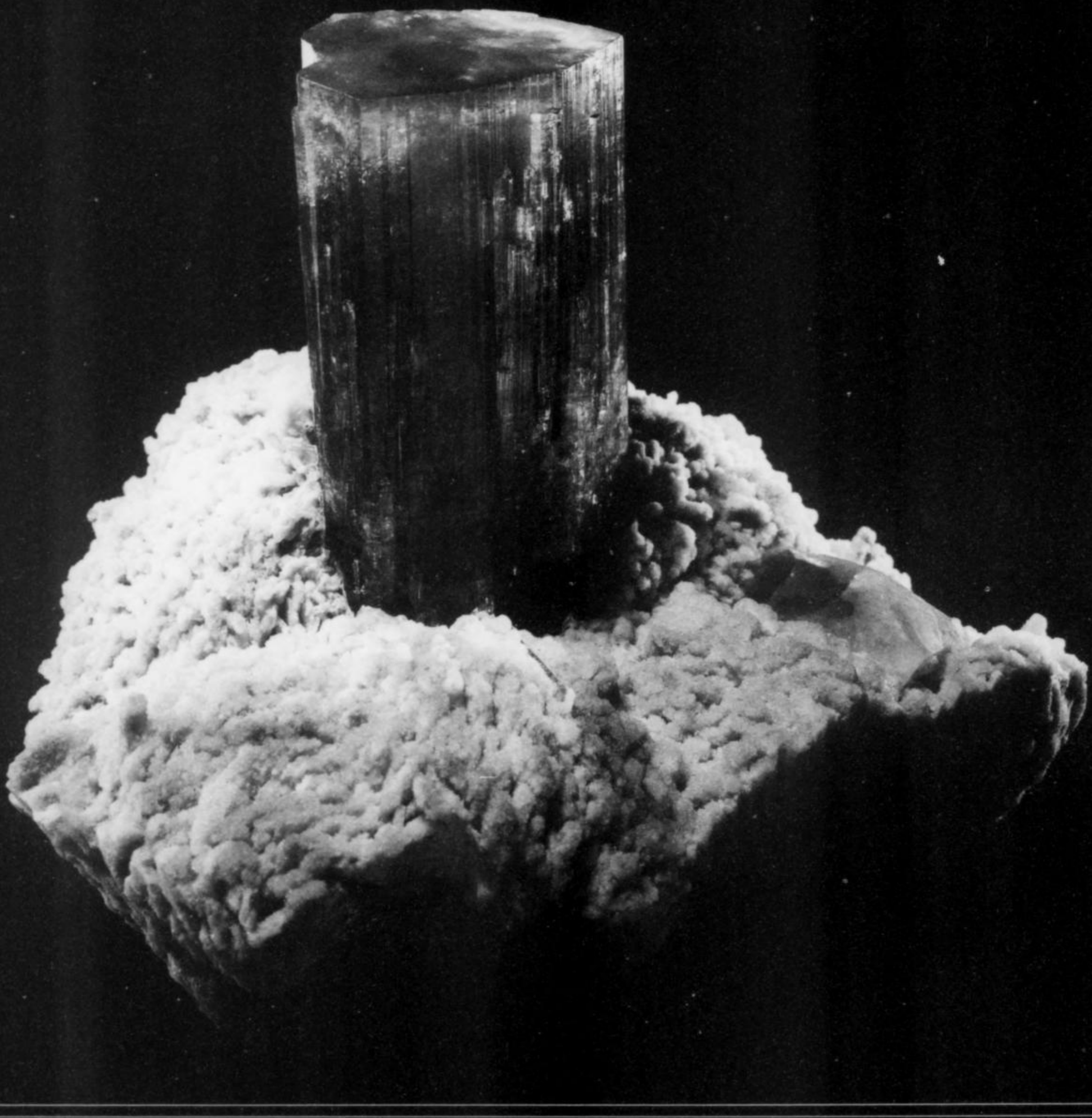
Recent Acquisitions From CHINA!

The Collector's Edge

P.O. Box 1169, Golden, Colorado 80402 U.S.A.

Tel: 303-278-9724 Fax: 303-278-9763

Mining inquiries: bryan@collectorsedge.com
Specimen inquiries: sandor@collectorsedge.com



Tourmaline from Pech, Laghman, Afghanistan; 5.5cm
Acquired from Collector's Edge, ex Wayne Thompson, ex James Horner

Clara and Steve Smale
COLLECTORS

PHOTO BY STEVE SMALE

Sulfur from the Perticara Mine Area, *Pesaro-Urbino, Italy*

Alessandro Guastoni and **Federico Pezzotta**
Natural History Museum of Milan
Corso Venezia 55
I-20121 Milan, Italy

The Perticara mine area in northern Italy has long been famous among mineralogists as a source of superb crystallized sulfur. Mined since Roman times, it has yielded the world's largest known crystals of sulfur.

INTRODUCTION

The Perticara mine is located in the Marches region of north-central Italy near the village of Perticara, and spans the border between Pesaro and Urbino provinces. The mine has long been famous for producing spectacular crystals of sulfur and gypsum. Luigi Bombicci (1833–1903), a renowned professor of mineralogy in Bologna, wrote in 1895: "The Perticara mine is honored for producing large quantities of superb, aesthetic and precious, perfectly crystallized sulfur and associated minerals." In fact, the Perticara mine has yielded the largest known single crystal of sulfur in the world (13 x 18 x 24.5 cm), which also qualifies as the largest known natural crystal of any native (terrestrial) element. Another sulfur crystal nearly this large (11 x 16.5 x 22.5 cm) was reported by Rickwood (1981). Today the 24.5-cm crystal can be seen on display in the Mineral Hall of the Natural History Museum of Milan.

Sulfur crystals from the Perticara mine and other local mines have found their way into European museum collections through the generous donations of a number of mineral collectors, including mining engineers and managers of the Perticara mine. Today the most important collections of Perticara specimens are in the Mineralogy Museum of the University of Bologna, the Museum of Natural History in Milan, and the Museum of Natural Science in Bergamo. The Bologna Museum, as mentioned by Bombicci (1888, 1895), owns 920 specimens including single sulfur crystals and crystals on matrix, all donated by Professor Augusto Bordoni and Engineer Augusto Pancaldi, managers of the Societa Anonima Miniere Solfifere della Romagna, and by Engineer Venceslao Cavaletti, manager of the nearby Cabernardi sulfur mine. Many of these specimens have been studied scientifically, and some have been illustrated in plates published by Bombicci (1895). Cavaletti also donated several sulfur specimens to the Museum of Natural Science in Bergamo, probably the most spectacular pieces from his personal collection, some of which were exhibited at the 1900 Paris World's Fair (see Wilson, 1990, for a general review of that event),

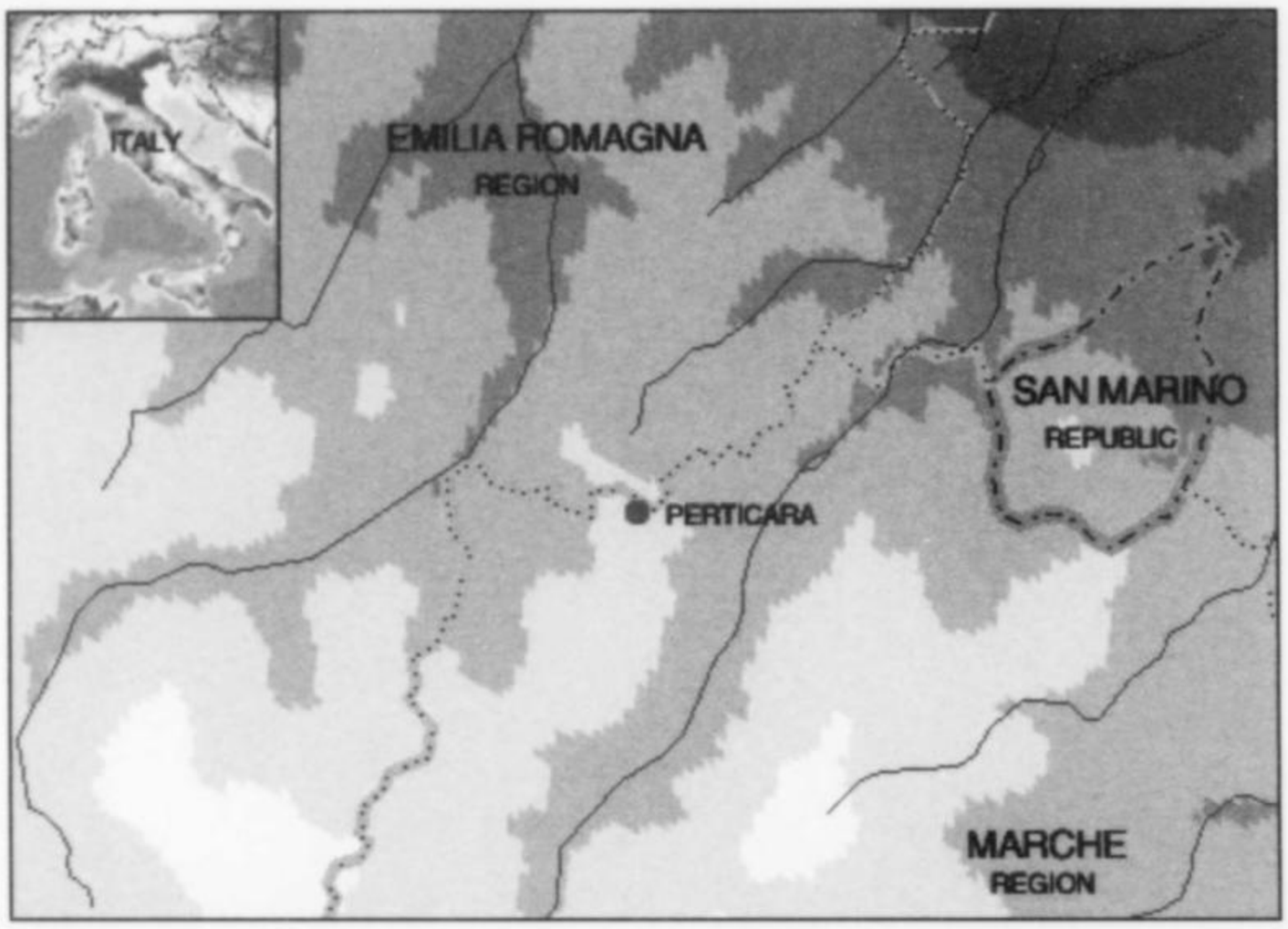


Figure 1. **Location map**

Figure 2. **Miners at work in the Perticara mine.**

where they were awarded a commemorative gold medal. Of the 212 specimens originally donated by Cavaletti, 185 are still preserved in the museum. The Perticara specimens in the Museum of Natural History in Milan were donated by several other private collectors, including Engineer Francesco Mauro, Engineer Carlo Battaini and Maria De Angelis.

Some confusion can arise in attributing specific mine names to historical "Perticara mine" specimens. In the published works of Bombicci are morphological descriptions based on many sulfur and gypsum specimens which are actually from the nearby Cabernardi and Cafabri mines. Cavaletti, having served as manager of those two properties, surely donated to museums many

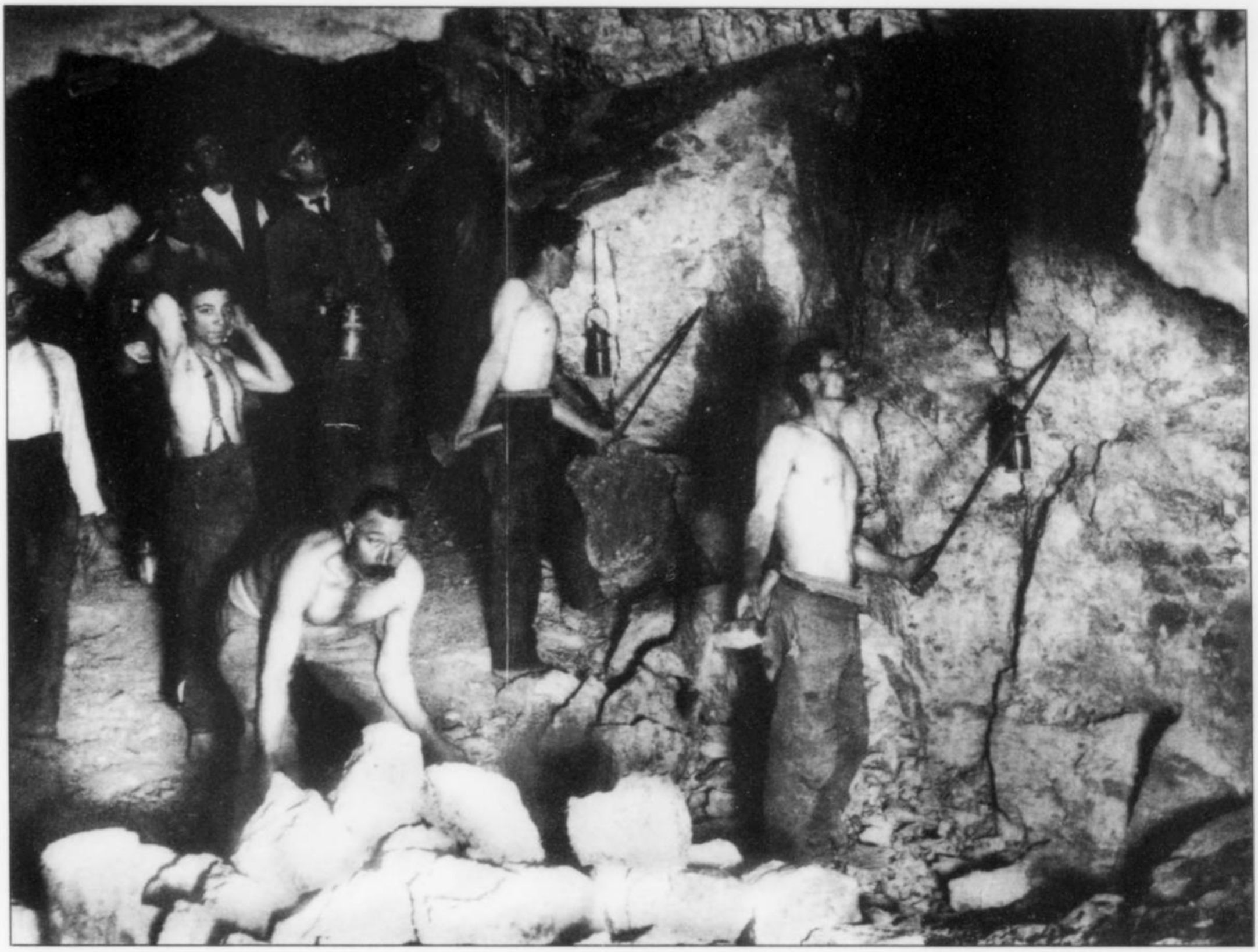


Figure 3. **Miners at work in the Perticara mine.**

specimens bulk-labeled as having come from the "Perticara mine." To muddy the waters further, the organization known as the Societá Anonima Miniere Solfifere della Romagna consolidated together a number of local sulfur mines (including the Perticara mine, Cabernardi and Cafabri) around the turn of the 19th century.

HISTORY

The Perticara mine, thanks to the advantageous exposure of the orebody, ranks first among the major Italian sulfur districts in terms of the quantity of ore removed. Mining activity dates back to the Roman Age, as evidenced by numerous archeological discoveries. In the 8th century the Byzantines exploited "La Perticara," as they called it, referring to an area on the border between the Papal States and the northern Italian territories.

In 1741, according to historical documents, a mining lease was registered in the Perticara area by a public notary at Mercato Saraceno; it states:

> Domenico Marzi from Perticara rents out to Giovanni Balducci from Mercato Saraceno village the rights to dig the sulfur stone from the underground of his property in the territory of Perticara called Ripa del Fanante (Rinaldi, 1998; translated).

Under this lease several shallow shafts were sunk to reach the sulfur orebody; sulfur was removed and melted in crucibles called *calcarelle* (Santagata, 1845).

During the 18th century the Perticara mining claims belonged to the Masi family, landowners in the area, who boosted production. In 1816 the mine was acquired by Count Cisterni from Rimini; he restructured the operations and initiated new workings. Count Cisterni sold the mine to the Picard Company in 1836, but the company went bankrupt in a few years. A group of local creditors of the Picard Company took over management of the mine in 1844, and production resumed.

In 1855 the Perticara mine was absorbed by the Societá Anonima delle Miniere Sulfuree di Romagna (SAMSR) mining company. During 1865–1876 production was stepped up, reaching an annual output of 96,000 metric tons of sulfur (Bianchi, 1863). Following a period of intense mining activity the market price of sulfur collapsed and the SAMSR decreased production, until operations were halted in 1896. That same year a cooperative of laid-off workers took over the mine and ran it very capably until 1902, when they sold their interest for a substantial sum to the Trezza Albini Company.

Under the management of the Trezza Albini Company, Perticara mine production reached 5,000 tons per year by 1912, but the economic devastation resulting from World War I caused production to cease. The company was purchased at a bankruptcy sale in 1917 by the Montecatini Company, and mining resumed once again at Perticara. Under the management of Engineer Donegani, sulfur production peaked at 49,581 tons in 1938, a level comparable to that of Italy's other most important sulfur districts. Mining

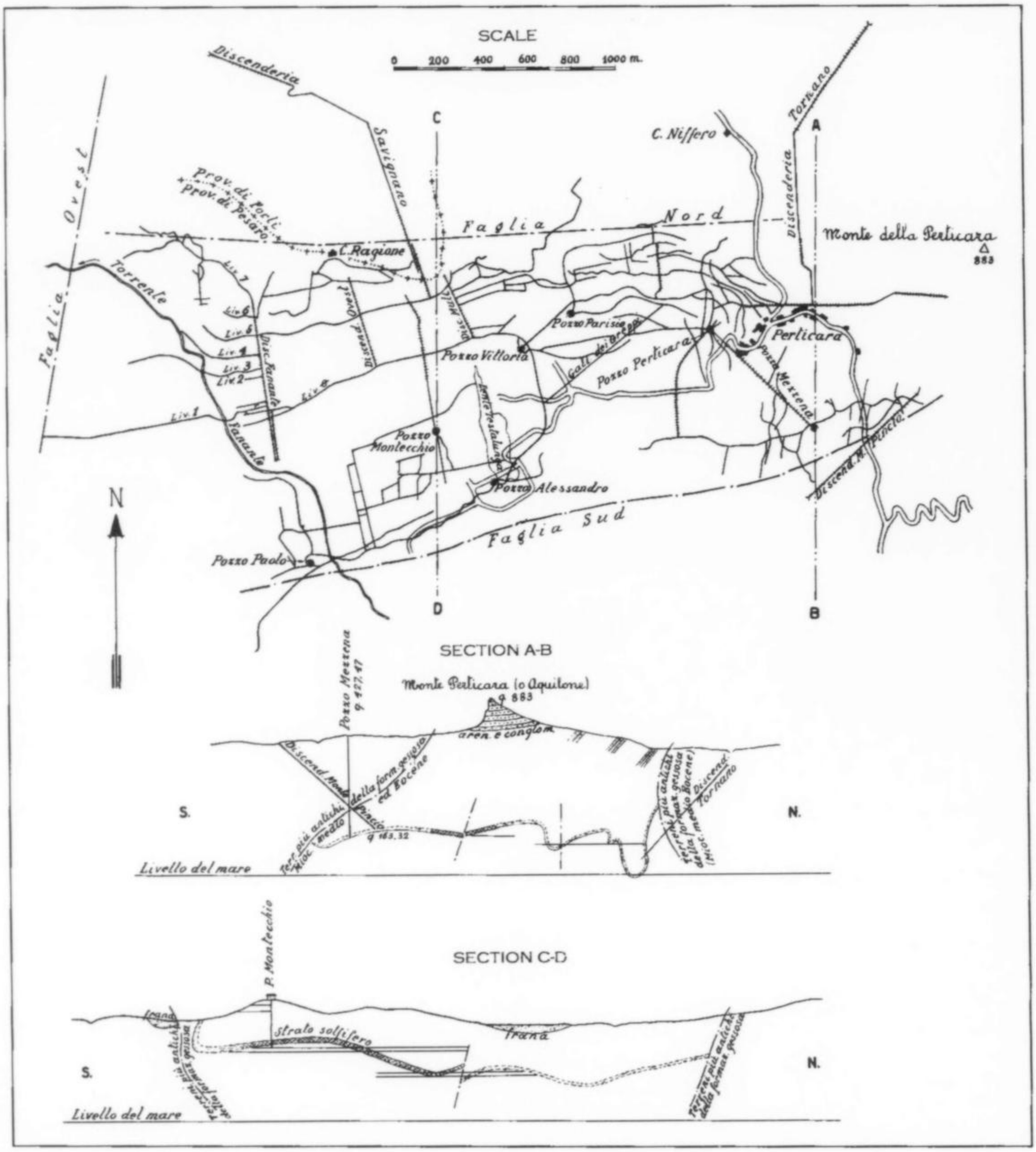


Figure 4. **Simplified map of the underground workings of the Perticara mine, with two cross-sections (Scicli, 1972).**

operations continued until 1964, when economic conditions caused by the advent of lower-cost mining methods elsewhere reduced the price of sulfur below the profitable level. At the time of its closure, remaining sulfur reserves at Perticara were estimated at 1,200,000 tons (Scicli, 1972).

GEOLOGY

The geologic structure in the Perticara area is related to the Appenine Orogenesis, characterized by compressive and upthrusting tectonic movements. Terranes which crop out are part of the Umbro-Marchigiano Series; this series includes the Argille Varicolori Formation (Lower Eocene to Lower Cretaceous), consisting of multicolored claystones with subordinate siltstone horizons, limestones and marls. The Colombacci Formation (Uppermost Miocene), consisting of marly claystones, siltstones, sandstones, multicolored pelites and marly limestones, overlies the Gressoso-Solfifera Formation (Upper Miocene), which contains the Perticara sulfur orebody (Conti, 1989). The origin of the orebody is related to sedimentary evaporitic conditions existing about 6 million years ago, which were a consequence of the closing of the Straits of

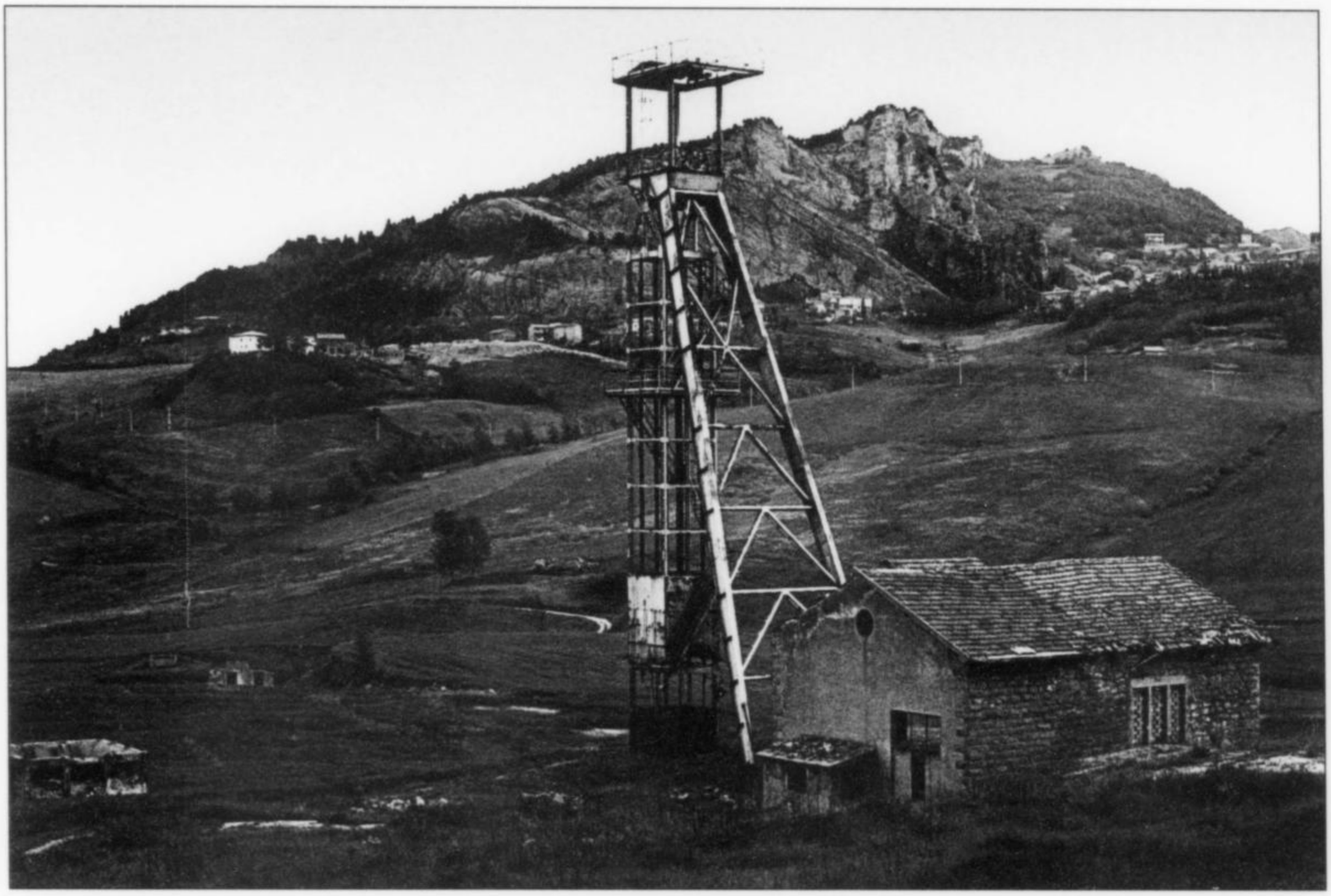


Figure 5. **The Vittoria shaft of the Perticara mine in 1972, eight years after the mine closed.**

Gibraltar and the associated salinity crisis in the Mediterranean Basin.

Sulfur in the Gessoso-Solfifera Formation has been explained by two differing hypotheses. The **syngenetic hypothesis** postulates that sulfur precipitated in euxinic (stagnant, anerobic) sea basins having extremely limited inflow of fresh water. Anerobic bacteria are thought to have extracted and precipitated sulfur from water saturated in H_2S and SO_4^{-2}. The **epigenetic hypothesis** ascribes the massive concentrations of sulfur to diagenetic processes (chemical changes following deposition), and to the circulation of meteoric water under reducing conditions in the presence of abundant hydrocarbons (Gualtieri, 1968).

An idealized stratigraphic section through the Perticara orebody would begin (at the bottom) with marls and siliceous limestones (2 meters), followed upward by gypsiferous limestone and sulfur layers (1–2 meters) and then the main layer of sulfur mineralization (called the "maestro layer," 14 to 22 meters thick) consisting of 38–40% sulfur. Above the maestro layer are marls (to 2 meters) followed by gypsum layers (1–2 meters) interlaminated with thin marl horizons. The complete stratigraphic section reaches a maximum thickness of 120 meters in places (Scicli, 1972).

At the Perticara mine, exploitation took place along an area bounded by three important tectonic elements: (1) **The South Fault**, along the Paolo, Alessandro and Mezzena wells where the Argille Varicolori Formation was thrust over the Gressoso-Solfifera Formation; (2) **The North Fault**, converging to the east with the South Fault; and (3) **the West Fault**, near the ancient Tomba shaft and cutting across the Gessoso-Solfifera Formation. Along the South Fault the sedimentary layers are strongly deformed into a

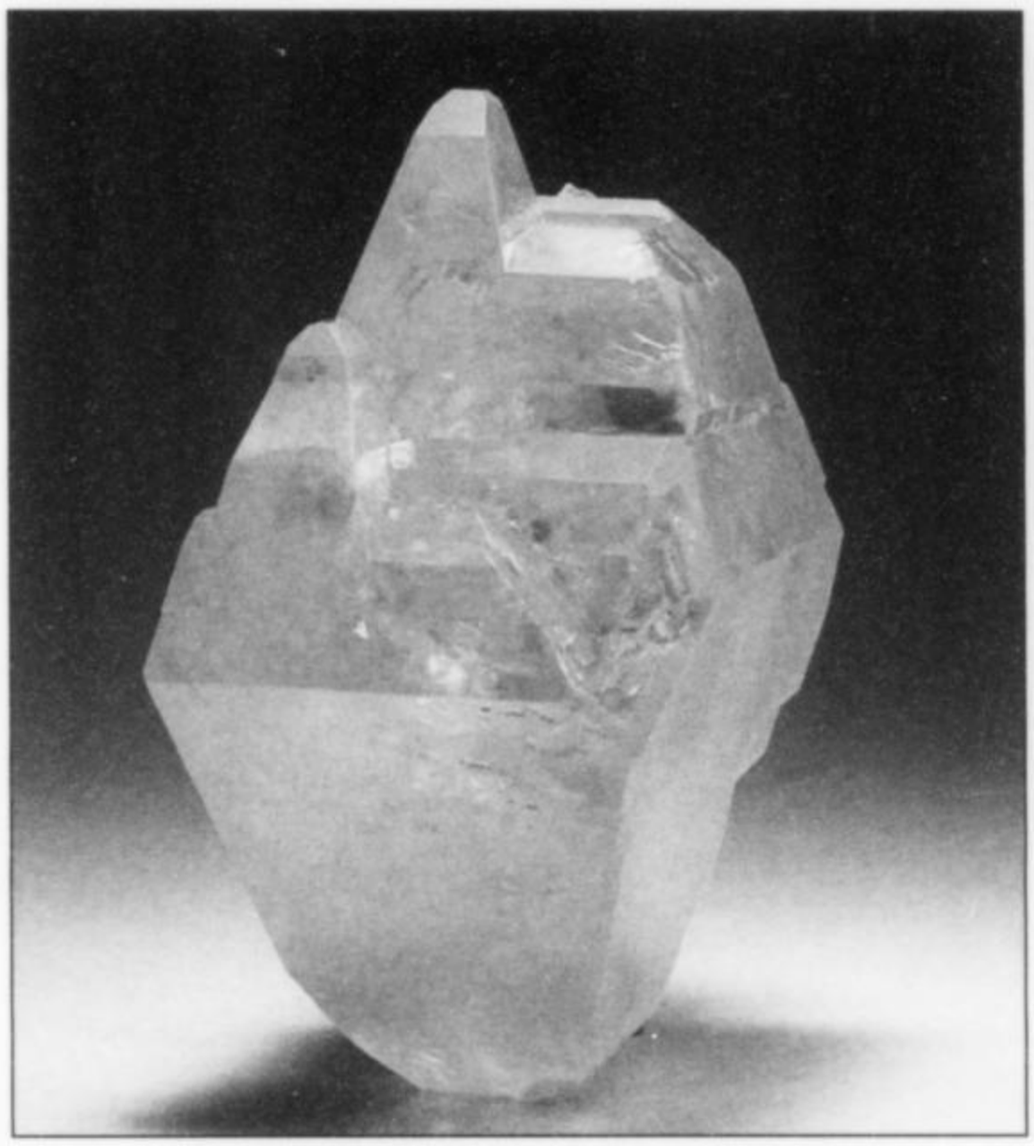


Figure 6. **Sulfur crystal, 11 cm, from the Cafabri mine. Collection of Renato and Adriana Pagano (No. 573); photo by Roberto Appiani.**

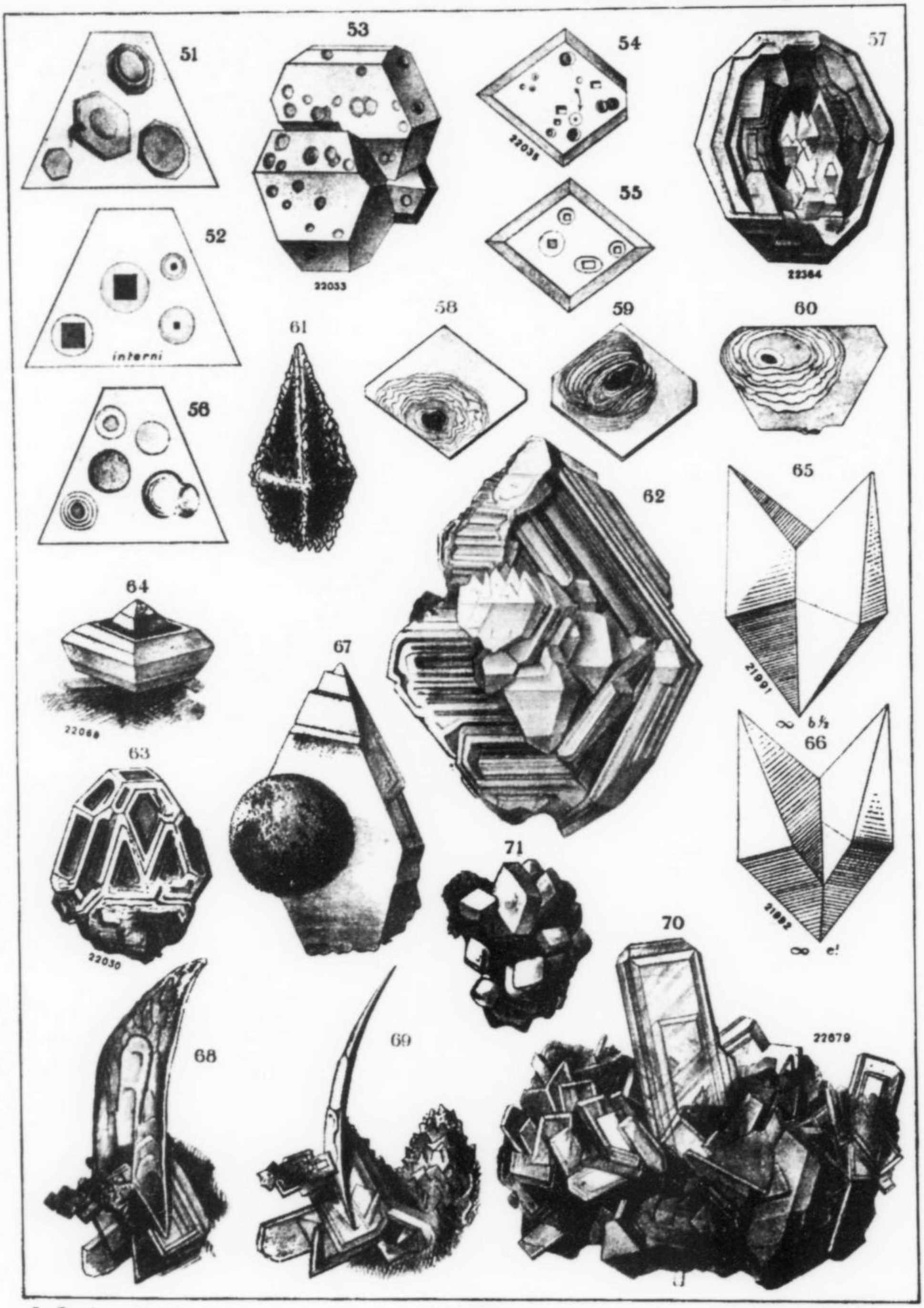
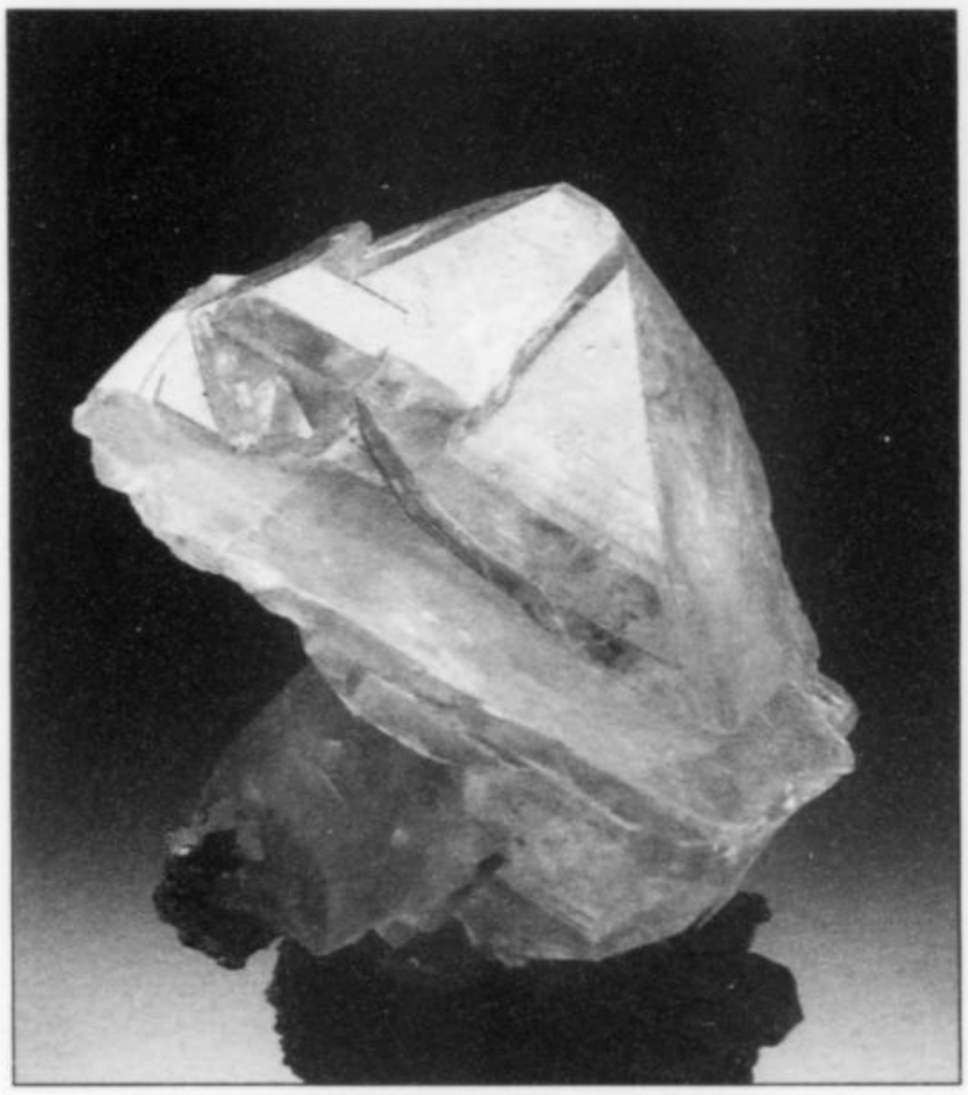


Figure 7. **Plate depicting Perticara area sulfur crystals, from Bombicci (1895).**

Figure 8. **A parallel group of doubly terminated sulfur crystals to 5 cm, showing the typical acute dipyramidal habit. Perticara mine; collection of the Museum of Natural History, Milan (No. 16558); photo by Roberto Appiani.**

Figure 9. **Sulfur crystal cluster, 3.5 cm, showing a habit typical of sulfur from the Cabernardi mine illustrated by Bombicci (1895). Collection of the Museum of Natural Science in Bergamo (No. 892/AD); photo by Roberto Appiani.**



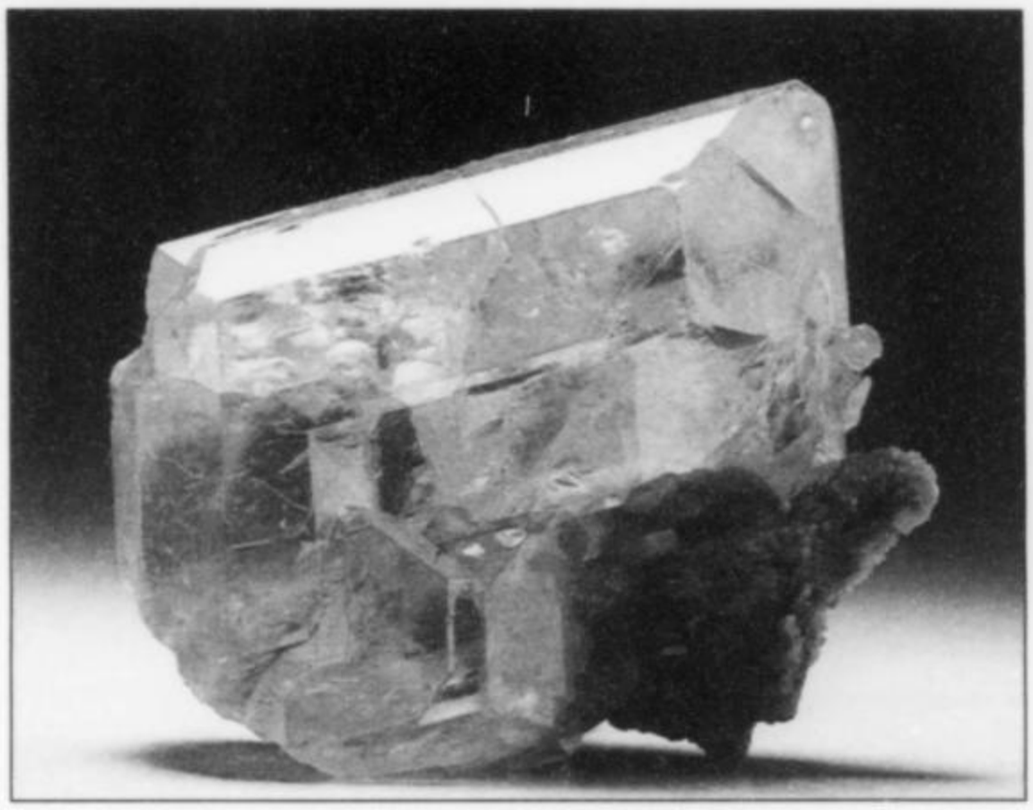


Figure 10. **Tabular/dipyramidal sulfur crystal, 5.5 cm, from the Perticara mine. Collection of the Museum of Natural Science in Bergamo (No. 892/H); photo by Roberto Appiani.**

large syncline where the mineralized layer dips nearly vertically and thins dramatically.

The mining basin extends over an area of approximately 400 hectares (990 acres). The Perticara mine consists of workings on seven drifts, with prospect holes down to a depth of 59 meters (Ricerca Tornano). The oldest workings are in the area of the Montecchino, Alessandro and Croce shafts. The Croce shaft was the site of a visit, in 1823, by Cardinal Sermattei della Menga, who a few years later became Pope Leo XII.

SULFUR MINERALIZATION

Cavities and veins in marls and marly breccias at Perticara have been found to contain superb sulfur crystals associated with crystals of gypsum and calcite. Sulfur crystals commonly occur in gypsum layers, and sometimes included within gypsum crystals. Sulfur crystals have also been found in vugs in silicified limestone, associated with calcite crystals and pseudohexagonal crystals of aragonite. Some of the most spectacular sulfur crystals were recovered from cavities filled with petroleum or bitumen.

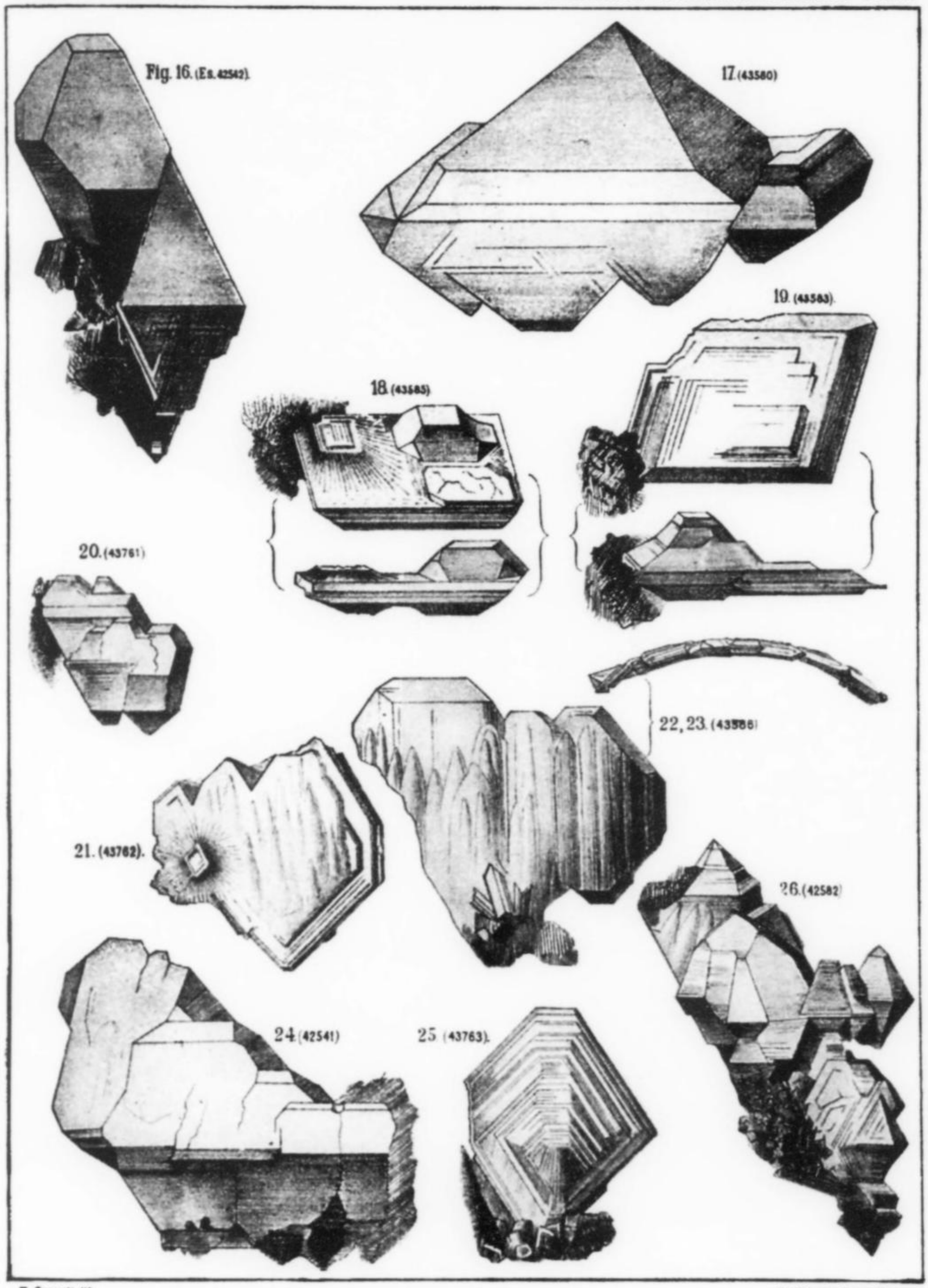


Figure 11. **Plate depicting Cabernardi mine sulfur crystals, from Bombicci (1895).**

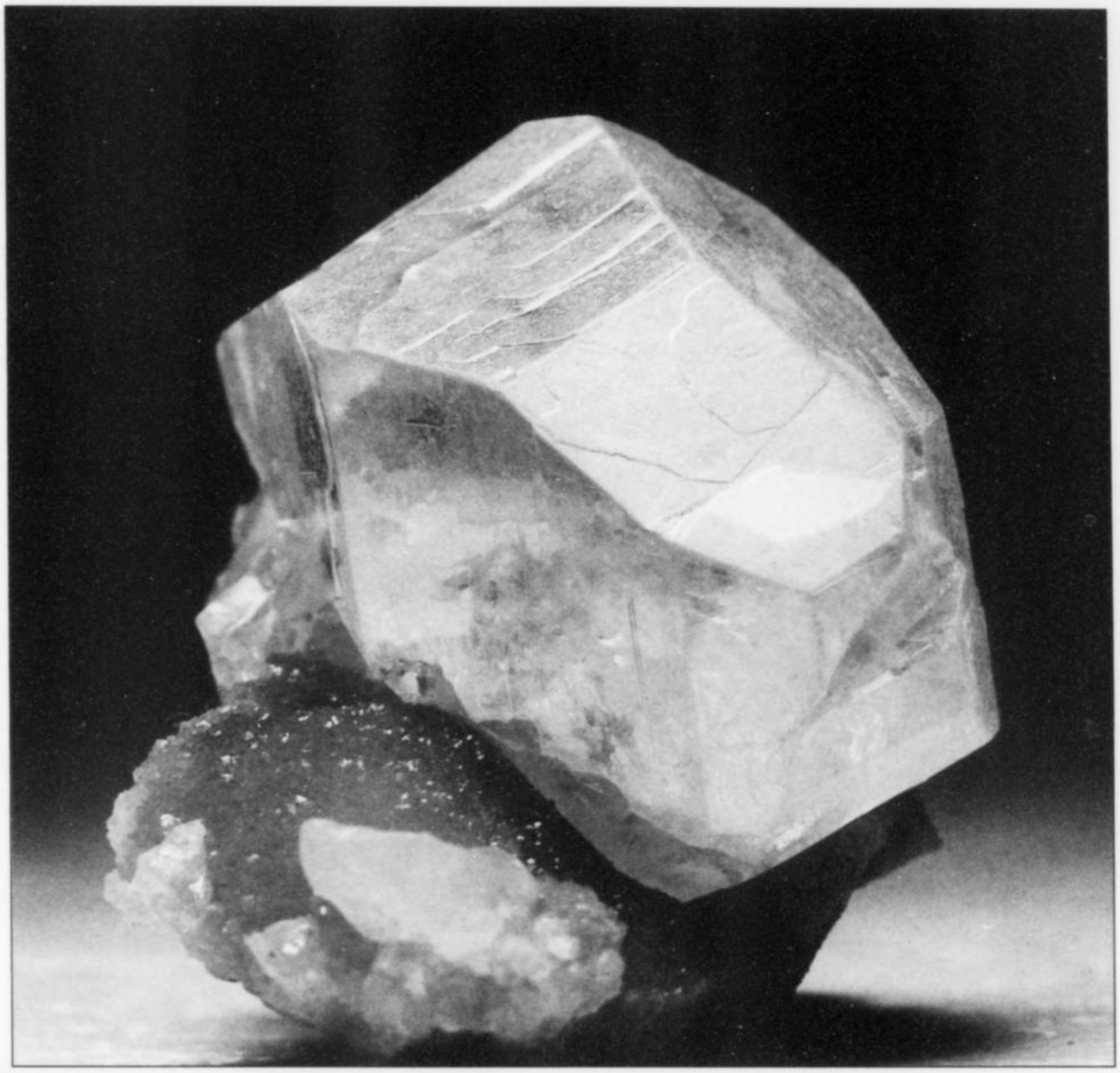


Figure 13. **Sulfur crystal, 3 cm, from the Perticara mine. Collection of the Museum of Natural History in Milan (No. 16628); photo by Roberto Appiani.**

Figure 12. **Sulfur crystal, 9 cm, with black bitumen, from the Perticara mine. Collection of the Museum of Natural History in Milan (No. 280); photo by Roberto Appiani.**

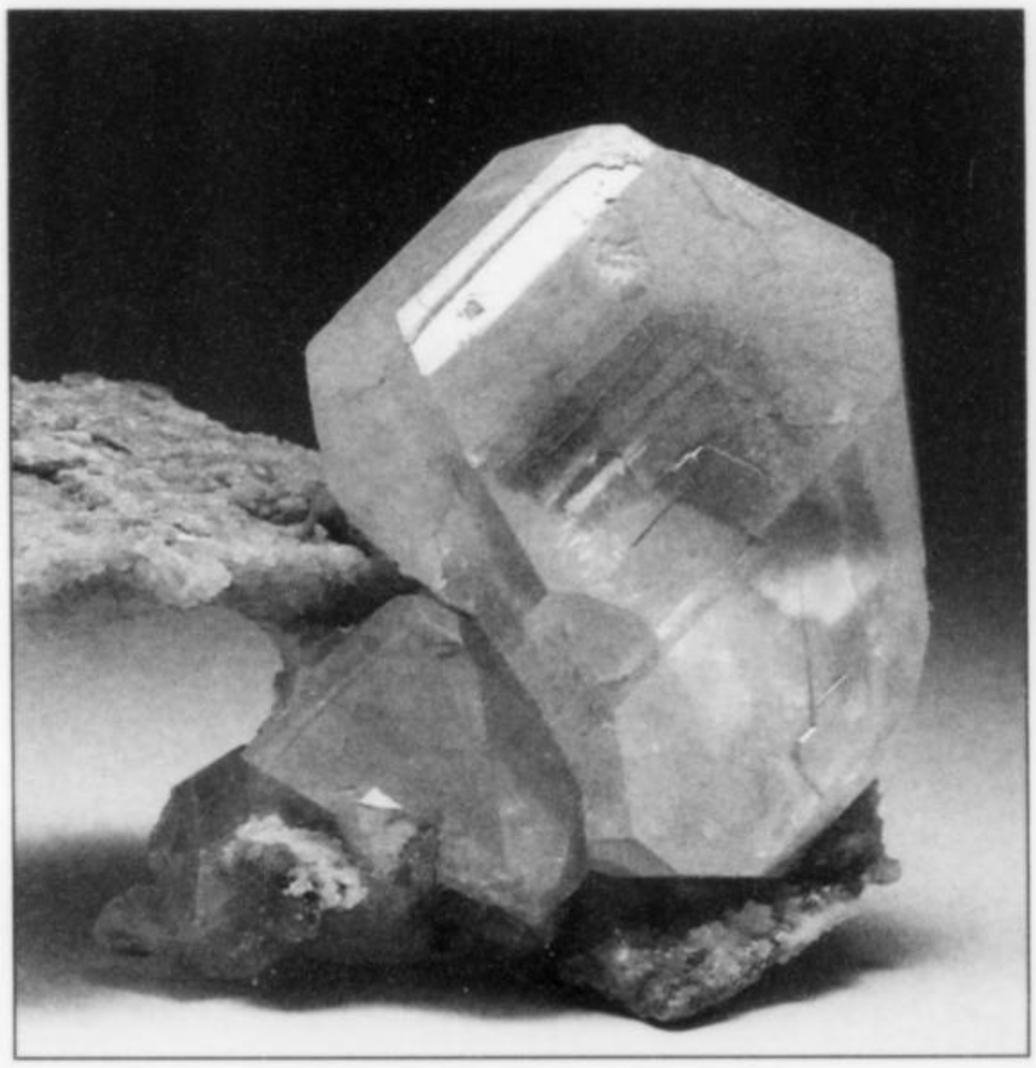


Figure 14. **Sulfur, 8 cm, from the Cafabri mine. Collection of Renato and Adriana Pagano (No. 933); photo by Roberto Appiani.**

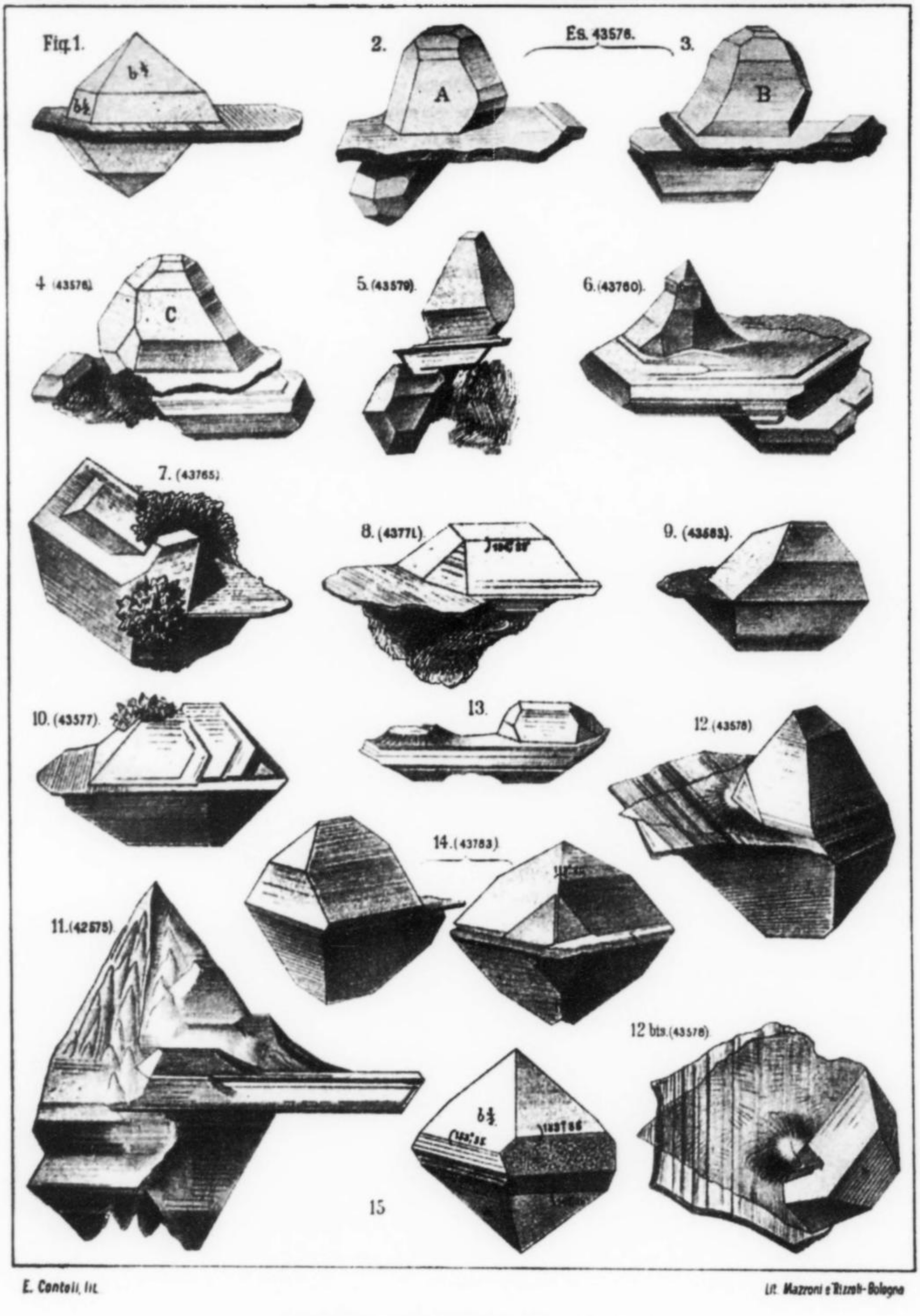


Figure 15. **Plate depicting Cabernardi mine sulfur crystals, from Bombicci (1895).**

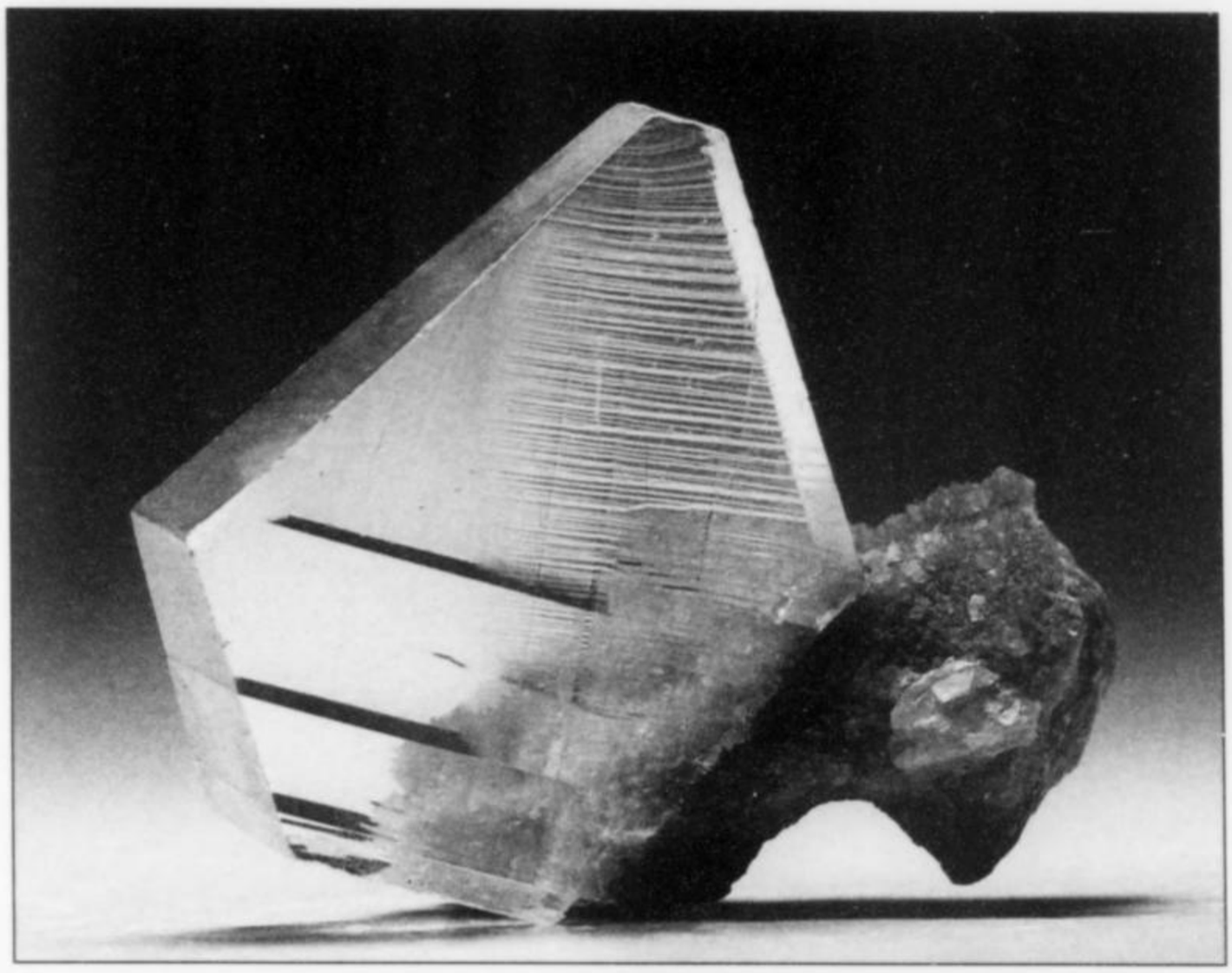


Figure 16. **Gypsum crystal, 3 cm, with sulfur, from the Cabernardi mine. Collection of Renato and Adriana Pagano (No. 520); photo by Roberto Appiani.**

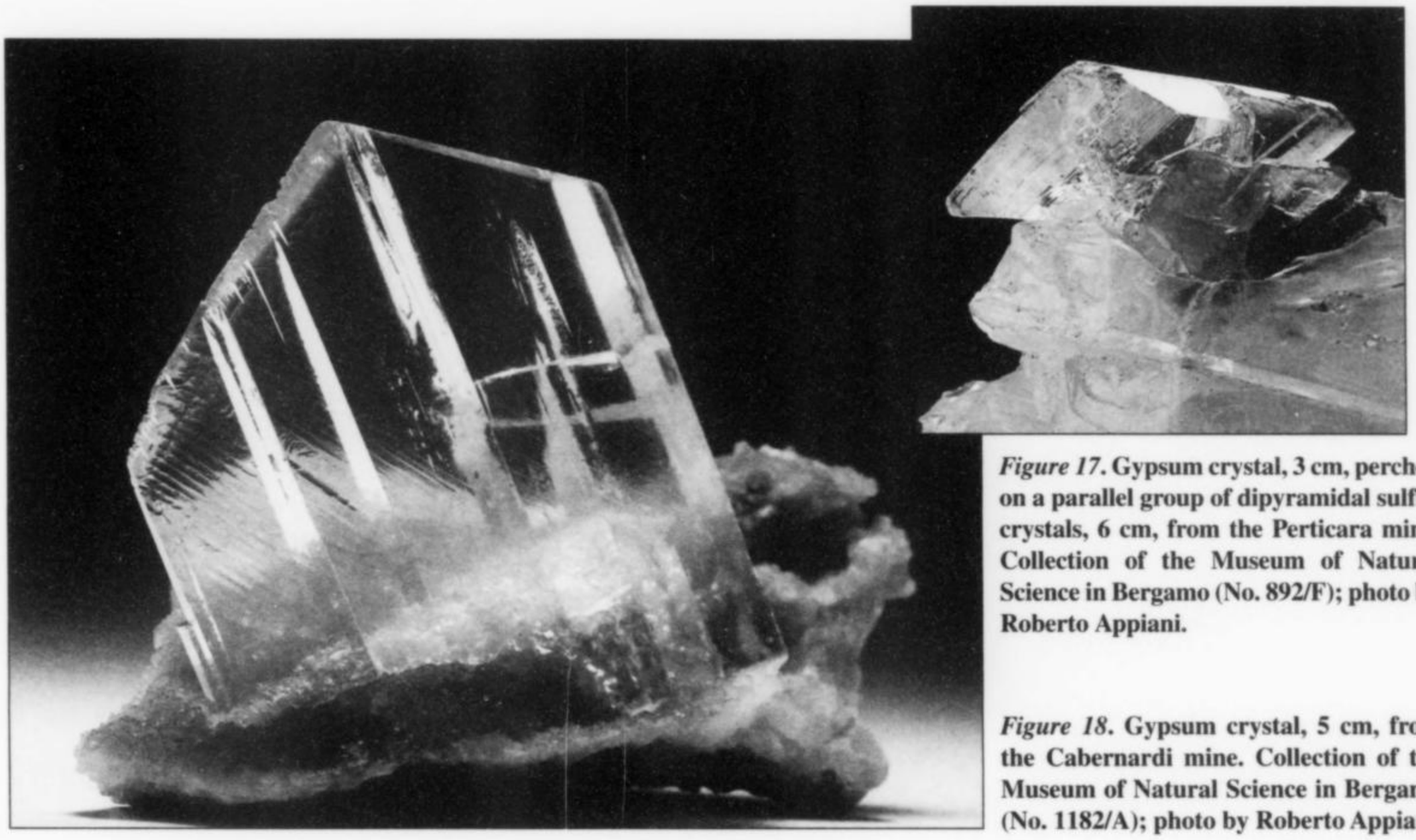


Figure 17. **Gypsum crystal, 3 cm, perched on a parallel group of dipyramidal sulfur crystals, 6 cm, from the Perticara mine. Collection of the Museum of Natural Science in Bergamo (No. 892/F); photo by Roberto Appiani.**

Figure 18. **Gypsum crystal, 5 cm, from the Cabernardi mine. Collection of the Museum of Natural Science in Bergamo (No. 1182/A); photo by Roberto Appiani.**

Perticara sulfur crystals show peculiar morphological features unlike those from any other locality. The predominant habit is acute (elongated) to obtuse (blocky) dipyramidal. Beautiful tabular crystals favoring the basal pinacoid faces have also been found, as have rare prismatic crystals.

In some cases, oriented and circular streaks groove the faces of sulfur crystals. Some crystals also show skeletal growth, as illustrated by Bombicci (1895). Parallel growths appearing as large crystals bounded by many steps are also known. Aggregates of curved crystals show an elongated dipyramidal habit. In some cases a second generation of small, oriented sulfur crystals is found covering the surfaces of larger crystals.

The color of Perticara sulfur ranges from deep yellow to yellow-orange, yellow-green and brownish black (caused by bitumen inclusions). Translucent to beautifully transparent crystals are quite common.

Associations include pseudohexagonal twins of aragonite, rhombohedral to scalenohedral crystals of calcite, tabular to (rare) prismatic and colorless celestine crystals to 5 cm, and beautifully gemmy gypsum crystals to 10 cm (especially from the Cabernardi mine). Hydrocarbons are widespread in the Perticara area; the orebodies are soaked in petroleum-like bituminous fluids near the fault zones. Cavities in limestone are also commonly found filled with black fluid; in fact, bituminous petroleum is commonly found

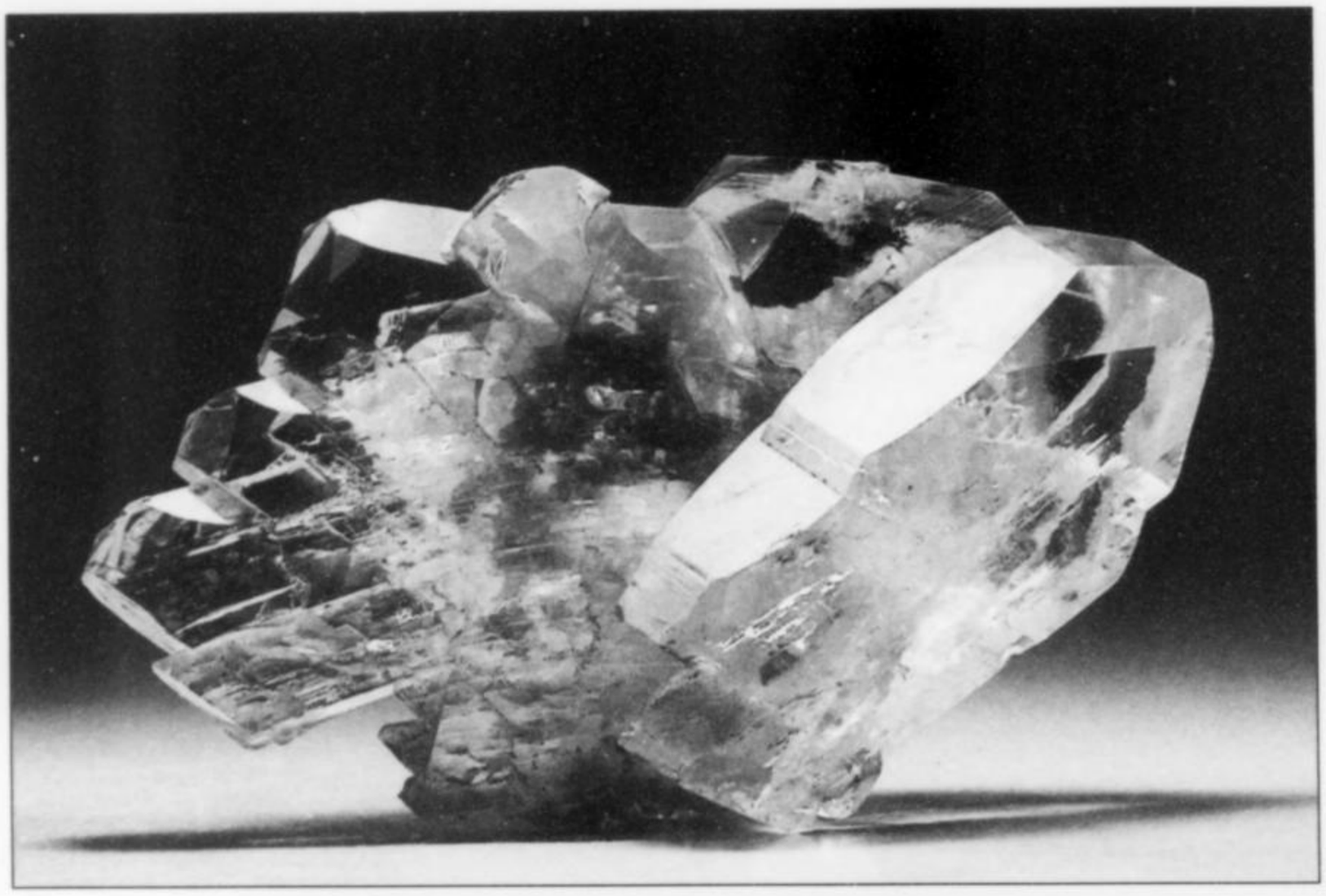
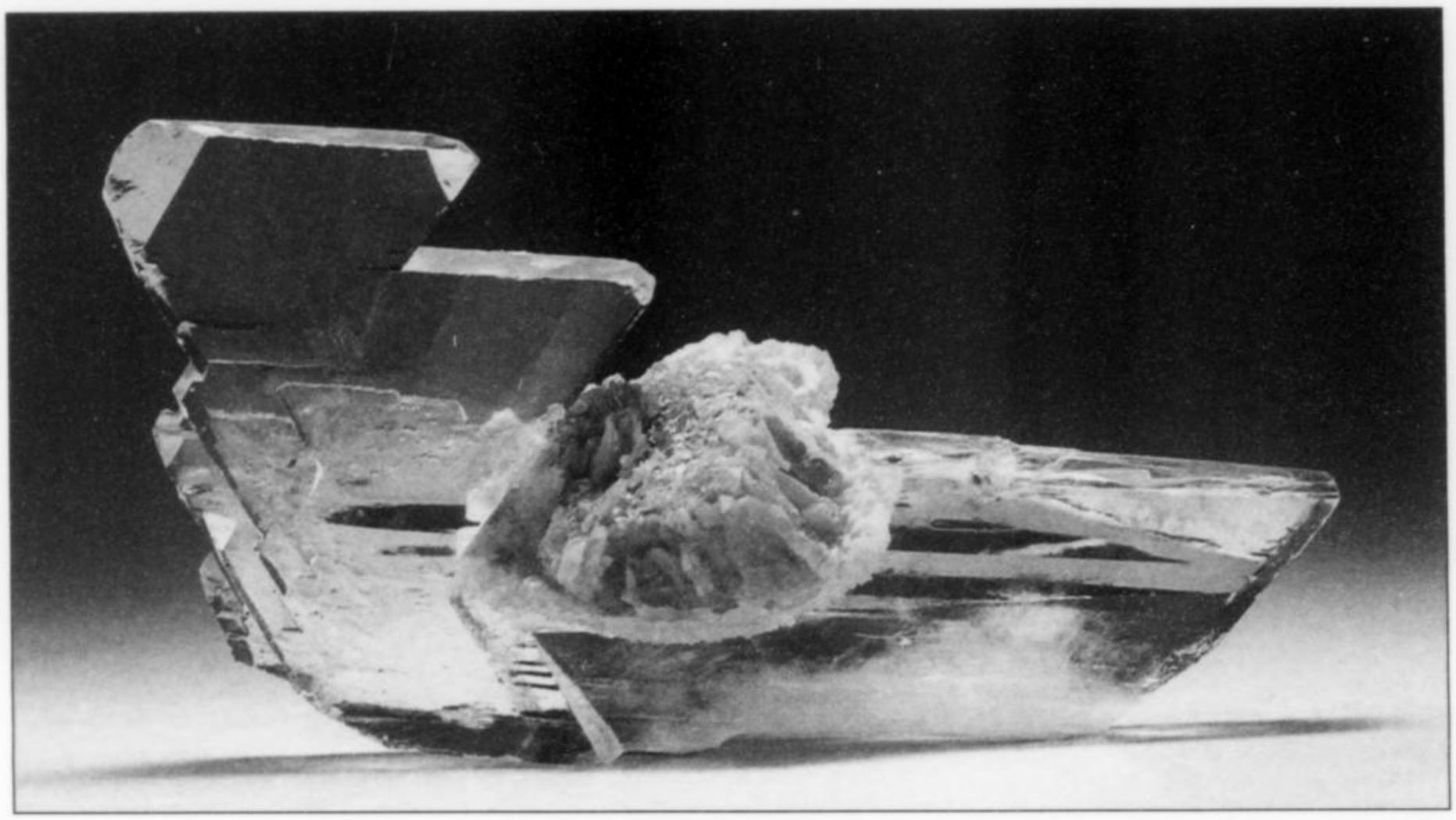


Figure 19. **Gypsum crystal cluster, 10 cm, from the Cabernardi mine. Collection of Renato and Adriana Pagano (No. 7487); photo by Roberto Appiani.**

Figure 20. **Gypsum, 9 cm, from the Cafabri mine. Collection of Renato and Adriana Pagano (No. 999); photo by Roberto Appiani.**



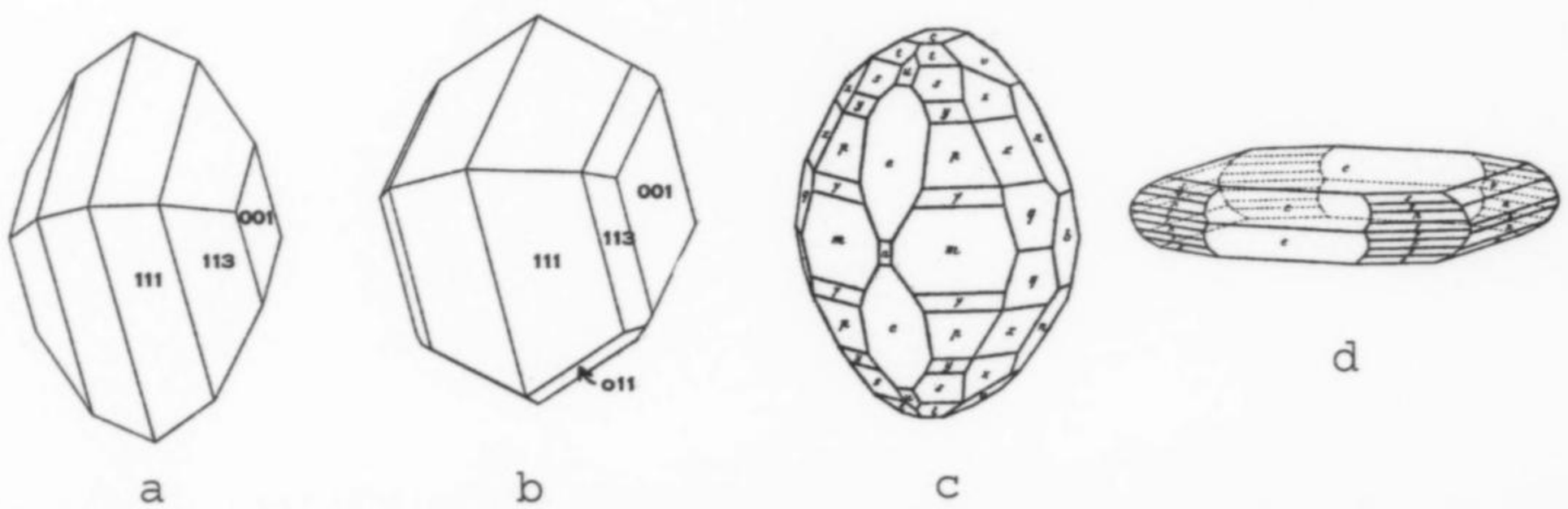


Figure 21. **Crystal drawings of sulfur from the Perticara mine (c and d from Eakle, 1895; see Goldschmidt).**

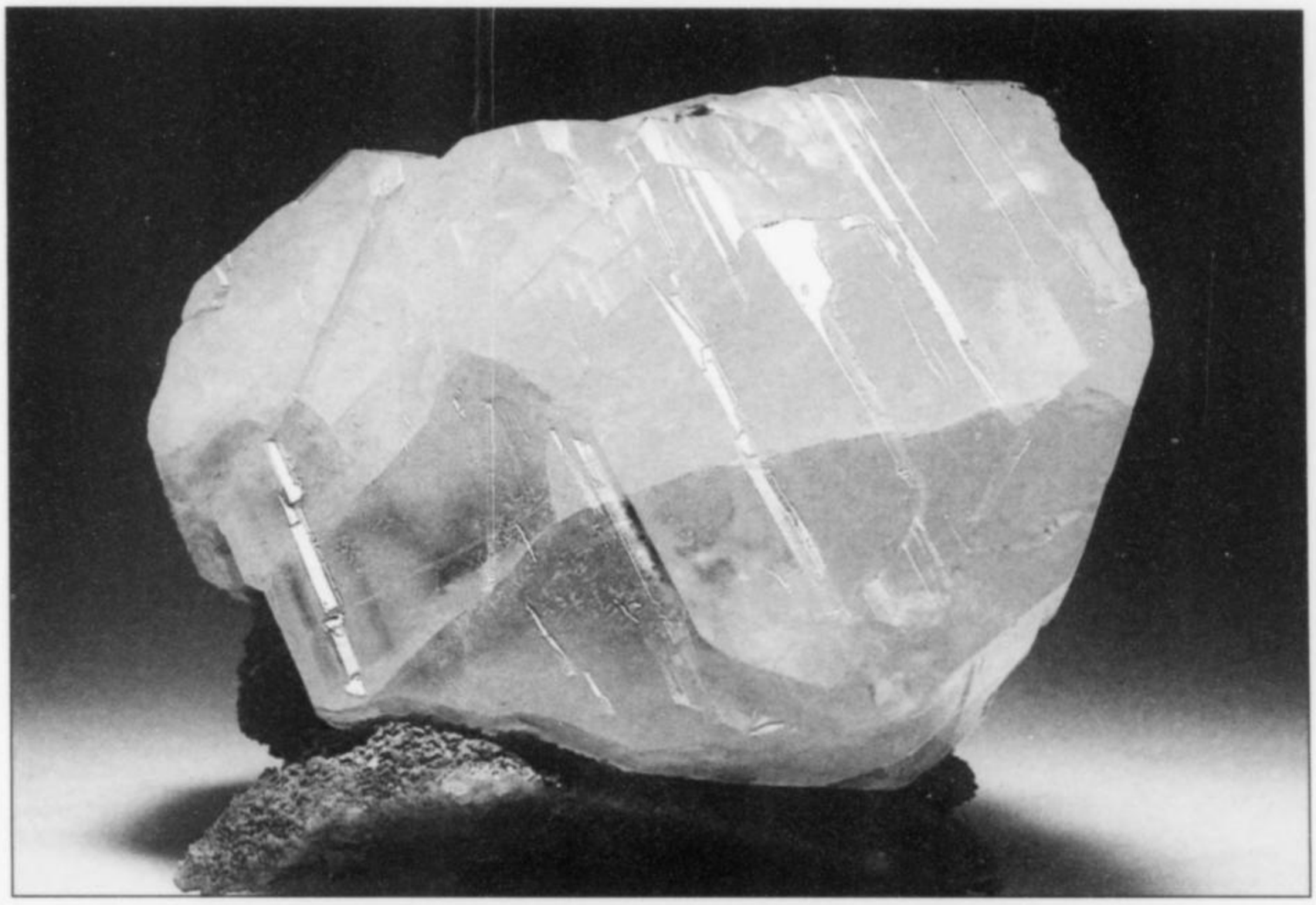


Figure 22. **Large sulfur crystal, 14 cm, from the Perticara mine. Collection of the Museum of Natural History, Milan (No. 15559); photo by Roberto Appiani.**

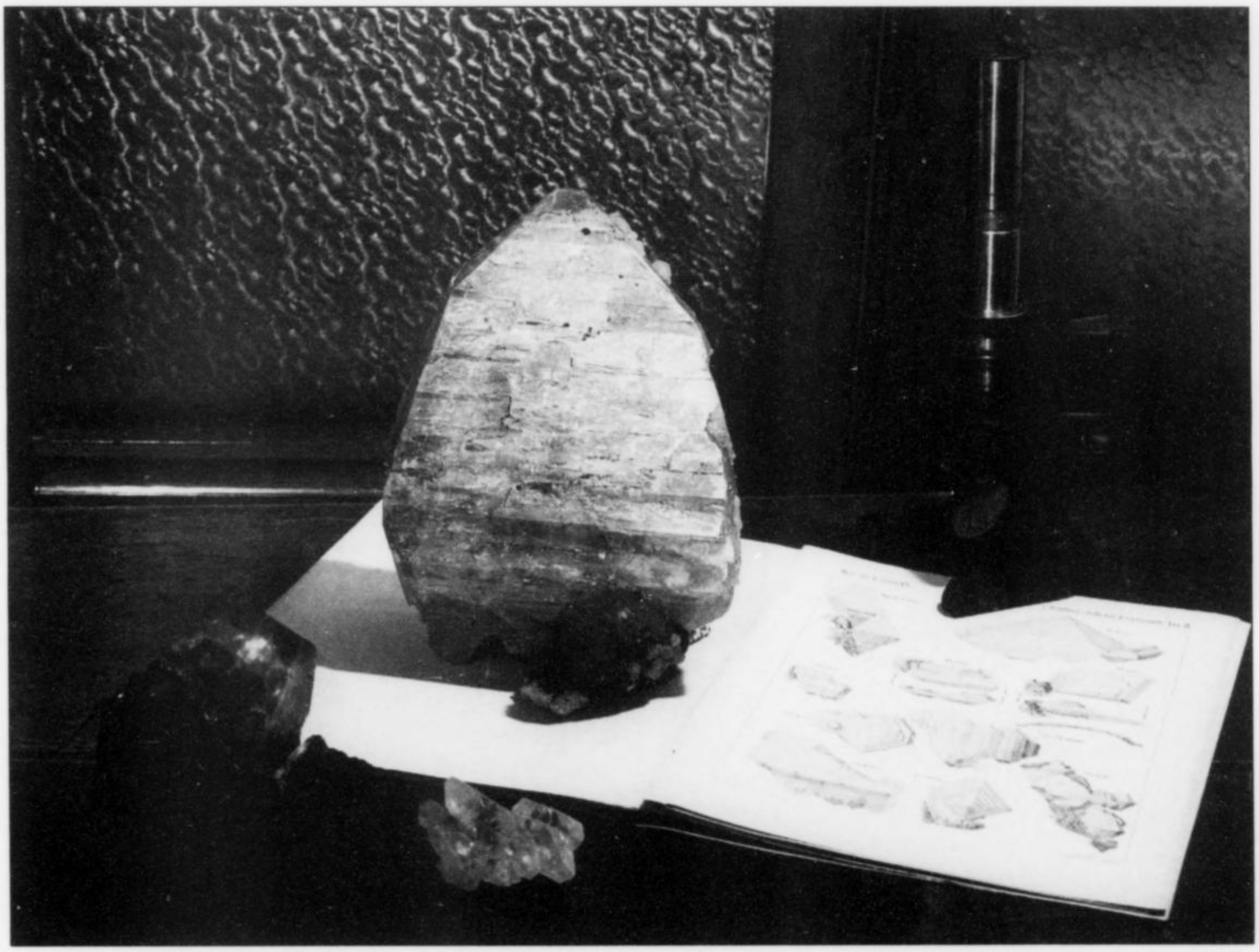


Figure 23. **World's largest single sulfur crystal (24.5 cm, 9.6 inches), from the Perticara mine. Collection of the Museum of Natural History in Milan (No. 30273); photo by Roberto Appiani.**

Figure 24. **Sulfur crystal cluster, 7 cm, from the Perticara mine. Collection of the Museum of Natural Science in Bergamo (No. 892/P); photo by Roberto Appiani.**

seeping from tunnel walls and pooling on the floor. Black bitumen is typically seen penetrating into cleavage fractures in gypsum crystals and coating sulfur crystals cemented together by thicker bituminous material.

ACKNOWLEDGMENTS

We would particularly like to thank Dr. Anna Paganoni, Curator of Geology at the Museum of Natural Science in Bergamo, for her kind cooperation and for permitting museum specimens to be photographed; and Dr. Paolo Genlile for assisting with bibliographic research.

REFERENCES

BIANCHI, P. (1863) Cenni e Studi sulle Miniere Solfifere di Romagna. *Stamperia dell' Unione Tipografica Editrice*, Torino, 99 p.

BIANCONI, G. G. (1861) Descrizione delle forme cristalline di zolfo delle miniere del Cesenate. Mem. Acc. Delle Scienze dell'Ist. Di Bologna, **XI**, *Tipografia Gamberini e Pennaggiani*, Bologna, 20 p.

BOMBICCI, L. (1888) Il Gabinetto Universitario de Mineralogia in Bologna. XXVII Anni dopo la sua fondazione. Relazione terza a S.E. il Ministro. *Tipografia Gamberini e Parmeggiani*, Bologna, 78 p.

BOMBICCI, L. (1895) Descrizione degli esemplari di zolfo nativo cristallizzato delle solfare di Romagna. Raccolti e classificate dell'Autore nel Museo Mineralogico della R. Universitá di Bologna. *Tipografia Gamberini e Parmeggiani*, Bologna, 82 p.

BOMBICCI, L. (1898) Le interessanti anomalie (dissimmetrie e spostamenti) dei mirabilis cristalli di solfo nativo della miniera di Ca' Bernardi. *Memorie Regia Accademia delle Scienze dell' Istituto di Bologna*. Serie V, tomo VII, 474–480.

CONTI, S. (1989) Geologia dell'Appennino Marchigiano-Romagnolo tra le valli del Savio e del Foglia (Note illustrative alla carta geologica scala 1:50,000). *Bollettino Societá Geologica Italiana*, **108**, 453–490.

GUALTIERI, R. (1968) Genesi dei giacimenti di zolfo italiani. *Bollettino Servizio Geologico Italiano*, **89**, 75–89.

MINISTERO AGRICOLTURA INDUSTRIA COMMERCIO (1885) Catalogo dei Campioni di zolfo d'Italia, presentato all'Esposizione Universale di Anversa dal Corpo Reale delle Miniere. *Eredi Botta*, Roma, 27 p.

PEZZOTTA, F., GENTILE, P., NOVAGA, M., and FABBRI, F. (1998) Lo zolfo della miniera di miniera di Perticara. *Rivista Mineralogica Italiana*, **22** (4), 26–38.

RICKWOOD, P. C. (1981) The largest crystals. *American Mineralogist*, **66,** 885–907.

RINALDI, I. (1988) Perticara, la Miniera di zolfo, la sua Gente. *Pazzini Edizioni*, Villa Verucchio, 224.

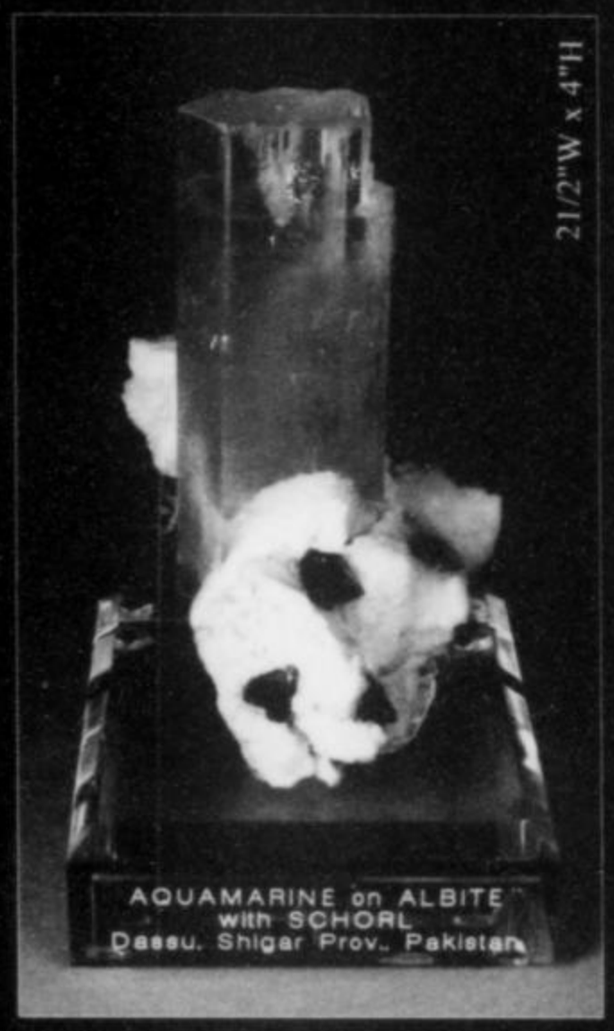
RINALDI, I. (1998) La miniera di zolfo di Perticara, storia per immagini. *Pazzini Edizioni*, Villa Verucchio, 310.

SCICLI, A. (1972) L'industria estrattiva e le risorse minerarie della Regione Emilia-Romagna. *Poligrafico Artioli*, Modena, 728 p.

SANTAGATA. A., and SANTAGATA, D. (1845) Intorno alla composizione ed All'Origine dei Bitumi trovati nel Terreno della Miniera di Zolfo in Perticara. *Nuovi Annali delle Scienze Naturali*, **4**, Series 2, Tipografia Sassi nelle Spaderie, Bologna, 385–398.

SANTAGATA, D. (1845) Dei Gessi a della Formazione dello Zolfo in Perticara. *Nuovi Annali delle Scienze Naturali*, **4**, Series 2, Tipografia Sassi nelle Spaderie, Bologna, 358–381.

WILSON, W. E. (1990) L'Exposition Universelle de 1900, Paris: The greatest mineral show of all time. *Mineralogical Record*, **21**, 63–82.



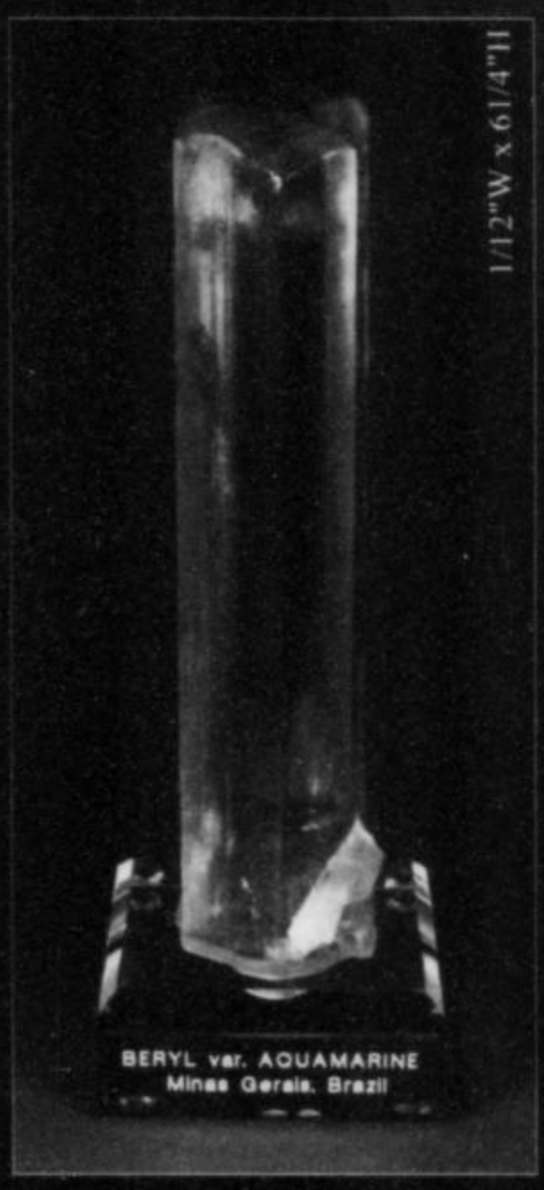
THE SUNNYWOOD COLLECTION™

Specialists in Presentation of Natural Art

Fine Minerals, Fossils and Carvings
Mounted on Acrylic and Hardwoods
CUSTOM MOUNTING AVAILABLE
Showroom by Appointment
Aurora,Colorado
Phone 303-363-8588
Fax 303-363-8640
minerals@sunnywood.com

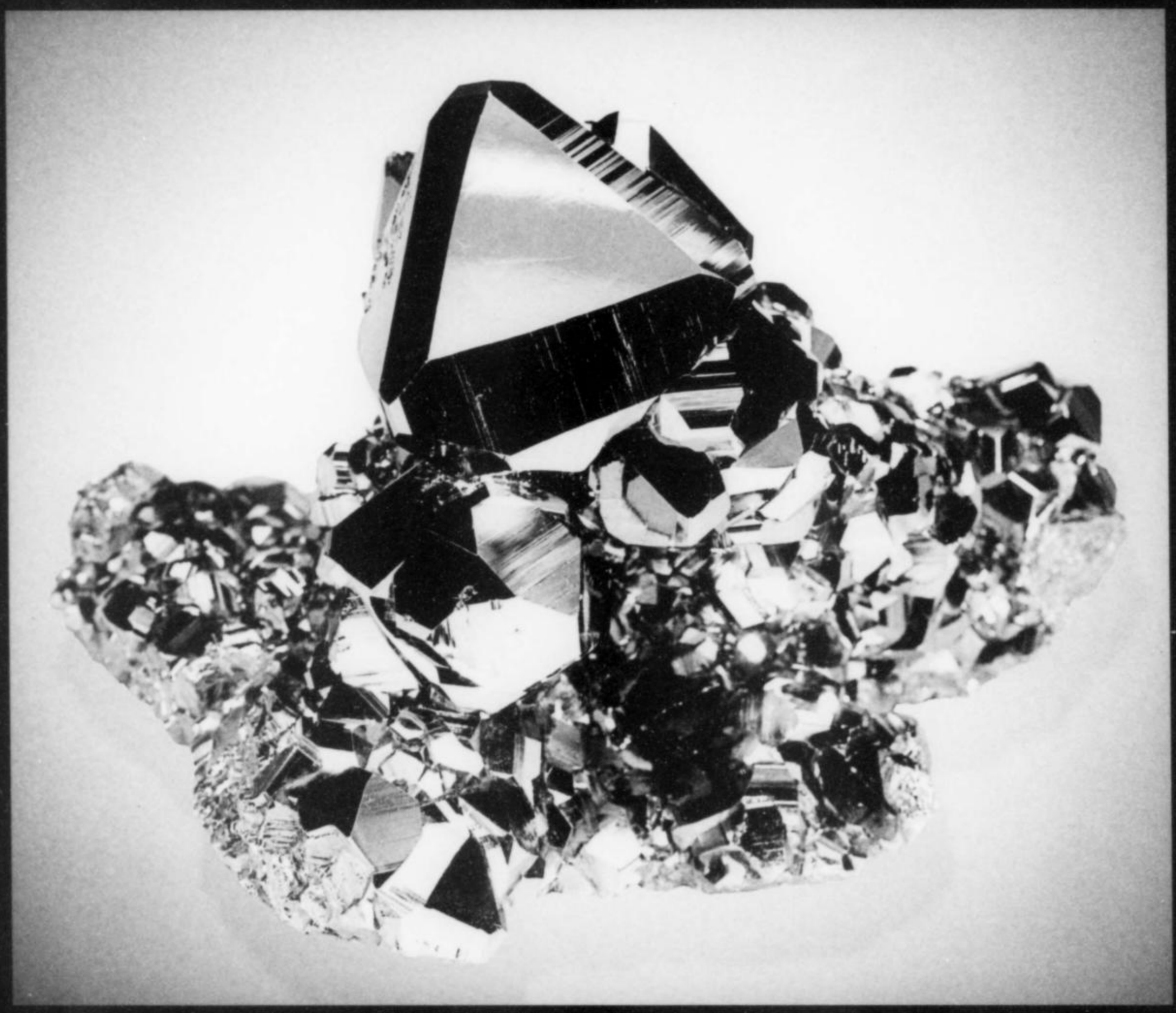
www.sunnywood.com

Visit Our Showroom



Stuart & Donna Wilensky

WE PURCHASE IMPORTANT SPECIMENS AND COMPLETE COLLECTIONS



Pyrite from Quiruvilca, Peru; 5.25 inches across

Photos Sent Upon Request.

Order Our Video Catalogs for $15.00

Outside U.S. & Canada, $25.00

#127 Sullivan St., Wurtsboro, NY 12790
Shop: (845) 888-4411 Home: (845) 695-1550
Fax: (845) 888-2889 E-MAIL: stuwil@aol.com

See Our Online Mineral Shop At: www.wilenskyminerals.com

Famous mineral localities:

The Lord Brassey Mine, Tasmania

Peter Anderson
P.O. Box 2418
Mildura, Victoria 3502, Australia

Ralph Bottrill
Tasmanian Geological Survey
Tasmania Development & Resources
P.O. Box 56
Rosny Park, Tasmania, 7018, Australia

Peter Davidson
Department of Geology
Royal Museum of Scotland
Chambers Street
Edinburgh, Scotland EH1 1JF

The Lord Brassey Mine is a world-famous mineral locality situated in northwestern Tasmania, Australia. This former nickel mine is the type locality for heazlewoodite and hellyerite, and the source of many rare minerals, including awaruite, dypingite, retgersite, reevesite, theophrastite and several new, unnamed minerals.

INTRODUCTION

The Lord Brassey mine has been a source of rare nickel minerals for mineral collectors for many years. In the past, collectors concentrated mainly on three minerals: what they labeled green *zaratite*, blue *hellyerite,* and the massive sulfide *heazlewoodite*. The Lord Brassey mine is the type locality for the latter two minerals. There was for many years no attempt made to properly identify these green, blue and massive sulfide minerals. It is only recently that detailed examinations of these phases have been undertaken by professional mineralogists in order to definitely identify the minerals.

The first investigation was by Dermot Henry and Bill Birch of the Museum Victoria. They were the first to identify the nickel minerals *otwayite* and *theophrastite* as occurring in the Lord Brassey mine (Henry and Birch, 1992). The second investigation was undertaken by the current authors, who have confirmed a number of earlier mineral identifications and have also added a

Table 1. **Minerals from the Lord Brassey mine (derived from the literature and confirmed by the authors except as noted).**

Native Elements
- Awaruite
- Unnamed Bi-Ni-Fe-Pt alloy†
- Unnamed Au-Cu alloy†

Sulfides
- Covellite*
- Digenite*
- Heazlewoodite
- Millerite
- Molybdenite*
- Pentlandite
- Polydymite*
- Pyrite†
- Pyrrhotite*
- Violarite†

Halides, Oxides & Hydroxides
- Atacamite*
- Brucite*
- Magnetite
- Theophrastite

Arsenates, Sulfates
- Annabergite†
- Retgersite*
- Unnamed nickel iron sulphate†

Carbonates
- Dypingite*
- Gaspéite*
- Hellyerite
- Magnesite†
- Otwayite†
- Pyroaurite*
- Reevesite*
- Zaratite

Silicates
- Andradite
- Antigorite
- Chrysotile
- Clinochlore
- Diopside*
- Enstatite†
- Glossular†
- Lizardite
- Opal
- Palygorskite*
- Pecoraite*
- Stevensite (or Saponite?)*
- Talc†

† Derived from the literature but not confirmed by this study.
* Derived from investigations undertaken by the authors; not previously reported.

further 16 species to the list of minerals currently known to occur at this mine. This brings to 40 the total number of mineral species known to occur in the Lord Brassey mine (see Table 1).

If these mineralogical studies had been undertaken 20 years ago (when the senior author collected the specimens used in this investigation), the Lord Brassey mine could have been the type locality for at least two other mineral species. These are the minerals *otwayite* and *theophrastite*, both of which were described as new minerals in the late 1970's (Nickel *et al.*, 1977) and early 1980's (Macropoulos and Economou, 1981). There are also four other mineral species from this mine which need further investigation: *atacamite* (which may be the natural occurrence of the unnamed nickel analog of atacamite, so far only known synthetically; Saini-Eidukat *et al.,* 1994), an unnamed nickel-iron sulfate, an unnamed bismuth-nickel-iron-platinum alloy and a gold-copper alloy.

Collectors should note that because of the variety of green nickel minerals now known to occur at the Lord Brassey mine, the mineral name "*Zaratite,*" which formerly applied to all of the green crusts, smears and globule minerals found in this mine, can no longer be used with any certainty. In fact the only way to be sure of the proper identification of Lord Brassey mine nickel minerals is by X-ray diffraction analysis.

Most of the specimens used in this study were collected by Peter Andersen in the early 1970's when he worked as a geologist for the Renison Goldfields company at their Renison tin mine. Other specimens used in this investigation were collected by Ralph Bottrill and Steven Sorrell. In addition, some specimens stored in the mineral collection of the Tasmanian Museum and Art Gallery were analyzed as part of this investigation.

LOCATION

The Lord Brassey mine is situated in the Heazlewood district of western Tasmania, near the summit of Brassey Hill (also known as Nickel Hill). It is situated 1.5 km northeast of the bridge over the Heazlewood River on the Waratah-Corinna road, approximately 10 km east of Savage River township and 240 km northwest of the State Capital, Hobart (Fig. 2). The mine is reached by a 4-wheel-drive track which leaves the Waratah-Corinna road 100 meters beyond the Heazlewood River bridge, crosses Nickel Creek and ascends Brassy Hill to where the mine is located.

The general topography of western Tasmania is bleak and inhospitable. A cool, wet climate, with rugged hills covered by lush vegetation and fast-flowing rivers, made it difficult for early settlers and prospectors, and even today this part of Tasmania is only sparsely populated.

HISTORY

Because of the hostile terrain of western Tasmania, serious prospecting for mineral resources did not begin till the late 1850's. It was a lone bushman/prospector, James "Philosopher" Smith, who in 1871 discovered a tin lode in the Arthur River area. This discovery led to the establishment of the Mount Bischoff tin mine at Waratah, a large mine which became very significant in Tasmania's economic development (Wright, 1990). This sparked off a wave of exploration leading to the discovery of numerous important mineral fields in Western Tasmania, including: Heemskirk (Sn)—1876, Savage River and Pieman River tributaries (alluvial Au and Os/Ir)—1879, Zeehan-Dundas (Pb, Ag)—1882, and several world-class deposits still in operation: Iron Blow (Au), which developed into the Mount Lyell mines (Cu, Au)—1883, Renison (the world's largest underground Sn mine)—1890, and the Mt. Reid (Hercules)-Rosebery-Mt. Farrell deposits (Pb, Zn, Ag and Au)—1894 (Haupt, 1988). Exploration is continuing in the area; the most recent discoveries include deposits at the Que River mine (Pb, Zn), the Henty mine (Au) and the huge Hellyer mine (Pd, Zn). The area is one of the most richly mineralized parts of the world.

The discovery of the nickel mineralization around Brassy Hill came in the 1890's when prospectors were searching for gold, silver and other metals (Twelvetrees, 1900). In 1896, a single adit was driven into the hill by the Lord Brassey Nickel Company, and a few tons of nickel ore in the form of primary sulfides were extracted. After a short working life, the mine was abandoned and no further development took place till the 1950's when it was

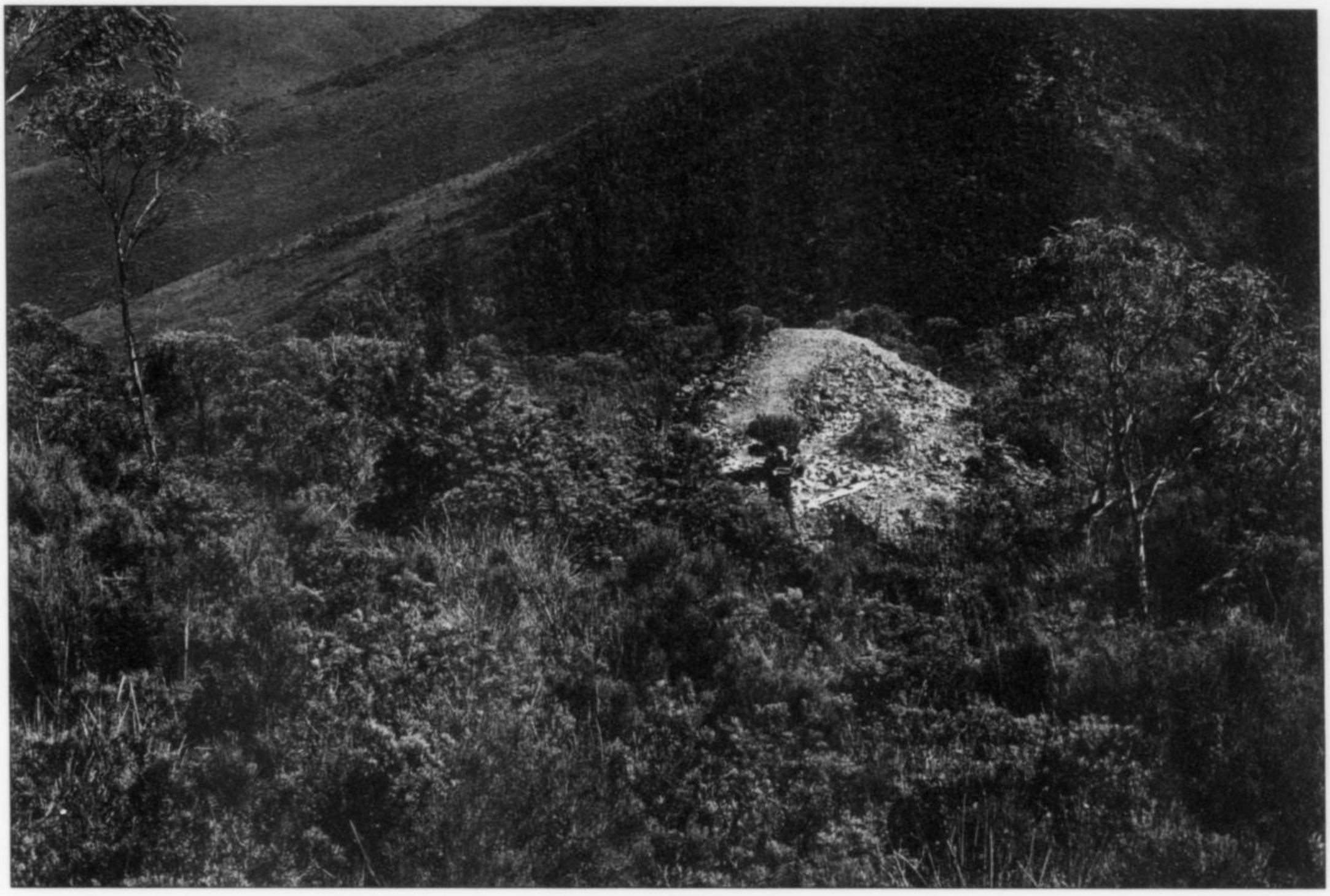


Figure 1. **The Lord Brassey mine dump with two Victorian collectors (John Bosworth and Ed Richards) collecting the rare nickel minerals which are to be found there (J. Haupt photo).**

renamed the McCormick-Miller nickel prospect (Hughes, 1957). At this stage a track was put in and some ore brought down by horse sledge, but apparently no significant work has been done since (Hughes, 1957). The mine was also known as Miller's nickel prospect at about the same time.

The area has also been extensively prospected up to recent times for platinum-group elements (mostly osmium-iridium-ruthenium alloys, usually referred to as "osmiridium"), of which the Bald Hill mining field 5 km to the north-northwest was an important source (mostly in alluvials: Reid, 1921; Ford, 1981; Peck 1990; Peck and Keays, 1990).

The main workings of the Lord Brassey mine consists of an adit about 90 meters long with one main branch and several shorter drives (Fig. 5). Only a few other small workings for nickel exist in the area. The mine entrance is located close to the summit of Brassy Hill and about 330 meters of adits exist. Only a few other small workings for nickel exist in the Heazlewood area (e.g., the Jupps mine, which is located 100 meters to the south of the Lord Brassey mine), and there are numerous small copper and silver-lead prospects and mines close by.

GEOLOGY

The regional geology of this part of Western Tasmania is rather complex (Fig. 2). It is dominated by rocks of Precambrian, Cambrian and Siluro-Devonian age, intruded by Late Devonian granites, and overlain by relatively undeformed sedimentary sequences of Permo-Triassic, Tertiary and Quaternary age, and sporadically zeolite-bearing Tertiary basalts (Collins and Williams, 1986).

The basement rocks of the Heazlewood district consist of Precambrian quartzites and slates (which form part of a major structural unit called the Rocky Cape Group), and the Arthur Metamorphic Complex (consisting of schist, amphibolite, iron formation and magnesite-rich and dolomite-rich units). Assumed Cambrian sedimentary rock sequences include sandstone, siltstone and mudstone, and are usually considered a part of the Dundas Trough (Collins and Williams 1986; Burrett and Martin, 1989).

The nickel ores of the Lord Brassey mine, and the iridium-osmium ores of Bald Hill, occur within the Heazlewood Ultramafic Complex, a body of largely serpentinized gabbro, pyroxenite, harzburgite, peridotite, dunite and related rocks of Cambrian age (Williams, 1958; Peck, 1990; Peck and Keays, 1990). Recent studies suggest that this body, and similar complexes around Tasmania, are remnants of extensive sheets of ophiolite-like sequences of layered cumulate ultramafic rocks and oceanic/island-arc basalts, thrust over proto-Tasmania and later dismembered by faulting, folding and erosion (Berry and Crawford, 1988; Brown and Jenner, 1989). The complexes probably formed in a supra-subduction zone situation during island-arc-continent collision (Berry and Crawford, 1988; Brown and Jenner, 1989).

The nickel mineralization occurs in a sequence of feldspathic harzburgite with minor orthopyroxenite, dunite and troctolite,

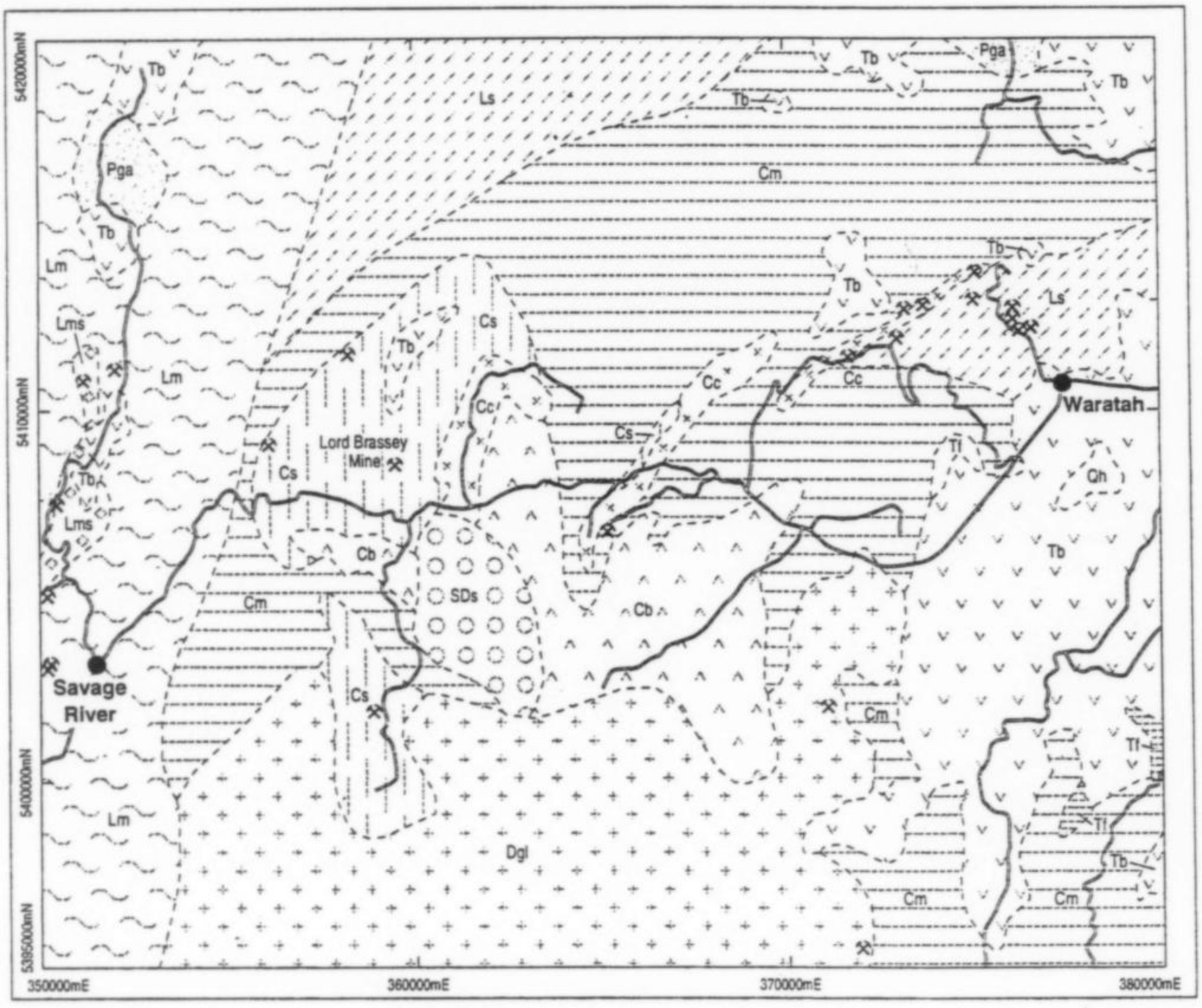
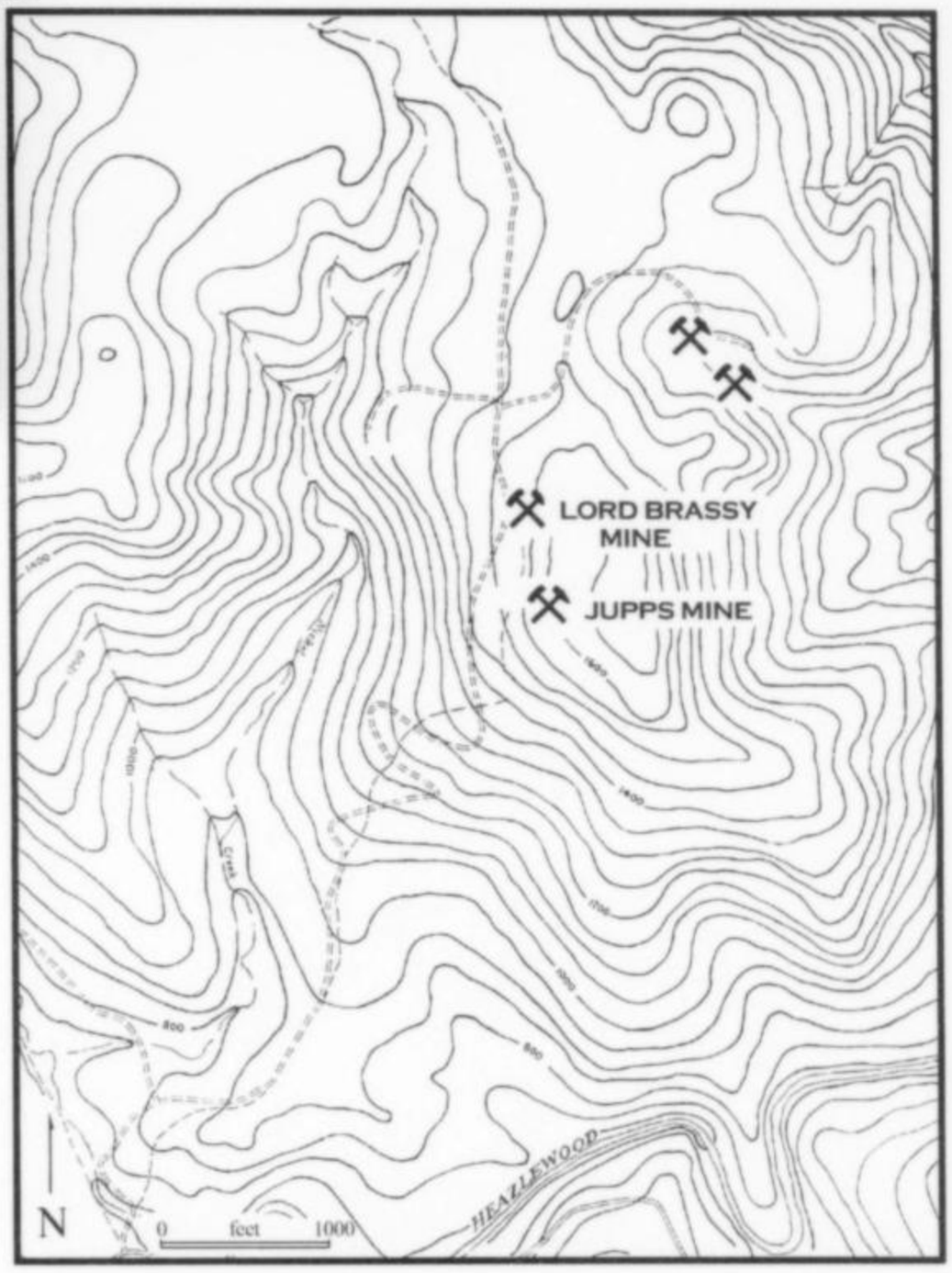


Figure 2. **Location of the Lord Brassey mine and the regional geology of the Heazlewood district, Western Tasmania.**

Figure 3. **The entrance adit of the Lord Brassey mine (P. Andersen photo).**

Figure 4. **Map showing nickel workings, access tracks and topography in the Lord Brassey mine area. Adapted from Tasmanian Mines Dept. Plans.**



intruded by dikes of dolerite, gabbro and anorthosite. The host rocks were originally rich in enstatite, forsterite, anorthite, augite and chromite, but are now largely altered to mixtures of serpentine, chlorite, amphibole, epidote, garnet, and minor prehnite, magnetite, talc, magnesite, opal and chalcedony. Small chromitite bodies near Brassey Hill contain uvarovite, native copper and a varied assemblage of platinum-group minerals (Carthew and Bellairs, 1988; Peck, 1990; Peck and Keays, 1990). The nickel mineralization is confined to narrow veins in a north-south trending, garnet and chlorite-bearing, serpentinite-rich shear zone body in the feldspathic harzburgite.

The primary mineralization consists of nickel sulfides (pentlandite and heazlewoodite) with minor Ni-Fe alloy (awaruite) intergrown with grains of magnetite and various silicates (Williams, 1958).

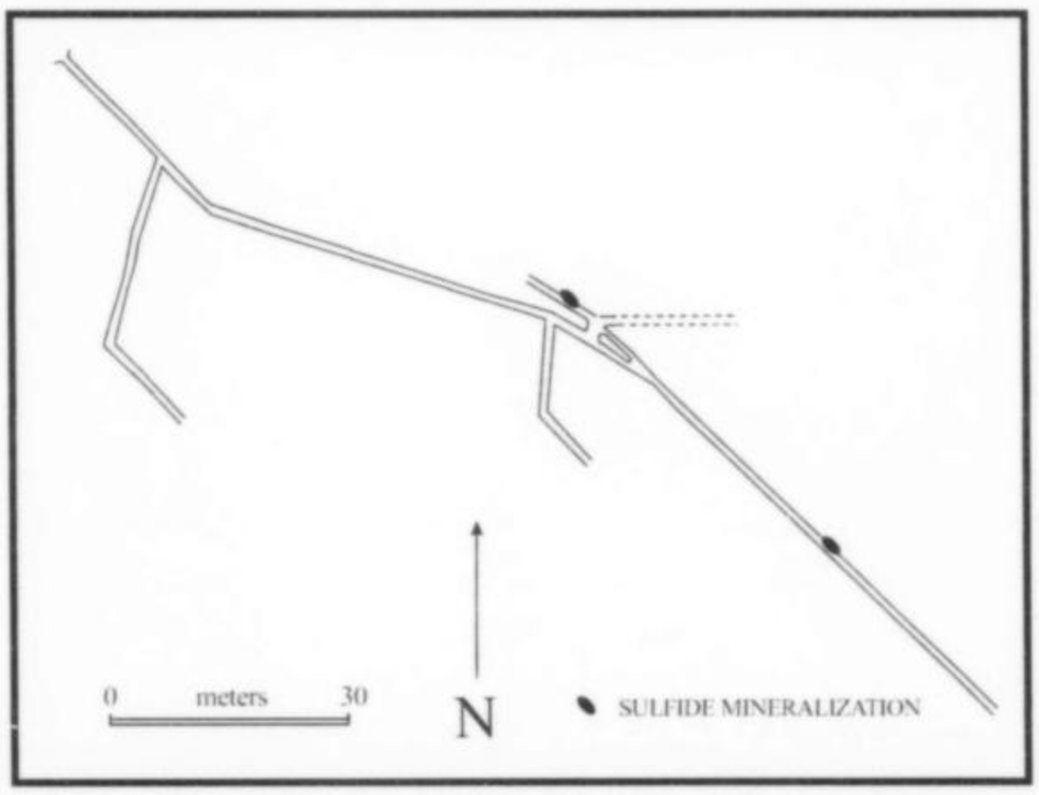


Figure 5. **Plan of underground workings at the Lord Brassey mine; adapted from Tasmanian Mines Dept. Plans.**

Carbonate-bearing groundwater percolating up through shear planes within the serpentine have reacted with the primary sulfides to form the secondary nickel mineralization (Henry and Birch 1992).

MINERALOGY

The mineralogy of the Lord Brassey mine can be subdivided into three main categories: primary nickel/iron sulfides, secondary nickel minerals, and gangue minerals.

Information on minerals listed below is derived from several sources:

(a) Published literature;

(b) Investigations undertaken by the authors on specimens collected by Peter Andersen, Ralph Bottrill and Steve Sorrel (Hobart, Tasmania); and

(c) Specimens lodged in the General Mineral Collections of the National Museums of Scotland (NMS), the Tasmanian Museum and Art Gallery, and the Museum of Victoria.

The bulk of the analytical work was undertaken in the laboratories of the Department of Geology, NMS, using Philips PW 1024/30 Debye-Scherrer X-ray diffraction (XRD) cameras on Cu Kα and Fe Kα radiation, and in the Tasmanian Geological Survey using a Philips PW1710 diffractometer with Cu Kα radiation and a graphite monochromator. Unless otherwise stated, all elemental analyses were undertaken using a Philips PV9500 energy dispersive spectrometer incorporating the DX-4 software and a Rh target.

Andradite $Ca_3Fe^{3+}_2(SiO_4)_3$

Andradite is relatively abundant in serpentinized mafic and ultamafic rocks in the Lord Brassey mine, as very fine-grained, pale green masses of granular crystals to a few micrometers in size, in shear planes in serpentine (Ford, 1970), and commonly associated with heazlewoodite. Analyses (X-ray fluorescence and wet chemical) show about 1.9 weight % Cr_2O_3 and 0.9 weight % H_2O, indicating a hydrous chromian andradite (Ford, 1970). The species was confirmed by XRD. Reports of hydrogrossular (Rubenach, 1973) and grossular (Williams, 1959) replacing plagioclase in these rocks may refer to the same material.

Annabergite $Ni_3(AsO_4)_2 \cdot 8H_2O$

Green crusts of annabergite have been recorded on the massive sulfides present in the mine (Petterd, 1910). This is doubtful, considering that no other As-bearing minerals have been identified; it may be a misidentification of zaratite.

Antigorite $(Mg,Fe^{2+})_3Si_2O_5(OH)_4$

This serpentine group mineral was identified as a common gangue mineral by Williams (1958).

Atacamite $Cu^{2+}_2Cl(OH)_3$

Small clusters of emerald-green prismatic crystals on serpentine were X-rayed and found to give an atacamite pattern. As there is no obvious source of chlorine, and copper is very minor in the ores, this requires further study (it may be the unnamed nickel analog, known synthetically: Saini-Eidukat *et al.*, 1994).

Awaruite Ni_2Fe to Ni_3Fe

Petterd (1910) described awaruite as silver to grayish white masses occurring in polished ore sections. X-ray powder diffraction analyses of a sliced silvery mass collected by Peter Andersen gave a mixture of heazlewoodite, magnetite and a nickel-iron phase. This latter was analyzed by electron microprobe and found to be awaruite with a composition of 75% Ni, 25% Fe (C. Stanley, personal communication). It occurs as fine-grained colloform aggregates of granular to dendritic crystals, interbanded with heazlewoodite, rimming, veining and replacing magnetite.

Brucite $Mg(OH)_2$

Traces of brucite were disclosed by XRD in altered serpentinite, with palygorskite, stevensite and pyroaurite.

Chrysotile $Mg_3Si_2O_5(OH)_4$

A fibrous serpentine mineral was identified as rare veinlets to 0.2 mm wide in host rocks by Williams (1958). It is probably one of the chrysotile subgroup of serpentine minerals, but the precise species has not yet been established.

Clinochlore $(Mg,Fe^{2+})_5Al(Si_3,Al)O_{10}(OH)_8$

A green chlorite-group mineral (confirmed by XRD) is common as a gangue mineral. Qualitative electron microprobe analysis indicates a Mg-rich composition, most probably clinochlore, the typical chlorite in ultrabasic rocks. The nickel content is very low.

Covellite CuS

Covellite was identified by optical microscopy as rare small grains in heazlewood-magnetite ore, with traces of digenite.

Digenite Cu_9S_5

Digenite was identified by optical microscopy as rare, very small grains in heazlewoodite-magnetite ore, with covellite.

Diopside $CaMgSi_2O_6$

Rare, thin veins of off-white, granular diopside (confirmed by XRD) occur in the mine, cutting the serpentinite.

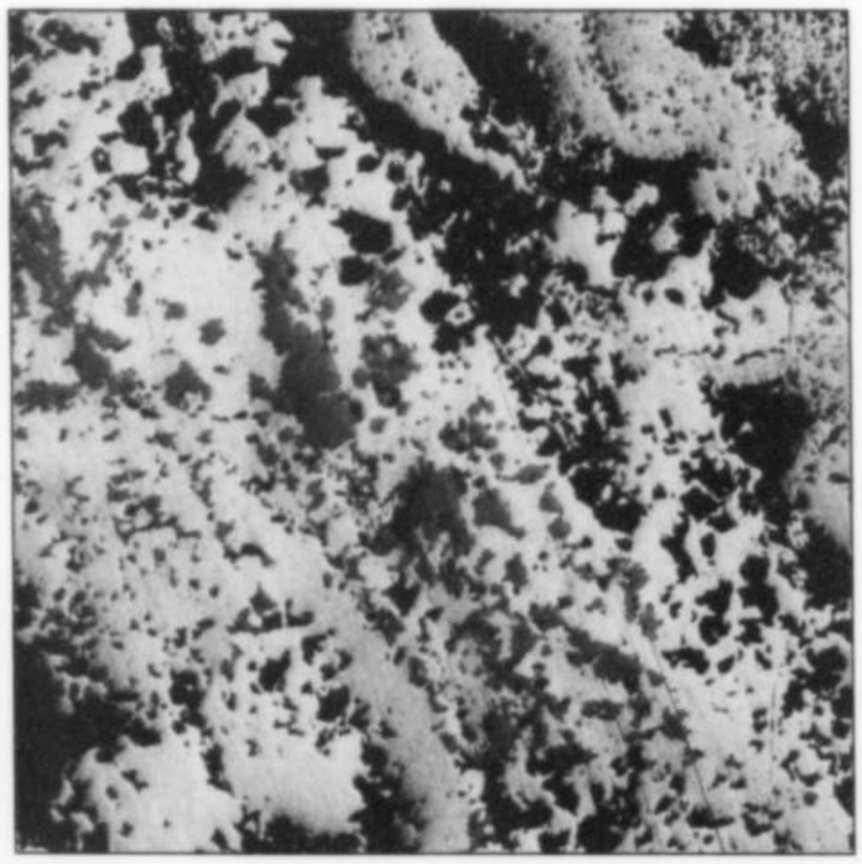


Figure 6. **Polished section showing awaruite (pale cream) and heazlewoodite (creamy yellow), replacing magnetite (pale gray) in serpentinite and andradite (dark gray). Field of view: 1.1 mm. P. Andersen specimen; R. Bottrill photo.**

Figure 7. **Dypingite (white-cream yellow globules and crystals. Field of view: 3.4 mm. P. Andersen specimen; R. Bottrill photo.**

Dypingite $Mg_5(CO_3)_4(OH)_2 \cdot 5H_2O$

Dypingite occurs as white to cream to pale blue and green botryoidal masses and crusts on serpentine. The best specimens were found in shear-plane fractures within the serpentine.

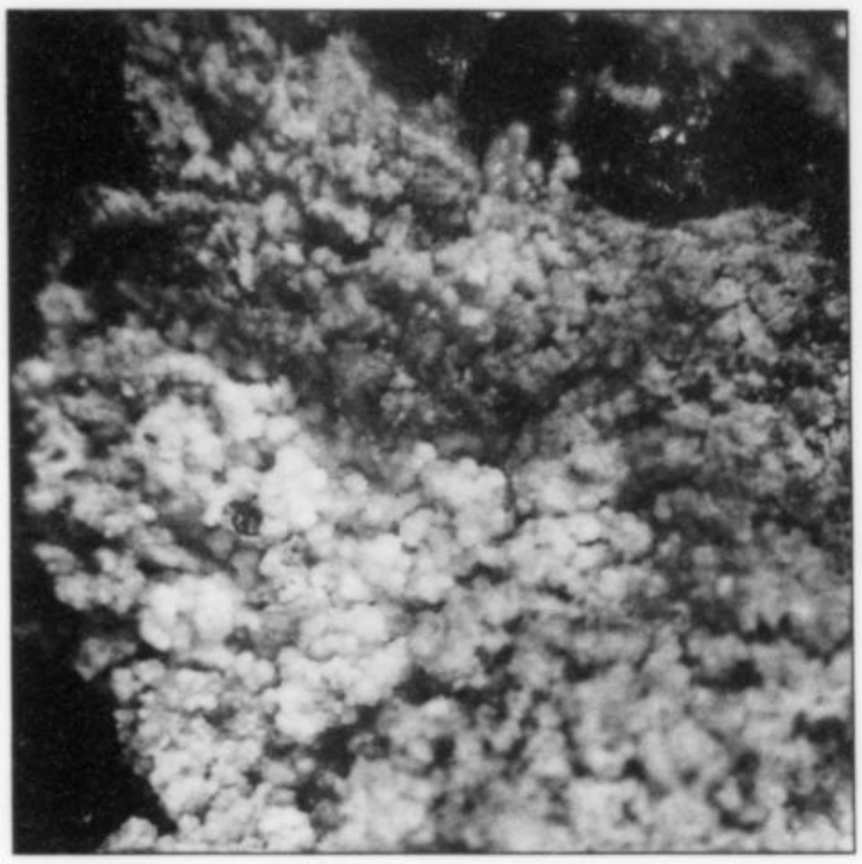


Figure 8. **Dypingite in white crystalline globules, with the green nickel-rich dypingite. Field of view: 1.2 cm. J. Haupt specimen and photo.**

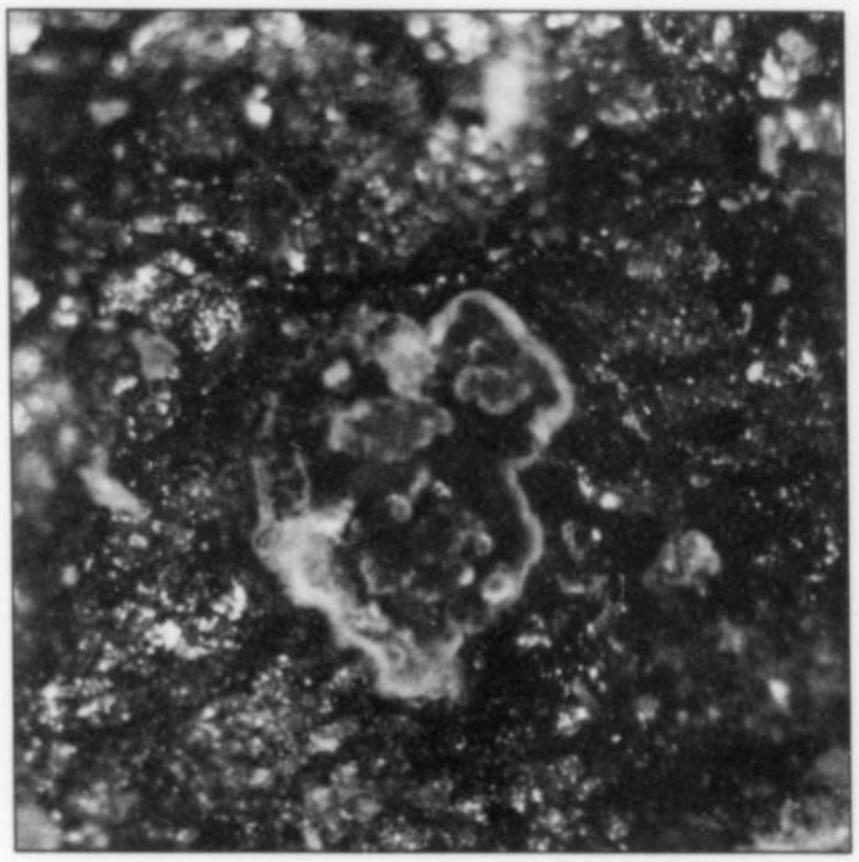


Figure 9. **Heazlewoodite (brassey yellow masses) with zaratite (green crystals). Field of view 4 mm. J. Haupt specimen and photo.**

X-ray diffraction analysis of these pale blue to white, botryoidal to finely fibrous crusts on serpentine gave a dypingite pattern. Electron microprobe analysis indicates a moderate nickel content, but subordinate to magnesium (see Table 2).

Enstatite $Mg_2Si_2O_6$

Enstatite, a pyroxene, was reported as rare residuals, partly altered to talc and chlorite, in the serpentinite gangue by Williams (1958).

Gaspéite $(Ni,Mg,Fe^{2+})CO_3$

Green gaspéite was tentatively identified by XRD as a constituent of a yellow-green secondary coating (mostly an unnamed Ni-Fe sulfate: see below) on pentlandite and polydymite.

Grossular $Ca_3Al_2(SiO_4)_3$

Grossular has been reported in serpentinites from the Lord Brassey mine, Heazlewood district, usually as "hydrogrossular" (Williams, 1959; Rubenach, 1973; Peck and Keays, 1990) but may be hydrous andradite (Ford, 1970).

Heazlewoodite Ni_3S_2

The bronzy yellow sulfide, heazlewoodite, was first recorded from this locality. Petterd (1910) initially described it as a variety of pentlandite, but it was subsequently elevated to species status by Peacock (1947), who named it after the Heazlewood district where the Lord Brassey mine is located. Heazlewoodite generally occurs as small (up to 8 mm) patches in serpentine and magnetite, though larger masses have been recovered. It is the principal nickel mineral at the Lord Brassey mine, but the mineral is best seen in polished section. Colloform aggregates replacing magnetite, with awaruite, occur. Crystalline heazlewoodite is rare but has been seen here (Steve Sorrell, personal communication).

Hellyerite $NiCO_3 \cdot 6H_2O$

The Lord Brassey mine is the type (and only?) locality for hellyerite. It occurs as pale blue coatings and very attractive crystals to about 2 mm, with a vitreous luster, along shear plains in the serpentine. It was first described by Williams *et al.* (1959) and named after Henry Hellyer, first Surveyor General of the Van Dieman's Land Company, who was responsible for exploring and

Table 2. **Chemical analyses of minerals from the Lord Brassey mine.**

	1. Retgersite	*2. Zaratite*	*3. Theophrastite*	*4. Dypingite*	*5. Dypingite*
NiO	21.6	58.68	61.72	12.7	9.86
MgO	1.98	0.10	1.66	28.94	35.40
CaO	0.79			0.05	0.09
FeO	0.30			0.04	0.06
CoO	0.07				
SO_3	27.3	4.92		0.92	0.38
H_2O	15.8	21.68	36.62	26.05	18.57
CO_2	0.23	14.62		31.30	35.64
Total	68.1	100.00	100.00	100.00	100.00

1. ICP Analysis by V. K. Din, Natural History Museum, London; the low total is due to the loss of loosely bound water from the sample during the dry helium purge of the CHN analyser prior to analysis.
2. Average of 14 microprobe analyses by Henry and Birch (1992); described as "otwayite" but mostly XRD-amorphous. H_2O by difference, CO_2 calculated.
3. Average of 4 microprobe analyses by Henry and Birch (1992). H_20 by difference, CO_2 calculated.

4, 5. Microprobe analyses, Cameca SX-5O, Central Science Laboratories, University of Tasmania. H_20 by difference, CO_2 calculated.

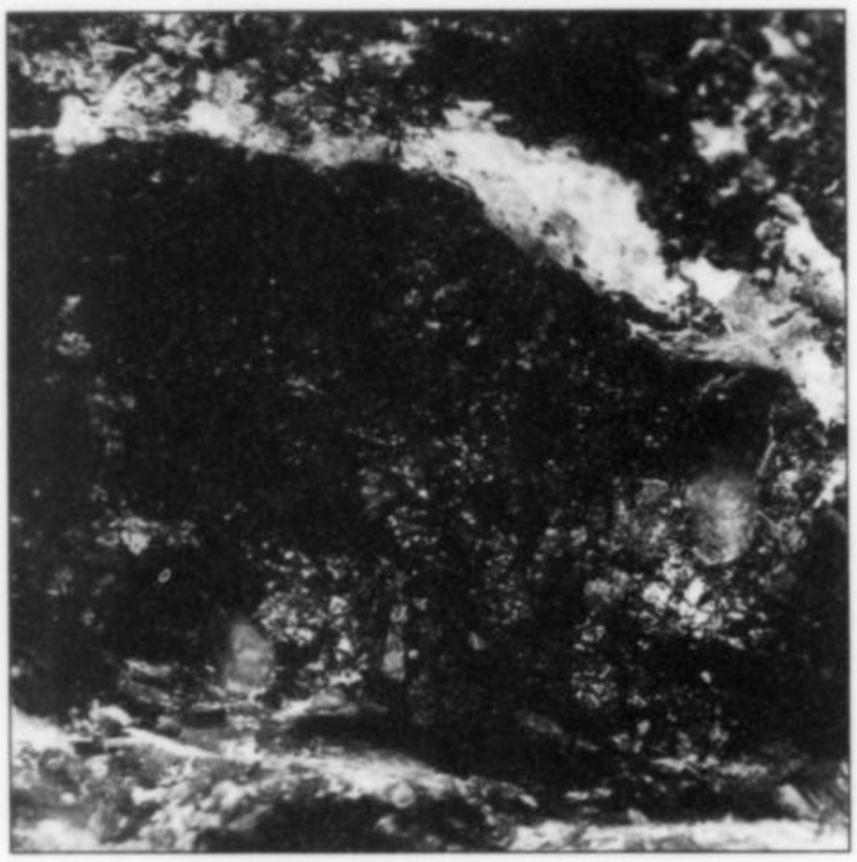


Figure 10. **Heazlewoodite (metallic masses) with retgersite (blue crystals). Field of view 1.5 cm. J. Haupt specimen and photo.**

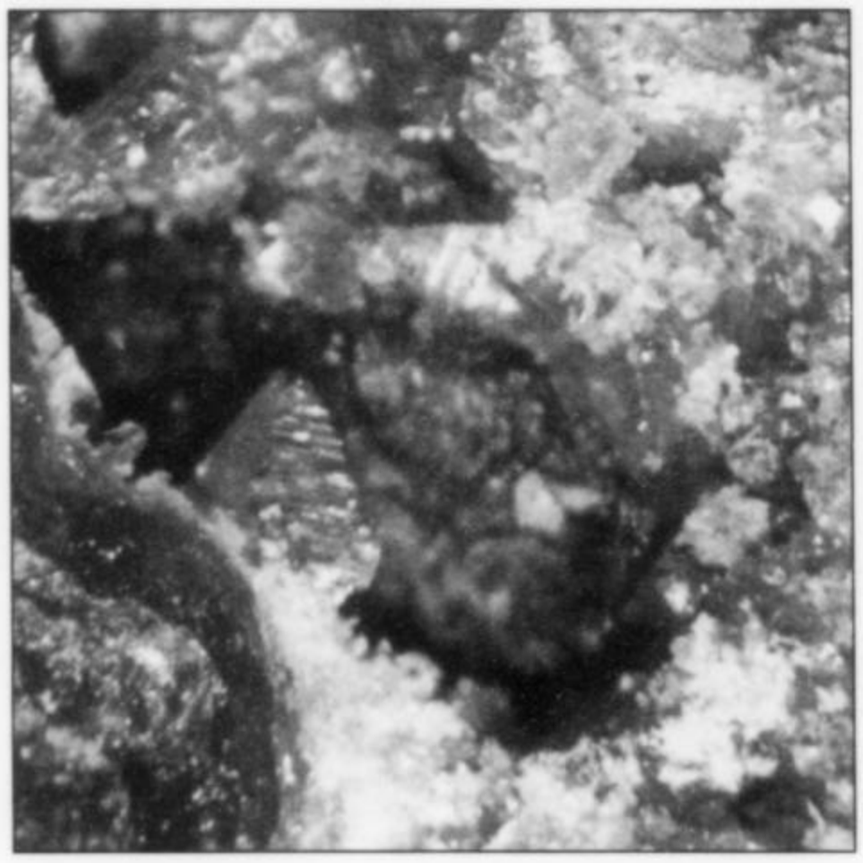


Figure 11. **Hellyerite (blue crystal 0.5 mm in size) with zaratite (green crust). Field of view: 1.8 mm. S. Sorrell specimen and photo.**

surveying much of North Western Tasmania during 1826–1830. Crystalline hellyerite has not, to our knowledge, been recorded before. The best examples are found in the collections of Steve Sorrel (Hobart), the authors and the Museum Victoria. Its rarity is probably due to the fact that hellyerite is relatively unstable and, if not kept in an air-tight environment, decomposes in time to an unidentified poorly crystalline phase (Henry and Birch, 1992).

Lizardite $Mg_3Si_2O_5(OH)_4$

Lizardite, a serpentine group mineral, was identified (by the obsolete term "ortho-antigorite") as a gangue mineral by Williams (1958). X-ray diffraction indicates that the specific polytype is probably lizardite-1T.

Magnesite $MgCO_3$

Magnesite occurs in talc-carbonate veins cutting the serpentinite (Mann, 1988).

Magnetite $Fe^{2+}Fe^{3+}_2O_4$

Magnetite occurs as interstitial filling between heazlewoodite grains and is also quite common throughout the host rocks, sometimes in massive form. Electron microprobe analysis indicated that the magnetite contains minor amounts of nickel (C. Stanley, personal communication).

Millerite NiS

Millerite was reported by Williams (1958) as fine inclusions in heazlewoodite and as an alteration product of pentlandite.

Molybdenite MoS_2

Small patches of massive, dark gray to occasionally purple-gray sulfides were X-rayed and identified as molybdenite.

Opal $SiO_2 \cdot nH_2O$

Opal was identified as thin films on shear planes by Williams (1958).

Otwayite $Ni_2(CO_3)(OH)_2 \cdot H_2O$

Henry and Birch (1992) analyzed some zaratite from the Lord Brassey mine by XRD and noted the presence of otwayite inclu-

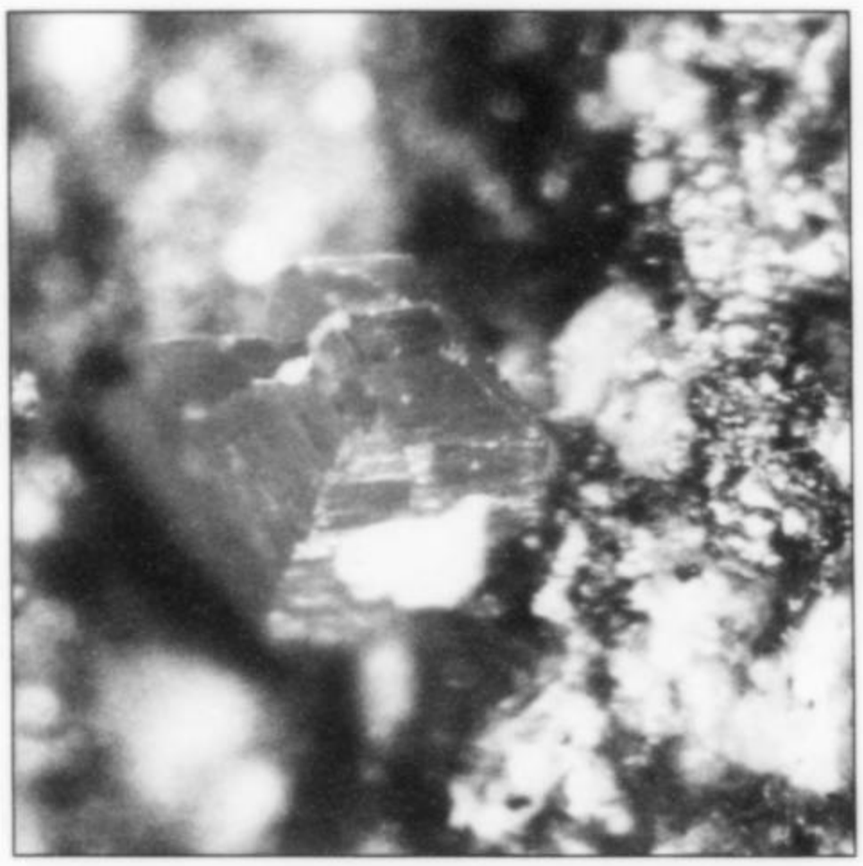


Figure 12. **Hellyerite (blue crystal 0.5 mm in size) with serpentine. Field of view: 1.1 x 1.8 mm. S. Sorrell specimen and photo.**

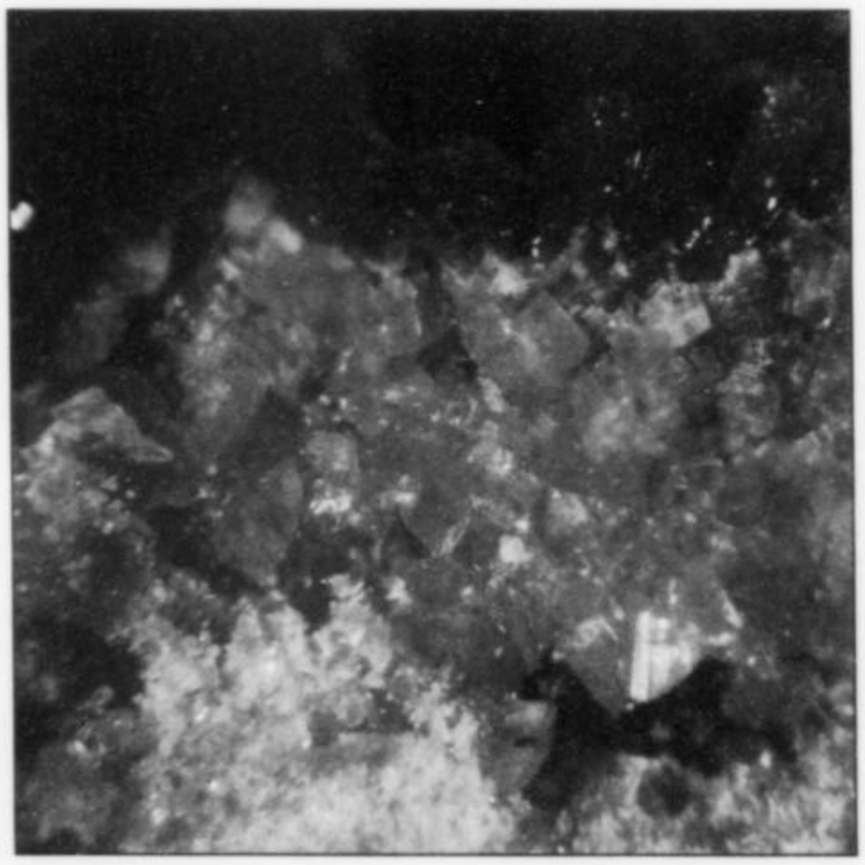


Figure 13. **Helleyrite (blue crystals) with zaratite (green crusts). Field of view: 6 mm. J. Haupt specimen and photo.**

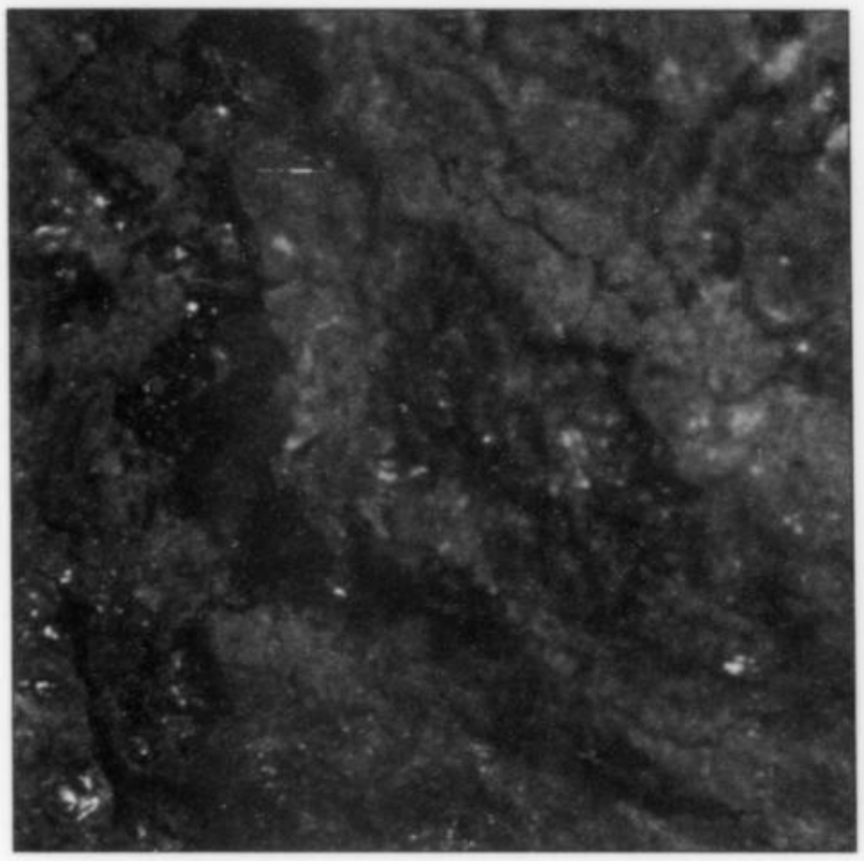


Figure 14. **Otwayite (dark green bands with lighter green theophrastite). Field of view: 10 mm. Museum of Victoria specimen: M2023, D. Henry photo.**

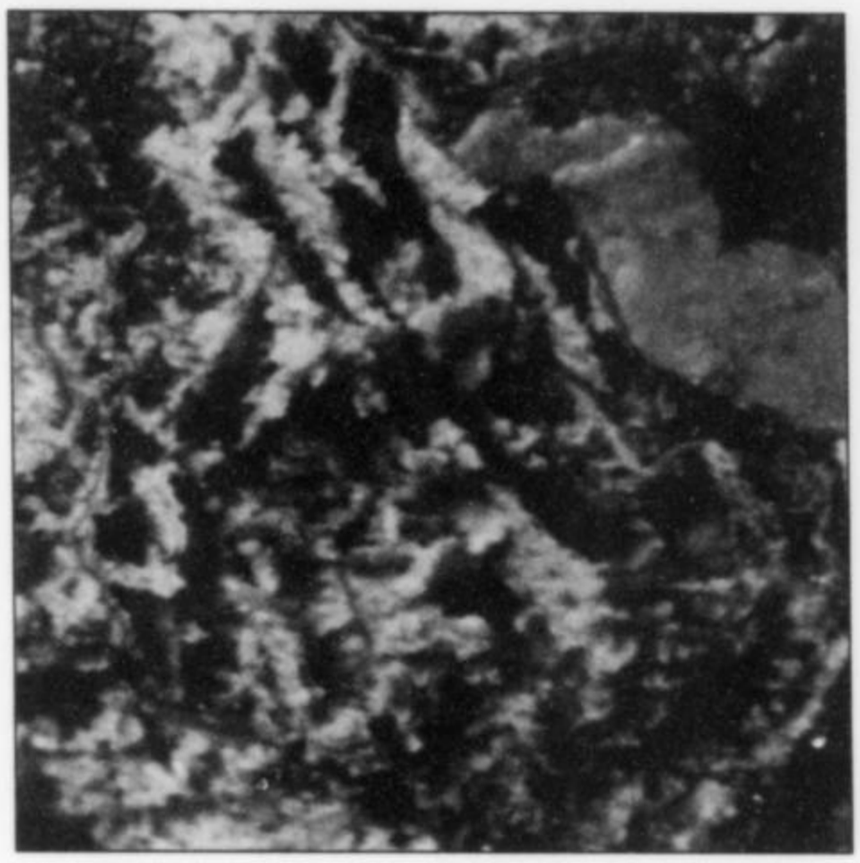


Figure 15. **Reevesite (yellowish green crusts). Field of view: 7 cm. Tasmanian Museum and Art Gallery specimen X4095; R. Bottrill photo.**

sions, apparently formed as a result of breakdown and recrystallization of the amorphous zaratite matrix.

Palygorskite $(Mg,Al)_2Si_4O_{10}(OH)\cdot 4H_2O$

Palygorskite occurs as fine-grained white material intergrown with pyroaurite, stevensite and brucite in altered serpentinite.

Pecoraite $Ni_3Si_2O_5(OH)_4$

The rare nickel mineral pecoraite has been identified on only one specimen, where it occurs as a dark green crust on serpentine with small blue retgersite crystals.

Pentlandite $(Fe,Ni)_9S_8$

Pale bronze-yellow pentlandite occurs as intergrowths with heazlewoodite in the serpentine, but is usually subordinate. It is best seen microscopically in polished section, where it can be distinguished from heazlewoodite by its paler color (Petterd, 1910; Williams, 1958).

Polydymite $NiNi_2S_4$

Polydymite was identified by XRD as metallic gray material associated with pentlandite. The X-ray powder pattern is very similar to that of violarite (q.v.). The composition needs checking.

Pyrite FeS_2

A nickel-rich variety of pyrite was reported by Williams (1959) as fine-grained mauve (in reflected light) intergrowths with millerite, replacing pentlandite.

Pyroaurite $Mg_6Fe^{3+}_2(CO_3)(OH)_{16}\cdot 4H_2O$

Pyroaurite occurs as fine-grained white material intergrown with palygorskite, stevensite and brucite in altered serpentinite.

Pyrrhotite $Fe_{1-x}S$

Pyrrhotite occurs as fine-grained, pale brown, rounded grains to about 40 micrometers, in awaruite-heazlewoodite-magnetite aggregates.

Reevesite $Ni_6Fe^{3+}_2(CO_3)(OH)_{16}\cdot 4H_2O$

A lemon-yellow crust on serpentine gives an X-ray powder diffraction pattern close to that of reevesite, and qualitative EMPA indicates Ni:Fe approximately 3:1, confirming the composition.

Retgersite $NiSO_4\cdot 6H_2O$

Retgersite occurs as pale to medium blue crystals and crusts on serpentine. Identification was confirmed by X-ray powder diffraction photographs and X-ray spectrometric and ICP analysis (Table 2, V. K. Din, personal communication).

Saponite $(CaNa)_{0.3}(Mg,Fe^{2+})_3(Si, Al)_4O_{10}(OH)_2\cdot 4H_2O$

Saponite occurs as fine-grained white material intergrown with pyroaurite, palygorskite and brucite in altered serpentinite.

Talc $Mg_3Si_4O_{10}(OH)_2$

Talc was reported by Williams (1958) as a gangue mineral, and by Mann (1988) in veins with magnesite.

Theophrastite $Ni(OH)_2$

In this study, theophrastite was found to occur as a green crystalline crust on a slickensided serpentine face. The X-ray diffraction pattern confirms the findings of Henry and Birch (1992) and is closer to Greek theophrastite (Macropoulos and Economou, 1981) than to the Unst material (Livingstone and Bish, 1982). The material of Henry and Birch (1992) consists of dull blue-green to olive-green, compact vein fillings in massive magnetite in serpentinite, with zaratite.

Violarite $Fe^{2+}Ni^{3+}_2S_4$

Violarite has been observed microscopically as an alteration product of pentlandite (Petterd, 1910; Williams, 1958). However, it may be polydymite; the composition needs checking.

"Zaratite" $Ni_3(CO_3)(OH)_4\cdot 4H_2O$

What has long been called "zaratite" occurs at the Lord Brassey mine as emerald-green coatings and mammillary, stalactitic or amorphous encrustations along the shear planes and joint surfaces of the serpentine. Identification is difficult due to the X-ray–amorphous nature of the mineral, its usual occurrence as thin films difficult to separate from other minerals, and its unstable nature, breaking down to several other minerals, including otwayite (Henry and Birch, 1992). The actual identity of the mineral is in some doubt. Isaacs (1963) noted the mineral to be a mixture of at least two different nickel carbonates, one fibrous and one amorphous (the fibrous inclusions he observed were not otwayite); inconsistencies exist between recorded powder patterns. The material

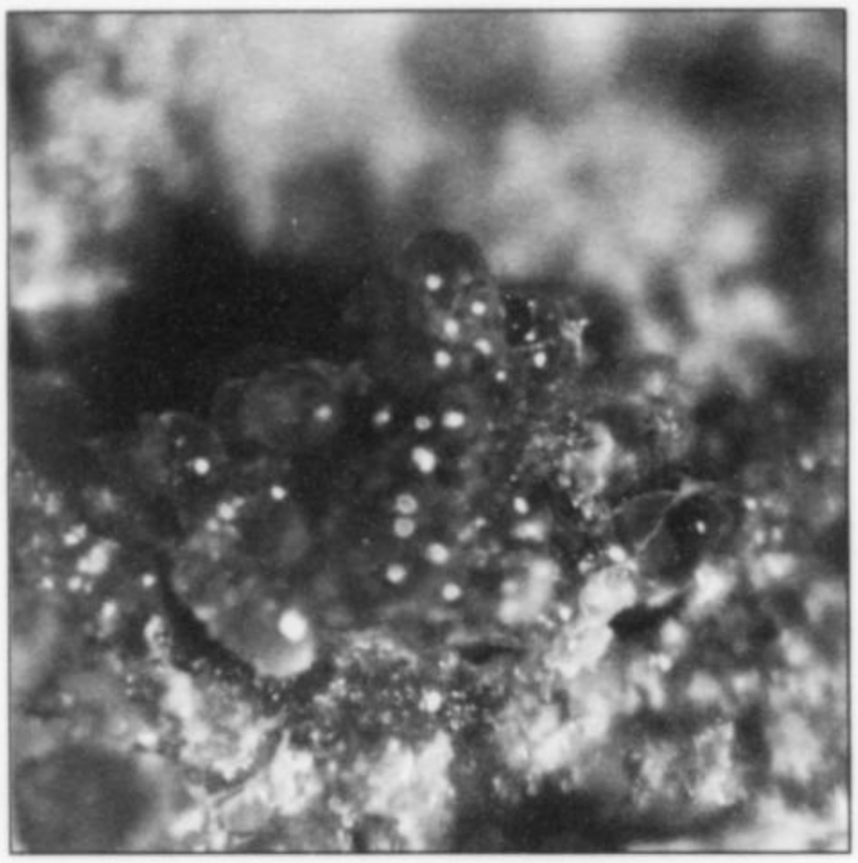


Figure 16. **Altered serpentine (green globules, often called "zaratite" by collectors). Field of view: 6 mm. J. Haupt specimen and photo.**

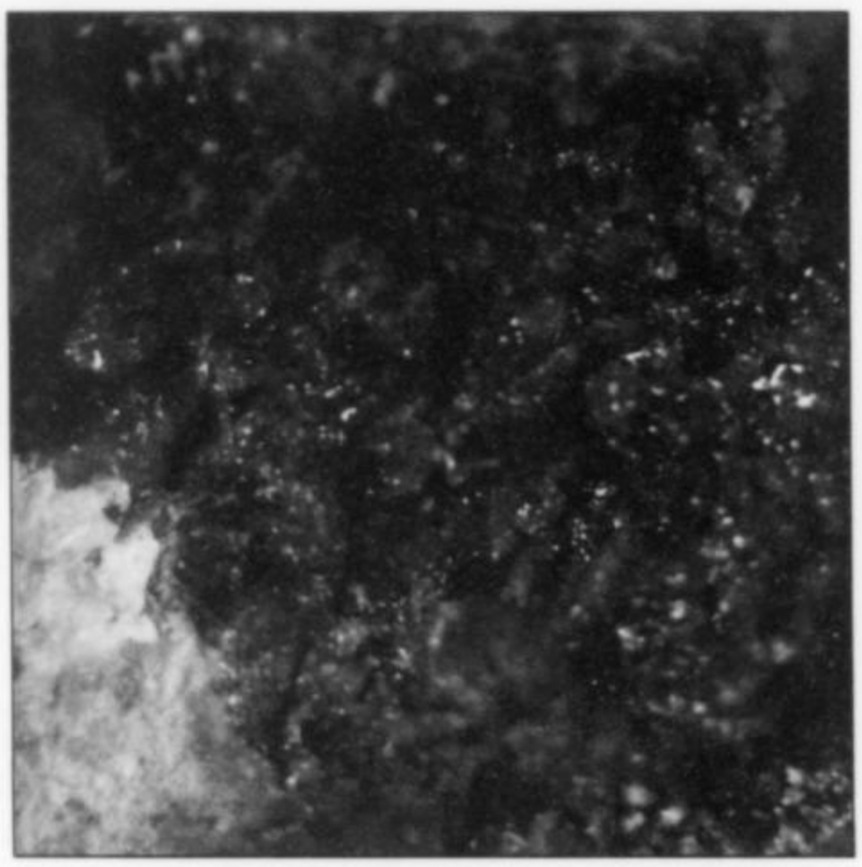


Figure 17. **Zaratite (dark green crusts). Field of view: 1 cm. J. Haupt specimen and photo.**

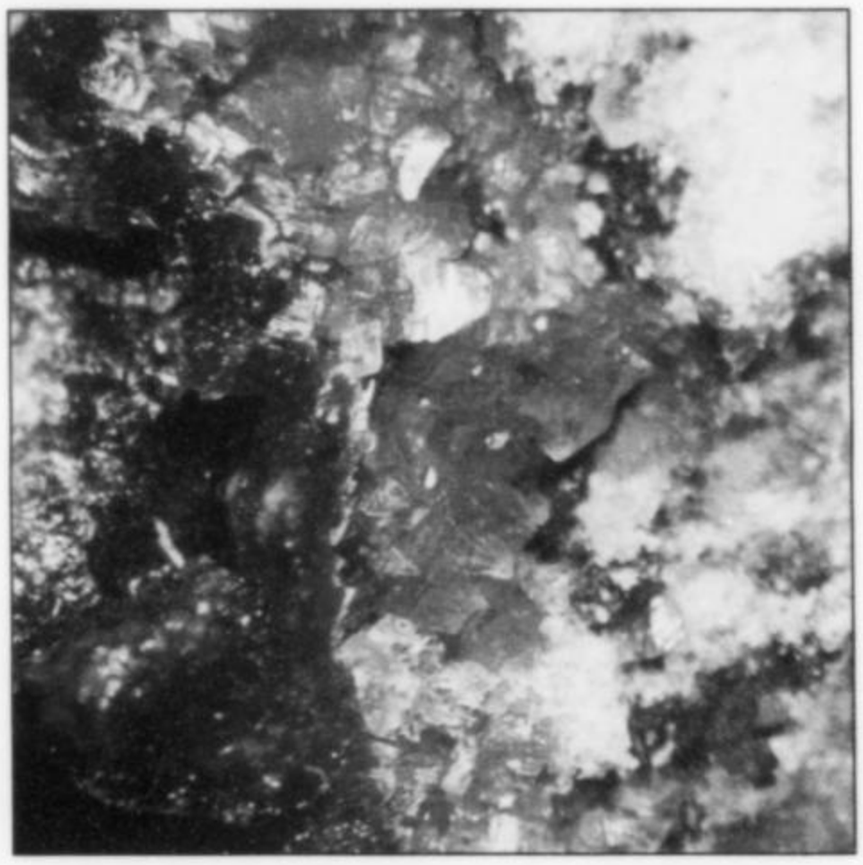


Figure 18. **Zaratite (green crusts) with hellyerite (blue crystals). Field of view 7.3 mm. S. Sorrell specimen and photo.**

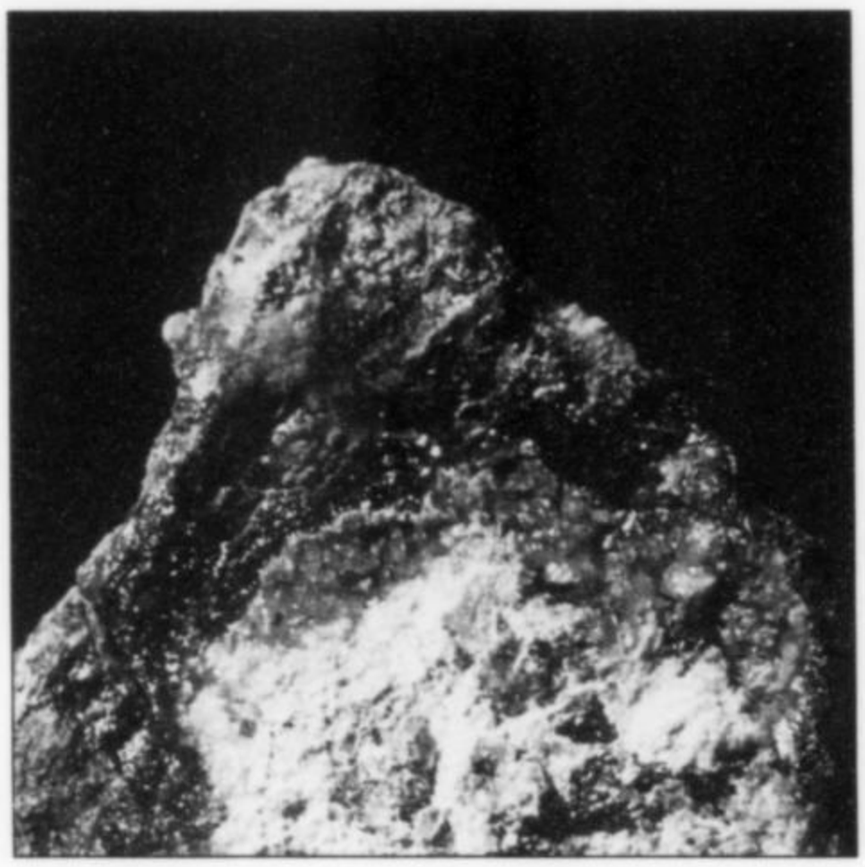


Figure 19. **Zaratite (dark green crusts) with hellyerite (blue crystals). Field of view 10 cm. R. Bottrill specimen and photo.**

examined here, however, is completely amorphous when fresh. Nickel *et al.* (1994) described a similar mineral from Widgiemooltha, Western Australia.

Unnamed nickel-iron sulfate

A fine-grained yellowish olive-green mineral on pentlandite-chlorite-magnetite-andradite-bearing serpentinite has a very similar XRD pattern to the 11Å nickel aluminium sulfate described by Nickel and Clarke (1976), with minor gaspéite. Qualitative electron microprobe analysis, however, indicates an Ni-Fe rather than Ni-Al sulfate.

Unnamed Bi-Ni-Fe-Pt alloy

Reported by Mann (1988).

Unnamed Au-Cu alloy

Auricupride? Reported by Mann (1988).

PARAGENESIS

There are four broad stages of mineral formation evident in the Lord Brassey deposit: magmatic, metamorphic, hydrothermal and supergene alteration. The magmatic stage began with crystallization of the primary minerals in the Cambrian igneous host rocks in layered cumulate magma chambers. These primary minerals probably included enstatite, forsterite, anorthite, augite and chromite, but in the immediate vicinity of the nickel mineralization there are little or no remnants of them.

The primary minerals are now largely altered to mixtures of serpentine, chlorite, amphibole, epidote, garnet, and minor prehnite, magnetite, talc, magnesite, opal and chalcedony, depending on the original rock type and degree of alteration. Most of this alteration is considered to be metamorphic, due to pre-mid-Devonian, possibly Cambrian, greenschist-facies burial metamorphism or emplacement-related metamorphism (Peck, 1990). The common black to green-brown serpentines at the Lord Brassey mine, consisting mostly of lizardite and chrysotile, are typical of this stage of serpentinization of the ultramafics (Peck, 1990).

During the latest stage of Devonian metamorphism, fault-controlled bodies of fibrous and waxy green serpentinite (chryso-

tile and antigorite) were formed due to local metasomatism (Peck, 1990). The nickel mineralization at the Lord Brassey mine appears to be localized within such an antigorite-bearing serpentine body and can be probably be ascribed to this stage (Peck, 1990). Mann (1988) noted the occurrence of calcic metasomatism (forming garnets) and talc-magnesite veins in the area, which he relates to fluids from Devonian granites, postdating serpentinization. The occurrence of molybdenite in these nickel ores is also good evidence for introduction of granitic fluids, although molybdenite may also form in ultrabasic rocks due to assimilation of black shales (Peltonen *et al.*, 1995). The diopside veins are probably also connected to this granite-related metasomatism.

Ramdohr (1969) considered awaruite to be typically formed in ultrabasic rocks during or following metamorphism, at <200°C, by reduction of iron in magnetite, possibly by hydrogen released during serpentinization (hydration of olivine to produce serpentine, hydrogen and magnetite). Dick (1974) noted the occurrence of awaruite with andradite, magnetite and serpentine in shear zones in the Josephinite Peridotite. He related the formation of awaruite to the reduction of iron and nickel from magnetite and silicates by overprinting igneous fluids, and considered the alteration of magnetite to andradite to be particularly important in its formation. Similar reactions are seen at the Lord Brassey mine.

Heazlewoodite was considered by Ramdohr (1969) to be of probable hydrothermal origin, perhaps by oxidation of pentlandite (a reaction not supported by textures seen in this study). The banded awaruite-heazlewoodite-magnetite-andradite-pyrrhotite intergrowths observed here suggest formation through the alteration of magnetite by fluctuating, low-temperature, highly reducing and weakly sulfidic fluids.

The alteration of magnetite to andradite, awaruite and heazlewoodite thus indicates the late, probably granite-related, nature of the mineralization, as opposed to the magmatic source proposed by Williams (1958). The nickel may derive from a trevorite component in the magnetite, but originally probably resided in olivine and enstatite; ultrabasic rocks usually contain few sulfides except where contaminated by assimilated sulfidic sediments.

Weathering and supergene alteration is relatively recent, due to exposure by Pleistocene glaciation and subsequent rapid erosion, and may be post-mining in part. The rarity of iron sulfides in the lode resulted in relatively slow oxidation of the ores under relatively alkaline conditions, with little gossan formation (Thornber, 1985). Most of the heazlewoodite appears to have reacted with carbonate-rich groundwater to form hellyerite, which has now largely dehydrated to zaratite. Dypingite formed in areas with higher Mg/Ni in the waters. Reevesite is rarer and appears to derive from reaction of carbonate-rich waters with nickel and ferric iron released from the oxidation of awaruite and pentlandite. The retgersite and unnamed Ni-Fe sulfate appear to be rather restricted in distribution, possibly to areas of low water flow. Theophrastite may form from groundwaters of lower carbonate and sulfate content. The supergene mineralogy is buffered by the presence of small amounts of pre-existing (predominantly alkaline) phases, including brucite, pyroaurite, palygorskite, dypingite and magnesite.

When removed from the cold, damp mine environment to areas of lower humidity and/or higher temperature, some samples may deteriorate; samples of hellyerite tend to decay to an amorphous pale green material, probably zaratite, and zaratite itself may recrystallize to otwayite (Henry and Birch, 1992) and other phases (Isaacs, 1963). However, the former reaction may take some years in cool areas like Hobart, and the breakdown of zaratite has not been confirmed even in very old (90+ years?) samples in the mineral collection of the Tasmanian Museum and Art Gallery (Hobart), suggesting appropriate storage may overcome this problem.

The Lord Brassey deposit is interesting to compare and contrast with the Western Australian nickel deposits, particularly Widgiemooltha (132 North) (Nickel *et al.*, 1994). This latter deposit is more highly metamorphosed and altered, and more sulfide-rich, with abundant iron sulfides and minor copper and arsenic as well as the nickel. Despite its present arid climate, weathering there is far older and consequently much deeper and more intense than in Western Tasmania. This has resulted in a well-developed series of supergene zones, with a correspondingly more diverse mineralogy. There are, however, many minerals in common and the more interesting of these include the secondary minerals: gaspéite, otwayite, reevesite, retgersite and zaratite.

The apparent restriction of hellyerite to this one locality (Lord Brassey) is due to two factors: the unusually high Ni/Fe ratio in the sulfide ores, and preservation by the low temperature, high humidity environment. It may occur in other heazlewoodite deposits in cool temperature environments.

COLLECTING

The mine area is now designated as a "fossicking" (field collecting) reserve by the Tasmanian Government, and the rules and restrictions are available from the Registrar for Mines (P.O. Box 56, Rosny Park, Tasmania 7018, Australia). Good specimens of most of the listed minerals are still available from the dumps, particularly zaratite, heazlewoodite and hellyerite.

ACKNOWLEDGMENTS

The authors would like to acknowledge the help which the following people have provided in the preparation of this paper. Our thanks are extended to: Dr. Tony Brown, who improved the geological section; A. Hollick drafted Figure 2; W. Jablonski assisted with microprobe analyses; Richie Woolley assisted with X-ray diffraction; Noel Kemp provided access to the Tasmanian Museum and Art Gallery mineral collection; Dr. Bill Birch and Dermot Henry provided access to the Museum Victoria's mineral collection and a photograph of the otwayite specimen in that collection; Chris Stanley and V. K. Din of the British Museum of Natural History provided microprobe analyses of the awaruite and retgersite samples; John Haupt provided photographs of specimens from his collection and of the Lord Brassey mine; and Steve Sorrell provided photographs and access to his specimens. Pat Sutton provided help in proofreading one of the earlier drafts and his constructive criticism was greatly appreciated.

REFERENCES

BERRY, R. H., and CRAWFORD, A. J. (1988) The tectonic significance of Cambrian allochthonous mafic/ultramafic complexes in Tasmania. *Australian Journal of Earth Sciences*, **35**, 523–534.

BROWN, A. V., and JENNER, G. A. (1989) Geological setting, petrology and geochemistry of Cambrian boninite and low-Ti tholeiite lavas in western Tasmania. *In: Boninities and Related Rocks* (ed. A. J. Crawford). Unwin Hynman, London, 232–263.

BURRETT, C. F., and MARTIN, E. L., (1989) *Geology of Tasmania*. Geological Society of Australia, Special Publication 15, 182–237.

CARTHEW, S .J., and BELLAIRS, P. G. (1988) Heazlewood Prospects, NW Tasmania. EL 21/35. Unpub. Rept. for Metals Expl. Ltd. [88-2876].

COLLINS, P. L. F., and WILLIAMS, E. (1986) Metallogeny and tectonic development of the Tasman Fold belt system in Tasmania. *Ore Geology Reviews*, **1**, 153–201.

DICK, W. J. B. (1974) Terrestrial nickel-iron from the Josephinite Peridotite; its geological occurrence, associations and origin. *Earth and Planetary Science Letters*, **24**, 291–298.

FAUST, G. T., FAHEY, J. J., MASON, B., and DWORNIK, E. J. (1960) Pecoraite, nickel analogue of clinochrysotile, formed in the Wolf Creek meteorite. *Science* (165), 59–60.

FORD, R. J. (1970) A hydrogarnet from Tasmania. *Mineralogical Magazine*, **37**, 942–943.

FORD, R. J. (1981) Platinum group minerals in Tasmania. *Economic Geology*, **86**, 498–504.

HALL, P. (1988) New mineral species from Australia—the first 200 years. *Australian Mineralogist*, **3**, 37–40.

HAUPT, J. (1988) Minerals of Western Tasmania. *Mineralogical Record*, **19**, 381–388.

HENRY, D. A., and BIRCH, W. D. (1992) Otwayite and theophrastite from the Lord Brassey Mine, Tasmania. *Mineralogical Magazine*, **56**, 252–255.

HUGHES, T. D. (1957) McCormick-Miller nickel prospect. Tasmanian *Department of Mines, Technical Rept. No.* **2**, 106–109.

HUGHES, T. D. (1965) Nickel mineralisation of Tasmania. *Geology of Australian Ore Deposits*, **1**, 523–524. (Eight Commonwealth mining and metallurgical congress).

ISAACS, T. (1963) The mineralogy and chemistry of the nickel carbonates. *Mineralogical Magazine*, **33**, 663–678.

LANCASTER, K. (1975) Corinna and the North Pieman Country of Tasmania. *Australian Gems and Crafts Magazine, No.* **10**, 50–53.

LIVINGSTONE, A., and BISH, D. L. (1982) On the new mineral theophrastite, a nickel hydroxide, from Unst, Shetland, Scotland. *Mineralogical Magazine*, **46**, 1–5.

MACROPOULOS, T., and ECONOMOU, M. (1981) Theophrastite, $Ni(OH)_2$, a new mineral from northern Greece. *American Mineralogist*, **66**, 1020–1021.

MANN, B. (1988) The geology of Brassey Hill. The nature and genesis of nickel mineralization in the Heazlewood River Complex. Unpub. BSc (hons.) Thesis, Univ. Melb.

NAWAZ, R. (1973) Nickel hexahydrite from Tasmania, Australia. *Mineralogical Magazine*, **39**, 246–247.

NICKEL, E. H., and CLARKE, R. M. (1976) Carrboydite, a hydrated sulphate of nickel and aluminium: a new mineral from Western Australia. *American Mineralogist,* **61**, 366–372.

NICKEL, E. H., CLOUT, J. F. M., and GARTRELL, B. J. (1994) Secondary minerals from Widgiemooltha, Western Australia. *Mineralogical Record*, **25**, 283–292.

NICKEL, E. H., ROBINSON, B. W., DAVIES, C. E. S., and McDONALD, R. D. (1977) Otwayite, a new nickel mineral from Western Australia. *American Mineralogist*, **62**, 999–1002.

PEACOCK, M. A. (1947) On heazlewoodite and the artificial compound Ni_3S_2. *University of Toronto Studies*, Geol. Ser., No. **51**, 59–69.

PECK, D. (1990). Platinum-group element geochemistry and petrogenesis of the Heazlewood River mafic-ultamafic complex, Tasmania. Unpublished PhD thesis, Univ. Melb.

PECK, D. C., and KEAYS, R. R. (1990) Geology, geochemistry and origin of platinum-group element-chromitite occurrences in the Heazlewood River Complex, Tasmania. *Economic Geology*, **85**, 765–793.

PELTONEN, P., PAKKANEN, L., and JOHANSON, B. (1995) Re-Mo-Cu-Os sulphide from the Ekojoki Ni-Cu deposit, SW Finland. *Mineralogy & Petrology*, **52**, 257–265.

PETTERD, W. F. (1910; revised 1969) *Catalogue of the Minerals of Tasmania*. Geological Survey Record No. 9, Tasmania Department of Mines.

RAMDOHR, P. (1969). *The Ore Minerals and Their Intergrowths.* Pergamon, Oxford.

REID, P. B. (1921) Osmiridium in Tasmania. *Geological Survey of Tasmania Bulletin*, **32**.

RUBENACH, M. J. (1973) The Tasmanian ultramafic-gabbro and ophiolite complexes. Unpub. Ph.D. thesis, Univ. Tasm. 213 p.

SAINI-EIDUKAT, B., KUCHA, H., and KEPPLER, H. (1994) Hibbingite, γ-$Fe_2(OH)_3Cl$, a new mineral from the Duluth Complex, Minnesota, with implications for the oxidation of Fe-bearing compounds and the transport of metals. *American Mineralogist*, **79**, 555–561.

SOLOMON, M. (1965) Geology and mineralization of Tasmania. *Geology of Australian Ore Deposits*, **1**, 464–477. (Eighth Commonwealth mining and metallurgical congress).

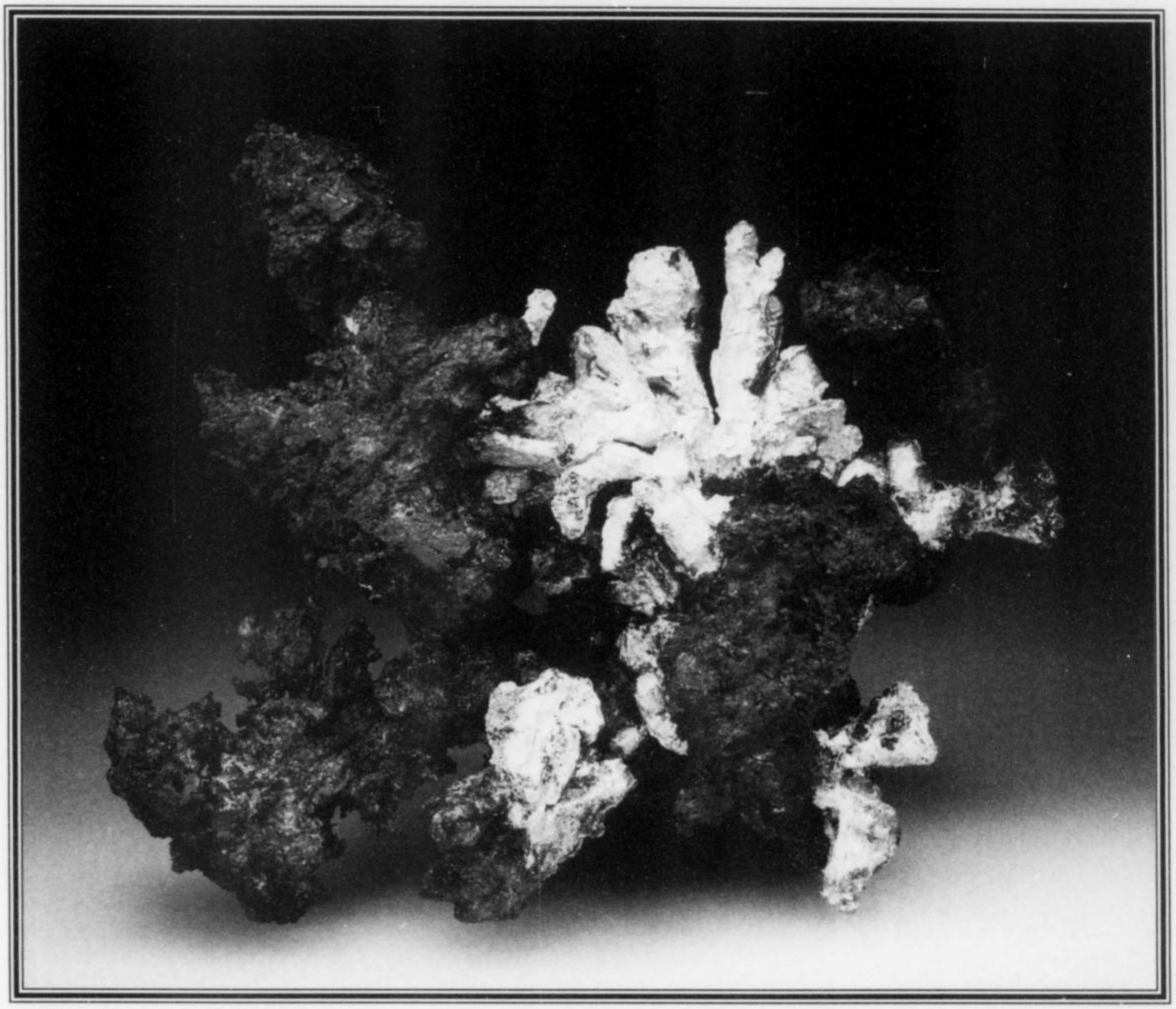
THORNBER, M. R. (1985) Supergene alteration of sulphides. VII. Distribution of elements during the gossan-forming process. *Chemical Geology*, **53**, 279–301.

TWELVETREES, W. H. (1900) Report on the mineral fields between Waratah and Corinna. Unpublished Report, Secretary for Mines, Tasmania, [OS 158].

WILLIAMS, K. L. (1958) Nickel mineralisation in Western Tasmania. *Proceedings of the Australian Institute of Mining and Metallurgy*. Stillwell Anniversary Volume, 263–302.

WILLIAMS, K. L., THREADGOLD, I. M., and HOUNSLOW, A. W. (1959) Hellyerite, a new nickel carbonate from Heazlewood, Tasmania. *American Mineralogist*, **44**, 533–538.

WRIGHT, J. H. (1990) Mount Bischoff Tin Deposit. *In: Geology of the Mineral Deposits of Australia and Papua New Guinea* (ed. F. E. Hughes). Australasian Inst. Mining & Metallurgy, Monograph 14. pp. 1185–1189.



William Severance Collection

Jeff Scovil Photo

Silver and copper, 14.9 cm

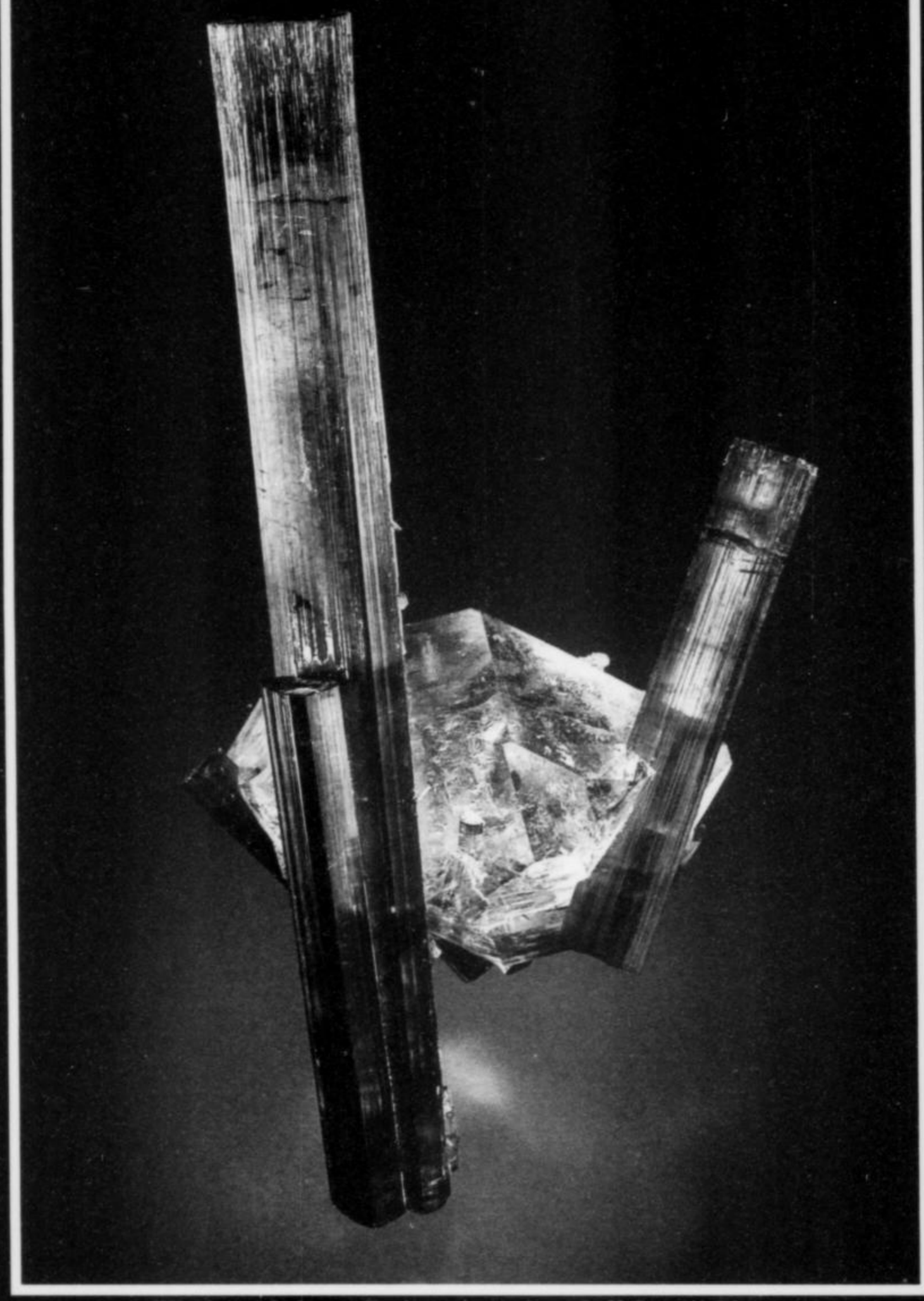
Kearsarge Mine, Kearsarge Amygdaloid Lode
Calumet, Houghton County, Michigan

from the collection of Lincoln Ellsworth (1880–1951)

PEDERNEIRA MINING, *Inc.*

450 N Granada,
Tucson, AZ 85701

Our firm is working around the clock exclusively mining the world-renowned Pederneira tourmaline mine. Pederneira Mining is held and owned by both the owners of the mine in Brazil and by Fine Minerals International Inc. in the U.S. We are working together, using the latest mining techniques to bring direct from the source to the collector the finest tourmaline crystal specimens obtainable.



Elbaite, 10.6 cm, Pederneira mine. Jeff Scovil Photo.

Fine Minerals Int'l—U.S.
c/o DeTrin Fine Minerals
14-52 128th Street
College Point, NY 11356

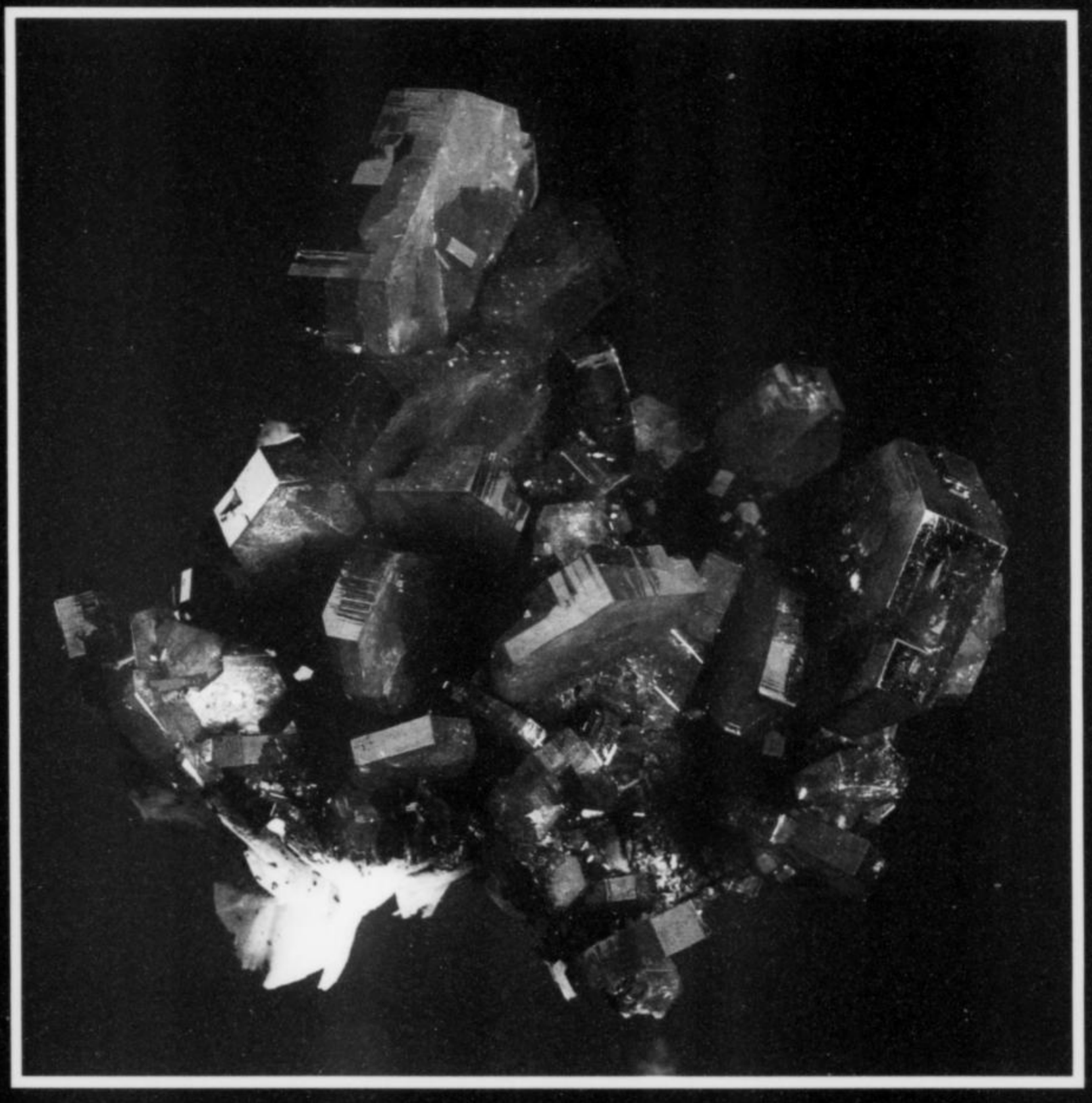
Contact:
Daniel Trinchillo, Jr.
Tel: (917) 295-7141
Fax: (718) 461-1874
danieltr@ix.netcom.net

Fine Minerals Int'l—Germany
c/o Marcus Budil Minerals
Raiffeisen Strasse 14
D-83607 Holzkirchen, Germany

Contact:
Marcus Budil
Tel: 49-8024-608070
Fax: 49-8024-608071
info@wohndesign.net

Gem Crystal MASTERPIECES

450 North Granada, Tucson, Az 85701



Vanadinite, 5.2 cm, Mibladen, Morocco. Jeff Scovil Photo.

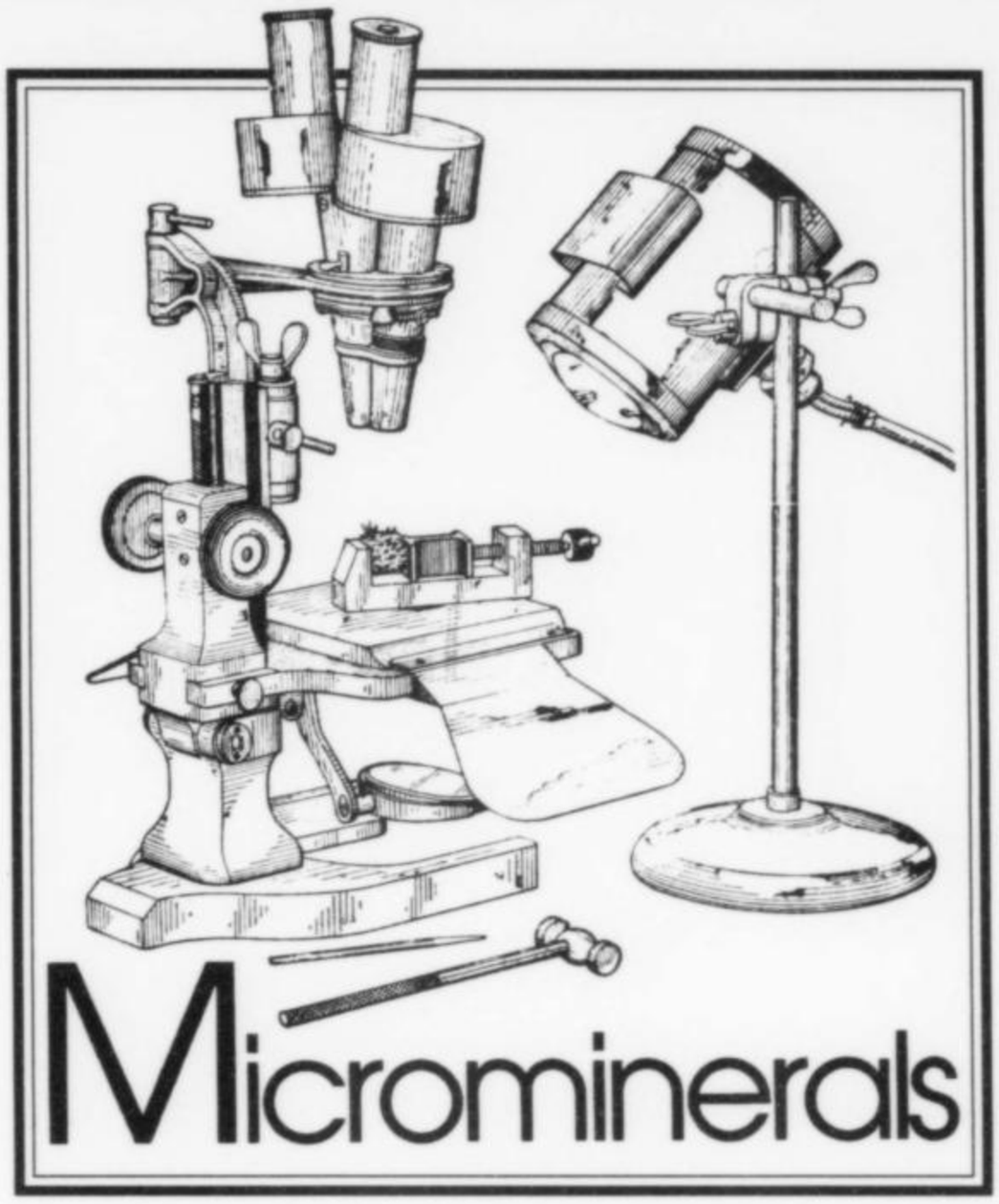
Providing the finest specimens available for discerning collectors. Worldwide mineral specimens, specializing in China and Brazil. State-of-the-art cleaning and trimming services @ US$100 to US$150 per hour. Professional and discreet, with fast turn-around time. Highest market values paid for fine collections or specimens.

Fine Minerals Int'l—U.S.
c/o DeTrin Fine Minerals
14-52 128th Street
College Point, NY 11356

Contact:
Daniel Trinchillo, Jr.
Tel: (917) 295-7141
Fax: (718) 461-1874
danieltr@ix.netcom.net

Fine Minerals Int'l—Germany
c/o Marcus Budil Minerals
Raiffeisen Strasse 14
D-83607 Holzkirchen, Germany

Contact:
Marcus Budil
Tel: 49-8024-608070
Fax: 49-8024-608071
info@wohndesign.net



by Quintin Wight

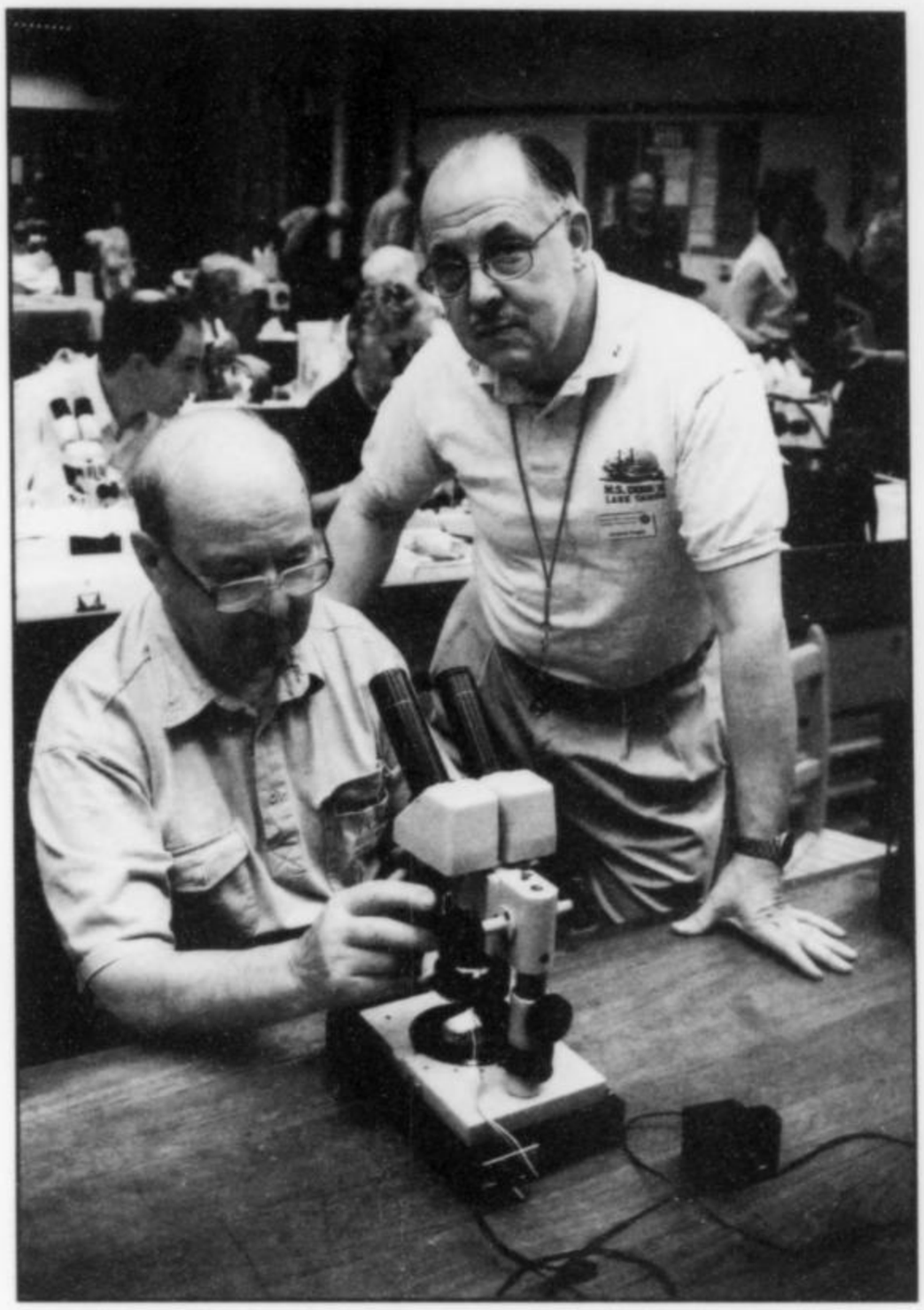


Figure 1. **Doug Morgan of the British Micromount Society (seated) and his home-made lighting system for the microscope.**

LIGHTS

Travel can be illuminating. I discovered that recently in England at the University of Leicester, where the British Micromount Society (BrMS) members hold their annual symposium. The British have always had the reputation of being experimenters, and one of the BrMS members, Doug Morgan, illustrates that to perfection. One of the biggest problems facing micromounters, especially beginners, is light. Good lights are very expensive. Furthermore, they require power. Just check the miles of cable snaking everywhere at a micromount meeting. Doug Morgan thought about that.

At the symposium (Fig. 1), Doug invited me to look at his microscope. It had a black ring-light housing surrounding the lens. The odd part was that there were thin wires from the ring-light disappearing into what looked like a black-painted cigar box under the microscope. I had a look through the scope. The light was as bright as one could want, although it had an unusual blue tinge. Doug flipped a catch and swung the whole microscope over on its side, opening the box beneath. It had another aluminum housing underneath to provide transmitted light. It was also rigged up to provide power either from a small plug-in transformer or three "C" cells, providing 4.5 volts. There was a switch to change from one to the other as necessary. What microscope illuminator runs on three "C" cells? Doug Morgan's does—and those three batteries will last a long time.

So—what's his secret? White high-intensity light-emitting diodes (LEDs). These fancy LEDs provide light at 8,000°K, which lies toward the blue end of the spectrum. The thing is that they provide a lot of it, and that they use very little power. Doug estimates that his battery pack of three "C" cells will last a couple of years in ordinary use. Think of what that can mean to a traveling micromounter: no more worrying about whether plugs will fit; no more wondering if cables will be long enough: no more searching for an unoccupied outlet, no more worrying about 50 Hz versus 60 Hz. In short, total portability. The bluish light will be a little off for photography, but filters will take care of that. Doug's system provides incident, oblique, transmitted, and polarized light, and is a real boon for the traveling micromounter.

Doug's work on this light was inspired by a design of Douglas H. Laycock, reprinted from the *Balsam Post* newsletter of the Postal Microscopical Society in England.

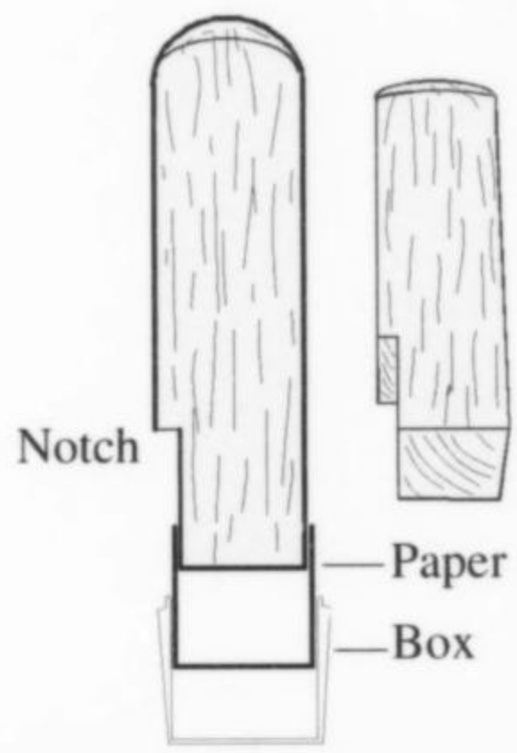


Figure 2. **Bill Hunt's tool for inserting paper liners in a micromount box.**

BOX LINERS

In an earlier issue, I spoke of the two crossed strips of black paper used by Hall of Fame member Bill Hunt to line micromount boxes. Bill wrote subsequently to say that he had seen that technique used by the late Frank Leans of Philadelphia. He also sent a very interesting tool for inserting the paper into the box. It is a square oak peg with one dimension the inner width of the micromount box, and the other slightly larger. At one end, the larger dimension is trimmed down to make a fit for the box. The trimmed portion is the exact height of the inner box wall. In use, the top edge of the paper strip is placed against the notch formed by the untrimmed portion, and the rest is folded over the bottom. It is then pushed into the box (Fig. 2). Doing it in this manner ensures that the paper is always at the precise height for a proper fit. One then inserts the second strip at 90° to the first, and the box is lined. The good things are usually simple!

PHOTOMICROGRAPHY

Photomicrography is not easy. Depth of field is always a problem, lighting is difficult, and posing the tiny subject is often a lesson in frustration. For those reasons, micromounters are often tempted to use bellows rather than the microscope. The bellows set-up has provision for a diaphragm to help with depth of field; there is more space for lighting, and one doesn't have to remember which eyepiece should be used for focus. Sadly, a lot of those who try don't succeed, because they have missed one vital point: to be used for photomicrography, the bellows must be equipped with a special photomicrographic lens (Fig. 3). The ordinary macro lenses normally used with the bellows do not provide enough magnification.

Figure 3. **Bellows lens of the type specifically designed for photomicrography.**

Finding such a lens is itself an exercise in frustration. There are very few manufacturers who make them on a regular basis. The one I use myself is a Nikon model, now probably more than 30 years old. It was owned originally by the late Violet Anderson, who used it to great advantage in the photomicrographic work that made her famous among micromounters. Unfortunately, a long internet search for a modern equivalent in the Nikon line proved fruitless. On the other hand, Olympus does still produce a lens suitable for this type of work. Photomicrographer Dan Behnke uses Olympus equipment for his excellent slides. In the long run, the choice for those wishing to try the bellows route is to haunt the outlets for used equipment or to go directly to Olympus.

In either case, it is important to buy the lens first. That's because unless one wants to indulge in a lot of what the British refer to as "bodging," the make of the lens will dictate the make of the bellows, which, in turn, will dictate the make of the camera. I speak from experience, since my Nikon lens and bellows are attached to a Pentax camera. To attach the two, I had to find a reverse adapter designed to attach a lens backwards to the bayonet mount of a Pentax bellows. (In normal bellows work, attaching a 50-mm lens in reverse to the bellows gives better definition. In that use, the adapter screws onto the threaded front of the lens as if it were a filter, then the adapter bayonet fits into the bellows.) Then I bought the faceplate for a Nikon camera as a spare part from Nikon. Finally, I had a machinist friend make a small ring spacer of heavy aluminum. On one face, he threaded on the reverse adapter; on the other, he mounted the faceplate for the Nikon camera. Now I had an adapter that looked at one end like a Pentax lens, and at the other like a Nikon camera. It connects the Pentax camera and Nikon bellows very nicely. Why didn't I just buy a Nikon camera? Well, I already had a professional Pentax. To get the equivalent performance in a Nikon would cost me $1,000 or more. The whole adapter, complicated as it may sound, set me back about $50.

One must also remember that any camera bought for photomicrographic work is going to be expensive. That's because of the features required. Some of those features can be found in less expensive cameras, but others can't. Things such as the requirement for an aperture-preferred capability and automatic long exposure are obvious. Others, such as the capability for mirror lock-up to prevent jarring during shutter release are less so. The two least thought-of features, however, are the necessity for interchangeable focusing screens and the requirement for a right-angled viewfinder.

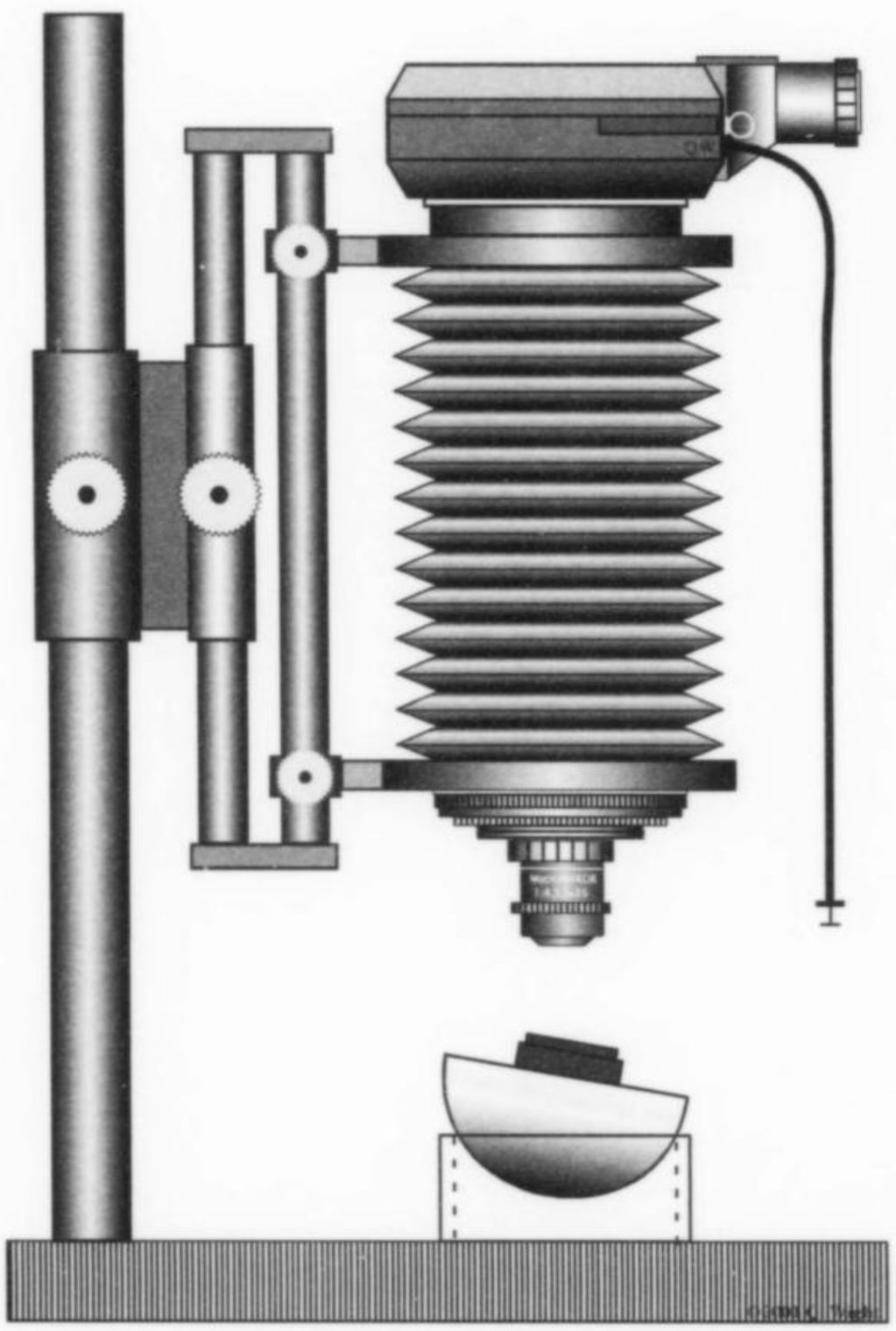


Figure 4. **Bellows arrangement with lens in place and an interchangeable right-angle viewfinder assembly attached.**

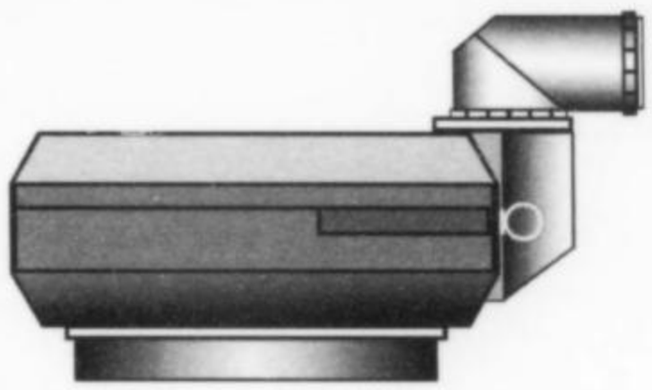


Figure 4. **For cameras lacking an interchangeable viewfinder assembly, a right-angle viewfinder attachment can be mounted in the eyepiece as shown.**

Forget about photomicrography with a standard split-image focusing screen. It can be done, but it's annoyingly difficult. Photomicrography requires a matte focusing screen. That, in turn, means that the camera must be capable of accepting different focusing screens. Again, while it is possible to use the standard eye-level viewfinder for focusing on the specimen, it means that the bellows arrangement must be near floor level, or one must stand on a stool or ladder and bend over to peer through the viewfinder. The answer is to use a right-angled viewfinder. That allows the bellows to be positioned comfortably on the desk top while one looks straight ahead through the viewfinder. Cameras with interchangeable viewfinder capability are expensive, as are the interchangeable viewfinders themselves. It is best to buy a camera in which the entire viewfinder housing simply slips off for replacement (Fig. 4). Failing that, some manufacturers make a right-angled prism attachment that slips into the guides at the rear of a fixed viewfinder, and gives the same effect (Fig. 5).

Finally, the ultimate answer is *light*. Bellows photomicrography, like any other kind, needs really strong light. I use as many as six illuminators at a time. Four of them use fiber-optic light guides, one uses a quartz-halogen projector lamp, and one is a standard Nicholas. Their total output is in the region of 450 watts. Sometimes that still isn't enough.

DIGITAL PHOTOMICROGRAPHY

Time, of course, stands still for no one. It may be some years before digital photography catches up to regular 35-mm slides in terms of resolution, but it is already doing very well compared with print film. In an earlier column, I recommended the AFM site, *www.micromineral.org*, as a source of references for digital work. Now I would like to suggest another, related site: *www.micromineral.org/Debutants/photonum/photodigit-uk.html*. This site is basically a set of links that lead to basic information, sources of equipment, techniques, and so on. Things are getting better all the time.

Quintin Wight
525 Fielding Drive
Ottawa, Ontario K1V7G7
qwight@sympatico.ca

CALIFORNIA DEALERS

Attard's Minerals
John & Kathy Attard
P.O. Box 17263
San Diego, CA 92177
Tel: (619) 275-2016
www.attminerals.com

The Arkenstone
Rob & Bailey Lavinsky
P.O. Box 12801
La Jolla, CA 92039
Tel: (858) 587-1141
www.thearkenstone.com

Coogan Gold Company
Ed and Kay Coogan
P.O. Box 1631
Turlock, CA 95381
Tel: (209) 634-5222
Micromounts, TN's, Min., Cab.

Si and Ann Frazier
Si and Ann Frazier
Suite 306, 6331 Fairmont Ave.
El Cerrito, California 94530
Fax: (510) 558-8486
e-mail: siannfraz@aol.com

Gemini Minerals
Joe & Susan Kielbaso
P.O. Box 70062
San Diego, CA 92167
Tel: (619) 223-0620
FAX: (619) 223-0385
E-mail: geminiminerals@home.com
We buy collections

Cal Graeber Minerals
Cal and Kerith Graeber
P.O. Box 2347
Fallbrook, California 92088
Tel: (760) 723-9292
By Appointment Only

Jewel Tunnel Imports
Rock H. Currier
13100 Spring Street
Baldwin Park, CA 91706-2283
Tel: (626) 814-2257
FAX: (626) 338-4617
Wholesale Only

Kristalle
875 North Pacific Coast Hwy.
Laguna Beach, California 92651
Tel: (949) 494-7695
E-mail: leicht@kristalle.com
WEB: http://www.kristalle.com

Debbie Meng's Minerals
Debbie Y. Meng
P.O. Box 8393
Monterey, CA 93943
Tel: (831) 484-7418,
Fax: (831) 484-7419
E-mail: debbie_meng@usa.com
Specialty: Fine Chinese Minerals

Pala International & The Collector
912 So. Live Oak Park Road
Fallbrook, California 92028
Tel: (760) 728-9121
US Wats 1-(800)-854-1598

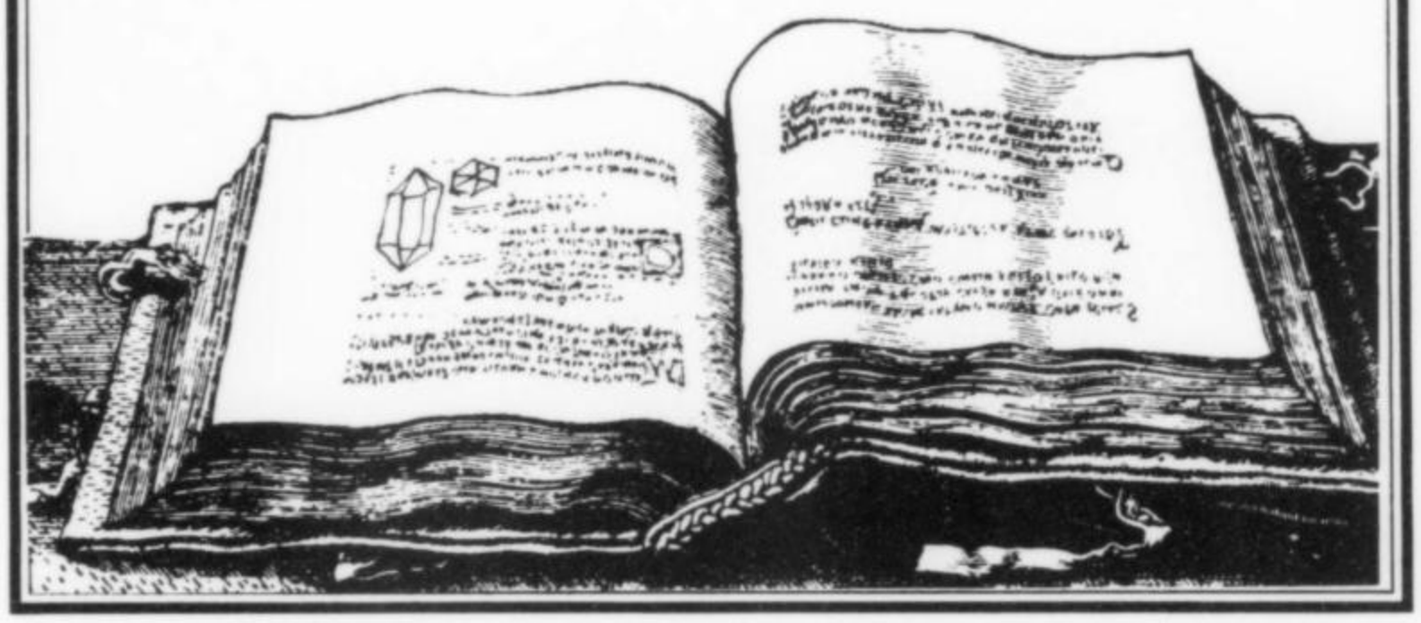
Steve Perry Minerals
P.O. Box 136
Davis, California 95617
Tel/Fax: (530) 753-7861
e-mail: steve@steveperrygems.com
website: steveperrygems.com

Bruce & Jo Runner Minerals
13526 South Avenue
Delhi, California 95315
Tel: (209) 634-6470
Micromount List $2
Showroom by Appt. only

Andy Seibel Minerals
Andy Seibel
P. O. Box 2091
Tehachapi, CA 93581
Tel: (661) 823-8091
www.andyseibel.com

Silverhorn
Mike Ridding
1155 Coast Village Road
Montecito, California 93108
Tel: (805) 969-0442

Book Reviews



Murzinka

By Valentina I. Popova, Vladimir A. Popov, A. Kanonerov. Editor Igor V. Pekov, Mineralogical Almanac, Volume 5, 2002 (www.webcenter.ru/~minbooks).

Volume 5 of *Mineralogical Almanac*, the Murzinka issue, does not describe the Murzinka pegmatites or hydrothermal quartz veins but rather the most important mines of the Alabashka Pegmatite Field, Murzinka region. On page 3 the authors explain that specimens from this field have historically been labeled simply "Murzinka" rather than "Alabashka (Granitic) Pegmatite Field, Murzinka"; the publisher has chosen "Murzinka" as the book's title simply because this well-known name so often appears on Alabashka specimen labels in collections. The Alabashka Pegmatite Field is a few kilometers north of the village of Murzinka, but is topographically and geographically somewhat separated from the pegmatites that are clustered around Murzinka.

The issue is the finest of the recent softcover Mineralogical Almanac publications, not only because its superb photography and printing quality are much better than in previous issues, but even more importantly because its text, written by dedicated experts in the field, is very detailed and thorough.

The introduction is short and easily read. Perhaps a small-scale map pointing out the location of the Urals in Russia could have been provided, but three good maps do show the region's location within the Urals, and pinpoint specific mines of the Alabashka Pegmatite Field. However, one caption reads "Scheme showing location of mines in the Murzinka region," and this is incorrect, since the Murzinka region really covers a much vaster area to the south.

Included in the introduction is also a table covering twelve of the Alabashka Granite pegmatites and the minerals which have been found in the respective mines, and indicating each mineral's abundance in volume or weight percent. This reviewer, having studied the veins and dumps in the field, has the impression that some of the species are, in fact, less abundant than noted in the table. For example, the table notes beryl as being 1% to 10% of the material in five of the veins, but in none of the four veins out of the five that I have visited have I seen any signs suggesting a beryl content of even 1%. The Kazennitsa mine has produced a few kilograms of gem or specimen-quality beryl for each several thousand cubic meters of rock, albeit there were locally numerous beryl segregations around pockets in the frozen zone. I strongly doubt that the mined part of the vein would have yielded dozens of tons of beryl. Another example is the Staraja Mylnitsa mine, where, as noted on page 58, 2.8 kg of pocket beryl were recovered during recent work in 1987–1991—not much in terms of bulk percentage! Instead of 1–10% beryl as stated in the table, a figure of 0.1% beryl or less should probably be substituted; this beryl is localized in pockets and frozen in pocket-rich zones of the pegmatites. Rarely, a couple of kilograms have been found in large pockets, such as pocket 133, encountered in 1990 at a depth of 14 meters in the Staraja Mylnitsa mine.

Topaz is noted as constituting 10% to 20% of the Mokrusha vein. This may be true for parts of the topaz-horizon pocket zone (the upper pocket zone) which were extremely rich in topaz and also rather rich in lepidolite: 1200 kg of topaz were produced during a few years of operation of the Mokrusha vein. However, a figure of 10% to 20% is not plausible for the vein as a whole, including the lower two pocket zones; one of these zones only very rarely yielded topaz, and the other carried no gem species. Most of the accessory minerals are moderately to very rare.

Indeed, the percentages given for all species in the table for the Mokrusha vein add up to more than 121%, counting the minimum percentage given for each species, and excluding the rare ones. Nevertheless, the list gives a good proportional idea of the mineralogy of the 12 veins, and it certainly conveys the richness of the Mokrusha vein in rarer species.

The Kazennitsa vein comes in a close second to the Mokrusha in species diversity, perhaps because it was the last vein to be actively worked (until November 1993), and provided much material for study at the mining company and on the small dumps before they could be overgrown. In general it must be said that accessory species are quite rare in the Alabashka pegmatites, in comparison with other well-known pegmatite districts of the world.

Perhaps it would have been better to place this table at the start of the geology or mineralogy section, rather than in the Introduction.

The first chapter of the main text, "History of Exploration and Mining," is 19 pages long, and is ushered in by photographs of fine and typical Alabashka topaz and beryl specimens. The chapter is illustrated further with pictures of old documents, mine workings, and people, includ-

ing two of the best known miners of the Alabashka Field, Kraushkin and Orlov/Yuzhakov. The type of hoist illustrated on page 19 was still being used in the 1980's in the Adui district. Six more color photographs of specimens are offered, with detailed information in their captions, and there are good photographs of the Kazennitsa headframe and the Murzinka Museum.

It is regrettable that the names of the miners pictured on page 27 have been omitted; such personal names are never superfluous, and should, for historical reasons, be preserved. The man to the left is probably Vladimir P. Dyomyochkin, the miner who found several very important pieces, including the aquamarine on this book's cover, which he collected on November 12, 1992 from pocket number 4 at a depth of 28 meters in the Kazennitsa mine.

The picture caption on page 28 is lacking the information that it was geologist Sergei Borschev who collected the famous Pobeda topaz at 28 meters depth in the Mokrusha mine in 1985. At one point during the removal process, the specimen was poised to drop out of the pocket, and Sergei, standing below, stopped its fall with his hand and mouth, thus losing several of his front teeth. We all owe gratitude to these miners and geologists for conserving the specimen-wonders of nature during mining operations.

All of these well-chosen pictures accompany an adequate text, which could, of course, have been even richer in information, but which provides a good, clear summary of the history of the Alabashka field. The account of past and recent explorations of the field is anchored by well-chosen citations from Ihrmann, Fersman, Shaskolskaya and several hard-to-find old documents in the Russian State Archives in Ekaterinburg (Sverdlovskaya Oblast). It is clear that the authors have spent much more time searching old archives and literature for each part of this chapter than the size of the chapter suggests, and for this the reader can be most thankful to them. One very important source has been the book *Miarolitic Pegmatites of the Urals,* written in Russian by the now-deceased Professor Anatoly Stepanovich Talantsev, dealing with the geology of all the gem-carrying miarolitic pegmatite areas of the Urals, excluding the Ilmen/Miass area. We hope that the authors of the present book will consider publishing a monograph on the famous Ilmen pegmatites as well.

The next chapter, "Geological Review," is a five-page summary of the local geology, with a simplified geological map of the Alabashka vein field.

Chapter 4, "Pegmatites, Morphology and Structures," is an exceptionally well-illustrated and up-to-date presentation of eight of the most important granitic pegmatites of the Alabashka field. The descriptions are very thorough, and the geological cross-sections are excellent. Several very fine photographs of mineral samples, field views, and rare underground scenes add to the beauty of the chapter. Note that the heliodor crystal from the Mokrusha mine, illustrated on page 39, is associated with a tourmaline-group mineral, probably elbaite.

Perhaps it should have been pointed out that the Golodnaja mine is *very* famous for deep golden-colored heliodor crystals; a photograph of a specimen would have been nice to see. The famous Startseva Yama beryl found in 1828 (mentioned as 1824 on page 91 of the text) is illustrated on page 49. A more recent picture would have been welcome, and although the text says that this beryl can be seen in the Mining Institute, it is not on display there, but has long since been "locked up in a safe place."

An accurate and very valuable cross section of the Kazennitsa Pegmatite, showing local mineralization, is found on page 56. Small concentrations of beryl and topaz were found in two sections of the vein, whereas its middle part was almost completely barren of pockets and gem species. From a collector's point of view it is a pity that pockets containing gem species are generally not illustrated.

There are a few small errors in the text and figure captions in this chapter. What is called "almost colorless amethyst like" from the Bolshaya Tyazhelovesniy mine would be better called very pale, almost colorless amethyst overgrowths. "*Rauchtopaz*," a German term meaning smoky topaz, should have been corrected to "smoky quartz." On page 43 there is a drawing of a topaz mined in 1825, purportedly the same specimen as is shown in a color photograph, but it is hard to reconcile the drawing with the photograph. The dimensions given ("25 x 27 cm") for the clear blue topaz crystal pictured on page 47 are incorrect; according to editor Igor V. Pekov, the dimensions of the crystal are actually 7 by 10 cm. Please note, though, that very large topaz crystals have indeed been encountered in the Mokrusha mine—the large Pobeda specimen on page 28 and 29, for instance. Another large crystal is in the Museum of Natural History in Milano (several cleavages of one large, blue, translucent crystal). Topaz crystals already broken in the pocket, with diameters of 15 cm or more, were not uncommonly encountered during recent work in 1976 and 1985 (reviewer's collection). Although this book perhaps does not make it sufficiently clear, the fact is that 99.99% of all fine blue topaz from "the Urals" is from the Mokrusha vein; other topaz occurrences in the region are negligible by comparison. The beryl spray from the Starzeva Yama mine was collected 1.5 meters under the turf during exploratory digging in 1991, not in 1993 as noted (page 51). It is not entirely clear what the authors mean in the last sentence on page 57, describing the Kazennitsa mine: "This was a first steep-dipping vein whose druse material does not exceed in beauty the lumps of Mokrusha."

I will note here that several fantastic beryl specimens were found in the Kazennitsa mine; they are probably better than most of those that have been found in the Mokrusha mine during recent operations. As already mentioned, one of these Kazennitsa mine beryls is shown on the cover of the book. It is a 15.6-cm aquamarine crystal weighing 950 grams, appearing blue in daylight and greenish blue to green in incandescent light. A couple of fabulous heliodor crystals (one on smoky quartz), a flawless electric-green "aquamarine" beryl, and a 23.5-cm, doubly terminated green "cat's-eye" beryl were among other superb finds in the Kazennitsa mine.

When it comes to topaz the Kazennitsa produced some small blue crystals to 3 cm growing on albite, with smoky quartz. These were found in 1991 at the 20-meter level, and one pocket was also found there containing champagne-colored topaz in association with green elbaite (the latter two illustrated on page 55). The Kazennitsa Pegmatite is 2 to 3 meters wide in its central section where mining was conducted, although the central core zone/zones (two parallel core zones exist) reach only 1 to 1.5 meters in width. The two largest pockets found in the Kazennitsa mine measured 4 and 6 meters across and yielded smoky quartz crystals to 45 cm in association with stilbite and albite, but no gem minerals.

One additional comment for this chapter: geologist Sergei Borschev, in the middle of the picture on page 53, is wearing his "good luck outfit," which he was wearing when he found the Pobeda Topaz in 1985, and has worn while collecting ever since.

The book's Chapter 5, the last and most extensive chapter, is "Mineralogy." Please note that, although they are not discussed in the book, the Alabashka area also includes numerous genetically different hydrothermal amethyst veins, as well as other interesting non-pegmatitic mineralization (such as gem corundum in marble and in alluvial deposits).

Specimens of feldspars, micas, beryl and topaz from Alabashka are generously illustrated throughout the book; the mineralogy

chapter also offers many crystal drawings. Each mineral species is very well described as to occurrence, sizes of crystals, and paragenesis with reference to veins. In many cases, extensive chemical analytical data are provided. The authors have made a major effort to describe the crystal forms of the fabulous blue topaz of the Mokrusha vein.

The authors, editors and publisher must be thanked for this chapter's numerous pictures of beautiful crystals, many of which clearly show diagnostic morphological features and interesting phenomena such as etching, and for the pictures of specimens of rare species. The real rare-mineral freak (including this reviewer) will want to see pictures, including SEM pictures, of each rare species, but it is understandable that limitations on production costs and on the final sale price had to be taken into account.

Foitite from the Kazennitsa mine has previously been described by this reviewer and Frank Hawthorne; it formed as thin needle-crystals to 8 cm during the very late stage of pocket formation. Foitite crystals are orange-brown to cola colored in incandescent light and purplish brown in daylight. The beryl on lepidolite pictured on page 93 and the hambergite pictured on page 96 were collected by the former geologist of the Mokrusha mine, Igor Gurkov.

The "Mineralogy" chapter concludes with a detailed sequence of formation for the main minerals of the Mokrusha vein, and a reproduction of Wendell E. Wilson's fascinating painting, "The Czar's Pocket, Mursinka 1915." This is, of course, a fantasy painting as no such pocket is known to have been discovered in 1915, although very large topaz crystals (weighing up to 30 kg) were discovered in 1911 at Mokrusha, and a large pocket with 800 kg of gem aquamarine was discovered in 1930 at the Semenichinskaja mine in the Adui Pegmatite Field (not described in this book) to the south, in addition to the pocket of 1899–1900 which yielded 500 kg of aquamarine.

At the end of the book there is a valuable glossary of Russian names of Alabashka Pegmatite-related words, with their equivalents in English. There is also an extensive reference list with many rare and hard to find references, although some which perhaps should have been included are missing. Finally, there is an index of minerals, with references to page numbers both for descriptions and photos.

The layout of the book is very attractive, the text format easy to read, and only a few minor flaws have escaped the editing process. All informational contents have been very thoroughly researched. In summary, this is an excellent book, the best one ever written about the Alabashka Pegmatite field in a mineralogical and geological context. Its richness of illustrations—colored drawings, geological maps and cross sections of veins, and numerous and lovely mineral photographs—adds to its impressiveness.

The book is highly recommended for anyone interested in mineralogy or geology, and it is absolutely a must-have for anyone seriously interested in classical deposits, Russian mineralogy or history, or pegmatites. The gemologist will also benefit from this publication, although there are no gem-production statistics. Unfortunately, most of the beautiful beryl and topaz crystals produced in Russia in recent decades up to the early 1990's have been cut and sold within the country, and probably much valuable source information about them has been lost.

This book (despite the need for a few small corrections and additions as noted), is a real "classic," indispensable for any serious private or public geological/mineralogical library. We hope that the publisher will consider publishing similar monographs on the other famous pegmatite and greisen deposits of Russia and perhaps other ex-Soviet states including Ukraine, Kazakhstan, Uzbekistan and Tajhikistan, as well as the Ilmen Mountains pegmatites.

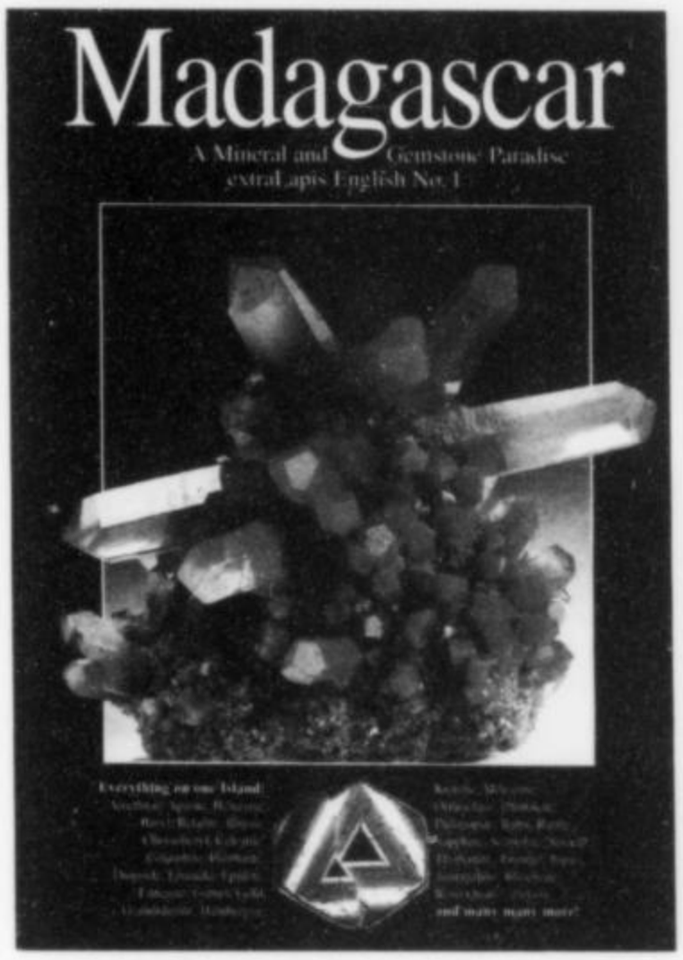
Peter Lyckberg*
Sweden/Luxembourg

*In 1992 this reviewer was the first Westerner since George F. Kunz (1915) and Gustav Flink (1916) to visit the mines of the Alabashka field, and by then the mining company had almost nothing left uncut of the gem minerals recovered. Exceptions were 8 kg of non-cutting-quality blue Mokrusha topaz, a few beautiful beryl specimens and lots of poor-quality amethyst. All gem-quality amethyst scepter crystals recovered from the hydrothermal veins east of Mursinka (Wattika, Artemjeva, etc.) had either been cut or at least heavily damaged by sawing.

Madagascar, A Mineral and Gemstone Paradise

by Federico Pezzotta. Published (2001) by Lapis International LLC, available from the Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740; e-mail order: minrec@aol.com. Stiff softcover, 8.25 x 11.7 inches, 98 pages, price: $25 postpaid in the U.S. (+$8 shipping foreign).

This special publication on Madagascar inaugurates *Lapis* publisher Christian Weise's new series of English-language



versions of his popular ExtraLapis monographs (originally published in German). As usual for the German ExtraLapis issues, the production quality is superb, and the photographs excellent.

The book leads off with indexes of Madagascar localities and mineral species mentioned, then launches into a history of gem hunting and mineral collecting on the big island. Alfred Lacroix (the French mineralogist and author of the monumental three-volume *Minéralogie de Madagascar,* 1922–1923) figures prominently, of course, along with later workers such as Jean Behier; a bibliographical list covers all of the major references. The introductory chapter also discusses sociopolitical problems specific to Madagascar and how the relevant laws have changed in recent years. The most important modern collections of Madagascar minerals are identified, not surprisingly, as those of the Musée National d'Histoire Naturelle, the Musée de Minéralogie at the School of Mines, and the Sorbonne (Université Pierre et Marie Curie), all located in Paris. Also noted are the collections of the Museo Civico di Storia Naturale in Milan, Italy (source of many of the illustrated specimens), the Kristallmuseum Riedenburg in Altmühltal, Germany, and the mineralogical museum of the Service des Mines in Antananarivo, Madagascar.

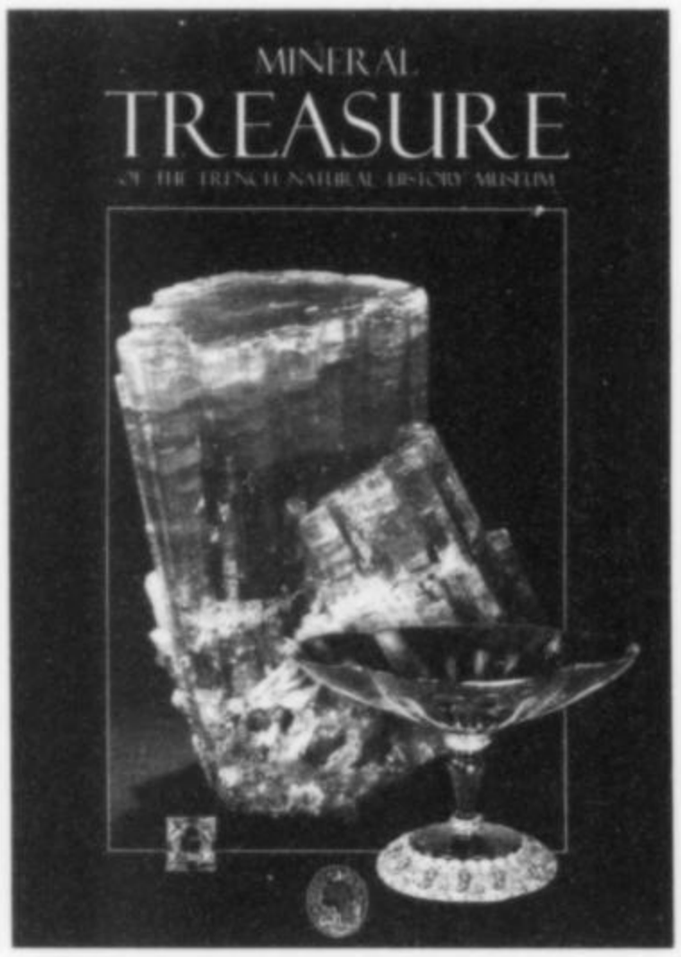
A brief review of Madagascar geology in general is then followed by a succession of brief notes (usually only a page or two each) and many color photos on the many interesting localities in Madagascar, including the Itrongay gem orthoclase occurrence; the Betroka-Bekily uranothorianite skarns; the pegmatites at Lake Alaotra, Betafo-Antsirabeé, Sahatany, Antandrokomby, Anjanabonoina, and Antsongombato;

the many occurrences of fine quartz and amethyst crystals, the Sakoany celestite geode locality, and many others.

In keeping with *Lapis*'s usual style, these locality and mineral descriptions don't go far into the technical mineralogical details. The text is designed to be entirely understandable by most average collectors without a professional mineralogical background.

This is a valuable collector's review of an area difficult to acquire information about; and it is very reasonably priced; and, as a service to our readers, it is available directly from the *Mineralogical Record.*

Wendell E. Wilson



Mineral Treasure of the French Natural History Museum

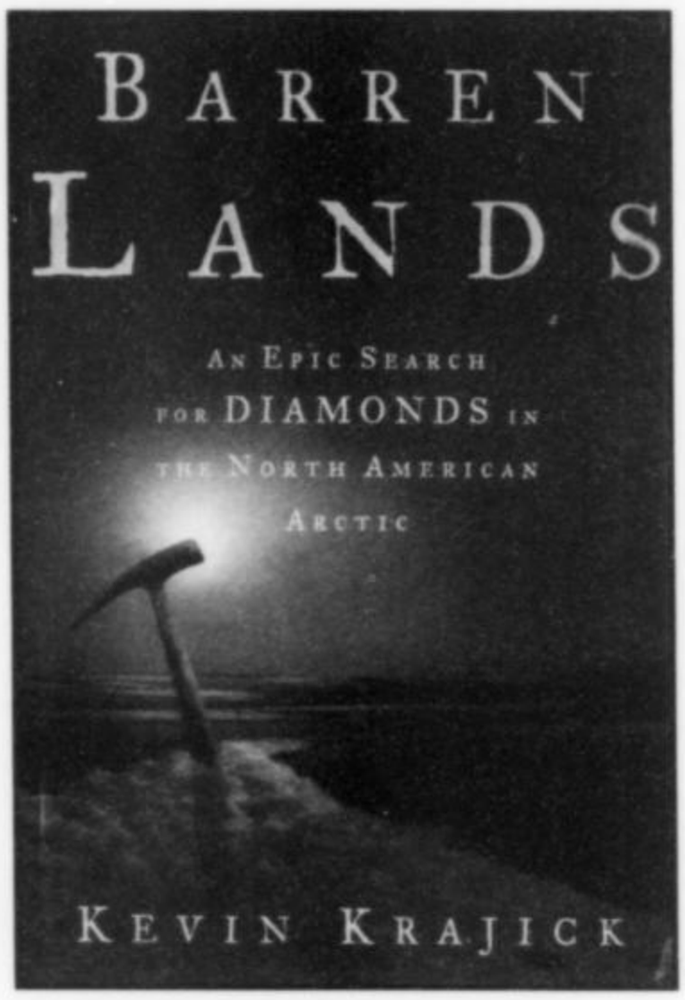
by Henri-Jean Schubnel, Pierre-Jacques Chiappero and Erik Gonthier. Published (ca. 2001) by Muséum d'Histoire Naturelle, Paris, France and available from the Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740; send e-mail orders to minrec@aol.com. Hardcover, 8.5 x 12 inches, 120 pages; price: $18 plus $4 shipping..

Great mineral museums are few in the world, and they hold a special place of honor and awe in the minds of mineral collectors. Consequently it is always happy news when one of these museums comes out with a new book on their collection, like this beautiful yet modestly priced hardcover edition on the minerals of the famous Natural History Museum in Paris. Actually this is the new English-language edition of the French version published in 1998, now made easier to read for non-francophones.

It begins with a historical review, "from the pharmacist of Louis XIII to the Museum of 1793"; then leads into a section showing and discussing many precious historical lapidary objects and also some interesting early mineral specimens in the collection. At page 47 begins the section on minerals, filling the rest of the book with lavish illustrations supported by substantial discussions of the rich historical background of the specimens from early collections. Following the initial historical subsection comes a remarkable photo series devoted to the many superb specimens acquired by the museum in modern times through the support of the TotalFinaElf Group. Fortunate indeed is the museum that can lay claim to one of the most historically significant collections of early mineral specimens in the world, *and* have the financial resources necessary to purchase top-quality museum specimens from modern occurrences and discoveries on today's pricey market!

This is a highly affordable and immensely enjoyable book that every collector will want to own.

Wendell E. Wilson



Barren Lands: an Epic Search for Diamonds in the North American Arctic

By Kevin Krajick. Published (2001) by Times Books, Henry Holt & Company, New York. Hardcover, 442 pages, ISBN 0-7167-4026-5. $26.00.

This book covers literally a very great deal of ground. In its early chapters it ranges from Europe to India to Brazil to the Soviet Union to South Africa before settling on North America; historically, its account of the quest for diamonds begins with the New World explorations of the 16th century and ends in 1998, with the opening of the Ekati diamond mine in the tundra of far northern Canada. Along its way the book is a chronicle of the romance of diamonds in the human imagination, and hence a history of diamond rushes, with all their predictable avarice, cruel and obsessive competitiveness, and glory. But Krajick's own particular quest is to tell how diamonds were found in Canada's "Barren Lands," hundreds of miles north of any road and well beyond even the northernmost treeline. This region, the cratonic nucleus of North America, is now known to contain one of the planet's greatest swarms of diamondiferous kimberlite pipes. Over an area larger than many European countries, among glacial eskers and lakes and caribou trails, whole diamond-mining cities are even now being airlifted in, and Krajick's lively style does a fine job of showing how this odd fact came to be.

The book's 20 chapters, grouped in four parts, tell a historical story which gradually settles into the personal stories of Chuck Fipke and Stewart Blusson, the two prospectors who found the Ekati pipe on Lac de Gras, Northwest Territories, in 1997, and were made billionaires by it. Two helpful maps, 35 pages of chatty endnotes, and a thorough index anchor the book in its sources—although bibliographical data are somewhat hard to retrieve, buried as they are in the endnotes rather than being offered separately in an alphabetized list.

The earliest chapters take us from glimpses of diamonds brought back to France in 1541 by Jacques Cartier; through random and tantalizing discoveries made (mostly by children) in such unlikely places as Ithaca, New York and Brindletown Creek, North Carolina; through a notorious Great Diamond Hoax perpetrated in Colorado in 1872; through the discovery in 1906 of the kimberlite pipe under what is now Crater of Diamonds National Park in Arkansas. In this part of the book we meet the famous mineralogist George Fredrick Kunz, enthusiast of American gemstones and "perpetual 10-year-old," rushing about the United States to appraise every gem find of which rumor told. Kunz and others at last came vaguely to understand that the southern alluvial finds of diamonds implied a source somewhere far to the north, which the glaciers had scoured.

The great international diamond cartel called De Beers, we learn, took its name from a pair of simple Boer farmers in South Africa, the De Beers brothers, who sold their diamond-rich land for almost nothing, then fretted that they couldn't think what to do with the money except maybe buy "a new wagon and some ox yokes." In South

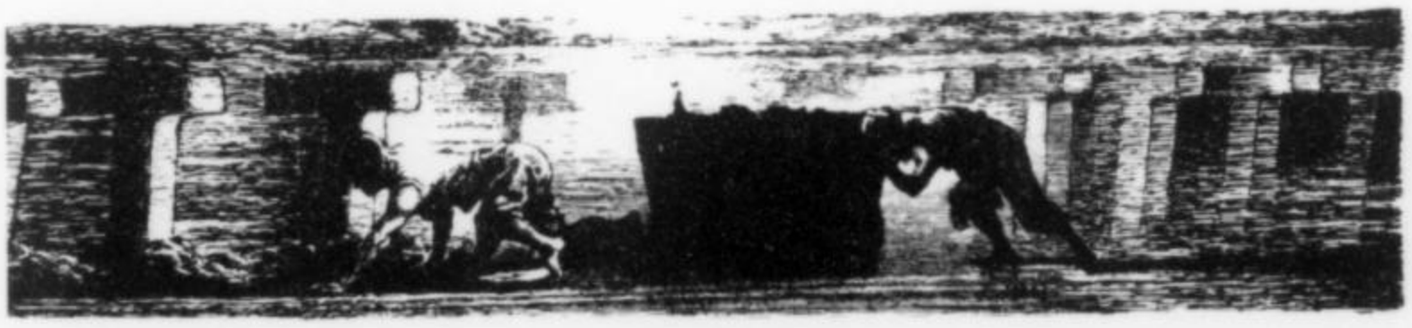
Africa, De Beers evolved a fairly accurate understanding of the intrusive peridotite rock now called kimberlite, and learned how to look for "indicator minerals" which can signal diamonds. Some years later, Chuck Fipke, a young Canadian, acquired a precious jar full of grains of these minerals, and it is more or less at this point that Krajick's narrative of the Barren Lands and its explorers/exploiters takes over.

We learn to admire and respect Stew Blusson, an eccentric Ph.D. geologist with a helicopter pilot's license, a death wish, and a worried mother. But the most vividly drawn character is Chuck Fipke: a hard-driving, barely articulate, downright fanatical quester from Kelowna, British Columbia. He is, on balance, likable, and yet so "difficult" that the reader unfailingly sides with his opponent in whatever argument is going on—Chuck against his wife, his son, his brother, his business partners or long-suffering field employees or trusting investors, or even his innocent neighbors. For many chapters we follow Fipke and Blusson as they move from one crackpot diamond claim to the next, always just ahead of De Beers agents (or so their paranoia insists), and a hairsbreadth from ruin. But Chuck has a certain genius with a binocular microscope, and a feeling for "indicator" minerals . . . I'll not divulge here what these minerals are, but will say that parts of the book are immensely instructive mineralogically.

The general story told by the book has a certain anti-authoritarian, David-vs-Goliath appeal, for the Fipke/Brusson partnership beat De Beers, finally, to the Ekati pipe, although it only could do so after Chuck's own Dia Met Exploration Company allied itself with a large, powerful Australian concern called BHP: Broken Hill Proprietary. The book ends with an alcohol-soaked, on-site ceremony marking the official opening of the Ekati mine in 1998; a few pages earlier, though, we saw Chuck Fipke heading off into another quest, pursuing King Solomon's lost gold mines in the deserts of Yemen.

You will likely not find a more outrageous-character-filled, interesting, true tale of mineral prospecting than the one offered here.

Thomas P. Moore



Arizona Dealers

De Natura
Les & Paula Presmyk
P.O. Box 1273
Gilbert, Arizona 85299
Tel: (480) 892-0779
FAX: (480) 497-8349
Website: www.denatura.com
See us at the Tucson & Denver Shows, specializing in fine minerals from Arizona and the Southwest; Professional trimming & cleaning services

Top-Gem Minerals
1201 B North Main Street
Tucson, Arizona 85705
Tel: (520) 622-6633
FAX: (520) 792-2928
Mon-Fri 8:30–4:30 and by Appt.
No Catalog or List
Wholesale Only
Mex. & Tenn. minerals, boxes

David Shannon Minerals
David & Colleen
6649 E. Rustic Drive
Mesa, Arizona 85215
(480) 985-0557
Minerals, Boxes & Supplies.
Send $1 for 72-page catalog.

Evan Jones Minerals
3520 N. Rose Circle Dr.
Scottsdale, Arizona 85251
Tel/Fax: (602) 946-5826
e-mail: evjonesusa@netscape.net
By Appointment Only.
Fine Minerals for Collectors.
Specializing in Arizona,
Mexico & Worldwide Classics.
We Buy Collections.

Douglass Minerals
P.O. Box 69550
Tucson, Arizona 85737
(520) 742-0294
www.douglassminerals.com
e-mail: douglassminerals@aol.com
Quality, affordable, world-wide minerals

Kino Rocks & Minerals
6756 S. Nogales Highway
Tucson, Arizona 85706
(520) 294-0143
9–11:15/Noon–5:30 (Closed Sun.)
No Catalog—No List

Letters

BOTALLACKITE—
A LOCALITY CORRECTION

A fair quantity of superbly crystallized botallackite reached the market during and after the mid 1960's via the late Cornish mineral dealer Richard (Dick) W. Barstow. It is invariably listed and labeled as coming from the old Botallack mine, a site totally inaccessible and flooded for over 100 years. Because I was personally involved in collecting this material I would like to set the record straight regarding the correct locality.

Dick Barstow and I had been allowed access to the site of the actual occurrence and were permitted to collect specimen material, ostensibly for our own collections and for investigative work, by the management of the recently de-watered **Levant mine**. Dick subsequently became an established and successful mineral dealer and it now seems most probable that he considered it unwise to attribute his commercial material to its true locality, approximately 1 km north of the Botallack (Crowns) mine. The true locality is therefore the **24-fathom level, Levant mine, Trewellard, St. Just in Penwith, Cornwall.** The material was the subject of an article in Rainer Bode's short lived magazine *Magma*, vol.1/no.1 (1983), in which is shown an excellent color photo and the correct attribution to the Levant mine. I donated specimens of this well-crystallized material with correct attribution to the American Museum of Natural History in New York, to the Smithsonian Institution in Washington, and to the Natural History Museum in Santa Barbara via Dr. Frederick H. Pough. The British Museum and possibly others were also presented with specimens correctly attributed by my late friend Dick Barstow. The BM(NH) carried out the determinative single-crystal X-ray diffraction work.

The issue is further complicated by the fact that it is now thought that the type locality for this species is not the Botallack mine either, and that the original material collected by Richard Talling in the 19th century almost certainly came from Wheal Cock, a rich little copper mine very close to the Botallack (Crowns) mine. This reconsideration comes about following a study of surviving Talling personal communications. (Talling was famous for vague locality in-

formation and for giving actual "bum steers.")

J. R. Knight
Manchester, England

EARLY PORTUGUESE COLLECTIONS

Recently I had the pleasure of reading the magnificent *History of Mineral Collecting 1530–1799* (*Mineralogical Record*, vol. 25, no. 6, 1994) This issue has provided me many fascinating hours of reading. I am writing to give you a little additional information about early mineral collecting in Portugal. There are several known cases of Portuguese collectors in the 18th century who had mineral collections in their natural history cabinets.

António Jacinto de Araújo offered his collection and cabinets to the Royal Ajuda Museum (Lisbon) on 25 May 1798. This large collection included agates, opals, topaz, emeralds, amethysts, sapphires, etc. From this mineralogical collection 106 ore specimens, with several high-quality specimens of native gold, were purchased from Mr. Jacob Foster, along with his own catalog.

Luís de Albuquerque Pereira Cáceres' collection was offered or sold to the Royal Ajuda Museum (Lisbon) at about the same time.

Padre José Mayne created a natural history cabinet where minerals were included. Most of them were from the Caucasus and Siberia, purchased from a Russian dealer who lived in Oporto, Portugal. That collection was integrated into the Natural History Museum of the Royal Sciences Academy of Lisbon in 1792, the year of his death.

There are also references to collections which belonged to foreigners and which came to Portugal as purchases made by the Natural History Museum of the Coimbra University, such as the collection of Dr. **Domenico Vandelli** (1735–1816), bought by contract in 1772 and probably taken possession of between 1773 and 1775 (a catalog of this collection survives).

José Rollen Van Deck's collection was offered Coimbra University in 1774. This and the Vandelli collection mentioned above are the two collections which founded the Natural History Museum of the Coimbra University.

At least three 18th-century natural history museums in Portugal had mineral collections: **The Royal Ajuda Museum** (Lisbon); **The Natural History Museum of the Royal Science Academy** (Lisbon); and **The Natural History Museum of Coimbra University.** Of these three ancient museum collections, only the Natural History Museum of the Coimbra University still preserves 18th-century specimens today. We aren't very sure about most of the early specimens because a large part of their documentation has disappeared or degraded, and there were several reorganizations of the ancient collections during which the provenance of most of them was lost. Unfortunately the specimens from the Lisbon Museums were all destroyed in a fire in 1978, and we lost this national patrimony.

José Bonifácio d' Andrada e Silva (1763–1838), whom you mentioned, is considered to be the Patron of the mineralogical gallery of the Geological and Mineralogical Museum of Coimbra University, where we can probably find in the ancient collections some examples of his own private collection (though lacking identification). Most specimens of José Bonifácio d' Andrada e Silva's collection traveled with him to Brazil in the 19th century and were lost. Thank you very much for your magnificent magazine!

Ricardo Jorge Pimentel
Portugal

MINERAL SPECIMEN MORTALITY

[The following letters were received in response to the article "Mineral specimen mortality" by Wendell Wilson and Rock Currier, published in volume 32, number 4, 2001.]

I inherited an Arkansas quartz cluster the size of a dinner plate from my father, and displayed it proudly in my new office on a low bookshelf near the door. The specimen, though not especially valuable, featured dozens of crystals protruding upward. Above it on the wall I hung a matted and metal-framed sheet of the United States ten-cent mineral postage stamps issues to commemorate our mineral heritage in 1974. Failure analysis subsequently revealed that wall vibration caused by closing of the door, combined with a too-short nail and a too-small hook, resulted in the picture smashing down on the crystals. While not a total loss, the specimen was certainly never the same after that.

Eric Van Valkenber
Tucson, Arizona

In March of 1982 I received a call from a science teacher at Hingham High School in Massachusetts. He had heard that I was connected with Plumbago Mining Corporation, miners of the Newry tourmalines, and he wanted to get a faceted stone for his mother. He had specimens to trade from the high school's collection, which the administrators had told him to get rid of or they would be sent to the dump. I went to his house and we made a deal; I received in trade the following:

—Two good Phoenixville pyromorphites
—One fine Phoenixville pyromorphite
—One fine Chessy azurite
—An excellent Somerville, MA prehnite
—A good Leadhills orange pyromorphite
—A fine Libertytown, MD malachite
—A damaged Phoenixville anglesite
—An excellent Isle of Man sphalerite
—A good Fitchburg, MA matrix schorl
—plus several other average specimens

He also had a fine specimen of quartz crystals with chalcopyrite from Ellenville, New York, but he wanted to keep that one. There were also perhaps a hundred other specimens, all of them badly damaged, presumably by students over the years. As I was leaving he informed me that the specimens had been given to the school by the Hingham Public Library. It was not until 1990, when I read your article on "The disposition of some American collections" in volume 21, number 1, that I discovered the origin of those specimens. The entry read:

> "Bouve, Thomas T., Boston, Mass. He gave most of his collection to the Boston Society of Natural History. He also gave some choice specimens to the Public Library in Hingham, Mass."

Another fine collection that ended up largely destroyed was that of Trinity College in Hartford, Connecticut. The campus consisted mainly of Victorian brownstone buildings; the old science building, three or four stories high, was finally scheduled to be razed for the construction of a new modern facility. I think the mineral collection was stored on the top floor. Much of it (according to your article) originated with the collection of John H. Caswell of New York City, whose widow donated it to Trinity College in 1911.

The first anyone knew of a threat to the collection was in November of 1979. The late Ron Bentley had purchased Schortmann's Minerals and opened a shop in Windsor, Connecticut. One day a couple of young men came into the shop carrying some brown bags and asked Ron if he wanted to buy some rocks. The first piece they pulled out was a superb old Japanese stibnite. Ron immediately became suspicious and asked them where they had gotten it. The fellows replied that they were geology students at Trinity, and their professor had told them to take whatever they wanted from the old mineral collection because it was going to the dump. Ron raced down to Trinity but it was too late; the top of the building had already been

demolished, and a huge crane had hoisted out the old glass and cherrywood cases and deposited them in dump trucks now gone. I purchased two of the Trinity specimens from Ron, a pyromorphite on galena which is a carbon-copy of the best of the Bouve specimens mentioned above, and a tourmaline crystal section from Haddam, Connecticut, which yielded three fine cut stones.

John Marshall
Westport, MA

I enjoyed your article on "Mineral specimen mortality." While doing research for an article on the pricing of minerals I came across the following letter written by Arthur Montgomery to Sam Gordon at the Philadelphia Academy of Natural Sciences, dated October 27, 1937. Montgomery was discussing the Fairfield, Utah variscite nodules and other phosphates which he and field collector Ed Over had found—one of which had been named for Sam Gordon:

> "I could write about this material all night. I am so enthusiastic about it. It is by far the most important find Over and I ever made, and ever will make, I guess. One thing more while I think of it, and that is that none of these minerals will be sold indiscriminately or cheaply enough to flood the market and make them appear as common in the eyes of anyone [even though they were, apparently, found in abundance]. Although I have a very great number of superbly crystallized gordonites, for example, it is likely that only a number of the best ones will be sold at all, only as much as for which there is a real demand by the important museums and private collectors. I would rather keep the prices extremely high, and only sell a handful of the finest specimens to places where their excellence and rarity will be fully appreciated, than sell a hundred times as many at low prices [even though] the latter way may be the most successful financially. That is my personal philosophy, as applied to mineral selling anyway."

Wow! What an interesting, and chilling, philosophy! Did the unsold majority of Montgomery's Fairfield phosphates get dumped in the river to create artificial rarity? "Mineral specimen mortality" by design rather than by accident!

Lawrence H. Conklin
New York, NY

Your article on mineral specimen mortality brought to mind the following four stories:

[1] One Sunday afternoon in the spring of 1986, when I was living in Santiago, Chile, I decided to visit an open-air handicraft market near Los Dominicos. Among the countless stalls I came across a small booth selling rocks. The aged booth owner invited me to enter and look around. The place was a dusty jumble of rotted cartons, some lying partially open, with faded wrapping paper scattered about in the twilight. I wasn't very enthusiastic about the idea of unwrapping piles of junk rocks so, just to be polite, I lifted the lid of a box and examined a specimen at random. I was amazed to find a heavy specimen of brown crystals accompanied by an old and faded label from the Museo de Santiago; the handwriting on the label (in Spanish) identified the specimen as cassiterite from Altenberg, Germany!

My blood pressure began to rise as my shaking fingers unwrapped more of the dusty old "rocks," most of which were accompanied by crumpled museum labels. In a short time I had about 120 specimens spread out before me, almost all of them from German, Bohemian, French and a few Chilean localities. Included were beautiful, well-crystallized specimens of chalcopyrite, pyrite, galena, sphalerite, wolframite, zinnwaldite, garnets, more cassiterite, calcite and barite among the more common species. Most outstanding were a 350-gram specimen of Schneeberg silver, a fine cabinet-size skutterudite, fine annabergite, chloanthite, tetrahedrite, a perfect little proustite group from Chañarcillo, and a well-formed, pale copper-red nickeline group containing 3-inch pyramidal crystals from Saxony.

I asked the booth owner, who had been watching me with amusement, where he had acquired all these "rocks." He just smiled, and said that he had bought this junk a few years ago at the estate sale of an old fellow who had worked in an old museum. He said there had been many more specimens in the lot but, because they were larger and heavier, he assumed they would end up being shelf-warmers so he threw them away. I must have stared like a ghost.

I bought the whole collection for a very reasonable price, and the old man helped me rewrap them all. When we came to the pink nickeline specimen he stopped and thought for a moment, then said he thought there was a similar piece around somewhere that I might also be interested in. He had been using it as a door-stop for the door to the booth! It was the largest nickeline crystal group I had ever seen or heard of, almost 5.5 inches and entirely composed of large crystals which, by now, were dirty, scratched and heavily damaged, ruined by its utilitarian employment rolling about on the floor in front of his door. I was near tears about this act of vandalism, but the old man was unable to understand my pain. He just found it remarkable that this strange guy was paying him money for junk rocks which no one else wanted.

[2] I first visited Sri Lanka in 1972, to see for myself the Island of Gemstones and to acquire some blue corundum crystals and graphite specimens. I visited the then-small but well-organized mineral museum in Ratnapura and had lunch with the curator and two local mine owners. Among the stories told that day was an incident recounted by one of the mine owners, about the time a huge, gemmy, deep red, single pyrope crystal "as big as a dog" was found in a skarn near the village of Demodara. The big crystal had been carefully set aside by the miners, but proved to be too heavy to carry very far. The lucky discoverer went to a nearby village to arrange for a truck to transport it. While he was gone, the other miners thought the situation over and decided that it made no sense to spend good money for a truck when all they had to do was break the crystal down into manageable-size pieces. So they smashed it to bits and packed the pieces in jute bags, proudly presenting them to the finder upon his return with truck, and congratulating themselves on a job well-done. According to the miner telling this story, it had been the largest well-formed garnet crystal ever found, and would have sold to a museum for far more money than the bags of cutting rough.

[3] In 1991, on one of my numerous collecting trips to Morocco, I was able to acquire nine or ten flats of the finest deep blue azurite crystal specimens from the Touissit mine. I returned to Casablanca with one of my friends (not a mineral collector), where we intended to stay for a few days while I cleaned and wrapped the specimens before returning home to Europe.

We found a neat and comfortable hotel in Ain Diab, a suburb of Casablanca, built on rocks overlooking the ocean. We spent the whole first evening working on the azurites, and had them spread over the hotel room floor. Finally, very tired, we decided to get some sleep and continue the job in the morning.

At some time after midnight we awoke to an infernal racket of barking dogs directly beneath our window. My friend, extremely angry about having his sleep so rudely interrupted, was standing at the open window and throwing azurite after azurite at the offending pack of hounds. Still bleary-eyed, I couldn't believe what I was seeing—almost an entire flat had been pitched out the window! Luckily he hadn't grabbed the top specimens, but the rest of the night

was not very cordial for either of us.

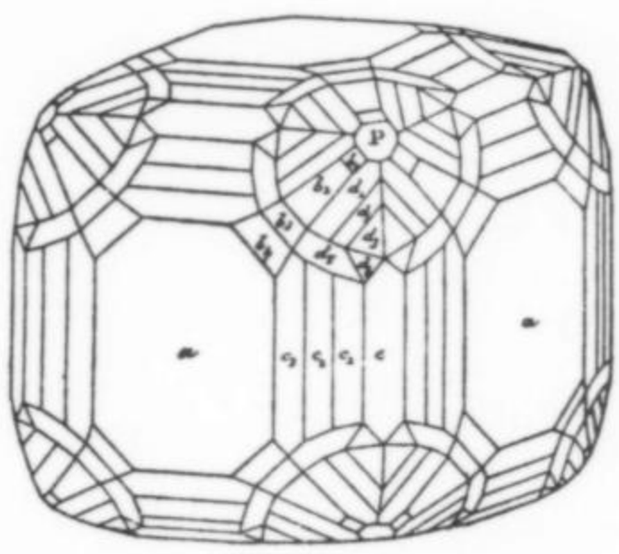
[4] Most specimens may indeed be mortal, but a few do give a good imitation of immortality, an example of which is now in my collection.

One of Europe's oldest mining areas is located near the village of Cabrières, Department of Herault in southern France. Here you can visit France's oldest copper mine, the Pioch Farrus mine, originally exploited between 1,000 and 3,000 B.C. in the late neolithic to chalcolithic "copper stone age," then later by the Romans and Gauls, and sporadically thereafter up until the 19th century.

Around 1930 a French collector looking for minerals on the prehistoric dumps found a fine cabinet specimen of undamaged quartz crystals on matrix, covered by lustrous, gemmy purple fluorite cubes to a half inch, with some associated malachite. A neolithic or Roman-Gaul miner had found it about 2,000 years ago and then discarded it. A protective layer of mud and sand had prevented any damage. Recovered once again, it is now being carefully preserved.

Peter G. Seroka
Frankfurt, Germany

Abstracts of New Mineral Descriptions



J. A. Mandarino
Chairman Emeritus of the Commission on
New Minerals and Mineral Names
of the International Mineralogical Association
and
Curator Emeritus
Department of Mineralogy
Royal Ontario Museum
100 Queen's Park
Toronto, Ontario, Canada M5S 2C6

Cobalttsumcorite — Monoclinic

$Pb(Co,Fe^{3+})_2(AsO_4)_2(H_2O,OH)_2$

Locality: Am Roten Berg, Schneeberg-Neustädtel, Saxony, Germany.

Occurrence: From the oxidation zone of the deposit associated with quartz on the type specimen. Associated minerals on other samples are: Co- and Ni-bearing mawbyite, cobaltlotharmeyerite, galena, arseniosiderite and plumbogummite.

General appearance: Rosette-like aggregates (up to 2 mm in diameter) composed of tabular crystals up to 0.3 mm.

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* transparent. *Color:* brown to red-brown. *Streak:* light brown. *Luminescence:* nonfluorescent. *Hardness:* VHN_{25} 500 kg/mm², Mohs 4½. *Tenacity:* brittle. *Cleavage:* {001} good. *Fracture:* conchoidal. *Density:* could not be measured, 5.31 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C*2/*m*, *a* 9.097, *b* 6.313, *c* 7.555 Å, β 115.08°, *V* 393.0 Å³, Z 2, *a*:*b*:*c* = 1.4410:1:1.1967. Morphology: {$\bar{2}$01} dominant, {001} and {$\bar{1}$11}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.656 (87) (11$\bar{1}$), 4.462 (96) (20$\bar{1}$), 3.243 (100) (11$\bar{2}$), 3.010 (58) (201), 2.868 (50) (021), 2.733 (47) (31$\bar{1}$), 2.538 (40) (112). ***Optical data:*** Biaxial (+), α 1.92 (calc.), β 1.94, γ 1.98, 2V(meas.) 70°, dispersion not determined; pleochroism strong, X = light brown, Y = red-brown, Z = yellow; X ∧ *c* = 15° in acute angle β, Y = *b*, Z ∧ *a* = 40° in obtuse angle β. ***Chemical analytical data:*** Means of seven sets of electron microprobe data: CaO <0.05, NiO 5.20, CoO 9.10, CuO <0.05, ZnO 0.52, PbO 34.23, Al_2O_3 0.29, Fe_2O_3 8.47, Bi_2O_3 <0.05, P_2O_5 0.06, V_2O_5 <0.05, As_2O_5 36.49, SO_3 0.09, H_2O (4.65), Total (99.10) wt.%. Empirical formula: $Pb_{0.97}(Co_{0.77}Fe^{3+}_{0.67}Ni_{0.44}Zn_{0.04}Al_{0.04})_{\Sigma 1.96}[(AsO_4)_{2.02}(SO_4)_{0.01}(PO_4)_{0.01}]_{\Sigma 2.04}[(H_2O)_{1.41}(OH)_{0.46}]_{\Sigma 1.87}$. ***Relationship to other species:*** It is a member of the tsumcorite group; specifically, the cobalt-dominant analogue of tsumcorite.

Name: For the relationship to tsumcorite. ***Comments:*** IMA No. 1999-029.

KRAUSE, W., BERNHARDT, H.-J., EFFENBERGER, H., and MARTIN, M. (2001) Cobalttsumcorite and nickellotharmeyerite, two new minerals from Schneeberg, Germany: description and crystal structure. *Neues Jahrbuch für Mineralogie, Monatshefte* **2001**, 558–576.

Dickthomssenite — Monoclinic

$Mg(V_2O_6)\cdot 7H_2O$

Locality: The Firefly-Pigmay mine, Sec. 30, T. 28 S., R 26 E., 16 km east of La Sal, San Juan County, Utah, USA.

Occurrence: A coating on sandstone which locally contains organic material, including log fragments, some of which contain uranium and vanadium mineralization. Associated minerals are: pascoite, sherwoodite, selenium, bariandite, devilline, rossite, hewettite, carnotite, clausthalite, coffinite, tyuyamunite, uraninite, corvusite, montroseite, roscoelite, galena, pyrite and tennantite.

General appearance: Crystals from 0.25 mm needle-like to 0.5 x 1.5 mm platy, prismatic with basal terminations. The crystals are in fibroradial groups up to 5 mm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* light golden brown. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 2½. *Tenacity:* brittle. *Cleavage:* {100} perfect. *Fracture:* hackly. *Density:* between 1.96 and 2.09 g/cm³ (meas.), 2.04 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C*2/*c*, *a* 38.954, *b* 7.2010, *c* 16.3465 Å, β 97.602°, *V* 4544.0 Å³, Z 16, *a*:*b*:*c* = 5.4095:1:2.2700. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 9.704 (100) (400), 8.117 (60) (002), 5.843 (100) (400), 4.061 (50) (004), 3.139 (90) (1$\bar{2}$02), 2.920 (60) (804), 2.707 (50) (006). ***Optical data:*** Biaxial (–), α 1.6124, β 1.6740, γ 1.7104, 2V(meas.) 74°, 2V(calc.) 73°; dispersion r < v; nonpleochroic; Y ∧ *c* = 16.5° in acute angle β, X ∧ *a* = 24.5° in obtuse angle β, Z = *b*. ***Chemical analytical data:*** Electron microprobe data were elevated due to decomposition of the sample under the electron beam. The analytical results with H_2O calculated to give $7H_2O$ (as indicated by the crystal structure determination) and the oxides recalculated to give 100.00 wt.% are: MgO 10.99, FeO 0.41, V_2O_5 52.43, H_2O (36.17), Total (100.00) wt.%. Empirical formula: $(Mg_{0.95}Fe_{0.02})_{\Sigma 0.97}(V_2O_6)\cdot 7.00H_2O$. ***Relationship to other species:*** None apparent.

Name: For Richard ("Dick") W. Thomssen (1933–), consulting geologist from Dayton, Nevada, USA. ***Comments:*** IMA No. 2000-047. The mineral was discovered by J. Marty. Note that the crystal structure has been determined.

HUGHES, J. M., CURETON, F. E., MARTY, J., GAULT, R. A., GUNTER, M. E., CAMPANA, C. F., RAKOVAN, J., SOM-

MER, A., and BRUESEKE, M. E. (2001) Dickthomssenite, $Mg(V_2O_6)\cdot 7H_2O$, a new mineral species from the Firefly-Pigmay mine, Utah: descriptive mineralogy and arrangement of atoms. *Canadian Mineralogist* **39**, 1691–1700.

Felbertalite — Monoclinic

$Cu_2Pb_6Bi_8S_{19}$

Locality: The Felbertal scheelite deposit, Felbertal, Salzburg Province, Austria.

Occurrence: It is a minor to trace constituent in laminated discordant quartz veins which contain scheelite, pyrite, pyrrhotite and chalcopyrite. Locally, associated sulphosalt minerals are: galenobismutite, cosalite, members of the bismuthinite-aikinite series (krupkaite-lindströmite range and gladite-hammarite range), argentian lillianite, Se-free junoite and members of the pavonite homolgous series. Felbertalite is always intimately intergrown with argentian lillianite and, rarely, with cannizzarite, Se-free junoite, Se-free proudite, bismuthinite derivatives and cosalite.

General appearance: Elongated crystals (up to 0.5 mm).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* bright white, very similar to the color of the associated sulphosalts from which it is indistinguishable. *Streak:* grayish black. *Hardness:* VHN_{25} 206 kg/mm², Mohs about 3½. *Tenacity:* brittle. *Cleavage:* {001} perfect. *Fracture:* uneven. *Density:* could not be measured, 6.88 g/cm³ (calc.) (given as 6.95 g/cm³). ***Crystallography:*** Monoclinic, *C2/m*, *a* 27.637, *b* 4.0499, *c* 20.741 Å, β 131.258°, *V* 1745.1 Å³, Z 2, *a:b:c* = 6.8241:1:5.1214. Morphology: no forms were mentioned. Twinning: none observed. ***X-ray powder diffraction data:*** 3.78 (S) (203), 3.51 (S) ($31\bar{3}$), 3.38 (S) ($40\bar{6}$), 2.320 (S) ($11\bar{6}$), 2.096 (S) ($11.1.\bar{7}$), 2.062 (S) ($11\bar{7}$), 2.031 (S) (020), 1.744 (S) ($62\bar{6}$), 2.918 (S) (510), 1.791 (S) (223). ***Optical data:*** In reflected light: white, distinct anisotropism, perceptible bireflectance in air (a little more in oil), slightly pleochroic in grayish white and creamy white. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (42.70, 46.10; 27.40, 29.55 %) **470**nm, (40.65, 44.30; 25.50, 27.40 %) **546**nm, (39.50, 43.20; 24.65, 26.60 %) **589** nm, (38.90, 43.10; 23.95, 25.90 %) **650** nm. ***Chemical analytical data:*** Mean of seven sets of electron microprobe data: Cu 3.56, Ag 1.10, Cd 0.43, Pb 29.9, Bi 48.3, Te 0.21, S 16.8, Total 100.30 wt.% (given as 100.4). Empirical formula: $Cu_{2.02}Ag_{0.37}Cd_{0.14}Pb_{5.20}Bi_{8.33}Te_{0.06}S_{18.89}$. ***Relationship to other species:*** It is a homologue of junoite.

Name: For the locality. ***Comments:*** IMA No. 1999-042. The structure has been solved.

TOPA, D., MAKOVICKY, E., CRIDDLE, A. J., PAAR, W. H., and BALIČ-ŽUNIĆ, T. (2001) Felbertalite, $Cu_2Pb_6Bi_8S_{19}$, a new mineral species from Felbertal, Salzburg Province, Austria. *European Journal of Mineralogy* **13**, 961–972.

Fluoro-edenite — Monoclinic

$NaCa_2Mg_5(Si_7Al)O_{22}F_2$

Locality: Near Biancavilla, Catania, Sicily, Italy.

Occurrence: In autoclasts of gray-red altered benmoreitic lavas. Associated minerals are: microgranular K-feldspar and plagioclase, quartz, clinopyroxenes, orthopyroxenes, fluorapatite, ilmenite and hematite.

General appearance: Prismatic to acicular crystals (up to 2 mm long) often in parallel bundles.

Physical, chemical and crystallographic properties: *Luster:* vitreous to resinous. *Diaphaneity:* transparent. *Color:* intense yellow. *Streak:* white-yellow. *Luminescence:* nonfluorescent. *Hardness:* 5 to 6. *Tenacity:* not mentioned but probably brittle. *Cleavage:* {110} perfect. *Fracture:* conchoidal. *Density:* 3.09 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *P2/m*, *a* 9.847, *b* 18.017, *c* 5.268 Å, β 104.84°, *V* 903.45 Å³, Z 2, *a:b:c* = 0.5465:1:0.2924. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 8.403 (57) (110), 3.376 (13) (131), 3.271 (48) (240), 3.125 (100) (310), 2.938 (17) (221), 2.807 (33) (330), 2.703 (25) (151), 1.8939 (18) ($\bar{5}10$), 1.6489 (14) (461), 1.4384 (14) ($\bar{6}61$). ***Optical data:*** Biaxial (–), α 1.6058, β 1.6170, γ 1.6245, 2V not measured, 2V(calc.) 78°, dispersion not given; pleochroism not visible; Y = *b*, Z ∧ *c* = 26° (in obtuse angle β), X ∧ *a* = 11° (in acute angle β). ***Chemical analytical data:*** Mean of three sets of electron microprobe data: Na_2O 3.20, K_2O 0.84, MgO 22.65, CaO 10.83, MnO 0.46, FeO 1.60, Al_2O_3 3.53, Fe_2O_3 1.00, SiO_2 52.92, TiO_2 0.29, F 4.35, Cl 0.07, sum 101.74, less O = F + Cl 1.85, Total 99.89 wt.%. Empirical formula: $(Na_{0.61}K_{0.15})_{\Sigma 0.76}(Na_{0.26}Ca_{1.63}Mg_{0.06}Mn_{0.05})_{\Sigma 2.00}(Mg_{4.67}Fe^{2+}_{0.19}Fe^{3+}_{0.11}Ti_{0.03})_{\Sigma 5.00}(Si_{7.41}Al_{0.58})_{\Sigma 7.99}O_{22.00}(F_{1.93}O_{0.05}Cl_{0.02})_{\Sigma 2.00}$. ***Relationship to other species:*** A member of the amphibole group.

Name: Complies with the amphibole classification approved by the IMA. ***Comments:*** IMA No. 2000-049.

GIANFAGNA, A. and OBERTI, R. (2001) Fluoro-edenite from Biancavilla (Catania, Sicily, Italy): Crystal chemistry of a new amphibole end-member. *American Mineralogist* **86**, 1489–1493.

Lanmuchangite — Cubic

$TlAl(SO_4)_2\cdot 12H_2O$

Locality: Lanmuchang thallium (mercury) deposit, Xinren County, Guizhou Province, Peoples' Republic of China (Lat. 25°31′28″ N, Long. 105°30′30″ W).

Occurrence: In the oxidation zone. Associated minerals are: melanterite, pickeringite, potassium alum, jarosite, gypsum, arsenolite, sulphur and some unknown minerals.

General appearance: Anhedral granular crystals (40 to 90 μm) in aggregates 2 to 10 mm. Occasionally in parallel columnar form consisting of subhedral to euhedral columnar crystals 15 to 65 μm in diameter.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* yellow to white. *Streak:* white. *Luminescence:* not given. *Hardness:* VHN 94-124 kg/mm², Mohs 3 to 3½. *Tenacity:* brittle. *Cleavage:* not given. *Fracture:* not given. *Density:* 2.22 g/cm³ (meas.), 2.35 g/cm³ (calc.). *Other properties:* water soluble. ***Crystallography:*** Cubic, *Pa*3, *a* 12.212 Å, V 1821 Å³, Z 4. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.03 (54) (111), 6.11 (27) (200), 4.314 (100) (220), 3.524 (24) (222), 2.801 (70) (331), 2.731 (35) (420). ***Optical data:*** Isotropic, n 1.495. ***Chemical analytical data:*** Means of six sets of electron microprobe data (H_2O by TGA): Tl_2O 33.25, Na_2O 0.00, K_2O 0.35, MgO 0.06, CaO 0.08, FeO 0.04, Al_2O_3 8.07, SiO_2 0.10, SO_3 25.19, H_2O 33.46, Total 100.60 wt.%. Empirical formula: $(Tl_{1.00}K_{0.05})_{\Sigma 1.05}(Al_{1.01}Si_{0.01}Mg_{0.01}Ca_{0.01})_{\Sigma 1.04}(SO_4)_{2.01}\cdot 11.88H_2O$. ***Relationship to other species:*** It is the Tl-Al-dominant member of the alum group.

Name: For the locality. ***Comments:*** IMA No. 2001-018.

CHEN DAIYAN, WANG GUANXIN, ZOU ZHENXI, and CHEN YUMING (2001) A new mineral—lanmuchangite. *Acta*

Mineralogica Sinica **21**, 271–277 (in Chinese with an English abstract).

Lukrahnite — Triclinic

$CaCuFe^{3+}(AsO_4)_2[(H_2O)(OH)]$

Locality: Tsumeb, Namibia. Probably also from the Pucher Shaft, Schneeberg, Saxony, Germany.

Occurrence: Associated minerals are: beudantite, cuprian adamite, conichalcite, wulfenite, quartz and chalcocite. The mineral from the Saxony locality is associated with bismuthian nickellotharmeyerite.

General appearance: Spherical aggregates (up to 0.5 mm); from the Saxony locality, tiny overgrowths <10 μm thick.

Physical, chemical and crystallographic properties: *Luster:* dull to subadamantine. *Diaphaneity:* transparent. *Color:* yellow. *Streak:* light yellow. *Luminescence:* nonfluorescent. *Hardness:* VHN_{25} 630 kg/mm², Mohs 5. *Tenacity:* brittle. *Cleavage:* none observed. *Fracture:* not given. *Density:* could not be measured, 4.18 g/cm³ (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$ (by analogy with gartrellite), *a* 5.457, *b* 5.539, *c* 7.399 Å, α 68.43°, β 68.90°, γ 69.44°, *V* 187.8 Å³, Z 1, *a:b:c* = 0.9852:1:1.3358. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.953 (22) (010, 100), 4.444 (20) (1$\bar{1}$1), 3.416 (100) (11$\bar{2}$), 3.186 (40) (012, 102), 2.927 (64) (11$\bar{1}$), 2.832 (26) ($\bar{1}\bar{1}$1, 1$\bar{1}$1), 2.700 (30) (211), 2.533 (30) (201, 212), 2.468 (25) (020, 0$\bar{1}$2, 10$\bar{2}$, 200, 113). ***Optical data:*** Biaxial (+), α 1.83, β 1.834 (calc.), γ 1.89, 2V(meas.) 30°; dispersion could not be determined; pleochroism moderate, X = yellow, Y = Z = pale yellow; orientation could not be determined. ***Chemical analytical data:*** Means of nine sets of electron microprobe data (with H_2O calculated to give OH + H_2O = 2): CaO 11.42, NiO 0.05, CoO 0.15, CuO 10.00, ZnO 8.19, PbO 0.69, Al_2O_3 0.37, Fe_2O_3 13.75, P_2O_5 0.16, As_2O_5 47.72, SO_3 0.09, H_2O (6.21), Total (98.80) wt.%. Empirical formula: $(Ca_{0.97}Pb_{0.01}Co_{0.01})_{\Sigma 0.99}(Cu_{0.60}Zn_{0.48})_{\Sigma 1.08}(Fe^{3+}_{0.82}Al_{0.03})_{\Sigma 0.85}[(AsO_4)_{1.98}(PO_4)_{0.01}(SO_4)_{0.01}]_{\Sigma 2.00}[(H_2O)_{1.30}(OH)_{0.70}]_{\Sigma 2.00}$. ***Relationship to other species:*** It is the Ca-dominant analogue of gartrellite.

Name: For Ludger Krahn (1957–) who provided the first specimen of the mineral for investigation. ***Comments:*** IMA No. 1999-030. A slightly different calculated value for H_2O is given here.

KRAUSE, W., BLASS, G., BERNHARDT, H.-J., and EFFENBERGER, H. (2001) Lukrahnite, $CaCuFe^{3+}(AsO_4)_2[(H_2O)(OH)]$, the calcium analogue of gartrellite. *Neues Jahrbuch für Mineralogie, Monatshefte* **2001**, 481–492.

Natrolemoynite — Monoclinic

$Na_4Zr_2Si_{10}O_{26}\cdot 9H_2O$

Locality: Poudrette Quarry, Mont Saint-Hilaire, Rouville County, Quebec, Canada.

Occurrence: In pegmatites cutting nepheline syenite. Associated minerals in altered pegmatites are: microcline, lemoynite, lepidocrocite, galena, sphalerite, calcite and pyrite. Associated minerals in unaltered pegmatites are: biotite, microcline, albite, magnetite, a chlorite group mineral, a burbankite group mineral, an unidentified donnayite-(Y)-like mineral, zircon and pyrochlore.

General appearance: Bladed to prismatic crystals (up to 1 x 2 mm); typically in compact radial aggregates and spheres up to 4 mm in diameter.

Physical, chemical and crystallographic properties: *Luster:* vitreous to subadamantine. *Diaphaneity:* transparent to translucent. *Color:* colorless to white; may have a slightly pink to red tinge. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 3. *Tenacity:* brittle. *Cleavage:* {100} and {010} perfect, {001} poor. *Fracture:* uneven. *Density:* 2.47 g/cm³ (meas.), 2.50 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C*2/*m*, *a* 10.5150, *b* 16.2534, *c* 9.1029 Å, β 105.462°, *V* 1499.4 Å³, Z 2, *a:b:c* = 0.6469:1:0.5601. Morphology: {100}, {010} and {001} dominant; also minor unidentified pinacoid-like forms. Twinning: none mentioned. ***X-ray powder diffraction data:*** 8.832 (30) (001), 8.132 (100) (020), 5.975 (40) (021), 3.974 35) (201), 3.693 (30) (041), 3.564 (40) (221), 3.490 (35) ($\bar{2}$22), 2.804 (30) ($\bar{2}$42). ***Optical data:*** Biaxial (–), α 1.533, β 1.559, γ 1.567, 2V(meas.) 63°, 2V(calc.) 57_; dispersion crossed axial plane, weak; nonpleochroic; X = *b*, Y ∧ *c* = 25.5° in acute angle β, Z ∧ *a* = 41° in obtuse angle β. ***Chemical analytical data:*** Means of nineteen sets of electron microprobe data (with H_2O calculated to give 9H_2O; presence confirmed by IR and structure determination): Na_2O 7.47, K_2O 1.29, CaO 0.37, MnO 0.12, Al_2O_3 0.04, SiO_2 54.51, TiO_2 0.38, ZrO_2 21.97, H_2O (14.72), Total (101.88) wt.%. Empirical formula: $(Na_{2.67}K_{0.30}Ca_{0.07}Mn_{0.02})_{\Sigma 3.06}(Zr_{1.97}Nb_{0.08}Ti_{0.05})_{\Sigma 2.10}(Si_{10.05}Al_{0.01})_{\Sigma 10.06}O_{25.96}\cdot 9.04H_2O$. ***Relationship to other species:*** It is chemically and structurally related to lemoynite, $(Na,K)_2CaZr_2Si_{10}O_{26}\cdot 5–6H_2O$, and altisite, $Na_3K_6Ti_2Al_2Si_8O_{26}Cl_3$.

Name: For the relationship with lemoynite. ***Comments:*** IMA No. 1996-063. The crystal structure has been solved.

McDONALD, A. M. and CHAO, G. Y. (2001) Natrolemoynite, a new hydrated sodium zirconosilicate from Mont Saint-Hilaire, Quebec: description and structure determination. *Canadian Mineralogist* **39**, 1295–1306.

Nickellotharmeyerite — Monoclinic

$Ca(Ni,Fe^{3+})_2(AsO_4)_2(H_2O,OH)_2$

Locality: The Pucher shaft, Schneeberg-Neustädtel, Saxony, Germany.

Occurrence: From the oxidation zone of the deposit associated with quartz on the type specimen. Associated minerals on other samples are: lukrahnite, Ni- and Co-bearing ferrilotharmeyerite, mawbyite, arseniosiderite, zeunerite and barium-pharmacosiderite.

General appearance: Tiny aggregates (up to 0.5 mm) and crusts grown in small cavities; single crystals are usually < 50 μm.

Physical, chemical and crystallographic properties: *Luster:* subadamantine. *Diaphaneity:* transparent. *Color:* brown to yellow. *Streak:* light brown to yellow. *Luminescence:* nonfluorescent. *Hardness:* VHN_{25} 500 kg/mm², Mohs 4½. *Tenacity:* brittle. *Cleavage:* none observed. *Fracture:* conchoidal. *Density:* could not be measured, 4.45 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C*2/*m*, *a* 9.005, *b* 6.205, *c* 7.411 Å, β 115.31°, *V* 374.4 Å³, Z 2, *a:b:c* = 1.4512:1:1.1944. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.393 (55) (20$\bar{2}$), 3.182 (76) (11$\bar{2}$), 2.962 (100) (201), 2.816 (66) (021), 2.703 (66) (31$\bar{1}$), 2.538 (75) (22$\bar{2}$), 1.697 (53) (33$\bar{1}$, 420, 51$\bar{1}$, 40$\bar{4}$). ***Optical data:*** Biaxial (+), α 1.80 (calc.), β 1.81, γ 1.87, 2V(meas.) 40°, dispersion not determined; pleochroism strong, X = yellow, Y = brown, Z = pale yellow; X ≈ *c*, Y = *b*, Z ∧ *a* ≈ 25° in obtuse angle β. ***Chemical analytical data:*** Means of eleven sets of electron microprobe data: CaO 9.29, NiO 12.86, CoO 3.83, CuO 0.11, ZnO 0.62, PbO 0.90, Al_2O_3 <0.05, Fe_2O_3 12.88, Bi_2O_3 8.56, P_2O_5 0.23,

V_2O_5 <0.05, As_2O_5 45.32, SO_3 0.12, H_2O (5.35), Total (100.07) wt.%. Empirical formula: $(Ca_{0.83}Bi_{0.18})_{\Sigma 1.01}(Ni_{0.86}Fe^{3+}_{0.81}Co_{0.26}Zn_{0.04}Pb_{0.02}Cu_{0.01})_{\Sigma 2.00}[(AsO_4)_{1.98}(PO_4)_{0.02}(SO_4)_{0.01}]_{\Sigma 2.01}[(H_2O)_{1.00}(OH)_{0.99}]_{\Sigma 1.99}$. ***Relationship to other species:*** It is a member of the tsumcorite group; specifically, the nickel-dominant analogue of lotharmeyerite.

Name: For the relationship with lotharmeyerite. ***Comments:*** IMA No. 1999-008.

KRAUSE, W., BERNHARDT, H.-J., EFFENBERGER, H., and MARTIN, M. (2001) Cobalttsumcorite and nickellotharmeyerite, two new minerals from Schneeberg, Germany: description and crystal structure. *Neues Jahrbuch für Mineralogie, Monatshefte* **2001**, 558–576.

Ominelite — Orthorhombic

$(Fe,Mg)Al_3BSiO_9$

Locality: Along the Misen River, Misen pluton, Omine Mountains, Nara Prefecture, Japan.

Occurrence: In a porphyritic granite and granodiorite. Associated minerals are: alkali-feldspar, plagioclase, quartz, sekaninaite, andalusite, topaz, garnet, biotite, muscovite, dumortierite, schorl, zircon, apatite, monazite, ilmenite, pyrite, cordierite, sericite and chlorite.

General appearance: Elongated and euhedral to equant and anhedral grains (up to 0.5 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* not mentioned but probably transparent to translucent. *Color:* blue. *Streak:* pale blue. *Luminescence:* none mentioned. *Hardness:* about 7. *Tenacity:* not given but probably brittle. *Cleavage:* none. *Fracture:* not given. *Density:* not measured, 3.20 g/cm³ (calc.); given as 3.169 g/cm³. ***Crystallography:*** Orthorhombic, *Pbnm*, *a* 10.343, *b* 11.095, *c* 5.7601 Å, *V* 661.0 Å³, Z 4, *a:b:c* = 0.9322:1:0.5192. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.21 (vs) (200), 5.05 (vvs) (101), 2.97 (s) (301), 2.79 (s) (040), 2.18 (s) (150, 421, 312). ***Optical data:*** Biaxial (–), α 1.631, β 1.654, γ 1.656, 2V(meas.) 31.5°, 2V(calc.) 32°; dispersion v ⩾ r, strong; pleochroism X = pale blue-green, Y = colorless, Z = pale blue-green; orientation, Y = *c*. ***Chemical analytical data:*** Means of five sets of electron microprobe data: MgO 1.20, CaO –, MnO 0.44, FeO 21.05, ZnO 0.20, B_2O_3 10.69, Al_2O_3 47.98, SiO_2 19.22, P_2O_5 0.21, F –, Total 100.99 wt.%. Empirical formula: $(Fe_{0.92}Mg_{0.09}Mn_{0.02}Zn_{0.01})_{\Sigma 1.04}Al_{2.97}B_{0.97}(Si_{1.01}P_{0.01})_{\Sigma 1.02}O_{9.00}$. Two other sets of analytical data are given. ***Relationship to other species:*** It is the Fe^{2+}-dominant analogue of grandidierite, $(Mg,Fe^{2+})Al_3BSiO_9$.

Name: For the Omine Mountains. ***Comments:*** IMA No. 1999-025.

HIROI, Y., GREW, E. S., MOTOYOSHI, Y., PEACOR, D. R., ROUSE, R. C., MATSUBARA, S., YOKOYAMA, K., MIYAWAKI, R., MCGEE, J. J., SU, S.-C., HOKADA, T., FURUKAWA, N., and SHIBASAKI, H. (2002) Ominelite, $(Fe,Mg)Al_3BSiO_9$ (Fe^{2+} analogue of grandidierite), a new mineral from porphyritic granite in Japan. *American Mineralogist* **87**, 160–170.

Orthominasragrite — Orthorhombic

$V^{4+}O(SO_4)(H_2O)_5$

Locality: The North Mesa mine group (west ½, southwest ¼ of section 35, Township 24 South, Range 11 East), Temple Mountain mining district, Emery County, Utah, USA.

Occurrence: In a silicified tree, approximately 46 cm wide by 30 cm high by an undetermined length. Associated minerals are: pyrite, "various iron sulfates," sulfur, minasragrite and an as-yet undescribed vanadium sulfate.

General appearance: Rounded aggregates (up to 200 μm across).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* not mentioned. *Color:* pale blue to bright blue. *Streak:* pale blue. *Luminescence:* nonfluorescent. *Hardness:* approximately 1. *Tenacity:* not mentioned. *Cleavage:* none observed. *Fracture:* not mentioned. *Density:* could not be measured, 2.00 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, $Pmn2_1$, *a* 7.246, *b* 9.333, *c* 6.210 Å, *V* 420.0 Å³, Z 2, *a:b:c* = 0.7764:1:0.6654. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.699 (100B) (101), 3.734 (20) (021), 3.622 (20) (200), 3.322 (50) (121), 3.108 (20) (002), 2.865 (40) (220), 2.602 (30) (221), 2.363 (20) (230, 202), 2.030 (20) (321). ***Optical data:*** Biaxial (–), α 1.529, β 1.534, γ 1.534, 2V(meas.) +2°, 2V(calc.) 0°; dispersion not mentioned; nonpleochroic; orientation, X = *b*, Y = *c*, Z = *a*. ***Chemical analytical data:*** Electron microprobe data (with H_2O calculated to give 5 H_2O): VO_2 33.88, SO_3 31.97, H_2O (36.30), Total (102.15) wt.%. Empirical formula: $V_{1.01}O_{1.04}(SO_4)_{0.99}\cdot 5.00H_2O$. ***Relationship to other species:*** It is the orthorhombic polymorph of minasragrite.

Name: For the relationship with minasragrite, the monoclinic polymorph. ***Comments:*** IMA No. 2000-018.

HAWTHORNE, F. C., SCHINDLER, M., GRICE, J. D., and HAYNES, P. (2001) Orthominasragrite, $V^{4+}O(SO_4)(H_2O)_5$, a new mineral species from Temple Mountain, Emery County, Utah, U.S.A. *Canadian Mineralogist* **39**, 1325–1331.

Oswaldpeetersite — Monoclinic

$(UO_2)_2CO_3(OH)_2\cdot 4H_2O$

Locality: The Jomac uranium mine, Brown's Rim, San Juan County, Utah, USA.

Occurrence: In the Tertiary Shinarump conglomerate which is rich in organic material such as black coal-bearing smears and logs of partially petrified wood. Associated minerals are: gypsum, cuprite, antlerite, goethite, lepidocrocite, mbobomkulite, hydrombobomkulite, sklodowskite and two undefined uranium minerals.

General appearance: Micrometric prismatic crystals (approximately 0.1 x 0.01 x 0.002 mm) arranged in radiating groups.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* canary yellow. *Streak:* pale yellow. *Luminescence:* nonfluorescent. *Hardness:* between 2 and 3. *Tenacity:* weak. *Cleavage:* parallel to the elongation. *Fracture:* uneven. *Density:* greater than 4.10 g/cm³ (meas.), 4.55 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/c$, *a* 4.1425, *b* 14.098, *c* 18.374 Å, β 103.62°, *V* 1042.8 Å³, Z 4, *a:b:c* = 0.2938:1:1.3033. Morphology: {100}, {010}, {001}, acicular and heavily striated parallel to the length. Twinning: none mentioned. ***X-ray powder diffraction data:*** 8.95 (65) (002), 7.54 (63) (012), 4.55 (96) (031), 4.26 (60) (014), 3.46 (62) (015), 3.32 (100) ($\bar{1}$14), 3.029 (85) (043), 2.273 (62) (062). ***Optical data:*** Biaxial (–), α 1.583, β 1.669, γ 1.712, 2V not measured, 2V(calc.) 67°; dispersion not observed; pleochroism X and Y = very pale yellow to colorless, Z = pale yellow; Z ≈ *a*, elongation is positive. ***Chemical analytical data:*** Means of ten sets of electron microprobe data: UO_3 81.47, H_2O 12.30 (by TGA), CO_2 (6.23) (by difference), Total (100.00) wt.%. Empirical formula: $(UO_2)_{2.03}(CO_3)_{1.01}(OH)_{2.04}\cdot 3.85H_2O$. ***Relationship to other species:*** None apparent.

Name: For Maurice Oswald Peeters (1945–), structural crystallographer at the University of Leuven, Belgium, and researcher in

the field of uranium mineralogy. ***Comments:*** IMA No. 2000-034. The mineral was discovered by Patrick Haynes of Cortez, Colorado, USA.

VOCHTEN, R., DELIENS, M., and MEDENBACH, O. (2001) Oswaldpeetersite, $(UO_2)_2CO_3(OH)_2 \cdot 4H_2O$, a new basic uranyl carbonate mineral from the Jomac uranium mine, San Juan County, Utah, U.S.A. *Canadian Mineralogist* **39**, 1685–1689.

Pararsenolamprite — Orthorhombic

As

Locality: The dump of the Mukuno mine (Lat. 33°28′47″ N, Long. 131°26′15″ E), Yamago-cho, Oita Prefecture, Kyushu, Japan.

Occurrence: In a hydrothermal Sb-As-Ag-Au ore deposit. Associated minerals are: arsenic, stibnite and quartz. Other minerals in the deposit are: pyrite, miargyrite, argentian tetrahedrite, gold, löllingite, claudetite and kankite.

General appearance: Radial or parallel aggregates of bladed crystals (up to 0.8 mm long).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* lead gray. *Streak:* black. *Hardness:* VHN_{25} 66 to 91 kg/mm^2, Mohs 2 to 2½. *Tenacity:* sectile and brittle. *Cleavage:* {001} perfect. *Fracture:* not mentioned. *Density:* 5.88 g/cm^3 (meas.), 5.99 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, $Pmn2_1$ or $P2_1nm$, *a* 3.663, *b* 10.196, *c* 10.314 Å, *V* 382.1 Å^3, Z 18, *a:b:c* = 0.3563:1:1.0116. Morphology: {001}, elongated on [100] and flattened on {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.17 (100) (002), 4.60 (24) (012), 3.259 (58) (013), 2.840 (27) (032), 2.580 (22) (004), 2.299 (23) (024), 1.794 (26) (105). ***Optical data:*** In reflected light: white with a slightly greenish blue tint, strong anisotropism (dark brown, greenish gray), distinct bireflectance (cream parallel to elongation and brown, gray, green perpendicular to elongation). R_1, R_2; $^{im}R_1$, $^{im}R_2$: (49.0, 44.0; 33.6, 29.3 %) 470nm, (47.0, 42.1; 31.5, 28.0 %) 546nm, (44.8, 39.9; 29.7, 26.9 %) 589nm, (44.9, 40.3; 29.2, 26.0 %) 650nm. ***Chemical analytical data:*** Means of eight sets of electron microprobe data: As 91.89, Sb 7.25, S 0.48, Total 99.62 wt.%. Empirical formula: $(As_{0.94}Sb_{0.05}S_{0.01})_{\Sigma 1.00}$. ***Relationship to other species:*** It is the third polymorph of As; the others are arsenic (trigonal) and arsenolamprite (orthorhombic).

Name: For the relationship with arsenolamprite. ***Comments:*** IMA No. 1999-047.

MATSUBARA, S., MIYAWAKI, R., SHIMIZU, M., and YAMANAKA, T. (2001) Pararsenolamprite, a new polymorph of native As from the Mukuno mine, Oita Prefecture, Japan. *Mineralogical Magazine* **65**, 807–812.

Rinmanite — Hexagonal

$Zn_2Sb_2Mg_2Fe_4O_{14}(OH)_2$

Locality: The Garpenberg Norra zinc-lead mine, Hedemora, Dalarna, south-central Sweden.

Occurrence: In a skarn assemblage within dolomite marble. Associated minerals are: dolomite, calcite, manganoan tremolite, zincian manganocummingtonite, manganoan talc, franklinite, barite and svabite.

General appearance: Euhedral prismatic crystals (up to about 0.5 mm).

Physical, chemical and crystallographic properties: *Luster:* submetallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* brown. *Hardness:* VHN_{100} 880 kg/mm^2, Mohs about 6. *Tenacity:* not given. *Cleavage:* {100} well developed. *Fracture:* splintery. *Density:* could not be measured, 5.11 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3mc$, *a* 5.9889, *c* 9.353 Å, *V* 290.53 Å^3, Z 1, *c:a* = 1.5617. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.474 (34) (102), 2.994 (43) (110), 2.673 (44) (103), 2.522 (100) (112), 1.6597 (28) (213), 1.5170 (33) (205), 1.4972 (54) (220). ***Optical data:*** In reflected light: gray, moderate anisotropism, weak bireflectance, nonpleochroic. R_o, R_e: (13.6, 12.2 %) 460nm, (12.9, 11.8 %) 540nm, (12.7, 11.7 %) 580nm, (12.1, 11.3 %) 660nm. In transmitted light, uniaxial (–), dichroic with O dark red and E orange-red; approximate indices of refraction calculated from reflectance data at 589nm are ω 2.10, ε′ 2.04. ***Chemical analytical data:*** Means of thirty sets of electron microprobe data: MgO 8.97, MnO 2.47, ZnO 14.24, Al_2O_3 0.82, Fe_2O_3 34.33, TiO_2 0.01, Sb_2O_5 36.31, H_2O 1.99, Total 99.14 wt.%. Empirical formula: $(Zn_{1.58}Mn_{0.31}Mg_{0.06})_{\Sigma 1.95}Sb_{2.03}(Mg_{1.95}Fe_{3.88}Al_{0.15})_{\Sigma 5.98}O_{14.01}(OH)_{1.99}$. ***Relationship to other species:*** It is isostructural with nolanite, $(V^{3+},Fe^{2+},Fe^{3+},Ti)_{10}O_{14}(OH)_2$.

Name: For Sven Rinman (1720–1792), mining scientist, metallurgist and chemist who was a member of the *Bergskollegium* (Board of Mines). He is sometimes considered the father of the Swedish mineral industry. ***Comments:*** IMA No. 2000-036.

HOLTSTAM, D., GATEDAL, K., SÖDERBERG, K., and NORRESTAM, R. (2001) Rinmanite, $Zn_2Sb_2Mg_2Fe_4O_{14}(OH)_2$, a new mineral species with a nolanite-type structure from the Garpenberg Norra mine, Dalarna, Sweden. *Canadian Mineralogist* **39**, 1675–1683.

Rouaite — Monoclinic

$Cu_2(NO_3)(OH)_3$

Locality: The old copper mines at Roua, Alpes Maritimes, France. It has been identified also from the Sterling Hill mine, Ogdensburg, New Jersey, USA.

Occurrence: In cavities in cuprite. Associated minerals are: cuprite, copper, silver, algodonite, domeykite, malachite, connellite, olivenite, theoparacelsite and gerhardtite.

General appearance: As aggregates (up to 0.5 mm in diameter) of equidimensional to elongated crystals (up to 0.1 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* dark emerald green. *Streak:* green. *Luminescence:* nonfluorescent. *Hardness:* could not be measured because of the small size. *Tenacity:* brittle. *Cleavage:* {001} perfect. *Fracture:* uneven. *Density:* 3.38 g/cm^3 (meas.), 3.38 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1$, *a* 5.596, *b* 6.079, *c* 6.925 Å, β 94.67°, *V* 234.8 Å^3, Z 2, *a:b:c* = 0.9205:1:1.1392. Morphology: {001}, {100}, {110}, {1$\bar{1}$0}, {0$\bar{1}$1}. Twinning: rare on {001}. ***X-ray powder diffraction data:*** 6.91 (100) (001), 3.457 (90) (111, 002), 2.669 (80) (120), 2.462 (80) (121), 2.250 (50) ($\bar{2}$02), 2.154 (40) (013), 2.078 (50) (122, 103). ***Optical data:*** Biaxial (+), α 1.700, β 1.715, γ 1.738, 2V(meas.) 81°, 2V(calc.) 79°; dispersion r < v, strong; pleochroism X = dark green blue, Y = green blue, Z = light green to colorless; X ∧ *a* = 5° (in obtuse angle β), Y = *b*, Z ≈ *c*. ***Chemical analytical data:*** Mean of five sets of electron microprobe data (H_2O by CHN): CuO 65.50, N_2O_5 21.64, H_2O 11.90, Total 99.04 wt.%. Empirical formula: $Cu_{1.99}(NO_3)_{0.97}(OH)_{3.19}$. ***Relationship to other species:*** It is a dimorph of gerhardtite (orthorhombic).

Name: For the type locality. ***Comments:*** IMA No. 1999-010.

SARP, H., ČERNÝ, R., and GUENEE, L. (2001) Rouaite, $Cu_2(NO_3)(OH)_3$, un nouveau mineral: sa description et sa structure cristalline Alpes-Maritimes, France). *Riviéra Scientifique* **85**, 3–12.

Advertisers Index

New Video!

An Exhaustive BUYER'S GUIDE and tour-de-force of the Gem Species and the Native Elements. Hundreds of specimen and locality photos! $39.75 ppd.

* Also order our previous Video! Professionally produced video documentary program on worldwide localities and minerals from the Proctor Collection $32 ppd.

You can preview this collection with a 96-minute, professionally prepared video. This live-action presentation features 180 specimens, individually filmed, and 35 mine location photos to illustrate the history and workings of many great mines and their crystal treasures. This unique, educational video graphically illustrates the 12 criteria used to assemble this world-class collection. To order your video send $29.50 plus $2.50 postage.

Dr. Wendell Wilson in his video review in *M.R.*, Nov/Dec 1992, p. 504, says "The collector of aesthetic mineral specimens will find much to savor in Keith Proctor's video catalog of his collection. . . . It really delivers in terms of extraordinary mineral images and specimen information and will stand for many years to come as a historically valuable documentation of one of the great private collections of our time."

"The video offers an opportunity to see and study Proctor's exquisite specimens at leisure. Many are pictured on slowly revolving turntables, allowing all sides of the specimens to be seen, and their three-dimensional shapes to be fully realized, as reflections play across crystal faces and gemmy interiors . . . this really is one of the best private collections ever assembled." Video Review: Nov/Dec '92

KEITH PROCTOR

Contact Brook Proctor at 801-501-0995

Address: 663 E. 13800 S., Draper, UT 84020

Photo by Harold & Erica Van Pelt

All the wonder and wealth of the mine
In the heart of one gem

- Robert Browning

Pala International
Palagems.com Collectorfinejewelry.com
800 854 1398; 760 728 9121