THE MINERALOGICAL RECORD

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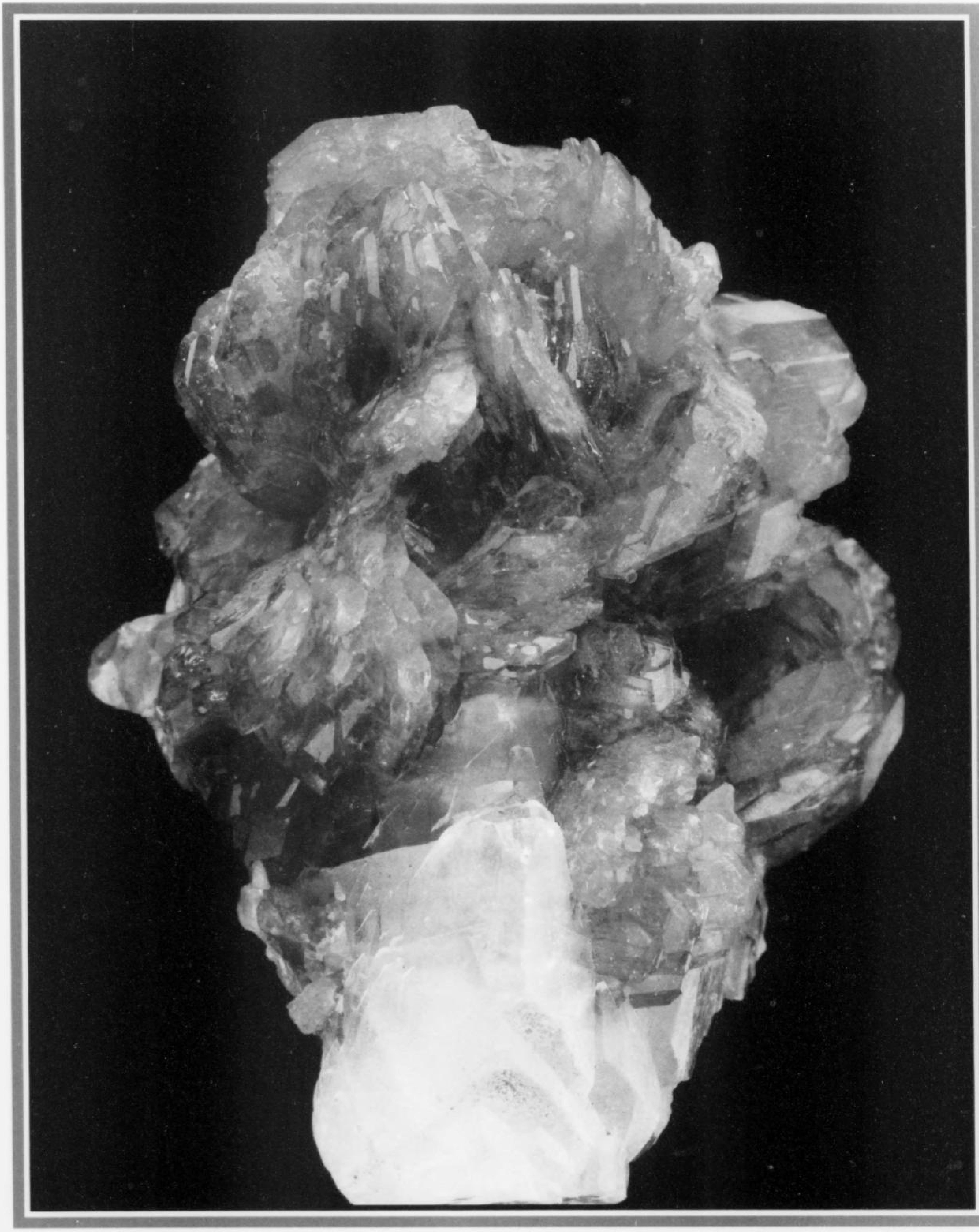

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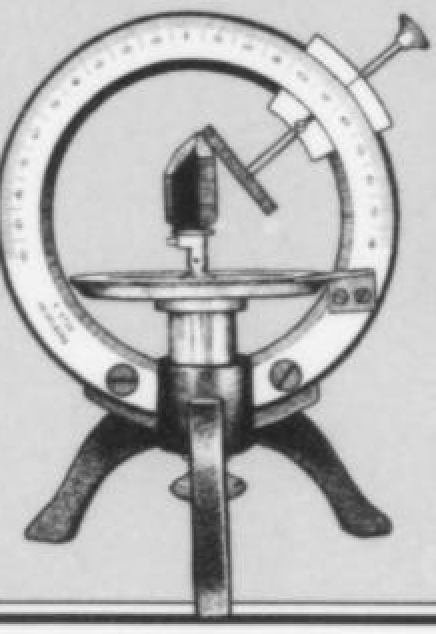

THE MINERALOGICAL RECORD

July–August 2007 Volume Thirty-eight, Number Four

Articles

Columns

COVER: TINZENITE crystal cluster, 3.9 cm, on calcite, from Wessels mine, Kalahari Manganese Field, South Africa. This specimen, from the Charles Key collection, is probably the world's finest example of the species. Rob Lavinsky/Arkenstone/Marshall Sussman specimen, now in the Steve and Ciara Smale collection; Jeff Scovil photo.

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Editorial:

PHOTOGRAPHS: A PRIORITY FOR MUSEUMS?

Much has been written over the years regarding the place of mineral museums in society, and the various services and functions that curators can perform. Nothing, however, has been said about the responsibility that museums have for showing their treasures to the world via color photography.

Back in 1987, the *Mineralogical Record* published a position paper by the International Mineralogical Association, written by Peter G. Embrey (former curator of mineralogy at the Natural History Museum, London), entitled "Mineral curators, their appointment and duties." This document listed some of the main responsibilities of a mineral curator: (1) Care and cataloging of the collection; (2) Growth of the collection; (3) Exhibition and education; (4) General duties and public relations; and (5) Personal research. Additionally, under "general duties" one of the duties specified was to "process loan requests," presumably the loan of research specimens but surely also the loan of exhibit specimens for temporary display at other institutions and events. The Embrey document said nothing about the preparation of specimen photographs for loan, or providing access to specimens specifically for the purpose of having such photographs prepared, or, for that matter, the value inherent in making color photographs of museum specimens available for publication.

"Loan requests" most often come from mineralogical researchers, that small but hardy band of scientists determined to extend our scientific understanding of the mineral world. Pete Dunn and Joel Grice (Smithsonian Institution and Canadian National Museum of Natural Sciences, respectively) discussed the relationship between researchers and museums in their 1991 essay in the *Mineralogical Record* entitled "Mineral research in museums." They talked about the various aspects of taxonomic and systematic mineralogical research, crystal structure analysis, new mineral descriptions, species discreditations, species redefinitions and revalidations, group studies and locality-oriented studies (all laudable scientific goals), with an emphatic note about the *value of publication*. They said nothing about the value inherent in publishing photos of museum specimens—just the scientific data extracted from them.

Going back even farther, Pete Dunn wrote a 1979 guest editorial entitled "When you are all through collecting," in which he urged collectors to bequeath their collections to deserving and well-managed museums, for the good of society. Surely a donor would want, above all else, that his specimens be of use to someone . . . to a researcher or simply to people who want to *see* his specimens. Insufficient thought is sometimes given to how, or whether, that is achieved, other than by public display and research loans.

In the past, photographic documentation has not generally been put on the same level of priority as actual research, perhaps because it requires little, if any, learned interpretation. On a photograph, information about the species and the specimen is clearly visible for all to see. The viewer can see the subtle details of crystallization, habit, luster, clarity, color, etc. for himself, and the researcher is not needed to write a detailed description, other than to specify the species identity and locality. Instead, the written description has almost always taken scientific precedence over the visual image, in part because of the higher cost of printing high-quality color photography in technical journals, and also because encoding visual information in the written word makes that information more portable, quotable, tabulatable, and indexable for the scientific community. Nevertheless, much indefinable information is always lost when a picture is converted to words. There is no perfect substitute for documentation via visual imagery. This is especially true in the case of specimens that are later stolen or accidentally destroyed.

Each specimen has its potential uses that will be of benefit to science and society. Many certainly will have potential research value at some time in the future, but the likelihood of that varies with each piece. Display-quality specimens of the common species are relatively unlikely to ever be of much scientific use. Those species have, in many cases, been known for centuries, and generations of mineralogists worldwide have pored over them, characterizing and describing their every aspect in exquisite detail, their every secret prized lovingly from them and recorded in the literature. There is just not a lot left to learn from some species. Most of the fine fluorite specimens in the world, for example, will probably never be needed for scientific research.

There are no absolutes, of course, and future scientific techniques, revelations and paradigms cannot be predicted. But the odds are overwhelming that, even after new analytical approaches and concepts have been developed, the vast majority of the countless thousands of fine specimens of relatively common species in museums today will never be needed for scientific research. Those specimens have only *one useful destiny*: to be *seen*, to be visually appreciated, to educate and to inspire interest in mineralogy among members of the public who are allowed to see them. That destiny can be fulfilled in only two ways: public display and published photography. And if anyone other than the limited population of museum visitors (and visitors to traveling exhibits) is to benefit from that destiny, it will need to be via published photography. Otherwise many of those specimens will probably do nothing but absorb public funds to pay storage expenses for the next thousand years.

It costs a lot in terms of floor-space and overhead to store and maintain a large mineral collection. Given such an investment, is it not a corresponding responsibility to make certain that the specimens can be of some actual use to the mineral world and the general public? The sad case of the Vaux collection at the Philadelphia Academy of Science is a prime example of a collection gone almost entirely unused for generations. Locked away and generally unexhibited, it did no one any good. If, however, the Academy administration had arranged for a significant selection of the specimens to be photographed, or had given outside photographers access, or had arranged for photographic services to be made available upon request, the resulting bonanza of fascinating specimen images would have benefitted the mineralogical community worldwide.

It is fine for distinguished curators to tell us their professional viewpoints regarding the function of museums in society. We have a lot to learn from them and their many years of experience. But once in a while those of us who comprise the external constituencies of public mineral museums need to ask ourselves what *we* would like them to do for us. We are, after all, the source of most specimens that go into public museums, and our tax dollars help to support such institutions. So, what do we want most from the world's mineral museums? The answer is quite simple: we just want to see what they have.

Exhibits in the museum and the occasional temporary traveling exhibit give some of us a taste—those of us, that is, who can personally visit the museum or the events sponsoring traveling exhibits. But there are so many museums, and so many interesting specimens not on public display. And each of us has only limited opportunities for travel. There is a more egalitarian service that we can ask for, one which serves members of our constituency worldwide, and which has a permanency outlasting even many of the specimens themselves: high-resolution *color photographs*. Photographs in books, photographs in magazines, photographs in show catalogs, photographs on CD's and DVD's, and photographs on the Internet. An extra advantage is that depiction in a publication allows far more related information to be conveyed in the accompanying text than will fit on an exhibit label, thus the result is much more educational, and can be repeatedly revisited at leisure. For many museum specimens this may be the only way that they can ever be of use to anyone.

It should go without saying, of course, that photos can never actually replace the real specimens in museums. There is no perfect substitute for the privilege of seeing a specimen in person, looking at it from all sides, examining critical areas very closely, and studying it under varying lighting conditions. There is also the possibility that someday the specimen may be split or trimmed and will reveal surprising aspects inside that were previously hidden. Mineral specimens are a cultural and scientific treasure which must be protected and preserved. Many are actually extinct at the localities where they were found, and may never be found again in the habits and colors they show. This needs to be remembered—a photo of a dodo bird would be great to have, but not as great as having the real thing!

It is certainly true that a number of museums have taken admirable steps in the direction of photodocumentation. Some have published or aided in the publication of books illustrated with photos of their specimens, and this is something we must all be grateful for. Some museums do permit qualified professional photographers access in order to document their specimens; some have curators who can take publication-quality photos themselves upon request; and some maintain files of specimen photos that are available to authors and publishers. In fact, a few museums (like Harvard, the Carnegie Museum and the École des Mines) have begun programs to photograph their specimens and post an illustrated catalog of their collection on the Internet! Bravo! They are serving the mineralogical community and deserve our wholehearted support!

In other cases, however, there is little or no effort made to generate photography, and access is routinely blocked. Requests for photos are scorned. Specimens (usually of relatively low dollar value) are loaned freely for research, but not for photography. In-house museum photographers are often more of a hindrance than a help, providing justification for blocking outside photographers, operating on interminably sluggish timetables, and charging exorbitant fees, so that the end result is very few photos published.

My suggestion in this editorial is simply that the administrators of mineral museums consider it one of their goals, an important category of service, a part of their mission, and a wise precaution against future problems, to somehow facilitate the photographic documentation of their collections as needed for legitimate publication purposes and Internet databases. A museum should feel an obligation to document and show off its treasures to the world, and should be willing to devote a modest fraction of curatorial time and resources in pursuit of that goal.

Wendell E. Wilson

notes from the EDITORS

The Lost Arts of Mineralogy

Back in the "old days," before the ready accessibility of X-ray and microprobe analysis services for the mineral collector, we had to (gasp!) know how to do *our own* mineral identifications in *our own* home, on a desktop or workbench laboratory. Using comparatively simple tools and techniques which required a functional understanding of some rudimentary chemistry and physics, we performed our own tests to identify unknown species. In those days, that was the essence of being an "amateur mineralogist" rather than just a mineral collector. It was fun and educational.

With the changing trends in mineralogy and mineral collecting over the years, the practice of "classical mineralogy" has become virtually a lost art among the general population of collectors, and in fact is not much taught in University mineralogy courses anymore either. Even back in the 1960's, my old chemistry professor at the University of Minnesota, Dr. Cowles, was quite disgruntled over the trend. He used to complain that, before the young upstarts could get their big fancy machines warmed up to do a chemical analysis, he could find the answer using just an eyedropper, a test tube and a couple of liquid reagents.

Every collector runs into identification problems from time to time. Sometimes, you have the sneaking suspicion that there is a simple analytical technique to answer the identification problem before you, but you just can't remember it, nor are you sure where to look it up, or even whether you still have the necessary collection of ancient texts in your library. Well, now you need wonder no more. To the rescue comes the Mineralogical Record, lighting a candle in the darkness with the publication of Donald Peck's unique manual, *Mineral Identification, A Practical Guide for the Amateur Mineralogist.*

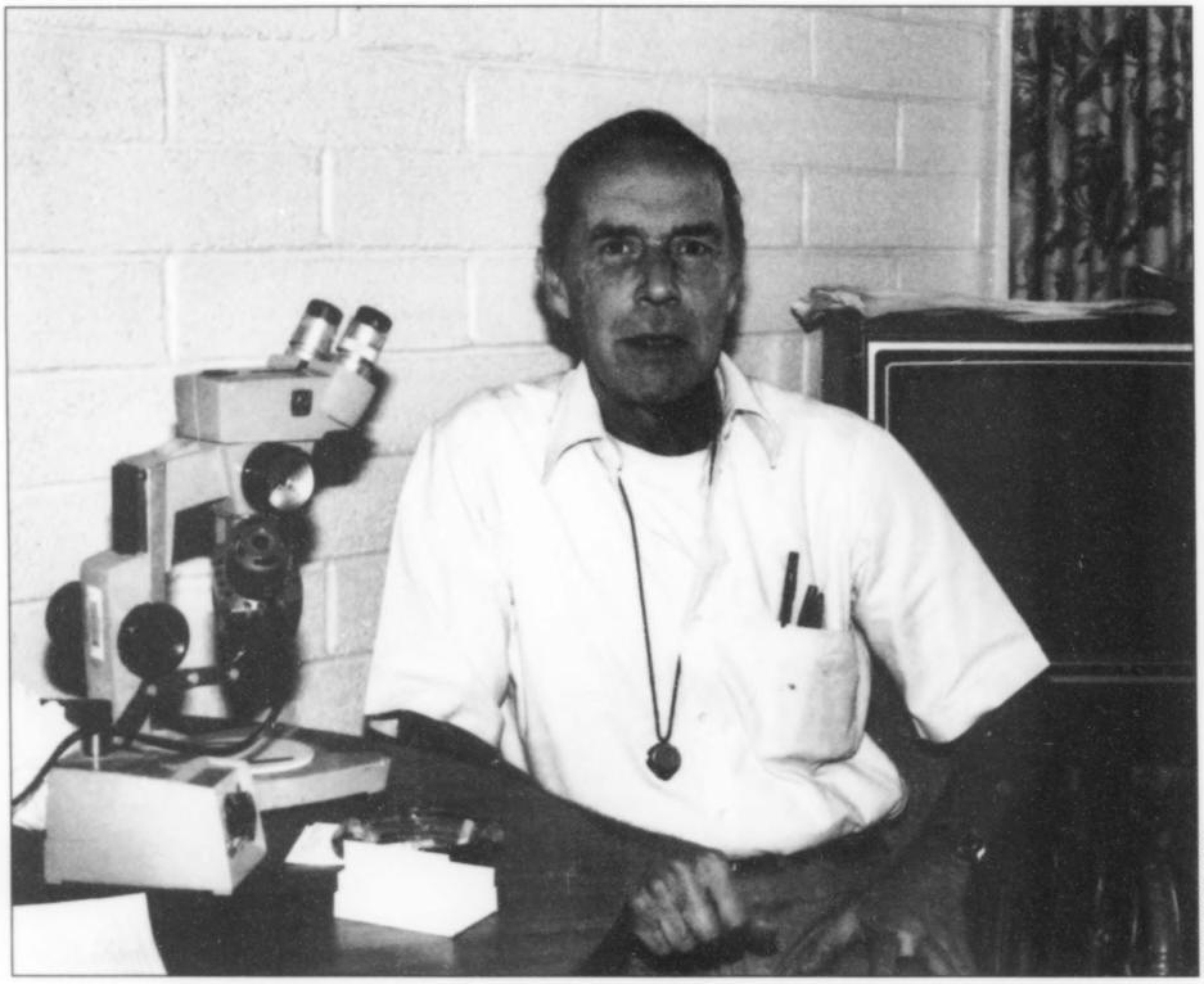
In a succinct 262 pages, Peck provides a compendium of techniques for home identification using physical properties, crystal morphology, simple chemical analysis, and optical properties—all without utilizing a single machine in the six-figure price range. These lost arts of mineralogy have been gathered together from a dusty array of old books and publications that are now hard to find, even if you know what to look for. Nearly half the book consists of useful appendices covering reference works, instruments you can make yourself, reference tables, suppliers, and a shopping list of reagents and simple equipment for stocking your home lab. You can even make your own crystal models. And it comes with a CD full of additional information, all for just $35.

The book has a sturdy spiral binding that will lie flat on the workbench. Copies can be ordered via the Bookstore at www.MineralogicalRecord.com, or by e-mailing the Circulation Manager at minrec@aol.com. We don't expect to make much, if any, profit on this publication, nor does the author. Publication is being carried out primarily as a service to the mineralogical community. So take the opportunity now to acquire this treasury of hard-to-obtain information all in one volume. The press run is limited, and we can't guarantee how long we will be able to afford to keep it in print.

Big Bucks in Tucson

The Metropolitan Tucson Convention and Visitors Bureau estimates that the January-February 2007 "Tucson Gem, Mineral and Fossil Showcase" (their term for the agglomeration of 49 individual shows including the Tucson Gem & Mineral Society's show at the convention center) attracted some 55,000 attendees, 50% of whom were from out of town (from 43 states and 24 foreign countries). This is up 57% from the attendance in 2000. A total of 5,079 dealers were recorded at the various shows, coming in from 42 states and 38 foreign countries. The event pumped approximately $100 million into the local economy, primarily via hotel, car rental and restaurant purchases, among other things. This figure (which does *not* include mineral, fossil and gem sales) is up 31% from the year 2000. Nearly half of the dealers at the various shows did some shopping while in town, and a third of them reported taking some time off to visit some of the area's tourist attractions. Two-thirds of the out-of-town buyers planned to return in 2008.

A survey of the various promoters of the 49 shows revealed that the average cost to produce a show in Tucson was nearly $350,000. The average cost to attend the show as a dealer from out of town was over $6,000, whereas the average cost for an out-of-towner attending simply as a buyer was $1,825. Everyone from out of town (show promoters, dealers and buyers) accounted for a total of 195,000 room nights in local hotels and motels, at an average nightly room rate of $130.


KENT ENGLAND

Sidney A. Williams (1933–2006)

Died, Sidney A. Williams, 72

Sidney Arthur Williams died in his home in Douglas, Arizona on December 8, 2006 from lung cancer. Sid was born December 26, 1933 in Ann Arbor, Michigan, the son of Edward Watkin and Helen (Southgate) Williams. He attended the Michigan College of Mining and Technology (now Michigan Technological University), where he completed a Bachelor of Science program in Geology and a Master of Science program in Mineralogy (1957) with a thesis titled "A Study of Chlorastrolite."

Sid's interest in mineralogy was sparked at an early age when he found a 2.5-carat diamond that had been lost in the family driveway many years before. This interest was reinforced by Clarence Seebaldt, a neighbor. Seebaldt's father was a practicing mining engineer in Colorado and had assembled a mineral collection that was eventually given to Sidney by the family. Dr. Edward Kraus at the University of Michigan also encouraged Sid to pursue a career in mineralogy.

He continued his education at the University of Arizona, and graduated with a PhD in 1962. His dissertation is oriented towards mineralogy-petrology-geochemistry, and is titled "The Mineralogy of the Mildren and Steppe Mining Districts, Pima County, Arizona." During this time he met and became good friends with Richard Thomssen and Richard Bideaux. The three published the *Mineral Explorer* series of informal notes on mineralogy and mineral collecting locations.

Sid returned to Michigan Tech from 1960 to 1963 while finishing his dissertation, becoming an assistant professor. During the summer of 1962 Sid worked for Anaconda as a petrographer in the Salt Lake City office, and returned to Michigan Tech in the fall. He left Michigan Tech and joined Einer Erikson at Silver King Mines in Ely, Nevada in 1963, where he worked as an exploration geologist. In January 1964 Sid received a two-circle goniometer from Heidelberg, Germany that he used to measure crystal forms. This was a pride of his and he was always ready to show it off.

In 1965 he left Silver King Mines to manage the Research Laboratory for Phelps Dodge Corporation, Western Exploration Office, in Douglas, Arizona. The main emphasis of the lab was research into porphyry copper and molybdenum systems. Sid had an arrangement with Phelps Dodge whereby he was allowed to take consulting jobs on his own time. It was then that Sid, with his wife and partner, Betty Jo, began their mineral dealership, called *Globo de Plomo* ("Lead Balloon!").

In 1971 he took a sabbatical from Phelps Dodge to spend some time in the British Museum (Natural History) in London. During his studies there he worked on the naturally occurring lead-chromate minerals, resulting in the description of embreyite. He then met Fabien Cesbron, and developed a lasting friendship with Fabien, Peter Embrey, Max Hey and several others on the staff at the Museum. By September of 1980 Sid had expanded his consulting business to include a Kevex (X-ray fluorescence) unit, while continuing to manage the research laboratory for Phelps Dodge. Within a few years he purchased a new electron microprobe for his consulting company.

In 1985 Fabien Cesbron named a new molybdenum oxide mineral *sidwillite*, in honor of Sid and his work in copper–molybdenum porphyry exploration (see *Bulletin de la Société Française de Minéralogie et Cristallographie,* vol. 108, p. 813–823). Richard S. Mitchell later wrote about Sid in *Rocks & Minerals* (see vol. 57, p. 11; vol. 62, p. 167; and vol. 63, p. 36–37). In 1982, Sid left Phelps Dodge when the company moved the Western Exploration Office from Douglas to Tucson. Sid remained active in his consulting business until 2005, with the amount of work tapering off in the later years.

Sid Williams was a remarkable mineralogist and a good friend. His contribution to mineralogical research has provided science with 53 new mineral species and a much greater understanding of the occurrence and character of many other species. Sid authored or co-wrote over 80 papers on mineralogy and related exploration geology. As an exploration geologist his understanding of mineralizing systems, based on mineralogy and chemistry, led to several major discoveries. His concepts were so successful in Chile that he earned the nickname *El Mago* ("The Magician").

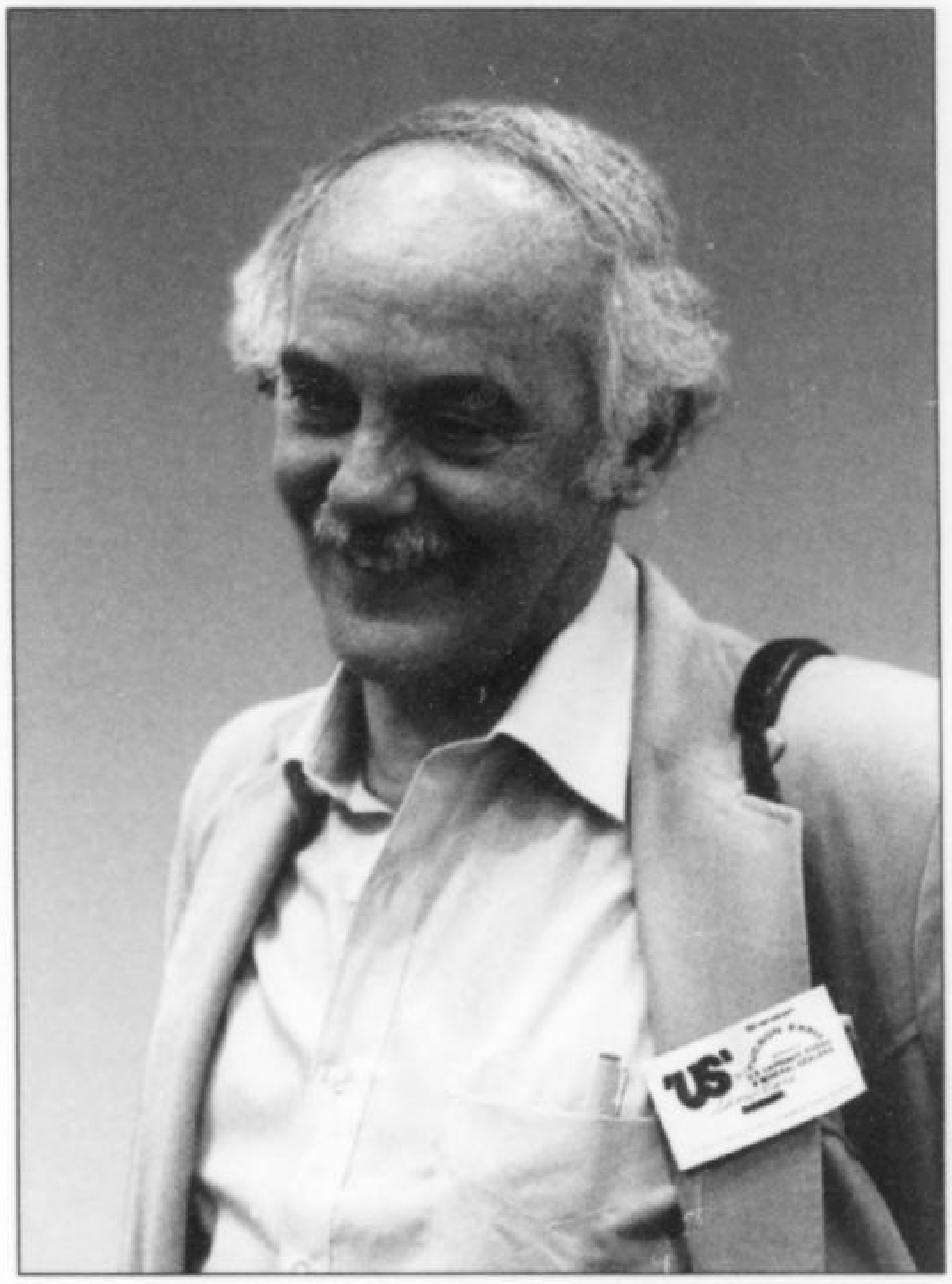
Sid was a mentor to many of the young geologists at Phelps Dodge Corporation during the 1960's and 1970's, with his unique style of teaching by detailed observation and questioning. As a student you had to understand the concepts in order to ask the questions that would take you to the next level. This form of education instills confidence as well as understanding of the physical and chemical systems involved in the formation of mineral deposits.

In closing is must be noted that Sid's real love was mineralogy and the description of new minerals. His studies of the petrology and mineralogy relating to the oxidized zones of base metal and precious metal deposits will be used by geologists far into the future. In addition, he had a great interest in the history of chemistry and mineralogy, especially during the 18th and early 19th centuries.

Dr. Sidney A. Williams was a Fellow of the Mineralogical Society of America, and a member of the following organizations: the Society of Economic Geologists, the Canadian Mineralogical Society, the Mineralogical Society of Japan, and the Mineralogical Society of Great Britain.

Sid's greatest single contribution to mineralogy was the monumental effort that he put into co-authoring the *Mineralogy of Arizona*, all three editions. This is a reference work that will be used for decades to come by professional as well as amateur geologists and mineralogists working in Arizona.

Jim McGlasson



KENT ENGLAND

Ernest S. Schlichter (1929–2007)

Died, Ernie Schlichter, 77

Ernest S. "Ernie" Schlichter was born in Minesite (Lower Macungie), Pennsylvania on May 30, 1929, the son of Cora Reese and Jacob Schlichter, a house carpenter. He grew up in Pennsylvania and graduated from Allentown High School in 1946, then went on to earn his Bachelor's degree in Electrical Engineering from Lehigh University in 1950. After a stint in the Air Force as a 1st Lieutenant during the Korean War he spent the rest of his professional career working for Sylvania (1952–1967), Digital Group Multiplex and Raytheon, settling in Sudbury, Massachusetts in 1967 with his wife Vera (nee Hanke).

Ernie was an enthusiastic mineral collector, and built a large and interesting collection over the years, not only by purchase but by field collecting. It had depth and historical interest as well as quality, and included a well-known Michigan Copper Country suite among many other things. He and John Marshall formed their own specimen recovery company in the late 1960's, which they called the *Resurrection Mining Company;* they obtained leases on the Wise fluorite mine in New Hampshire and the amethyst occurrence at Bellingham, Massachusetts, and were rewarded with some fine specimens. Ernie also collected excellent specimens at Mont Saint Hilaire and Acushnet, Massachusetts; he traveled widely in the search for specimens, and was a regular at the Tucson, Springfield and Munich Shows, among others. He dealt in minerals on the side (under the company name of "The Show Case"), but not regularly, and sold off most of his dealer stock during the last few years before he died; Rob Lavinsky received some specimens to sell for him. Much of Ernie's personal collection remains with his wife Vera at present, and is being appraised for future sale.

During his off hours Ernie was also an excellent woodworker, and specialized in four-drawer mineral cabinets in a variety of hardwoods, but primarily mahogany and oak. They are fine examples of craftsmanship, well-designed, well-made and smoothly operating.

Ernie was an intelligent, dedicated collector, always friendly and full of gentle good humor. He died on March 16, 2007, after a two-year battle with cancer.

Wendell Wilson
and **John Marshall**

Online Label Archive is now the Biographical Archive

We have recently renamed the **Label Archive** portion of our website as the "**Biographical Archive,**" so that we can feel free to add biographies and portraits of anyone in the mineral world, even if they have not left labels. Naturally the Label Archive will remain the principal basis for selections of biographical subjects and the labels to illustrate them. Interestingly, in terms of hits, the Label/Biographical Archive is the single most popular feature of our website!

The Label Archive itself continues to receive donations of labels from readers, making it ever more valuable as a historical resource. Thus far we have received collections and small lots of labels from over 40 individuals and institutions. Readers may wonder whether duplication is a problem; it's not. We like to archive as many labels as possible from the same dealers and collectors because it gives a better perspective on the kinds of minerals they carried, and the kinds that were available on the mineral market in their time period. A label is truly a duplicate only if the species, locality and handwriting are identical, as well as the pre-printed portion. So, if you have labels you don't need but are concerned that we might already have them, don't worry—they will be gratefully received and archived.

Bear in mind that in most cases we do not advocate separating a mineral from its old label, even if subsequent labels preserve the species/locality data. The exceptions might be old specimens of such commonness and poor quality that they are essentially worthless to science and as modern-day collectibles. We do advocate the photocopying of labels so that the original can be donated to us and the photocopy kept with the specimen as documentation of its provenance. A photocopy of a label will probably last longer and be more durable than the original.

So make a visit to the Biographical Archive. There is a great deal of interesting reading on dealers, collectors, curators and institutions—including many people who are currently still active. If you have a favorite dealer who is included, you can get to know him better by reading about his background. If you sell minerals yourself through your website, and you have a specimen with an old label, add a link to the appropriate page in the Biographical Archive to give your potential buyers some extra provenance information and history to associate with the specimen. They may never have heard of A. E. Foote, for example, and the extra information will add interest to the specimen.

Recent additions to the Biographical Archive on our website include those listed above (among many others); many are accompanied by portrait photos. Take a look, and remember to refresh the page with the drop-down menu first, if you haven't lately. Should you prefer to browse through the list without using the drop-down menu, just click on the crossed hammers on the title page of our website to access the "secret" site map, and click on page 2 where you will find the list. If any of the profiled individuals were personal friends

Some Recent Additions to the Biographical Archive at www.MineralogicalRecord.com

Parker Cleaveland
Forrest E. Cureton II
Rock Currier
Susie Davis
Paul Desautels
Laszlo Dudas
Thomas Alva Edison
Benny Fenn
Walter F. Ferrier
Lewis Feuchtwanger
Gustav Flink
Jacon Forster
Will Frech
Freiberg Mining Academy
August Frenzel
David Garske
J. R. Geigy
Ewald Gerstmann
Christian Gobin and sons
Marion Godshaw
Beau Gordon
Hatfield Goudey
John Graves
James Gregory
John Grieger
Jean Hamel
Jesse Hardman
George Harlow
Andrew Hartman
William E. Hidden
Charles Hitchcock
Harold H. Hodgkinson
Albert F. Holden
Albin Jahn
Dick Jones
Frank J. Keeley
Richard Kelley
Rustam Kothavala
Saul Krotki
George F. Kunz
O. Ivan Lee
Bryan Lees
John I. Legro
Stan and Beth Lesnick
Thomas J. Lewis
E. P. "Matt" Matteson
James McGlasson
Al McGuinness
Tom McKee
Jim Minette
Henri Minod
Vincent Morgan
Tony Nikischer
Chester D. Nims
Reuben S. Nolt
Arch Oboler
Don Olson
Tom Palmer
Bill Panczner
Jack Parnau
Willard ("Perky") Perkin
Les Presmyk
Charles Purrington
Rocky Quinn
Julian Reasenberg
Miguel Romero
Robert "Bob" Roots
Sir Arthur Russell
Ernie Schlichter
Bill Schneider
Theodor Schuchardt
Anthony Schumacher
Benjamin Silliman (Jr.)
Brad Van Scriver and family
Lee Shale
Rick Smith
J. Selden Spencer
Frederick Staebner
Bob Sullivan
Erberto Tealdi
Victor Vescovi
Kevin Ward
Benjamin Waterhouse
Charles M. Wheatley
John Whitmire
Prosper Williams
Sidney A. Williams
Charles P. Willimott
Neal Yedlin
Martin Zinn
Peter Zodac
Miriam & Julius Zweibel

of yours and you have more information about them to contribute, just click on the e-mail link at the end of their biography.

We still have a ways to go in filling out the Biographical Archive, inasmuch as we have over 3,000 dealers and collections represented among the 15,000 labels in the Label Archive, whereas "only" about 850 biographies (along with over 2,400 label images and portraits) have been posted so far. It's a work in progress. You can see our complete inventory of names in the *Axis* portion of our website. We would be very pleased to hear from anyone who can offer more information on any of the biographies posted. We also need a volunteer to research some of the early French dealers; if you'd like to help out in this way, contact the editor at minrec@earthlink.net.

Production Editor for the (British) Mineralogical Society

An enthusiastic Production Editor with a science-editing background is required for the Mineralogical Society's modern Twickenham office. Working closely with colleagues and the scientific editors of the Society's journals and books, you will manage production of all publications, including copy-editing and proof reading.

Excellent administrative and IT skills are a must; familiarity with graphics packages would be an advantage, as would experience of on-screen editing and with an online manuscript submission and tracking system.

The salary offered will be commensurate with experience. Please send your CV with a covering letter to: Dr. Adrian Lloyd-Lawrence, Executive Secretary, Mineralogical Society, 12 Baylis Mews, Amyand Park Road, Twickenham TW1 3HQ, UK. or email to: Adrian@minersoc.org. Tel. 020 8891 6600. Further information can be found at "Updates and Announcements," www.minersoc.org.

Call for Papers! Tucson 2008!

The 29th annual Mineralogical Symposium sponsored jointly by the Friends of Mineralogy, the Tucson Gem and Mineral Society, and the Mineralogical Society of America will be held in conjunction with the Tucson Gem and Mineral Show, Saturday, February 16, 2008. The topic of the symposium is **Classic United States Mineral Localities.** Presentations on descriptive mineralogy, paragenesis, classic and new locations, and related subjects are welcome. An audience of amateur and professional mineralogists and geologists is expected.

Authors wishing to present a paper should submit a 200–300 word abstract to:

Julian C. Gray
Weinman Mineral Museum
P.O. Box 3663, Cartersville, GA 30120
Phone 770-386-0576, extension 415
Fax 770-386-0600
email: juliang@weinmanmuseum.org

Presentations will be 20 minutes in length, with a brief question and answer period. Abstracts must be submitted by August 1, 2007 and will be published in the *Mineralogical Record* (subject to approval by the editor).

Correction

In our Tucson Show Report in the previous issue we erroneously reported that Carolyn Manchester won only the Best Australian Thumbnail Award. She also won Best Australian Miniature and Best Australian Large Cabinet Award. Congratulations Carolyn!

Famous Mineral Localities:

The Trepča mine
Stari Trg, Kosovo

Jean Féraud
BRGM, B.P. 36009
F-45060-Orléans cedex 2, France
E-mail: j.feraud@brgm.fr

Gani Maliqi
Chief geologist
UNMIK/Trepča
Mitrovice, Kosovo

Vjollca Meha
Curator
Trepča mineralogical Museum
Kosovo

The war-torn region of Kosovo in the Balkans has a long and involved history of mining. Over the years the world-famous Trepča mine has yielded millions of tons of lead and zinc as well as thousands of tons of silver and bismuth. More than 60 mineral species have been identified from the deposit. Minerals that have reached the specimen market include countless thousands of fine specimens of sulfides such as pyrrhotite, arsenopyrite, sphalerite and galena, associated with well-crystallized quartz, dolomite, vivianite, ludlamite, calcite and rhodochrosite. The Trepča mine has just reopened, and the associated Trepča mining and mineral museum is also coming back to life, but needs urgent help from international funding institutions.

INTRODUCTION

The famous old Trepča (pronounced "Trep-cha" or "Trept-sha") lead-zinc mine lies near Stari Trg village in Trepča Valley, Kosovo, in the middle of the Balkans. Since 1999, Kosovo has been under the interim administration of the United Nations. It is a landlocked, very small territory (11,000 km^2, one-fiftieth the size of France), bordered by Macedonia, Albania, Montenegro and Serbia proper. Kosovo is "looking for a common European future and the country's political climate is now stable, safe and strong" (Ceku, 2005), but life there nevertheless is hard; the Gross Domestic Product is only 1,000 Euros per person. The people of Kosovo are proud and hard-working, and they have a long mining tradition. They are doing their best to restart the economy of Kosovo, and particularly to revive their mines, most of which were flooded or otherwise rendered inactive during the war. These mines are now open to foreign capital, and their potential is great—particularly the Trepča mine, with its famous mining and mineralogical museum.

The United Nations currently considers the official Kosovo name of the mine to be "Trepca, Stan Terg." The previous name of the

Figure 1. **Location map.**

Figure 2. **The main shaft of the Trepča mine. J. Balazuc photo.**

mine under Serbian administration was Trepča, Stari Trg, which is the designation still used in all the mineralogical treatises and museums of the world. Therefore, both terms will be used in this article.

HISTORY

The history of the Trepča mine and of the surrounding region is long and rich, and culminates in the ethnologic-political-economic imbroglio which has resulted from the recent war. In attempting to understand the present confusion it would be wise not to place too much faith in claims made on various passionate Internet sites which have proliferated since 1999, as these are creations of interests which seek to manipulate the present situation to their respective advantages. What follows is an objective summary of events during the many centuries in which mining of metals has gone on at Trepča.

Ancient Beginnings

The word "Trepča" occurs very early in written records. Perhaps it derives from two words in the extinct Illyrian language, "tre," meaning "three," and "psha," meaning "furnace"; in that case the word may signify "three ore-smelting furnaces." A more poetic theory is that the word derives from an ancient legend and refers to women preparing for a wedding. According to the legend, the parents of a beautiful girl who was to be wed adorned her from head to foot with gold and silver on the day of her wedding. "Trepča" from then on denoted the gold and silver adornments of girls at weddings, and it signified beauty.

Mining of the Trepča deposit during Roman times may have occurred but is conjectural. Roman mining of other ore deposits in the Balkans, in particular in Kopaonik and Kosovo, is attested in texts and confirmed by discoveries of Roman oil lamps in some of the old underground mine workings, and by the existence of huge Roman-era slag heaps at Srebrenica, to the northwest of Trepča, at Rudnik and Sočanica to the north, and at Gračanica to the south. Texts carved on Roman ruins refer to the assignment of a Roman *procurum metallorum municipi* at Sočanica, where a Roman lead sarcophagus has been found. Probably the Romans were greatly interested in alluvial gold deposits like the Lece deposit (Dusanic *et al.*, 1982, and Dusanic, 2003).

Following Roman times the region was colonized, influenced, or dominated politically by ever-changing populations. The long history of the successive influxes of Byzantine, Bulgarian, Serbian, Albanian and Turkish peoples helps explain the cultural mixing and the legacies of old grievances which underlie the chaos of the 1990's.

The Middle Ages

The first definitely known phase of mining (for silver, lead and iron), beginning in 1303, was intense. Although probably not yielding as much silver as did the nearby mines of Novo Brdo

Figure 3. **The historical gossan with entrances to old mine workings dating from 1927.**

Figure 4. **Medieval mine workings on the top of the gossan in Trepča. J. Balazuc photo.**

and Rudnik, the Trepča mine did answer to the needs of Serbian suzerains to fund their military activities; for example, Trepča silver financed the building of fortresses all along the Ibar Valley against the Ottoman threat. Meanwhile the silver of Novo Brdo and Rudnik, extracted from argentiferous lead ores, was used for coinage by successive despots: the first Serbian silver dinars were made at these mines. In 1412, despot Stefan Lazarevič instituted a mining code in a very well written document which specified mining regulations, rights, and obligations, and described mining techniques, in great detail.

A colony of settlers from the coastal town of Dubrovnik lived in Trepča during the 15th century, and the role of Dubrovnik businessmen in the management of the Trepča mine and in the trade in Trepča ores is attested by texts dating from that time. Numerous experienced Saxon miners were brought in to work at Trepča. Today, the tall ruins of St. Peter's Saxon basilica, dating from the 14th century, may be seen between the Stari Trg miners' village and the open pit. The walls of this basilica were originally covered by beautiful frescoes, some of which are still visible. A proposal to restore this still-impressive building has just been submitted to the European Commission and to the Council of Europe (Vidishiqi and Mehmetaj, 2005). In the slope between the basilica and the bottom of the open pit, at the base of some rocky gossan outcrops, it is still possible to see the collapsed entrances of ancient, very narrow mine workings covered by vegetation. Another very old stope and shaft are still open above the open pit, amid the bushes on the rocky slope.

In 1936, some very old underground workings at Trepča yielded interesting remnants of tools which have not yet been scientifically dated but which probably come from the 14th or 15th century. These archaeological finds were examined by Harold Abbott Titcomb (1874–1953), a mining engineer and passionate amateur archaeologist, who was a close friend of Alfred Chester Beatty, chairman of the Trepča mining company. Titcomb reported on many artifacts from medieval mining at Trepča, including an axe "made of nickel

Figure 5. **Ruins of the Muslim mosque in Trepča dating from the 15th Century. J. Balazuc photo.**

Figure 6. **Ruins and frescoes of the Saxon basilica of St. Peter in Trepča.**

and steel" found at 200 meters depth—possibly hammered out of a nickel-iron meteorite. In the Trepča mining museum one may see a few very old tools, most of which came from the Artana mine (Novo Brdo). One is a small wooden shovel composed of a round handle 15 cm long and a bucket 30 cm tall; another is a kind of spoon, 15 × 40 cm, made of wood, which possibly was used to scrape ore.

On June 15, 1389, on the Kosovo plain 30 km southeast of Trepča, the Serbian army was overwhelmed by the Turks in the Battle of Blackbirds Field (Kosovo Polje). Following this event a Turkish kadi was installed at the Gluhavica mine near Novi Pazar, but it seems that for the Dubrovnik mine properties a kind of Turkish protectorate was established, with the overlord to whom the Trepča mine then belonged, Shala e Bajgorës, retaining some independence. Historians do not record any interruption in Trepča ore production during this period.

Generally, in the mines of Kosovo, ore extraction was hampered by anarchic management and by the flight of qualified miners, with the new Turkish supervisors disregarding representatives of the Serbian mine owners and endeavouring to prevent silver exports. However, by 1455, the date of the Turks' conquest of the last areas of Kosovo which had remained independent, Turkish administration of the mines was functioning rather well. The Turks improved the old Serbian mining code, and they very actively worked Trepča and other mines for metals from which to make coinage and weapons. But 1685 saw the beginning of a rapid decline of mining in the Balkans—even at the famous gold, silver and lead mines of Novo Brdo. Today the most impressive relics of the period of Turkish rule are the ruins of a mosque 1 km from the Trepča mine, along the road to Melenica.

The Mid-20th Century

We read nothing more of the Trepča mine until 1925, when the Serbian province of the newly created Republic of Yugoslavia was opened to foreign investors. French mining companies having

Figure 7. **Medieval mine workings in the breccia at the top of the gossan in Trepča. J. Balazuc photo.**

Figure 8. **Medieval illustrated manuscript illustrating the Serbian mining code of despot Stefan Lazarevic, dating from 1412 (photo Trepča).**

Figure 9. **Mining license for Trepča, delivered by the Turks in 1488 (photo Trepča).**

focused on the copper deposit at Bor, the British company Selection Trust sent its best geologists to select the most promising targets for mining. Selection Trust at this time was a "junior" company, i.e. a small one, but it would soon become a large, "major" company. It was created in 1913 by Sir Alfred Chester Beatty (1875–1968), an American-born mining engineer whose fabulous life story is told by Lawton (1987)—see the summary in the sidebar.

Alfred Chester Beatty had the genius to select experienced geologists who quickly went on to discover profitable ore deposits in Siberia, along the west coast of Africa, in Northern Rhodesia and in what was then Yugoslavia. The engineer Harold Abbott Titcomb served as a consultant from 1925 to 1932, and excellent work was done later on by Charles B. Forgan. In 1926, Selection Trust signed a contract with Radomir N. Pašić (pronounced "Pashitsh"), son of the former Yugoslav prime minister Nikola Pašić, inaugurating a large regional exploration program with geologic mapping as well as sampling and drilling in the old underground workings at Trepča. The results made clear the huge potential of the ore deposit. On December 9, 1927, in London, a subsidiary of Selection Trust called Trepča Mines Limited was capitalized for £1,789,028. A mining concession was granted by Serbia on March 1, 1928. The company survived the 1929 stock market collapse without difficulty, and the Stan Trg mine opened in 1930 on the site of the medieval open-pit mine. "Stan Trg" represents a phonetic distortion by Kosovar shepherds of "Stari Trg," which means "old place" or "old market." The geologist Friedrich Schumacher restored the correct term—Stari Trg—in his memoir of 1950.

A. C. Beatty and the Selection Trust Company

Alfred Chester Beatty was born in New York City, in a neighborhood whose former site is now occupied by Rockefeller Center. Even as a small boy he was an avid mineral collector, and a person who knew what he wanted. He made his first major salesroom killing at the age of 10. "At one auction," he recounted, "I fell in love with a beautiful . . . specimen of pink calcite. I was sitting in the front row [with my father] and bid 10 cents. The auctioneer was disgusted and all the men laughed . . . [but] not a single one would bid against me." The auctioneer finally had to knock down the prize specimen to young Beatty.

He pursued his childhood interest in minerals at Columbia University's School of Mines and graduated as a mining engineer. Though his father was a wealthy banker and stockbroker, Beatty refused his parents' offer of an allowance, bought a one-way train ticket to Denver, and headed West with 200 dollars in his pocket. In Colorado, Beatty began his career by taking the only mining job he could find, that of a mucker shovelling rock for 10 hours a day, at a wage of 25 cents per hour, in the Kekionga gold mine at Boulder (years later he would name his yacht after that mine). In three years Beatty worked his way up from mucker to manager of the mine, and after another two years he had become assistant general manager of the Guggenheim Exploration Company, helping to acquire and develop many of the richest mines held by that company. By 1912, aged 37, Beatty had acquired a million dollars and a serious case of silicosis. He realized that London, the capital of the British Empire, was both a safer place to live and an ideal city from which to pursue capitalistic ventures in mining. While living in London he became acquainted with Herbert Hoover, later the 31st President of the United States, and together they developed mines in Burma and Russia.

Beatty became a British subject during the 1930's, and during the Second World War, by now a close personal friend of Winston Churchill, he played an important behind-the-scenes role in the provision of strategic raw materials for the Allies. Beatty is also remembered for his philanthropic support of cancer research and for his strong interests in impressionist art and Oriental manuscripts. When he retired in 1950, he handed over the management of Selection Trust to his son, Alfred Chester Beatty Jr. On Beatty Sr.'s death in 1968 he was accorded a state funeral. The Selection Trust Company was later acquired by British Petroleum, and in 1989 it was taken over by the giant RTZ Corporation (formerly the Rio Tinto-Zinc Corporation).

Figure 10. **Alfred Chester Beatty (right) speaking with King Alexander of Yugoslavia during the inauguration of the Trepča mine in 1927. G. Ellison photo, 1933.**

The Stan Terg mine quickly reached a production level of between 600,000 and 700,000 tons of ore per year, with the annual metal output between 50,000 and 60,000 tons—figures which would never again be matched after 1939. From 1930 to 1940 the mine yielded 5.7 million tons of ore, and the on-site flotation plant produced 625,000 tons of lead concentrates, 685,000 tons of zinc concentrates, and 444,000 tons of a mixed concentrate of lead, copper and pyrite. By 1936, however, Trepča Mines Ltd. was in need of more capital. The sale of 4,500,000 shares to new stockholders at 5 shillings per share, mostly in March 1936 and March 1937, raised £1,125,000. With these new funds the company invested in new equipment and built a lead smelter at Zvecan in 1940.

During these years preceding World War II, Germany bought 40% of the ores produced at Trepča. After the Germans seized the mine in 1941, Hermann Goering's Reichswerke Company managed the facilities largely as a slave labor camp, producing batteries for German U-boats. Many Trepča miners were fighters in the Yugoslavian resistance movement during the war. In 1946 the Tito government nationalized the Trepča mine and smelter, together with all other mines which had been owned by the company. Between 1945 and December 23, 1948, Trepča Mines Ltd. was liquidated and its assets were split between the British and Yugoslavian governments (Dauti, 2002). Numerous webpages are available on the Internet providing lawyers with reference case histories regarding the liquidation of Trepča Mines Ltd. and the sharing of its assets by the British and Yugoslavian governments, together with judgments concerning private persons involved. These cases set a precedent for world jurisprudence concerning cross-border insolvency issues, liquidation of assets of overseas companies, and entitlement to interpreters in civil matters (cf. New Zealand Law Commission Report 52, 1973).

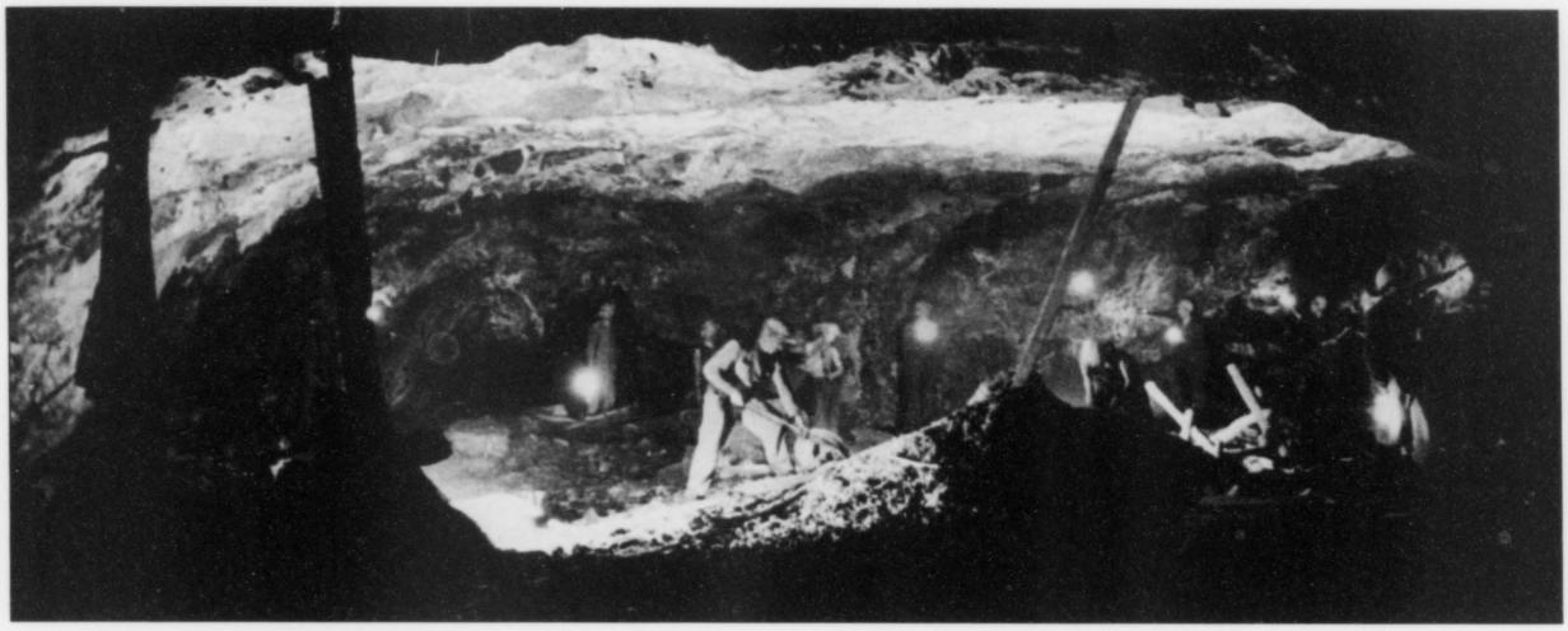


Figure 11. **A large stope in the 1930's (photo Trepča).**

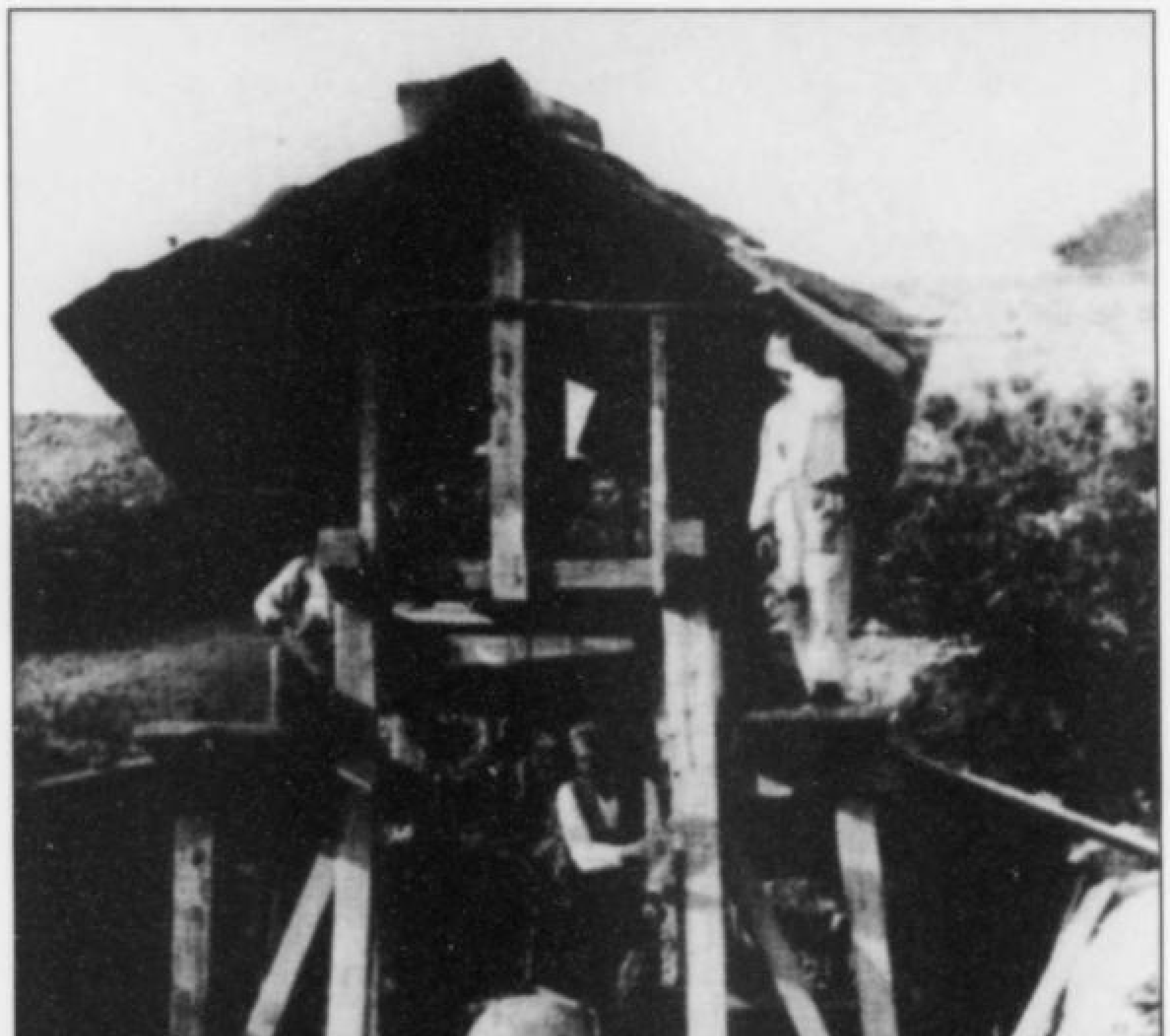


Figure 12. **Ore bucket from the shaft emptying into an ore car in the 1930's (photo Trepča).**

After 1948, the Mining, Metallurgical and Chemical Conglomerate of Lead and Zinc, Trepča (Rudarsko Metalurški Hemijski Kombinat Olova i Cinka Trepča) became one of the most important mining complexes in the Balkans. It consisted of several groups of mines. In the north was Crnac and Belo Brdo (whose ore was treated in the Leposavic concentrator), and the exploratory workings at Koporic and Zuta Prlina. In the center of the region was Stari Trg and the Tuneli i Pare concentrator. And in the south and southeast (towards Pristina) were Artana-Novo Brdo, Hajvalija and Kisnica-Badovac, served by the Gracanica concentrator. The complex as a whole yielded an astronomical 60.5 million tons of mine-run ore containing more than 8% lead and zinc, half of which production came from Trepča. This is one of the largest Pb-Zn ore districts in Europe, having produced nearly 3 million tons of lead and 2 million tons of zinc; its silver production has been assessed at more than 4,500 tons. Its present remaining reserves are impressive, although the figures, once calculated according to the criteria of a state-controlled and centrally planned economy, must now be drastically recalculated in terms of profitability in a free-market economy.

Since 1975

This great mining complex, which at its peak employed 20,000 people and produced an important part of the mining income of Yugoslavia, began around 1975 to go into major decline. The problems included obsolescence of the facilities, neglect of maintenance, failure to reinvest funds, the absence of control over ore production and grades, and the theft of equipment, sometimes of whole workshops. Half-hearted attempts at privatization came to very little. The decline accelerated in 1990, when Belgrade revoked the autonomy of Kosovo, Albanian workers left, and ethno-political tensions increased. During the Kosovo war which began in 1998, Trepča and Mitrovica, where the ethnic populations were highly mixed, were among the most grimly contested territories. It was even rumored that hundreds of Kosovar bodies were burned in the furnace of the lead smelter (an investigation by French police found no evidence for this claim).

The arrival of KFOR (the NATO-led international military force responsible for establishing and maintaining security in Kosovo) and the separation of the belligerent parties in June 1999 led to a *de facto* partition of the mining complex. The northern mines came under the control of the Serbs. The southern mines, which had been flooded, were seized by returning Albanian workers who, however, could not restart production immediately. In the center of the district, KFOR promoted the resumption of production at Trepča and Mitrovica, and the flooded Trepča mine was dewatered. But a French-Danish environmental appraisal of the sites revealed such an accumulation of polluting substances around the two smelters that the civil administrator, Bernard Kouchner, ordered in August 2000 that operations be stopped immediately. Since then, Trepča

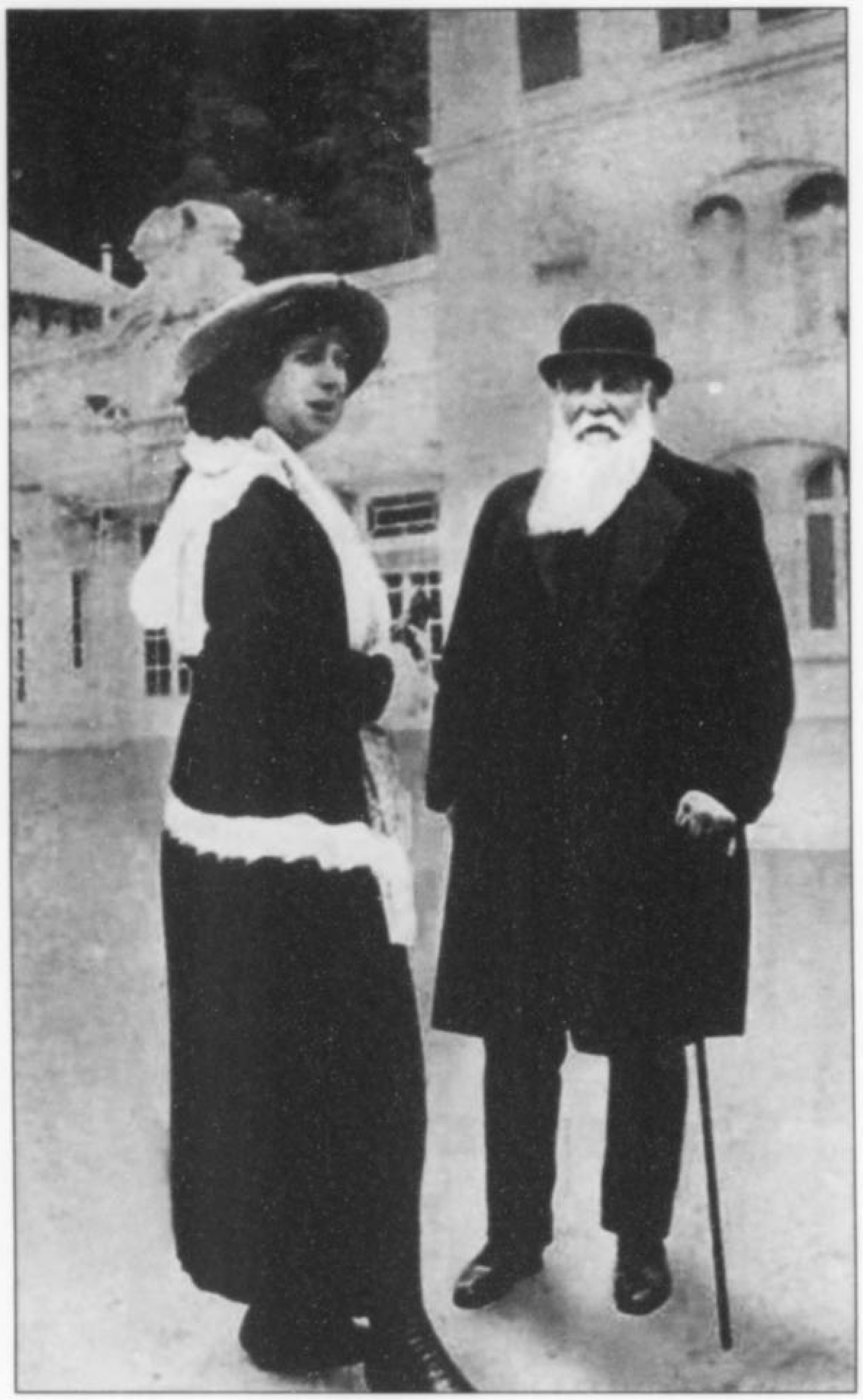


Figure 13. **Nikola Pašić and the famous British writer Grace Ellison. G. Ellison photo, 1933.**

has been on stand-by, its two smelters destroyed. There are claims on various sides concerning the debt from previous bank loans and the legal ownership of mining rights, and there is even a rumor that British interests have demanded an indemnification for the former nationalization by Tito.

To crown it all, there was a website report (Tanjug, 1999) that on September 18, 1999, the mineralogical museum of the mine was plundered by thieves benefiting from the confusion. However, fortunately, we can report that this news was totally false and that the museum collections have been preserved.

Authorities are now cautiously optimistic that restoration of mine production to its former level may be possible. With the approval of all concerned parties, the United Mission for Kosovo (UNMIK), which rules this area for the time being, has launched an important program of technical and economic appraisal in all of the industrial sites of the complex. In August 2000 this program was subcontracted to the ITT (Interim Team for Trepča) consortium, composed of the American Morrison & Knudsen-Washington Group, Boliden Contech, and TEC Ingénierie, a French society of the Eramet group. In August 2005, thanks to the energy of mine management and of the workers, ore production was resumed in the Trepča mine and the zinc concentrator was restarted. Trepča has obtained an exploration license, and an exploitation license is under discussion, as is the question of how best to attract private investors.

GEOLOGY

History of Published Works

The geology of Trepča is fairly well understood but not yet fully assessed. Excellent studies done between 1930 and 1940 by the geologist of the mine, Charles B. Forgan, were published in 1950, as was the work of Friedrich Schumacher, but during the following 50 years no comprehensive, detailed, well-illustrated study of the giant deposit has appeared. During this interval the known extent of the orebody as traced along the dip has doubled. The workings now reach to 900 meters below the surface! All the publications issued since 1950 are short interpretive syntheses for either the ore deposit or for the whole mineralized belt (Jankovič, 1978, 1984), guidebooks, short accounts of official visits, or detailed publications devoted to a particular topic, such as the innovative stratigraphic datings by Klasic *et al.* (1972), boldly interpreted by Strucl (1981). An excellent PhD dissertation was written (in Serbian) in 1978 by Aleksandar Topalovic, but there exist only a few printed copies, available only in geoscience libraries in Belgrade. The only piece of this work that has been published is a very pertinent map of the orebodies which reflects the high quality of the whole thesis (Topalovic, 1980).

Studies of the mineralogy of Trepča were published over a long period following the pioneering work of Friedrich Schumacher (1950, 1952). Professor Ljudevit Barič of the University of Zagreb deserves the gratitude of the scientific community for his numerous publications, particularly those describing the discovery of vivianite and ludlamite at Trepča (1953, 1954, 1965). Among noteworthy later publications are those of Slavoljub Terzic *et al.* (1975), on the

Figure 14. **Stock certificate for the Trepca Mines Ltd. company (incorporated in 1917), dated 1936.**

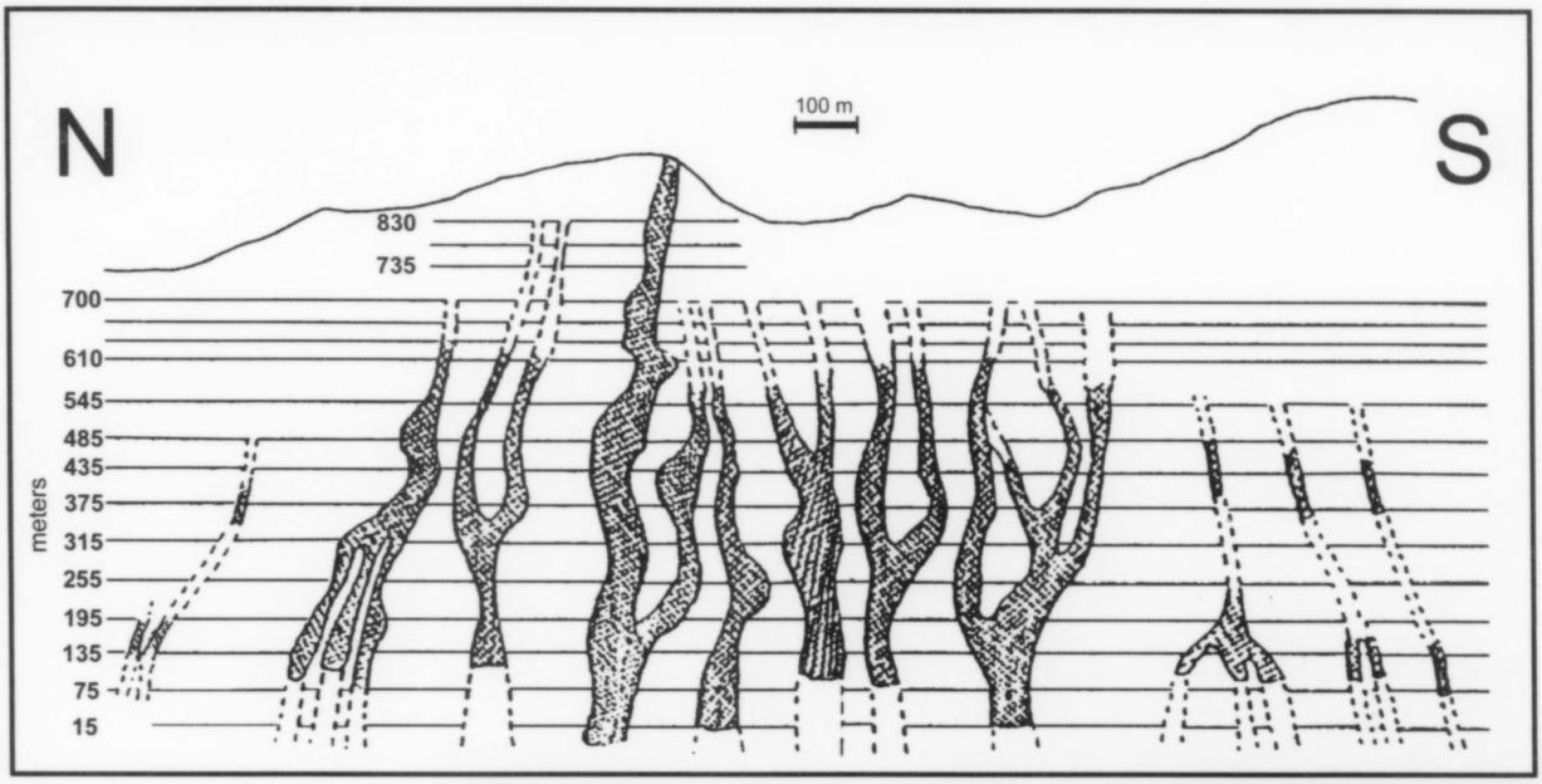


***Figure 15.* Vertical section following the contact between schist and marble, showing the various Trepča orebodies (from Kepuska, 1998).**

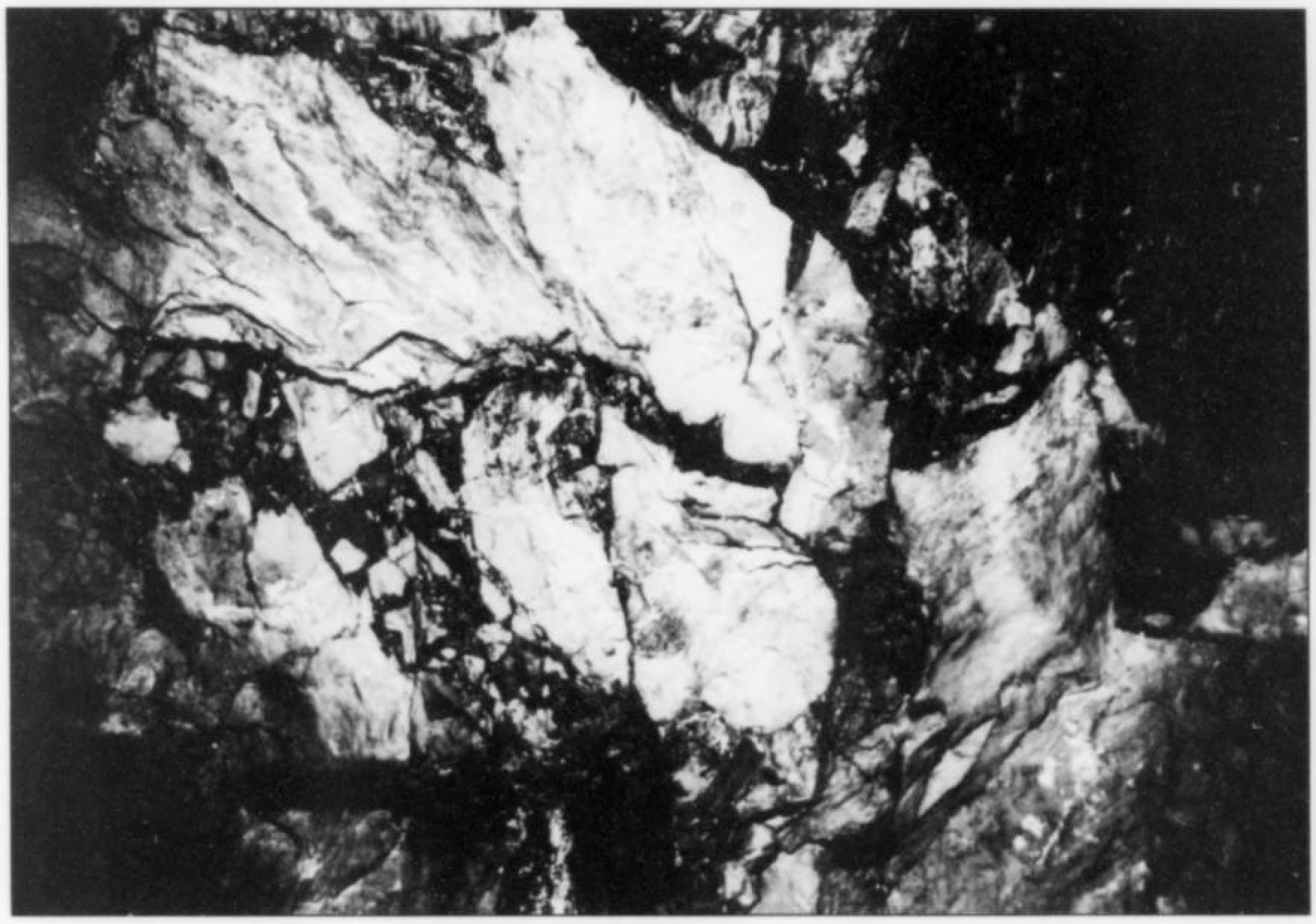


***Figure 16.* Hydraulic breccia in marbleized and mineralized limestones.**

discovery of cosalite; Mirjan Žorž (1991) and Vladimir Bermanec *et al.* (1995), on the discovery of childrenite; and works by other scientists including Vladimir Zebec and Vesna Srot. Concurrently with these scientific advances, the beautiful microphotographs of Werner Lieber, particularly as seen in the *Mineralogical Record*, enlightened Western collectors concerning the "magic" of Trepča specimens, and promoted interest in mineral parageneses at the locality.

The doctoral dissertation of Gani Maliqi (2001), followed by the work of Tmava and Koliqi (2003) and others, has opened the way to a major increase in knowledge about the geological framework of the deposit. At the same time, the work of Hashim Këpuska and others (1998–2001), presenting results of geochemical analyses of rare metals (Sn, In, Bi, etc.) in the ore minerals, sheds light on the geochemical nature of the Trepča ore deposit, and his block diagrams enable geoscientists to visualize the deposit clearly.

Structural Framework

The Trepča mine is located in the Vardar zone, a nappe of folded and overthrust rock units within the Dinarides Alpine Belt. The Vardar zone consists of a Paleozoic basement, a Jurassic sedimentary cover, and overthrust Cretaceous ophiolites. Post-tectonic magmas (granodiorite and dacite-andesite) intruded the assemblage during the Tertiary period. The Trepča ore deposit consists of a series of manto orebodies and mineralized skarns within the sedimentary pile (known as the Stari Trg Series), below a thick layer of volcanic tuffs and ignimbrites of Tertiary age. More precisely, within the Stari Trg Series the orebodies are intercalated between thick marbleized limestones at the bottom and thick schists at the top; in some places along the stratigraphic contact there is an intercalated layer of quartzite. The contact is folded in an anticline, the northwest-southeast axis of which plunges 40° towards the northwest.

Along the crest of the anticline, at the contact between the schists

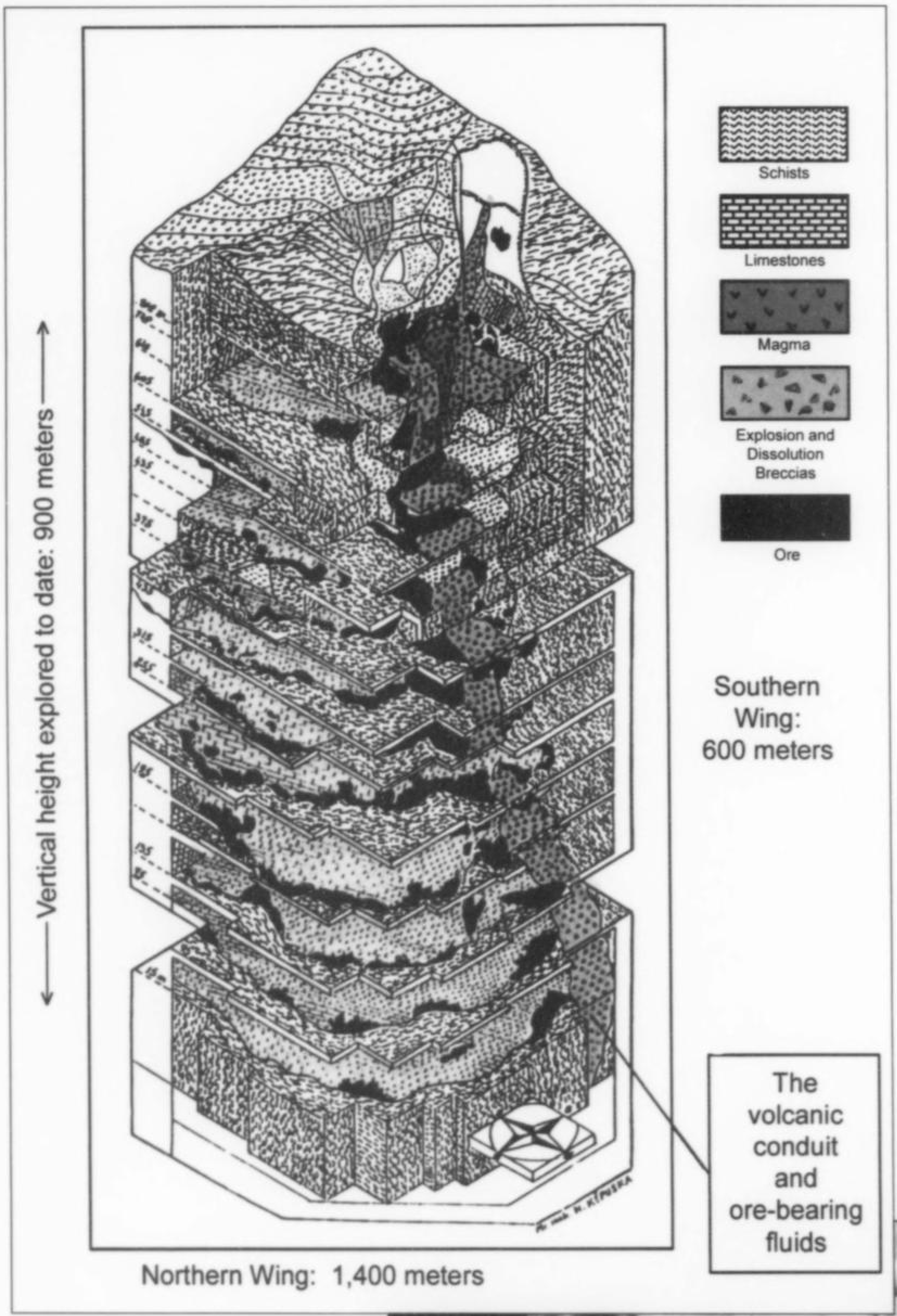
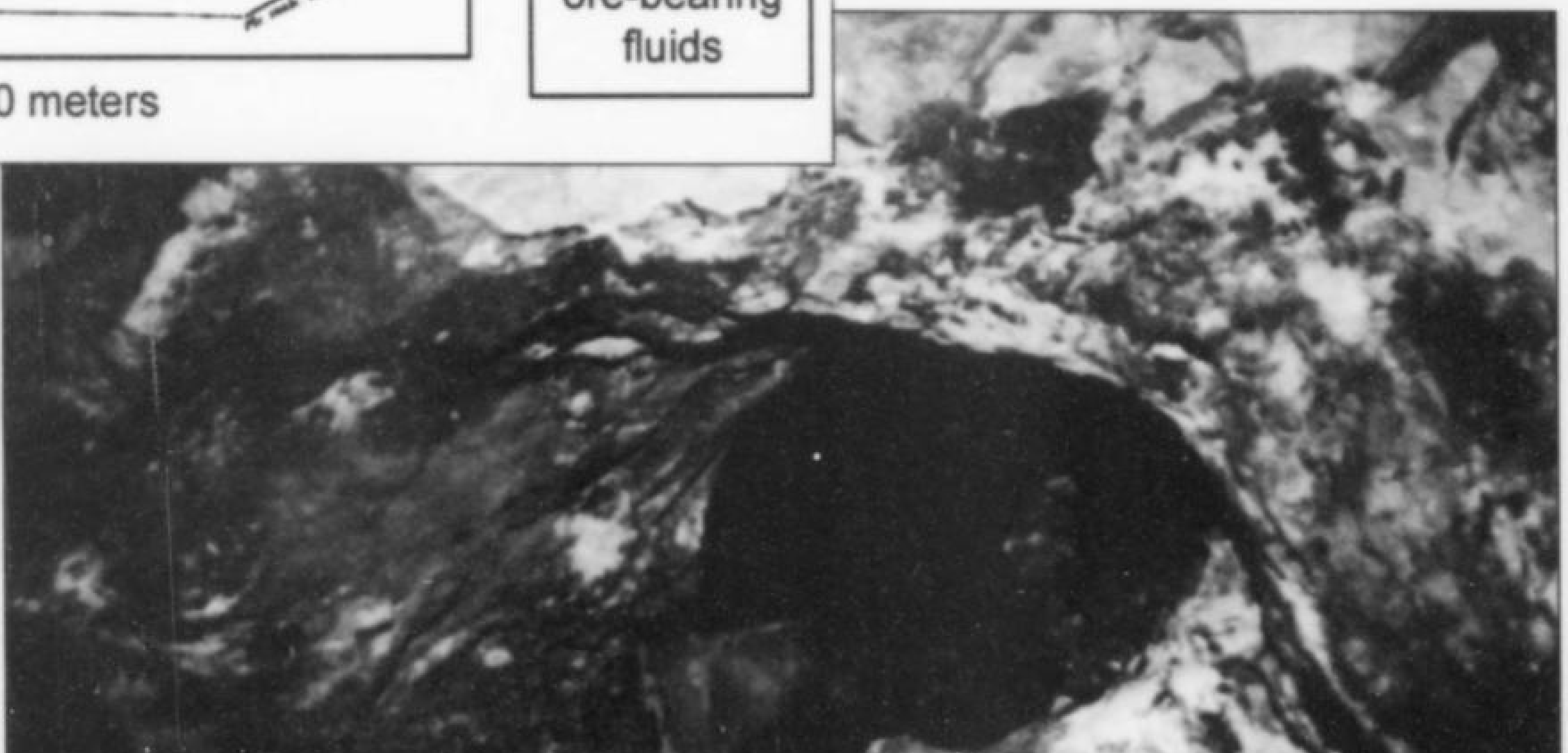


Figure 17. **Geological block diagram of the Trepča ore deposit (modified from Kepuska, 1998). The projection shown increases the apparent pitch of the volcanic chimney and the axis of the mineralized anticlinal hinge.**

Figure 18. **Exploration of a mineralized Trepča vug in skarn and marbleized limestone on the 10th level at Trepča.**



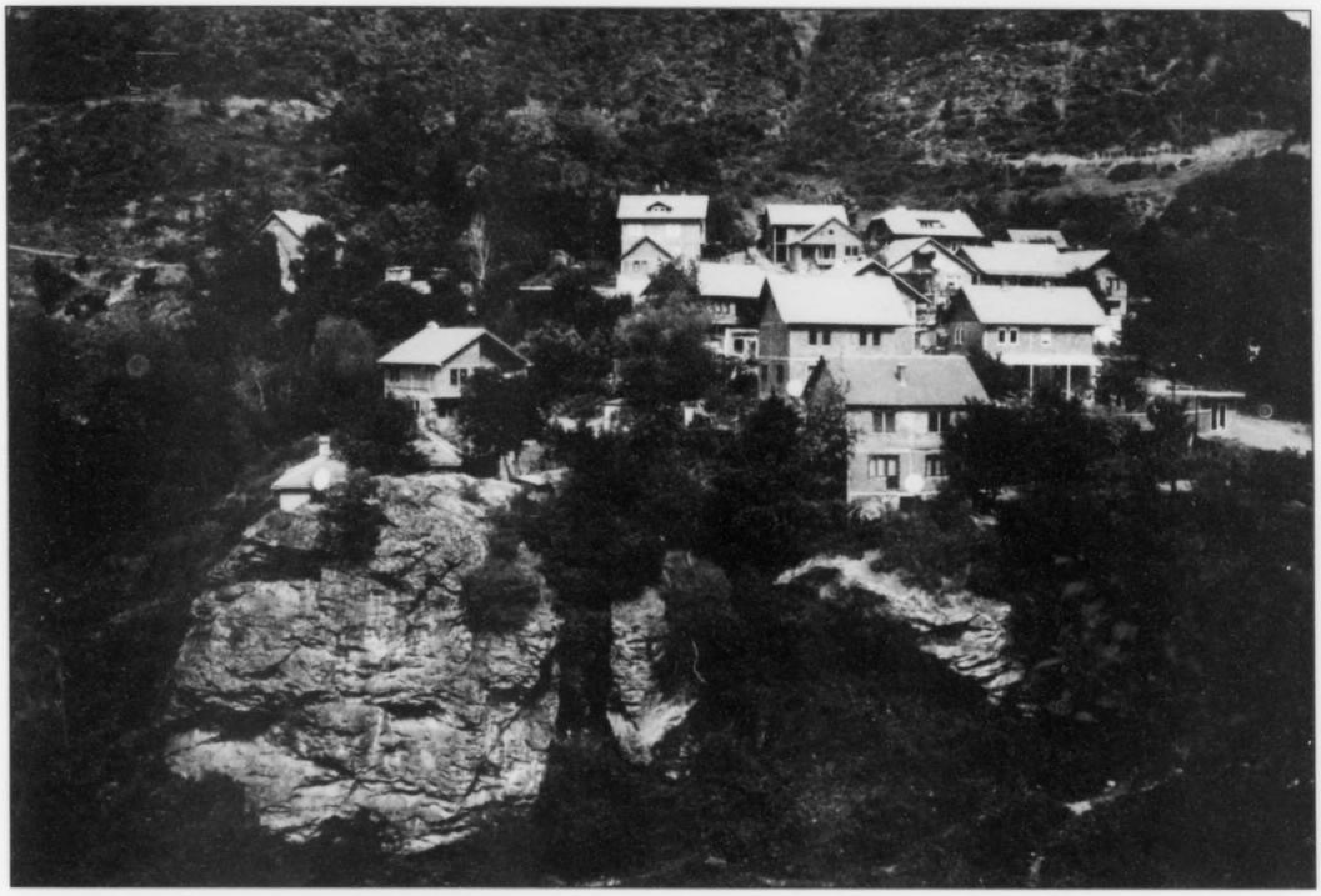


Figure 19. **Tertiary volcanites of felsic-intermediate composition (N1 series) crosscut by faults under the new Stari Trg village.**

Figure 20. **A 1-meter karstic orebody cut by the mine workings in the marbleized limestones of the 10th level, containing pyrrhotite, pyrite, sphalerite and calcite with some white rhodochrosite.**

and the limestones, a volcanic chimney was emplaced: the chimney, measuring 100 × 200 meters in oval cross-section, consists of a pipe of trachyte or dacite surrounded by an explosion breccia. It is this chimney which controlled the distribution of mineralization. A manto layer of ore between 30 and 60 meters thick has wormed its way into the schist/limestone contact along the sides of the volcanic pipe, with a few discordant oreshoots which were formerly explored by small prospects in the neighborhood of the Trepča mine.

The granodiorite which now makes up the Kopaonik Range ascended during the Miocene period. The magma body was also the source of trachyte and dacite plugs and pipes intruded into the upper crust, leading to the formation of skarns with garnet, pyroxene, amphibole and magnetite in the Trepča orebodies. Within the host rocks, hydrothermal mineralization was accompanied by propylitization-sericitization, silicification, carbonatization, pyritization and kaolinitization. On the summit of the mountains all around Trepča, a very important period of extrusive felsic Tertiary volcanism is represented by a large sheet of pyroclastic rocks, especially ignimbrite. This ignimbrite is also present in the deeper levels of Trepča mine, where it appears as a veinlet a few centimeters thick within the breccia which forms the root of the trachyte pipe.

Ore Emplacement and Mineralization

For the most part the Miocene-age Trepča ore deposit is hydrothermal (both mesothermal and epithermal), but it also includes replacement-type skarns. Isotope analyses suggest that domes ascending from anatexis zones within the lower crust and the upper mantle exerted strong thermal and structural influence; however, ore deposition occurred at the subvolcanic level and at shallow depth. Such a geological setting, with a hydrothermal plume of magmatic origin mineralizing carbonate host rocks within favorable hydrologic and tectonic traps, looks very similar to the Kipushi model and to some of the orebodies of Dalnegorsk, Russia and Zletovo, Macedonia.

The volcanic breccia is mainly composed of fragments of schist and phyllite; fragments of trachyte and of limestone constitute no more than 2% of its volume. Dissolution structures are common in the schist fragments and even more so in the limestone fragments. Within the massive limestones (and marbles) hosting the oreshoots on both sides of the chimney, hydraulic breccias are very abundant. Therefore we suggest that the explosive character of the breccia

Figure 21. **North wing of the gossan and dumps of 1927, seen from the medieval mine workings. Stari Trg new village in the background.**

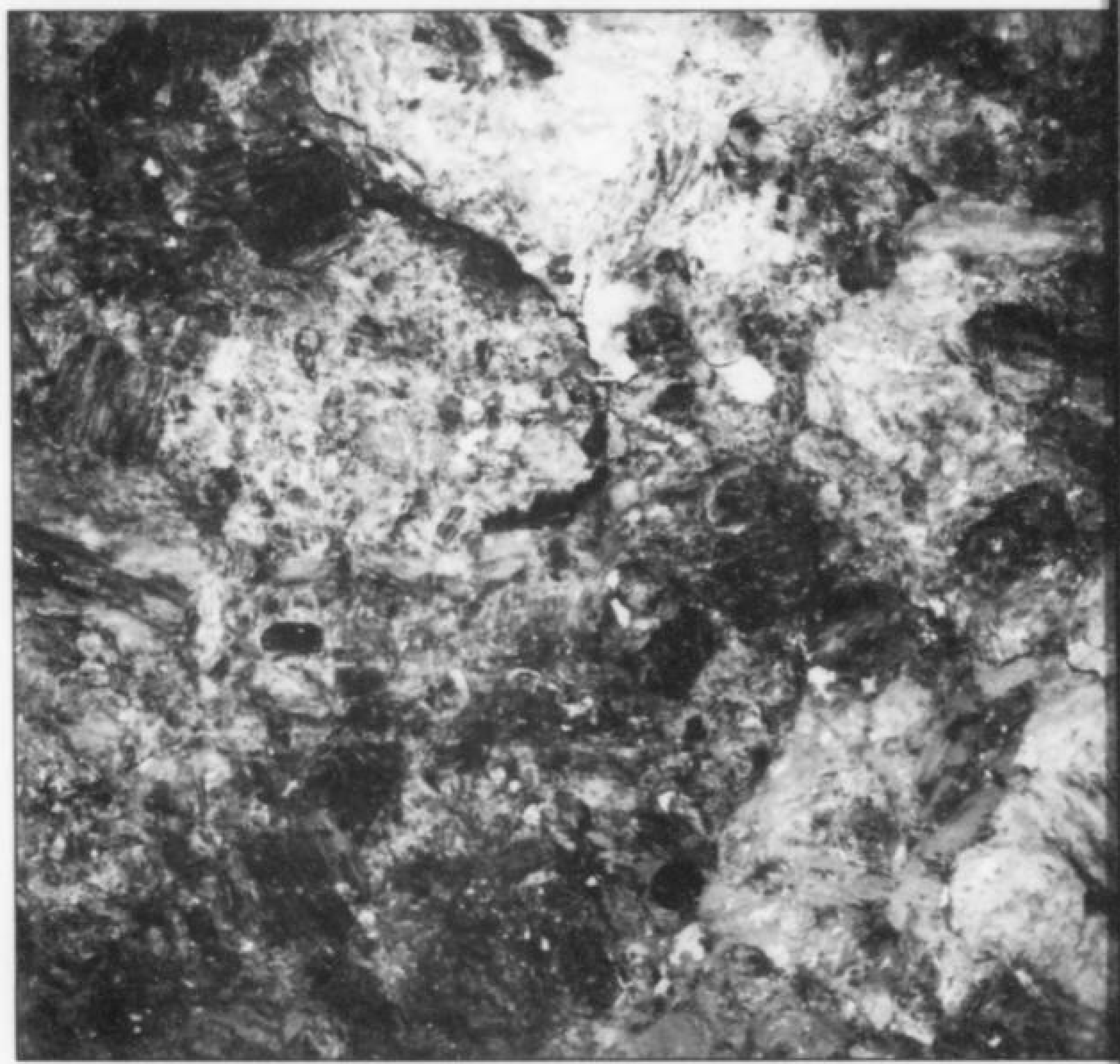


Figure 22. **The volcanic breccia showing fragments of schists, dacite and pyrite-pyrrhotite oxidized to limonite.**

was associated with the high content of mineralized fluids around the chimney; because of this high hot water content, there was a strong dissolution process all around the chimney and along all the contacts with the impermeable schists. Such hydraulic brecciation suggests the "maar"-type explosions at the bottom of trachytic-volcanic chimneys when they encounter the water table.

During the Tertiary Alpine Orogeny, water heated by the magmatic intrusions percolated down through the rocks and took abundant metallic ions into solution. When these waters re-ascended, they were blocked by the impermeable "roof" formed by the thick schists. Their high temperature and aggressive chemical properties enabled the solutions to attack the limestones below the schists, digging out huge solution cavities. Gradually, salts precipitating from the solutions coated the walls of the cavities, and where voids remained, large crystals grew. The metallogenetic classification of Trepča (as given in the GIS databases on the Internet) as a hydrothermal/replacement deposit is not complete: the deposit should also be considered a karst deposit trapped under an unconformity.

Thus, the formation of the ore deposit at Trepča is largely understood: formation of karst caves by the corrosive action of metalliferous hydrothermal solutions, deposition of ore minerals, formation of ore shoots in a hydrogeological trap, and skarn formation controlled by a volcanic pipe. But the origin of the metallic elements in the underlying magma is still conjectural. Since it is known that volcanogenic sulfides are commonly present in massive deposits in belts of ophiolitic rocks, it could be that such a deposit existed at depth in this case, giving up the metals to hydrothermal solutions during the tectonic processes accompanying the subduction of one crustal plate under another.

A related problem, perhaps, is one concerning the ages of the rock units around the mineralization. In fact, no one really knows whether the schists are older than the limestones or vice versa. Until 1973, geologists assumed that the Stari Trg Series sedimentary sequence was Silurian-Ordovician, but in that year Yugoslavian geologists found fossils (conodonts) in the sequence which suggest that some of the limestones could be of Triassic age (Topalovič, personal communication, 1973). What had been thought to be the bottom of the sequence may well be the top! How may this overthrust and distorted zone between the African and Eurasian Plates be accounted for? Instead of an anticline, the purists speak cautiously of an antiform. And if the limestones are Triassic, then, as Strucl (1981) has suggested, the Trepča deposit is a very early manifestation of the mineralizing processes which generated stratabound lead-zinc ore deposits all along the Alps (e.g. Mezica, Raibl, Salafossa, La Plagne, Largentière, Les Malines, etc.).

It is intriguing, and surely of interest to mineral collectors, that none of the common Trepča specimens showing stalactites of carbonates overgrown by sulfide crystals have so far shown axial canals in the carbonate stalactites to give evidence of water dripping from ceilings of caves. This implies that the karst cavities were totally flooded and that their walls were overgrown by sulfides not in void spaces but under a water table. The authors would like to hear of any Trepča specimens of this type which show axial canals.

MINERALS

More than 60 mineral species have been found at Trepča (see Table 1). Naturally, most of these species do not occur in the deposit as collectible crystal specimens. Without doubt, the locality's most beautiful specimens are those in which crystals of sulfides with bright metallic or adamantine luster are combined with vitreous or pearly crystals of quartz, dolomite, calcite or rhodochrosite. Of the Trepča sulfides, galena is probably the most interesting because of its great variety of habits, even if the galena specimens generally are not as magnificent as are many from Dalnegorsk, Russia or the Madan district, Bulgaria. Arsenopyrite and sphalerite are also found as excellent crystal specimens in the deposit.

The major Trepča species of collector interest are briefly described below.

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

Among the skarn silicates, andradite is the best crystallized, occurring as colorless to greenish brown and dark brown crystals to 1 cm which display {110} and/or {211} forms. The other skarn minerals have not been found as attractive specimens.

Aragonite $CaCO_3$

Aragonite is not as common at Trepča as calcite, dolomite and rhodochrosite. It forms colorless, transparent crystals and aggregates of crystals to 3 cm long.

Arsenopyrite FeAsS

Arsenopyrite occurs commonly as short prisms with flat, diamond-shaped {012} faces. These crystals average only a few millimeters long but can reach 5 cm. Epitactic growth on galena and marcasite is common (Zebec, 1975, 1978). Rarely, cubo-dodecahedral galena crystals rest in the middle of arsenopyrite crystal faces. In some specimens the arsenopyrite crystals form mosaic-like sheets of lozenge-shaped faces; much more rarely the species is seen as long-prismatic and acicular crystals, as dendritic aggregates, and as beautiful "crests" of parallel crystals to 3 cm.

Barite $BaSO_4$

Barite is rare at Trepča (Barič, 1948; Zebec, 1974). It forms tabular, white to pale blue crystals, in some cases transparent, to 7 cm on edge, and aggregates of smaller crystals.

Boulangerite $Pb_5Sb_4S_{11}$

Boulangerite is found at Trepča as fibrous and very thin acicular gray crystals entangled in downy masses informally called "plumosite." It is generally implanted on rhodochrosite aggregates, within geodes made of rhodochrosite and other minerals, on galena and pyrite, and frequently as microscopic inclusions in calcite which color the calcite gray or dark blue. The crystals, reaching 30 cm long, have a bright metallic luster when freshly collected, but after a few years the specimens alter to much less attractive, dark gray, velvety-looking masses.

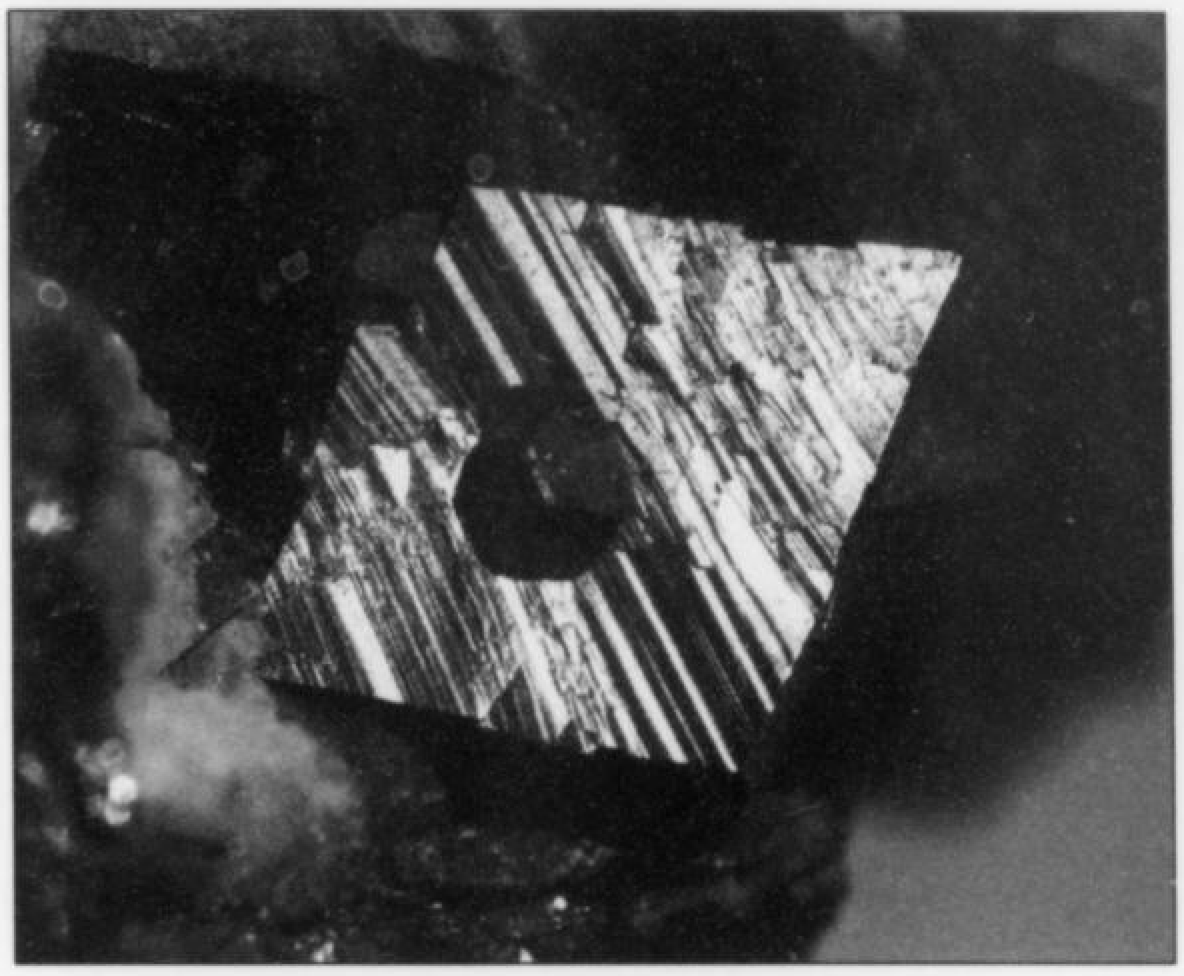


Figure 23. **Arsenopyrite crystal, 1 cm, with an epitactically oriented galena spinel-law twin, from Trepča.**

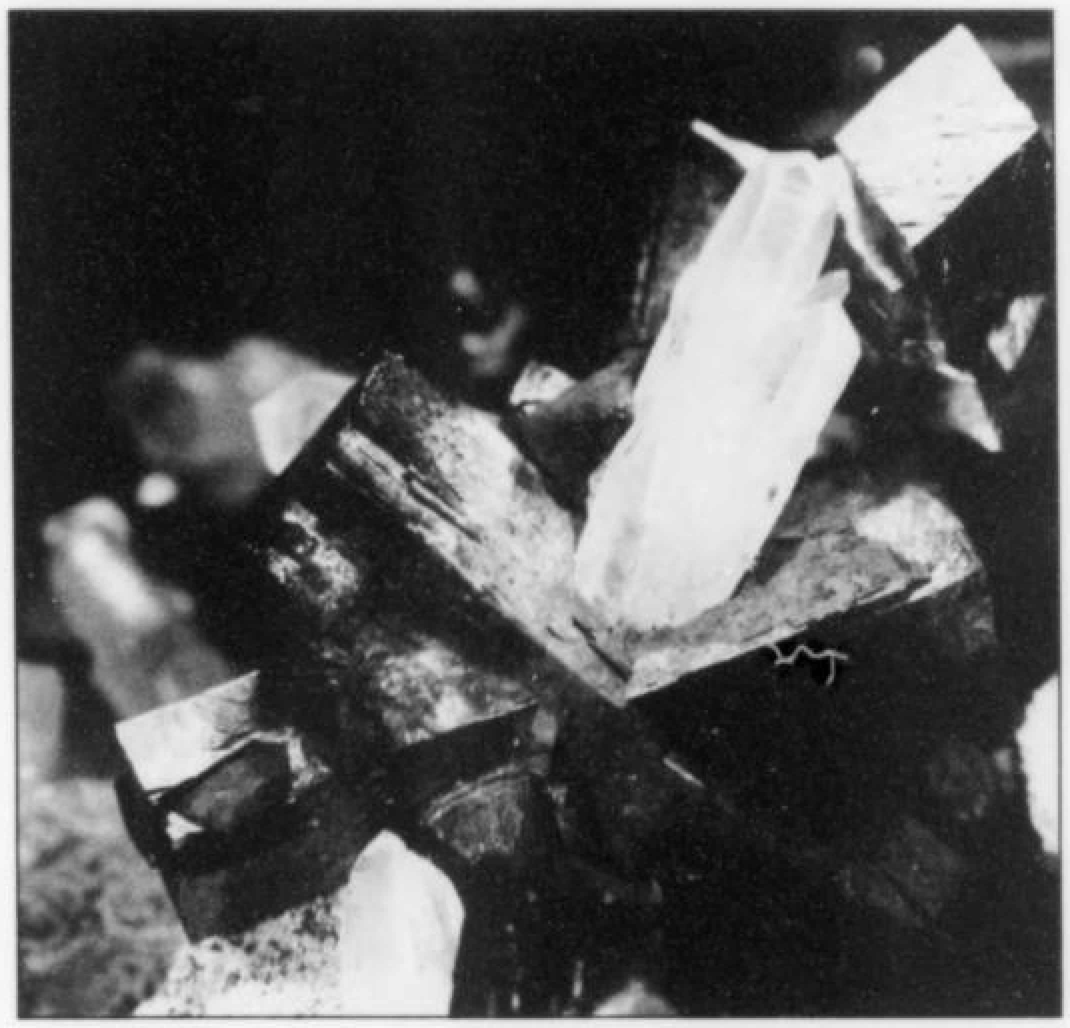


Figure 24. **Arsenopyrite twins with quartz; the field of view is 3.5 cm; from Trepča. Werner Lieber photo.**

Figure 25. **Arsenopyrite needles, 1 cm, from Trepča.**

Figure 26. **Arsenopyrite twins with "fir tree" habit (each needle is 1 mm thick), from Trepča.**

Figure 27. **Arsenopyrite crystals in parallel growth, from Trepča.**

Figure 28. **Dense plumose growth of acicular boulangerite crystals on a druse of rhodochrosite crystals, 14 cm, from Trepča.**

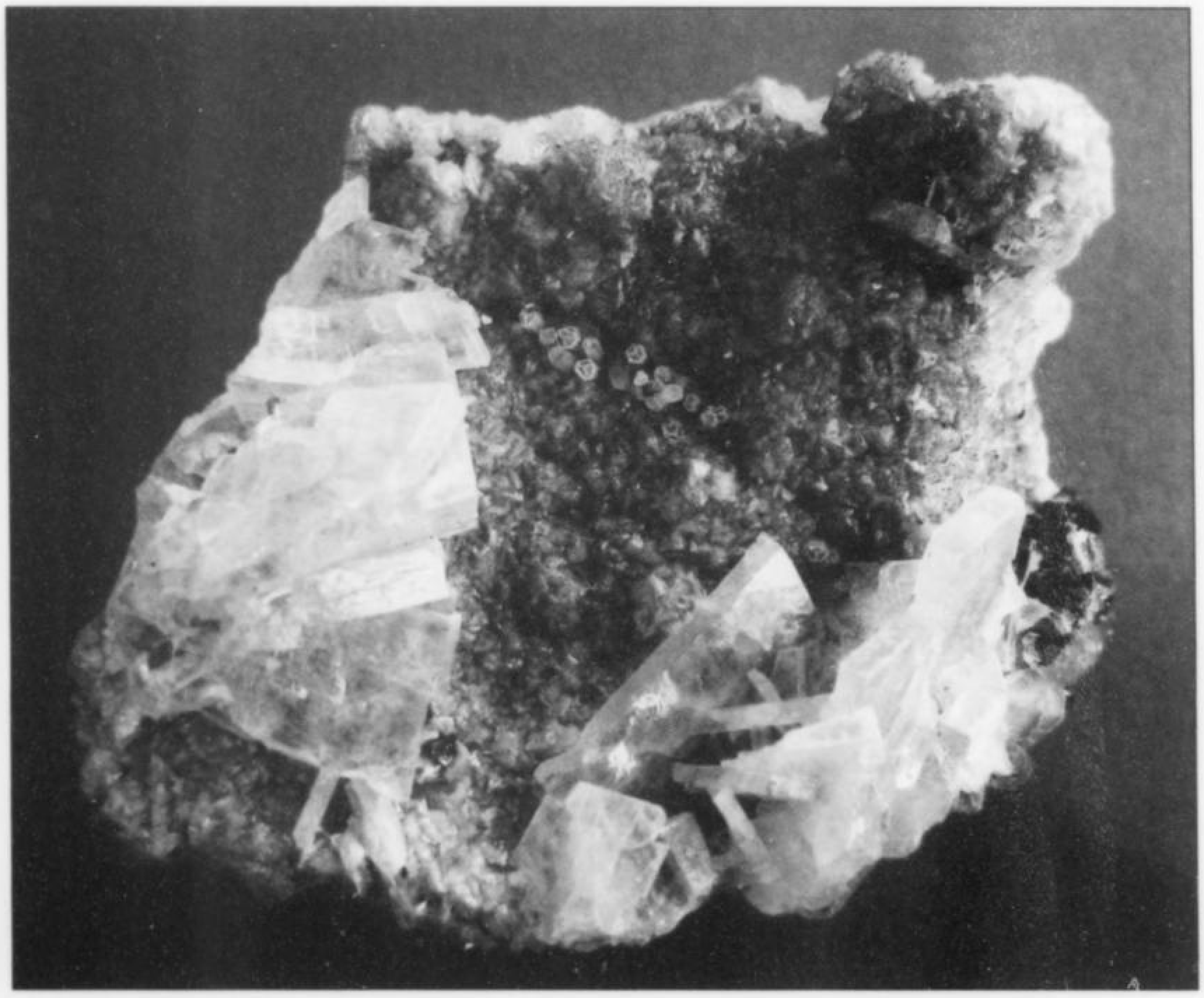


Figure 29. **White barite crystals on a druse of rhodochrosite, from Trepča. Frank Wierich photo.**

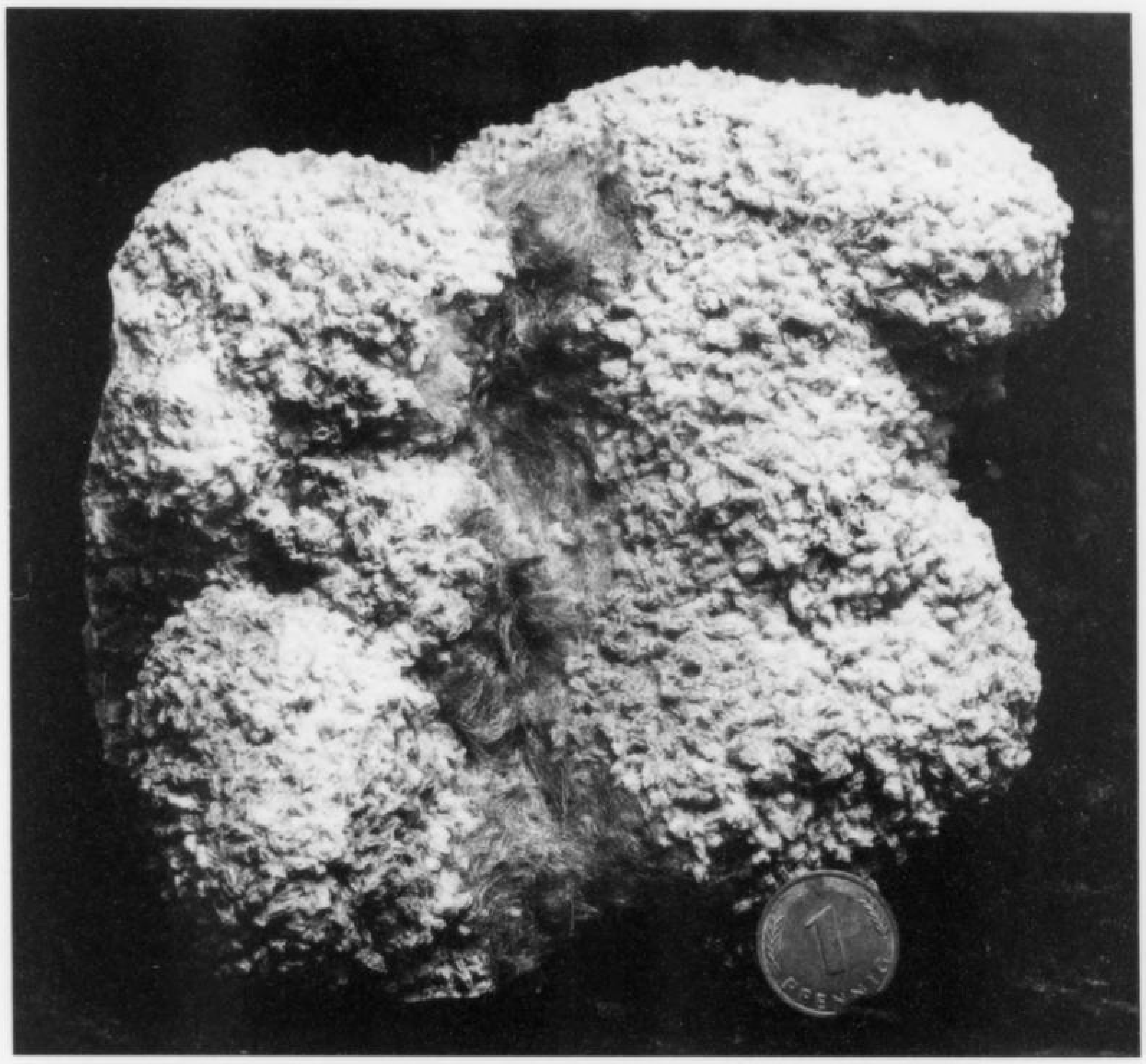


Figure 30. **Boulangerite (gray, felted plumose habit) and rhodochrosite from Trepča. A. Larghi photo.**

Figure 31. **Acicular boulangerite on rhodochrosite crystals, 4 cm, from Trepča. Werner Lieber photo.**

Bournonite $PbCuSbS_3$

Bournonite crystals are very rare at Trepča. They are either tabular single crystals or multiple twins of the cogwheel habit, to 1 × 1 cm, implanted on galena and pyrite and associated with quartz and carbonates. They are never implanted on sphalerite.

Calcite $CaCO_3$

Among the carbonates, calcite is the most abundant at Trepča. It formed as a result of the dissolution of the hosting limestones by volcanic explosions accompanied by a pervasive plume of hot water under pressure which created hydraulic brecciation throughout the deposit. Most commonly calcite forms tightly intergrown coatings of flat rhombohedrons, in many cases twinned, covering vast surfaces of sulfides (sphalerite, galena, pyrrhotite, pyrite) which are thus nearly totally hidden. Some magnificent specimens of sphalerite and pyrrhotite offered for sale at the mineral shows are the result of miners' having dissolved the calcite coatings away with dilute acid. Individual calcite crystals average 1 cm but some reach 7 cm on edge. Most are white, but some are pale yellow to orange because of the alteration of nearby pyrrhotite. Some rare crystals are transparent; others are blue, dark blue, gray or nearly black because of abundant fine inclusions of bournonite or boulangerite.

Chalcopyrite $CuFeS_2$

Beautiful crystals of chalcopyrite are rather rare in the deposit, despite the production of 2,000 tonnes/year of copper concentrates at Trepča (copper in the ore is contained in chalcopyrite, pyrrhotite, tetrahedrite, tennantite, bournonite, bornite and enargite). Sphenoidal chalcopyrite crystals reach 1 cm on edge.

Childrenite $Fe^{2+}Al(PO_4)(OH)_2 \cdot H_2O$

Childrenite was identified from the lowest horizons of Trepča in 1983, but this discovery was published much later, when specimens started to appear at the mineral shows (Žorž, 1991; Bermanec *et al.*, 1995). The mineral (accompanied by crandallite, its alteration product) forms free-standing, doubly terminated crystals to 1 cm, in aggregates associated with manganese and iron carbonates (siderite, ankerite, rhodochrosite) or quartz. The childrenite is pale yellow, with zones of white in the cores of crystals and with transparent honey-brown areas at the corners. The specimens with childrenite often contain tiny vivianite crystals. The occurrence of inclusions of boulangerite in childrenite suggests that the latter was formed under low-temperature hydrothermal conditions.

Cosalite $Pb_2Bi_2S_5$

Cosalite crystals from Trepča are rare but very beautiful. In the first discovery (Terzic *et al.*, 1974, 1975), lustrous, steel-gray to

Table 1. **Minerals of the Trepča deposit.**

Elements	
Bismuth	Bi
Gold	Au
Sulfur	S
Sulfides and Sulfosalts	
Arsenopyrite	$FeAsS$
Bornite	Cu_5FeS_4
Boulangerite	$Pb_5Sb_4S_{11}$
Bournonite	$PbCuSbS_3$
Chalcopyrite	$CuFeS_2$
Cosalite	$Pb_2Bi_2S_5$
Covellite	CuS
Cubanite	$CuFe_2S_3$
Enargite	Cu_3AsS_4
Falkmanite	$Pb_{5.4}Sb_{3.6}S_{11}$
Galena	PbS
Jamesonite	$Pb_4FeSb_6S_{14}$
Löllingite	$FeAs_2$
Marcasite	FeS_2
Pyrargyrite	Ag_3SbS_3
Pyrite	FeS_2
Pyrrhotite	$Fe_{1-x}S$
Sphalerite	ZnS
Stannite	Cu_2FeSnS_4
Stibnite	Sb_2S_3
Tennantite	$Cu_6Cu_4(Fe,Zn)_2(As,Sb)_4S_{13}$
Tetrahedrite	$Cu_6Cu_4(Fe,Zn)_2(Sb,As)_4S_{13}$
Valleriite	$4(Fe,Cu)S\cdot 3(Mg,Al)(OH)_2$
Oxides and Hydroxides	
Chalcophanite	$(Zn,Fe^{2+},Mn^{2+})Mn^{4+}_3O_7\cdot 3H_2O$
Coronadite	$Pb(Mn^{4+},Mn^{2+})_8O_{16}$
Hematite	$\alpha\text{-}Fe_2O_3$
Magnetite	$Fe^{2+}Fe^{3+}_2O_4$
Carbonates	
Ankerite	$Ca(Fe^{2+},Mg,Mn)(CO_3)_2$
Aragonite	$CaCO_3$
Calcite	$CaCO_3$
Cerussite	$PbCO_{3}2$
Dolomite	$CaMg(CO_3)_2$
Kutnohorite	$Ca(Mn^{2+},Mg,Fe^{2+})(CO_3)_2$
Rhodochrosite	$Mn^{2+}CO_3$
Siderite	$Fe^{2+}CO_3$
Smithsonite	$ZnCO_3$
Silicates	
Actinolite	$\square Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$
Andradite	$Ca_3Fe^{3+}_2(SiO_4)_3$
Chlorite Group	
Diopside	$CaMgSi_2O_6$
Epidote	$Ca_2Al_2(Fe^{3+},Al)Si_3O_{12}(OH)$
Hedenbergite	$CaFe^{2+}Si_2O_6$
Illite Series	$K_{0.65}Al_{2.0}\square Al_{0.65}Si_{3.35}O_{10}(OH)_2$
Ilvaite	$CaFe^{3+}(Fe^{2+})_2O(Si_2O_7)(OH)$
Quartz	SiO_2
Wollastonite	$CaSiO_3$
Phosphates	
Childrenite	$Fe^{2+}Al(PO_4)(OH)_2\cdot H_2O$
Crandallite	$CaAl_3(PO_4)_2(OH,H_2O)_6$
Ludlamite	$Fe_3(PO_4)_2\cdot 4H_2O$
Struvite	$(NH_4)Mg(PO_4)\cdot 6H_2O$
Vivianite	$Fe^{2+}_3(PO_4)_2\cdot 8H_2O$
Sulfates	
Anglesite	$PbSO_4$
Barite	$BaSO_4$
Chalcanthite	$Cu^{2+}SO_4\cdot 5H_2O$
Gypsum	$CaSO_4\cdot 2H_2O$
Melanterite	$FeSO_4\cdot 7H_2O$
Tungstates	
Scheelite	$CaWO_4$

Table 2. **Rare metal content of Trepča sulfides (from H. Këpuska, 1998).**

(in ppm)	*Minimum*	*Maximum*	*Average*	*Mine levels hosting the highest grades*
Cd in sphalerite	1210	7800	2640	
Cd in galena	0	326	51	
In in sphalerite	40	602	97	+75 and +15 (220 to 602 ppm)
In in galena	0	720	55	+315 to +75
Te in pyrrhotite	0	12		
Ga in sphalerite	0	28	10	+15 (more than 16 ppm)
Ge in pyrite	3	180		+255
Tl in galena	0	285	32	+485 (285 ppm), +135
Se in sphalerite	125	250		
Hg in sphalerite	0	54	22	
Bi in galena	17	11,080	342	

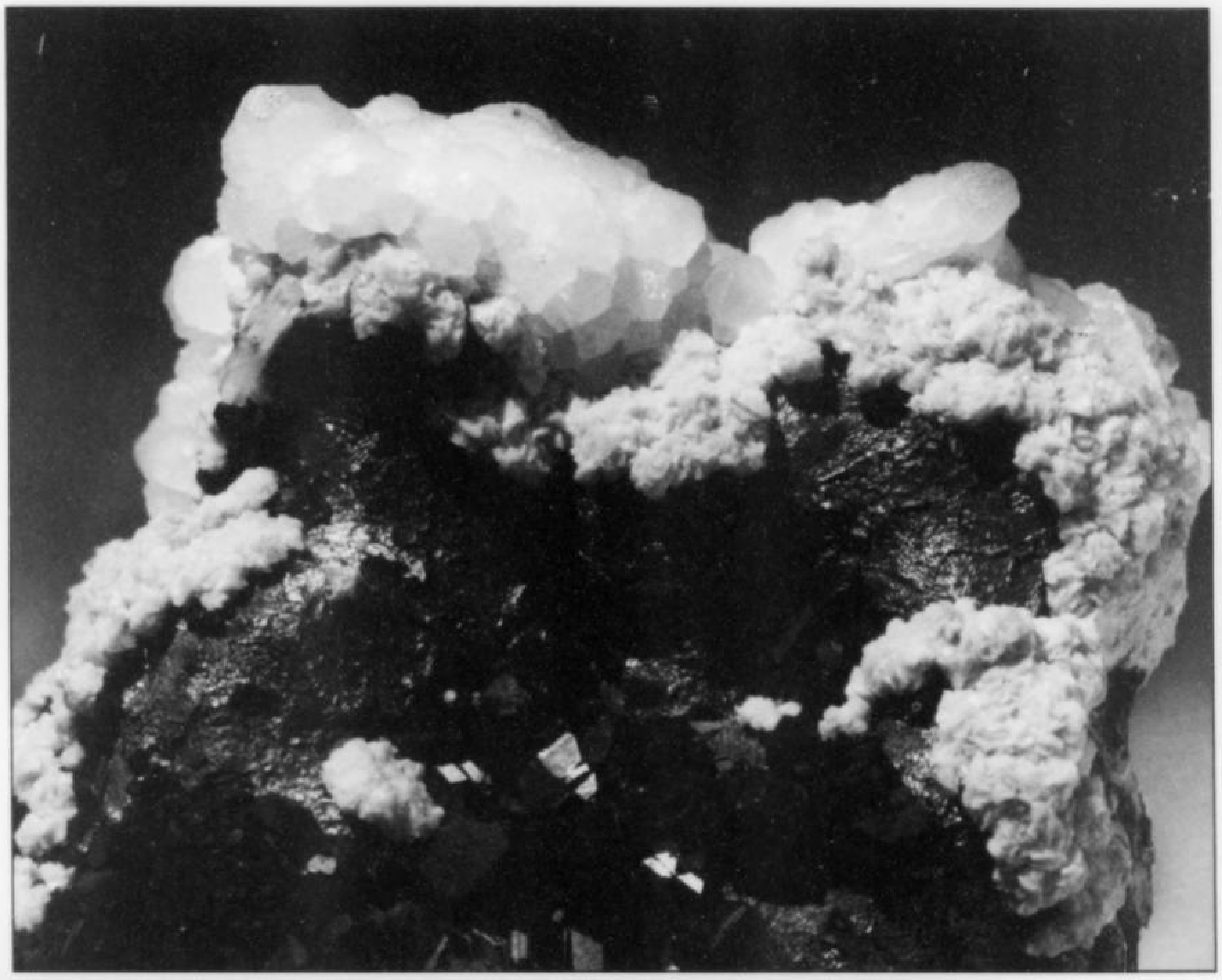
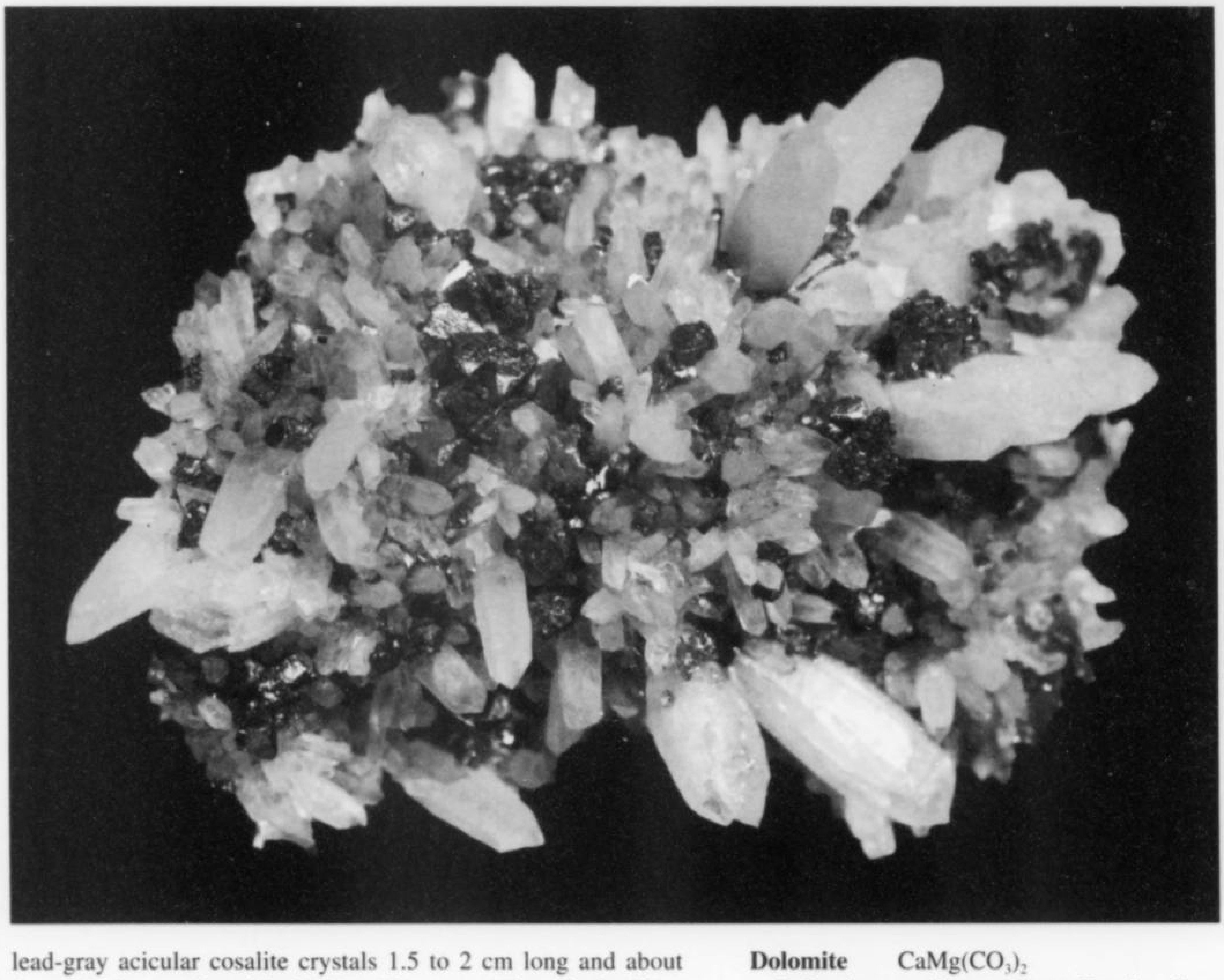


Figure 32. **Galena spheroids, 5 cm in diameter each, with a rhodochrosite capping, calcite and quartz, from Trepča.**

Figure 33. **Hedgehog-like quartz with chalcopyrite tetrahedra 2 to 4 mm in diameter, from Trepča.**



lead-gray acicular cosalite crystals 1.5 to 2 cm long and about 1 mm thick were found in the 8 × 10-cm central void of a 10 × 15 × 20-cm mass of pyrrhotite, pyrite and marcasite coated by calcite and galena. The galena closely associated with cosalite in this mass has an unusual habit, occurring as elongated, needle-like, isolated crystals, while cosalite appears as much thinner, hairlike crystals.

Dolomite $CaMg(CO_3)_2$

Dolomite specimens from Trepča show beautiful pinkish rhombohedral crystals exceptionally reaching 16 cm on edge and weighing several kilograms, associated with long-prismatic quartz crystals. The Trepča museum exhibits many large and fine dolomite specimens, one of which is recorded as exceptional in the inventory of Guillemin and Mantienne (1989). In 1974, a dealer

Figure 35. **A "floater" crystal cluster of dolomite in parallel growth, 16 cm, from Trepča.**

Figure 34. **Dolomite with quartz, 5 cm field of view; from Trepča. Werner Lieber photo.**

from Geneva displayed a very beautiful 25 × 30-cm specimen to one of the authors (JF) while this author was working with a colleague to expedite an exchange with a famous museum in Paris. In this specimen, a perfect, pale pink rhombohedral crystal of dolomite measuring 5 cm on edge hangs delicately, secured by several acicular, transparent quartz crystals 4 cm long, within a cavity lined by black sphalerite crystals to 3 cm on edge. The dealer whispered that the Trepča Kombinat had been on the verge of giving this magnificent piece to President Tito, but when the President's scheduled visit to Trepča was cancelled the dealer himself secured the specimen.

Galena PbS

Galena occurs at Trepča as cubic, octahedral, cuboctahedral and cubo-dodecahedral crystals to 7 cm on edge, many of them highly lustrous. Some of the crystals have corroded or melted-looking faces. Hillock-shaped features on the faces may reveal helical growth. Spinel-law twinned galena crystals are fairly common.

Ilvaite $CaFe^{3+}(Fe^{2+})_2O(Si_2O_7)(OH)$

On the Internet, a German dealer recently offered an ilvaite aggregate reportedly from Trepča; it measures 8 × 8 × 9 cm and shows dark brownish green, striated crystals to 4 cm on edge.

Jamesonite $Pb_4FeSb_6S_{14}$

Jamesonite is rare at Trepča. Guillemin and Mantienne (1989) describe a specimen in the mine museum showing jamesonite crystals to 4 cm long and 1.5 cm in diameter. Many collectors believe that a part of the "plumosite" of Trepca is jamesonite, but (to our knowledge) all the mineralogical analyses done on plumosite from Trepča have identified boulangerite and never jamesonite.

Kutnohorite $Ca(Mn^{2+},Mg,Fe^{2+})(CO_3)_2$

A 3 ×3 × 5-cm specimen from an old collection, labeled as having come from Trepča, was recently sold to us by a French collector as kutnohorite. The specimen displays compact, radial aggregates of pale pink fibrous crystals; the aggregates, reaching 2 cm long and 5 mm thick, are hexagonal in cross-section. Inspection with a binocular microscope reveals that the faces of the minute rhombohedral crystals composing the fibers are curved, and the crystals regularly offset, such that the edges of the compound prisms tend to form helical lines. Analyses done in the BRGM lab by X-ray diffractometry, electronic scanning microscopy and X-ray spectrometry show that this specimen consists of varying ankerite-kutnohorite-dolomite phases: some areas are a Ca-rich rhodochrosite, others are Fe-rich kutnohorite, Mn-rich ankerite, or Mg-dominant phases of either species. From these results one may at least conclude that the occurrence of kutnohorite at Trepča is highly probable.

Figure 36. **Galena spinel-law twins, 3 cm each, with very high luster, from Trepča.**

Figure 37. **Rounded "flowed galena" in streams, with 1-cm sphalerite crystals and pyrite, from Trepča.**

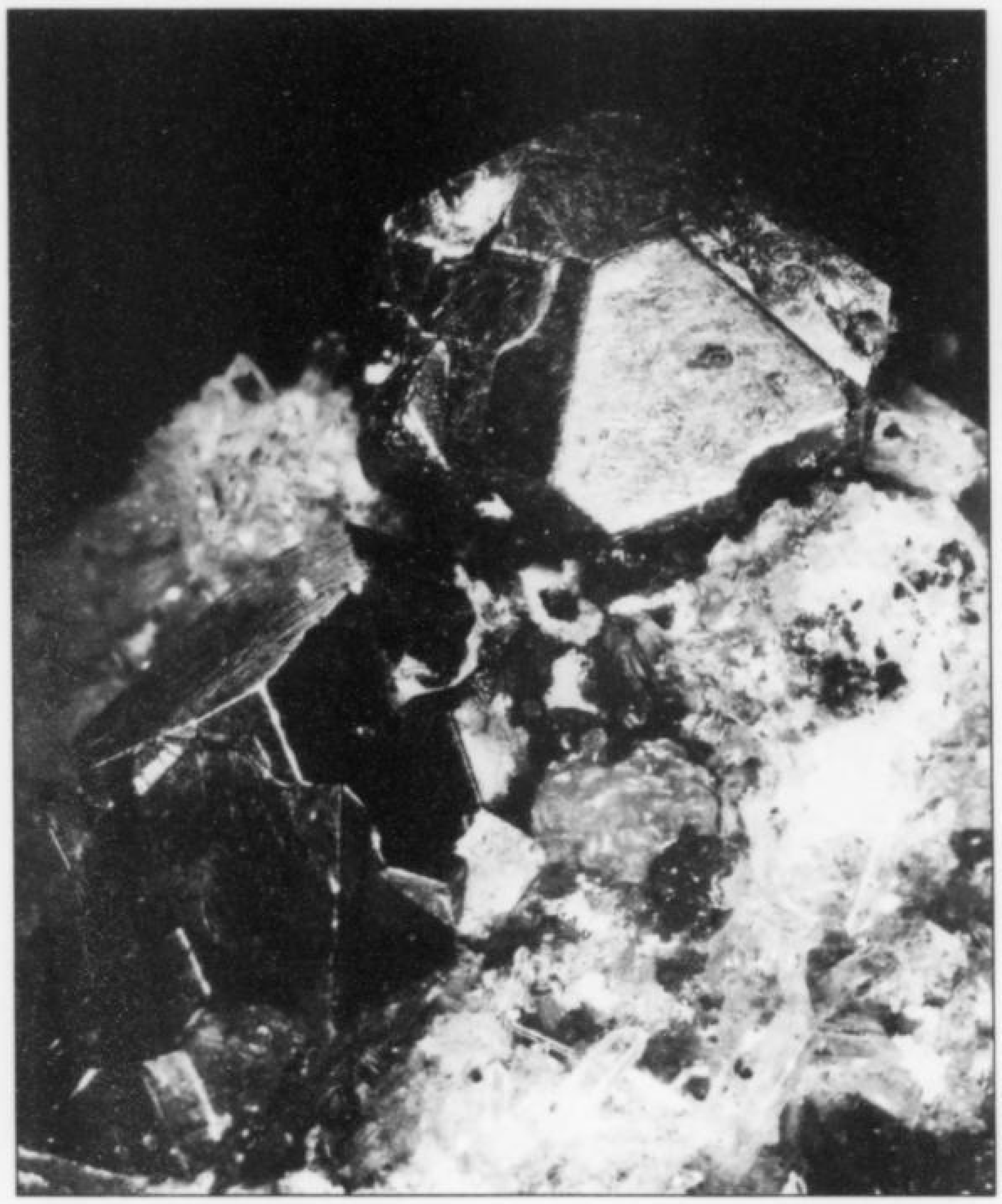


Figure 38. **Galena crystal, 3.5 cm, on quartz, from Trepča. Werner Lieber photo.**

Figure 39. **Galena with terraced crystal growth on the faces, 5 cm, with calcite, from Trepča.**

Ludlamite $Fe_3(PO_4)_2 \cdot 4H_2O$

Ludlamite is apple-green, much paler than vivianite and much rarer (Barič, 1953, 1954). It forms crystals up to 3 cm on edge. Tabular crystals with dominant {001} are up to 8 mm.

Pyrite FeS_2

Pyrite is not one of the most spectacular sulfides of Trepča, although it is widespread, generally in groups of cubic crystals with individuals 5 mm on edge (exceptionally to 5 cm on edge), or in beautiful globular aggregates. The surfaces of the pyrite crystals are commonly iridescent, showing red, orange, blue, green and violet hues. Pyrite is, with marcasite, one of the sulfides which most commonly replace pyrrhotite in the pseudomorphs for which the locality is so famous.

Pyrrhotite $Fe_{1-x}S$

Trepča has produced remarkable specimens of pyrrhotite, with sharp hexagonal-tabular crystals to 16 cm across, very commonly in parallel aggregates. The faces of the crystals may be clean and lustrous but more often they show coverings or sprinklings of tiny crystals of calcite, dolomite, arsenopyrite, galena or other species, in some cases epitactically oriented. The abundance of pyrrhotite is one of the indications of the very high temperature of formation of the Trepča deposit. Këpuska (1998) identified up to four generations of pyrrhotite crystallization (and three of sphalerite, arsenopyrite, galena, pyrite and chalcopyrite).

Very commonly pyrrhotite has been replaced pseudomorphically by pyrite (the largest known crystal of pyrite pseudomorphous after pyrrhotite is 30 cm across!) and/or by marcasite. Rare specimens of galena pseudomorphous after pyrrhotite show beautiful, lustrous tabular crystals to 2 cm thick, grown tightly together in parallel aggregates to several centimeters across. Unfortunately, some unstable pyrrhotite specimens have altered by exposure to humidity into a powder of sulfates after a dozen or so years of storage. Another consequence of the pseudomorphic replacement of pyrrhotite by other minerals is an increase of volume which makes cracks appear in various other sulfides which have grown on the surfaces of specimens; for instance, many of the sphalerite

Figure 40. **Ludlamite crystal, 1.7 cm, with quartz and siderite, from Trepča. École des Mines collection, Paris; Olaf Medenbach photo.**

Figure 41. **Ludlamite crystals to 1.7 cm with vivianite on quartz with siderite, from Trepča. École des Mines collection, Paris; Jeff Scovil photo. (Same specimen as shown in Fig. 40.)**

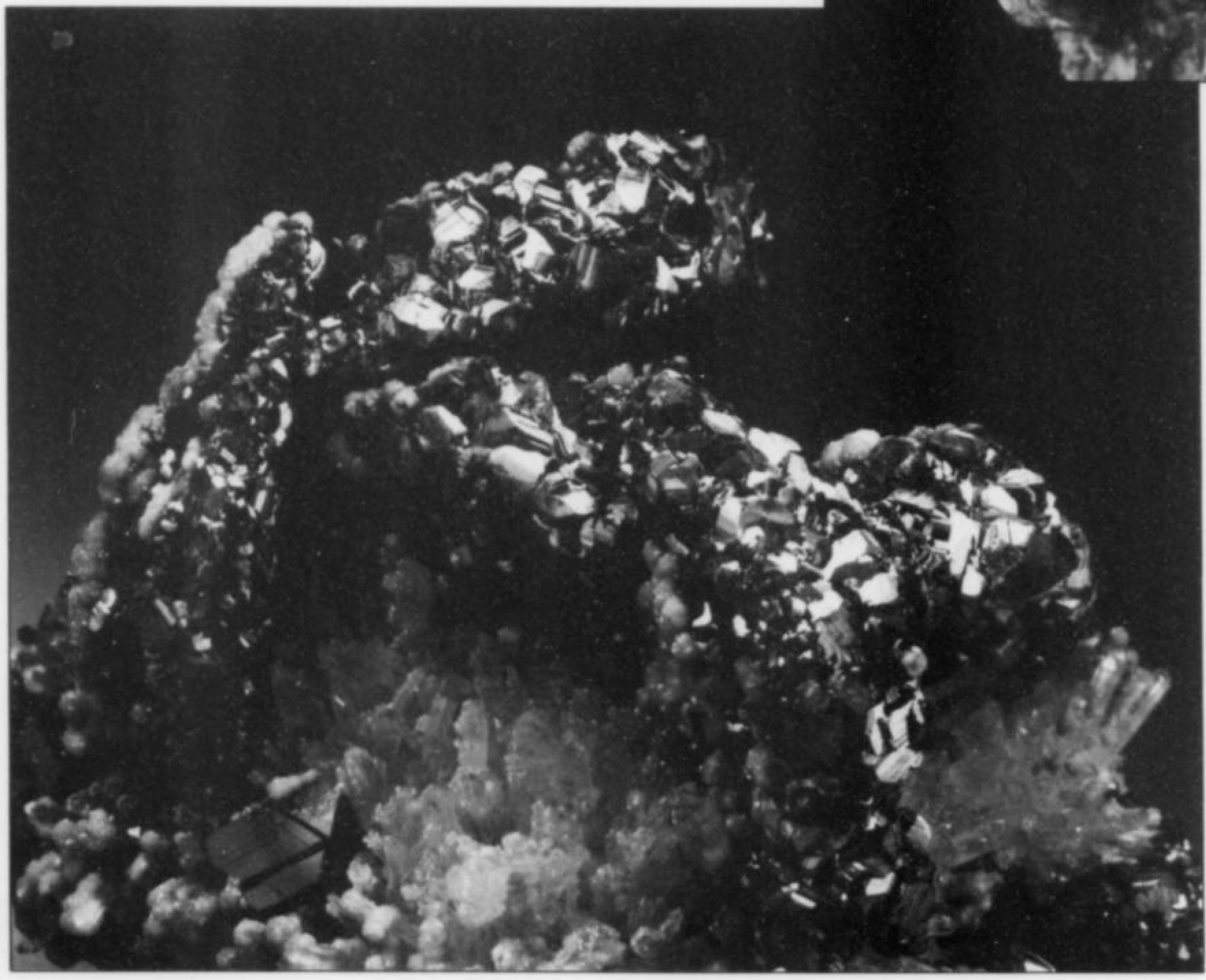


Figure 42. **Pyrite pseudomorphs after pyrrhotite crystals to 6 cm, with siderite and sphalerite on quartz, from Trepča. Gene Schlepp specimen; Wendell Wilson photo.**

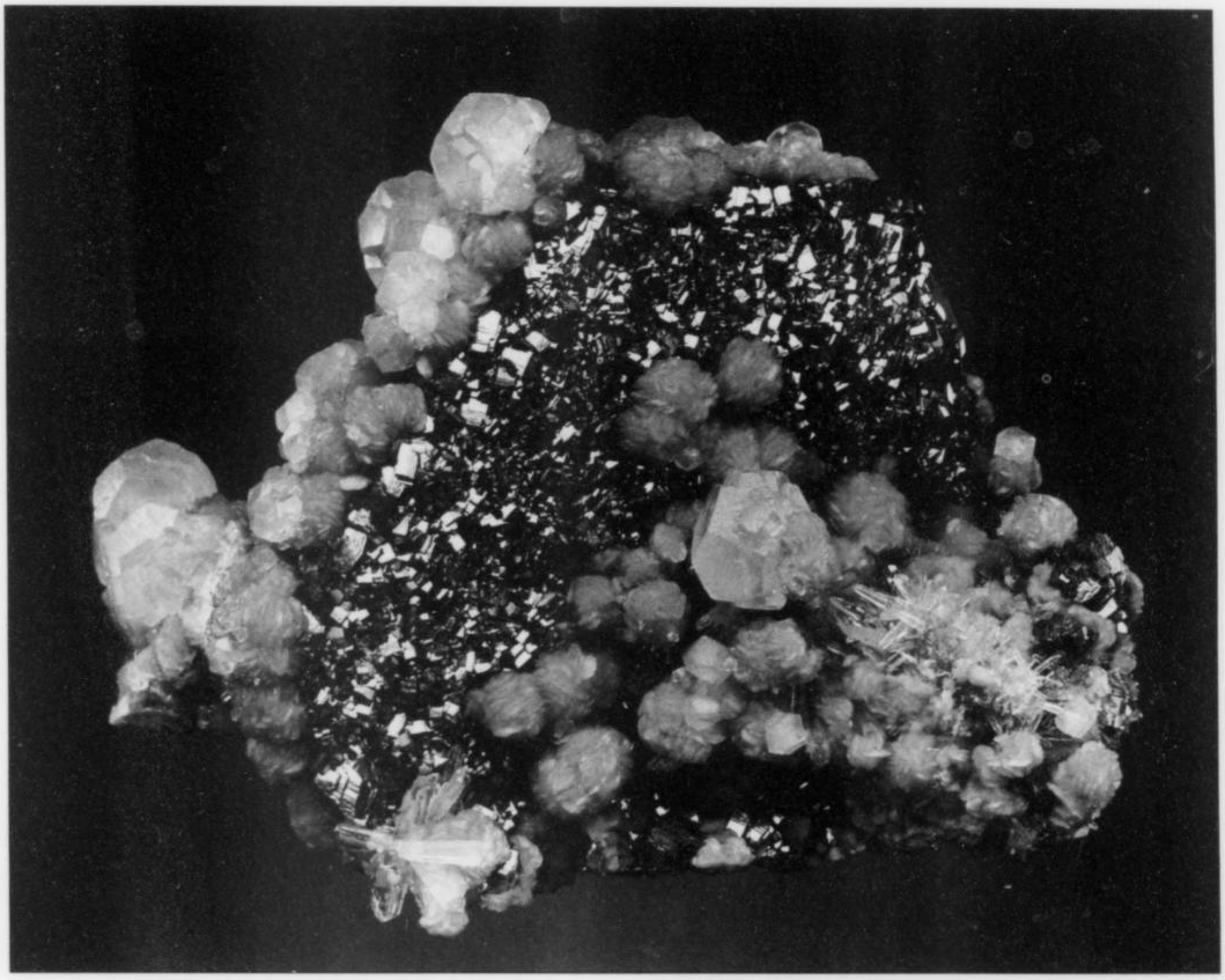


Figure 43. **Pyrite pseudomorph after pyrrhotite with calcite, quartz and rhodochrosite, 4 cm, from Trepča. Martin Zinn collection; Jeff Scovil photo.**

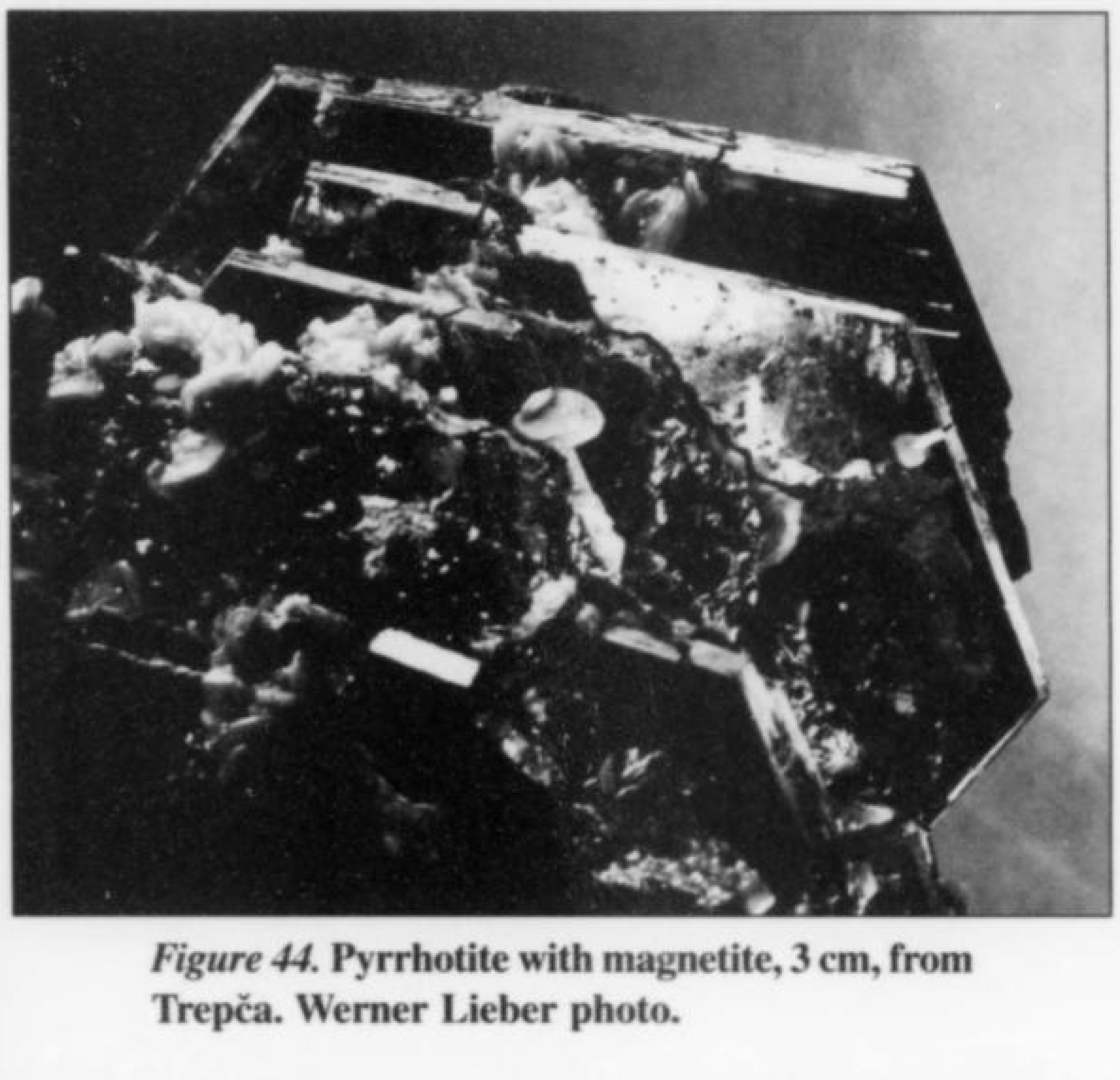


Figure 44. **Pyrrhotite with magnetite, 3 cm, from Trepča. Werner Lieber photo.**

Figure 45. **Pyrrhotite rosettes to 6 cm, with calcite, from Trepča.**

or galena crystals larger than 5 cm are crosscut by open fissures up to 6 mm which rise from the interiors of the specimens.

Quartz SiO_2

Crystals of white and opaque to colorless and transparent quartz are common, mostly as tiny needles 5 mm long and 1 mm thick, sometimes as prisms of 1 to 5 cm long with a tapered, club-shaped habit, and in some rarer cases sceptered. Thick prismatic crystals rarely exceed about 15 cm long. Wonderful micromount-size specimens are composed of orange-brown, pearl-like spheres of siderite or ankerite seemingly hung like fruits on, or scattered among, acicular crystals of quartz. Very rarely, Japan-law twins composed of two orthogonal prisms each 2.5 cm long have been found (Barič 1977).

Rhodochrosite $MnCO_3$

Rhodochrosite occurs at Trepča as coatings with surfaces composed of crystals between 1 and 3 cm on edge; as stalactites; and more rarely as isolated rhombohedral crystals less than 1 cm on edge. The rhodochrosite ranges in color from creamy white to pale

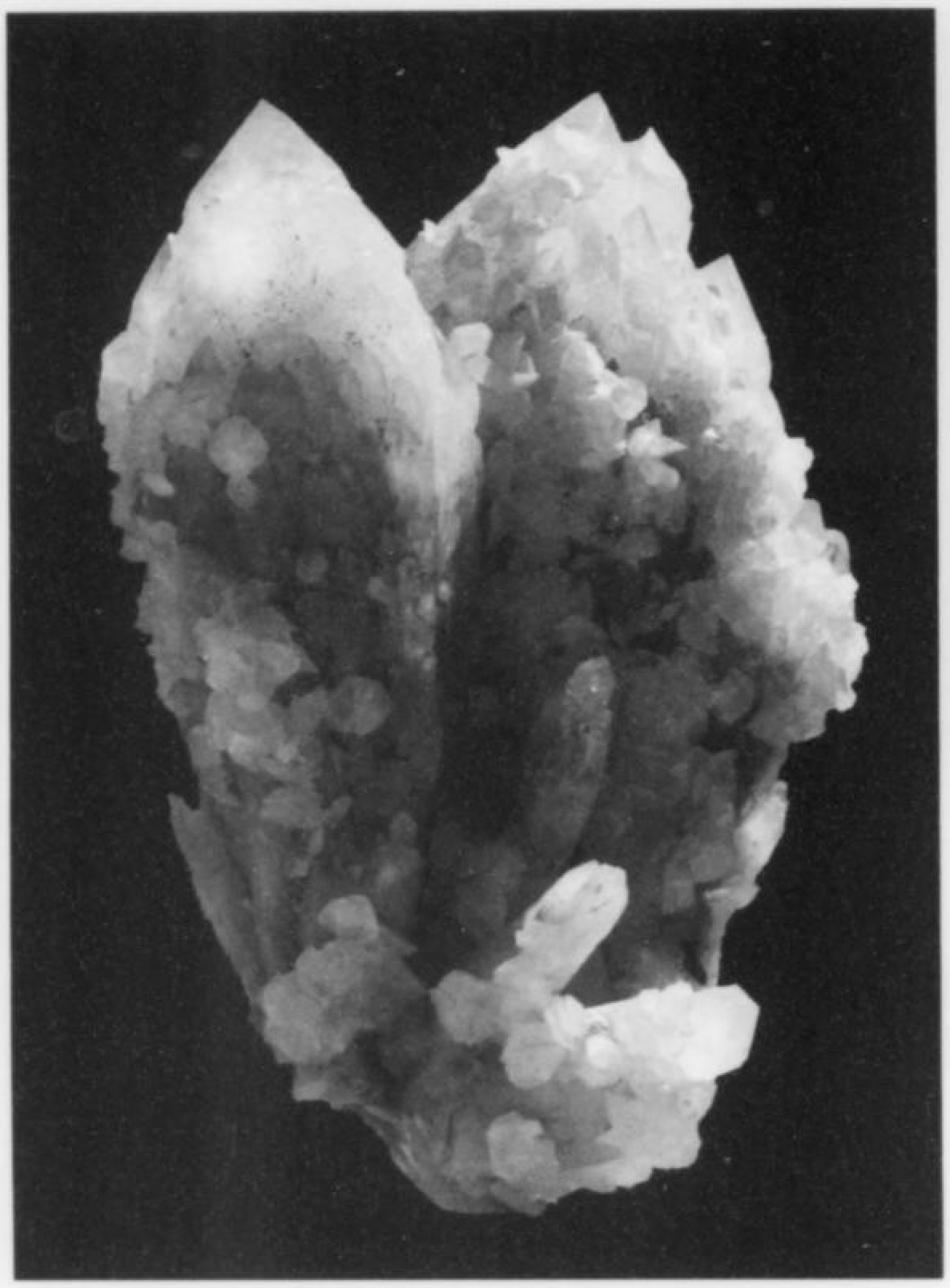


Figure 46. Sceptered quartz crystals, 16 cm, partially coated by calcite crystals, from Trepča.

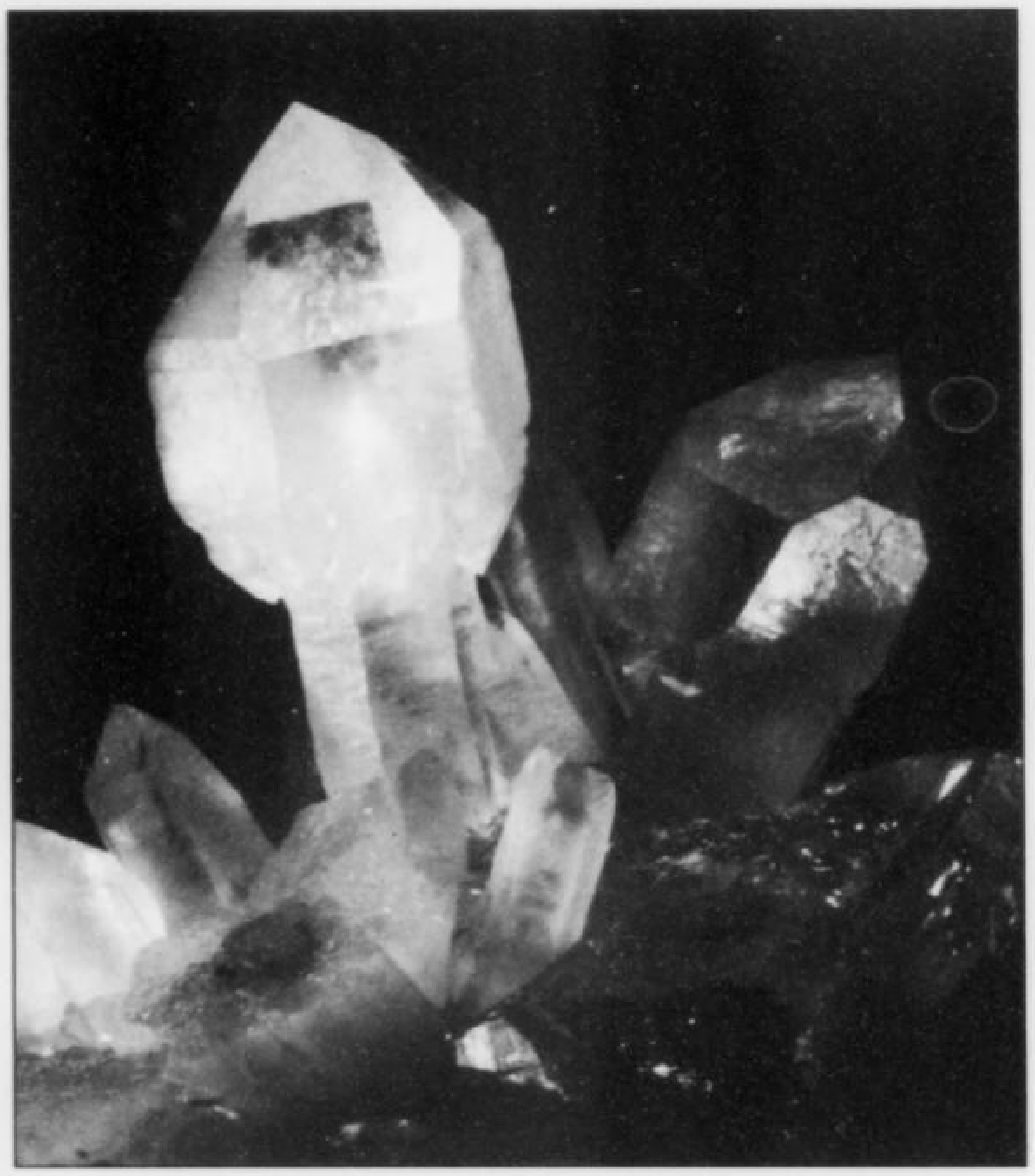
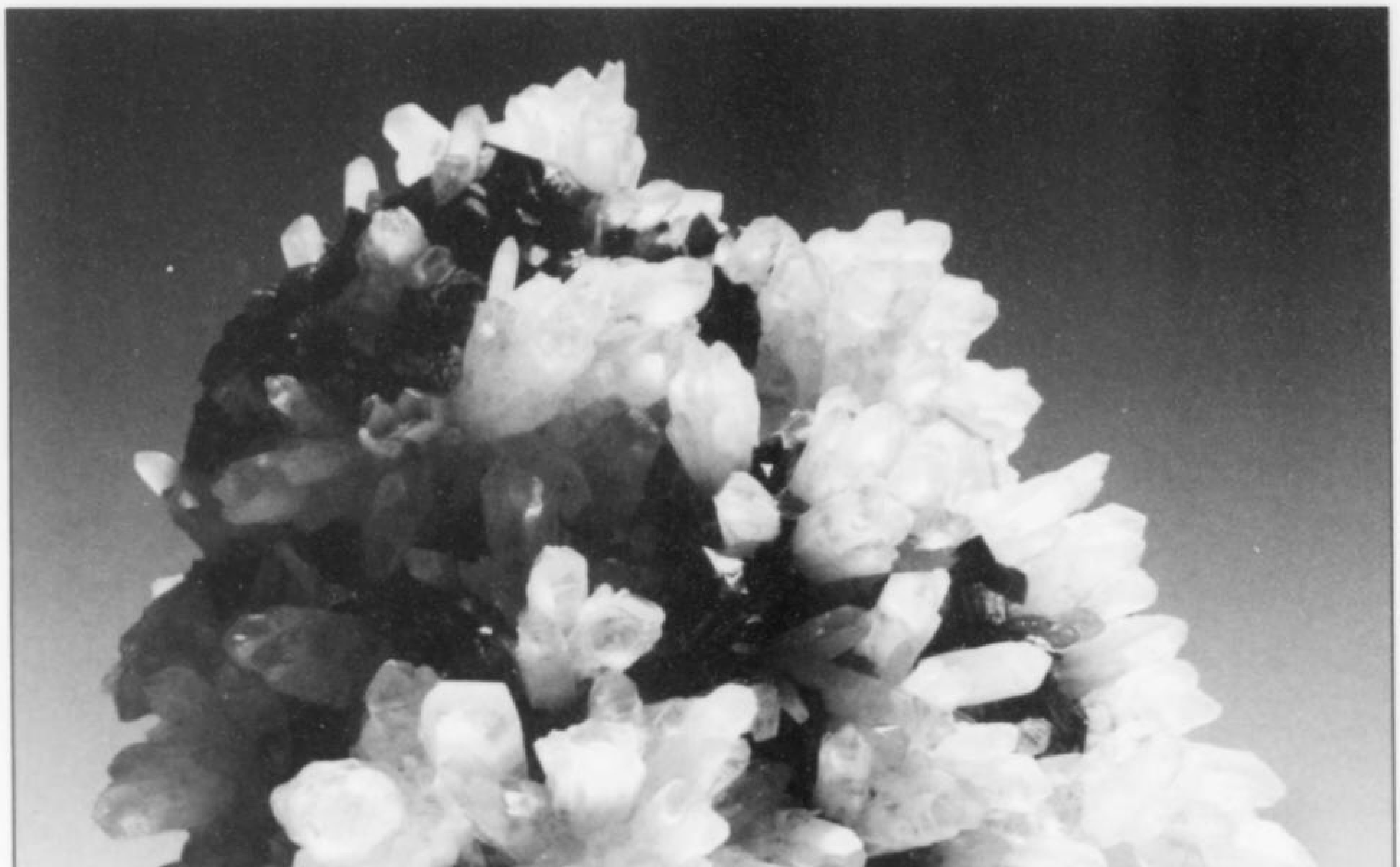


Figure 47. Scepter quartz crystal, 3 cm, from Trepča. Werner Lieber photo.

Figure 48. Hedgehog-like aggregate of short quartz prisms (16 cm total diameter), intergrown with pyrite and arsenopyrite, from Trepča.



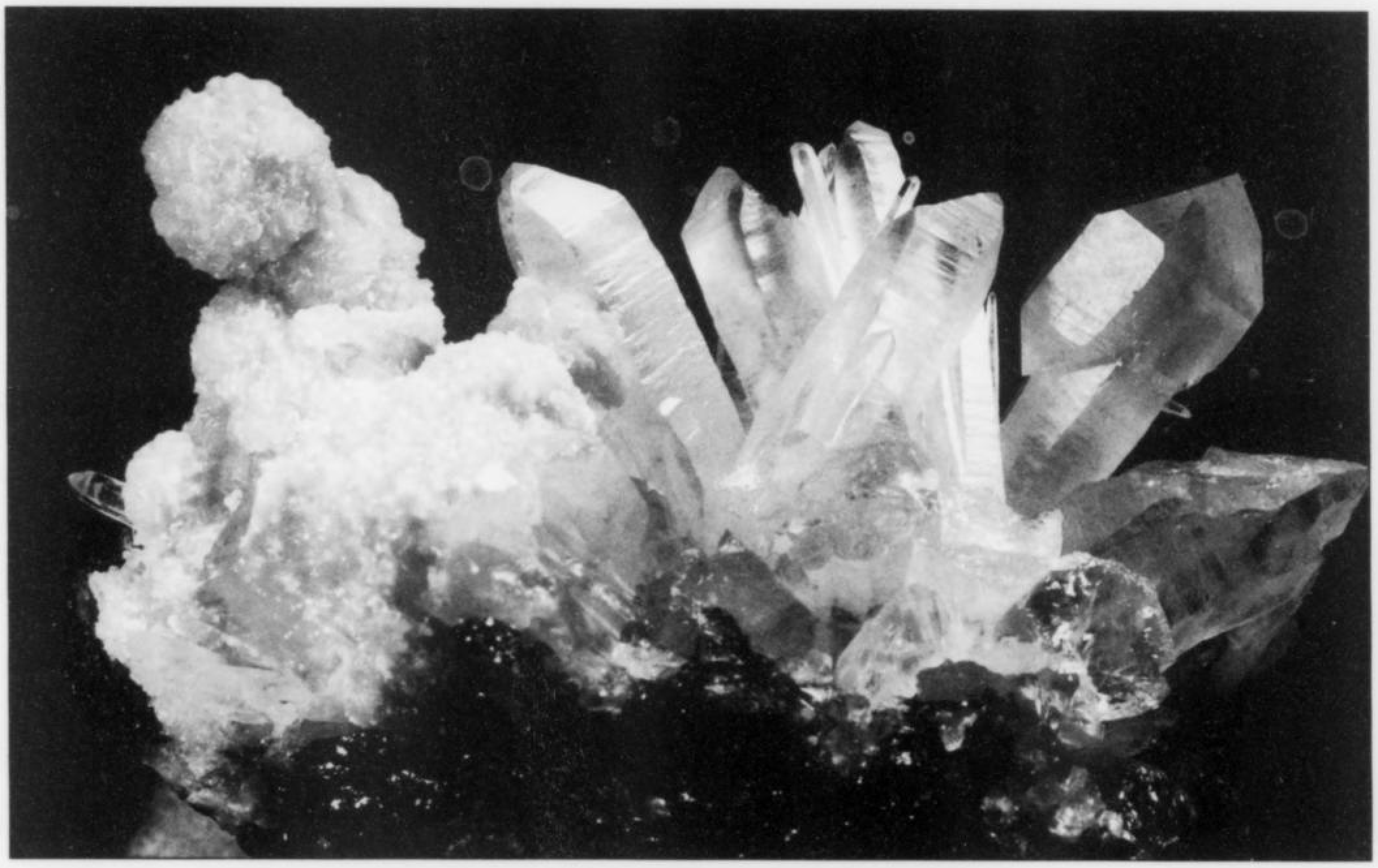


Figure 49. **Rhodochrosite druse with quartz crystals, including a scepter, on sphalerite, 4 cm, from Trepča. Werner Lieber photo.**

Figure 50. **Magnificent 5-cm-diameter stalactite composed of black, spinel-law twinned sphalerite, rounded galena crystals, drusy rhodochrosite and calcite, from Trepča.**

pink when the specimen is fresh, but it can oxidize to a pale gray or dirty brown after a few years of exposure. For that reason, collectors should be cautious when buying a specimen on the basis of an old photo on the Internet.

Siderite $FeCO_3$

A Mn-rich siderite (locally called "oligonite") is typical of the Trepča deposit. Stalactites to 1 meter long and 25 cm in diameter have been found. Siderite, despite being widespread, is not spectacular in Trepča, the crystals being mostly pink-brown flattened rhombs less than a few millimeters on edge, with curved faces, sometimes in spherulitic aggregates and crusts. Barič (1977) described amazing pseudo-octahedric crystals and rhombs, 1 mm on edge, on quartz needles from the Riesinger collection.

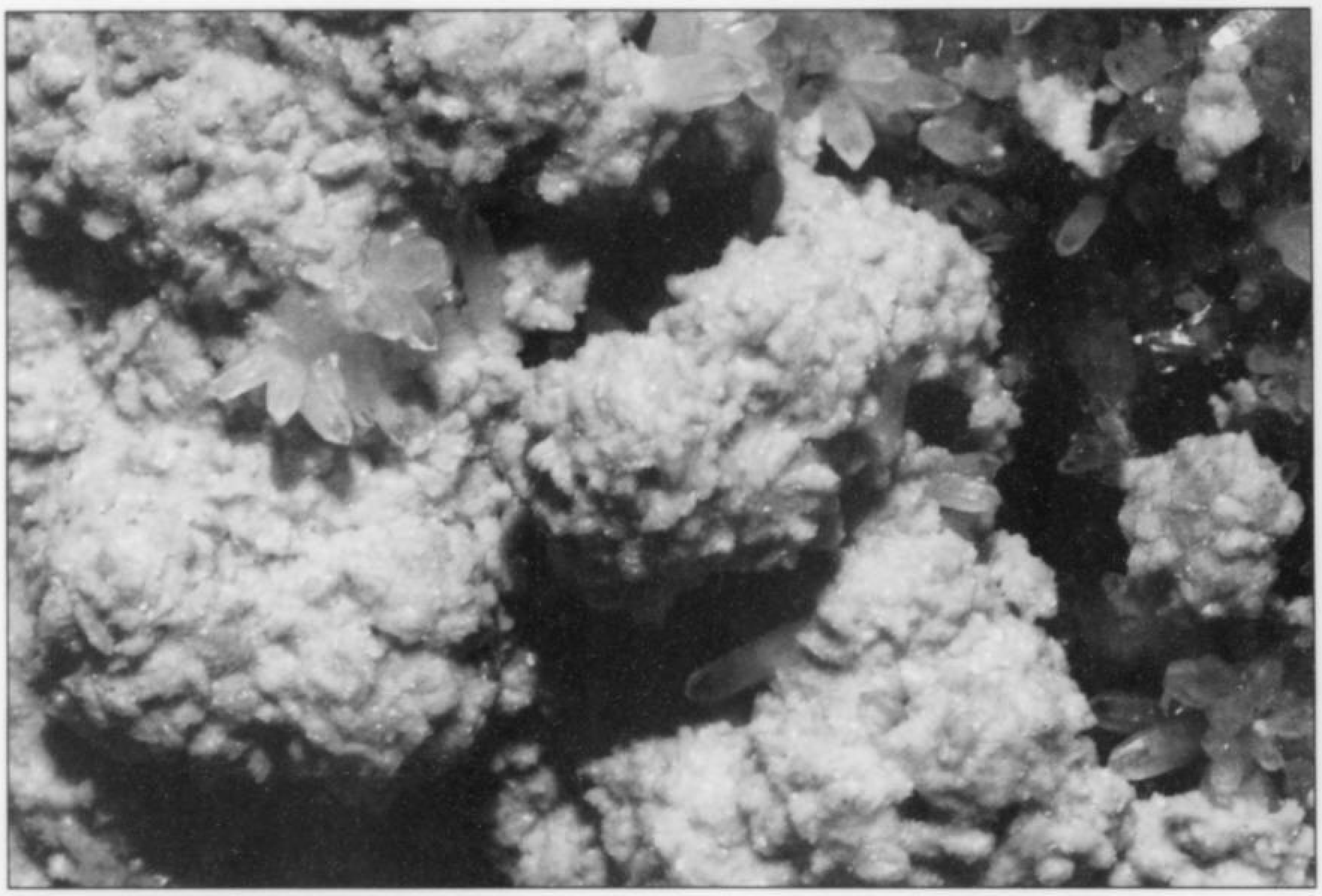


Figure 51. **Rhodochrosite druse with quartz crystals to 1 cm, on black sphalerite, from Trepča.**

Figure 52. **Rhodochrosite crystals perched on quartz crystals to 1 cm, from Trepča. Werner Lieber photo.**

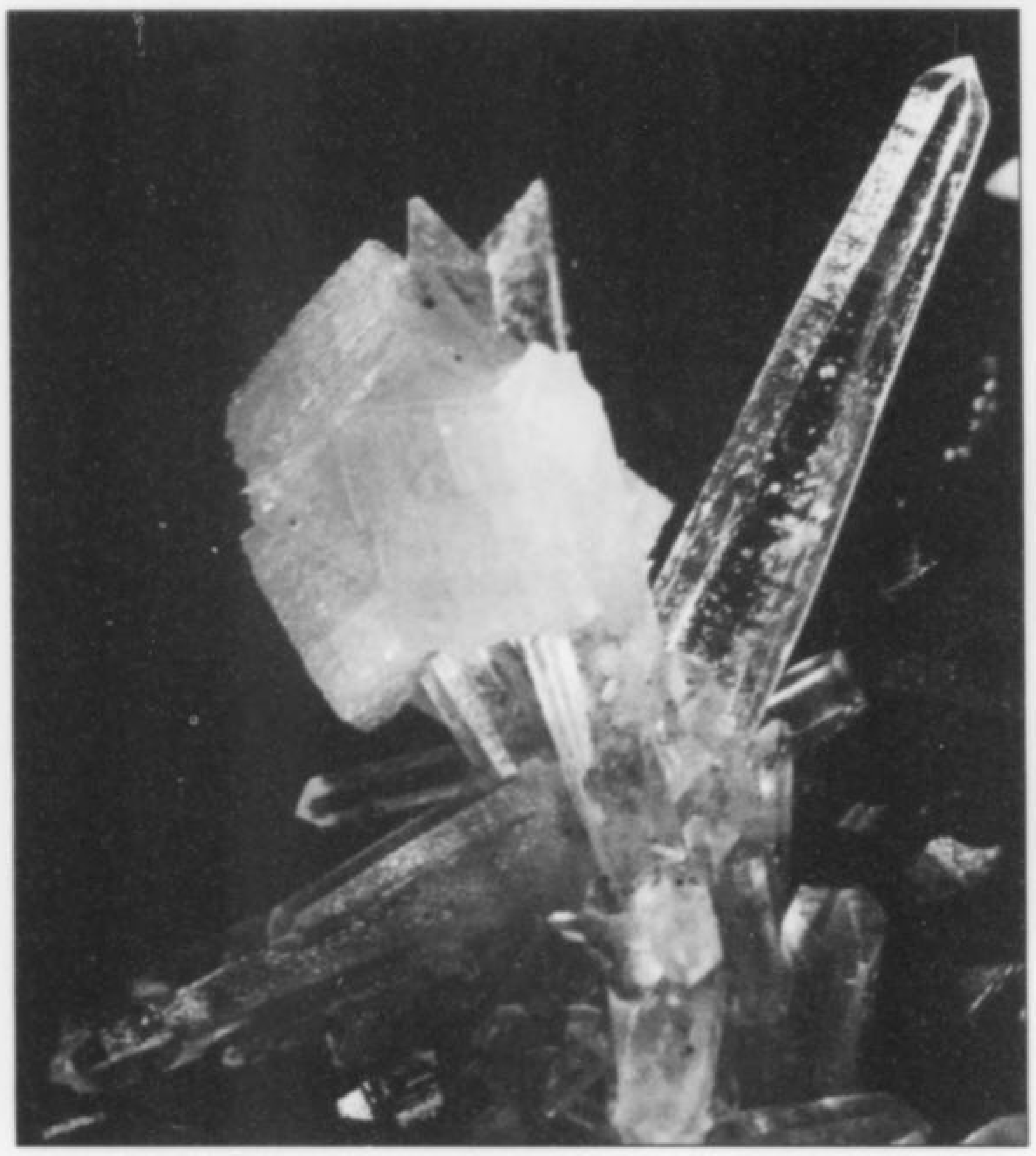


Figure 53. **Sphalerite crystal cluster, 4 cm, from Trepča. Werner Lieber photo.**

Sphalerite ZnS

Sphalerite from Trepča is black, being very rich in iron; it is found most commonly as octahedral crystals (actually composed of two tetrahedrons in equal development) and spinel-law twins with striated, highly lustrous faces. The crystals have an average size between 2 and 3 cm, but some reach 7 cm and exceptionally 10 cm. Epitactic orientation with pyrrhotite, chalcopyrite or pyrite is frequent (Zebec, 1976, 1977). Calcite, as large, well-developed crystals, is an abundant association. Sphalerite is sometimes associated with small (5 mm), isolated crystals of chalcopyrite, in many cases epitactic on sphalerite. A recent study by Slovenian and German scientists (Srot *et al.*, 2003) showed that the twin planes (111) of sphalerite are depleted in S and enriched in O, Mn, Fe and Cu; an excess in copper generates the formation of minute chalcopyrite crystals along this plane.

Tetrahedrite $Cu_6Cu_4(Fe,Zn)_2(Sb,As)_4S_{13}$

Beautiful specimens of tetrahedrite are rare in the deposit. Generally, the crystals protrude from a 1 cm-thick coating of calcite and quartz, and only some parts of their characteristic edges, up to 2 cm long, are visible.

Vivianite $Fe^{2+}_3(PO_4)_2\cdot 8H_2O$

Vivianite, one of the most famous Trepča minerals, forms beautiful specimens (Barič, 1965). Its thick-prismatic crystals are up to 10 cm long and 2 cm thick and are relatively stable. They display a very beautiful deep green color and transparency. This iron phosphate has formed as a result of the Trepča deposit's very high iron content (31.5%). The vivianite crystals, averaging 1 cm long, commonly rest on pyrrhotite or pyrite, and in some cases on quartz or carbonates. Previous authors thought the mineral was restricted to the upper third of the mine, but new specimens were found last year on the lowest levels.

Figure 54. **Sphalerite crystal cluster, 11.1 cm, with quartz and pyrite, from Trepča. Francis Benjamin collection; Jeff Scovil photo.**

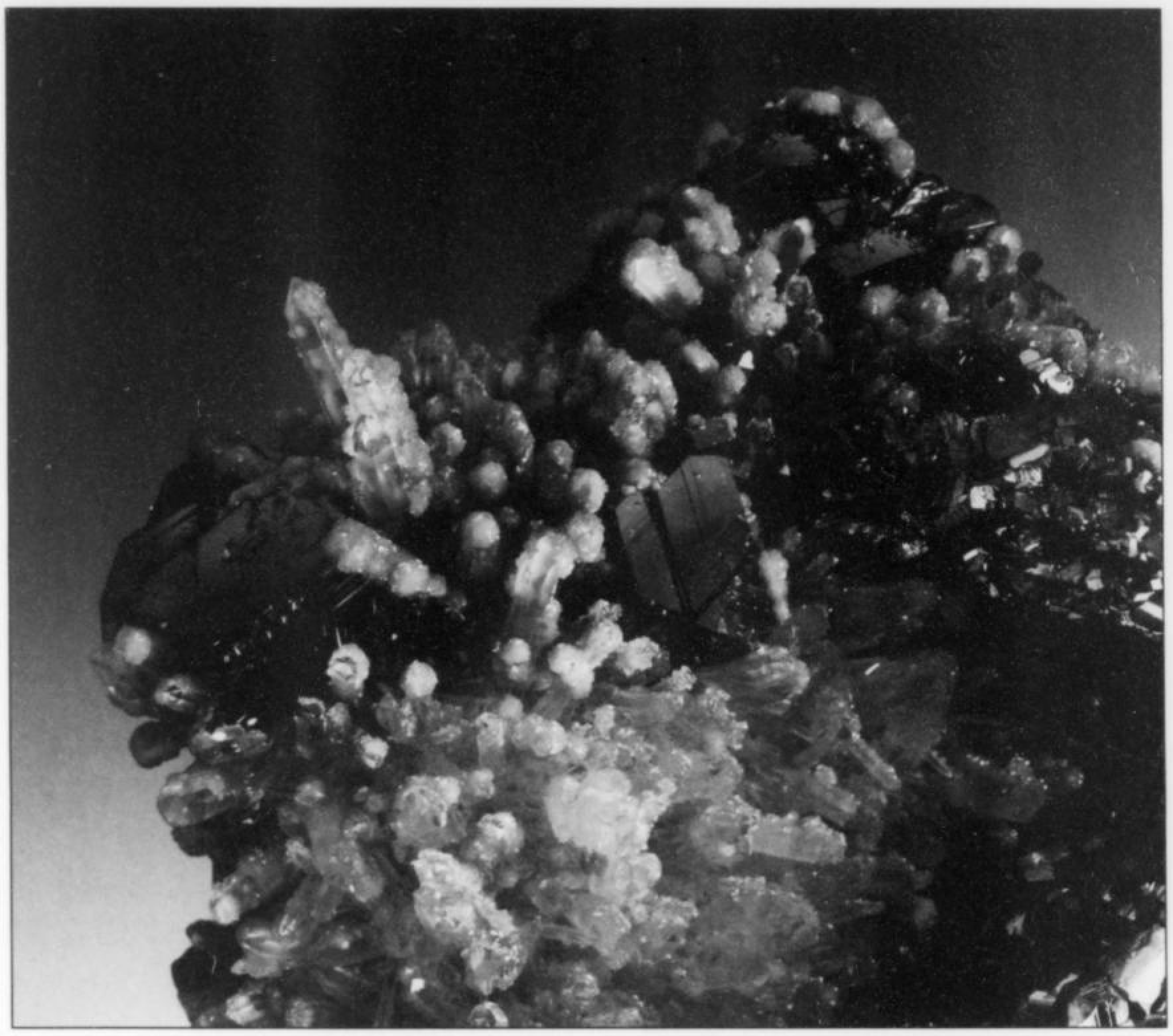


Figure 55. **Black sphalerite crystals to 1.5 cm, with quartz, siderite and pyrite after pyrrhotite, from Trepča. Gene Schlepp specimen; Wendell Wilson photo.**

Rare Metals

In addition to the 60+ mineral species already identified there, the Trepča deposit seems likely to yield still more, since mineralization occurred under a wide range of conditions: pyrometasomatic, catathermal, mesothermal, epithermal and supergene. Abundant iron and sulfur in the ore-bearing solutions gave rise to abundant pyrrhotite, and the many other available metals gave rise to numerous other sulfides and sulfosalts. However, the most surprising aspect

Figure 56. **Vivianite crystal, 3 cm, on needle quartz, from Trepča. Ben DeWit specimen; Wendell Wilson photo (1987).**

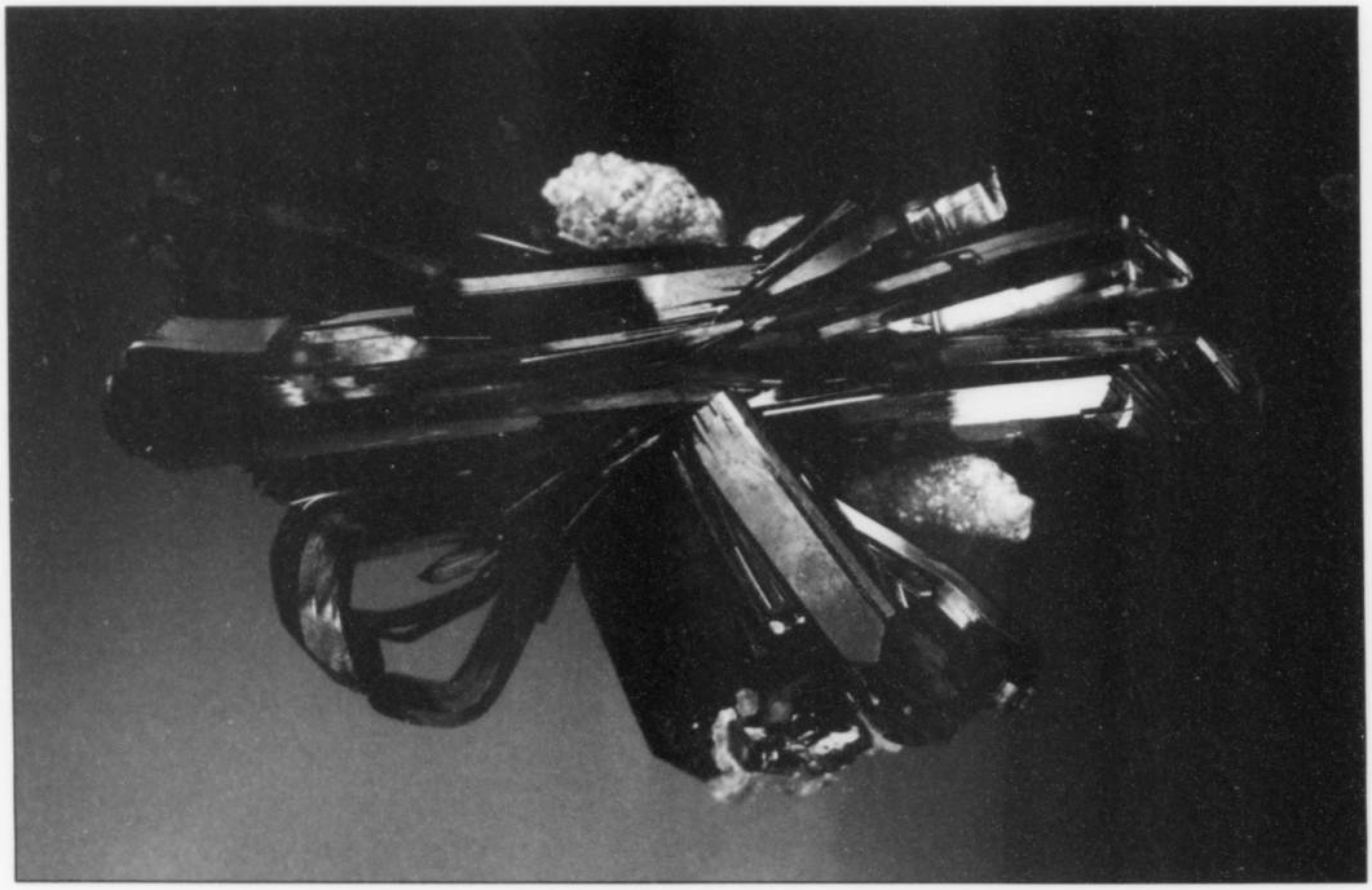


Figure 57. **Vivianite crystal cluster, 4.2 cm, from Trepča. Julius Zweibel specimen; Jeff Scovil photo.**

of Trepča mineralogy so far is the presence of secondary iron phosphates such as vivianite, ludlamite and childrenite. Since rare metals such as indium, germanium, gallium, thallium and selenium become increasingly abundant as investigation proceeds downdip in the orebody, discoveries of additional species during the coming years seem highly likely.

No data concerning occurrences of these rare metals at Trepča had been published before the work of Këpuska (1998), who collected 128 ore samples at various depths in the deposit and, through electron probe microanalysis and atomic absorption spectrometry, assayed the rare metals present in sphalerite, galena, pyrrhotite and pyrite crystals, with the results shown in Table 2.

Unfortunately, data are still lacking concerning germanium in sphalerite—the mineral which is the usual Ge and Ga-bearer in world zinc deposits. For Ge, besides the maximum 180 ppm in pyrite, Këpuska reported 3 ppm in rhodochrosite, 1 ppm in dolomite and 2 ppm in skarn (the latter three figures do not seem convincing).

Concerning indium, the figures that have been published do not appear to be representative of the orebody (UNMIK/Trepca Ch. Carron Brown's personal communication of a table by Sh. Kelmendi, 2006, comparing two analyses done by the Swiss SGS laboratory). According to this table, one rather old (1997?) sample of Stari Trg ore concentrate containing 46.8 % Zn yielded 20 ppm indium. This figure is low as compared to the 200 ppm indium found in one old sample of Novo Brdo (Kishnica) ore concentrate which was rather rich in tin (110 ppm Sn). Within the Stari Trg concentrate sample, Sn, Tl, Te and Se were below the detection limit. Elevated indium grades might well be expected during the next few years of ore exploitation, in light of the significant increase of indium grades downdip as shown by the analyses of Këpuska (1998).

Further analyses by the authors are currently in progress in the BRGM laboratories, and the results will be published as soon as possible.

THE PRESENT SITUATION AT TREPČA

Mine Workings

Starting from the medieval open pit at the 935-meter elevation mark, underground mining has proceeded by the cut-and-fill method. Access to the stopes was previously provided by a few adits at the top of the mine (at heights of 865, 830, 795 and 760 meters), but then, in order to follow the orebody downdip, a first shaft was dug at 610 meters to give access to other levels. A dewatering adit called the "Prvi Tunnel," running southwest for 2.2 km, begins at the 605-meter mark. Shafts dug later as the mine developed include the "blind shaft," running down to an elevation of 15 meters above sea level, the "new shaft," and two accessory shafts for ventilation and rescue. The main shaft has a circular cross-section and is 7 meters in diameter, including four separate compartments respectively for the 5-ton skip, the 2-floor lift for workers or materials, the ladders and the logistical pipes. The deepest level of mining attained to date is the 11th level, at 15 meters above sea level. Drill-holes have proven that the mineralization extends still further downdip. The total vertical extent of the mine is presently 800 meters and the total elongation of the ore deposit along the strike is over 1,000 meters. At each level, the mining stopes are elongated horizontally on both sides of the volcanic pipe intersection, along the two sides of the antiform, over a total length of about 1,400 meters toward the northeast and 600 meters to the south. Each stope is about 70 meters wide and 100 meters long.

Production Figures

The total production of Trepča from 1931 to 1998 is estimated at 34,350,000 tonnes of mine-run ore having grades of 6% Pb, 4% Zn, 75 grams/tonne Ag and 102 grams/tonne Bi. The ore was beneficiated in the Prvi Tunnel (Tuneli Pare) concentrator (flotation), whose capacity was 760,000 tonnes/year. The lead concentrates were brought to the lead smelter of Zvecan (capacity 80,000 tpy),

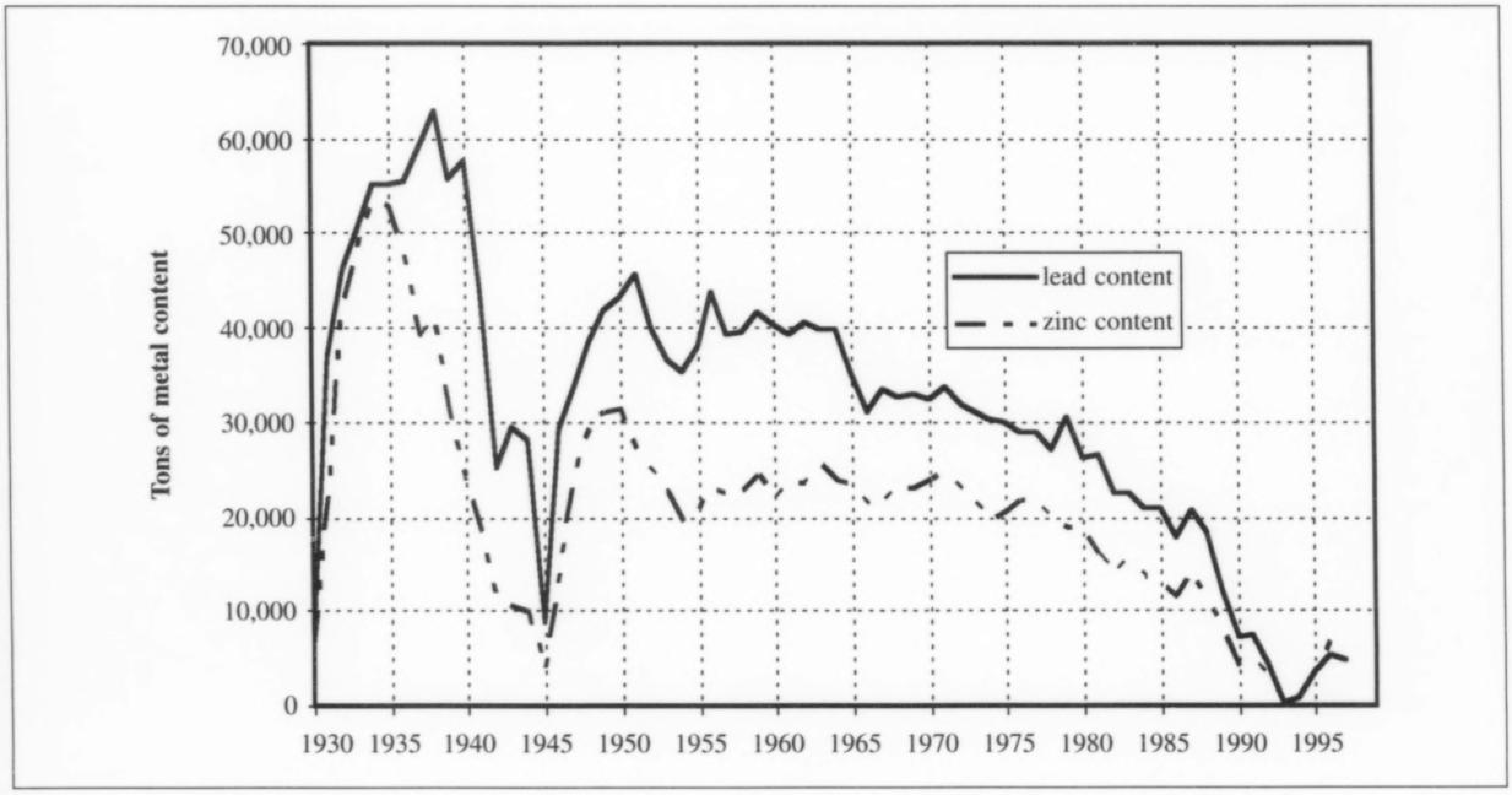


Figure 58. **Metal production from the Trepča mine, 1930–1997. Source data from Tiosav Lazarević, *A Brief History of Trepča* (Trepča internal document). After 1997, production collapsed because of growing political tensions.**

Figure 59. **The Trepča museum building, showing signs of deterioration. J. Balazuc photo.**

and the zinc concentrates were brought to the zinc electrolytic smelter of Mitrovica (capacity 50,000 tpy). There was also a unit for the production of fertilizers using the sulfuric acid byproduct of the hydrometallurgy, and lines of battery production and battery recycling.

The total metal tonnage produced from 1931 to 1998 was 2,066,000 tonnes lead, 1,371,000 tonnes zinc, 2,569 tonnes silver and 4,115 tonnes bismuth. Gold production is estimated at 8.7 tonnes from 1950 to 1985, i.e. an average of 250 kg per year. Cadmium production is estimated at 1,655 tonnes from 1968 to 1987. Traces of germanium, gallium, indium, selenium, thallium and tellurium in the mine-run ore have also been reported, and these were extracted at the smelters.

Future Mining

Resumption of full-scale mining at Trepča in the near future is now expected. First, however, private investors must be attracted, and mining techniques must be improved so as to prevent any new environmental pollution. Implementing the present program for updating the plants will be expensive: a cost of 15 to 30 million U.S. dollars for the whole industrial complex has been suggested. For the time being, the smelters have not been reactivated. Since September 2005 the mine has only produced zinc, lead and copper concentrates at an average rate of 5,000 tonnes/month, and these concentrates have been sold to traders. The silver, gold, bismuth, cadmium, indium, germanium and gallium of the various ore concentrates are extracted at the foreign smelters which buy and process the Trepča concentrates (together with batches from other deposits).

Calculations published on the Internet (ITT Kosovo Consortium LTD, 2001) suggest that enough ore reserves remain at depth in the Trepča mine to justify the effort and cost of resuming full-scale mining. The ITT/UNMIK 2001 report concluded that about 29,000,000 tonnes of mine-run ore at grades varying (according to the panels considered) from 3.40 to 3.45% Pb, 2.23 to 2.36% Zn and 74 to 81 grams/tonne Ag, i.e. around 999,000 tonnes Pb, 670,000 tonnes Zn and 2,200 tonnes Ag, could be produced. This potential would justify several more years of mining, if the operating costs and the prices on the metals market permit it. At current market prices, copper produced in Trepča at a 2,000 tonnes/year would be a bonus.

Politically and socially, reawakening the sleeping "Trepča giant" is a worthy goal. Full-scale mining would provide many new jobs and thus revitalize this part of Kosovo economically, returning pride and hope again to the people. And mineral collectors, meanwhile, would have their own very good reasons to welcome any revival of major mining at Trepča.

However, if selective mining methods go on being privileged, the consequence for mineralogy will be that the lowest grade orebodies, those hosting unworkably large masses of Mn-rich siderite ore and drusy carbonate karst fillings, will not be mined. In that case, the only crystals unearthed by new mining will be sphalerite, pyrrhotite, pyrite and minor amounts of galena and jamesonite—the typical components of the massive sulfide ore bodies. Discoveries of the wonderful geodes made of various mixed carbonates and sulfides will cease, and that would be a great loss for science, for museums and for collectors.

The Mineral Museum

When bad luck seemed to have overtaken the Trepča museum, a few mineralogists and friends of Trepča in France volunteered to bring help, at their own cost, to the Trepča mine directorate and to the curator of the Trepča museum. The aim of an independent team that visited Trepča was to assess the situation and, with the consent of the authorities in Kosovo, to find ways to advise and assist the museum in recovering its financial resources and its worldwide influence, and in recovering whichever of its mineral specimens had been stolen (happily, it turned out that none had been stolen). From September 11 to September 18, 2005, an exploratory team made the

Figure 60. **Interior of the Trepča museum building, showing signs of deterioration. B. Larderet photo.**

journey to Kosovo. On the team were Joël Balazuc, Carole Frima, Pierre-Christian Guiollard, Benjamin Larderet, Skender Plakolli, Michel Schwab, Jérôme Schwab, Jocelyn Vendel and Jean Feraud. This team received a very warm welcome and efficient help from authorities in Kosovo. Great thanks are extended to the Trepča/UNMIK Managers in the Kosovo Trust Agency, to the directors of the Trepča mine, and to all the engineers and scientists who made the visit so pleasant and so professional.

The team observed that the mineralogical collections are intact and in a rather good state of preservation. Clearly the Trepča mineral museum is a heritage of national importance for Kosovo: the collection is invaluable, and of an interest far beyond the merely local or regional. Many specimens are of international importance, i.e. "world-class," and the team judged that the entire museum deserves to be ranked among the top 100 mineralogical museums worldwide.

Unfortunately, the team could not report such good news about the condition of the building itself. The roof and the walls are no longer waterproof, the paint on various walls and on the ceilings is seriously damaged, and the museum lacks a heating system, and even a fire-prevention system. In the collection, many iron sulfide specimens have disintegrated as a result of the high humidity.

Encouraged by the warmth and supportiveness of all the Kosovan authorities, engineers and scientists whom they met, the team members wrote a report (in French, with an English summary: Feraud *et al.*, 2005) offering the following:

(1) Ideas to improve the building, including its roof; to install an electrical heating system (or to shift the building to another place nearby); and to repaint all surfaces.

(2) Ideas to improve the way in which the collections are exhibited; to clean the specimens; to inventory and catalog the collection; to improve the exhibit areas by introducing teaching tools in order to increase the interest of visitors (e.g. put some educational posters on the walls, select the most interesting specimens to display and put many less interesting ones into storage, collect and display old machines and documents concerning the mine and the processing plants and smelters).

(3) Ideas about the legal status of the museum. The mine, once run by a state-owned company, was expected to be purchased by a private investor soon; thus the museum would be controlled by a private company. But a museum can receive money from public entities—from the EU and from UNESCO—only if it is state-owned. Therefore it is urgent that UNMIK-Trepča help to transfer the museum to the Ministry of Culture or some public institution instead of allowing it to be sold to a private investor. Thanks to our efforts to sensitize the authorities to these matters, the transfer process is now underway. Nonetheless, we strongly suggest that the mine should retain its place in the museum directorate and that the government of Kosovo, by creating tax incentives, should promote patronage.

(4) Ideas to enhance the reputation of the museum (without huge expenditure) so that Trepča becomes a place of national and even international importance in the mineral world, and perhaps also a recreational resort. It is suggested that an Internet website be created to publicize Trepča, including its possibilities for sustainable development. The Trepča museum deserves to play a great role in teaching young generations of Kosovans about minerals, mining and the environmental heritage, and in encouraging the interest of youth in the scientific and technological professions.

This report has been widely distributed, as paper copies and as e-mails with attached .pdf-files (together with personalized cover letters), to national and international institutions and experts in positions to help the museum. Recipients include the Kosovan President, the parliament and concerned ministers and administrators in Kosovo, the European Union, the United Nations, UNESCO, the European Bank for Reconstruction and Development, The World Bank, The Council of Europe, the great museums, etc. Additional copies are available upon request.

In another step following its report, the team established a "supporting committee," the mission of which is to pursue the efforts and in particular to launch communications on behalf of the museum. This committee is made up of the team members who went to Kosovo, but it is open also to any institute and individuals of good will who would participate in the committee's activities or who simply wish to "join the crew."

In order to attract French and international grants for the museum, a Trepča exhibition was presented by the committee, together with Euromineral, at Sainte-Marie-aux-Mines, France, on June 22–25, 2006. The exhibition benefited from the support of several organizations and scientists, including Michel Schwab and his MINERAL Concepts Sarl, the BRGM, P-C. Guiollard Editions, the GEOPOLIS association, and Hacene Bouafia of GRAFIK'Expo Sarl (for the design of the poster). The General Director of Trepča (Nazmi Mikullovci), the Director of the mine (Myftar Hyseni), and the three authors of this article were on hand to welcome visitors and to explain the geology and mineralogy of Trepča and the current situation there. Contributions to a fund to aid the museum were solicited, and the 1,000 Euros collected were used to purchase two binocular microscopes for the museum.

Another exhibition was presented at the München Mineralientage of November 2006 in Germany. Other exhibitions are planned in Dortmund and in Hamburg. Also, the supporting committee began taking subscriptions which were coupled with a contest, the prizes of which were spare mineral specimens provided by the mine and/or the museum.

The Trepča museum is a national patrimony for Kosovo, and its rejuvenation should be given higher priority than heretofore, even in view of the fact that postwar Kosovo has innumerable problems yet to be solved. To make an inquiry, to offer help, or just to join the crew, please contact musee-trepca@hotmail.fr or the senior author.

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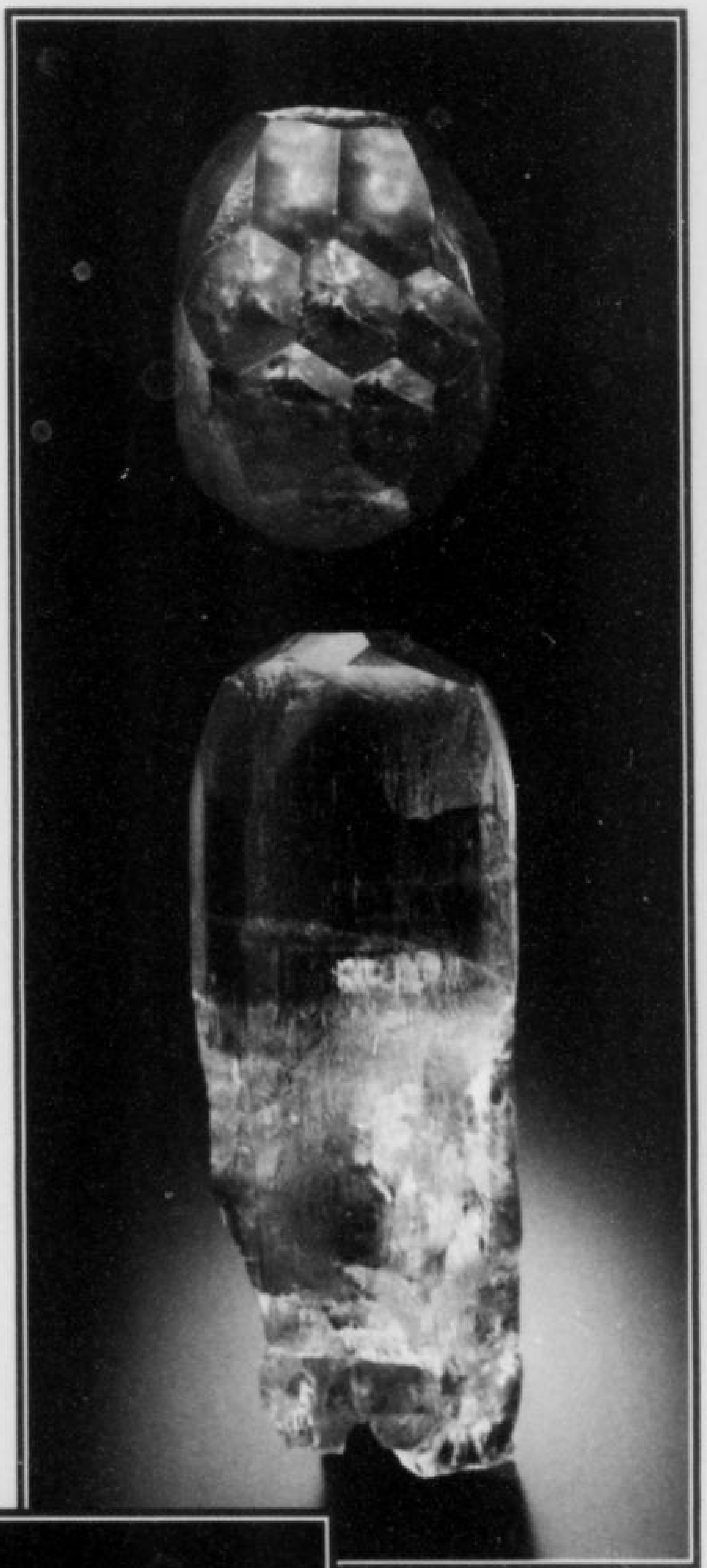

Beryl
var. Heliodor,
3 x 7.1 cm; Brazil.
Jon Sigerman
Collection

Phosphophyllite,
2.6 cm,
Unificada mine,
Potosi, Bolivia.
Wendell Wilson
Collection

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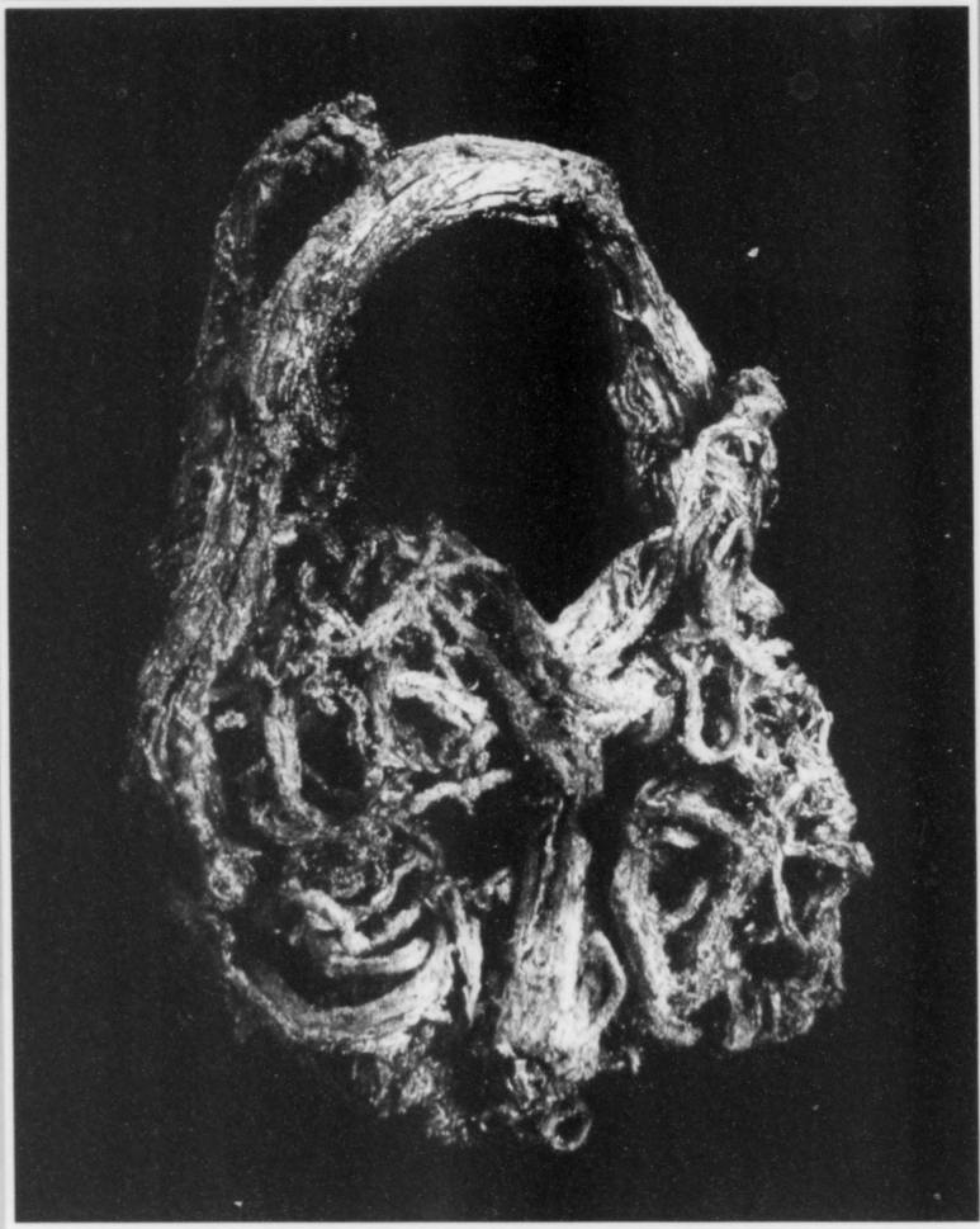
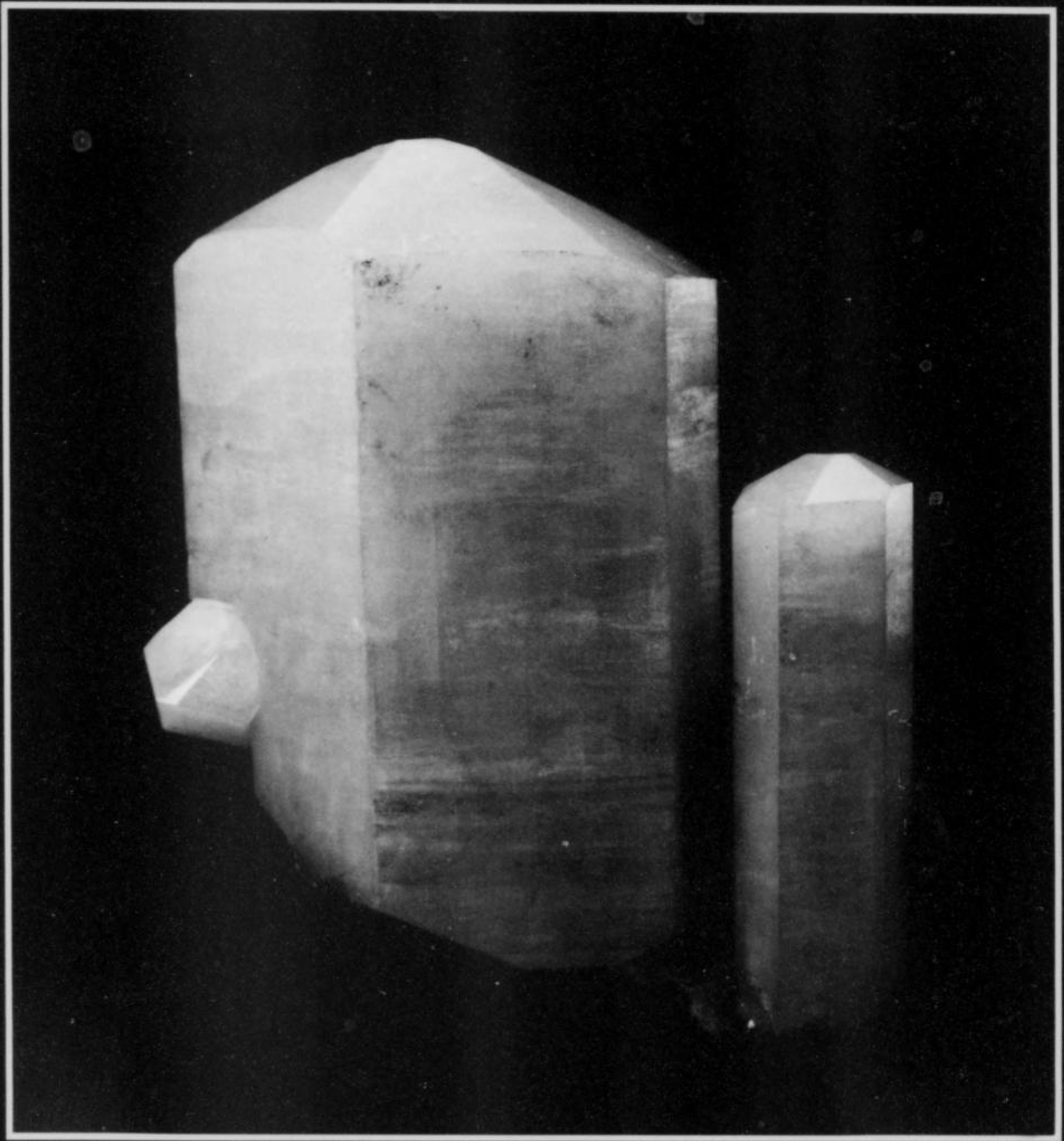


Silver, 5.5 cm, Imiter mine, Ourzazate, Morocco.

Jeff Scovil photo.



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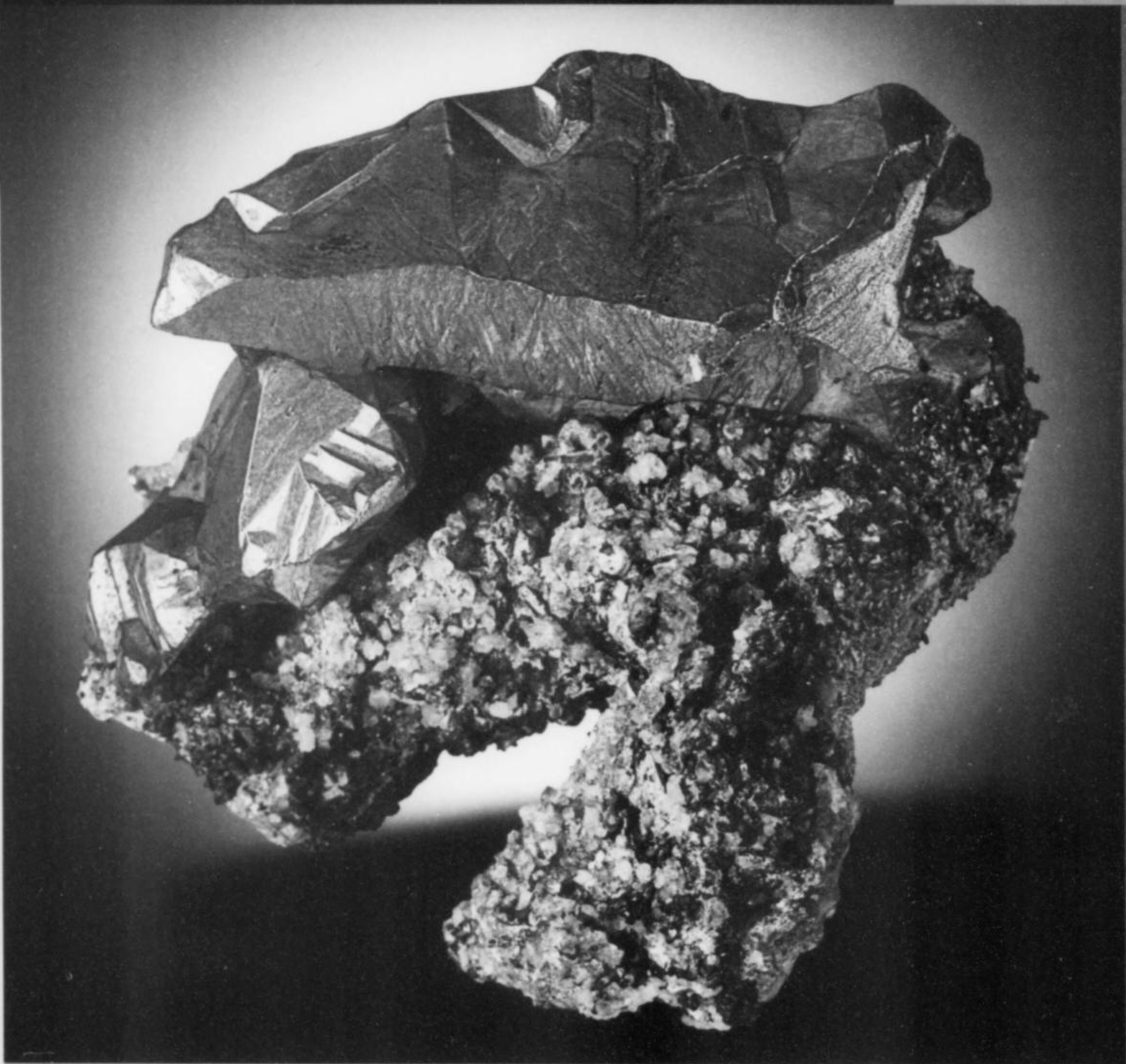


Copper, 2.25 inches, Calumet mine, Houghton Co., Michigan. Ex-collections Kosnar and Fuss.

Wilensky photo

The David Eidahl Mineral Collection

Anthony R. Kampf
Mineral Sciences Department
Natural History Museum of Los Angeles County
900 Exposition Boulevard
Los Angeles, California 90007

The small but superb mineral collection of the late David Eidahl (1956–1982) has now found a permanent home in the Natural History Museum of Los Angeles County, thanks to a commitment from his parents, Duane and Charlotte Eidahl.

The Natural History Museum of Los Angeles County is pleased to announce the donation of a portion of the David Eidahl Mineral Collection by Duane and Charlotte Eidahl, parents of the late collector. The Eidahls have placed the remainder of the collection on loan to the museum with the intent of donating the entire collection in installments in coming years. They have made clear their desire to keep the collection together and to make it available for the enjoyment of the public in their son's memory. His untimely death in 1982, at the age of 26, shocked and saddened the mineral collecting community, locally and around the world.

David Duane Eidahl was born January 27, 1956 and grew up in Los Angeles; he began collecting minerals at an early age. He graduated from Pacific Palisades High School in 1974 and, while attending Pepperdine University in Malibu, he began working part-time for Pala International in Fallbrook, California. He became a full-time employee there in 1976, and by 1982 had become director of mineral sales and purchases for the company and its shop "The Collector."

His intense love for minerals and sophisticated appreciation for mineral aesthetics helped him to become the youngest major mineral collector and dealer of his time. In a very short time span he assembled a world-class collection of fine mineral "miniatures." At the 1980 Tucson Gem and Mineral Society Show, he won the coveted Ed McDole Memorial Trophy for "Best Rocks in the Show," as well as the Walt Lidstrom Memorial Award for the best individual mineral—an exquisite crystallized gold from the Colorado Quartz mine in Mariposa County, California. He died suddenly on May 31, 1982, from a congenital cerebral aneurism while unloading recently mined tourmaline specimens at The Collector Shop.

***Figure 1.* David Eidahl putting in his exhibit of fine miniatures at the 1978 Tucson Show. Kent England photo; Mineralogical Record Photo Archives.**

Figure 2. **David Eidahl at the 1980 Tucson Show, having just received the McDole Trophy and the Lidstrom Award for his collection. Kent England photo; Mineralogical Record Photo Archives.**

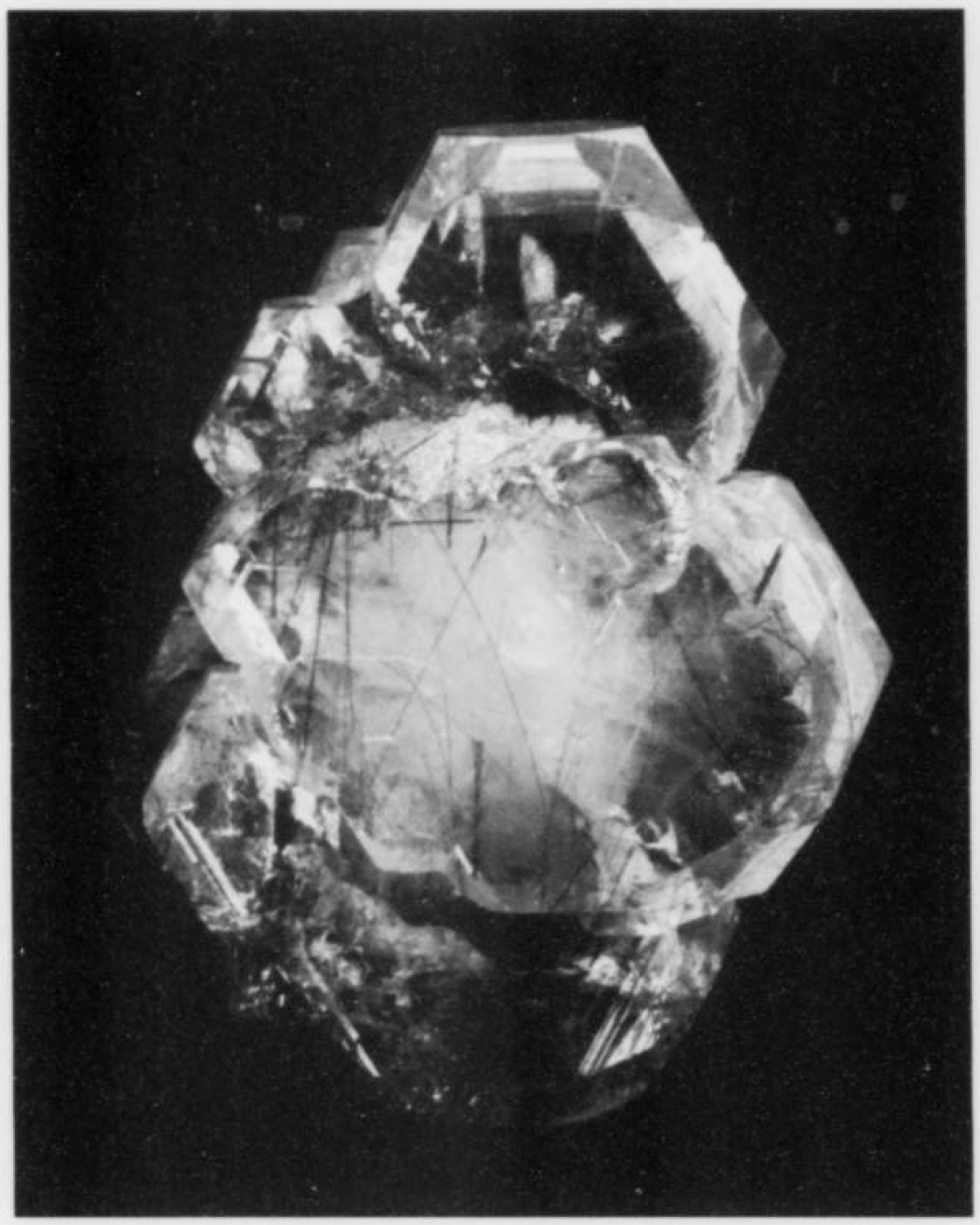


Figure 3. **Fluorapatite with actinolite, 4 cm, from Knappenwand, Untersulzbachtal, Austria. David Eidahl collection.**

Figure 4. **Bournonite, 6.5 cm, from the Herodsfoot mine, Liskeard, Cornwall, England. David Eidahl collection.**

David's collection is not large in number, consisting of only 32 specimens; the largest specimen, a gemmy aquamarine crystal, is a mere 9 cm in length. But it has been said that each and every piece in the collection approaches perfection, and four have appeared on the cover of the *Mineralogical Record.* The collection is especially rich in old classics, such as a dramatic stacking of epidote chevron twins from Knappenwand, Austria, elegant specimens of both crystallized and wire silver from Kongsberg, Norway, a remarkable cluster of large, lustrous azurite crystals from Bisbee, Arizona, and a group of fine gold crystals from the Massachusetts Lode in Grass Valley, California that was one of the "Famous 25" specimens originally in the collection of William Sansom Vaux (1811–1882). Contemporary masterpieces are also well represented by such wonderful pieces as a 6-cm, deep blue crystal of jeremejevite from near Swakopmund, Namibia and a gemmy cherry-red rhodochrosite crystal from the N'Chwaning No. 2 mine, Kuruman, South Africa. Every specimen provides

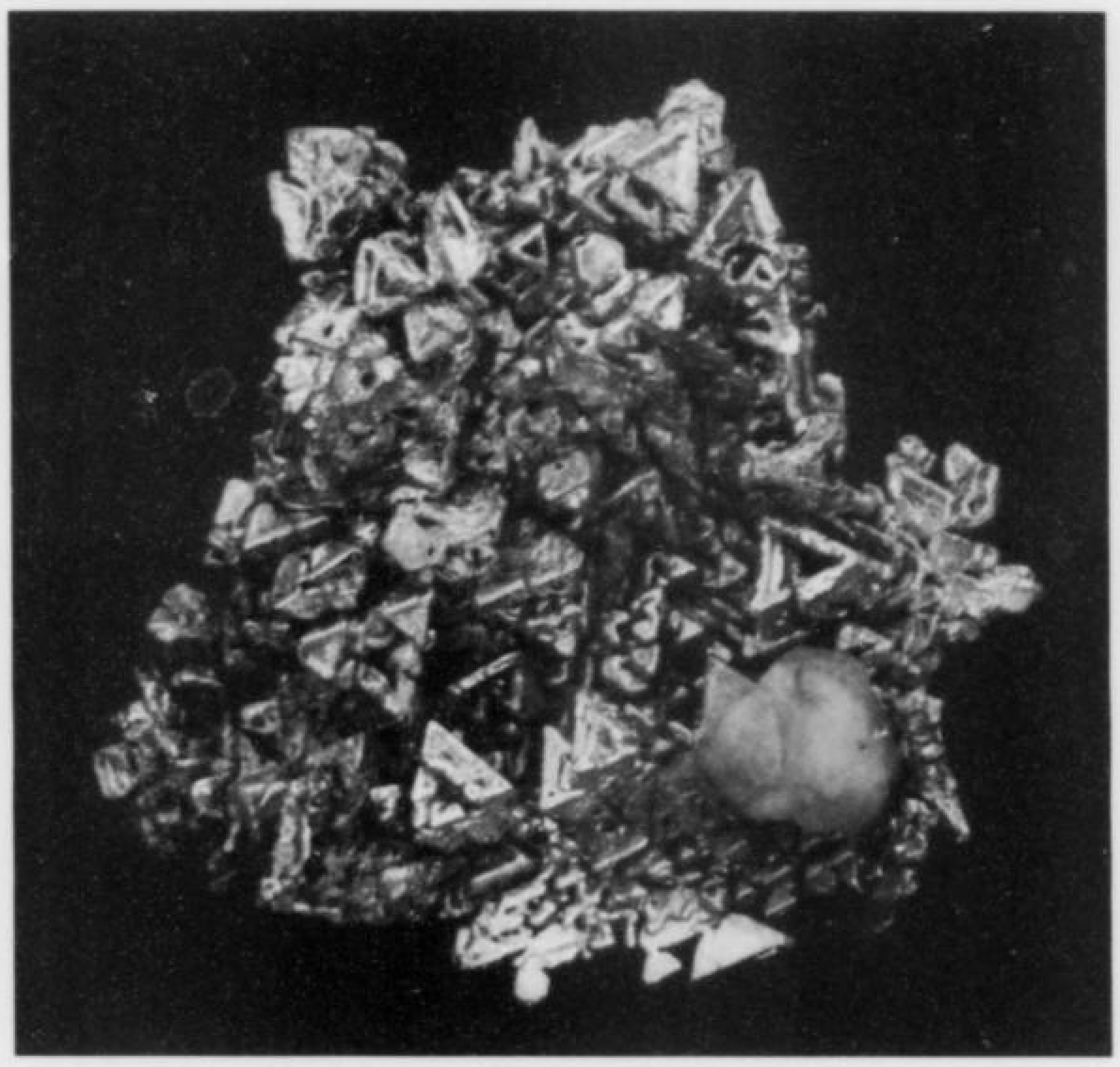


Figure 5. Gold, 4.5 cm, from the Colorado Quartz mine, Midpines, Mariposa County, California. David Eidahl collection. (Illustrated in vol. 8, no. 6, p. 441.)

Figure 6. Wulfenite, 4 cm, from the Tsumeb mine, Tsumeb, Namibia. David Eidahl collection.

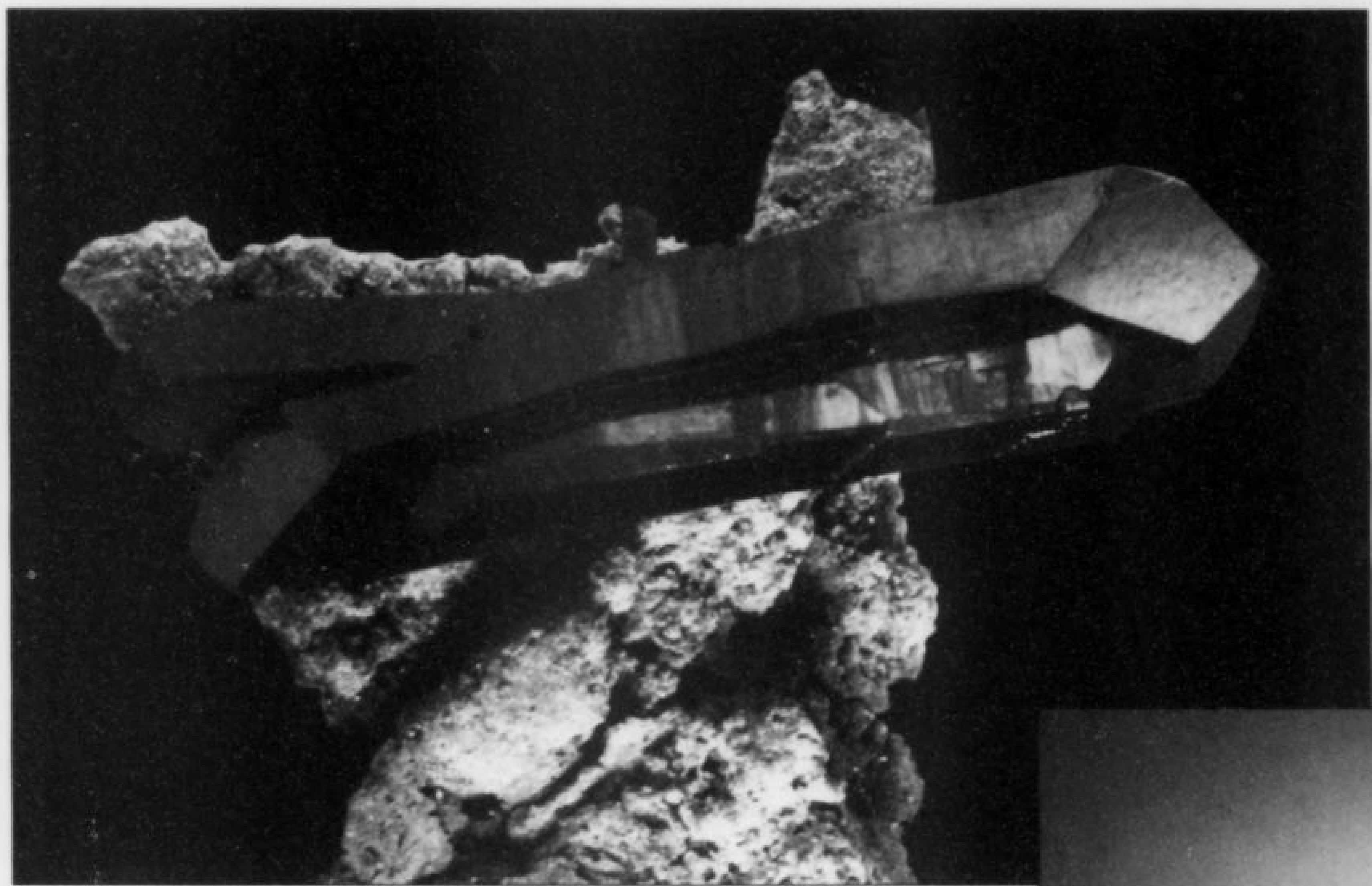
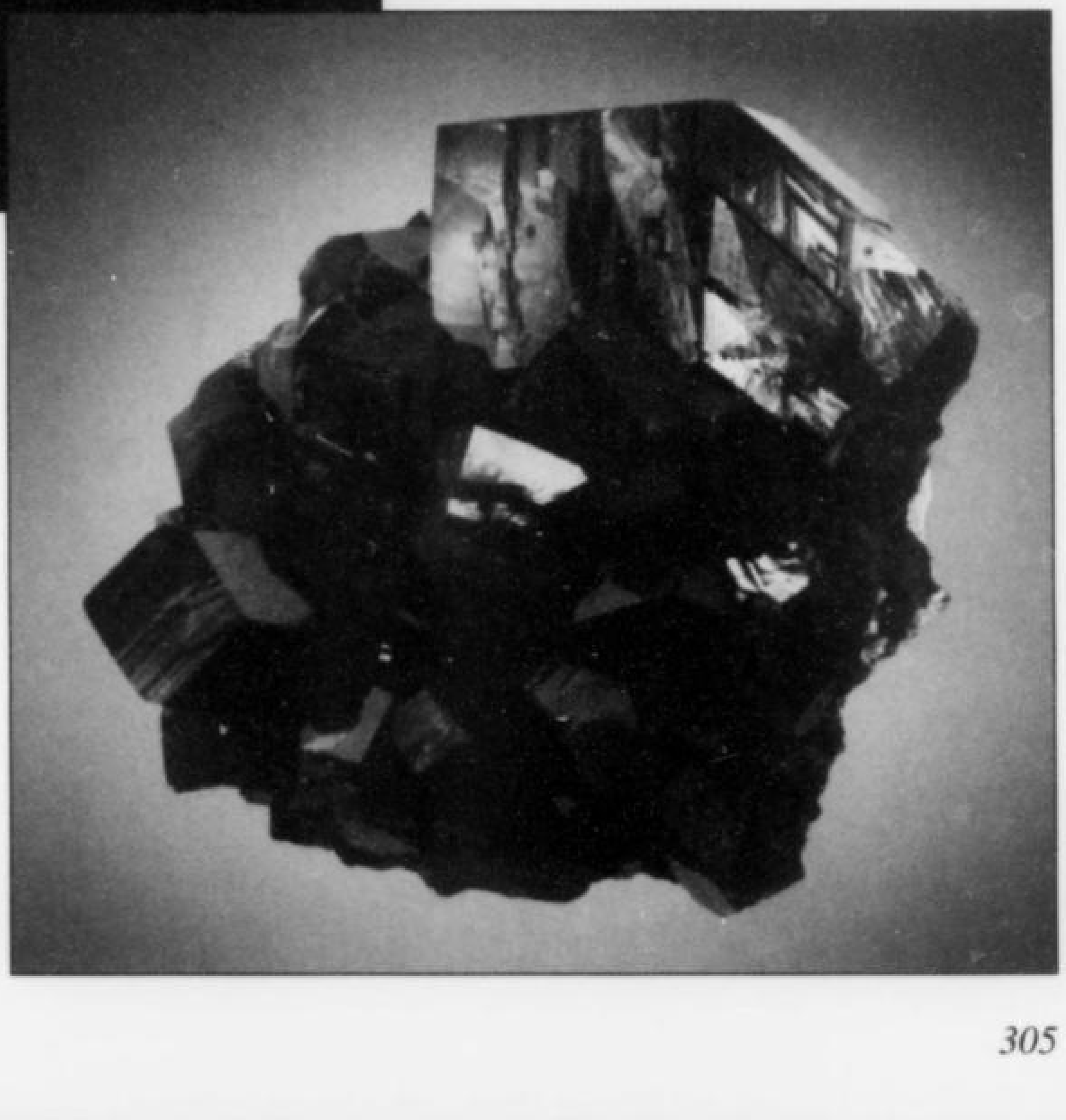


Figure 7. Azurite, 5.5 cm, from the Tsumeb mine, Tsumeb, Namibia. David Eidahl collection.

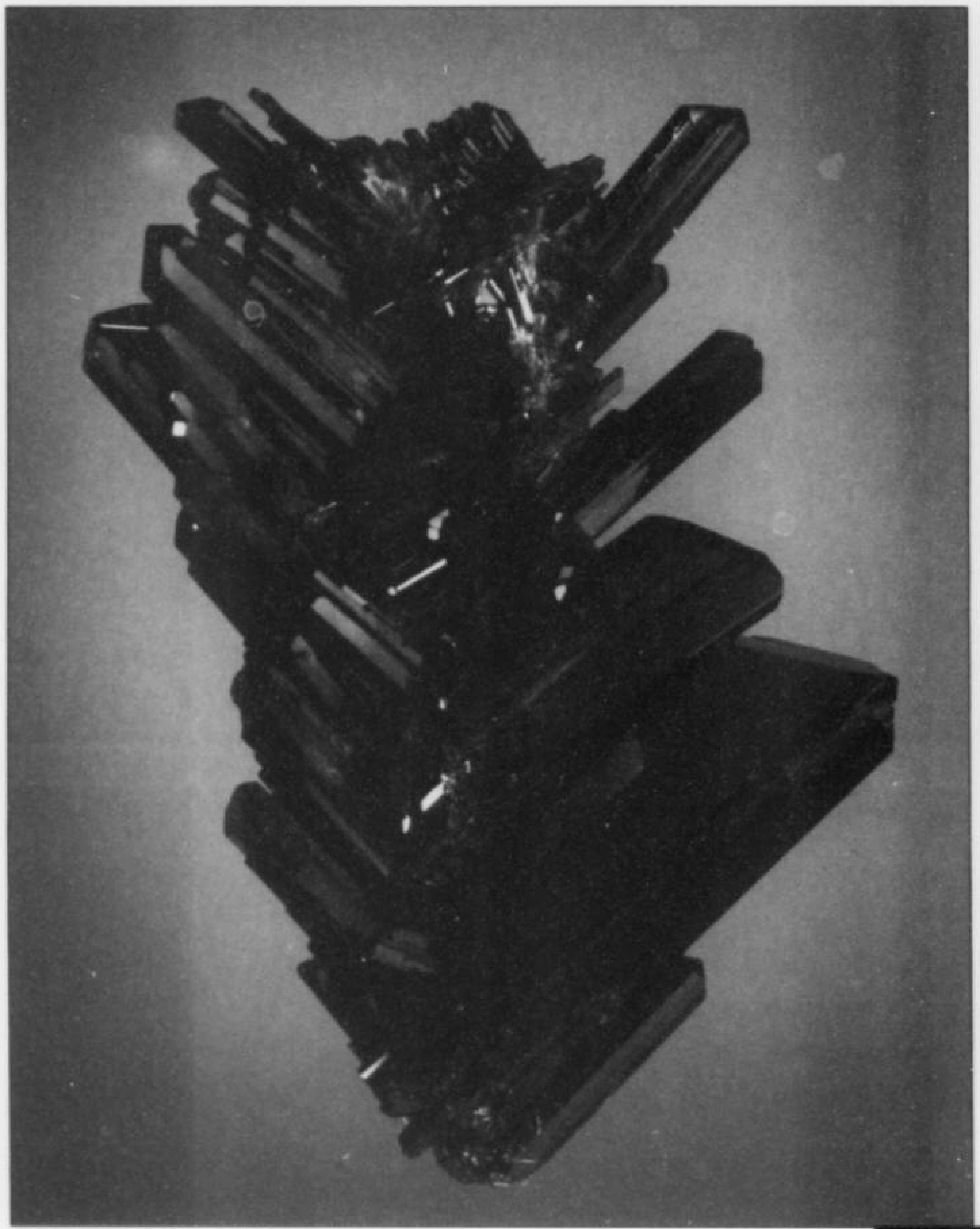
All Specimens photos by Anthony Kampf (except as noted)

Figure 8. Dioptase, 4.5 cm, from the Tsumeb mine, Tsumeb, Namibia. David Eidahl collection.



the viewer with a unique visual delight and a new appreciation for the best that the mineral world has to offer.

David relished sharing his love of minerals and took it upon himself to give other young collectors a hand, as exemplified by a guest editorial that he wrote for the *Mineralogical Record* in 1977 (vol. 8, p. 426) entitled "Helping the New Collectors." It is in this context that it is especially appropriate that his collection will be on display in the Natural History Museum of Los Angeles County, where it will provide encouragement and inspiration to many generations of mineral collectors to come.



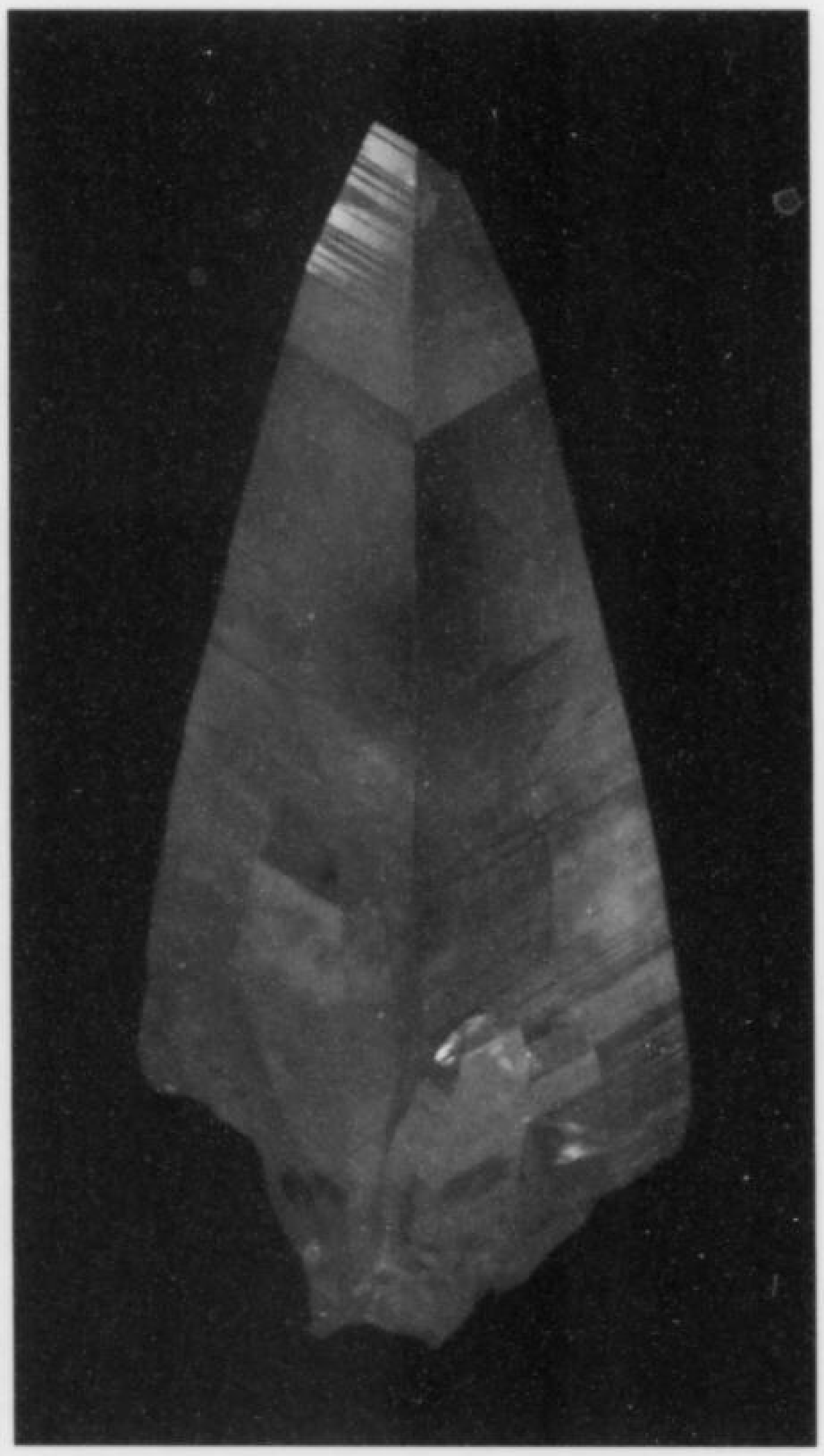
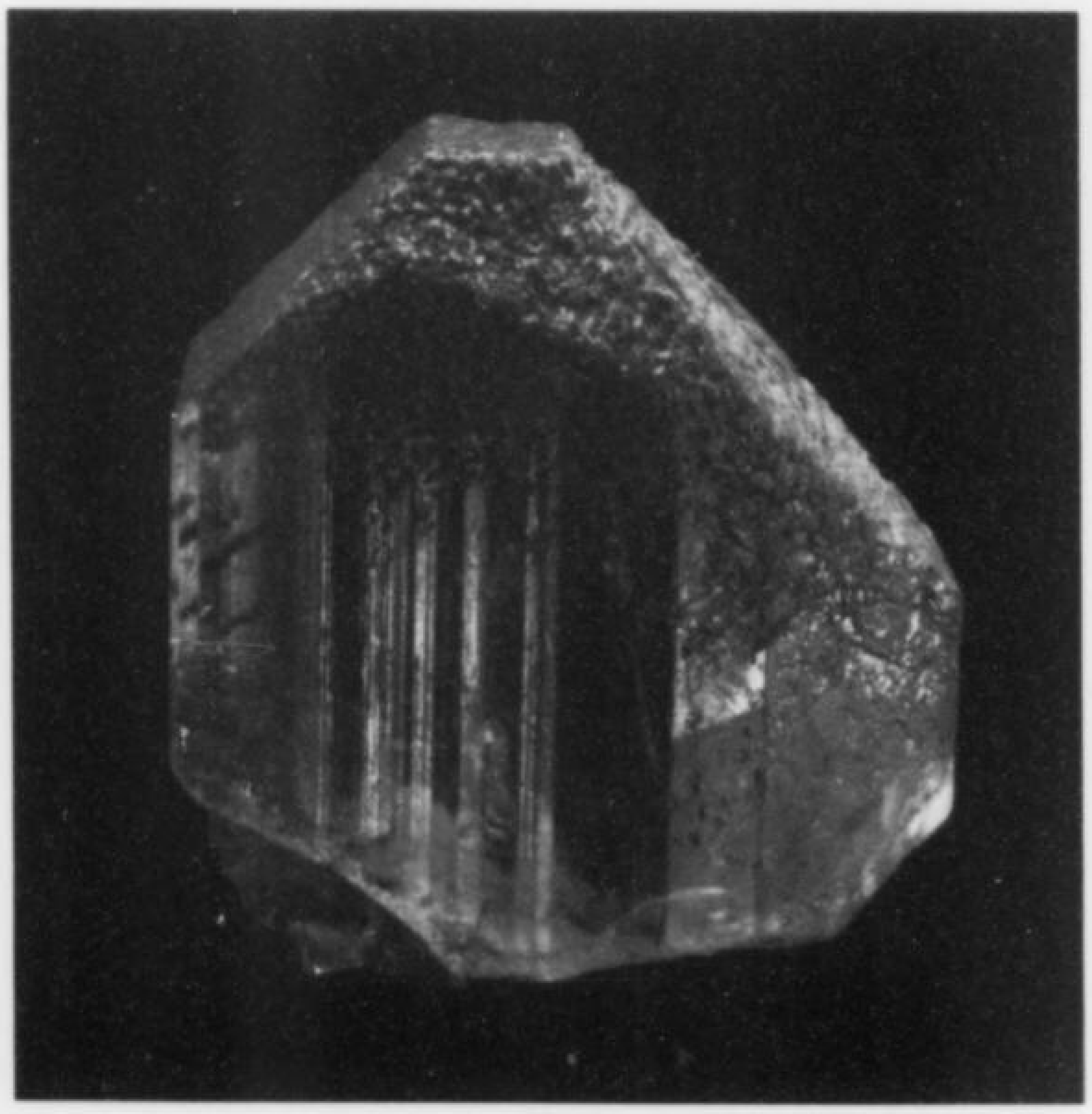


Figure 10. Rhodochrosite, 5 cm, N'Chwaning No. 2 mine, Kuruman, Cape Province, South Africa. David Eidahl collection.

Figure 9. Epidote, 7 cm, from Knappenwand, Untersulzbachtal, Austria. David Eidahl collection. (Cover of the *Mineralogical Record*, vol. 17, no. 3.)

Figure 11. Forsterite ("peridot"), 3 cm, from St. John's Island, Egypt. David Eidahl collection.



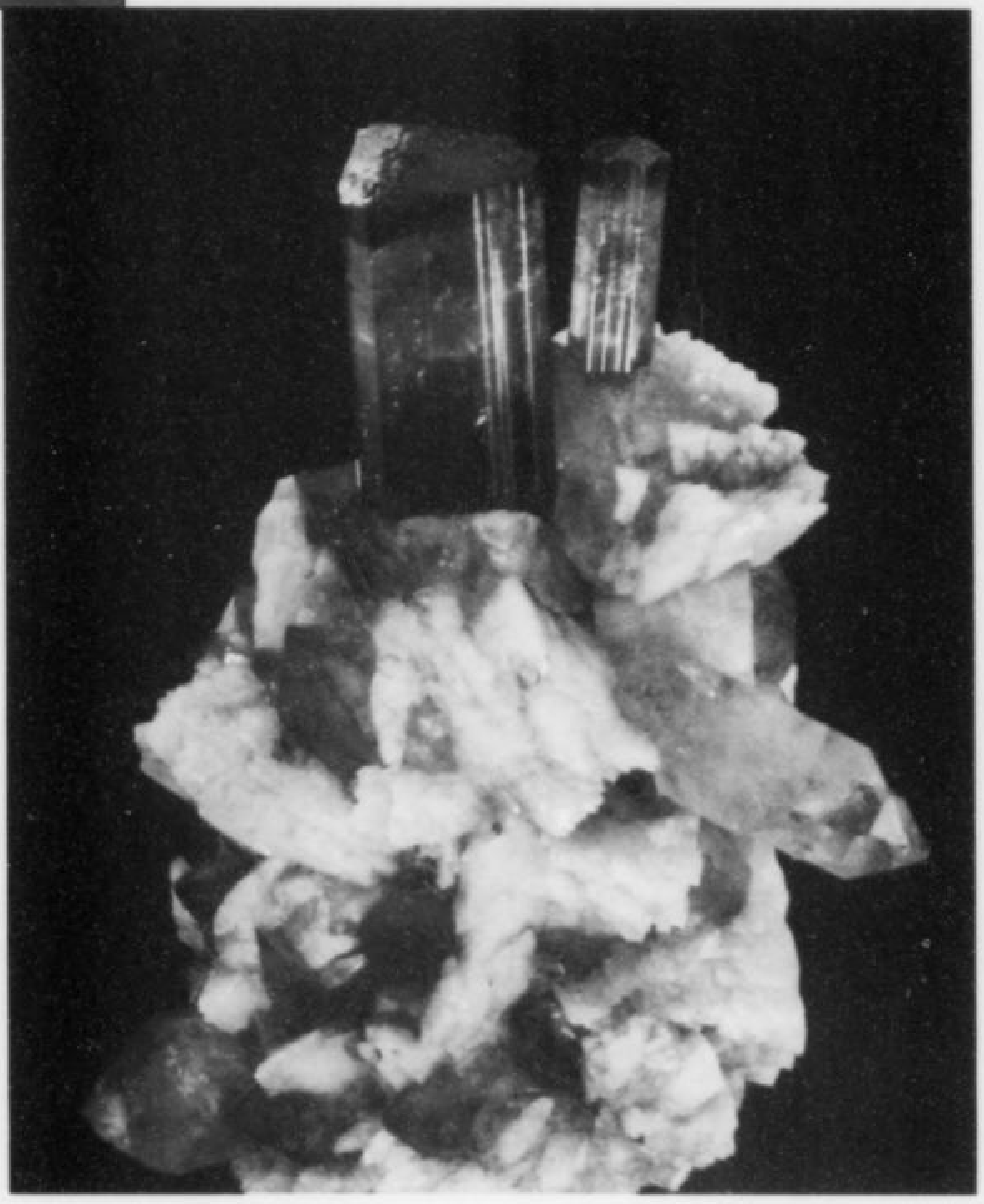


Figure 12. Elbaite, 6.5 cm, from the Grotta d'Oggi mine, San Piero in Campo, Elba, Italy. David Eidahl collection.

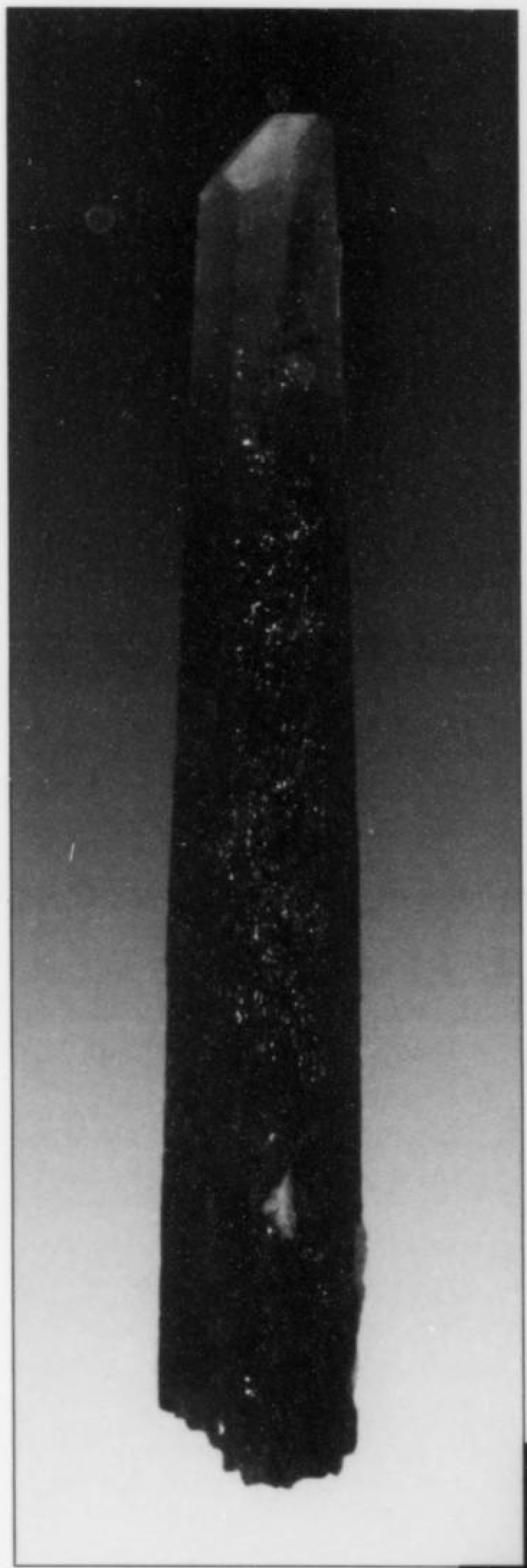


Figure 14. **Ferro-axinite with quartz, 5 cm, from Le Bourg d'Oisans, Isère, France. David Eidahl collection.**

Figure 13. **Jeremejevite, 6 cm, from Mile 72, Cape Cross, Namibia. David Eidahl collection.**

Figure 15. **Goshenite beryl, 9 cm, from the Verdinho mine, Itatiaia, Minas Gerais, Brazil. David Eidahl collection.**

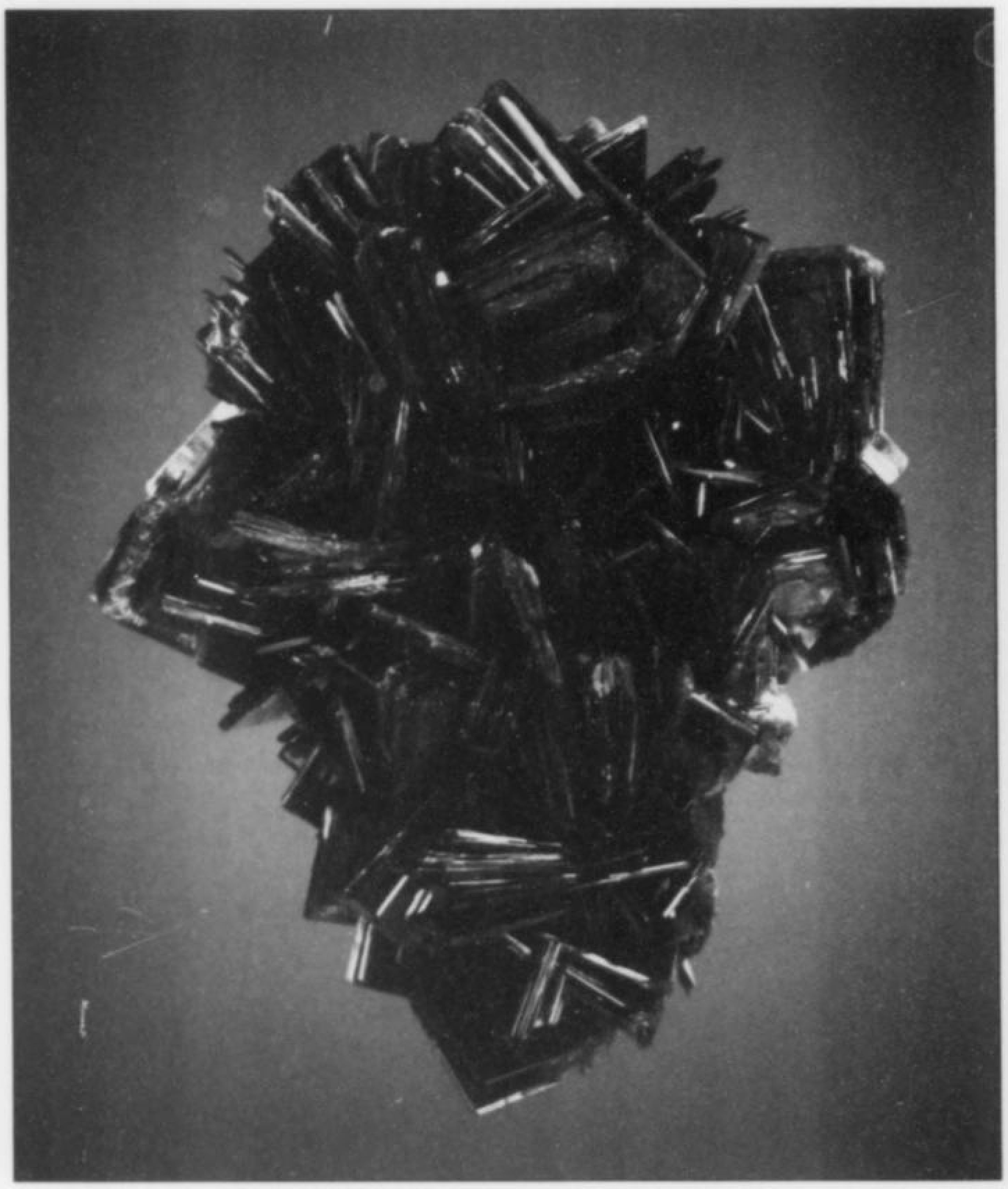
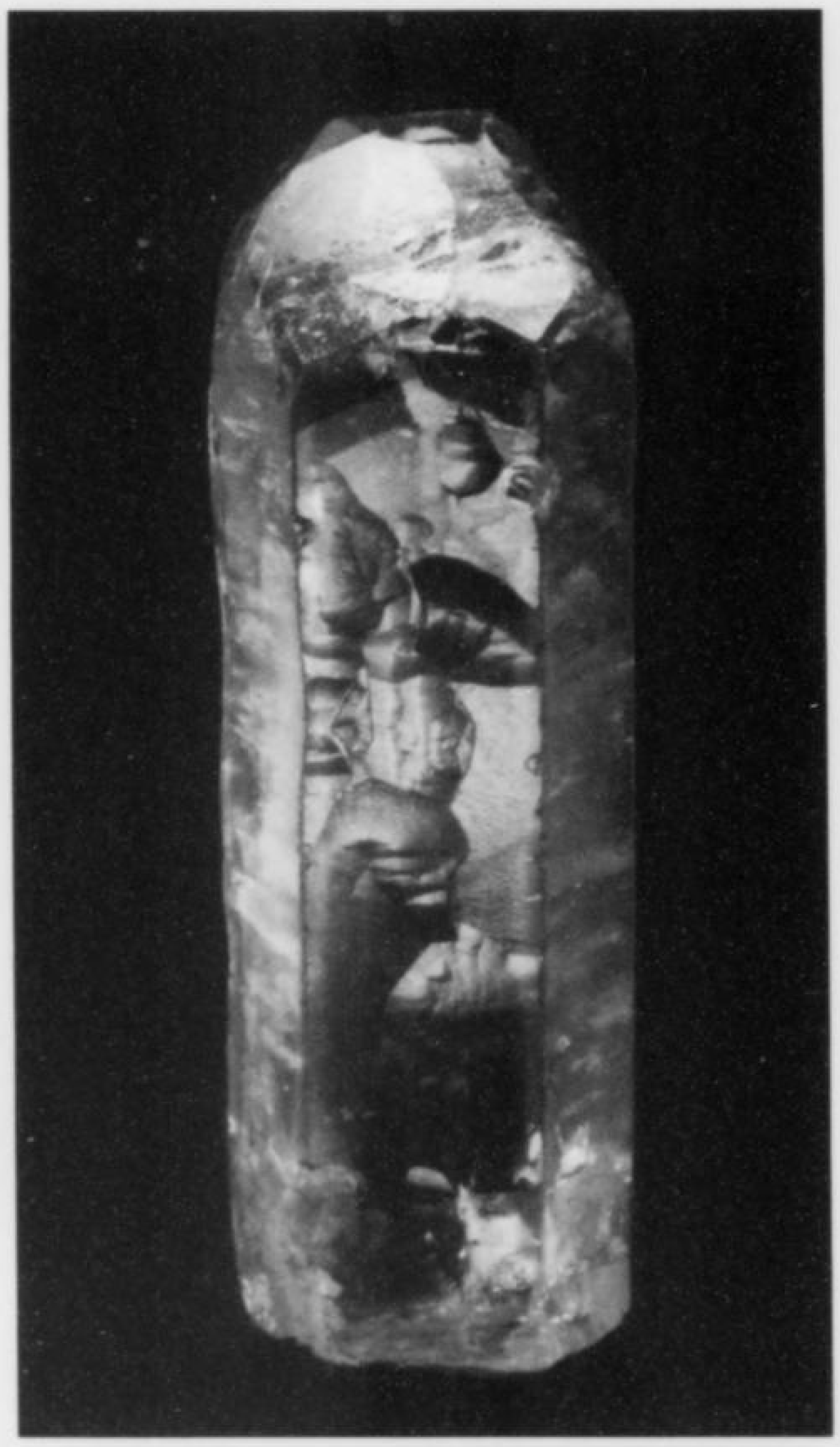


Figure 16. **Torbernite, 7 cm, from the Musonoi mine, Kolwezi, Katanga, Democratic Republic of the Congo. David Eidahl collection.**

Figure 17. **Heliodor beryl, 7.5 cm, from Minas Gerais, Brazil. David Eidahl collection.**



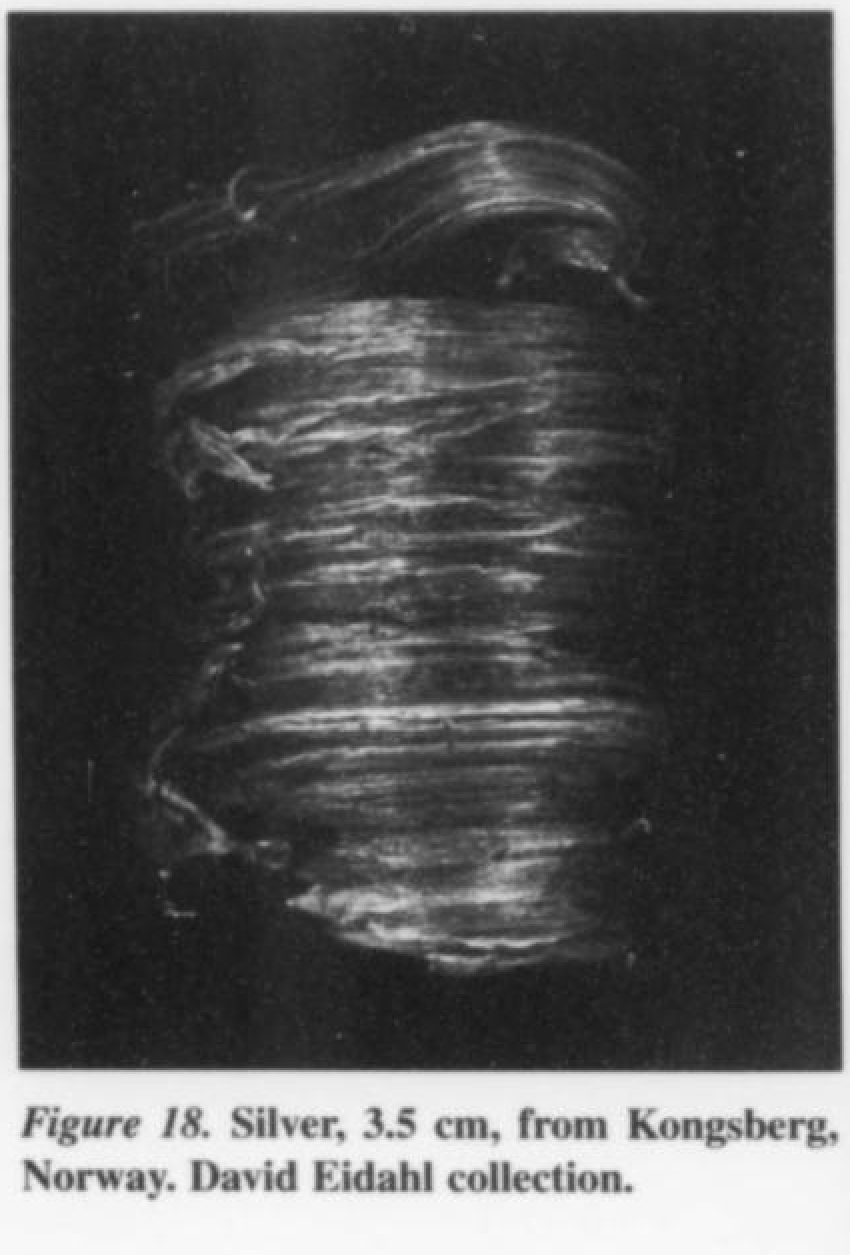


Figure 18. **Silver, 3.5 cm, from Kongsberg, Norway. David Eidahl collection.**

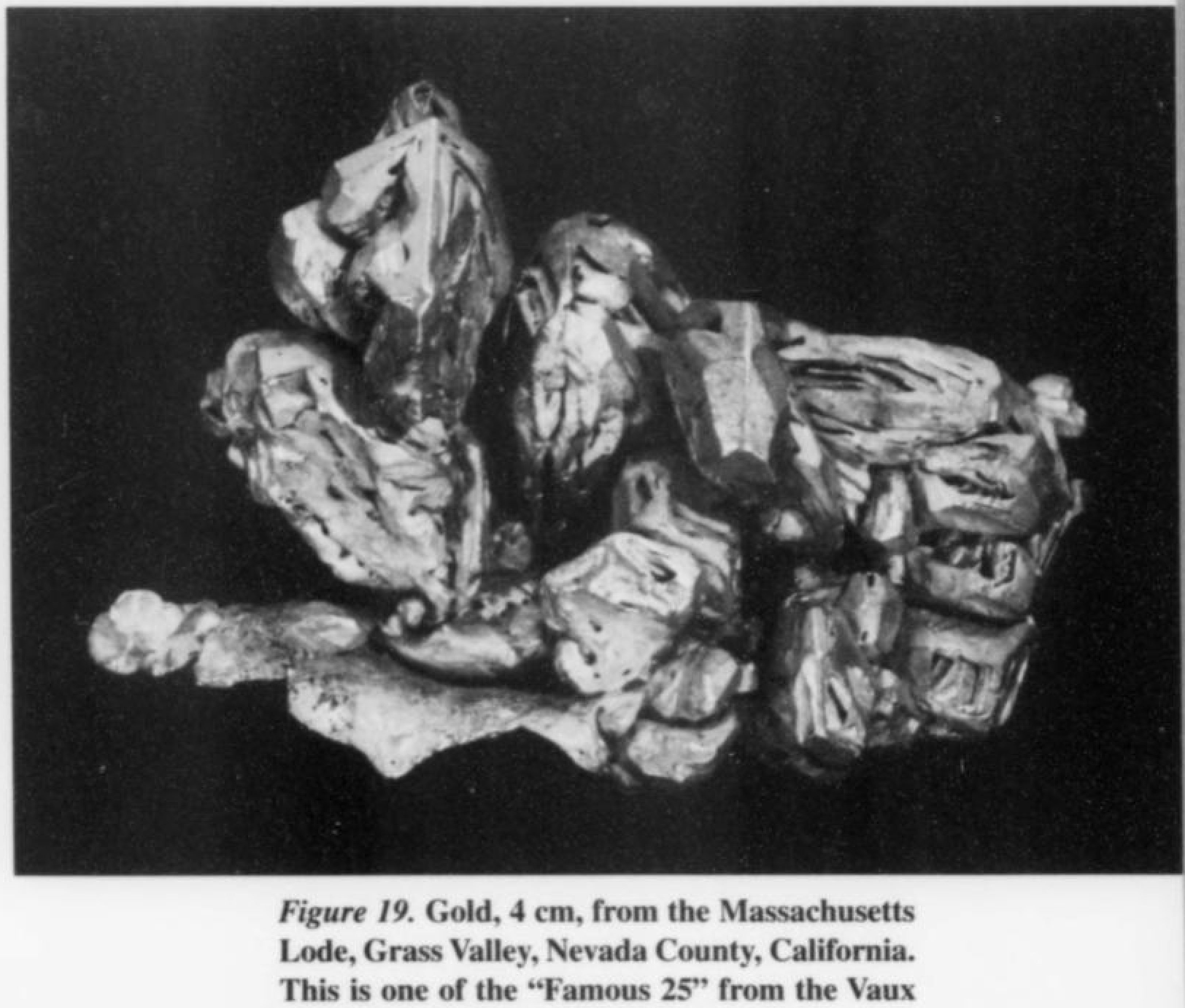
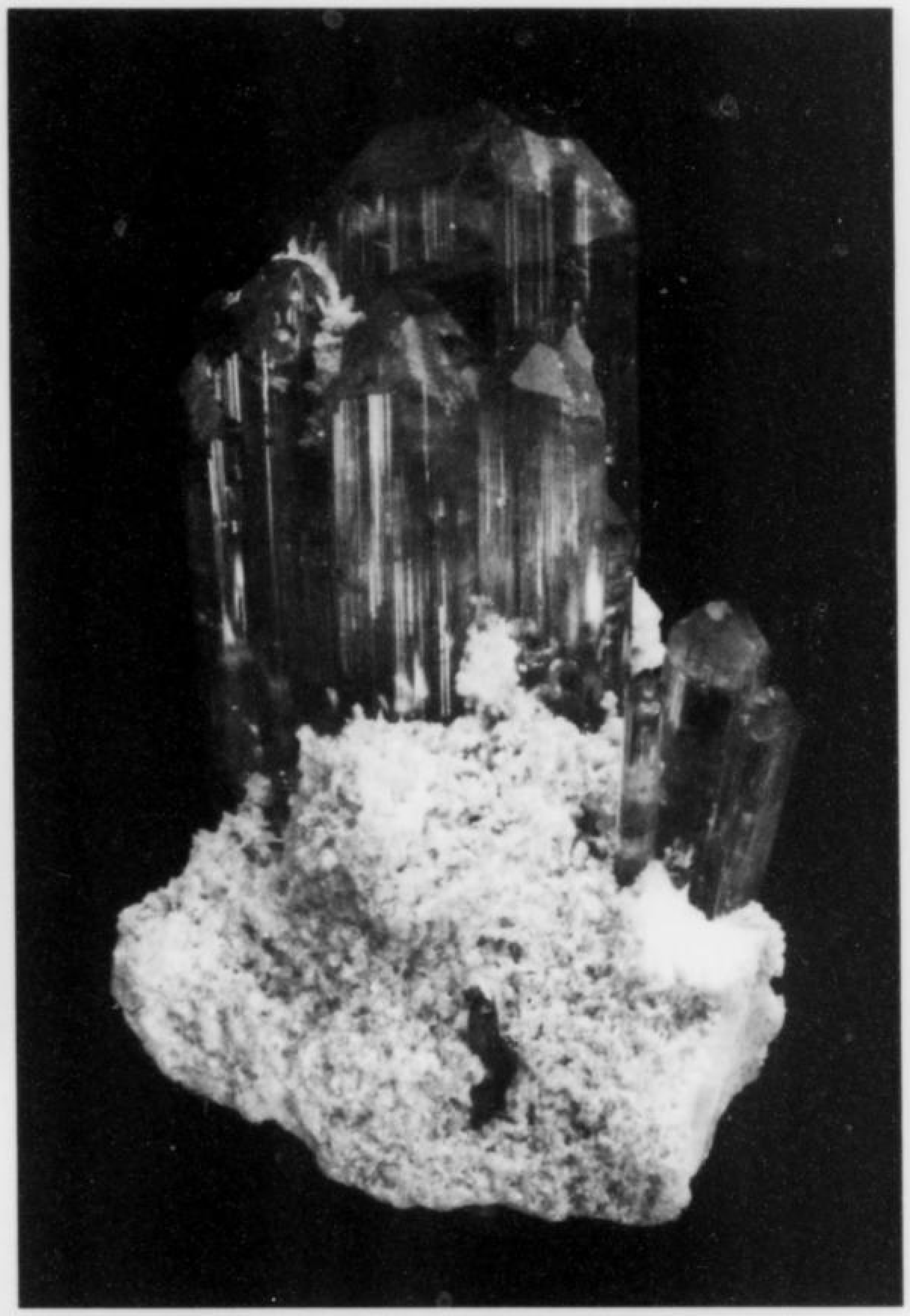


Figure 19. **Gold, 4 cm, from the Massachusetts Lode, Grass Valley, Nevada County, California. This is one of the "Famous 25" from the Vaux Collection. David Eidahl collection.**

Figure 20. **Hematite (with epitactic rutile) on quartz, 4.5 cm, from Cavradi, Tavetsch, Switzerland. David Eidahl collection.**

Figure 21. **Elbaite, 6.5 cm, from the Golconda mine, Coroaçi, Minas Gerais, Brazil. David Eidahl collection. (Cover of the *Mineralogical Record*, vol. 1, no. 4.)**



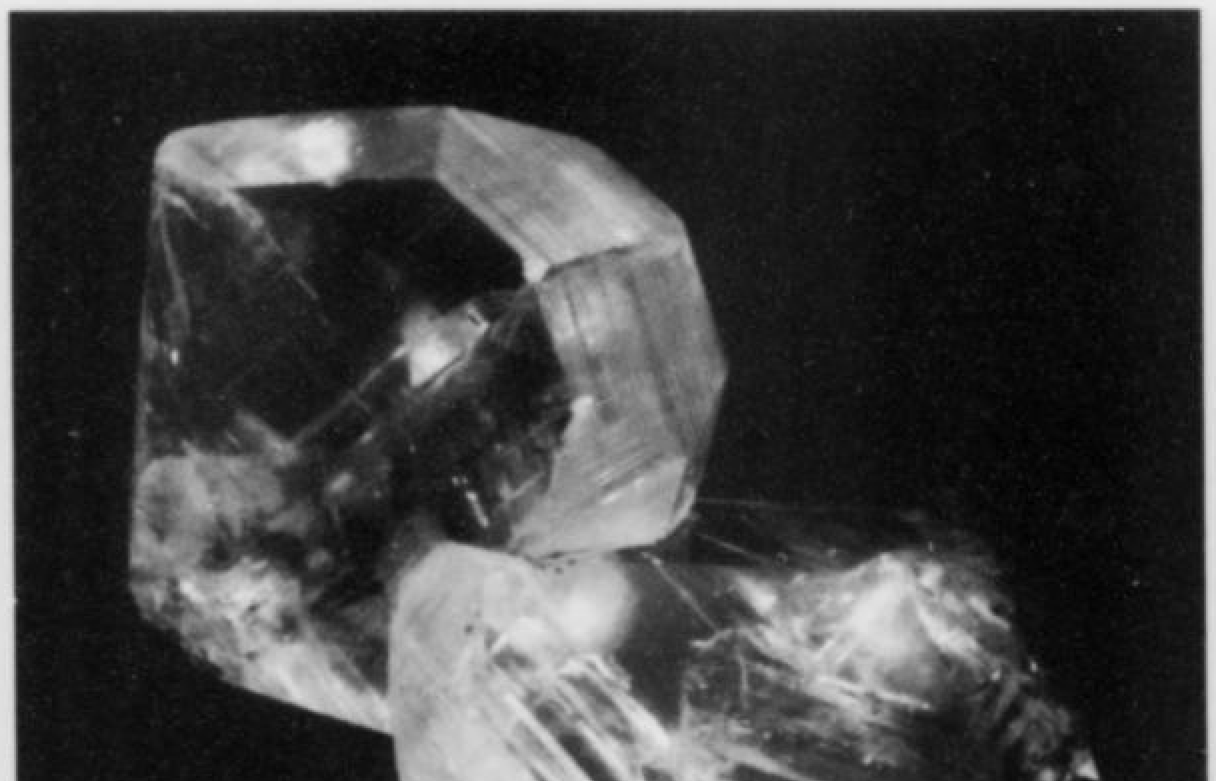


Figure 22. **Calcite, 6.5 cm, from the Pallaflat mine, Bigrigg, Cumbria, England. David Eidahl collection.**

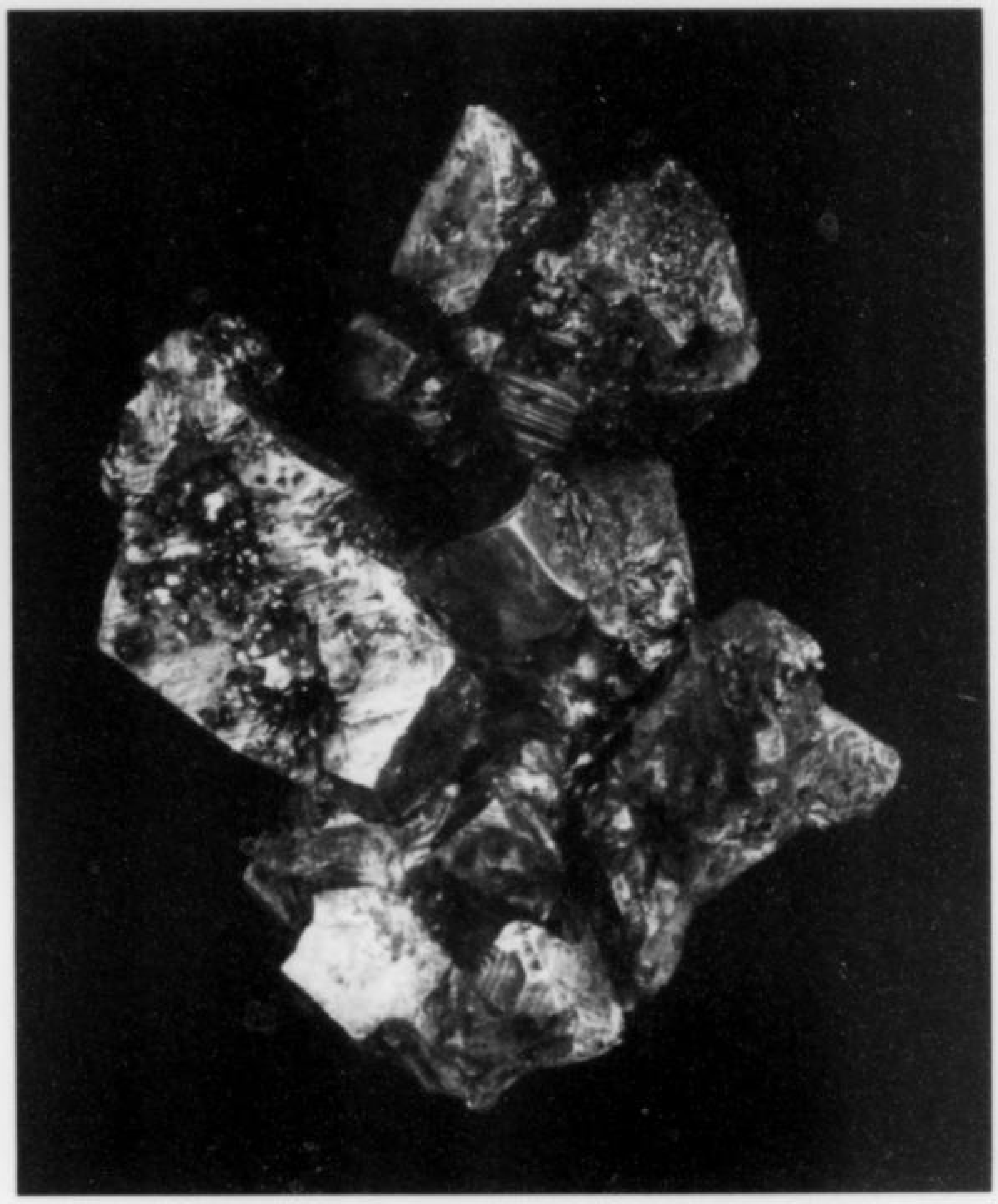


Figure 23. **Silver crystals, 4.5 cm, from Kongsberg, Norway. David Eidahl collection. (Cover of the *Mineralogical Record*, vol. 17, no. 1.)**

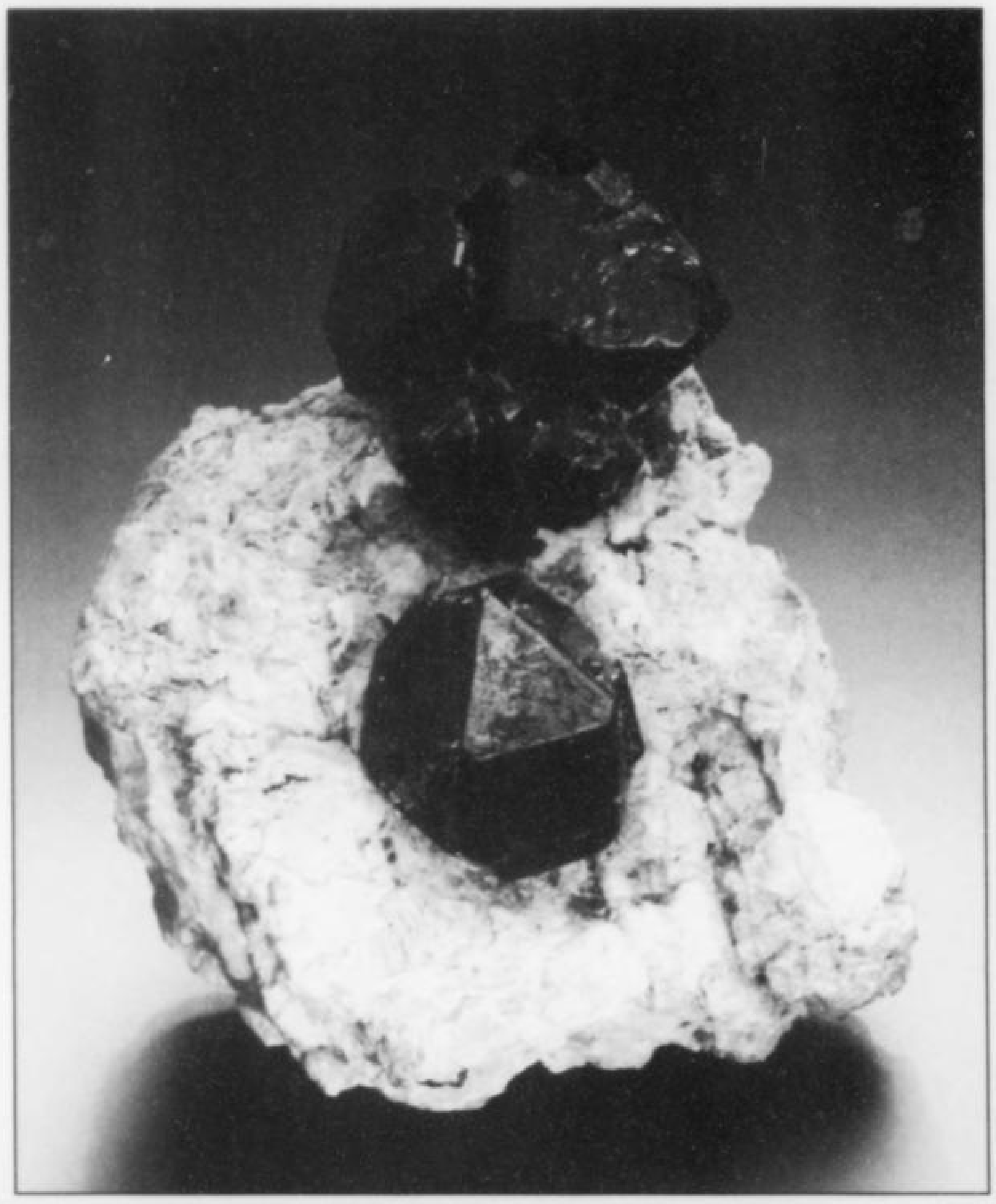


Figure 24. **Boleite, 5 cm, from the Amelia mine, Boleo, Baja California Sud, Mexico. David Eidahl collection.**

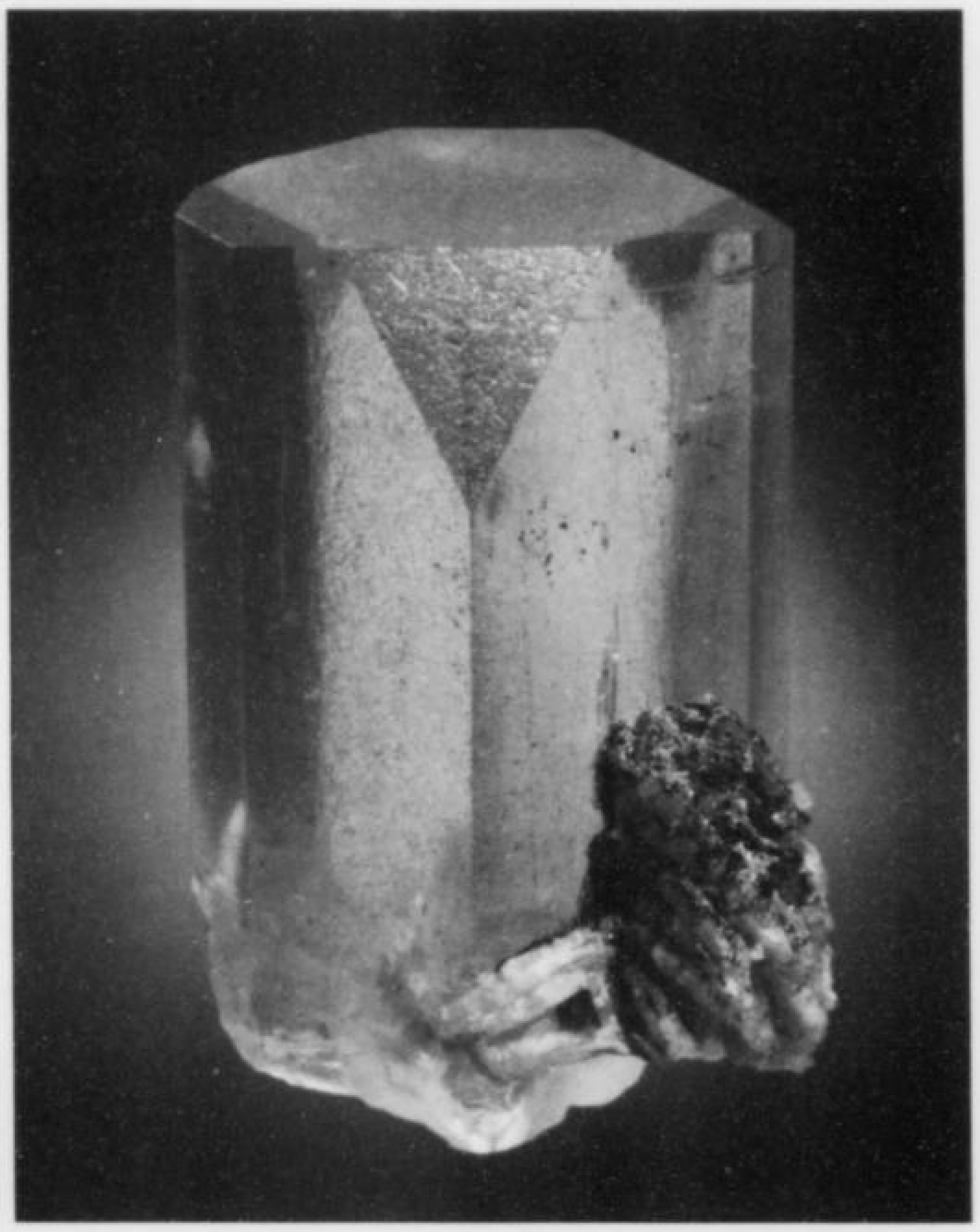


Figure 26. **Topaz with albite, 4 cm, from Yuzhakova village, Sverdlovskaya oblast, Ural Mountains, Russia. David Eidahl collection.**

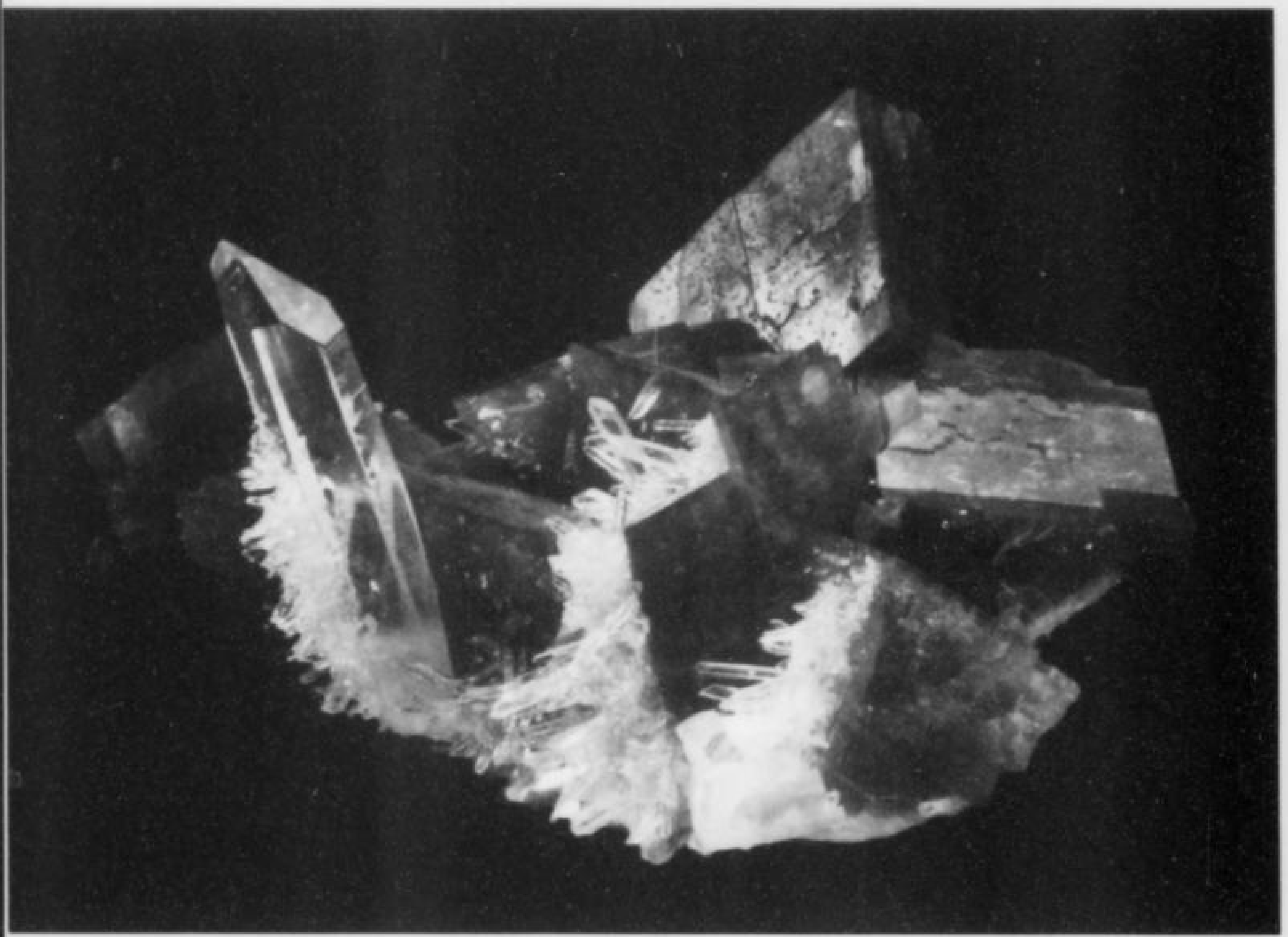


Figure 25. **Siderite, 8 cm, from Allevard, Isère, France. David Eidahl collection.**

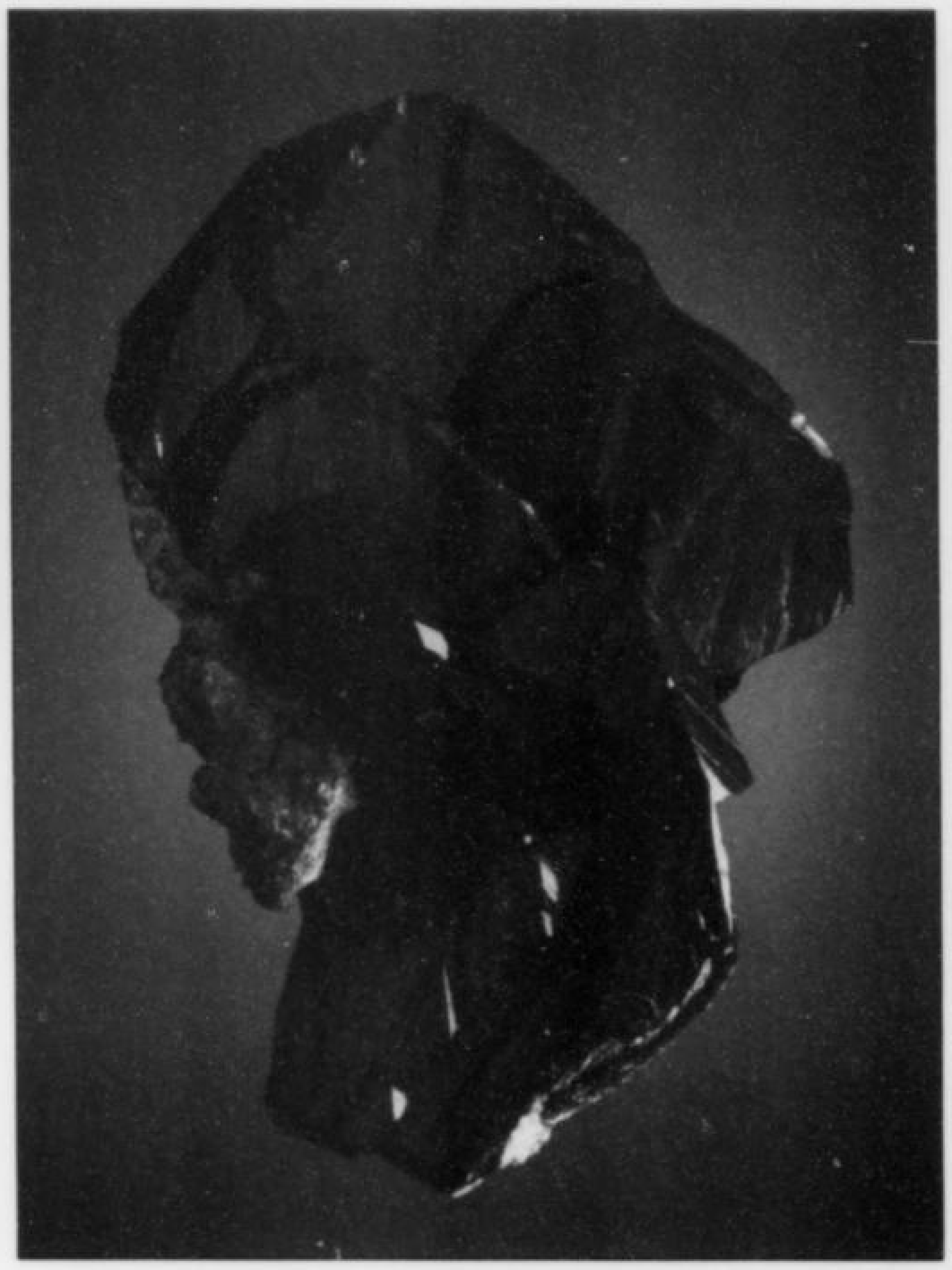


Figure 27. **Azurite, 6 cm, from Bisbee, Cochise County, Arizona. David Eidahl collection.**

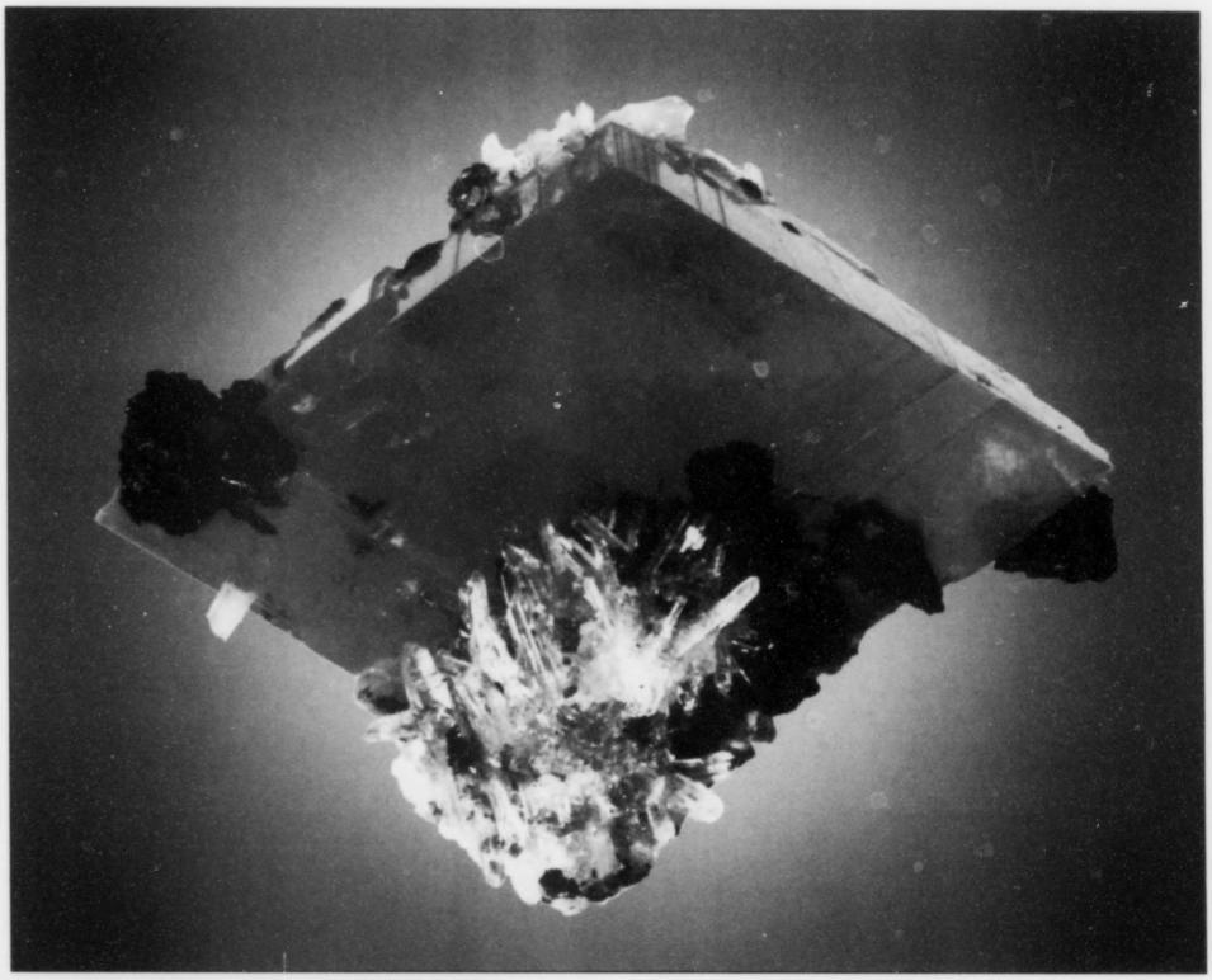


Figure 28. **Rhodochrosite, 5 cm, Sweet Home mine, Alma, Colorado. David Eidahl collection.**

Figure 29. **Silver, 6.5 cm, from Houghton County, Michigan. David Eidahl collection.**

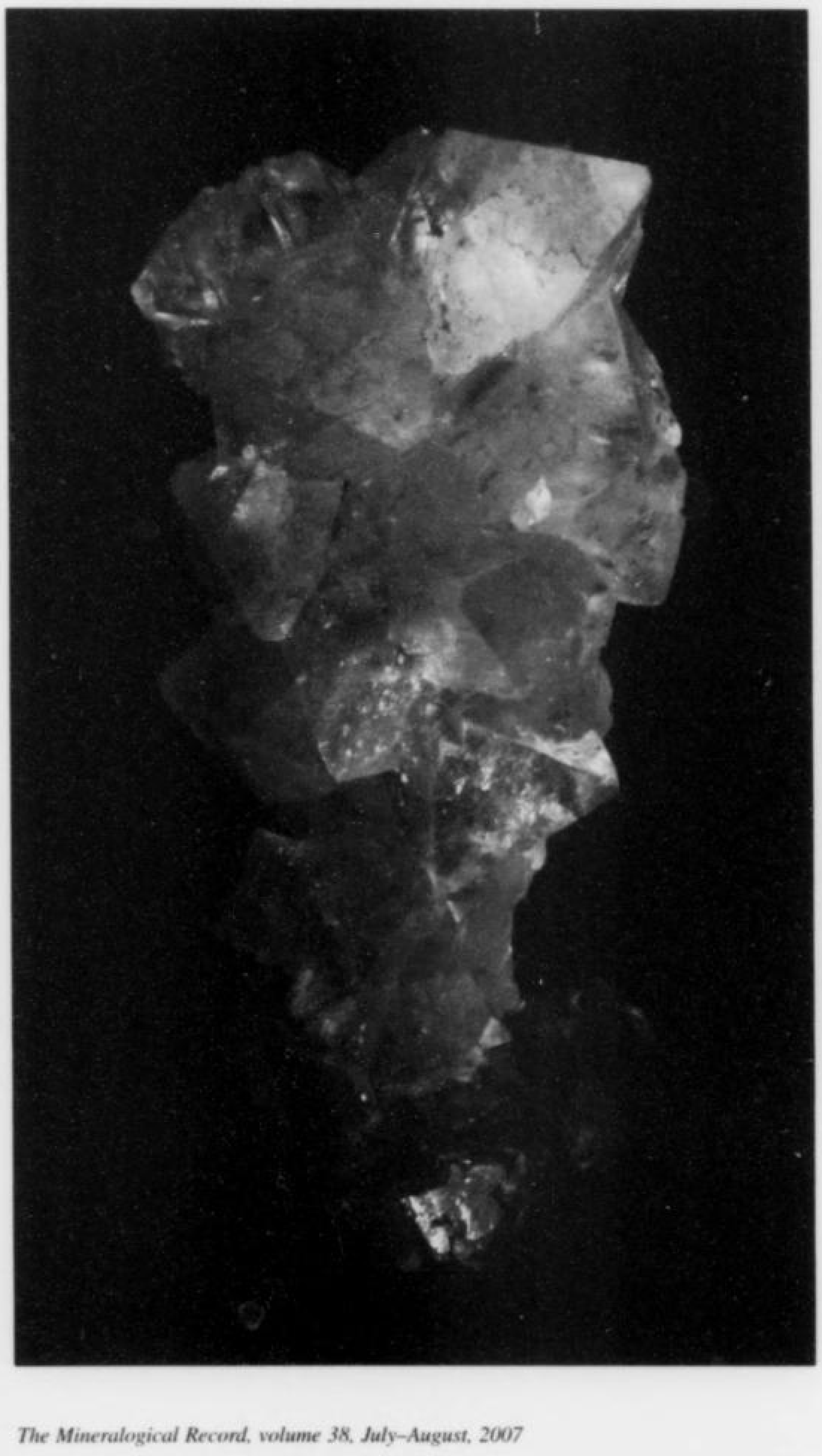


Figure 30. **Fluorite, 7 cm, from the Goscheneralp, Canton Uri, Switzerland. David Eidahl collection.**

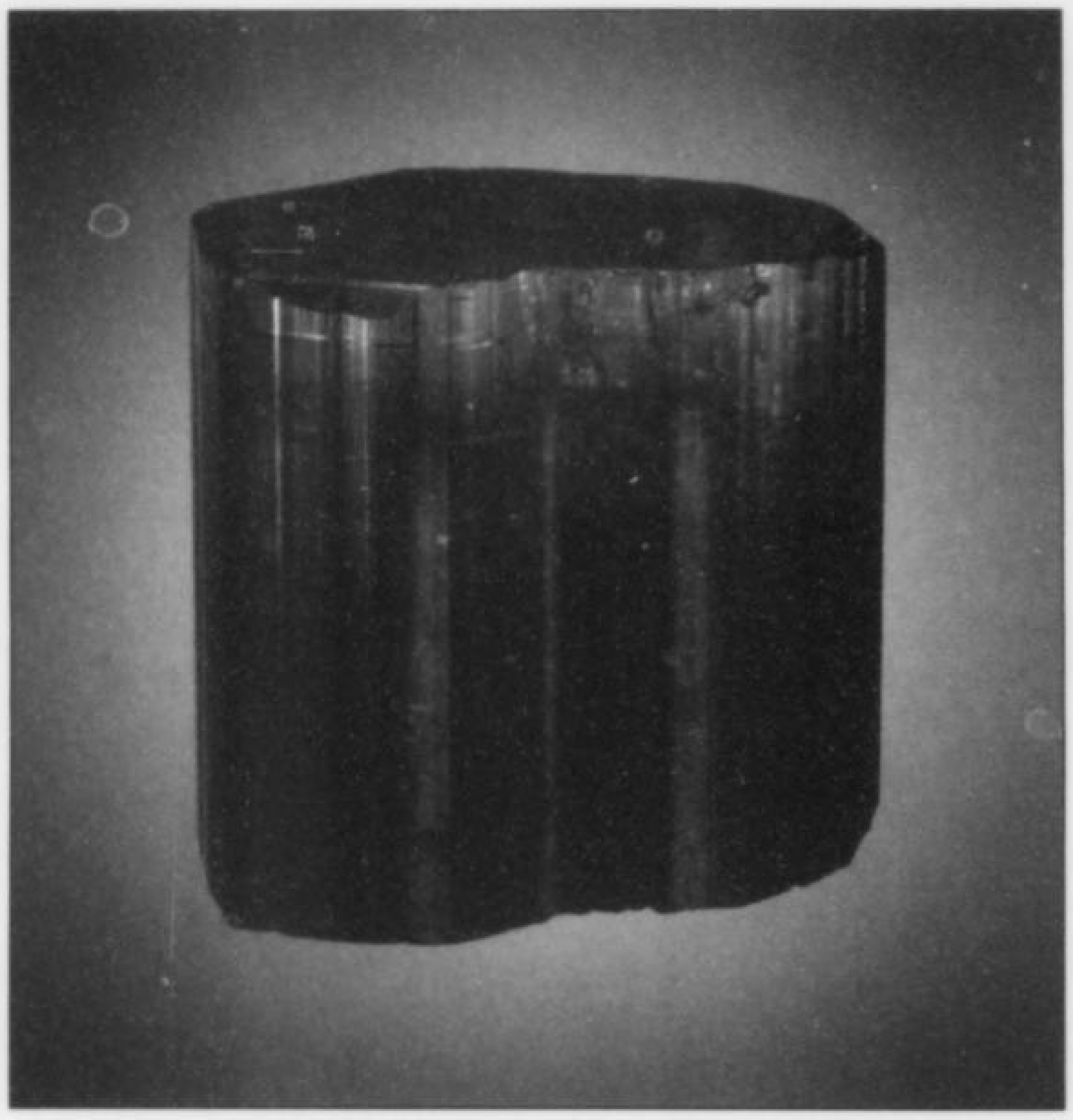


Figure 31. Fluorapatite, 2.5 cm, from Panasqueira, Castelo Branco district, Beira Baixa, Portugal. David Eidahl collection.

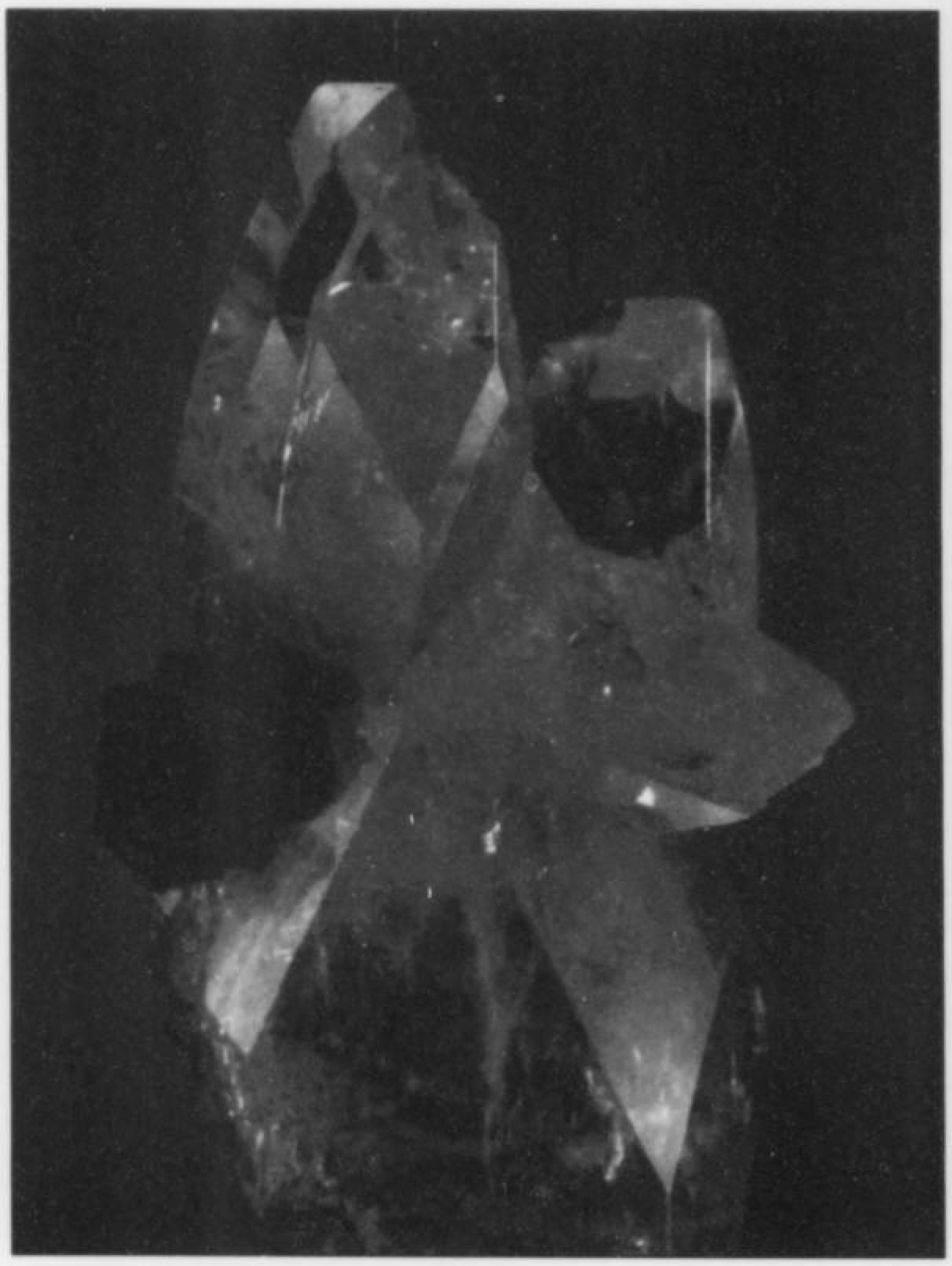


Figure 32. Phosphophyllite, 2.8 cm, from the Unificada mine, Cerro Rico de Potosí, Bolivia. (Cover of the *Mineralogical Record*, vol. 12, no. 5; since broken and awaiting repair.) David Eidahl collection; photo by Harold and Erica Van Pelt.

Figure 33. Silver wire, 6 cm, from Mineral Park, Dos Cabezas district, Arizona. This is a specimen from the 1886 auction of the Dohrmann Collection, picture in the *Mineralogical Record* article in vol. 23, p. 10, Fig. 7. David Eidahl collection.

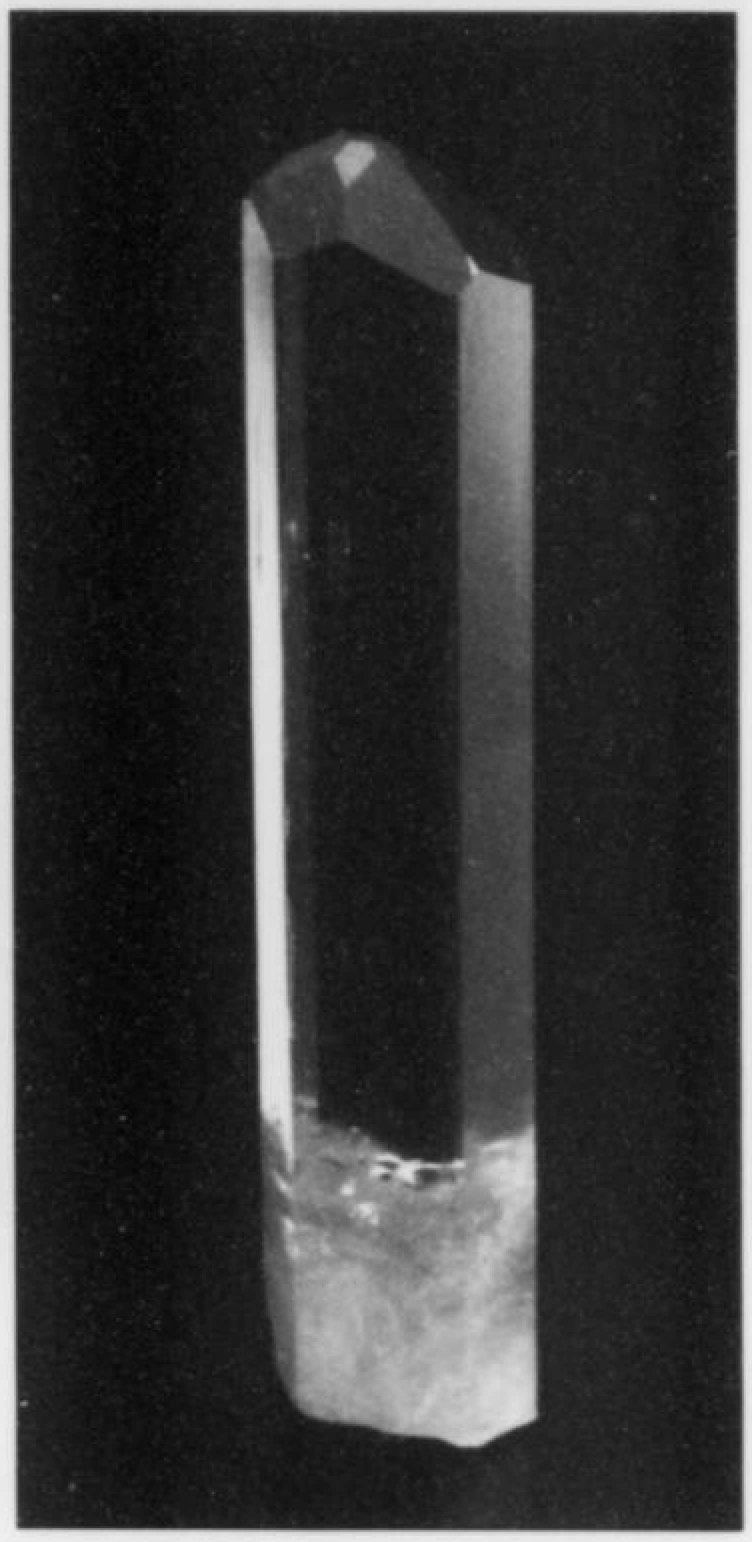
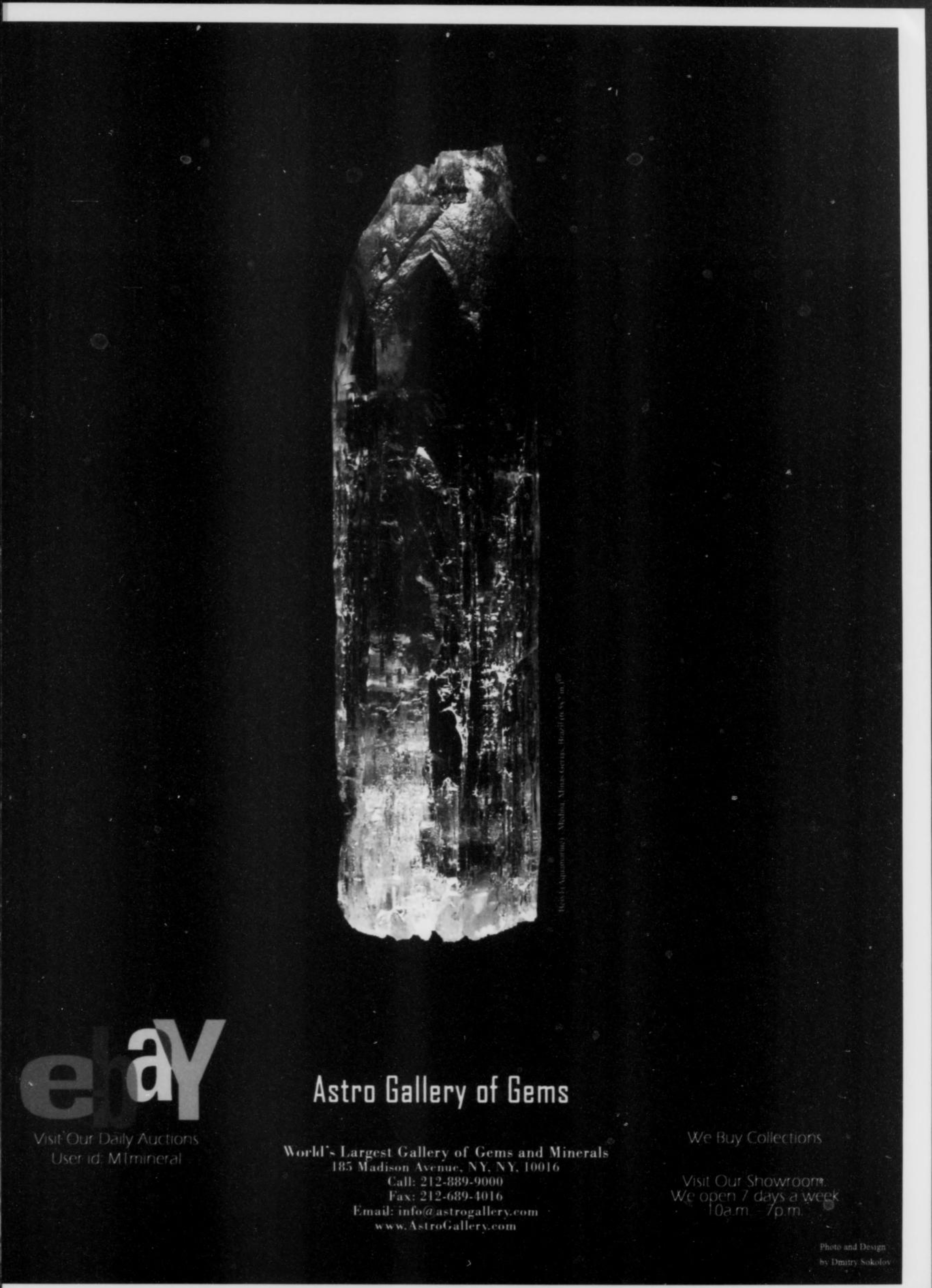


Figure 34. Aquamarine beryl, 9 cm, from Minas Gerais, Brazil. David Eidahl collection.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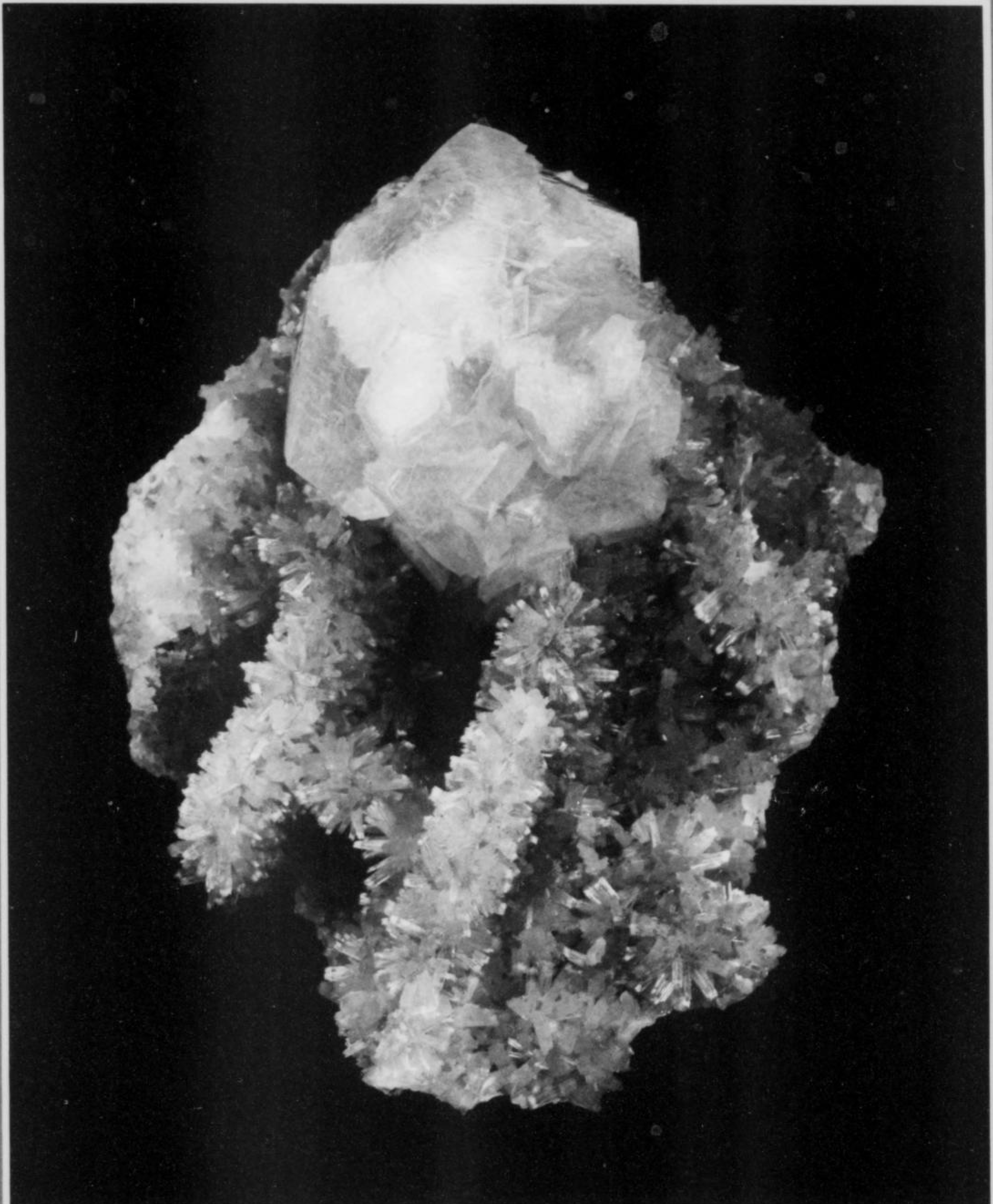

SMITHSONITE on WILLEMITE, 8.5 cm, from Berg Aukas, Namibia.
Obtained from Prosper Williams in February 1972.

ABSTRACTS

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GEMS AND MINERALS FROM DOWN UNDER

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Pegmatite mineralogy of Western Australia

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Pegmatites are widespread in the Archean and Proterozoic terranes of Western Australia, a state that covers one-third of the Australian continent. Attractive as well as rare mineral specimens have been recovered from several areas.

Archean LCT (Li-Cs-Ta) complex pegmatites are abundant in the East Pilbara, particularly in the areas south of Port Hedland. Some of these pegmatites have produced excellent specimens of rare and common minerals. Excellent euhedral simpsonite crystals up to 1 cm in diameter are known from its type locality, the Tabba Tabba Main tantalite pegmatite. Lustrous, white, equant, terminated beryl crystals in matrix are also common from this pegmatite. The depleted Wodgina Main tantalite dike is known for wodginite, its co-type locality, as well as having produced cesium-rich beryl, lithium phosphates and sharply formed tantalite crystals. Massive primary and secondary phosphates are known from several pegmatites, including Lewis's Rock hole, the Wodgina Main tantalite, the Strelley pegmatite and Congo ML at Mount Francisco. The Cooglegong area, possibly the Trigg Hill pegmatites, is the type locality for formanite and tanteuxenite and is also known for its yttrotantalite, fergusonite and gadolinite. The Pilgangoora pegmatite field is the type locality for ferrocolumbite.

The Proterozoic Gascoyne Province is well-known by collectors for its terminated dravite crystals in muscovite schist from Yinnietharra. The adjacent LCT beryl-columbite pegmatites at Morrissey Hill, Beryl Hill and Pyramid Hill only rarely contain lithium minerals such as lepidolite, elbaite and triphylite. Columbite, beryl, schorl and uranpyrochlore are the more common minerals. The Kempton brothers beryl pegmatite, south of Pyramid Hill, is the type locality for clinobisvanite, where it was found with beryl, ferrocolumbite, triphylite, rockbridgeite and uranpyrochlore.

The Archean Yilgarn Craton contains an array of LCT complex pegmatites and at least one NYF (Nb-Y-F) pegmatite field. The Murchison terranes at the north end of the craton contain numerous pegmatite fields. The pegmatites at Poona have only produced opaque green beryl with cassiterite and rarely lepidolite. The adjacent schists and quartz boudins are well known for their attractive but mostly non-gem-quality emeralds. Silvery brown bladed zinnwaldite in spherical clusters and botryoidal masses is particularly common in the Dalgaranga-Mount Farmer pegmatite field. Microlite, manganocolumbite and opaque but euhedral white to blue topaz are also known. The Goodingnow feldspar pegmatites south of Paynes Find have produced attractive opaque yellow to yellow-green beryl and columbite crystals. Other cleavelandite-rich pegmatites in the field have produced 2 to 4-cm tantalite crystals and very fine-grained, dense masses of purple lepidolite.

The NYF Mukinbudin pegmatite field has been known for rare minerals including allanite, euxenite, fergusonite, ilmenorutile, monazite, xenotime and zircon since 2000. Excellent smoky quartz crystals to 30 cm long and microcline have been found for several years in vugs in the Mukinbudin feldspar and Calcaling pegmatites.

Numerous specimens of spodumene, elbaite (opaque pink, green, blue and watermelon), montebrasite, sphalerite, manganocolumbite and beryl are commonly found at the Cattlin Creek pegmatite, located just 2 km north of Ravensthorpe. Just 15 km to the southeast, silvery brown zinnwaldite in bladed spheres exceeding 5 cm is particularly common in the quarry pegmatite, one of many in the Cocanarup pegmatite field.

The 1986 discovery of gemmy pink elbaite, tantite and kimrobinsonite from the strongly weathered Forrestania Rubellite pegmatite near Mount Holland is further proof that vast unexplored areas in Western Australia still remain. The Forrestania Rubellite pegmatite is the type locality of kimrobinsonite, as well as being known for the rare minerals cesstibtantite and hafnon. Vugs were found in the central area of the pegmatite containing pink, green and blue elbaite, clear quartz crystals, pink beryls in association with albite (variety cleavelandite) and lepidolite. The largest previously illustrated elbaite was 2 by 2.5 cm.

The best-colored and best-formed emeralds from the Wonder Well emerald mine, Riverina Station, west of Menzies and the Bulla Bulling emerald mine, west of Coolgardie are all found in schist or quartz boudins and only rarely along the edges of quartz-feldspar pegmatites. Usually, the beryl in the pegmatites is only a moderate to dark green and not true emerald.

In Western Australia, the Coolgardie pegmatite field is probably the best known. Within this field, world-class specimens of ferrocolumbite have been mined for many decades from the Giles beryl-columbite pegmatite at Spargoville. Gemmy green and blue elbaite, rarely preserved as matrix specimens on quartz, have been found at the Giles elbaite pegmatite, just south of the beryl-columbite pegmatite. The Londonderry feldspar pegmatite has been a well known source for gem petalite, excellent ixiolite and columbite crystals, and the rare minerals eucryptite, bavenite, bityite and moraesite. The thin Barbara gold mine pegmatites are known for their sharply-formed brown danalite crystals. The Lepidolite Hill pegmatite is the only known locality for pollucite in Australia, discovered in a 1960's exploratory core hole prior to mining.

The famous Greenbushes pegmatite, although a key world source of tantalum and lithium and the type locality for holtite and stibiotantalite, is not a good producer of mineral specimens. Only lustrous terminated schorl crystals in kaolinized pegmatite and holmquistite in pegmatite contact schists have been abundant enough to be found in many collections.

Western Australia's size and diversity of pegmatites assures that new discoveries will be made as collectors continue to inspect the outcrops. Most of the new finds will remain in Australian collections as self-collected specimens. Only a few Australian pegmatites have produced a handful of world-class mineral specimens.

Unusual secondary copper assemblages from deposits in eastern Australia

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Recent open-cut mining operations associated with Cu and Cu-Au orebodies in eastern Australia have revealed a number of exotic assemblages of secondary minerals. The cases examined here all feature secondary phosphates or arsenates and other rather rare species; each of them is noteworthy in terms of the abundance of material that has been recovered.

In the Northparkes E22 and E27 deposits at Goonumbla, New South Wales, upper oxidation zones are dominated by libethenite and pseudomalachite, with azurite and malachite emplacement at greater depths. In the nearby E26 deposit, oxidation associated with much more saline (NaCl) ground waters has led to extensive development of sampleite in the phosphate assemblage. Lower in the profile much atacamite was present. A similar pattern of zoning is associated with the oxidized zone of the Girilambone mine, at Girilambone, New South Wales. Secondary copper phosphates were encountered at all levels of the oxidized zone but were particularly pronounced in the upper benches. Deeper in the profile, abundant crystalline native copper was encountered, together with magnificent groups of azurite crystals. Related secondary copper arsenates were conspicuous in a paragenetically early sequence of the oxidized zone of the New Cobar mine, Cobar, New South Wales. Associated phases were bayldonite, duftite, gartrellite, agardite, mimetite and various arsenic-bearing members of the jarosite supergroup. A later carbonate sequence (azurite-malachite) was superimposed on this assemblage.

The Great Australia mine, at Cloncurry, Queensland, displays a related phosphate sequence that carries rarer phases including hentschelite and cloncurryite, a basic copper vanadyl phosphate fluoride closely related to nevadaite. However, a remarkable assemblage of rare species was found in highly siliceous cuprite-native copper ore in both the main and B Tangye lodes from near the surface to the water table. This was protected from further reaction by encapsulation and bears a chemical relationship to certain material recovered from deposits at Bisbee, Arizona. Many tonnes of nantokite associated with cuprite and native copper were mined and processed. Associated with this material were atacamite, brochantite, claringbullite, gerhardtite and considerable amounts of connellite.

Geochemical processes responsible for the generation of these assemblages have been explored. Unusual groundwater compositions are important to a large extent, as is the lack of carbonate gangue in several instances. Rare secondary copper nitrate mineralization in the Great Australia deposit has its origin in a bizarre relationship involving termite activity.

Observations on Specimen Gold in Southeastern Australian Museums

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Specimen gold was recently examined in three major Australian Museums—the Australian Museum in Sydney; Museum Victoria, Melbourne; and the Gold Museum, Ballarat. At the Australian Museum gold specimens both on display and in storage were inspected. Here display gold is dominated by exceptional nuggets including the 9.8-ounce "Sesquicentary Nugget" from Goanna Patch, Leonnora, Western Australia, and a peculiar and attractive flattened sheet-like 19.5-ounce nugget from the Ovens River, Victoria, and by good matrix specimens from Welha, Victoria and a 32-ounce piece from Hill End, New South Wales. Also on display are two historically significant gold specimens from Great Britain and casts of the enormous Welcome Stranger, Platypus, and Hand of Faith nuggets. A wide array of locality and second-tier display gold specimens are stored in the systematic collection. Specimens of note include sharp complex gold crystals on matrix from Tooloom Drake, New South Wales; deep yellow gold in the central part of quartz veins from Rutherglen, Victoria; gold in and on quartz from several localities at Lauriston, Victoria; peculiar "fibrous" gold in serpentine from Gundagai, New South Wales; gold and gold tellurides in calcite from Major's Creek, New South Wales; and somewhat crude gold crystals on quartz matrix from the Murchison Gold Field, Western Australia.

Virtually all of the excellent gold collection of Museum Victoria is in storage. Of particular note are well-crystallized golds from Matlock, Castlemain and Wedderburn, Victoria; Beaconfield, Tasmania; and the Murchison Gold Field, Western Australia. Attractive matrix specimens include a variety of localities such as Mongalata, South Australia and the Golden Crown mine, Victoria. Good nuggets are represented from Kingower and Bridgewater, Victoria. Other Australian specimens of note include those from Bendigo, Woods Point, Ballarat, and Beechworth, Victoria; and the Carnation mine at Payne's Find, and Kalgoorlie, Western Australia. The collection also contains an array of good to excellent specimens from many of the world's other gold specimen-producing localities.

Exceptional nuggets and matrix or crystalline gold specimens are on display in the Gold Museum, which is located conveniently across the street from the Soverign Hill Museum, a living history museum depicting life on the Ballarat goldfields in the 1850's. Included are the 21-ounce Terry and 13-ounce Knight nuggets, and the attractive 40-ounce Eureka nugget found on the outskirts of Ballarat in 1992 with a metal detector. Central to the collection is a group of 13 huge nuggets belonging to a single collector. Good specimens of gold crystals from Tasmania and crystalline gold from Echunga, South Australia are also on display.

Although the best of Australia's gold specimens have either been exported or melted, these three museums collectively preserve a uniquely important selection of Australia's gold heritage.

Minerals of the Cobar District, New South Wales

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The Cobar district in central western New South Wales, Australia, has a mining history that dates back over 130 years, with significant production of copper, lead, zinc, silver and gold. The total mineral endowment for the district exceeds $14 billion in value at current metal prices and mining is ongoing with five mines currently in production. Although the combination of deep weathering and the typical pipe-like configuration make Cobar-type deposits difficult exploration targets, a number of new discoveries have been made in recent decades.

Weathering over an extended period, at least back to the Tertiary, has resulted in deep oxidation of the primary sulfide bodies to typically 80-100 meters below the surface. Migration of metals downward formed rich supergene deposits of oxide and secondary sulfide minerals at the redox boundary.

Early underground mining encountered fine specimens of native copper, malachite and azurite but few of these are preserved in collections. More recent mining of the oxide zones at the Girilambone, New Cobar and Elura (Endeavor) deposits has exposed a rich diversity of secondary minerals including copper carbonates and phosphates, copper and lead arsenates, and silver minerals. Mining has also enabled the recovery of some spectacular specimens, particularly of native silver and mimetite from the Elura (Endeavor) deposit and azurite from the Girilambone deposit. Mimetite specimens from Elura are regarded as amongst the finest of this species in the world.

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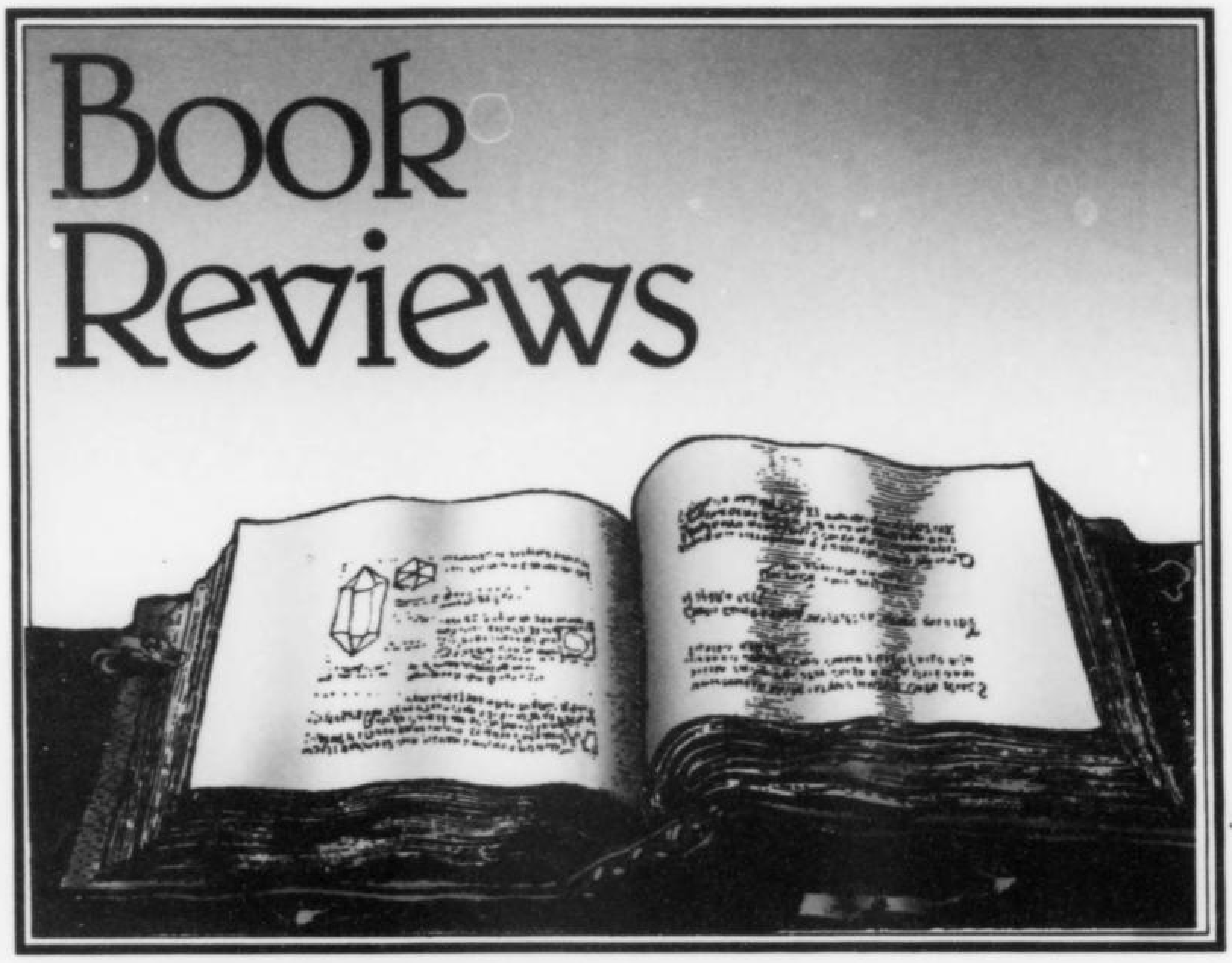
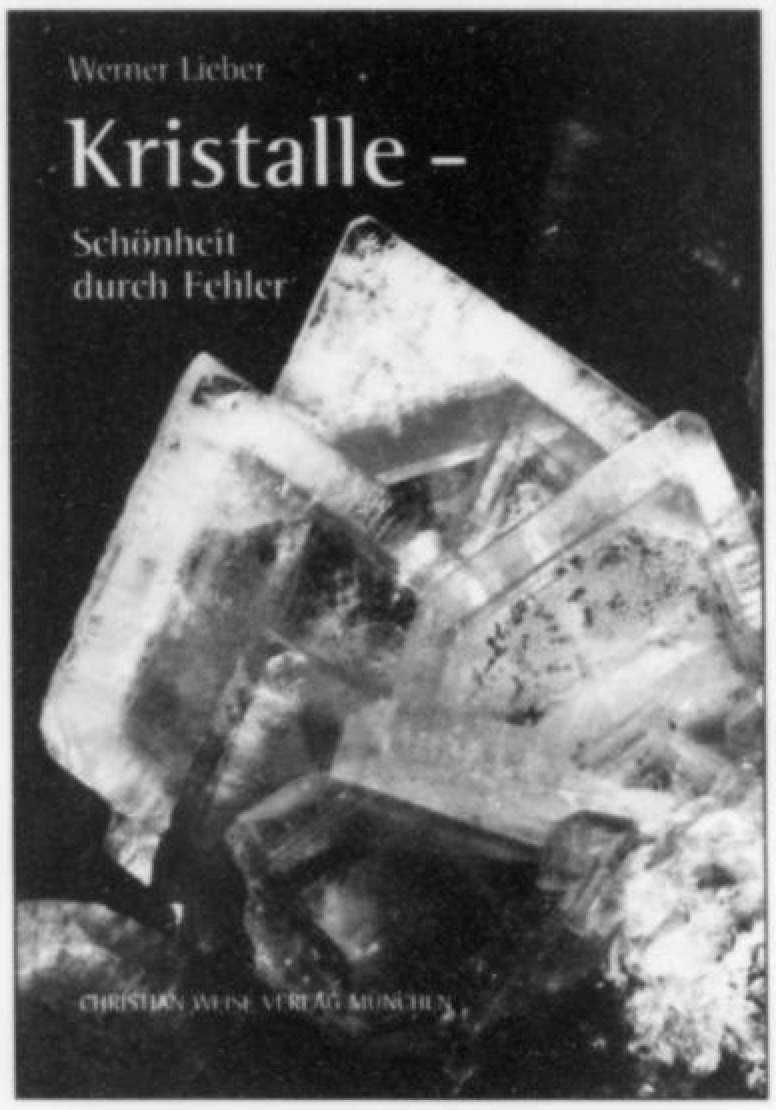




Kristalle—Schönheit durch Fehler ["Crystals—Beauty through Imperfection"]

by Werner Lieber. Published (2006) by Christian Weise Verlag GmbH, Orleansstr. 69, 81667 München, Germany. Hardcover, 8.5 × 12 inches, 178 pages. Price €59 plus shipping. ISBN 3-921656-66-4.

Dr. Werner Lieber of Heidelberg, a professional chemist now retired from industry, has been a mineral collector for more than 55 years and is a prolific writer on mineralogical topics. The many books and articles he has produced since the 1960's, while addressed to collectors and other mineralogical "amateurs," bespeak both a high level of knowledge and a born teacher's drive to enthusiastically communicate that knowledge. Furthermore, his writing conveys a voracious curiosity concerning what *more* might be learned about just why minerals form as they do. The refined aesthetic sensibility which should properly accompany such an intellect is there too: Dr. Lieber has long enjoyed a firm reputation as one of the world's leading mineral photographers.

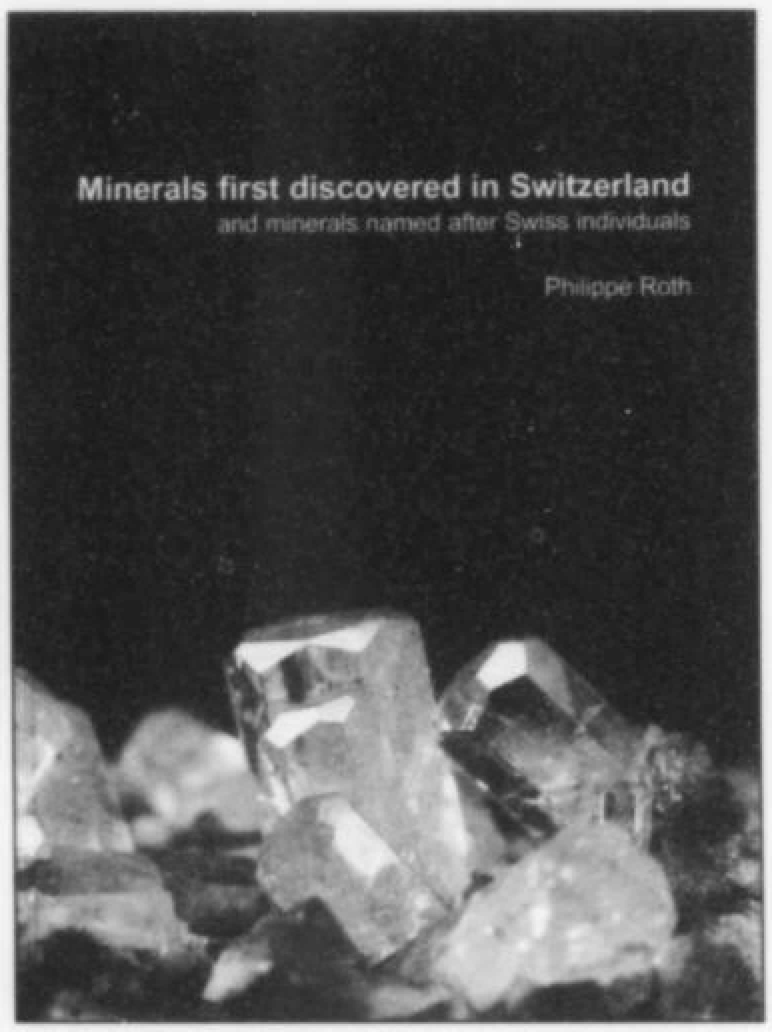
Such is the sensibility which has produced *Kristalle—Schönheit durch Fehler* ("Crystals—Beauty through Imperfection"), brought out in 2006 by Christian Weise, publisher of *Lapis* magazine. The author tells us in an introduction that he regards this book as a kind of sequel or update to one that he wrote (and Weise published) in 1977, entitled *Kristalle—wie sie wirklich sind* ("Crystals—as they really are"). The theme of both books is that it is really *Fehler*—imperfection, wild-card variability—and not perfection or predictability, which drives the processes of the natural world, and it is the faintly puckish mineralogical products of *Fehler* which most often win the hearts of mineral collectors. To translate loosely from Lieber's introduction: "We sometimes like to consider that crystals, with their precise geometric forms, are 'masterpieces of nature' somehow formed whole in mysterious secrecy. Closer inquiry reveals, however, that absolute purity and perfection are vanishingly rare; one is inclined to say that there are no absolutely perfect crystals, no actual chemical compositions perfectly matching the formulas, and no ideal sets of physical characteristics. Crystals—as they really are—always deviate from their ideal forms, since conditions during their (usually very long) formation times do not remain constant. . . . The diversities of forms and habits, the varying colors, the irregularities and charming inclusions—these are the things that lend crystals their true distinctiveness. These things speak to our sense of beauty, and thus we cherish such 'imperfect' crystals both as splendid creations of nature and as playful denizens of the mineral kingdom."

The table of contents reveals that this sense of *Fehler* is broad enough to let the author pursue his idea gracefully through 169 foot-tall, thick, glossy pages. The book's two broad divisions are "Single Crystals" and "Crystal Aggregates." In the first category we read about distortions of crystal growth, irregular growth phenomena on crystal faces, inclusions in crystals, color varieties in single species as functions of trace-element chemistry, optical effects, pseudomorphism, and many tangential topics. The second division, Crystal Aggregates, includes discussions of parallel growth, acicular-radiating and stalactiform aggregates, oddities such as rings and cylinders, twinned crystals, epitactic intergrowths, and more. The Bibliography contains 140 titles, and there are two Indexes, one for mineral species and one for terms and concepts.

Although the text is entirely in German, it seems to me that most English-only readers could follow it adequately for most purposes, given only patience, some mineralogical savvy, and a good German-English dictionary. Besides, the graphics are very helpful, as they are abundant, creatively chosen and clearly executed. Among them are not only the requisite crystal drawings from Goldschmidt but also fine drawings and sketches illuminating such topics as the "trapiche" habit in emerald crystals, unit cells, and microstructures (e.g. the "spiral staircase" aggregation of SiO_4 tetrahedra in quartz), the formation of pseudomorphs, crystal twinning and laws thereof, and even (you guessed it) snowflakes, also known as ice crystals. Among the generous number of photographs there are photomicrographs, including SEM images, imparting exquisite close-ups of oriented inclusions, striations, faden lines, jamesonite rings and cylindrite cylinders, and all manner of other microphenomena. The photos of macro-specimens, almost all by Lieber himself, are vivid enough to cause "wow!" responses even though most of the specimens themselves are not exceptional. On this point the author writes in his introduction, "In this book, written for collectors, no 'super pieces' from the world's best collections are pictured. For the most part . . . the specimens illustrated are of the kinds that the majority of collectors can acquire." This is not to say, though, that any are dull or mundane: there are many gorgeous items, particularly from European localities, pictured here.

Again, and finally, do not be put off by the fact that the text is in German: this is a highly attractive book, at once learned and good-humored, aimed squarely at curious (as opposed to incurious) mineral collectors. Even at present exchange rates, the price of 59 Euros offers no excuse for not acquiring a copy.

Thomas P. Moore



Minerals First Discovered in Switzerland *and* Minerals Named after Swiss Individuals

by Philippe Roth. Published by Philippe Roth; the Swiss Academy of Sciences; the B. & T. Tissières Martigny Foundation; and the Museum of Geology, Lausanne, Switzerland. Available in North America from Excalibur Mineral Corporation, 1000 North Division St., Peekskill, NY 10566-1830 (www.excaliburmineral.com). Hardcover, 8.5 × 11 inches, 239 pages. Price $45.00 plus shipping. ISBN 3-980-7561-8-1.

The title, although unwieldy, says it all: this book offers extremely thorough accounts of all mineral species whose type localities lie in Switzerland—there are 64 of these—and just-as-detailed accounts of another 23 species which were named after Swiss citizens, though their type localities lie in other countries. The book will be of great interest, naturally, to Switzophiles (Helvetiophiles?) among mineral collectors (see later), but will be valued, as well, by professional mineralogists and mineral collectors of all nations. For each species there is a two-page spread presenting all technical parameters characterizing the species; very full geological information about the species' mode of occurrence and paragenesis; a sketch of relevant historical information, including information on where type specimens presently are to be found; a list of pertinent references in the literature; and a photograph of a good specimen (many of these necessarily are SEM images, but otherwise all of the photographs are in color). From tremolite (the first valid species described from Switzerland, in 1789) to a slew of extremely rare Lengenbach sulfosalts described as late as 2005, the gamut of information is extremely full.

Moreover the information is people-centered in a way, and to an extent, that makes this book unique among regional mineralogies. For every species which was named after a person (and this is the great majority of them), the two-page spread is headed by a picture of the person in question, followed further down on the page by a biographical sketch. It is fun to find these pictures-plus-stories of human beings linked to minerals—from Philipus Theophrastus Aureolus Bombastus von Hohenheim, called Paracelsus (1493–1541), namesake of the copper arsenate theoparacelsite, described in 2001, to Simon Engel (1973–), namesake of simonite, a Tl-Hg-As sulfide which the then-nine-year-old's father Peter Engel helped to describe in 1982. With these "human interest" stories the book's main section nicely complements a chapter at the beginning called "Brief history of mineralogy in Switzerland from Paracelsus to the creation of the IMA," wherein we learn of the major importance of this small country in the larger history of mineralogy. Probably we have read or heard the names Gessner, Scheuchzer, Euler, Placidus a Spescha, Kenngott, Wiser, Baumhauer, Ashcroft, Niggli, Parker and Graeser before, but this short chapter clarifies how these assorted mineralogists, mathematicians, *Strahlers*, savants and expatriates (e.g., for the last, the Englishmen Ashcroft and Parker) made their significant contributions. As Philippe Roth says in his introduction, it is still Parker's *Die Mineralfunde der Schweizer Alpe* (1954, 1973) and Stalder *et al.*'s *Mineralienlexikon der Schweiz* (1998) which are the "final" references for Swiss minerals—but there is nothing in either of these works like the bio-historical backgrounds to be found here.

There is also, near the beginning, a special account of the mineralogy of the Lengenbach quarry, in the Binn Valley, Wallis—long renowned for its extensive suite of rare arsenic sulfosalts and, Roth informs us, number ten on the list of the world's most species-prolific localities. Along similar lines, a chapter called "Evolution in time and distribution in space" offers an intriguing table ranking the world's *countries* in terms of species described from each, both in absolute numbers of species (here the U.S. is first, with 670 species) and in terms of area, i.e. species per square kilometer. In the latter category—guess what!—Switzerland is Number One, with 64 species in 39,700 km^2, for a world-beating "density" of 1.609 species per thousand square kilometers (the next four down on the list are the Czech Republic, Italy, Germany and Austria; the U.S. is Number 24, and geographically giant Russia, with 590 species, is Number 33). It is also somewhat surprising to learn from a pie chart in this chapter that 64% of the indigenous Swiss species come from the numerous small, economically unimportant metallic ore deposits of Switzerland; only 13% come from the revered Alpine clefts.

Supporting apparatus at the end of the book includes a chronological catalog of descriptions of minerals from Switzerland; a geographical ordering of the same minerals; an ordering by the descriptions' authors; a glossary of varietal and obsolete names; a list of type specimens keyed to the institutions which hold them; and a chart showing how selected cantons and towns are denoted in each of Switzerland's four languages, plus English. This reference work will burden your shelves with precious little redundancy with other works—no mean feat, considering the extensiveness of the literature on Swiss minerals already extant before Philippe Roth came along.

Thomas P. Moore

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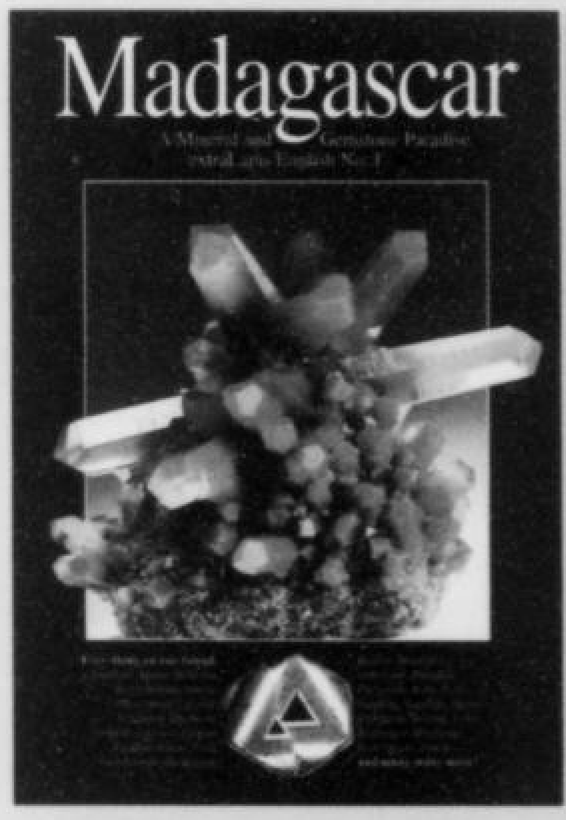

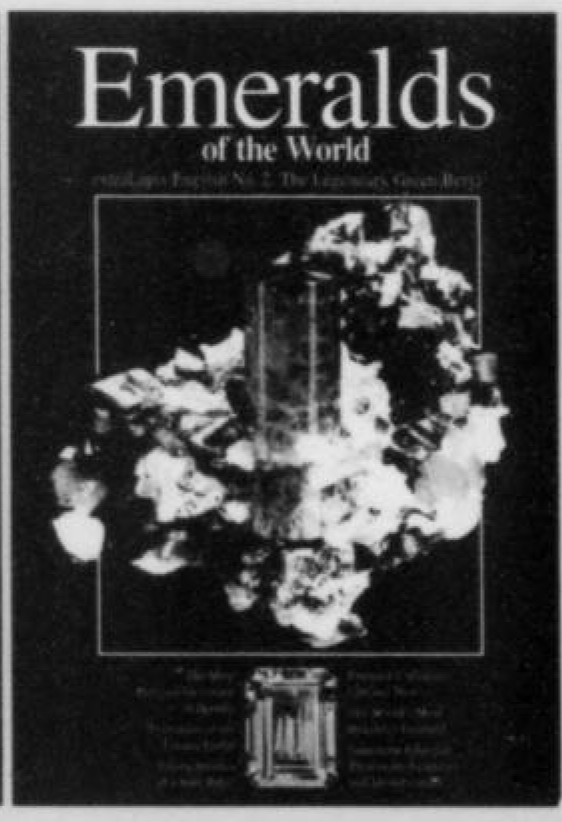

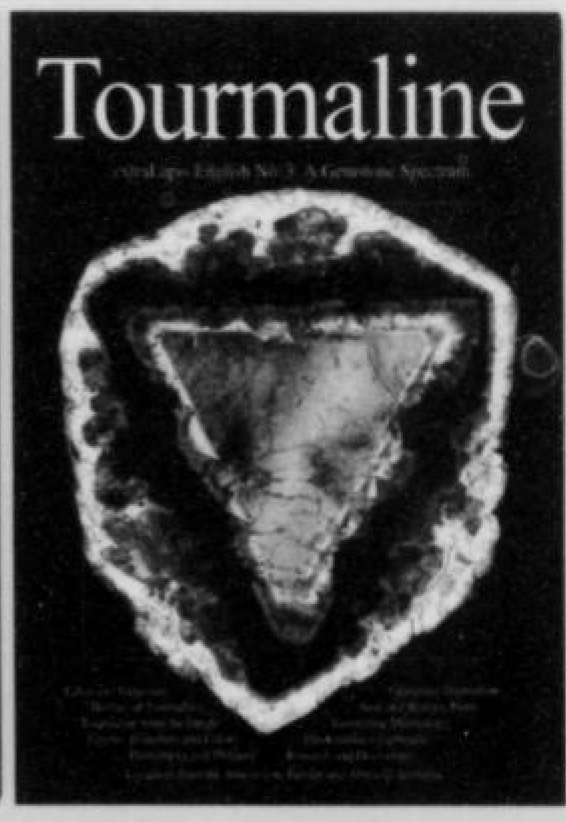

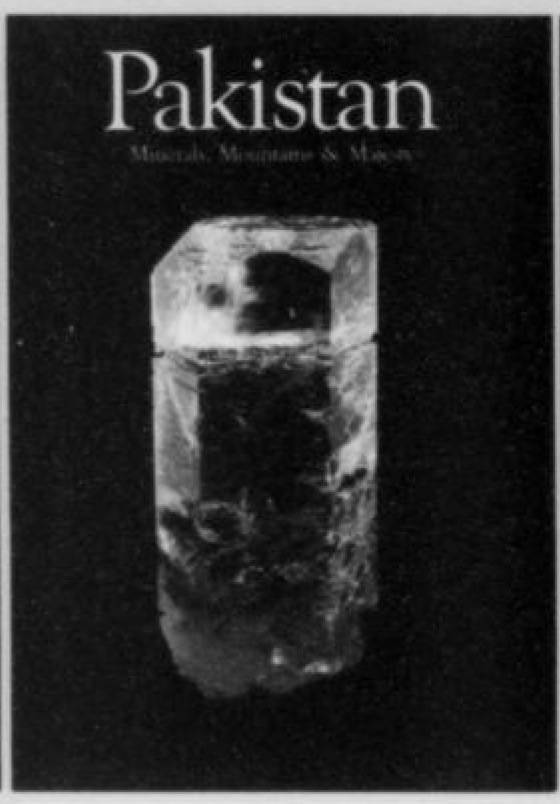

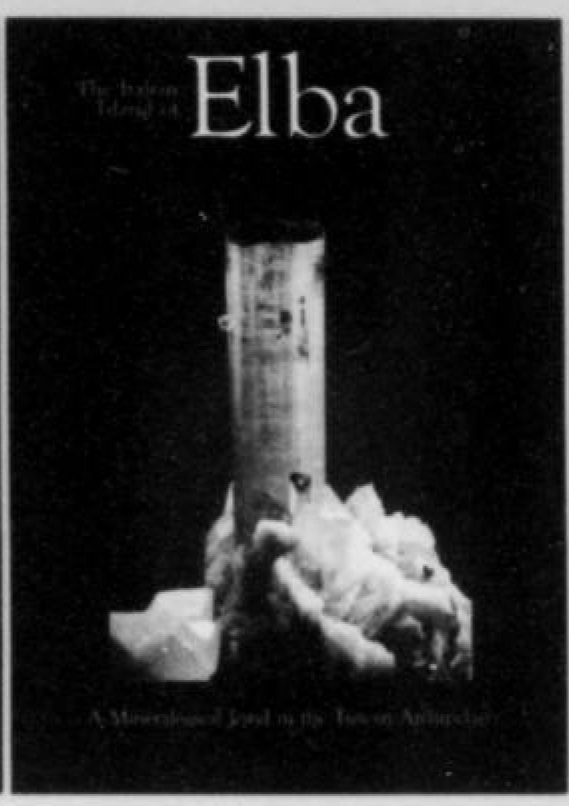

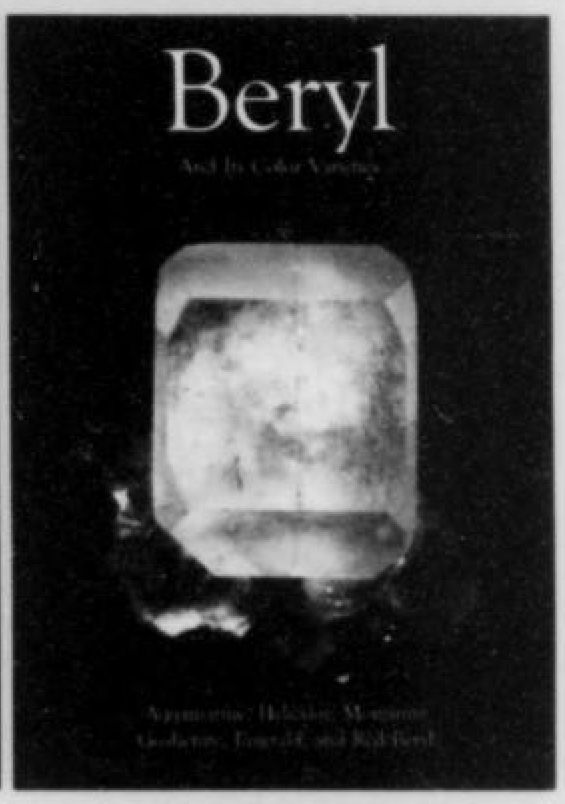

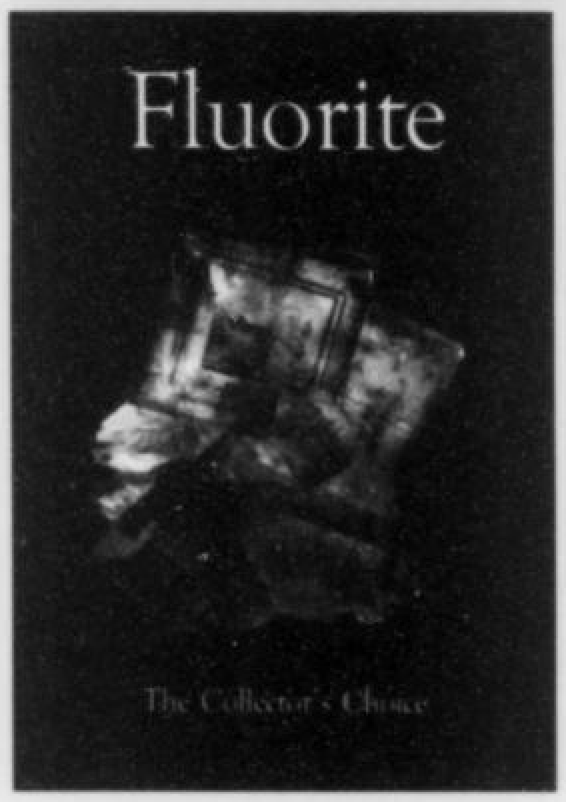

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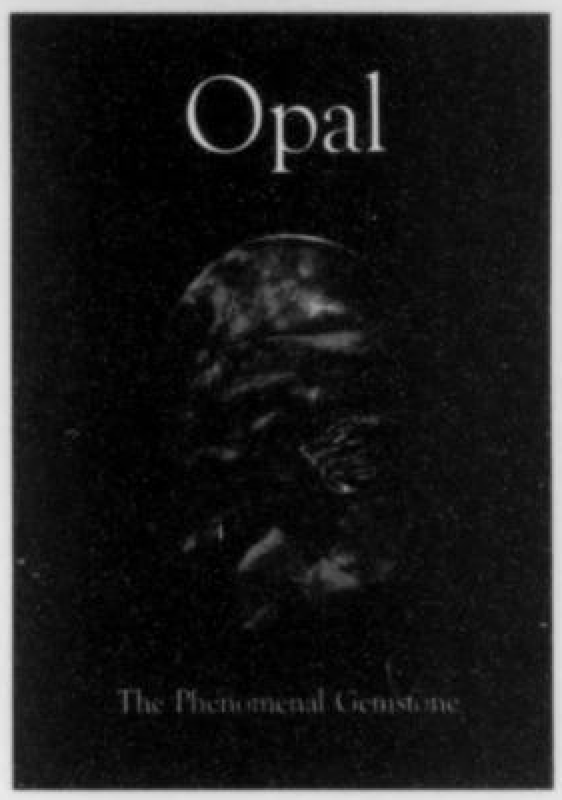

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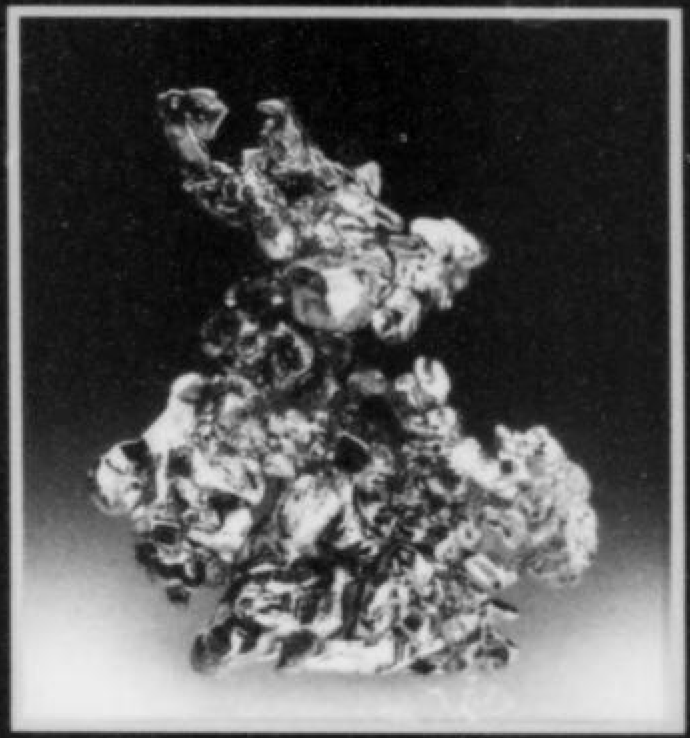

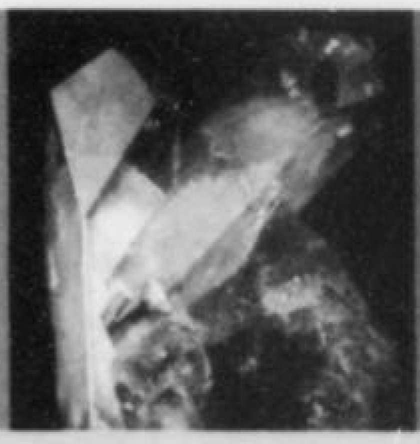

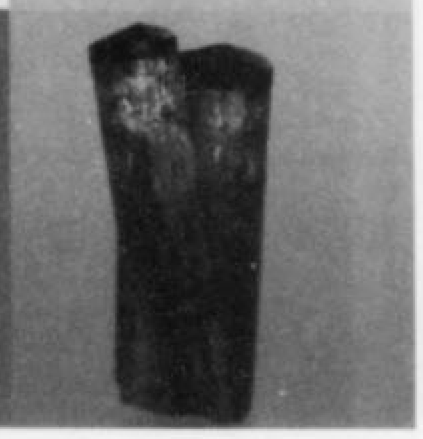


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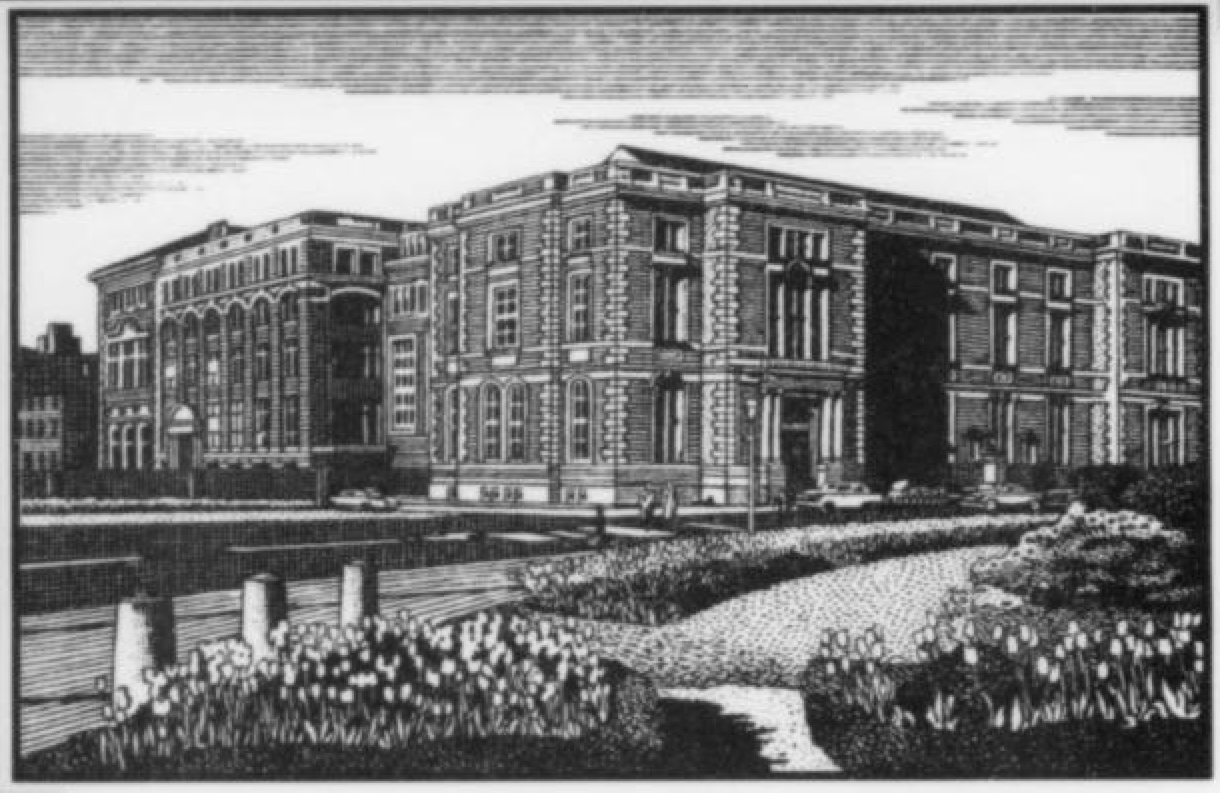

Philadelphia Academy of Natural Sciences

In the early years of the Republic, Philadelphia was known as "the Athens of America" because of its cosmopolitan egalitarianism and its many learned institutions. But up until the 1790's no one in America knew anything about mineralogy. The first American to receive formal training in that subject was Adam Seybert, a 1794 graduate of the School of Medicine at the University of Pennsylvania. With medical degree in hand, he left for Europe in 1794 to continue his studies in Edinburgh, London, Paris and Göttingen. During the next two years he developed in increasing interest in mineralogy, studied under the famous crystallographer René Haüy in Paris, and acquired a substantial study collection of minerals in Göttingen. Upon his return to Philadelphia he found himself to be the leading local authority on minerals. When Benjamin Silliman of Yale brought his college's collection of minerals in a candlebox to Philadelphia to be identified in 1802, he was directed to Seybert, who had meanwhile been enlarging his own mineral collection by field collecting. Eventually it numbered 1,725 specimens, housed in a specially built mahogany cabinet.

In January 1812, six local devotees of natural history met in the apothecary shop of John Speakman to arrange for the establishment of an academy of natural sciences in Philadelphia, "to occupy their leisure, in each other's company, on subjects of natural science," their objective being "the advancement and diffusion of useful, liberal human knowledge." In anticipation of the formation of the academy, Speakman had already purchased the Seybert mineral collection for $750, and was later reimbursed. Gerard Troost, one of the six founders, had studied crystallography under Haüy in 1807, and had begun his own collection of minerals in 1811, so he was appointed the first curator. Thus the Seybert mineral collection became the core around which the academy's collections developed in the following decades.

The Academy mineral collection grew rapidly. In 1814 a box of minerals was received from the Chemical and Physiological Society of Pittsburgh, and in 1816 the collection of Silvain Godon (ca. 1769–1840), a Parisian mineralogist and one of the first American mineral collectors, was acquired. The geologist William Maclure (1763–1840) made a succession of donations, and by 1817 the Academy collection numbered between 4,000 and 5,000 specimens. One hundred specimens were purchased in Freiberg, Saxony in 1820, and the collection of Seybert's son Henry was added in 1825. Other early mineral collections acquired included those of Thomas B. Wilson (1807–1865), Isaac Jones Wistar (1827–1905), and the American Philosophical Society. By the mid 19th century, thanks to its superb collections and extensive library, the Academy was considered to be the best-equipped institution in the country for the study of mineralogy and the other natural sciences.

In 1882 the Academy acquired its most famous and significant mineral collection as a bequest from William Sansom Vaux (1811–1882), one of the Academy's longstanding supporters. Vaux had donated many mineral specimens over the years, but upon his death he presented the Academy with main body of his collection (excluding 25 specimens that went to the family of his brother George Vaux), consisting of 6,391 specimens representing 466 species or groups, plus a $10,000 endowment intended to finance future purchases of specimens. Thus the Academy mineral collection continued to increase for some years thereafter, ranking as the finest such collection in America, and by 1909 had grown to over 30,000 specimens.

William S. Vaux's nephew, George Vaux, Jr. (1863–1927), eventually built a mineral collection to rival that of his late uncle, though he chose not to donate it to the Academy (it went to Bryn Mawr College). Nevertheless, he financed mineral collecting expeditions to Greenland, Bolivia and Tsumeb on behalf of the Academy, led by the Academy's legendary curator, mineralogist Sam Gordon, in the 1920's and 1930's. But interest in mineralogy at the Academy waned following the departure of Gordon (who had received more support from Vaux than from the Academy's own Board of Directors). Mineral exhibits were occasionally mounted, but by the 1950's there was no longer a full-time curator of minerals, as the emphasis of the Academy turned increasingly to the study of plants, insects, birds, fossils and ecological dioramas of stuffed animals. The famous mineral collection was taken off public display and relegated to more or less permanent storage. In 2007 the Academy sold the main body of the mineral collection, including many Vaux specimens but excluding the 1882 bequest and the Seybert collection.

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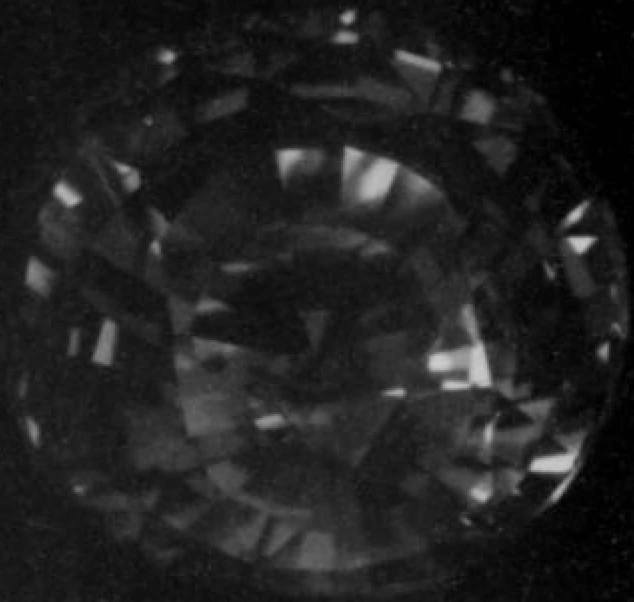

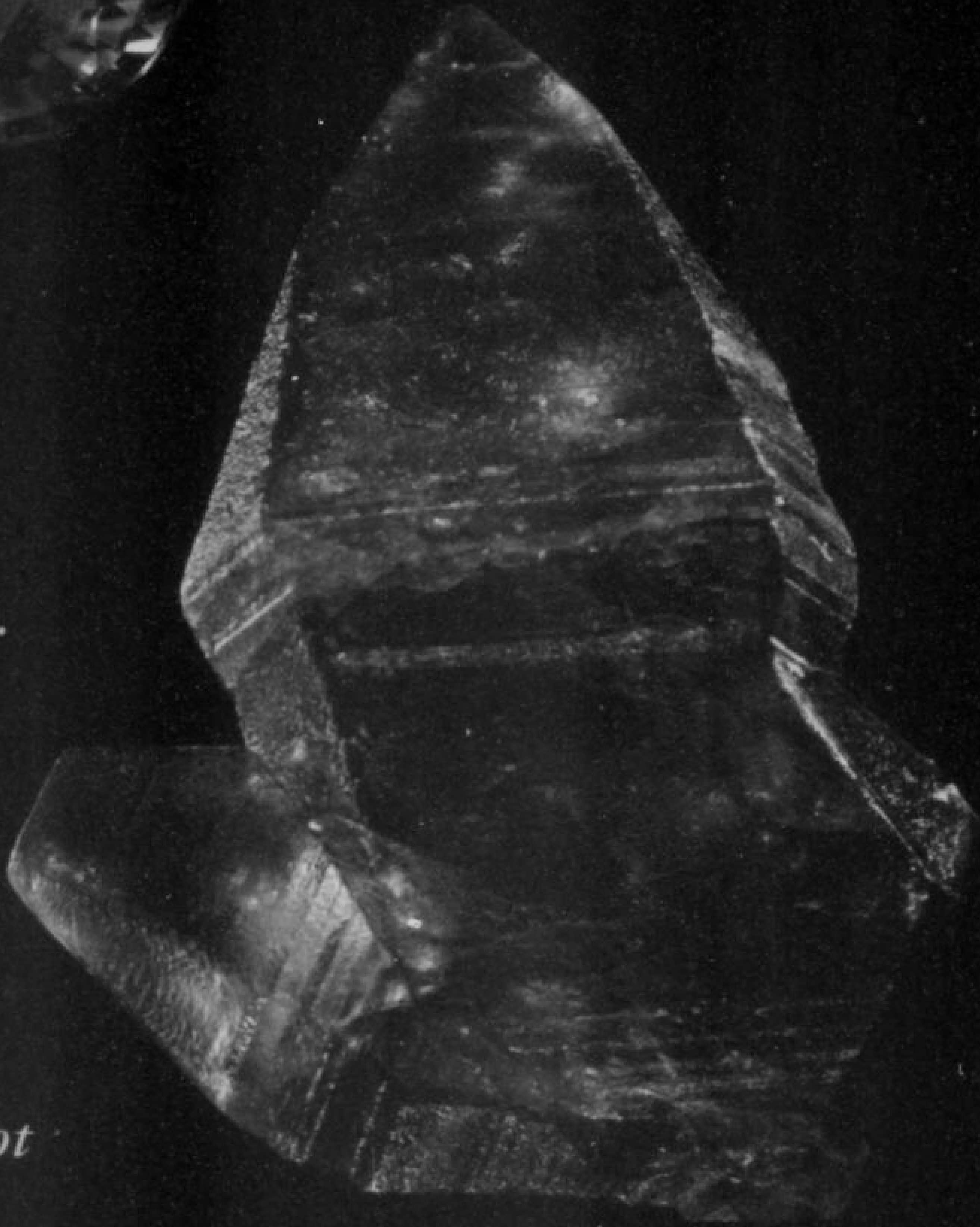

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