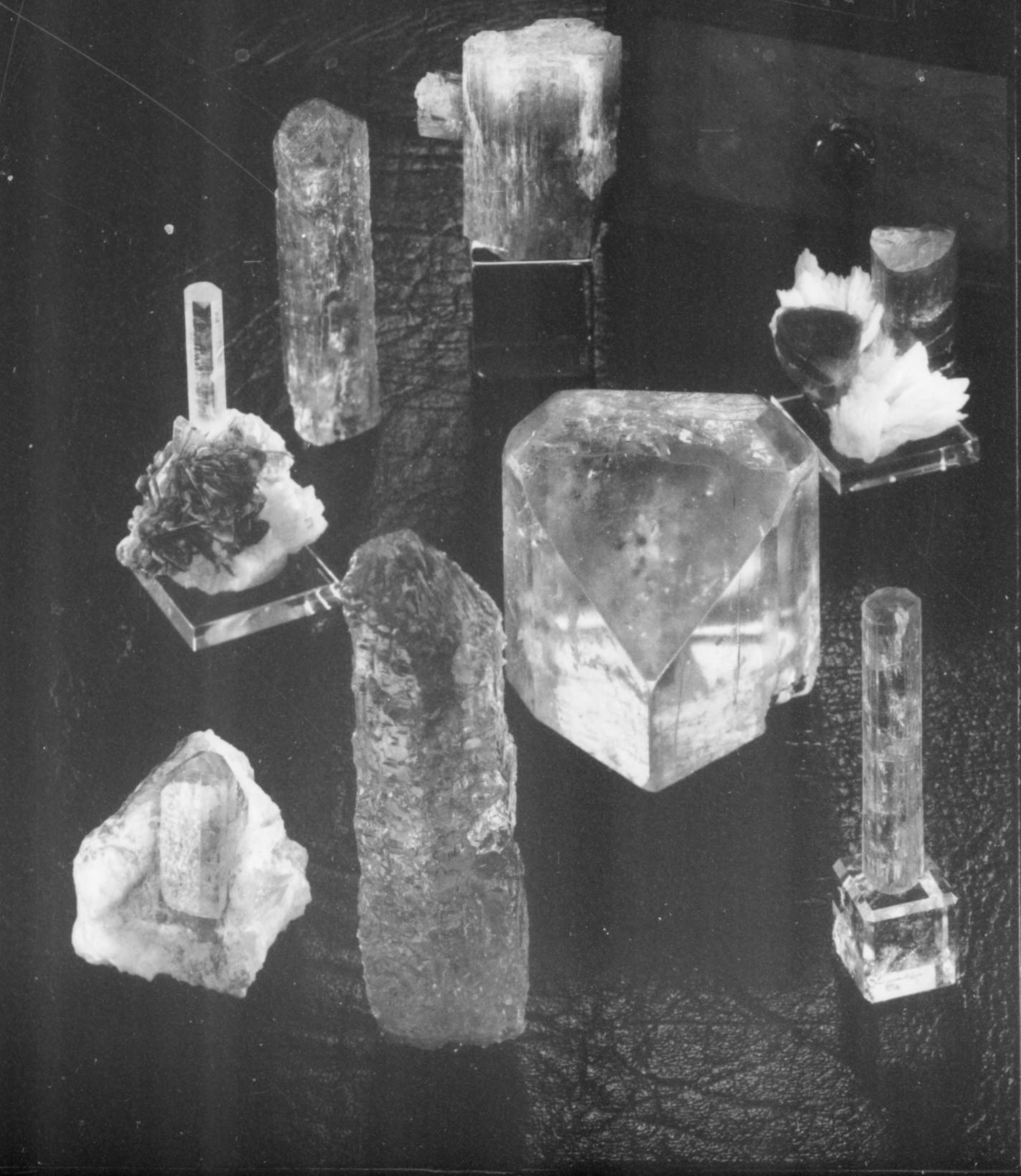
礦物 CHINA 中国

THE MINERALOGICAL RECORD

JANUARY-FEBRUARY 2007 • VOLUME 38 NUMBER 1 • $20


MINERA-
LOGIE

CHINA-II

MINERALOGICAL RECORD SPECIAL CHINA ISSUE II

矿物学纪录

The Mineralogical Record

January-February 2007 ▪ Volume 38, Number 1

Publisher & Editor-in-Chief
Wendell E. Wilson

Editor
Thomas P. Moore

Circulation Manager
Mary Lynn Michela

Associate Editors
Piere Bariand
Bill Birch
Michael P. Cooper
Anthony R. Kampf
Joseph A. Mandarino
Steven R. Morehead
Donald R. Peacor
Andrew C. Roberts
George W. Robinson

Design & Layout
Wendell E. Wilson

Typesetting & Graphics
Capitol Communication
Systems, Inc.

Associate Photographers
Nelly Bariand
Dan Behnke
Werner Lieber
Erich Offermann
Jeffrey A. Scovil
Harold & Erica Van Pelt

Scanning
Wendell E. Wilson

Printing & Mailing
Allen Press

Single Copies of this issue are available, while supply lasts, at $20 per copy plus $2 postage (softcover).

Subscription price for one year is $58 [in the U.S.], $65 [outside the U.S.] for individuals, and $175 for libraries and institutions.

Editorial & Advertising
4631 Paseo Tubutama
Tucson, AZ 85750
Tel: 520-299-5274
e-mail: minrec@earthlink.net

Subscriptions, Books & Back Issues
P.O. Box 35565
Tucson, AZ 85740
Tel: 520-297-6709
Fax: 520-544-0815
e-mail: minrec@aol.com

The Mineralogical Record [ISSN 0026-4628] is a bi-monthly publication of the Mineralogical Record Inc., a non-profit organization. Special second class postage [USPS 887-700] paid at Tucson, Arizona and additional mailing offices. Postmaster, Send address changes to:
Mineralogical Record
P.O. Box 35565,
Tucson, AZ 85740.

Website
www.MineralogicalRecord.com

Front Cover
TOPAZ with Smoky Quartz and Albite, 15.3 cm, from the Wahtuwah mine, Gaoligangshan, Wenshan, Yunnan Province, China. James and Gail Spann collection; photo by Jeff Scovil.

Editorial Note

This is our second special issue on the mines and minerals of *China*, a land which is proving to be an incredible storehouse of fine mineral specimens. And thankfully, China is populated by a people who readily catch on to specimen values and who quickly develop proper collecting techniques that preserve specimens undamaged. These are good times for the mineral collector. Our special congratulations for this issue must go to Berthold Ottens, who not only wrote most of the articles but who, in this issue, is being honored by the naming of a new Chinese mineral species, *ottensite*. Bravo, Bert! Thanks must also go to our long-time donor, Philip Rust, whose generosity has once again helped us to produce a publication that would otherwise have been impossible for us. All of our subscribers owe him a debt of thanks.

Included in your mailing envelope with this issue is our third special supplement (the first was the 96-page *Petrographic Microscope* monograph in 2003, and the second was the 184-page *50-Year History of the Tucson Show* book in 2004). At 192 full-color pages and a cover price of $35, it is a remarkable gift to our subscribers, made possible by a generous grant from the author, Wayne Thompson. Wayne, as you will recall, was the subject of a biographical sketch in our previous issue.

This new supplement is entitled *Ikons, Classics and Contemporary Masterpieces*. Wayne prefers the spelling "Ikon" instead of "icon" (either is correct) because it is more exotic and evocative of something special. And the subject is indeed special: a discussion of the process of collecting minerals at the highest financial and aesthetic levels. It emphasizes the careful recording of provenance, and provides, for the first time, a categorization scheme for world-class mineral specimens.

Wayne must be complimented not only on his authorship and his generosity but also on his foresight, as one of the very few dealers who have consistently taken the trouble over the years to have their best specimens professionally photographed before being sold. (Admittedly, it helps living in the same city as Jeff Scovil!) Wayne was consequently able to draw on his extraordinary photographic archive for illustrations to fill his book. Photographic records such as this are especially commendable to have because, as time passes, such images take on significant historical value. We hope the practice will be adopted by more dealers and collectors in the future.

WEW

CHINESE STIBNITE:

Xikuangshan, Lushi, Wuning and Other Localities

Berthold Ottens
Klingenbrunn Bahnhof 24
D-94518 Spiegelau
Germany

Among the most dramatic of all Chinese mineral specimens are the extraordinary stibnite crystals and crystal clusters from the Xikuangshan, Lushi and Wuning mines which reached the market in the 1990's and early 2000's. These three (among many) Chinese antimony deposits are the leading localities for antimony minerals from China. In 2002 a thus-far unidentified Chinese locality joined the list by providing the world's finest specimens of the antimony oxy-sulfide kermesite.

INTRODUCTION

Ever since the political opening of China began in the late 1980's, stibnite has been among its most cherished collector minerals. The interest of collectors and curators worldwide was captured by brilliantly lustrous, sharply developed Chinese stibnite crystals of a size known earlier only in old specimens from Shikoku, Japan. No sooner had wonderful stibnite specimens and spectacular clusters from a single locality made an impression than even newer specimens from other Chinese discoveries also reached the market. Collectors soon realized that China is endowed with a great number of antimony deposits, and that among their minerals, not only stibnite, the main ore of antimony, but some of its oxidation products and associated species are also noteworthy. Extraordinary kermesite crystals to 20 cm long are particularly spectacular, but specimens showing fluorite on stibnite, and specimens of rare species such as ottensite, are also of interest.

USES OF STIBNITE AND ANTIMONY

Stibnite, described in 1832, is antimony sulfide, Sb_2S_3. Its name comes from "stibium," the Latin word for antimony—an element whose long and curious history of medicinal uses can be traced back 3000 years. At different times its compounds have been used to treat all manner of ailments, but their obvious effectiveness as emetics made them indispensable to those who believed that the primary task of a physician was to purge anything from bad "humors" to evil spirits (McCallum, 1999). In China as elsewhere, stibnite, with other natural substances such as cinnabar, was used very early in medical applications.

From remote antiquity (3000 B.C. or earlier), antimony was recognized as an element in various compounds, and it was prized for its usefulness in metal-casting. First described scientifically by Tholden in 1450, antimony was recognized as itself a metal by the beginning of the 17th century. The origin of the word "antimony" is not clear; it may come from the Greek words "anti" and "monos," the two together meaning, approximately, "opposed to solitude," as antimony was thought not to exist in pure form in nature. Or the word may come from the Arabian expression "Anton Ammon," which could be translated "the bloom of the god Ammon."

Stibnite is important economically as the most common ore of antimony. The annual world production of antimony ranges between 50,000 and 130,000 tonnes; more than half of all the antimony produced today is used as a flame-retardant additive in plastics, textiles, rubber and adhesives. First applied to tents and vehicle coverings during World War II, the fireproofing compound antimony trichloride saved the lives of many American GI's. In a fire, Sb and Cl recombine to form unstable compounds that suck oxygen out of the air, smothering the flames. Ironically, antimony

Figure 1. **Locality map.**

(without chlorine) is also used to make chemicals for starting fires: antimony sulfide, for example, has weak chemical bonds which cause it to melt and catch fire at relatively low temperatures. For that reason it is a key combustion-supporting ingredient in tracer bullets, smoke screens, "glitter effect" fireworks, and the striking surface of safety matches (Gibbson, 1998).

CHINESE ANTIMONY DEPOSITS—GENERAL

China has at its disposal the world's largest reserves of antimony, and presently it accounts for about 75% of world antimony production. Antimony occurrences have been investigated in 114 ore districts. As of the end of 1970, China possessed reserves of 4.228 million tonnes of antimony in working deposits and 2.732 million tonnes in other locations (Zhu Xun, 2002).

Until the beginning of the industrial age in China, antimony in the form of stibnite was used only for pharmaceutical purposes and in making fireworks, but with the increasing influence of Europeans in the late 19th and early 20th centuries, the significance of all metals changed fundamentally. As the 20th century approached, metal alloying became increasingly important, so that both the production and the use of metals increased. At the very end of the 19th century, while the Xikuangshan deposit was already being exploited, the deposits at Banxi (in Taojiang, Hunan), Lonshan (in Xinshan, Hunan) and Woxi (in Taoyuan, Hunan) were opened successfully. Hunan was the most important region for antimony production, not only in China, but in the world (Ting and Wong, 1921). Somewhat later, the antimony deposits in Guizhou, Yunnan, Gansu and Guangxi provinces were investigated. Between 1912 and 1935 the Xikuangshan deposit alone accounted for up to 36.6% of annual world production.

The use of antimony in the manufacture of munitions led to an enormous demand for the metal during World War I, and its price climbed to unnatural heights, this in turn leading to further accelerated production. When the war ended and antimony lost some of its usefulness, both prices and production levels sank drastically. New uses for antimony, however, were gradually discovered, e.g. as a flame-retardant additive to plastics and textiles, and China's yearly production gradually increased once again—from 6,000 tonnes in 1916 to about 130,000 tonnes at the end of the 20th century.

After the founding of the People's Republic of China there was wide-ranging prospecting activity, and new deposits were discovered. Major mines such as the one at Xikuangshan came to be operated by large state-owned businesses. However, it should be noted that in modern China, ore production from small mines worked mostly by local rural inhabitants is enormously significant. In 1999, antimony production from these small mines amounted to over 46% of the country's total production (Gunson and Yue, 2001). The technological level in these mines, as well as the safeguards to prevent accidents and protect the environment, vary from extraordinarily primitive to entirely absent.

When, because of the considerable increase in small-mining activity, the production of stibnite and of metallic antimony increased too rapidly, the State was motivated to limit production in order to stabilize prices. Consequently, as in the case of the tungsten mines, it shut down several operations, both large and small. Moreover, the government sought, by reducing mining activity, to attain a long-range security with regard to its stibnite reserves. In recent times it has sought the additional benefit of greater profits through the production of finished goods within the country, rather than simply exporting raw materials; therefore the export of stibnite concentrate or of metallic antimony has diminished while the export of finished products has increased.

A few of the antimony deposits (such as those at Qinglong, Zhenxu and Woxi) are significant not only for their stibnite but also for the appreciable gold content of their ores.

Most of the stibnite occurrences of the world are found in the circum-Pacific, Mediterranean and Central Asia-Tianshan tectonic belts. About 77% of these, including the most important Chinese

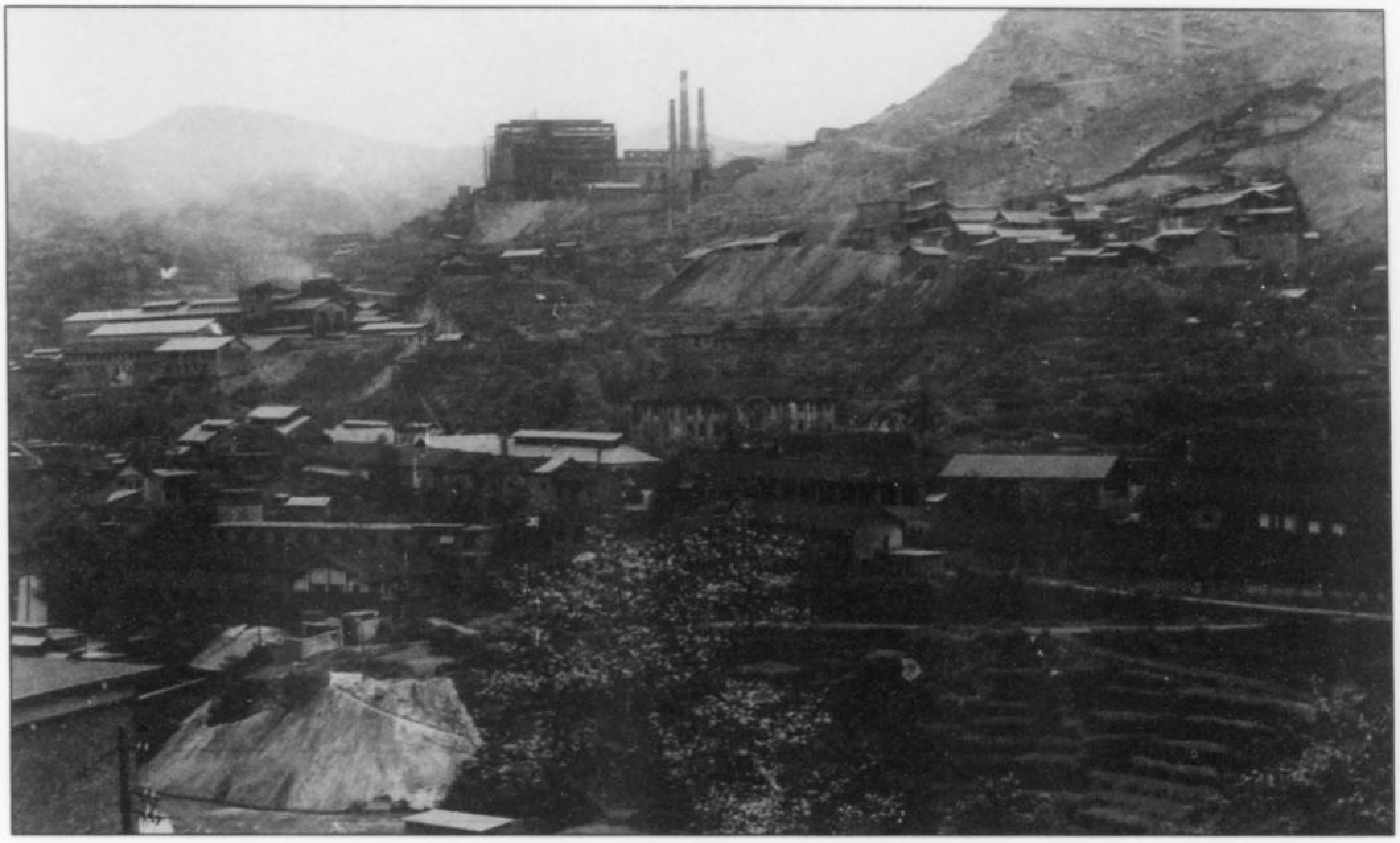


Figure 2. **The Xikuangshan ("Tin Ore Mountain") antimony mines, discovered in 1897. Guanghua Liu photo.**

occurrences, lie in the circum-Pacific belt. Of these the major deposits are those of the Xikuangshan antimony orefield (Hunan), the Dachang Sb-Pb-Zn-Sn orefield (Guangxi), and a series of large deposits (with total antimony reserves of more than 100,000 tonnes) including Zhazaixi (Sb) in Anhua (Hunan); Xiangxi, or Woxi (Au-Sb-W) in Yuanling (Hunan); Jianzhupo (Sb) near Wuyu, Hechi (Guangxi); Chashan (Sb) in Nandan (Guangxi); Qinglong (Sb)(Guizhou); Banpo (Sb) in Dushan (Guizhou); and Muli (Sb) in Guangnan (Yunnan).

Most of the important Chinese stibnite deposits are found in sedimentary carbonate rocks of Devonian age; less important deposits occur in low-grade metamorphic rocks. According to commentary presented on the Metallogenic Map of China (Liu *et al.*, 1987), 60% of these deposits were emplaced during the Yanshanian Epoch (Jurassic-Cretaceous Periods). The most important belt of deposits is the South China belt, belonging to the larger circum-Pacific belt.

XIKUANGSHAN

History

During the Ming Dynasty (1541) an ore deposit was discovered in Hunan province which would later turn out to be the largest concentration of antimony in the world. According to tradition, the mining activities there were very limited, and the ore extracted was believed to be tin ore. In a report by Bao Qing Fu, revised by Daoguang (1846), it was written that "In the western part of Yanjingshan . . . [at] a place called Xikuangshan . . . tin is produced." Even at this time, apparently, the investigator believed that he was examining a tin deposit: the name Xikuangshan (pronounced "Shi-kwang-shan") means "tin ore mountain." Only later, during the Qing Dynasty, was the main substance tested, and people came to understand that it was really antimony ore.

During the reign of the Emperor Guangxu of the Qing Dynasty (1897), Chen Bao Zhen, provincial governor of Hunan, appointed Yuan Fan Zou of Xinhua chief of the Hunan Mining Bureau. Zou conferred with his relative Yong Lu Yan, who came from the same town and knew much about mining, and he studied old reports concerning the region of Xinhua, which includes Xikuangshan. Later Yan traveled to Taotang to investigate the deposit, using techniques of geomancy then widely applied to ore deposits. At this time the region boasted only a few villages and no commerce, but much vegetation with many old forests, as well as wild tigers and leopards. The inhabitants lived as simple family units in small settlements, supporting themselves by agriculture. When Yan and a companion rode on horseback into the region for the first time, carrying parasols, the locals were completely amazed; they thought that the horses were hornless oxen. Yan found mine excavations and the ruins of ore smelting facilities from Ming Dynasty times. He collected 15 kilograms of ore for testing in Changsha, the capital of Hunan, where it was determined to be stibnite. This, however, did not prevent the misleading name Xikuangshan ("tin ore mountain") from continuing to be used for the most important antimony deposit in the world.

The Xikuangshan deposit lies in the county of Lengshuijiang. The modern city of Lengshuijiang, with 130,000 inhabitants, is a creation of the stibnite-mining industry and is not very attractive. The air is so heavily polluted that a clear view of the city and its surrounding region is never possible. Only a few kilometers north of Xikuangshan, uphill in a little valley, lies the so-called South mine, which exploits the Feishuiyan deposit. A smelting plant not far away, on the eastern side of the valley, can be made out through the thick haze. Further uphill, several small groups of men and women can be observed; with the simplest of tools they wash antimony concentrates from piles of ore delivered by trucks. In the vicinity are countless abandoned small mines and prospect pits. After another 5 km one reaches the so-called North mine, exploiting the Tongjiayuan deposit.

Intensive mining here began in 1897–1898, at which time the first antimony ore smelter in Xikuangshan, called Jishan Chang, was built. As of today the government has provided Xikuangshan with two ore-preparation facilities and three smelters for the four discrete stibnite orebodies, which are called Feishuiyan, Tongjiayuan, Laokuangshan and Wuhua. However, because of the overproduction of stibnite in China during the past decade, several mines and smelters have been shut down; since 1999, only the orebodies at Feishuiyan and Tongjiayuan have been actively mined. At present the Feishuiyan orebody is being mined at level 25 (–142 meters elevation) and the Tongjiayan ore is being mined at level 4 (+480 meters elevation), while the Laokuangshan and Wuhua deposits lie idle.

On June 18, 2003, the government of Lengshuijiang County ordered the closing of 60 of the smallest privately operated mines at Xikuangshuan, giving rise to a serious unemployment problem. It is interesting that the federal government, seeking to boost employment, entrusts freshly mined ore to former miners, who then use the most primitive of facilities to produce enriched concentrate. In the smelters, metallic antimony of a purity between 99.65% and 99.99% is produced. Other facilities in Lengshujiang prepare derivatives, particularly antimony oxide and antimony trichloride.

The Xikuangshan deposit is one of the first in Hunan to have been exhaustively studied and understood as a result of geological exploration. In 1914, Japanese experts made available a 1:150,000-scale map of the Xinhua area; the map includes Xikuangshan, formerly a part of Xinhua County, later incorporated in Lengshuijiang City. A Swede named Dingerlan studied the geology of the area in the winter of 1915–1916 and described it in his report "Hunan Xinhua Xikuangshan Antimony Investigation" (*The Discovery History of Mineral Deposits of China*, 1994). At this time it was already known that four separate orebodies existed. Between 1916 and 1948, several Chinese geologists undertook further investigations of the occurrence and its ores; following the last of these, Zhi Wang and Qing Ru completed a geologic map on a scale of 1:5000 which served as the basis for all further studies for many years.

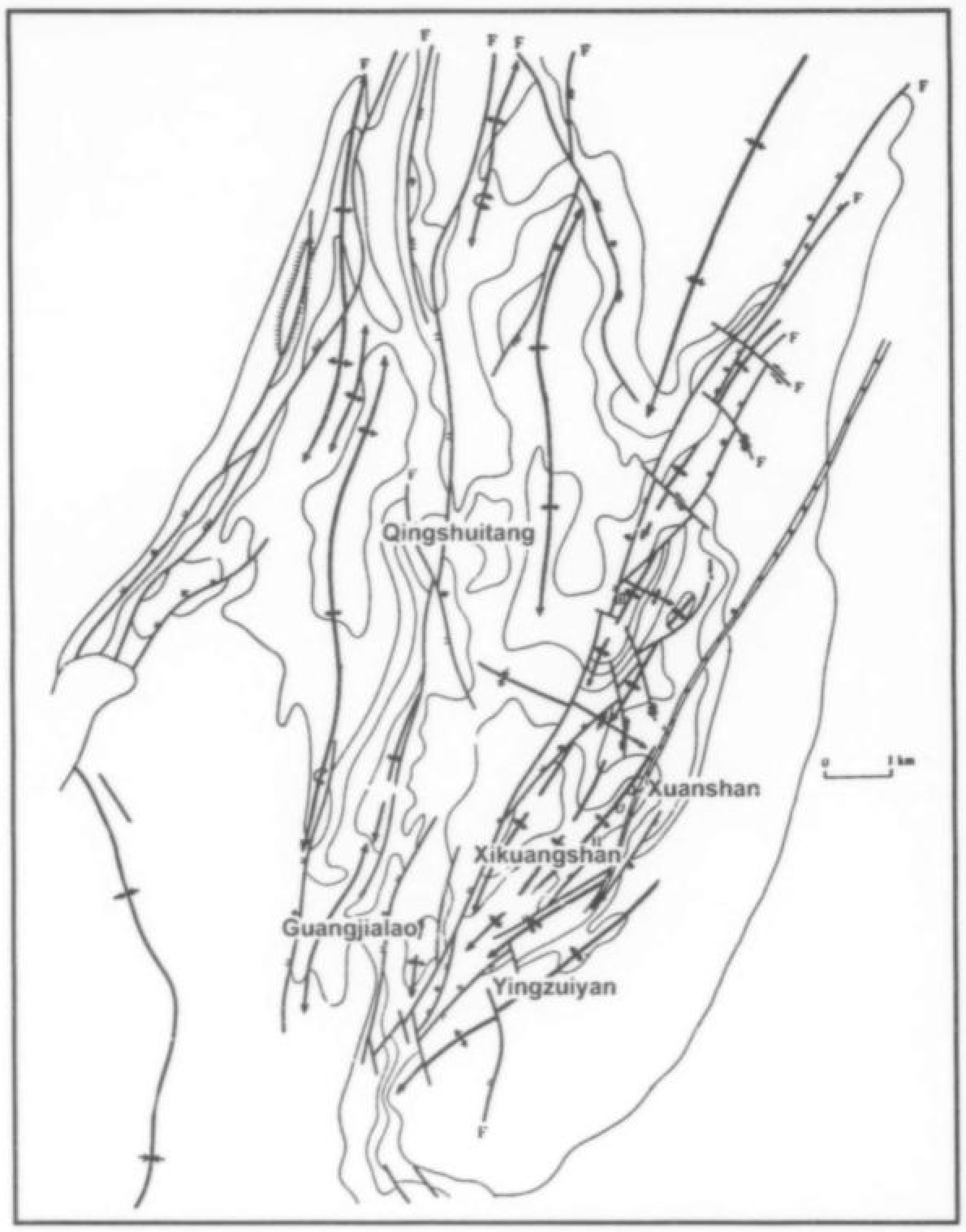


Figure 3. **The complex structural geology of the Xikuangshan mining district (adapted from Wu *et al.*, 1990).**

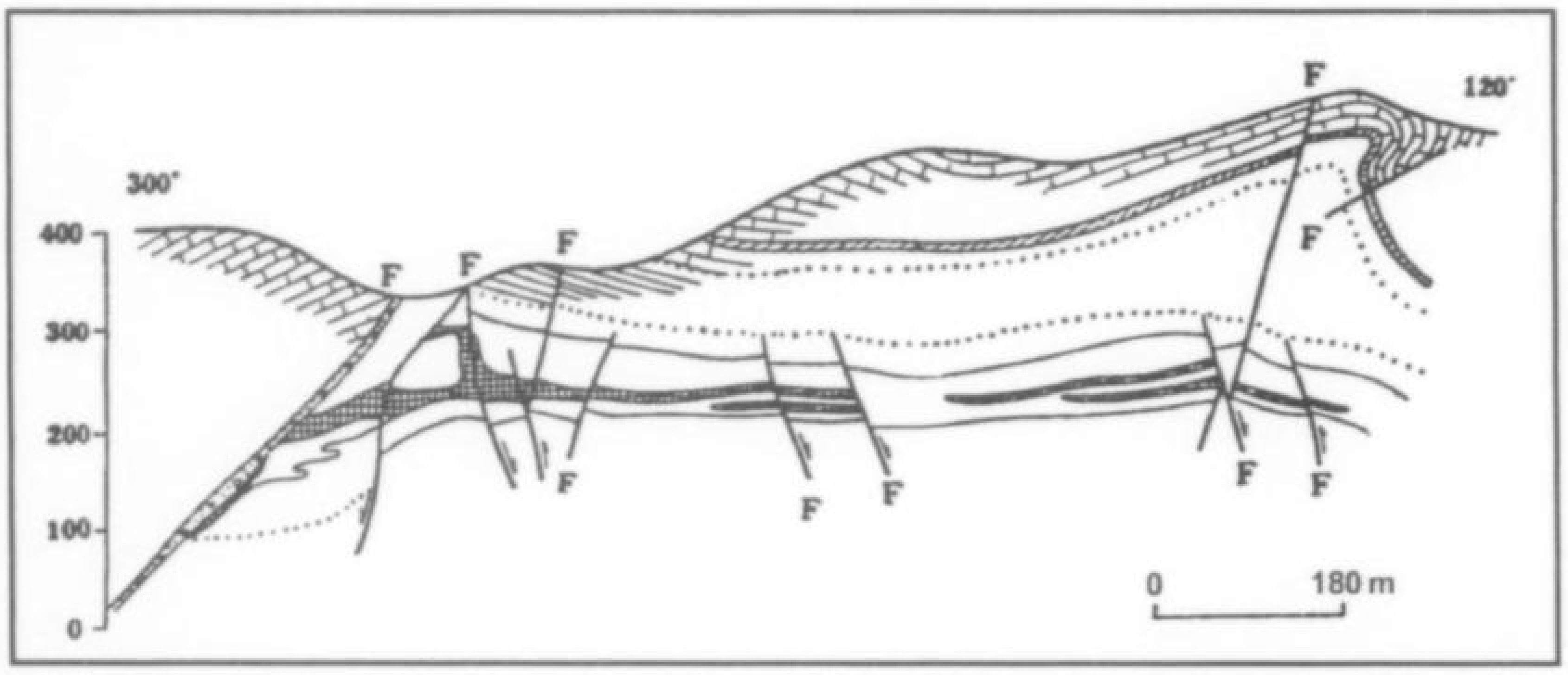


Figure 4. **Geological section through the Xikuangshan area (adapted from Wu *et al.*, 1990).**

After the founding of the People's Republic, the Hunan Department of Nonferrous Geological Exploration began new, systematic studies in 1955. A group of 11 people (Brigade 223) surveyed the deposit in light of the newest knowledge, the Soviet geologist C. K. Kemoric serving as an advisor. After four years of field work, 23,000 meters of drill holes, and 7,700 meters of prospect holes, a precise picture of the geology finally emerged. The work of other expert groups during several further studies conducted up to the end of the 20th century clarified previously unclear details.

Although the four known orebodies at Xikuangshan had been studied at great expense, and detailed understandings of them had been won, the Chinese central government in 2005 shut down many of the region's established mine workings which had been productive for many years, such as Yaogangxian and Xikuangshan, in order to study them anew in the hopes of discovering further economically profitable orebodies. For the years 1897–1949, a total production of 386,000 tonnes is recorded for Xikuangshan, and from 1950 to 1990 another 415,000 tonnes of ore were produced.

Geology

The nearly monomineralic ore zone at Xikuangshan is about 2 kilometers wide and 9 kilometers long. The antimony ore was introduced into carbonaceous rocks of the Middle Devonian-age Shetian Formation. These rocks contain 15–35 ppm of antimony; for comparison, the earth's crust generally contains only 0.5 ppm of antimony, and the rocks of the wider region around Xikuangshan contain about 6 ppm of antimony. In the course of tectonic events the antimony of the calcareous rocks was mobilized, to be deposited as stibnite in pre-existing fissures and karstic cavities. Granitic intrusions dating to the Yanshanian Epoch, so characteristic of other ore deposits in Hunan, e.g. at Yaogangxian and Xianghualing, played no role at Xikuangshan, whose antimony deposit is mesothermal to epithermal in origin.

The formation sequence of primary minerals might be divided into three stages (phases) consisting of five generations. In the first phase, mesothermal metasomatism at 200–300° C deposited stibnite in major ore masses and as vein fillings. In the second phase, epithermal mineralization at 100–200° C brought about the filling of cracks and cavities by stibnite, quartz and/or calcite.

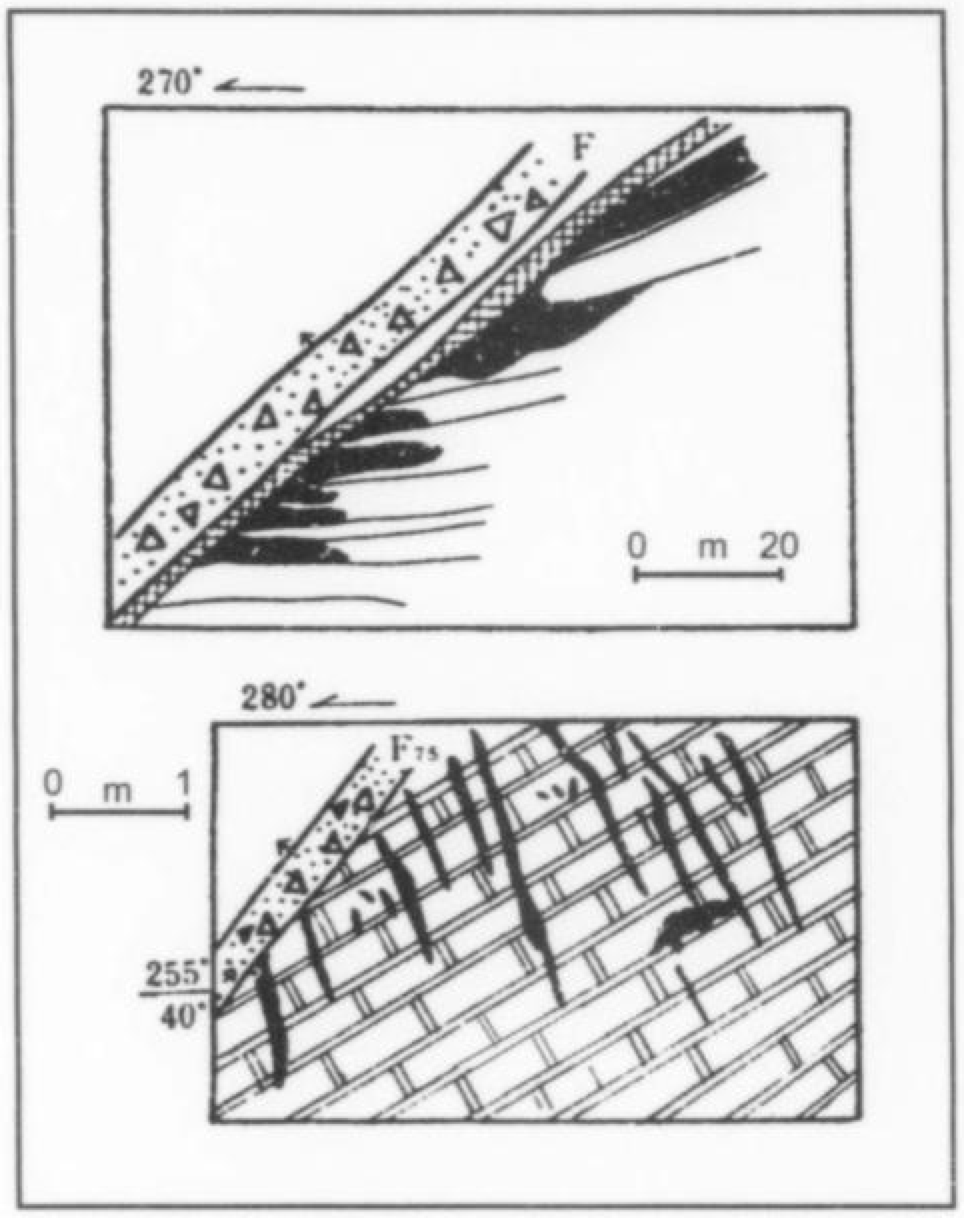


Figure 5. (top) **Cross-section of a banded orebody showing lateral feather-like orebodies.** ***(bottom)*** **Cross-section showing small feather-like ore veins in limestone (from Wu** ***et al.*****, 1990).**

In the final, exogenic phase, stibnite was oxidized, giving rise to a series of antimony oxide minerals such as valentinite and stibiconite. Stibnite thus occurs both as massive, granular ore and in well-developed crystals. In cavities lined by drusy stibnite, the crystals are intergrown such that almost no free-growing individuals are recognizable. But when wide fissures or, even better, former karstic cavities in which stibnite could precipitate were available, perfect crystals resulted. The carbonate rock of the cavity walls is

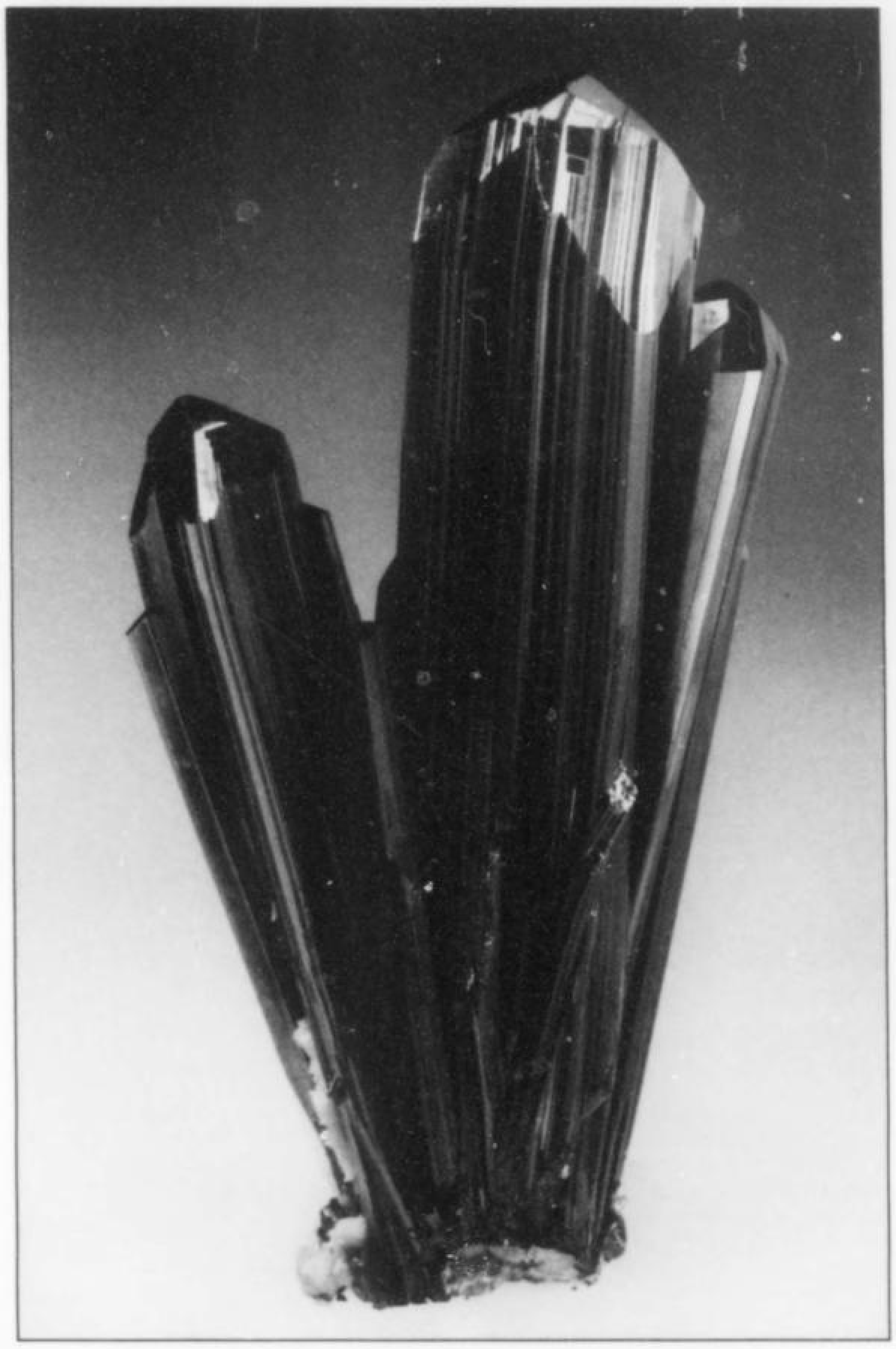


Figure 6. **Stibnite cluster, 5.1 cm, from the Xikuangshan mine. Note polysynthetic twinning. Wendell Wilson collection and photo.**

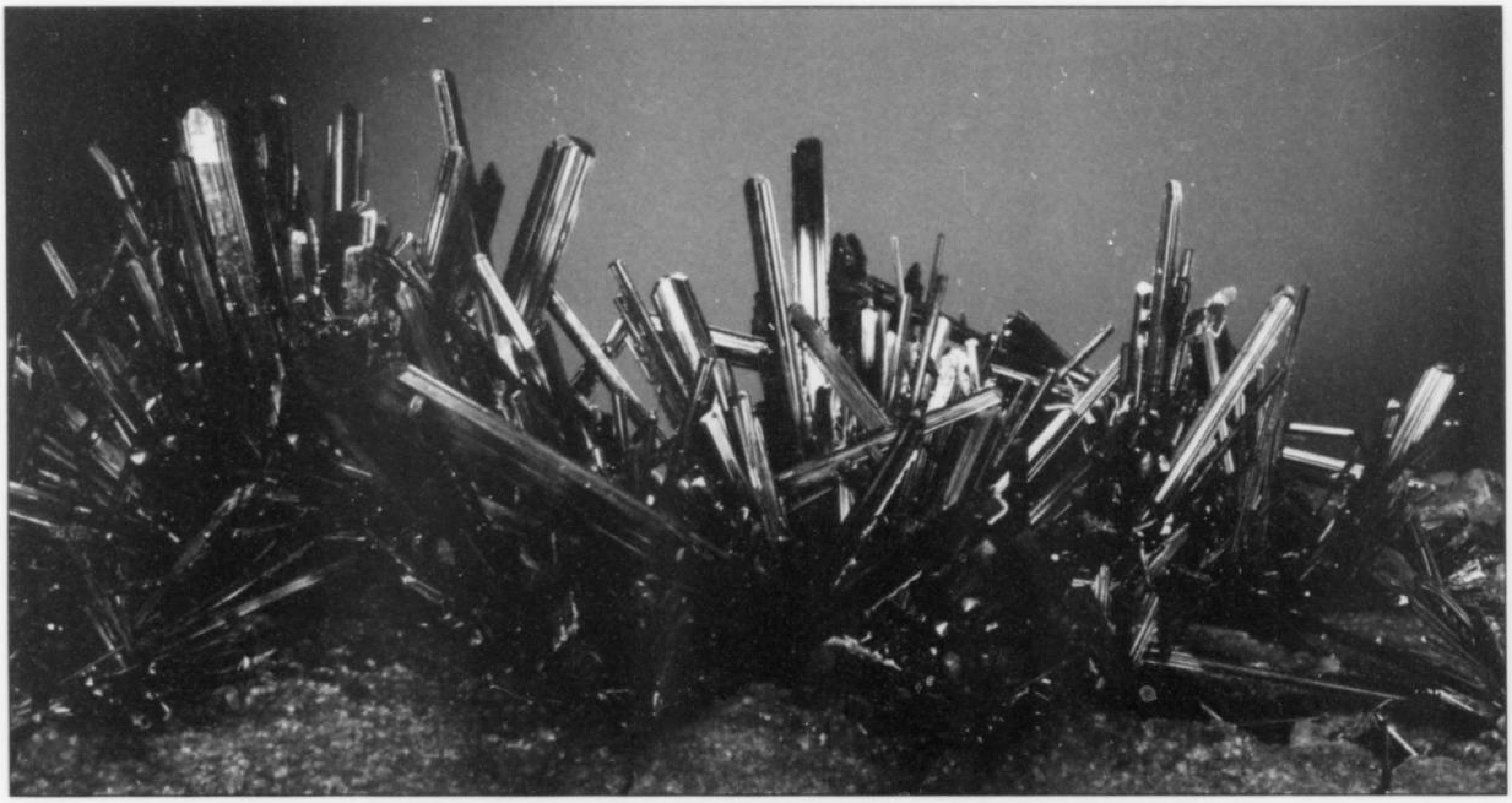


Figure 7. **Stibnite crystals on matrix (34 cm across as shown), from the Xikuangshan mine. Daniel Trinchillo specimen; Jeff Scovil photo.**

extensively silicified, making it difficult to secure matrix specimens of the extremely brittle stibnite crystals.

Stibnite and Stibiconite

The Xikuangshan mine (sometimes referred to on labels as Lengshui Jiang) has produced many finds since the 1980's, with varying habits and associations. The largest stibnite crystal ever found there (in the Feishuiyan deposit) measures over a meter long, but on average the crystals tend to be 5 or 10 cm long and only a few millimeters thick. Stibnite from the deeper zones exhibits a brilliant silvery luster, whereas in the upper zones, where oxidation has proceeded, complete pseudomorphs of stibiconite after stibnite have been found.

Mineral dealer Doug Parsons (who was among the first Western dealers to personally travel through China acquiring specimens) offered crystals to 15 cm at the 1989 Tucson Show (Robinson and King, 1989). In 1990 Parsons had matrix stibnite specimens from Xikuangshan up to 25 × 65 cm (Robinson and King, 1990). In 1991–1992 the bonanza was still continuing; Parsons and French dealer Frédéric Escaut had hundreds of fine specimens of stibnite, in bright, clean, striated prisms and clusters 5 to 30 cm in size. Parsons also had loose, thin, terminated prisms of valentinite/cervantite pseudomorphs after stibnite to 22 cm (Cooper, 1992; Moore, 1992). One of the best discoveries to reach the Western mineral market took place in 1999 and appeared at the following Tucson Show in January 2000; the crystals from this find are up to 18 or 20 cm long and 1 to 2 cm thick, with complex, highly lustrous terminations. Other finds have been characterized by large clusters with thin crystals only 1–3 mm in diameter and up to 15 cm length. A recent find consists of thin crystals about 1 mm diameter and up to 10 cm in length, with a second generation of shorter and even thinner crystals. Crystals can be overgrown by calcite or quartz crusts, or coated by secondary stibiconite.

Other Minerals

The ore of Xikuangshan is a very pure stibnite; only tiny amounts of pyrite, pyrrhotite, sphalerite and magnetite are observable in it. Non-metallic associations include orpiment and, as gangue minerals, quartz, calcite, gypsum, barite and fluorite; native sulfur is a very late-formed member of the suite. In the oxidation zone, cervantite, valentinite, stibiconite, kermesite and senarmontite are found to depths of about 100 meters. When the oxidation zone was worked in the beginning of the mining period at Xikuangshan, cervantite and valentinite accounted for about 20% of the ore recovered.

Other than stibnite, only barite is of some interest to collectors. The yellow-brown tabular barite crystals reach lengths of 5 to 10 cm and average 2 cm thick, although they are only slightly translucent. These crystals are not especially attractive except when, as in rare cases, they are associated with stibiconite-coated stibnite or with sulfur crystals. Senarmontite and kermesite from Xikuangshan, although mentioned in the literature (Wu *et al.*, 1990), have not been taken out in collector-quality specimens.

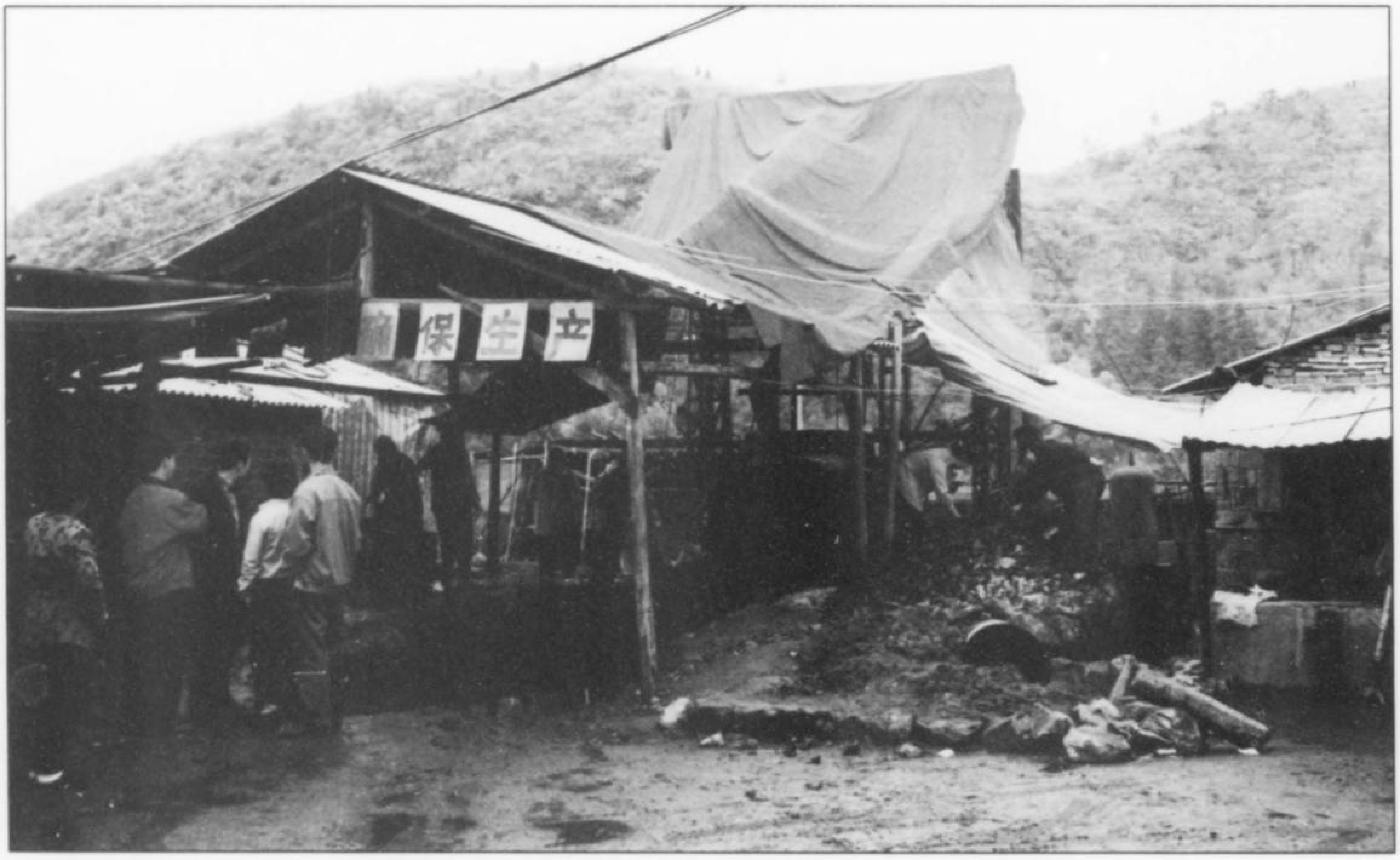


Figure 8. Wuning mine, Shaft #3 (foreground), with Tuobeishan Hill in the background. Guanghua Liu photo.

WUNING

The stibnite occurrence at Qingjiang, in Wuning County, Jiangxi Province, has been described by Behling *et al.* (2002) in the *Mineralogical Record* under the title "Stibnite from the Wuling antimony mine, Jiangxi province, China." Although locals tend to pronounce the name "Wuling," the more recent foreign literature has employed the Pinyin-system transcription: "Wuning."

Production of the wonderful stibnite specimens from the Wuning mine began in December 1997 with the discovery of the first of several extraordinary crystal pockets. This pocket measured 3 × 6 × 20 meters, and was completely lined with crystals up to 1.5 cm wide and a meter long. Most of the specimens recovered are without matrix, although a small number of matrix pieces were

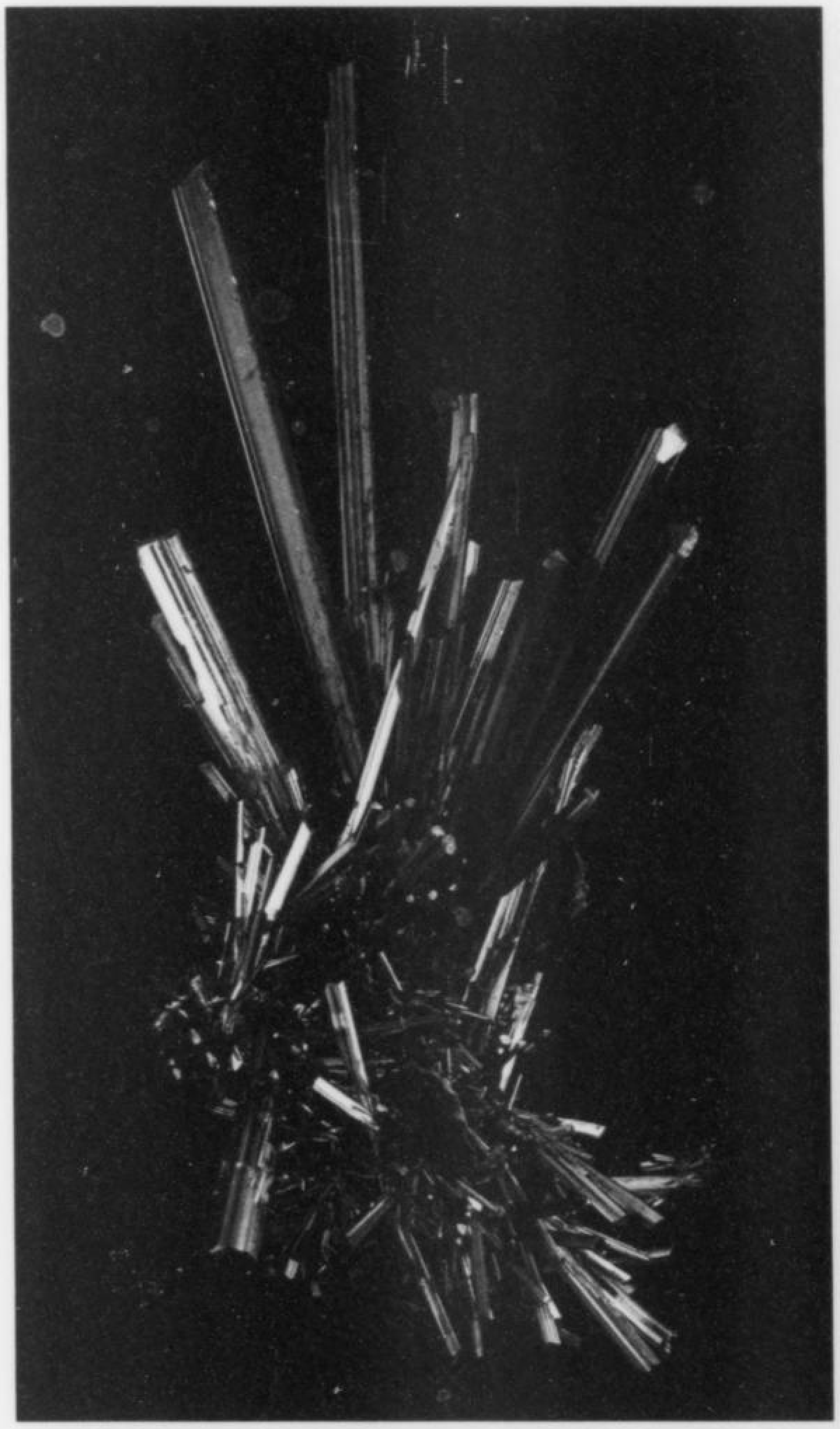
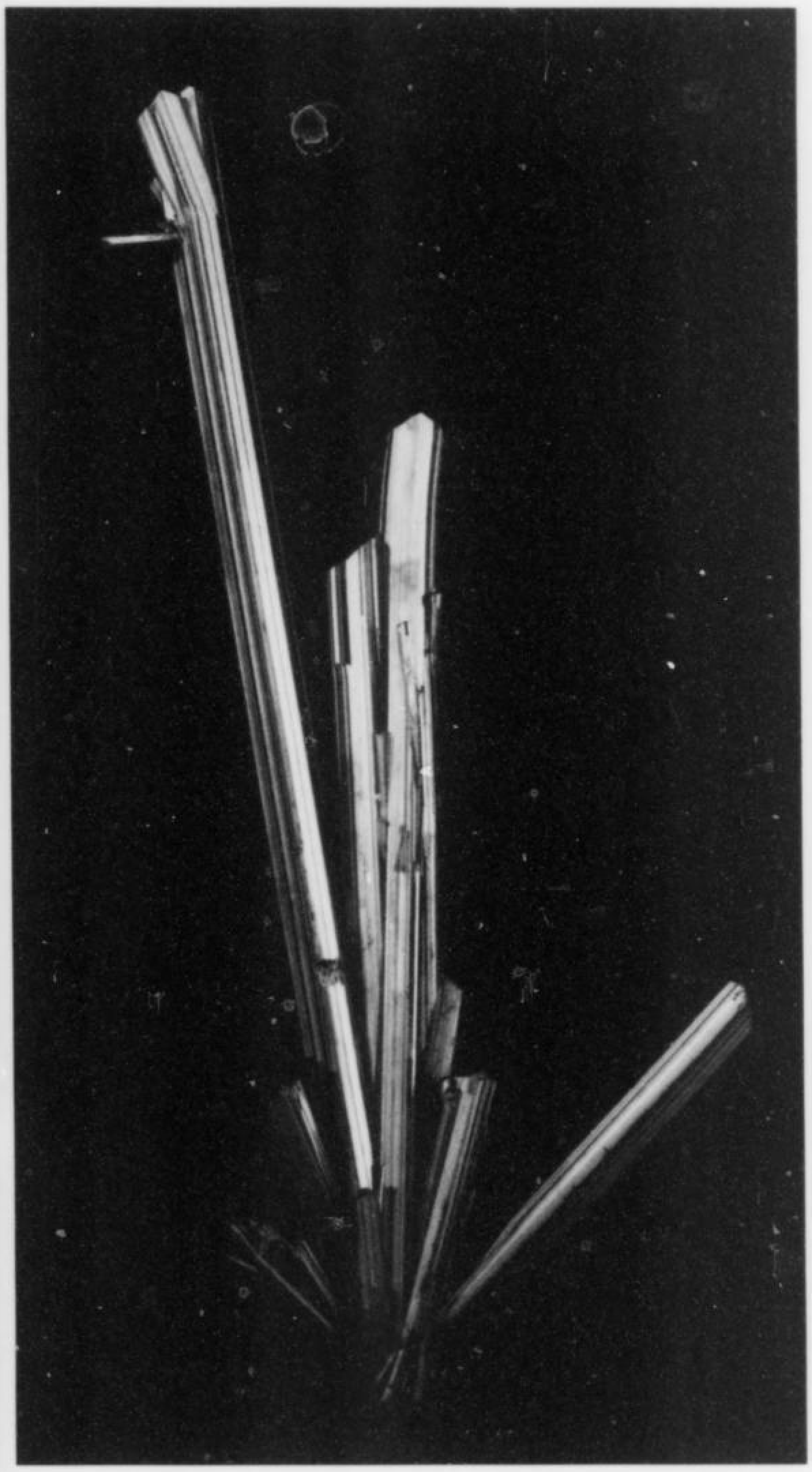
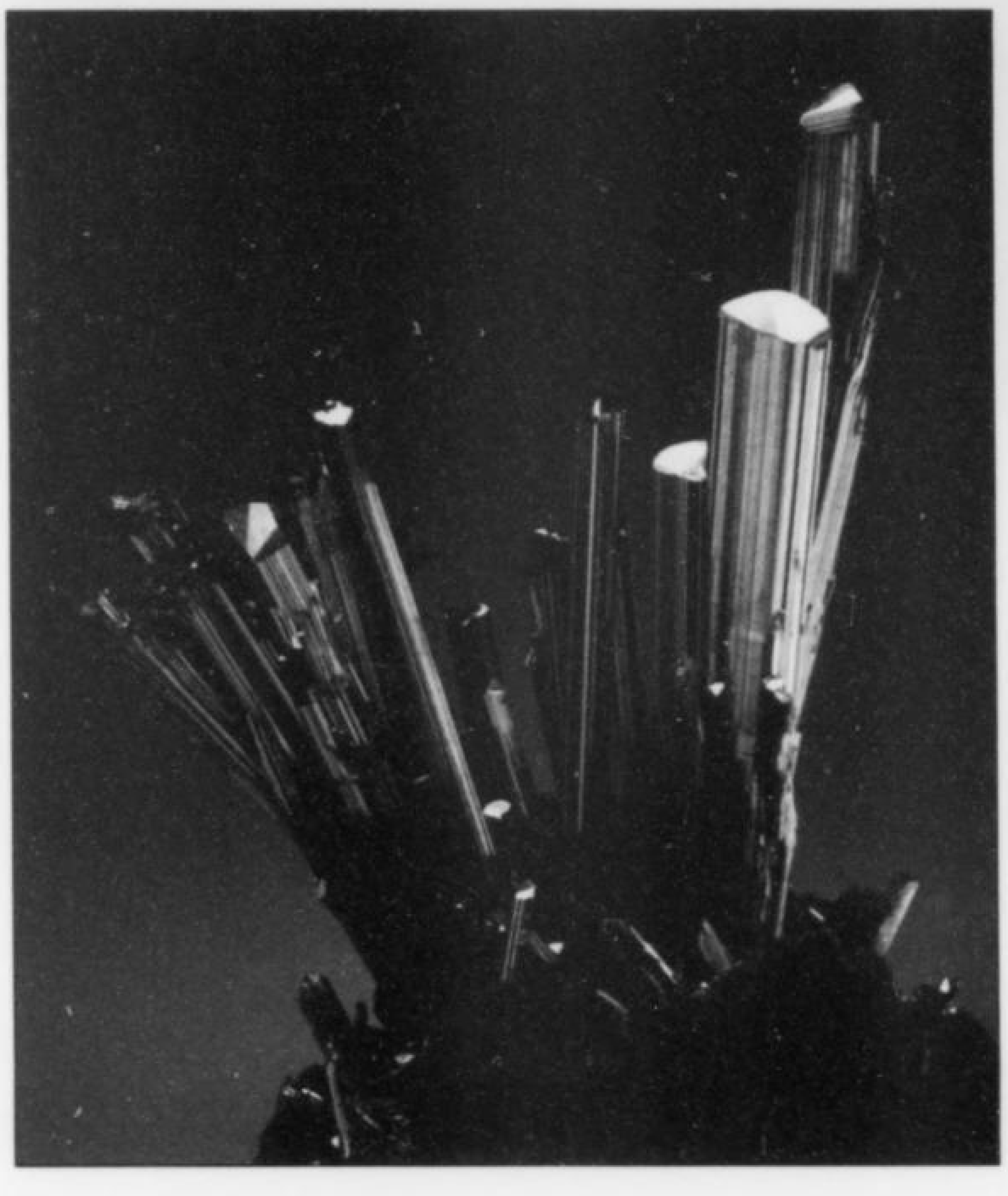


Figure 9. (left) **Stibnite crystal cluster, 26 cm, from the Wuning mine. Collector's Edge Minerals specimen; Jeff Scovil photo.**

Figure 10. **Stibnite crystal cluster, 19.9 cm, from the Wuning mine. Collector's Edge Minerals specimen; Jeff Scovil photo.**





recovered which measure up to 57 cm across. A large number of perfect single crystals, intergrown crystals and clusters were mined and sold, most of the crystals measuring 5 to 20 mm in diameter and up to 30 cm length. The next two pockets, considerably smaller than the first, were not found until November-December of 2000.

Since the time of the *Mineralogical Record* article, new discoveries have occurred, necessitating an additional account here. Beyond a doubt, one of the most dramatic high points of the 2004 Munich Show was the stibnite crystal cluster from Wuning displayed in its own glass showcase by the dealership *Fine Minerals International*. Although this piece was astonishing enough for its size (about 60 × 70 × 70 cm), for the perfection of its individual crystals, and no

Figure 11. **Stibnite crystal cluster, 14 cm, from the Wuning mine. Collector's Edge Minerals specimen; Jeff Scovil photo.**

doubt also for its price, it is not the largest specimen, or the one with the longest crystals, among the great discoveries of the year 2004. And it is not only such enormous stibnite specimens from Wuning which have attracted attention: *Fine Minerals International* also displayed several crystal groups measuring 20 to 30 cm, all similarly remarkable for wonderful crystal development and aesthetics.

In the late autumn of 2003, in Shaft #1 in the Qingjiang stibnite mine, a zone with many small and large crystal pockets was entered. A first discovery in November 2003 yielded a small number of specimens with remarkably stout stibnite crystals 5 to 7 cm thick and reaching 15 cm long. Hardly had this discovery been recorded when, at the very beginning of 2004, a much larger pocket was breached, this one containing many stibnite crystals measuring to 1 meter long. Because the chief owner of the mining company, Mr. Hefu Wu, had learned along the way of the very high financial value that stibnite specimens can carry, the collecting process went on under the supervision and with the participation of dealers from Changsha.

Since stibnite is very brittle, the long and fragile crystals can easily be damaged or broken off their matrix. Crystals are found on all the walls of the cavities, most of them projecting inward perpendicularly. The most successful collecting begins with removing the crystals on the cavity floor, proceeding with exquisite caution and constantly trying to minimize any vibrations which might dislodge crystals or pieces of rock from above to fall onto the crystals below. When the floor of the cavity is fully cleared, the collecting of crystals from the side walls can begin. Stripping the ceiling of crystals always proves to be the most difficult part of the process. It is not a viable technique to lay something soft on the floor below and let specimens fall onto it, as when taking quartz crystals from overhead in a quartz cleft; in the case of stibnite, the great weight of the crystals would cause them to break. The freeing of small and medium-sized specimens from the ceiling can only proceed step by step, the collectors using their hands to keep each specimen from falling.

The structure of the wall rock and of the soft, massive stibnite layer resting on it is unfavorable to the goal of collecting well-proportioned specimens showing crystals on matrix; these consequently are very rare. In general, extensive experience and much patience are required for collecting fine stibnite specimens with thick, long crystals. In the process many individual crystals are inadvertently damaged, but many small crystal groups (some of them quite aesthetic) are recovered.

The stibnite specimens which were gathered from the great cavity in Shaft #1 at Qingjiang in February and March 2004 must be regarded as the *ne plus ultra* of all stibnites so far discovered in China. Their distinguishing characteristics are the superb sharpness of the crystals, their brilliant metallic luster, and the interesting aesthetics of the crystal clusters. In all cases the Wuning crystals show fairly good development of the termination faces, though usually only showing two faces in a chisel-like termination. Termination faces on most crystals are also rather dull and frosty rather than sharp and bright. Barite is a very rare association, mainly as small, transparent, colorless crystals up to 1 cm.

An additional distinction is simply that it has been possible to collect so many very large, yet essentially undamaged groups. Altogether, 11 specimens were collected which measured at least 80 × 80 cm, with crystals reaching 60 cm long. More than 60 pieces measure 30 to 60 cm wide, 20 to 50 cm deep and 30 to 50 cm tall; there are more than 300 smaller crystal groups and about 2000 single crystals measuring more than 10 cm long.

When I visited Shaft #1 in May 2004 with my Austrian companion Helmut Czuba, we appraised the collecting situation as it was at that time. Countless cavities could be seen in the orebody, still in place in the mine, but they either were filled with very tightly intergrown stibnite crystals or were extremely small. Mr. Wu was an exceptionally friendly, helpful and generous host throughout our visit, but he was unable to answer our question about the likelihood of encountering other large crystal pockets. The dimensions of the ore lens in which the great pocket had occurred were not known; moreover, large pockets occur preferentially along the axis of the Tuobeishan Syncline (Behling *et al.*, 2002), and this structure's position and extent within the mine are unclear. It is noteworthy that since March 2004 only a few small finds with stibnite crystals to 10 cm have been made. Anyway, it is probably desirable that the mineral market enjoy an interval without new finds from Wuning. There is presently a large number of beautiful specimens from the finds of 2000–2004 in the stocks of dealers in the U.S. and Europe, and most of these are not being purchased for the prices the dealers have hoped for.

***Figure 12.* Barite crystals with stibnite, 11.5 cm, from Lushi. Mike Bergmann specimen; Jeff Scovil photo.**

LUSHI

Between 1995 and 2000, very large and well-developed stibnite crystals attributed to a locality called Lushi, Henan Province, reached the mineral market. No information whatever could be found in the relevant Chinese technical literature about an antimony deposit at Lushi. Since China possesses countless antimony deposits of all sizes, it is not surprising that some smaller ones, in the absence of special economic or scientific interest, have not yet been described in print. For the Lushi occurrence, only one report, that of Liu (1995), has provided information—Dr. Liu has in fact visited the locality.

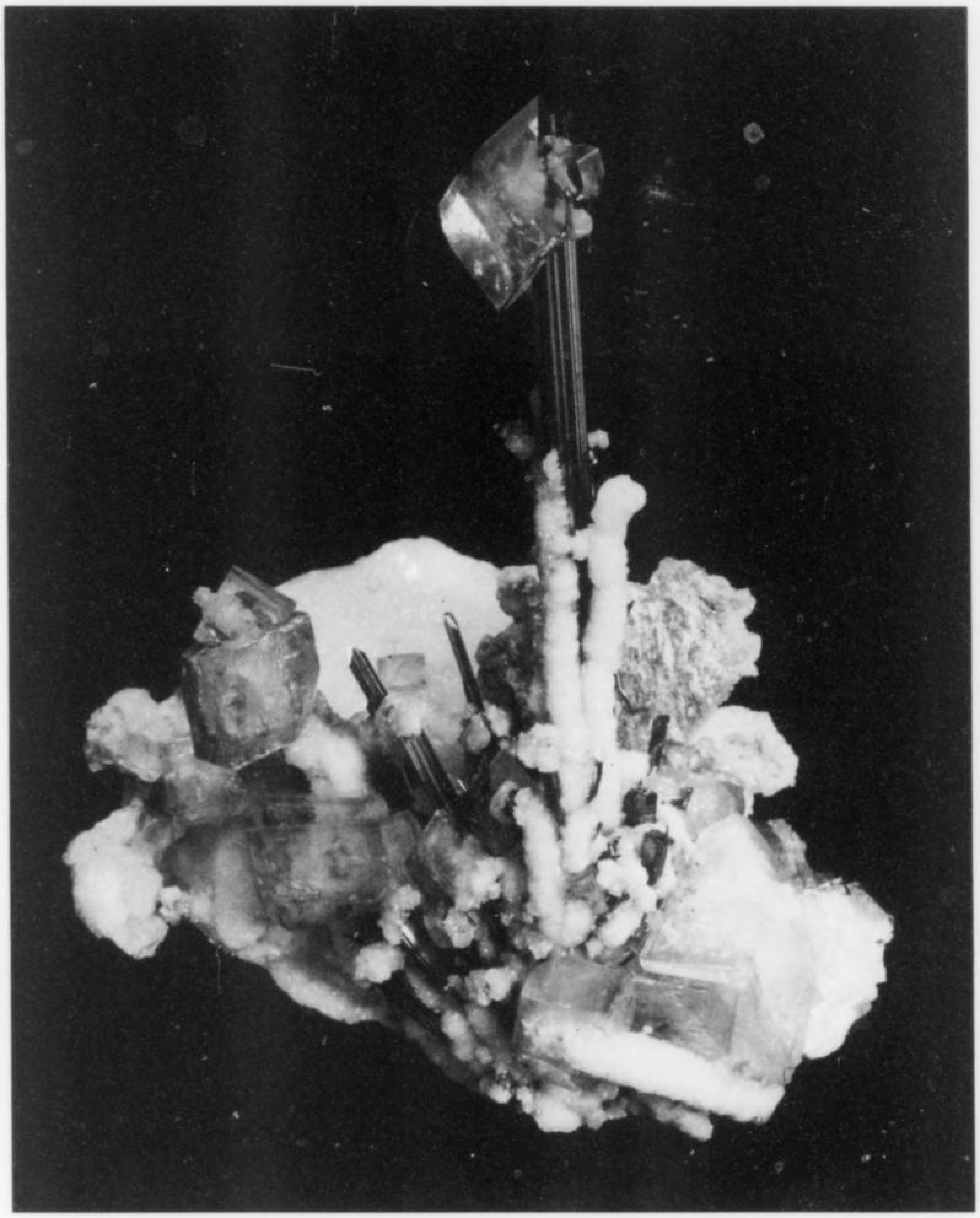


Figure 13. **Barite crystals with stibnite, 11 cm, from Lushi. Collector's Edge Minerals specimen; Jeff Scovil photo.**

Between December 1994 and March 1995, in the privately operated Zhanergou and Dahegou mines near the town of Lushi, a few pockets containing large stibnite crystals were discovered. Up to this time, mining had proceeded exclusively for industrial purposes, with no thought of gathering collector specimens. There had been no concept of careful collecting in order to avoid damage: the miners simply broke the large stibnite crystals off the walls of the pockets, then stowed them in bags without any packing material, and so almost all of the crystals gathered were damaged to some degree. In 1996 a fine lot of these stibnites reached the Tucson Show, associated with barite in lustrous, translucent, blocky, colorless to smoky gray crystals up to 6 cm across (Moore, 1996).

When the owners of the Lushi mines finally came to recognize the high value of collector-quality specimens, they began to encourage the collecting of crystals on matrix. Thus at the end of the 1990's a few outstanding and beautiful specimens reached the mineral dealers, some showing white, tabular barite crystals to several centimeters wide with the stibnite crystals. Moore (2000) reported crystal clusters of Lushi stibnite on matrix up to 45 cm across and 30 cm tall, "of highest luster and very little damage, with thick, terminated spears."

Although the occurrence at Lushi closely resembles that at Wuning, the association of large barite crystals with stibnite is a distinguishing characteristic of Lushi specimens; the barite crystals on Wuning specimens measure to only a few millimeters and form drusy coatings.

Most of the stibnite crystals from Lushi measure around 5 cm long and 5 mm thick, but exceptional crystals to almost 1 meter long were found. The crystals are of very high quality: the brilliant metallic luster, the excellent development of the prism and terminal faces, and the attractive arrangements of crystal groups led these specimens to be judged, on the whole, far more desirable than those which were being found at the same time at Xikuangshan. Counted as particularly desirable were those specimens in which the growth direction of crystals changed several times, resulting in knee-like bends.

Ore reserves at Lushi are very small: only a short working life for the mines was planned in the first place, and meanwhile the workings have been shut down because of the fall in the world market price for antimony, and because of wrangling between the mine owners. Specimens from Lushi which show the association of barite with stibnite should surely be counted among the Chinese stibnite "classics."

OTHER STIBNITE OCCURRENCES

Since the mid-1990's, specimens from the Xikuangshan, Lushi and Wuning localities have set the standard for high quality in Chinese stibnite in the minds of many Western collectors. However, it is now common knowledge that a great many other stibnite occurrences also exist in the country. A glance at the table of important Chinese antimony deposits shows that, in addition to the best known ones in Hunan Province, there are the Nandan deposits in Guangxi

Province; Qinglong and Banpo-Dushan in Guizhou Province; and more occurrences, both dormant and actively worked, in Yunnan Province. To date these deposits are known less for good stibnite specimens than for specimens of associated minerals, and therefore they will be but briefly treated in this report.

Dachang Orefield, Nandan, Guangxi

The Dachang orefield between Nandan and Hechi, Nandan County, Hechi Prefecture, Guangxi Province was discovered in 1127 and boasts a long history of mining, particularly for silver. After the founding of the People's Republic of China, systematic exploration work was initiated, so that precise information is available now for the whole of the 170 square-kilometer district.

The mining district is not only important for its antimony; an enormous deposit of tin at Dachang ranks the district as China's second greatest source of tin, behind only Gejiu in Yunnan. For antimony the district is important thanks to a newly discovered orebody at Chashan (not to be confused with the Chashan near Xianghuapu in Hunan).

James F. Carlin, Antimony Commodity Specialist of the U.S. Geological Survey, wrote in 2002 that

> In southwest China, the local government of the Guangxi Autonomous Region announced that it has granted China's state-owned Minmetals Group the right to redevelop its Nandan antimony mines, which are the largest in China.

Preceding this announcement, an accident took place on June 17, 2001 in the Lajiapo mine in the Nandan district: 80 miners lost their lives when water broke through a wall. Until this time, several state-run mines and more than 300 illegal mine operations had been active in the district. As a consequence of the accident, complaints of corruption were investigated, many important employees of the mines and a few local politicians were arrested, and the mines were shut down. Mine production before the closure had reached 50,000 tonnes per year, and the district had overtaken all of the mining areas in Hunan to become China's leading producer of antimony. Because ore production is economically very important for Hechi Prefecture, a few mines have since been reactivated after being modernized.

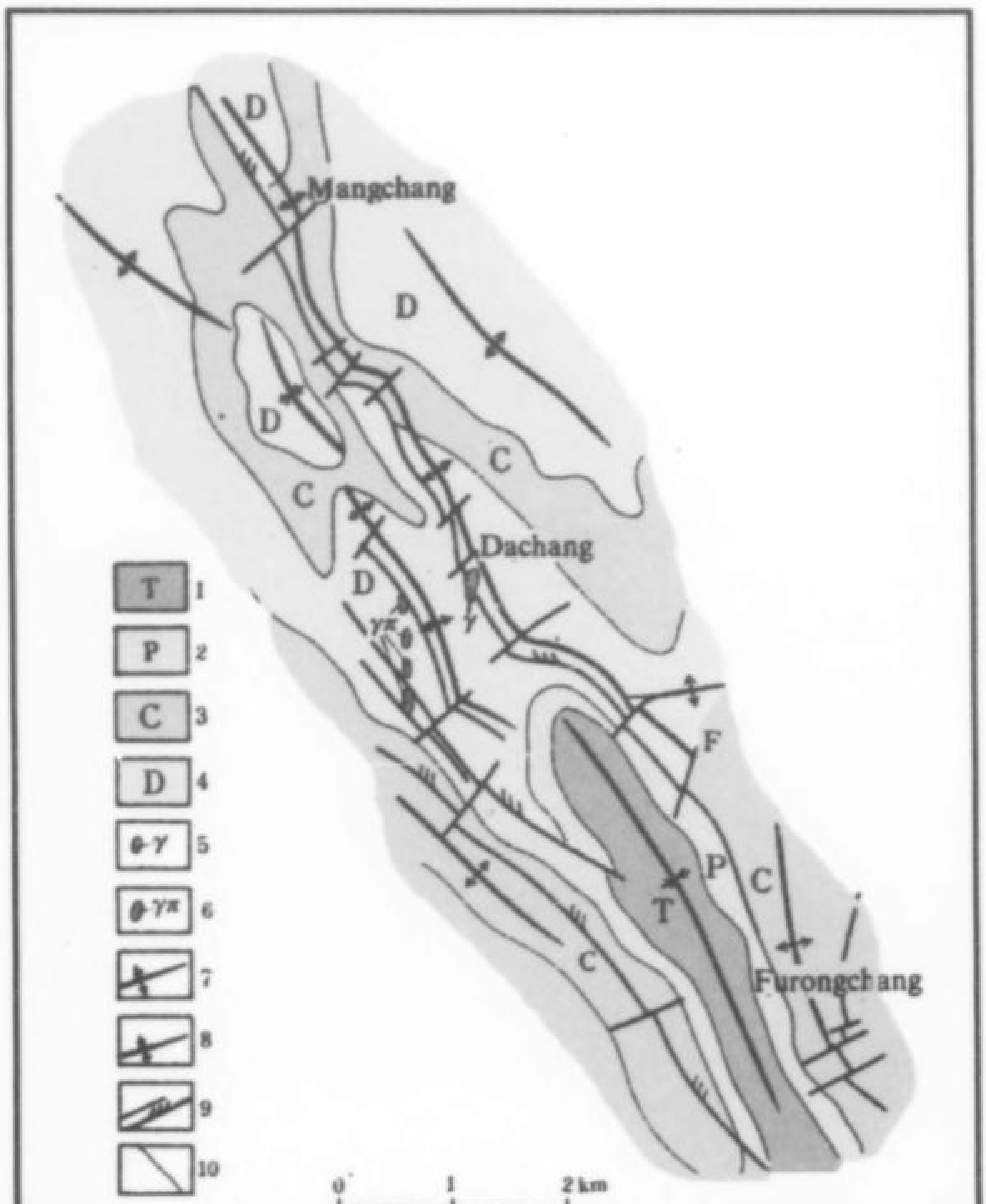


Figure 14. **Structural geology of the Nandan-Hechi polymetallic antimony ore belt (after Wu *et al.*, 1990).**

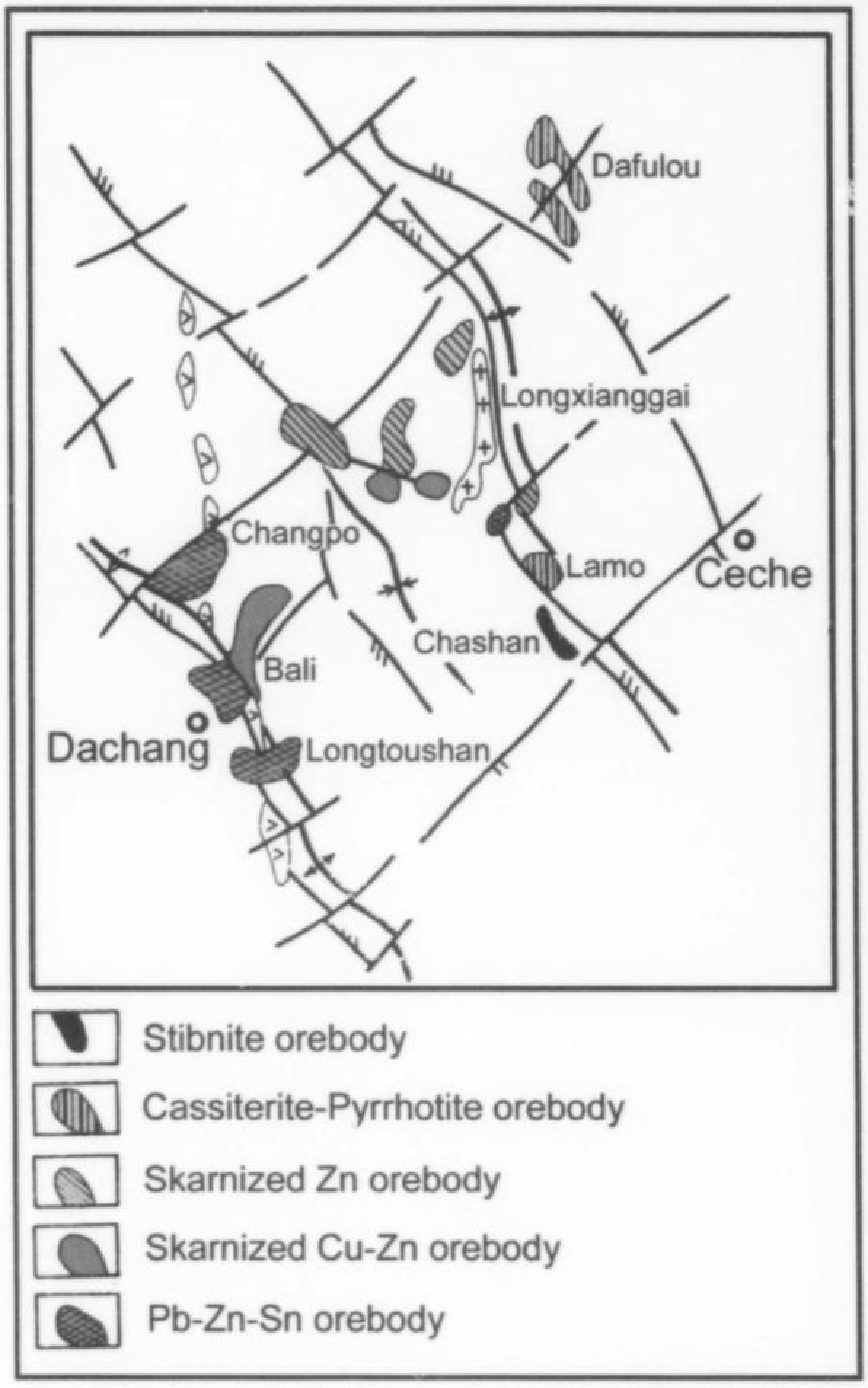


Figure 15. **Sketch map showing the chess-board structure of the Dachang orefield and the various orebodies (Wu *et al.*, 1990).**

Geologically, the belt of mineral deposits between Nandan and Hechi comprises the so-called Dan-Chi polymetallic zone (Wu *et al.*, 1990). This zone extends over 15 km, from Mangchang southeast via Dachang to Wuyu, and includes a number of mines producing various kinds of ore. The deposits are dominated by antimony, silver, lead and zinc minerals in the northern section of the zone, near Mangchang; by tin, silver, copper and arsenic minerals in the middle section, near Dachang; and again by antimony, silver, lead and zinc minerals in the southern section, near Wuyu. Sb, W, Ag, Hg, Bi, Cd, Ga, In and Au minerals, as well as crystals of fluorite and calcite, are found in these deposits. The ore-bearing bodies are mainly associated with tension faults cutting Devonian marine carbonates and shales that host granitic intrusions emplaced during the late Mesozoic. The mineral-forming processes, generally regarded as hydrothermal and contact-metamorphic, occurred in multiple phases at different times.

Figure 16. Calcite (untwinned) on stibnite, 9.4 cm, from the Xionhuang Kuang mine, Wuyu, Nàndan. Irv Brown specimen; Jeff Scovil photo.

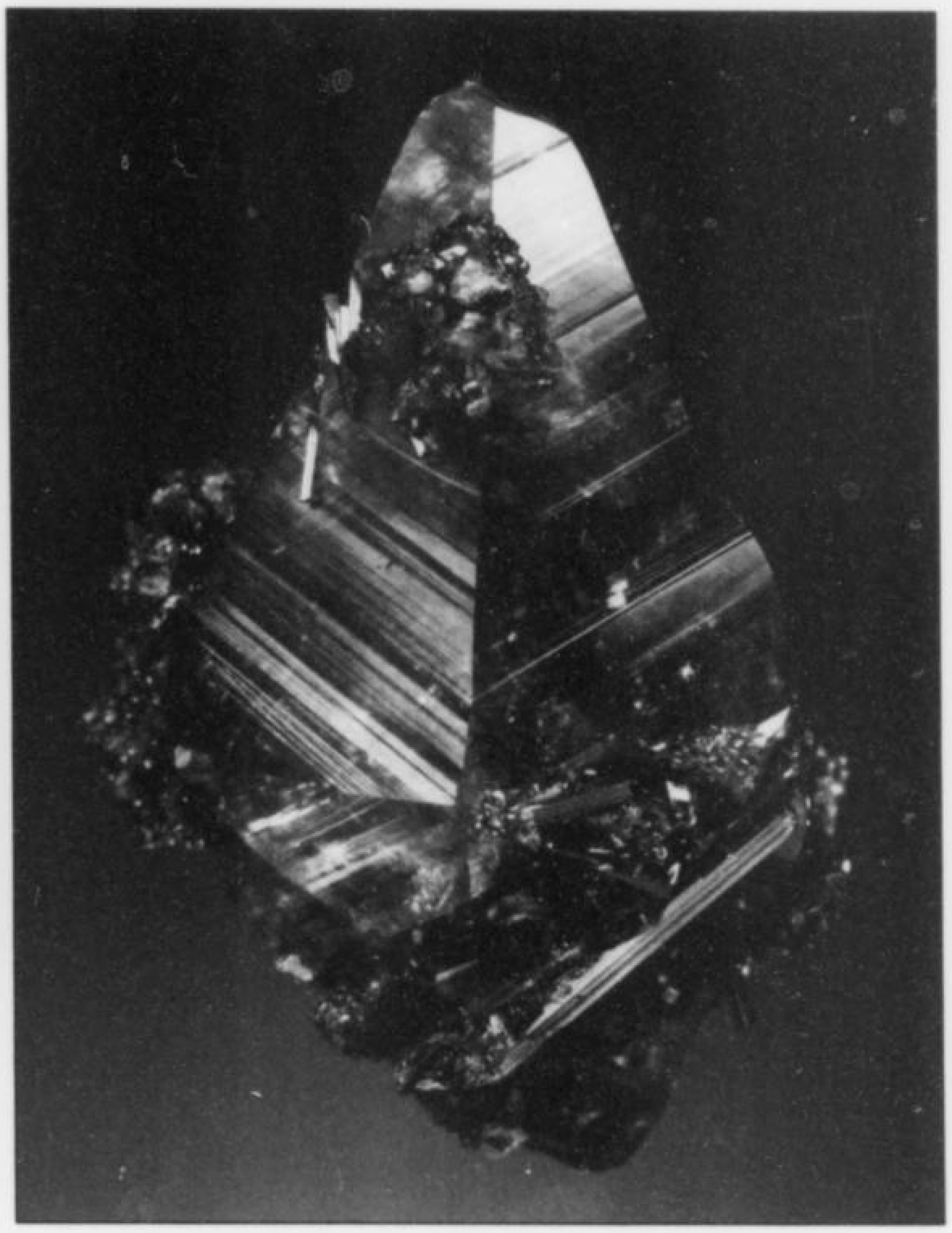


Figure 17. Calcite (twinned) on stibnite, 5.9 cm, from the Xionhuang Kuang mine, Wuyu, Nandan. Jeff Starr collection; Jeff Scovil photo.

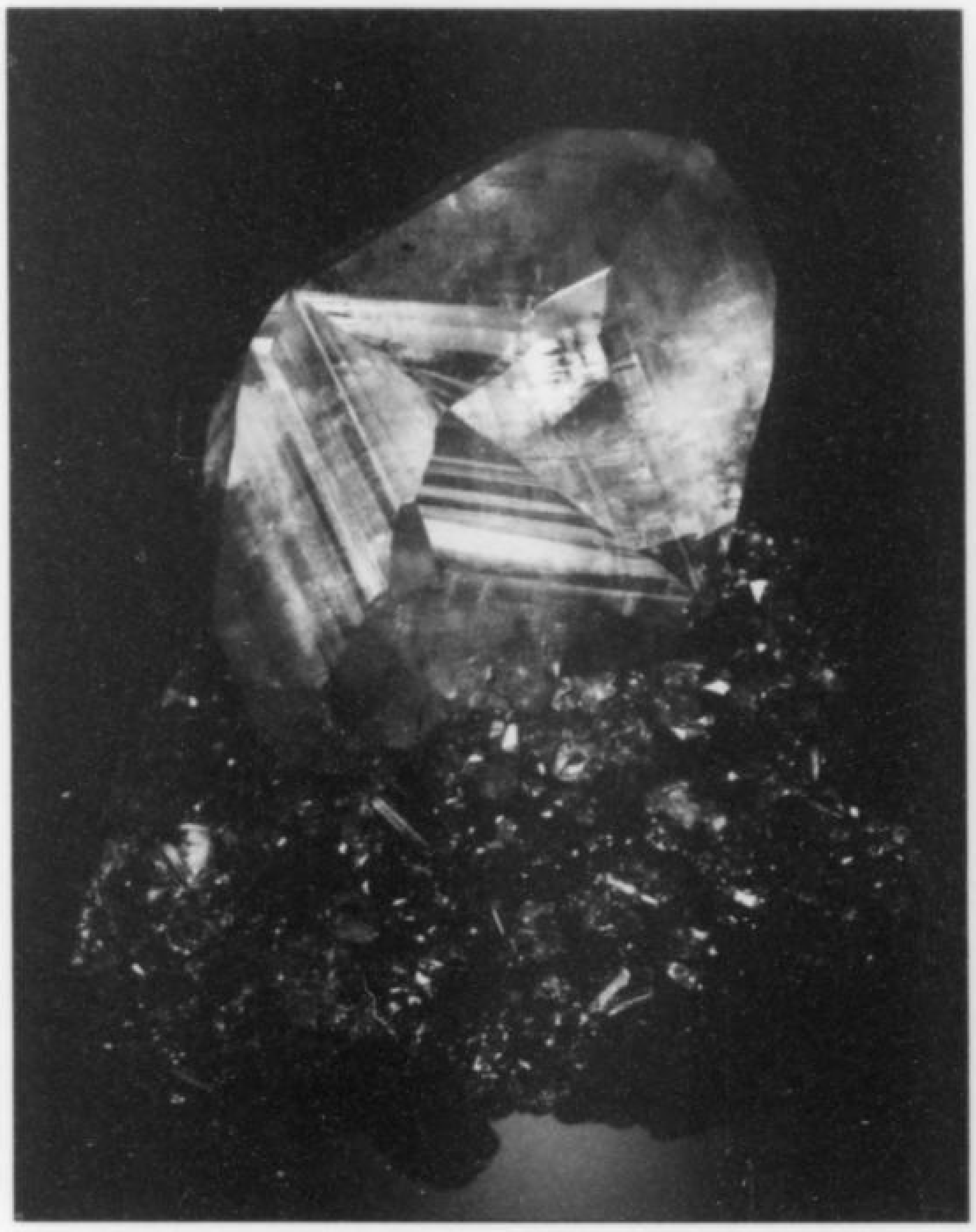
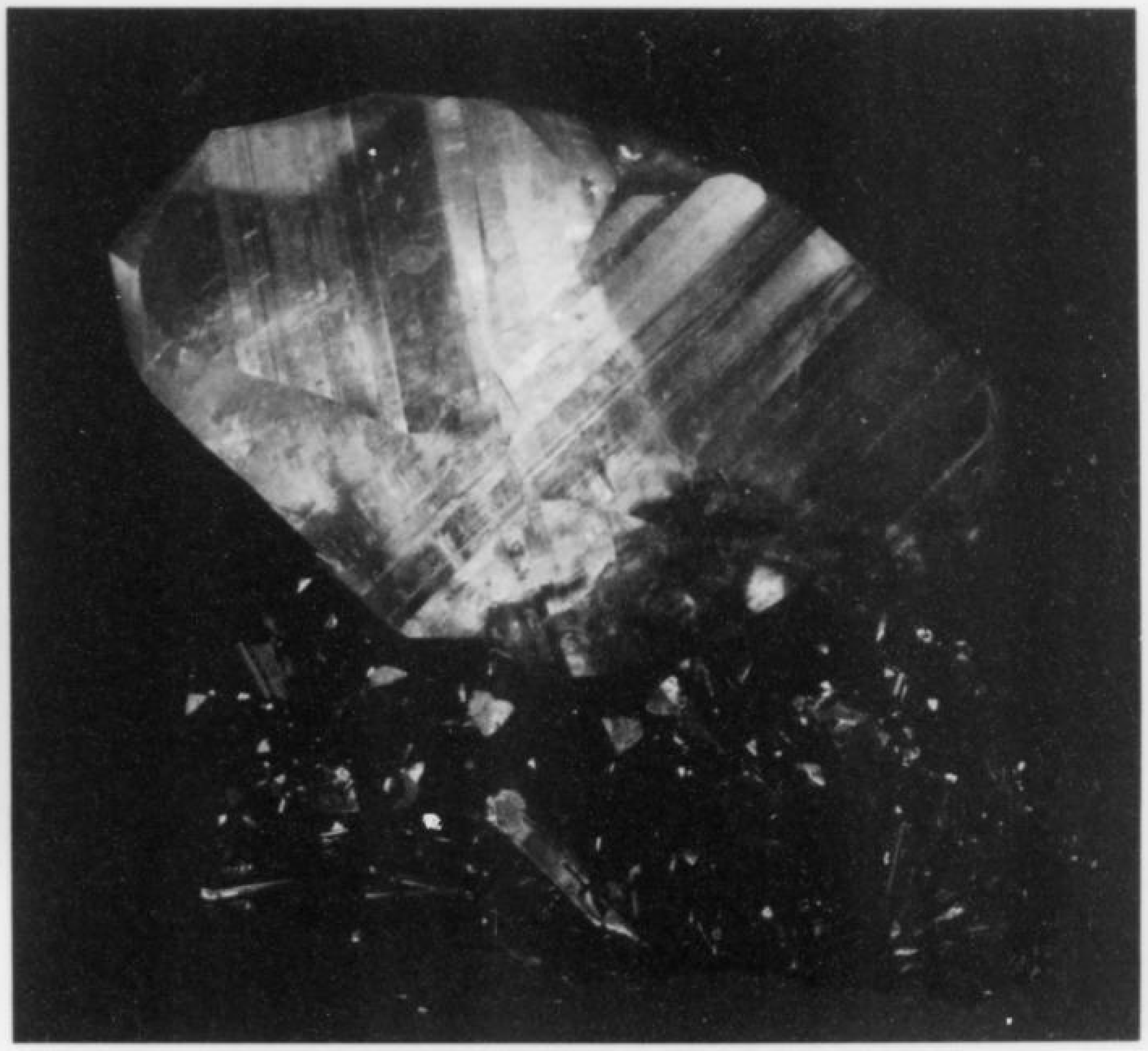


Figure 18. Calcite (twinned) on stibnite, 7 cm, from the Xionhuang Kuang mine, Wuyu, Nandan. Irv Brown and Stuart Wilensky specimen; Jeff Scovil photo.

Figure 19. Calcite (twinned) on stibnite, 5.8 cm, from the Xionhuang Kuang mine, Wuyu, Nandan. Sandor Fuss collection; Jeff Scovil photo.



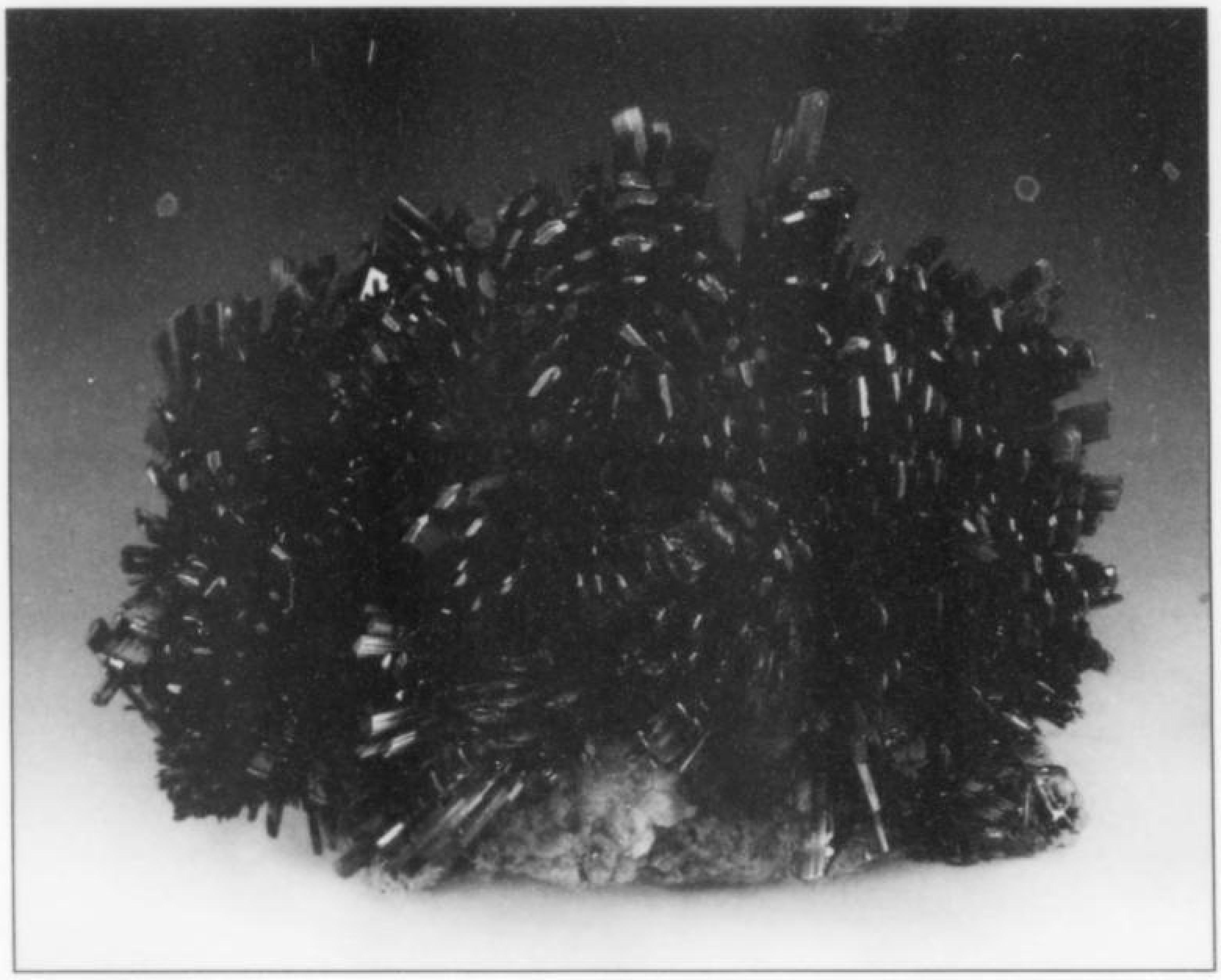


Figure 20. **Stibnite "hedgehog" cluster, 9 cm, from Chashan. Rob Lavinsky (irocks.com) specimen and photo.**

Figure 21. **Stibnite crystal cluster, 8 cm, from Chashan. Rob Lavinsky (irocks.com) specimen and photo.**

By contrast with the essentially monomineralic occurrences at Xikuangshan and Qingjiang/Wuning, many mineral species are found in the many discrete mine workings and small prospects in the polymetallic ores of the Dachang ore field. For the community of collectors this fact is cheering, though unfortunately the names of particular mines are little or not at all known.

Collector-quality stibnite specimens from the Nandan district were marketed in March 2005. These specimens probably came from the Chashan deposit. The crystals, to 5 cm long, are found in radiating sprays that closely resemble Romanian stibnite. Although the crystals are not especially large when compared to those from the famous localities in Hunan, Henan and Jiangxi, the aesthetically pleasing "hedgehog" aggregates are finding much favor, and amazingly high prices are being asked and paid for the finest examples. The locality name cited has been merely "Nandan"; no specific mine has yet been ascertained as the source of these specimens.

Xionhuang Kuang Mine, Wuyu, Nandan, Guangxi

In 1998, in the privately operated Xionhuang Kuang realgar mine near Wuyu, spectacular, golden yellow, highly lustrous, transparent crystals of calcite were found (Liu, 2003). These beautiful crystals are intergrown with stibnite, and some are partly overgrown by a younger generation of stibnite. About 2000 specimens were collected. Among the first of these calcite specimens to reach the Western market were those reported by Moore (2000): beautiful stibnite specimens from "Lantan" (probably Nandan), Guangxi province which were available at the 2000 Tucson Show. Beautiful calcite crystals were associated—"lustrous, complex, rounded, butterscotch-orange and gemmy, all a-glitter with a myriad of little faces, [and up to] 5 cm," on a matrix of massive stibnite with brilliant stibnite crystals, some as "thick as chopsticks," in stunning combinations up to large cabinet size.

Among the further highlights from the Nandan district are colorless, transparent crystals of calcite. From the Zn-Cu skarn deposit of Lamo, also in the Nandan district, have come specimens of sphalerite, galena, rhodochrosite, pyrite, quartz and pink apatite.

Qinglong, Guizhou

The antimony deposits of Qinglong, Guizhou Province, are among the largest in China. Only a few stibnite specimens from this locality have reached the mineral market, but it is interesting as a source of other minerals, some of them rare. The Qinglong antimony area, in Qinglong County, has an area of about 400 square kilometers; the deposit is of marine volcanic origin. The so-called Dongwu Displacement in the early Permian caused the crust to rise, and with massive amounts of extruded basalt providing a source of the metals, stibnite and other kinds of deposits were laid down. Four stibnite-fluorite-pyrite horizons can be observed.

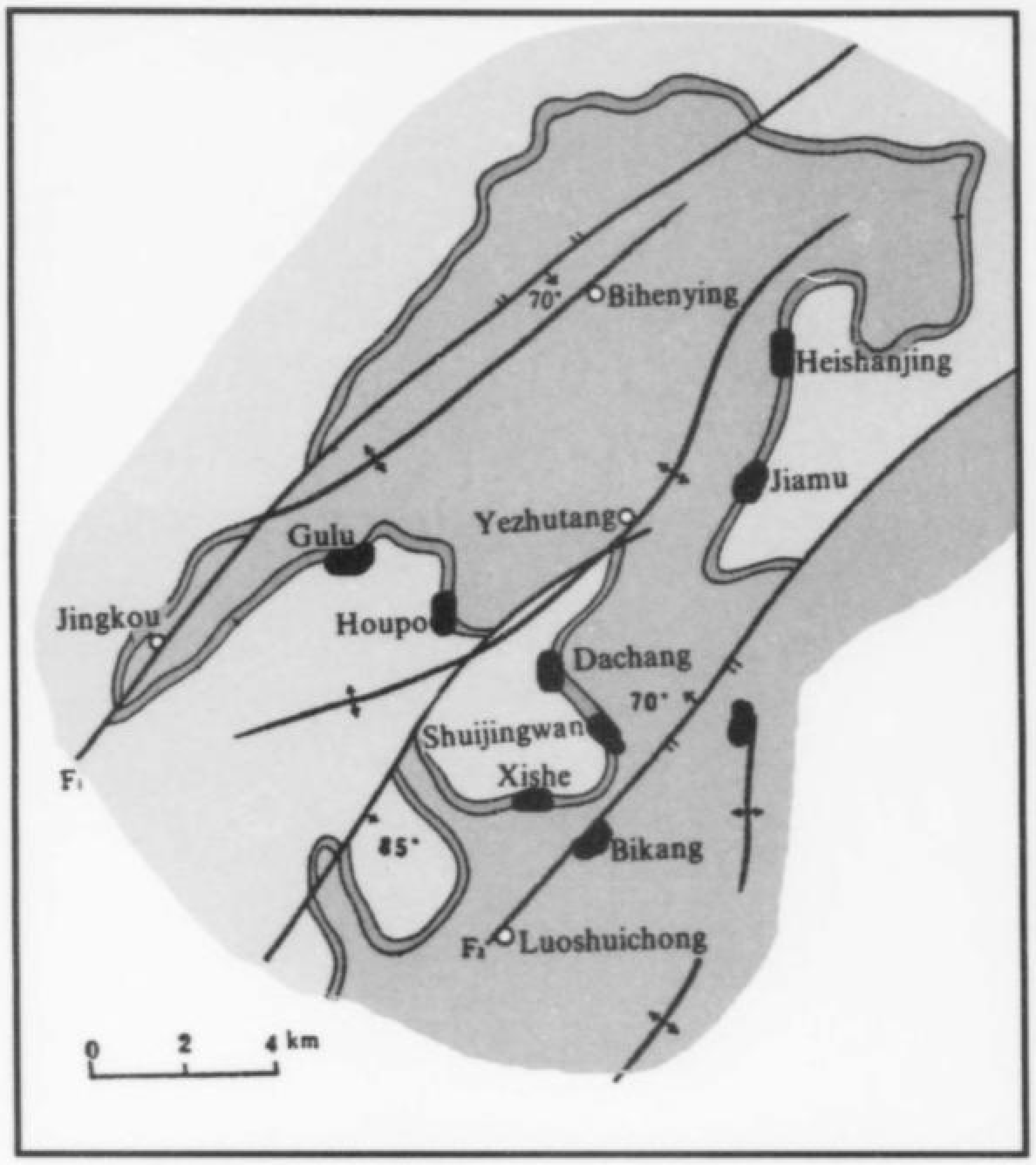


***Figure 22.* Sketch map of the geology of the Qinglong antimony district showing the nine major deposits (Wu *et al.*, 1990).**

In 2003, a few dealers in Changsha and Guilin offered specimens showing needle-like crystals of a blue mineral thought to be cyanotrichite. Further testing established finally that this secondary mineral was the rare carbonate-cyanotrichite (Niedermayr, 2004). In a few of the specimens, carbonate-cyanotrichite is associated with cubic crystals of fluorite, which occurs in various colors at Qinglong; well-developed crystals of the uncommon species creedite were discovered as well. As an exceptional rarity, Qinglong produces specimens in which stibnite crystals to a few centimeters long are encrusted by an amorphous oxide on which is found, in turn, the very rare mineral ottensite. In 2004 and 2005, fine specimens with very beautiful gypsum crystals were found. The deposit at Qinglong seems to have begotten a series of interesting secondary minerals; it remains to be seen what further ones will be found, or whether new species might be discovered.

Banpo, Dushan, Guizhou

The antimony deposit of Banpo, in Dushan County in the southern part of Guizhou Province, has an area of about 200 square kilometers and a mining history which has lasted almost 100 years, although it was not recognized as a significant antimony occurrence until near the end of the 20th century. Its geological features resemble those of carbonate-type deposits. So far, stibnite has not been observed in good, large crystals from the locality, but for fluorite collectors, Banpo specimens showing violet-colored, 2-mm fluorite crystals overgrown on stibnite are especially desirable.

KERMESITE OCCURRENCES

Given the large number of antimony deposits in China, the occurrence of other antimony minerals besides stibnite is to be expected. The oxidation zones of the deposits generally contain stibiconite, valentinite and senarmontite. Kermesite has been said to come from Xikuangshan, although no such specimens have appeared on the mineral market. Cervantite and kermesite have been noted from the upper oxidation zone of the antimony-gold occurrence at Zhenxu (Wu

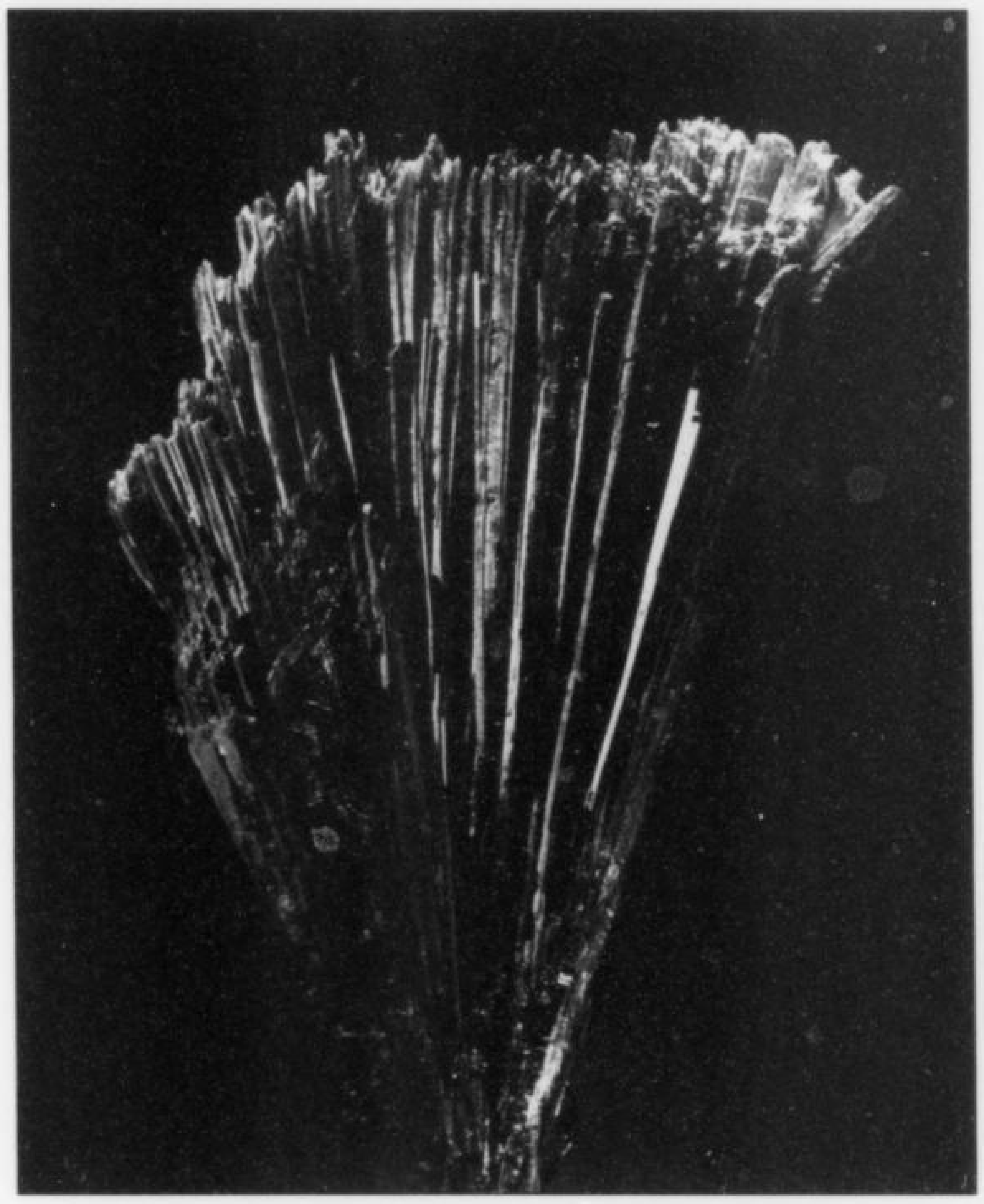


***Figure 23.* Kermesite spray, 9.5 cm, from the Damingshan Mountain area near Dafeng, Shanglin County, Guangxi. Dave Bunk and Geoprime specimen; Jeff Scovil photo.**

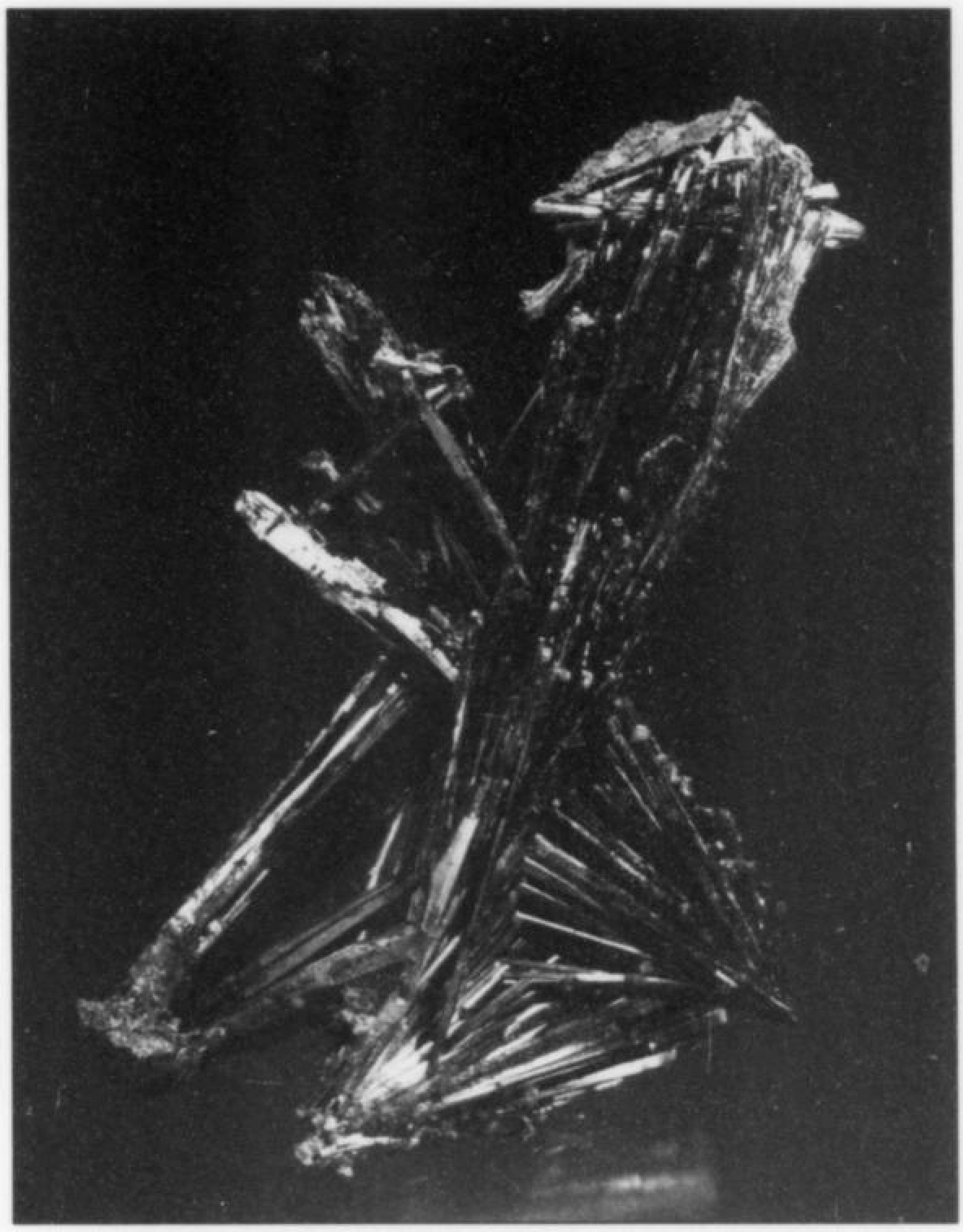


***Figure 24.* Kermesite sprays, 6.5 cm, from the Damingshan Mountain area near Dafeng, Shanglin County, Guangxi. V. and E. Martinson collection; Jeff Scovil photo.**

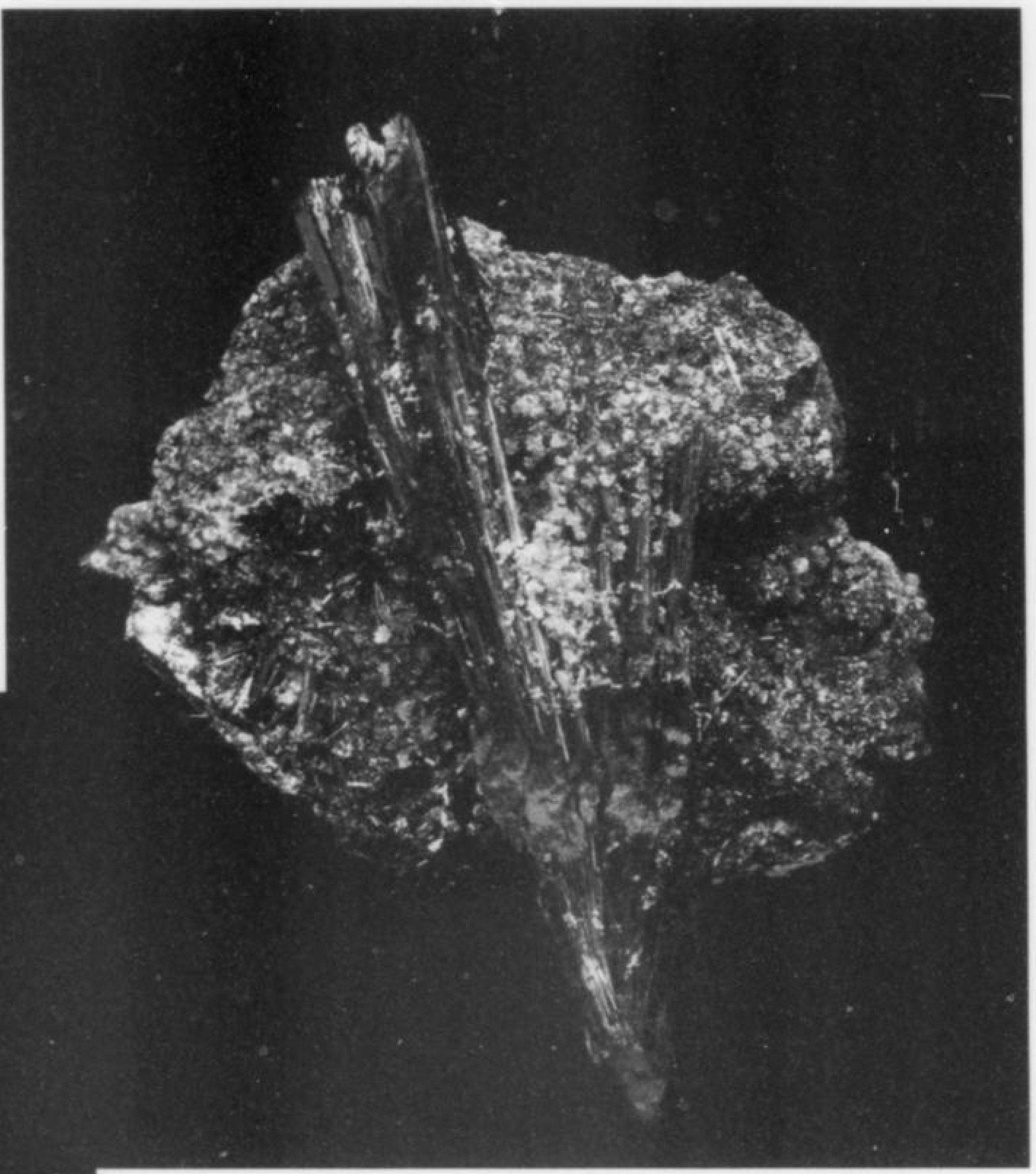


Figure 25. **Kermesite spray, 7.8 cm, from the Damingshan Mountain area near Dafeng, Shanglin County, Guangxi. Jordi Fabre specimen; Jeff Scovil photo.**

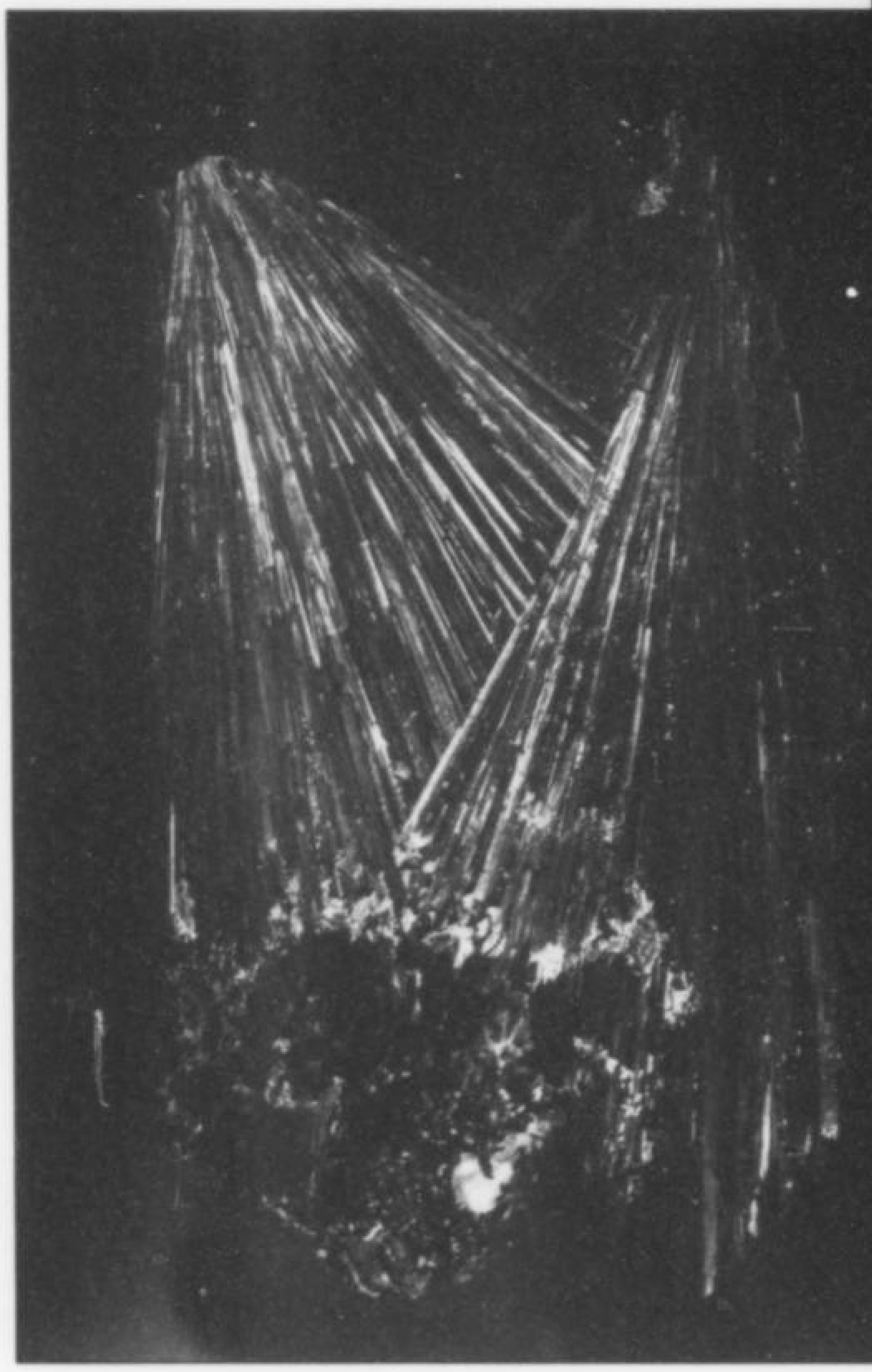


Figure 26. **Kermesite spray, 17 cm, from the Damingshan Mountain area near Dafeng, Shanglin County, Guangxi. Dave Bunk and Geoprime specimen, now in the Smithsonian collection; Jeff Scovil photo.**

et al., 1990). In the weathered material there, cervantite is present to an average proportion of 20–30 kg per cubic meter, and locally to 100 kg per cubic meter. Kermesite has been called economically significant, although large kermesite crystals do not occur at this locality.

The most spectacular find of all, however, surfaced in early 2002 when two mineral dealers in Changsha offered long, thin, reddish crystals intergrown in radiating groups, identifying them as "bismuthinite"—the name commonly applied there to any thin or acicular crystals from Yaogangaxian. Unfortunately, the true species was not recognized and the false identification of the material as bismuthinite was accepted unchallenged for a while. But the red color, as well as the association with stibnite, soon made clear that in fact the species was kermesite—in amazing specimens, with crystals to a previously unheard-of length of 15 cm.

At a later date in the early part of 2002, the same two Changsha dealers offered additional kermesite specimens, this time correctly labeled as to species. These specimens, mostly loose crystal groups but a few with matrix as well, were obviously exceptional rarities. When asked about prices, the dealers as a matter of course named horrendously high sums, but when repeatedly asked where the specimens had been found they remained silent. Finally they asserted that Wenshan, in Yunnan Province, was the locality. But it was immediately clear to all who know Chinese mineral deposits that this is incorrect: Wenshan, near the border with Vietnam, is a zinc deposit entirely lacking in antimony. Unfortunately, however, the false locality was passed on to American dealers and subsequently published on the Internet.

Liu (2006) suggests that locality is the Caiwa mine in Danfeng, Shanxi Province. There is in fact a large mercury-antimony occurrence, described in the literature (Wu *et al.*, 1990), lying near Gongguan, in Shanxi Province, not too far from Danfeng. About the Caiwa mine at Danfeng, however, no information is currently available (the Danfeng Antimony Product Smelting Liability Company is registered in Danfeng).

In May 2005, a group of small specimens of stibnite with kermesite was marketed; most of the kermesite crystals are very thin, but a few of the shorter ones are more than 1 mm thick, as in some of the specimens from the 2002 discovery. The locality given for these stibnite/kermesite specimens is the previously unknown "Dayao mine, Guangxi Province" [the Dayao copper mine is actually in Yunnan province].

The correct locality for the 2002 find has only just now been revealed, by the original dealer who obtained them from the miners. It turns out that all the kermesite specimens had been purchased by the two Changsha dealers at a rural "stone market" (of a kind often visited by dealers) in Guilin, Guangxi Province, from a local mineral dealer named Youhui Wang. Wang had obtained all of the specimens from a single pocket found at an unnamed mine at **Damingshan Mountain,** near **Dafeng town, Shanglin County, Guangxi province**, and sold them as "stibnite." Not knowing that the mineral was a rare and more valuable species, he sold the entire lot for about $2000. Shortly thereafter, however, he learned of his mistake and decided to keep the locality secret in the hope that he could obtain more there without interference from other dealers. Unfortunately, no more was ever found. Finally, in October 2006, Wang agreed to reveal the correct locality (Weigang Chen, personal communication via Wendell Wilson).

The Damingshan kermesite specimens display flattened crystals to 15 cm long in radial aggregates. The color is dark brown by transmitted light, but dark red by strongly reflected light. The size and the quality of the kermesite crystals is so exceptional that the locality clearly deserves to be called the world's best occurrence of the species. The matrix, when present, is stibnite; associated species include valentinite, senarmontite in sharp crystals to 5 mm, and, very rarely, spherical aggregates of pääkkönenite to 1 mm.

CONCLUSIONS

Just knowing the date of a stibnite specimen can help to determine its locality, or can at least narrow the list of possibilities. A summary of the major periods of specimen production is as follows:

Xikuangshan	1989–1999, 2006
Lushi	1995–2000
Wuning	2000–2004
Nandan	2000?, 2004–2005

The 2006 Xikuangshan specimens show two generations of stibnite, and the 2004–2005 Nandan specimens are in the form of easily recognized "hedgehog" clusters like the classic Romanian specimens. The Wuning specimens generally have simple, frosty terminations.

To date, only a few of the very many active Chinese antimony deposits have provided interesting collector minerals. Whenever they have been successfully gathered, these specimens have profoundly impressed collectors by virtue of their extraordinary size and outstanding crystal development. These pleasant facts are, of course, the results of the development of the stibnite deposits in karst carbonaceous rocks, rich in cavities and caverns. The occurrences in Dachang and Qinglong (Guangxi Province) and in Muli (Yunnan Province) are much farther from Changsha and have not so far enjoyed close surveillance for collector material. But since mineral dealers in China do indeed seek new sources, future discoveries from deposits in Guangxi and Yunnan may be expected. Of special interest too are the rare oxidation species, even though these are not especially aesthetic; the deposits offer optimal conditions for the formation of many different species of this kind.

ACKNOWLEDGMENTS

For their helpful support during my visits to the mines in China, and for providing abundant information, I am grateful to Mrs. Puhong Zheng, Mr. Wen and Mr. Yuanming He. I am also grateful to Mr. Weigang Chen who, at the urging of Wendell Wilson, researched the origin of the kermesite specimens on our behalf and discovered for us the correct locality. Also, a special thanks to Mr. Hefu Wu, chief owner of the Antimony Company, Ltd., in Wuning, for his exceptional hospitality. And additional thanks go to Tom Moore for translating the German manuscript of this article.

BIBLIOGRAPHY

ANONYMOUS (1994) *The Discovery History of Mineral Deposits of China.* Hunan Province Volume (in Chinese). Beijing: Geological Publishing House, 279 pages.

BEHLING, S. C., LIU, G., and WILSON, W. E. (2002) Stibnite from the Wuling antimony mine, Jiangxi Province, China. *Mineralogical Record*, **33**, 139–147.

CARLIN, J. F. (2002) Antimony minerals. usgs.gov/minerals/pubs/commodity/antimony/060499.pdf

COOPER, M. P. (1992) Letter from Europe: Paris Show 1992. *Mineralogical Record*, **23**, 268.

GIBBSON, R. I. (1998) Antimony, the metallic sidekick, sets the world on fire—and puts it out. *Earth*, http://www.miningmuseum.org/antimony.htm

GUNSON, A. J. and YUE JIAN (2001) Artisanal mining in the People's Republic of China. *MSD Report*, **74**, 1–19.

JIANG, NIANSHENG, YANG SHIRUI, CHENG MIAZHANG, and LUO LUJING (1989) The Xikuangshan antimony ore deposit and Woxi gold-tungsten-antimony ore deposit, Hunan Province. *30th IGC Field Trip Guide* T343, 1–9.

LIU, MENGGENG (Ed.) (1987) Guide to the metallogenic map of endogenic ore deposits of China, 1:4,000,000. Beijing: Cartographic Publishing House.

LIU, G. (1995) Zinnober und Antimonit: ausgezeichnete Kristalle und ihre Fundstellen in China. *Lapis*, **20** (10), 33–43.

LIU, G. (2003) China: a promising new entry in the mineral specimen market. *ExtraLapis English*, **4**, 48–54.

LIU, G. (2006) *Fine Minerals of China*. Zug, Switzerland: AAA Minerals AG. 366 pages.

McCALLUM, R. I. (1999) *Antimony in Medical History*. Pentland Press, 125 pages.

MOORE, T. (1992) What's new in minerals? Tucson Show 1992. *Mineralogical Record*, **23**, 277.

MOORE, T. (1996) What's new in minerals? Tucson Show 1996. *Mineralogical Record*, **27**, 222.

MOORE, T. (2000) What's new in minerals? Tucson Show 2000. *Mineralogical Record*, **31**, 283.

MOORE, T. (2004) What's new in minerals? Tucson Show 2004. *Mineralogical Record*, **35**, 256.

NIEDERMAYR, G. (2004) Ein bemerkenswerter Neufund von Carbonat-Cyanotrichit aus China. *Mineralien Welt*, **15** (5), 58–60.

OTTENS, B. and LIU, G. (2004) Weltberühmt—Antimonit in höchster Perfektion. *ExtraLapis*, **26/27**, 60–67.

PEAKSEARCH (2003) www.peaksearch.com: China's antimony output, htm in Business Recorder on July 2, 2003.

PREMOLI, C. (1986) China's tin potential with special reference to Dachang Tinfield. *Mining Magazine*, January 1986.

ROBINSON, G. W., and KING, V. T. (1989) What's new in minerals? *Mineralogical Record*, **20**, 394.

ROBINSON, G. W., and KING, V. T. (1990) What's new in minerals? *Mineralogical Record*, **21**, 488.

TING, V.K., and WONG, W. H. (1921) Special Report of the Geological Survey of China, No. 1: General Statement on the Mining Industry. Peking: Commercial Press Works.

WU, J., XIAO, Q., and ZHAO, S. (1990) The Editorial Committee of the Mineral Deposits of China (Antimony) in *Mineral Deposits of China*, Vol. 1. Beijing: Geological Publishing House.

YI, L., SHAN, Y., and CHEN, G. (1998) The role of post-orogenic extensional tectonics in genesis of the Xikuangshan antimony deposit in the central part of Hunan province in southern China. *Proceedings of the Ninth Quadrennial IAGOD Symposium*. Stuttgart: Schweizerbart'sche Verlagsbuchhandlung, 47–56.

ZHU XUN (Ed.) (2002) *Mineral Facts of China*. Beijing: Science Press, 776 pages.

ARIZONA

MINERAL & FOSSIL SHOW

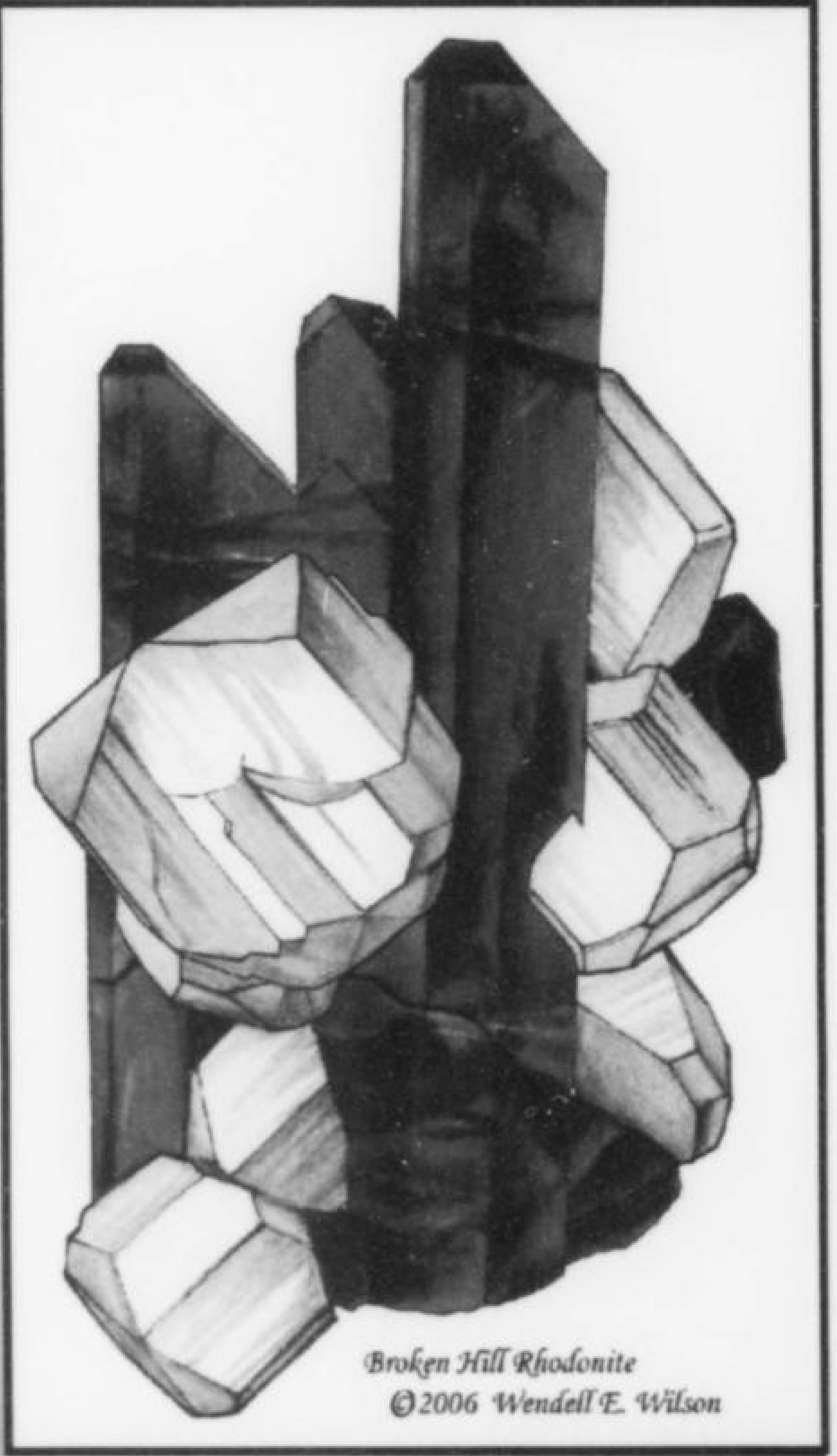
TUCSON — JAN. 27 - FEB. 10, 2007

Open 10 to 6 Daily (*except Sat., Feb. 10th only, 10 to 5*)

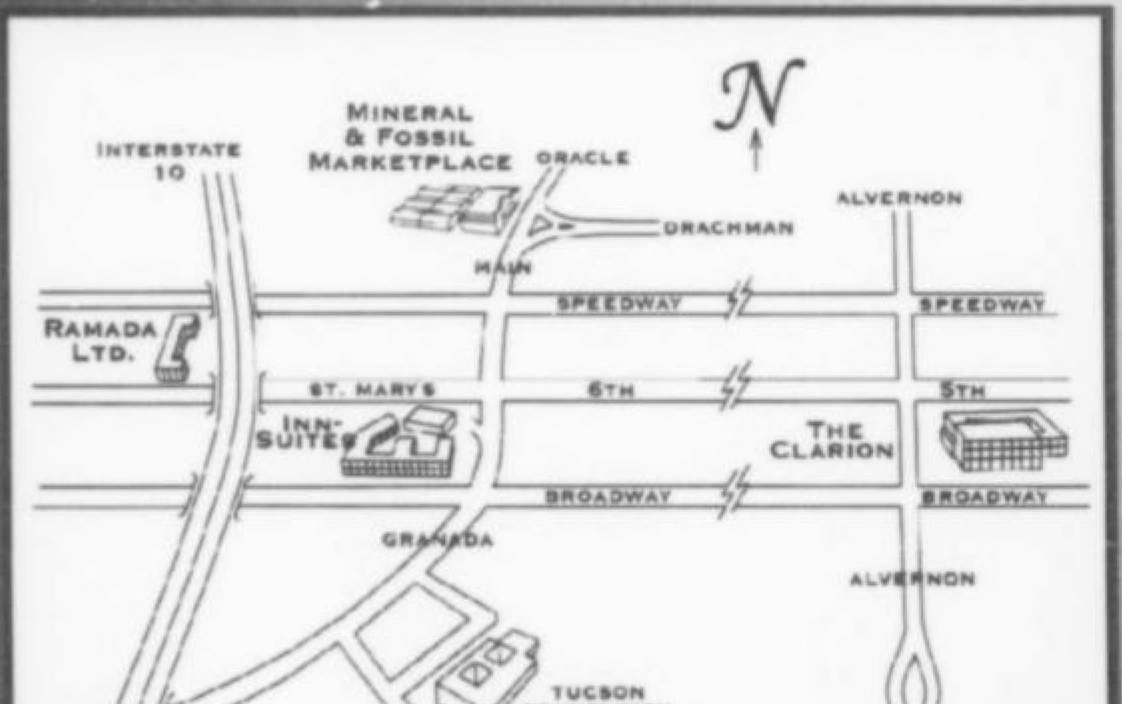
For the best minerals & fossils in Tucson . . . visit the 400 great dealers in these

5 Easy to Find LOCATIONS ~

- **★ Quality Inn - Benson Hwy.**
  Interstate 10 at Exit 262
- **★ Clarion Hotel - Randolph Park**
  102 N. Alvernon, at Broadway
- **★ Ramada Ltd. - Downtown**
  665 N. Freeway, at St. Marys
- **★ InnSuites Hotel - Downtown**
  475 N. Granada Ave., at St Marys
- **★ The Mineral & Fossil Marketplace**
  1333 N. Oracle, at Drachman

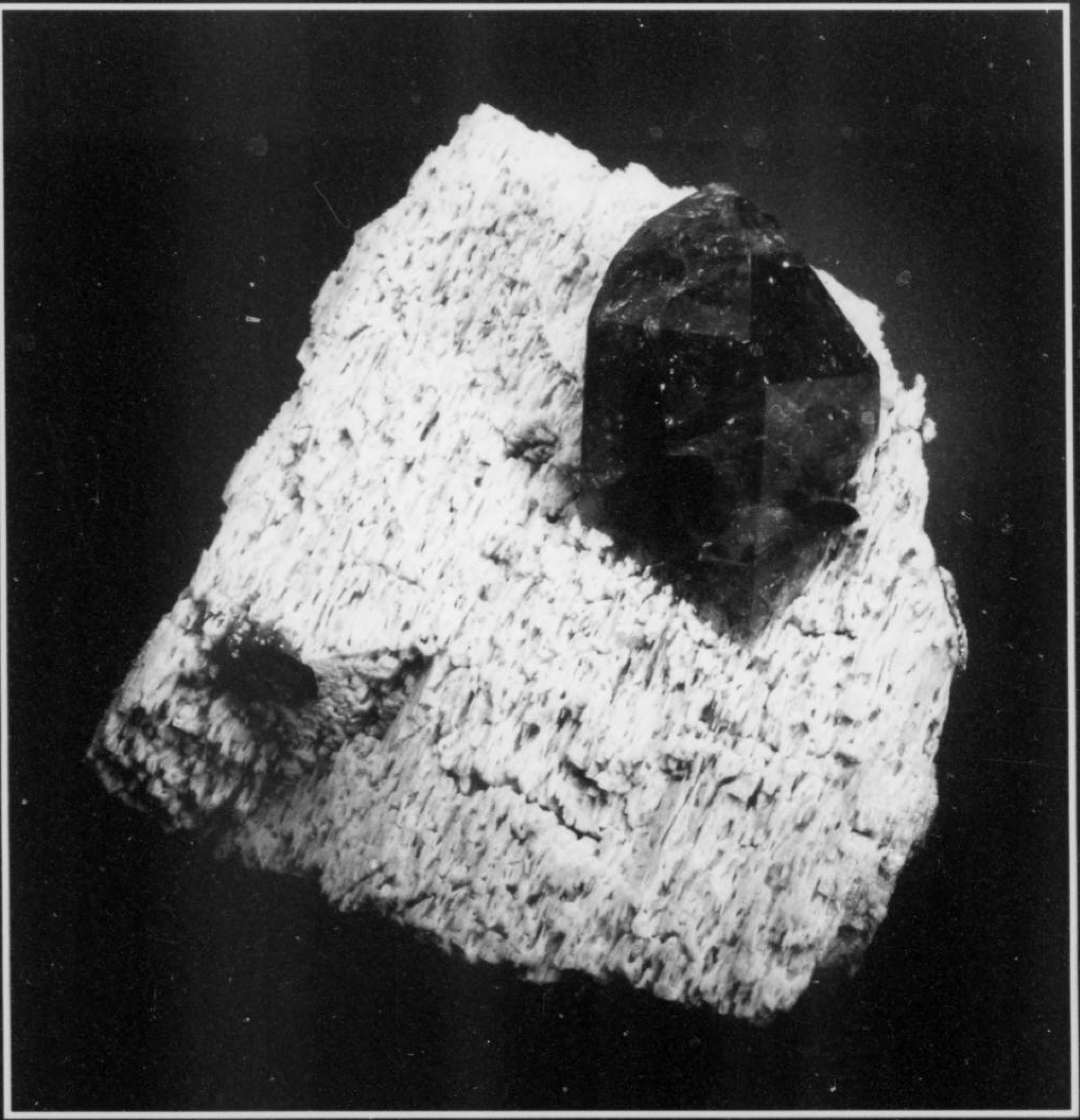


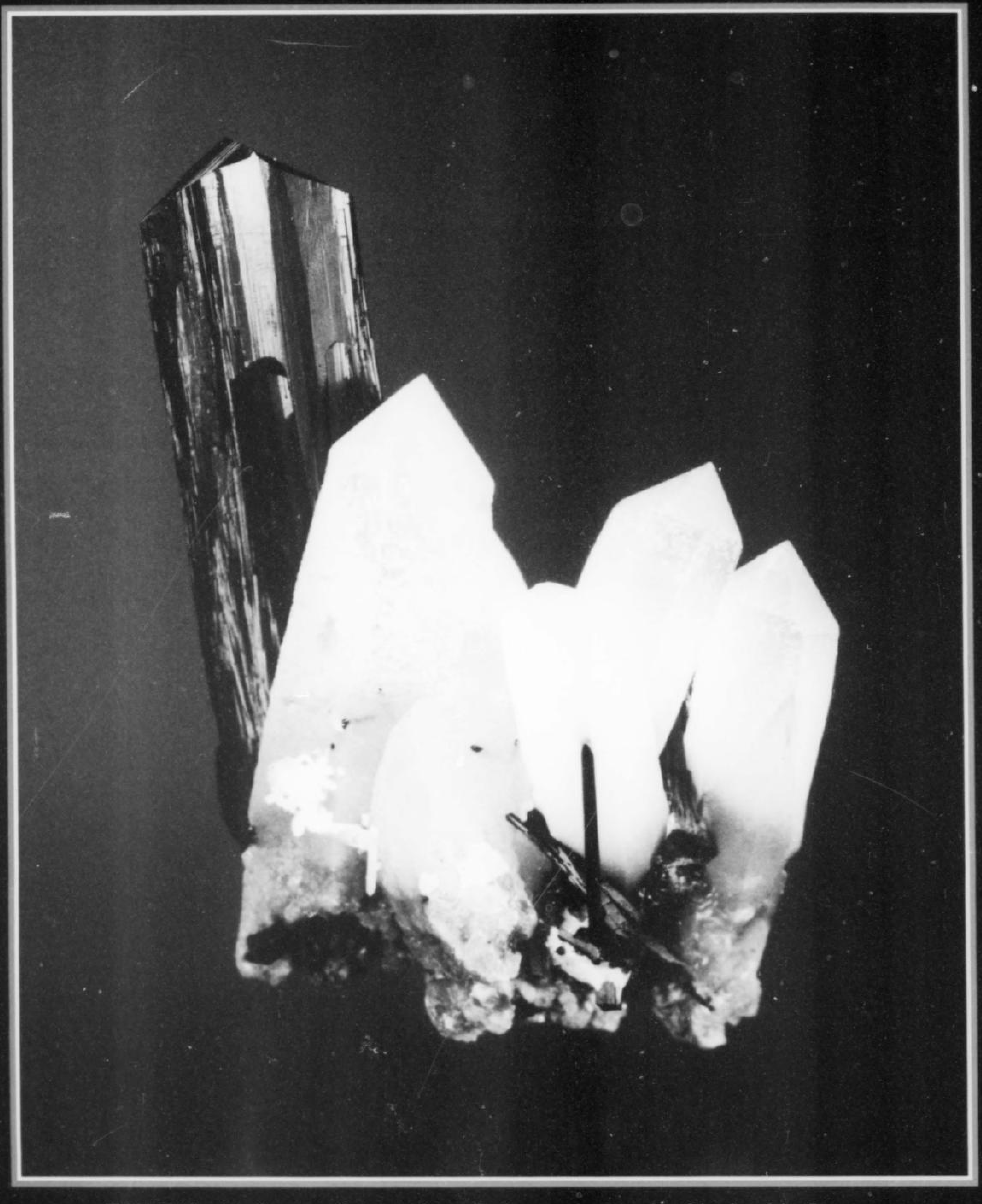
Broken Hill Rhodonite
©2006 Wendell E. Wilson



Free Shuttle Bus to ALL 5 Locations
Wholesale ★ Retail
Open to the Public
Free Admission ★ Free Parking

Martin Zinn Expositions, L.L.C. • P.O. Box 665 • Bernalillo, NM 87004 • Fax: (505) 867-0073 • email: mz0955@aol.com • www.mzexpos.com





ILVAITE with Quartz, 6.4 cm, from Dalnegorsk, Russia. Obtained in January 2000 from Sandor Fuss, who had obtained it from Daniel Trinchillo.

Clara and Steve Smale

COLLECTORS

PHOTO BY JEFF SCOVIL

FINDING NEW HOMES
for your TREASURES!

FINEST KNOWN PYROMORPHITE FROM THE FAMOUS ROUGHTON GILL MINE, ENGLAND, CA. 1840'S; 14 CM TALL. SOLD BY BRYCE WRIGHT SR. IN THE 1860'S; DONATED TO THE ROYAL EDINBURGH MUSEUM IN THE 1870'S; EXCHANGED TO SIMON HARRISON IN THE 1980'S; SOLD TO RALPH SUTCLIFFE; THEN SOLD TO LINDSAY GREENBANK; THEN SOLD TO ED DAVID (1998); NOW IN THE WALLACE MANN COLLECTION, DALLAS.

The Arkenstone

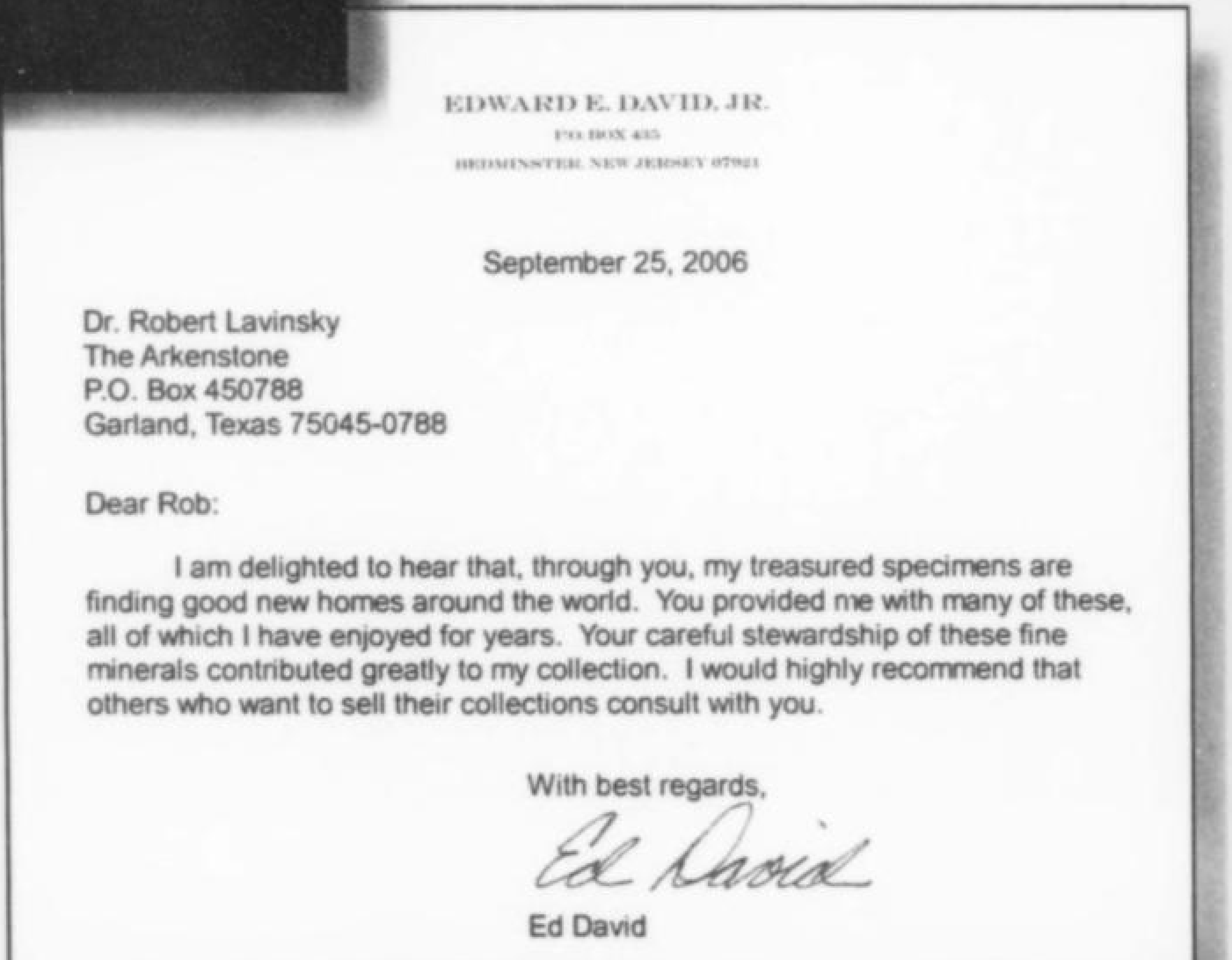
Thank you!

... To all my friends who
have allowed me to sell
their collections in recent
years, including:
Marshall &
Charlotte Sussman
Charlie Key
Gary Hansen
Ed David
Eric Asselborn
Dick Hauck
...and many more!

Dr. Robert Lavinsky
The Arkenstone
P. O. Box 450788
Garland, TX 75045-0788
E-mail:
Rob@irocks.com
Tel.: 972-437-2492
(normal hours CST)

•

Large showroom now
open! Call us to
schedule a visit
when you are in Dallas



EDWARD E. DAVID, JR.
P.O. BOX 435
BEDMINSTER, NEW JERSEY 07921

September 25, 2006

Dr. Robert Lavinsky
The Arkenstone
P.O. Box 450788
Garland, Texas 75045-0788

Dear Rob:

I am delighted to hear that, through you, my treasured specimens are finding good new homes around the world. You provided me with many of these, all of which I have enjoyed for years. Your careful stewardship of these fine minerals contributed greatly to my collection. I would highly recommend that others who want to sell their collections consult with you.

With best regards,

Ed David

Ed David

Photos by Jeff Scovil

The
PINGTOULING MINE
Liannan County, Guangdong Province, China

Wendell E. Wilson
Mineralogical Record
minrec@earthlink.net
Tucson, Arizona 85750

World-class yellow-orange mimetite crystals to more than 2 cm, found at a mine in Guangdong province, China, first reached the world mineral market in January 2003. A total of several thousand mimetite specimens were recovered, as well as about 30 attractive specimens of scorodite found later in 2003. The locality now appears to be exhausted.

INTRODUCTION

Large and fine mimetite crystals have come from few places in the world, the most prominent being the Tsumeb mine in Namibia, Hat Yai province in Thailand, and the Mt. Bonnie mine in Australia. In all cases the number of specimens produced was quite small. In August 2002 a zone containing brilliant crystallized mimetite was encountered in the Pingtouling lead-zinc mine, Liannan Yao Autonomous County, Guangdong province, China. Some of the specimens found their way to the Tucson Show in January 2003 and caused great excitement in the mineral world.

As is typical in China, the locality was at first concealed by dealers or by their suppliers; it was identified variously as "near Bapu, Guangdong," and the "Wu Chuan mine, Guangxi" (Moore, 2003). However, the true source was eventually revealed as the Pingtouling ("flat-topped mountain") mine about 200 meters from Pingtouling village, about 10 km southwest of the town of Zhaigang in Liannan, Guangdong province. An unpaved 12-km road connects the mine area to the regional highway from the town of Zhaigang.

The beautiful, sub-tropical, forested mountainous area in which the mine is located is populated mainly by the Yao people, one of 11 ethnic groups in Liannan County. The Yao are a unique people with their own culture and language, though most of them also speak Mandarin Chinese. The Yao homeland is rich in spectacular vistas and relatively undeveloped natural resources such as timber, hydroelectric power and more than 20 exploitable mineral deposits (mainly lead, zinc, iron and copper, but also gold, tin, tungsten, manganese and bismuth). Though formerly operated by the government, most of the small mines are now being worked by private owners and township cooperatives.

The occurrence was admirably described in an article by Guanghua Liu (2005), from which much of the information here is taken. Specimens have also been pictured in Liu (2006), Moore (2003) and Moore (2004), as well as on the cover of the May-June 2003 issue of the *Mineralogical Record*.

MINING HISTORY

Mining has been carried on in the area for at least the last 2,000 years. The Pingtouling lead-zinc deposit was discovered accidentally by a local farmer in 1952. Ore cropped out in a river bed where the farmer had been "fishing" with explosives. Between 1952 and 1954 he extracted about 5,000 tons of high-grade oxide ore averaging more than 40% metal content. In 1956 a drilling company owned by the provincial government completed a drilling project on the site and delineated the orebody, much of which lies under the riverbed. Large-scale mining by the Damaishan Copper Mining Company (owned by the county government) did not begin until 1967, following diversion of the riverbed in order to make possible a hand-dug open pit operation. About 30 miners were employed in the pit, but as the excavation deepened, water-pumping began to

Figure 1. **View from the dump of the Pingtouling mine, looking down on the small village of Pingtouling. Graham Sutton photo.**

Figure 2. **Locality map.**

cause surface subsidence in the surrounding area. Mining ceased in 1970, the workings were abandoned, and the mine pit was allowed to flood. The local people eventually forgot that the excavation had been officially named the Pingtouling mine, and began referring to it simply as the Dashuihu ("big water pool") mine.

By 1999 the Damaishan Copper Mining Company had gone bankrupt. A former miner named Li Yutang purchased the rights to the mine for 80,000 yuan (about $9,750) and began working it again. The flooded open pit seemed beyond reclamation, so he sank three inclined shafts in an attempt to intercept the heavily oxidized portion of the orebody that was not under the riverbed. Despite investing close to another $100,000, he failed to find the ore. In 2001 he leased the mining rights to a Mr. Zhou, a miner from Yunnan province, who sank two additional shafts and recovered a few hundred tons of oxidized lead ore, but lost money in the process. Several pockets of beautiful mimetite were encountered in 2001 and early 2002, but were crushed as ore.

In 2002 the mining rights were leased to Jiang Zemin. He opened a narrow adit (called the Dashuihu adit), just 1.2 × 1.8 meters across, at the margin of the old open pit and succeeded in reaching the orebody. Employing just six miners, he began extracting arsenic-rich ore (locally up to 30% As).

In August of 2002, more crystallized mimetite was encountered, but the crystals were of rather poor quality and a dirty brown color. These were given away free to some mineral dealers from Guilin, who later sold them to several European dealers. In October 2002 another pocket was encountered, consisting of better-quality specimens with brightly colored crystals from 1 to 10 mm in size. These crystals are rather varied in color, ranging from a deep yellow resembling mimetite to a red or red-orange resembling vanadinite to dark brown and brown-green resembling pyromorphite; some of the crystals are bi-colored. Berthold Ottens (personal communication) puchased some of these in Changsha in late 2002.

Figure 3. Adit entrance to the Pingtouling mine. Graham Sutton photo.

Between October and November of 2002 the main pocket was apparently encountered and even better specimens were brought out; these are primarily yellow in color, with crystals up to nearly 2 cm. A total of around 3,000 specimens were collected from this find with amazingly professional care, and a significant percentage of them were preserved in a relatively undamaged state, including approximately 300 pieces of good quality and a few dozen of top quality. Most of these were purchased by one dealer in Changsha, for the remarkable price of around $250 per ton—the same as the ore value! He sold about half of the find to New York mineral dealer Daniel Trinchillo. Berthold Ottens and other European dealers obtained lots as well, which they sold in Europe. Trinchillo and others brought specimens to the following Tucson Show (Moore, 2003). Through Trinchillo, Rob Lavinsky of *The Arkenstone* acquired a major portion of the find. Mike Bergmann and a handful of other dealers also acquired lots for resale. Lower-end specimens were also marketed in Tucson by a number of Chinese dealers.

A period of furious collecting ensued at the mine, but apparently nothing more was found after November 2002. It was later said (Moore, 2004; Liu, 2005) that additional pockets were discovered as late as September 2003. At least four more lots of specimens came on the market, including some top-quality pieces. This material may have been from newly found pockets or may simply have been the second half of the big lot of specimens found in the original October-November 2002 pocket. (Chinese dealers like to speculate in specimens, waiting for prices to go higher.) In any case, nothing has been found there since 2003. Jiang Zemin, however, continued to mine the deposit for ore, and by May of 2004 he had extracted more than 10,000 tons of high-grade oxide ore, but by 2005 mining had penetrated into the unoxidized ore.

Bryan Lees of *Collector's Edge Minerals* hired a contract crew of Chinese miners to work the mine from April to December of 2005, part of that time under the direction of Bryan's mining supervisor, Graham Sutton. They concentrated on the zone about 20 meters down the 80-meter inclined shaft where the original mimetite pockets had been encountered. Despite driving over 20 meters of exploratory drifts they unfortunately found virtually nothing except traces of white pyromorphite and scraps of bad brown mimetite—not even worth exporting. The original miners, it seems, had been meticulously thorough in removing any trace or hint of good mineralization. It is now relatively certain (as anything can be in the mining world) that the occurrence is exhausted.

GEOLOGY

According to Liu (2005), the Pingtouling orebody is a hydrothermal deposit genetically related to the emplacement of nearby granitic plutons. The presence of iron, copper and arsenic deposits elsewhere in the local area suggests the existence of a polymetallic belt. The orebody is heavily oxidized in the surface zone, down to a level about 2 meters below the level of the river, below which unoxidized lead ore predominates.

MINERALS

Mimetite $Pb_5(AsO_4)_3Cl$

The first specimens found in 2002 range in color from bright red (at first assumed to be vanadinite) to orange, yellow and brownish green (thought perhaps to be pyromorphite); some crystals are elongated, tapered, and bi-colored orange-red and yellow. Subsequent finds proved to be of higher quality and primarily yellow to yellow-orange in color. So spectacular are the crystals, and so surprising the quantity (for mimetite), that when they first reached the American market in 2003 suspicion immediately arose that the yellow crystals were pyromorphite instead of mimetite. However, analyses conducted at the University of Arizona (Marcus Origlieri, personal communication) soon confirmed their identity as mimetite, and those results were later repeated by analysts in China and Germany. The red crystals and the green crystals were analyzed at the University of Stuttgart and, amazingly, both were found to be pure end-member mimetite, with hardly a trace of vanadium or phosphorus (Berthold Ottens, personal communications).

The vast majority of the mimetite crystals are simple, blocky, hexagonal prisms with large, smooth pinacoid faces. All of the faces generally have a mirror-bright, adamantine luster and very sharp edges. The crystals are beautifully translucent to gemmy in places (though no large, completely water-clear crystals like those

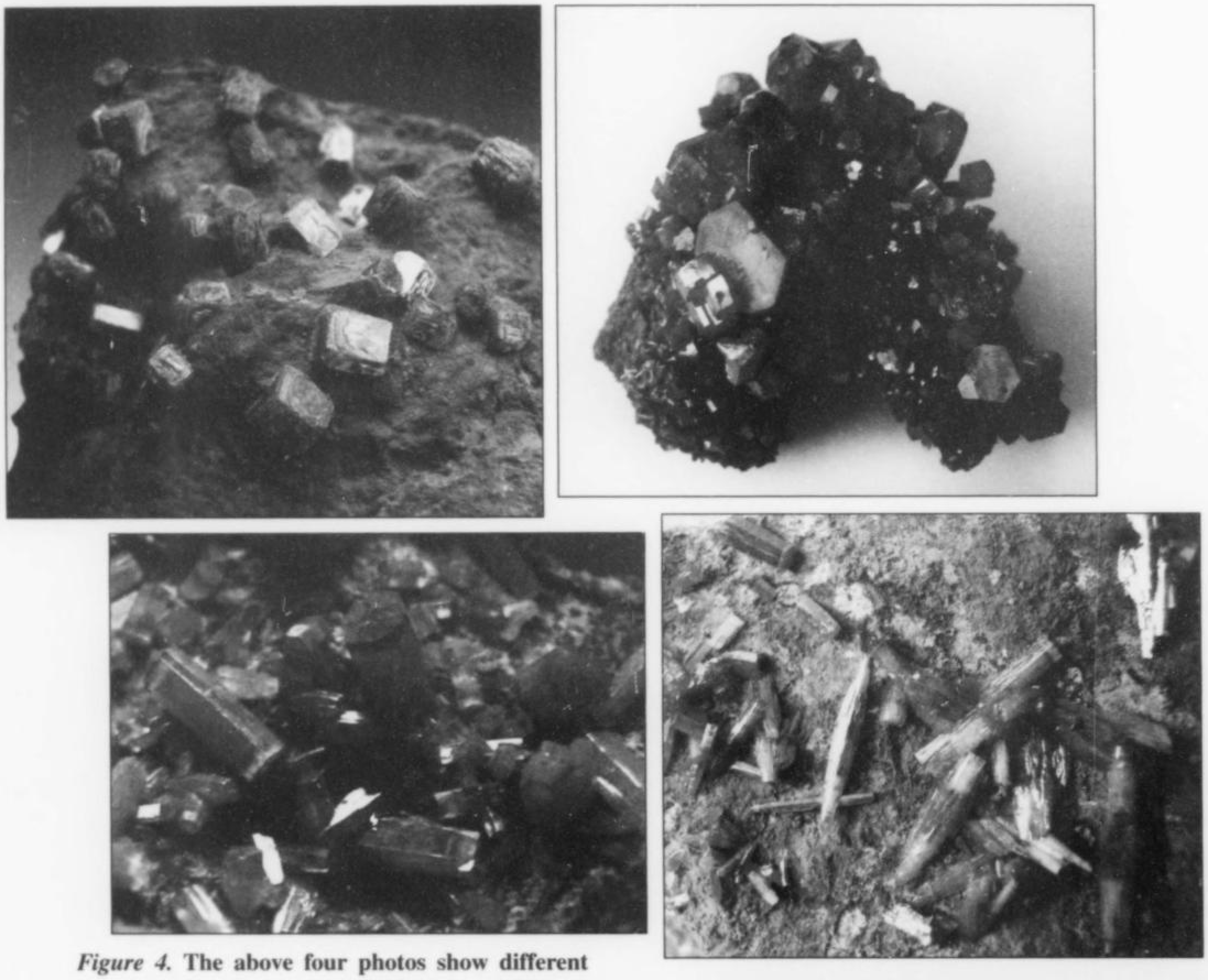


Figure 4. **The above four photos show different colors of mimetite recovered in the first small batch to reach the market in China. All have been chemically analyzed and are pure end-member mimetite. Berthold Ottens specimens and photo.**

Figure 5. **Mimetite in barrel-shaped crystals on limonite matrix, 7 cm, from Pingtouling. Guanghua Liu specimen; Jeff Scovil photo.**

from Tsumeb were found). Most crystals are 1 cm or less, but single crystals up to over 2 cm were recovered, in thick crusts and intergrown clusters on a blackish to ochre-colored limonitic gossan matrix. The exposed terminations tend to be perfect, whereas the end attached to matrix tends to taper down irregularly, as is often seen with large vanadinite crystals. In other cases the prism sides and even the pinacoid face are broken up into striated or terraced surfaces that grade into parallel crystal aggregates.

Crystals vary in proportions from tablets that are two or three times as large across the pinacoid face as along the c axis, to primarily prismatic crystals where the elongation ratio is 4 or 5 to 1. The smallest crystals can be equant or nearly acicular, grading up to the largest crystals which are generally tabular. A few rare specimens show striated, elongated crystals tapering almost to a point. Some crystals show reflective, silky zones just below the prism surfaces indicative of micro-voids, exactly as seen on some large vanadinite crystals from Morocco.

Aside from the first few crystals found (which, as mentioned, range in color from red to orange, yellow and brownish green), the color of the mimetite specimens reaching the market ranges from colorless (very rare) to grayish yellow, but primarily pale yellow,

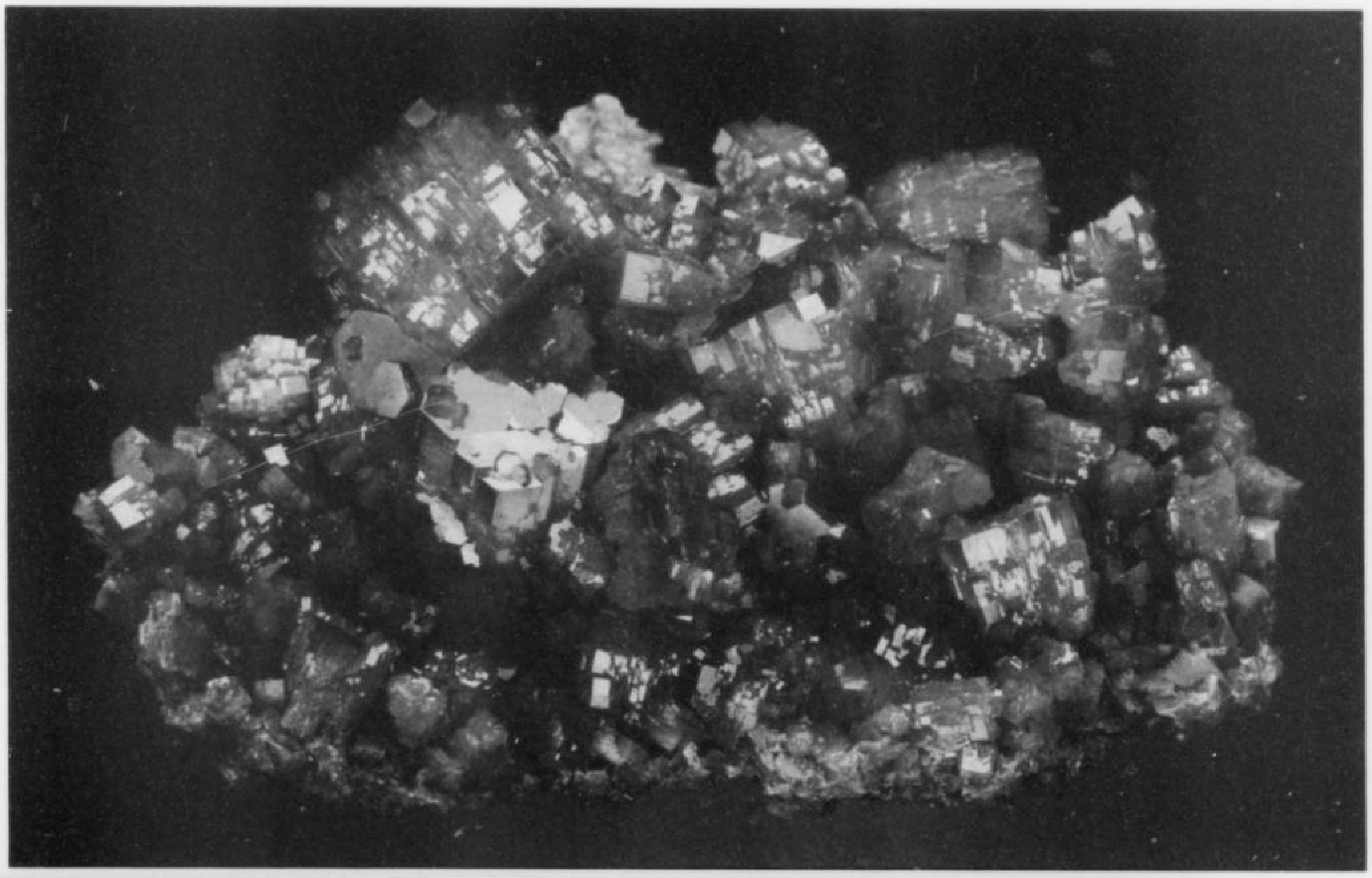


Figure 6. **Mimetite cluster, 7 cm, from Pingtouling. Stuart Wilensky specimen; Jeff Scovil photo.**

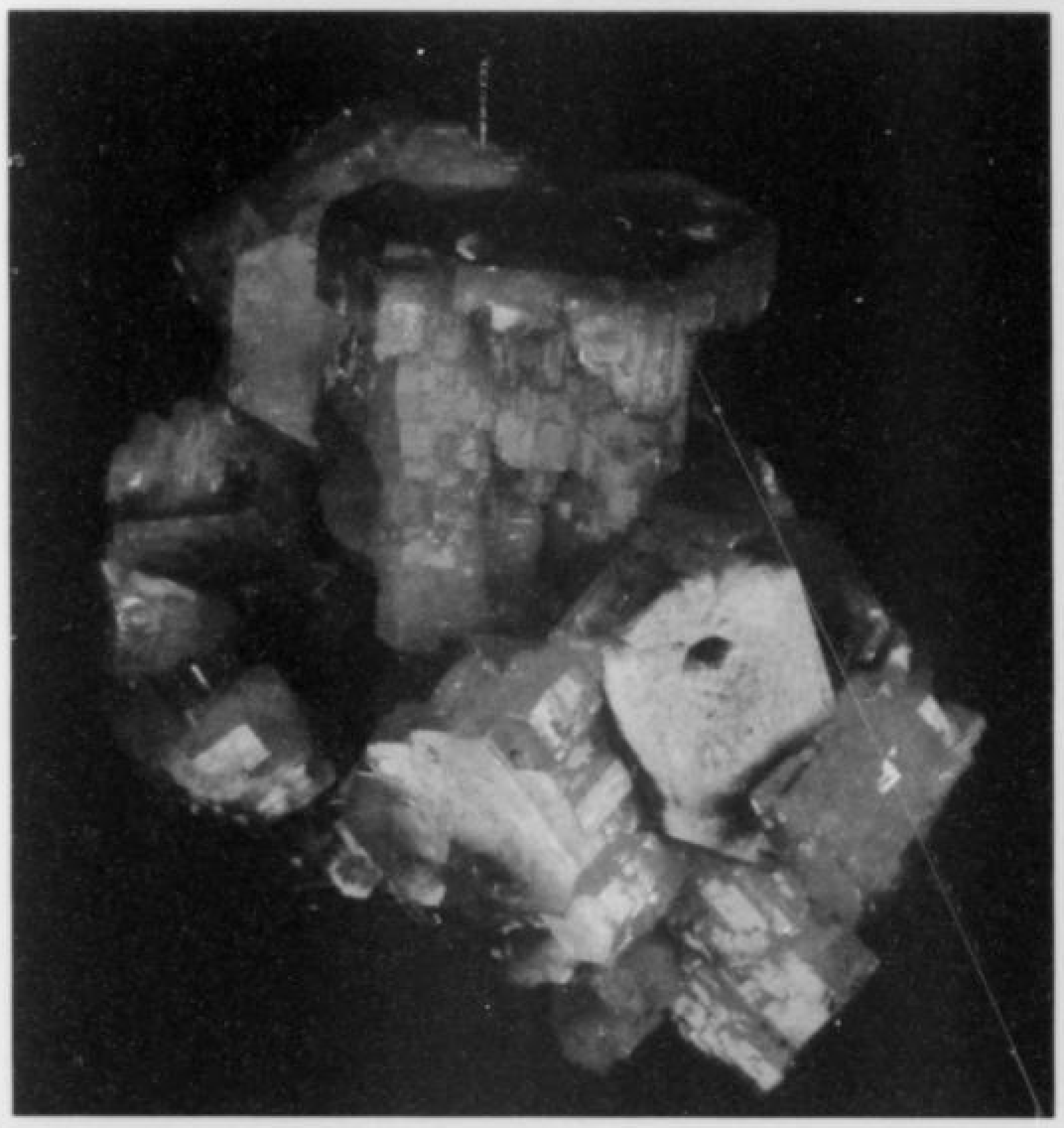


Figure 7. **Mimetite crystal cluster, 3.1 cm, from Pingtouling. Daniel Trinchillo specimen; Jeff Scovil photo.**

Figure 8. **Mimetite crystal cluster, 3.5 cm, from Pingtouling. Daniel Trinchillo specimen; Jeff Scovil photo.**

Figure 9. **Mimetite crystal cluster on limonite, 7.6 cm, from Pingtouling. Steve Smale collection; Jeff Scovil photo.**

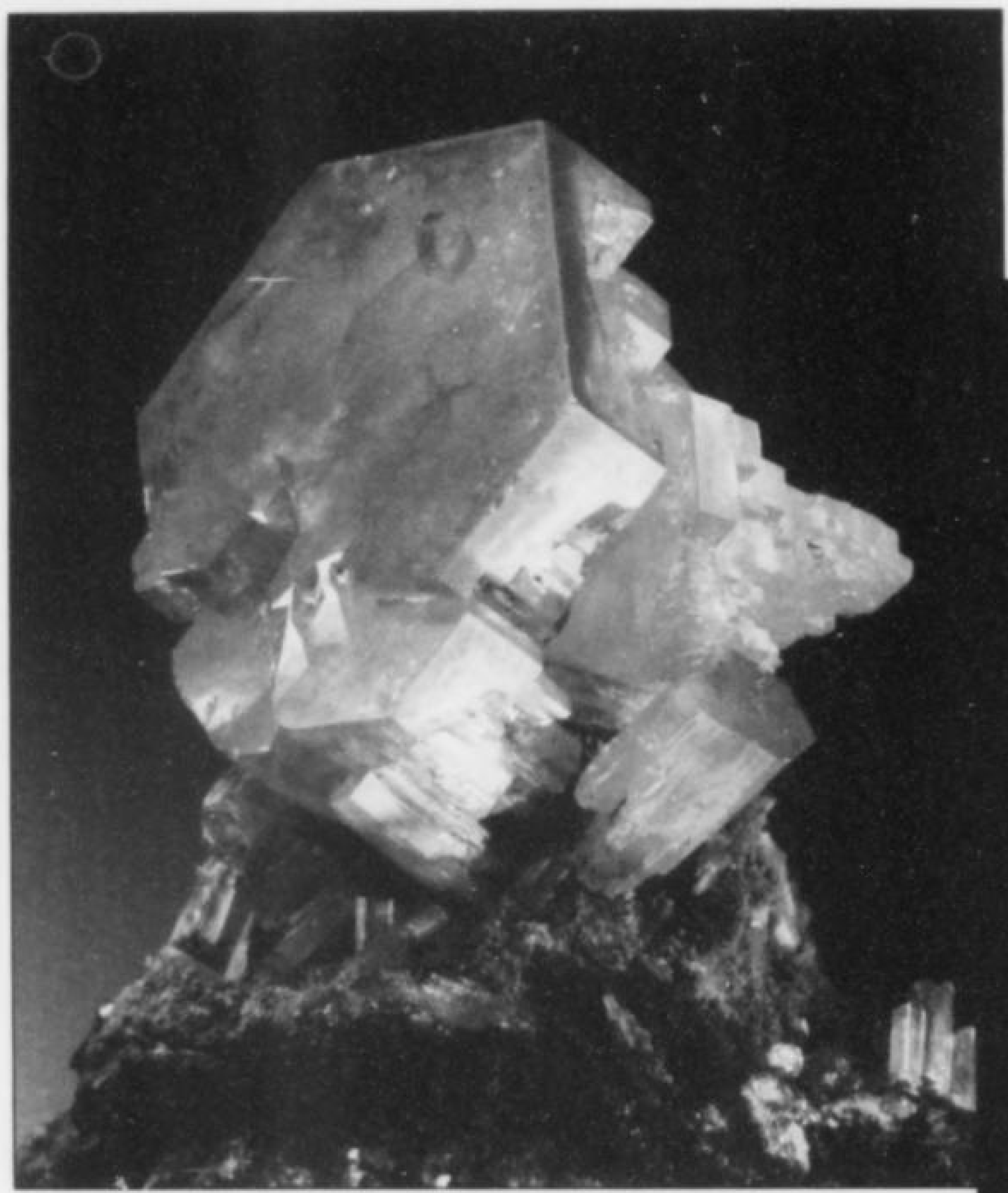


Figure 10. **Mimetite crystal 1.8 cm across, from Pingtouling. Guanghua Liu specimen; Jeff Scovil photo.**

Figure 11. **Mimetite crystals on matrix, 11 cm, from Pingtouling. Marv Rausch collection; Jeff Scovil photo.**

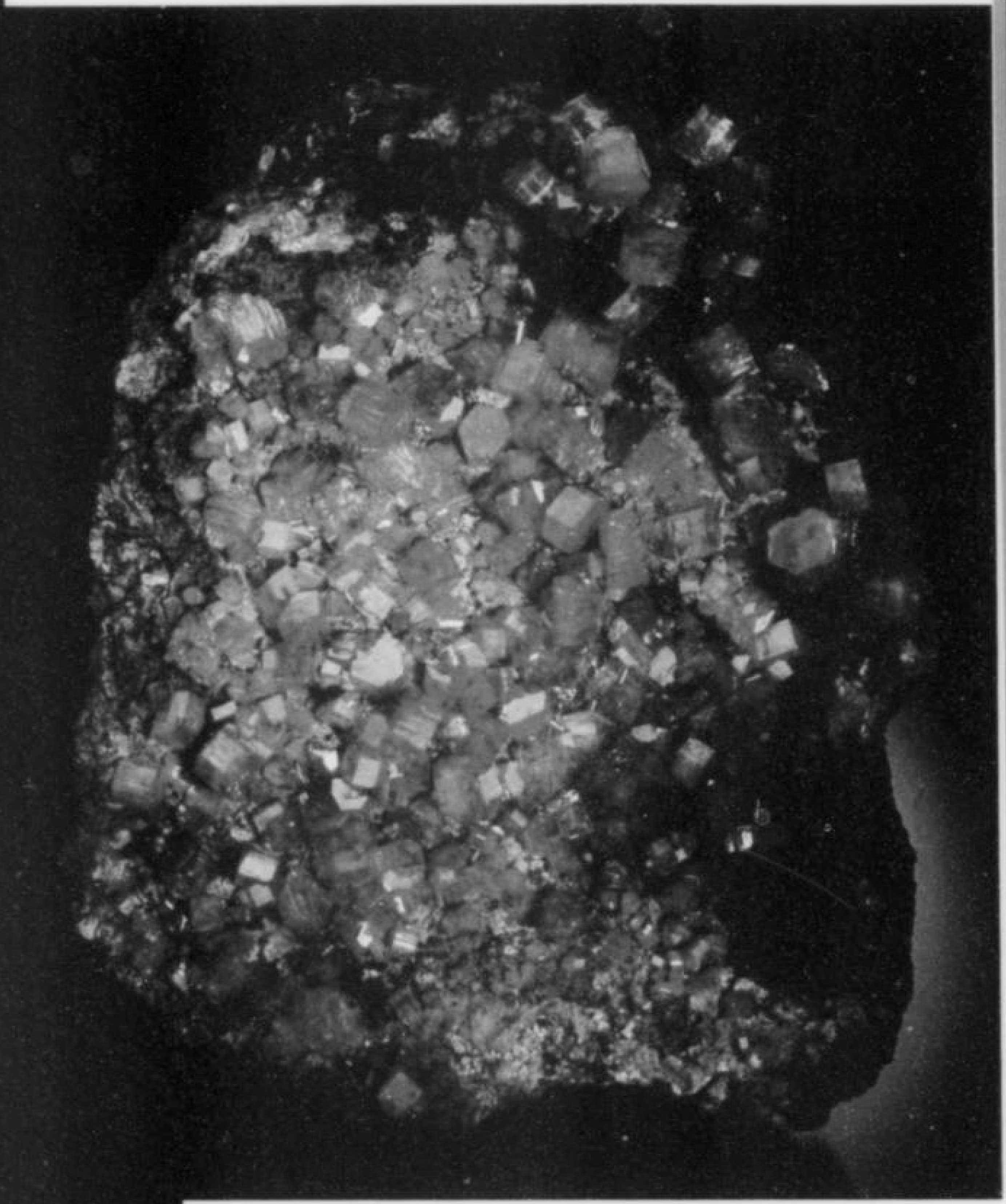


Figure 12. **Mimetite crystals to about 1 cm, from Pingtouling. Rob Lavinsky specimen (irocks.com); Jeff Scovil photo.**

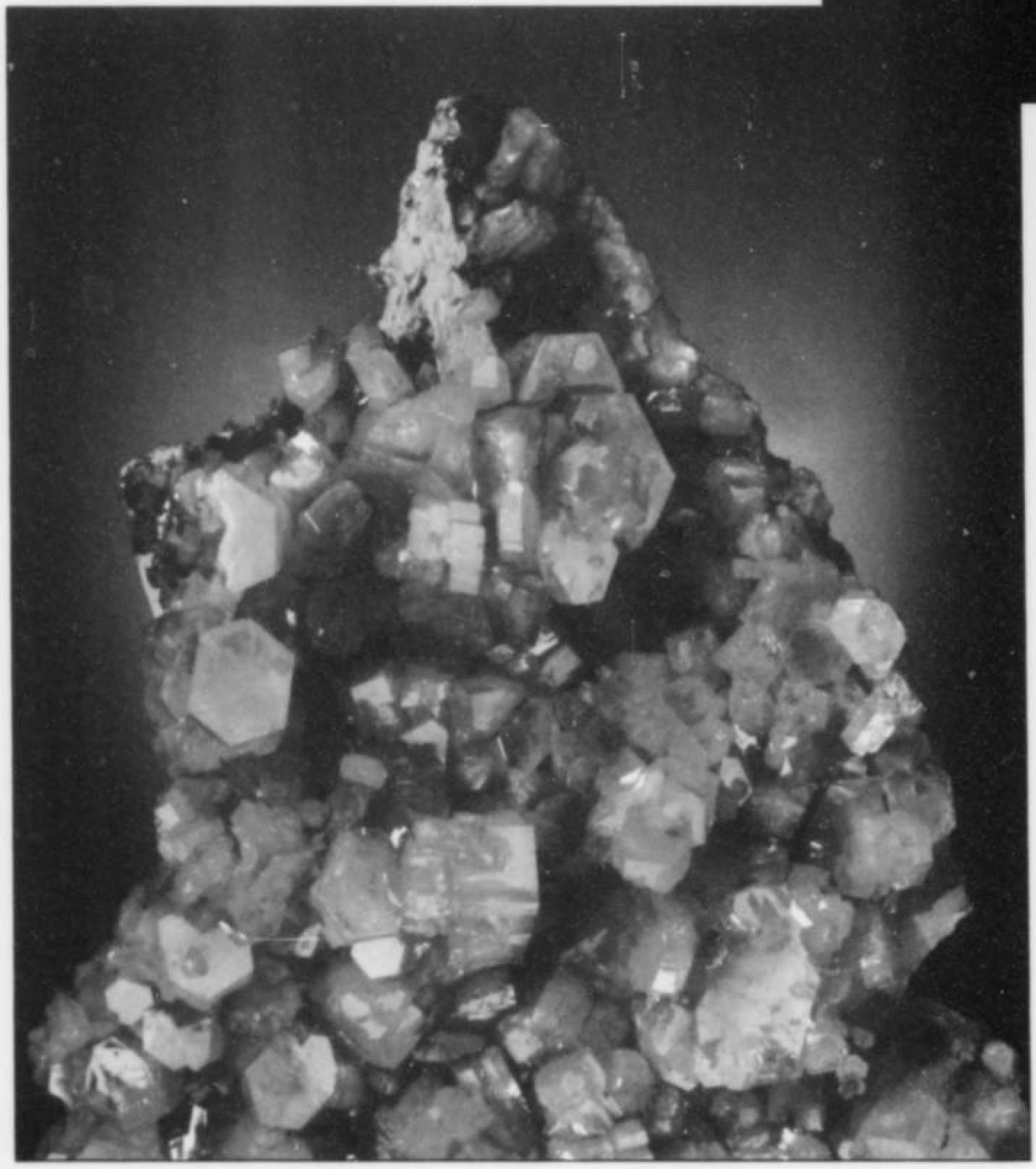


Figure 13. **Mimetite crystal cluster, 2.6 cm, from Pingtouling. Wendell Wilson specimen and photo.**

Figure 14. **Mimetite crystals on limonite, 5 cm, from Pingtouling. Guanghua Liu specimen; Jeff Scovil photo.**

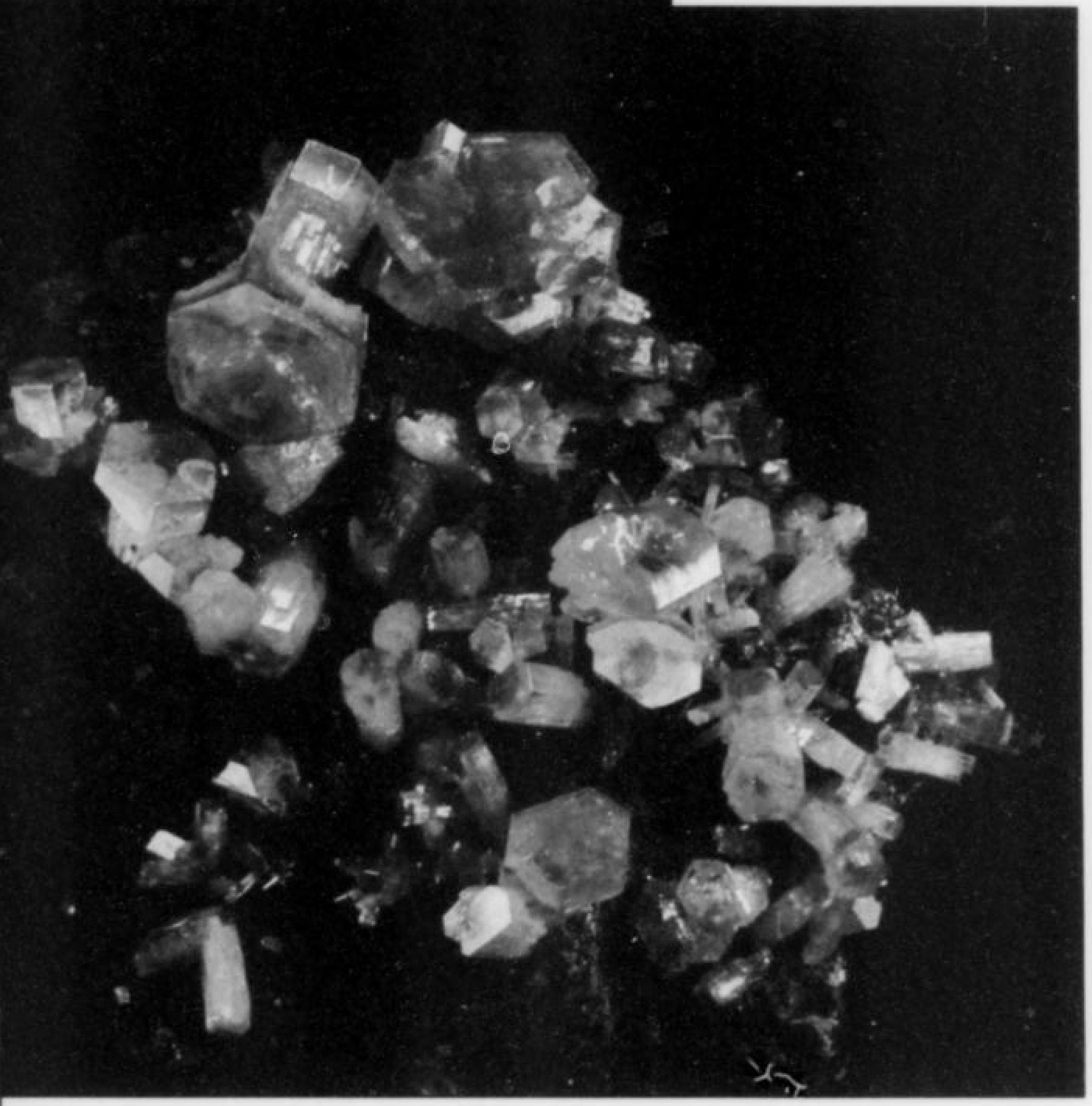


Figure 15. **Mimetite crystals to 1 cm on limonite, from Pingtouling. Martin Zinn collection; Jeff Scovil photo**

Figure 16. **Scorodite crystal, 1 cm, from Pingtouling. John Veevaert (trinity minerals.com) specimen and photo.**

canary-yellow, bright yellow-orange (exactly like the color of Old Yuma mine wulfenite) and darker yellow-orange (probably darkened by limonitic inclusions). Some crystals have selected faces rendered opaque brown by a thin layer of dirty inclusions. Most loose crystal clusters are around 2 to 5 cm in size, but fabulous cabinet specimens to over 17 centimeters were recovered, some of them heavily encrusted by large, superb crystals. Botryoidal mimetite was also found but was not considered to have sufficient specimen value and was generally not saved.

Scorodite $Fe^{3+}AsO_4 \cdot 2H_2O$

According to mineral dealer Martin Jensen (Moore, 2005), a major zone of scorodite was encountered in the Pingtouling mine in November 2003. Apparently a whole ore car full of crystallized scorodite was mined but its specimen value was not recognized until most of it had been processed as ore; only about 30 specimens were saved. Martin purchased the specimens on behalf of his employer at the time, *Collector's Edge Minerals* in Golden, Colorado. Internet mineral dealer John Veevaert of *Trinity Minerals* purchased five of them. The lustrous scorodite crystals, up to 1 cm in size, are sharp and mirror-faced with light striations, and show a pronounced color change, from blue-green under incandescent lighting to purple-blue in daylight. The crystals line cavities to a few centimeters across in earthy brown limonite, associated with microcrystals of anglesite, arsenian siderite and beudantite. Some of the larger specimens with dense crystal pocket-linings are quite attractive.

CONCLUSION

Unlike the case with its mineral cousins, vanadinite and pyromorphite, discoveries of world-class crystallized mimetite have always been very limited in quantity and duration of production. Fine mimetite specimens from the Pingtouling mine were collected during only a few months in 2002. This was one of those cases where collectors had only a small window of time in which to obtain a high-quality specimen before the opportunity passed. Because mining in the small deposit has now passed through the oxidized zone, it is highly unlikely that any more specimens will be discovered. Like Kongsberg silver and Bolivian phosphophyllite, the specimens of Chinese mimetite now in collections will circulate among future generations of collectors as highly valued classics of mineralogy—among the first to come forth in the 21st century.

ACKNOWLEDGMENTS

My thanks to Jeff Scovil for the use of his superb specimen photography; to Steve Behling and Graham Sutton of Collector's Edge Minerals for locality photos and information on their mining activities there; and to Berthold Ottens, Anthony Kampf and Guanghua Liu for reviewing the manuscript.

REFERENCES

LIU, G., and OTTENS, B. (2004) Pyromorphit und Mimetesit, die farbigen Bleiminerale. In: *ExtraLapis No. 26/27: China.* Weise Verlag, München. 26–31.

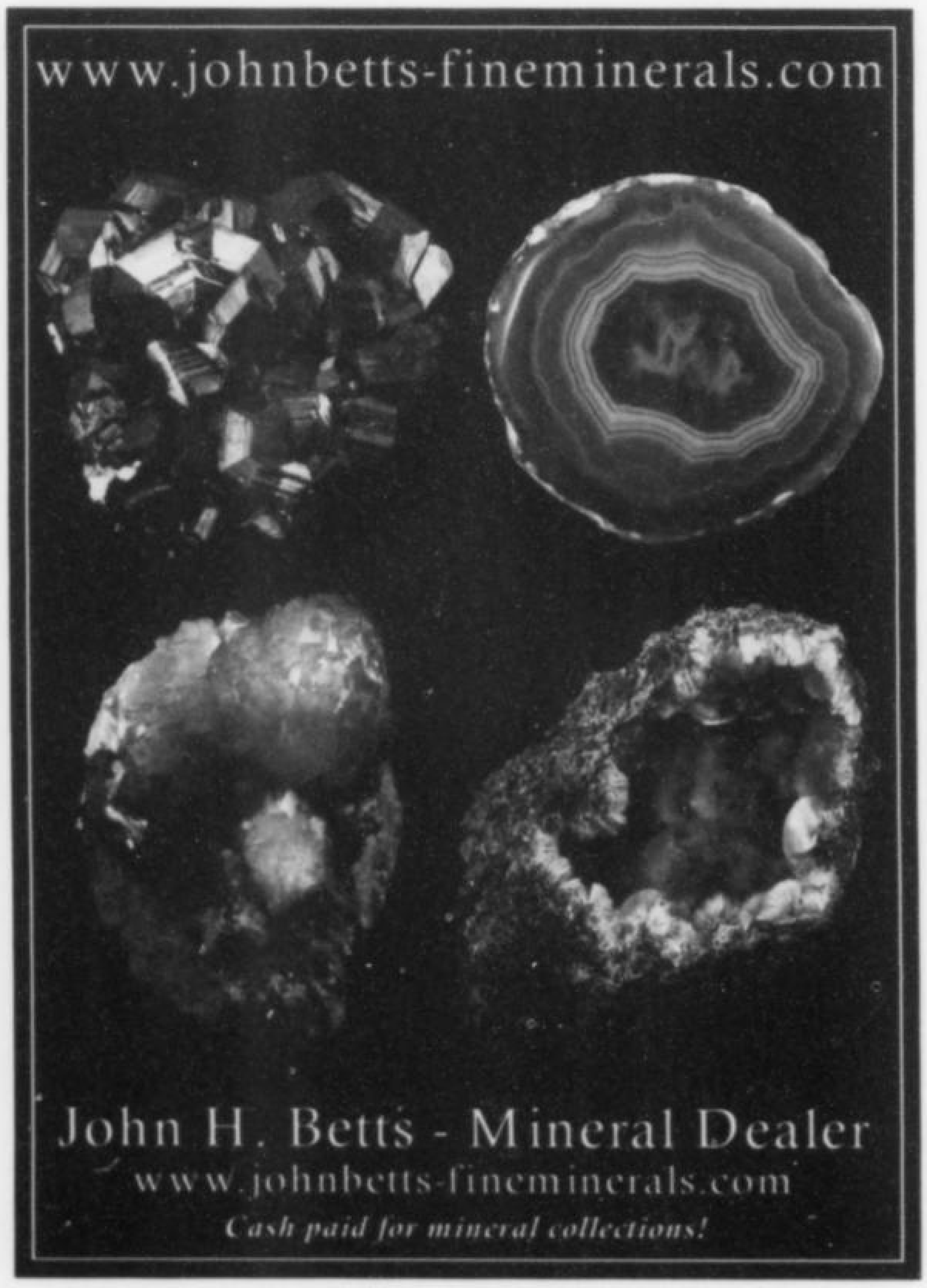
LIU, G. (2005) The mystic mimetite location of Liannan Yao Autonomous County. *Rocks & Minerals,* **80** (1), 24–31.

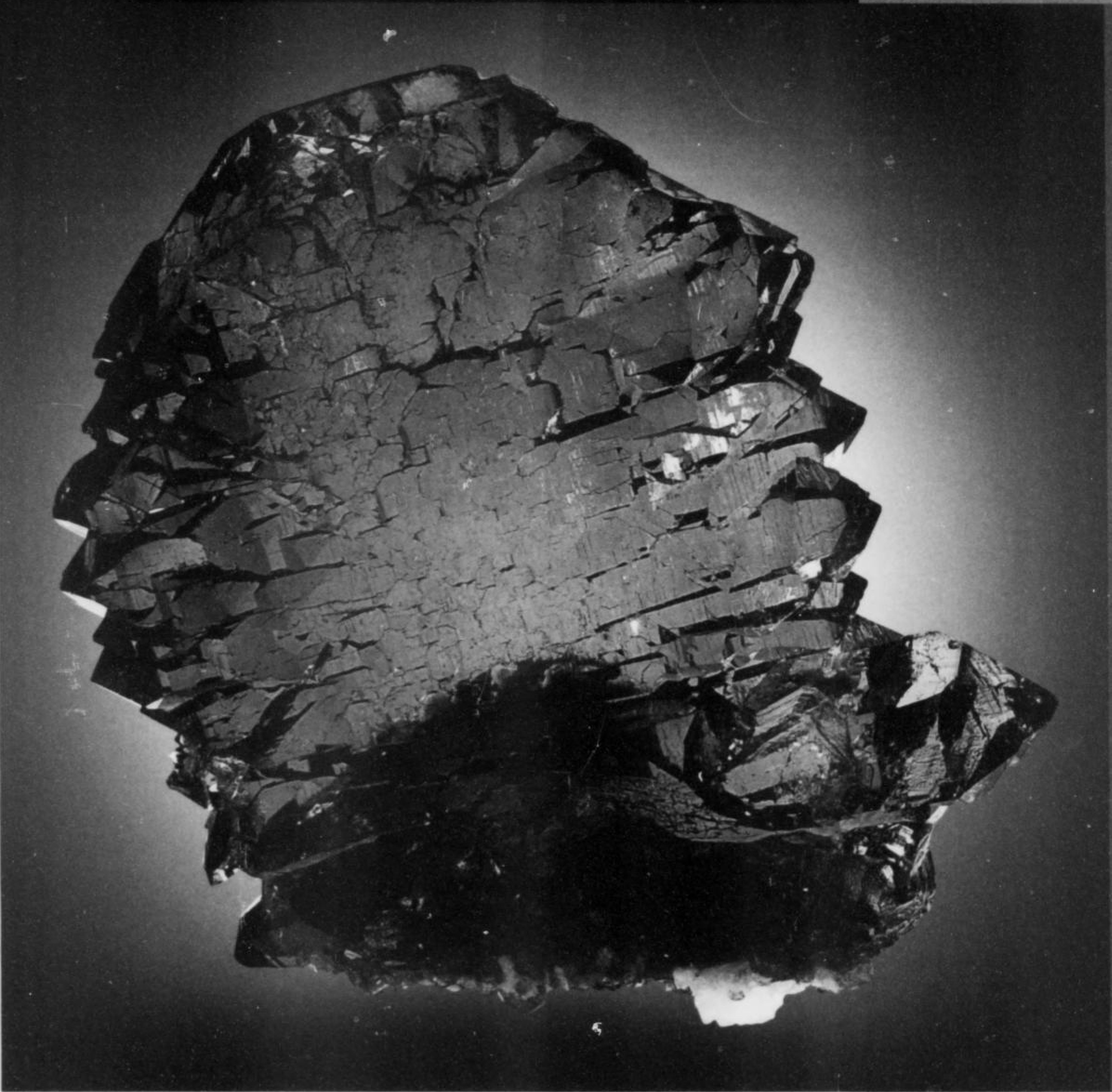
LIU, G. (2006) *Fine Minerals of China.* AAA Minerals AG, Zug, Switzerland, p. 64–73.

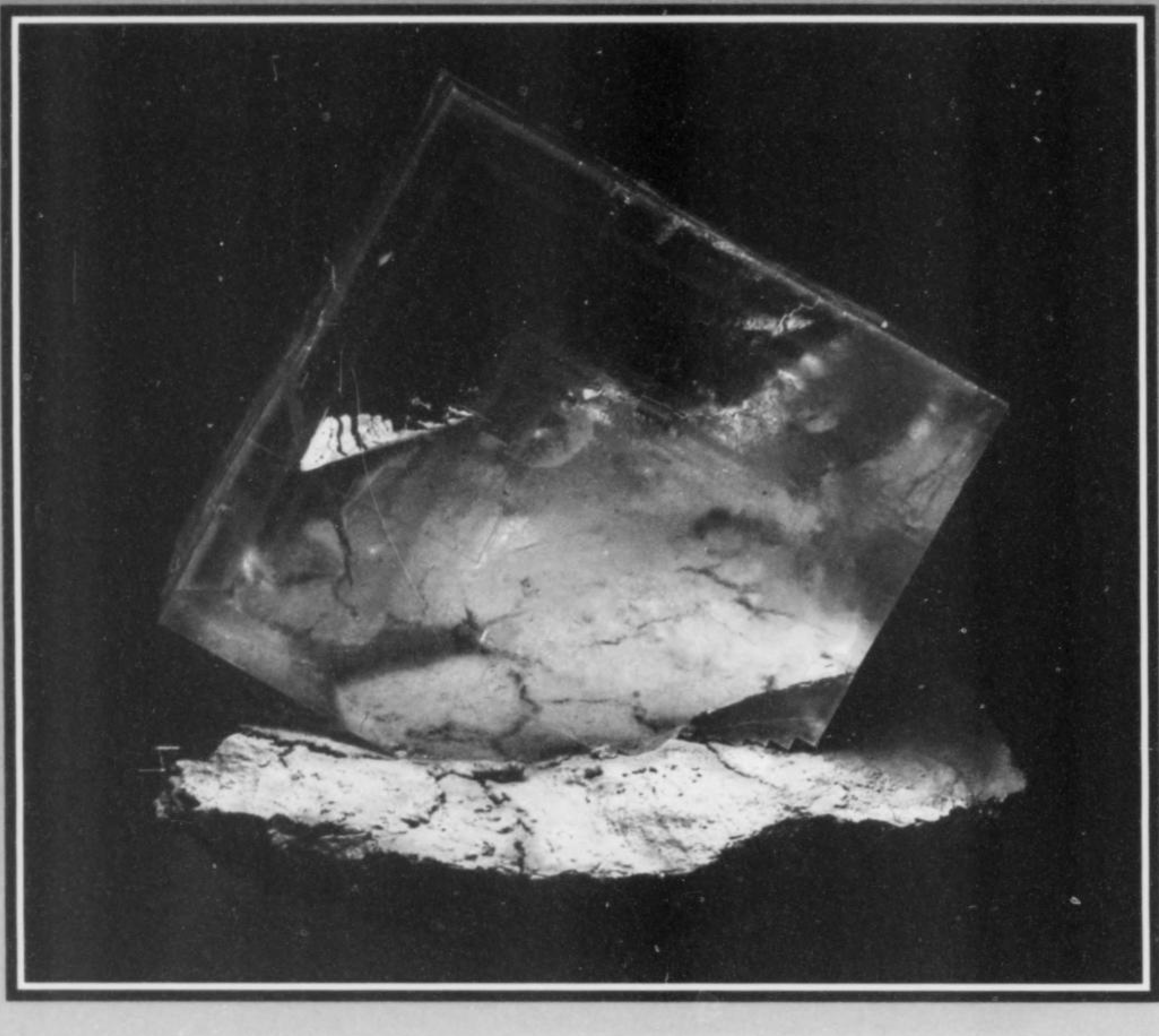
MOORE, T. (2003) What's new in minerals: Tucson Show 2003. *Mineralogical Record*, **34**, 280, 283.

MOORE, T. (2004) What's new in minerals: Tucson Show 2004. *Mineralogical Record*, **35**, 257.

MOORE, T. (2005) What's new in the mineral world. Posted 7/18/2005 on www.MineralogicalRecord.com.







FLUORITE, 12 cm, Dalnegorsk, Russia. Jeff Scovil photo.

The Fengjiashan Mine

Daye District, Ezhou Prefecture, Hubei Province, China

Berthold Ottens
Klingenbrunn Bahnhof 24
D-94518 Spiegelau
Germany

The Fengjiashan mine, also known as the Daye mine, is famous among mineralogists and mineral collectors as the type locality for hubeite and the source of some of the world's best crystallized inesite. Opened as a copper mine in 1966, it became unprofitable and was converted to a wollastonite mine in the early 1980's. Quartz, scheelite, apophyllite and other species of collector interest have been found there as well.

INTRODUCTION

During the past three years there has been a considerable increase in the number of collector-oriented publications concerning the minerals and mineral occurrences of China. One of these (among many others) was the article by Hawthorne *et al.* in vol. 33, no. 6 of the *Mineralogical Record* (November-December 2002) describing the new mineral species *hubeite*, recently approved by the International Mineralogical Association. With great precision and thoroughness the article presented all relevant mineralogical data; however, only sketchy information on the purported locality was given, and a full description of the deposit was conspicuously absent. At the time, specimens of the new mineral were being brought onto the market solely by Chinese mineral dealers, who were selling them to American and European dealers and collectors. The locality itself had not yet been visited by any professional mineralogist or by any dealers seriously interested in mineralogy. Thus it is not surprising that since the first appearance of hubeite, it has commonly been misidentified as manganbabingtonite, and specimens have been attributed to various incorrect localities.

With a view to obtaining accurate information on hubeite and on its occurrence, I decided to visit the locality early in 2002, accompanied on the trip by the Chinese dealer Yunfu Gao, of Changsha, and the German collector J. Backhauss.

In Hawthorne *et al.* (2002) the "Daye mine," in Hubei province, was cited as the type locality for hubeite. In fact, the mineral comes from the Fengjiashan wollastonite mine in the Daye district, sometimes also known as the "Daye copper mine." This locality should not be confused with the nearby Daye iron mine, a large opencast mine which has yielded no specimens of note. Therefore it is preferable to use the name Fengjiashan.

Since the initial appearance of hubeite on the market, other, associated minerals have aroused great interest (for example, inesite, Japan-law twinned quartz, and unusually formed amethyst), and so I published detailed reports on Fengjiashan mine minerals in the German mineral magazine *Lapis* (vol. 28, no. 9; September 2003) as well as in *ExtraLapis* (26/27, 2004, p. 134–137).

GEOLOGY

The Middle-Lower Yangtze Metallogenic Belt, extending from Wuhan in Hubei Province in the west to Zhenjiang in Jiangsu Province in the east, contains more than 200 polymetallic (Cu-Fe-Au, Mo, Zn, Pb, Ag) deposits and is one of the most important metallogenic belts of China (Yu Sheng Zhau *et al.*, 1996). This belt is controlled by faults and aulacogens (sediment-filled tectonic troughs in cratons) in the continental plate. In the Early Yanshan Epoch (Jurassic Period), the dominant west-northwest and east-west lithospheric faults controlled the distribution of Cu, Mo and Au

***Figure 1.* Old headframe of the Fengjiashan I shaft. Weigang Chen photo.**

***Figure 2.* Location map.**

mineralization, whereas in the Late Yanshan Epoch (Cretaceous Period) the north-northeast and northeast lithospheric faults controlled Cu-Fe mineralization. The ore deposits are quite diverse in their types, including Fe and Cu skarns, Cu porphyries, Fe magma injections, Fe hydrothermal deposits and remobilized sedimentary Fe and/or Cu deposits. The major orebodies include the iron-copper deposits of Tieshan, Chengchao, Tonglushan and Tongshankou in the Daye area; Chengmenshan, Wushan and Yangjishan in the Jiurui area; Tonguanshan, Shizihshan (Dongguashan), Fengjuangqiao and Xinqiao in the Tongling area; and the deposits in the Ningwu-Luzong area.

The skarn-type Fe and Cu deposits are major contributors to China's copper reserves and significant contributors to its iron reserves. These deposits developed in the contact zones between felsic intrusions and carbonate country rocks. At the Tonglushan deposit, a typical representative of this type, quartz diorite porphyries have intruded gypsum-bearing limestones of the Triassic-age Daye Formation.

The porphyry copper deposits of the Metallogenic Belt are similar to those in the western United States; important examples include the Chengmenshan deposit in Jiujiang prefecture, Jiangxi province; the Fengsandong deposit in Hubei province; and the Shaxi deposit in Anhui province.

There are a number of vein-type Cu-Fe-Mo-Au deposits. Even though they are small compared with the skarn and porphyry deposits, they contain higher percentages of Cu than these do. The Tongniujing deposit, Anhui, is typical.

Two metallogenic series occur in the Middle-Lower Yangtze Metallogenic Belt: sedimentary and magmatic-hydrothermal. The sedimentary series were generated primarily during the development of sedimentary cover on the Yangtze Craton during late Paleozoic and Triassic times. The environments for sedimentation were commonly littoral to shallow-marine. Carbonate rocks, with minor siliceous and clastic rocks, were the dominant types deposited. The magmatic-hydrothermal series were formed during the Mesozoic. The genetic styles of the magmatic-hydrothermal deposits are numerous, but they are commonly characterized by the following traits:

(1) They are products of magmatic evolution during the Yanshan Epoch and are intimately associated with magmatic bodies.

(2) Although the ore-forming materials are thought to have been

Figure 3. **Wollastonite stockpiles at the Fengjiashan mine site. Weigang Chen photo.**

supplied mainly by magmas, in some deposits they were supplied by alkaline metasomatism caused by intrusive bodies, and in others they were supplied by remobilization of sedimentary or volcanic-sedimentary proto-ore.

(3) The mechanisms of ore formation include hydrothermal alteration and vein filling, ore magma injection, and remobilization of sedimentary proto-ore by magmatic-hydrothermal activity.

MINES OF THE DAYE DISTRICT

The County of Daye lies in the southern part of the middle reaches of the Yangtze River, in southeastern Hubei province, between east longitude 114°31″ to 115°21″, and north latitude 29°40″ to 30°15″. Daye County belongs to Huangshi prefecture, which is comprised of one county-grade city (Daye), one county (Yangxin), and four districts (Huangshi Port, Shihuiyao, Xialu and Tieshan), as well as 19 subdistricts, 51 towns, 247 neighborhood commissions and 1,026 village commissions. Daye County (alternatively, the city of Daye) manages six rural areas, 12 towns and 494 administrative villages; it has an area of 1593 square kilometers and a population of 840,000. The climate is subtropical, with an average yearly temperature of 17° C.

Daye County is rich in natural resources, including a great variety of metallic and non-metallic mineral deposits. It is one of China's ten major centers of iron production, an important center of coal production, and one of China's six most important cities for the manufacture of bronze. Gold and silver production is the first-ranking revenue source for Hubei province. It is important to point out that there is a considerable number of mines, mining camps and quarries in the Daye region; among these are many specimen-producing localities, especially for calcite, which often are impossible to specify precisely. Exact locality data may confidently be provided only in cases of major discoveries, or when there is a distinctive suite of associated species.

Huangshi prefecture, including Daye county, is one of the birthplaces of Chinese bronze-age culture. Thousands of years ago the ancestors of the present inhabitants created the Yangtze River culture, which produced China's earliest artworks in bronze. During the Yin Dynasty, copper mining began in the Daye area; the ancient ruins

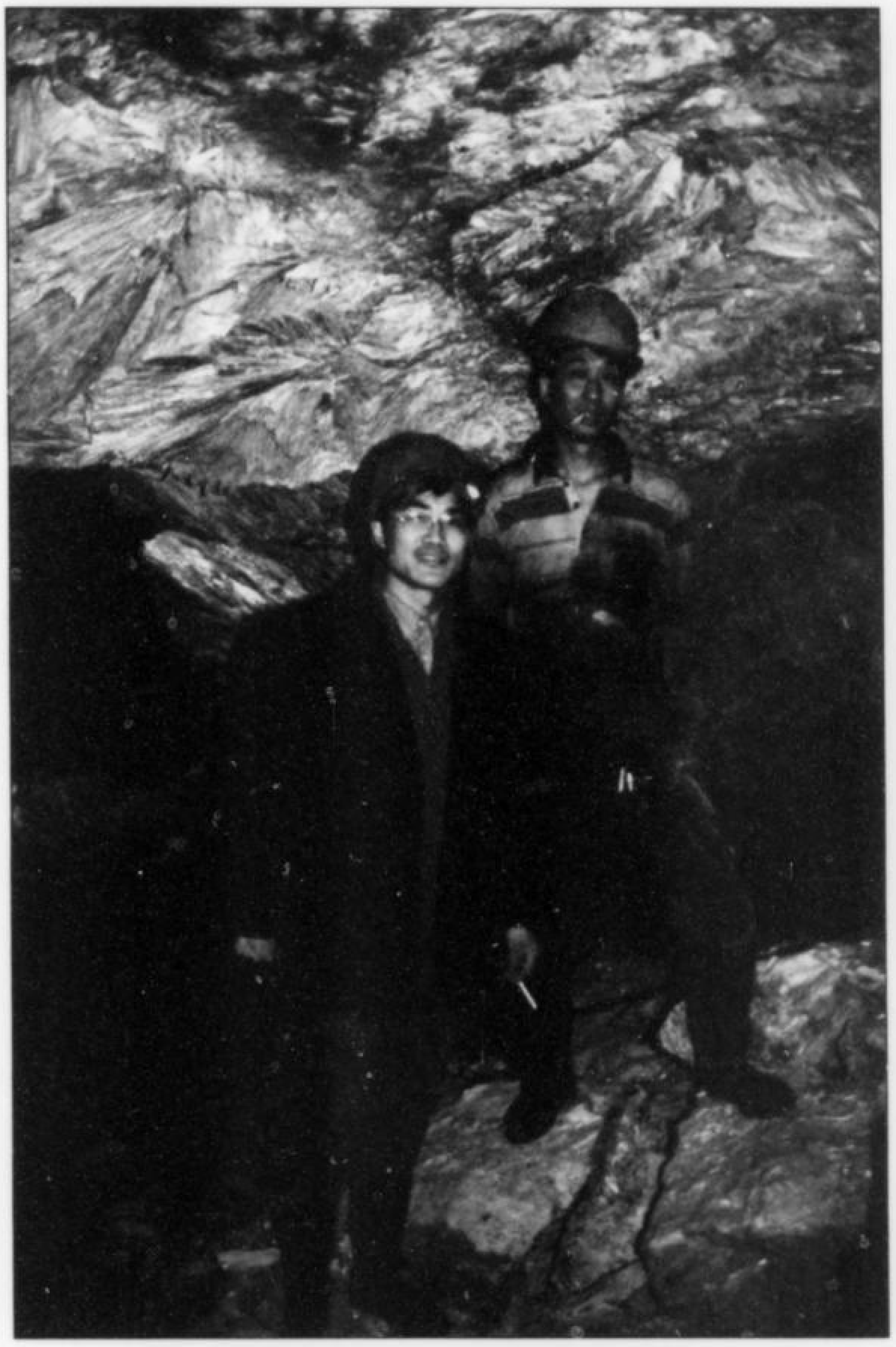


Figure 4. **Underground at the Fengjiashan mine. Note large sprays of wollastonite in the background wallrock. Berthold Ottens photo.**

of the Tonglushan copper mines and smelters were discovered in 1973. Iron mining and smelting at Tieshan, near Daye, also dates to ancient times: Zhan Zhidong began the Daye iron mine at Tieshan during the Qing Dynasty.

THE FENGJIASHAN MINE

Of all the mines of the Middle-Lower Yangtze Metallogenic Belt, it is the Fengjiashan wollastonite mine (also known as the Daye copper mine) which has become most significant to mineral collectors during the past ten years.

Begun by the government in 1966 as a copper mine exploiting chalcopyrite ore, the Fengjiashan mine proved only marginally profitable, and so in the early 1980's, at which time it was employing 200 workers, it was converted to a privately operated wollastonite mine. The operating company describes the mine as follows:

Huangshi Jinshan Wollastonite Co., Ltd. is a wollastonite manufacturer integrating extraction, sizing, processing and marketing. It is a large enterprise with the most advanced equipment and richest mining resources in the middle region of China. The wollastonite produced by this company under the brand name "Fengjiashan" is world-renowned for its unique filamentary structure and fine physical and chemical performance, and is competitive with the wollastonite produced in India and the U.S. Located in the southern suburb of Daye city, the world-reputed "Capital of Copper," the company plant is accessed conveniently by land or water.

Presently the mine produces about 50,000 tons of wollastonite per year, the major share of production being exported to Japan. Wollastonite is a versatile raw material, with many industrial uses; it is widely used in ceramics as a bond between the earthenware base and the glazing of wall tiles. In 2002 the mine workings consisted of a 140-meter-deep shaft and three tunnels. In May 2006 it could be seen that this shaft, called *Fengjiashan I*, had been closed, and that about 500 meters from it a second shaft, 50 meters deeper, called *Fengjiashan II*, had been activated. Meanwhile, near the old shaft a complete ore-preparation facility for wollastonite had been built; here the wollastonite ore was being broken down, ground up, and packed for shipment. A further 500 meters away, another company was operating a still deeper working called *Fengjiashan III*: this is not a shaft but a tunnel which accesses the ore directly.

The orebody is a typical skarn deposit, with zones of very pure wollastonite reaching 1 meter thick, lying along a contact between marble and intrusive diorite. The wollastonite is never found as free crystals in pockets; rather, elongated wollastonite crystals to 20 cm form compact radial aggregates. Green andradite crystals to several centimeters across may be seen in direct contact with chalcopyrite crystals. The famous and attractive inesite specimens, as well as amethyst specimens showing long-prismatic crystals and a distinctive color zoning, came from the Fengjiashan I shaft. Inesite has only rarely been found in Fengjiashan II, and the specimens are unattractive. Amethyst crystals from Fengjiashan II are short-prismatic and are associated with calcite. Fengjiashan III primarily produces chalcopyrite and molybdenite, with minor amounts of wollastonite. Hubeite has been found in all three workings, but is especially common in Fengjiashan III, where it is associated with pyrite and chalcopyrite.

Occasionally the Fengsangdong mine, near Yangxin, has been given as a locality for inesite and hubeite, but this attribution has turned out to be false: these minerals occur only in the Fengjiashan mine. Mineral specimens for collectors are not recovered by the Haungshi Jinshan Wollastonite Company, Ltd., but rather through a Mr. Cao, who employs up to 15 people as specimen-miners. Of first importance among the types of specimens gathered are inesite, amethyst and Japan-law twins of quartz.

Figure 5. **Apophyllite on amethystine quartz, 10.1 cm, from the Fengjiashan mine. Irv Brown and Stuart Wilensky specimen; Jeff Scovil photo.**

The Cao family has also collected and marketed mineral specimens from other localities; for example, they were first to market the azurite from Guichi. From their headquarters in Daye, the Cao family members have extended their operations to the east and to the west. It is thanks to them that many localities throughout Hubei province and in the southeastern part of Sichuan province have been developed.

MINERALS

Apophyllite Group $KCa_4Si_8O_{20}(F,OH)\cdot 8H_2O$

Apophyllite is distributed widely in the Fengjiashan mine. It is a late-forming mineral, occurring as overgrowths on quartz, calcite, inesite and hubeite. Unfortunately the beauty of many potentially very fine specimens of these species is often compromised by coatings of apophyllite which cannot be chemically removed. According to Hawthorne *et al*. (2002), this apophyllite is compositionally zoned, with inner regions of natroapophyllite ($Na_{0.8}K_{0.2}$) and outer rims of fluorapophyllite ($K_{1.0}$); it is unknown whether these relations remain constant with varying crystal size. The colorless apophyllite crystals display a thin-tabular habit and reach considerable sizes: to 10 cm along an edge. Specimens in which apophyllite crystals to 1 cm have grown over pale violet amethyst can be quite attractive.

Calcite $CaCO_3$

Calcite is encountered very frequently in the Fengjiashan mine, a first generation occurring as squat rhombohedrons and a second generation as steep scalenohedrons. For the most part the crystals are opaque and colorless, and only rarely are they transparent and yellow.

Chalcopyrite $CuFeS_2$

Chalcopyrite was the ore mineral originally mined at Fengjiashan. The crystals reach several centimeters across, but usually have weathered surfaces and consequently a blackish blue color.

Datolite $CaBSiO_4(OH)$

Datolite is found extremely rarely at the Fengjiashan mine, as greenish, translucent to transparent crystals reaching 7 cm.

Epidote $Ca_2Al_2(Fe^{3+},Al)Si_3O_{12}(OH)$

Early in 2005, a dealer in Changsha offered a specimen, presumably of heulandite, from a new discovery at Fengjiashan. After the sheaf-shaped crystal aggregates had been cleaned, however, they were seen to be transparent and of an olive-green color—clearly not heulandite. Analysis showed that the species in question is epidote, a skarn mineral. The crystals are rough-surfaced but reach 4 cm long

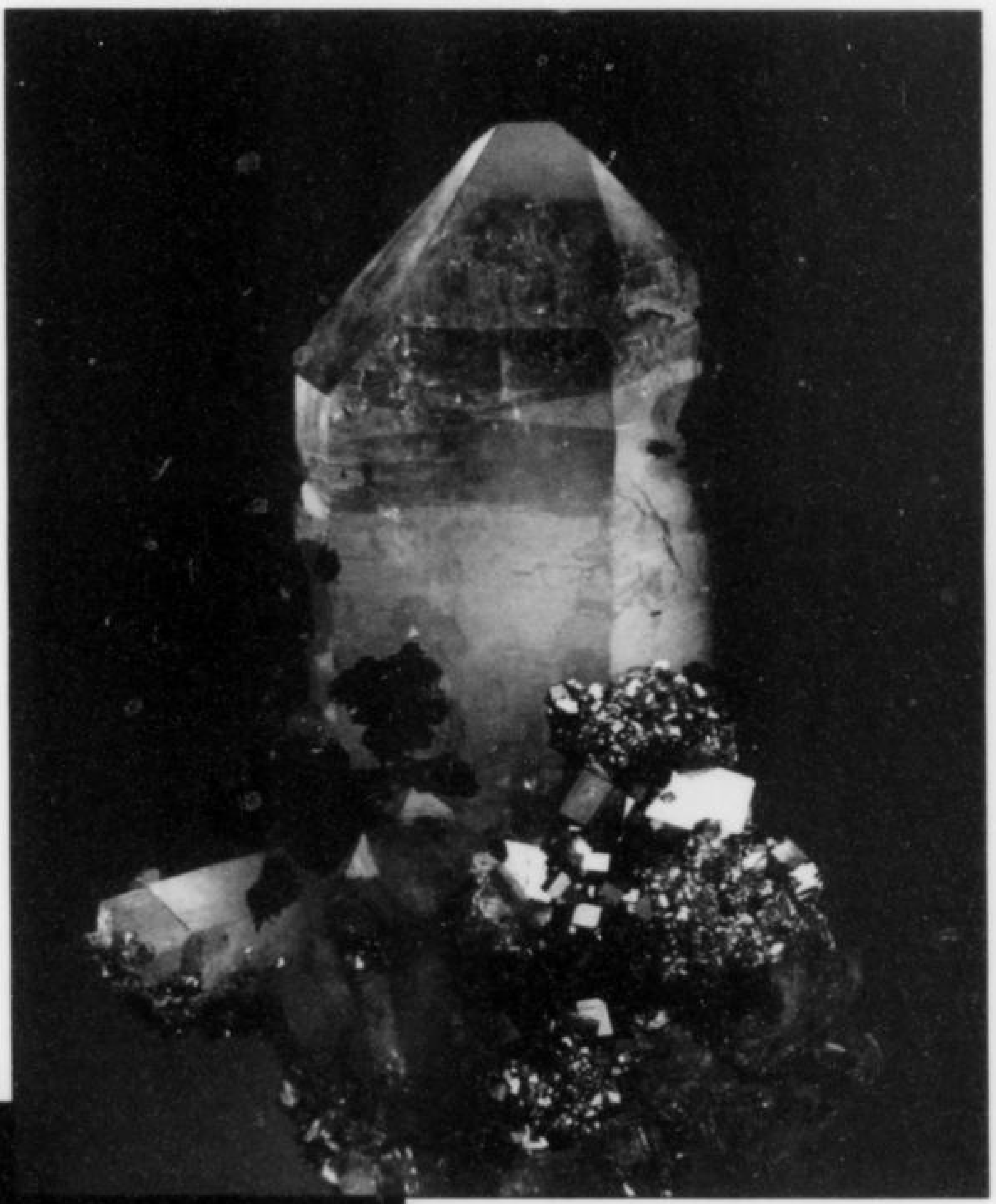


Figure 6. **Dark brown hubeite with pyrite on quartz, 7.6 cm, from the Fengjiashan mine. Jeremy Smith collection; Jeff Scovil photo.**

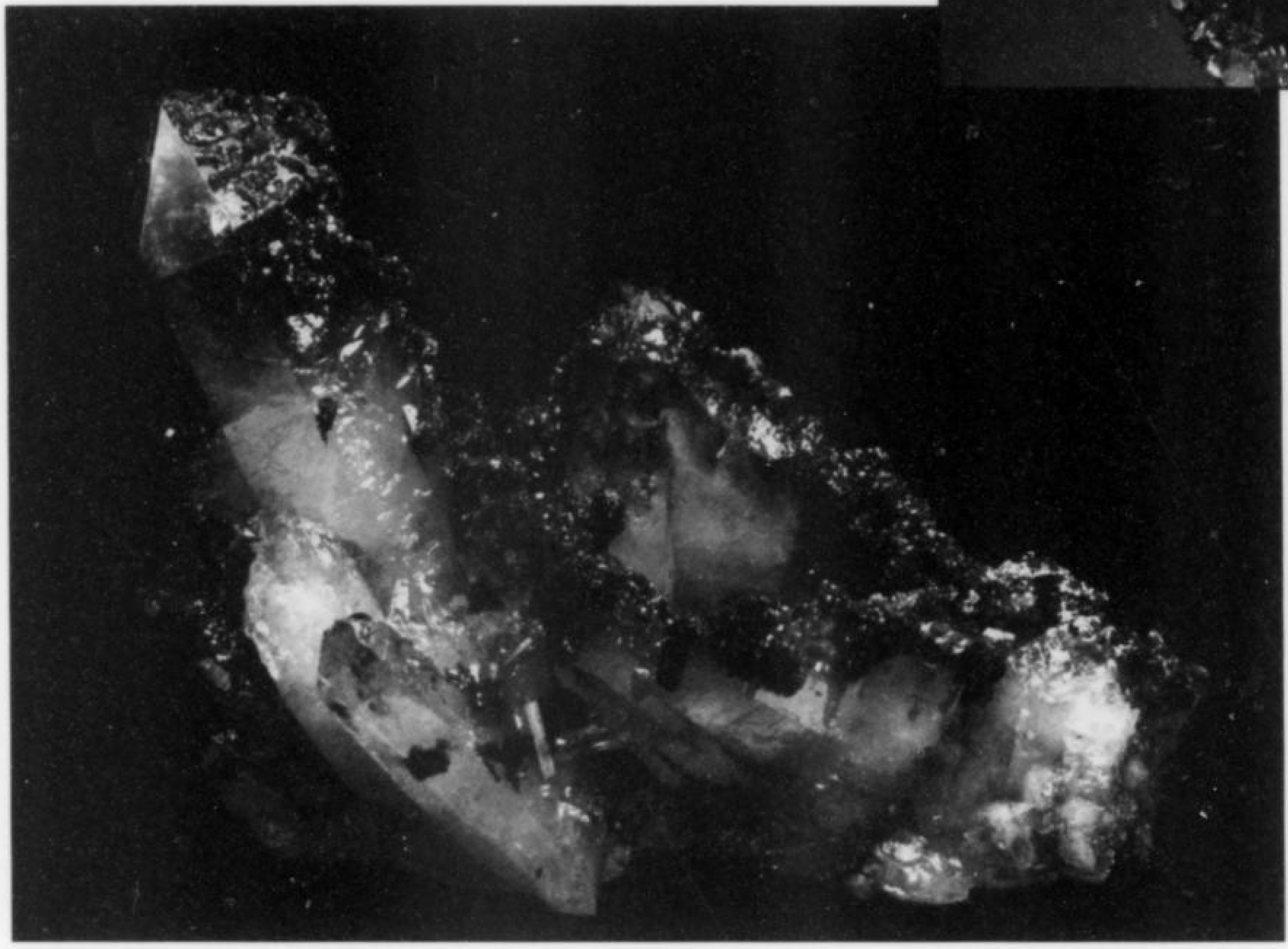


Figure 7. **Dark brown hubeite on quartz, 9 cm, from the Fengjiashan mine. William Pinch collection; Jeff Scovil photo.**

Fluorite CaF_2

Fluorite is very rare at Fengjiashan. Crystals thus far observed are bluish and reach 2 cm; they are tightly intergrown and do not have clearly recognizable forms.

Hematite Fe_2O_3

Tabular hematite crystals to about 1 mm are occasionally seen scattered on quartz.

Hubeite $Ca_2Mn^{2+}Fe^{3+}[Si_4O_{12}(OH)](H_2O)_2$

Hubeite, the recently describeded manganese-iron silicate (Hawthorne *et al.*, 2002), forms bladed, wedge-terminated, dark brown to black crystals averaging 5 mm long. The crystals cluster in small fan-shaped aggregates and in radial sprays perching typically on rose-pink inesite or quartz crystals, with apophyllite, calcite, pyrite and ilvaite. This new mineral species was named for the province of Hubei (pronounced "Hoo-bay"). Actually the name should not have been spelled "hubeite" but rather "hubeiite"—retaining the "i" in "Hubei" for proper pronounciation, apart from the "-ite" ending.

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

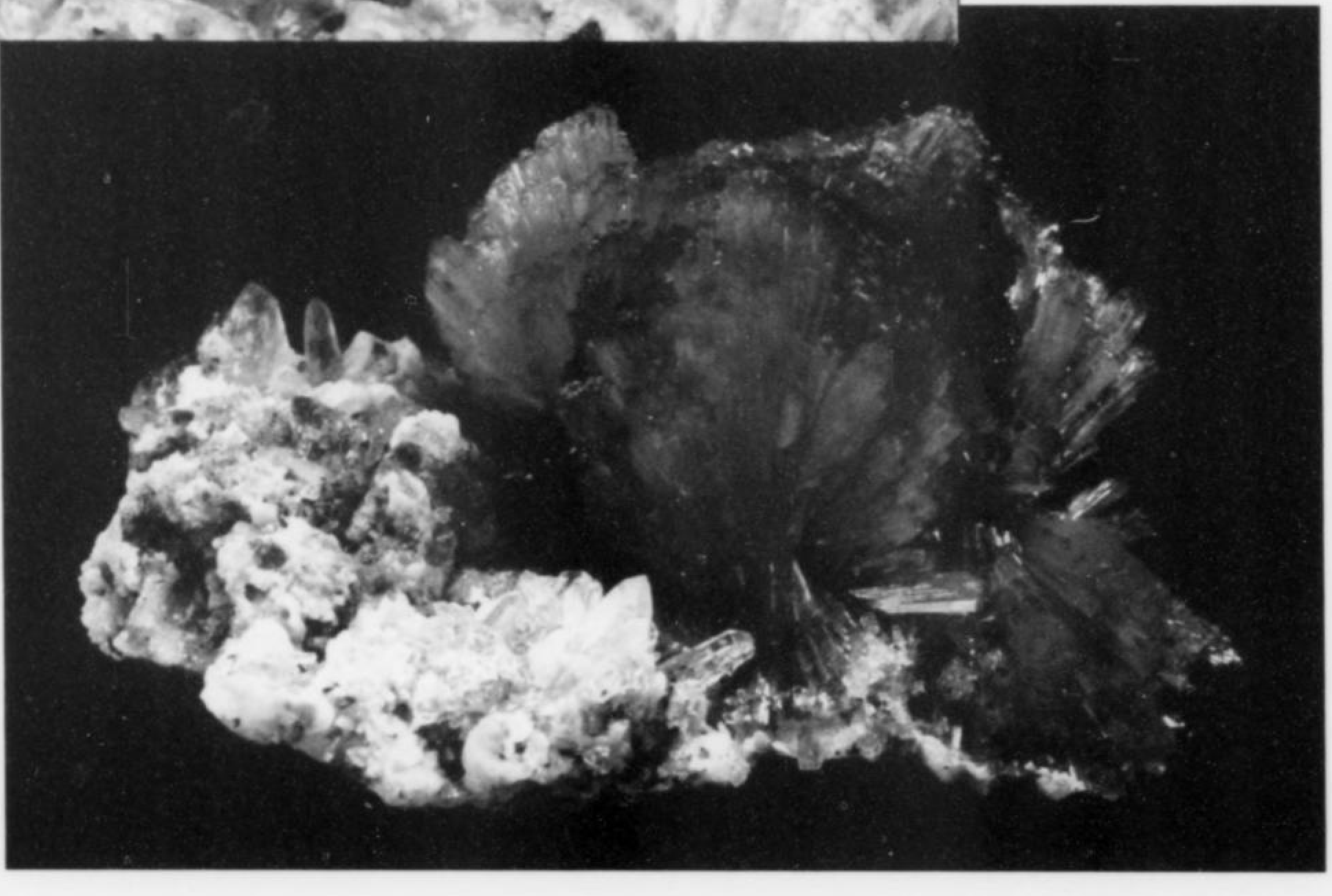
The calcium-iron silicate ilvaite is commonly seen as black microcrystals on quartz or calcite. The crystals, reaching about 2 mm long, show dipyramid faces but no prism faces. (Jordi Fabre reports that the ilvaite from Fengjiashan is actually manganoilvaite.)

Inesite $Ca_2Mn_7^{2+}Si_{10}O_{28}(OH)_2 \cdot 5H_2O$

Inesite from the Fengjiashan mine displays a characteristic raspberry-red or reddish orange coloration. Individual crystals are

Figure 8. **Inesite, 5.6 cm, from the Fengjiashan mine. Sandor Fuss collection; Jeff Scovil photo.**

Figure 9. **Inesite, 5.4 cm, from the Fengjiashan mine. Francis Benjamin collection; Jeff Scovil photo.**



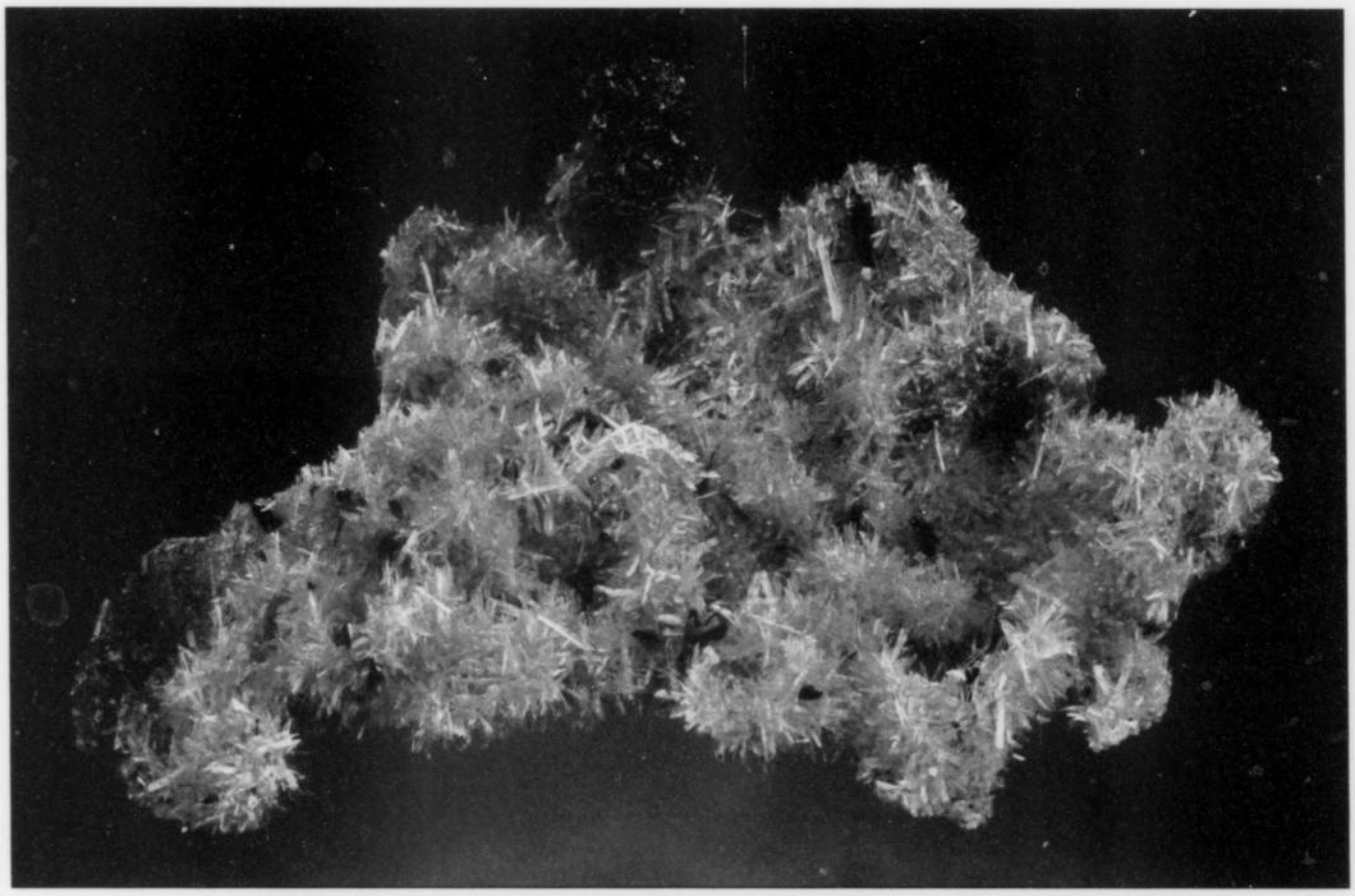


Figure 10. **Inesite with dark brown hubeite, 11.7 cm, Fengjiashan mine. Dan Weinrich specimen; Jeff Scovil photo.**

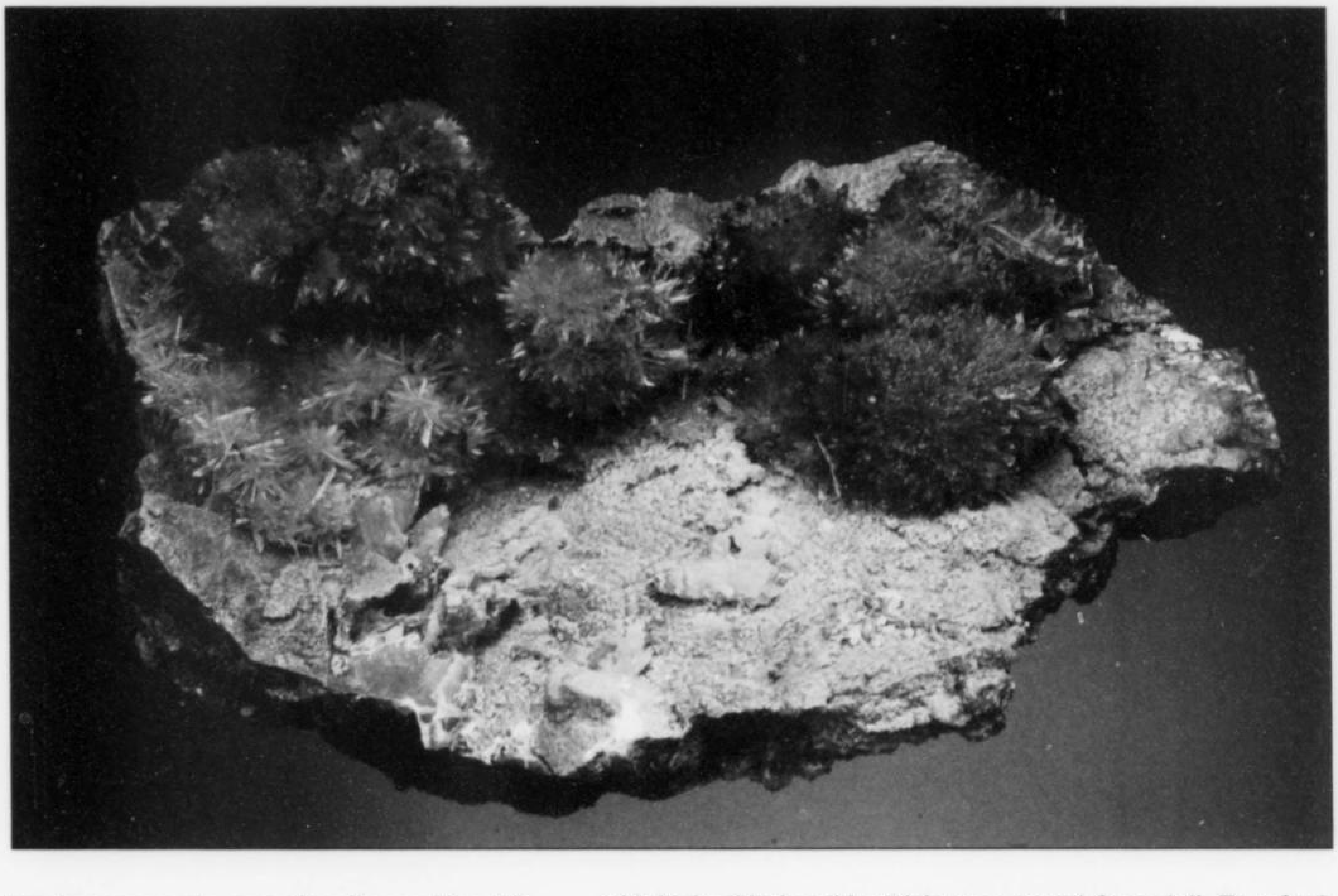


Figure 11. **Inesite with dark brown hubeite, 23.5 cm, Fengjiashan mine. Dave Bunk specimen; Jeff Scovil photo.**

only a few millimeters long as a rule, exceptionally reaching 1.5 or 2 cm long. The crystals are thin-tabular, greatly elongated and very brittle, aggregating in drusy crusts and in sheaves to radiating spherical clusters. In many cases the druses of inesite are fully or partly encrusted (unfortunately) by tiny blackish hubeite crystals or apophyllite crystals, rendering the specimens less attractive. On the other hand, specimens with sheaves or spherical clusters of inesite on prismatic quartz crystals are very attractive. For top specimens of this type, high prices in U.S. dollars are asked in China.

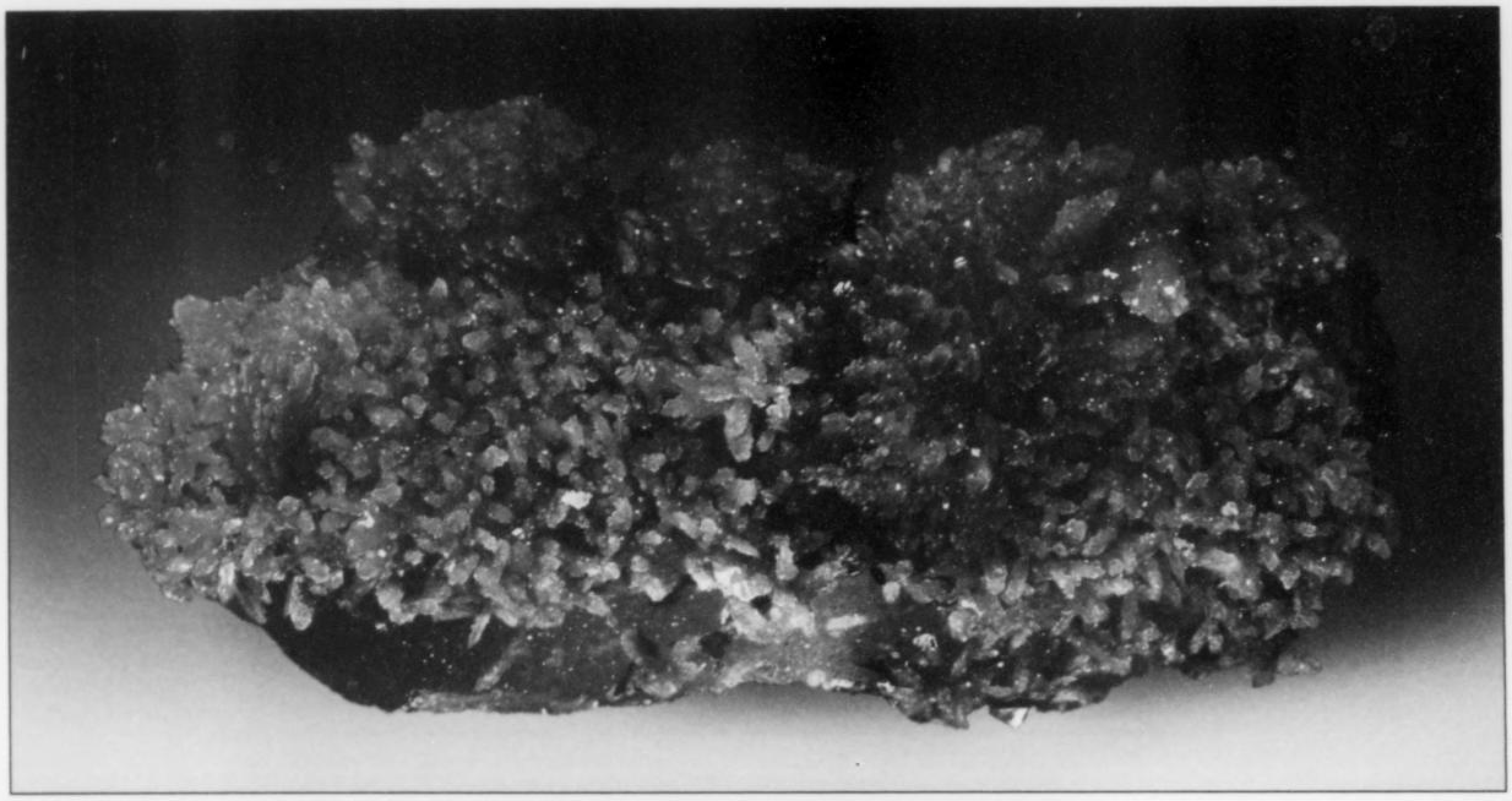
The cleaning and preparation of inesite/hubeite specimens presents a problem. Unfortunately, Chinese dealers treat many specimens with hydrochloric acid, which turns crystal faces dull. To refresh their colors the crystals are then oiled. When acquiring specimens from Fengjiashan one should exercise due caution.

Marcasite FeS_2

Irregular, tarnished, striated, blocky to platy or bladed marcasite crystals to about 1.5 cm have been found with colorless scalenohedral calcite crystals.

Pyrite FeS_2

Pyrite occurs in cubic crystals to 6 cm. Pyrite pseudomorphs after chalcopyrite crystals are also known.



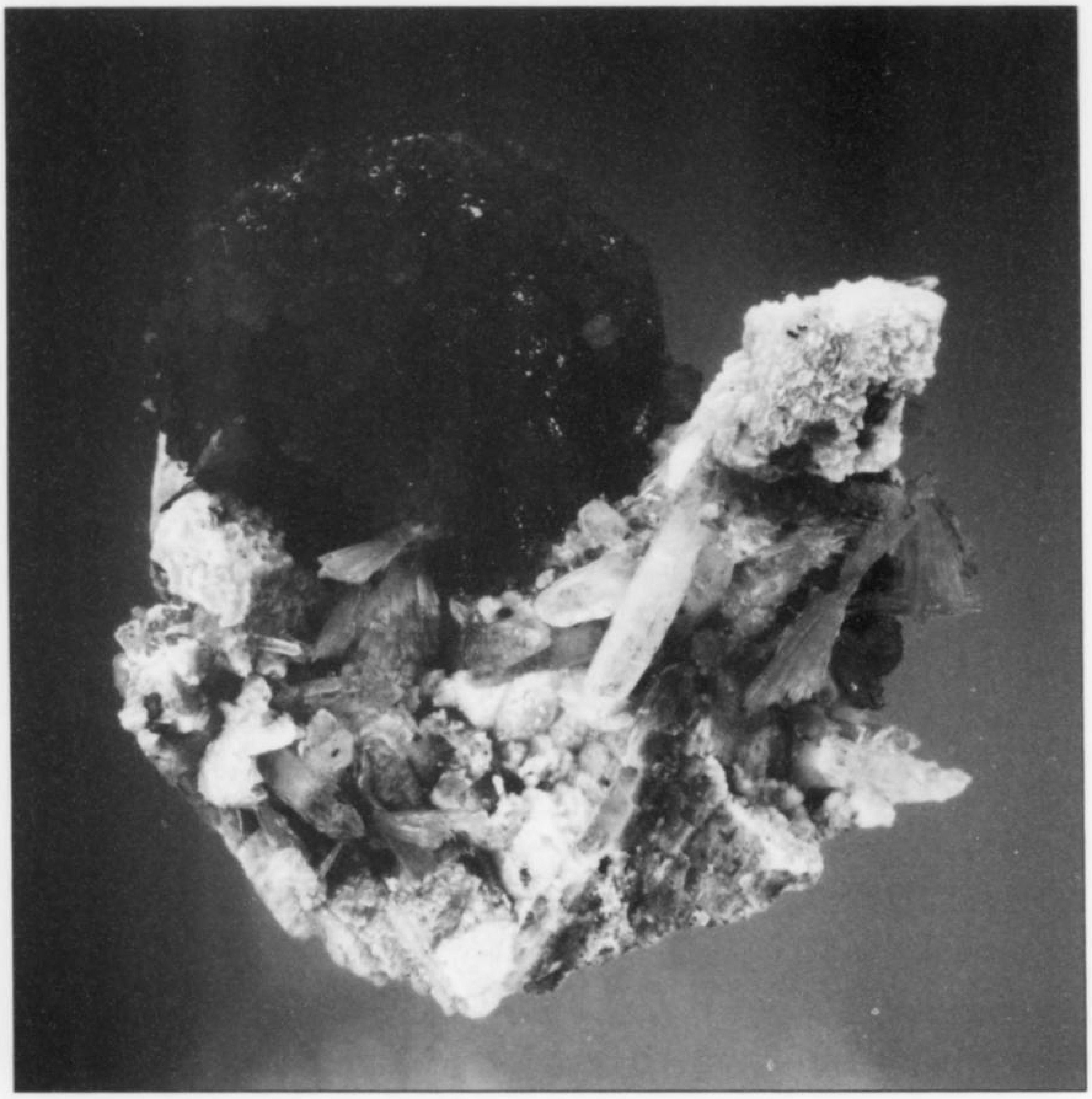


Figure 12. **Inesite on quartz, 11.2 cm, from the Fengjiashan mine. Collector's Edge specimen; Jeff Scovil photo.**

Figure 13. **Inesite on quartz, 6.8 cm, from the Fengjiashan mine. Sandor Fuss collection; Jeff Scovil photo.**

Quartz SiO_2

Colorless to milky quartz occurs in the Fengjiashan mine as crystals commonly measuring 10 cm long, but exceptionally reaching 30 cm. A specialty of the mine is the common occurrence of Japan-law twinned quartz crystals, which reach 10 cm along one "arm." Very few of these crystals are lustrous or wholly transparent; as a rule they are cloudy, with dull surfaces.

Pale violet amethyst crystals to 15 cm long are also found. For a few of the pocket discoveries it has been observed that only the lower parts of the crystals have a violet color, while the upper

Figure 14. **Pyrite crystal with quartz, 13.3 cm, from the Fengjiashan mine. Stuart Wilensky specimen; Jeff Scovil photo.**

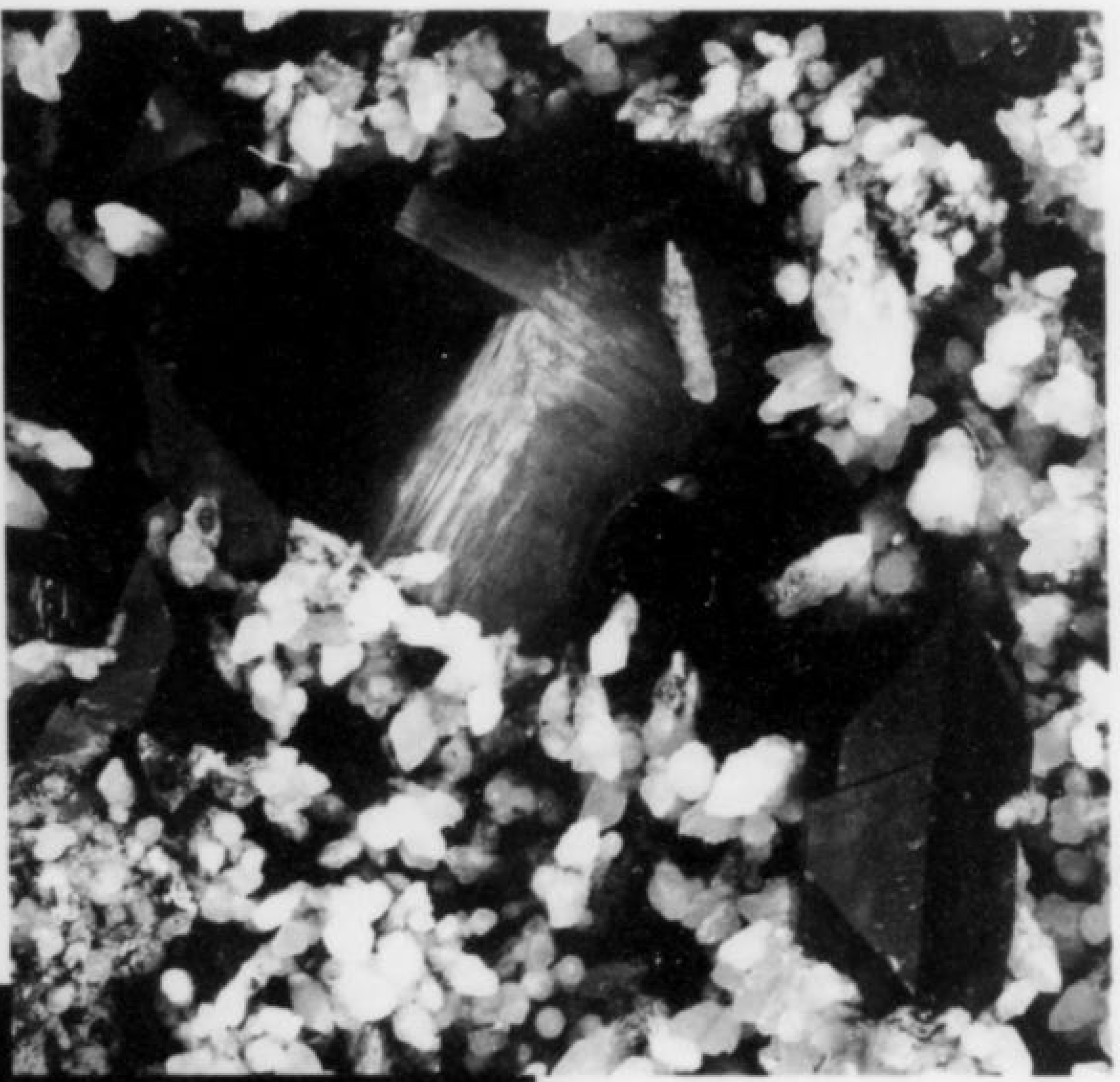


Figure 15. **Japan-law twin of amethystine quartz, 8 cm, from the Fengjiashan mine. Adalberto Giazotto collection; Jeff Scovil photo.**

Figure 16. **Japan-law quartz twin with pyrite, 12.7 cm, from the Fengjiashan mine. S. and C. Maslansky collection; Jeff Scovil photo.**

parts are largely colorless; in other cases the crystals are a uniform lavender color. Deep violet-colored amethyst crystals were found for the first time in 2001; they measure up to 5 cm long. In 2002, deep violet Japan-law twins measuring 4 cm along an arm were discovered.

Scheelite $CaWO_4$

Scheelite crystals to 1 cm associated with quartz and pyrite are among the rarer specimens from Fengjiashan. It is interesting that good crystals of scheelite have been observed to occur in so many mines in southern and central China: a clear indication that the magmas which intruded during the Yanshan Epoch, giving rise to most of the region's endogenetic ore deposits, had a common origin.

Stilbite/Stellerite $(Ca_{0.5},K,Na)_9[Al_9Si_{27}O_{72}]\cdot28H_2O$ — $Ca_4(Al_8Si_{28}O_{72})\cdot28H_2O$

Sheaf-shaped aggregates of yellowish to cream-colored stilbite/stellerite crystals, the sheaves reaching 4 cm, have been observed rarely in the mine. Whether the species is stilbite or stellerite has not yet been determined.

Wollastonite $CaSiO_3$

Wollastonite is not found as free crystals in pockets but, rather, as typical aggregates of elongated crystals to 20 cm.

FUTURE OUTLOOK

To date, only four mines in the area of the Middle-Lower Yangtze Metallogenic Belt have supplied mineral specimens to the market, although about 30 named deposits and many individual workings are registered. These include not only copper and iron deposits, but a great number of polymetallic ones. In the future, with closer monitoring of individual mines and further training of mine workers, we may expect more interesting mineral discoveries. One such new occurrence worthy of mention is the Huangtun lead-silver mine, which lies not far from Tongling at Lujiang. This is the source of the remarkable wire silver specimens first offered on the mineral market in 2005.

BIBLIOGRAPHY

CHINA WINDOW WEBSITE: http://www.china-window.com/

THE EDITORIAL COMMITTEE OF THE MINERAL DEPOSITS OF CHINA, Chief editor Song Shuhe (1990) *Mineral Deposits of China.* Geological Publishing House, Beijing, Vol. 1, 355 pages.

GOLAS, P. (1999) *Science and Civilization in China.* Vol. 5, Part 13: Mining. Cambridge University Press. 538 pages.

HAWTHORNE, F. C., COOPER, M. A., GRICE, J. D., ROBERTS, A. C., COOK, W. R. JR., and LAUF, R. J. (2002) Hubeite: a new mineral from the Daye mine near Huangshi, Hubei province, China. *Mineralogical Record*, **33**, 465–471.

HUANGSHI JINSHAN WOLLASTONITE CO. LTD. http://www.hanli.com.cn/hsking/main/english_1.htm

OTTENS, B. (2003) Inesit, Hubeit und Japanerzwillinge aus Hubei, China. *Lapis*, **28**, 41–47.

OTTENS, B. (2004) Wollastonitmine Fengjiashan bei Daye. *ExtraLapis*, **26/27**, 134–137.

VOGEL, H. U. (1982) Bergbauarchäologische Forschungen in der Volksrepublik China. *Der Anschnitt*, **34**, 138–153.

YU SHENG ZHAI, YONG-LIANG XIONG, SHUZHEN YAO, and XINDUO LIN (1996) Metallogeny of copper and iron deposits in the eastern Yangtze craton, east-central China. *Ore Geology Reviews*, **11**, 229–248.

ZHU XUN (2002) *Mineral Facts of China.* Beijing: Science Press, 776 pages.

THE SHIMEN MINE

Jiepaiyu, Shimen County, Hunan Province, China

Wendell E. Wilson
Mineralogical Record
minrec@earthlink.net
Tucson, Arizona

The Shimen realgar mine, which has been in more or less continuous operation for nearly 1500 years, has yielded world-class specimens of realgar and orpiment, associated with fine calcite crystals, at least since 1988 and as recently as 2006. The miners are well aware of specimen values, and further discoveries are possible as mining continues.

INTRODUCTION

The Shimen mine (formerly the Jiepaiyu mine), sometimes referred to simply as the Realgar mine, is located adjacent to the village of Jiepaiyu ("boundary stone valley"), about 33 km northwest of the town of Shimen in Shimen County, Hunan Province, China (Liu, 2006). The low-temperature hydrothermal orebodies exploited by the mine, which constitute one of the largest realgar deposits in the world, have been worked since at least the 6th century AD primarily for medicinal arsenic compounds (important in Chinese medicine).

Fine realgar and orpiment crystals have probably been encountered in the Shimen mine for centuries; however, specimens were rarely saved during the years before the development of a separate market for them, except perhaps by visiting geologists and mining men. Specimens in the collection of the Museum of Geology in Shanghai, collected in the 1970's or before, are illustrated in the 1980 book *Minerals in China*; though captioned simply as coming from Hunan, there is no doubt that they are from Shimen.

The first Shimen minerals on the Western market may have been the extraordinary specimens of orpiment in cabinet-size clusters on matrix which were brought to the 1988 Tucson Show by Edward Tripp (Wilson, 1988). A large crystal of realgar measuring 8.5 cm was also exhibited at the show (Weigang Chen, personal communication). In August of 1989, more beautiful blood-red realgar specimens from Shimen began reaching the Western mineral market via mineral dealer Doug Parsons, when he brought specimens to the Springfield, Massachusetts gem and mineral show—matrix specimens up to 30 cm with realgar crystals to 6 cm and gray scalenohedral calcite crystals (Robinson and King, 1990). From these first showings it was immediately clear that Shimen realgar ranked as the finest known specimens of the species. Parsons had semi-transparent to gemmy red crystals to over 3 cm, in miniature and cabinet-size groups with scalenohedral calcite (Wilson, 1989).

The following November, spectacular specimens appeared at the Munich Show as well, courtesy of Peter Wu of the *Tradewell* company in San Francisco (Moore, 1990). Wu concealed the true locality, claiming they were from Guizhou province, but it is obvious in retrospect that Shimen was the source. Bright yellow orpiment crystals rivaling in quality the specimens from Quiruvilca, Peru, have also been recovered at the Shimen mine, although good, newly collected specimens have not been common on the market for many years. On the other hand, very attractive scalenohedral calcite specimens continue to be found at the Shimen mine, as well as white drusy to acicular picropharmacolite.

Since those early finds, specimens of Shimen realgar have continued to appear intermittently on the world mineral market; a Chinese dealership called *Hunan Bafang Mineralshop* has offered substantial lots of very fine realgar specimens as recently as the 2003, 2004 and 2005 Munich Shows. Weigang Chen of *Tianci Mineral Crystal World* in Xiamen, Fujian, China reports (personal communication) that especially good vugs of realgar crystals were found in 2003, but only one good vug was encountered in 2005, and two good vugs in 2006. The most recent find took place in August 2006, and yielded a substantial number of fine specimens, the best of which is a museum-quality 24-cm matrix piece covered with gemmy prismatic crystals to 4.5 cm. Orpiment continues to

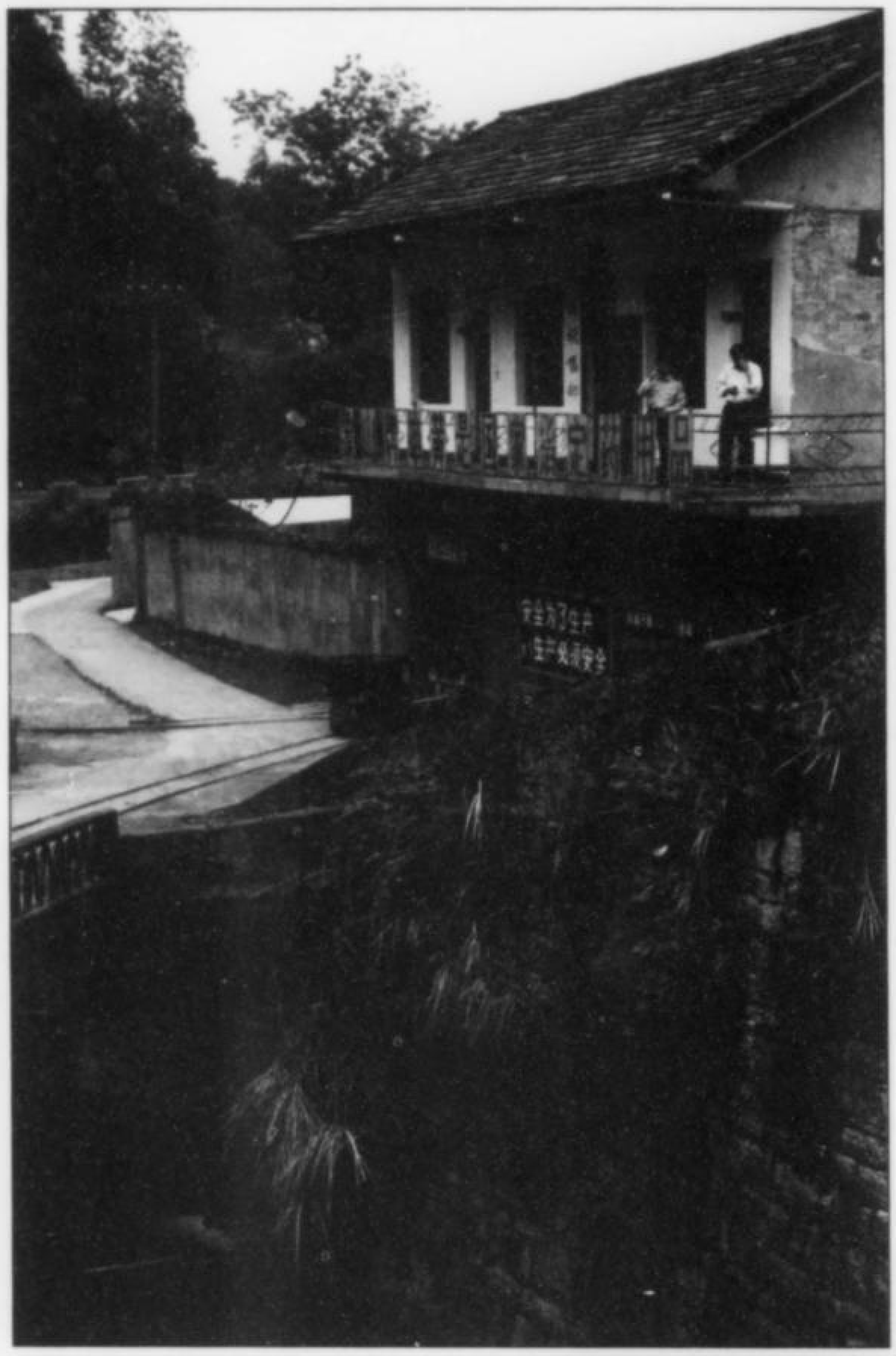


Figure 1. **Mine office, Shimen mine (2004). Jeff Scovil photo.**

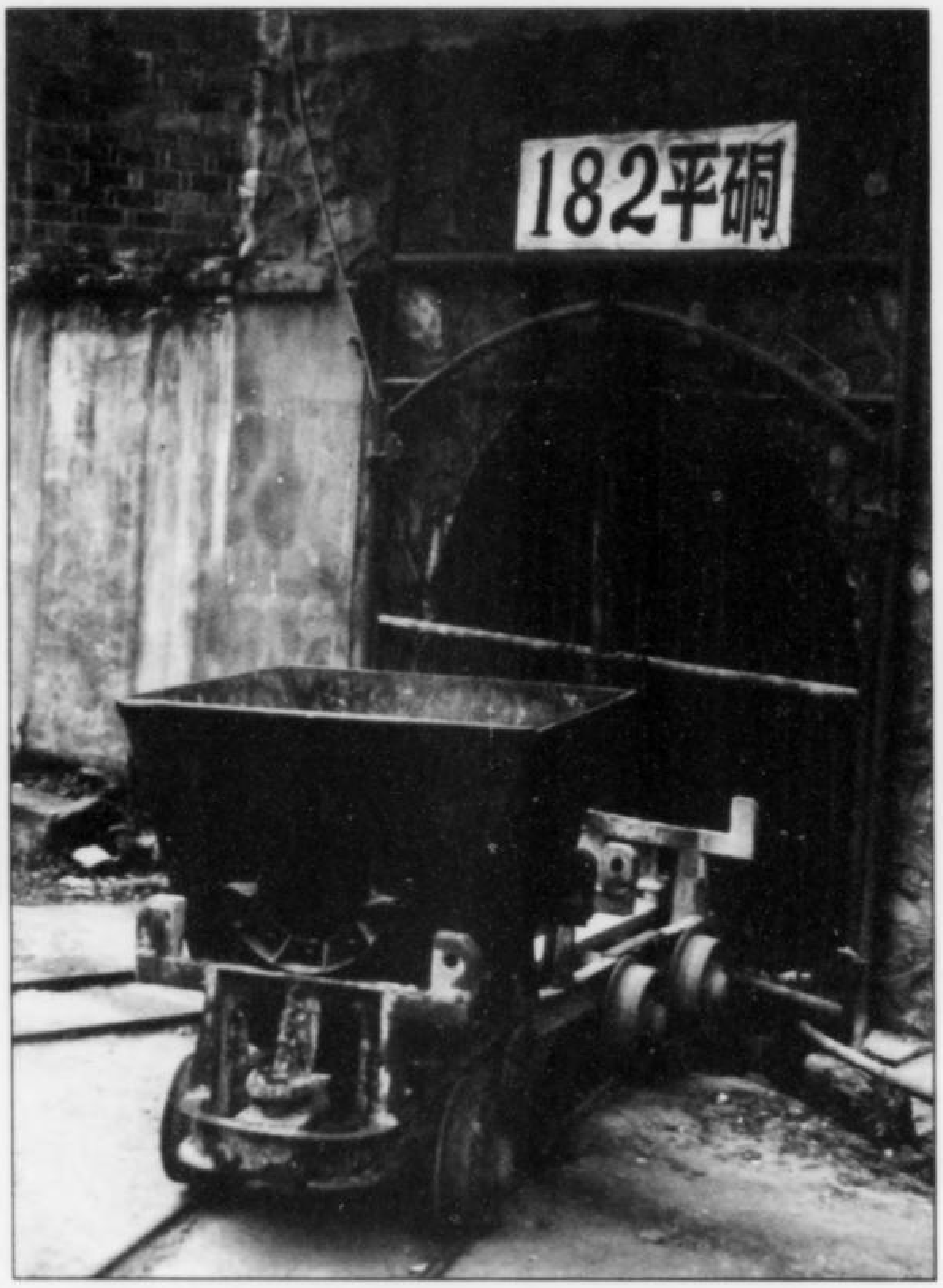


Figure 2. **Adit, 182-level, Shimen mine (2004). Jeff Scovil photo.**

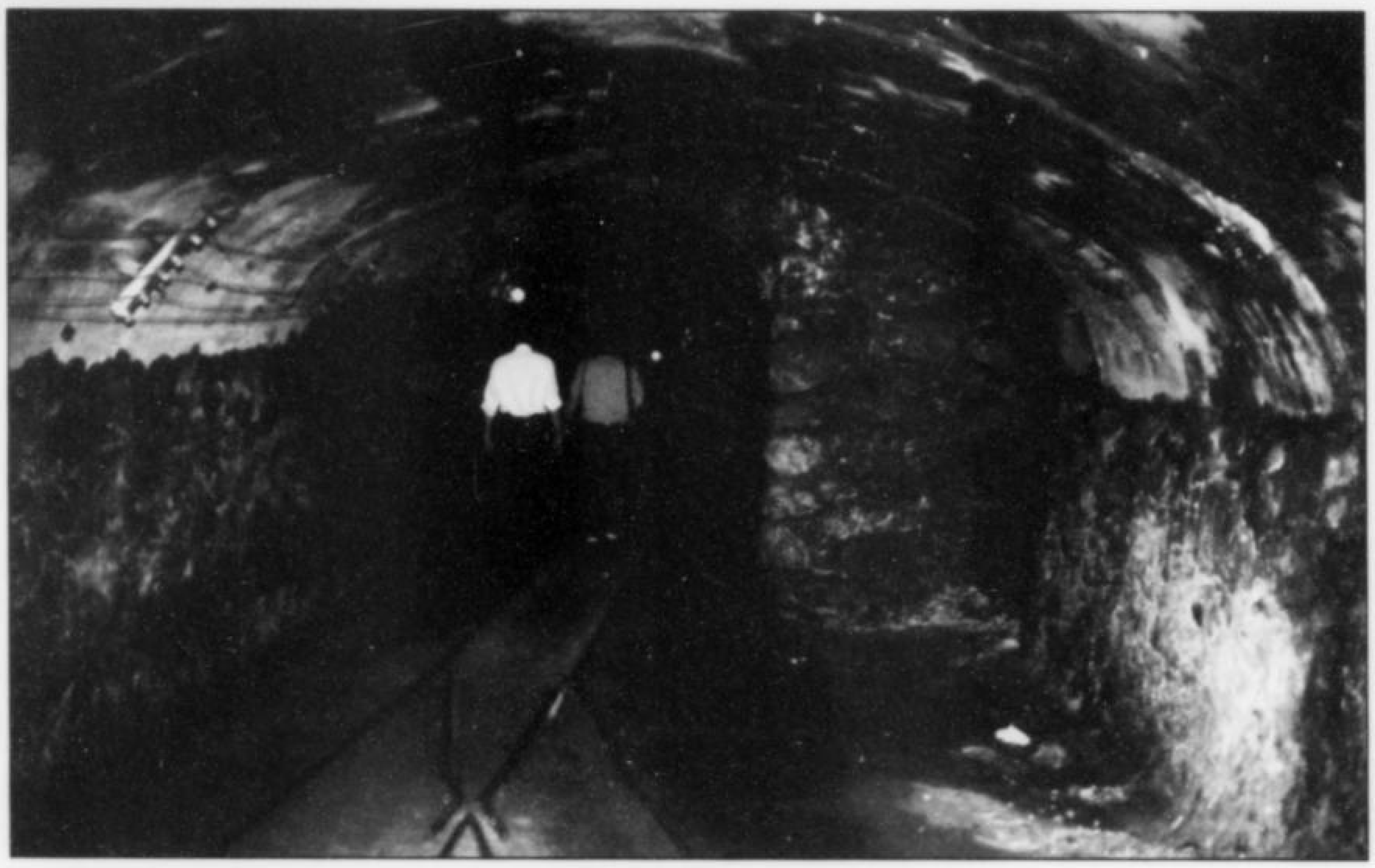


Figure 3. **Main adit, Shimen mine (2004). Jeff Scovil photo.**

be found as well, though usually in dark, opaque, unattractive specimens. Gemmy, bright yellow orpiment is found only rarely, but some nice specimens were recovered in 2006.

Jiepaiyu village is home to about 10,000 people, 3,000 of whom were empoyed in the mine until May 2004 when the provincial government closed it because of declining profitability. After converting to private ownership the mine reopened with a staff of about 70, and is still in operation. The mine management is very cordial to visitors, and offers tours for a small fee (though none of the guides speak English).

GEOLOGY and MINE WORKINGS

The workings, which may be entered through several adits driven into a hillside bordering a creek, extend to a depth of over 500 meters. Two main shafts provide access to stopes on six levels. The lowest level, at –350 meters, is partially flooded and currently inactive. All haulage within the mine is by hand-pushed trams on rails, and the workings are fully electrified.

The geology of the deposit has been discussed by Yao *et al.* (1999), Zhou (1986), and especially by Xianxiao Xiong and his colleagues.

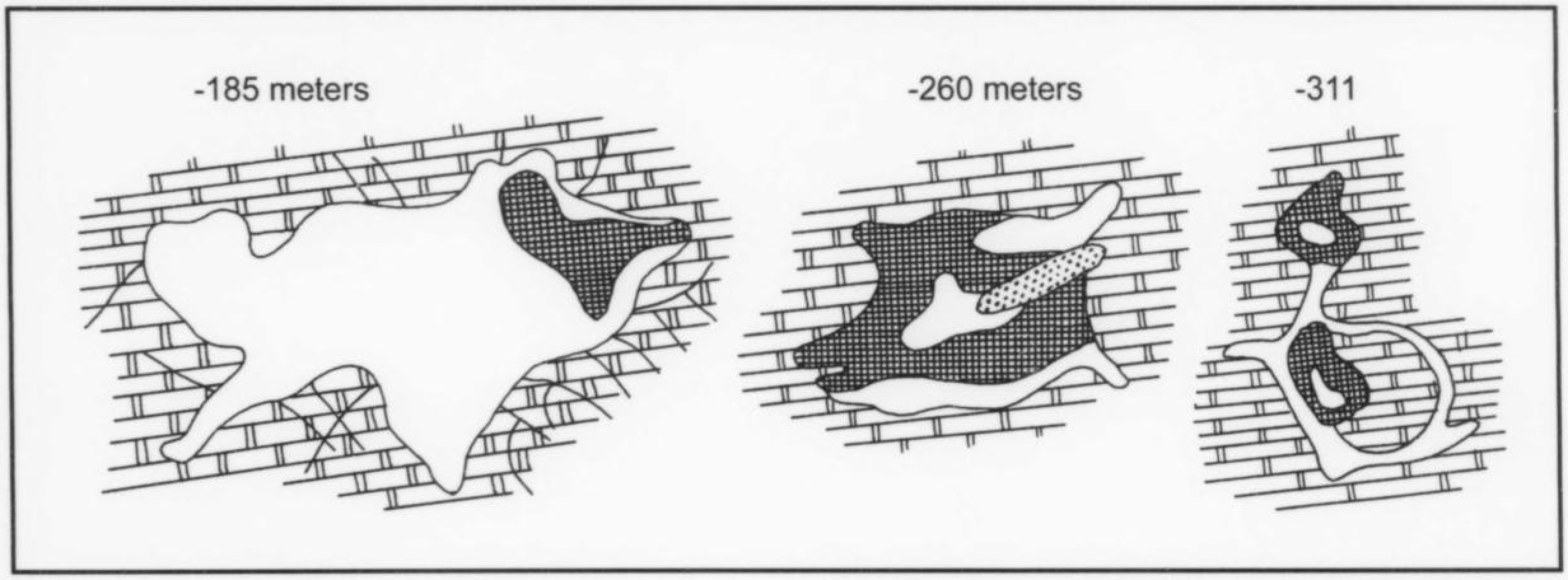


Figure 4. **Cross-sections of the Shimen pipe showing pipe breccia (white) and orebody at different levels (after Zhou, 1986).**

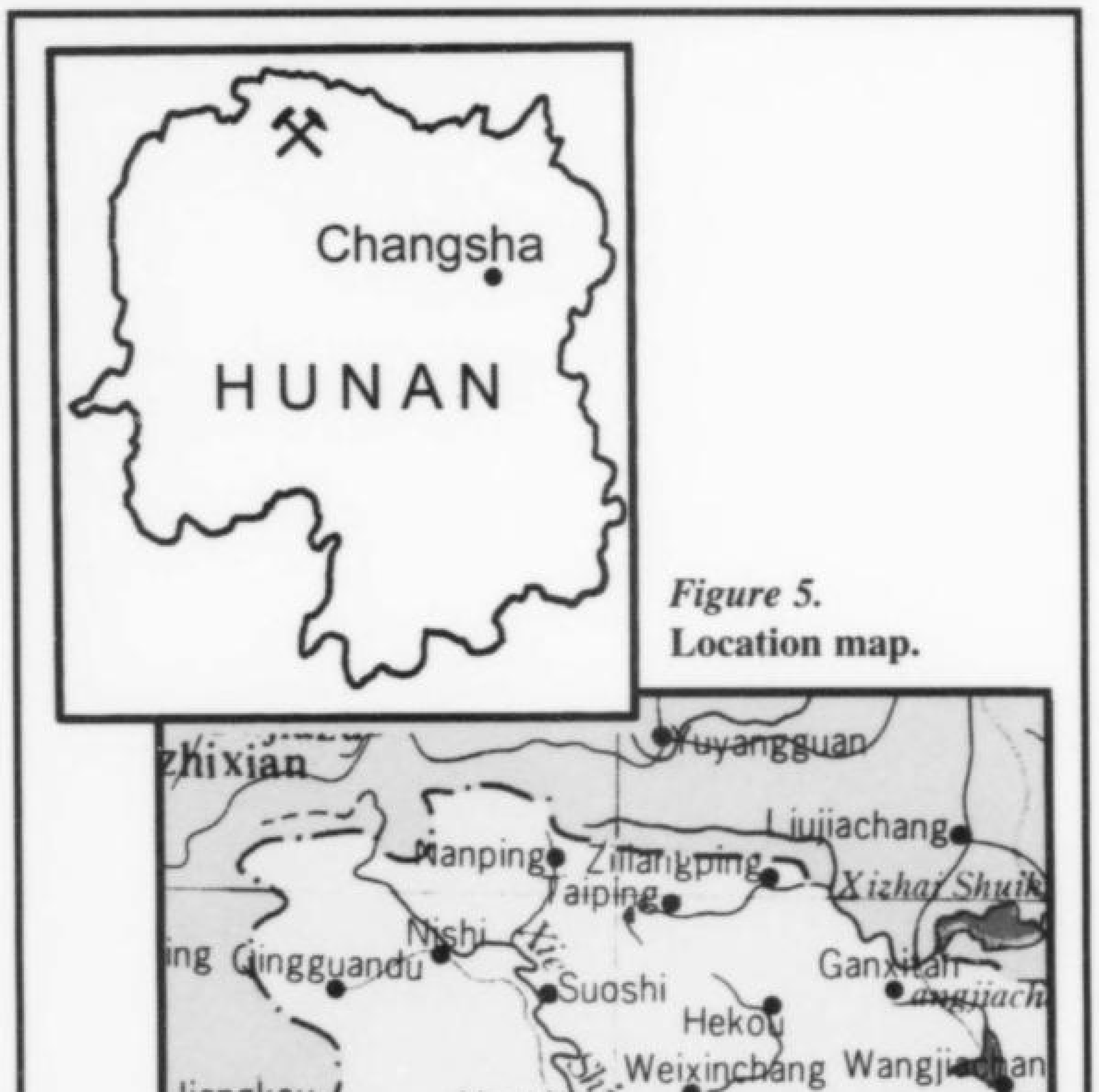


Figure 5. **Location map.**

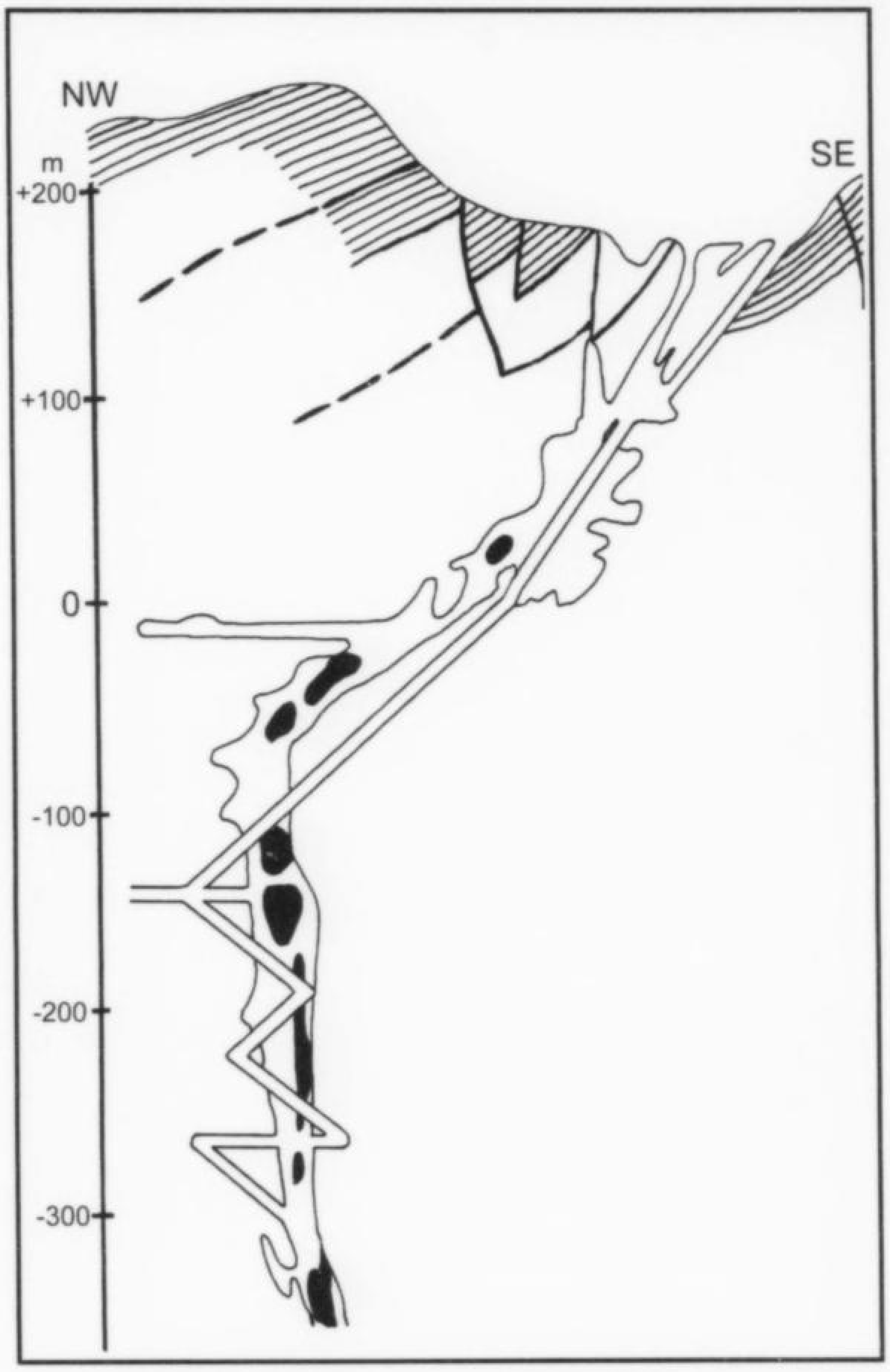


Figure 6. **Vertical section through the Shimen ore pipe showing ore concentrations (after Zhou, 1986).**

Xiong (2000) classified Chinese realgar/orpiment deposits into three major types and seven sub-types, one of which is exemplified by the Shimen deposit. Rising hydrothermal solutions concentrated arsenic from local sedimentary rocks and followed faults toward the surface. As chemical conditions evolved to permit the deposition of silica, the channels were temporarily blocked until the rising pressure broke through, resulting in the formation of so-called cryptoexplosion breccias conducive to further precipitation of minerals.

A number of pipe-like veins in the Shimen mine area contain realgar, but only the main vein is sufficiently rich to be mined economically. It passes vertically through three horizons: siliceous carbonate at the top, a karst breccia in the middle, and a lower realgar-orpiment-rich breccia horizon. The realgar concentrations occur at the contact zone between the Lower Ordovician Nianjingguan Formation and the Fengxiang Formation.The main country rocks are composed of oolitic dolomitite, limestone, marl and claystone. The realgar is concentrated around the 165-meter, 140-meter and 125-meter levels, reflecting favorable stratigraphic and

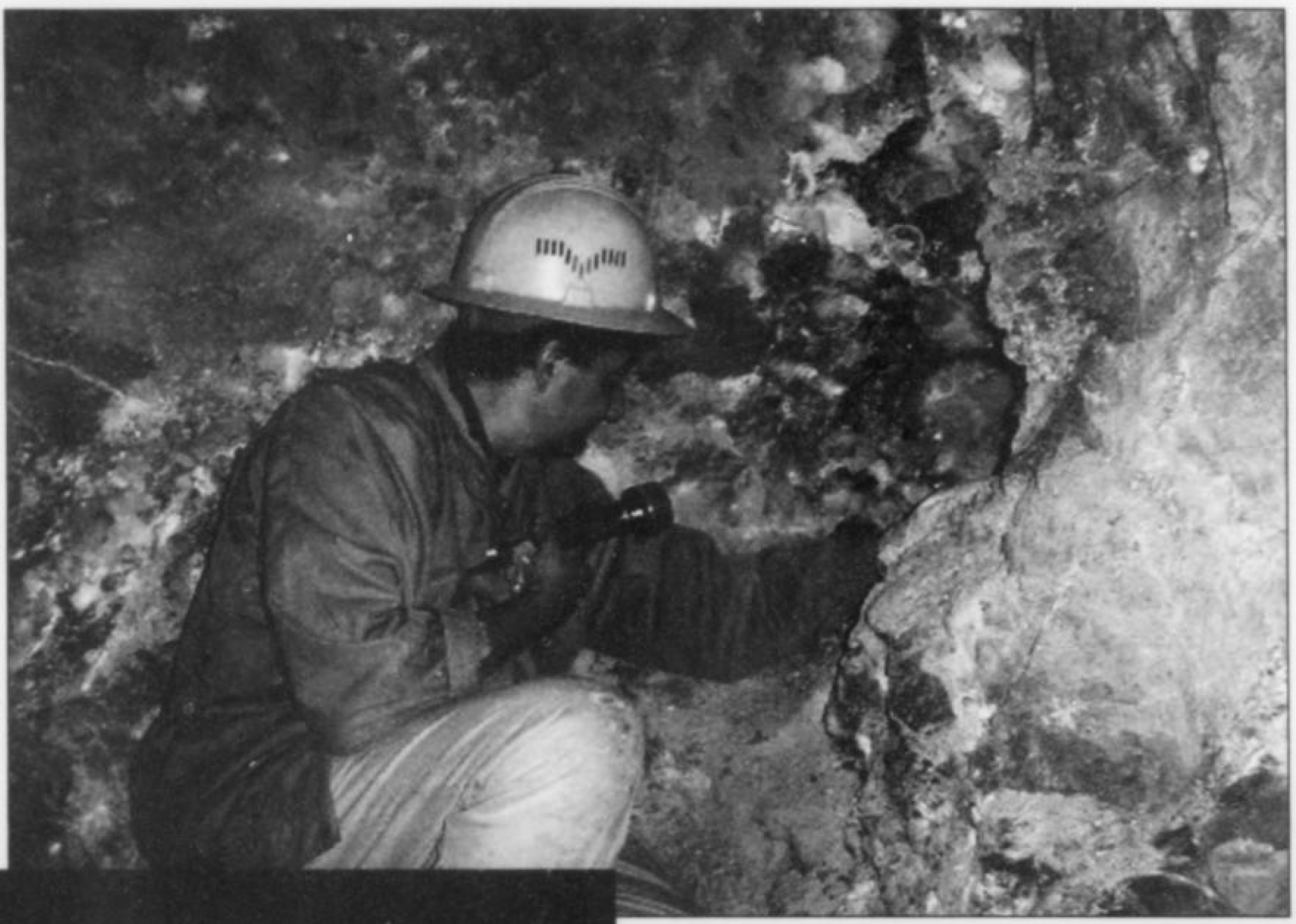


Figure 7. Examining a calcite pocket underground at the Shimen mine. Smartminerals photo.

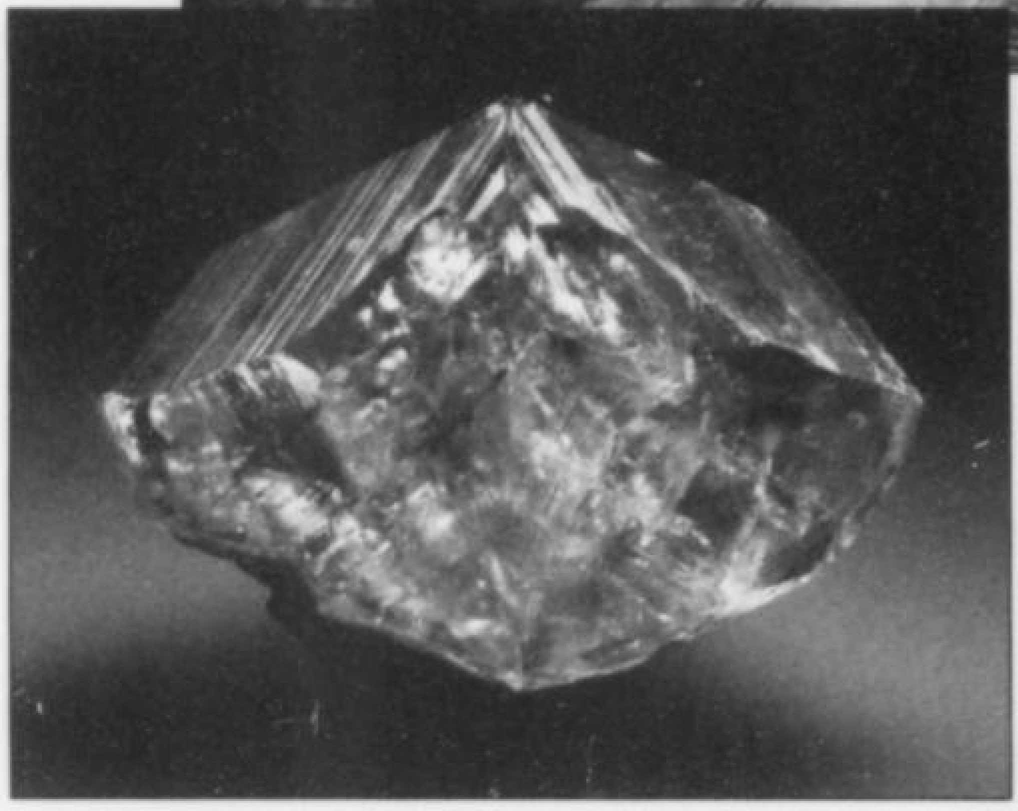


Figure 8. Calcite crystal, 6 cm, with inclusions of realgar, from the Shimen mine. William Larson collection; Jeff Scovil photo.

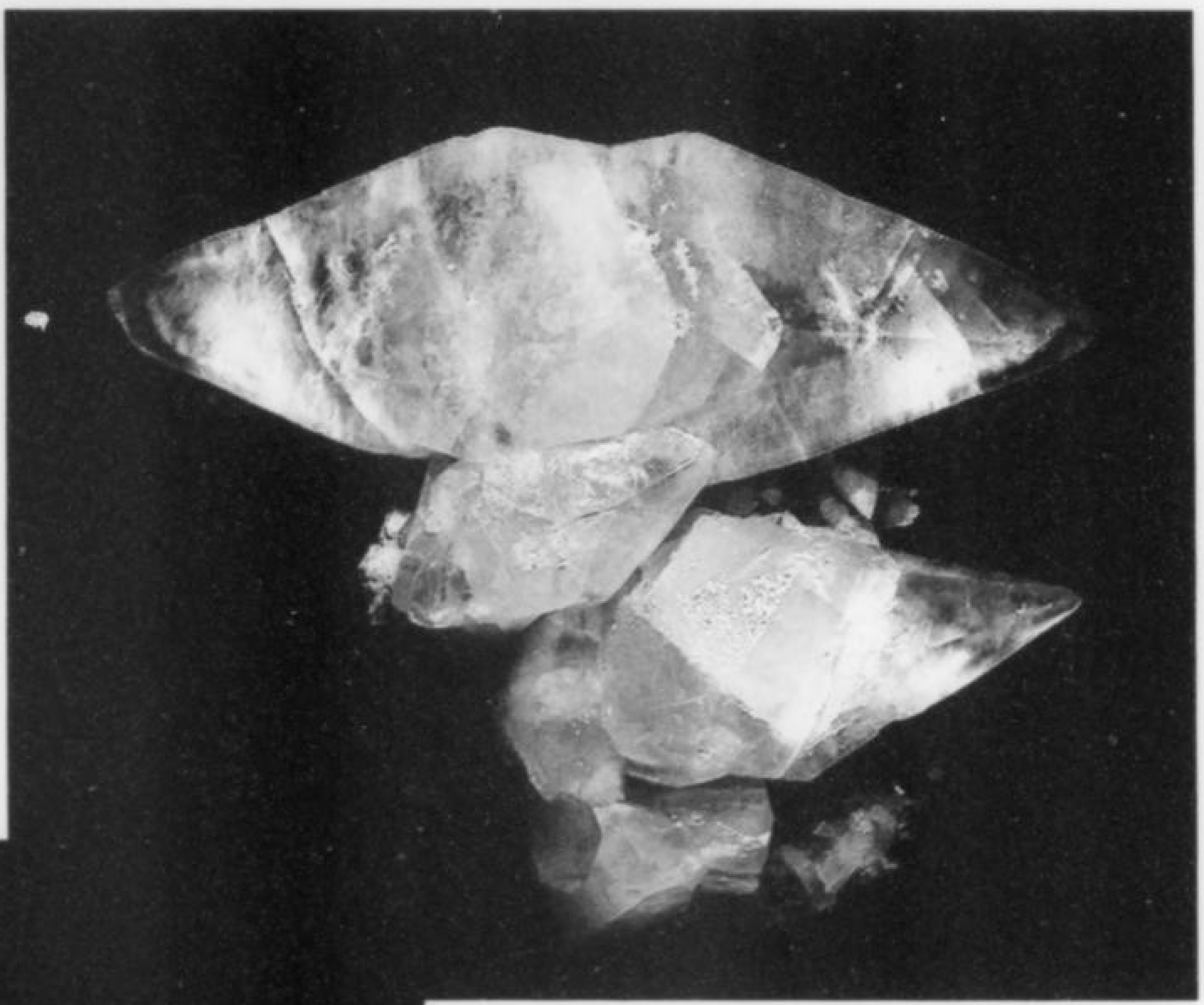


Figure 9. Calcite crystals, 23 cm, from the Shimen mine. Kevin Ward specimen and photo.

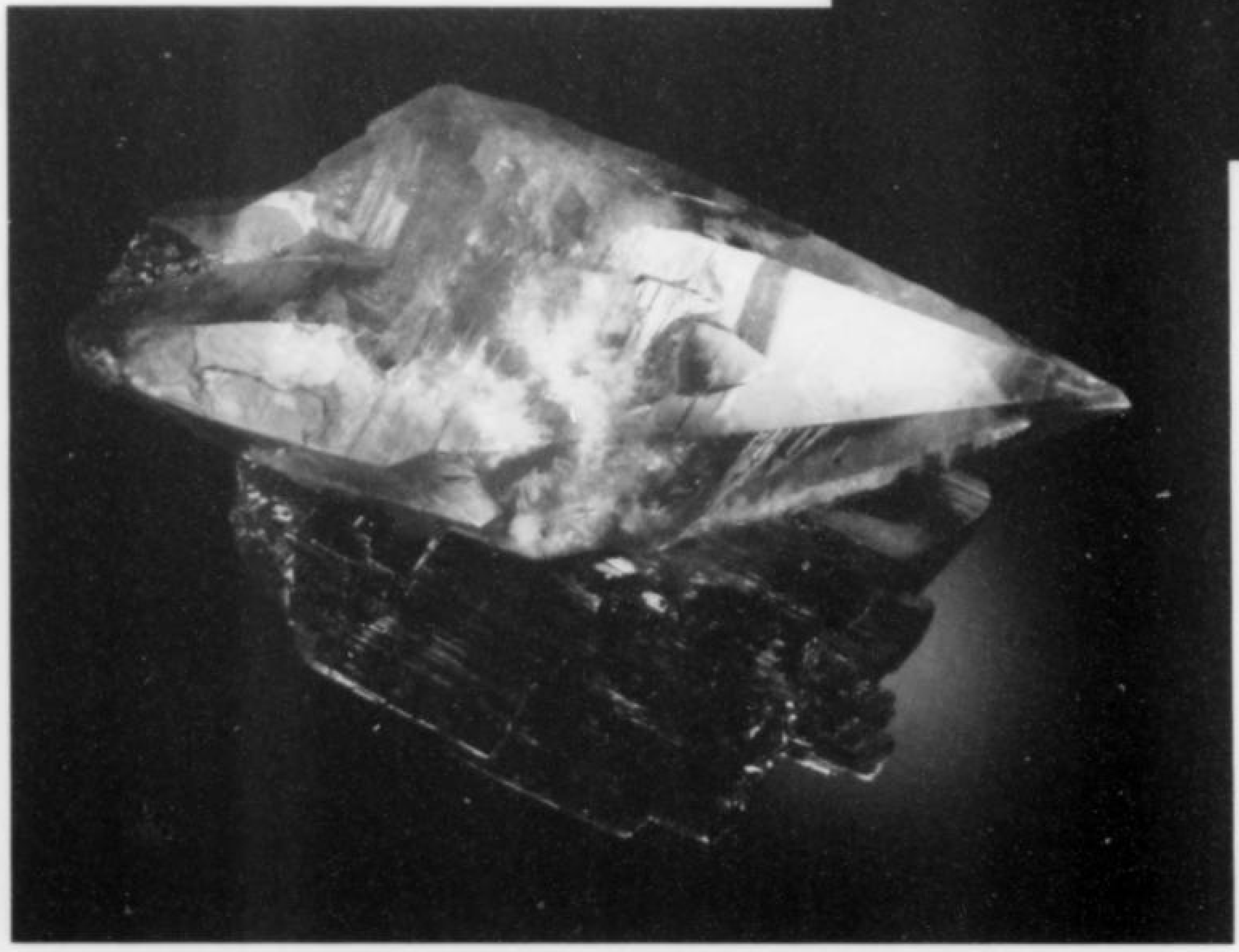


Figure 10. Calcite crystal on realgar, 9.5 cm, from the Shimen mine. Mel Gortatowsk collection; Jeff Scovil photo.

Figure 11. **Mine wall with coatings of red realgar and white picropharmacolite. Smartminerals photo.**

Figure 12. **Orpiment crystals with calcite crystals, 6 cm, collected in 2006 at the Shimen mine. Weigang Chen specimen and photo.**

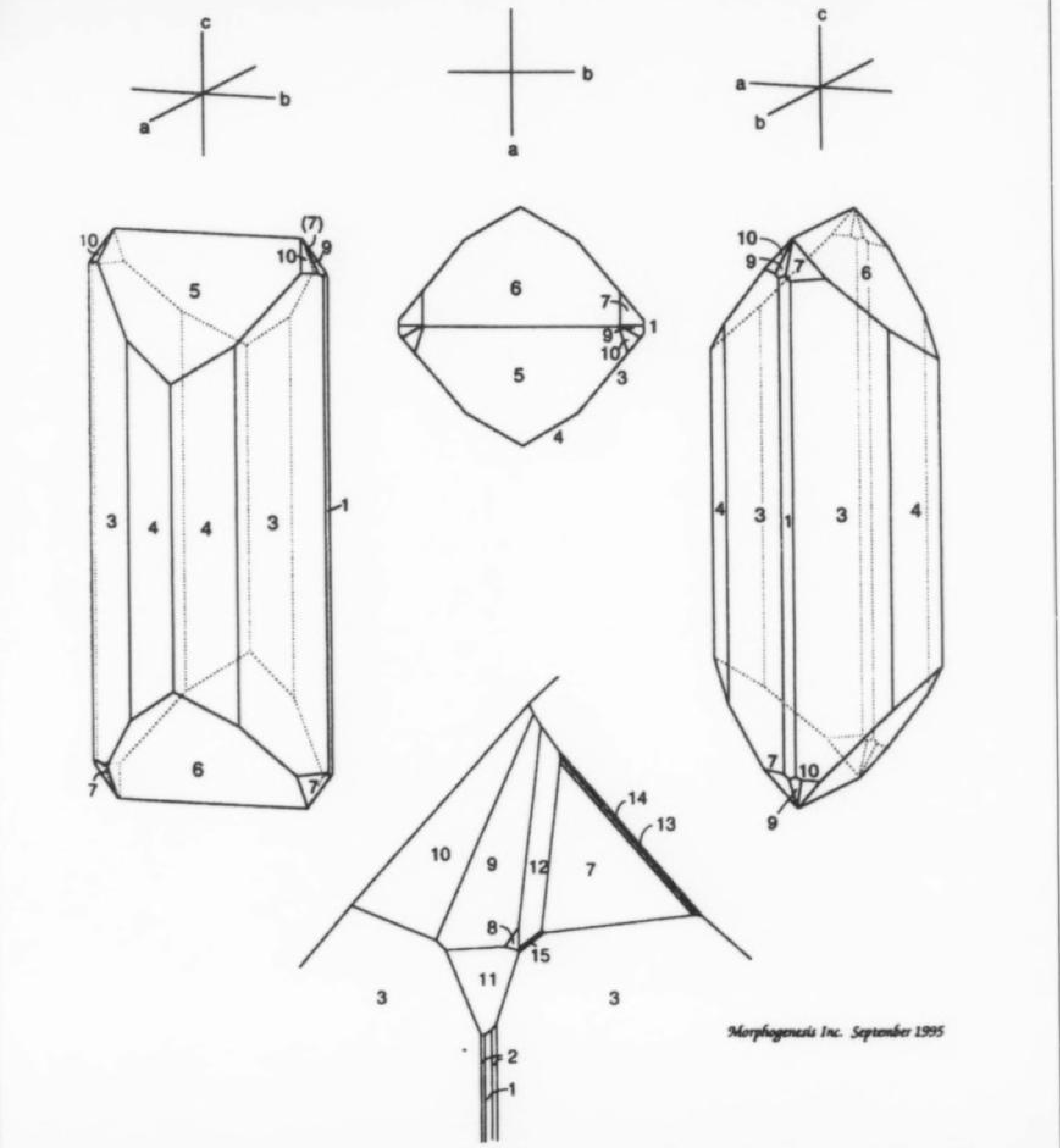


Figure 13. **Morphology of orpiment crystals from the Shimen mine. Forms: 1 = {010}, 2 = {140}, 3 = {110}, 4 = {210}, 5 = {301}, 6 = $\{\bar{3}01\}$, 7 = $\{\bar{3}31\}$, 8 = {2.10.0}, 9 = {131}, 10 = {451}, 11 = {271}, 12 = $\{\bar{1}31\}$, 13 = $\{\bar{3}21\}$, 14 = $\{\bar{6}52\}$, 15 = $\{\bar{3}51\}$ (Richards, 1998).**

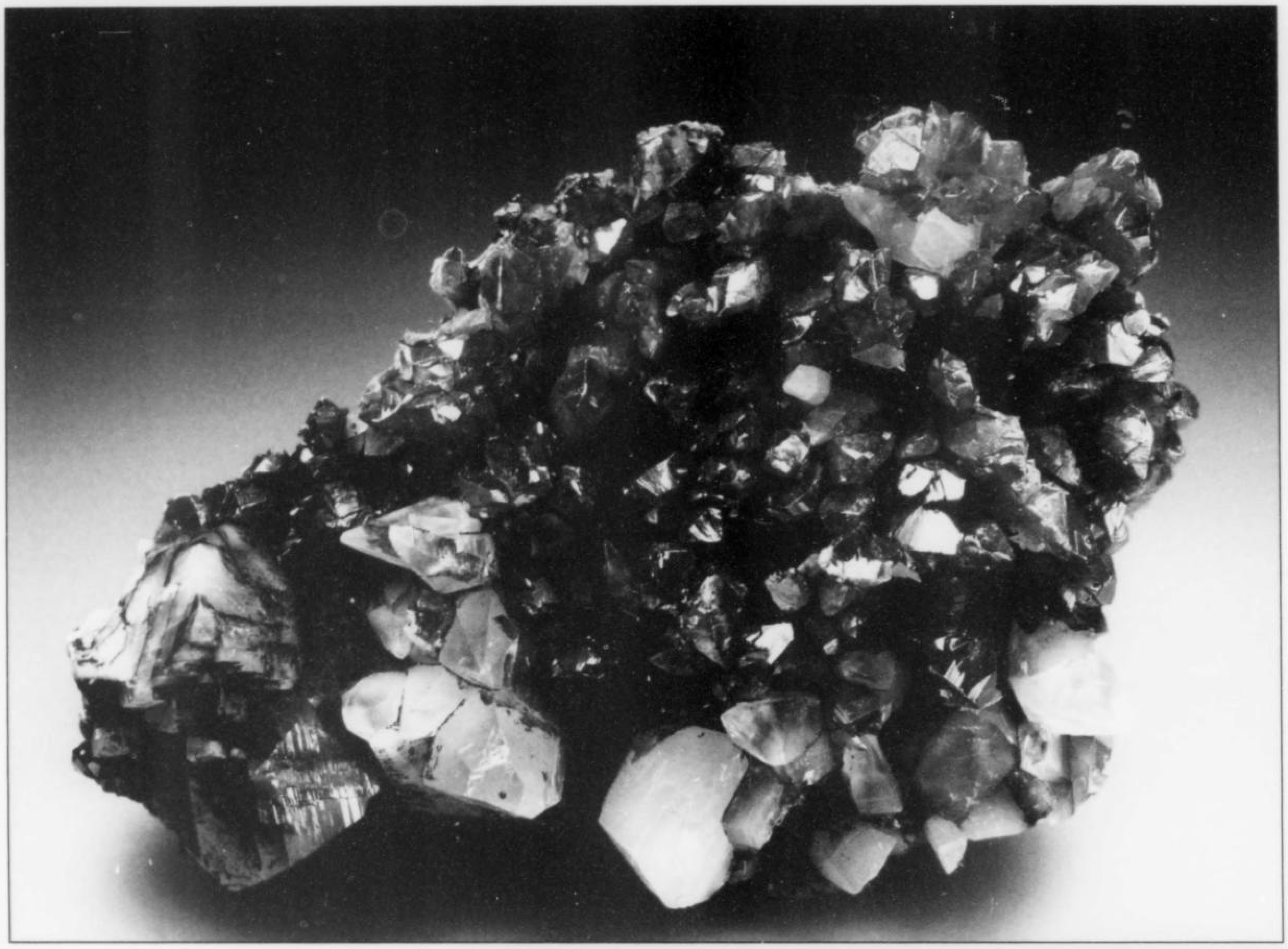


Figure 14. **Orpiment crystals with calcite, 15 cm, collected in 1988 at the Shimen mine. Edward Tripp collection; Wendell Wilson photo.**

Figure 15. **Orpiment crystals with calcite, 10.2 cm, from the Shimen mine. Mike Bergmann specimen; Jeff Scovil photo.**

lithological characteristics of the rocks and the karstic structure. Drifts are driven along the realgar-bearing horizons, following veins that are typically 50 cm to 2 meters thick. In some parts of the veins the vugs are small and may contain only calcite crystals, whereas in other areas the vugs contain realgar crystals on calcite. Stibnite and pyrite have also been found occasionally (Liu, 2003).

Unfortunately the zone which yielded the many fine crystallized realgar and orpiment specimens appears to be exhausted. Although massive realgar continues to be mined, no significant crystallized realgar specimens have been found since 2004. Nevertheless, occasional pockets still yield attractive calcite crystals. And considering the size of the deposit and the longevity of mining there, it is entirely possible that new pocket zones will be encountered in the future.

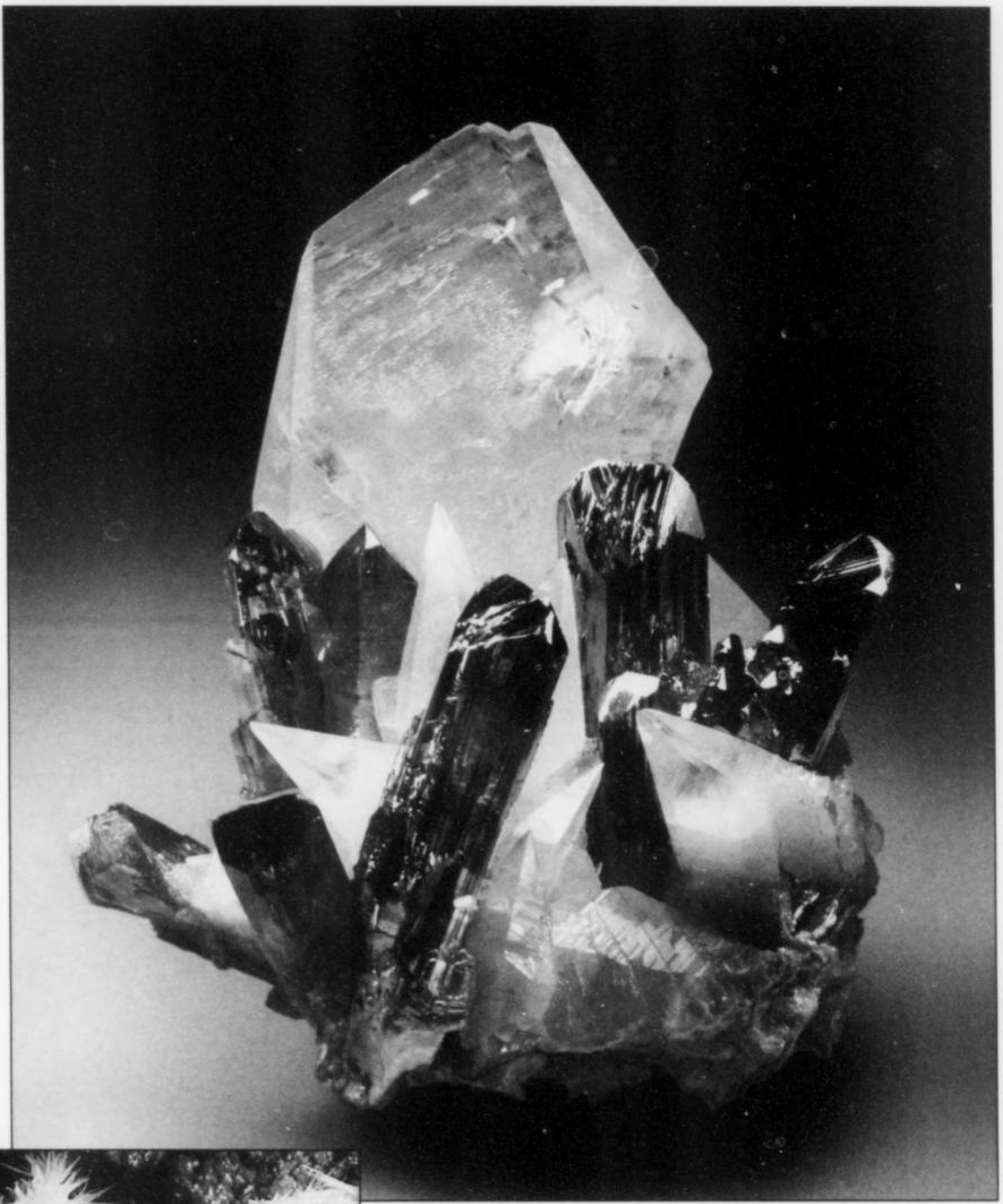


Figure 16. **Orpiment crystals with calcite, 8.5 cm, collected in the Shimen mine in 1993. Mike Bergmann specimen; Wendell Wilson photo.**

Figure 17. **Picropharmacolite crystals to 5 mm, from the Shimen mine. Tom Loomis specimen and photo.**

MINERALS

Calcite $CaCO_3$

Calcite crystals from Shimen are predominantly scalenohedral in habit, in some cases with complicated modifications involving other forms. They are generally quite lustrous and sharp, colorless or white to pale yellow in color, and vary from virtually opaque white to semi-transparent. Inclusions of small realgar crystals and yellow orpiment are common. Crystal size ranges up to 23 cm or more. Calcite occurs as monomineralic clusters and crusts, and also in association with fine crystals of realgar and orpiment (though generally not with the two simultaneously). Some calcite specimens are slightly fluorescent under shortwave ultraviolet light.

Orpiment As_2S_3

Orpiment crystals from Shimen tend to be elongated and prismatic pseudo-orthorhombic in habit, looking quite similar in overall shape to the elongated realgar crystals from the same locality though generally not found in direct contact with them. Crystals and crystal clusters also resemble the world-class orpiment specimens found in the Quiruvilca district, Peru in the early 1970's, though perhaps with a somewhat larger length-to-width ratio. Crystal size ranges from druses of short acicular crystals measuring only a millimeter or two, sometimes coating scalenohedral calcite crystals, up to crystals exceeding 10 cm long and over 1 cm in diameter. The crystals vary from dark and unsightly to rich, deep yellow to brownish yellow and reddish orange, and are opaque to transparent. Orpiment is fairly common in the mine, but is very rare in collector-quality specimens. Generally the only associated species is white calcite, in comparatively large scalenohedral crystals. Orpiment can occur as inclusions in calcite and as large crystals with calcite.

Richards (1998) described the morphology of Shimen orpiment. The long prismatic sides consist of the forms {010}, {110}, {140} and {210}. The chisel-like terminations consist of two different

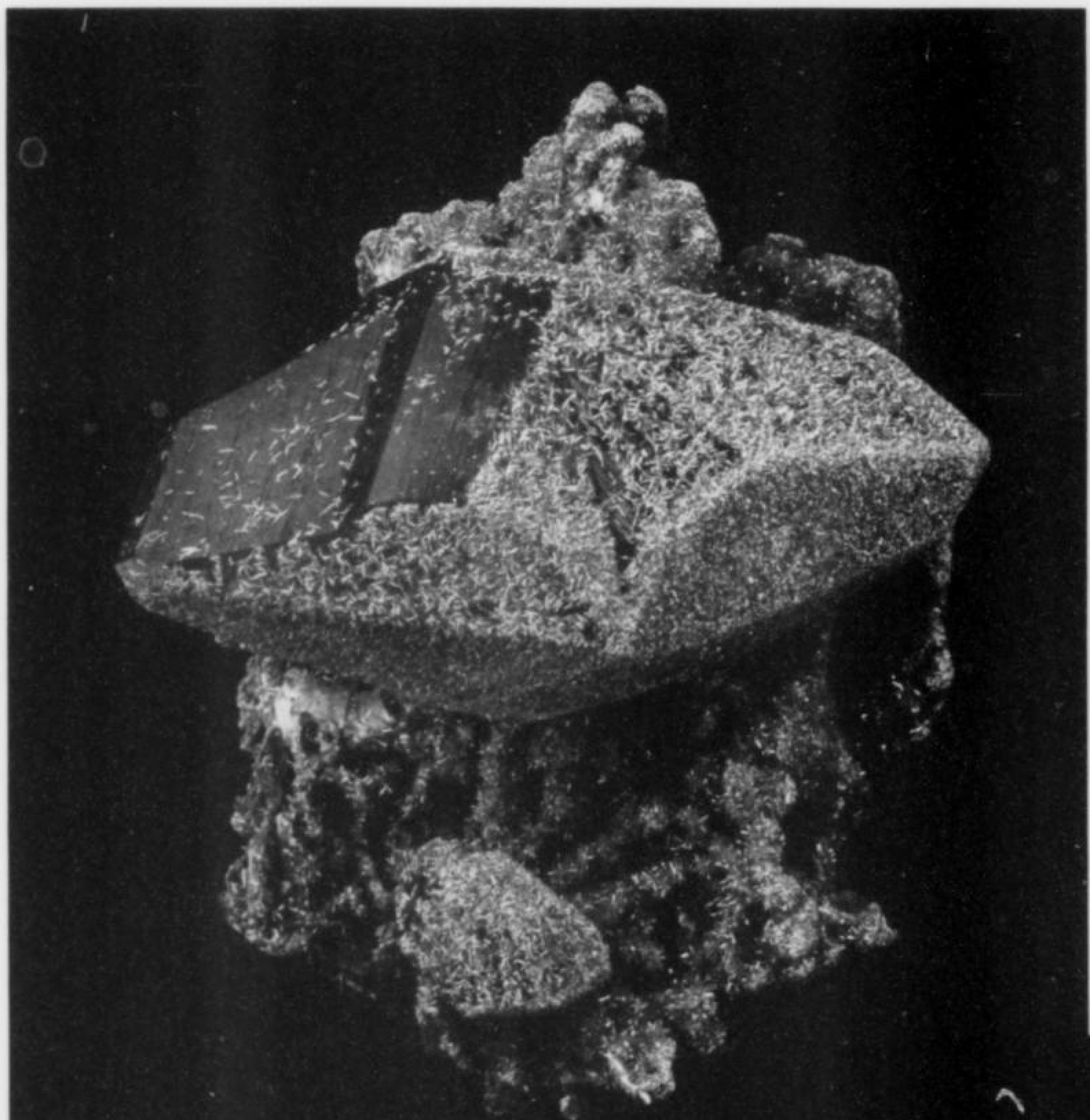


Figure 18. **Tiny acicular orpiment crystals on calcite, 7.5 cm, from the Shimen mine. Martin Zinn collection; Jeff Scovil photo.**

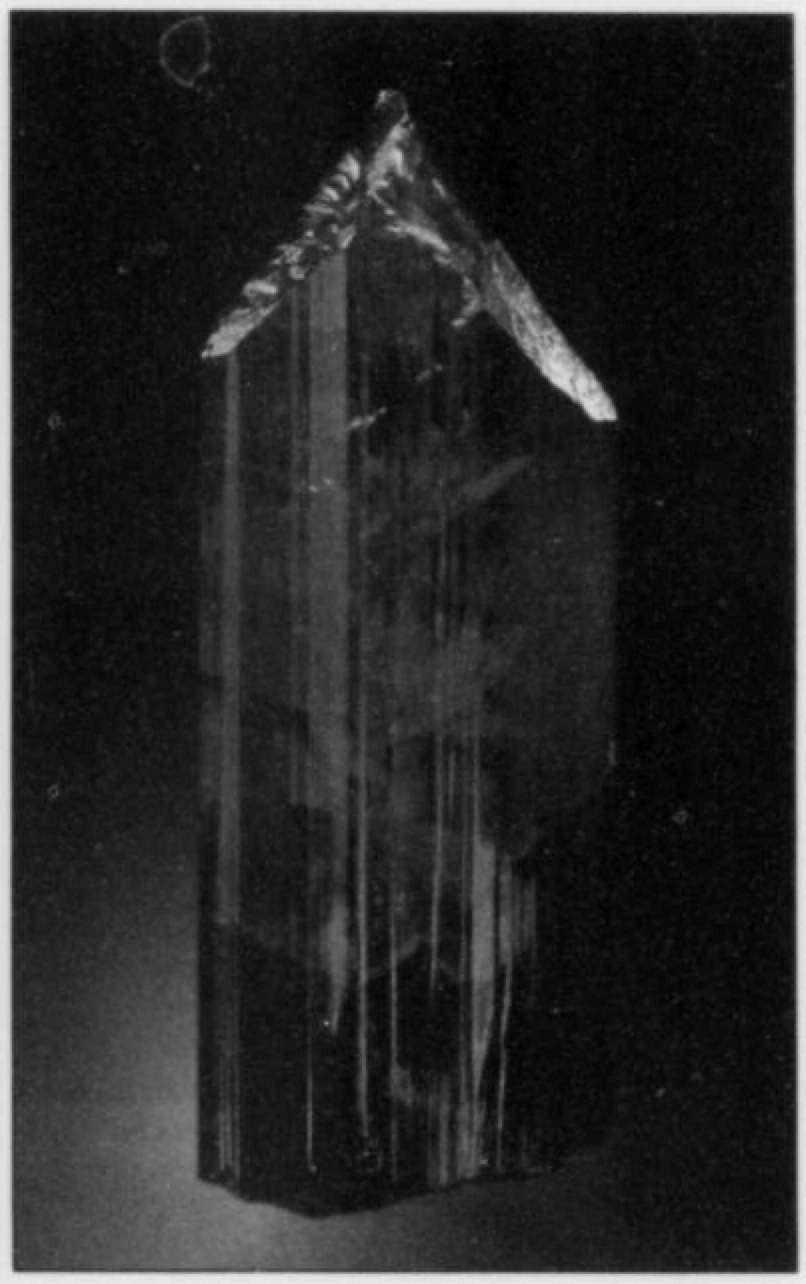


Figure 19. **Realgar crystal, 9 cm, from the Shimen mine. Keith Proctor specimen; Jeff Scovil photo.**

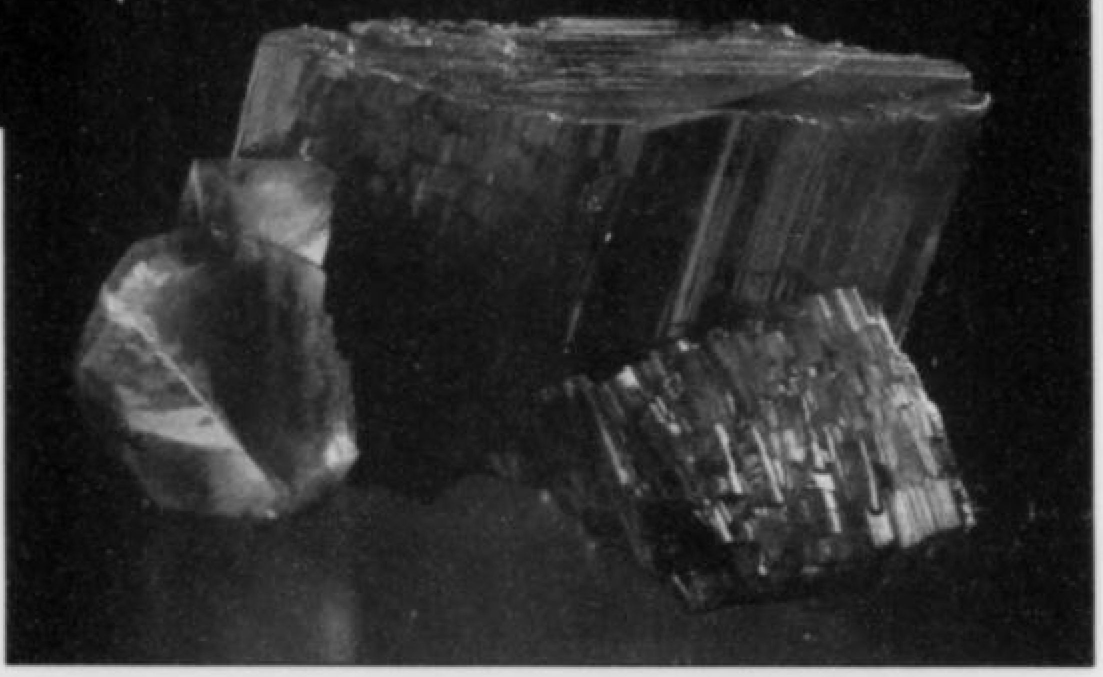


Figure 20. **Realgar crystals with calcite, 9.2 cm, from the Shimen mine. Steve Smale collection; Jeff Scovil photo.**

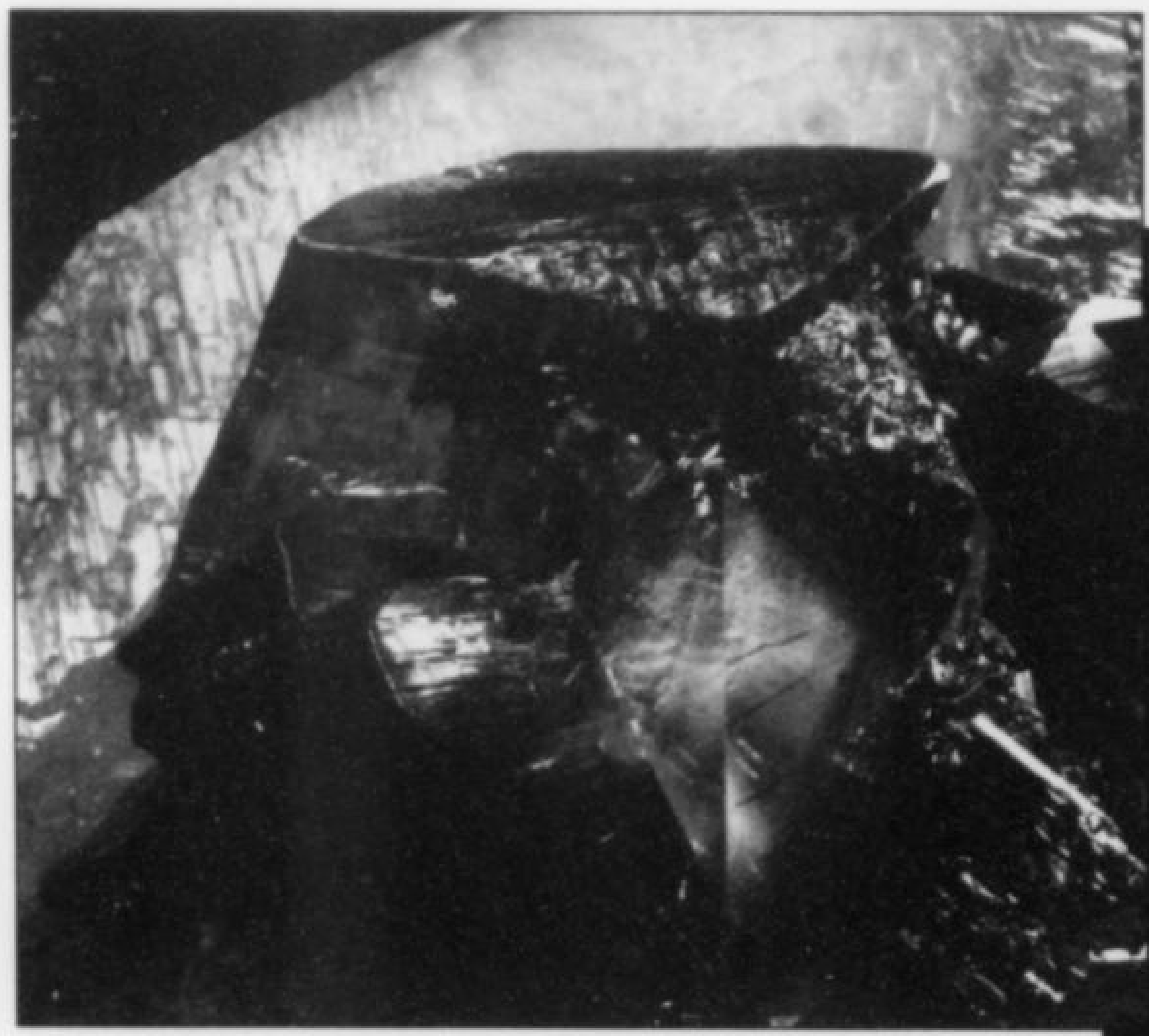


Figure 21. **Realgar crystals to 5.3 cm, collected in 1990 at the Shimen mine. Doug Parsons specimen; Wendell Wilson photo.**

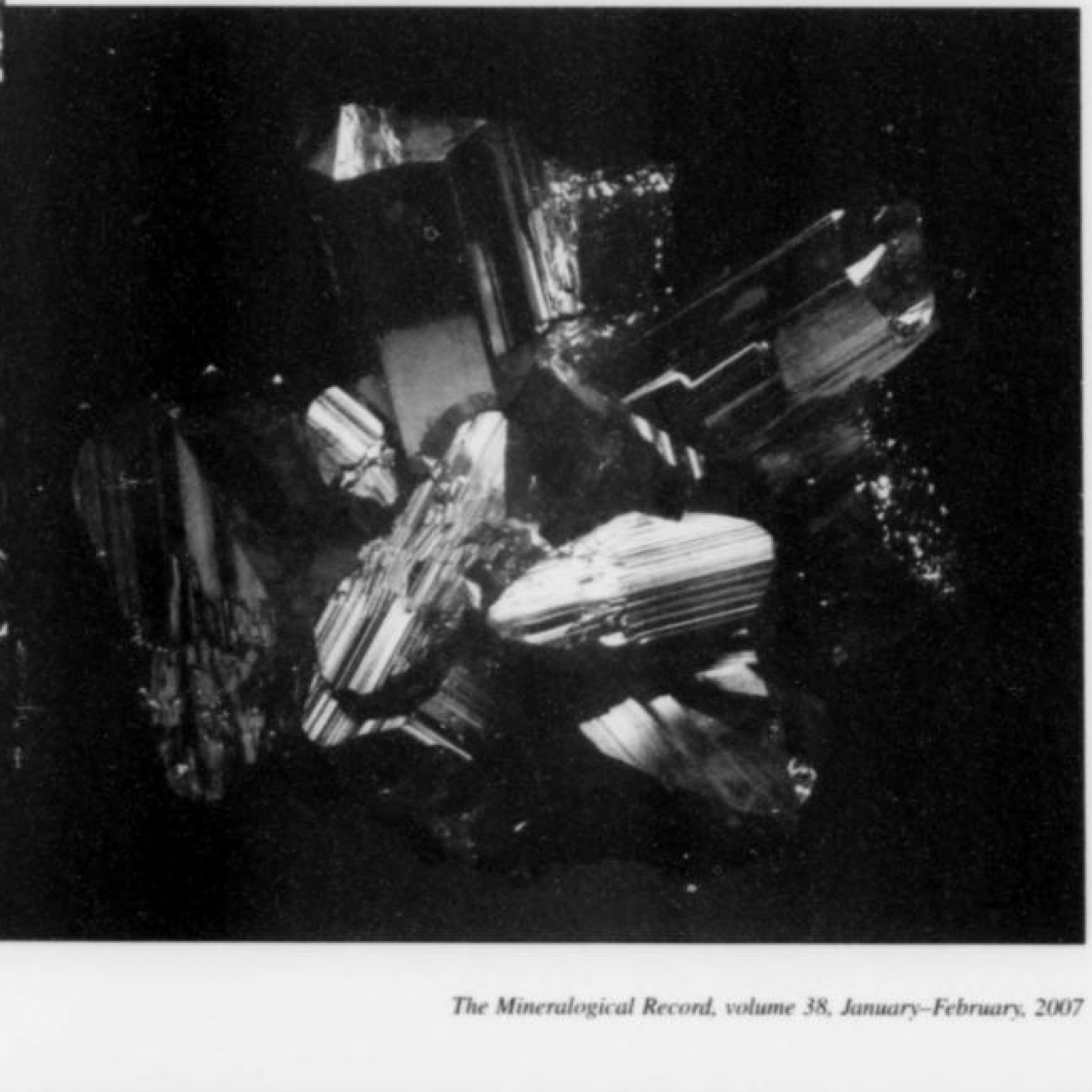


Figure 22. **Realgar, 6.4 cm, from the Shimen mine. Dan Weinrich specimen; Jeff Scovil photo.**

Figure 23. Realgar crystals to 4.5 cm, collected in 2006 at the Shimen mine. Weigang Chen specimen and photo.

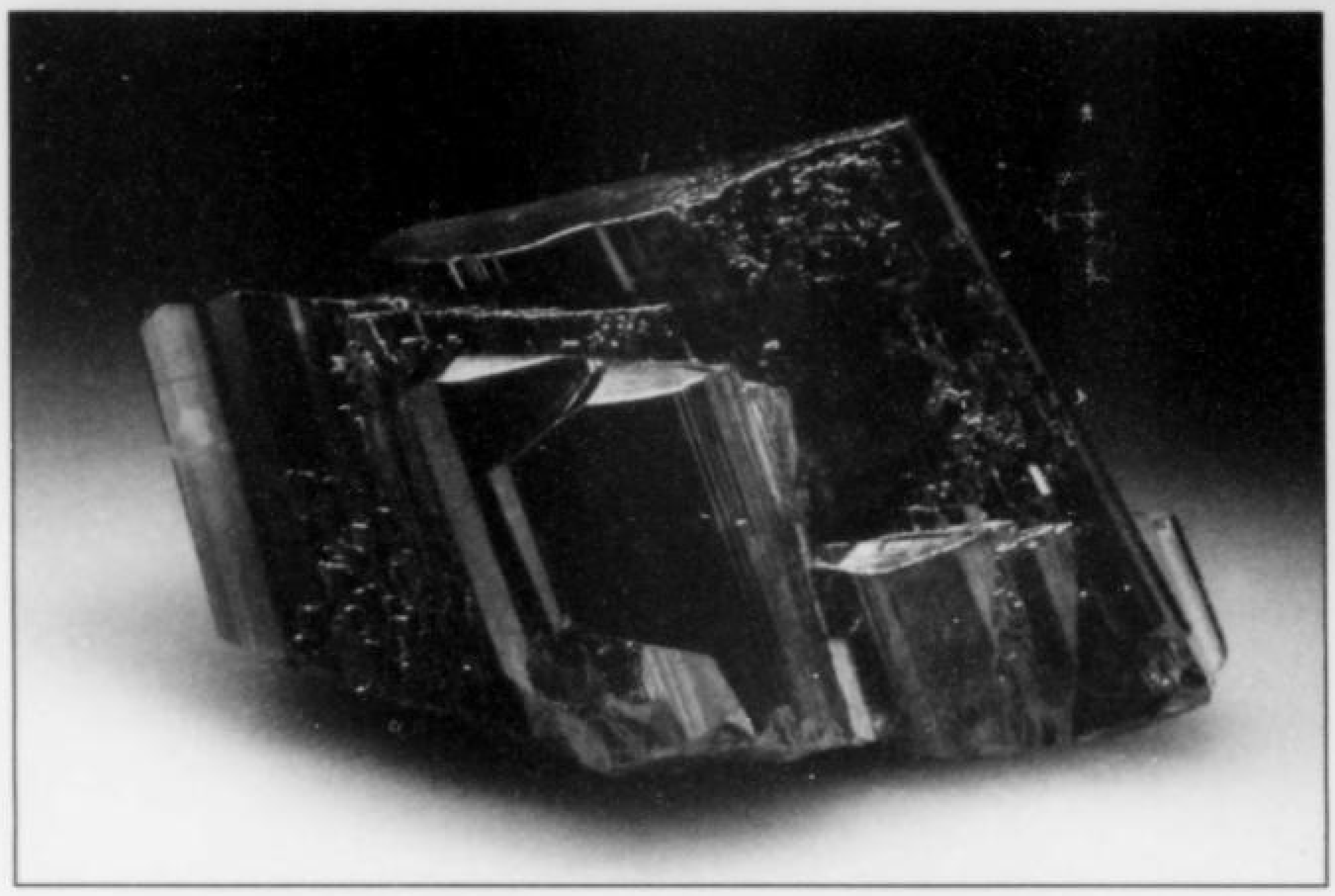


Figure 24. Realgar crystals, 8 cm, from the Shimen mine. William Larson specimen; Jeff Scovil photo.

Figure 25. Realgar crystal cluster, 3.5 cm, collected at the Shimen mine in 2006. Weigang Chen specimen and photo.

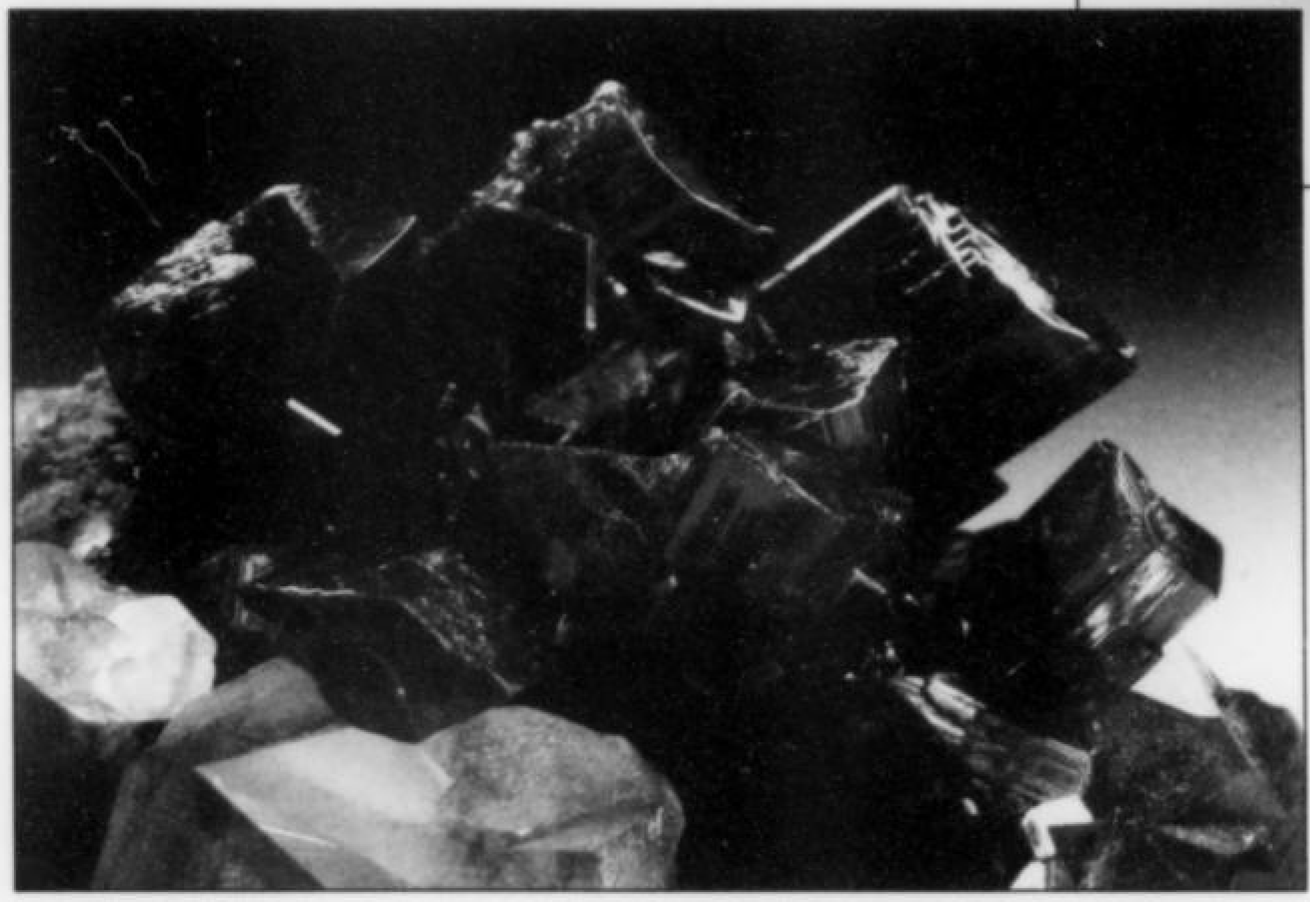


Figure 26. Realgar crystals to 1.7 cm on calcite, from the Shimen mine. Forrest Cureton specimen; Wendell Wilson photo.

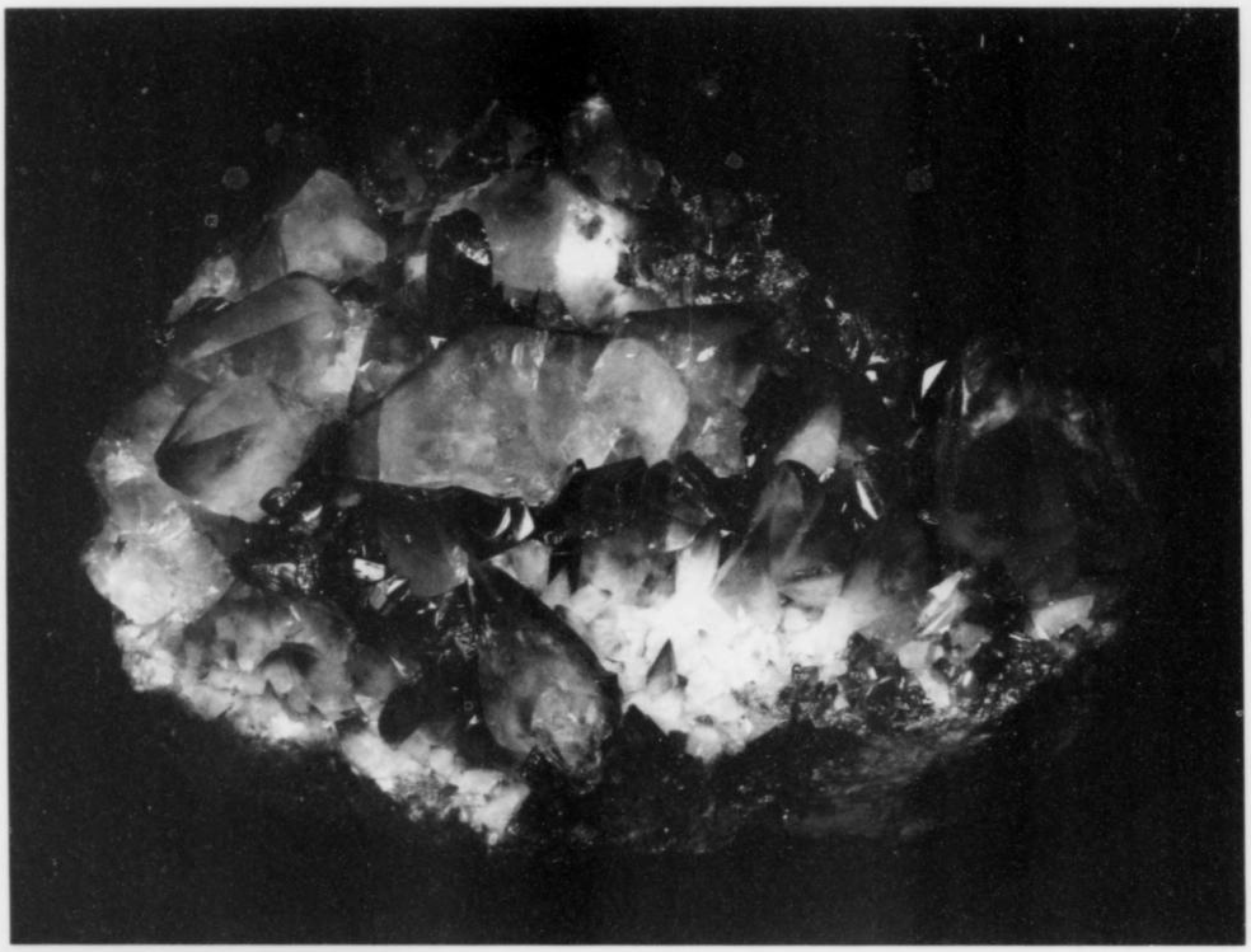


***Figure 27.* Large plate of calcite crystals with realgar, 33 cm, from the Shimen mine. Natural History Museum of Los Angeles County collection; Richard Meier photo.**

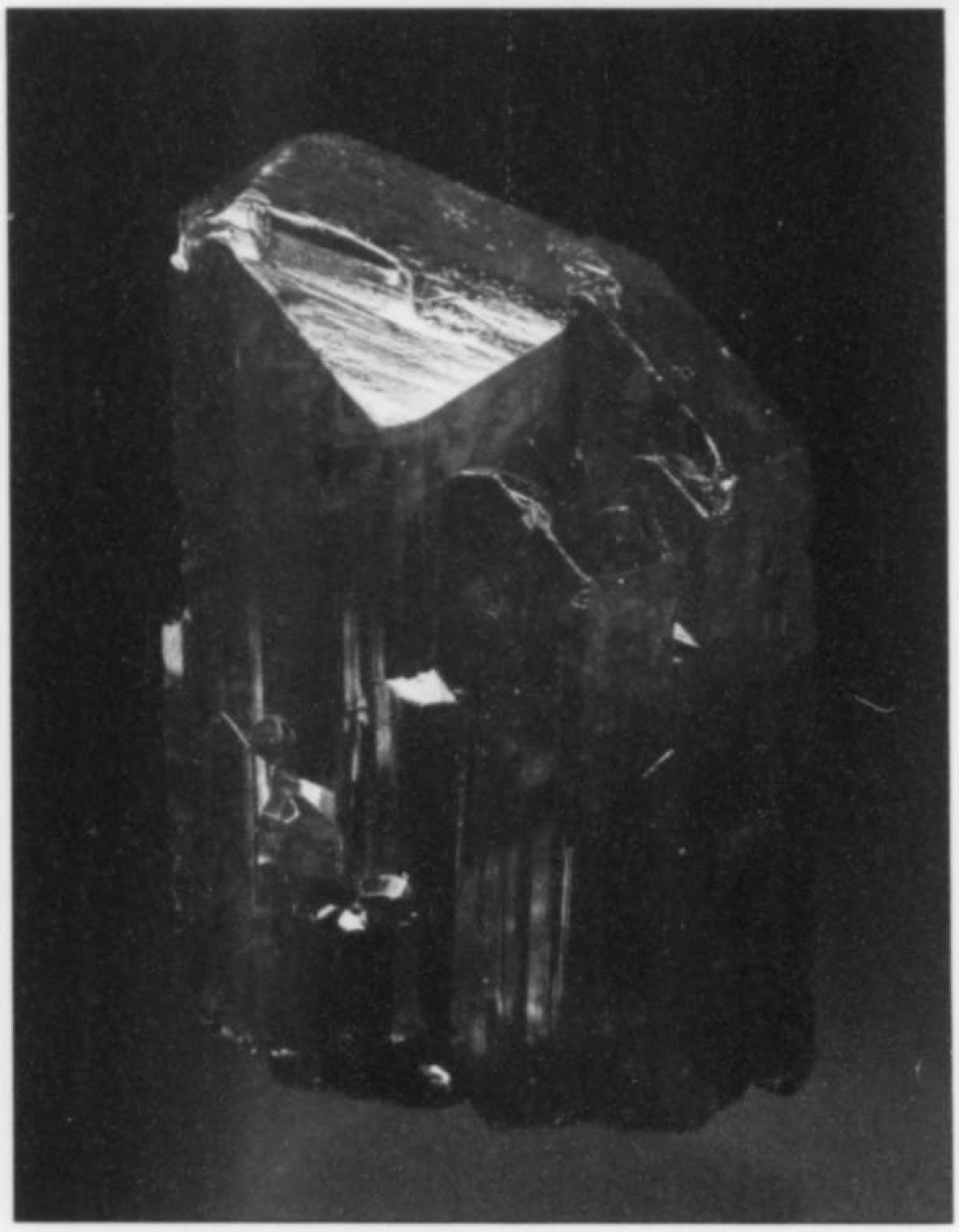


***Figure 28.* Realgar crystal, 6.8 cm, from the Shimen mine. John White collection; Jeff Scovil photo.**

prism faces, {301} and{$\bar{3}$01}, oriented parallel to the *b* axis, modified by an array of small faces on the corners including {$\bar{3}$31}, {131}, {452}, {$\bar{1}$31}, {$\bar{3}$51} and possibly others less certain.

Picropharmacolite $Ca_4Mg(AsO_3OH)_2(AsO_4)_2 \cdot 11H_2O$

Picropharmacolite occurs as drusy coatings of acicular white crystals lining vugs in massive realgar and partially covering realgar crystals.

Realgar As_4S_4

Realgar is the principal ore mineral at the mine, where it occurs massive and in crystals. The translucent to transparent crystals can be extraordinarily attractive, with brilliant glassy luster and intense red color. Crystal size in the better specimens ranges from 2 to 12 cm (Cook, 2005). The habit varies from more or less equant and short prismatic to prisms several times longer than they are wide. The prism faces appear to be predominantly the *m*{110} and *l*{120} forms, and the termination is usually dominated by the two *n*{011} faces, in some cases with the *c*{001} face, though striations and oscillating forms render identification difficult. Other, smaller forms are present on some crystals. The prism and termination faces all tend to be striated. Calcite is the principal gangue mineral in the veins, and the realgar crystals typically occur on or intergrown with attractive calcite crystals.

The realgar contains some Sb and traces of Hg, Se, Te, Bi and Au; chemical analyses indicate a formula of $(As_{0.9997}Sb_{0.0013})_{1.001}S$. Infrared absorption appears at 343 and 375 cm^{-1}. Unit cell parameters are a = 9.309~9.511Å, b = 13.52~13.61Å, c = 6.572~6.593Å (Xiong and Liu, 1998).

Like all realgar specimens, Shimen realgar tends to spontaneously convert to powdery yellow pararealgar upon extended exposure to light (see Bonazzi *et al.*, 1996, who conducted new studies on Shimen realgar), so specimens should always be stored in the dark except for brief periods on display.

CONCLUSIONS

The flow of fine realgar specimens from the Shimen mine, though intermittent, appears to be continuing, at least on a modest scale. Whether more are encountered in the future or not, the best specimens now in collections will certainly join the ranks of the "modern classic" world-class specimens, always to be sought after as the finest examples of their species. The great orpiment specimens appear to have been of much more limited distribution in the mine, and we may have seen the last of them quite some time ago.

Unfortunately, the majority of the great Shimen realgar specimens may carelessly be allowed to deteriorate because of inadequate protection from the deleterious, cumulative effects of exposure to light. And orpiment, though not as light-sensitive (it eventually alters to arsenolite), is quite soft and easily damaged. Consequently these wonderful specimens present a real challenge in conservation for future generations of collectors and curators. Otherwise, fine Chinese realgar and orpiment, in their pristine state, are destined to dwindle sadly in numbers during the coming decades.

ACKNOWLEDGMENTS

My thanks to Jeff Scovil for specimen photography, Smartminerals for locality photos, and Berthold Ottens for locality photos and for reviewing the manuscript. Anthony Kampf reviewed the manuscript as well. John Veevaert of *Trinity Minerals* and Weigang Chen of *Tianci Mineral Crystal World* in Xiamen, Fujian, China also provided information.

REFERENCES

BONAZZI, P., MENCHETTI, S., PRATESI, G., MUNIZ-MIRANDA, M., and SBRANA, G. (1996) Light-induced variations in realgar and -As_4S_4: X-ray diffraction and Raman studies. *American Mineralogist*, **81**, 874–880.

COOK, R. B. (2005) Connoisseur's choice: Realgar, Jiepaiyu mine, Shimen, Hunan province, China. *Rocks & Minerals*, **80** (2), 108–112.

LIU, G. (2003) China: promising new entry in the mineral specimen market. *ExtraLapis English* no. **4**, "Calcite: the mineral with the most forms." Lapis International LLC, East Hampton, CT, p. 48–49.

LIU, G. (2006) *Fine Minerals of China*. AAA Minerals AG, Zug, Switzerland; p. 156–161.

MOORE, T. (1990) What's new in minerals? Munich Show 1989. *Mineralogical Record*, **21**, 173–175.

REN, K., JIN, B., and GUO, K. (1980) *Minerals in China.* Museum of Geology, Ministry of Geology, People's Republic of China, and Shanghai Scientific and Technical Publishers, Shanghai, 165 p.

ROBINSON, G. W., and KING, V. T. (1990) What's new in minerals? *Mineralogical Record*, **21**, 488.

RICHARDS, R. P. (1998) Orpiment from Hunan, China: a crystallographic note. *Rocks & Minerals*, **73**, 279–280.

WILSON, W. E. (1988) What's new in minerals? Tucson Show 1988. *Mineralogical Record*, **19**, 210.

WILSON, W. E. (1989) What's new in minerals? Springfield Show 1989. *Mineralogical Record*, **20**, 481.

XIONG, X. (1996) The genesis and breccias in Jiepaiyu top-like ore-prospecting significance of the area, Hunan Province. *Acta petrologica et mineralogica*, **15** (3) , 228– 234 [in Chinese with English abstract].

XIONG, X. (1997a) Hot-water origination of silicalite in Shimen realgar deposit. *Geology of Chemical Minerals,* **19** (2), 109–114 [in Chinese with English abstract].

XIONG, X. (1997b) On the genetic classification of mineralized breccias realgar ore district in the Shimen, Hunan Province. *Geological Review*, **43** (5), 483–489 [in Chinese with English abstract].

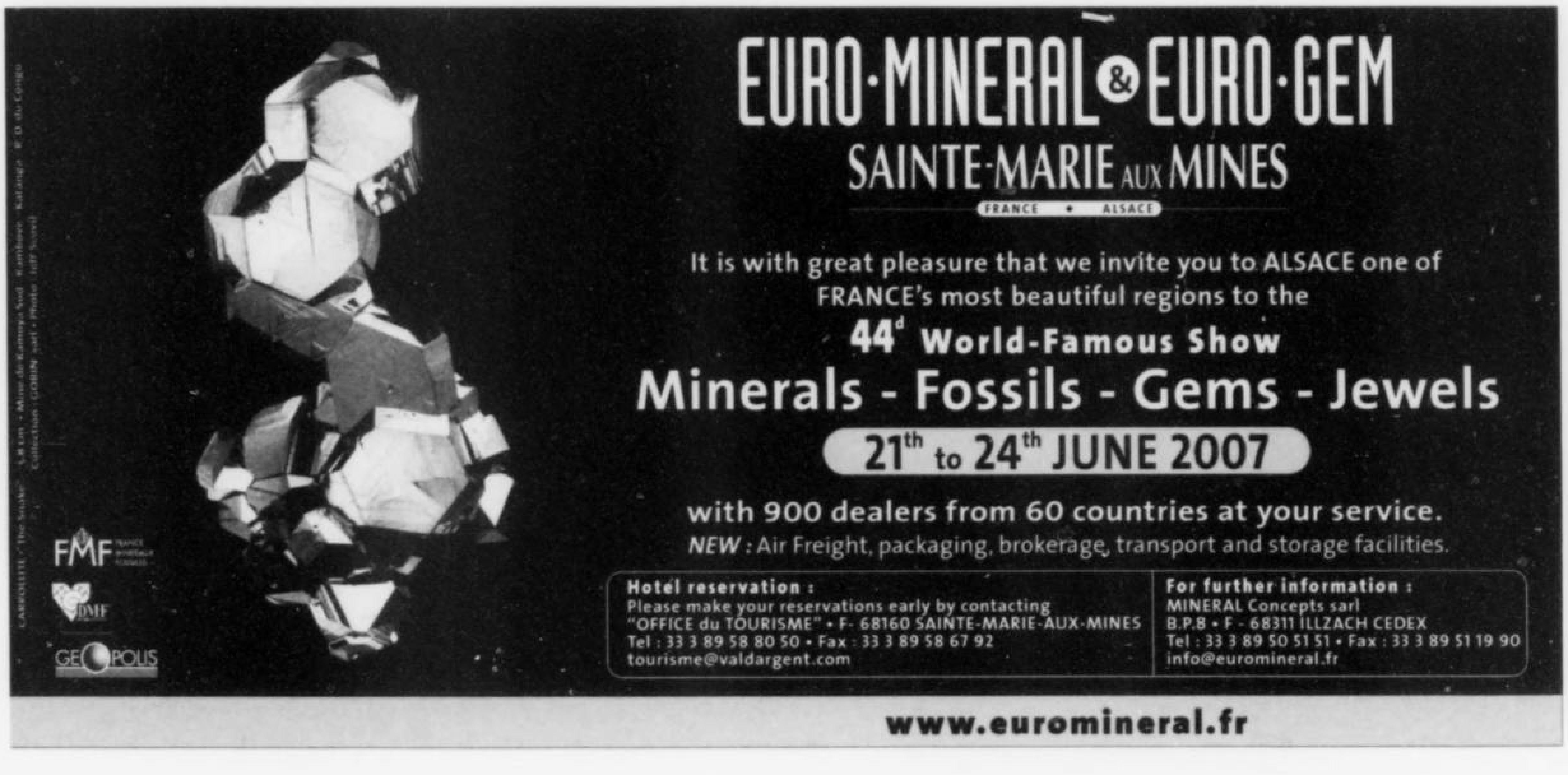
XIONG, X., and YAO, C. (1998) Geological features and metallogenic model of Shimen realgar deposit. *Mineral deposits*, **17** (Louis), 515–518 [in Chinese with English abstract].

XIONG, X., and LIU, C. (1998) Mineralogical study of realgar from the Shimen As(Au) deposit, Hunan Province. *Rock Mineralogy Magazine*, **17** (4), p. 378–384 [岩石礦物學雜誌] [in Chinese with English abstract].

XIONG, X. (2000) Classification, and prospecting of minerogenic models [of] realgar/orpiment deposits in China. *Acta Geologica Sinica,* **74** (3), 618–622.

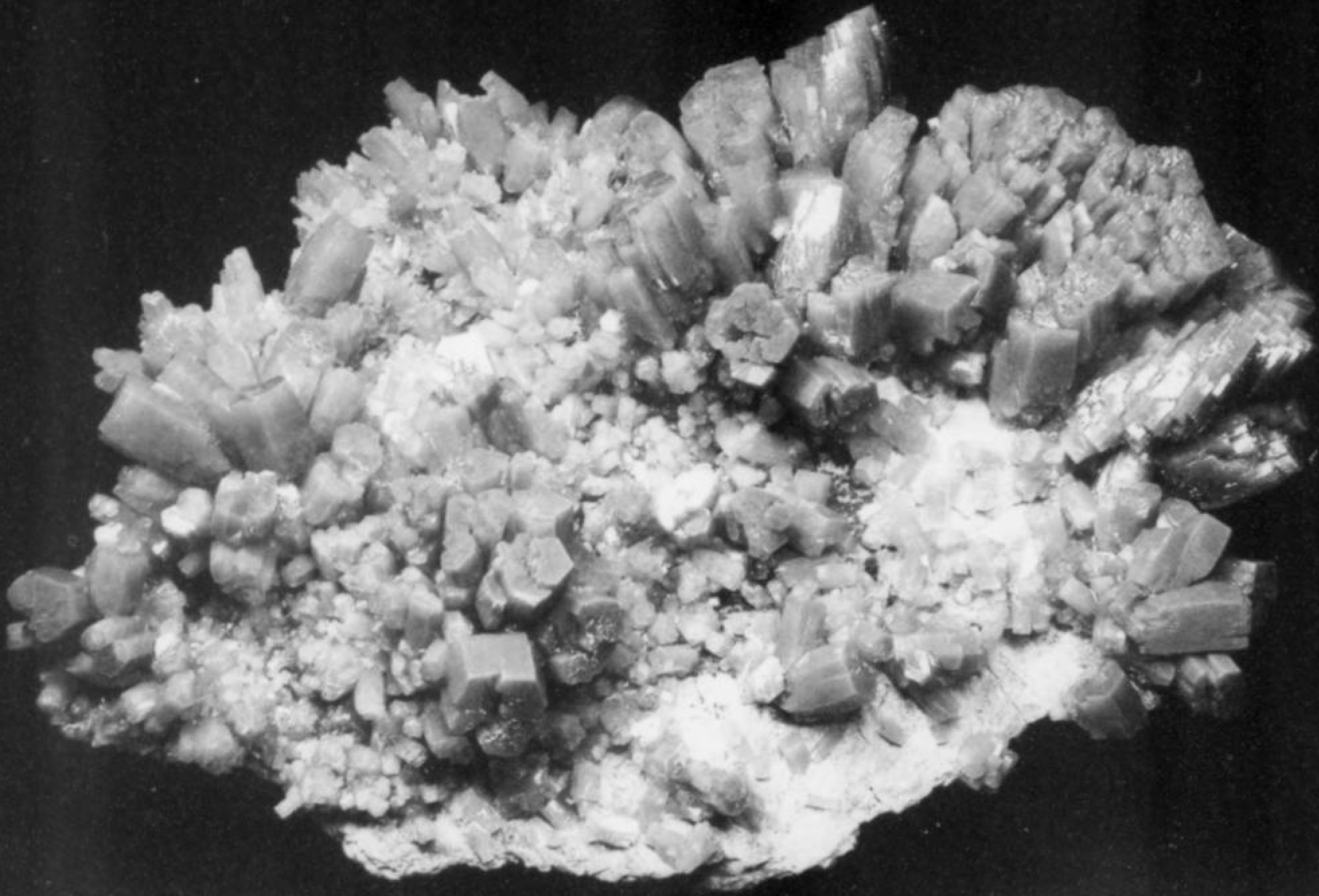
YAO, C., XIONG, X., LIU, C., and YANG, P. (1999) A study of deep-ore prospecting work in No. 2 gallery of the Shimen realgar deposit. *Mineral Deposits*, **18** (2), p. 182–187 [in Chinese with English abstract].

ZHOU, Z. (1986) Preliminary study on karstification and hydrothermal metallogenesis of the Jiepaiyu realgar deposit, Hunan province. *Carsologica Sinica*, **5** (2), 71–77.



from the Collection of

STEVE NEELY



PYROMORPHITE

16.5 cm, from the

Bunker Hill mine, Kellogg, Idaho

Wayne Sorensen to Harvey Gordon to Ron Bentley
(for Perkins Sams) to Norm & Roz Pellman to Collector's
Edge Minerals -- Purchased at the Denver Show 2006

The
XIANGHUAPU MINES

Chenzhou Prefecture, Hunan Province, China

Berthold Ottens
Klingenbrunn Bahnhof 24
D-94518 Spiegelau
Germany

Thousands of beautiful clusters of lustrous, transparent, cubic to cubo-dodecahedral crystals of green fluorite have come from the Xianghuapu deposit in Hunan province. The mines continue in operation, and even more specimens will probably be forthcoming.

INTRODUCTION

Countless green fluorite specimens from China reached the worldwide mineral market in the mid-1990's. The first offerings were predominantly flat crystal plates, ranging in size from a few centimeters to 50 × 50 cm, showing green fluorite crystals up to 4 cm on edge. The luster and transparency varies; commonly they exhibit a soft frosty luster and pale green to gray-green color.

The locality names given at the time were often simply "Chenzhou" or "Linwu," although in some cases the specimens were more precisely assigned to the **Xianghualing mine**. A second wave of specimens exhibited larger crystals, some with an intense green color. Word leaked out, however, that some of these specimens had been given this very attractive color by artificial irradiation. For these specimens too, the Xianghualing mine was specified as the point of origin. In addition to the fluorite, very attractive large, white, flattened rhombohedral crystals of calcite were attributed to the same locality.

Around 1997, a third wave of green fluorite specimens appeared, this time in the form of octahedral crystals with stepped faces composed of small cube faces. These specimens, being less attractive, found less favor with collectors than the earlier ones had, but only a short time later a large fourth find of green fluorite from the Xianghualing mine came onto the market. These specimens proved to be of greater appeal because they show fluorite crystals of several generations, with interesting combinations of the cube and octahedron forms, and are associated with white quartz crystals. Among the rarities from the Xianghualing mine which emerged at this time are scheelite and hsianghualite, the latter named for the Xianghualing mine, the type locality ("Xianghualing" was formerly written as "Hsianghualing"). In August 2005 a particularly remarkable discovery came to light from this mine: a black, perfectly formed pseudo-octahedral scheelite crystal measuring 15 cm.

Around 1998, the Xianghuapu deposit (*Xianghuapu* = "after flowers good-smelling market") began producing specimens of green cubic crystals of fluorite, commonly with brown phantoms, on deeply weathered brown matrix. At that time only a very few fluorite specimens from Xianghuapu could be seen in the stocks of Chinese dealers, but these did include several with colorless to bright blue cubic crystals to more than 5 cm on edge.

Early in 2004 the Chinese dealers began offering bright green, lustrous, completely transparent fluorite crystals which clearly show both the cube {100} and dodecahedron {110} forms. In the following months, increasingly spectacular specimens with larger crystals were found at Xianghuapu; on some of the specimens the fluorite is associated with flattened, white to bright pink rhombohedral crystals of calcite to more than 10 cm across. Inspired by the quality of these specimens, I visited the mining area in March 2005, and by extraordinary good luck a crystal pocket measuring more than 1 cubic meter in volume was being breached at this time; its walls were lined by fluorite crystals to 25 cm on edge and by flattened rhombohedral calcite crystals.

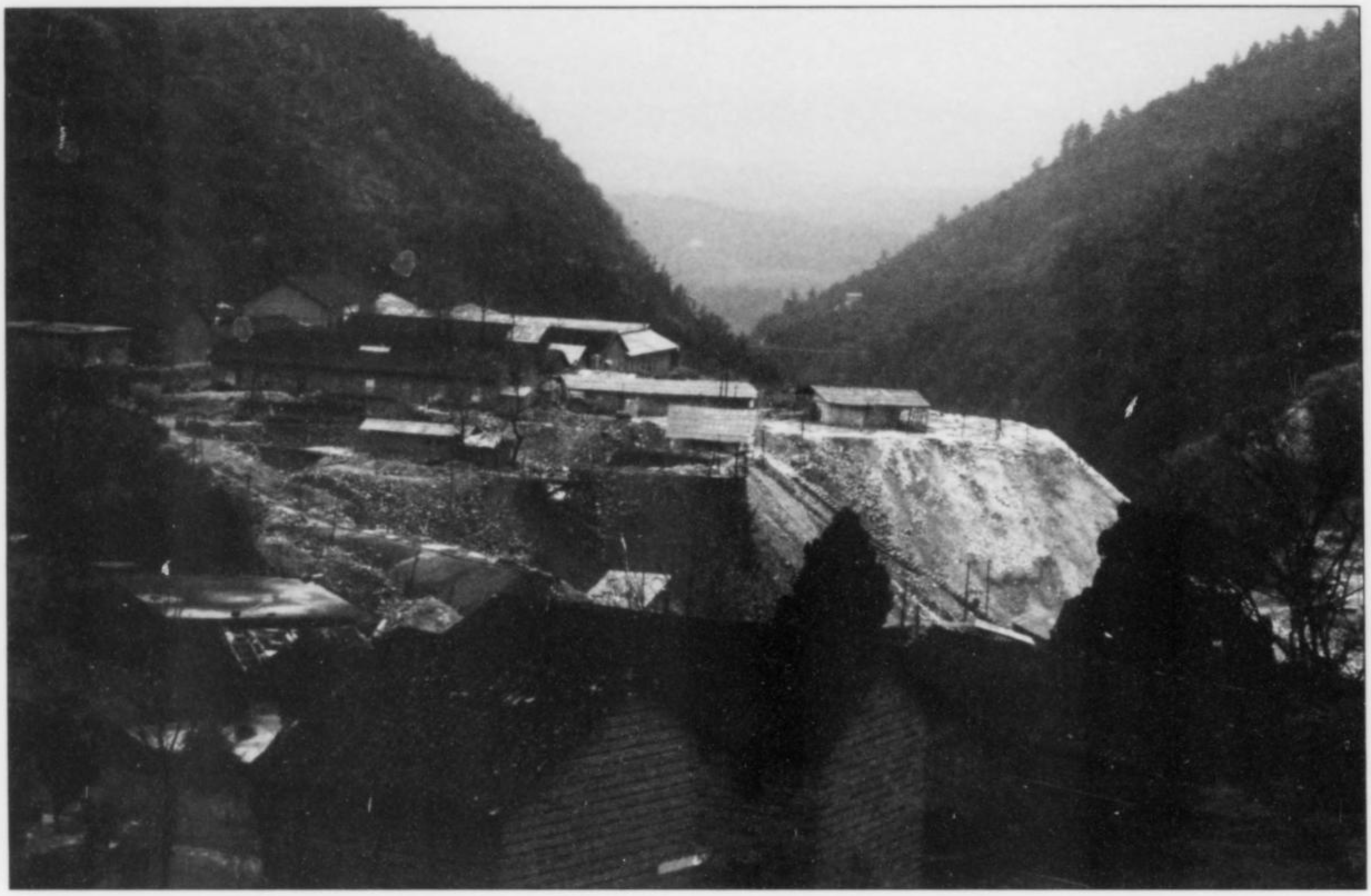


Figure 1. **The Maiwang dump and mine buildings. Ottens photo.**

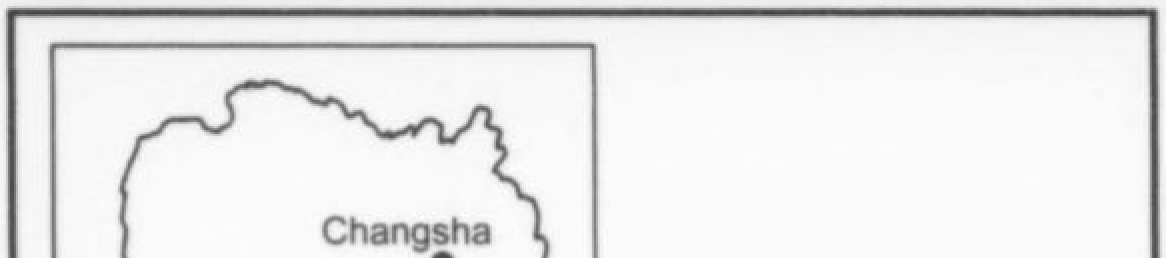


Figure 2. **Location map.**

HISTORY

Some accounts suggest that tungsten, lead, zinc and tin were being mined in the Xianghuapu area during the Qing Dynasty (1644–1911). Before 1930 the emphasis was on the production of tungsten and tin, but prospecting work begun in that year showed that various base-metal ore deposits are present in the area (no scheelite deposits had yet been discovered).

Between February and August 1957, a team from the Hunan Geology Ministry of the Metallurgical Industry finally found and delineated a scheelite deposit, and developed a geological profile of the region. In September 1957, geologists from the nearby Xianghualing mining area discovered a scheelite skarn deposit, and the Shenkengli mine was opened on the site; it is still in operation. Further prospecting work revealed a second major polymetallic deposit, this one rich in lead-zinc ores, situated on the opposite side of the valley. It is now known as the Xianghuapu lead-zinc mine, source of the now-famous fluorite crystal bonanzas. For the last 60 years or so this lead-zinc orebody has been exploited via the Maiwang and Chashan portals, both of which are under private ownership.

THE ORE DEPOSIT

This area of Linwu County has proven to be an Eldorado for mineral collectors, regularly yielding fine specimens of fluorite from both the Xianghualing and Xianghuapu mines, and fluorite with yellow-brown scheelite from nearby Dongshan. In the Xianghualing mine, a large, government-owned operation in a greisen deposit, tin ore is the main product, and fluorite is encountered only occasionally.

The Xianghuapu deposit, covering 4.5 square kilometers at the surface, lies 13 km northeast of Linwu, in Chenzhou Prefecture, Hunan Province. It is in the Nanling Mountains, which also hold numerous other important deposits, including Shizhuyuan and Yaogangxian. The region is hilly and rugged; Xianghualing Mountain, about 20 km from Xianghuapu, reaches an altitude of 1594 meters. The climate is subtropical, with much rain.

Figure 3. **Portal to one of the privately owned mines exploiting the Xianghuapu orebody from the western side of the hill. Ottens photo.**

At the Xianghuapu mines, at an altitude of 600 meters, the vegetation is dense, with coniferous trees and ferns on the upper slopes. From Chenzhou, a city of about 500,000 inhabitants, Xianghuapu may be reached via Guiyang and Xianghualing, or alternatively via Yizhang and Linwu. The roads in the Nanling Mountains are extremely narrow, curving, and for the most part not very firm; motorists are advised to use four-wheel-drive vehicles.

The Xianghuapu lead-zinc deposit was emplaced, together with granite intrusions, in carbonate country rocks of Devonian age during the Yanshanian Epoch; it yields ores predominantly of lead and zinc, and to a lesser degree of tungsten and tin. The occurrence of fluorite as a gangue mineral in the deposit is so significant that fluorite, too, is extracted as ore for industrial uses as well as for the collector market.

The fluorite from Xianghuapu ranks as the best collector-quality fluorite from the Linwu region. The mineral occurs in veins to 20 meters long and 5 meters thick, which formed during the intrusion of the so-called Qianlishan Granite into Devonian limestones and marbles. Some of the crystal pockets are very small, but others are large enough to hold several seated people.

MINE WORKINGS

As is usually the case for mines in the mountains of southern China, no shaft towers or other mine installations are to be seen at the portal to the Maiwang workings. All work sites are accessed through a single adit opening, then via several connecting cross-cuts and numerous inclined drifts having slopes of about 30°. The ore is taken to the surface in cars running along an underground track. Interestingly, the power to run the underground train comes from an electrical cable, drooping overhead, which connects to the power cables running along the walls; the current is tapped

Figure 4. **Maiwang mine portal. Jeff Scovil photo.**

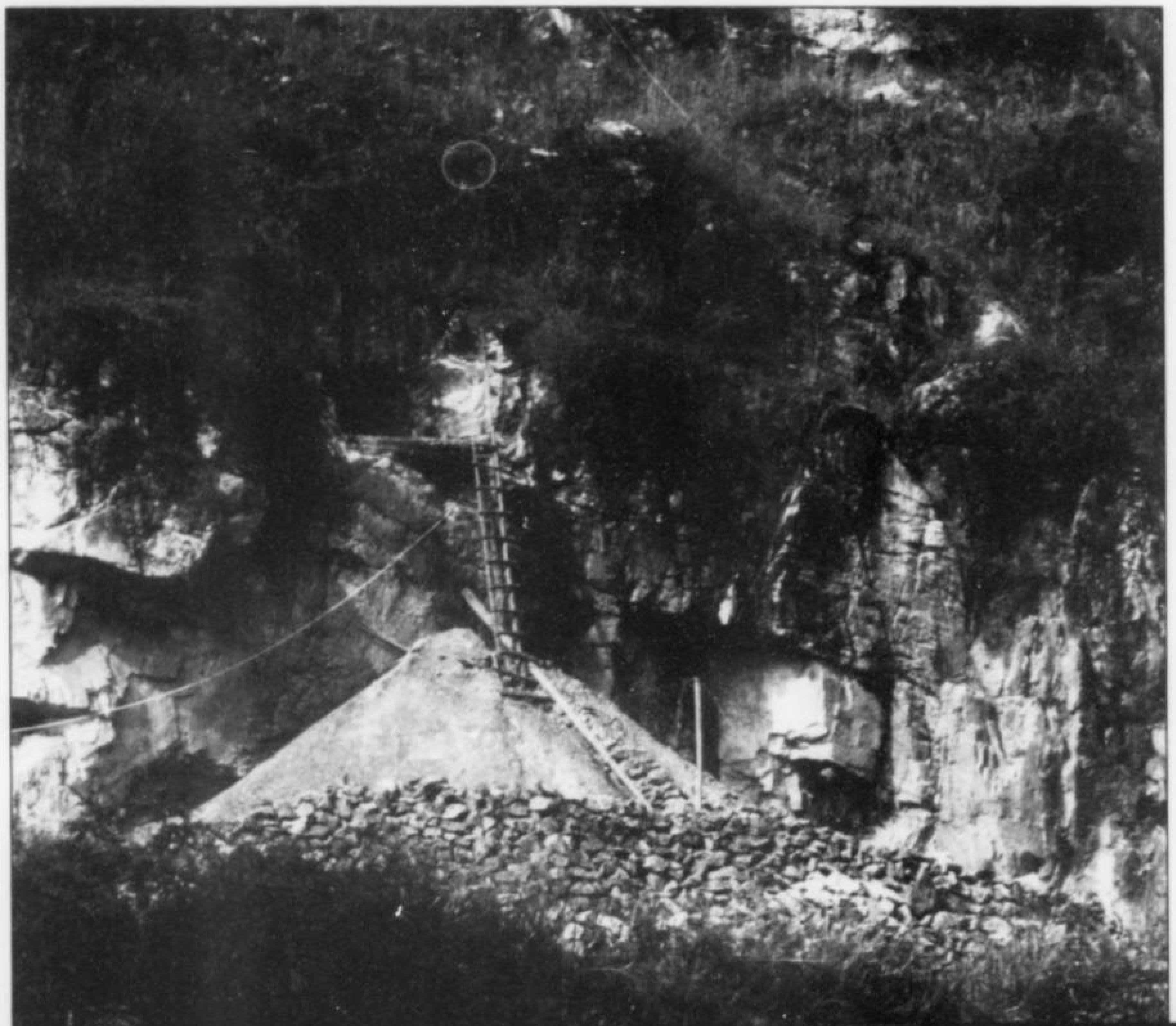


Figure 5. **Exploratory tunnels have been driven into the hillside using the most primitive methods. Ottens photo.**

Figure 6. **The electrically driven tram engine is activated by touching a cable held by a wooden stick to the power line strung overhead. Ottens photo.**

by the train operator by means of a wooden stick. While several electrically powered compressors are available in the main tunnel to provide the compressed air supply for running the drills, there is no cooling system whatever to ameliorate the inhuman temperatures, and no powered ventilation system to increase the scant supply of oxygen.

Extracted ore is run through crushing machines and is immediately concentrated by a flotation process. The concentrate is then further sorted by size. As a result of this process, unsightly lakes of mire and mine waste cover large areas adjacent to the mine. The flotation technology now in use is quite inefficient; perhaps some day this ugly waste can be effectively re-processed.

The facilities at the Chashan workings are almost exactly like those on the Maiwang side.

MINERALS

The minerals of principal collector interest at Xianghuapu are **fluorite** and **calcite**. During the author's visit in December 2004 a well developed, 10-cm **quartz** crystal was discovered in a small, privately operated mine in the western part of the mining area. The main ore species at Xianghuapu are **galena**, **sphalerite**, **cassiterite** and **wolframite**, found as disseminated grains in the greisen and as small crystals in thin seams, but never as larger crystals of any note. Rarely, **scheelite** crystals to 1 cm have been observed.

Fluorite CaF_2

The fluorite crystals which have emerged since early 2004 are dominated by the cube {100}, but dodecahedron {110} faces are also present in most specimens. In smaller crystals the dodecahedral faces are inconspicuous or almost entirely absent, whereas in larger crystals they are more prominent. The cubic faces are characterized by a high luster and total transparency whereas the dodecahedral "faces" are rough, being approximated by myriads of tiny stepped cube faces.

The very lustrous crystals reach 25 cm on edge, and their extraordinary transparency makes them appear bright green. Commonly the matrix on which the large crystals rest can be clearly identified by looking at it right through the crystals. The majority of the crystals so far collected exhibit multiple zoning parallel to the cube faces.

Calcite $CaCO_3$

The calcite crystals found in association with fluorite in the Xianghuapu mine are highly flattened rhombohedrons to 15 cm

***Figure 7.* Fluorite crystal cluster, 12 cm, showing cubic crystals with dodecahedral modifications, from the Xianghuapu mine. Ottens specimen and photo.**

***Figure 8.* Fluorite crystal cluster, 8 cm, showing cubic crystals with dodecahedral modifications, from the Xianghuapu mine. Ottens specimen and photo.**

***Figure 9.* Fluorite showing typical phantoms, 18 cm, from the Xianghuapu mine. Ottens specimen and photo.**

across. The color varies from white to pale pink, the latter color attributable to trace manganese. In some cases the large, flat rhombohedral crystals are twinned. For some reason, probably having to do with its morphology, this calcite unfortunately seems to be extremely sensitive to bruising and other damage.

A VISIT TO THE MINES

In March 2005, during my sojourn in Changsha with two friends from Berlin, some free time arose which it seemed best to use by visiting some mines. A Chinese dealer declared himself ready to organize a trip to the Xianghuapu mining area, which I had already visited several times. A large pocket with well-developed green fluorite crystals had just been opened, and naturally such an opportunity was not to be passed up. In none of my many previous visits to productive mines in China had I been lucky enough to be present while fine mineral specimens were being taken from their crystal pockets.

After many days of cold, rainy weather in Changsha, we enjoyed sunny weather during the few hours' drive, in a private car on a good highway, to the prefectural capital city of Chenzhou. There we had to switch to a cross-country vehicle which, because of a technical problem, did not arrive for a few hours. We passed the time by having a large Chinese meal with many courses, and then a good acquaintance among the mineral dealers of Changsha picked us up in the brand-new vehicle.

Our journey first took us along a fine new road proceeding from Chenzhou toward Jiahe via Guiyang, but after 20 km we turned off on an unmarked road which was extraordinarily rough and could only be negotiated slowly. Our driver was remarkable, not only for the fine clothes he wore, but also because he found time, between making countless calls on his cell phone, to operate the steering wheel, gearshift and air-conditioner while coping also with rules of the road which to us Europeans seemed totally outrageous.

The route ran through hilly country with a strongly marked karst terrain. It was amazing to see how every square meter between the steeply rising slopes of the limestone hills was being utilized for agriculture, especially rice fields. The few villages we passed consisted mainly of conventional brick houses, offering a pleasant impression of uniform, orderly rural life. The newer, architecturally unsightly concrete buildings seen in larger towns have not yet reached this region.

After about a 45-minute drive we came into a valley where we caught our first sight of a large lake. Soon it became apparent that this unfortunately was an artificial lake of mine effluent, at least 10 km long—a byproduct primarily of the flotation process used to treat ore from the Xianghualing tin mine. As it was now too late to drive on to Xianghuapu, we decided to spend the night at a hotel near the Xianghualing mine. The word "hotel" does not in this case imply a lodging with even minimal Western amenities, especially in matters of sanitation.

Before dinner we gazed out from the village of Xianghualing, almost 1,000 meters high, over the countless mine workings which cover the mountain, also called Xianghualing; however, swiftly gathering clouds and haze made it impossible to take good photographs.

Early the next morning, on a still-terrible road with countless curves, we drove past steep cliffs at an altitude of about 1,000 meters and past the Chashan workings towards Xianghuapu, 18 km distant. Our escort, dressed all in black, was a distributor of products of Chinese mines and clearly had never been underground in a mine before; when we arrived he paid a courtesy visit to the manager of the government-operated Shenkengli mine. The copy of the China Issue of the *Mineralogical Record* (Jan.-Feb. 2005) which we presented as a gift helped to make the purpose of our visit understandable.

Accompanied by the manager of the Shenkengli mine (in which no interesting finds were being made at the time), we visited the director of the privately operated Maiwang lead-zinc workings. After we had briefly explained what we sought, we were provided with miners' helmets and pocket lights, and a worker was recruited to guide us on a mine tour. Before entering the mine we were asked to take off our sweaters. It was cold outside, and during an earlier visit to the Yaogangxian mine I had practically frozen, but we complied anyway.

After a short walk along a horizontal stretch we came to a flight of stone stairs going downhill for about 90 meters. It was explained to us that we would be riding on the mine train from this point on. Getting into this train was not easy, as the electrical cables hung low overhead. Finally we were crowded into the little mine car, and my knee was being twisted, giving me some pain (I had recently had a knee operation). The operator controlled the speed of the train by pressing with a stick at short intervals on the cables which contacted the overhead electrical system. There was a constant shower of small sparks which burned many little holes in my plastic windbreaker.

***Figure 10.* Underground in the Maiwang tunnel, Xianghuapu. Jeff Scovil photo.**

After about a 20-minute trip in increasingly stooped postures we were finally able to climb out of the train car. Two cars were uncoupled and were made ready to set off again down a steep incline. We had to climb in again, and after a short pause we were transported down about another 90 meters. During this time it began to get very warm, and there did not seem to be any ventilation. Our guide stripped down to his shorts and advised us likewise to take some clothes off. We refrained, however, not knowing what awaited us.

On foot we proceeded for another 50 meters down another incline with steps poorly carved out of rubble, then followed another short horizontal stretch. But then, clearly, we had reached our goal: several miners, pausing in their work, turned to look at us. All were dressed

Figure 11. **The pocket named "The Green Vault" extends in an upward direction. Over the course of a year, the rock was painstakingly chipped away from all sides to free the pocket in one enormous egg-shaped block. Ottens photo.**

only in briefs; some were crouching against the mine walls or napping on pallets. No provisions for their safety were to be seen.

We—not the miners—felt and expressed great surprise and joy, because we now stood before a huge pocket which was full of beautiful, sharp green crystals of fluorite. We could hardly wait to get down on the ground and, insofar as it would prove possible, crawl into the pocket to savor the unique sight. Viewing the total scene was difficult because our pocket lamps could provide only partial illumination. The vein which widened at this point held a pocket about 1.2 meters wide, 1 meter deep and 1.5 meters high. Fluorite crystals up to 25 cm on edge could be seen, and there was a beautiful color contrast between the green fluorite and the pinkish calcite.

We couldn't get enough of the sight, and almost forgot to take photographs. Because of the high temperature and humidity of the air, our glasses and camera lenses immediately steamed up; we had to keep wiping off the lenses before we could focus the cameras and take any shots. Shortly before taking this trip I had visited the city of Dresden and looked in at the famous Green Vault, with its treasures of the old kings and dukes of Saxony. In remembrance of Dresden I now conferred on this great fluorite pocket the name "The Green Vault of Xianghuapu."

Inspecting the area around the pocket, we could see that the entirety of it could be extracted as a single piece: the rock had already been detached all around it except for points at the top and the bottom. The mine director later told us that work had already gone on here for almost a year. In order to save all the fluorite it had been decided not to employ explosives; all the work was being done laboriously by hand, in the foul air and very high temperatures. In the tunnel walls, numerous other, but much smaller, pockets containing good, transparent fluorite crystals could be seen. Above the roof of the pocket, calcite crystals were still in place: they were covered with mine dust, and no one had yet seen fit to remove them. Mining in the vein was continuing meanwhile. A drill rested before the place where the vein receded, and fluorite cleavage pieces lay on the ground all around. The pocket lay about 2,200 meters from a point 300 meters below the mine entrance. Along the way to it there were no support structures, as the ground here beneath the mountain was consistently firm.

Our excitement at having been lucky enough to witness such an important discovery firsthand caused us to forget about the oppressive heat and bad air. The temperature hovered around 45° C (113° F), and the oxygen content of the stagnant air was surely minimal. Besides, we were sharing cigarettes (smoking is ubiquitous in China), and this reduced the air quality still further. I was streaming with sweat, and needed urgently to take a break to restore my circulation. Clearly the miners, although most of them were very young, habitually took frequent breaks while working in these conditions. Later we were told that a year ago a miner had succumbed to the strain and died, probably of dehydration and heat stroke.

Then, thoroughly exhausted but happy, we found it was time to leave. The demands of the ascent from the site made us all feel like "old" people. Again we experienced the showers of sparks from the electrical control system of the train car. Two Chinese miners clung to the outside of the car. And finally there came the last ascent to the mine entrance, with members of our party hanging on inside of, and between, four loaded ore cars. The rhythm of the ride was somewhat violent—but better a bad ride than a long climb. The air outside the mine was bracingly fresh, and we delighted in pouring over our faces the water we found running by in a little stream near the entrance.

After we had cleaned up, changed our clothes and enjoyed a small meal, the director showed us another place full of large fluorite specimens: a room where about 100 specimens measuring up to about 1 meter square were lying, partially packed. Most of these specimens were damaged to some degree, but on all of them the side which had faced inward from the vein was completely covered by transparent green fluorite crystals. Although we were assured that the specimens were destined for a museum and were not for

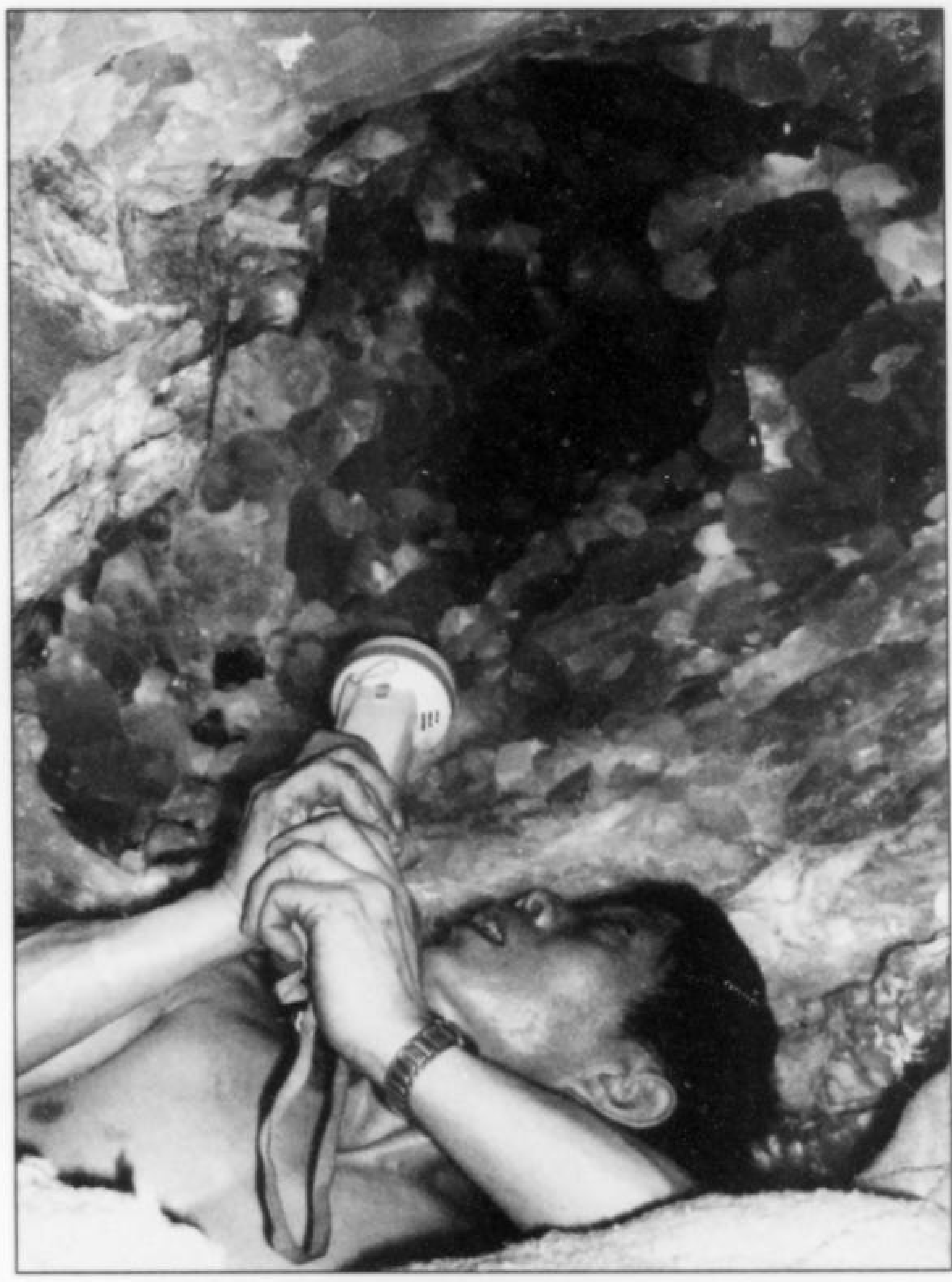


Figure 12. **Looking up into "The Green Vault" fluorite pocket in the Maiwang workings, Xianghuapuu. Ottens photo,**

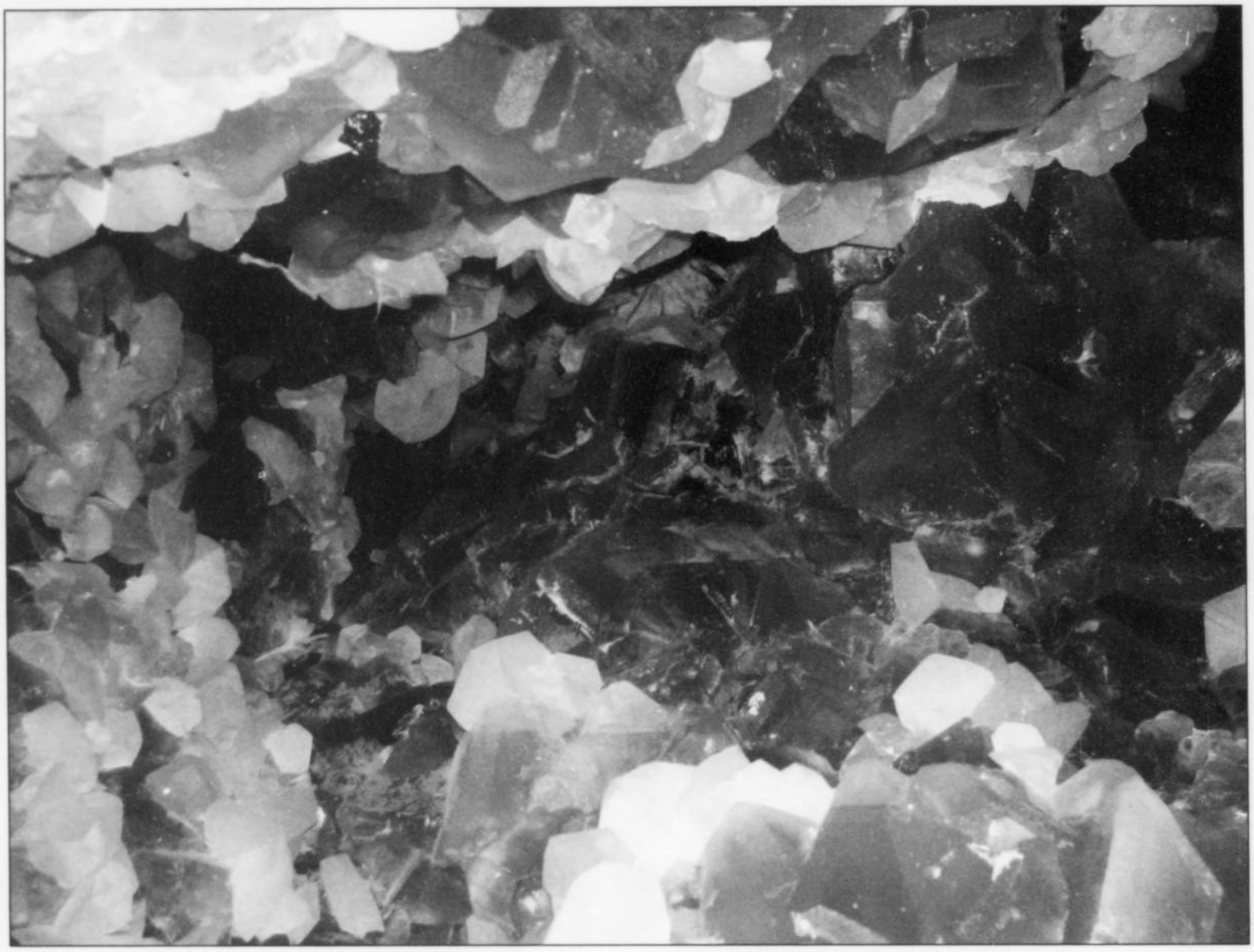


Figure 13. **Inside "The Green Vault," cubo-dodecahedral crystals of beautiful, transparent, apple-green fluorite occur intermixed with two generations of white calcite (scalenohedral and rhombohedral). Ottens photo.**

sale, we were convinced that in fact they were going into the large Chinese market for decorative objects. Indeed, great numbers of pieces of this material were soon enough offered in the relevant markets in Chenzhou and Guilin.

After we had received patient answers to several more of our questions, our black-clothed guide was clearly happy to lead us away from this place. For him the assignment, although it had been rewarding, had also been dreary. He drove us quickly by the shortest route back to Chenzhou, where, without further adventures, we boarded a comfortable bus for the return trip to Changsha. The easy ride inspired reveries of caverns and vaults full of green fluorite. The journey had been well worthwhile, and the experience was unforgettable for all of us. The question remains, how much longer will the beautiful fluorite specimens continue to emerge from Xianghuapu. Perhaps the momentary abundance will quickly come to an end. But there remains the hope that more pockets will be found in newly mined veins, delivering yet more fluorite and calcite to excite collectors.

Five months later, in August 2005, with a friend from Vienna, I traveled again to China. Investigation revealed that huge fluorite crystal plates were still being extracted in the Xianghuapu mine, and that a visit could be arranged, although we would still find the conditions underground to be difficult. Our curiosity got the better of us, and we agreed. Luckily for us, brand-new train cars had just been delivered to the mine, and since they were larger than the old ones we had an easier time reaching the site on this second visit. On the other hand, our clothing later showed many signs of the train car's new, still-wet paint, which numerous launderings could not remove.

This time the ventilation was somewhat better, although the tunnel was still horribly hot. Even though it had been five months since my last visit, not much forward progress in the work was evident. The rock surrounding the pocket had been further chipped away, and there was now a complete separation in the region above the pocket; simple scaffolding had been erected to facilitate work in this upper area. On the tunnel floor there had accumulated a pile of waste which would later be hauled away. Also, a diamond saw had been brought in, although with a diameter of only 15 cm it seemed just a toy. It was no wonder that the work was going so slowly: probably several more months would be required to complete the removal process. The director estimated the total cost of "harvesting" the pocket at about $100,000.

During the same trip we heard reports from several dealers that major fluorite discoveries had been made during the summer in the Chashan workings. Because the two mine workings, although they enter from different places, exploit the same vein system, it is not surprising that fluorite discoveries in them are similar. When the Chashan people learned of the value of the fluorite specimens being taken from the Maiwang workings, it was only natural that Chashan miners looked hard for similar things on their side.

It should be noted that specimens from what is really a single fluorite occurrence have been designated on labels during this period as coming both from "Xianghuapu" (the mine name) and "Chashan" (the more specific workings name). In the Chinese literature no distinction is made between the Maiwang and Chashan workings; the deposit as a whole is referred to simply as the Xianghuapu mine.

CONCLUSION

Although considerable numbers of collector-quality fluorite specimens have been found in the Xianghualing and Xianghuapu mines, it should be remembered that the recovery of specimen material is always merely a byproduct of ore production in these mines. As in the Taolin, Shangbao and Yaogangxian mines, the miners and mine-management people alike have learned that considerable profits can be earned on the side by collecting and selling mineral specimens for collectors. Since this realization has dawned, a few of the fluorite-bearing mines, such as Taolin and Dongshan, have ceased commercial operations, and Shangbao is now worked only for specimens.

For the immediate future, however, there is no danger of any supply shortage of beautiful fluorite specimens from the Middle Kingdom. Within the broad zone of granite intrusions in southern China, a great many ore deposits have been located in neighboring greisens and skarns, and recent times have seen numerous discoveries of fluorite of differing habits, colors and associations in previously unknown mine workings. Chinese dealers and their suppliers protect their interests by monitoring likely mines, and keeping up with interesting occurrences of fluorite. Although the market is now temporarily saturated with fluorite from Xianghuapu, the exceptional quality of this material nevertheless makes it a highlight of collections all over the world.

ACKNOWLEDGMENTS

A few Chinese dealers, fearing competition, are not pleased when foreign mineral dealers visit the mines, but others recognize the value of internationally publicizing reports on Chinese minerals. The latter are wholly supportive of my efforts to gather information on localities and to pass it on, in reports like this one, to all interested people. Accordingly, my special thanks go to Liu San Zhong for arranging my visit to Xianghuapu; thanks also must go to the management of the Maiwang workings for granting me permission to see the extraordinary fluorite pocket in place in the mine.

For translating into English my articles on the mineral localities of China, with their relevent background information, I am indebted to Thomas Moore, with his patience, hard work, and good understanding of German. Last but not least, I heartily thank Wendell Wilson for making appropriate choices of photos to accompany the text, and for his excellent editing and layout work.

BIBLIOGRAPHY

EDITORIAL COMMITTEE OF THE MINERAL DEPOSITS OF CHINA (1992) *Mineral Deposits of China*, Vol. 2. Beijing: Geological Publishing House.

JENSEN, M. (2005) Fluorite from the Xianghualing polymetallic ore field, Hunan Province, China. *Rocks and Minerals*, **80**, 32–38.

OTTENS, B. (2004) Fluorit—alle Farben und Formen. *ExtraLapis* **26/27**, 44–55.

OTTENS, B. (2005) Chinese fluorite. *Mineralogical Record*, **36**, 59–68.

OTTENS, B. (2005) Xianghuapu—grüner Fluorit der Superlative. *Lapis*, **30** (6), 24–26, 39–43.

SCOVIL, J. A. (2005) A mineral excursion to China: 2004. *Rocks and Minerals*, **80**, 12–22.

SHEN, GANFU (1994) Study of greisen-pegmatite in the Xianghuapu district, Hunan. Geological Review, Chengdu Institute of Geology and Mineral Resources, **40** (4), 305.

INTERNET DIRECTORY

AARockshop
Cool rocks at affordable prices!
www.aarockshop.com
e-mail: andrei@aarockshop.com

A&M Schrander-Hettinga
Rare minerals + platinoids
http://perso.orange.fr/rare.microminerals/index.htm
e-mail: schrahett@wanadoo.fr

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

Apalachee Minerals
Worldwide and Southeastern U.S. Minerals
www.apalachee-minerals.com
e-mail: gary@apalachee-minerals.com

The Arkenstone
Fine minerals online since 1996
www.irocks.com
e-mail: rob@irocks.com

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

Russ Behnke
Exemplary Minerals & Gem Crystals
website: www.russbehnke.com
e-mail: russbehnke@yahoo.com

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

Cascade Scepters
Fine Rare Quartz & Worldwide Minerals
www.cascadescepters.com
e-mail: scepterguy@cascadescepters.com

CK Minerals
Cyril Kovac
www.ckminerals.com.au
e-mail: info@ckminerals.com.au

The Collector Showcase
Modular storage and display cabinetry
www.thecollectorshowcase.com
e-mail: dougwahl@thecollectorshowcase.com

Colorado Gem & Mineral
Fine Minerals, Gems, & Collectibles
www.ColoradoGem.com
e-mail: cgmaz@Cox.net

ColoradoMinerals.com
Your #1 Source for Colorado Minerals
www.coloradominerals.com
e-mail: robert@coloradominerals.com

ConnRox Minerals
Beginner & Intermediate Grade Specimens
www.ConnRoxMinerals.com
e-mail: larryrush@att.net

Crystal Classics
Fine Minerals for every Collection
www.crystalclassics.co.uk
e-mail: orders@crystalclassics.co.uk

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

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

Demineralia
High-quality & rare Madagascar specimens
www.demineralia.com
e-mail: info@demineralia.com

Diederik Visser Minerals
Worldwide Minerals & Mining Memorabilia
www.dvminerals.com
e-mail: diederik.visser@dvminerals.com

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

Dragon Minerals
Affordable Minerals: VISA, MC, Paypal OK
www.dragon-minerals.com
e-mail: steve@dragon-minerals.com

Edelweiss Minerals
Fine affordable worldwide minerals
www.edelweissminerals.com
felix@edelweissminerals.com

Fabre Minerals
High-Quality Worldwide Minerals
www.fabreminerals.com
e-mail: mineral@fabreminerals.com

Brice & Christophe Gobin
Fine Minerals from Africa & Worldwide
www.mineralsweb.com
e-mail: gobin@club-internet.fr
e-mail: customerservice@graeberminerals.com

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

Hummingbird Minerals
Fine Mineral Specimens for Collectors
www.hummingbirdminerals.com
e-mail: hummingbirdminerals@hotmail.com

Ibermineral
Fine minerals from Spain and Portugal
www.ibermineral.com
e-mail: ibermineral@ibermineral.com

IC Minerals
Fine Minerals–Est. 1989–online since 1998
www.icminerals.com
e-mail: icminerals@earthlink.net

ItalianMinerals.com
Quality Minerals from Italy
& Worldwide
www.ItalianMinerals.com
e-mail: italianminerals@libero.it

Jewel Tunnel Imports
Indian & Worldwide Minerals Wholesale
www.jeweltunnel.com
e-mail: jeweltunnel@hotmail.com

Key's Mineral Collection
Kiyoshi Kiikuni
www.keysminerals.com
e-mail: keysminerals@keysminerals.com

Lawrence H. Conklin
Over 50 years selling fine minerals
www.LHConklin.com
e-mail: LHC@LHConklin.com

Majestic Minerals
Fine worldwide specimens
www.majesticminerals.com
e-mail: scott@majesticminerals.com

Marcus Grossmann Minerals
Top specimens worldwide
www.THE-MINERAL-WEB.com
e-mail: info@THE-MINERAL-WEB.com

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

The Mineral Cabinet
Select Mineral Specimens, Min Records
www.mineralcabinet.com
e-mail: themineralcabinet@comcast.net

Mineralium.com
Fine Mineral Specimens Worldwide
www.mineralium.com
e-mail: info@mineralium.com

Mineralogical Research Co.
Minerals for display & research, books
www.minresco.com
e-mail: xtls@minresco.com

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

Minerals Unlimited
Rare Species to Common Minerals
www.mineralsunlimited.com
e-mail: wendi@mineralsunlimited.com

Minerals Village
Fine & Rare Italian, Worldwide Minerals
www.Mineralsvillage.com
E-mail: rcarlini@aliceposta.it

Minernet.it
Fine Specimens and a Great Sales Policy
www.minernet.it
e-mail: info@minernet.it

Minservice
Worldwide Classic & Rarities
www.minservice.com
e-mail: info@mail.minservice.com

MinVision
Top Minerals from the Best Dealers
www.minvision.com
e-mail: info@minvision.com

Northern Nevada Gold
Gold in quartz specimens & gold nuggets
www.NorthernNevadaGold.com
e-mail: info@northernnevadagold.com

Pala International
Best in Worldwide Gems & Collector Minerals
www.palagems.com
e-mail: john@palagems.com

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

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

Simkev Micromounts "+"
Rodney Lee/Maureen Campeau
www.simkevmicromounts.com
e-mail: simkev@sympatico.ca
www.thefinemineralcompany.com
e-mail: anatase@sympatico.ca

Spanish Minerals
Specializing in Classic Spanish Minerals
www.spanishminerals.com
e-mail: juan@spanishminerals.com

Spectrum Minerals
Colorful quality minerals. Cabinet size.
www.spectrumminerals.com
e-mail: wslogan@carolina.rr.com

Spheres to You
More than 8,500 Beautiful Mineral Spheres
www.spherestoyou.com
e-mail: spheres@spherestoyou.com

Stuart's Minerals
Quality minerals from Canada & New York
www.StuartsMinerals.com
e-mail: stuartp@gisco.net

The Sunnywood Collection
Bill and Elsie Stone
www.sunnywood.com
e-mail: minerals@sunnywood.com

Top Shelf Minerals
Quality minerals for advanced collectors
www.topshelfminerals.com
e-mail: greg@topshelfminerals.com

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

The Vug
A very extensive mineral link portal
www.the-vug.com
e-mail: steve@the-vug.com

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

Gerd M. Wiedenbeck
Alpine Minerals, Fine Worldwide Specimens
www.alpine-minerals.de
e-mail: minerals@uc-tec.de

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

Unique Private Collection!

The 1,000+ specimens in the world-famous Keith & Mauna Proctor Collection of minerals and gem crystals are now for sale! Few collections in history have received as many major awards as this superb collection of museum-quality specimens

"The collector of aesthetic mineral specimens will find much to savor in Keith Proctor's [DVD] catalog of his collection ... It really delivers in terms of extraordinary mineral images and specimen information, and will stand for many years to come as a historically valuable documentation of one of the great private collections of our time--one of the best ever assembled." *Dr. Wendell E. Wilson, The Mineralogical Record (Nov-Dec 1992)*

"I'm very impressed with your Buyers' Guide video—a grand presentation of exquisite minerals with excellent photography illustrating the stunning depth of a premier collection, with specimens carefully chosen by a critical collector who also wanted investment potential ... Congratulations!" *Dr. Peter Bancroft, author of Gem & Crystal Treasures*

Order your hour-long DVD! $19.50 postpaid. Phone: 719-598-1233

I'll be traveling around the U.S. and Europe giving private showings of this unique collection. If you are at all interested, please give me a call (or e-mail) to arrange a showing when I am in your area. Of course, we all occasionally like to "window-shop," so, in looking, there is absolutely no obligation to buy. Just meeting other people and seeing their collections is reward enough for me.

KEITH PROCTOR

88 Raven Hills Court, Colorado Springs, CO 80919

E-mail: maunaproctor@aol.com Visit my website at www.keithproctorcollection.com


Superb

RED WULFENITE

From the Kuruktag Mountains, Xinjiang Uygur, China

Wendell E. Wilson
Mineralogical Record
4631 Paseo Tubutama
Tucson, Arizona 85750
minrec@earthlink.net

Marcus J. Origlieri
1505 West St. Mary's Road #106
Tucson, Arizona 85745
marcus@mineralzone.com

Wulfenite appears to be quite rare in China. Until recently, only a few mediocre specimens with small yellow to red crystals have reached the specimen market, from a rare-earth mine in the Mianning area, Sichuan province. In October 2006, however, the first really fine Chinese wulfenite specimens were brought out of a remote area in Xinjiang Uygur Autonomous Region which has a geology and arid climate similar to that of the great Arizona/Mexico wulfenite province.

INTRODUCTION

Red wulfenite was discovered in a small iron-manganese deposit about 300 km south of the ancient city of Hami, and about 500 km south of the Mongolian border in the hinterlands of Xinjiang Uygur Autonomous Region of China in 2004. The nearest airport is in the city of Ürümqi about 600 km to the west of Hami. The Jianshan iron deposit (尖山铁矿) is located in the Kuruktag Mountains in Shanshan County (鄯善县), near ancient Lake Luobupo (罗布泊), also called Lop Nur (*Nur* = "Lake"), now only a dry lakebed of 3,000 square kilometers at the edge of the Taklamakan Desert. Luobupo is one of the largest salt playas in the world, with a large-scale sylvite mining operation exploiting parts of the lakebed evaporite zone and subsurface potassium-rich brines.

The ancient city of Loulan (楼兰) was founded on the northwest side of the lake in the second century BC, and was a bustling town with a large population of merchants and businessman for over 800 years. It served as the capital of Loulan Province and was an essential stop on the "silk road." The city disappeared mysteriously after 700 AD, and by the time of Marco Polo's visit in 1224 it had become buried in the desert. He saw no living creatures, but only tons of yellow sand. Today it is being excavated as an archeological site.

WULFENITE IN CHINA

Despite the voluminous outpouring of mineral specimens from China during the last 20 years or so, the mineral wulfenite has been almost completely absent. A small number of modest but intriguing wulfenite specimens from China began reaching the Western market in the late 1990's, labeled as coming from Mianning, Xichang, in the Liangshan Yi autonomous prefecture of Sichuan province. These are generally small, gemmy, yellow wulfenite crystals on a white barite matrix. Weigang Chen (a dealer in Xiamen, Fujian province) also has advertised small, red, bipyramidal to tabular crystals on white matrix from Mianning, and has researched the origin of these specimens. He says they are from the Maoniuping mine, near the town of Maoniuping in Mianning County (which is adjacent to Xichang County). A new mineral species from this

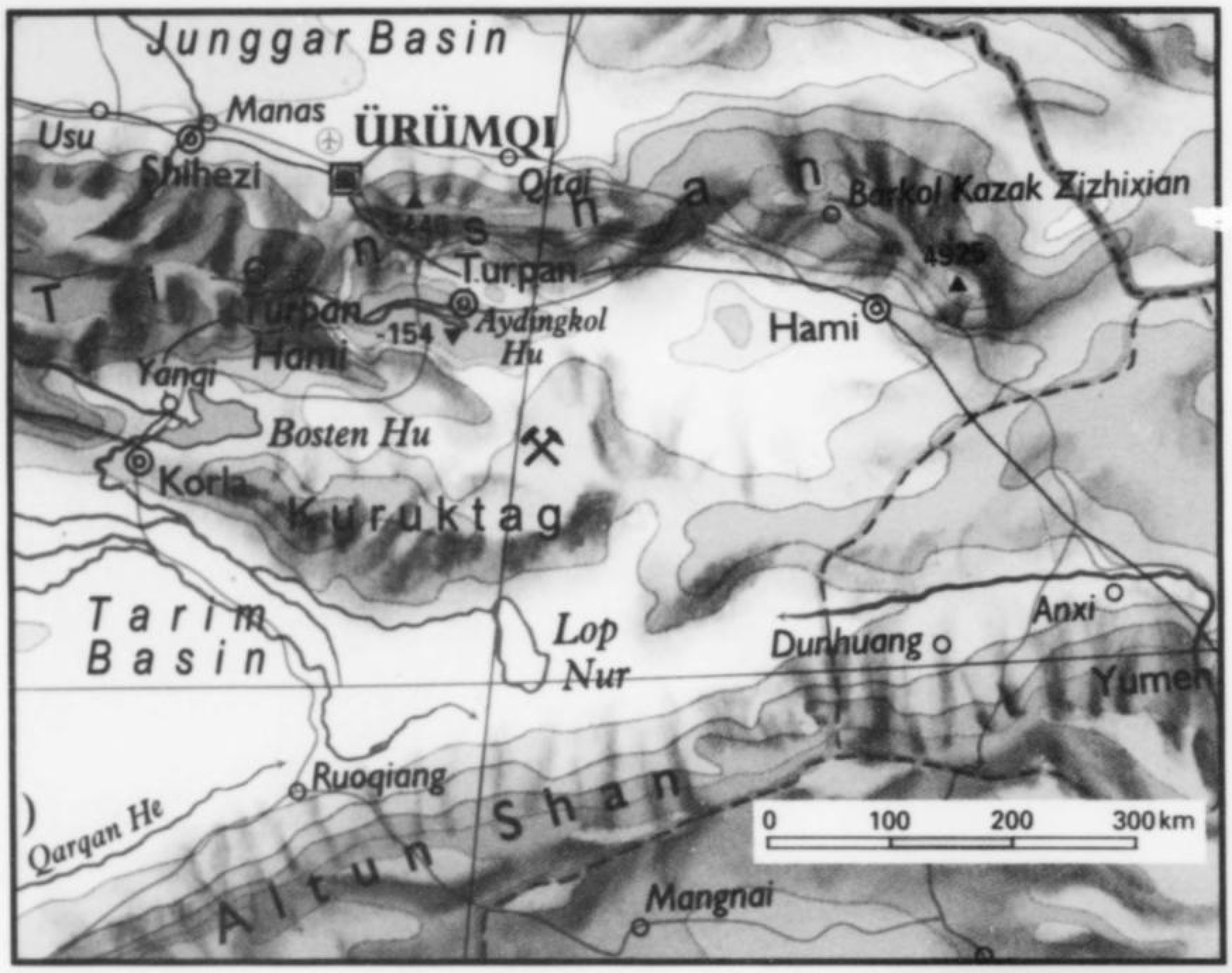
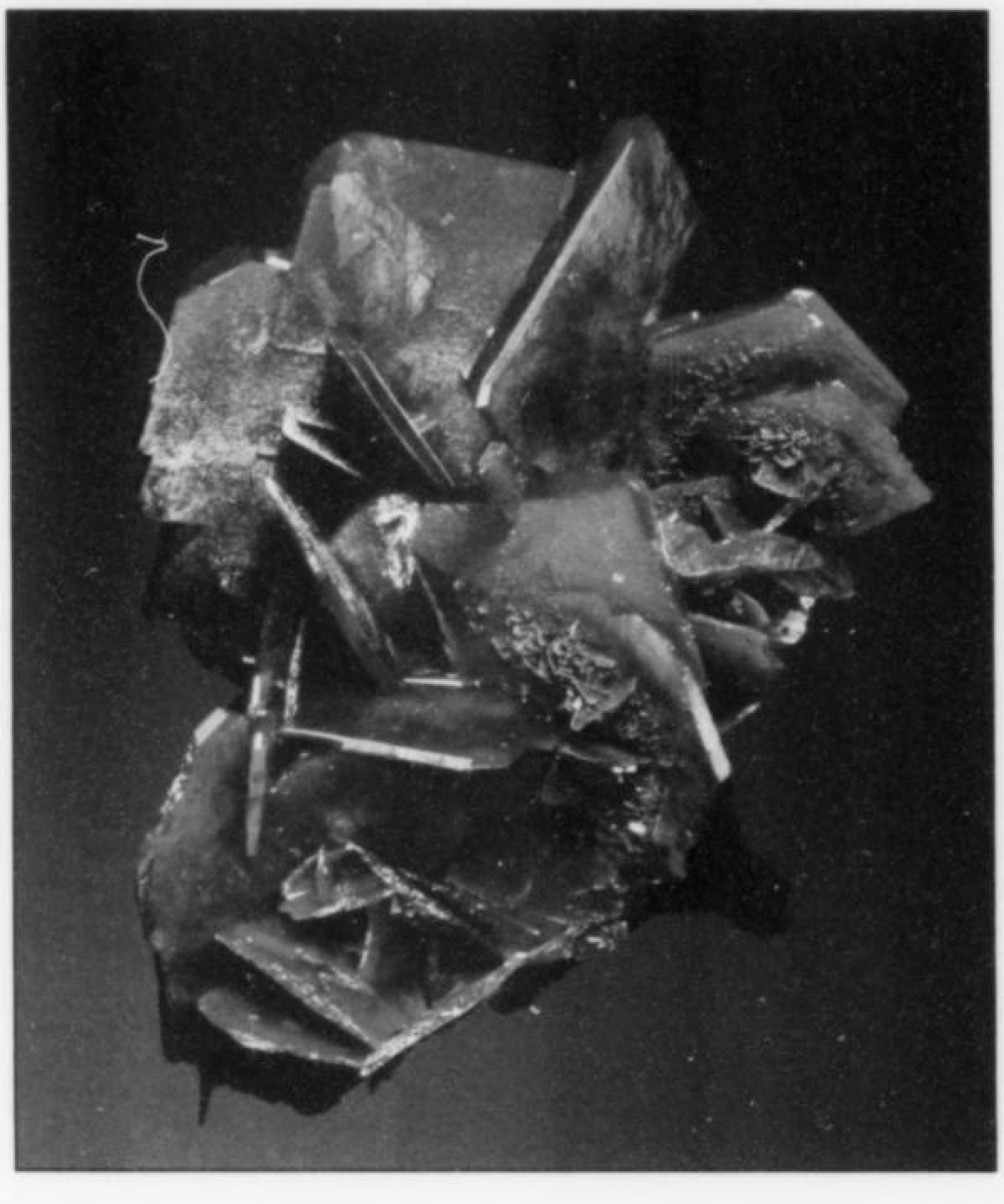


Figure 1. **Location map.**

Figure 2. **Wulfenite, 4.5 cm, from the Kuruktag Mountains. Wayne Thompson, Bill Larson and Rob Lavinsky specimen; Jeff Scovil photo.**



mine, maoniupingite-(Ce), has recently been described (Shen *et al.*, 2005). The mine is owned by a private consortium of about a dozen people, and has been in operation for 40 or 50 years. It began as a molybdenum mine, but in later years converted to the production of rare-earth minerals (Wang *et al.*, 2001; Xie *et al.*, 2006). The sulfide-rich carbonatite orebody, which is quite interesting geologically, contains large quantities of massive bastnäsite and is considered to be the second largest rare-earth deposit in China. No wulfenite crystals larger than about 1 cm have been found there.

Ren (1980), in the book *Minerals in China*, pictures two mediocre wulfenite specimens, from unnamed localities in Gansu and Liaoning, but, as far as we know, no specimens from these areas have ever reached the international market. Zhou and Guo (1996), in the book *Mineral Treasures*, published by the Geological Publishing House in Beijing, cites no Chinese localities for good wulfenite specimens, relying instead on Mexican and American examples for illustrations. Smith *et al.* (2005), in their "Guide to mineral localities in China" (in the previous China Issue, vol. 36, no. 1), also list no localities for wulfenite. Liu (2006), in his book *Fine Minerals of China*, mentions only the Mianning locality as having produced wulfenite specimens for the collector market. There seems to be little doubt that the geochemical and climatological conditions necessary for wulfenite formation are rarely met with in China.

Recently, however, a group of attractive wulfenite specimens in deep red crystals appeared on the market, labeled as coming from "Nonan," Xinjiang Autonomous Region. These were purchased from Chinese wholesalers and offered for resale in 2005 by Scott Werschky (*Miner's Lunchbox*), Kevin Downey and Guanghua Liu. The new specimens are of considerably higher quality and larger crystal size than the Mianning specimens, and have a matrix of soft gossany Fe-Mn oxides. Investigations in China have tracked these to an iron-manganese mine in the Kuruktag Mountains southeast of the provincial capital of Ürümqi—probably the Jianshan mine. (It turns out that "Nonan" is where the miner lives who dug the specimens, and is a long distance from the mine.)

The Kuruktag specimens all originated with one miner, who sold them to a single dealer in Guilin, from whom various dealers in Changsha have purchased small lots. The best specimens were retained, however, and much of the lower-grade material was apparently discarded by this dealer in order to keep the average quality high. The bulk of these specimens was not sold until one of us (MO) visited Guilin in October 2006 and made a deal to purchase the lot on behalf of several American mineral dealers including Bill Larson, Rob Lavinsky and Wayne Thompson. A number of fine pieces were hand-carried back to Arizona, and the major portion of the lot has been shipped.

Figure 3. **Wulfenite with partial coating of white calcite, 10 cm wide, from the Kuruktag Mountains. Wayne Thompson, Bill Larson and Rob Lavinsky specimen; Jeff Scovil photo.**

Figure 4. **Wulfenite with partial coating of white calcite, 4.5 cm, from the Kuruktag Mountains. Wayne Thompson, Bill Larson and Rob Lavinsky specimen; Jeff Scovil photo.**

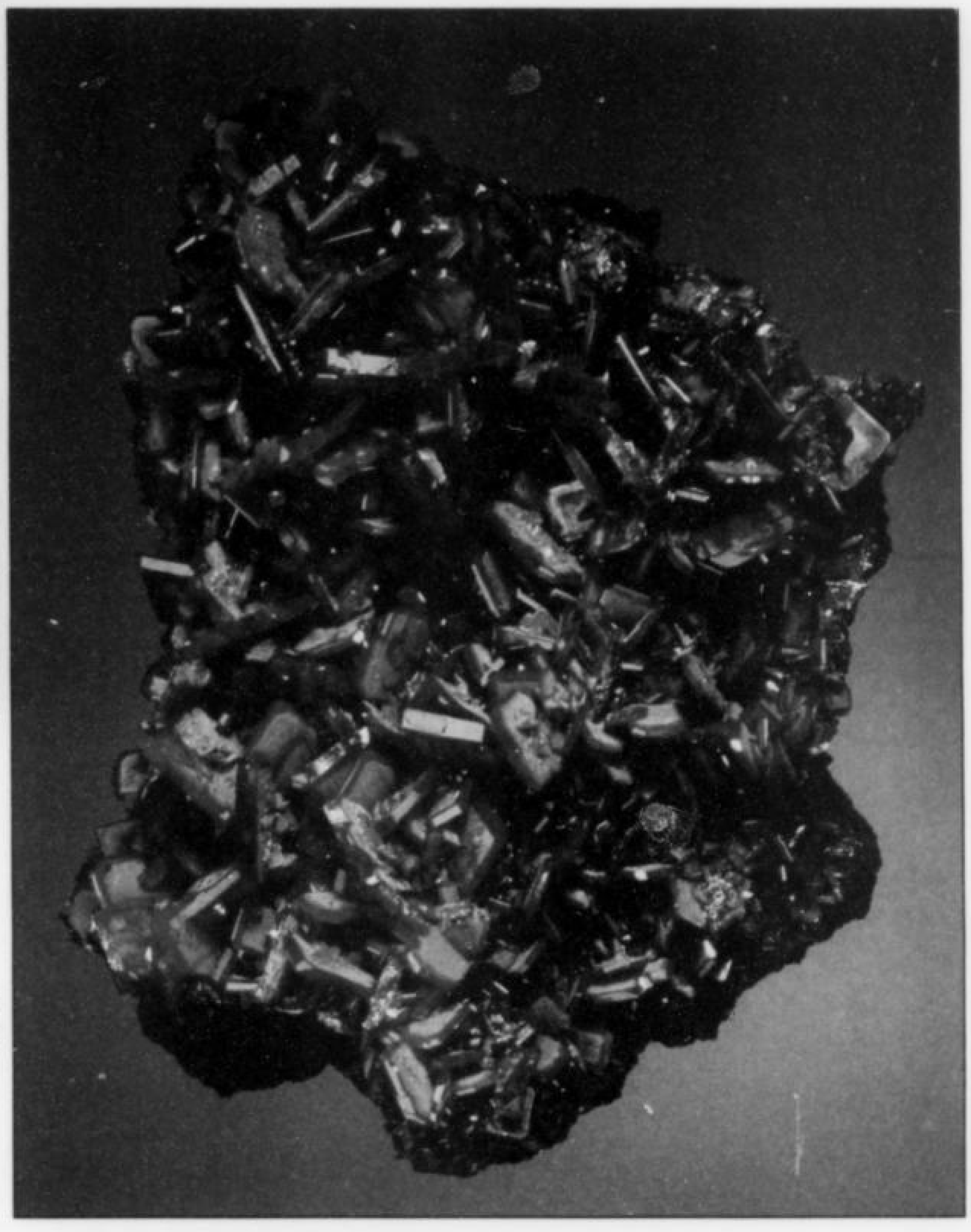


Figure 5. **Wulfenite, 12 cm, from the Kuruktag Mountains. Wayne Thompson, Bill Larson and Rob Lavinsky specimen; Jeff Scovil photo.**

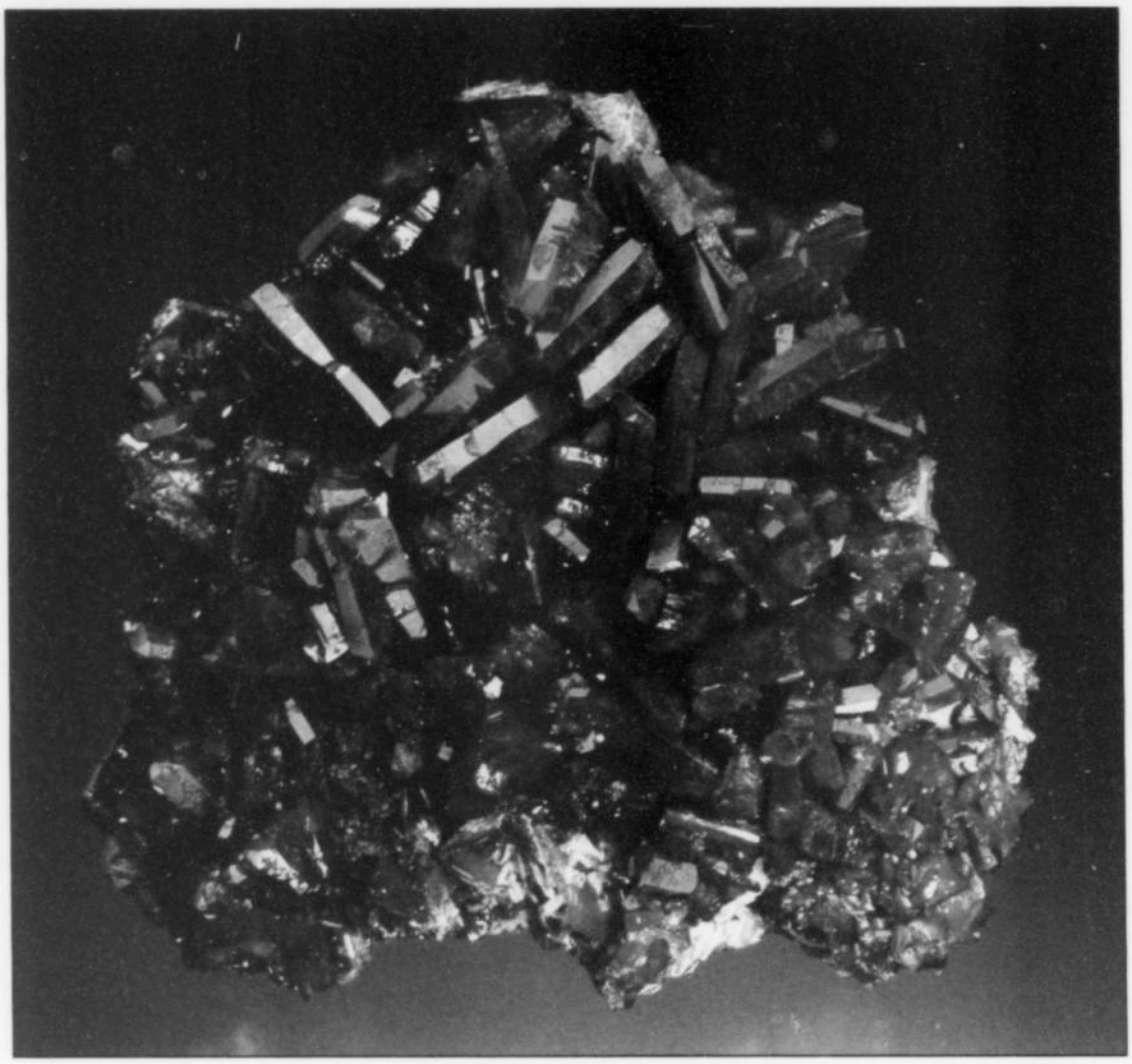


Figure 6. **Wulfenite, 6.5 cm, from the Kuruktag Mountains. Wayne Thompson, Bill Larson and Rob Lavinsky specimen; Jeff Scovil photo.**

GEOLOGY

The Kuruktag Mountains form a southern branch of the Tianshan Range, just north of the Altunshan Range in central Xinjiang Uygar Autonomous Region of China. The Tianshan, Kuruktag and Altunshan ranges are products of the Hercynian Orogeny. These mountain ranges circumscribe to a large extent what is called the "Tarim Block," a vast expanse of flat desert incorporating the Tarim Basin and the Taklamakan Desert. Six major ore-bearing formations formed within the mountainous perimeter of the Tarim Basin. Since the 1970's over a thousand ore deposits have been located around the Tarim Block (He *et al.*, 2000), including a number of gold, copper-molybdenum porphyry, iron-copper, copper-nickel sulfide, manganese, and Cu-Ag-Pb-Zn skarn deposits in the eastern portion of the Tianshan Range (Mao *et al.*, 2005), adjacent to the Kuruktag Range. This area is referred to as the Jueluotage Orogenic Belt.

The Jianshan iron-manganese mine is in the general vicinity of the much larger Hongshijing gold mine (Xiao *et al.*, 2003), in Paleozoic marine volcanic rocks known to host manganese, copper, iron and gold deposits. The Hongshijing deposit is in a shear zone that was mineralized 267-261 Ma (million years ago) and again 220-209 Ma, at middle to low temperatures (381–115° C). This area of the range separates the desert basin south of Hami from the eastern end of the Tarim Basin and the Luobupo playa.

The Cu-Mo porphyry deposits in this area have been dated at 322 Ma, whereas the Au, Ni-Co and Pb-Zn deposits formed more recently, around 290-270 Ma. These late Carboniferous to early Permian metallic deposits appear to be associated with basaltic to andesitic eruptive rocks. The presence of Cu-Mo porphyry deposits and secondary lead deposits in a region of arid weathering sets the stage for the formation of wulfenite deposits. The molybdenum from the weathering porphyry (many of the skarn deposits also contain molybdenite) can be carried in ground water for great distances, until encountering weathering lead deposits where the reaction occurs to precipitate lead molybdate (wulfenite). A similar geological situation prevails in Arizona and northern Mexico, where many of the world's greatest wulfenite deposits occur, commonly emplaced within andesite flows. Limonite-jarosite gossan zones are common in the near surface zones of the deposits; the red wulfenite specimens occur on a friable, dark brown to ochre-yellow rock, probably a mixture of iron and manganese oxides (which can be stabilized by impregnation with a thin solution of water and white glue).

MINERALS

Wulfenite $PbMoO_4$

Thus far, wulfenite is the only collectible mineral to emerge from the locality, although some specimens of unidentified lustrous radiating needles resembling a manganese oxide have also been seen (MO). The wulfenite ranges in color from red-orange to bright red to a somewhat darker blood-red to brown-red. Some crystals are coated on one or both sides by a thin layer of dull, white, porcelaneous calcite (identification by powder X-ray diffraction and Raman spectroscopy), removal of which leaves a pitted, lusterless surface; in many cases the specimens are more aesthetic with the partial calcite coating left intact, as it provides a nice contrast.

The specimens show a range of habits, probably reflecting the four or five different pocket zones that have been mined over the last couple of years. The first crystals to reach the market ranged from tabular to bipyramidal (probably actually contact-twinned single pyramids) showing no trace of a *c* face. Tabular crystals range from paper-thin to fairly robust plates up to 5 or 6 mm thick. The modifying pyramid faces tend to be rather steep; in some cases the tablets are essentially square, with the first-order pyramid predominating almost exclusively, whereas in other cases the second-order pyramid becomes increasingly prominent, ultimately becoming more-or-less equal with the first-order pyramid to produce octagonal rather than square tablets. Some crystals appear hemimorphic, exhibiting pyramidal modifications on only one side of the tablet, and a larger flat *c* face on the other.

Crystal size ranges from microscopic to around 4 cm on an edge; most of the best crystals seen so far are 1 to 2 cm on edge, in dense clusters on matrix. A bright luster adds to the beauty of the red crystals.

CAVEAT

It must be emphasized that we have not actually visited the mine. The location of the occurrence in the Kuruktag Mountains has been attested to by several sources, but the exact mine name given here has been deduced from the details of the location given by the mineral dealer in Guilin and by a private mineral collector in Hami, Xinjiang, the nearest town to the northeast of the mine (see map).

ACKNOWLEDGMENTS

Our thanks to Chen Li for facilitating communications with the Guilin dealer by telephone, and to Wayne Thompson for providing specimens to Jeff Scovil (who also deserves thanks) for photography. Berthold Ottens and Anthony Kampf kindly reviewed the manuscript.

REFERENCES

HE, J., RUI, X., GUO, K., WU, Q., and LIU, H. (2000) Ore-bearing formations and mineral resource prospects of the peripheral areas of the Tarim Block. *Acta Geologica Sinica,* **74** (3), 473–477.

LIU, G. (2006) *Fine Minerals of China.* AAA Minerals Ag, Zug, Switzerland,

MAO, J. GOLDFARB, R. J., WANG, Y., HART, C. J., WANG, Z., and YANG, J. (2005) Late Paleozoic base and precious metal deposits, East Tianshan, Xinjiang, China: Characteristics and geodynamic setting. *Episodes,* **28** (1), 23–36.

REN, K. (1980) *Minerals in China.* Shanghai Museum of Geology and Shanghai Technical Publishers, 166 p.

SHEN, G., YANG, G., and XU, J. (2005) Maoniupingite-(Ce): a new rare-earth mineral from the Maoniuping rare-earth deposit in Mianning, Sichuan. *Sedimentary Geology and Tethys,* 2005 (1).

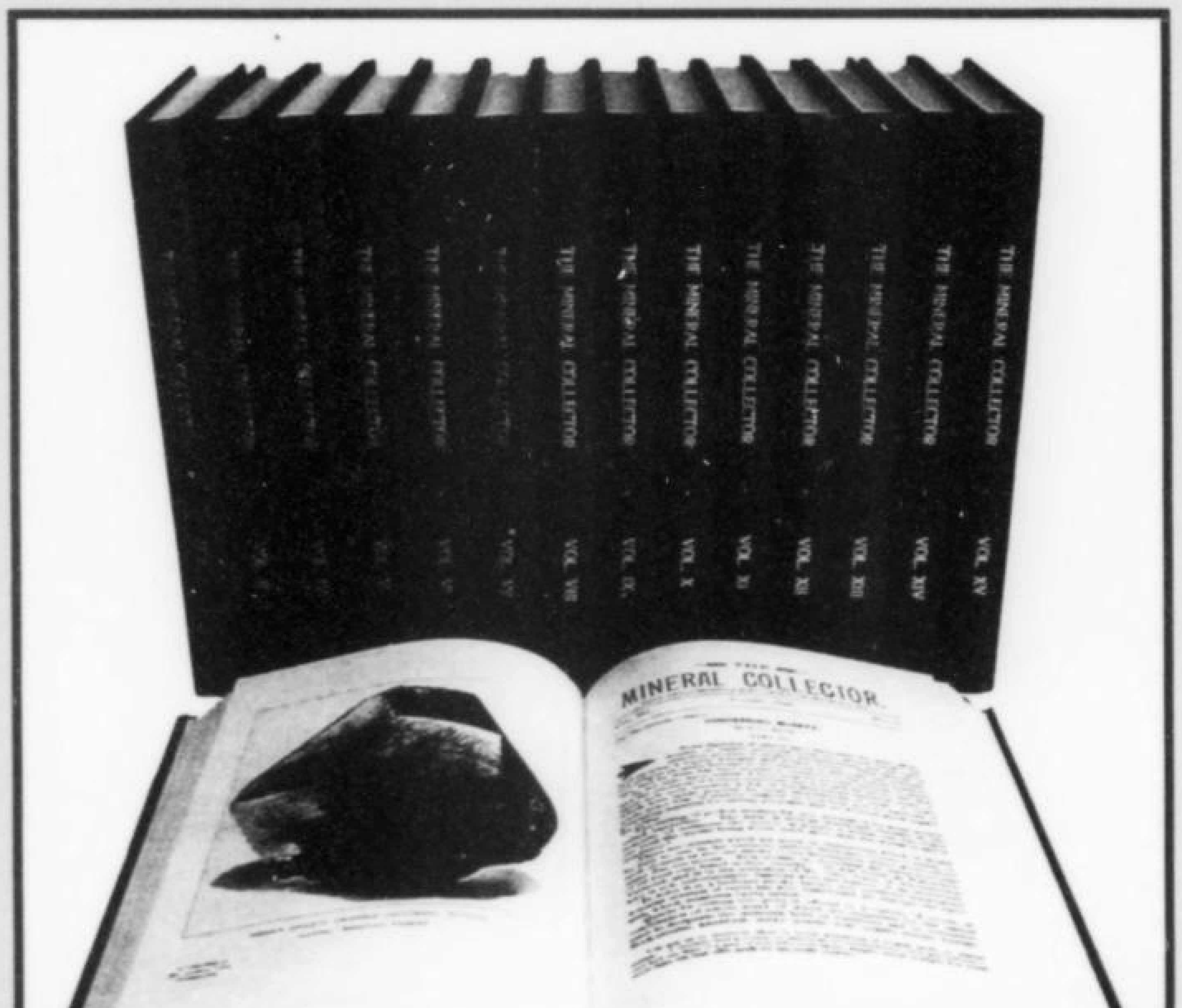
SMITH, B., SMITH, C., LIU, G., and OTTENS, B. (2005) A guide to mineral localities in China. *Mineralogical Record,* **36** (1), 87–101.

XIAO, H., ZHOU. J., WANG, H., CUI, B., and CHEN, S. (2003) Geology, geochemistry and genesis of the Hongshijing gold deposit in Ruoqiang, Xinjiang. *Chinese Journal of Geochemistry,* **22** (3), 280–288.

XIE, Y., HOU, Z., XU, J., YUAN, Z., BAI, G., and LI, X. (2006) Discovery of Cu-Zn, Cu-Sn intermetallic minerals and its significance for genesis of the Mianning-Dechang REE Metallogenic Belt, Sichuan Province, China. *Science in China, series D: Earth Sciences,* **49** (6), 597–603.

WANG, D., YANG, J., YAN, S., XU, J., CHEN, Y., PU, G., and LUO, Y. (2001) A special orogenic-type rare earth element deposit in Maoniuping, Sichuan, China: geology and geochemistry. *Resource Geology,* **51** (3), 177–188.

ZHOU, Z., and GUO, K. (1996) *Mineral Treasures.* Geological Publishing House, Beijing, 220 p.



The Friends of Mineralogy, Inc.

Visit the National Friends of Mineralogy website:

www.friendsofmineralogy.org

President: Bill Dameron, 1609 NW 79th Circle, Vancouver, WA 98665.
Email: baritebill@aol.com

What We Do!

The Friends of Mineralogy (FM) operates on a national level and also through regional chapters and membership is open to all. (See our website for membership application.) FM's objectives are to promote, support, protect and expand the collection of mineral specimens and to further the recognition of the scientific, economic and aesthetic value of minerals. The annual meeting is held during the February TGMS Show.

We co-sponsor a **free symposium** during the annual Tucson Gem and Mineral Show. The 2007 symposium theme is ***"AUSTRALIA-Minerals from Down Under!"*** FM helps produce locality indexes for specimen mineral localities. Among its activities it also sponsors awards for best articles each calendar year in *The Mineralogical Record, Rocks & Minerals* and *extraLapis English.* The Friends of Mineralogy is affiliated with the *American Geological Institute* and the *Mineralogical Society of America.*

See the above website for FM Chapter information about activities in each regional area throughout the nation.

Individual and Institutional Educational Exhibits at the TGMS Show

Instructive exhibits help the hobby grow and underline its scientific basis. Exhibitors at Tucson are asked to consider seriously such a feature for their displays.

The Friends of Mineralogy sponsors non-monetary recognition for displays that help explain an aspect of mineralogy. There is no restriction on the theme, but the exhibit should have some special instructive feature. In keeping with the high standards of the TGMS, cases should be aesthetically pleasing and contain specimens worthy of the show. Two certificates are awarded, one for private collections and one for institutions. The winners are honored at the Saturday night banquet and on plaques displayed in the FM case during the TGMS Show at the Tucson Convention Center, Tuscon, AZ.

Douglass Minerals

www.douglassminerals.com

Quality, affordable, world-wide minerals
Miniature to large cabinet size

P.O. Box 69550 • Tucson, AZ 85737

(520) 742-0294 • douglassminerals@aol.com

MOUNTAIN MINERALS INTERNATIONAL

In Tucson:

Dudley Blauwet Gems
Feb. 1–6 AGTA (TCC)
Booth 2410 & 1723

Mountain Minerals International
Feb. 9–12 T.G.M.S. (TCC) Aisle 11

Mountain Minerals International
P.O. Box 302
Louisville, Colorado 80027-0302
Tel: (303) 665-0672
FAX: (303) 664-1009

HAWTHORNEDEN

FINE MINERAL SPECIMENS
Thumbnail to Cabinet Size

WANTED TO PURCHASE—OLD COLLECTIONS

Open Mid-June to September
(Otherwise By Chance or By Appointment)

Three miles south of Bancroft, Ontario,
on the West side of Hwy. 62

Wendy & Frank Melanson
L'Amable, Ontario K0L2L0
Tel: (613) 332-1032 • FAX:
(613) 332-0585

MRC

MINERALOGICAL RESEARCH CO.

SEARCHING THE WORLD

. . . . to bring you the finest in mineral and meteorite specimens, books, UV lamps, video microscopes, stereo microscopes and specimen boxes, all at competitive prices!

Shop our Web Site @ http://www.minresco.com

Possibly the largest earth science web site in the world!

EUGENE & SHARON CISNEROS
15840 EAST ALTA VISTA WAY
SAN JOSE, CA 95127-1737 USA

Phone: 408-923-6800
FAX: 408-926-6015
Email: xtls@minresco.com

Roger's Minerals *Worldwide Rare Minerals*

3171 Romeo St. Val Caron
Ontario, Canada, P3N 1G5
1-(705)-897-6216
HTTP://www.rogersminerals.com
email: rmineral@isys.ca

SHANNON & SONS MINERALS
Mike Shannon e-mail: xlhunter@msn.com
SHANNONSMINERALS.COM
SEE US AT THE TUCSON ECONO LODGE
I-10 @ 6TH AVE EXIT; MINERALS
FOLD UP BOXES; GEO-TAC PUTTY

THE MUSEUM DIRECTORY

Colburn Earth Science Museum

Curator: Phillip M. Potter
Tel: (828) 254-7162
Fax: (828) 257-4505
Website: www.colburnmuseum.org
Pack Place Education,
Arts & Science Center
2 South Pack Square
Asheville, NC 28801
Hours: 10–5 Tues.–Sat.
1–5 Sun. Closed Mondays
and holidays
Specialties: North Carolina and worldwide minerals and gems
Accessible to persons with disabilities

Montana Tech Mineral Museum

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

The Gillespie Museum of Minerals, Stetson University

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

Colorado School of Mines

Curator: Paul J. Bartos
Tel: (303) 273-3823
E-mail:pbartos@mines.edu
Website: www.mines.edu/academic/ geology/museum
Golden, Colorado 80401
Hours: 9–4 M–Sat., 1–4 Sun.
(closed on school holidays &
Sundays in the summer)
Specialties: Worldwide minerals; Colorado mining & minerals

A. E. Seaman Mineral Museum

Website: www.museum.mtu.edu
Curator & Professor of Mineralogy:
Dr. George W. Robinson
E-mail: robinson@mtu.edu
Tel: 906-487-2572; Fax: 906-487-3027
Electrical Energy Resources Center
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295
Summer Hrs (July-Sept.): M–F: 9–4:30,
S–S: 12–5
Winter Hrs (Oct–June): M–F: 9–4:30
Specialty: Michigan minerals, Lake Superior region & Midwest U.S. minerals

Houston Museum of Natural Science

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

Natural History Museum of Los Angeles County

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

University of Delaware Mineralogical Museum

Penny Hall
Newark, DE 19716
University of Delaware
Tel: (302) 831-4940
For directions, hours, contacts and a virtual tour see www.udel.edu/ museums
Specialty: Worldwide Classics & New Minerals

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

Museums listed alphabetically by city

THE MUSEUM DIRECTORY

Arizona Mining & Mineral Museum
Department Director: Dr. Madan Singh
Curator: Sue Celestian
Tel: (602) 255-3795
1502 W. Washington Avenue
Phoenix, AZ 85007
Hours: 8–5 M–F, 11–4 Sat.,
closed Sun. & holidays
Specialty: Arizona minerals, worldwide minerals & fossils, uses of minerals

Matilda and Karl Pfeiffer Museum and Study Center
Executive Director: Teresa Taylor
Tel: (870) 598-3228
E-mail: pfeifferfnd@centurytel.net
P.O. Box 66
1071 Heritage Park Drive
Piggott, AR 72454
Hours: 9–4 Tues.–Fri.,
11–4 Sat. (Daylight Savings Time)
Specialties: Fine collection of geodes from Keokuk, Iowa, area; worldwide collection of minerals

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

W. M. Keck Earth Science & Engineering Museum
Administrator: Rachel A. Dolbier
Tel: 775-784-4528, Fax: 775-784-1766
E-mail: rdolbier@unr.edu
Website: http://mines.unr/edu/museum
Mackay School of Earth Science & Engineering
University of Nevada, **Reno,** NV 89557
Hours: 9–4 Mon.–Fri. (closed university holidays) and by appointment
Specialty: Comstock ores, worldwide minerals, mining artifacts, Mackay silver

New Mexico Bureau of Mines & Mineral Resources—Mineral Museum
Director: Dr. Virgil W. Lueth
Tel: (505) 835-5140
E-mail: vwlueth@nmt.edu
Fax: (505) 835-6333
Associate Curator: Robert Eveleth
Tel: (505) 835-5325
E-mail: beveleth@gis.nmt.edu
New Mexico Tech,
801 Leroy Place
Socorro, NM 87801
Hours: 8–5 M–F, 10–3
Sat., Sun
Specialties: New Mexico minerals, mining artifacts, worldwide minerals

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

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

William Weinman Mineral Museum
Website: www.weinmanmuseum.org
Tel. (770) 386-0576
Director: Jose Santamaria x401
E-mail: joses@weinmanmuseum.org
Curator: Julian Gray x415
E-mail: juliang@weinmanmuseum.org
Collections Manager: Cherry Johnson x405
E-mail: cherryj@weinmanmuseum.org
51 Mineral Museum Dr.
White, GA 30184
Mailing Address:
P.O. Box 3663
Cartersville, GA 30120
Hours: Mon-Sat 10-5, closed Sundays
Specialty: Georgia and worldwide minerals, fossils and mining artifacts

---

Museo Civico di Storia Naturale
Curator: Dr. Federico Pezzotta
Tel: +39 02 8846 3326
Fax: +39 02 8846 3281
E-Mail: Federico.Pezzotta@comune.miland.it
Department of Mineralogy and Petrography
Corso Venezia, 55
I-20121 **Milano,** Italy
Hours: 9 am–6 pm daily, closed Mondays
Specialties: Italian minerals, pegmatite minerals

Gargoti Mineral Museum
Director: K. C. Pandey
Tel: ++91 2551 230528
Fax: ++91 2551 230866
D-59 MIDC, Malegaon, **Sinnar**, Nashik 422 103 India
Specialty: Minerals of India

Crystal Clear.

MEIJI TECHNO

The Meiji EM Series of Modular Stereo Microscopes.

If you are looking for precision, durability, quality and value in a Stereo Microscope, we invite you to take a closer look at Meiji's EM Series of Stereo Microscopes.

The modular design (A wide variety of bodies, single magnification or zoom - rotatable 360°, auxiliary lenses, eyepieces, stands, holders, etc.) gives you the freedom to create the ideal instrument for your specific need or application, and Meiji stands behind every instrument with its ***"Limited Lifetime Warranty."***

For more information on these economically priced Stereo Microscopes, please call, FAX, write us or log on to our website today.

MEIJI TECHNO AMERICA

2186 Bering Drive, San Jose, CA 95131,
Tel: 408.428.9654, FAX: 408.428.0472

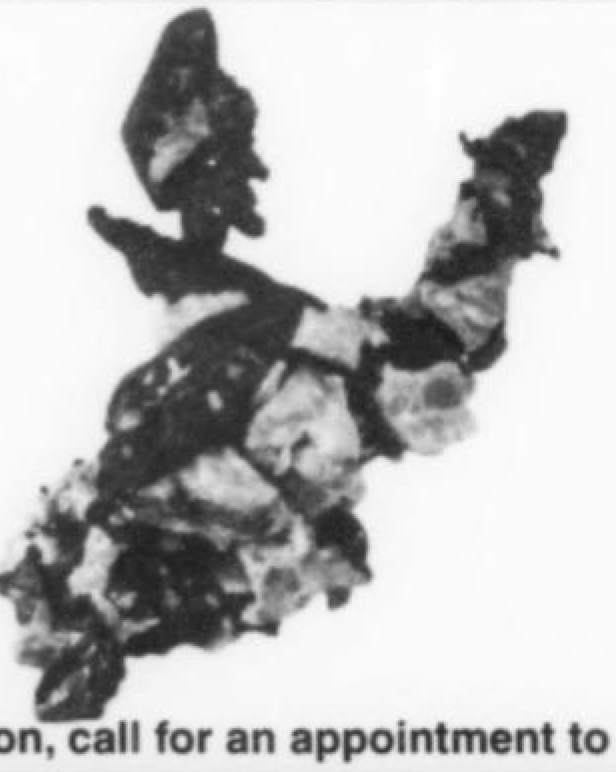
Toll Free Telephone: 800.832.0060 or visit our website at www.meijitechno.com

43 Years

Of Experience and Professional Excellence

Specializing in Select Specimens for Collectors & Museums. Diverse Price Ranges – Intermediate to Advanced.

We Offer Immediate & Highest Payment for Mineral Collections or Individual Specimens.



NATIVE COPPER –
Quincy Mine
Houghton Co., Michigan

- **Premium Prices Paid for Choice Specimens.**
- **APPRAISAL SERVICES:** ***Review & Evaluate***
- **COLLECTIONS RESTORED:** ***Catalogued & Classified***
- **If you're shopping for quality & fair price, visit our web site at www.wmtucson.com**

When in Tucson, call for an appointment to visit our studio

Western Minerals

ESTABLISHED 1962 GENE & JACKIE SCHLEPP

P.O. Box 43603 • Tucson, Arizona 85733 • Call Collect at 520-325-4534
Fax 520-318-0573 • E-mail: schlepp@wmtucson.com

OTTENSITE

a New Mineral from Qinglong, Guizhou Province, China

Jiří Sejkora
Department of Mineralogy and Petrology,
National Museum
Václavské nám. 68
CZ-11579 Praha 1, Czech Republic

Jaroslav Hyršl
Ke kurtům 383
CZ-14200, Praha 4, Czech Republic

ABSTRACT

Ottensite, $Na_3(Sb_2O_3)_3(SbS_3)\cdot 3H_2O$, is hexagonal, space group $P6_3$, with unit-cell parameters derived from X-ray powder data: a = 14.1758(2), c = 5.5712(1) Å, V = 969.57(3) Å^3, Z = 2. It is the Na-dominant analog of cetineite. The strongest reflections in the X-ray powder diffraction pattern are [d(Å)(I)(hkl)]: 12.29(60)(100); 4.64(50)(120); 4.12(50)(201); 2.991(80)(221); 2.906(100)(131); 2.679(50)(410). The mineral was found on specimens from the Qinglong antimony deposit (25°30′N; 105°10′E), which is situated in Qinglong County, Guizhou Province, China. Ottensite is a supergene product of stibnite weathering. It forms crusts about 1 mm thick on well-formed, terminated stibnite crystals which are up to 5 cm long and 6 mm wide. The ottensite crusts are composed of spheres with a diameter of up to 0.3 mm. The color is red-brown with an adamantine luster and yellow-brown streak. It is brittle with irregular fracture; cleavage was not observed; it is non-fluorescent. Hardness (Mohs) is about 3½; calculated density is 4.14 g/cm^3. Optically, it is uniaxial positive, n (calculated from the Gladstone-Dale relationship) is 1.99; pleochroism is weak: orange-red to red. Average electron microprobe analysis: Na_2O 7.44, K_2O 0.10, Sb_2O_3 84.64, S 7.43, H_2O (derived from TG analysis) 4.60, –S=O –3.71, total 100.50 weight %, corresponding to an empirical formula $(Na_{2.89}K_{0.03})_{2.92}(Sb_2O_3)_{3.03}(Sb_{0.93}S_{2.79})(OH)_{0.13}\cdot 3.01\ H_2O$, based on 15 anions. The mineral name is for Berthold Ottens (born 1942).

INTRODUCTION

Specimens containing ottensite were first noticed in 2004, and were originally thought to be cetineite. They probably came from a single find, because no other similar specimens have turned up since then. Probably only a few dozen specimens exist.

The mineral name honors Berthold Ottens (born 1942), mineral collector and dealer from Spiegelau, Germany. Mr. Ottens is the author of numerous articles about mineral localities in China and India, published in the *Mineralogical Record, Rocks & Minerals, Lapis, Mineralien-Welt*, etc.; the most important ones are Ottens (2003) and Ottens *et al.* (2004, 2005), as well as several articles in this issue of *Mineralogical Record.* He is widely recognized as one of the few experts in Chinese minerals and localities. The mineral and mineral name *ottensite* (pronounced "ahten-zite") have been approved by the Commission on New Minerals and Mineral Names, I.M.A. (2006-014). The holotype specimen is deposited in the collection of the National Museum, Prague, Czech Republic, under catalog number P1p 1/2006.

OCCURRENCE

Ottensite was found on several specimens from the Qinglong district (25°30′N; 105°10′E), which is situated in Qinglong County, southwestern part of Guizhou Province, China. Qinglong is a large ore district with many mines, the most important one being the Dachang mine. Unfortunately, the exact locality for the ottensite specimens remains unknown.

The Qinglong deposit is of volcano-sedimentary origin and the most important ore mineral is stibnite, which forms crystals to several centimeters long. Associated minerals include quartz, pyrite, fluorite, calcite and clay minerals (Wu and Zhao, 1990). Several supergene minerals are known from Qinglong, including carbonate-cyanotrichite and stibiconite (Ottens, 2005). Ottensite is a supergene product of stibnite weathering in the oxidation zone.

Ottensite forms crusts about 1 mm thick on well-formed termi-

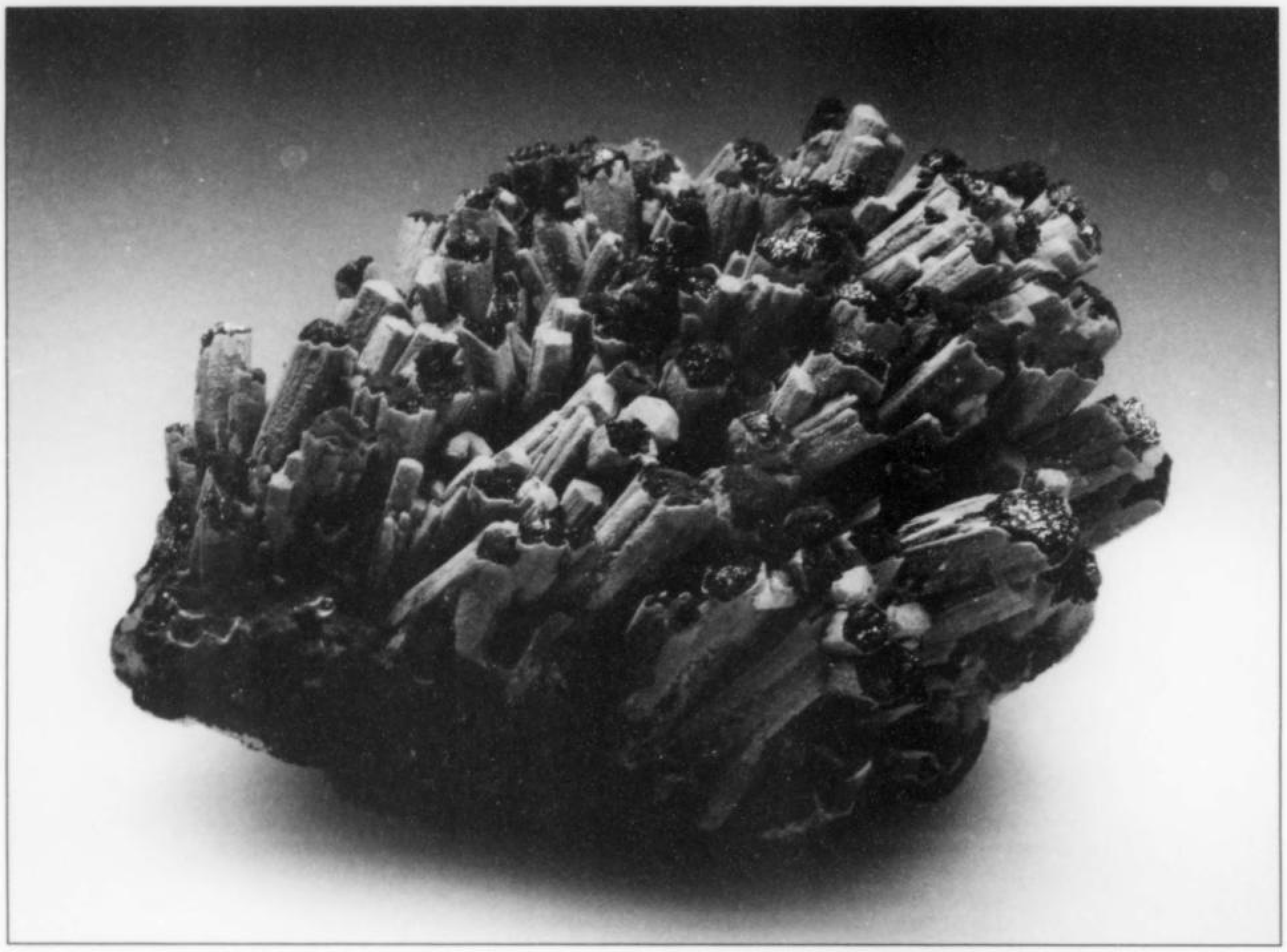


Figure 1. Botryoidal dark red ottensite on stibnite with pale yellow, amorphous oxide, 7.6 cm, from Qinglong. Marcus Origlieri specimen; Wendell Wilson photo.

Figure 2. Botryoidal dark red ottensite, 3 mm, on stibnite with a coating of a pale yellow, amorphous oxide and microcrystalline fluorite, from Qinglong. Marcus Origlieri specimen and photo.

nated stibnite crystals which are up to 5 cm long and 6 mm wide, in some places ottensite is covered by a very thin yellow powdery coating of an amorphous antimony oxide. The ottensite crust has generally grown directly on stibnite, but in some cases there is an empty space between the stibnite and the ottensite crust. The crust is composed of spheres with a diameter up to 0.3 mm. The spheres typically have a smooth and lustrous surface, but in some cases are composed of crystals with a hexagonal prism {100}, terminated by *c*{001}. Radially oriented groups of well-developed columnar crystals were seen only rarely.

***Table 1.* X-ray powder-diffraction data for ottensite.**

I	$d_{meas.}$	$d_{calc.}$	h	k	l
60	12.288	12.277	1	0	0
21	7.094	7.088	1	1	0
7	5.075	5.073	1	0	1
51	4.643	4.640	1	2	0
16	4.381	4.380	1	1	1
52	4.125	4.125	2	0	1
41	4.091	4.092	3	0	0
44	3.566	3.565	1	2	1
57	3.406	3.405	3	1	0
			1	3	0
36	3.299	3.298	3	0	1
32	3.070	3.069	4	0	0
77	2.991	2.990	2	2	1
100	2.906	2.905	1	3	1
			3	1	1
27	2.816	2.816	2	3	0
41	2.785	2.786	0	0	2
10	2.716	2.717	1	0	2
32	2.689	2.688	4	0	1
51	2.679	2.679	4	1	0
12	2.593	2.593	1	1	2
6	2.536	2.537	2	0	2
16	2.4552	2.4553	5	0	0
10	2.4149	2.4144	1	4	1
16	2.3880	2.3883	2	1	2
			1	2	2
11	2.3627	2.3626	3	3	0
40	2.3199	2.3201	4	2	0
32	2.2048	2.2050	1	5	0
			5	1	0
23	2.1748	2.1751	3	3	1
28	2.1560	2.1560	1	3	2
20	2.1416	2.1418	2	4	1
			4	2	1
46	2.0496	2.0502	1	5	1
28	2.0181	2.0183	3	4	0
23	1.9805	1.9805	2	3	2
39	1.9656	1.9658	5	2	0
			2	5	0
31	1.9309	1.9309	1	4	2
			4	1	2
14	1.8976	1.8976	4	3	1
			6	1	0
23	1.8538	1.8538	2	5	1
21	1.8418	1.8419	5	0	2
11	1.8362	1.8362	1	0	3
38	1.7828	1.7827	4	2	2
51	1.7743	1.7747	1	6	1
46	1.7536	1.7538	5	3	0
22	1.7285	1.7289	1	5	2
			5	1	2
7	1.7022	1.7025	2	6	0
			6	2	0
23	1.6886	1.6886	4	4	1
11	1.6727	1.6729	5	3	1
			3	5	1
22	1.6454	1.6449	2	2	3
33	1.6302	1.6303	1	3	3
			3	1	3
10	1.6061	1.6062	5	2	2
12	1.5888	1.5889	4	0	3
16	1.5718	1.5719	5	4	0
22	1.5609	1.5610	1	7	1
11	1.5539	1.5538	6	1	2
7	1.5465	1.5467	3	6	0
30	1.5127	1.5128	5	4	1
8	1.4998	1.4998	7	2	0
11	1.4952	1.4951	4	4	2
27	1.4902	1.4903	3	6	1
51	1.4842	1.4842	7	0	2
			5	3	2
45	1.4792	1.4795	8	0	1
4	1.4599	1.4600	3	3	3
26	1.4484	1.4483	7	2	1
			2	7	1
7	1.4205	1.4204	5	1	3
			1	5	3
10	1.4175	1.4176	5	5	0
3	1.4045	1.4043	1	7	2
9	1.3930	1.3928	0	0	4
6	1.3915	1.3913	8	1	1
7	1.3812	1.3812	7	3	0
			3	7	0
7	1.3692	1.3690	5	4	2
13	1.3666	1.3667	1	1	4
4	1.3521	1.3522	6	3	2
5	1.3498	1.3500	2	5	3
23	1.3395	1.3395	2	8	0
11	1.3343	1.3340	1	2	4
3	1.3245	1.3249	9	0	1
6	1.3206	1.3206	2	7	2
			7	2	2
10	1.3184	1.3185	1	6	3
			6	1	3
3	1.3023	1.3024	8	2	1
3	1.2964	1.2963	2	2	4
2	1.2893	1.2891	1	3	4
4	1.2869	1.2869	1	9	0
			5	6	0
5	1.2819	1.2820	4	4	3
4	1.2747	1.2751	3	5	3
8	1.2538	1.2539	9	1	1
			6	5	1
			5	6	1
5	1.2486	1.2485	2	3	4
7	1.2410	1.2410	4	7	1
9	1.2375	1.2375	7	3	2
			3	7	2
7	1.2358	1.2358	1	4	4
4	1.2251	1.2251	9	0	2
9	1.2234	1.2234	1	7	3
11	1.2164	1.2164	8	3	1
7	1.2116	1.2115	5	0	4
13	1.2097	1.2097	2	9	0
			9	2	0
10	1.2073	1.2072	2	8	2
8	1.1994	1.1998	5	4	3
4	1.1942	1.1941	2	4	4
			4	2	4
3	1.1885	1.1885	3	6	3
2	1.1829	1.1830	8	0	3
16	1.1820	1.1821	9	2	1
5	1.1668	1.1668	2	7	3
9	1.1651	1.1653	10	1	0
			1	10	0
12	1.1557	1.1556	6	6	1
13	1.1505	1.1505	7	5	1
			5	7	1
9	1.1354	1.1357	8	4	1
4	1.1221	1.1221	4	6	3
10	1.1174	1.1175	6	1	4
11	1.1096	1.1097	1	0	5
			9	2	2
8	1.1084	1.1083	3	7	3
3	1.1022	1.1025	10	2	0
			2	10	0
7	1.0948	1.0950	4	4	4
			11	0	1
12	1.0906	1.0907	5	3	4
			7	0	4
6	1.0894	1.0894	7	6	0
2	1.0873	1.0876	6	6	2
8	1.0809	1.0809	5	8	0
5	1.0751	1.0750	1	10	2
3	1.0710	1.0709	4	8	2
10	1.0690	1.0691	6	7	1
4	1.0645	1.0645	4	9	0
			1	11	0
6	1.0591	1.0590	1	3	5
			3	1	5
8	1.0580	1.0578	1	7	4
			6	5	3
			9	1	3
4	1.0510	1.0511	9	3	2
			3	9	2
9	1.0457	1.0456	4	9	1
			11	1	1
7	1.0352	1.0350	6	3	4
			8	3	3
5	1.0252	1.0251	2	10	2
			10	2	2
11	1.0145	1.0146	6	7	2
			7	6	2
8	1.0134	1.0136	9	2	3
3	1.0128	1.0126	2	11	0
2	0.9991	0.9991	9	5	0
5	0.9969	0.9967	6	6	3
7	0.9944	0.9945	5	1	5
			1	5	5
			4	9	2
2	0.9800	0.9807	7	3	4
		0.9798	1	12	0
4	0.9754	0.9754	10	3	2
		0.9745	9	0	4
7	0.9681	0.9680	4	10	1
10	0.9651	0.9655	2	8	4
		0.9650	12	1	1
			1	12	1
2	0.9576	0.9575	6	1	5
			1	6	5
3	0.9517	0.9516	11	2	2
			2	11	2
4	0.9477	0.9476	3	11	1
			11	3	1

Diffractometer Philips X'Pert APD, Cu$K\alpha_1$ radiation; all observed reflections were used for unit-cell refinement.

Table 2. **Comparison of ottensite and similar phases.**

	ottensite	*cetineite*	*synthetic*
	this paper	Sabelli and Vezzalini, 1987; Sabelli *et al.* 1988	Sabelli *et al.* 1988
formula	$Na_3(Sb_2O_3)_3(SbS_3)\cdot 3H_2O$	$(K,Na)_{3+x}(Sb_2O_3)_3(SbS_3)(OH)_x\cdot(2.8-x)H_2O$	$Na_{3.6}(Sb_2O_3)_3(SbS_3)(OH)_{0.6}\cdot 2.4H_2O$
crystal system	hexagonal	hexagonal	hexagonal
space group	$P6_3$	$P6_3$	$P6_3$
unit a	14.1758(2)	14.2513(3)	14.152(3)
cell c	5.5712(1)	5.5900(1)	5.5758(7)
parameters V	969.57(3)	983.22	967.10
Z	2	2	2
$d_{calc.}$	4.14	4.22	4.22
strongest lines in the powder pattern	12.288/60	12.41/80	*12.256/100
	4.643/51	4.67/54	*4.633/31
	4.125/52	4.11/55	*4.124/44
	2.991/77	3.000/74	*2.987/76
	2.906/100	2.916/100	*2.902/100
	2.679/51	2.690/61	*2.675/24

* X-ray powder data calculated from crystal structure information

PHYSICAL AND OPTICAL PROPERTIES

The color of ottensite is red-brown, with a vitreous luster. It is brittle with an irregular fracture; the streak is yellow-brown; and cleavage was not observed. The mineral is translucent in thin fragments, showing a dark red color. It is non-fluorescent under both shortwave and longwave ultraviolet light. The hardness (Mohs) is estimated to be about 3½. The density could not be measured because of the small aggregate size, but the calculated density, based on the empirical formula and unit-cell parameters refined from X-ray powder diffraction data, is 4.14 g/cm³. The mineral is uniaxial positive, with an index of refraction much higher than 1.74. N calculated from Gladstone-Dale rule is 1.992. Ottensite is weakly pleochroic: orange-red and red.

X-RAY STUDIES

A hand-picked sample of ottensite was used to produce the X-ray powder diffraction pattern. The observed diffraction lines are similar to the pattern of cetineite and especially synthetic $Na_{3.6}(Sb_2O_3)_3(SbS_3)(OH)_{0.6}\cdot 2.4H_2O$ (Sabelli *et al.*, 1988). The unit-cell parameters were obtained from the X-ray powder diffraction pattern (Table 1). Diffraction data were collected using a Philips X'Pert APD diffractometer (40 kV, 40 mA) in the range 5–110° 2θ in the step-scan mode (0.02°/30 s) with Cu$K\alpha_1$ radiation. The positions and intensities of reflections were calculated using the Pearson VII profile shape function in the ZDS program package (Ondruš, 1993). The hexagonal unit-cell (space group $P6_3$) was proposed by analogy to that of cetineite having the formula $(K,Na)_{3+x}(Sb_2O_3)_3(SbS_3)(OH)_x\cdot(2.8-x)H_2O$ (Sabelli and Vezzalini, 1987; Sabelli *et al.*, 1988), and synthetic material having the formula $Na_{3.6}(Sb_2O_3)_3(SbS_3)(OH)_{0.6}\cdot 2.4H_2O$ (Sabelli *et al.*, 1988). The unit-cell parameters of ottensite are a = 14.1758(2), c = 5.5712(1) Å, V = 969.57(3) Å³, refined from X-ray powder diffraction data using the program of Burham (1962). A comparison of the physical properties of ottensite and similar phases is given in the Table 2.

CRYSTAL STRUCTURE

Single-crystal X-ray studies were not possible because of the lack of crystals of sufficient size and quality. The crystal structure of a synthetic analog close to ottensite, as well as that of cetineite, was studied by Sabelli *et al.* (1988). Characteristic for the crystal structures of cetineite-like compounds is the presence of infinite tunnels parallel to the 6_3 axis, formed by the linkage of SbO_3 pyramids. The first alkali-site ($M(H_2O)_6$) is statistically located within the tunnel and has a "zeolitic" character, whereas the second site is localized on the interior of the tunnel wall (Sabelli *et al.*, 1988). Synthetically prepared cetineite-like compounds are an attractive subject for research because of their porous crystal structures (containing tunnels with a diameter of about 0.7 nm) and semiconducting properties (e.g. Wang and Liebau, 1999; Starrost *et al.*, 2000; Krasovskii *et al.*, 2001).

Table 3. **Chemical composition of ottensite.**

Constituent	*Wt.%*	*Range*
Na_2O	7.44	6.96–7.91
K_2O	0.10	0.07–0.11
Sb_2O_3	84.64	83.92–85.22
S	7.43	6.96–7.91
H_2O*	4.60	
–S=O	–3.71	
Total	**100.50**	

* H_2O content derived from TG analysis.

CHEMICAL COMPOSITION

Quantitative chemical analyses (Table 3) were carried out by means of a Cameca SX 100 electron microprobe in wavelength-dispersive mode (Masaryk University, Brno), operated at an acceleration potential 15 kV, a sample current of 20 nA, and an electron beam size of 5 µm. Albite, sanidine, Sb and ZnS were used as standards. When other standards for S were used, such as chalcopyrite, barite or stibnite, erroneous sulfur levels (about 30% too low) resulted for ottensite as well as for cetineite from the Cetine mine. Raw intensities were converted using the automatic PAP (Pouchou and Pichoir, 1985) matrix correction software package. The average of eight analyses of ottensite is given in Table 3, indicating an empirical formula of:

$$(\mathbf{Na}_{2.89}\mathbf{K}_{0.03})_{\Sigma 2.92}(\mathbf{Sb}_2\mathbf{O}_3)_{3.03}(\mathbf{Sb}_{0.93}\mathbf{S}_{2.79})(\mathbf{OH})_{0.13}\cdot\mathbf{3.01H_2O}$$

based on 15 anions. The simplified formula of ottensite is $Na_3(Sb_2O_3)_3(SbS_3)\cdot 3H_2O$.

THERMAL AND INFRARED ANALYSES

Thermo-gravimetric and differential thermal analysis curves with an analysis of escaping gases were obtained on a Setaram Setsys Evolution 1750 under the following conditions: 10° C min^{-1}, a dynamic air atmosphere of 20 ml.min^{-1}, a sample mass of 7.5 mg, measured over the range 20° to 1050° C. In the range 20–400° C a decrease in mass of 4.60 weight % with no release of SO_2 was observed; in the range 400–1050° C the thermal curves have a much more complex character, with several mass decreases and increases, several exotherms and endotherms, and a release of SO_2 in at least three temperature ranges.

The infrared spectrum of ottensite was obtained using an FTIR Nicolet 740 spectrophotometer and the KBr pellet method in the range 4000 to 400 cm^{-1}. The measured absorption bands are: 3444, 1634, 1018, 993, 762, 633 and 498 cm^{-1}. This IR spectrum is similar to the spectrum of cetineite from the Cetine mine (Sabelli and Vezzalini, 1987). A very strong band at 3444 cm^{-1} is related to O-H stretching vibration in H_2O molecules and OH groups. A distinct band at 1630 cm^{-1} indicates the presence of structural H_2O molecules. The bands in the region 800–450 cm^{-1} (with the strongest band at 633 cm^{-1}) are due to vibrations of the metal-oxygen (Sb-O) bonds.

RELATED MINERALS

The composition of ottensite is very close to the ideal Na end-member composition in the cetineite-ottensite series. The presence of Na in cetineite from the Cetine mine (Sabelli and Vezzalini, 1987, and our results) suggests the possible existence of at least a partial isomorphous series between cetineite and ottensite. For the ideal formulae of cetineite-like minerals of the composition $(K,Na)_{3+x}(Sb_2O_3)_3(SbS_3)(OH)_x\cdot(2.8-x)H_2O$, as proposed by Sabelli *et al.* (1988), values of x = 0.5 (cetineite from the Cetine mine, Sabelli *et al.*, 1988) and x = 0.6 (synthetic Na analog of cetineite, Sabelli *et al.*, 1988) have been published. For ottensite from Qinglong, with K+Na = 2.69 to 3.09 *apfu*, the x value is close to 0.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the cooperation of Radek Škoda (Masaryk University, Brno), Jana Ederová, Miroslava Novotná (Institute of Chemical Technology, Prague), Martin Mazuch (Charles University, Prague) and František Veselovský (Czech Geological Survey, Prague). Joseph A. Mandarino kindly reviewed the manuscript and offered helpful suggestions. This work was supported by a grant from the Ministery of Culture of the Czech Republic (Project MK00002327201).

REFERENCES

BURNHAM, C. W. (1962) Lattice constant refinement. Carnegie Institute, Washington Year Book **61**, 132–135.

KRASOVSKII, E. E., TIEDJE, O., BRODERSEN, S., SCHATTKE, W., STARROST, F., JOCKEL, J., and SIMON, U. (2001) Bonding of guest molecules in the tubes of nanoporous cetineite crystals. *Materials Research Society Symposium Proceedings*, 658, GG4.9.1–4.9.6.

ONDRUŠ, P. (1993) ZDS—A computer program for analysis of X-ray powder diffraction patterns. *Materials Science Forum*, 133–136: 297–300, EPDIC-2. Enchede.

OTTENS, B. (2003) Minerals of the Deccan Traps, India. *Mineralogical Record*, **34**, 1–82.

OTTENS, B. (2005) Antimonit aus China. *Lapis*, **31**, 2, 23–34.

OTTENS, B. et al. (2004) China. *ExtraLapis*, **26/27**, 1–200.

OTTENS, B. et al. (2005) China. *Mineralogical Record*, **36**, 1–101.

POUCHOU, J. L., and PICHOIR, F. (1985) "PAP" procedure for improved quantitative microanalysis. *Microbeam Analysis*, **20**, 104–105.

SABELLI, C., NAKAI, I., and KATSURA, S. (1988) Crystal structures of cetineite and its synthetic Na analogue $Na_{3.6}(Sb_2O_3)_3(SbS_3)(OH)_{0.6}\cdot 2.4H_2O$. *American Mineralogist*, **73**, 398–404.

SABELLI, C., and VEZZALINI, G. (1987) Cetineite, a new antimony oxide-sulfide mineral from Cetine mine, Tuscany, Italy. *Neues Jahrbuch für Mineralogie, Monatshefte*, **H9**, 419–425.

STARROST, F., KRASOVSKII, E. E., SCHATTKE, W., JOCKEL, J., SIMON, U., ADELUNG, R., and KIPP, L. (2000) Cetineites: Electronic, optical, and conduction properties of nanoporous chalcogenoantimonates. *Physical Review*, **B61**, 15697–15706.

WANG, X., and LIEBAU, F. (1999) Crystal structures of cetineites, $A_6B_{12}O_{18}[SbX_3]_2D_xY_{6-y}$, and their changes with chemical composition. *Zeitschrift für Kristallographie*, **214**, 820–834.

WU, J., XIAO, Q., and ZHAO, S. (Editors) (1990) *The Mineral Deposits of China*. Geological Publishing House, Beijing, Vol. 1, p. 355.

A NOTE
on the
PARAGENESIS OF OTTENSITE

Marcus J. Origlieri
1505 West St. Mary's Road #106
Tucson, AZ 85745
marcus@mineralzone.com

Thomas A. Laetsch
Department of Geosciences
University of Arizona
Tucson, AZ 85721-0077
tomtal@email.arizona.edu

Robert T. Downs
Department of Geosciences
University of Arizona
Tucson, AZ 85721-0077
downs@geo.arizona.edu

INTRODUCTION

During the Denver mineral show of 2005, the senior author noticed a specimen of stibnite with red and yellow encrustations, identified as "cetineite" and "cervantite," respectively. The specimen owner, Guanghua Liu, could not supply a specific locality, nor provide analytical data supporting the identifications. Rather than let this specimen slip away into oblivion, the senior author purchased it (see Fig. 1 of the previous article).

Initial X-ray powder diffraction of the red encrustation yielded a pattern generally consistent with cetineite. Cetineite is a rare antimony mineral originally described from the Cetine mine, Italy (Sabelli and Vezzalini, 1987) and not apparently recognized elsewhere (Anthony *et al.,* 1997). To check the internal consistency of the results, these diffraction data were indexed as cetineite, and the unit cell dimensions were refined. The unit cell dimensions, however, appeared significantly smaller than those reported for cetineite, but closely matched those of the synthetic Na analog of cetineite (Sabelli *et al.,* 1988). Based on the indication that the mineral might represent a natural equivalent of the Na analog of cetineite, further work began. In June 2006, however, a notice on the web site of the International Mineralogical Association listed new mineral IMA 2006-014 (Burke and Ferraris, 2006). The authors realized that the presently labeled "cetineite" material and the new mineral were indeed the same. In this issue, this mineral is described as the new species ottensite (Sejkora and Hyršl, 2007).

X-RAY STUDY

X-ray diffraction data were collected on a Philips X'Pert MDP diffractometer located in the Department of Chemistry, University of Arizona. The unit cell parameters were calculated using in-house software developed by the authors (TAL, RTD), using non-linear least squares regression. The ottensite unit cell dimensions found here were **a** = 14.1788(2) Å and **c** = 5.5736(2) Å. These data more closely approximate those of the sodium analog of cetineite (a = 14.152 Å, c = 5.5758 Å) rather than cetineite (a = 14.2513 Å, c = 5.5900 Å) (Sabelli *et al.,* 1988).

Certain peaks in the indexed X-ray powder diffraction data for ottensite did not fit the expected positions. Assuming an admixture of another mineral, another search matched $NaSb(OH)_6$. This natural phase has been previously described as the mineral mopungite (Williams, 1985).

OCCURRENCE

While visiting Guilin in April 2006, the senior author asked many dealers for information about the red encrustations on stibnite. One dealer indicated that perhaps five beer flats of material had been produced in 2004, and distributed. Sejkora and Hyršl (2007) give the type locality as the Qinglong district in Qinglong County, Guizhou. Liu (2006) cites more specifically the Dachang antimony mine in the Qinglong district (see Wu and Zhao, 1990) as the source for what he believed to be cetineite. The specimen examined in this study is among those sold by Liu as cetineite, and has subsequently proven to be ottensite. Therefore it seems possible that all of what had previously been identified as cetineite from China is actually ottensite.

PARAGENESIS

The sequence of deposition begins with the deposition of well-formed stibnite crystals, followed by encrustation by fluorite. Many such specimens, without further alteration of the stibnite, have appeared on the mineral market. There are attractive examples of this occurrence from another occurrence in Guizhou Province, specifically the Banpo mine, Dushan County (Ottens, 2005: Fig. 18).

In the case of the ottensite specimens from the Qianlong deposit, the stibnite crystals have been partially leached away, leaving hollow void space between the fluorite encrustation and the underlying stibnite. Ottensite develops subsequently, sometimes completely filling the void, but often forming in open space as spherical aggregates somewhat reminiscent of red caviar (see p. 78, Fig. 2). X-ray diffraction analysis confirms these botryoidal aggregates as ottensite. An unidentified amorphous antimony oxide stains the fluorite coatings yellow on some specimens (Fig. 1, p. 78). These yellow coatings have previously been labeled "cervantite," an identification which remains unconfirmed.

Mopungite, tetragonal $NaSb(OH)_6$, was originally described from

Nevada (Williams, 1985) and subsequently found with cetineite in Italy (Anthony *et al.*, 1997). This new material apparently represents a third world occurrence for mopungite, and the first occurrence of the mineral in China. The mopungite is not distinctly visible under the microscope and is apparently finely intermixed with the ottensite.

ACKNOWLEDGMENTS

We would like to thank Robert Dzwillo for many helpful discussions concerning Chinese mineral localities. We also thank Michael Scott for donating X-ray equipment to the University of Arizona, which enabled the characterization of the minerals involved, and Micharl Carducci for collecting the X-ray diffraction pattern. Many thanks to Tom Moore and Wendell Wilson for their help and interest in this work.

REFERENCES

ANTHONY, J. W., BIDEAUX, R. A., BLADH, K. W., and NICHOLS, M. C. (1997) *Handbook of Mineralogy.* Volume III. Mineral Data Publishing, Tucson, Arizona, 628 p.

BURKE, E. A. J, and FERRARIS, G. (2006) Minerals approved in June 2006. http://www.geo.vu.nl/~ima-cnmmn/minerals06-06.pdf

LIU, G. (2006) *Fine minerals of China.* Zug, Switzerland: AAA Minerals AG. 366 p.

OTTENS, B. (2005) Chinese fluorite. *Mineralogical Record*, **36**, 59–68.

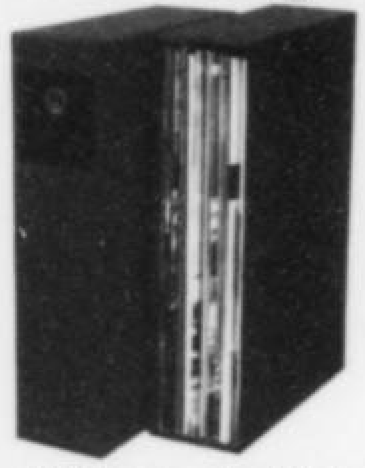
SABELLI, C., and VEZZALINI, G. (1987) Cetineite, a new antimony oxide-sulfide from Cetine mine, Tuscany, Italy. *Neues Jahrbuch für Mineralogie Monatshefte*, 419–425.

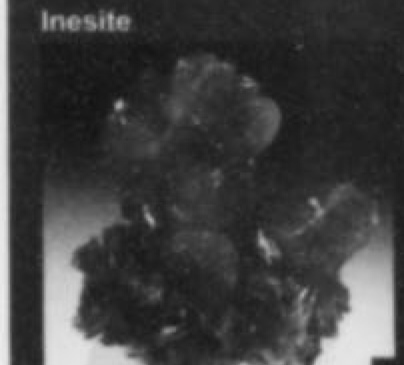
SABELLI, C., NAKAI, I., and KATSURA, S. (1988) Crystal structures of cetineite and its synthetic Na analogue $Na_{3.6}(Sb_2O_3)_3(SbS_3)(OH)_{0.6}\cdot 2.4H_2O$. *American Mineralogist*, **73**, 398–404.

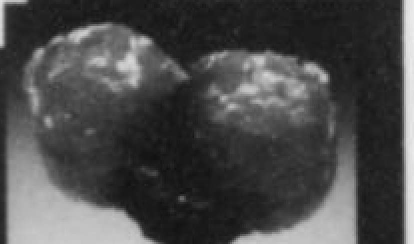
SEJKORA, J., and HYRŠL, J. (2007) Ottensite, a new mineral from Qianlong, Guizhou Province, China. *Mineralogical Record*, **38**, 77–81.

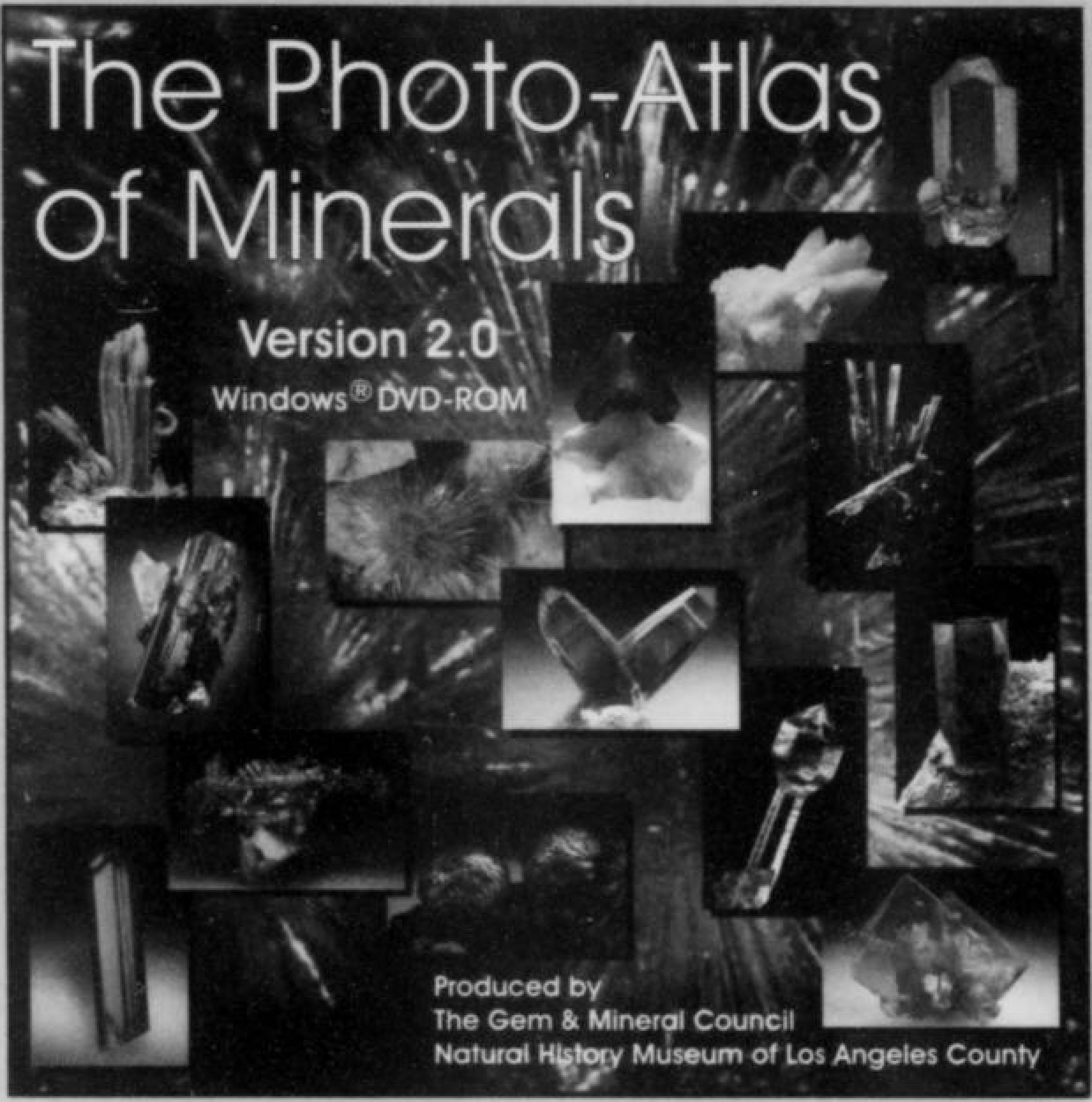
WILLIAMS, S. A. (1985) Mopungite, a new mineral from Nevada. *Mineralogical Record*, **16**, 73–74.

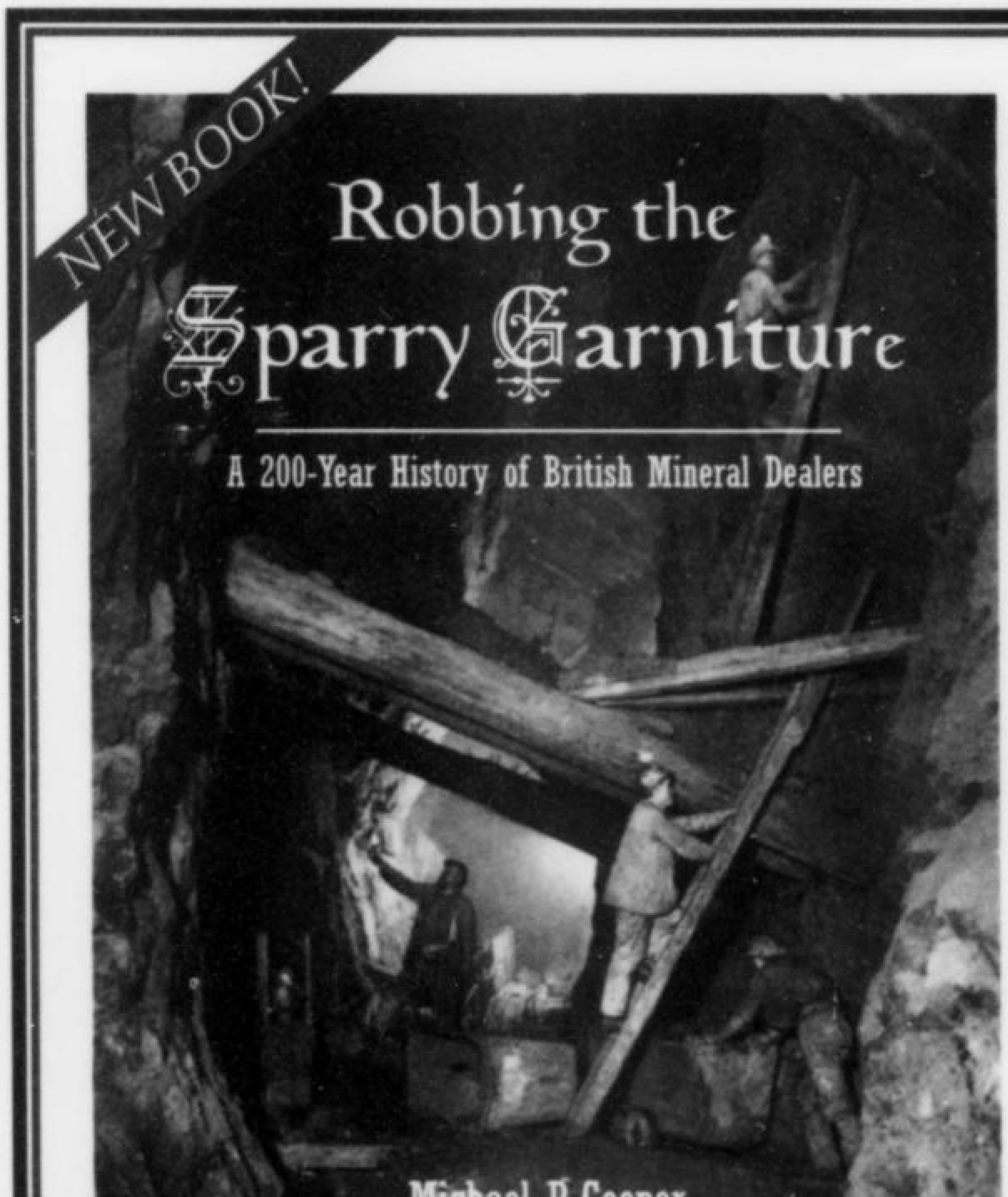
WU, J., XIAO, Q., and ZHAO, S. (1990) Antimony deposits of China. *In:* Liu, N. (editor), *The Mineral Deposits of China*. Volume 1. Geological Publishing House, Beijing, 265–269.

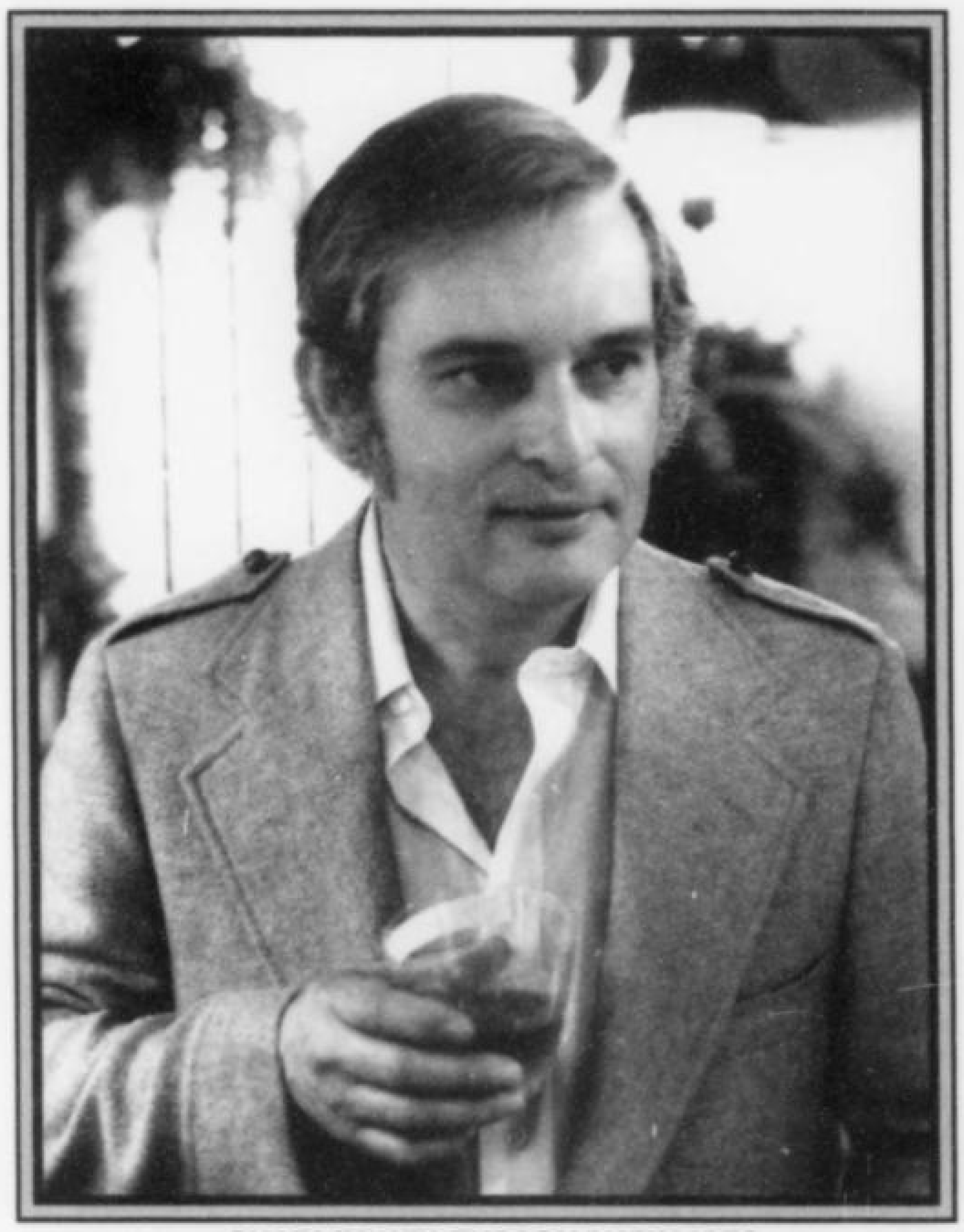




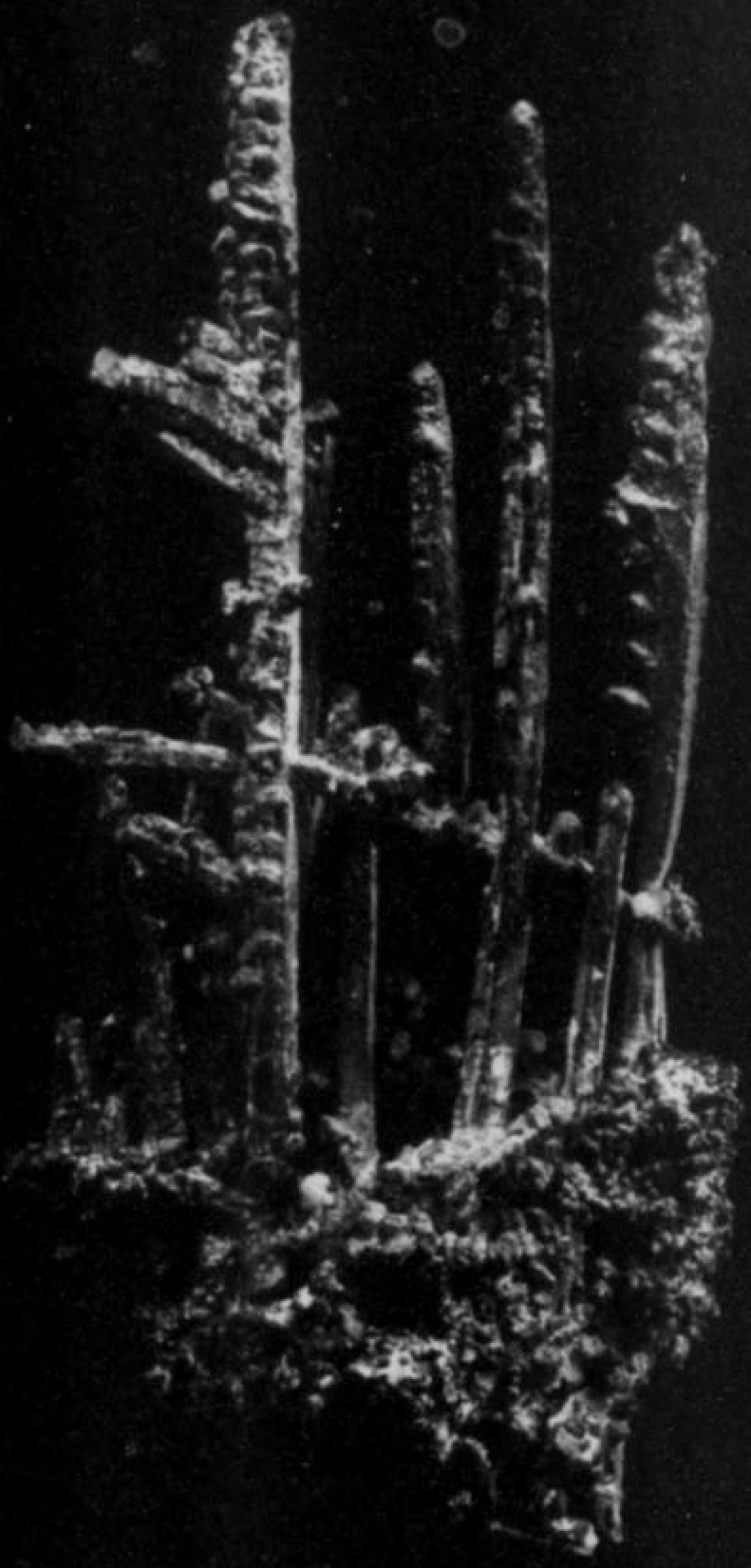



The Photo-Atlas of Minerals
Version 2.0
Windows® DVD-ROM
Produced by
The Gem & Mineral Council
Natural History Museum of Los Angeles County


NEW BOOK!
Robbing the Sparry Garniture
A 200-Year History of British Mineral Dealers
Michael P. Cooper



CHARLES KEY, TUCSON SHOW 1976



DAN WEINRICH

Dealer in Fine Mineral Specimens Open Every Day on the Internet!

www.danweinrich.com

See me at:
TUCSON SHOW
SPRINGFIELD SHOW
DENVER SHOW

Or see me in
ST. LOUIS
By Appointment

P. O. Box 425 • Grover, MO 63040 • Tel: 314-341-1811

Canadian Minerals,
Rare Minerals
International Sulfides,
Sulfosalts, Elements

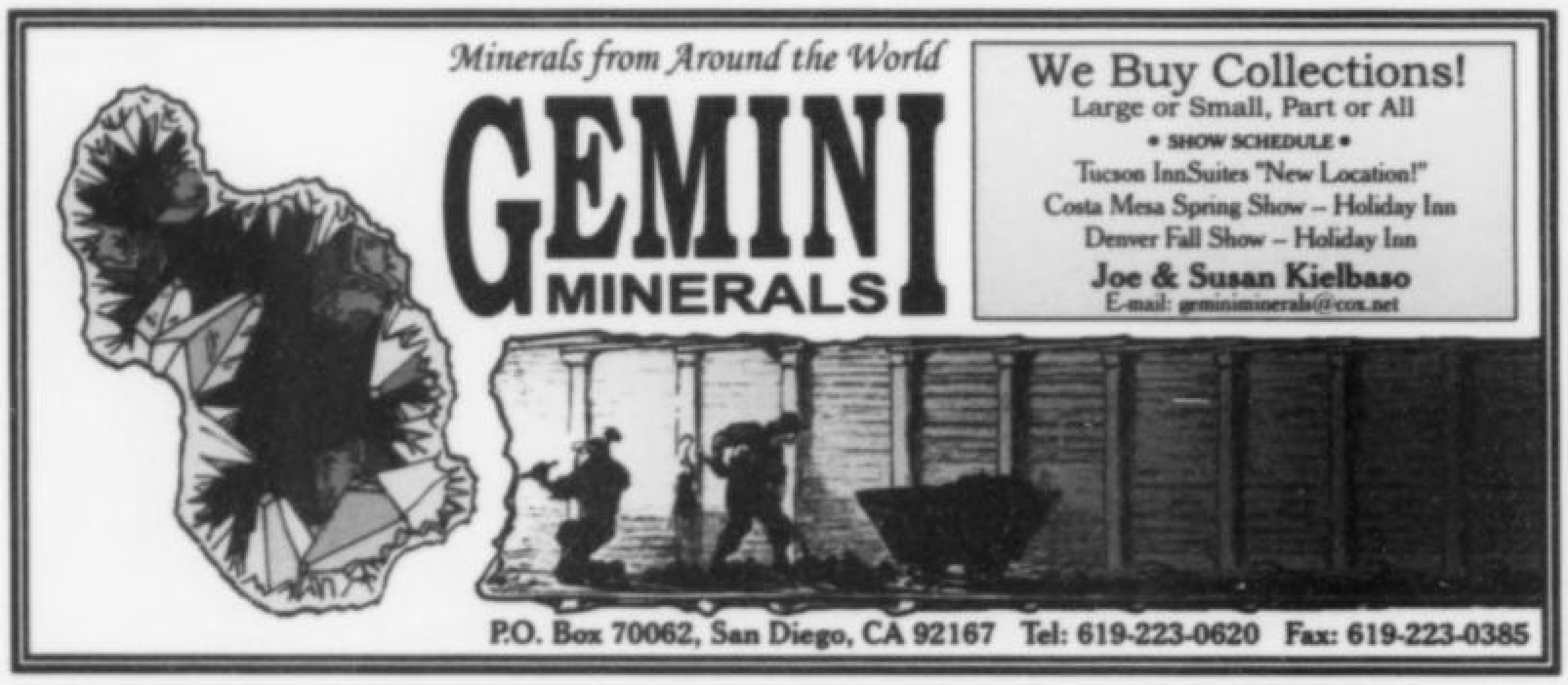
Visit our website for
beauriful, rare &
high-quality specimens
different from most dealers

David K. Joyce
www.davidkjoyceminerals.com
Box 95551, Newmarket, Ontario
Canada L3Y 8J8
Email: dkjoyce@bellnet,ca
Tel: 905-836-9073
Fax: 905-836-5283

RARE MINERALS since 1974!

Old classics, rare species, microprobed samples, meteorites and thin sections, plus a full line of microscopes, geiger counters, our comprehensive photo CD, UV lamps and old & new books. Request a specific catalog or view our well illustrated website at www.excaliburmineral.com. Analytical services offered.

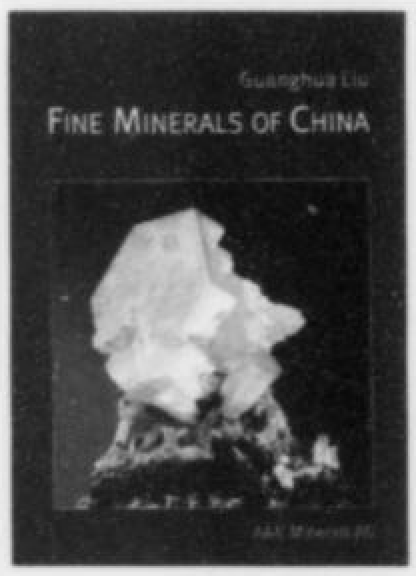
Excalibur Mineral Corporation
1000 N. Division St. • Peekskill, NY 10566 • Tel: (914) 739-1134 • Fax: (914) 739-1257
email: info@excaliburmineral.com



Minerals from Around the World
GEMINI MINERALS

We Buy Collections!
Large or Small, Part or All
• SHOW SCHEDULE •
Tucson InnSuites "New Location!"
Costa Mesa Spring Show – Holiday Inn
Denver Fall Show – Holiday Inn
Joe & Susan Kielbaso
E-mail: geminiminerals@cox.net

P.O. Box 70062, San Diego, CA 92167 Tel: 619-223-0620 Fax: 619-223-0385



$148
plus postage
from our
Bookstore

Guanghua Liu's
Fine Minerals of China!
Over 500 color specimen photos!
www.MineralogicalRecord.com

Advertisers

CALCITE, Fozichong Mine, Guangxi Zhuang A.R., China,
8.5 cm × 7 cm. Photo by Kevin Dixon