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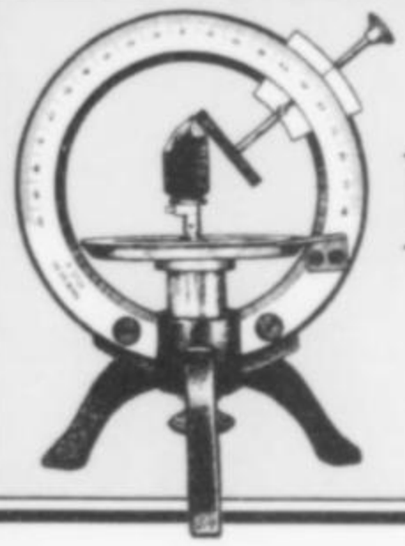

THE
MINERALOGICAL RECORD

January–February 1999 Volume Thirty, Number One

Articles

Columns

COVER: PHOSPHOPHYLLITE twin, 13 cm, on matrix with arsenopyrite crystals, from the Unificada mine, Cerro Rico de Potosí, Bolivia. Research Charitable Trust specimen; Harold and Erica Van Pelt photo.

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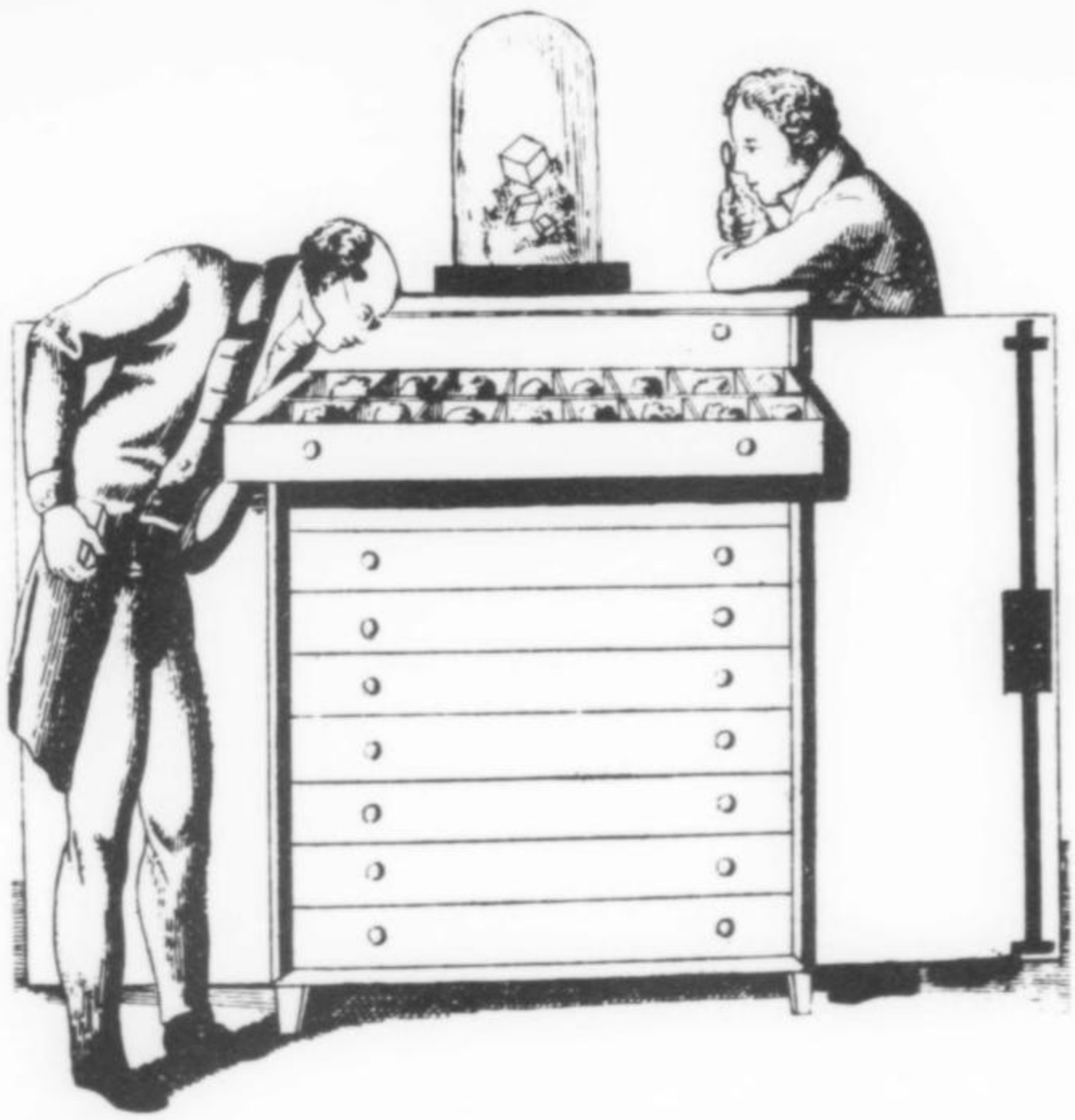

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Memorial:

Michael Fleischer 1908–1998

Joseph A. Mandarino
94 Moore Avenue
Toronto, Ontario M4T 1V3, Canada

Dr. Michael Fleischer died on 5 September 1998 and is survived by his wife, Helen; his sons, Walter and David; and Walter's wife and daughter, Candace and Ilona. Parts of this memorial repeat things I said at Mike's funeral service in Washington. I am indebted to Walter Fleischer for providing other material.

Mike was born on 27 February 1908, the son of Hungarian immigrants who had little formal education. Like many such parents, they recognized the desirability of education and sent their six children through university. Mike graduated *magna cum laude* from Yale and whenever this was brought up, he was quick to point out that his two older brothers had been *summa cum laude*. He subsequently received a Ph.D. degree in chemistry from Yale and although he was to spend most of his professional career in mineralogy he always said he was a chemist, and didn't know much about mineralogy. We should all aspire to not knowing as much as he did about mineralogy.

One of the bonuses of living in a rather tight ethnic community was that Mike met Helen, a beautiful part-Hungarian woman, whom he married in 1934. Mike's first job after receiving his Ph.D., was as a chemist in a toothpaste factory, during the Depression. This factory produced imitations of leading brands and put them in packages similar to those of the brand-name toothpastes. His task was to make the fake stuff taste like the real thing. He wasn't proud of his work and he left as soon as he could.

Fortunately, his next job was at the Carnegie Institution's Geophysical Laboratory in Washington. He commuted between work and the family's home in Connecticut for some time, but eventually the job became secure enough for his wife to join him in Washington. In 1939 he received a permanent position with the U.S. Geological Survey. He worked there for 40 years until he retired and then continued for an additional eight years on contract. He then moved to the Smithsonian Institution where he served as a research associate for several more years.

Mike received many honors but he never flaunted them. He was the recipient of the distinguished service medal of the U. S. Department of Interior and the Roebling medal of the Mineralogical Society of America (MSA). He served as president of the MSA and was a member or Fellow of several other scientific societies around the world. His expertise in matters mineralogical, geochemical and chemical, and his willingness to share it, gained him friends in many countries.

I met Mike Fleischer in 1961 when I visited Washington for the first time. He was the chief "tour guide" for scientists visiting the U.S. Geological Survey. At this meeting, he greeted me with "Oh, yes, you've done work on synthetic ruby." Imagine! Michael Fleischer had read my paper! That was quite flattering to this young mineralogist who quite naively thought that his Ph.D. thesis was the most important contribution of the previous decade.

Mike had been writing abstracts of new mineral descriptions for the *American Mineralogist* since 1941. In the mid-60's, he put out a call for help. I offered to abstract the descriptions which appeared in the *Canadian Mineralogist* and the *Mineralogical Magazine*. This was my first collaboration with Mike and I learned much from it. Over the years, we carried on a long correspondence. Any time I asked for information, this man, with his encyclopedic knowledge of mineralogy and his extensive files, willingly filled me in.

Mike served as the first Chairman of the Commission on New Minerals and Mineral Names of the International Mineralogical Association and, until he stepped down in 1974, he set the standard for new mineral proposals. He was succeeded by Dr. Akira Kato

Michael Fleischer (1908–1998)

who served until 1983 and by me who served from 1983 until 1995. Dr. Joel Grice is the present Chairman.

Mike compiled the first edition of the *Glossary of Mineral Species*, published by the Mineralogical Record in 1971. He was the sole author of this book for five editions. About ten years ago, Mike asked me to be his co-author for the "*Glossary*." The invitation to work with him on succeeding editions was an unexpected but welcome opportunity, which I accepted with pleasure.

Mike was a giant in the field of mineralogy, but a kindly and humble one. He gave freely of himself to young people. I remember a national mineralogical meeting where some three or four of us "rookies" were chatting with Mike. He suggested that we retire to a coffee shop where there would be less noise. Imagine the thrill we experienced—being invited to sit down and have coffee with this man! He listened to each of us, told numerous stories and made followers of us all.

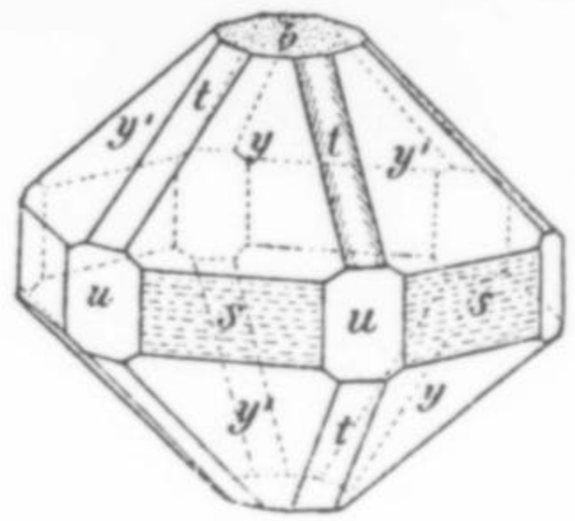
He was at ease with everyone and put them at ease also. My wife, Joan, reminded me of an incident when Mike and Helen were visiting us in Toronto. Our eldest child, then about seven, asked who these people were. My wife told him that Dr. Fleischer was the greatest mineralogist in the world (Mike would have disputed this, of course). Well, our son was very impressed and latched on to Mike as soon as he could. I remember looking at Mike and Jay from time to time as Joan and I talked with Helen. It was a toss-up whether Mike or Jay was having the better time.

When I heard of Mike's death, I sent e-mail messages to mineralogists throughout the world. The responses I received were most gratifying. One young mineralogist, a former student of mine, said that although he had never met Mike, he had profited from his generosity; Mike often translated Russian mineralogical papers into English and had made some of these available to him. Other appreciative messages were received from Dr. A. J. Naldrett, president of the International Mineralogical Association; the presidents of various national mineralogical societies; and people from all over the world who either knew him personally or professionally.

In their e-mail messages, Dr. A. L. Levinson in Calgary and Dr. E. H. Nickel in Australia summed up the way many of us felt about Mike. Both knew him very well and recalled his many kindnesses. Both ended their messages with the following comment: "This is the end of an era."

Indeed it is, but hopefully, Mike's influence on so many of us should extend that era a long time.

The next edition of the *Glossary of Mineral Species* is almost finished and will be released in February. It will bear a new name—*Fleischer's Glossary of Mineral Species*. This is as close as I can come to making this legendary man a bit more immortal.



The Zeolite Group

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The Zeolite group has been the subject of a major review by a subcommittee of the Commission on New Minerals and Mineral Names of the International Mineralogical Association. The subcommittee, headed by Dr. Douglas S. Coombs, has published its report in several journals. Presented here is a summary of that report.

INTRODUCTION

Zeolite minerals are defined as silicates having framework structures which contain open cavities in the form of channels and cages. These are usually occupied by H_2O molecules and so-called "extra-framework" cations which are commonly exchangeable. In many zeolites, not only do the extra-framework cations vary widely, but so also does the Al:Si ratio. This in turn changes the total extra-framework cation charge and commonly the number of extra-framework cations. The number of H_2O molecules is also variable; as the number of extra-framework cations increases, H_2O tends to decrease. The formulae given are therefore to be regarded as no more than simplified representative formulae. The crystallography varies greatly within the zeolite group; representatives exist within all crystallographic systems. The report establishes *series* which are comprised of two or more species based on the dominant extra-framework cation present. All members of a series have the same root name but are distinguished by a suffix consisting of a hyphen and the chemical symbol of the extra-framework cation. Note that this zeolite suffix differs from the Levinson-type suffix in that the latter consists of a hyphen followed by a chemical symbol (or symbols) enclosed in parentheses (i.e., brackets). Ideal chemical formulae are not given for individual species within series in the report, but I have given them here based on the general series formulae and the extra-framework cations.

I recommend that readers interested in more details about this group of minerals read the report by Coombs *et al.* (1997) *Canadian Mineralogist* **35**, 1571–1606 where detailed references are given for all of the species.

MEMBERS OF THE ZEOLITE GROUP

The following species (and series) are recognized. Note that two of the species, pahasapaite and weinebeneite, are beryllophosphates rather than silicates.

Amicite	$K_4Na_4[Al_8Si_8O_{32}]\cdot 10H_2O$, mon.
Ammonioleucite	$(NH_4)[AlSi_2O_6]$, tet.
Analcime	$Na[AlSi_2O_6]\cdot H_2O$, cub., tet., trig., orth., mon., and tric.
Barrerite	$Na_2[Al_2Si_7O_{18}]\cdot 6H_2O$, orth.
Bellbergite	$(K,Ba,Sr)_2Sr_2Ca_2(Ca,Na)_4[Al_{18}Si_{18}O_{72}]\cdot 30H_2O$, hex.
Bikitaite	$Li[AlSi_2O_6]\cdot H_2O$, mon. and tric.
Boggsite	$Ca_8Na_3[Al_{19}Si_{77}O_{192}]\cdot 70H_2O$, orth.
Brewsterite (series)	$(Sr,Ba)_2[Al_4Si_{12}O_{32}]\cdot 10H_2O$, mon.
Brewsterite-Sr	$(Sr,Ba)_2[Al_4Si_{12}O_{32}]\cdot 10H_2O$, mon.
Brewsterite-Ba	$(Ba,Sr)_2[Al_4Si_{12}O_{32}]\cdot 10H_2O$, mon.
Chabazite (series)	$(Ca_{0.5},Na,K)_4[Al_4Si_8O_{24}]\cdot 12H_2O$, trig. and tric.
Chabazite-Ca	$(Ca_{0.5},K,Na)_4[Al_4Si_8O_{24}]\cdot 12H_2O$, trig.
Chabazite-Na	$(Na,K,Ca_{0.5})_4[Al_4Si_8O_{24}]\cdot 12H_2O$, trig.
Chabazite-K	$(K,Na,Ca_{0.5})_4[Al_4Si_8O_{24}]\cdot 12H_2O$, trig.
Chiavennite	$CaMn[Be_2Si_5O_{13}(OH)_2]\cdot 2H_2O$, orth.
Clinoptilolite (series)	$(Na,K,Ca_{0.5},Sr_{0.5},Ba_{0.5},Mg_{0.5})_6[Al_6Si_{30}O_{72}]\cdot \sim 20H_2O$, mon.
Clinoptilolite-K	$(K,Na)_6[Al_6Si_{30}O_{72}]\cdot \sim 20H_2O$, mon.
Clinoptilolite-Na	$(Na,K,Ca_{0.5})_6[Al_6Si_{30}O_{72}]\cdot \sim 20H_2O$, mon.
Clinoptilolite-Ca	$(Ca_{0.5},Na,K)_6[Al_6Si_{30}O_{72}]\cdot \sim 20H_2O$, mon.
Cowlesite	$Ca[Al_2Si_3O_{10}]\cdot 5.3H_2O$, orth.

Dachiardite (series)	$(Ca_{0.5},Na,K)_{4-5}[Al_{4-5}Si_{20-19}O_{48}]\cdot\sim 13H_2O$, mon.
Dachiardite-Ca	$(Ca_{0.5},K,Na)_{4-5}[Al_{4-5}Si_{20-19}O_{48}]\cdot\sim 13H_2O$, mon.
Dachiardite-Na	$(Na,K,Ca_{0.5})_{4-5}[Al_{4-5}Si_{20-19}O_{48}]\cdot\sim 13H_2O$, mon.
Edingtonite	$Ba[Al_2Si_3O_{10}]\cdot 4H_2O$, orth. and tet.
Epistilbite	$(Ca,Na_2)[Al_2Si_4O_{12}]\cdot 4H_2O$, mon. and tric.
Erionite (series)	$(K,Na,Ca_{0.5})_{10}[Al_{10}Si_{26}O_{72}]\cdot\sim 30H_2O$, hex.
Erionite-Na	$(Na,K,Ca_{0.5})_{10}[Al_{10}Si_{26}O_{72}]\cdot\sim 30H_2O$, hex.
Erionite-K	$(K,Na,Ca_{0.5})_{10}[Al_{10}Si_{26}O_{72}]\cdot\sim 30H_2O$, hex.
Erionite-Ca	$(Ca_{0.5},K,Na)_{10}[Al_{10}Si_{26}O_{72}]\cdot\sim 30H_2O$, hex.
Faujasite (series)	$(Na,Ca_{0.5},Mg_{0.5},K)_{3-4}[Al_{3-4}Si_{9-8}O_{24}]\cdot 16H_2O$, cub.
Faujasite-Na	$(Na,Ca_{0.5},Mg_{0.5},K)_{3-4}[Al_{3-4}Si_{9-8}O_{24}]\cdot 16H_2O$, cub.
Faujasite-Ca	$(Ca_{0.5},Na,Mg_{0.5},K)_{3-4}[Al_{3-4}Si_{9-8}O_{24}]\cdot 16H_2O$, cub.
Faujasite-Mg	$(Mg_{0.5},Ca_{0.5},Na,K)_{3-4}[Al_{3-4}Si_{9-8}O_{24}]\cdot 16H_2O$, cub.
Ferrierite (series)	$(K,Na,Mg_{0.5},Ca_{0.5})_6[Al_6Si_{30}O_{72}]\cdot 18H_2O$, orth. and mon.
Ferrierite-Mg	$(Mg_{0.5},K,Na,Ca_{0.5})_6[Al_6Si_{30}O_{72}]\cdot 18H_2O$, orth.
Ferrierite-K	$(K,Na,Mg_{0.5},Ca_{0.5})_6[Al_6Si_{30}O_{72}]\cdot 18H_2O$, orth.
Ferrierite-Na	$(Na,K,Mg_{0.5},Ca_{0.5})_6[Al_6Si_{30}O_{72}]\cdot 18H_2O$, mon.
Garronite	$NaCa_{2.5}[Al_6Si_{10}]O_{32}\cdot 14H_2O$, tet. and orth.
Gaultite	$Na_4[Zn_2Si_7O_{18}]\cdot 5H_2O$, orth.
Gismondine	$Ca[Al_2Si_2O_8]\cdot 4.5H_2O$, mon.
Gmelinite (series)	$(Na,Ca_{0.5},K,Sr_{0.5})_8[Al_8Si_{16}O_{48}]\cdot 22H_2O$, hex.
Gmelinite-Na	$(Na,K,Ca_{0.5})_4[Al_8Si_{16}O_{48}]\cdot 22H_2O$, hex.
Gmelinite-Ca	$(Ca_{0.5},Sr_{0.5},Na,K)_4[Al_8Si_{16}O_{48}]\cdot 22H_2O$, hex.
Gmelinite-K	$(K,Ca_{0.5},Sr_{0.5},Na)_4[Al_8Si_{16}O_{48}]\cdot 22H_2O$, hex.
Gobbinsite	$Na_5[Al_5Si_{11}O_{32}]\cdot 12H_2O$, orth.
Gonnardite	$(Na,Ca)_{6-8}[(Al,Si)_{20}O_{40}]\cdot 12H_2O$, tet.
Goosecreekite	$Ca[Al_2Si_6O_{16}]\cdot 5H_2O$, mon.
Gottardiite	$Na_3Mg_3Ca_5[Al_{19}Si_{117}O_{272}]\cdot 93H_2O$, orth.
Harmotome	$(Ba_{0.5},Ca_{0.5},K,Na)_5[Al_5Si_{11}O_{32}]\cdot 12H_2O$, mon.
Heulandite (series)	$(Ca_{0.5},Sr_{0.5},Ba_{0.5},Mg_{0.5},Na,K,)_9[Al_9Si_{27}O_{72}]\cdot\sim 24H_2O$, mon.
Heulandite-Ca	$(Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot\sim 24H_2O$, mon.
Heulandite-Sr	$(Sr_{0.5},Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot\sim 24H_2O$, mon.
Heulandite-Na	$(Na,Ca_{0.5},K)_9[Al_9Si_{27}O_{72}]\cdot\sim 24H_2O$, mon.
Heulandite-K	$(K,Ca_{0.5},Na,Mg_{0.5},Sr_{0.5})_9[Al_9Si_{27}O_{72}]\cdot\sim 24H_2O$, mon.
Hsianghualite	$Li_2Ca_3[Be_3Si_3O_{12}]F_2$, cub.
Kalborsite	$K_6[Al_4Si_6O_{20}]B(OH)_4Cl$, tet.
Laumontite	$Ca_4[Al_8Si_{16}O_{48}]\cdot 18H_2O$, mon.
Leucite	K[AlSi$_2$O6], tet.
Levyne (series)	$(Ca_{0.5},Na,K)_6[Al_6Si_{12}O_{36}]\cdot\sim 17H_2O$, trig.
Levyne-Ca	$(Ca_{0.5},Na,K)_6[Al_6Si_{12}O_{36}]\cdot\sim 17H_2O$, trig.
Levyne-Na	$(Na,Ca_{0.5},K)_6[Al_6Si_{12}O_{36}]\cdot\sim 17H_2O$, trig.
Lovdarite	$K_4Na_{12}[Be_8Si_{28}O_{72}]\cdot 18H_2O$, orth.
Maricopaite	$(Pb_7Ca_2)[Al_{12}Si_{36}(O,OH)_{100}]\cdot n(H_2O,OH)$ n ~ 32, orth.
Mazzite	$(Mg_{2.5}K_2Ca_{1.5})[Al_{10}Si_{26}O_{72}]\cdot 30H_2O$, hex.
Merlinoite	$K_5Ca_2[Al_9Si_{23}O_{64}]\cdot 22H_2O$, orth.
Mesolite	$Na_{16}Ca_{16}[Al_{48}Si_{72}O_{240}]\cdot 64H_2O$, orth.
Montesommaite	$K_9[Al_9Si_{23}O_{64}]\cdot 10H_2O$, orth.
Mordenite	$(Na_2,Ca,K_2)_4[Al_8Si_{40}O_{96}]\cdot 28H_2O$, orth.
Mutinaite	$Na_3Ca_4[Al_{11}Si_{85}O_{192}]\cdot 60H_2O$, orth.
Natrolite	$Na_2[Al_2Si_3O_{10}]\cdot 2H_2O$, orth.
Offretite	$CaKMg[Al_5Si_{13}O_{36}]\cdot 16H_2O$, hex.
Pahasapaite	$(Ca_{5.5}Li_{3.6}K_{1.2}Na_{0.2}\square_{13.5})Li_8[Be_{24}P_{24}O_{96}]\cdot 38H_2O$, cub.
Parthéite	$Ca_2[Al_4Si_4O_{15}(OH)_2]\cdot 4H_2O$, mon.
Paulingite (series)	$(K,Ca_{0.5},Na,Ba_{0.5})_{10}[Al_{10}Si_{32}O_{84}]\cdot 27–44H_2O$, cub.
Paulingite-K	$(K,Ca_{0.5},Na)_{10}[Al_{10}Si_{32}O_{84}]\cdot 27–44H_2O$, cub.
Paulingite-Ca	$(Ca_{0.5},K,Na)_{10}[Al_{10}Si_{32}O_{84}]\cdot 27–44H_2O$, cub.
Perlialite	$K_9Na(Ca,Sr)[Al_{12}Si_{24}O_{72}]\cdot 15H_2O$, hex.
Phillipsite (series)	$(K,Na,Ca_{0.5},Ba_{0.5})_{4-7}[Al_{4-7}Si_{12-9}O_{32}]\cdot 12H_2O$, mon.
Phillipsite-Na	$(Na,K,Ca_{0.5},Ba_{0.5})_{4-7}[Al_{4-7}Si_{12-9}O_{32}]\cdot 12H_2O$, mon.
Phillipsite-K	$(K,Na,Ca_{0.5},Ba_{0.5})_{4-7}[Al_{4-7}Si_{12-9}O_{32}]\cdot 12H_2O$, mon.
Phillipsite-Ca	$(Ca_{0.5},K,Na,Ba_{0.5})_{4-7}[Al_{4-7}Si_{12-9}O_{32}]\cdot 12H_2O$, mon.
Pollucite	$(Cs,Na)[AlSi_2O_6]\cdot nH_2O$, where (Cs + n) = 1, cub.
Roggianite	$Ca_2[Be(OH)_2Al_2Si_4O_{13}]<2.5H_2O$, tet.
Scolecite	$Ca[Al_2Si_3O_{10}]\cdot 3H_2O$, mon.
Stellerite	$Ca[Al_2Si_7O_{18}]\cdot 7H_2O$, orth.
Stilbite (series)	$(Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot 28H_2O$, mon.
Stilbite-Ca	$(Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot 28H_2O$, mon.
Stilbite-Na	$(Na,Ca_{0.5},K)_9[Al_9Si_{27}O_{72}]\cdot 28H_2O$, mon.
Terranovaite	$NaCa[Al_3Si_{17}O_{40}]\cdot >7H_2O$, orth.
Thomsonite	$Ca_2Na[Al_5Si_5O_{20}]\cdot 6H_20$, orth.
Tschernichite	$Ca[Al_2Si_6O_{16}]\cdot\sim 8H_2O$, tet.
Tschörtnerite	$Ca_4(K_2,Ca,Sr,Ba)_3Cu_3(OH)_8[Al_{12}Si_{12}O_{48}]\cdot nH_2O$, n ~ 20, cub.
Wairakite	$Ca[Al_2Si_4O_{12}]\cdot 2H_2O$, mon. and tet.
Weinebeneite	$Ca[Be_3(PO_4)_2(OH)_2]\cdot 4H_2O$, mon.
Willhendersonite	$K_{0-1}Ca_{1.5-1.0}[Al_3Si_3O_{12}]\cdot 5H_2O$, tric.
Yugawaralite	$Ca[Al_2Si_6O_{16}]\cdot 4H_2O$, mon. and tric.

Tvedalite may be structurally related to **Chiavennite**, but a structural study is required. **Paranatrolite** is considered a doubtful species and requires further study. Herschelite, leonhardite, svetlozarite, tetranatrolite, and wellsite are officially discredited.

ACKNOWLEDGMENTS

This article is the result of many discussions which Dr. Douglas S. Coombs and I had (via e-mail) about basic principles pertaining to the Zeolite group. In addition, Dr. Coombs graciously read earlier versions of this paper and corrected many errors and offered several important suggestions which greatly improved the final paper. Most of the foregoing material plus new entries for each of the species will appear in the *Glossary of Mineral Species 1999*.

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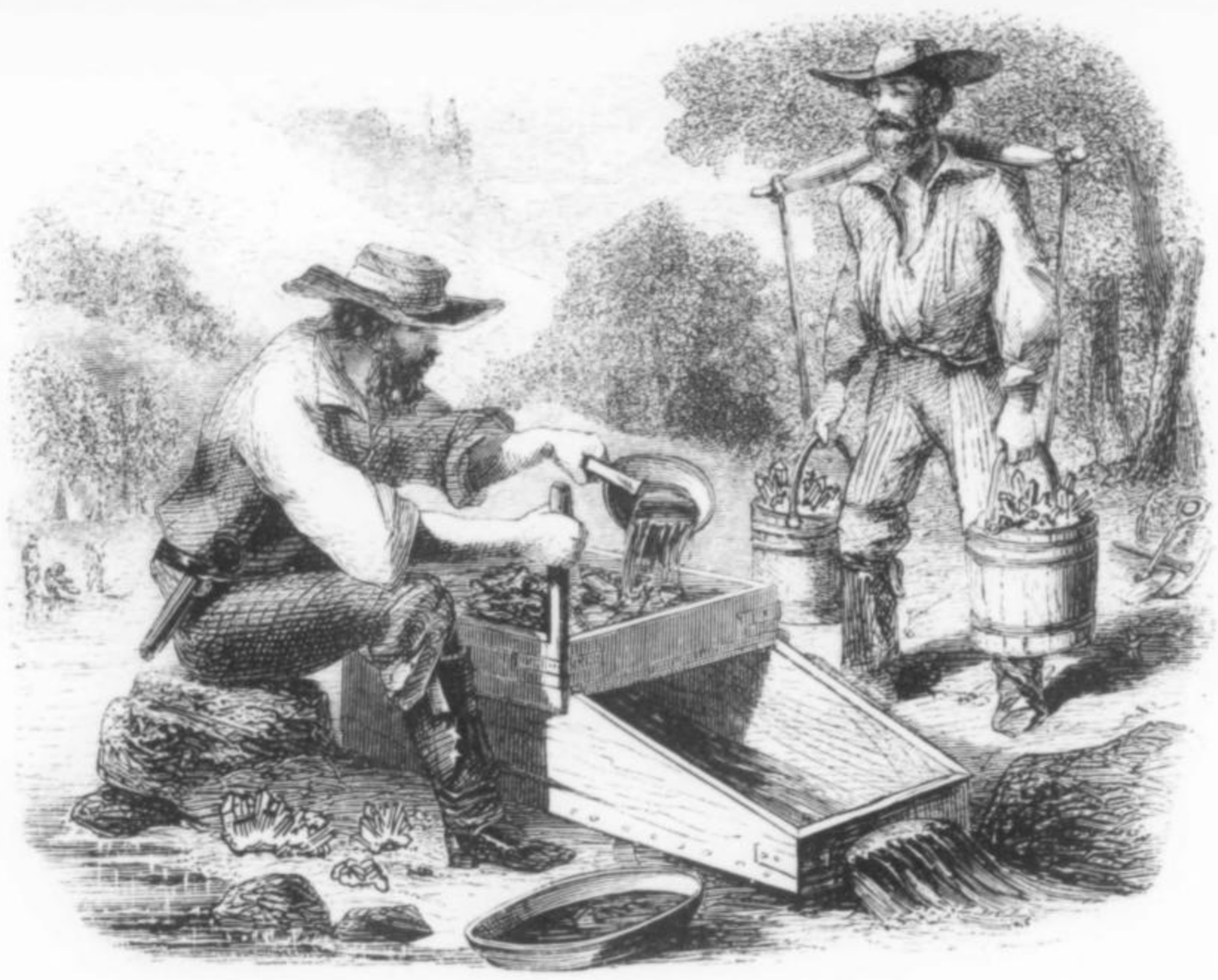

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famous mineral localities:

Cerro Rico de Potosí Bolivia

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Tucson, Arizona 85750

Alfredo Petrov
Casilla 1728
Cochabamba, Bolivia

Cerro Rico ("Rich Mountain") de Potosí is among the oldest and most famous orebodies in South America, has yielded billions of dollars in silver, is the type locality for two tin sulfides—berndtite *and* ottemannite—*and has produced the world's finest specimens of phosphophyllite.*

"I am rich Potosí, the treasure of the world and the envy of kings."

Motto bestowed by
Charles V of Spain

INTRODUCTION

Charles V of Spain was the fortunate ruler in charge when Cortez conquered Mexico (1519–1521) and Pizarro conquered Peru and what is now Bolivia (1531–1535). Tons of silver began to pour from mines in the New World, and for a time Potosí was the world's leading producer. Oddly enough, despite its enormous output of silver, Potosí is famous among mineral collectors for a small occurrence of a rare zinc-iron-manganese phosphate, phosphophyllite, discovered there in the 1950's.

Mineral specimens considered to be from Cerro Rico de Potosí (except perhaps phosphophyllite) must bear documentation specifically for "Cerro Rico" and not just "Potosí." Although the town of Potosí is indeed at the foot of Cerro Rico, the *department* in which it is situated is *also* named "Potosí." Consequently confusion is possible with the other important localities in the department, which include Colquechaca and Llallagua, not to mention other less notable occurrences such as Chocaya, Chulchucani, Carguaicollo, Cerro Tazna, Cerro Malmisa, Huayna, Machacamarca, Maragua, Ocuri, Porco, Pulacayo, San Vincente and Uncia (all of which, incidentally, are represented by specimens in the Smithsonian collection).

Figure 1. **View of the "Mountain of Potosí" from an early engraving.**

Figure 2. **The image of Cerro Rico has become a national icon in Bolivia, even appearing on coins such as the gold 8-escudo piece (above) and the 5-centavo postage stamp.**

HISTORY

Discovery by the Incas

According to legend, the silver deposits at Potosí were first discovered by the Inca King Huaina Ccapac in 1462, while traveling from Cantumarca to Colque-Porco. He is said to have admired the grandeur and beauty of the mountain, remarking to his vassals that within its bowels there must, no doubt, be much silver. Subsequently a well-equipped mining expedition was dispatched to the site, but after ascending the mountain and being on the point of commencing work, the miners heard thunderous noises which seemed to be warning them away. They returned immediately to their king, referring to the mountain as *Potocsi*, which in the Quechua language means "thunder" or "place of great noises" (Wendt, 1891). This is not an unlikely story, considering that strong thunderstorms are commonly seen playing around the summit. Bancroft (1984), however, maintains that the name derives from the Quechua word *potojchi*, meaning "fountain of silver" . . . certainly a more romantic interpretation.

Discovery by the Spanish

Following the Spanish conquest, a Quechua Indian by the name of Diego Guallca is said to have rediscovered the deposits in 1545. Guallca was a native of Chunvivillca, a town near Cuzco, and had become a servant of the Spanish captain Juan de Villarroel, who was involved in mining at Porco about 75 km away. He had been chasing some lost llamas up the side of the mountain but was forced to make camp there at nightfall. Because of the cold he built a campfire; in the morning he was surprised to see that the rock beneath it had melted, and a small rivulet of molten silver had formed. He quickly returned to Porco and told captain Villarroel of his discovery, who registered claims in April of 1545.

In December Juan de Villarroel traveled to Potosí with Diego Centeno, Pedro Cotamito and a man named Santandia, and they began mining the rich surface ores. Production continued through 1572, yielding native silver and chlorargyrite ore containing 25% silver. The soft ore was melted in small furnaces called *guairachinas*, using litharge as a flux. No air needed to be forced through the furnaces; they were simply constructed with their mouths facing the prevailing wind. A local friar, Joseph de Acosta, estimated that a quarter of a billion dollars in silver was removed between 1545 and 1572. Spanish government records show that duty was paid on roughly a billion dollars in silver from 1556 to 1791, although far less silver was reported as being dutiable than was actually mined.

Zarate's Description

Agustin de Zarate was sent from Spain to Peru in 1543 as Comptroller-General ("Auditor") by Charles V (Kuhner, 1980). He wrote a book about the country, which was first published in Europe in 1555; an English translation of 1581 is entitled: *The strange and delectable History of the discoverie and Conquest of the Provinces of Peru, in the South Sea, And of the notable things which there are found; and also of the bloudie civil warres which there happened for government . . . And also of the ritche Mines of Potosi*. A copy exists in the Herbert Hoover collection, now a part of the Sprague Library at Claremont College in Claremont, California. Because this is such an extremely rare work, and the entry regarding Potosí is short, it is quoted here in full. Some spellings have been updated to make it more easily understood but no words have been omitted or otherwise much altered.

The Discovery of the Rich Mines of Potosí, & how Captain Caravajall took it into his Power

Fortune having showed herself so amiable to Captain *Caravajall*, it appears now that she has brought him to the top of the Hill of Prosperity. It happened that after certain days, that the Indians and Anaconas of *Juan de villa Roell*, citizen of the town of Plata [= "silver"], went traveling in the country; about 18 leagues distant from the said town, they chanced to come to a high hill, situated in a plain, in the which, they found manifest tokens of silver, whereupon they began to melt out a vein which seemed rich.

The riches was so great which here they found, that almost in every vein where they made their assay, they found the greatest part of ore to be fine silver, and the basest mines were by valuation 480 ducats in every hundredweight of ore, which is the greatest riches that ever has been seen or written of. When the Justice of the town of Plata had understanding of this fortunate success, the ruler of the said town came and divided the said mines among the townsmen, and each of them made his choice according to his lot.

The Indians and Anaconas which came thither to work were many in number, in such sort that in a short time they built at the foot of the said hill a town to dwell in, which multiplied in such wise, that there inhabited of Indian workmen above 7,000 persons, which did so well understand that business, that they came to agreement with their masters to allow unto them a weekly pension: but their gain was twice so much as they paid unto their masters.

The veins of these mine are of such quality that the ore will not melt with the winds of bellows, as in other mines are accustomed: but their melting is in certain little furnaces called *Guayras*, wherein they use to melt with coals and sheep's dung, with only the force of the air, without any other instrument. These mines are called *Potosi*, by reason that all the borders thereabouts are so called.

These Indian workmen are rich, for he that hath but four or five thousand *poyzes* [of silver] is counted but poor: notwithstanding the great pension or tribute which they pay unto their masters, and all such workmen which come thither to work will not willingly depart from thence, by reason that their pains and peril is not comparable to other mines, by blowing of the bellows, with the great smoke of the coals: and likewise the sulfur of the veins of ore.

When the repartitioning[?] of these mines were made, they began to provide all sorts of necessary victuals for the workmen, which daily came to serve in those works, whereby victuals grew to such a dearth that the bushell of maize came to be worth twenty castlins of gold, and a bushell of wheat as much; and a sack of the herbs called *Coca*, was worth 30 poyzes, yea, and afterward it came to be dearer: yet though the great treasure which there was found, all the other mines were left uninhabited, and especially the mines of *Porco*, where *Hernando Pisarro* had a great portion of ground, out of the which he gathered great riches.

The miners also which gathered gold in *Cambaya*, and other rivers, left there works and came to *Potosi*, because they found there greater profit without comparison. They which understand in these works, hold opinion that by manifest tokens these mines are of perpetuity.

With this good success, Captain *Caravajall* began to gather great sums of treasure, in such sort that he took possession of all the [property of the] Indians and Anaconas, of such Spaniards as were slain or fled, or had been against him in his former war: so that in a short time he obtained into his power the sum of seven hundred thousand poyzes, and would not thereof aid his soldiers with anything, who had followed him in all his wars: whereupon they began to murmur among themselves, and were minded to kill him.

The chiefs of this mutiny, were Luis Pardomo, Alonso de Camargo, Diego de Balmazeda, and Diego de Luxan: there were near 30 persons, which determined to execute the said pretense within one month after Caravajell was come to the town of Plata: But through a mischance which happened, they deferred the matter til another day. This practice was not so secretly wrought, but that Caravajall came to knowledge thereof, whereupon he commanded Luis Pardomo, Camargo, Orbaneja, Balmazeda and another 10 or 12 persons of the principallest to be quartered, and others banished: so that with the execution of such cruel justices, in causes of mutinies, the people were so afraid that they never dared at any time after to deal in the like practices.

FINIS

By 1572 the surface ores had been exhausted and production temporarily declined. The Spanish government sent a new viceroy, named Toledo, to Potosí in order to restore production. He and Don Pedro Fernandez de Velasco introduced the "patio" process in 1574, which had been invented only 17 years earlier by Bartolome Medina at Pachuca, Mexico. The process involves the cold amalgamation of ore with mercury in large open troughs stirred by slave labor. (In 1793 mules and horses were first used in the process, saving 75% in labor cost, as well as the lives of many enslaved Indians who would have continued to die of mercury poisoning.) The mercury was available in ample quantities from the Peruvian mines at Huancavelica.

ARTE

DE LOS METALES

EN QVE SE ENSEÑA EL

verdadero beneficio de los de oro, y plata por açogue.

EL MODO DE FVNDIR LOS TODOS, y como se han de refinar, y apartar vnos de otros.

COMPVESTO POR EL LICENCIADO Albaro Alonso Barba, natural de la villa de Lepe, en la Andaluzia, Cura en la Imperial de Potosí, de la Parroquia de S. Bernardo.

CON PRIVILEGIO.

En Madrid. En la Imprenta del Reyno.

Año M. DC. XXXX.

Figure 3. **Title page of Barba's 1640 treatise on silver ore processing at Potosí, now an extreme rarity. Claremont College Library, Herbert Hoover collection.**

Barba's Work

In 1588 another Spaniard was sent to Peru, a priest by the name of Alvaro Alonso Barba. He further developed the amalgamation process which proved so important to ore processing at Potosí. He presented to the Spanish government a detailed report on mining technology as it had evolved at Potosí in 1637. This landmark work was first published in Spain in 1640, under the title *El Arte de los Metales* ("The Art of Metallurgy"). It is the first significant treatise on metals to be written in Spanish. Unfortunately, the book was banned and burned by the Spanish Inquisition, and only four copies seem to have survived: three owned by the British Museum and one in the Herbert Hoover collection at Claremont College, Claremont, California. It was reprinted in 1675 and 1729. The Spanish government wished to keep the work proprietary (an early "industrial secret"). But Edward Montagu, the Earl of Sandwich and the British Ambassador Extraordinary to Spain, obtained a copy and published a poor translation of the first two of the five major chapters in 1669. German translations and reprints subsequently appeared in 1676, 1696, 1726, 1739, 1749 and 1767. French editions were published in 1730, 1751 and 1752. Three Spanish-language editions published in South America are said to contain many errors. Finally, in 1923, an excellent English translation was published by Ross E. Douglass and E. P. Mathewson.

Decline of the District

In 1599 the mine operators began to complain that rich ore of easy access was becoming scarce, and profits were poor. In 1618 they complained again to the King of Spain, begging for a reduction in duties because the ore was running only 52 ounces of silver per ton.

In order to make the stamping and amalgamating works more efficient, large water reservoirs were constructed in 1621 to supply waterpower and water for processing. These reservoirs continued in use for nearly three centuries, although in a progressively worse state of decay and disrepair. On March 3, 1626, one of the reservoir dams gave way, and the resulting flash flood destroyed nearly all of the 136 individual ore-reduction facilities, a loss estimated at over $10,000,000. With the help of a Spanish government loan, most of these had been rebuilt by 1633. Ore was still coming primarily from surface workings, yielding about 50 ounces of silver per ton.

Again in 1636 the mine operators complained of meager profits. Only about 1500 Indian slaves were actively engaged in mining, although 70,000 Indians were in residence at Potosí. Disputes between mine operators over the possession of various complex ore veins at depth had been resulting in lawsuit expenses exceeding $200,000 per year. Losers in these disputes had been known to sabotage the mines before vacating them, some veins having been yielding ore containing 150 ounces of silver per ton at the time.

In 1690 a miner named Ouiroga is on record as having paid $21,000,000 in duty to the crown, then set at 20%. Therefore he had removed over $100,000,000 in silver from his one mine, the Cotamitos mine. With some of the profits he built the Cathedral of San Francisco in Potosí, and was eventually buried there.

By 1693 production was beginning to dwindle, and in 1712 an epidemic killed many of the Indian miners. To assist the mine operators, the Spanish government reduced the required duty from 20% to 10%. Difficulties nevertheless gradually worsened. Finally, in 1759, the Miners' Corporation prepared for the King a detailed report on the district. According to this report, the silver veins vary in width from paper-thin to several meters. Workings had reached a depth of several hundred meters, and the deepest mines were suffering from a high water flow combined with bad ventilation. The adits, shafts, veins and orebodies formed a complex labyrinth which was not understood by anyone. In the upper 300 meters of the 900-meter mountain there was said to be no veins which had not been worked out. Mine accidents were also reported: in the Mendieta vein, for example, a cave-in had killed 300 Indians and two Spaniards in a rich zone which had never been reopened. The miners found themselves unable to accurately follow veins at depth, even though these often led to some of the richest pockets. It is reported that in the lowest workings they had recently stumbled upon metal "like fringes of solid white silver, without any tarnish, and some of the finest kind of sulfides."

Following extensive surveys, it was recommended that a 3000-meter-long adit be driven at depth to intersect the lower reaches of the vein system and to ventilate and drain the entire mountain. However, since total output had already fallen to less than $2,500,000, the Spanish government delayed the project for many years. From 1778 to 1790 roughly a third of the planned adit was driven. Nevertheless, the Governor of Potosí described the mines in 1794 as being in bad condition, all shafts having filled with water

Figure 4. **Entrance to *La Moneda*, the old Potosí mint. Terry Szenics photo.**

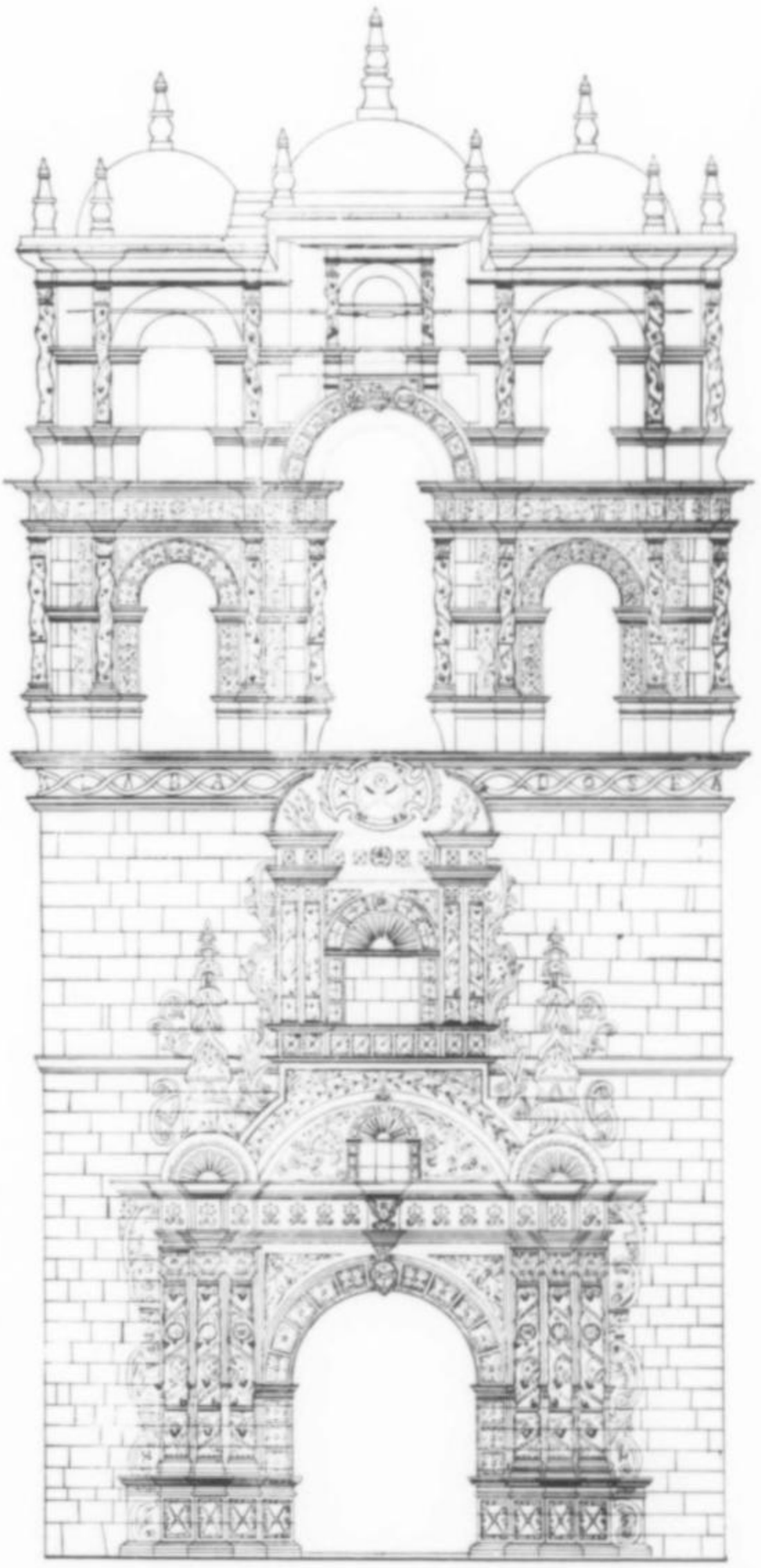


***Figure 5.* Church tower of the Compañia de Jesus, constructed in Potosí in 1581 and remodeled in 1707.**

up to a depth of 80 meters. By 1799 only 35 ore-reduction facilities were still in operation.

In 1809 the War of Independence broke out and Potosí suffered repeatedly in the cross-fire, putting a temporary end to all mining activities.

Attempts at Revival

In 1825 an English company shipped a large quantity of machinery intended for use in reopening and dewatering the Potosí mines, but the financial panic of the following year caused the machinery to be abandoned on the coast, and it never reached Potosí.

In 1886, Arthur Wendt was sent to Potosí by an American mining company intending to reopen the mines. After three years of work and half a million dollars in expenses he succeeded in pumping out and reopening the Cotamitos vein, where he was rewarded by finding ore averaging 70 ounces of silver per ton.

Tin mining began in Cerro Rico in the late 19th century as the exploitation of silver was declining. The colonial Spanish knew about the tin, of course, but had little use for it. The Spanish had, however, produced small quantities of tin for such purposes as local manufacture of liquor stills. Tin mining received a welcome boost from the high demand in WWI. But production methods remained haphazard until several mines were unified with the Pailaviri to form the Unificada, permitting the introduction of rational techniques. By the 1930's silver production had ceased completely, and it was often stated that the silver minerals had been totally worked out. During WWII, tin production enjoyed another surge, due in part to the demand for canned food for U.S. servicemen.

During the early 20th century the "tin baron" in possession of the Unificada (Pailaviri) mine was one Moritz (Mauricio) Hochschild, black sheep of a German-Jewish family. Hochschild had been sent off to South America to make his fortune, and proved quite successful. When he was finally expelled from Bolivia in 1952, he offered the German mineralogists in Bolivia (Ahlfeld, Herzenberg and Berndt) new jobs at his mines in Peru. However, the three felt an attachment to Bolivia's mines and minerals, and elected to take their chances with the new Revolutionary Government. The Hochschild Group today still owns important mines in Peru.

In the mid-20th century Bolivia was still a feudal society, with the "tin baron" billionaires controlling the political system while the majority of the population, the Indians, lived as illiterate serfs. This unstable social system died with the revolution and land

Figure 6. **Early photo of the town square (Plaza Pinchincha) at Potosí, with statue of Simón Bolivar in the foreground and Cerro Rico in the background. Note the brand-new Model-T ford which has drawn a crowd.**

reform of 1952, which also nationalized the largest mines (including the Pailaviri/Unificada on Cerro Rico) under the grossly inefficient bureaucracy of COMIBOL (Corporación Minería de Bolivia), the State mining corporation. The many small and medium-sized mines on Cerro Rico remained in private hands.

With the government's financial inability to continue subsidizing COMIBOL's losses from corruption and inefficiency, and the worldwide pressure in the 1980's for privatization of state-owned industries, the Bolivian government gave up most of its mines, including the Unificada. The present situation at Cerro Rico is that the Unificada, the largest mine, is operated as a joint venture, while several small to medium-size mines are operated by either private companies or miner-owned cooperatives. In total, a few thousand miners still work in Cerro Rico, with the number fluctuating according to world metal prices.

A surprising development in the early 1990's was the discovery of a rich new vein of massive pyrargyrite-miargyrite which was named the *Veta Potosí* (Potosí Vein). It was discovered by a cooperative about 50 meters above the Zero Level, on the southeast side of the mountain; on working it downwards it was found to cut the busy main haulageway (zero level) of the Pailaviri mine, a couple of kilometers from the entrance on the north side of the mountain, where it had apparently not been noticed. One retired COMIBOL geologist says the vein was in fact known to Pailaviri

Figure 7. **Plaza 10 de Noviembre in Potosí. Terry Szenics photo, 1984.**

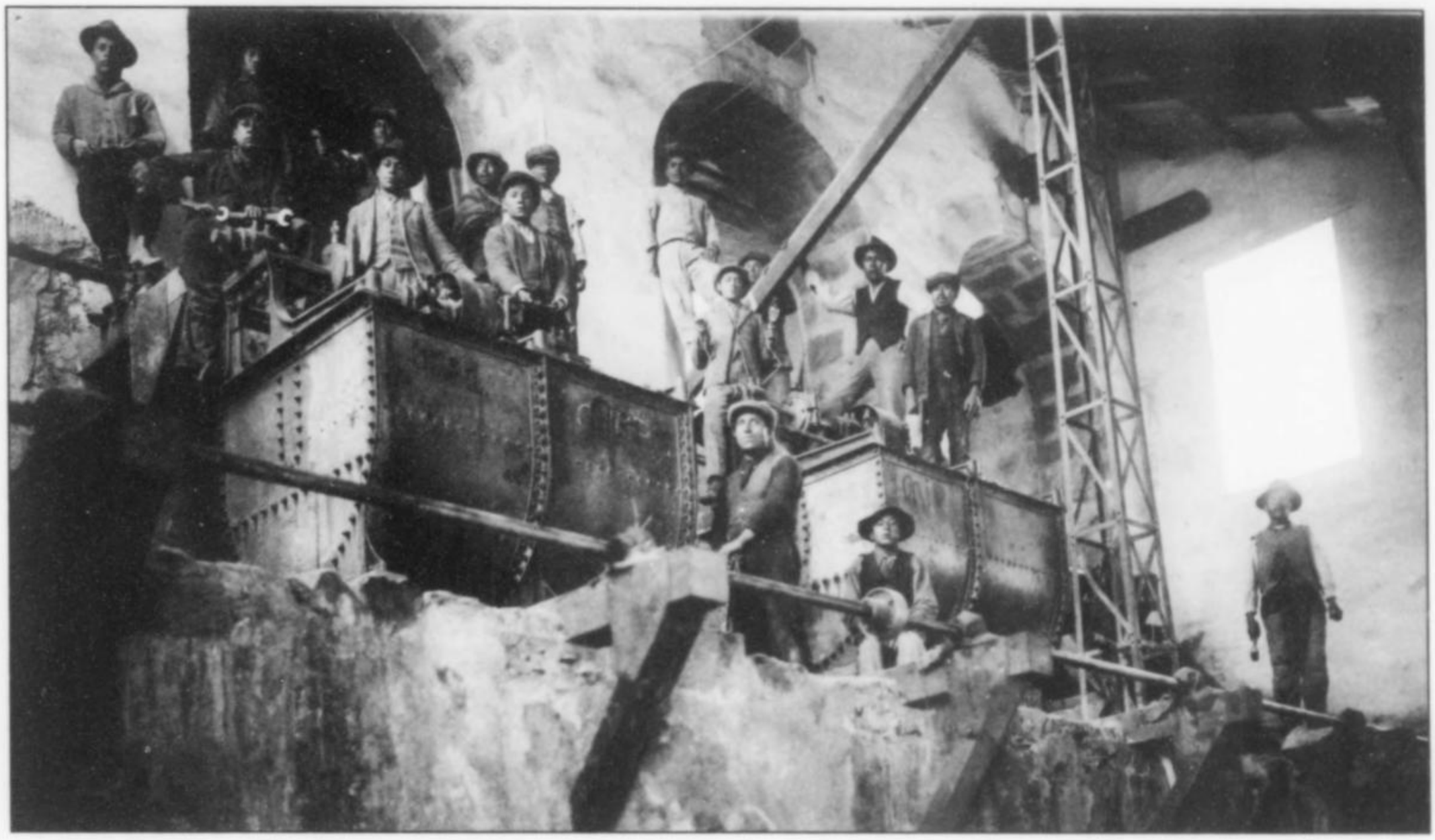


Figure 8. **Miners and mill workers at Potosí, ca. 1910.**

geologists in the 1960's, but was ignored because silver prices were very low and COMIBOL's policy at the time was to promote increased tin production. Decades later, after successive politically motivated personnel changes, no one was left who remembered the silver vein. The Veta Potosí is now known to extend 70 meters below the Zero Level. In 1998 it caused armed conflict, including underground hostage-taking, between the Pailaviri and the cooperative. So the Cerro Rico is once again a producer of silver. Silver is also being produced from tetrahedrite at other mines on the mountain.

After centuries of producing only silver, it was only in the 20th century that the full polymetallic potential of the mountain was realized. Tungsten and bismuth were produced while the deep levels (5 to 10) of the Pailaviri were operational, reaching over 400 meters below the zero level, or over 1,000 meters below the peak of the Cerro. The deep levels were abandoned starting in the 1960's because of declining ore values (1% Sn, plus small amounts of W and Bi), combined with rising temperatures and even the eruption of an underground hot spring. These levels are now unventilated, and are hot and poisonous due to intensive pyrite decomposition. Production is limited to no further down than Level One below the Zero Level. Nevertheless, the upper and middle levels of Cerro Rico still produce tin, silver, antimony, zinc, lead and copper.

GEOLOGY

The central Bolivian tin belt is one of the world's richest metallogenic provinces, stretching from eastern Peru through Bolivia and into northern Argentina. The belt follows the eastern Andes, mineralization being most intense in a restricted area between Oruro and Potosí where the Andean Cordillera curves toward the south. The northern portion of the belt hosts primarily hypothermal and mesothermal deposits, whereas the southern and central sections are characterized by xenothermal mineralization, of which Cerro Rico is a prime example.

The entire belt of mineralization, which includes silver, tungsten, lead, zinc, antimony and gold as well as tin, is related to Middle Tertiary intrusions representing the uppermost cupolas and apophyses of an underlying batholithic basement complex. Nearly all of the metalliferous deposits in the belt appear to have been emplaced under low-pressure, near-surface conditions (Lindgren and Creveling, 1928, estimate a depth of 3,000 feet or less). Veins, sheeted zones and stockworks were the sites of deposition for the ore minerals.

The oldest rocks in the Potosí area are Ordovician shales and slates, unconformably overlain by Tertiary volcanic rocks; these are called the Caracoles tuff, the Venus breccia and the Pailaviri conglomerate, together known as the Cerro Rico Series. Probably during late Miocene or early Pliocene time this series of rocks was intruded by the Cerro Rico Stock, a funnel-shaped body of altered dacite now forming the large pyramidal hill called Cerro Rico. (A small hill protruding from the north slope of Cerro Rico and genetically related to it is known as Cerro Chico or Huayna Potosí.) The dacite in the lower part of the stock is marked by strong propylitization, sericitization and pyritization, whereas silicification dominates in the upper levels. Silicification is commonly so intense (over 95%) that no trace remains of original feldspar crystals in the dacite; feldspar-shaped vugs are commonly hollow but may be lined or filled with quartz, hematite or jarosite. The stock is riddled by shear fractures and normal faults of only slight displacement. In general, the mineralized veins trend northeasterly with a steep dip. The shallower veins are primarily in the Cerro Rico Stock, but as the stock narrows with depth, veins are found in the surrounding Paleozoic shale as well.

The Cerro Rico Stock has an oval-shaped outcrop measuring about 1200 x 1600 meters; by a depth of 700 meters the stock has decreased to 100 x 400 meters. At least 35 veins and vein branches have been located thus far, all of which unite at depth into five principal vein systems: (1) the Tajo Polo, (2) the Encinas, (3) The

Figure 9. **Location map.**

Mendieta, (4) the San Miguel, and (5) the Alco Barreno systems. The Mendieta is the most important; the Tajo Polo and Encinas probably merge with it at greater depth. The veins have a distinct *en echelon* structure, especially below the Caracoles Level; each vein seems to divide into a succession of strongly mineralized sections separated by weakly mineralized stringers.

The Cerro Rico deposits have been divided into at least four zones: (1) the upper oxide zone, (2) the lower oxide zone, (3) the upper sulfide zone, and (4) the lower sulfide zone. Mineralization in the sulfide zones probably began with quartz, pyrite and cassiterite, followed by stannite and chalcopyrite, then andorite and tetrahedrite, and lastly galena, pyrargyrite, lead sulfosalts and late-stage gangue minerals. This sequence represents a gradual drop in temperature, from 400–500°C down to 100–150°C. Spatially this conforms to the deep central zone characterized by bismuthinite and wolframite, surrounded by a zone of silver sulfosalts and, beyond this, a lead-zinc zone. Differences in wall-rock chemistry appear to have had no effect on mineralization; deposition was controlled solely by changes in temperature and pressure.

The early stages of deposition have been characterized as xenothermal, although part of the later stages appear to be the near-surface equivalent of mesothermal (i.e., kryptothermal), while the sulfosalts of the upper stage were probably deposited in the epithermal range. Metallogenically the silver is primarily epithermal whereas the tin mineralization was xenothermal. The kryptothermal mineralization has proven to have little if any economic value.

The above discussion of Cerro Rico geology and paragenesis has been synthesized from the various works of Ahlfeld, and of Turneaure (1960), and Ridge (1972).

MINERALS

It is important to note that, in general, there are no well-crystallized secondary minerals in the Cerro Rico oxidized zone. Although species such as chalcocite, covellite, anglesite and cerussite have been identified, they are actually present only as earthy films and masses in piles of decomposing sulfosalt ores:

Table 1. **Important veins in the Cerro Rico de Potosí.**

Alcko Barreno	Mendieta
Animas	Mesapata
Bolivar 1	Potosí
Bolivar 2	Ramo San Miguel
Bolivar 3	Ramo Bolivar Nueva
Bolivar 4	Ramo Tajo Polo
Bolivar 5	Ramo San Antonio
Bolivar 13	Rica 1
Bolivar Nueva	Ricuch
Claudio	San Antonio
Cotamitos	San Miguel
Don Mauricio	Tajo Polo
Eduardo	Utne 2
Encinas	Utne 3
Este	Utne 9
Exaltación	Utne 12
Krause	Vásquez
Machume	Zalle

Figure 10. **Map of the Cerro Rico showing the locations of important mines.**

hardly of interest to the collector. This may come as a surprise to people more familiar with lead-copper-silver oxide-zone mineralization in other arid regions such as Arizona and Mexico, but the cold, dry, high Andes provide a much less productive environment for weathering and oxidation. All minerals of collector interest at Cerro Rico (as at Oruro, Colquechaca, Huanuni, Llallagua, Morococala, etc.) are of primary hydrothermal origin.

The following data have been compiled from published sources, from our own observations of specimens, and from private communications regarding the observations and analyses conducted by others. We are especially indebted to Richard Kosnar for information on several Cerro Rico species which he has had identified by X-ray diffraction, electron microprobe analysis and polished section studies over the years.

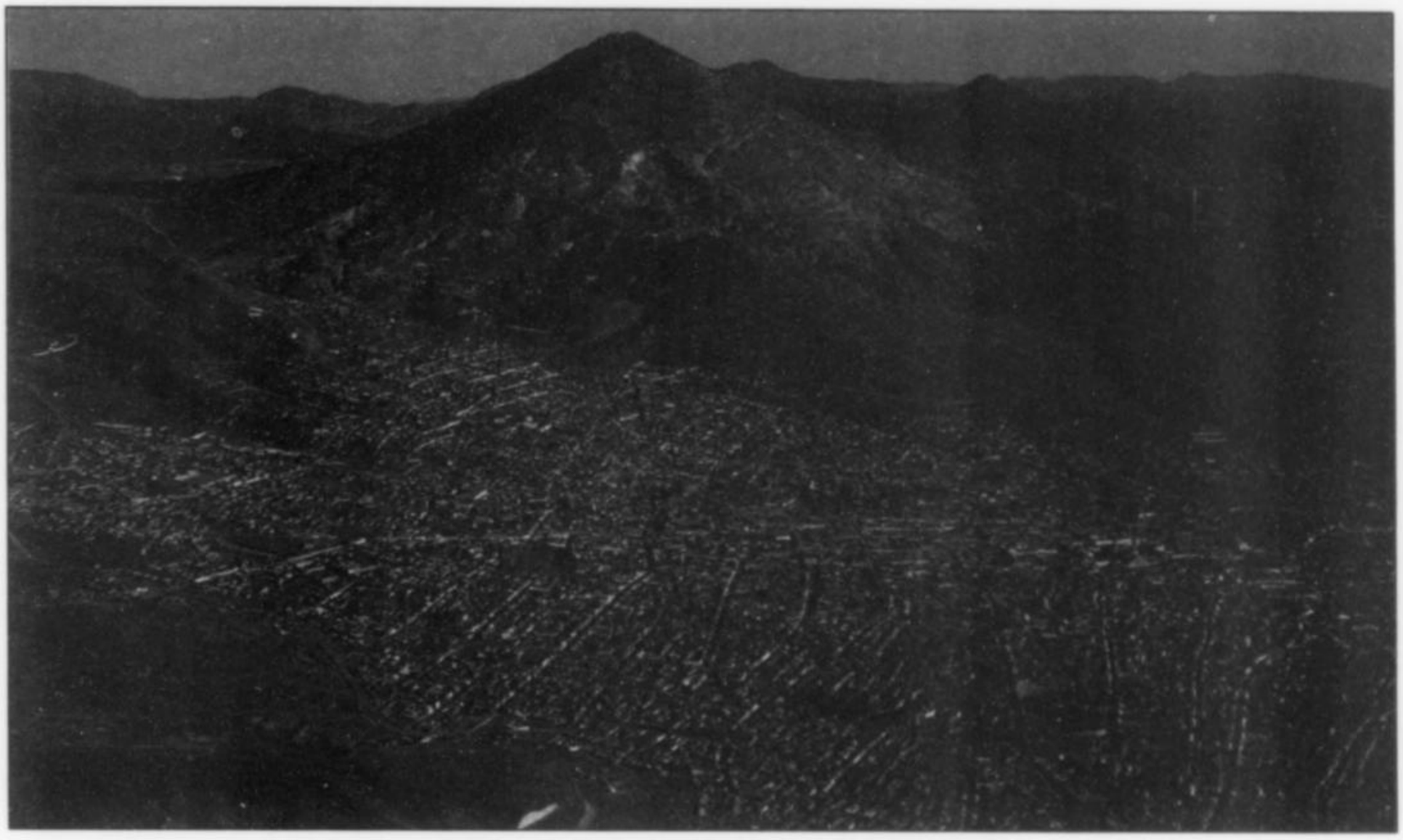


Figure 11. Cerro Rico, with the smaller Cerro Chico in the foreground, overlooking the town of Potosí. Willy Kenning photo.

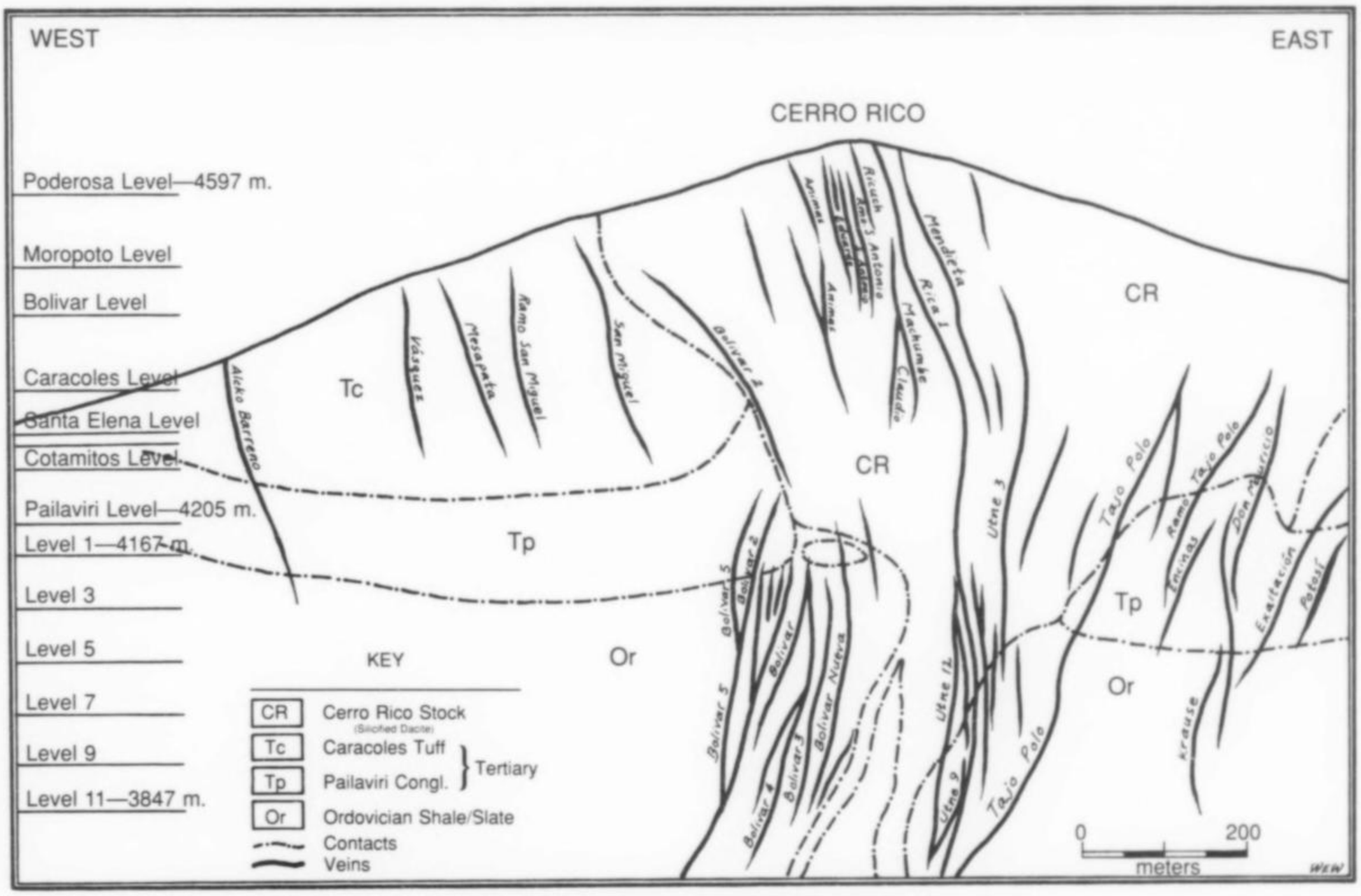


Figure 12. East-West cross-section through the Cerro Rico showing geology and major veins (after an unpublished COMIBOL map). Note the newly discovered Veta Potosí at right.

Figure 13. The Encinas mine, East Slope, Cerro Rico. Jaroslav Hyrsl photo.

Figure 14. Mining supply shop in Potosí. Jaroslav Hyrsl photo.

Figure 15. Ruins of an old Spanish ore mill. Jaroslav Hyrsl photo.

Figure 16. **The town of Potosí as seen from the top of Cerro Rico. Jaroslav Hyrsl photo.**

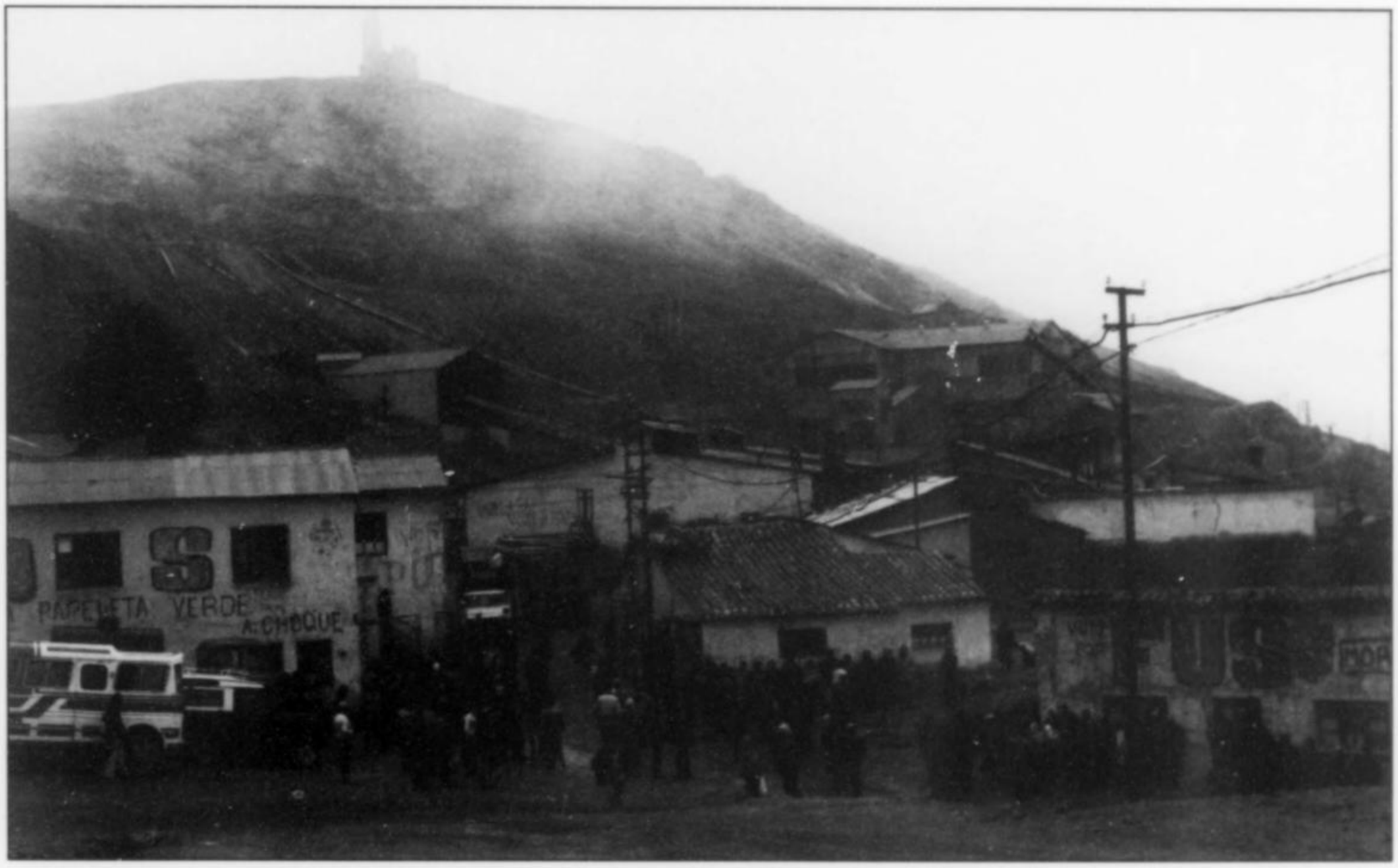


Figure 17. **The morning shift of miners at the Pailaviri mine, ready to go underground. Terry Szenics photo, 1984.**

Figure 18. **Acanthite crystals to 1.8 cm with calcite, from Cerro Rico. Terry Wallace collection; Wendell Wilson photo.**

Figure 19. **Arsenopyrite crystal cluster, 1 cm, from Cerro Rico. Alfredo Petrov collection; Wendell Wilson photo.**

Acanthite Ag_2S

Acanthite ("argentite") was once an important ore mineral in the oxide-sulfide transition zone at Potosí, finely disseminated in limonite, but is now rarely encountered. Ahlfeld and Reyes (1955) described it from the San Antonio vein of the Bolivar mine as microcrystals covered by blebs of chlorargyrite on a dacite matrix. There is, however, a superb specimen with octahedral crystals (after argentite) to 1.8 cm in the Terry Wallace collection.

Alunite Group

Unidentified white, massive minerals of the alunite group occur as late-stage hydrothermal gangue in several veins. The material is especially abundant in the Bolivar-Santa Rita section on the west flank of Cerro Rico (Ahlfeld and Reyes, 1955).

Andorite $PbAgSb_3S_6$

Lindgren and Creveling (1928) report andorite as occurring in compact masses with pyrite, quartz and cassiterite in the Santa Rita adit, and give an analysis which shows more silver (13.12%) and less lead than Oruro andorite. Ahlfeld and Reyes (1955) reported massive andorite with pyrargyrite. Recently found andorite specimens characterized by 3-mm, longitudinally striated prisms, some of them tubular (!), have been identified by Jaroslav Hyrsl (personal communication).

Arsenic As

Native arsenic has been found in fist-size metallic masses at Cerro Rico. A 12-cm specimen is illustrated in Perez and Tenago (1992).

Arsenopyrite FeAsS

Arsenopyrite occurs sporadically at Cerro Rico, especially in the deeper levels of the Rica and Tajo Polo veins (Ahlfeld and Reyes, 1955). Many specimens showing thin prisms to 1 cm long were found in 1993, with quartz and stannite crystals. It is the most abundant sulfide accompanying phosphophyllite.

Arsenosulvanite $Cu_3(As,V)S_4$

Microcrystals of arsenosulvanite intergrown with stannite and arsenopyrite crystals (on the matrix of phosphophyllite crystals) were identified by the late Gene Foord through XRD (R. Kosnar, pers. comm.)

Barite $BaSO_4$

Ahlfeld and Reyes (1955) reported barite crystals with cassiterite from the Rosario mine near the peak. Excellent, gemmy, colorless crystals to 1 cm, showing an unusual double wedge-shaped habit, can still be collected as crusts on dacite near the peak.

Berndtite SnS_2

Cerro Rico is the type locality for this rare tin sulfide, and also for ottemannite (Sn_2S_3). Moh and Berndt (1964) first described it from Cerro Rico ore samples, and Moh named it for Berndt in 1966. It occurs as minute, tabular, hexagonal crystals included in pyrite crystals that are replacing stannite (Cu_2FeSnS_4). In polished section it appears gray with intense orange-yellow internal reflections.

Berthierite $FeSb_2S_4$

Kosnar (pers. comm.) reports having had berthierite identified in polished sections, associated with andorite and prismatic crystals of zinkenite.

Bismuthinite Bi_2S_3

Small amounts of bismuthinite occur sporadically in the deepest levels of the Mendieta-Tajo Polo vein system as small lance-like prisms associated with quartz, cassiterite, stannite and pyrite (Ahlfeld and Reyes, 1955). A white, 7-cm group of crude, corroded crystals from Cerro Rico is in the Museo D. Felipe de Borbón in Madrid.

Boulangerite $Pb_5Sb_4S_{11}$

Jaskolski (1933) described boulangerite from the Cerro Chico, in compact masses with galena and sphalerite.

Bournonite $PbCuSbS_3$

Ahlfeld and Reyes (1955) described large, dull, corroded crystals of bournonite from the Encinas vein. Sharp "cogwheel" twins to 1 cm occur rarely, on tetrahedrite. A single crystal and a penetration twin are illustrated in Dufrénoy's (1856) *Minéralogie*, with the locality given simply as "Potosí."

Calcite $CaCO_3$

Carbonate minerals, calcite included, are rare at Cerro Rico. The only reference to crystals is Bournon's 1808 work on carbonates in which he attributes three crystal drawings to "Potosí."

Cassiterite SnO_2

Fine-grained, almost invisible disseminations of cassiterite are virtually ubiquitous at Cerro Rico, and currently constitute the main ore mineral (Ahlfeld and Reyes, 1955; Jaskolski, 1933). It occurs both as an early and late-stage hydrothermal mineral in veins and disseminations through silicified volcanic rocks. It has also formed as a supergene alteration product of stannite and "varlamoffite." Black to honey-yellow druses of microcrystals can still be found lining vugs in pyrite on the dumps.

Chalcanthite $CuSO_4 \cdot 5H_2O$

Blue efflorescences of post-mining chalcanthite can be found on tetrahedrite ore piles at Cerro Chico. Long, deep blue stalactites in the mine workings are referred to by the miners as "chalcanthite" but in fact usually prove to be cuprian melanterite.

Chalcopyrite $CuFeS_2$

As an early-stage hydrothermal mineral, chalcopyrite is rare in the upper levels but common in the deeper levels, where it occurs associated with stannite, cassiterite and arsenopyrite. It also occurs as a late-stage hydrothermal mineral associated with sphalerite and tetrahedrite. None of the Cerro Rico occurrences have produced significant crystals.

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

Mrose, Strunz and Ahlfeld, in an unpublished paper on Potosí phosphophyllite, list childrenite as one of the minerals Ahlfeld found at Cerro Rico.

Chlorargyrite AgCl

Ahlfeld and Reyes (1955) state that: "The enormous wealth of silver in the Cerro [Rico] de Potosí came not from any abundance of proustite-pyrargyrite and other noble minerals of silver, nor from native silver, but rather principally from low-grade chlorargyrite ores." After 1640, when amalgamation was introduced at Potosí, oxide-zone rock containing as little as 0.06% silver in the form of chlorargyrite became the main ore and was exploited in huge quantities. Specimens today are very rare, consisting mainly of small blebs on altered silicified dacite from near the peak.

Copiapite Group

Abundant yellow masses of unidentified copiapite-group minerals tend to form wherever acidic water is draining out of the mines. Surfaces of these masses are featureless, but tiny pseudo-hexagonal scales can sometimes be found in protected or enclosed areas.

Diaphorite $Pb_2Ag_3Sb_3S_8$

Diaphorite has recently been identified (by X-ray diffraction) as complex, 3-mm crystals associated with miargyrite in vugs in massive pyrargyrite. The specimens are from the recently discovered Veta Potosí (Potosí vein).

Fluorapatite $Ca_5(PO_4)_3F$

Well-formed, high-quality crystals of apatite (presumably fluorapatite) have been recovered at Potosí, mostly in the 1950's. Recently only colorless, blocky microcrystals have been found. But Kosnar (pers. comm.) recalls seeing a lilac-colored short hexagonal prismatic crystal in Ahlfeld's collection in 1976.

Franckeite $(Pb,Sn^{2+})_6Fe^{2+}Sn_2^{4+}Sb_2^{3+}S_{14}$

During the last couple of years, several specimens of franckeite have been recovered at Potosí. The mineral occurs as 5 to 6-mm spherical aggregates associated with prismatic to tabular andorite.

Freibergite $(Ag,Cu,Fe)_{12}(Sb,As)_4S_{13}$

Published analyses of ore minerals have cited freibergite; Kosnar (pers. comm.) reports having one specimen confirmed by X-ray diffraction and EDX as freibergite, and also having several other crystals of exactly the same appearance.

Galena PbS

Argentiferous galena occurs sporadically as unremarkable specimens, especially at Cerro Chico where it is found with sphalerite.

Goethite $Fe^{3+}O(OH)$

Earthy goethite is the primary component of the limonitic cassiterite ore found in the upper parts of the Cerro Rico. Vugs sometimes contain shiny, brownish black, mammillary to stalactitic growths.

Goslarite $ZnSO_4 \cdot 7H_2O$

Goslarite is occasionally found at Cerro Rico as white acicular to filiform crystals on sphalerite.

Halotrichite $Fe^{2+}Al_2(SO_4)_4 \cdot 22H_2O$

Fast-growing fibrous masses of halotrichite and pickeringite are common in many of the Cerro Rico adits and drifts. (This is the infamous, so-called "asbestos" with which Potosí guides have frightened gullible tourists!)

Hematite Fe_2O_3

Hematite, in the form of iridescent botryoidal "turgite," is common as thin crusts on silicified dacite on the upper slopes. It also forms earthy red pseudomorphs after feldspar phenocrysts.

Figure 20. **Diaphorite in complex, black, 1-mm crystal aggregates on sharp crystals of miargyrite and red pyrargyrite, from the Unificada mine. Rock Currier collection; Wendell Wilson photo.**

Figure 21. **Miargyrite crystals with pyrargyrite and pyrostilpnite, 4 cm, from the Veta Potosí, Cerro Rico. Rock Currier collection; Wendell Wilson photo.**

Hopeite $Zn_3(PO_4)_2 \cdot 4H_2O$

An unpublished paper by Mrose, Strunz and Ahlfeld lists hopeite as being among the species Ahlfeld found at Cerro Rico.

Jamesonite $Pb_4FeSb_6S_{14}$

Massive jamesonite occurs sporadically in peripheral veins, as for example at the Lourdes mine on the south flank of Cerro Rico, where it is found with wurtzite.

Jarosite $K_2Fe^{3+}_6(SO_4)_4(OH)_{12}$

Minute, golden yellow rhombs of jarosite abundantly impregnate a Pliocene tuff on the west flank of the mountain, forming about 16% of the rock. Analysis (Milton, 1935) indicates that this is a potassium-rich jarosite. The mineral also constitutes a component of the limonitic cassiterite ore, and forms druses of small crystals lining feldspar-shaped vugs in dacite. Hydronium jarosite is probably also present, and perhaps even argentojarosite (thought by mining engineers to be the main ore mineral at a new operation on the east slope).

Lazulite (?) $MgAl_2(PO_4)_2(OH)_2$

On the dumps of the Potosí tunnel, on the southeastern flank of Cerro Rico, and on other small dumps nearby, Ahlfeld and Reyes (1955) observed pale blue pseudomorphs after feldspar in the dacite; they speculated that this material is "probably" lazulite but give no reasons for this assumption. Specimens (labeled "lazulite") are preserved in the Smithsonian collection.

Lepidocrocite $Fe^{3+}O(OH)$

Iridescent, botryoidal to vermiform coatings of lepidocrocite on matrix were returned to Spain by Heuland's 1803 expedition, and are now in the National Museum of Natural Science in Madrid. Two specimens are pictured in Perez and Tenago (1992).

Löllingite $FeAs_2$

Kosnar (pers. comm.) reports having five supposed specimens of arsenopyrite prepared for polished section analysis, three of which proved instead to be löllingite. Gene Foord confirmed the analysis.

Matildite $AgBiS_2$

Matildite has been reported from Cerro Rico as brilliant, gray to black, imperfectly formed crystals in granular aggregates and compact, laminary masses associated with tetrahedrite, sphalerite, andorite and pyrargyrite (Lindgren and Creveling, 1928; Perez and Tenago, 1992).

Melanterite $Fe^{2+}SO_4 \cdot 7H_2O$

Melanterite is abundant at Cerro Rico as beautiful, transparent, sea-green stalactites to several decimeters long in old tunnels and stopes. Ahlfeld and Reyes (1955) report finding it on old wooden beams in the Lourdes mine (southern flank of Cerro Rico). The miners commonly break off these stalactites and present them as gifts to tourists visiting underground. Unfortunately, these invariably dehydrate to a white powder within a few hours of their removal from the moist mine environment. Blue stalactites (called "chalcanthite" by mine engineers) often turn out to be cuprian melanterite.

Miargyrite $AgSbS_2$

Ahlfeld and Reyes (1955) report that miargyrite was once abundant in the upper portions of the Tajo Polo vein system, as compact masses in pyrite with associated pyrargyrite and cassiter-

ite. The recently discovered Potosí vein is producing complex, lustrous, 4-mm to 5-mm crystals associated with crystals of diaphorite, pyrostilpnite and pyrargyrite, in vugs in massive pyrargyrite and miargyrite. Somewhat flattened, rectangular crystals from "Potosí" were illustrated in 1865 by Weisbach in *Poggendorf's Annalen*.

Nacrite $Al_2Si_2O_5(OH)_4$

Nacrite, a clay mineral, occurs in the Veta Potosí as 1-mm spherules composed of minute, radiating, pearly white crystal plates. Associations include pyrite, franckeite, and silver sulfosalts.

Ottemannite Sn_2S_3

Cerro Rico is the type locality for this rare tin sulfide, and also for berndtite (SnS_2). Moh and Berndt (1964) first described it from Cerro Rico ore samples, and Moh named it for Professor Joaquin Ottemann of Heidelberg. It occurs as minute, twinned, orthorhombic laths replacing stannite. In polished section it is gray with orange-brown internal reflections.

Pharmacosiderite $KFe^{3+}_4(AsO_4)_3(OH)_4 \cdot 6–7H_2O$

Kosnar (pers. comm.) reports finding cubic microcrystals of greenish brown pharmacosiderite with jarosite in 1978.

Phosphophyllite $Zn_2Fe^{2+}(PO_4)_2 \cdot 4H_2O$

Phosphophylllte was first described from Hagendorf, Bavaria, in 1920, and may have been known to the miners at Potosí as early as the 1930's. Not recognizing its specimen value, the miners usually hammered the bigger crystals into pretty cleavages as toys for their children. It was not until 1957 that Dr. Fritz Berndt, chief chemist for COMIBOL, correctly identified the gemmy blue-green crystals as phosphophyllite. Berndt found that, unlike its Bavarian counterpart, the Potosí phosphophyllite contains very little, if any, manganese; Avila-Salinas (1982) confirmed Berndt's observation (Table 2). At Potosí it is thought to have formed by hydrothermal alteration of sphalerite and pyrite in the presence of phosphate ions supplied by associated hypogenic apatite (Avila-Salinas, 1982).

Table 2. **Composition of Cerro Rico phosphophyllite (Avila-Salinas, 1982).**

	(1)	*(2)*	*(3)*
ZnO	36.30	34.26	36.42
FeO	11.35	12.24	14.97
MnO	4.62	4.96	0.12
P_2O_5	31.66	32.51	32.72
H_2O	16.07	16.52	16.40
Total:	100.00	100.49	100.63

(1) Ideal formula, with Fe:Mn = 17:7 (Palache *et al.*, 1951)
(2) Hagendorf
(3) Cerro Rico

Cerro Rico phosphophyllite has been found mainly on the 7th–10th levels of the Kraus vein, about 1,000 feet below the main haulage tunnel of the Unificada mine. Those deep workings have long been abandoned and unventilated, and suffer from the effects of intense pyrite decomposition (which liberates sulfuric acid and heat). According to a recent rumor in Potosí, three miners intent on recovering more phosphophyllite descended into the acidic heat of the abandoned levels in March of 1996 and at least one of them (some say all three) died of asphyxiation. Peter Bancroft had descended alone to the abandoned 535-meter level in 1957 and spent several hours trying unsuccessfully to work thin seams of phosphophyllite in solid, massive chalcopyrite, only to find that he was nearly unable to crawl out due to exhaustion and bad air (Bancroft, 1984).

Figure 22. **Aurelio Bustos Ortuño in 1978, when he was head of the geology office of COMIBOL (the Bolivian national mining company) in Oruro. He was for many years the principal supplier of fine Bolivian mineral specimens to the international market. Photo by Terry Szenics.**

Many phosphophyllite specimens that have reached the mineral market came out by way of Aurelio Bustos, head of the geology office of COMIBOL in Oruro. For over 20 years he was the major source of Bolivian mineral specimens, and was well known to every traveling international mineral dealer. Bustos claimed (though some dispute him) to have personally collected the "Swoboda Phosphophyllite," a 7-cm twin now in the Houston Museum of Natural Science, in 1960 and has even pinpointed the exact location of the vug.

Edward Swoboda, in his memoirs, talked about the initial encounters the miners had with phosphophyllite, as recounted to him by Aurelio Bustos:

> Many years ago, when mining was focussed on stoping between the seventh and ninth levels [of the Unificada mine], they had mined along a section of the vein which produced many vugs of a bright green, transparent mineral initially thought to be fluorite. During this period an unknown quantity of phosphophyllite was discarded on the waste dumps. Vugs up to 30 cm in diameter were found filled with the green crystals, which were systematically destroyed. Not long after these splendid crystals were finally correctly identified and sporadically collected and saved, mining was discontinued on these levels.

Some rough unpublished notes on the phosphophyllite occurrence, written during the early 1960's, were found among Friedrich

Figure 23. **The "Great Phosphophyllite," also known as the "Wilbur Phosphophyllite"; it was found at the Unificada mine in 1962 by a mining engineer named Urquidi, was sold by him to Richard Kosnar in 1977, was purchased from him by David Wilbur in 1978. It is now in the collection of the Research Charitable Trust, New York. The large twinned crystal measures about 13 cm (over 5 inches!). Harold and Erica Van Pelt photo.**

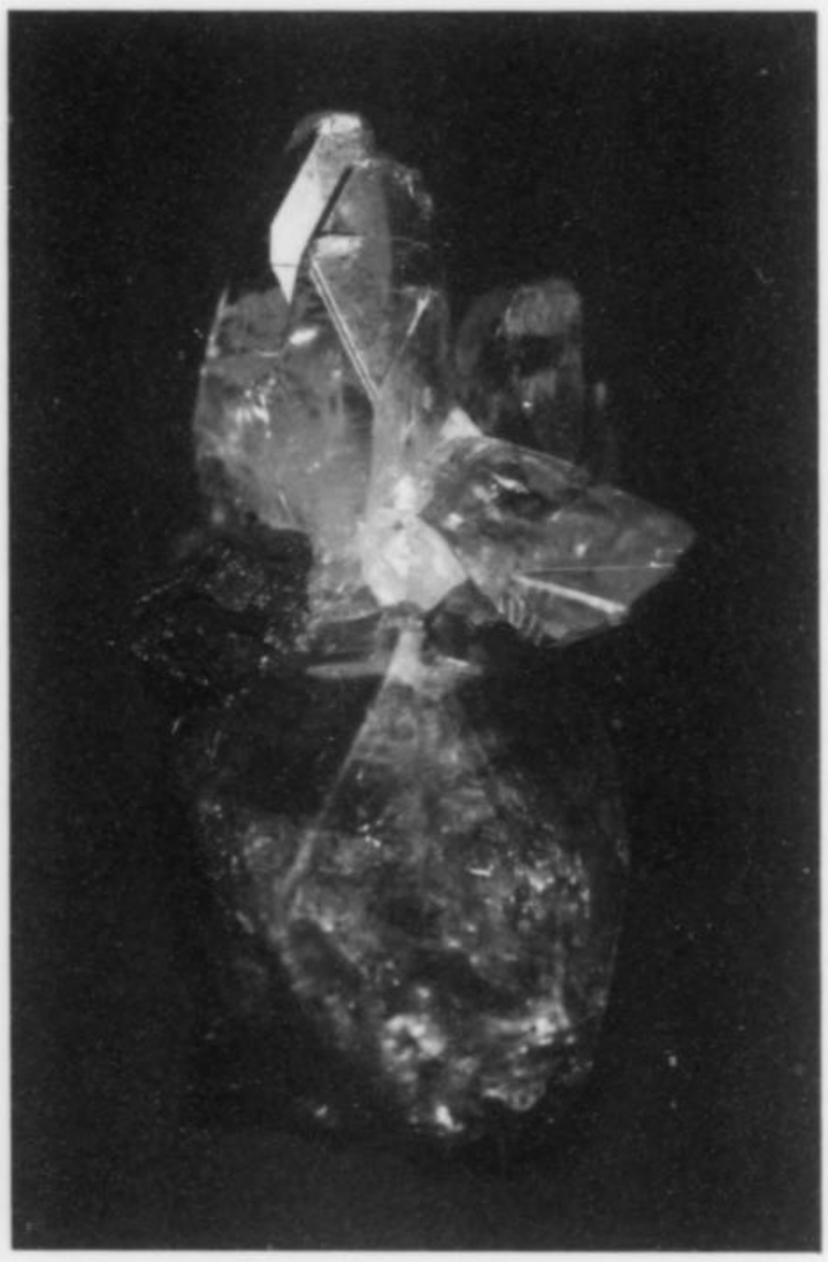


Figure 24. **The "Eidahl Phosphophyllite," 6 cm; found in 1962, sold to Phil Gregory in 1970, then sold to David Eidahl (now deceased). It has since been accidentally destroyed. Wendell Wilson photo.**

Figure 25. **Large, 7-cm phosphophyllite twin from the Houston Museum of Natural Science collection (the "Swoboda Phosphophyllite"). Photo by Harold and Erica Van Pelt.**

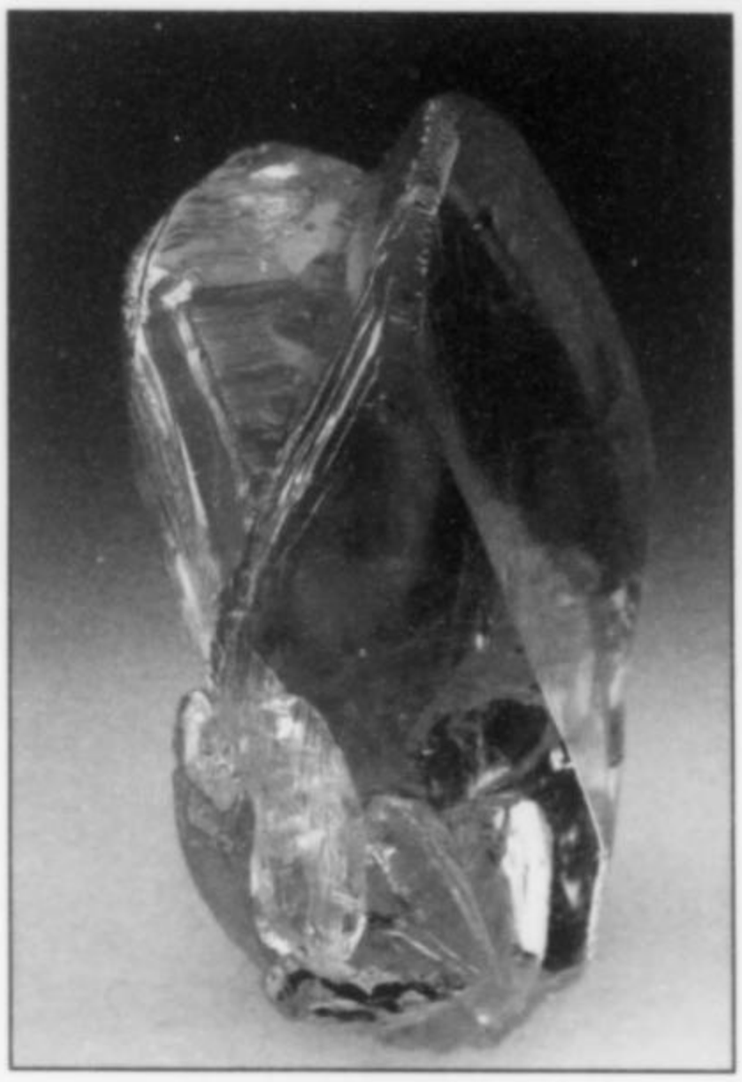


Figure 26. **Phosphophyllite twin, 3.3 cm, showing possible solution-etching surface featured. William Larson collection; Wendell Wilson photo.**

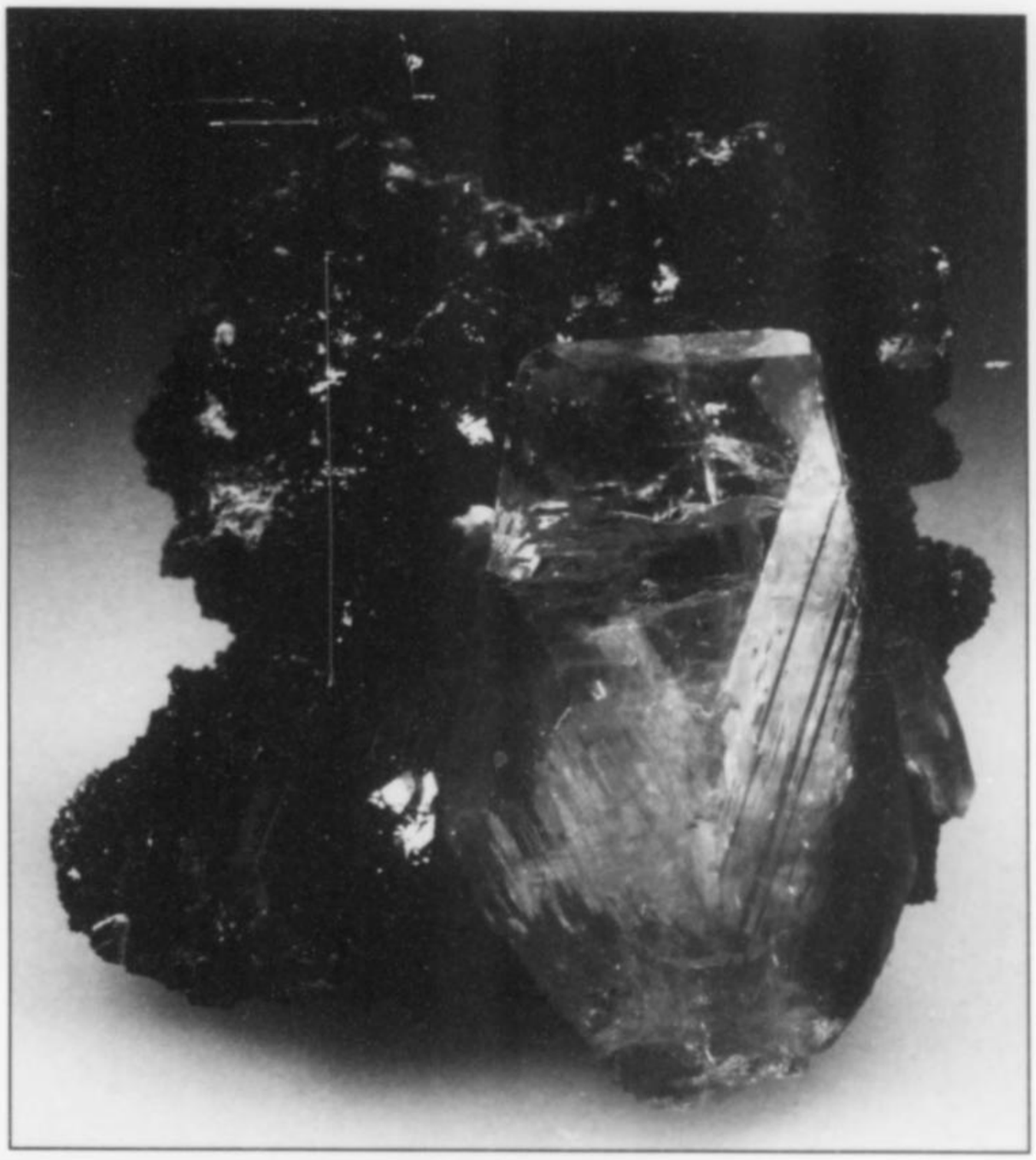
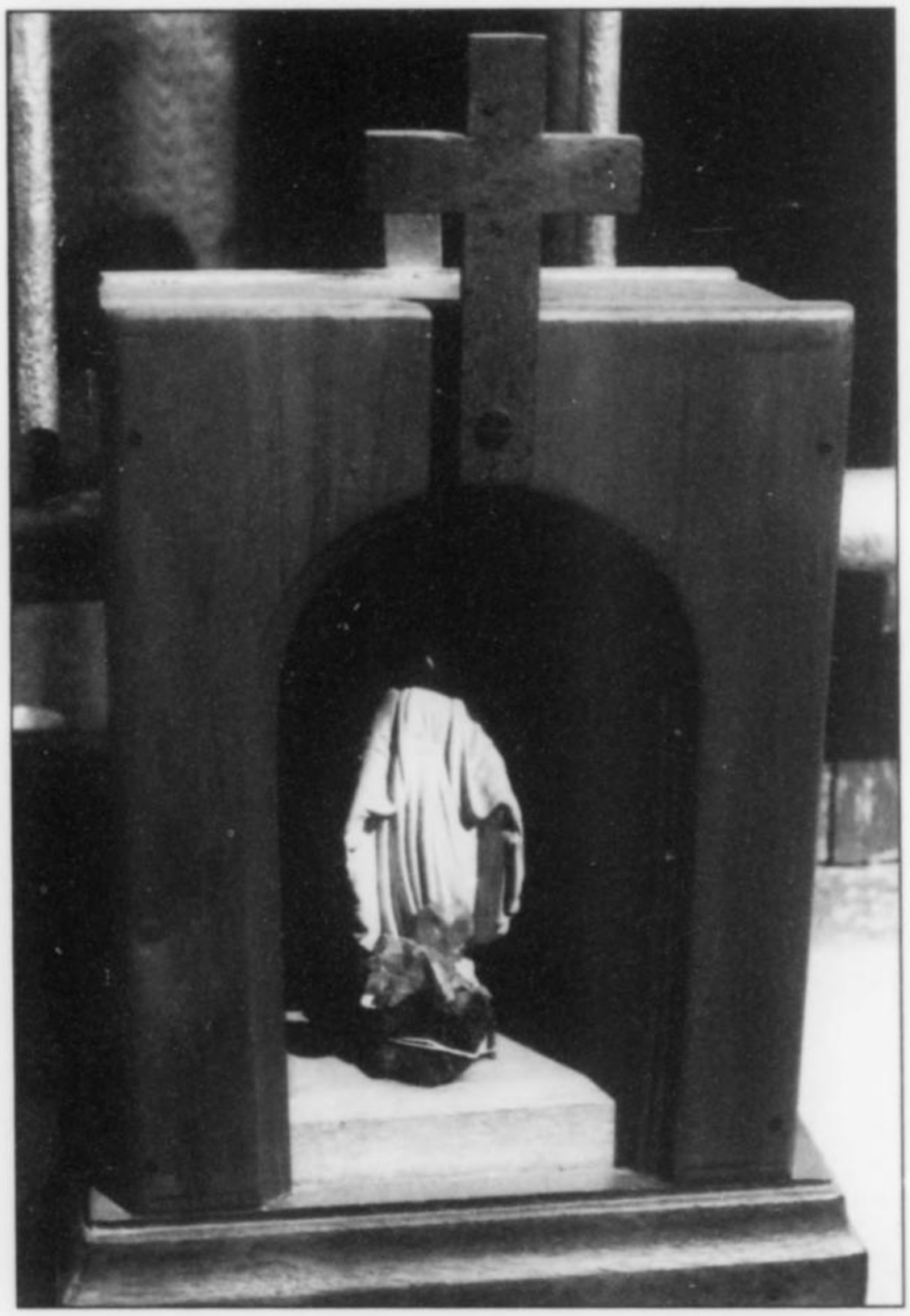


Figure 27. **Untwinned phosphophyllite crystal, 3.7 cm, on matrix. Note smaller prismatic crystals at lower left. William Larson collection; Wendell Wilson photo.**

Figure 28. **Rather flattened, 5-cm twin (100) of phosphophyllite. Smithsonian collection; Wendell Wilson photos.**



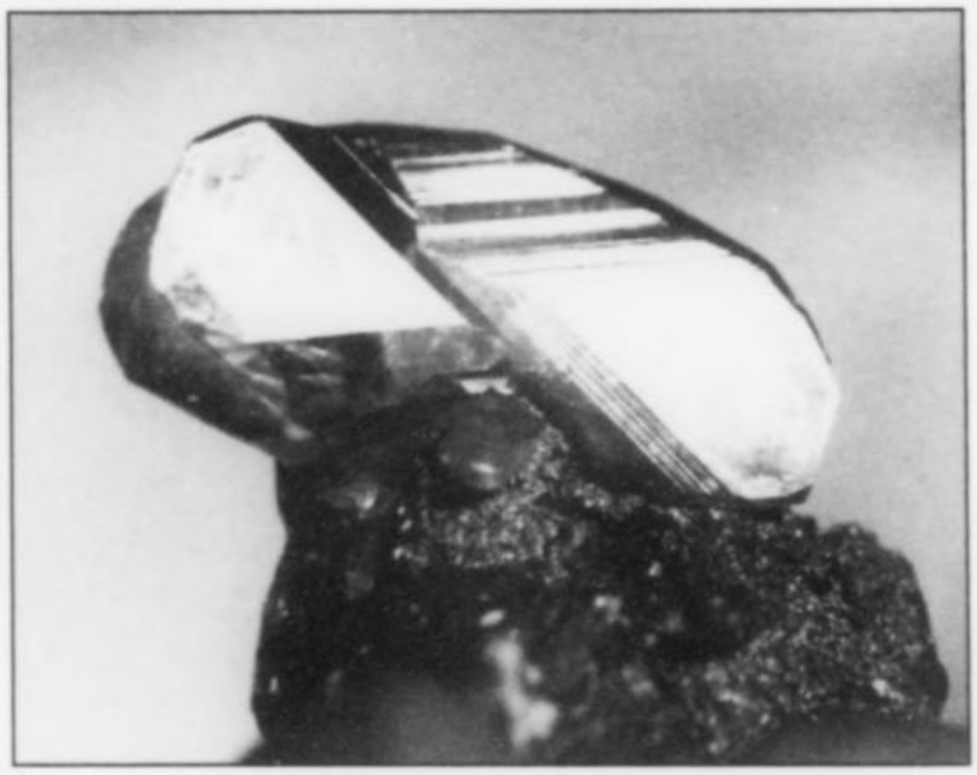


Figure 30. **Superb, doubly terminated twin of phosphophyllite, 3.7 cm, on pyrite matrix. This is the back side of the specimen from the small shrine shown at left. Terry Szenics photo, 1986.**

Figure 29. **Superb (dusty) phosphophyllite crystal group on matrix, tied to a Catholic shrine. The shrine and specimen were being offered for sale as a unit by the miner. (Does anyone know where this specimen is today?)**

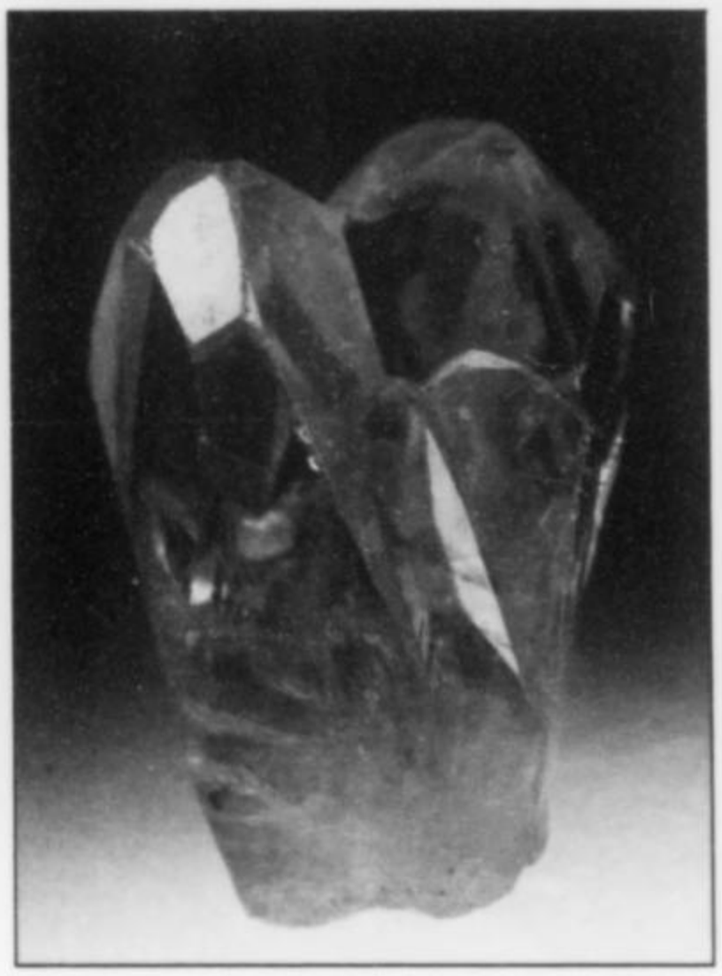


Figure 31. **The Ralph Clark thumbnail phosphophyllite twin, 1.8 cm; the sole survivor from a bag of 48 superb thumbnail twins found in 1962 (the others were cut into gemstones). Wendell Wilson photo.**

Figure 32. **The Carleton Davis thumbnail phosphophyllite twin, 1.8 cm. Jeff Scovil photo.**

Figure 33. **The Paula Presmyk thumbnail phosphophyllite twin, 2.2 cm. Jeff Scovil photo.**

Figure 34. **Phosphophyllite twin, 3 cm. Keith Proctor collection; now in the Research Charitable Trust Collection. Wendell Wilson photo.**

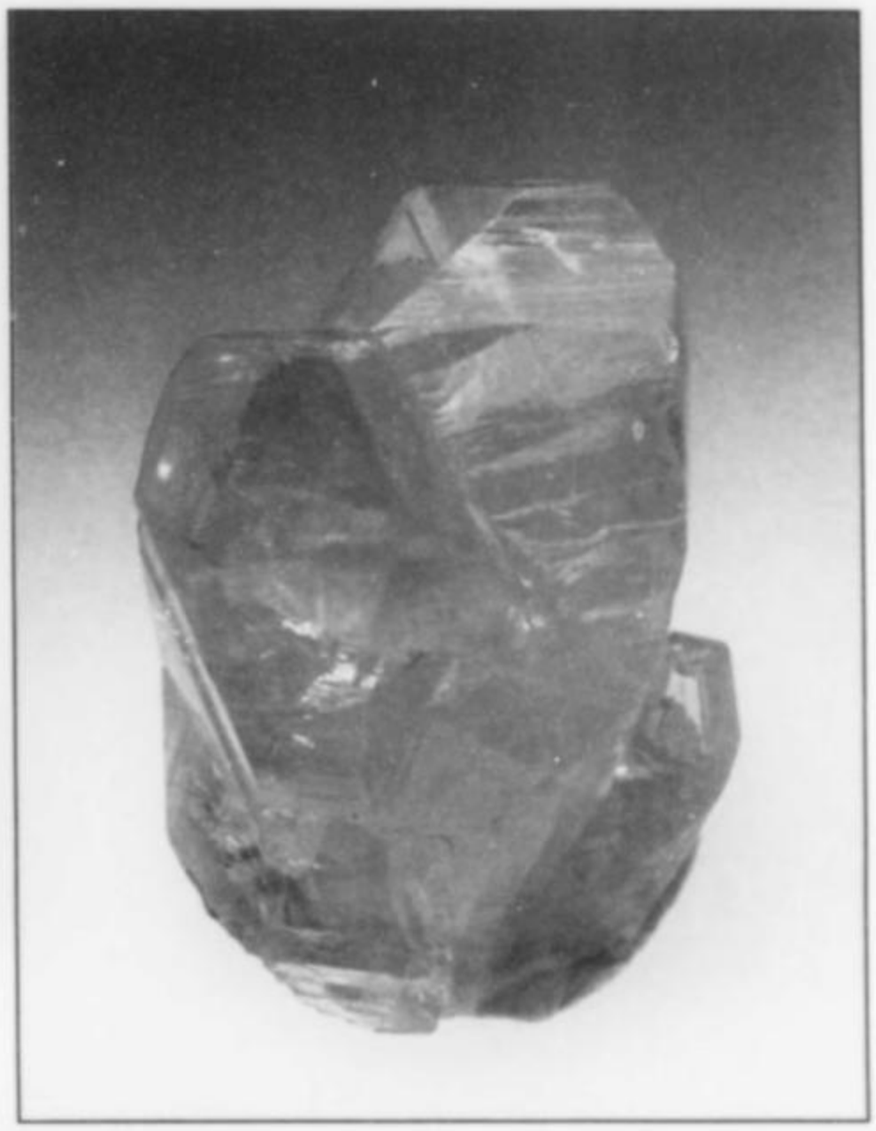


Figure 35. **Phosphophyllite twin, 3 cm. Martin Zinn specimen; Wendell Wilson photo.**

Figure 36. **Doubly terminated phosphophyllite twin, about 5 cm, on matrix. Richard Kosnar collection (since 1980); formerly Keith Proctor collection; formerly in the David Wilber collection; sold recently to Wayne Thompson; now in the Steve Smale collection. Jeff Scovil photo.**

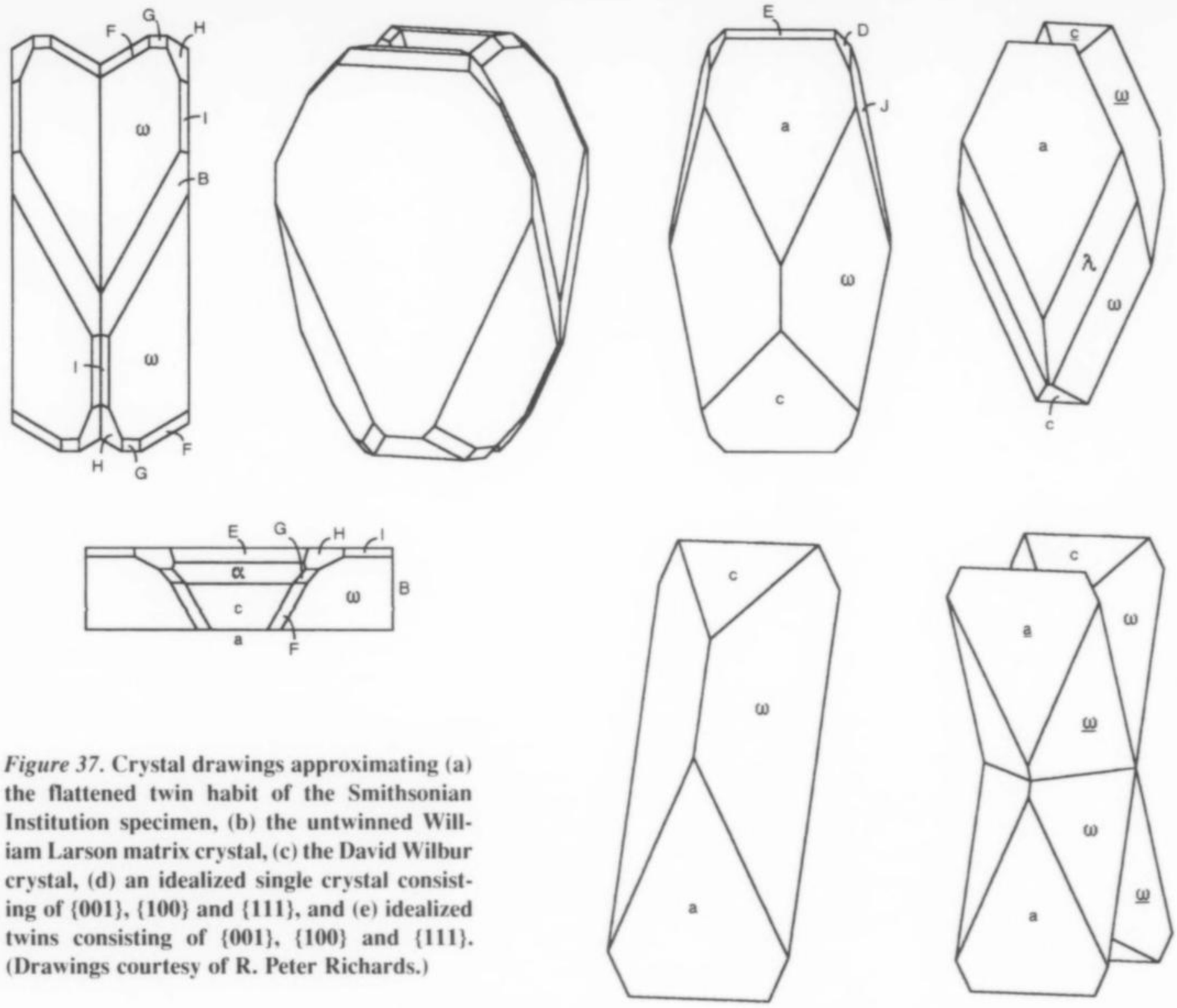


Figure 37. **Crystal drawings approximating (a) the flattened twin habit of the Smithsonian Institution specimen, (b) the untwinned William Larson matrix crystal, (c) the David Wilbur crystal, (d) an idealized single crystal consisting of {001}, {100} and {111}, and (e) idealized twins consisting of {001}, {100} and {111}. (Drawings courtesy of R. Peter Richards.)**

***Table 3.* Form list and angle table for the phosphophyllite drawings. Form letters are those used for phosphophyllite in Dana's System. Form letters for forms not listed in Dana's System are all capital letters, and are arbitrary choices. Drawings are based on the unit cell listed in Dana's System, Seventh Edition. Faces on the second member of the twin are indicated by underlining. Some Miller indices require confirmation but are correct with regard to zonal orientation. Other forms reported include {110}, {210}, {011}, {$\bar{3}$11}, {120}, {013} and {$\bar{2}$11}. (Table courtesy of R. Peter Richards.)**

	Form	*phi*	*rho*	*Listed in Dana?*
c	001	90°00′	30°25′	Yes
a	100	90°00′	90°00′	Yes
B	010	90°00′	0°00′	No
ω	$\underline{1}11$	40°31′	69°55′	Yes
D	$\bar{1}11$	–16°10′	65°12′	No
α	$\underline{\bar{1}}02$	–90°00′	0°27′	Yes
E	$\bar{1}01$	–90°00′	31°05′	No
F	112	48°40′	57°34′	No
λ	211	54°58′	74°34′	Yes
G	$\underline{1}24$	40°24′	53°46′	No
H	$\underline{\bar{3}}24$	–16°22′	47°18′	No
I	$\underline{\bar{2}}33$	–5°40′	64°25′	No
J	$\bar{1}31$	–5°31′	80°56′	No

Ahlfeld's papers following his death. Following is an (edited) excerpt:

> The mineral [phosphophyllite] was first observed by miners and mining engineers who mistook it for vivianite, a mineral common in Bolivian ore deposits. It is not known how many crystals have been found. Many were carried away by the miners to their homes and were destroyed by their children. I have seen eight good crystals, all twinned. Two of these are in the collection of Mr. P. Zubrzyski, a mining engineer. The largest crystals, however, are said to be in a private collection which I have not seen [according to Kosnar, this is a reference to Urquidi's collection]: 11 crystals to 6 cm in size are preserved there. I saw the place [Potosí] in 1958, when it was completely exhausted, but I was able to purchase some good crystals from the same miners who had earlier supplied study specimens to Hugo Strunz and Mary Mrose.

The "Wilbur Phosphophyllite," by far the largest twin at 13 cm and on matrix besides, was recovered by a man named Urquidi in 1962; according to Richard Kosnar (pers. comm.), Urquidi was a mining engineer at the Unificada mine from 1956 to 1964 and saw a great many fine crystals, most of which came out in 1957. But in 1964 the "phosphophyllite stope" in the Unificada mine was sealed off by a concrete bulkhead to prevent further collecting by miners. The 13-cm crystal on matrix was sold by Urquidi to Kosnar in

1977; Kosnar sold it to David Wilbur in 1978; Wilbur later sold it to the Research Charitable Trust in New York, in whose possession it remains today. Though repaired, it is widely regarded as one of the finest mineral specimens in the world.

According to Kosnar, Urquidi told him that on that fateful day in 1962, when the miners returned to the stope following a blast, the entire floor of the drift was completely covered by broken and loose crystals of phosphophyllite; it looked as if someone had smashed hundreds of green glass bottles in the stope! It took several days for the miners to muck out all of the debris. Kosnar also purchased a plastic bag containing 48 small, relatively undamaged, highly gemmy loose twins from this find; one fine thumbnail-size specimen was sold to Ralph Clark, and the rest went to a New York gem cutter who turned them all into faceted stones.

Another fine specimen, the 6-cm "Eidahl Phosphophyllite" once pictured on the cover of the *Mineralogical Record* (vol. 12, no. 1) was also found around 1962 and was first purchased by Phil Gregory in 1970. Gregory then sold it to Dave Eidahl (now deceased); the specimen remained in Eidahl's family after his death but was recently accidentally destroyed while on loan for an exhibition.

Kosnar also reports that a superb, doubly terminated, gemmy crystal measuring 1.9 x 1.9 x 5.7 cm, with a little matrix, was sold to the late mineral dealer Ed McDole in 1969, and after his death was retained by his brother in northern Idaho; Kosnar rates it as being better than the Phil Gregory/Dave Eidahl specimen. Other smaller but nonetheless excellent twins are currently in the collections of Richard Kosnar (obtained from Keith Proctor in 1980), Ernie Schlichter, Wendy Melanson, William Larson, the Carnegie Museum of Natural History in Pittsburgh, John Barlow, Martin Zinn, the Canadian Museum of Nature in Ottawa and the Smithsonian Institution.

A phosphophyllite crystal apparently originating from a 1965 find was pictured on the cover of *Der Aufschluss* by Weninger (1974). He wrote:

> Through a meeting with Mr. Xavier M. Prevost of La Paz in June of 1974, I was able to briefly view an outstandingly beautiful crystal [of phosphophyllite] from Cerro Rico de Potosí and photograph it for this report. The crystal is a swallow-tail twin . . . pale blue-green, transparent . . . measuring 1.5 x 3.1 x 7.9 cm. According to Mr. Prevost, it was found in 1965 in a 2.5-meter cavity in the stannite zone of the Cerro Rico, together with a few smaller crystals which (because of their excellent cleavage) had all broken off their matrix during blasting.

This is clearly not the "Bustos Cavity" found in 1960. The current location of the specimen is not known. However, Kosnar reports that a superb, doubly terminated, 6-cm crystal from this pocket (which he dates at 1962–1964) was in the collection of Kurt Kontrus in Vienna, Austria, in 1969.

Mining may someday resume in the phosphophyllite zone of the vein; ore values there are still good. Only time will tell whether new specimens will be found.

Potosí phosphophyllite ranges from nearly colorless to pale green to a rich, slightly bluish green which is quite distinctive. Crystals occur in sizes from a few millimeters to perhaps 13 cm (the Wilbur crystal), but most specimens that have survived measure from 1 to 5 cm.

Avila-Salinas (1982) studied the crystal morphology of Cerro Rico phosphophyllite, and reported that {100}, {110}, {210}, {011}, {111}, {211} and {$\bar{3}$11} are commonly seen forms whereas {001}, {120}, {013}, {101}, {$\bar{1}$02} and {$\bar{2}$11} are present but relatively rarely. In the specimens we have studied, {100}, {111} and {001} are usually dominant, and a variety of small modifications are typically present as well (provisionally identified as {010}, {$\bar{1}$11}, {$\bar{1}$02}, {211}, and possibly also {$\bar{1}$01}, {112}, {124}, {$\bar{3}$24}, {$\bar{2}$33} and {$\bar{1}$31}). Some of these forms have not previously been reported for the species; but the large crystal sizes, damaged edges, oscillatory development and other problems render positive identification of some forms difficult. Additional forms beyond those listed above have been observed but remain unidentified.

The twinning appears to be simple contact twinning on (100), and penetration twinning according to the same law. In some cases the twins are flattened markedly parallel to the composition plane, and in other cases there is no noticeable flattening, the twin

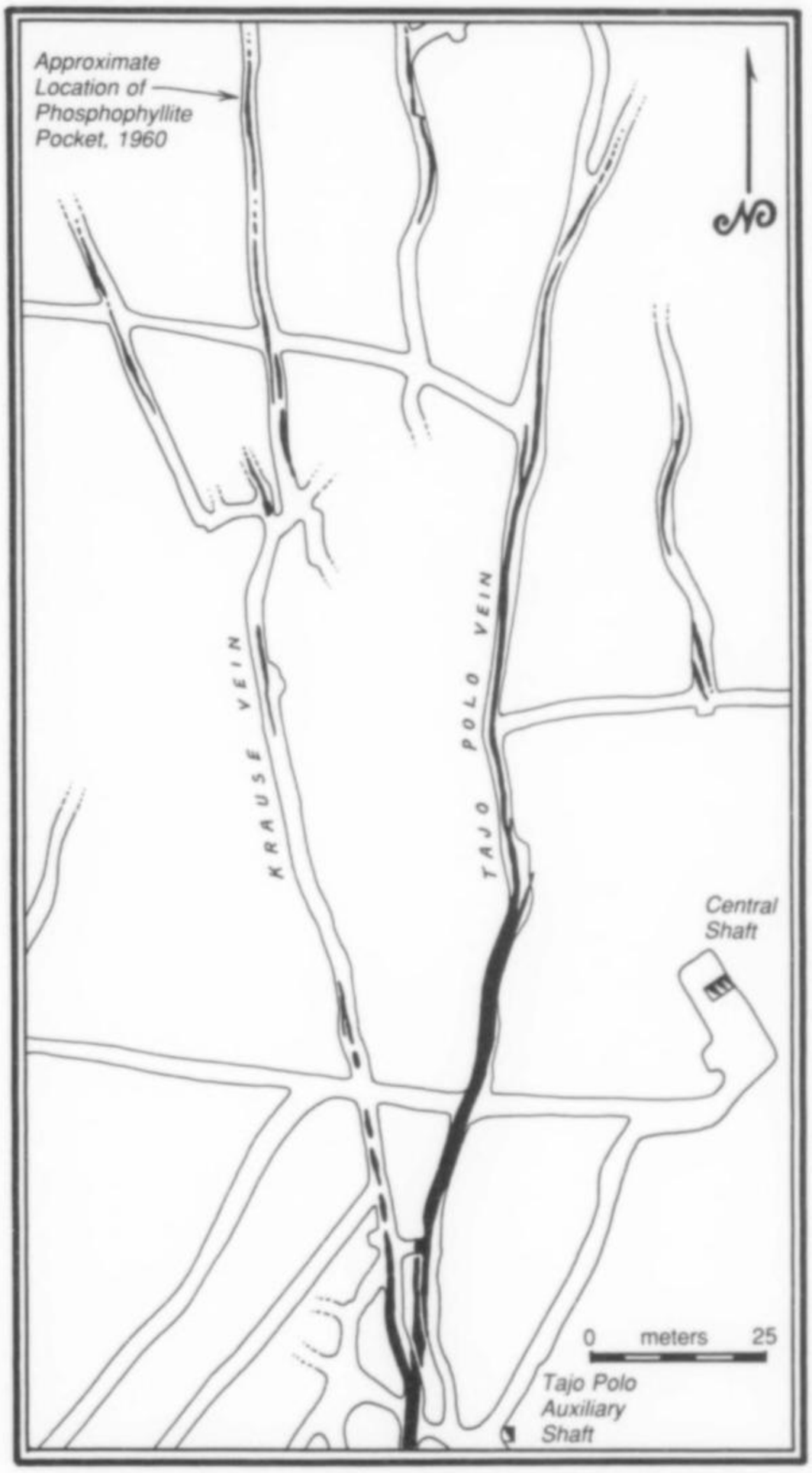


Figure 38. **A section of the workings along the Tajo Polo and Krause veins, Level 8 of the Pailaviri mine (3980 meters elev.), showing vein mineralization and the location of Aurelio Bustos's 1960 phosphophyllite pocket (after an unpublished COMIBOL map).**

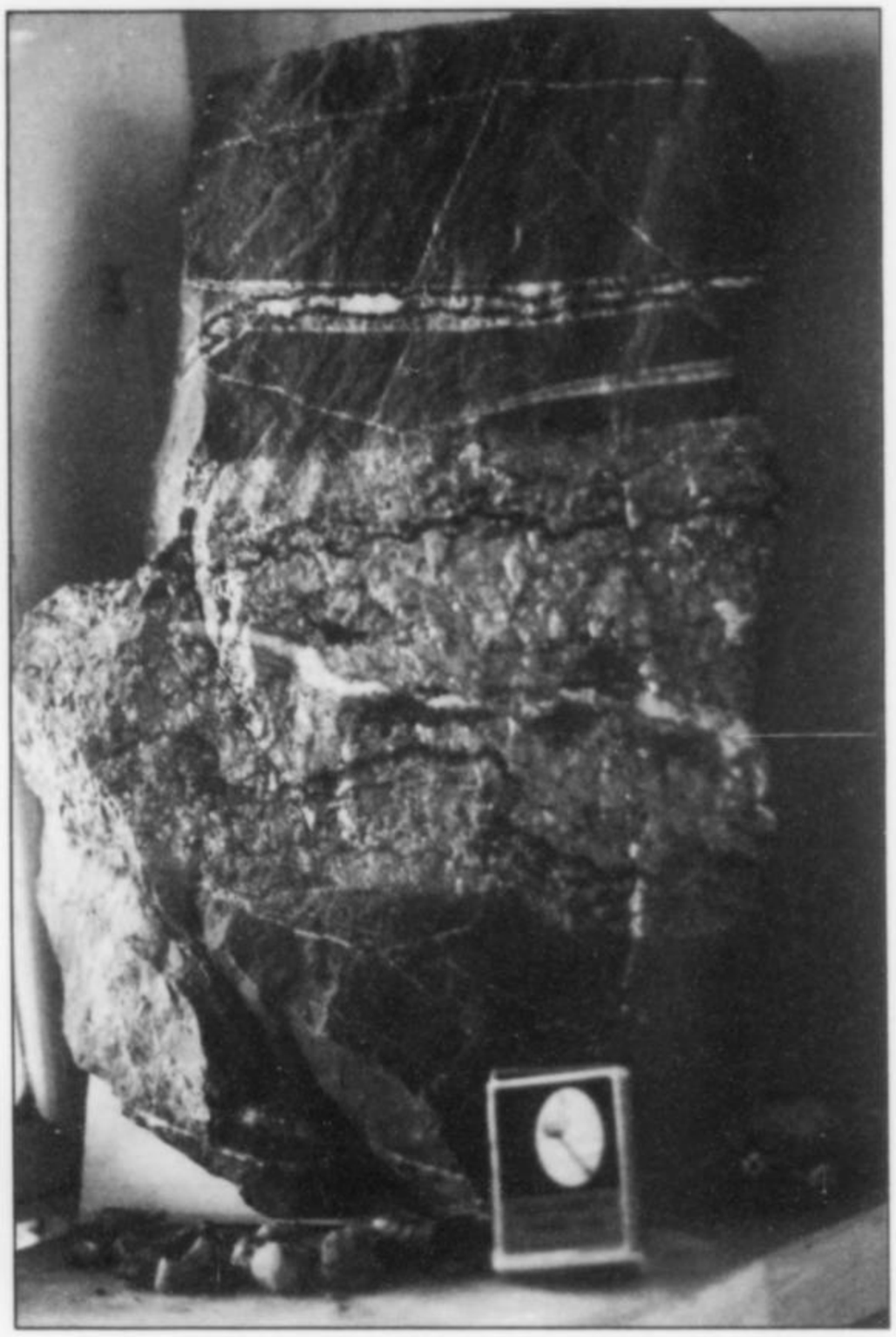


Figure 39. **Chunk of vein material from the Bolivar vein, Pailaviri mine. The massive pyrite contains thin, black stringers of cassiterite, the main ore mineral. Terry Szenics photo.**

Figure 40. **Red pyrargyrite crystals on black miargyrite with elongated red crystals of pyrostilpnite to 1 mm, from the Unificada mine. Rock Currier collection; Wendell Wilson photo.**

Figure 41. **Red pyrostilpnite crystals to 1 mm with black miargyrite, from the Unificada mine. Rock Currier collection; Wendell Wilson photo.**

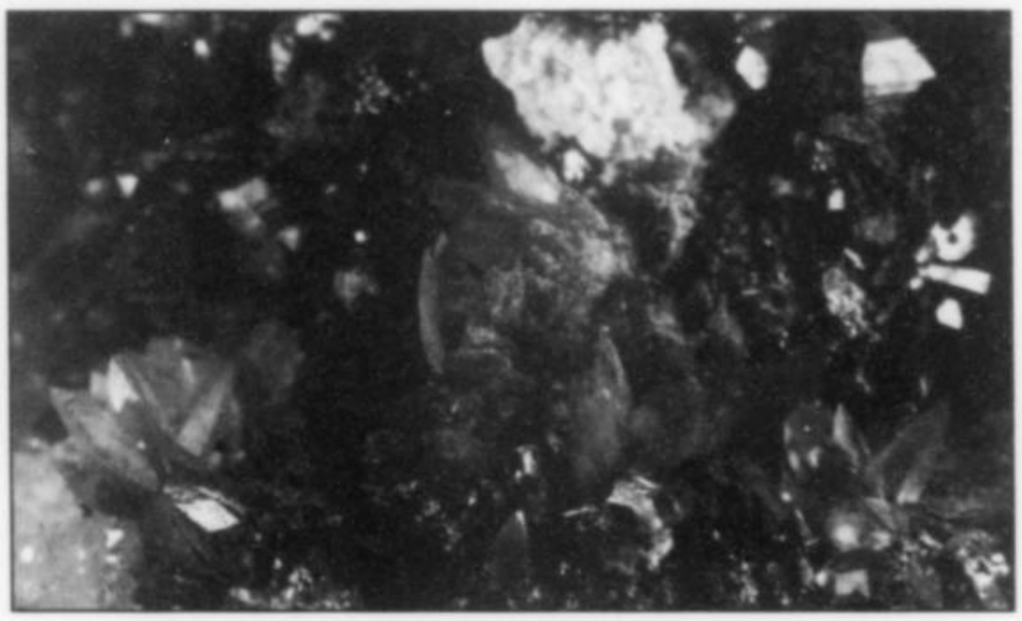


Figure 42. **Yellow siderite crystals to 1 mm, from the Unificada mine. Rock Currier collection; Wendell Wilson photo.**

members each being relatively equant. The re-entrant angle, looking rather like a fish-tail or swallow-tail twin, is bounded primarily by two corresponding triangular *c* faces meeting at an apex. Untwinned crystals are very rare, especially in the larger crystal sizes. Single crystals of an elongated prismatic habit are also known. Complete penetration twins, having a bow-tie aspect, are also very rare. Most twins are simple V-twins broken off at the base. Most of the crystal drawings shown here (prepared by R. Peter Richards) are in non-standard orientations so as to be more recognizable in comparison to actual specimens and the way they are typically mounted in collections. No crystal drawings of Cerro Rico phosphophyllite have previously been published.

Phosphophyllite crystals are generally very transparent, often showing incipient cleavage planes along {100} (perfect), {010} (distinct), and {102} (distinct). Some crystals show rounded edges and surface features which may indicate solution etching. Matrix, where present, usually contains associated arsenopyrite, stannite, and occasionally other sulfides.

The phosphophyllite crystals from Potosí, for size, color and quality, are by far the finest in the world.

Pickeringite $MgAl_2(SO_4)_4 \cdot 22H_2O$

Fast-growing fibrous masses of pickeringite and halotrichite are common in many of the old workings at Cerro Rico.

Proustite Ag_3AsS_3

Bolivians tend to call any fresh pyrargyrite which has not yet darkened, "proustite." However, all analyzed specimens have thus far turned out to be pyrargyrite. In all of the subvolcanic Sn-Ag mines in Bolivia, Sb sulfosalts greatly predominate over their As counterparts.

Pyrargyrite Ag_3SbS_3

Ahlfeld and Reyes (1955) reported pyrargyrite/miargyrite intergrowths, often intimately mixed with cassiterite, to be locally abundant in the upper levels of the Tajo Polo, Rica, and other veins. Thin, poorly developed prisms to 1.8 cm were also found.

In the early 1990's a rich new vein of mostly massive pyrargyrite (now named the Potosí vein) was discovered in a cooperative mining operation just above the Pailaviri mine, and was subsequently found to actually cut across the main haulageway of the Pailaviri mine, where it had gone unnoticed! Small vugs in this vein contain short, prismatic pyrargyrite crystals to 2 mm, associated with crystals of miargyrite, pyrostilpnite, valentinite, pyrite and quartz.

Pyrite FeS_2

Much of the lower portions of the Cerro Rico volcanic stock have been pyritized. Pyrite is the most abundant vein mineral at Potosí, in both the early and late assemblages. Most pyrite is massive, however, and good crystal specimens are scarce. Small cubes, pyritohedrons and complex combinations can still be found, associated with cassiterite and quartz crystals, in vugs in boulders of massive pyrite on the dumps.

Pyrostilpnite Ag_3SbS_3

Small (1–2 mm), well-formed orange-red crystals of pyrostilpnite having typical gypsum-like habit and flexibility have been found since 1995 in the newly opened Potosí vein. They occur in small vugs in massive pyrargyrite and miargyrite. Filiform-dendritic crystals have also been found. Associated species include crystals of diaphorite, miargyrite, quartz, pyrargyrite, pyrite, siderite and valentinite.

Quartz SiO_2

Quartz, massive and as small, simple crystals, is an abundant gangue mineral in both early and late-stage hydrothermal veins. On the southern flank of Cerro Rico, the main Tajo Polo vein grades into more or less pure quartz. Supergene or late-stage hydrothermal quartz also forms yellowish to pale blue micro-botryoidal chalcedonic crusts on sphalerite from Cerro Chico.

Ramdohrite $Ag_3Pb_6Sb_{11}S_{24}$

Ramdohrite from "Potosí, Bolivia" was reported by Harcourt (1942), who commented on the close similarity of its X-ray diffraction pattern to that of andorite. No other description was given regarding the specimen or its precise locality.

Siderite $Fe^{2+}CO_3$

Siderite occurs in small quantities as a late-stage hydrothermal mineral. Sharp, translucent, yellow scalenohedrons to a few millimeters in size accompany silver sulfosalts in the recently opened Potosí vein. Hollow, thin-shelled siderite scalenohedrons found on sphalerite at Cerro Chico may be pseudomorphs after smithsonite.

Sideronatrite $Na_2Fe^{3+}(SO_4)_2(OH)\cdot 3H_2O$

Ahlfeld and Reyes (1955) report silky orange sideronatrite associated with voltaite in the ancient workings.

Siderotil $Fe^{2+}SO_4\cdot 5H_2O$

White, pulverulent masses of siderotil form abundantly as a post-mining mineral on the walls of tunnels, especially near entrance adits, as a dehydration product of melanterite.

Silver Ag

Native silver was abundant at Cerro Rico in the early colonial days, but the oxide zone in which it occurred has been completely mined out. Very fine-grained disseminations in dacite, associated with chlorargyrite, also occur. Highly fragile specimens of loose, micro-filiform silver "moss" are still occasionally dug out of the "cementation zone" separating the oxide and primary zones.

Very few colonial-era silver specimens from Potosí have survived. Massive, compact silver specimens from several veins are preserved in the Gumucio Collection. The Vienna Natural History Museum has an 11-cm specimen of reticulated silver and also a sub-dendritic mass weighing 8 kg, acquired during colonial times. Kosnar (pers. comm.) reports having once owned a 1.9-kg chunk of massive native silver from Cerro Rico, associated with sharp miargyrite and pyrargyrite microcrystals.

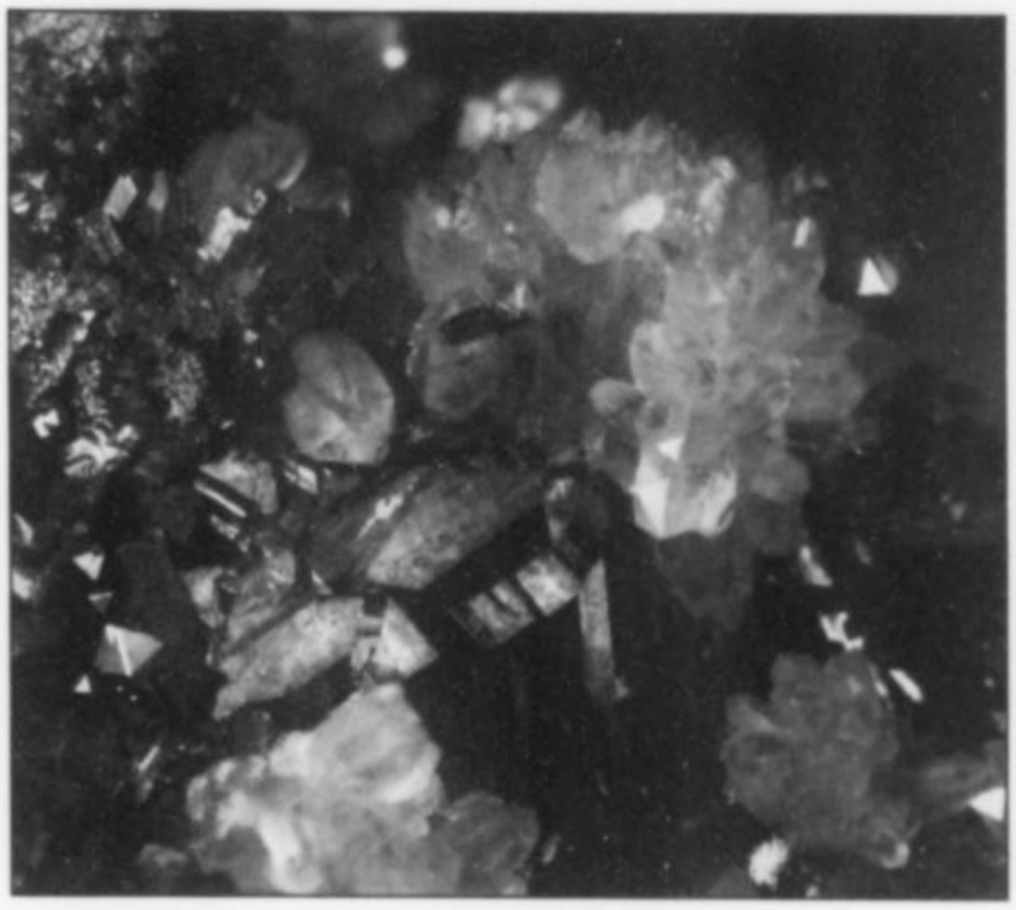


Figure 43. **Stannite crystals to 5 mm with quartz, from Cerro Rico. Alfredo Petrov collection; Wendell Wilson photo.**

Smithsonite $ZnCO_3$

Jaskolski (1933) and Ahlfeld and Reyes (1955) describe smithsonite from Cerro Chico de Potosí. It occurs as small, transparent, honey-yellow crystals and as reniform masses containing remnant inclusions of sphalerite, in cavities in galena. A recent find of hollow, thin-shelled siderite scalenohedrons on sphalerite may be pseudomorphs after smithsonite crystals.

Sphalerite (Zn,Fe)S

Sphalerite occurs sporadically in the Cerro Rico and Cerro Chico as both early and late-stage hydrothermal deposits, the earlier crystals tending to be more iron-rich.

Stannite Cu_2FeSnS_4

Good specimens of stannite from Cerro Rico were recognized and preserved as far back as the 19th century. Stelzner (1897) described crystals 1 to 3 mm associated with acicular arsenopyrite in vugs in pyrite from the Cotamitos vein. Similar specimens are still occasionally recovered, in association with crystals of arsenopyrite and quartz. The dominant habit of Potosí stannite is $p\{111\}$. Generally the crystals range from lustrous to dull gray, but in recent years several cabinet-size druses have been found which are brightly iridescent. Kosnar (pers. comm.) reports having owned "relatively sharp, somewhat lustrous, sphenoidal crystals to 1 cm on arsenopyrite microcrystals." The "Proctor/Kosnar phosphophyllite" (Fig. 36) matrix contains dull stannite crystals to 1 cm as well.

In the Mendieta-Tajo Polo vein system the abundance of stannite increases with depth, becoming quite common as botryoidal or concentric growths with pyrite and cassiterite. Chemically the stannite from Potosí is of usual composition in the upper levels but becomes increasingly zinc-rich with depth and takes on a dark brown to olive-green color (Ahlfeld *et al.*, 1935).

Figure 44. **Stannite crystals to 2 mm, from Cerro Rico. Alfredo Petrov collection; Wendell Wilson photo.**

Figure 45. **Arsenopyrite crystals to about 4 mm, with stannite and phosphophyllite, at the base of the "Wilber Phosphophyllite." Research Charitable Trust specimen; Harold and Erica Van Pelt photo.**

Stephanite Ag_5SbS_4

Kosnar (pers. comm.) reports having polished sections made in which minute amounts of stephanite have been identified.

Stibnite Sb_2S_3

Stibnite is a rare, late-stage hydrothermal mineral at Potosí. In 1995 some vugs in sphalerite in the Cerro Chico area produced fine acicular sprays of stibnite to 1 cm.

Teallite $PbSnS_2$

Kosnar (pers. comm.) reports the identification of lath-like crystals of teallite to 5 mm in polished sections.

Tetrahedrite $(Cu,Fe,Ag,Zn)_{12}Sb_4S_{13}$

Tetrahedrite is a common mineral at Potosí, as simple tetrahedrons to 1 cm. It is, at present, considered to be the most important silver ore mineral. Published references may cite tetrahedrite or freibergite, but analyses are absent.

Valentinite Sb_2O_3

Excellent sprays of transparent, adamantine valentinite blades to 1.5 cm were first found at Potosí in 1995, associated with pyrostilpnite in vugs in massive pyrargyrite-miargyrite in the Potosí vein. Dark gray valentinite colored by abundant microfiliform metallic inclusions is also known. The mineral is a primary late-stage hydrothermal product.

Varlamoffite $(Sn,Fe)(O,OH)_2$

Herzenberg (1946) described an amorphous hydrated tin oxide from Cerro Rico and named it *souxite* (after Luis Soux, a mine owner). It was found to occur abundantly as pale yellow, pulverulent masses with ferric iron and admixed silica, apparently having formed by the oxidation of stannite in the Utne vein, Cotamitos mine. It was described as being easily soluble in acids (unlike cassiterite), but unstable in the air, altering further to a very fine-grained, acid-insoluble cassiterite. His work was not convincing, however, and proved only that tin in some form soluble in acids was present. Reviewer Michael Fleischer wrote: "This may be a new mineral, but the evidence is certainly insufficient to justify a name or the assignment of a formula" (*American Mineralogist*, **32**, 372).

The following year DeDycker (Buttgenbach, 1947) described a similar yellow, earthy alteration product of stannite from tin-bearing veins in the Belgian Congo, naming it *varlamoffite* (after Nicolas Varlamoff, a mining engineer in the Belgian Congo who discovered it). Only analyses of mixtures were provided. Fleischer's comments appended to his abstract of the description read simply: "Compare the similar souxite" (*American Mineralogist*, **34**, 618); Fleischer remains unconvinced of its validity as a species, listing it in his *Glossary of Mineral Species 1995* as "perhaps a variety of cassiterite."

In 1982 the material was again analyzed, this time from a granite in China, by Deng *et al*. They retained the name varlamoffite, and

Table 4. **Mineral species occurring in the ore deposits at Cerro Rico de Potosí.**

Species	*Zone**	*Composition*
Elements		
Arsenic	O, C?	As
Silver	O, C	Ag
Sulfides		
Acanthite	O, C	Ag_2S
Arsenopyrite	EH	FeAsS
Arsenosulvanite	EH	$Cu_3(As,V)S_4$
Berndtite	C?	SnS_2
Bismuthinite	EH	Bi_2S_3
Chalcocite	C	Cu_2S
Chalcopyrite	EH, LH	$CuFeS_2$
Covellite	C	CuS
Fizelyite**	EH	$Pb_{14}Ag_5Sb_{21}S_{48}$
Galena	LH	PbS
Ottemannite	C?	Sn_2S_3
Pyrite	EH-LH	FeS_2
Semseyite**	EH	$Pb_9Sb_8S_{21}$
Sphalerite	EH-LH	(Zn,Fe)S
Stannite	EH-LH	Cu_2FeSnS_4
Stibnite	LH	Sb_2S_3
Teallite	LH?	$PbSnS_2$
Wurtzite	LH	(Zn,Fe)S
Sulfosalts		
Andorite	LH	$PbAgSb_3S_6$
Berthierite	LH?	$FeSb_2S_4$
Boulangerite	LH	$Pb_5Sb_4S_{11}$
Bournonite	LH	$PbCuSbS_3$
Diaphorite	LH	$Pb_2Ag_3Sb_3S_8$
Franckeite	LH	$(Pb,Sn^{2+})_6Fe^{2+}Sn_2^{4+}Sb_2^{3+}S_{14}$
Freibergite	LH?	$(Ag,Cu,Fe)_{12}(Sb,As)_4S_{13}$
Jamesonite	LH	$Pb_4FeSb_6S_{14}$
Löllingite	LH?	$FeAs_2$
Matildite	LH	$AgBiS_2$
Miargyrite	LH	$AgSbS_2$
Pyrargyrite	LH	Ag_3SbS_3
Pyrostilpnite	LH	Ag_3SbS_3
Ramdohrite	LH?	$Ag_3Pb_6Sb_{11}S_{24}$
Stephanite	LH?	Ag_5SbS_4
Tetrahedrite	LH	$(Cu,Fe,Ag,Zn)_{12}Sb_4S_{13}$
Xanthoconite	LH	Ag_3AsS_3
Zinkenite	LH	$Pb_9Sb_{22}S_{42}$
Halides		
Chlorargyrite	O	AgCl
Oxides, Hydroxides, etc.		
Cassiterite	EH-LH, O	SnO_2
Goethite	O	$Fe^{3+}O(OH)$
Hematite	O	Fe_2O_3
Lepidocrocite	O	$Fe^{3+}O(OH)$
Quartz	EH-LH, O	SiO_2
Valentinite	LH	Sb_2O_3
"Varlamoffite"	LH or O	$(Sn,Fe)(O,OH)_2$
Carbonates		
Calcite	LH	$CaCO_3$
Cerussite	O	$PbCO_3$
Siderite	LH	$Fe^{2+}CO_3$
Smithsonite	O	$ZnCO_3$
Witherite	LH?	$BaCO_3$
Sulfates		
Alunite Group	LH	
Anglesite	O	$PbSo_4$
Barite	LH	$BaSO_4$
Chalcanthite	O, P	$CuSO_4 \cdot 5H_2O$
Copiapite Group	P	
Goslarite	O, P	$ZnSO_4 \cdot 7H_2O$
Halotrichite	P	$Fe^{2+}Al_2(SO_4)_4 \cdot 22H_2O$
Jarosite	O, LH?	$K_2Fe_6^{3+}(SO_4)_4(OH)_{12}$
Melanterite	P	$Fe^{2+}SO_4 \cdot 7H_2O$
Pickeringite	P	$MgAl_2(SO_4)_4 \cdot 22H_2O$
Sideronatrite	P	$Na_2Fe^{3+}(SO_4)_2(OH) \cdot 3H_2O$
Siderotil	P	$Fe^{2+}SO_4 \cdot 5H_2O$
Voltaite	P	$K_2Fe_5^{2+}Fe_4^{3+}(SO_4)_{12} \cdot 18H_2O$
Zinc-melanterite	O	$(Zn,Cu^{2+},Fe^{2+})SO_4 \cdot 7H_2O$
Tungstates		
Wolframite	EH	$(Mn,Fe)WO_4$
Phosphates		
Childrenite	LH?	$Fe^{2+}Al(PO_4)(OH)_2 \cdot H_2O$
Fluorapatite	EH?	$Ca_5(PO_4)_3F$
Hopeite	LH?	$Zn_3(PO_4)_2 \cdot 4H_2O$
Lazulite?	AV?	$MgAl_2(PO_4)_2(OH)_2$
Phosphophyllite	LH	$Zn_2Fe^{2+}(PO_4)_2 \cdot 4H_2O$
Wavellite	LH	$Al_3(PO_4)_2(OH,F)_3 \cdot 5H_2O$
Arsenates		
Pharmacosiderite	O,LH?	$KFe_4^{3+}(AsO_4)_3(OH)_4 \cdot 6–7H_2O$
Sililcates		
Nacrite, Chlorite, Kaolinite, Tourmaline, Almandine (LH)		

*Zone abbreviations: O = Oxide zone, C = Cementation zone, EH = Early Hydrothermal zone, LH = Late Hydrothermal zone, P = Postmining

**Found as ore in the Don Mauricio vein (pers. comm. mine engineer Salomon Rivas)

provided a fuller description of apparently better-formed material: orange-red, semi-transparent, vitreous to greasy, sp. gr. 3.21–3.26, *nearly* amorphous with X-ray lines at 3.30, 2.5810 and 1.4105, unit cell parameters a = 4.6671, c = 3.0959 Å, and space group $p\,4_2/mnm$. This was apparently sufficient evidence for Nickel and Nichols (1991), who gave the mineral full species status in their *Mineral Reference Manual*.

Consequently it appears that Cerro Rico was very nearly the type locality for the questionable species currently referred to as varlamoffite.

Voltaite $K_2Fe_5^{2+}Fe_4^{3+}(SO_4)_{12} \cdot 18H_2O$

Lindgren and Creveling (1928) reported waxy, olive-green voltaite crystals associated with orange sideronatrite in the ancient workings.

Wavellite $Al_3(PO_4)_2(OH,F)_3 \cdot 5H_2O$

Crusts of tiny, colorless wavellite crystals lining vugs in stannite were described by Ahlfeld and Reyes (1955) from the Tajo Polo vein. Recently some yellowish, micro-botryoidal crusts have been found coating pyrite and silver sulfosalts in the newly opened

Potosí vein. The Roberto Herzenberg collection contained wavellite with pyrite, arsenopyrite and cassiterite from the San Miguel vein.

Wolframite series $(Mn,Fe)^{2+}WO_4$

Thin, tabular crystals of wolframite (exact composition undetermined) occur in the deeper levels of the Utne and Tajo Polo vein systems, associated with early hydrothermal quartz and pyrite. The Roberto Herzenberg collection contained specimens of Cerro Rico wolframite with cassiterite and stannite. Although wolframite is not especially abundant at Cerro Rico, the deeper levels of the Unificada mine at one time yielded several tons annually.

Kosnar (pers. comm.) contends that Cerro Rico wolframite is probably ferberite, the iron end-member of the series. Six specimens he has had analyzed from other mines in the Bolivian tin belt have all proven to be ferberite, and there seems to be (judging by the thousands of specimens he has seen) a general paucity of Mn throughout the Bolivian deposits. Kosnar once held a specimen concession at Ahlfeld's tungsten mine at Chicote Grande, which produced hundreds of "wolframite" specimens containing less than 1% Mn.

Wurtzite (Zn,Fe)S

Ahlfeld and Reyes (1855) reported compact wurtzite with jamesonite from the Lourdes mine on the southern flank of the Cerro Rico. Sharp, translucent, brownish red hexagonal platelets to 2 mm can still be found in vugs in sphalerite and tetrahedrite from ore piles on the northern flank of Cerro Rico.

Xanthoconite Ag_3AsS_3

In 1996 a single 1-mm, orange, thin-tabular hexagonal platelet of twinned xanthoconite was found with pyrostilpnite and pyrargyrite in the newly opened Potosí vein.

Zinc-melanterite $(Zn,Cu^{2+},Fe^{2+})SO_4 \cdot 7H_2O$

Small, 2-mm masses of compact, fine-grained, yellow-green zinc-melanterite were found in 1994 as an alteration product of zincian stannite.

Zinkenite $Pb_9Sb_{22}S_{42}$

Zinkenite was listed by Jaskolski (1933) as a late-stage hydrothermal mineral at Cerro Rico. Although we have not been able to confirm that report, zinkenite is a fairly common mineral in the Bolivian tin belt, so there is no reason to doubt its occurrence at Potosí. Kosnar (pers. comm.) has confirmed the presence of slender zinkenite prisms associated with stannite, franckeite and andorite (by X-ray diffraction analysis).

CURRENT COLLECTING OPPORTUNITIES

Nearly all of the surface of Cerro Rico is today covered by dumps, and there are no fences to keep out mineral collectors except in the vicinity of the Pailaviri mine. Most of the dump material consists of boulders of massive pyrite and tough, silicified volcanic rocks. With patience and a heavy hammer one can find vugs containing crystals (mostly microcrystals) of quartz, pyrite, arsenopyrite, cassiterite, jarosite and barite. Some of the smaller mining cooperatives have ore piles accumulating outside their adits, and the miners are quite happy to sell a vuggy lump out of the pile for a dollar to two. In such fresh sulfide ore one can find crystals of sphalerite, wurtzite, siderite, wavellite, tetrahedrite and other less common sulfosalts. Remember that, in the dry tropics at an altitude of 14,000 to 15,000 feet the sunlight (especially ultraviolet) is intense, and sunstroke and dehydration are serious dangers. Take a hat, sunscreen, and plenty of fluids.

Because of recent political conflicts, tours are no longer being offered at the Pailaviri mine, but some of the impoverished Indian-owned cooperatives are still willing to accept a few dollars for an underground tour of their workings. Climbing and sliding around inside working stopes which are two or three hours hike deep into the mountain seems to be the favorite entertainment lately for backpacker tourists visiting Potosí. Several tourist agencies are now organizing such excursions commercially. The independent mineral collector may be able to arrange a visit to a working stope by offering some traditional Bolivian miners' gifts such as liquor, cigarettes, a pound of coca leaves, or a few sticks of dynamite (all of which can be purchased legally on the streets of Potosí). It is also good to remember that every adit contains a small shrine or statue of Tio, the subterranean god who "owns" the minerals and who must be compensated for their removal. It is customary to leave some alcohol, coca leaves, cigarettes or money there as an offering.

A few of the old Spanish silver mines are still accessible in the upper oxide zone near the peak of Cerro Rico. Human bones are more common there than good mineral specimens, but for silver it is the only place to look because all of the old workings farther down the mountainside are buried under younger dump material.

POSTSCRIPT: BOLIVIAN COLLECTIONS

Most so-called Bolivian "collections" of minerals are merely shelves piled with massive, unlabeled ore samples. As a historical note it is worth mentioning that only four important collections of classic Bolivian specimens were built during the mid-20th century. These are the collections of Mark Bandy, Friedrich Ahlfeld, Roberto Herzenberg, and Julio Gumucio.

Mark Chance Bandy (1900–1963) was an American mining engineer and mineral collector. With a 1938 Harvard PhD degree under his belt, he set off on a career primarily in foreign mining geology that took him to Mexico, Europe, Africa, Venezuela, Chile and Bolivia (Chief Geologist for 11 years at Llallagua). He was also a Latin scholar, translating and publishing Agricola's *De natura fossilium*. A Chilean mineral he found was named *bandylite* in his honor. After retiring to Wickenburg, Arizona, in 1958 he set up his large and fine mineral collection, rich in Bolivian specimens, in a special out-building near his home. Ten years after his death in 1963 his widow, Jean Bandy, arranged for his collection to go to the Natural History Museum of Los Angeles County, where it is preserved today. (See "The Mark Chance Bandy collection" by Bob Jones in vol. 4, no. 5, and series of Bandy's Chilean collecting memoirs published in vol. 14, no. 6 and vol. 15, no. 2 and 3.)

Roberto Herzenberg (1885–1956), after whom the mineral *herzenbergite* was named, was a Latvian-born German mineralogist who was especially adept at quantitative analysis. He discovered several new species in Bolivia (including *rooseveltite*), but some of them described purely in chemical terms were later discredited. He worked in Oruro, Bolivia, as Chief Chemist for the German-Jewish "tin baron" Mauricio Hochschild. His extensive mineral collection of 2,731 specimens, most of them cabinet-size to museum-size Bolivian minerals, was sold to Pablo Biggemann, owner of several Bolivian mines. Biggemann gradually dispersed the better part of the collection through visiting foreign dealers (notably Martin Ehrmann), and left the remainder to the Technical University of Oruro where it is currently on display. Herzenberg's catalog lists 46 specimens from Cerro Rico de Potosí, including one alunite, 27 cassiterites, two sphalerites, ten stannites, two jamesonites and two wolframites (but no phosphophyllite, which was not recognized at Potosí until a year after his death).

Little seems to be known about **Julio Gumucio**, but he is the only collector of the four who was a native-born Bolivian. He was a mining engineer during the pre-revolution years at the Siglo Veinte mine in Llallagua, and in his old age managed the railroad yard of tin baron Simon Patino in Machacamarca. His collection

was obtained by the Banco Minero in La Paz, and was displayed there for many years. When the Banco Minero failed, the collection went into storage for a time, then reappeared recently in the old Spanish mint building (the *Casa Moneda*) in downtown Potosí, where it is open to the public. It still contains some good specimens, but many were probably pilfered during its years out of public view.

Friedrich Ahlfeld (1892–1982) was a German mining engineer and geologist who devoted himself to Bolivian mineralogy, and wrote important reference works including *Las Especies Minerales de Bolivia* (1937, 1943 and 1955). Ahlfeld was a geologist at the Unificada mine, Cerro Rico de Potosí from 1948 to 1950, but had relatively few specimens from there in his collection. He did sell specimens to museums and visiting dealers, including in later years a specimen of phosphophyllite sold to two young American dealers, Charles Key and Jack Young, for $50. Even after his death, specimens from his collection were being sold piecemeal by his widow. Presumably it is now totally dispersed.

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What's New in Minerals

Delaware Show 1998 by Joe Polityka

[March 7 and 8, 1998]

I made my way down to Claymont, Delaware, on Friday March 6th. As a club member I volunteer to help with the show set up (move tables, set up wiring, carry boxes of minerals for the junior booth, etc.). I enjoy the exercise, small talk and the Friday night dinner for the dealers and volunteers. It seems that the same small core group of people show up early to do most of the bull work. Of course, this is true with all mineral clubs, and volunteer groups in general, and I have been guilty in the past of not doing my share. Now to the minerals . . .

M. Phantom Minerals, Columbus, Ohio, had more **creedite** from Rodeo, Durango, Mexico. Most specimens are miniature-size, spherical aggregates of pale orange crystals to 1 cm. Some specimens are floaters that have areas covered by brown crystals that alternate with areas of orange crystals, a pleasing contrast. A new find of botryoidal **azurite/malachite** (reminiscent of Arizona material) was offered from Ibiajara, Bahia, Brazil. Most specimens are in the miniature range, although several small cabinet specimens were on display. Also from Brazil were about a dozen miniature-size, doubly terminated quartz groups with needle-like inclusions of a black **tourmaline** from the Arturo Costa mine, Jaguaraçu, Minas Gerais. **Amethyst** crystal groups from three locations were a prominent feature: a 15-cm mound (crystals to 8 cm) of amethyst from the Reel mine, Lincoln County, North Carolina, was going for about $800. This specimen was collected about a year ago and is one of the best to come out since the location's "glory days." Amethyst scepters (average size 1 cm) from Tamil Nadu, India, and doubly terminated matrix groups (crystals to 4 cm) from Lake Balkash, Dzezkazgan, Kazahkstan, rounded out the triad.

Broken Back Minerals, Newark, Delaware, had about a flat of **chalcocite** from the Flambeau mine, Ladysmith, Wisconsin. This mine is now closed and the area, to my understanding, has been filled and restored to its original condition. Also available were several flats of classic Colorado specimens. This is from an old collection which contained a lot of sulfides and associated species.

The Rocksmiths had a large inventory of minerals and fossils from China. The material sold rapidly, so you will have to catch them at their next show when the supply is replenished.

Clifton, New Jersey, Show 1998 by Joe Polityka

[March 14 and 15, 1998]

This great little show does its best to pack as many high-quality dealers as possible into the gymnasium of the Pope John Paul elementary school. Like the Delaware show, the folks who run this show are a friendly, down-to-earth group.

Rocko, Margaretville, New York, had herkimer diamond scepters on smoky stems from Little Falls, New York. A typical specimen has a 2.5-cm herkimer quartz crystal on a 2.5-cm-long single quartz crystal. These specimens first appeared at the Rochester Symposium several years ago and caused quite a stir. Rob of *Rocko* told me they have acquired the property on which the specimens are found; therefore, it is possible that more scepters will be found in the future.

Carter Rich, Aldie, Virginia, has just purchased a portion of the **Ed Swoboda Pseudomorph Collection.** All types of pseudomorphs from classic locations were available, including copper after calcite crystals from the Michigan copper country.

New Jersey Earth Science Show by Joe Polityka

[April 25–26]

This year, because of scheduling problems, the Rochester Symposium and the New Jersey Earth Science Show took place on the same weekend. Needless to say, quite a few folks suffered the psychological pain of having to choose between these two great events. I decided to say close to home and attended the New Jersey show. A lot of my old buddies chose to attend the Rochester show (not a bad choice), which reduced the time I would have spent socializing, schmoozing or rapping.

Mineral "fluorescence" was the show exhibit theme this year. You can be certain that, in the land of "glow in the dark rocks," the exhibits were exceptional. Never in my lifetime have I seen such color combinations in Franklin-Sterling Hill, New Jersey, minerals. Many specimens, in addition to the usual red and green of calcite and willemite, had multiple associated minerals such as esperite, sphalerite and hardystonite. The combination of red, green, yellow, blue and orange on specimens a foot across was a sight to behold. There were roughly 40 cases of superlative fluorescent minerals from around the globe and I can assure you that the emitted light made it easy to navigate about the darkened room.

I set up an exhibit this year; therefore, I was allowed to preview the dealer's stock. After the traditional Friday evening buffet, I made my way around the large hall and commenced to sniff out whatever was new, old or recycled, and soon realized that "sticker shock" was to become the main topic among serious collectors at the show. Prices have always been a sensitive topic, and the perspectives of buyer and seller are always at odds. The theories of supply and demand apply to pizzas, topsoil and yachts, with demand being governed by how much is available, how easy it is to produce and how many people have the money to pay for it. When it comes to one-of-a-kind items, such as collectibles, prices are always all over the map, with the top pieces commanding high prices. What poorer collectors such as myself have to do is follow the late Neal Yedlin's advice and "find other ways to get around high prices" by being educated, persistent, stubborn, crafty and energetic consumers. Honestly, I have yet to meet a collector who

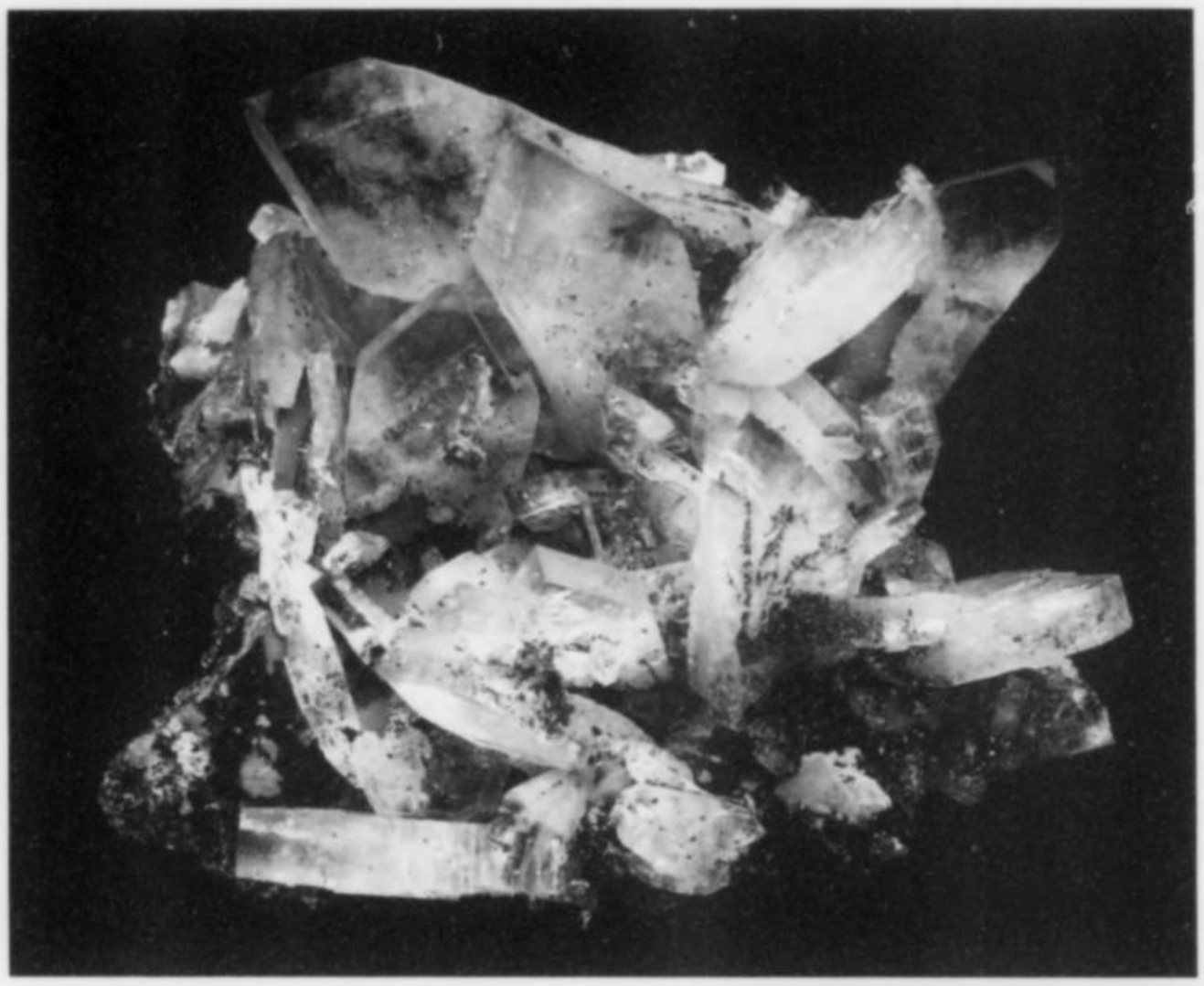


Figure 1. **Barite crystal group, 9 cm, from Shangulowe, Katanga, Congo. Pierre and Martine Clavel collection; L.-D. Bayle photo.**

Figure 2. **Brochantite crystals to 6 mm in gypsum, from Huancavelica, Peru. Multiaxes specimen; L.-D. Bayle photo.**

Figure 3. **Barite crystal group, 7.5 cm, from Shangulowe, Katanga, Congo. Pierre and Martine Clavel collection; L.-D. Bayle photo.**

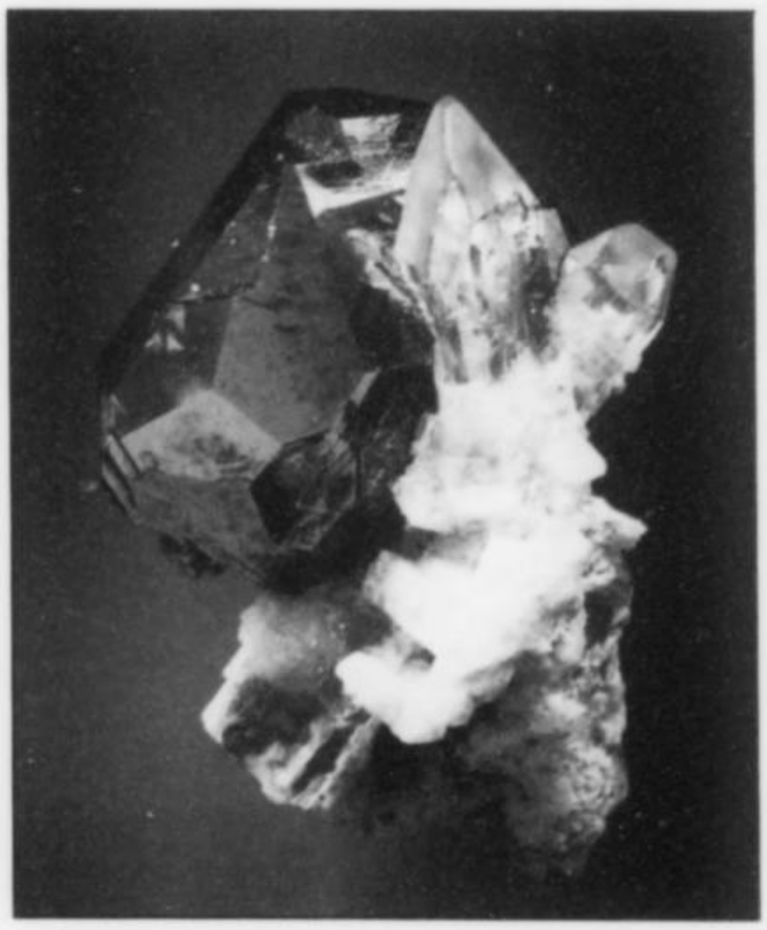


Figure 4. **Bixbyite crystal with topaz, 2.7 cm, from the Thomas Range, Utah. Utah Mineral and Fossil Company specimen; Jeff Scovil photo.**

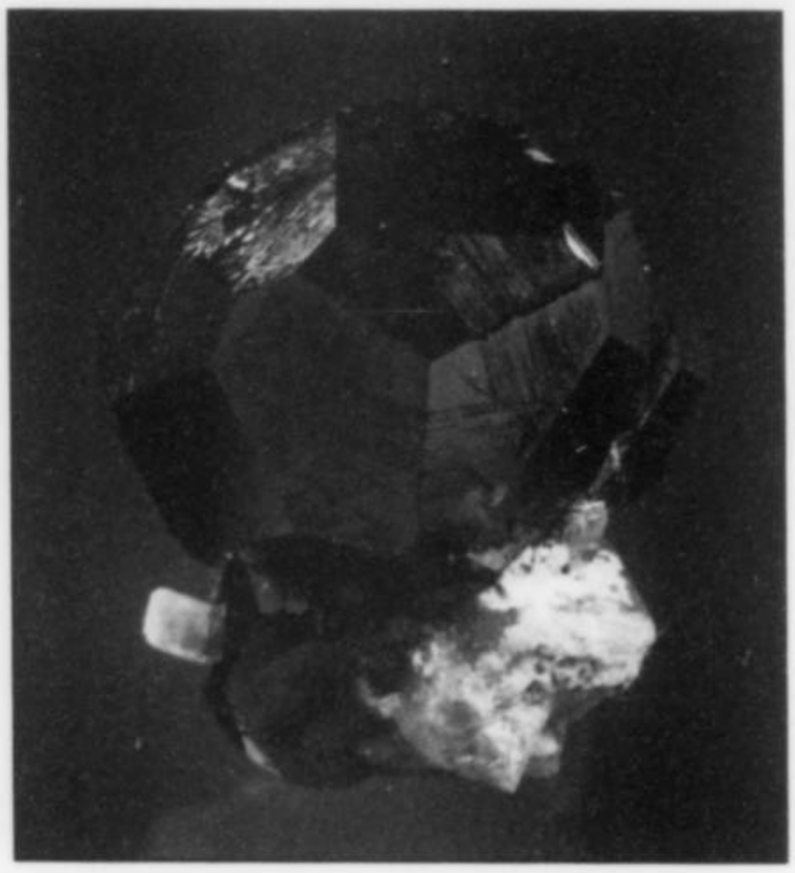


Figure 5. **Bixbyite crystal with topaz, 2.1 cm, from the Thomas Range, Utah. Utah Mineral and Fossil Company specimen, now in the Ralph Clark collection; Jeff Scovil photo.**

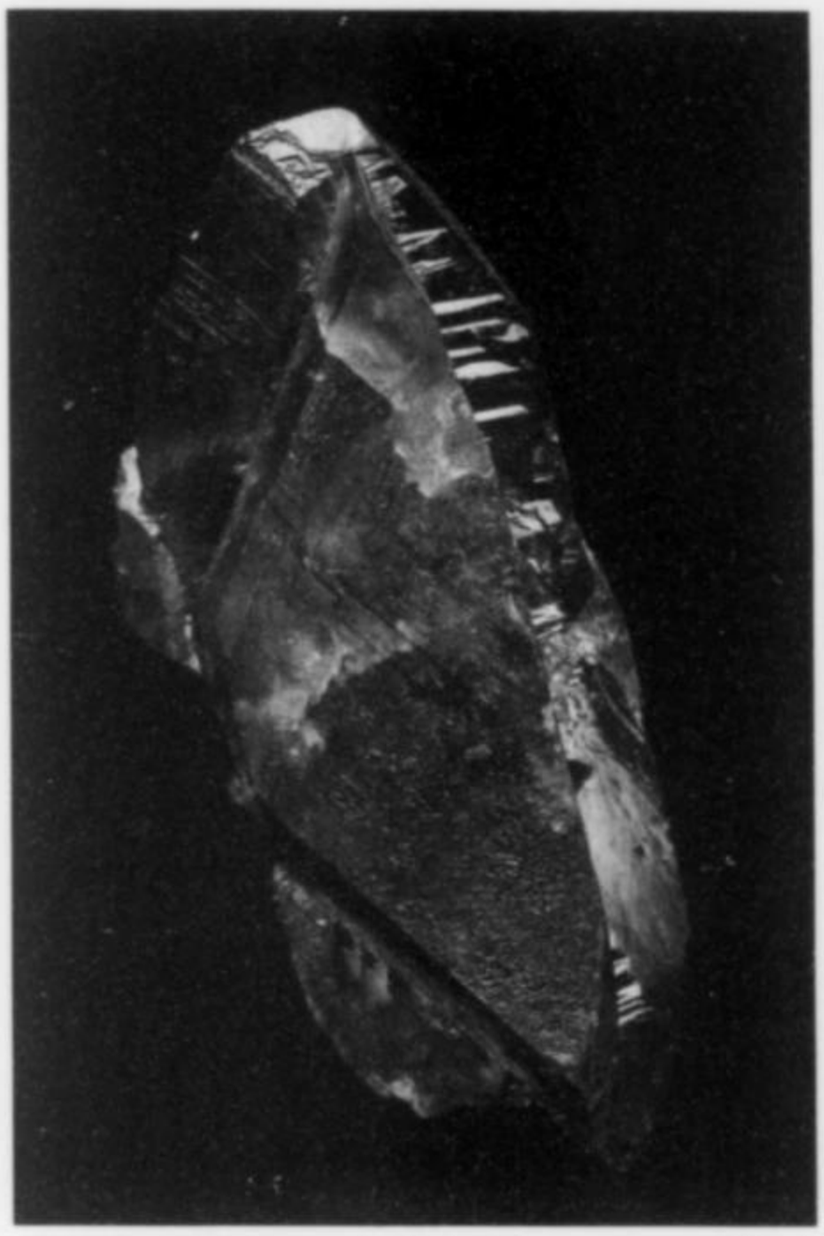


Figure 6. **Titanite twin, 5.4 cm, from Androy, Madagascar. Seibel Minerals specimen; Jeff Scovil photo.**

Figure 7. **Arsenopyrite crystals with quartz, 5 cm, from the San Antonio mine, San Antonio, Chihuahua, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.**

Figure 8. **Wulfenite crystals on matrix, 4.6 cm, from the Michelle prospect, Rayon, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.**

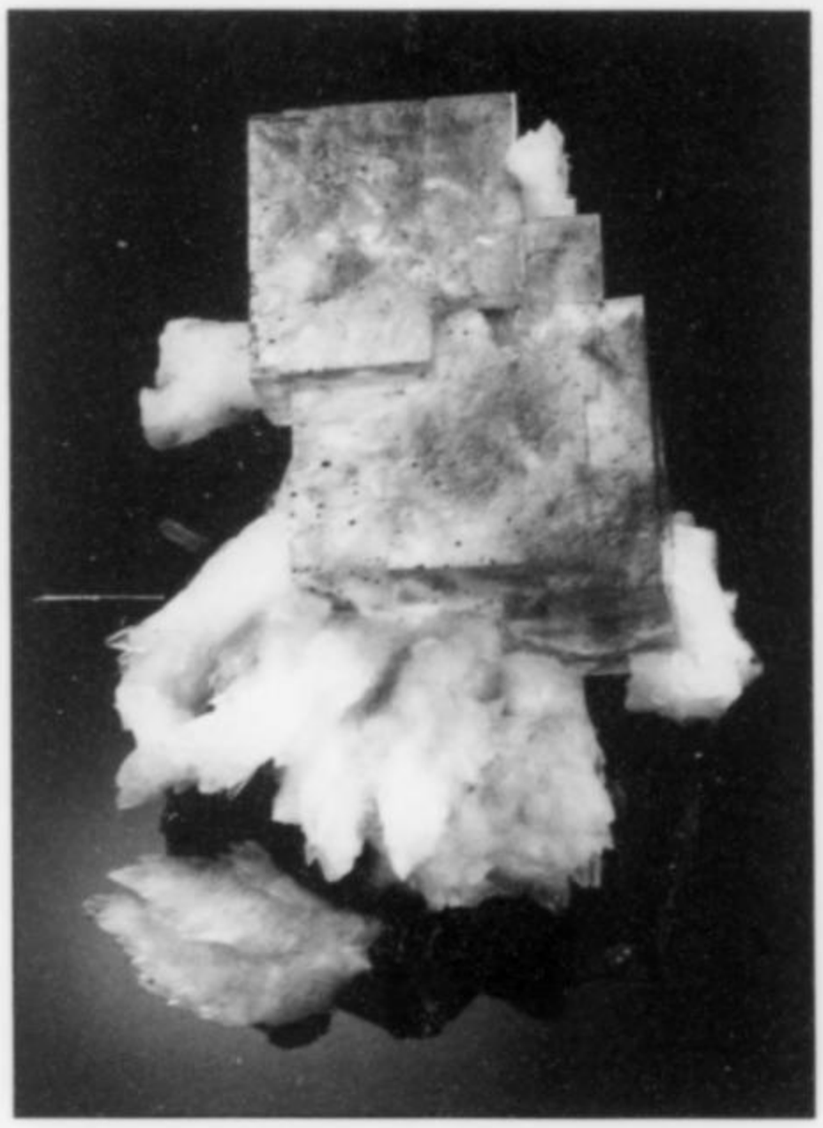


Figure 9. **Fluorite crystals with calcite, 6.5 cm, from the San Antonio mine, San Antonio, Chihuahua, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.**

Figure 10. **Hemimorphite crystal cluster, 2.5 cm, on limonitic matrix, from the 8th level ramp, San Antonio mine, San Antonio, Chihuahua, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.**

felt prices were too low or a dealer who felt prices were too high, myself included.

As usual, there was available at the show a wide variety of minerals with prices covering the entire spectrum.

Fred Parker (2409 Graystone Lane, Frederick, MD 21702) showed me some **smoky quartz** from a secret location in Howard County, Maryland. The single crystals reach about 12 cm in length and have a medium brown color. Fred says he might have more in the future. The specimens I saw (four single crystals) were not for sale. Fred also has stepped **calcite** crystals from an undisclosed limestone quarry in central Maryland. More specimens should be available in the future.

Weinrich Minerals has a large supply of **barite** from the Hammam Zriba mine, Hammam Zriba, Tunisia. The crystals are bluish gray with a red coating on the terminations. Dan had several 10 x 10-cm cabinet specimens and many single crystals averaging 5 x 5 cm. According to his Summer 1998 catalog, there are still some specimens in his inventory.

Dave Bunk had a nice selection of **quartz Japan-law twins** from the PC mine, Jefferson County, Montana. Dave also had a nice selection of **vanadinite** from the North Geronimo mine, La Paz County, Arizona.

Mountain Minerals International had the usual nice selection of specimens from India and Pakistan. What caught my eye, however, was **vesuvianite** from the Susa Valley, Italy. Dudley had several miniature specimens with prismatic, olive-green crystals to 3 cm (at first glance they remind you of tourmaline). The specimens were found in 1992 and are on consignment from the Italian collector who found them. *Dennis Beals* was sharing Dudley's booth and was offering a large assortment of **sulfides and sulfosalts** from Mexico. His selection of **pink grossular** from Sierra De Las Cruces, Mexico, was outstanding, with most specimens in miniature to cabinet sizes.

The Rocksmiths had some attractive **barite on malachite** from Mulinguisha, 120 km north of Lisaki, Democratic Republic of Congo. The pale green crystals reach 2 cm and sit proudly on the contrasting malachite matrix. The average specimen is about 5 x 5 cm in size. A show sleeper was the **lepidolite** pseudomorphs after tourmaline from the Jacare mine, Minas Gerais, Brazil. The single crystals are mostly thumbnail sized and are opaque pink, about the color of Bazooka bubble gum.

Wright's Rockshop had the best Maudlin Mountain, Arkansas, **wavellite** I have seen in a long time. The specimens have the sea-green color of fine prehnite, and are clean and undamaged. The specimens I saw were all cabinet sized, up to 7 x 7 cm.

I was told that next year's show will remain at the Armory and will definitely not be competing with the Rochester, New York Symposium. Hopefully I will see you at both shows.

Paris-Hilton Show 1998

by Pierre-Nicolas Schwab

[Mar. 20–22]

After being deprived of mineralogical events for 6 months (actually since the Munich "Mineralientage"), I'm always delighted to attend the Paris-Hilton show. It has indeed several positive sides. First of all, the attendance is good (about 5,000 visitors) and the dealers rank among Europe's best. Then, it's held in Paris (near the Eiffel tower) providing visitors ample opportunity to discover at least a tiny part of Paris's many charms. Furthermore, the show is held in a luxury hotel that provides high-quality services.

Mineralogically, however, this year's show yielded relatively few new mineral discoveries, though two in particular caught my eye:

A Belgian dealer offered numerous specimens of **gypsum with brochantite** inclusions recently mined in the Huancavelica region, Peru. The specimens consist of large gypsum crystals (up to 15 cm) containing acicular dark green brochantite crystals. Good groups of brochantite crystals, not included in gypsum, also were available.

Unfortunately, I wasn't able to obtain much information about the exact locality. Brochantite and gypsum are unusual for the Huancavelica area. According to the recent Peru Issue, these species have not previously been reported from there.

The other new find is some beautifully crystallized green **barite** specimens from the Democratic Republic of Congo (previously known as Zaire). Here I'd like to thank Mr. Pendeville, from Belgium, for providing additional information about the locality and the discovery itself. These barite specimens, colored green by malachite inclusions, are from Shangulowe, an abandoned open pit mined prior to 1943 for copper. Barite is currently mined with traditional methods by locals, who subsequently bring their specimens to Mulungwishi, a small village located 40 miles north of Likasi. The specimens are then transported to major towns in the country, where they are sold. Now to the description of the specimens: Large crystals, up to 5 cm (2 inches), were available, some of them in groups exceeding 15 cm. The crystals show various crystal habits; according to the dealer, more than 12 different habits have been reported. Finally, the matrix consists of pure malachite. The only negative side was the prices: the least expensive specimen was priced at $100. But Shagulowe can be considered as *the* classic occurrence for green barite; specimens from this locality are well represented in the collection of the Sangier-Cousin Museum in Likasi (Katanga). One might justify a little sacrifice.

Finally, Patrick Allier had some specimens of **mordenite**, a relatively uncommon zeolite. The occurrence is Ahmednagar, near Bombay, India. The specimens consist of white balls to 1 inch, on a basaltic matrix. Such attractive and affordable specimens of mordenite are seldom seen at shows.

It was not what one would call a tremendous show, but the Hilton precedes the Sainte-Marie-aux-Mines show, France's premier mineralogical event, with more than 500 dealers.

Spring Denver Show 1998

by Jeff Scovil

The spring mineral shows seem now to be in the distant past and my travels have delayed the writing of this report. I now have to dredge the depths of my memory (assisted luckily by notes) to recall what I have seen that is new and notable.

I'll start with the new Springtime-in-the-Rockies show in Denver, Colorado. It was held at the Holiday Inn North, April 17 through 19. Casey Jones of *Geoprime*, who recovered those wonderful Flambeau mine chalcocites, finalized his collecting contract with the Barrick Meikle mine in Nevada. On March 17th a vug of smoky **calcite** scalenohedra modified by the rhombohedron was found with crystals up to 5 cm long. On March 20 a vug about 30 feet deep by 20 feet wide by 40 feet high was hit. It was lined with greenish calcite crystals to 15 cm long in plates up to 40 cm across. Many crystals have blackish to brownish edges. A good selection of this material was for sale at the show.

Chris Tucker and his associates had secured a claim last year on the Pack Rat claim on Red Pryor Mountain, Carbon County, Montana. His room was filled with the **barite** this locality produces. They are brown to light tan, diamond-shaped crystals in

random to subparallel, to rosette-like clusters to 8 cm across. The attractive and reasonably priced specimens were available in sizes up to 48 cm.

In the room of *Seibel Minerals* I found some rather large, very well formed, yellow-green twinned **titanite** crystals. They are a new find from Androy, Madagascar. Although his largest were in excess of 15 cm long, I have heard that large, incomplete ones exceed 15 cm.

Dan Belsher of *Blue Sky Mining* has been busy in Mexico as usual and has found a new **wulfenite** locality: the Michelle prospect, Rayon, Sonora, Mexico. The mostly opaque, multiple crystals are a bright shade of orange in clusters to over 5 cm, often on matrix. From the same locality were also some deep orange **vanadinite** with pyramidal terminations. The San Antonio mine, San Antonio, Chihuahua, continues to produce fine specimens of **fluorite**, **arsenopyrite**, **sphalerite** and **hemimorphite**.

Costa Mesa Show 1998

by Jeff Scovil

The West Coast Gem and Mineral show was held May 15 through 17 in Costa Mesa, California. The weather was beautiful as usual and a bit cooler than in my home town of Phoenix. One of the first people I saw was John Attard. He had just received two beautiful **aquamarines** from Thanh Hoa, Vietnam. One is a deeply etched 11-cm crystal, and the other a very sharp 4.4-cm gemmy prism.

Mina Ojuela, Mapimi, Durango, Mexico, is still producing the occasional goody. At Costa Mesa it was a batch of very prismatic **hemimorphites** with the tips dusted red by hematite. Several dealers had bought them from Top Gem in the wholesale section. Probably the best were in the booth of *Roberts Minerals*. Individual crystals are up to 6 cm long.

Rob Lavinsky of *The Arkenstone* had acquired a portion of the **James Ferguson collection,** some of which he had for sale. Ferguson was actively collecting in Great Britain around 1800. (The mineral fergusonite is named after him.) There were many old classics in the collection for those who collect not just minerals but history too.

Another surprise in Rob's room was a new find of **fluorapophyllite** from Shauguang, Guangdong, China. The crystals are tabular, pale peach colored and up to 11 cm across! Many are on matrix with amethystine quartz and greenish calcite.

Luis Menezes always has good things from Brazil and this time it was **hydroxylherderite**. The crystals are tabular, brown to tan multiple twins with a curious sparkly effect as if dusted with mica flakes. The locality is Linopolis, Minas Gerais. All crystals are loose singles.

There were a number of interesting things in other rooms in smaller quantities. Debbie Meng showed me some wire **silver** from Hebei, China, in fine threads on matrix. *Great Basin Minerals* was sharing the room with The Arkenstone and had **aquamarines** from a unique locality: Jenshihlin, Northern Gobi Desert, Mongolia. The crystals are a little rough and not too large, but of good color and on matrix. Tim Sherburn showed me recently collected **stilbites** and **calcites** from the Isle of Skye in Scotland. In the room of *Douglas's Minerals* I found a very impressive group of large **chalcopyrites** on **sphalerite** from an as-yet undisclosed Mexican locality.

After the show I went over to Bill Larson's (*Pala International*) where I saw some new specimens from the classic locality of Mogok, Myanmar (Burma). One is a very clean **aquamarine** 4.5 cm high and quite transparent. The other is a nearly colorless **topaz** 4.8 cm high. Both are now in the collection of his son Carl.

Sainte Marie-aux-Mines Show 1998

by Jeff Scovil

I was fortunate enough to spend the month of June in France again this year, winding up at the show at Sainte Marie-aux-Mines. This is a wonderful show in the beautiful setting of the wooded hills of Alsace. I actually got to see the show in some detail this year, instead of shooting photographs the entire time in the cave-like basement of the theater as I did last year.

François Lietard wins the award for the most impressive new find of the show—pocket **lazulites** from the Dassu Valley, Skardu, Pakistan. The dipyramidal crystals are very gemmy and strikingly pleochroic in colors of blue, green and turquoise. I had only seen fragments of this material at recent shows. Hopefully there will be more and at least just as good to come.

François also had a recent find of very nice **faden quartz** from the Dara Ismael Khan district, Waziristan, Pakistan. Most crystals are loose, and some are even doubly terminated, and up to 25 cm long.

In March/April a find of **pargasite** made its way to the market. The rich green, short prismatic crystals appear to have formed in a massive white calcite. The locality François gave was Aliabad, Hunza Valley, Pakistan.

From Brazil there is **elbaite** from a new locality: the Sapo mine in Goiabeira, Minas Gerais. Several dealers had the classic "watermelon" crystals for sale, but the best seemed to be in the booth of Marcus Grossmann. The largest, a monster at 32.7 cm, was in the possession of Luis Leite. Smaller crystals are cleaner and less divergent in habit than the larger ones. Marcus had also gotten some very interesting "fish tail" twinned and curved **calcites** from Saint Gstöl, Vorarlberg, Austria. Most are doubly terminated and up to 10 cm in length.

Argentina has come up with a surprise: a granite pegmatite locality. Xavier du Gromont is the geologist working and collecting there who brought the specimens to Ste. Marie. The locality is Mina Rumi Tucu, Papachacra, Catamarca. Specimens are mostly of blocky, pinkish twinned **microcline**, many with **albite** and **smoky quartz**. There is also some pale blue **topaz** and severely etched **fluorite**.

John Holfert of Bountiful, Utah, has been busy working a new prospect for **bixbyite**. The crystals may be the finest and largest ever recovered from the Thomas Range. They are up to 2.5 cm, highly modified and are usually associated with topaz. At Ste. Marie this material was being sold by Jürgen Margraf.

Under short notes, Dan Belsher was there with more of his **vanadinite** and **wulfenite** from the Michelle prospect, Rayon, Sonora, Mexico. They seem to be getting bigger and better. Jordi Fabre had a very nice specimen of something you rarely see from Morocco—**mimetite**. This sample of orange/yellow crystals on matrix was from Taouz. A Russian fellow by the name of Sergey Baskakov had several very fine **polybasite** crystals from the locality of Rudniy, Kazakhstan, a locality best known for its superb calcites.

The last locality to report on is Majram, Morocco, which is producing some very nice **azurite** roses. While not very lustrous, they are of good blue color and quite esthetic. Several dealers had this new material.

Until next time, adieu.

Springfield Show 1998

by Thomas Moore

Although I arrived fifteen minutes before the doors opened on Friday (August 7) at the giant Eastern States Exposition Building

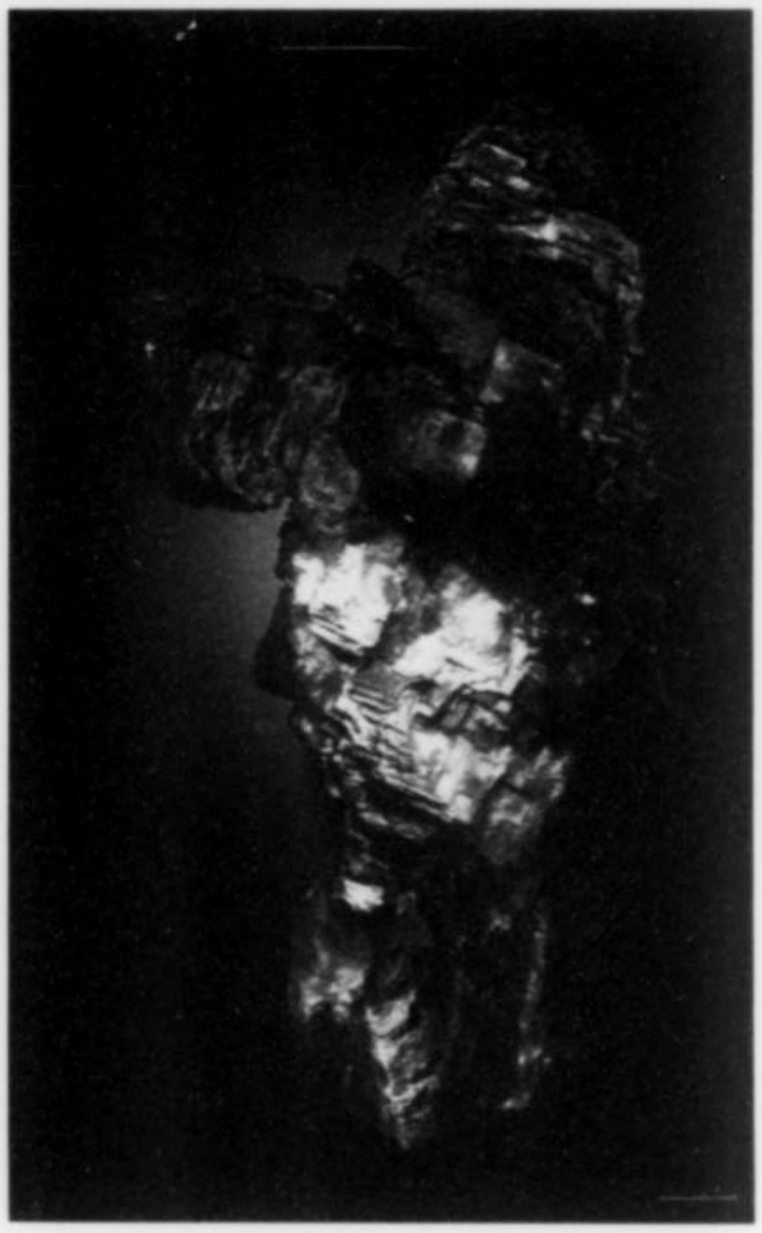


Figure 11. Metatorbernite crystal cluster, 4.2 cm, from the Old Gunnislake mine, Cornwall, England. The Arkenstone specimen, ex James Ferguson collection; Jeff Scovil photo.

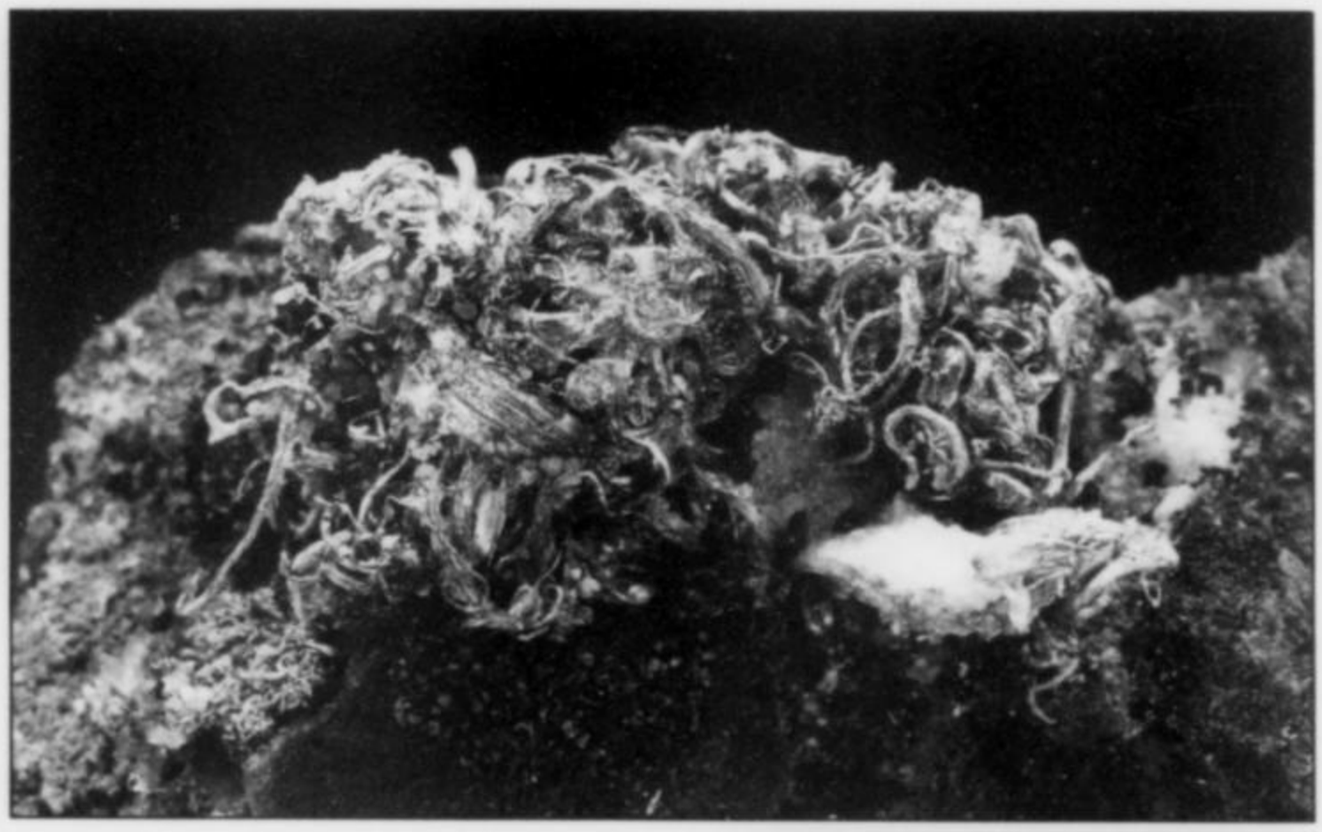


Figure 12. Wire silver on matrix, 3.4 cm wide as shown, from Hebei, China. Debbie Meng specimen; Jeff Scovil photo.

Figure 13. Beryl crystal, 4.4 cm, from Thah Hoa, Vietnam. John Attard specimen; Jeff Scovil photo.

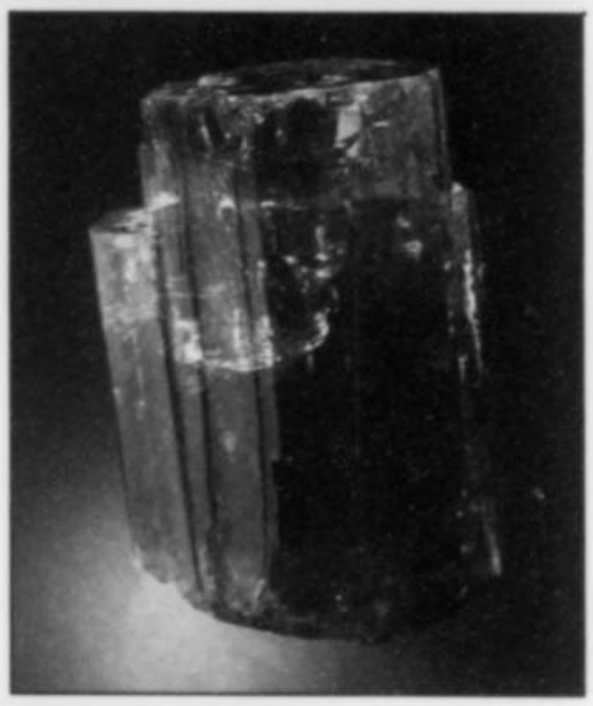


Figure 14. Botryoidal pyromorphite, 6 cm, from Argyleshire, Scotland. The Arkenstone specimen, ex James Ferguson collection, now in the Tim Sherburn collection; Jeff Scovil photo.

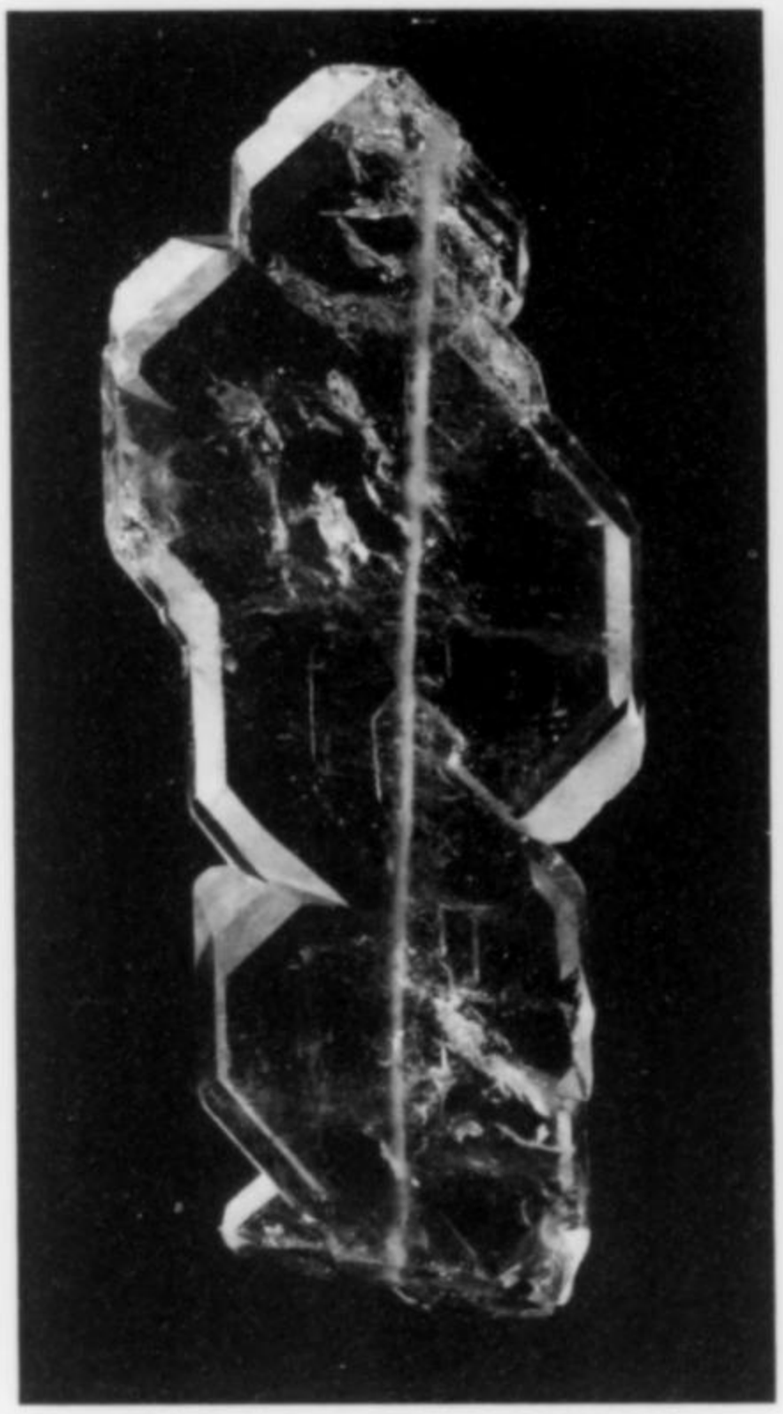


Figure 15. **Faden quartz crystal, 7.5 cm, from the Dara Ismael Khan district, Waziristan, Pakistan. François Lietard specimen; Jeff Scovil photo.**

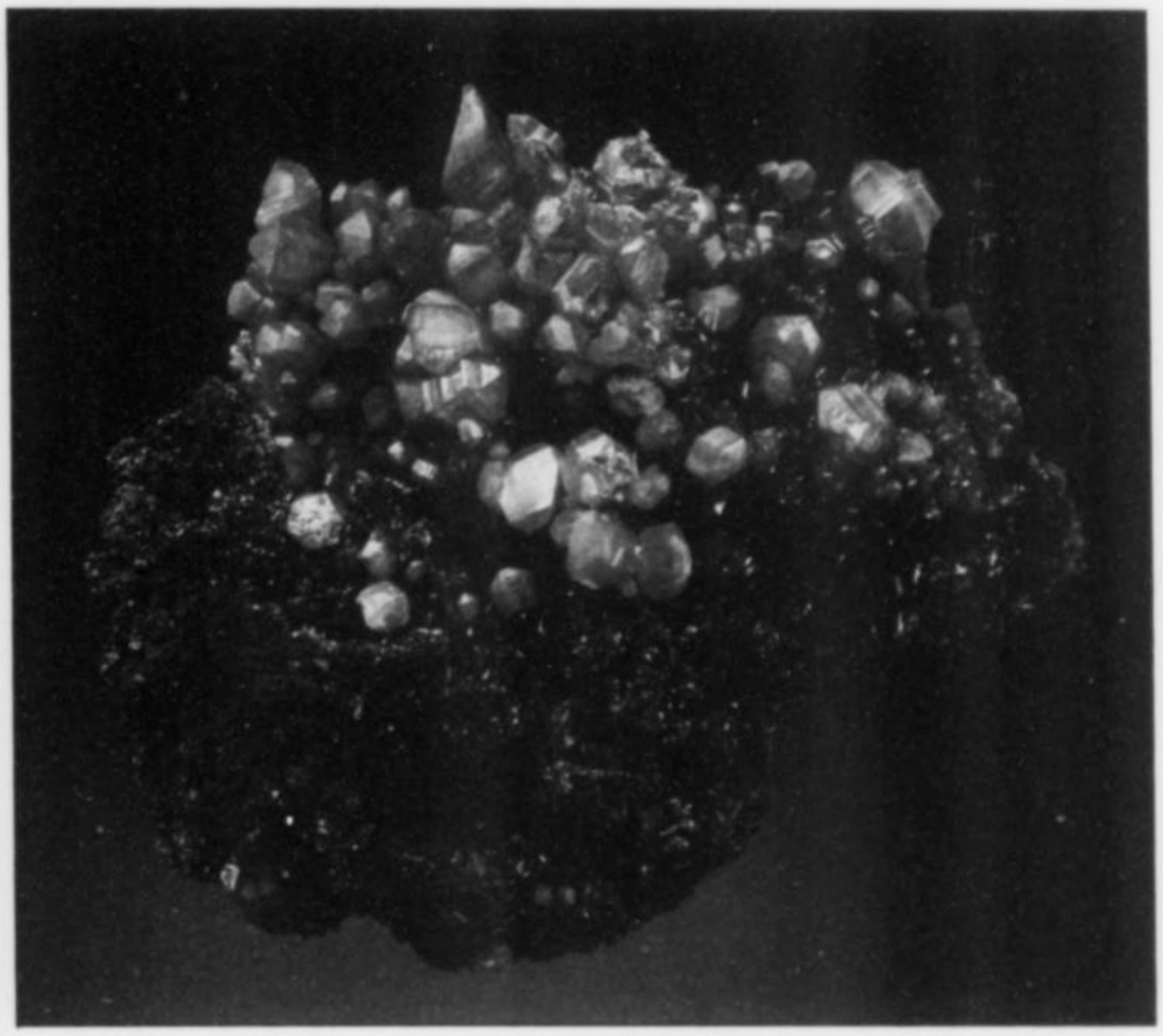


Figure 16. **Vanadinite on matrix, 6 cm, from the Michelle prospect, Rayon, Sonora, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.**

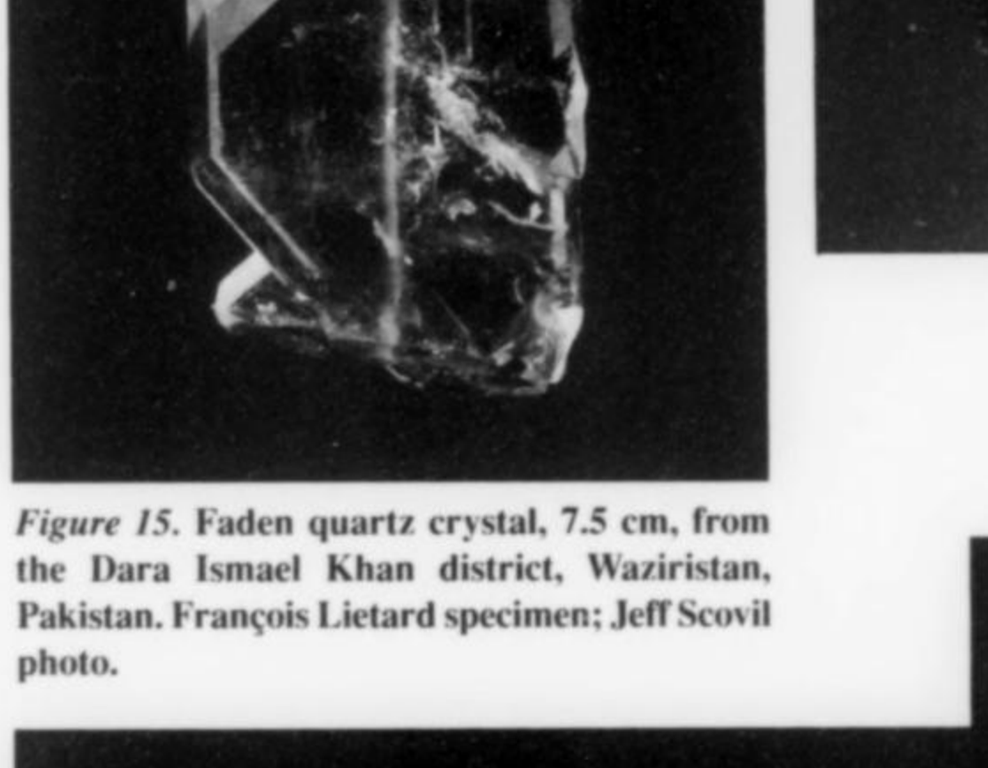


Figure 17. **Microcline crystal group, 8 cm, from Mina Rumi Tucu, Papachacra, Catamarca, Argentina. Xavier de Gromont collection; Jeff Scovil photo.**

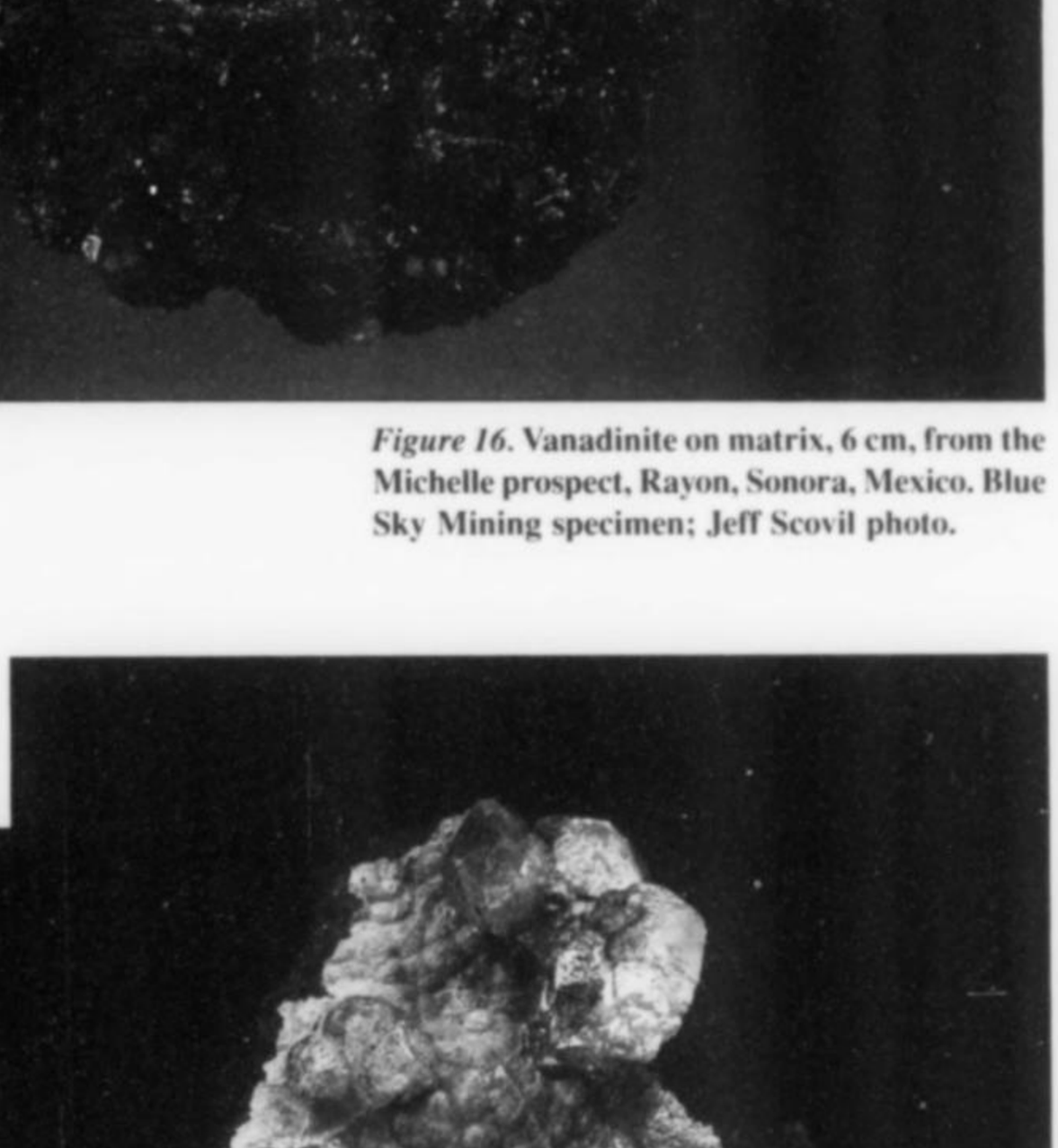


Figure 18. **Mimetite crystals on matrix, 5 cm, from Taouz, Morocco. Jordi Fabre specimen; Jeff Scovil photo.**

in West Springfield, Massachusetts, the extensive parking lots were already jammed, and irritable personnel in orange aprons were windmilling their arms at incoming cars; I had to park, finally, quite a hike away from the entrance. I don't have total attendance figures for the three days of this year's Springfield Show, but if you ask Marty Zinn for these figures I'm sure his answer will come with a smile. This edition of Springfield featured fewer side-show activities than in previous years (no "emerald mine" for the kids, for instance), but that, it would seem, was just to make room in visitors' psyches for the tremendous, single-mindedly exhaustive spread, in some 50 exhibit cases, of mineral specimens from the southern Illinois fluorite district. Surely this was the greatest gathering of fine minerals from this classic (and recently closed) locality ever assembled in a public place.

Naturally it's easy for anyone to enjoy simply looking at case after case of phenomenal fluorite, calcite, galena, sphalerite, witherite, strontianite etc. specimens from Illinois, but the real elite (i.e., *Mineralogical Record* subscribers) might have had the extra pleasure of finding here "in person" many specimens whose photographs appeared in the recent issue largely devoted to the area (Vol. 28, No. 1). In fact, the leading exhibit case, the only one facing outward onto the show floor, displayed a copy of this "Illinois" issue in its top-center, and the beautiful cover photo of Marvin Rausch's 13-cm blue fluorite group from the Minerva #1 mine floated just above the real thing. Filling out the rest of the case were seven more large classic specimens from Illinois.

To this super exhibit, Harvard contributed two cases, Ross Lillie's *North Star Minerals* contributed several more (I forgot to count these), and Mr. and Mrs. Thomas Weisner and Mr. and Mrs. Roy Smith contributed respectively *nineteen* and *twenty* cases, each single case, bear in mind, filled with some of the finest calcite and fluorite (especially) specimens you'll ever see from anywhere. The Smiths' cases, particularly, furnished detailed labels and textual commentary on crystal habits, associations and individual mines, these last including such magic names as the Denton, the Annabel Lee, the Minerva, the Victory, the Lead Hill and others which you'll find in your trusty Illinois Issue. Except for a nice case by Marty Zinn on "Classic Minerals From the Eastern U.S." (with a 4-cm gemmy green terminated elbaite from "Haddam, Connecticut"—I'd bet a bundle that it is from the venerable Gillette quarry), there were no cases except the Illinois ones. The exclusivity didn't at all feel narrow, but rather like "an effort to make the show exhibits especially important"; the flyer goes on, justifiably proudly, to say that "The interest created by this approach to exhibiting has been exciting. Show management has received calls from Ohio, Illinois, Missouri, Tennessee, California and even Germany, asking about attending the 1998 show." I hardly need add that all *Record*-readers should consider attending the 1999 show too: its theme will be **Garnets**.

This show was also quite strong in the "What's New" department—a more generous appetizer for Denver than usual. To begin close to home, the Valentine talc mine at Harrisville, New York, has produced some interesting and *very* new (a couple of weeks old as of early August) feldspar-association specimens, brought to market by Rocko Rosenblatt of *Rocko Minerals & Jewelry* (Box 3A, Route 3, Margaretville, NY 12455). Rocko describes a series of pockets along a zone of contact between syenite and marble in the Valentine mine, these pockets lined primarily with hematitic **quartz** prisms to 10 cm long—and there are a few specimens, from miniature-size up to about 10 x 12 cm, showing these attractive, transparent red-dusted quartz crystals all by themselves in solid groups. Much odder, however, are perhaps 30 specimens, mostly miniatures, on which the quartz is coated with druses of pinkish gray orthoclase in acicular *needles*, sometimes localized in distinct 3-mm sprays, with interspersed micro-size green **epidote** crystals, and with, sitting lightly on top, snow-white opaque **albite** in compound, spiky, vaguely dogtooth-shaped crystals to 1.5 cm. Given the peculiar habits of the albite *and* orthoclase, these are distinctive and worthwhile feldspar specimens for one's cabinet (and not expensive to put there).

Dale P. Hewin of *Hewin's Minerals* (P.O. Box 93, Chartley, MA 02712) is a New England Yankee whose recent serious work is seeing to it that a classic mineral locality of The South is Rising Again: I refer to the **rutile/lazulite/kyanite** locality at Graves Mountain, Georgia, where Dale has been busy since the middle of winter. Although large, lustrous, single crystals and twins of rutile from Graves Mountain do tend sporadically to show up in small lots on the market, I don't think I have ever seen a spread of recently collected material as impressive as this: sharp, clean (after much laborious cleaning by Dale), highly lustrous red-brown crystals ranging from 2 to 5 cm, as individuals, as clusters of two or three, and as elbow twins, sometimes lightly implanted on iron oxide matrix; there are perhaps 40 first-rate pieces in all. The best rutile specimens sold for up to $1200, but very fine miniatures could be had for $300 to $400. Further, Dale had a swarm of loose, thumbnail-sized stalagmites—or pillars, or candledripping-columns, or dead tree trunks—of "**turgite**," all showing a vivid, many-hued iridescence on their brown skins. This is really a finely botryoidal goethite coated with hematite, and certainly the merest sideshow to the rutiles, but the iridescence can be quite colorful, and yes, I'm afraid that "cute" is the word for these little turgite Aladdin's Cave pickings. Finally, Dale had about 10 thumbnails and small miniatures of Graves Mountain kyanite in loosely intergrown, iron-darkened platy crystals, like little piles of far-gone autumn leaves.

Dan and Shelley Lambert of *Lambert Minerals* (21 Halson Street, Ancaster, Ontario, Canada L9G 2S2) had their usual tasteful assortment of Canadian minerals old and new—one of each of these making the news this time. The "old" item, represented by just three miniatures collected 15 years ago, is **phlogopite** and **fluorrichterite** crystals in crisp open groups without matrix, from the famous Earle Occurrence, Monmouth Township, Wilberforce, Ontario. The phlogopite is as beautiful as phlogopite can get: rich yellow-brown and transparent, with high resinous luster, in crystals to 2 cm, the crystals *complete* on the basal as well as the prism faces. The fluorrichterite is seen as sharp, greenish gray, slightly splintery, blocky crystals to 2 cm, nestled among the phlogopite books. The Lamberts say that they are checking out this locality all the time in the hopes of getting new specimens as good as these older ones.

Then, too, the Lamberts had a handful of miniatures with rock matrix completely and thickly drused with white milky quartz, with, nestling sparsely amid the quartz, little pale violet part-gemmy octahedrons of **spinel** to 1 cm on edge. The locality for these new, pretty and promising spinel specimens is the Cameron quarry, Carleton Place, Ontario.

The Springfield Show visitor is greeted, just past the ticket takers at the front door, by the stand of Wayne and Dona Leicht's *Kristalle* dealership, all the way from southern California . . . but this year if you had the presence of mind to get past the gold spread, you will have noticed immediately a few pretty pink specimens of bladed **rhodonite** from the Chiurucu mine, Huanaco Department, Peru, on the Leicht's open shelving. Peruvian rhodonite was a hot new item when I reported on it from Europe in 1989, and when Wendell Wilson likewise did so from Springfield in the same issue (vol. 20, no. 6); and then came vol. 21, no. 2, with a terrific specimen of the stuff on the cover. But that was the last we have heard of Peruvian rhodonite these past eight years. Now, not

only the Leichts but also *Wright's Rock Shop*, *I.C. Minerals* and a few others around the Springfield Show had modest supplies, apparently from a newly struck pocket system in the Chiurucu mine. Specimens are plates from 4 to 10 cm across, blanketed with rounded aggregates of parallel-growth bladed crystals, with individual crystals to 1.5 cm. The chief differences from the older material are that (1) they are sometimes dusted with quartz microcrystals, for an attractive surficial glitter, and (2) unfortunately, the rhodonite color is much paler and milkier than in the deep rose-pink champs of the 1989/1990 strike. Clearly this occurrence bears watching, or rather a bit of refocused attention.

Also from Peru, specifically from the renowned Huallapon mine, Pasto Bueno, Ancash Province, some nice small cabinet specimens with needle quartz beds hosting translucent to transparent green, 3 to 4-cm compound octahedrons of **fluorite** (coarsely "stepped" crystals built of stacked cubes) could be had from Howard and Janet Van Iderstine of *Cardinal Minerals* (2 Tulip Lane, Huntington, CT 06484).

At an important show like this one we can hardly *not* expect to hear something new from Brazil, right? Christ Wright of *Wright's Rock Shop* had eight monstrous pieces, to 25 cm across, of **epidote/quartz** from a thus-far unspecified locality in Minas Gerais. They are great jackstraw groups of long, striated, lustrous, blackish green epidote crystals, most of them well-terminated, with many of the long, skinny prism faces preferentially dusted with clear quartz crystals. Most of these latter are tiny, coming in glistening druses, but some 1-cm crystals stick up like teeth. A second style of specimen from the same occurrence is represented by two 30-cm-long, doubly terminated, slightly grayish transparent quartz crystals with epidote prisms to 8 cm long shot all through them—ends protruding from the quartz faces and prisms showing clearly inside. Chris said that the find is "very recent," so let's, again, keep a sharp lookout from the crow's nest when in Brazilian waters.

Not "new" anymore but still pretty thrilling is the renascence of superfine **metatorbernite** from the Margabal mine, Aveyron, France—see my last Denver report (vol. 29, no. 2) concerning the fine lot of thumbnails and of large plates brought in by Eric Asselborn (and see the photo of Ralph Clark's prize thumbnail). I mention these here again because, voila, another batch showed up at Springfield, courtesy of Leonard Himes of *Minerals America* (P.O. Box 540257, Orlando, FL 32854), who picked them up at the Ste. Marie-aux-Mines Show in late June. There are about 15 pieces, the larger ones (to 8 cm wide) composed solely, like the earlier ones, of loosely packed sheaves of tabular deep green crystals, the sheaves to 1.5 cm; a couple of terrific thumbnails also reposed at Leonard's stand.

A vague, persistent, alarming rumor lately has whispered that the Russian government has tightened up on some laws controlling the export of at least some kinds of mineralogical/geological specimens. And indeed, at Springfield there was *almost* nothing new from Russia (for the exception, read on), and there was a sense of generally declining stocks even of older Russian material. However, no downside rumors or somber thoughts in the air seemed to bear any relevance whatsoever to the good cheer and abounding energy of a couple of Russians, Viktor Nikiforov and Aleksandr Zaytsev, who were ensconced at the stand of Jeff and Gloria Fast of *Jeff & Gloria's Minerals* (19 Oak Knoll Road, East Hampton, CT 06424). These gentlemen offered up great supplies of underpriced, unlabeled Dalnegorsk things—**fluorite**, **calcite**, **axinite**, **pyrrhotite**, **datolite**, **galena**—as well as green "prase" **quartz** and nice dark brown **garnets** from Sinya Rechka, the skarn locality to the north. Best of all, Viktor and Aleksandr topped off with a flat of something truly *new* from Dalnegorsk: about 20 newly collected miniatures of an odd and attractive **siderite** from the Nikolay mine. Specimens consist of perfect spheres, averaging 2 or 3 cm in diameter, attached lightly in twos, threes, etc., up to grape-clusters of ten, without matrix; the spheres are of a pleasant medium tan color, with surfaces composed of intricate fretworks of tiny lenticular blades (flattened rhombohedrons), and they glitter delicately from dustings of micro-size white calcite crystals. I have seldom seen more appealing siderites than these. Prices ranged from $12 for a small miniature to around $20 for the largest couple of clusters, around 4 x 4 x 5 cm.

Luckily, the former Kazakh S.S.R. is now the independent Republic of Kazakhstan, so no dour Russian *bureauchic* can threaten to impede our supplies of wonders from the great Dzhezkazgan copper mines: wire **silver, chalcocite**, **tennantite**, **copper**, the world's best **bornite** crystals, and other superlative supergene-metallics, to call the roll so far. At this show the Dzherkazgan scoop was a handful of thumbnails of exceptional crystallized **stromeyerite** (AgCuS) offered by Dudley Blanwet of *Mountain Minerals International*. This species comes as delicate spiky intergrowths of black, slightly irridescent, acicular and flakelike crystals averaging 1 or 2 mm, without matrix or associated species. We are not talking mineral beauty here: my ever-patient, ever-ironic wife surmised that the specimen I brought home was really something I'd scraped from the underside of my ancient Dodge Omni. But no (I told her), I'd been preceded at Dudley's by expert collectors Bill Smith and Bill Pinch, who both went away more than pleased with *their* stromeyerite thumbnails—and one of Pinch's that I got to see at Springfield has a peacock-iridescent V-twin of 5-mm stromeyerite laths. This is indeed an extraordinary occurrence of a seldom-seen silver species; I wonder what Dzhezkazgan will produce next.

From another ex-Soviet satrapy, namely (now) the Republic of Tajikistan, very fine golden yellow heliodor **beryl** has come intermittently during these past few years, and has been reported in this space. At Springfield this year there were, again, some top-grade gem specimens: about 20 loose crystals to 4.5 cm long, with sharp edges and lustrous prism and pinacoid faces, no matrix with any of them, the prisms either simple loners or parallel-growth groups. Christopher French of *PaleoArt & Minerals* (2 Lupine Lane, Titusville, NJ 08560) was selling these beautiful things as gem stock at $7/gram.

Finally, a very exciting news flash from Jiangshan, Guangdong Province, China: transparent, colorless, lustrous tabular crystals of **apophyllite** to 2 or 3 cm, in loose groups and as clusters perching demurely on quartz. Several dealers had these, but Dan and Jill Weinrich (16216 Copperwood Lane, Grover, MO 63040) had the best and the most; Dan said that perhaps 100 specimens in all had been dug within the past few months. The waterclear apophyllite tabs, when thick, may show very faint brown rims inside; when thin, they grow in parallel groups with regular offsets for a "rose" effect, on milky quartz crystals. Tiny **manganbabingtonite** and **datolite** crystals are also sometimes noted. Neither the Weinrichs nor anyone else seemed to know anything about what sort of occurrence this is, how promising for the future, how good the very best specimens are, etc., but my showsnooping instincts tell me that we may expect to see a major Chinese apophyllite locality unfold in the coming months.

This was probably the best Springfield Show I have yet attended.

The Carnegie Show 1998

by Jeff Scovil

The First Annual Carnegie Gem and Mineral Show was intended to be the classiest show in the country, setting new standards for the industry. I believe that goal was realized during the weekend of August 27th through the 30th of 1998.

Figure 19. **Pargasite crystals, 2.1 cm, from Aliabad, Hunza Valley, Pakistan. François Lietard specimen; Jeff Scovil photo.**

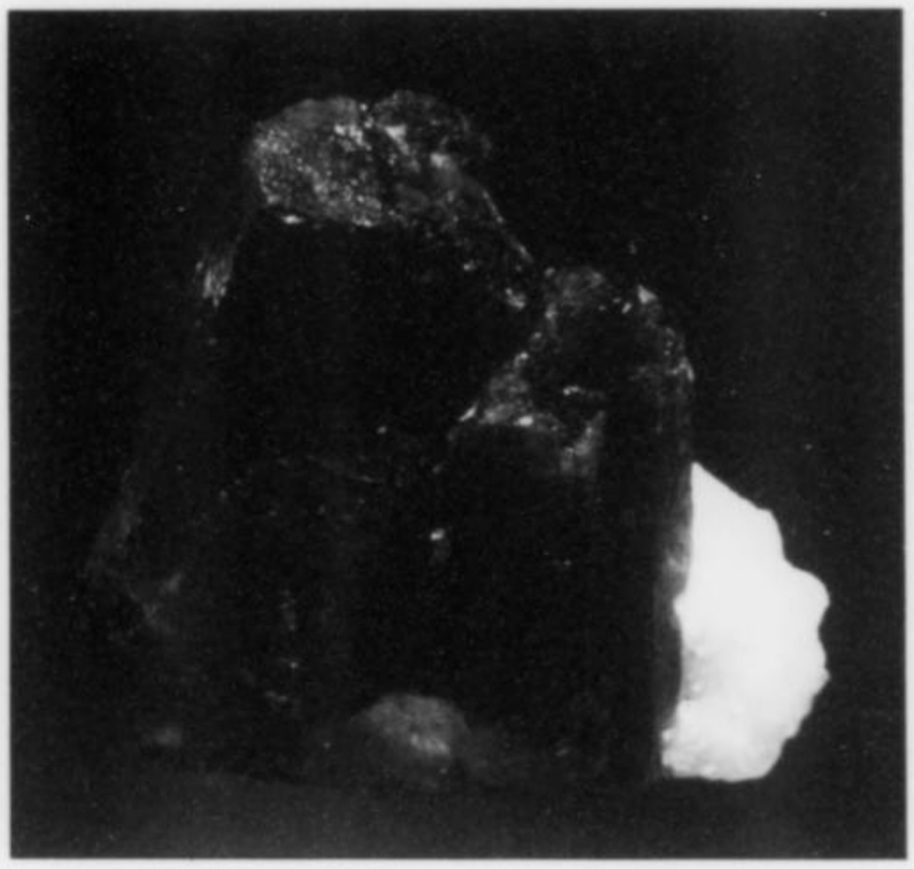


Figure 20. **Lazulite crystal group, 5.6 cm, from the Chilas area near Nanga Parbat Peak, Pakistan. François Lietard specimen; Jeff Scovil photo.**

Figure 21. **Lazulite crystal (backlit to show interior color), 4.8 cm, from the Chilas area near Nanga Parbat Peak, Pakistan. Herb Obodda specimen; Jeff Scovil photo.**

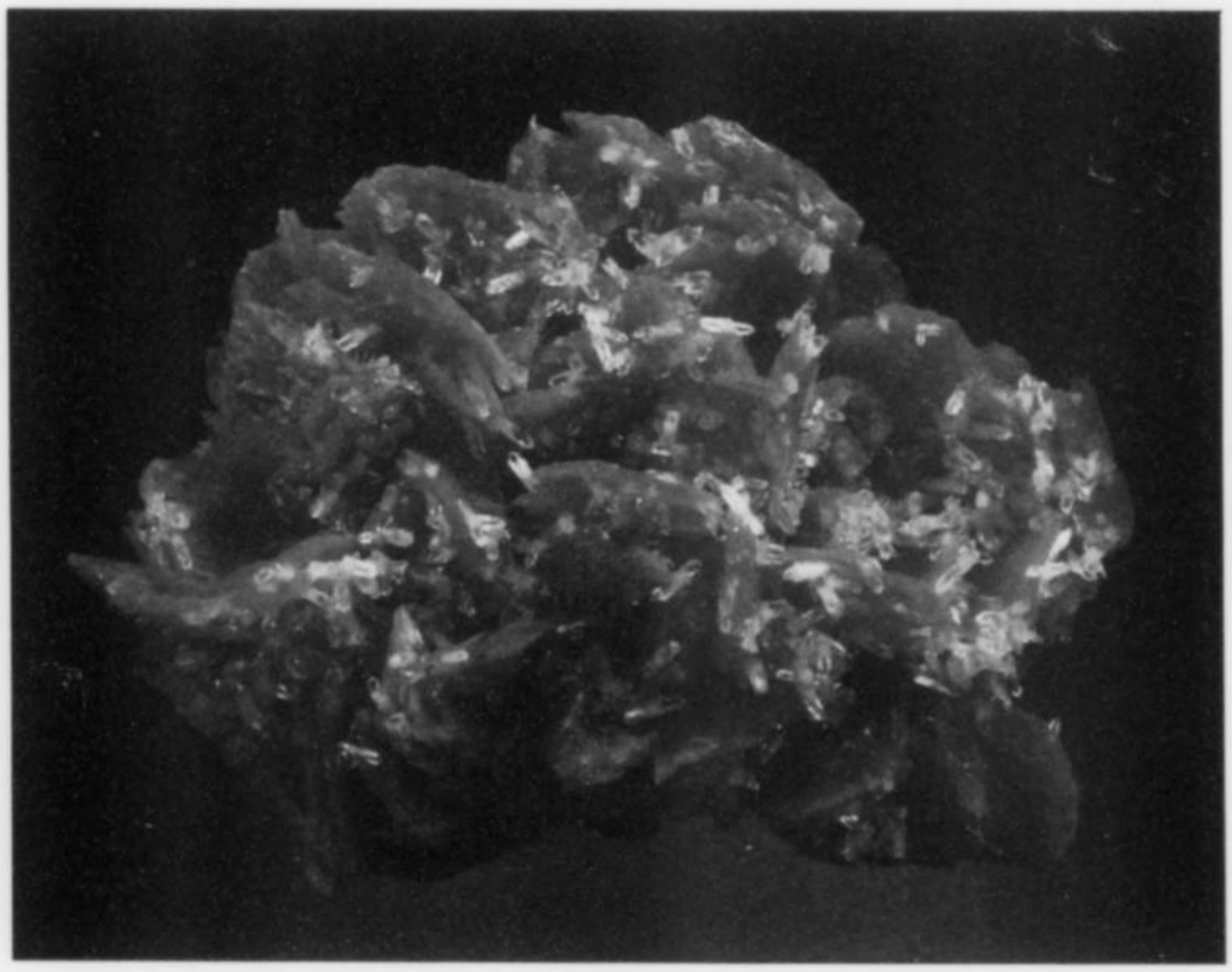


Figure 22. **Rhodonite with quartz, 5.1 cm, from the Chiurucu mine, Huanuco, Peru. Kristalle specimen; Jeff Scovil photo.**

Figure 23. **Zircon crystal, 5 mm, from the McLaren mine, Perth, Ontario. Lambert Minerals specimen; Jeff Scovil photo.**

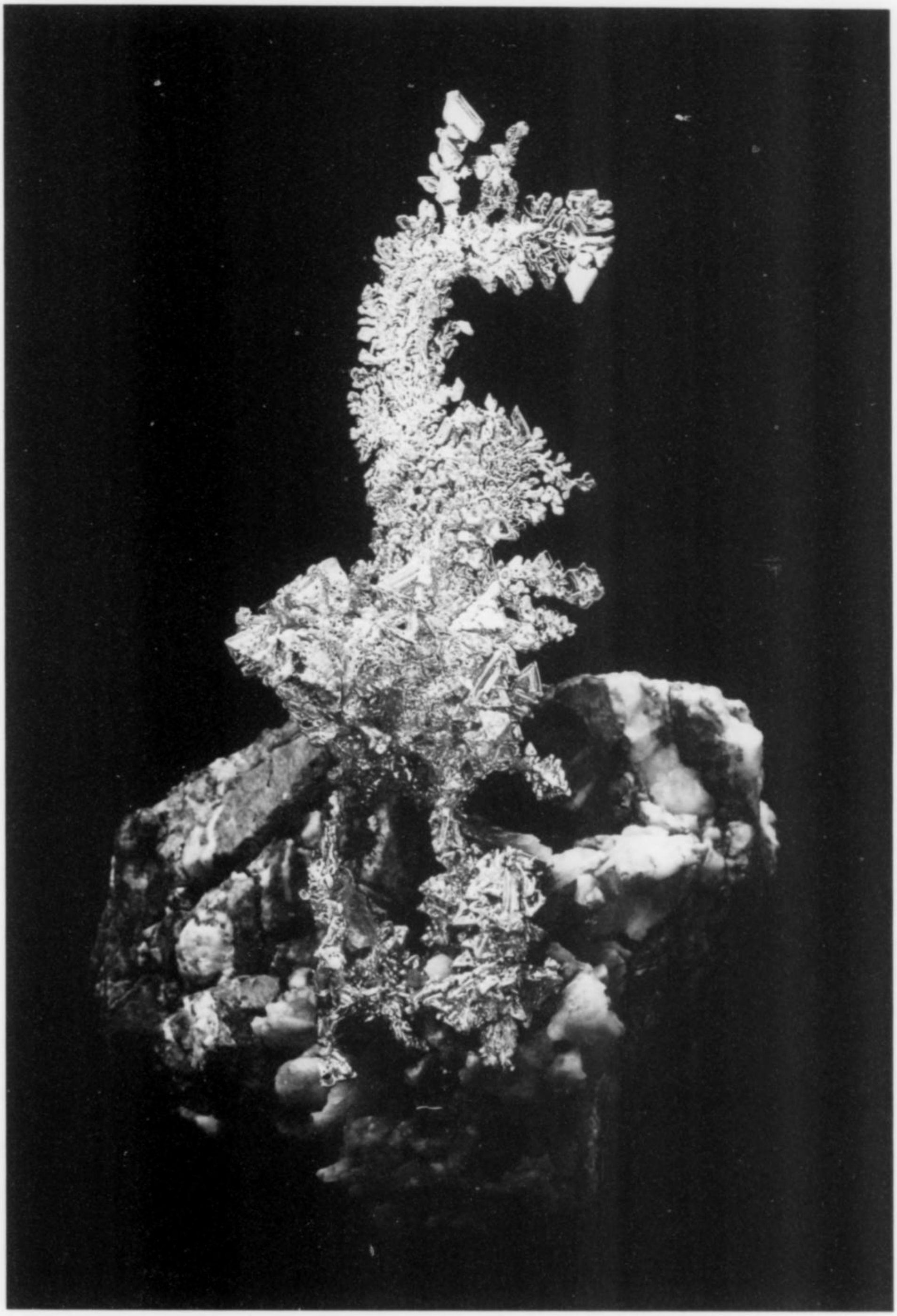


Figure 24. **Gold crystal group known as "The Dragon," 18.1 cm, from the Colorado Quartz mine, Mariposa County, California. The Collector's Edge specimen; Jeff Scovil photo.**

Marc Wilson of the Carnegie Museum of Natural History, along with a lot of other people, put an incredible amount of time, effort and money into creating this show. It started off Thursday evening with a Gala Preview Party and sale. The dress was not black tie, but it came close. Many dealers and collectors were nearly unrecognizable in jacket and tie (what fodder for Saturday night fun at the Tucson Show!). The surroundings were palatial to say the least. Classical façades, Greek and Roman statues, marble and bronze were the backdrops in the three museum halls where the show was held. The buffet was open and so was the bar, both seeing good use during the evening.

On Friday morning the show opened to the public, who arrived in impressive numbers. It seemed that Marc's extensive advertising paid off. The show was retail-only, with 23 dealers from around the country, four local jewelers, and two impressive booths representing the superb work of GANA (Gem Artists of North America). There were lapidary demonstrations of stone mounting, cutting and wire wrapping, along with fluorescent minerals and free specimens for the kids. The many exhibits in brand-new Cincinnati-style exhibit cases showed off the collections of both private collectors and dealers, with awards for the best cases. Special museum exhibits included the A. E. Seaman Mineralogical Museum, Harvard Mineralogical Museum, Houston Museum of Natural Science, L.A. County Museum of Natural History, Penn State University and Wayne State University. Other special exhibits included Steelers' Super Bowl rings, Mars and moon rocks and the "Bahia"—the world's largest cut gem.

After the show was over, attendees could stay for an outdoor concert that was part of the Carnegie's Summer Sounds concert series. Saturday night in the courtyard was an enjoyable Pig and Chicken Roast, followed by the awards presentations and the Gem and Mineral Auction. Phil Scalisi and Mike Haritos of *Argentum Auctioneers* did an admirable job of presenting and keeping the auction moving. The color catalog showed many of the specimens which were deaccessioned from the collections of both the Carnegie Museum and the Houston Museum of Natural Science.

Unfortunately, coming hard on the heels of the East Coast Gem and Mineral Show in Springfield, Massachusetts, there was not really very much that was really new in the way of minerals. I did, however, get a chance to photograph a few things that I was not able to corner at the Springfield Show. These include the new **rhodonites** from the Chiurucu mine, Dos de Mayo Province, Huanuco Department, Peru. This locality has been producing for many years, but the latest material has a sprinkling of lustrous microcrystals of quartz like sugar frosting on the rhodonite. There were also more of the impressive **epidote** crystals from Capelinha, Minas Gerais, Brazil, in the booths of both *Wright's Rock Shop* and *Victor Yount*. These very prismatic crystals are nicely set off by numerous small quartz crystals.

All in all the show was very impressive, especially considering that it was a first effort, and also the first major mineral show to be sponsored by a major mineral museum. Marc Wilson has obviously learned some lessons from the other great shows in this country. Congratulations and continued success to both Marc Wilson and the Carnegie Museum of Natural History.

Denver Show 1998

by Thomas Moore

At the Holiday Inn North in Denver this year I had that strong, comfortable "hothouse" feeling again that I've mentioned having before—the feeling that one is in one's element, however rarified that element may be, and in the company of one's own sort of benignly obsessive people, and doing what is *important* to do. Perhaps this feeling is stronger at Denver than at Tucson because of the Denver Holiday Inn's physical situation: its cozy isolation (with gemlike swimming pool in the courtyard) behind a view-blocking hill on one side and a roaring freeway overpass on the other—there are no wide-angle views out the windows, as of Tucson's enfolding dreamy mountains. Don't get me wrong, though: the hothouse feeling is *good*. We are here, we understand about things, and no possible leaked-in word of Starr, Yeltsin, Greenspan, or even McGwire and Sosa can distract us.

The scuttlebutt this time concerned such matters as mineral-marketing websites, dichroic Pakistani lazulite crystals 5 cm long, and the news that major collector Steve Neely of Tennessee has now sold his fabulous collection of cabinet specimens. Yes, Dr. Neely's assemblage of some 500 midwestern and 200 worldwide (and world-class) large specimens is being marketed by Bryan Lees, while Steve meanwhile is switching to miniatures. Most of the major specimens have already been placed with new owners by Bryan, but even those which remain made a mighty impressive showing by *not* being upstaged by rhodochrosite at the *Collector's Edge* booth at the Main Show.

About that activity on the web: on p. 186 of the Sweet Home Issue you'll find the ad of Rob Lavinsky and John Veevaert, two dealers who have hit on the fine idea of marketing specimens, both for themselves and for "outside" dealers, on the website www.thevirtualshow.com, which hosted over 5,000 visitors from 40 countries just last week (according to Rob of the dealership *The Arkenstone*). The site will attempt from now on to monitor offerings at the Tucson and Denver shows, and indeed will be served continuously from an office at the 1999 Tucson show. And now many folks will be happier than before: dealers who sell the specimens, buyers who buy online because they can't make it to major shows, beginners just learning minerals, and even non-*Mineralogical Record* subscribers (awk!) who will find, on the site, citations of *Mineralogical Record* columns and articles giving background on specimens offered (and who thus may turn, as God intended, into subscribers at last). It is all looking like another Cyber Age success story. And no, shopping for minerals online will never, *can* never, replace going to mineral shows when one can; it will only tempt more people to do just that, and thus encourage continued lush growth in our steamy little hothouse.

The Main Show's theme this year was—um . . . well . . . actually, it was fossils. Do not entirely despair: the theme did provide some real perks and diversions (see later), but for whatever reasons, the what's-new-in-minerals market seemed to be taking a bit of a breather. There's still, for example, that scary paucity of Russian things: this is the first American show report I have written without a single new occurrence from Russia to gab about. And much of what I will report on from elsewhere is, in truth, second-wave material, although some of it is still exciting for being by far the *best* wave yet, and although some true and major what's-new items do exist, as we'll see. So fasten seatbelts, update passports, and we will go seeing right now.

George Fisher of *The Crystal Group* (511 Foothills Road, Colorado Springs, CO 80906) had a Holiday Inn room pretty much filled up with specimens of **hematite** on microcline which he dug in February of 1997 from a hydrothermal vein in a pegmatite some 5 miles northeast of Lake George, in Teller County, Colorado. The **hematite** crystals perch on flesh-colored masses of small, curved **microcline** crystals; other associations may be **smoky quartz** and translucent, pale violet **fluorite** cubes to 3 cm on edge. The hematite (identity firmly verified) comes in sharp compound rhombohedrons with slightly rough, stepped faces, of 3 cm average size. The luster is submetallic to dull, but the overall composition makes the best of these pieces very attractive, as the hematite rhombs flare up in proud clusters from the feldspar matrix. About

600 specimens, ranging in size from small miniatures to matrix pieces 15 cm across, were taken from one huge pocket.

Colorado dealer Dave Bunk's room this time was enriched in old specimens of rare gold tellurides, from Dave's having bought up three different old stashes of these. From the classic Cripple Creek mines, small flat plates of granite or phonolite show gray or golden metallic smears, cleavage sections and little vugs of bright microcrystals of **calaverite**, **sylvanite** and **krennerite**; one miniature shows liberal numbers or calaverite crystal blades to 3 mm on off-white drusy quartz. Then, from Level 2 of the Rex mine, Boulder County, brilliant tin-white **altaite**, **coloradoite**, **petzite** and **hessite** are intermixed with duller gray massive **galena** on gray-white miniature-size rock matrix. And from the Eagle mine at Gilman, Dave had a few thumbnails and small miniatures showing crude gray 4-mm **hessite** crystals with **gold**, and, remarkably for this locality, two small thumbnails entirely of gold, one a little, dull-lustered ram's horn, the other a loose, bright wire.

For a very large change of pace, Dave had also a few giant specimens from a new pocket of **barite** hit recently at the Barrick Meikle mine, Elko County, Nevada. These barite crystals are not of the usual pale to lemon-yellow color, but of a rich, gemmy yellowish orange; they average 5 cm long and 1.5 cm thick, and occur in glistening handfuls over yellowish crystalline calcite seam linings on rock matrix to 10 x 16 cm. More generally, the Barrick Meikle (or just "Meikle") mine seems still to be going strong: very beautiful, often enormous clusters of gemmy lemon-yellow barite crystals from here were widespread around the show, with special barite-type kudos to Casey and Jane Jones (the mine's first exploiters for specimens) and Harvey Gordon.

Razor-sharp, metallic black, simple small cubes of **bixbyite** in association with orange **topaz** from the Thomas Mountains, Utah, has long been a staple in the mineral world—but a very few bixbyite thumbnails dug last February by John Holfert of *Utah Mineral and Fossil* (997 North Chapel Dr. #4, Bountiful, UT 84010) seem to me to qualify as a *new* item altogether. This is because of their forms—not simple cubes but complex isometric combinations, often with slightly curved faces and serrated edges—and because of their size, a record-breaking 1.5 to 2.5 cm. These bright, lustrous black crystals are so big that it's not a case of the usual bixbyite-on-topaz but rather of topaz-on-bixbyite: on the best thumbnail I saw (for $900), a single, blocky hematite-like black crystal seems in the process of swallowing the little topaz in its middle. And as for form, well, on a thumbnail grabbed up early in the show by Ralph Clark, a lone bixbyite crystal 2 cm high looks just like a big black modified-dodecahedral garnet. John Holfert says that only seven thumbnails in all were found, and he's understandably "guarded" about just where in the Thomas Range they *were* found.

A few shows ago I reported (enthusiastically, since this is my home state we're talking about here) on the **celestine** specimens from Pennsylvania then just being brought out by Doug Wallace of *Mineral Search, Inc.* (11882 Greenville Ave., Suite 123, Dallas, TX 75243). After a dry spell, a fertile pocket zone was again struck a few months ago at the locality which I can now name more precisely than earlier: Meckley's quarry, Mandata, Northumberland County, Pennsylvania. The new lot, three flats of pieces from small miniature to large cabinet sizes, features translucent blue-white celestine crystals to 1.5 cm growing in deep, drusy quartz-lined vugs in grayish brown limestone. The crystals are of a different habit than before—sharp pseudo-rhombohedrons, not blocky prisms—and are, regrettably, less lustrous than before. Let's hope that Doug's third strike at this potentially major celestine occurrence will be the big one.

The Jeffrey mine at Asbestos, Quebec, is always good for a nice surprise, very often involving new colorations of the gorgeous gemmy **grossular** dodecahedrons for which the place is renowned. The usual oranges and a few deep greens were around again this time, but the new item is a lovely pale *pink* grossular, with lustrous crystals, transparent almost to the point of vanishing, on gray matrix with nice drusy green **diopside**. The smaller crystals (to 6 mm or so) are purely pink, but as they get larger they increasingly take on salmon tones, enroute to the classic rich orange color; intermediate pink-orange crystals also exist. The best lot, in miniature-matrix sizes, was being offered at the Main Show by *Tyson's Minerals*, and Mike Bergmann at the Holiday Inn had some too.

Now while we have paused at the Tysons' always-enticing Main Show stand with its mainly Canadian offerings, let's look too at a couple of kinds of **apatite** specimens on view here. First, and more familiarly, there are the classic dark brownish green, gemmy, internally crackled, lustrous, fat hexagonal prisms (with pyramids and pinacoids, usually on both ends) of apatite from the Yates uranium mine, Otter Lake, Quebec. The apatite prisms on these 8 or so specimens are from 2 to 9 cm long, and they sit lightly on/in a salmon-colored massive calcite. The Tysons' really *new* apatites, though, are some beautiful yellow-green specimens from the Liscombe deposit, Monmouth Township, Wilberforce, Ontario—where skarnlike pods of coarse-grained calcite, Rod Tyson says, occur randomly in heavily metamorphosed intrusive bodies. The pods tend to be found in test pits dug near an old mica mine. Anyway, the yellow-green apatite crystals here are also doubly terminated, very slightly rounded hexagonal prisms, from 1 x 2 to 2 x 5 cm; lusciously lustrous and gemmy, they sit lightly embedded (like their Quebec brethren) in massive salmon calcite: the ten or so thumbnails and miniatures Rod had are pretty indeed. I must also salute the honesty of the labels, which all add a good-humored "with glue and Vinac" after the word "apatite." The Vinac is a stabilizing material with which the apatite crystals are coated, so they don't shatter while being trimmed; the stuff seeps into the cracks in the crystals to keep them together. It is then dissolved away, leaving the crystals' color and luster unchanged. As for the glue, most of the matrix specimens are "repaired." The point is that putting these data on labels is not only honest but smart, as it guards in advance against any outrage from buyers who find out the "secret," which of course there's no reason to *make* a secret of in the first place. Would that more dealers looked at the matter this way.

On the evening of my last night in Denver I had one of those little discovery-adventures that are always a cherished feature of mineral shows. Heading down the hallway to get my laundry out of the hotel's dryer, I was waylaid by two gentlemen, Mike Menzies of Calgary and Mark Mauthner of Vancouver, the latter carrying a small box. Inside, they said, were two specimens of the best **gormanite** ever found in the world, and might I mention it in the report? We had the Opening in the laundry room. Well . . . on the smaller of the two specimens, two 2-cm acicular tufts of satiny olive-green gormanite sit like puffballs on a flat piece of black shale; and on the other, a 7-cm strip of the same shale is covered completely with beautiful green upstanding acicular gormanite. This rare phosphate occurs at the Rapid Creek/Big Fish River locality in the northernmost Yukon; you might check your Yukon Phosphates Special Issue about it. Normally it is unattractive—but surely these gentlemen were right; these specimens set a new standard for the species. The find was made this past July by Gunther Kuhnlein of Calgary, who collected dozens of pieces in varying sizes. None were for sale at this show, but I'm told to tell you that Gunther (phone 403-273-4757) might have some "available." Best trip to the laundry room I have ever had.

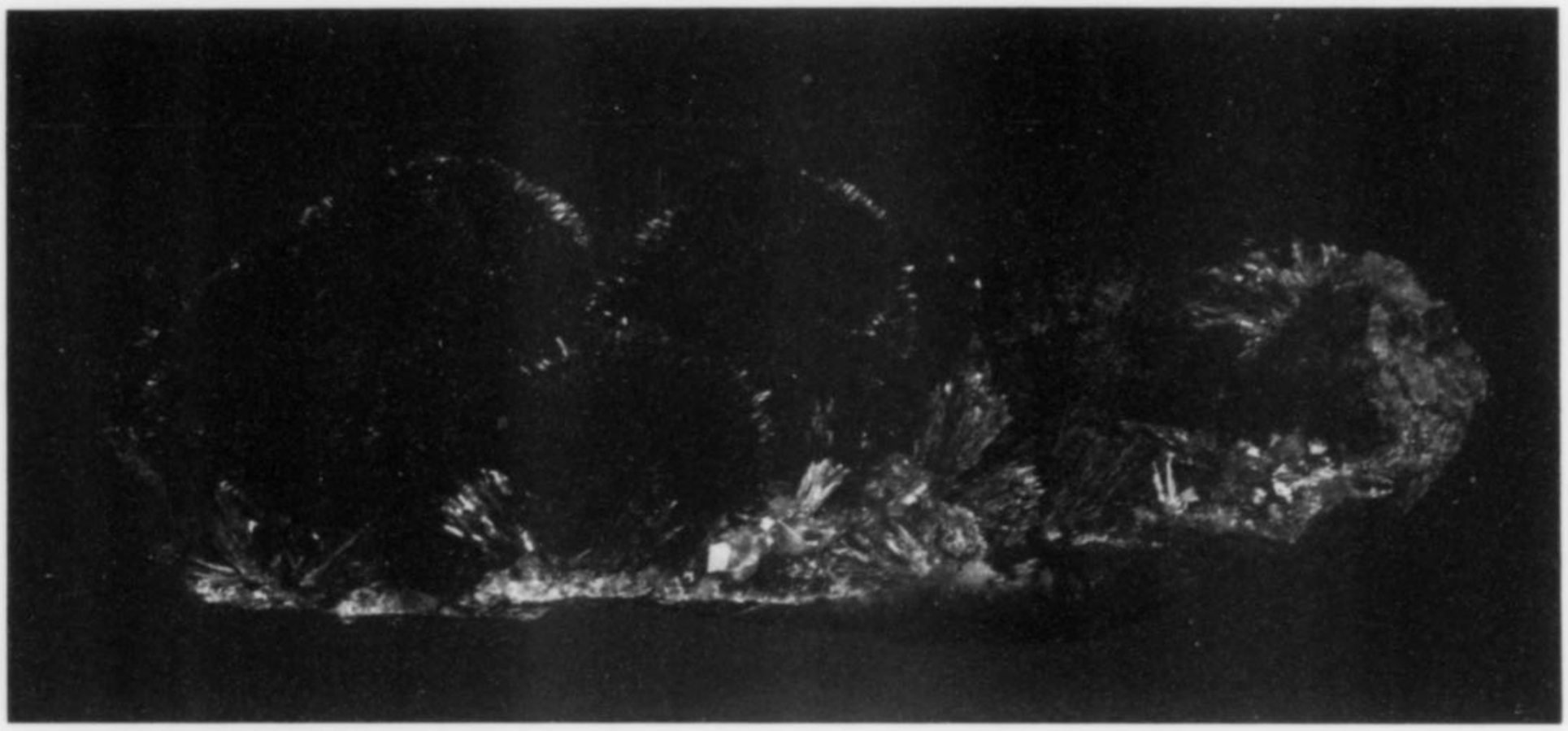


Figure 25. **Gormanite on matrix, 8.3 cm, from Locality 15, Area C, Big Fish River, Yukon Territory, Canada. Gunther Kuhnlein collection; Jeff Scovil photo.**

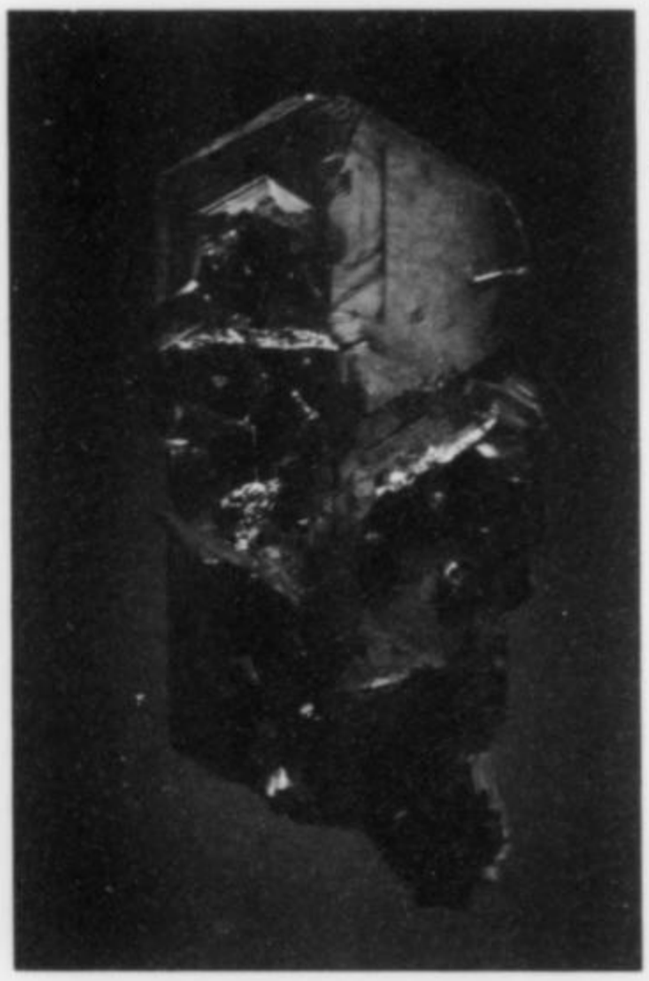


Figure 26. **Polybasite crystal, 2.4 cm, from Rudniy, Kazakhstan. Sergey Baskakov specimen; Jeff Scovil photo.**

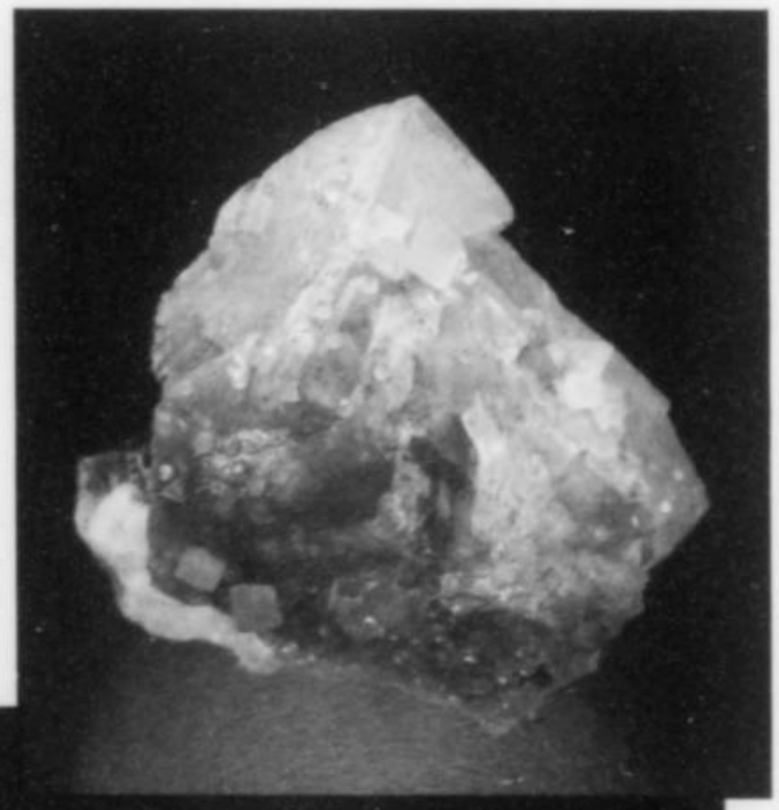


Figure 27. (right) **Fresnoite crystal group, 1.8 cm, from the Junilla claim, San Benito County, California. Great Basin Minerals specimen; Jeff Scovil photo.**

Figure 28. **Fluorrichterite crystals with phlogopite, 4 cm, from the Earle Occurrence, Wilberforce, Ontario. Lambert Minerals specimen; Jeff Scovil photo.**

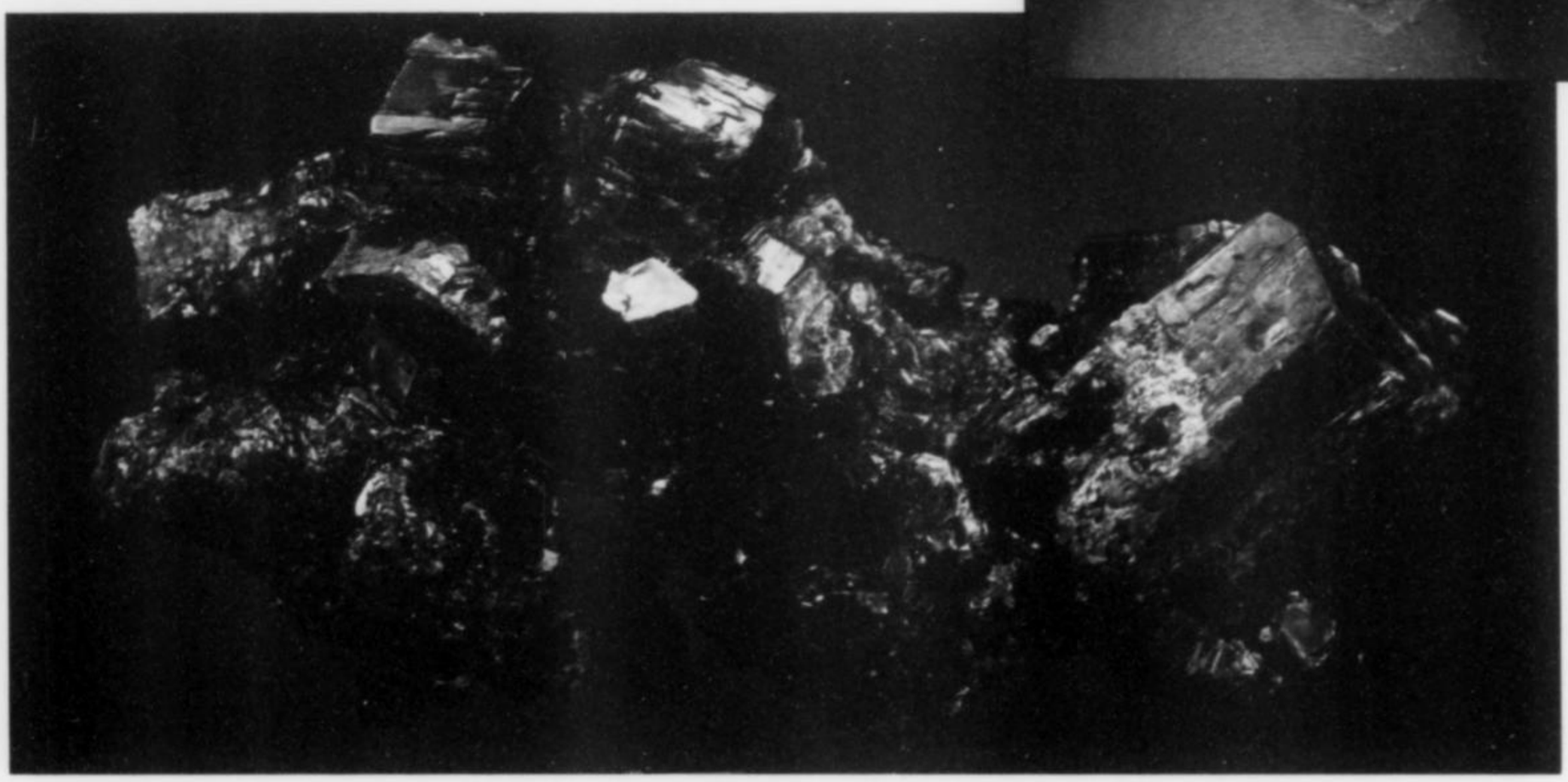


Figure 29. Dealers set up amid the classical surroundings at the Carnegie Museum Show. Jeff Scovil photo.

Figure 30. Carnegie curator Marc Wilson (center) with his wife Debbie and Richard Freeman, at the Carnegie Museum Show. Jeff Scovil photo.

Figure 31. Schorl crystal group, 11.5 cm, from the Jaqueto area, Bahia, Brazil. Helmut Brückner specimen; Jeff Scovil photo.

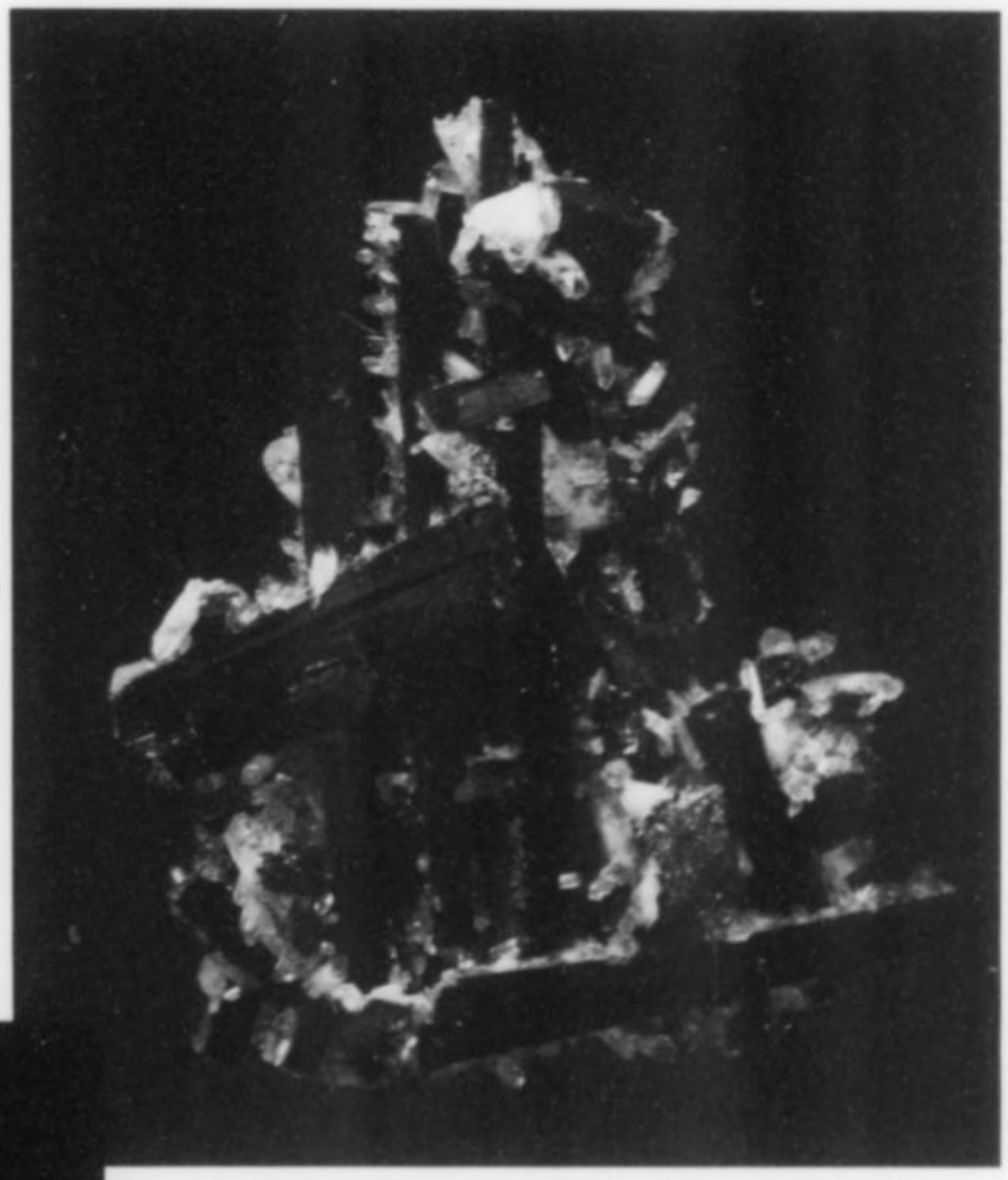


Figure 32. Epidote crystals with quartz, 11.2 cm, from Capelinha, Minas Gerais, Brazil. Victor Yount specimen; Jeff Scovil photo.

Figure 33. Euclase crystal, 3.3 cm, from the Chivor mine, Colombia. Le Minéral Brut specimen; Jeff Scovil photo.

The only new Mexican item that makes the news this time was seen in the Hereford Ballroom of the Holiday Inn with Doug Wallace: **celestine**. A so-far anonymous place in the Musquiz district, Coahuila, Mexico, has just lately produced some beautiful large celestine "spears" with fluorite. These are great twinned blades, with the twinning plane down the long axis. The colorless, transparent crystals are arrayed in toothed rows to 28 cm long and just 1.5 cm thick, on which pose transparent medium-purple compound cubes of fluorite to 2 cm on edge, Doug had about ten cabinet specimens of this handsome association, and hopes to have more on another day.

Out of Huanuni, Bolivia, has come a new surge of some of the world's finest **ludlamite**: sharp-pointed parallel-growth sheaves of crystals, the sheaves to 2 cm high, smoky green and translucent to transparent, sitting up well on a matrix of drusy pyrite. Gary Nagin of *Crystal Springs Mining & Jewelry* (P.O. Box 40, Royal, AR 71968) has just brought out 100 or so fine specimens, collected several years ago and saved in Bolivia until now. It seems that the Huanuni tin mine is closed for commercial mining purposes, and is being worked for specimens by individual miners, so that we may expect, at best, just a trickle of these fine ludlamites until such time as the government re-opens the mine. Gary's specimens range from thumbnails up to 7-cm matrix pieces, and prices for the best thumbnails are in the mid-three figures.

Having seen the ludlamites in their earlier runs, though, I found it more fun to ogle some new Bolivian things being offered at the Main Show by Alfredo Petrov (Casilla 1729, Cochabamba, Bolivia). Here were about a dozen floater **sulfur** crystals and groups from a volcanic fumarole at Napa, Potosi Dept., just about 150 yards (Alfredo says) from the Chilean border. The fumarole itself has been known for years (even though there's no road to the place; one drives across a vast salt flat 13,000 feet above sea level), but just a month ago these big sulfur specimens were found loose in an ash bed. The crystals are slightly hoppered bipyramids to 5 cm high, occurring as singles and in groups of two or three, bright yellow, partly transparent, and fairly pretty. Also, from the same weird place, there are miniature to small cabinet-size matrix specimens with rounded, gemmy sulfur crystals to 1 cm standing up straight all over—very much like the ones of recent note from Baja California, Mexico. There were about a dozen of these as well, priced at $20 to $40.

Among other, "old" but intriguing, Bolivian things (such as blue-gray floater **danburite** crystals from Alto Chapara; **sulfosalts** from the San Jose mine; even a fine thumbnail with 1.5-cm **wurtzite** crystals, from the Siglo XX mine), Alfredo had a small swarm of thumbnails and small miniatures of **bournonite** from a new find at Machacamarca, Potosi Dept. These are wonderfully sharp single cogwheels and clusters of two or three, but unfortunately they are a lusterless flat black, and heavily stained (in some areas coated) with brown limonite. If they were brighter they would be utterly outstanding bournonite specimens—and (look at it this way) they would cost a lot more than the $10 or $20 Alfredo was asking.

Brazil is much in the news this time out. Let's start with Carlos Barbosa, the ever-young Grand Old Man of Brazilian minerals (Rue Cell Roberto Soares Ferreira 586, Bairro Vila Bretas 35032-590, Governador Valadares, Minas Gerais, Brazil), who had perhaps 50 brilliantly black, lustrous toenails and small miniatures of a tourmaline-group mineral he was calling "**dravite-schorl**," from a new find at Vargem Alegre, Espirito Santo. One dramatic cluster of these crystals is 5 x 7 cm, and two other pieces have single dravite-schorl crystals sitting on prism faces of 8-cm milky quartz crystals. Most of the specimens, though, are 3-cm single crystals with short prism faces, low-angle trigonal terminations on one end, and a slightly rough and less lustrous simple flat pedion as a base. A few of the crystals have powdery white feldspar (?) patches.

Along similar lines, Carlos Vasconcelos of the dealership of *Vasconcelos* (Rue Alfonso Pena 3053, Governador Valadares, Minas Gerais, Brazil) has brought out about 1000 kilograms of **schorl** crystals from the Jaqueto area of Bahia (near the border with Minas Gerais). The top range of that tonnage was represented by about 100 beautiful crystal groups (Helmut Brückner having earlier gotten *the* best one) in a room at the Holiday Inn. The schorl crystals are brilliantly glassy black, striated prisms with trigonal terminations, reaching 2 x 4 cm individually, but clustered fairly tightly in groups of which the biggest I saw was fully 15 x 30 cm. Sizes range down from there through toenails. Sparse associations consist of pale brown muscovite books and snow-dustings of white feldspar microcrystals.

Champion among the Brazilian dealers for variety and sheer surprise, this time, was Luis Menezes (R. Esmeralda 534, Belo Horizonte 30410-080, Brazil). In this Holiday Inn room one found, first, a dozen dramatically large crystals of **wodginite** from a new locality: Sapucaia do Norte, Galileia, Minas Gerais. These are somewhat rough-faced, submetallic black twins from 2 x 3 to 4 x 6 cm: wide flat blades with the twin planes parallel to the *c* axes, standing tall without matrixes, though with small smears of a brownish mica on some surfaces. Not lustrous or particularly attractive, these nevertheless are sharp, enormous crystals for this rare species.

Next, a small, unnamed pegmatite near the Morro Redondo mine, Coronel Murta, Minas Gerais, has lately produced about 50 specimens of lavender twins of **hydroxylherderite**, from thumbnail-size to 5.5 cm high. The luster is bright, the form excellent, with sharp twinning notches on top, but the lavender color tends to be on the pale side; all crystals are transparent, with much internal crazing and crackling.

Next, some exquisite small thumbnails consisting of loose penetration twins of **manganotantalite** have very recently come from Parelhas in Rio Grande do Norte. The crystals are lightly striated, lustrous and sharp, with a vivid, meaty interior redness shining through the submetallic black surface sheen. Luis Menezes only had six of these (with, again, Ralph Clark snapping up the best, about six hours before breakfast).

And finally, watch for developments regarding the new, bright satiny pinkish red aggregates of parallel bladed crystals of what the labels indifferently call either **rhodonite** or **pyroxmangite**, and which may in fact be a new species; study is under way. This material resembles Peruvian rhodonite, but the locality, Luis is sure, is Conselheiro Lafaiette, Minas Gerais, Brazil.

Rocko Rosenblatt of *Rocko Minerals & Jewelry* (Box 3A, Route 3, Margaretville, NY 12455) comes in for notice again, not for his profusion of scepter quartz crystals from his mine in upstate New York, nor yet for the South African items he markets for Clive Queit, but for an abundance of excellent English **fluorite**, both of the smoky purple and deep sea-green kinds. The purple groups have been very recently dug from the Frazor's Hush mine, 360-fathom level, Westgate, Durham. Rocko had five flats of plates, to 10 x 20 cm, with massive *green* fluorite as vein linings over rock matrix but with further blanketings, over the green, of transparent purple cubes averaging 1 cm on edge, with some penetration twins, the thick fluorite crusts and mounds punctuated by 1-cm galena cuboctahedrons. The fluorite crystals are vividly fluorescent—as are the deep green crystals in Rocko's *other* flats, containing nice small cabinet specimens from the Rogerley mine, Weardale.

Perhaps you'll recall my 1997 Tucson ravings about the specimens of arborescent **gold** dug one lucky day from the "Speranza Pocket" on Monte Ciamusera, Brusson, Aosta, Italy. Well, at Ernesto Ossola's booth at the Main Show, Lino Caserini (via Don

Giuseppe Del Corno 1, 20132 Milano, Italy) was offering for sale five cabinet specimens from this find, the best one a 6 x 6-cm gray quartzitic matrix with branching, brilliant gold standing up all over its top. These are truly extraordinary golds for an Italian Alpine locality, and Lino showed me a photo of the most amazing one extant, a 25 x 30-cm plate at least half blanketed with bright gold (etched out of the quartz seam filling), now in a Milan museum.

Ernesto Ossola himself (8 rue du Luxembourg, 30140 Anduze, France) had about 20 very odd **gypsum** specimens from Gocate, 25 km from Midelt, Morocco. These are highly etched, transparent lumps (a few crystal faces partially surviving) of absolutely transparent and colorless gypsum; apparently they were fillings of calcite geodes. The lustrous, waxy-smooth specimens range from 3 x 3 to 6 x 6 cm.

As usual, Gilbert Gauthier's stand at the Main Show was all forest-green with Congo **malachite** specimens, but some of the darkest and lushest of the greens were contributed by a few miniature and cabinet-sized specimens of malachite-stained **heterogenite** (a cobalt oxide/hydroxide) on **chrysocolla** on altered rock, from the Star of the Congo mine near the city of Lubumbashi, Katanga, Congo. This old mine was known in Belgian colonial days as the Mine de l'Etoile, but the nifty new name was bestowed by the British concern now dewatering the old workings, where miners with primitive tools have been finding the heterogenite specimens in re-exposed veins as the water level falls. They are weird-looking: seam linings of sky-blue chrysocolla with asphalt-black heterogenite in mounds of mammillary spheres boiling up from them, the heterogenite stained deepest green by malachite films. Gilbert wanted $25 for a nice-looking 5 cm specimen.

As I've said, I saw *nothing* new from Russia. From Springfield I mentioned the new stromeyerite crystal clusters from Dzhezkazgan, Kazakhstan, and there were, sure enough, a few more of these around; and Herb Obodda had two small cabinet specimens of what is surely the finest **betekhtinite** yet produced from Dzhezkazgan or anywhere else. But there is one major revisitation from an ex-Soviet republic, little Tajikistan in Central Asia, worth lingering on for awhile. I refer to the wonderful top-gem-quality crystals of heliodor **beryl** from the Zelatoya Vada mine, which have been seen before in small lots. Imagine my dazzlement to find several hundred crystals in the Holiday Inn room of *Mine-Run Enterprises* (13337 E. South St., Suite 310, Cerritos, CA 90703-7308). Here, exporter Joe Garcia chatted amiably at me while I looked at length on these lovely loose heliodor crystals which ranged in color from pale yellow through deep yellow-orange, and in size from small thumbnails up to prisms 15 cm high. Export pipelines apparently are now opening up, and with greater numbers of specimens, of course, comes greater variety. Some of these hexagonal prisms terminate in simple basal faces, while others feature complexities of secondary pyramidal faces; some crystals are doubly terminated; some have color zoning; some occur in parallel-growth groups of two or more; some have bits of white matrix adhering; some have inclusions of tiny elbaite needles. And, if you're into gems (as Joe Garcia is; he cuts them), you'd have enjoyed the dozens of faceted yellow brilliants on display here. I must say I'm highly pleased with the three thumbnail crystals I picked up for much less than I'd have expected to pay: the robust orangish yellow color, sharp faces, and flawless gemminess make these loose crystals winning beryl specimens.

A very new and promising development out of Pakistan is a small number of loose, very large **lazulite** crystals reportedly found this year in an Alpine-type pocket in the Chilas area, near Nanga Parbat. Herb Obodda had just three crystals: the biggest, a largely complete bipyramid, is 5 x 7 cm, while a 90% complete crystal is 3 x 5 cm, and a thumbnail-sized fragment puts itself forward as prime gem rough. These lazulite crystals, though grayish and drab-looking in surface aspect, are totally gemmy inside, and dichroic; a pencil-flashlight beam shone into a face reveals that the color one way is brownish yellow, another way a stunning deep greenish blue. It's unclear how many such crystals were taken out, or who, if anyone, may have more.

Herb Obodda was also one of several dealers with large supplies of **faden quartz** floater groups from Toyee, South Waziristan, North West Frontier Province, Pakistan. Specifically, he had five flats with about 100 miniatures and small cabinet specimens of this fine, clean, lustrous faden quartz: much-flattened prisms strung out in chains or flaring in butterfly patterns. All of the quartz faces are complete, and frosty white faden lines run distinctly down the long axes of specimens—just like the pictures in the article on fadens in vol. 21, no. 3. Word is that the specimens were found loose in sand-filled or clay-filled fissures in five little prospects about two years ago. Andreas Weerth (Hochfeldstr. 37, 83684 Tegernsee, Germany) had nearly as many pieces as Herb, including two magnificent examples 18 cm high, which, when I last looked, were being browsed over by some major museum buyers. Considering what other dealers had too, it's probably true that there have never been as many fine faden quartz pieces as this available at one time, at one mineral show.

I can't resist mentioning a one-of-a-kind specimen which Andreas Weerth was handling on consignment for someone in Sri Lanka: a 2.5 x 4.5 x *14-cm* Sri Lanka **sapphire** crystal, complete all around, lustrous, gemmy through much of its interior, and of an odd smoky greenish blue color. The owner wanted $45,000 for this astounding crystal.

The tour will conclude in China, but will linger awhile there, as there are several exciting things to be seen. First, Danny Trinchillo of *DeTrin Minerals, Inc.* (14-48 128th Street, College Point, NY 11356) has at least one reason to be glad of his recent shift from Russian minerals to Chinese: about 10 excellent cabinet specimens of **stibiconite** pseudomorphs after stibnite, from the Lushi mine, Hunan Province. By now this mine is a well-known locality for top-quality stibnite groups, but these pseudomorphs are newly mined; Danny obtained them on his most recent trip to China. They are spindly, large loose sprays of prisms to 20 cm long by only about 1.5 cm wide and thick, and each crystal shows clearly all the characteristically complex terminal faces and striation ridges of what was once stibnite. Some broken areas show that the replacement by stibiconite goes all the way through the prisms. In short, these are very effective pieces, despite being colored dull, earthy, yellowish brown. Prices ranged from $50 up to $200 for a handsome spray 18 cm high.

Debbie Meng of *Debbie Meng's Minerals* (P.O. Box 117, Marina, CA 93933) is as knowledgeable about Chinese minerals as she is patient in explaining about them, and in her Holiday Inn room she had a couple of very fine things to explain: a handful of specimens of the new Chinese **apophyllite** that I mentioned sighting in Springfield, and a new **manganocalcite** hoard from the Chenzhou area of Hunan Province. The manganocalcite crystal groups formed in a limestone cave, and this lot was collected by local seekers who washed out the cave sometime around Christmas of 1996. Debbie had about 40 big specimens, from 7 x 7 cm up to 20 x 20 cm, consisting of vertical stacked-platelike piles of flattened rhombohedral crystals of manganocalcite rising all over, from matrix bases of gray limestone. The manganocalcite is translucent, lustrous, and palest pink to white; individual sharp discoids in the stacks are up to 2 cm across. These specimens, beautiful enough in natural light, are fluorescent a glowing deep orange. There have been no new such finds, Debbie says, for the past 20 months.

The apophyllite comes from an old copper mine at Huangshi, Hubei Province. Crystals are very thin and tabular, colorless and transparent, in perfect little square windows which, in the best specimens, grow in wing-fluttering little offset clusters, with individual crystals to 2.5 cm: at the centers of clusters, where all the wings or windows meet, there's often a delicate pale salmon tint. These creative formations sit on coatings of subhedral crystals of some carbonate (*not* calcite; Debbie is working on it), with tiny black spots of **manganbabingtonite** There were half a dozen miniature to small-cabinet-size pieces, and there was one 3 x 6 cm piece which is different: a loosely interlocked cluster of much thicker tabs of apophyllite, milky to colorless and transparent.

The item falling last in my organizational plan (such as it is) happens to be arguably the most exciting what's-new of this show: brilliant gemmy **cassiterite** from Ximong, Yunnan Province, China, offered at the Main Show by Ken Roberts, who had one flat of thumbnails and miniatures. On white matrix of granular quartz (with some 5-mm quartz crystals), textbook sixling twins of cassiterite, many complete around all 360 degrees, from 1 to 3 cm across, sit vividly perched, flashing brilliant mirror-faces at the onlooker. But what's most amazing is the transparency: a gemmy dark brown with yellowish highlights down through which you can look, almost to the centers of the twinned clusters, where clouds finally set in. The finest thumbnail went for a low 4-figure price to Tom Gressman, who agonized for fully five seconds before busting his show budget on it. Ken Roberts says that these specimens came out six months ago from an old mine now being dug and scraped around in by local people; hence it is not surprising that only 1% of the specimens found made it out to market undamaged. These were among them—and most are by now sold.

I have already broken the news that the theme of the Main Show this year was *fossils*. What can we make of this? One obvious downside was that a far greater number than usual of the display cases were filled with fossils, not minerals . . . but then there *was* "Mr. Bones," a *walking* 10-foot-tall lightweight foam-plastic skeleton of a carnivorous dinosaur of the Velociraptor type, made mobile by a nearly invisible man in black fitted into a position between the beast's hips. This dinosauroid kept strolling around the show floor in a reptilian sort of way, tail waving, ribs flapping, skull frequently dipping to threaten to bite off the heads of small children. A foghorn-like "roaring" sound vaguely accompanied the performance, and I couldn't at first locate the sound's source; but I eventually discovered that it issued from one of the displays—an inventive exhibit by the New Mexico Museum of Natural History and Science, in which, by pressing a button, one could elicit an approximation of how a crested Parasaurolophus sounded when it huffed through the trombone-like tube of bone on top of its skull.

At the usually deserted far end of one of the Main Show's "tunnels" of dealers' booths was the entrance to another huge chamber, this one entirely filled with fossil dealers and fossil displays. Entering, you saw that this room was sentried by another brown floppy skeletal specimen, a Stegosaurus; at the far end of the hall a Tyrannosaurus skeleton loomed, this one a more serious critter, as it was not made of toy-plastic but was a serious reconstruction in dense urethane. The average age of the people thronging this fossil hall was a decade or so lower than that of folks who preferred to throng among minerals—not that eager kids were scarce anywhere in the complex.

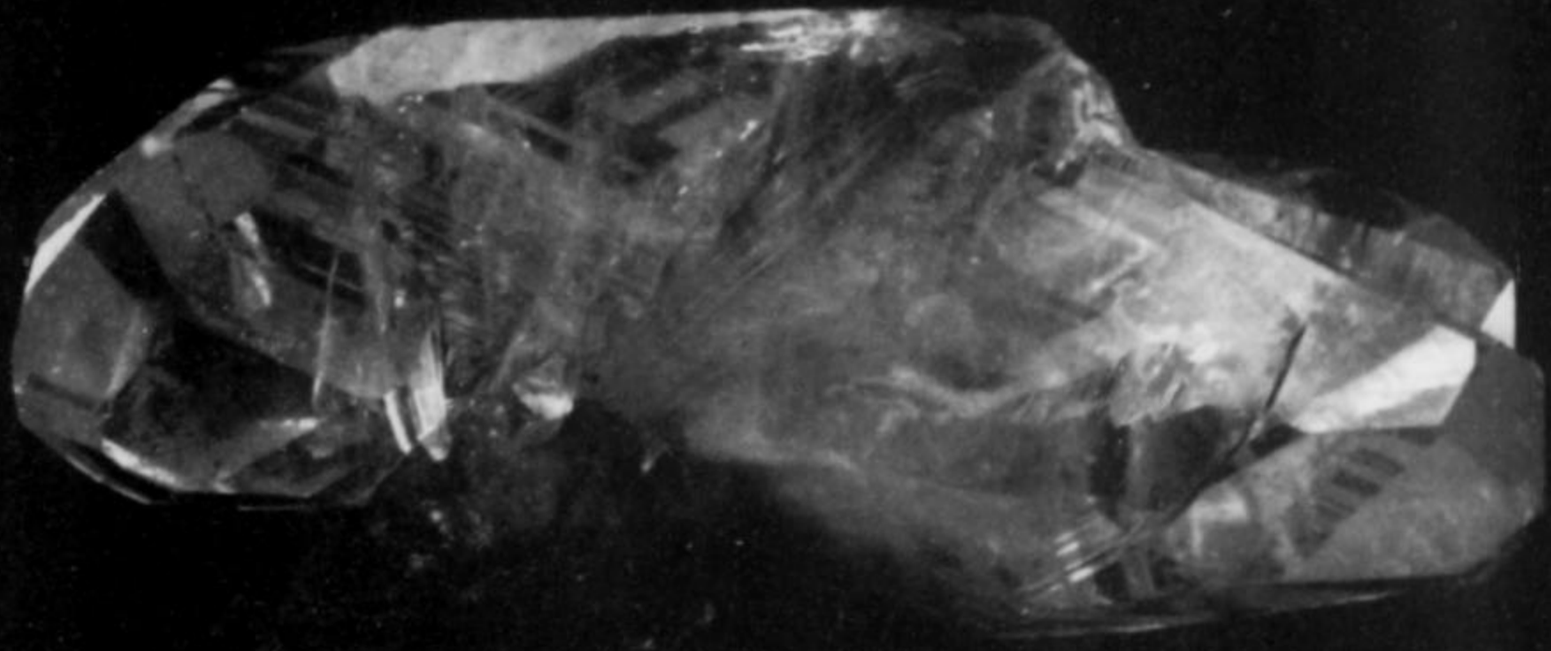
In a pedestal/showcase all by itself in the show floor's middle, Bryan Lees also put out the specimen of Colorado Quartz mine, California, gold which he calls "The Dragon," mined in January of 1998. On a reinforced 17-cm gray and white quartz breccia matrix, the dragon of solid gold rises, a full 15 cm of the brightest, best crystallized gold imaginable, all flattened and/or hoppered octahedrons, some of these 1 cm on edge and extremely sharp. Crowds of people of all levels of sophistication lingered long in awe around this specimen (though Mr. Bones did once threaten to bite its glass case off).

I can hope only to mention in the briefest way some impressive displays. The American Museum of Natural History, New York, had a very large case with about 40 Guanajuato, Mexico, calcites from the Bement Collection; Harvard showed classic American minerals from the collection of Elwood Hancock (1834–1916); the Cincinnati Museum of Natural History showed calcite pseudomorphs from the collection of Terry Huizing; the Los Angeles County Museum showed some recent acquisitions, including a 45-cm Japanese stibnite cluster and a 20-cm-high, richly gemmy Pakistan peridot.

Among cases by private collectors, there was a Ralph Clark update case, heavy in *new* superlative thumbnails; a fine case by Bill and Carol Smith on native elements; and, spectacularly, Clara and Steve Smale's two cases of Chinese specimens, many of them real mind-expanders, which Steve has acquired during these past three years of living in Hong Kong on a research/teaching grant. His giant cassiterite is of a different type and locality, and is much larger than the new specimens Ken Roberts offered, but seeing both will probably engrave this show in my mind as The Chinese Cassiterite Experience.

Or maybe the Sleep Deficit Show . . . having now at last finished this report, I must pack up for tomorrow's early flight home, getting maybe three hours of sleep. But I should revive by the time everyone meets again in the hothouse called Tucson.

Phosphophyllite
5 cm tall
Cerro Rico de Potosi
Bolivia



Wayne A. Thompson

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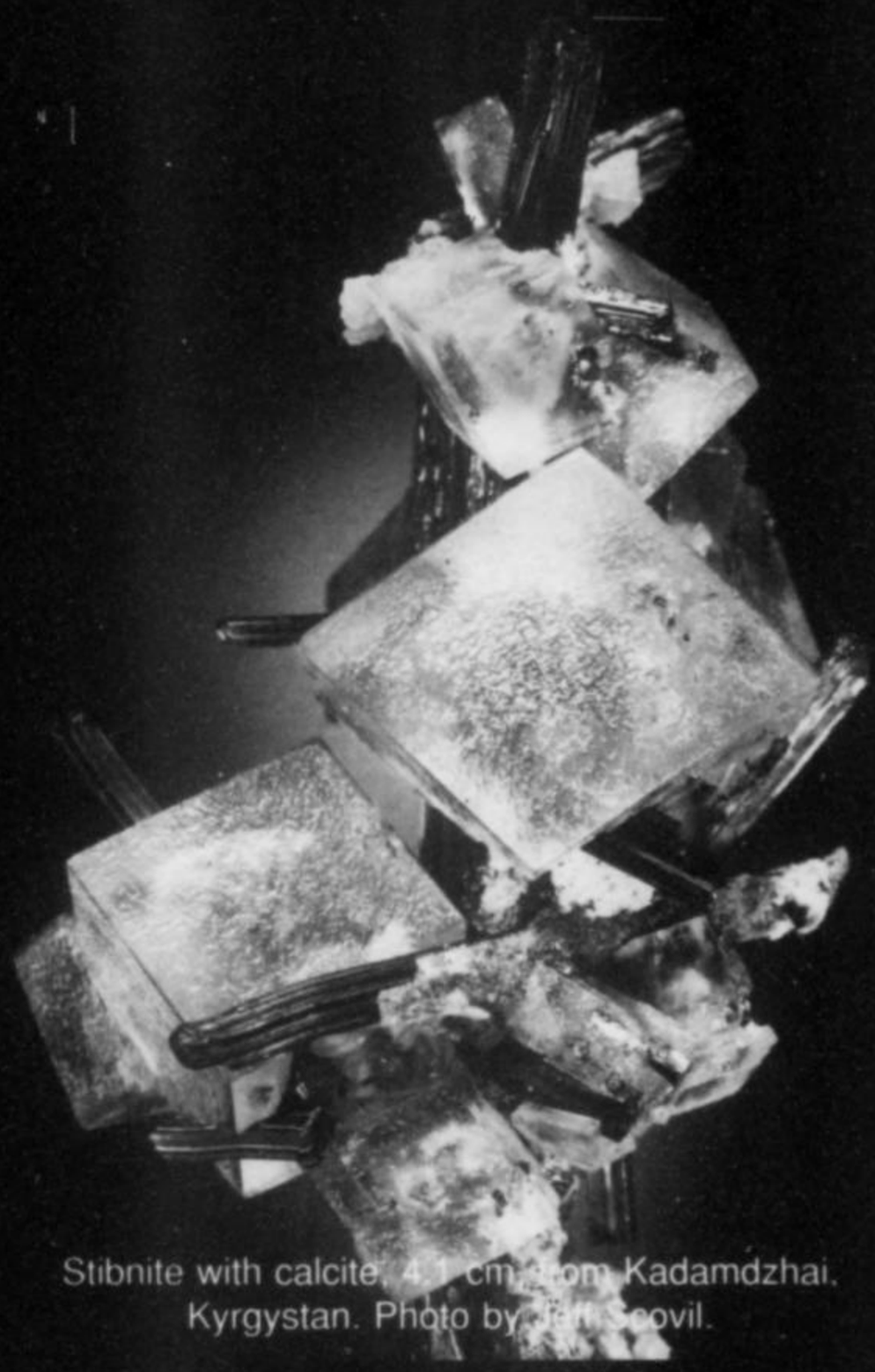
photo by Jeff Scovil

Stuart & Donna Wilensky



Stibnite with calcite, 4.1 cm, from Kadamdzhai, Kyrgystan. Photo by Jeff Scovil.

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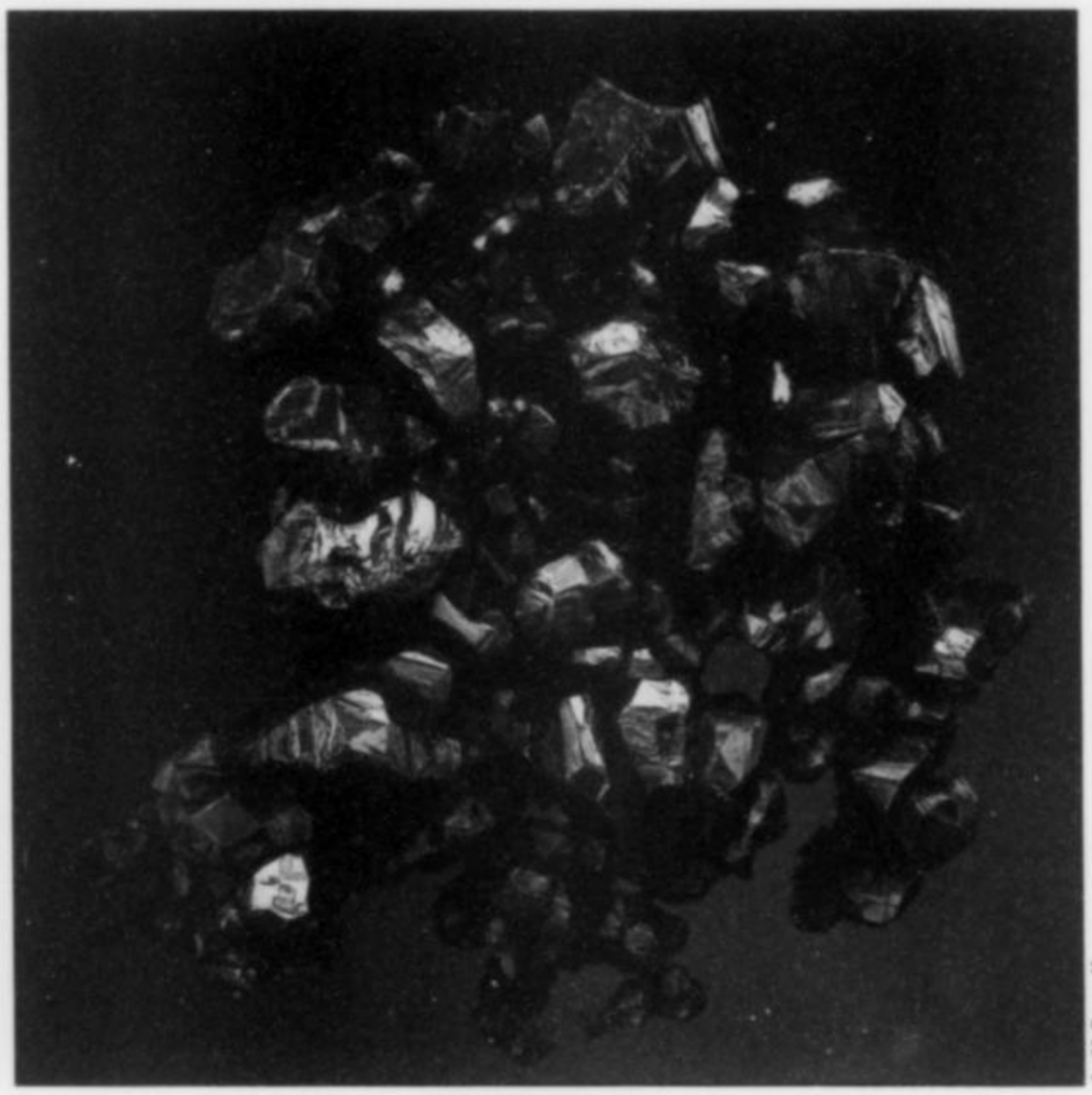
PHOTO: LUDLAMITE, Santa Eulalia, Mexico, 3.5 cm. Photo by Wendell E. Wilson.

Jeff Scovil



Jeff Scovil

COPPER
Keweenaw, Michigan
12 cm high
Steve Neely Collection

NOVACEKITE
Brumado, Brazil
7 cm wide
Steve Neely Collection

The Collector's Edge Minerals, Inc.

We have just purchased the Dr. Stephen Neely collection! This exquisite collection contains hundreds of superb worldwide mineral specimens. The quality of each piece reflects the years of devotion taken to assemble this fine material.

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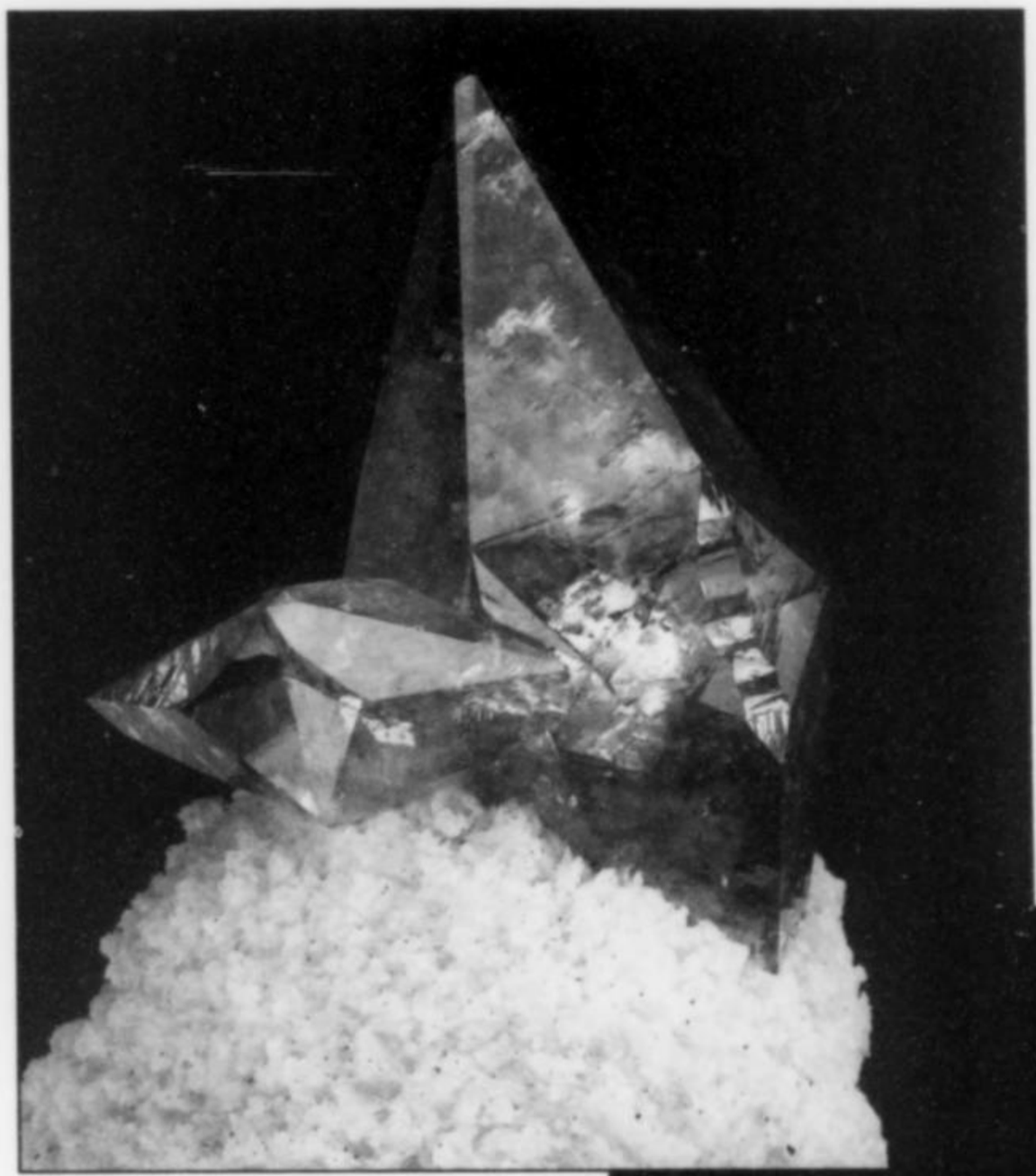
Come see the Dr. Stephen Neely collection and our other fine minerals at the Tucson Gem and Mineral Show in February 1999. Or, feel free to contact us directly.

Sandor P. Fuss, Sales



Jeff Scovil

CALCITE on BARITE
Elmwood, Tennessee
16 cm high
Steve Neely Collection

AZURITE
Tsumeb, Namibia
12 cm wide
Steve Neely Collection

Jeff Scovil

The Dr. Stephen Neely Collection!

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Letters

PHOTO ATLAS CD

My wife and I are members of the Gem and Mineral Council of the Los Angeles County Museum; the Council is the publisher of the *Photo Atlas of Minerals* CD which has recently been advertised in the *Mineralogical Record*, and which contains over 6,500 mineral photos (over half of which are your work). We were *very* impressed by the quality of the photographs when viewed on our computer. Can you tell us what equipment was used to take the pictures, and to transfer them to CD?

Michael L. Base
Upland, CA

The photos (at least my own photos) were shot using a Nikon F3 camera with Macro lens. For details on the technique see the article A Photographer's Guide to Taking Mineral Specimen Photographs for the Mineralogical Record *(vol. 18, no. 3, p. 229–235).*

For use in the CD the 35-mm slides were first scanned onto photo CD's by a commercial lab. At that high level of resolution, only about 100 photos can be contained on one CD. Working from those master CD's, the images were then touched up and refined (contrast, color balance, etc.) using the Picture Publisher *program (any standard image processing program will also work). Finally they were transferred in a lower-resolution version to the* Photo Atlas *CD, utilizing fractal compression to maximize the capacity of the CD. I am quite amazed myself at how well it turned out.*

If you would like more information on the computerization aspects involved in creating the Photo Atlas *CD, you may contact George Gerhold, 829 Racine, Bellingham, WA 98226. He's the one who handled that part of the production. Ed.*

DONATION

At the 17th annual Northeast Meeting of the Micromounters of New England our speaker was William A. Henderson, Jr. As a friend and member of our club, Bill declined remuneration for his services. In return for his generosity we are enclosing a check which we would like to have applied toward the use of color in the *Microminerals* column or in an article relating specifically to microminerals. We hope that other clubs or individuals may be inspired to add to this in order to show support for the hobby of micromounting, which we consider to be an important phase of mineral collecting. We are grateful to Bill for suggesting this use of his deserved honorarium.

Janet Cares, Treasurer

(continued on page 65)

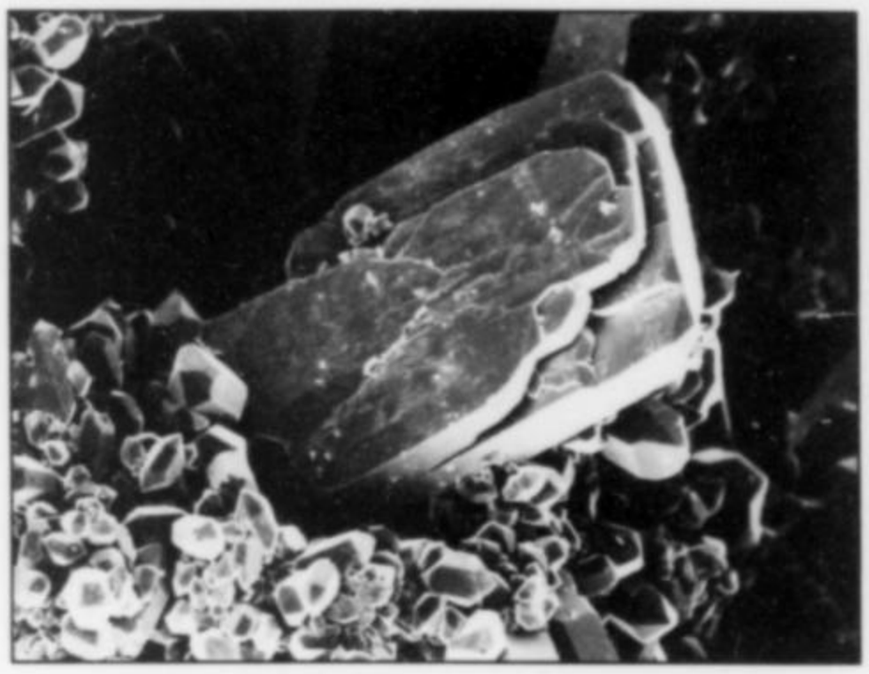
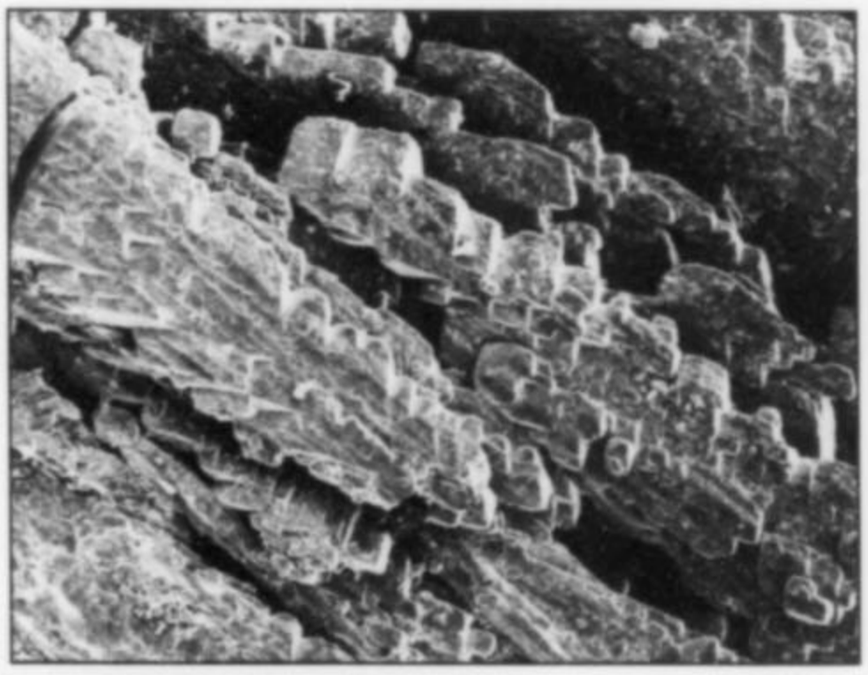


Figure 1. **Tabular anatase, 90 µm, Hall's Gap.**

Figure 2. **Rosettes, 10–20 µm, of hydrohonessite platelets, Hall's Gap.**

Figure 3. **Bladed marcasite, 50 to 80 µm wide, Hall's Gap.**



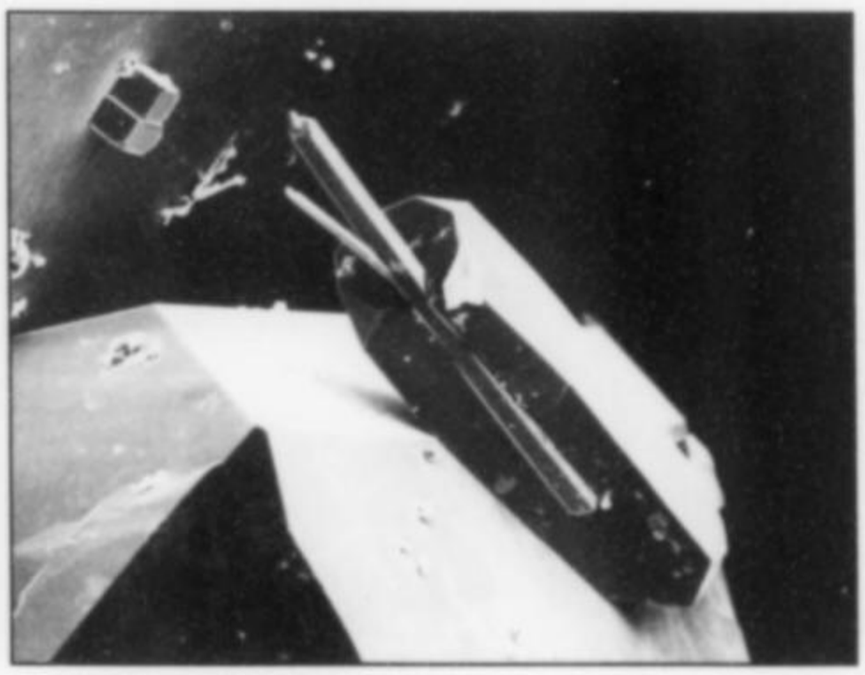


Figure 4. **Elongated pyrite crystals, about 210 µm, Hall's Gap.**

Figure 5. **"Fuzzy" pyrite rings, 80 µm in thickness, Hall's Gap.**

HALL'S GAP UPDATE

Further to my article on *Hall's Gap, Lincoln County, Kentucky* (September–October 1997), here are some SEM photos that were not available at the time of publication: a tabular **anatase**, hexagonal platelets of **hydrohonessite** (matching those of Nickle and Wildman's original 1981 description of the species), bladed **marcasite**, needle-like **pyrite** consisting of elongated cubes, and some spectacular **pyrite rings**. (All specimens shown are from the collection of Rudi Turner.)

A series of short articles with SEM photos in *Mineral News* were not listed in the bibliography; these are as follows:

GOLDSTEIN, A. (1992) Examining Hall's Group geodes. **8** (9).

——— (1992) Examining Hall's Gap geodes II; some notes on millerite. **8** (11).

——— (1992) Examining Hall's Gap geodes III; jamborite and other alterations of millerite. **8** (12).

——— (1994) Hall's Gap IV: Pyrite. **10** (6).

——— (1994) Hall's Gap V: Sphalerite, galena, and a note about cerussite. **10** (2).

——— (1994) Hall's Gap VI: Quartz. **10** (10).

——— (1995) Hall's Gap VII: Mineral miscellany. **11** (2).

Alan Goldstein

ERNSTITE

In response to the article by Karfunket *et al.* in the November–December 1997 issue, I would like to make a correction regarding "ernstite."

Evidently they analyzed two "crystals" that are only partly altered, and then they extrapolated those results to characterize all similar-appearing crystals from the locality as being 90% eosphorite. I was responsible for the original identification of ernstite using X-ray diffraction analysis, based on a "crystal" supplied by Carlos Barbosa. The lower one-fourth of the crystal was crushed for analysis, and *no* eosphorite or childrenite were found to be present. The only diffraction lines present were those of ernstite, and the weakness of those lines suggested the presence of a significant amorphous component.

I reported these results to Carlos and he sold the material correctly as [pure] ernstite pseudomorphs after eosphorite.

Karfunket *et al.* analyzed two specimens, and I analyzed one. Obviously, pseudomorphing can vary from partial to complete, and in the case of the specimen I studied, it was complete. I have since observed many such samples, most of which

appear to be completely replaced by ernstite. Consequently, in the absence of a destructive analysis of each crystal, the buyer is justified in assuming the "ernstite" label to be correct.

William R. Cook

Seems to me the buyer has no basis for assuming either way. Each "crystal" could conceivably be different in its degree of pseudomorphism and its ratio of ernstite to eosphorite. Ed.

N'CHWANING MINE

I would like to respond to the letter from Colin Owen in the recent September–October issue (p. 495), in which he writes about the N'Chwaning I mine.

The N'Chwaning I mine has *not*, in fact, been reopened. The N'Chwaning II mine is currently exploiting a very small pocket of high-grade manganese ore in the N'Chwaning I mine area. This is only a short-term operation, and no red rhodochrosites have been found to date. The three specimens pictured with Owen's letter (a hematite, a calcite, and an andradite on hematite) are nothing extraordinary and are certainly not rare species as described in his letter.

I just thought that, as Chairman of the mining company and a fellow mineral collector, I should clarify this issue.

Desmond Sacco
(Chairman, Ore & Metal Co., Ltd.)

MINERAL PAINTINGS

Some years ago I was looking for a hobby and decided to take up painting pictures of mineral specimens. Needless to say, the *Mineralogical Record* is an excellent source of photos to copy. Is there any problem with rights, permissions or copyright in such a case?

Name Withheld

Yes, there is. Photographic images are considered artworks like any other, and are copyrighted against unauthorized duplication. In the case of the Mineralogical Record, *the individual photographers retain the copyright on their photos, so permission would have to be obtained directly from them. Copying someone else's photo without giving proper credit is plagiarism.*

A person wishing to do mineral art must realize that the manipulation of paint is only one of the skills involved, and the most mechanical (least creative) one at that. The concept for a specimen photo, the specimen selection, orientation, cropping, lighting and composition are the real creative aspects. And even for an experienced mineral photographer, getting a photo with that "fine art" quality about it which would make a nice painting is rather rare. Consequently, the artist who simply copies someone else's photo has not really created his own artwork, but owes it all to the photographer.

The best advice that can be given to the aspiring mineral artist is to first learn mineral photography. Then you can copy your own study photos and create an artwork that is 100% yours. For those who really *want a challenge, do it the old-fashioned way and paint directly from a specimen. Secondly, don't put the cart before the horse. Learning to draw must come before learning to paint. Ed.*

PAKISTANI FAKES

I have recently returned from Northern Areas, Pakistan, where I encountered several sophisticated fake specimens. In fact, I am now the "proud" owner of several, having not recognized them at the time of purchase. All of the fakes were apparently made of material from Chumar Bakhoor, Nagar (the source of the specimens of aquamarine crystals on muscovite crystals). One such specimen consisting of a fairly nice green fluorite octahedron (real) with aquamarine was obtained in the bazar of Karimabad, Hunza. The fluorite and aquamarine is surrounded by a band of iron-stained fine-grained material. This became obvious when the specimen was cleaned. Another consisted of a tabular beryl with an aquamarine crystal which, on examination, could have not grown where it was sited. This specimen fell apart, allowing me to salvage the nice tabular beryl. Another was a specimen of a pink apatite crystal in a matrix of quartz and muscovite. These last two were obtained from the site on the Karakoram Highway known as Rakaposhi Main Point. Get only photos of Rakaposhi here—the summit is 19,000 feet above and seven miles horizontally from you. The last fake is really good, consisting of three fine aquamarine crystals on muscovite obtained from the hotel shop at the Riveria Hotel, Gilgit. It should be noted that some of the dealers volunteered the information that certain specimens were fake. It is likely that the dealers from whom I got some of the fakes were also conned by their sources. So all material allegedly from Chumar Bakhoor, Nagar, should be examined with care.

Jack Zektzer

NEW SPECIES

The best additions to the *Mineralogical Record* in recent years have been the "New minerals recently approved," and the "Abstracts of new mineral descriptions." It is the only way for an amateur to keep up with new minerals without subscribing to a variety of technical periodicals. I hope these two columns will continue to appear as long as *MR* is around.

Douglas Meron

ANTIQUARIAN REPRINTS

I want to write a few lines to express my appreciation for the "Wulfen" [Antiquarian Reprint No. 10]. It was well worth the wait! You are doing an outstanding job in making available high-quality reprints from originals that most of us could never find, much less afford. Thank you for making a major contribution through the reprinting of those rare color-plate mineral books, preserving them for posterity. Please continue the series!

Robert Greenawalt

Thank you, and we certainly will. The next one in the series is in production at this moment. Ed.

SWEET HOME ISSUE

Congratulations on a superb issue. Putting all that information together in one issue to explain the geology and mineralogy, and experience the day-to-day mining made this the most interesting issue in 20-some years of the M.R.

Brad Bond

Those of us who labor in the pursuit of mineralogical publishing have consistently held the *Mineralogical Record* as the standard of excellence. The quality of articles and supporting graphics, produced on a regular basis, has established a benchmark which I believe has made the other magazines improve their own efforts. After looking through the Sweet Home Issue in some detail and reading the first few articles, I realized that you have just raised the bar a few more notches. Congratulations on a remarkable issue.

Jay Lininger
***Matrix* magazine**

The Sweet Home Issue is one of the best *Mineralogical Record* issues ever. The only problem is that the specimens are tainted—taint mine!

Henry Fisher

After receiving the Sweet Home Mine issue, I felt the need to send a note of congratulations for an incredibly well done job. The many months of work necessary by many individuals to compile such an issue must have been enormous, but without a doubt, this will become one of *Mineralogical Record*'s premier issues.

What a fitting tribute to put together such a quality story on such a notable locality. I

thought that the photography was stunning which, also, helped to make it an easy decision to purchase the leatherbound edition.

Joseph Molon

I am looking forward to receiving my hardcover copy of the Sweet Home Issue. My [late] husband would have loved it. The *Mineralogical Record* was one of the highlights of his life; he looked forward to each and every issue. I have to agree that it is one of, no, *the* best mineralogical magazine published.

Helen V. Groman

Thank you for the beautiful Sweet Home Issue! We visited the mine twice last year as guest of Bill Kazel. Your magazine is the *crème de la crème* of mineralogy; we always look forward to each issue. Everyone involved in its production should be complimented for the fine portrayal of all the dream-seekers who worked the Sweet Home mine. Please save us two copies of the hardbound edition.

Steve Flowers

I began writing this fax about a minor ad change when in comes the most recent (July–August) issue of *Mineralogical Record*. I will refrain from repeating the expletives I spoke after tearing open the wrapper. WOW! This issue [on the Sweet Home mine] is something we have all been waiting for. It is gorgeous to browse through, exhaustive in its depth of information, and exciting to read. What an awesome accomplishment. The last publication that got me this excited was Peter Bancroft's book *Gem & Crystal Treasures*.

Stuart Wilensky

I just want to say congratulations on the latest issue (vol. 29, no. 4). It's a fantastic publication! Good illustrations, very interesting text . . . all is perfect. Your magazine is the best; may you continue for many years to provide pleasure to mineral collectors.

L. D. Bayle
***Le Règne Minéral* magazine**

Thank you for doing such a superlative job on the Sweet Home Issue!

I'm sure I speak for all of the Sweet Home Rhodo investors in saying that, even if the rocks hadn't been there, we would've had nothing but good things to say about Bryan Lees. And we appreciate the fact that Kathryn supported the venture, even in the early stages when risks loomed large. Bryan's skill in handling the multitude of challenges involved in managing Sweet Home Rhodo was truly impressive; I've often said that he could manage a project on the dark side of the moon. So far I haven't seen a proposal for a Collector's Edge/NASA joint venture, but I check the mail every day.

John C. Lucking

Congratulations on the latest issue of the *Mineralogical Record* (vol. 29, no. 4) about rhodochrosite and the Sweet Home mine. In my opinion it is one of the best and most beautiful issues of the *Record* ever published!

Rainer Bode
***Mineralien-Welt* magazine**

Just a short note of compliment on the Sweet Home Mine Issue. After the first few pages I realized that I could not simply sit down and read through it as I ordinarily would. This issue is so outstandingly different that, rather than simply reading it cover to cover as I normally do, I allotted time to enjoy the event. I did not just devour the work, rather, I *savored* it. Brewed up a pot of coffee, sat in my favorite reading chair, put on Glenn Gould playing Bach's *Goldberg Variations*, and thoroughly enjoyed myself.

Some noteworthy effects: the *wow* factor when I peeled back the temporary cover sheet; then, the increasing cardiac acceleration as I would turn a page to encounter yet another stunning photograph; the documentation that went into the article; the documentation that went into the origin, occurrence, and provenance of even individual specimens. It is incredible. I particularly enjoyed the sense of (above all) hard work, mixed with feelings of frustration and accomplishment that miners faced on a day-to-day (and, even, year-to-year) basis. With this issue, one understands why Bryan received the Carnegie Medal, and deservedly so. Under his stewardship, the mine is flourishing, rather than simply being exploited.

Thank you for a job well done. I know the task must have been technically challenging, even daunting at times, but the results are, simply put, outstanding. My hat's off to you and the staff. Keep up the excellent work.

Ed Huskinson, Jr.

After being astounded by the superb Sweet Home Mine issue, I found myself equally absorbed by your narrative in the subsequent issue dealing with the steps you took to insure accurate color rendition of the rhodochrosites. That the end result made it all worthwhile should be apparent to anyone treating his eyes—and his mind—to those dazzling photographs. Bryan's personal tale lent a value which I particularly appreciated. It bridged the gap between the scientific and the human aspects. I salute you, as well as each member of Bryan's team and of the Record staff and publishing team whose efforts produced this great work.

Jack Halpern

I would guess that you will get many letters about the excellent "Sweet Home" issue. Here is another one! The issue will be a collector's item.

That said, I would like to point out some additional data in the history of the Sweet Home: the mine's claimants in 1973 were *Samuel B. Morgan* and *Edward W. Henderson*. The mineral surveyor was *F. C. Morse*. On December 3, 1973, the claimants paid for their mining claim as Mineral Entry No. 39. Their survey, No. 106, was approved on September 10, 1973. The Patent No. was 2043. Also the Mining District was "Buckskin Joe." The area of the claim was about 3.1 acres. One end was triangular. I have copies of the original papers, as I mentioned in my letter to you that was published in the September–October, 1993 issue of the *Mineralogical Record*.

You have quite a challenge to produce a better issue than the "Sweet Home"!

Roland B. Fischer

The East Coast Gem, Mineral & Fossil Show in Springfield, Mass., has grown substantially in the last few years, and our sales at the *Mineralogical Record* table were commensurate with that growth. In fact, our results would have been considerably larger had we had more copies of the Sweet Home Mine Issue; our supply sold out by noon of the first day.

We received some comments of a critical nature from three people concerning the Sweet Home Issue: all suggested that the issue "smacked of commercialism," and "showed favoritism of one dealer [Bryan Lees] over others." It is my belief that the comments were from dealers, not general subscribers.

One subscriber also brought in his Sweet Home Issue to show that the pages were falling out. Others reported damage in the mails.

Charles H. Weber, Jr.

Apparently our bindery did not let the binding machine warm up thoroughly before beginning to bind the Sweet Home Issue. Consequently the first few dozen copies failed to adhere properly along the spine. We have thus far replaced about 60 such copies. Any reader who experiences this problem can simply tear off the front cover and mail it to the Circulation Manager, to receive a free replacement copy. The same can be done for copies received that have been damaged in the mail. Ed.

The Friends of Mineralogy

Who We Are:

Vol 1, No 1, Mineralogical Record, Spring 1970

The *Friends of Mineralogy* was founded in Tucson, Arizona, on February 13, 1970. Its objectives were to promote better mineral appreciation, education and preservation. The chief aims and activities of *FM* include:

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

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

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

Pacific Northwest Chapter: For information about the Pacific Northwest chapter contact Wes Gannaway, President, 1604 Brookwood Dr., Ferndale, WA 98248; 206-384-4209

Pennsylvania Chapter: *Reminiscences of a Mineralogist*, by Arthur Montgomery. Order from: Friends of Mineralogy, PA Chapter.

For information about the Pennsylvania chapter contact: Roland Bounds, 315 Stamford Dr., Newark, DE 19711-2723; 302-731-8407

Southern California Chapter: For information contact: Bob Reynolds, President, 2024 Orange Tree Lane, Redlands, CA 92374-2850; 909-798-8570

NOTE! Enter the **Werner Lieber Photo Contest!** Sponsored by FM: A traveling museum exhibit will be created from the best entries. *Categories:* Junior, Adult Amateur, Professional, and Digital or Computer-Enhanced. Submit 8x10 print in 11x14 matte, fully captioned, of a MEXICAN mineral. Submission Deadline: NOVEMBER 1, 1998. Mail to: Dr. Karen Wenrich, P.O. Box 5054, Golden, CO 80401 (for info contact Karen at (303) 278-1218 or at CrystalsUL@aol.com).

Chapter News:

Colorado Chapter: Order Now!! Minerals of Colorado.
Order from: Friends of Mineralogy—Colorado Chapter, P.O. Box 11005, Denver, CO 80211-0005
$150 + $3 p.&h. (Colo. residents add 7.3%)

For information about the Colorado chapter contact: Bill Chirnside, 2157 S. Cole Ct., Lakewood, CO 80228; 303-989-8748

Great Basin Chapter: For information about the Great Basin chapter contact: Jim Abbot, Highroller@hotmail.com

Midwest Chapter: Visit out Web page at: www.indiana.edu/~minerals

For information about the Midwest chapter contact: Dr. Henry Barwood, President, Indiana Geological Survey, 611 N. Walnut Grove, S-409-A, Bloomington, IN 47405

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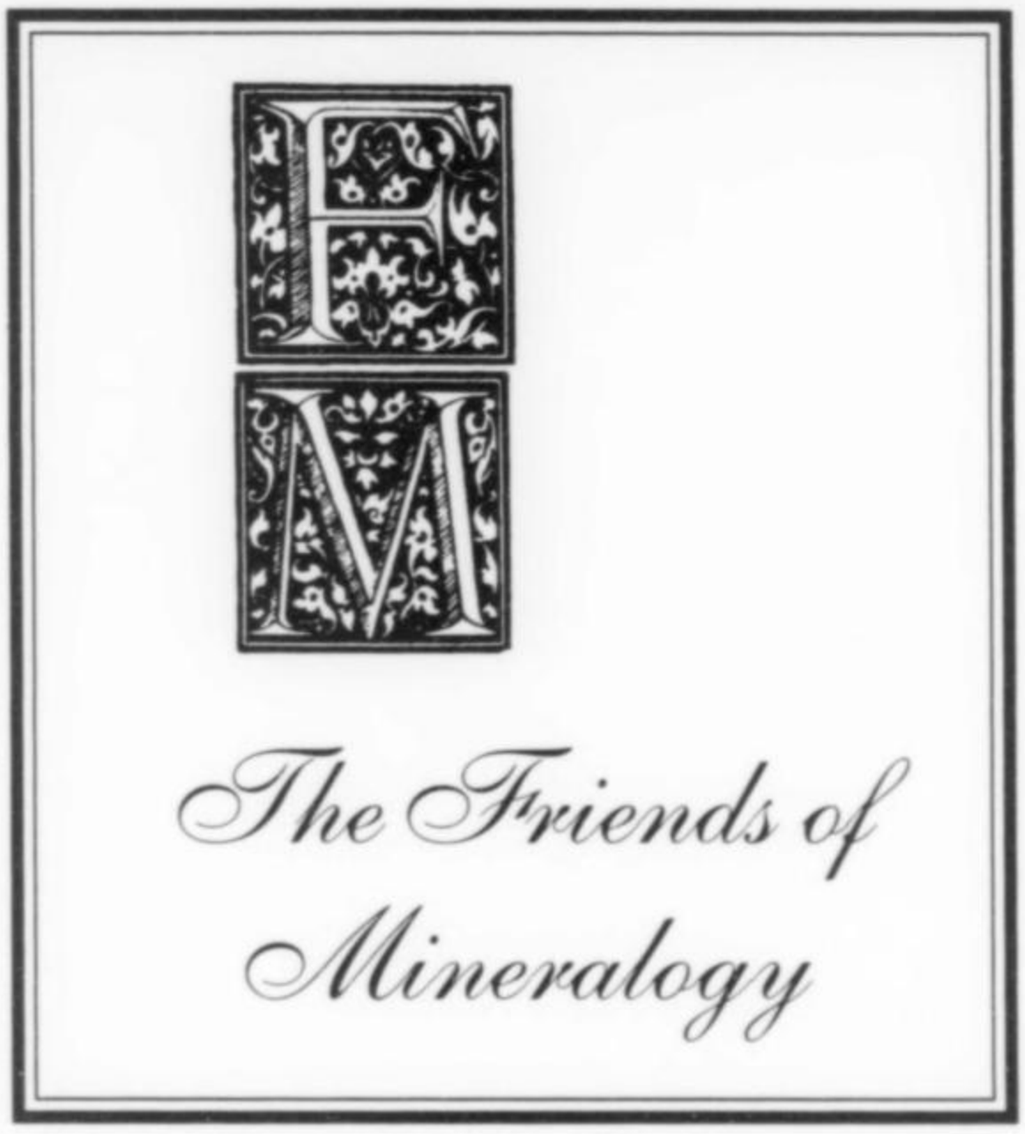


Marcelle H. Weber, Past President
1172 West Lake Avenue
Guilford, Connecticut 06437-1342

Competitive Spirit?—Alive and Well

Kay Robertson, Los Angeles, California, is a charter member of Friends of Mineralogy, having become a member immediately after its organization. When chapters were authorized, she became a member of the Southern California Chapter and has served as treasurer for many years. She is also a long-time Director, but she plans to retire when her term ends in February 1999.

At the February 13, 1998, board meeting in Tucson, Arizona, Kay announced that she wanted to endow an educational award for the Tucson Show displays. This proposal was accepted by Nelson Shaffer, President, and Bob Cook. Subsequently, the proposal was unanimously approved by the Show Committee of the Tucson Gem and Mineral Club. The grant has been made to the Friends of Mineralogy and guidelines will be determined.

Kay's proposal for the "Education" certificate, to be paid for by the income from her gift, is best described and explained by the donor.

The reason for my offering this certificate is that I consider it very flattering to be invited by the TGMS to exhibit at their annual show. As I never was able to acquire "show stopper" specimens, I have always tried to add another dimension to my displays; i.e., I have tried to exhibit the unusual and uncommon, or interesting locations that are not generally known to the public, nor to the professionals of this country. Due to health reasons, I may not be able to continue to exhibit in the future; therefore, I would like to encourage other collectors to continue this trend.

I do not want to create a competitive category, rather, the certificate should be presented to anyone who will display a fine case, who will not only show beautiful minerals (either of the annual "theme" or any other subject), but add some special feature that will teach something. It may be some rare or almost unknown forms of a mineral, an unusual locality, be historically interesting, etc.; it should be unrestricted as to subject matter, but it must also be aesthetically pleasing to the general public so as not to detract from the high standard of the TGMS show.

I have noticed several museum cases which displayed fine minerals to which were added descriptive labels that made the displays very interesting. It would be unfair to the amateur to be in competition with museums; therefore, I propose that there be two certificates given, one to a private collection and one to museums. If the judges do not deem any case worthy, no certificate should be presented that year.

Both FM and TGMS have many members who are extremely knowledgeable mineralogists. The judging should be done by two judges, one a FM member and one from TGMS. Their decision should be final.

I hope that the endowment I have donated to FM for this purpose will be sufficient to enable the society to present two printed, attractive documents, and possibly with a simple frame, ready to hang in the recipient's home (to be paid out of the annual income from the endowment). The certificates need not be elaborate, but should reflect appreciation for the extra effort and knowledge, and be something of which to be proud.

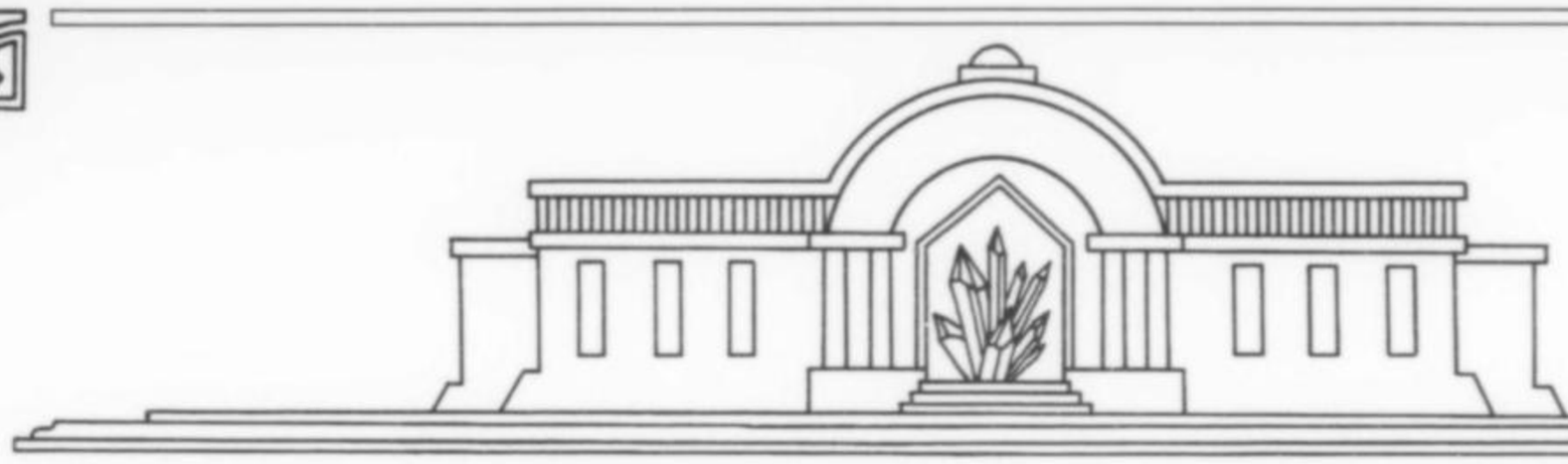
Several years ago FM received a gift from Werner Lieber and it was decided to use the income to fund the Werner Lieber Photo Contest and Traveling Museum Exhibit created from the best photographs submitted for the contest.

Four categories have been established: Juniors, Amateur Adults, Professionals, and Digital or Computer-enhanced Photography. The rules have been well publicized but might well bear repeating: (1) Matted 8 x 10 inch print. Matte must be 11 x 14 inches; (2) The photo must be related to the contest theme: MEXICAN MINERALS for 1999; (3) The photo must have a caption with locality, scale, photographer, and other information the submitter deems relevant; (4) Photos will be displayed at the 1999 Tucson Gem & Mineral Show. Winners will be announced then; (5) All photographs become the property of FM. Copyright will be retained by the author, but FM has royalty-free use; (6) A non-monetary award will be presented to the winners; and (7) Contest deadline will be November 1, 1998. Submissions should be mailed to Dr. Karen Wenrich, P.O. Box 5054, Golden, CO 80401.

The Board of Directors examined the photographs submitted for 1998 and awarded First Place to John Jenkins and Second Place to Jack Thompson.

Friends of Mineralogy has been selecting a "Best Article" in the *Mineralogical Record* since 1980, honoring the author(s) with a certificate and by donating money to the *Mineralogical Record* in the author's name. Recent winning articles were "The hyalophane occurrence at Zagradski Potok near Busovača, Bosnia and Hercegovina" by Mirjan Žorž, in 1996 (vol. 27, no. 5), and in 1997, "The Illinois-Kentucky Fluorite District" by Alan Goldstein (vol. 28, no. 1).

A Friends of Mineralogy page in the *Mineralogical Record* made its appearance during 1997. Information may be changed in any one of the four panels from time to time so readers should keep an eye on it from issue to issue.



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University of New Mexico

Curators: Gary Smith (Geology)
Adrian Brearley (Meteorites)
Tel: (505) 277-4204
Dept. of Earth & Planetary Sciences
Northrop Hall, Univ. of New Mexico
Albuquerque, NM 87131
Hours: 9–4 M–F (closed on school holidays)
Specialties: Worldwide minerals and meteorites, New Mexico fossils, Harding Pegmatite Mine Collection

Colburn Gem & Mineral Museum

Tel: (704) 254-7162
Fax: (704) 251-5652
Website: www.main.nc.us/colburn
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2 South Pack Square
Asheville, NC 28801
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Specialties: Systematic Mineral Collection

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51 Mineral Museum Dr.
White, GA 30184
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Telnet pac.ppld.ord (Library Cat.)
Dir. of Educ.: Eric L. Clements
Tel: (719) 488-0880
Fax: (719) 488-9261
www.wmmi.org
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Dept. of Earth Sciences
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Denver, CO 80205
Hours: 9–5 daily
Specialties: Colorado minerals

Geology Museum
Colorado School of Mines

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Golden, Colorado 80401
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Los Angeles, CA 90007
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Website: http://nhm.org/~gmc

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

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closed Mon. & holidays
Specialty: Worldwide minerals & gems

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
Assistant Curator: Lynn Heizler
Tel: (505) 835-5166
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

Museum of Geology

Director: Philip R. Bjork
Tel: (605) 394-2467
South Dakota School of Mines & Technology
501 E. St. Joseph Street
Rapid City, SD 57701-3995
Hours: 8–5 M–F, 9–4 Sat., 1–4 Sun.
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Penn State Earth & Mineral Sciences Museum

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

Collections Manager & Mineralogist: Anna M. Domitrovic
Tel: (520) 883-1380 ext. 152
Fax: (520) 883-2500
2021 N. Kinney Road
Tucson, AZ 85743-8918
Hours: 8:30-5 Daily (Oct.-Feb.)
7:30-6 Daily (Mar.-Sept.)
Specialty: Arizona minerals

Europe

Giazotto Mineralogical Museum

Curator: Adalberto Giazotto
Tel: 39-50-501587
Lungarno Gambacorti 39
Pisa, Italy
Hours: by Appointment
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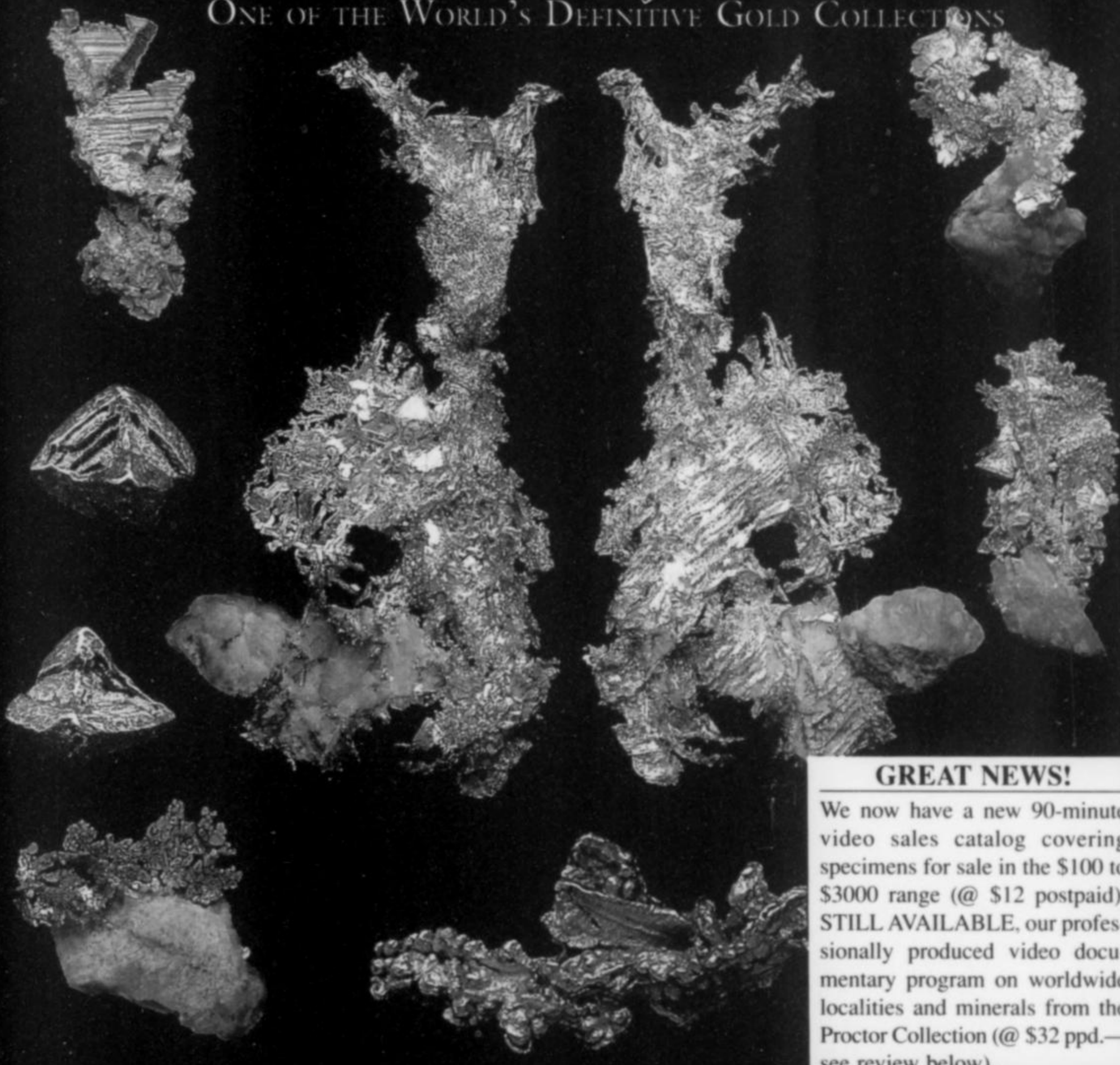

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