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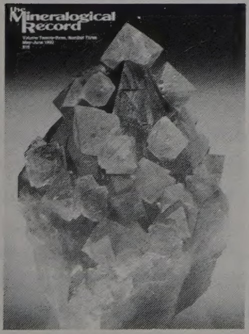
Articles

Columns



COVER: FLUORITE on quartz, 14 x 18 cm, from Mont Blanc, Chamonix, France. The largest fluorite crystals measure 2.9 cm. This specimen is the best of three found in an ice-filled pocket; another of the three is shown in vol. 22, no. 3, p. 219. John Barlow collection; photo by Harold and Erica Van Pelt.

Editorial:

FAREWELL TO THE BM(NH)

As most readers know by now, the venerable hall of systematic mineralogy at the British Museum (Natural History)[1] is scheduled to be dismantled and, for the most part, placed into storage. This is a result of the museum having come under new management in recent years, by people who do not see the value in comprehensive public exhibits devoted to systematics. The purpose of this essay is to bid a sad farewell to that exhibit.

The systematic mineralogy exhibit hall is located on the second floor of what has to be one of the most impressive 19th century museum buildings in the world. Completed in 1881, the exterior is a stunningly impressive construct in gray and tan stone, borrowing architectural elements from the designs of medieval churches. This is carried through to the interior, providing a richly historical backdrop for the great hall where the diplodocus skeleton dominates, and throughout the adjacent exhibit areas, including the systematic mineralogy hall.

The stonework in the mineral hall, as everywhere, is beautiful. The square columns supporting the ceiling carry the carved images of fish. One could have wished for carved crystals, but in the biochauvinistic world of Natural History, an almost exclusive emphasis on the plant and animal kingdoms was as common among administrators and their architects in Victorian times as it is today. The carved dodo (symbol of looming extinction) over a small doorway serves now as a depressing symbol of the dwindling respect today for systematic mineralogy and for substantial museum commitments thereto. Queen Victoria's initials festoon the ceiling, another reminder that the people who established this wonderful hall are long gone and unable to defend it.

It is good to see the hall in the daytime, when the natural light streaming through the tall, cut-glass windows is at its best. The mineral cases are fitted with interior fluorescent lights, but many of these, at the time of my visit in November, were burned out and had not been replaced. The exhibit cases themselves are mostly the typical 19th-century flat cases with slightly inclined glass tops. Despite its age, this is a design with inherent advantages, the most important of which is the fact that *all* specimens (not just those in the front row) are within 5 or 10 cm of the glass and may be closely examined. Admittedly it is somewhat unnerving to see beams of full sunlight passing gradually over the cases of sulfurs, vanadinites, proustites and so on. Such exposure would never be allowed in a modern museum. But by this time everything that was inclined to darken or decrepitate has already long since done so, and what remains is relatively stable.

The collection itself is probably the finest *old* systematic collection[2] in the world; for many of the older occurrences, especially those in Great Britain, the British Museum often has the best specimens. Aside from the specimen quality, perhaps the most admirable aspect of the exhibits is that an example of nearly everything which is really good and important is out on display. Richard Bideaux, co-author of *Handbook of Mineralogy,* went through the entire hall making notes on the exhibited specimens for inclusion in his detailed mineralogical database. Having done that, he next began going through what was in the drawers, but after a while gave it up because he was finding nothing additional of note. The student of rare minerals will see much that he had never expected to see, didn't know existed, and *never would have thought to ask about* had it not already been out and visible. This comprehensiveness is of enormous value. It has inspired many beginners and novices to take up the serious study of mineralogy, and has served as a long-standing testimonial to the fact that *all* minerals, regardless of color, chemistry, size or aesthetics, are interesting and have their own place in the larger scheme of things.

In an important way, the hall of systematic mineralogy at the British Museum is itself a specimen now, a rare and valuable specimen of 19th century mineralogical museology. Not only does it present the mineral world in a very thorough and still intrinsically educational way, but it is a cultural artifact which, if preserved, would continue to grow in historical value and appeal. Certainly not all museum displays around the world deserve to be frozen like time capsules, forever immune from progressive, conceptual modernization. But I submit that some do, and that it is a museum administration's responsibility to be able to tell the difference, and to preserve its best history. The British Museum already has enough glitzy exhibits aimed at gradeschool children. It needs to retain some in-depth exhibits which are of interest to the serious adult student of mineral science and mineral history. And it needs to retain a historical model from a time when a mineral museum's primary function was simply to show its specimens, and to show as many of them as possible.

* * *

According to the latest unofficial guestimates, the systematic mineralogy hall will remain in place for at least another year or two. There is still ample time to make a pilgrimage, so that in later years you will be able to say that you saw the famous hall in its original glory.

W.E.W.

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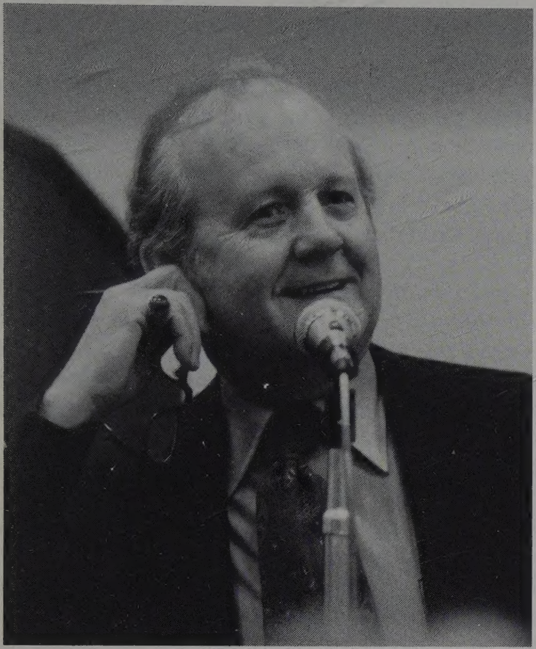
[1] Recently renamed "The Natural History Museum," although on museum stationery it states that the "statutory name" (whatever that means) is still "British Museum (Natural History)."

[2] And, it is also one of the largest, over 180,000 mineral specimens, although lack of funding in recent decades has hindered acquisition of modern mineral discoveries.

notes from the EDITOR



Saul Krotki

Paul E. Desautels
(1920–1991)

NOTICES

Died, Paul Ernest Desautels, 71, the most influential American mineral curator of the twentieth century. He was born in Philadelphia on September 24, 1920. At the age of 14 he developed an interest in minerals through the influence of Charles R. Toothaker, a prominent Philadelphia collector. He received his B.S. in chemistry from the University of Pennsylvania in 1942, worked as a petroleum chemist for Atlantic Refining Company (1942–1944), and served in the U.S. Navy (1944–1946) as a Lieutenant on the U.S.S. *Warrington*. Following the war he entered graduate school at the University of Pennsylvania, receiving his M.S. in chemistry in 1948. For a short time thereafter he taught chemistry at Haddon Heights High School in New Jersey, then took a position as professor of chemistry at Towson State University in Maryland. There he occasionally taught courses in mineralogy, gemology and crystallography in addition to the usual chemistry course load.

In 1957 Desautels left teaching to take a position as Curator of Gems and Minerals in the Department of Mineral Sciences at the Smithsonian Institution in Washington, a position he was to hold for the next 25 years. During his tenure as curator he pursued acquisitions with a zest, flair, energy and, above all, refined taste that has become a standard in public and private mineral collecting. The Carl Bosch collection of 25,000 mineral specimens, acquired in 1970, is the largest of countless acquisitions which have greatly elevated the stature of the National Collection.

His influence on the amateur community was profound as well. Through hundreds of public lectures, voluminous correspondence, a series of popular books on mineral and gem collecting,* his *Museum Record* columns and associate editorship in the early years of the *Mineralogical Record,* and his personal acquaintanceship with virtually all of the major (and many minor) mineral curators, collectors and dealers in the world, he influenced the path that collecting and curating have taken. His aesthetic sensibilities and his overall connoisseurship in minerals were unequalled.

Following his retirement from the Smithsonian, Desautels worked as a mineral acquisitions consultant for Texas oil millionaire Perkins Sams. The Perkins and Ann Sams collection was eventually acquired by the Houston Museum of Natural Science, where Paul continued for some years to serve as a curatorial consultant. This collection, featured in a supplement to the January-February issue, is rich in extraordinary, aesthetic specimens.

In 1979 a new mineral species, *desautelsite,* was named in his honor, recognizing his successful "efforts in expanding the [National] collection and assuring its pre-eminence." In 1991 he was awarded the Carnegie Mineralogical Award for his contributions in promoting mineralogical preservation, conservation and education. At the same time, a new award, the Desautels Trophy, was established in his honor, in recognition of his connoisseurship. He has also been a recipient of the American Federation of Mineralogical Societies Scholarship Award (1967) and the Smithsonian Director's Medal for outstanding service to the National Museum of Natural History. He was a Fellow of the Mineralogical Society of America, a member of the Micromounters' Hall of Fame, and a founder of the Baltimore Mineral Society. The Baltimore Micromount Symposium is being renamed in his honor, as is the Smithsonian's famous "Blue Room," where the most aesthetic and valuable new acquisitions not yet on public exhibit are stored.

Paul's charming, charismatic and sophisticated presence will be long remembered in the mineralogical community, and his influence on the course of the hobby must be regarded as a milestone in the centuries-old history of mineral collecting.

W.E.W.

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Died, Willard ["Perky"] Perkin, 84. Willard Perkin was born April 3, 1907, and died November 9, 1991. He was a well-versed field collector of mineral specimens and collected at many localities in the Southwest during the thirties and forties. He did much to popularize the collecting of thumbnail sized specimens by introducing what is now our standard plastic thumbnail box to collectors. He was an early member of the Mineralogical Society of Southern California and a charter member of the Southern California Micro Mineralogists. He made many trips to Mexico, ran a mineral business from his home, and sold and exhibited at mineral shows mostly in Southern California. He built a wonderful personal collection of cabinet and hand specimens as well as a superb collection of thumbnail specimens and micromounts. He was also interested in photography. All of this besides raising a family and holding a full time job.

He became interested in minerals in the mid thirties. At that time he was running a dry-cleaning business and the adjacent business was

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* Especially *The Mineral Kingdom* (1968) and *The Gem Kingdom* (1970), two books which set the standard for all future "coffee table" books on gems and minerals.

Kent England

Willard Perkin (1907–1991)

a gift shop whose proprietor used crystals in the manufacture of various ceramic items and had an interest in minerals. He took Perky along on a field trip to Texas Canyon near Newhall, California, to collect green fluorite. Other field trips followed and before long he was hooked. He soon joined the Mineralogical Society of Southern California which had just recently been established in 1931 and this must have introduced him to many other local mineral collectors and possibilities for further field collecting. Chucawala Slim, an early dealer in Southern California and a desert character, was soon parking his trailer behind their dry cleaning establishment.

Perky told hair-raising tales about crawling more than full length into barite pockets in the cliffs on the Palos Verdes Peninsula near Los Angeles, California, to retrieve barite crystal clusters and had wonderful examples of these in his collection. He also collected extensively at the benitoite locality in San Benito Co., California, and cleaned much of this typically natrolite covered material for local dealers as well as himself. He used much of this material as trading stock to build his personal collection. Before the second world war he told of collecting in the still open underground workings of the Gem mine. He encountered an open pocket containing well formed benitoite crystals, mostly floaters, up to three inches on an edge. They were, however, opaque because of numerous crossite inclusions and rather grey in color. He said he broke open a few to see if they contained any gem material and not encountering any proceeded to give them away.

During the war he worked a stint as a welder for a defense-related industry. In the early 1950's he worked three years for George Burnham, who was well-known to collectors in Southern California at the time for having fine specimens. Later he worked for many years for a company which made metal specification plaques and instrument dials.

In the 1930's, through an ad in an amateur magazine, he began trading specimens with Anton Berger, a well-known Austrian mineral dealer. After the war this was expanded, but for a while parcels of food and clothing were sent as well. A number of other California collectors were also involved in this but Perky was more or less Anton Berger's West Coast representative. Much of the material he received from Berger was of European origin and lent a distinction to his stock of minerals that local dealers found hard to match.

During his time with George Burnham, a salesman of plastic boxes came in and showed them an opaque black, 1.25-inch cubical plastic box. This box was eventually transformed into what is today our standard thumbnail box. He began to sell them, and soon they became known as "Perky boxes." The business eventually grew to the point that he began to dread receiving new orders. At this time he sold the business to other people.

Perky went to night school for Spanish and in 1949 he made his first trip to Mexico and the second with his son in 1951. These were the first of dozens of trips, and he had an agreement with the company where he worked that permitted his absence for up to three months a year. He typically made a month-long trip at Christmas, Easter and in the summer. Initially he went underground in the mines in Mexico and collected as well as purchased material but in later years he just purchased from the miners and local dealers.

He did not like to be hurried, and drove himself in a succession of VW vans that he cherished almost as a member of the family. One became locally notorious because it eventually had more than 400,000 miles on it. He usually traveled alone in Mexico but sometimes took his son or other youngsters with him. He would usually enter Mexico through El Paso. In Juarez he would stop and buy substantial quantities of candy for the children in the mining camps he would visit. He would typically stop in Santa Eulalia, Charcas, Mapami, Durango and Guanajuato which was his favorite Mexican town. He would visit many other places in Mexico over the years and the specimens he brought back found their way into many private collections and museums.

Perky sold a lot of thumbnail specimens in his business and had a wonderful ability to trim and mount specimens to show them to their best advantage. He was, on occasion, known to buy specimens, work his usual magic on them and sell them back to the person who originally sold him the specimens. All of his specimens were meticulously and neatly labeled. You could always spot his labels.

Perky built a fine mineral collection which was housed in the small garage of his Burbank home, which he had bought in 1940. It was housed in big glass fronted display cases which lined opposing walls of the garage which contained the largest and frequently his best specimens. They had glass shelves and sets of drawers below. To young collectors, myself included, it was like walking into a wonderland of specimens whose quality helped us set standards for what really fine specimens were.

In 1971 the Sylmar earthquake shattered the big glass display cases and the specimens cascaded with broken glass to the bottom and onto the cement floor between the cases. That morning before going to work he opened the door to the garage and looked in on the disaster, then just closed the door to deal with it when he returned in the evening. He took the loss with good grace, but not long after he began to sell much of his remaining collection. We who were able to buy some of his specimens counted ourselves lucky.

Perky retired from his job in 1977, which meant he had more time to devote to his minerals, traveling and photography. He kept his collection of thumbnail-size specimens and micromounts, and his family has decided to keep those collections. At the present time they are not for sale.

He was an early and enthusiastic micromounter in the West, and attended many micromount conferences, sharing specimens with his friends. He had an appreciation of the beauty in nature and even in the small things in which it was often displayed. He developed an intense interest in photography and specialized in photographing very small flowers on plants that are not commonly thought of as having much in the way of flowers. He sold large prints of some of these flowers at some mineral shows.

What else? Oh yes: he loved fried cod fish, kept goats in the back yard and we all miss him a lot.

The list of people who helped with this article reads like a who's who of the senior collecting fraternity of Southern California. Thanks to Pat Perkin and her son Bruce, Gus Meister, Morrey Hebner, Larry Higley, Bob Massey, Junata Curtis, Fred, Linda and Edward Elsnau, Jessie Hardman, Jack Streeter, Wendell Stewart, Peter Bancroft, Stanton Hill, Ralph Dietz and George Burnham.

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GOLD IN SOUTH AFRICA

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Gold has been mined in South Africa for over a century. Most of this precious metal, over 40,000 tons, has been won from conglomerate reefs of the Witwatersrand goldfields, where production from individual mines often exceeds other countries' entire national output. Notable gold specimens are relatively rare from these deposits, but some fine examples have been preserved. Large gold nuggets and crystal specimens have also been found in other gold producing regions of the country, particularly from the Barberton and Pilgrim's Rest areas.

INTRODUCTION

Gold was mined in pre-European times in South Africa by the indigenous tribes. Most of the gold was used for ornamental purposes; gold artifacts and jewelry have been found at Mapungubwe near Messina at the Zimbabwe border, and at Klipwal in the southeastern Transvaal.

For well over 100 years, gold has been mined in the Republic of South Africa. By far the most significant occurrence is that of the Witwatersrand Goldfield which has accounted for approximately 98% of all gold produced in the country. The name "Witwatersrand" is derived from the ridge-like outcrops of white quartzite which strike parallel to the basin margin and give the name "White Waters Ridge." The placer-type conglomerate reefs of the Witwatersrand have yielded over 40,000 tons of gold since their discovery in 1886 (Pretorius, 1986), thereby ranking South Africa as the world's leading gold producer. The other gold localities, such as the Barberton and Pilgrim's Rest goldfields, are much smaller; gold is mined there from sulfide and vein-type ores. Considerable alluvial gold has also been panned. Most of the Barberton Mountain Land consists of an Archean greenstone belt which is geologically unique (Anhaeusser, 1973; Viljoen and Viljoen, 1969).

The discovery and development of the various Transvaal gold deposits, like those at Eersteling, Lydenburg, Pilgrim's Rest and Barberton (Fig. 1), preceded the finding of the outcrop of Witwatersrand conglomerate. The stories of these early discoveries and mine developments, some of which were conducted under extremely primitive conditions, tell of pioneer days when fortunes were won and lost, when boom times came and went; but mining still takes place today at many of the early-found sites. On the Witwatersrand, some of the deepest mines in the world, which extend to depths exceeding 3,500 meters below the surface, employ unique mining techniques which were developed for these particular mining conditions. Income generated from gold still forms a major part of the South African economy, although gold production has declined in the last ten years (Minerals Bureau, 1988).

Gold specimens from the Witwatersrand deposits are relatively rare. Gold is either very finely disseminated in the pebbly reefs, or it occurs in association with sulfides, notably pyrite, and also with carbon (kerogen). Large native gold specimens originated from remobilization and recrystallization of gold already present in the strata. In contrast, the other Transvaal gold sites have yielded some excellent examples

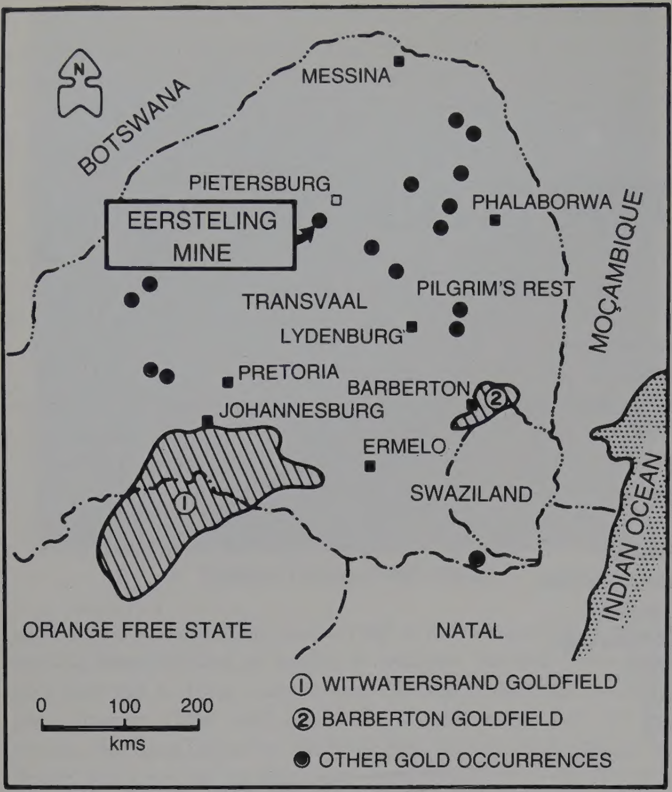


Figure 1. **Location of gold deposits in the Transvaal Province. The Eersteling mine was the first deposit to be seriously exploited in the region.**

of native gold. Most of these specimens were ultimately milled, although some have survived. Panning of the streams that dissect these mountainous localities still produces a showing of gold even today.

HISTORY

Early Discoveries

Most of the South African goldfields are located in the Transvaal province, although the Witwatersrand Basin also extends into the adjacent Orange Free State. Outcroppings of the Witwatersrand reef were discovered in 1886, but the gold story begins several decades earlier (Antrobus, 1986).

In 1838, pioneers left the British-controlled Cape Colony and trekked northward to establish settlements and to find independence away from the British colonial influence. These "Trekkers" were of predominantly Dutch descent and are the ancestors of the Afrikaner families in South Africa today. Frontier wars with southward-migrating black tribes occurred sporadically but, nonetheless, the pioneer spirit prevailed and small settlements became established in the areas which were later to become the Transvaal and Orange Free State provinces of the Republic.

Settlers in the Transvaal during the period 1856 to 1886 occupied only a few scattered communities. In 1870, there were only 45,000 Europeans in the Transvaal. There were few roads; ox wagons and horse carts were the main mode of transport and communication. Prospectors were actively searching for gold at this time, inspired by the 1849 California gold rush and the discoveries in Australia in the 1850's and 1860's.

John Henry Davis, an Englishman, is reputed to have been among the first prospectors to discover gold in 1857. It was rumored that the Boer Volksraad (local government) hushed up his report and deported Davis because it was feared that the British might annex the territory in order to gain control of any viable economic deposits. In 1868, Karl Mauch, an amateur German prospector, accompanied by Henry Hartley, a professional hunter, was traveling the country searching for gold. Although Mauch never made any major discoveries, his enthusiasm inspired others such as Edward Button, George Parsons, James Sutherland and Tom McLachlan, who searched the area around Lydenburg (Fig. 1) where gold was discovered.

In 1871 Button was in Goodwin's Store at Marabastad (southwest of present-day Pietersburg) when Du Preez (pronounced "do Prear"), owner of the nearby "Eersteling" farm, showed some gold-bearing vein quartz to Button, who then arranged to prospect the farm. The outcome was the discovery of a payable deposit, and the farm was purchased for £50. Button and Goodwin traveled to England, raised £50,000 capital and formed the Transvaal Gold Mining Company Limited. Mining conditions were initially primitive before appropriate machinery was brought in. Even so, the Eersteling mine was significant for two reasons. Firstly, the Transvaal Gold Mining Company was the first organization to mine and produce gold in the Transvaal. Secondly, the Volksraad began to establish legislation whereby gold mining could be performed in an orderly manner.

At about the same time, Tom McLachlan and friends had made discoveries of alluvial gold in the Lydenburg and Graskop areas. In May of 1873 diggings were officially opened at these localities. Diggers began to arrive (many of them from England, much to the annoyance of the Boer diggers). The preponderance of "Mac's" among the diggers prompted the name MacMac for the area. Even more significant discoveries were soon forthcoming. In September of 1873, "Wheelbarrow" Patterson decided that MacMac had become too crowded; he moved to a new valley nearby and almost immediately found rich gold dust and nuggets in his pan. Patterson kept quiet about his discovery but word soon leaked out and diggers flooded to this area, subsequently called Pilgrim's Rest, leaving MacMac a virtual ghost town. A major alluvial gold find had been made and the Transvaal was well and truly on the map as a major gold producer. Once the alluvial deposits were worked out, organized consortia took over mining vein deposits. This resulted in the formation of the Transvaal Gold Exploration and Land Company, later to become the Transvaal Gold Mining Estates Company, with production continuing up until 1971.

As a consequence of the administrative problems arising from the influx of diggers, a framework for gold law developed and the authorities gained experience in the mining industry. H. W. Struben, who owned farms on which many of the Pilgrim's Rest strikes were made, obtained copies of the mining laws from Australia, New Zealand and California and used these to draft an applicable law which, with a few minor alterations, was adapted and promulgated in 1875.

Barberton

These laws were given a further test before the discovery of the Witwatersrand gold reefs when the Barberton goldfields were discovered. This region is located in the Transvaal Lowveld (i.e., lower in altitude than Pilgrim's Rest and Lydenburg); it was not a very congenial area because malaria was rife in the warmer climate. Until 1880, the Barberton Mountain Land was virtually unexplored. Tom McLachlan visited the De Kaap Valley north of the present site of Barberton; he was driven out by fever, but not before discovering gold on Government land. In 1875 a party of Australians prospected the mountains in neighboring Swaziland without success. In 1881, McLachlan found alluvial gold in Jamestown in the De Kaap Valley. The major discoveries really began in 1883 when "French Bob" found gold in Concession Creek on the Moodies Estate, southwest of the site of Barberton. He followed this with the discovery of the source, the Pioneer Reef, the first payable gold reef to be discovered in the Mountain Land.

The discoveries prompted yet another gold rush, this time to the Barberton Mountain Land, where many finds were made: William Pigg found the Pigg's Peak reef in March 1884; in May 1884, Graham Barber found the Barber's Reef in Rimer's Creek, close to the site of

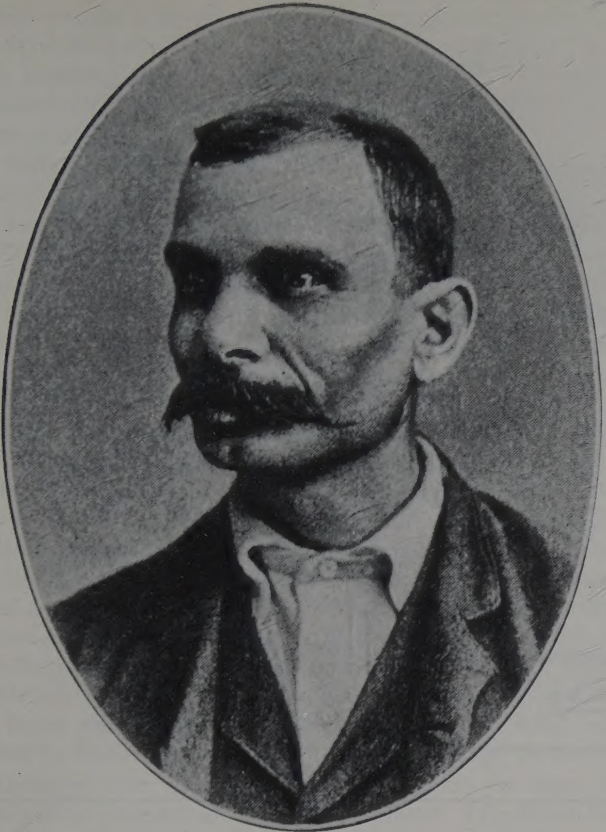


***Figure 2.* "French Bob," discoverer of the first lode gold in Concession Creek southwest of Barberton.**

Barberton; in November 1884, Forbes and Swears found the Forbes Reef in Swaziland. By this time, Eureka City was flourishing on the mountain tops away from the malaria-infested valleys. Barberton itself was a mining camp which grew dramatically following Edwin Bray's bonanza strike of the extremely rich Sheba Reef at Golden Quarry just below Eureka City.

Witwatersrand

The stage was therefore set when George Harrison discovered an outcrop of payable Witwatersrand conglomerate in the late summer of 1886 near the present-day city of Johannesburg. Pilgrim's Rest was developing into a coordinated reef-mining area, Eureka City and Barberton were booming and other gold finds were being made in the Transvaal.

The discovery of the outcrop of what was to be called the Main Reef on the Langlaagte farm was not an isolated event in that region. The dates of these various gold finds are shown in Figure 4. In 1874 Henry Lewis, an Australian, made a notable discovery of alluvial gold on the Blaaubank farm, 25 km west of Krugersdorp, and observed that associated auriferous quartz veins showed promise. Mining of reefs, however, required greater capital expenditure and mechanization, so the Nil Desperandum Co-Operative Quartz Company was created (Werdmuller, 1986). Profits were slim, however, and the company did not flourish. About this time, the Kromdraai Goldfield was found, and Stephanus Minnaar, Isac Sonnenburg and R. T. N. James produced 816.47 kg (1800 pounds) of gold in the first half of 1882. Assay results indicated a grade of 30 ounces of gold per ton. Gold was discovered northeast of Krugersdorp in 1884, before the most important find, in 1886, on the South Slope Rand Field. Controversy has surrounded the questions of who was the actual discoverer and what was the exact date of this find. Gray (1937), in an exhaustive study of over 100,000 documents in the State Archives in Pretoria, gives an in-depth record of the discovery. A comprehensive review is also provided by Werdmuller (1986) and part of this latter reference is reproduced and summarized below.

Towards the end of 1885, two wanderers, George Harrison and George Walker, arrived on the Wilgespruit farm on the northern slopes of the Witwatersrand range of hills. They were on their way to the Barberton Goldfield but decided to break their journey and approached Fred Struben for work at his new mine. Walker was offered the job of erecting the stamp mill recently delivered there amidst all the preparations for exploiting the Confidence Reef, which Struben had discovered in September of the previous year. Harrison, a mason by

***Figure 3.* Eureka City circa 1886, located in the Barberton Mountain Land.**

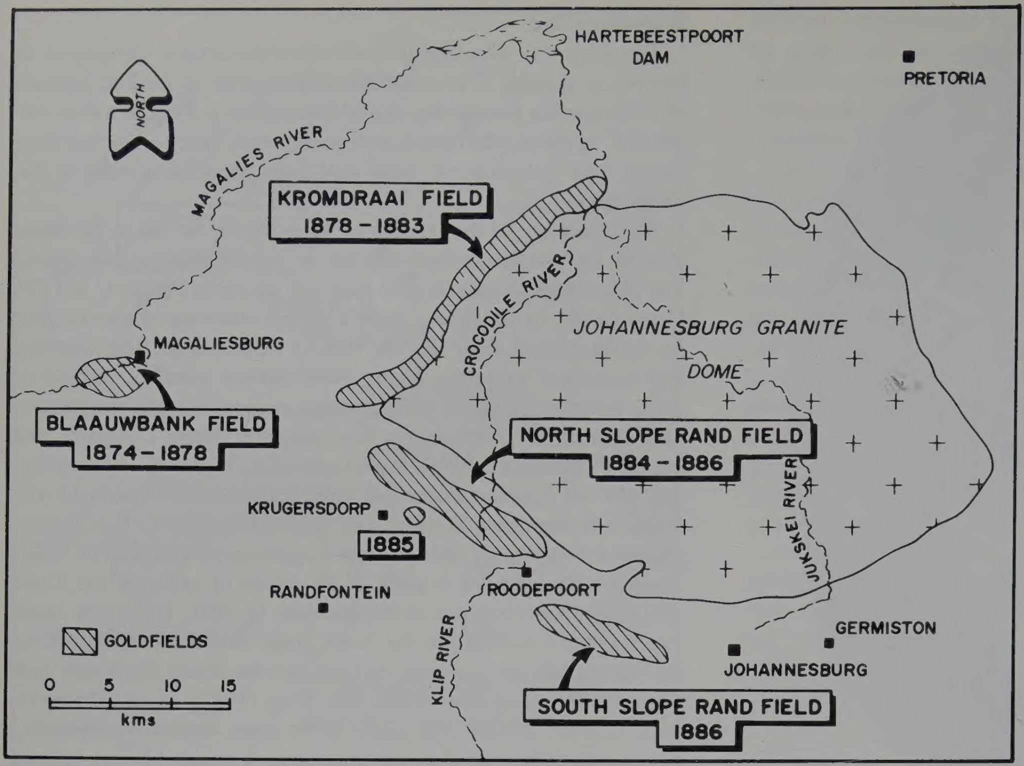


Figure 4. Localities and dates of discovery of gold deposits in the vicinity of the Main Reef in 1886. After Pretorius (1986).

Figure 5. Location of the more important gold occurrences in South Africa.

trade, was told to contact the widow Oosthuizen, who wanted a house built on her portion of the Langlaagte farm, not far from Wilgespruit but stretching down the southern slopes of the hill. The two friends parted with a pledge to meet again once their respective tasks had been completed.

Early in February of 1886, Walker left Wilgespruit to rejoin Harrison, still engaged in building the house on Langlaagte. Legend has it that the two went for a stroll one Sunday across the property of Mr. G. C. Oosthuizen, adjoining the widow's portion of the farm. Harrison stumbled over an outcrop of rock. He examined it and, having been a digger in Australia, as he later testified, he crushed and panned a piece of it to find a long "tail" of gold in the pan. He had stumbled over an outcrop of weathered conglomerate, later to be named the Main Reef. No record of the details of the discovery nor the exact date has been found, not even by Gray's (1937) exhaustive search.

Nevertheless, many years later, some credence was given to this event by several people active in the area at the time. George Walker, in a letter dated 15 February 1924 which was reproduced in the Johannesburg daily newspaper, the *Rand Daily Mail* of 28 August 1926, claimed that he had been the one to stumble over the outcrop and crush and pan a piece of the rock to find the tail of gold. Walker, however, stated that he made the discovery on the farm belonging to Wilhelm Oosthuizen. The date of the event was given simply as February 1886. Even before that, Fred Struben in 1903 indicated on a sketch plan "the spot where Main Reef was first struck early in 1886 by Walker and a friend on the farm Langlaagte. He was an old discharged miner of ours." Despite these claims and many others, such as the one made in the Cambridge History of the British Empire that F. and H. W. Struben discovered "gold-bearing conglomerate on the Witwatersrand . . . near its northwest extremity . . . in 1884," the authorities of the day requested Mining Commissioner Von Brandis to investigate the whole matter; eight days after the proclamation of Langlaagte, he named Harrison as the discovered who was therefore entitled to a discoverer's claim (Werdmuller, 1986).

CAPE PROVINCE GOLD OCCURRENCES

Prior to the discoveries of the Transvaal and Orange Free State deposits in the mid and late 1800's, a few other small but historically significant finds were made in the Cape Province and in Natal. Information on these areas is not as detailed, because they were soon abandoned in favor of the larger, more lucrative areas to the north. In a little known publication, Wilson-Moore and Wilmer (1893) provide valuable mineralogical, geological and historical data on these other localities. The sections which follow on the Cape Colony are summarized from their work.

Cape Province

Cradock

An unusual occurrence of gold associated with prehnite and quartz was found at several localities in the Cradock district. Geologically, the area consists of shales and mudrocks of the Beaufort Group (Permo-Triassic) which were subsequently intruded by dolerite dikes of Jurassic age. These igneous intrusives were auriferous, albeit to a very small degree. However, secondary mineralization associated with vug and fissure formation produced cavity and fissure infilling of prehnite together with gold. At one locality, the prehnite contained 4–15 dwts (20 dwts = 1 ounce) of gold per ton. At other sites, the gold is associated with quartz vein-filling and silver, copper and iron mineralization. One of these latter sites produced 80 ounces of silver and 2 ounces of gold per ton of ore (Wilson-Moore and Wilmer, 1893).

Knysna and Millwood

At Knysna, on the southeast Cape coast, alluvial gold was mined intermittently up until the late 1800's. The main site of mining activities was at Millwood Gully, situated 15 km north of the present day town of Knysna. The source of the gold is considered to be sandstones of the Table Mountain Group (Ordovician-Silurian) which crop out near the workings (Hammerbeck, 1976). Wilson-Moore and Wilmer (1893) quote a Mr. C. F. Osborne who worked the Millwood deposits: "All round Millwood, for miles, nuggets and heavy gold have been found scattered about in ravines and on the hills in all directions. . . . I have managed to raise upwards of 300 oz out of my claims. . . . I took 40 oz off of 6 square yards, the wash being 3 feet deep. . . . The gold is shotty, and in small nuggets, principally water worn. Numbers of nuggets have been found from 10 dwts (half oz.) to 3 oz, which is the largest recorded."

The gold was washed from alluvium of late Tertiary age and, although optimism at the time was high regarding the size and potential of the deposits, by the mid 1890's the area was almost deserted.

Prince Albert

Over a period of about 50 years, from 1870 to 1920, gold was recovered from alluvial diggings northeast of Prince Albert in the southern Cape. This area was known as the Gough or Prince Albert Goldfield (Hammerbeck, 1976). Gold most likely occurred as paleoplacers in Beaufort Group sandstones (Permo-Triassic) and was subsequently concentrated into erratic alluvial deposits containing nuggety gold.

The discovery of gold in the Prince Albert area was initially greeted with skepticism. In 1870 a nugget weighing just over 2 ounces was found on the Spreeuw Fontein farm, 50 km northeast of Prince Albert. Two individuals, Dr. Atherstone and T. Bain, went to investigate the find and returned concluding that "the formation could not be auriferous." However, in 1891 more gold was found on the same farm and Bain, now a government geologist, again went to investigate and report on this latest find. He recounts that due to the relatively "young" age of the local geological formations (now known to be Permo-Triassic sediments), the discovery of gold was something extremely unusual, and that "salting" was at first suspected. But when a nugget of 3.3 ounces was discovered by a laborer on the Klein Waterfal farm adjoining Spreeuw Fontein, more interest began to be shown in the area. Bain, on his second visit, mapped the area and discovered several quartz veins ranging from 6 cm to 40 cm in width. It was noted that two of the nuggets had residual quartz attached to the gold, leading to the conclusion at the time (1891) that the gold originated from secondary quartz veins.

Other Cape Localities

Other occurrences of gold are known from the Cape Province and almost all of these are alluvial in nature, the gold occurring in the form of grains and small nuggets. These localities were: (1) river beds in the Bredasdorp and Swellendam districts; (2) quartz veins near Heidelberg; (3) the Kragga River near Worcester where a 2-ounce nugget was found in 1854; (4) the Montagu district where a 2-ounce nugget was found; (5) at Prella on the Orange River; (6) near Calvinia, Ceres and Somerset West; and (7) in quartz on Lion's Head Hill overlooking Cape Town and at Hout Bay.

Further to the north and east gold has also been reported from the following areas: (1) quartz veins near Grahamstown; (2) near Kimberley, Barkly West and Hopetown (at the latter locality on the Probeerfontein farm, a quartz vein 1.2 meters thick yielded, in places, 5 to 10 ounces of gold per ton, although average grade was a half ounce per ton); and (3) near Burghersdorp, Aliwal North and Uitenhage, where in 1854 several small nuggets were found.

With the exceptions of Millwood at Knysna, and the Prince Albert and Cradock sites, the above mentioned localities are rarely described in the literature. These sites were perhaps small by today's standards and soon petered out, but nevertheless are of historical significance considering that many pre-dated the discoveries in the Transvaal.

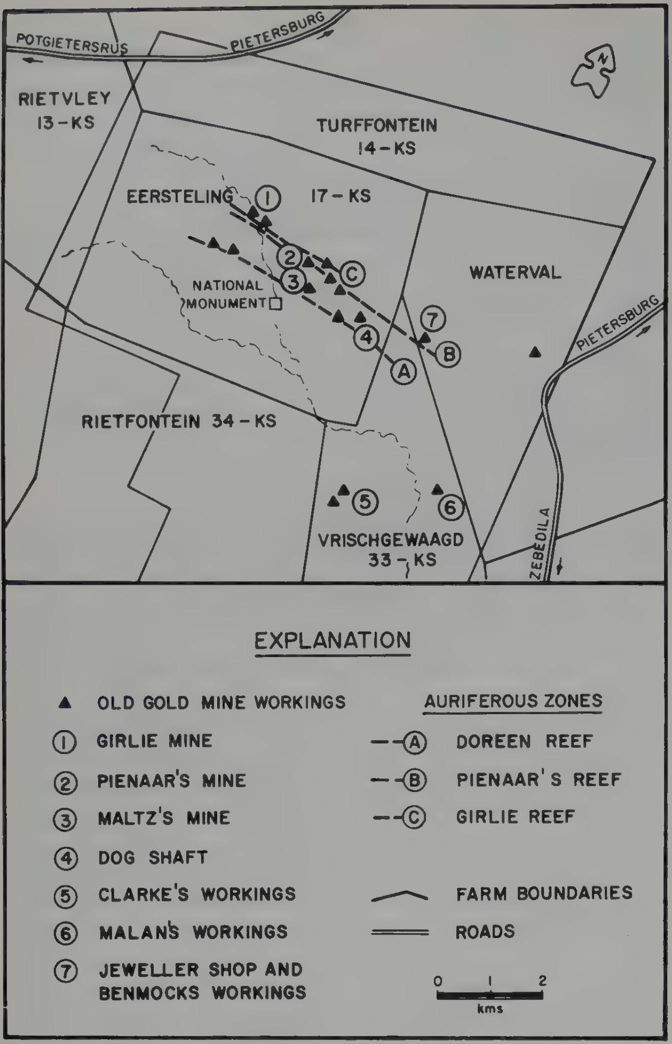


Figure 6. **Location of mines and reefs of the Eersteling goldfield. After Saager and Muff (1986).**

EERSTELING GOLDFIELD

The Eersteling goldfield is located in the Pietersburg greenstone belt (Saager and Muff, 1986). This site is of historic interest and significance because, as stated earlier, it was the site of the first lode gold deposit discovered in the Transvaal in 1871. A boiler house with a 25-meter-high chimney was erected in 1872; the remains of these buildings, including the chimney stack, have been declared a National Monument. The ore that was processed was at first crushed on a stone pavement which can still be seen on the banks of the Eersteling stream about 275 meters upstream from the National Monument. A large 500-kg boulder, which was used for crushing the gold ore on the stone pavement, is now on display on the grounds of the Geological Museum in Pretoria. In an early report on mining at this site, Baines (1877) quotes a letter from a Mr. Ash describing how the crushing rock operated: "Mr. Pigg has mounted a large boulder, but it is unwieldy, and he gets on badly. A tree is bolted across the top, and two Kafirs ride see-saw on it, while he feeds it with small pieces of quartz, and another man brushes the fragments under the stone to be crushed finer. What we need is machinery."

Mining operations were carried out sporadically by small companies, syndicates and one-man operations after Button's initial discovery. During the 1930's mining activities experienced a revival due to the increase in the price of gold.

Gold Mineralization

Three main ore zones have been identified in the Eersteling goldfield (Fig. 6). The northernmost zone is called the Girlie Reef, after the Girlie mine situated on this zone. This outcrop was described as a quartz reef (Willemse, 1938), but more recent work has shown that the ore represents a structurally deformed, sulfidic bandied iron-formation which has been silicified (Saager and Muff, 1986). Pienaar's Reef lies to the south of the Girlie Reef and constitutes a high-grade ore zone of oxidized and friable ore containing barren greenschist. The Doreen Reef also strikes west and consists of quartz veins and schists. Maltz's mine, northeast of the National Monument, was probably located on this zone (Fig. 6). Another gold-bearing area is Clarke and Malan's workings south of the three main zones on the Vrischgewaagd 33 KS farm, but these workings never yielded significant amounts of gold.

The gold ores can be divided into three main groups (Saager and Muff, 1986): (1) finely disseminated gold in quartz veins, which have gold enrichment along wall rock contacts; (2) shear zones of impregnated gold-bearing schists; and (3) weathered zones of supergene enrichments. It is the latter type which most likely accounted for some of the larger specimens found in the area. In December of 1871, Thomas Baines, the now-renowned explorer and artist, visited the Eersteling goldfield and describes some of the gold that he saw there: "We were kindly welcomed by him (Button) and Mrs. Button, and were fortunate in being just in time to see some very beautiful specimens of gold quartz, which were already packed to be sent to the diamond fields; some were very rich, and a few, collected by Mrs. Button, exceedingly so. A regular network of gold standing out in high relief all over the stones and looking like a filigree of gold thread." More recently, a Mr. Bakker found a 2.395-kg nugget in 1936, and in 1948, a 1.445-kg nugget was discovered by a Mr. Briel (Saager and Muff, 1986).

BARBERTON GOLDFIELD

The Barberton Goldfield, although no match for the Witwatersrand, has been a consistent producer of gold, yielding 251,553 kg (8,087,429 ounces) of gold and 8,875 kg (285,331 ounces) of silver for the period 1884 to 1983 (Anhaeusser, 1986a). Over 70% of the gold produced has come from four currently-operating mines: the Sheba (Wagener and Wiegand, 1986), New Consort (Voges, 1986), Fairview (Wiggett *et al.,* 1986) and Agnes (Wagener, 1986) (Fig. 7). The remaining 30% has been derived from an additional 350 gold deposits, most of which were small operations or short-lived prospects (see Anhaeusser, 1986a, Appendix A, which lists all of these sites). Geographically, over 95% of the gold has been recovered from the northwest flank of the Barberton greenstone belt, the remainder being mined in Swaziland and scattered sites elsewhere in the granite-greenstone terrane.

Geology

The Barberton Mountain Land is a rugged tract of country which straddles the border between the Transvaal Province and Swaziland. The rocks of the Barberton greenstone belt are assigned to the Barberton Sequence (Fig. 7) and consist of a wide range of early Archean volcanic, igneous and sedimentary lithologies. These are surrounded and intruded by younger granitic plutons of varying compositions and ages (see Allsopp *et al.*, 1968; Anhaeusser, 1973, 1976a, 1976b, 1978; Viljoen, 1984; Viljoen and Viljoen, 1970). This complex and ancient geological terrane has been the subject of extensive geological research which is summarized, in part, in Anhaeusser (1986a). In general, the overall stratigraphy consists of the basal Onverwacht Group, an ultramafic and mafic volcanic sequence which is considered to be the source of gold in the region. Komatiites, which are magnesium-rich ultramafic lavas, were discovered and first described from this area by Viljoen and Viljoen (1969). The upper portions of the Onverwacht Group are more felsic and also contain volcano-sedimentary strata. The Fig Tree Group (Fig. 7) above consists of argillaceous sedimentary sequences (graywacke, shale, chert, banded iron formation) and minor interbedded lava and tuff (Condie *et al.*, 1970).

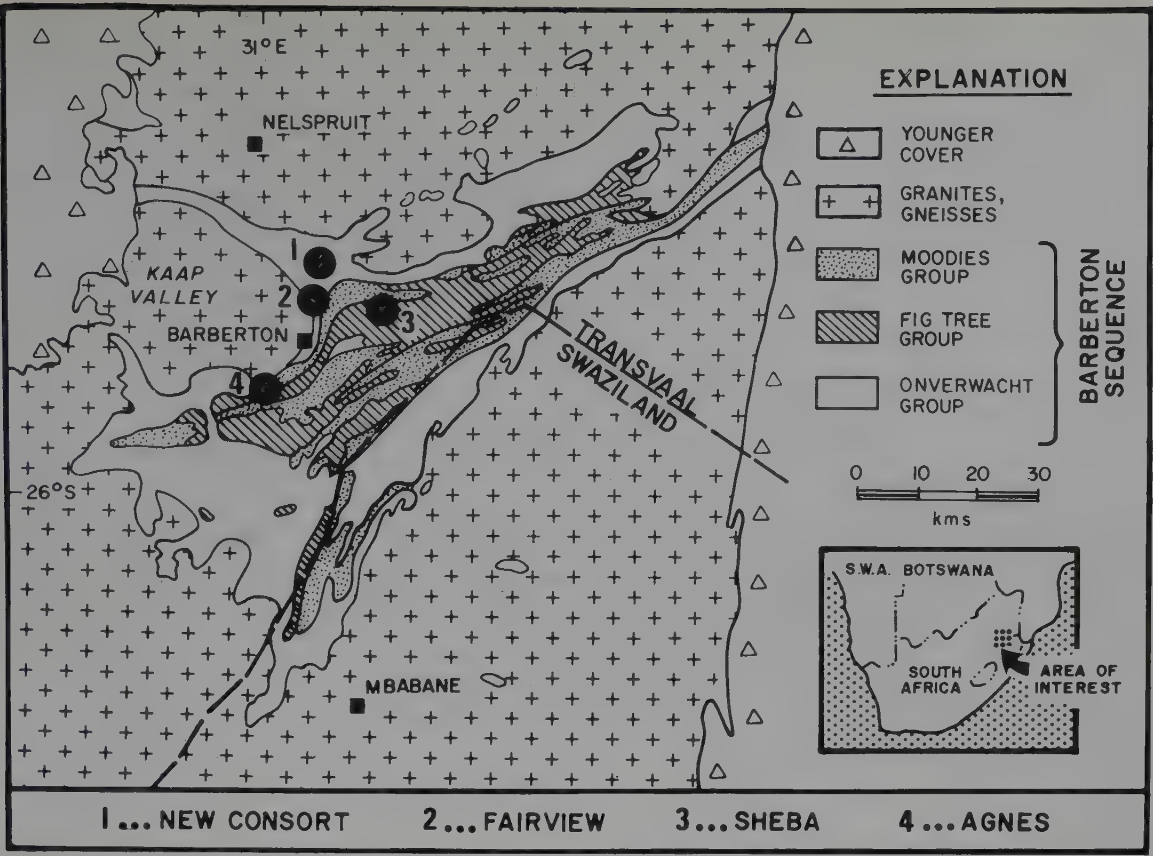


Figure 7. **Geology of the Barberton Mountain Land showing the four main gold mines. After Anhaeusser (1986a).**

The uppermost Moodies Group is an arenaceous sequence of conglomerate, quartzite and shale together with minor volcanic horizons, jaspilite and banded iron formation (Anhaeusser, 1976b). This entire sequence has undergone complex structural deformation, which produced a number of tight, steeply dipping synclinal folds, in places overturned, and with fold limbs separated by major strike faults. The ages of the Barberton Sequence have been summarized by Barton (1983), with the oldest Onverwacht succession dated at approximately 3,510 million years (Hamilton *et al.*, 1979).

Gold Mineralization

The distribution of about 60% of the gold workings in the Barberton Mountain Land is shown in Figure 9. The greatest concentration of workings occurs in the Jamestown schist belt (Fig. 10), and in the Sheba and Moodies Hills. Apart from these localities, gold also occurs along the major strike faults (e.g., the Barbrook Line, Fig. 9) and in a few Swaziland localities near the granite-greenstone contacts (e.g., the Hhohho, Pigg's Peak and Forbes Reef areas). Mineralization is notably less abundant in the central regions of the Mountain Land, for two main reasons: (1) there is a general absence of Onverwacht Group rocks, considered to have been the primary source of most of the gold and sulfide mineralization; and (2) the thermal influence of granite intrusions in the central regions was minimal away from the greenstone belt contacts.

Mineralogy

Table 1 lists the minerals found in the Barberton ores, gold being associated with 28 of them. Notably absent or rare are the tungstates, scheelite and wolframite, as well as the tellurides. No single mineral predominates in any of the ores, although pyrite is a common constituent. Three ore types are distinguishable (Schweigart and Liebenberg, 1966): (1) unoxidized, complex sulfide ore, the main ore type; (2) gold-bearing quartz veins with negligible sulfides; and (3) weath-

Table 1. **Ore minerals associated with gold in the Barberton Mountain Land.**

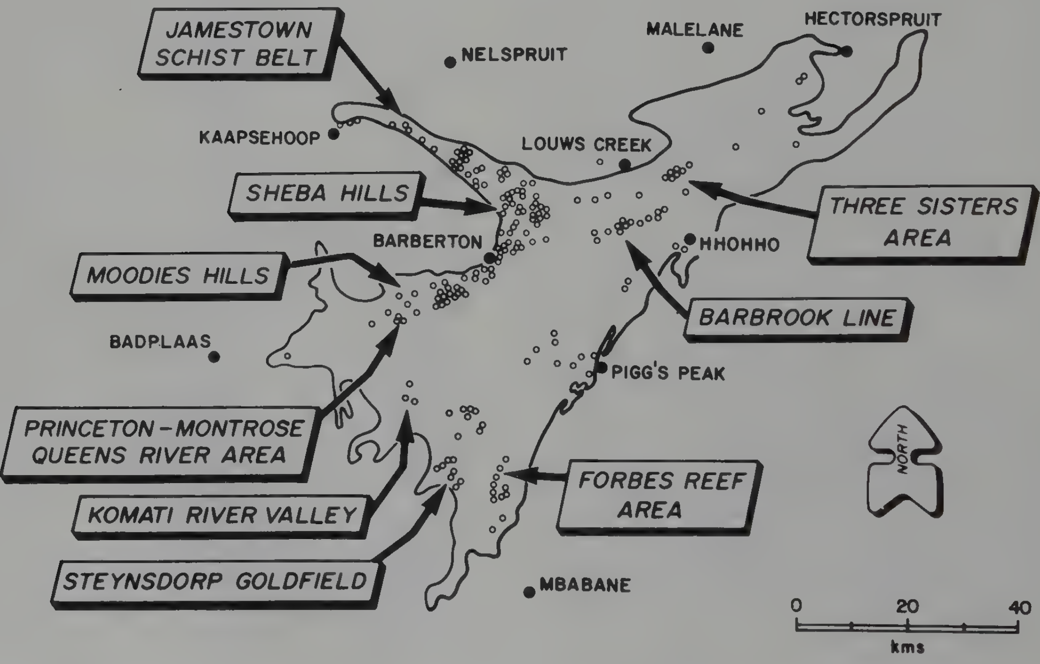
Acanthite
Ankerite
Anglesite
Antimony*
Arsenopyrite*+
Azurite
Berthierite
Bindheimite
Bismuth*
Bornite
Bournonite
Cerussite
Chalcocite*
Chalcopyrite*
Chromite
Cinnabar
Cobaltite*
Native Copper*
Covellite*
Cubanite
Digenite*
Electrum*
Enargite*
Famatinite*
Franklinite
Galena*
Gersdorffite
Goethite*
Gold+
Graphite
Greigite
Hematite*
Ilmenite
Jamesonite*
Lepidocrocite
Linnaeite-violarite
Loellingite*
Magnetite*
Malachite
Marcasite+
Maucherite
Millerite*
Molybdenite
Nickeline
Nickel-Skutterudite*
Pentlandite
Pyrargyrite
Pyrite*+
Pyrrhotite*
Safflorite
Scheelite
Siderite
Silver*
Skutterudite
Sphalerite*
Stibnite*
Tetradymite
Tetrahedrite*+
Trevorite
Ullmanite*
Valleriite

* = Found with gold
\+ = Main ore minerals

After De Villiers (1957), Schweigart and Liebenberg (1966), Liebenberg (1972) and Barton (1982).

Figure 8. (above) **The Stock Exchange was established in Barberton in 1886, the first such operation to be founded in the Transvaal.**

Figure 9. (below) **Distribution of gold occurrences (open circles) in the Barberton Mountain Land. After Anhaeusser (1986a).**

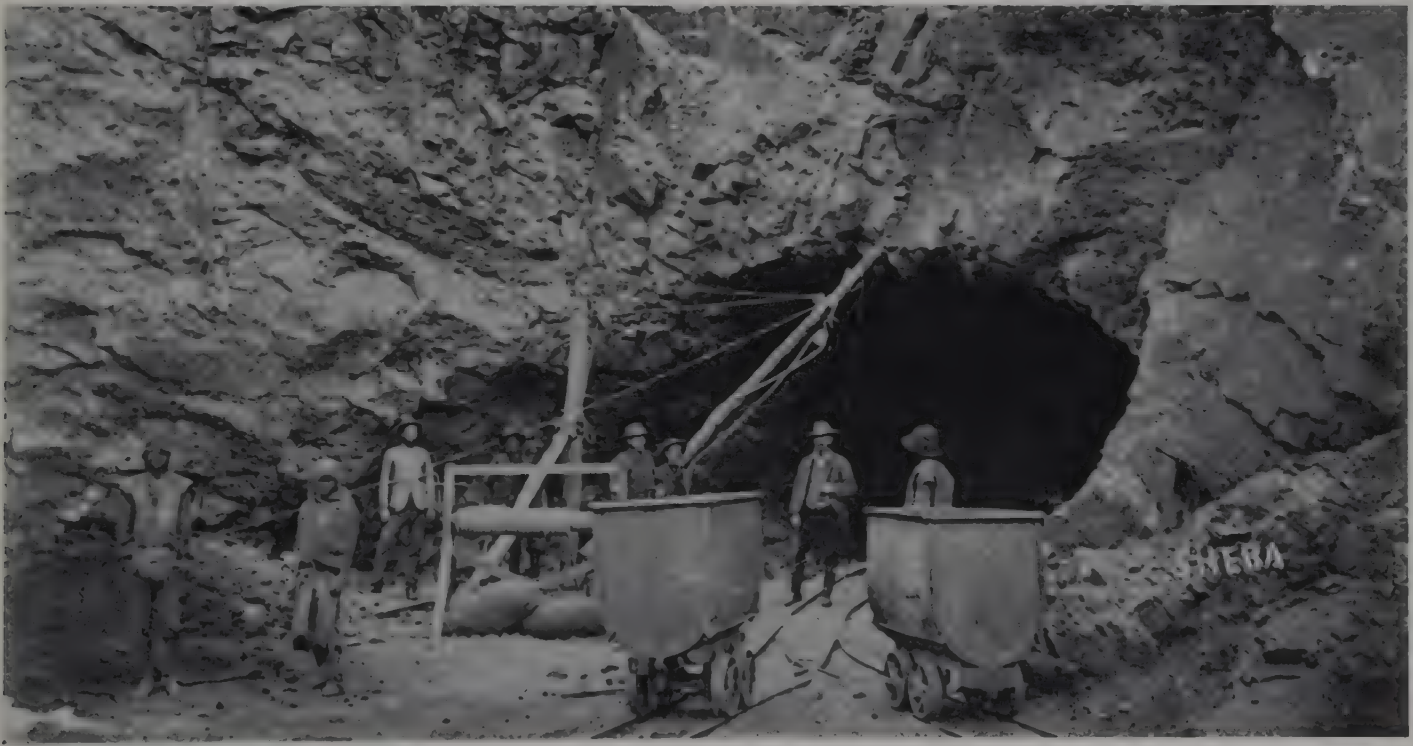


ered ore, in the oxidized zone, that provided the bulk of the gold recovered in the early days of mining.

A very complex paragenesis exists in the Barberton gold ores (Liebenberg, 1972). The ore minerals range from hydrothermal through mesothermal to epithermal mineral species; a general interpretation is as follows (based on Anhaeusser, 1986a): First-generation pyrite appears to be the oldest mineral present, followed by pyrrhotite and arsenopyrite, the latter, in turn, followed by second-generation pyrite. This sequence was followed by chalcopyrite, second-generation arsenopyrite and sphalerite, then by galena and tetrahedrite. Antimony represents the last phase of mineralization, filling in cracks; and gold occurs throughout the mineralogical assemblages. Arsenopyrite and possibly pyrrhotite are the oldest minerals associated with gold; galena and stibnite are the youngest. Gold also fills cracks found in early-

Figure 10. (above) **Alluvial diggings at Jamestown, 25 km north of Barberton. This was the site of the original discovery of alluvial gold in the district in 1882.**

Figure 11. (below) **Edwin Bray (with hat and pocket watch) at the portal to the Golden Quarry, now the Sheba gold mine. The discovery of this exceptionally rich bonanza took place in 1885 in the Sheba Hills area.**



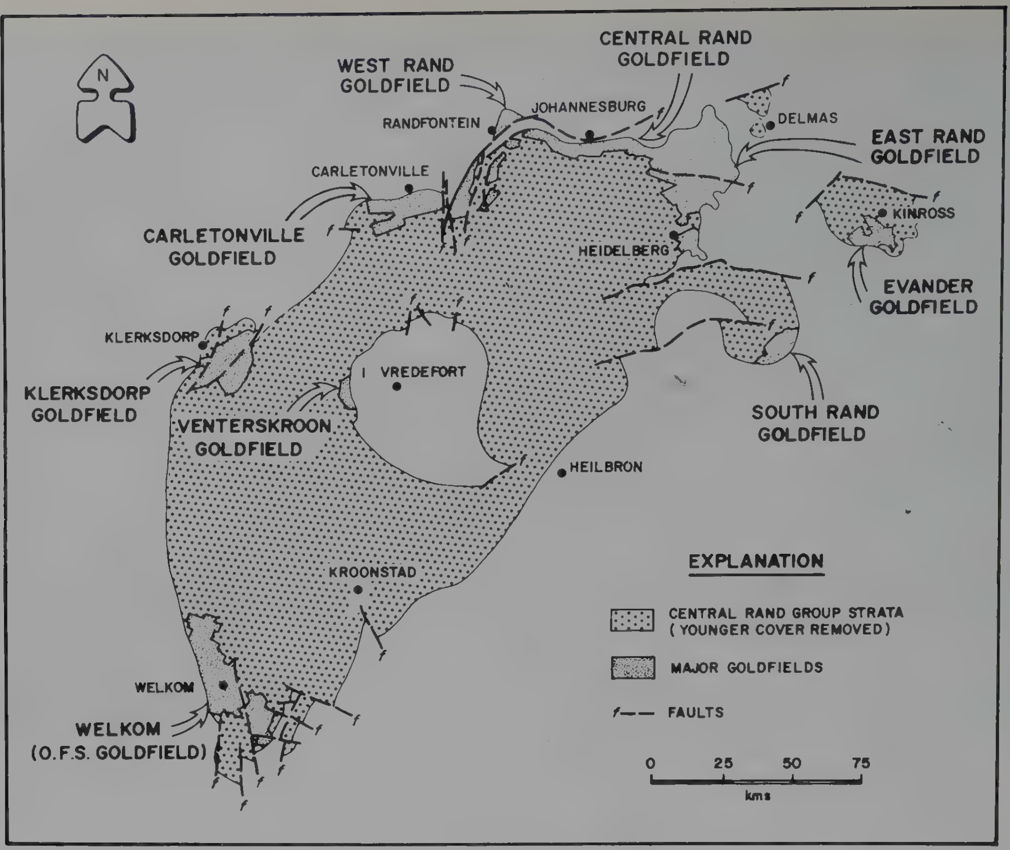


Figure 12. **The Witwatersrand Basin showing major structures (faults) and positions of the various goldfields.**

formed minerals such as first-generation pyrite, arsenopyrite and pyrrhotite, suggesting that the gold mineralization may be relatively young.

Although some of the gold is clearly "young," there is no single stage of gold mineralization. Gold particles entrapped in the early sulfide phases suggest early introduction of at least some of the metal. It is likely that successive stages of gold mineralization in the Barberton Mountain Land may reflect episodes of granite emplacement, tectonism and metamorphism.

Supergene Gold Enrichment

For much of the first decade of gold mining in the Barberton Mountain Land the mine workings were based largely on oxidized ores containing readily extractable gold (Anhaeusser, 1986b). Many of these operations ceased production immediately after fresh or sulfidic ores were encountered at depth, usually below the regional water table. Some orebodies could be mined below this level, particularly where faulting, fracturing and brecciation permitted oxidizing solutions to penetrate to greater depths.

Some of the early opencast operations were also developed to exploit gold in the zone of elluvial concentration. The quarries, being on the downslope sides of the orebodies, enabled creep of rock debris and rain wash to transport particulate gold as well as auriferous solutions in that direction. Visible gold was commonly observed in these ores, whereas in later years a marked decline in the availability of visible gold occurred in all but a few exceptional mines or sections of mines.

One of the most spectacular gold occurrences of the supergene type was the Devils Reef gold deposit in Swaziland. The occurrence was notable on two counts. Firstly, according to Barton (1982), the orebody, although small in size, was exceptionally rich. During 1890–1891, 87.63 kg of gold was produced from only 69 tons of ore, an average grade of 1.27 kg/ton (>0.1% gold). Secondly, Devils Reef is the only deposit documented in the Barberton Mountain Land in which gold occurs in pockets rich in manganese oxides and hydroxides together with large drusy quartz crystals. The quartz crystals reach several centimeters in length and contain a variety of colorful inclusions such as specular hematite, limonite, goethite and red phantom terminations defined by finely disseminated red hematite. The wad also contained rich pockets of gold and many of the surface excavations were located in areas where wad is well developed.

Some of the earlier gold mines that initially possessed high-grade gold values in the oxidized zone include the Maid of the Mountains, Montrose, Princeton, Florence-Devonian, Eagles Nest, Barbrook, French Bob's, the Maid of the Mists and the Lily mines.

The oxidized, free-milling reserves of most of the mines in the Barberton Mountain Land appear to have been largely depleted and all that remains, in most cases, are lower-grade sulfide ores, the mining of which will depend entirely upon an increased gold price and the successful low-cost processing of refractory ores.

WITWATERSRAND GOLDFIELDS

> *Even the most optimistic have underrated the vast quantities of gold concentrated in the enigmatic quartz pebble conglomerate reefs of the Witwatersrand Basin, a relatively small depository which has already produced over 40 thousand tons of the precious metal.*
>
> (Viljoen, 1986)

The economic significance of the Witwatersrand Basin has long been realized, and Pretorius (1975) provided some interesting statistics regarding the mineralization and extraction of gold from the reefs. A large proportion of the Witwatersrand strata is today covered by younger deposits and, when these are stripped away, the basin is seen to be approximately 350 km long and 200 km wide (Fig. 12). Mining operations have, in places, reached depths of 3,600 meters and

Figure 13. **Blue Rock battery. This was a typical 10-stamp mill used to crush the gold-bearing quartz ore. Water channelled in a furrow powered the wheel, which was geared to operate the batteries.**

exploration core-drilling has penetrated to 4,600 meters below the surface. In parts of the basin, certain horizons have been mined continuously for 70 km along strike and 8 km down dip. A single, large-sized deep-level mine nearing the end of its life would have been sampled at at least 10 million points where metal content, thickness of reef and the number of pebble bands in the reef would have been measured. It seems likely that from no other Precambrian sedimentary basin has so much data been gathered with respect to the inter-relationships between mineralization, structure, stratigraphy and sedimentology. The most perplexing fact, however, is that even with this enormous data base, no single theory or consensus of opinion exists which adequately explains the mode of origin of the gold in the reefs. In addition to gold, uranium has also been extensively mined from the conglomerates. The main uranium-bearing mineral is uraninite and, since 1953 when extraction commenced, over 130,000 tons of uranium oxide have been extracted (Table 2). This uranium production has been restricted to the western side of the Basin where the mineralization is concentrated.

Peak gold production was in 1970 (Fig. 15) when over 1,000 metric tons were mined which, at the time, generated US $1.164 billion in sales. Since then, gold production has steadily declined; in 1987 gold production was 605 tons (Minerals Bureau, 1988), the lowest since 1959. South Africa has also dropped in world rankings from producing 66.43% of all world gold mined in 1972 (Pretorius, 1975, Table 2) to 39.2% in 1987. This drop in production was related primarily to the rapid rise in the gold price which rose, on average, faster than unit working costs. As a result, producers reduced the grade of ore mined, thereby facilitating the exploitation of previously uneconomic reserves. The average recovery grade of the Witwatersrand gold mines (Fig. 16) has declined from 13.28 gm/ton in 1970 to 5.28 gm/ton in 1987 (Minerals Bureau, 1988). The total amount of gold produced from all of the goldfields since their discovery is shown in Table 3.

Geology

The rocks containing the gold-bearing reefs have been assigned to the Witwatersrand Supergroup, which is subdivided into the lower West Rand Group and the overlying Central Rand Group (Fig. 17). The entire succession attains a thickness of over 10,000 meters. Except for a few interbedded lava flows and post-depositional intrusives, the sedimentary sequence consists of shales (some magnetic), quartzites, pebbly quartzites and conglomerates. The latter consist mainly of well-

Table 2. **Uranium production from the Witwatersrand Basin goldfields up to 31 December 1985.**

Goldfield	Start of Production	Metric Tons Milled	Metric Tons Uranium Oxide
1. West Rand	Sep. 1952	68,620,000	28,953.932
2. Carletonville	Apr. 1953	73,358,000	13,099.562
3. East Rand	Apr. 1953	14,663,000	3,005.335
4. Klerksdorp	Oct. 1953	285,177,000	64,232.196
5. Welkom	Feb. 1955	184,657,000	27,378.324
6. Central Rand—			
7. Evander—			
8. South Rand—			
9. Venterskroon—			
Total Witwatersrand		628,475,000	136,669.349

After Pretorius (1986).

Figure 14. **Consort No. 1 adit, late 1880's.**

rounded quartz pebbles which, in the mineralized reefs, contain a high proportion of pyrite in the matrix. Overall, the strata of the Witwatersrand Supergroup show a coarsening-upward trend, with the greatest concentration of conglomerates being in the Central Rand Group. It is from these upper reefs that the bulk of gold is mined in the various goldfields. Nonetheless, economic reefs are also present in the West Rand Group, and these have been mined in the past (Pretorius, 1986). The age of the succession has recently been determined as ranging from a maximum at the base of 3,060 million years to 2,070 million years at the close of sedimentation (Armstrong *et al.,* 1986). Sedimentation, therefore, began in the Late Archean and progressed into Early Proterozoic times.

An enormous amount of literature has been published over the last 100 years dealing with the various goldfields, their lithologies, the gold mineralization and the source of the gold. For example, in a bibliography compiled over 25 years ago, Winter (1964) lists 501 publications dealing specifically with the geology and mineralization of the Witwatersrand rocks. This list can be extensively enlarged with articles appearing since that date. A very brief review of some of the major concepts and controversies is presented below.

Table 3. **Gold production from the Witwatersrand Basin goldfields up to 31 December 1985.**

Goldfield	Start of Production	Metric Tons Milled	Metric Tons of Gold
1. Central Rand	May, 1887	1,086,857,000	9,004.253
2. Klerksdorp	Nov. 1887	387,730,000	4,260.172
3. East Rand	Sep. 1888	992,589,000	8,437.253
4. South Rand—	Mar. 1892	243,000	1.424
5. West Rand—	Jul. 1893	552,651,000	3,774.666
6. Venterskroon—	Oct. 1909	26,000	0.127
7. Carletonville	Feb. 1942	292,278,000	4,846.110
8. Welkom	Nov. 1951	811,670,000	9,121,791
9. Evander—	Dec. 1958	130,687,000	1,072.257
Total Witwatersrand		4,254,731,000	40,518.008

After Pretorius (1986).

Origin of the Conglomerate Reefs

There is unanimous agreement that the gold-bearing reefs and associated strata are sedimentary in origin. There is also general, although not total, agreement that the conglomerates were deposited by alluvial fans and by braided rivers that eroded material from an extrabasinal source and deposited sediment near the basin margin, in areas now defined by the distribution of the various goldfields (Fig. 12).

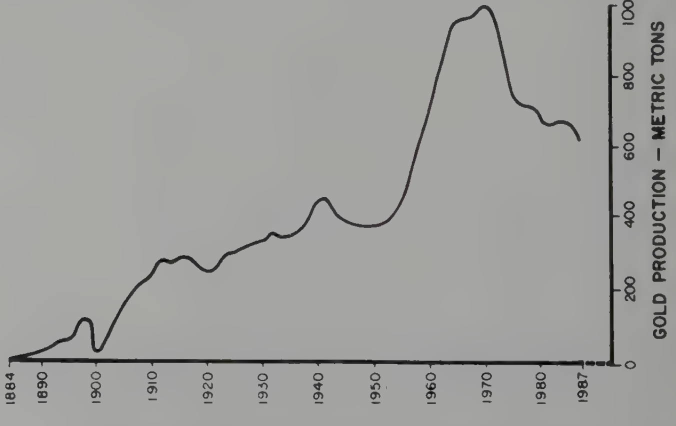


Figure 15. **Gold production from the Witwatersrand reefs for the last 103 years. After Minerals Bureau (1988).**

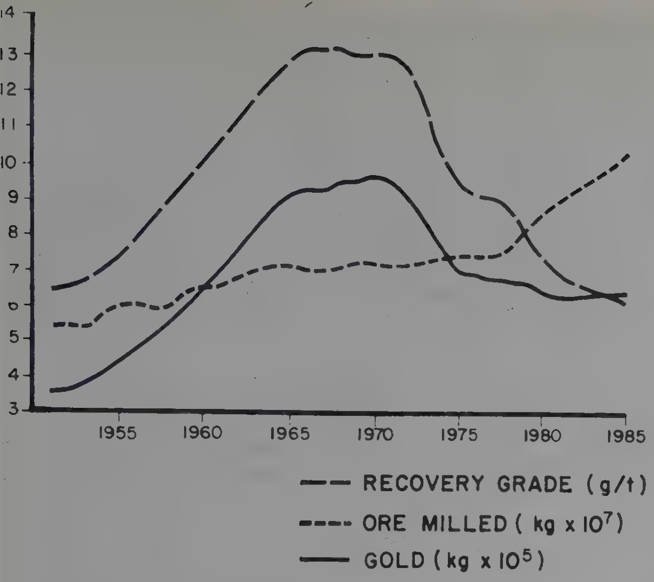


Figure 16. **Mining statistics for the Witwatersrand goldfields for the period 1950 to 1985. After Minerals Bureau (1988).**

These placer reefs commonly rest directly on major unconformity surfaces, thereby providing evidence for synchronous tectonic activity with sedimentation. Some workers (e.g., Cadle *et al.*, 1987) have questioned the fluvial model and have suggested instead that the reefs formed in a marine setting. Most of these hypotheses surrounding the mode of origin of the conglomerate reefs were proposed by the early workers soon after mining on the Witwatersrand commenced and all have, in one form or another, been voiced before. Most of the modern proposals are refinements of older ideas, backed up by more data and sophisticated analytical techniques. Pretorius (1975) gives a detailed review of the development of conceptual models for the origins of the Witwatersrand sediments.

Mineralogy

While there is no general consensus regarding the origin and formation of the host rocks, even less agreement has been attained with respect to the origin and source of the gold itself. Three main modes of origin have been put forward to account for the enormous quantities of gold present in the reefs (Skinner and Merewether, 1986): (1) The deposits are paleoplacers and the gold was introduced detritally together with the sediment from a hinterland source. (2) The deposit is syngenetic, with gold precipitating from a solute complex in surface waters (e.g., see Hutchinson and Viljoen, 1988). (3) The deposit is epigenetic, with gold introduced hydrothermally from solutions which percolated through the sediments.

Traditionally, the gold-bearing reefs have been viewed as paleoplacers, but all three of the above theories or combinations thereof were proposed soon after the goldfields had been discovered. One of the most widely accepted versions of the formation of the gold-bearing reefs is that of the modified placer theory, i.e., gold was introduced detritally and was subsequently redistributed hydrothermally. There can be no doubt that the entire sedimentary pile has been subjected to metamorphism (Phillips, 1987) with temperatures reaching 350° C, ± 50° C. This feature, together with the extremely varied mineralogy of the reefs and host rocks, lends some credence to the hydrothermal precipitation and formation of some minerals and the gold, although perhaps only on a local scale.

Phillips and Myers (1987) have provided a detailed review of all of the minerals listed in Table 4. These, numbering over 100, were gleaned from mineralogical studies dating back to 1917.

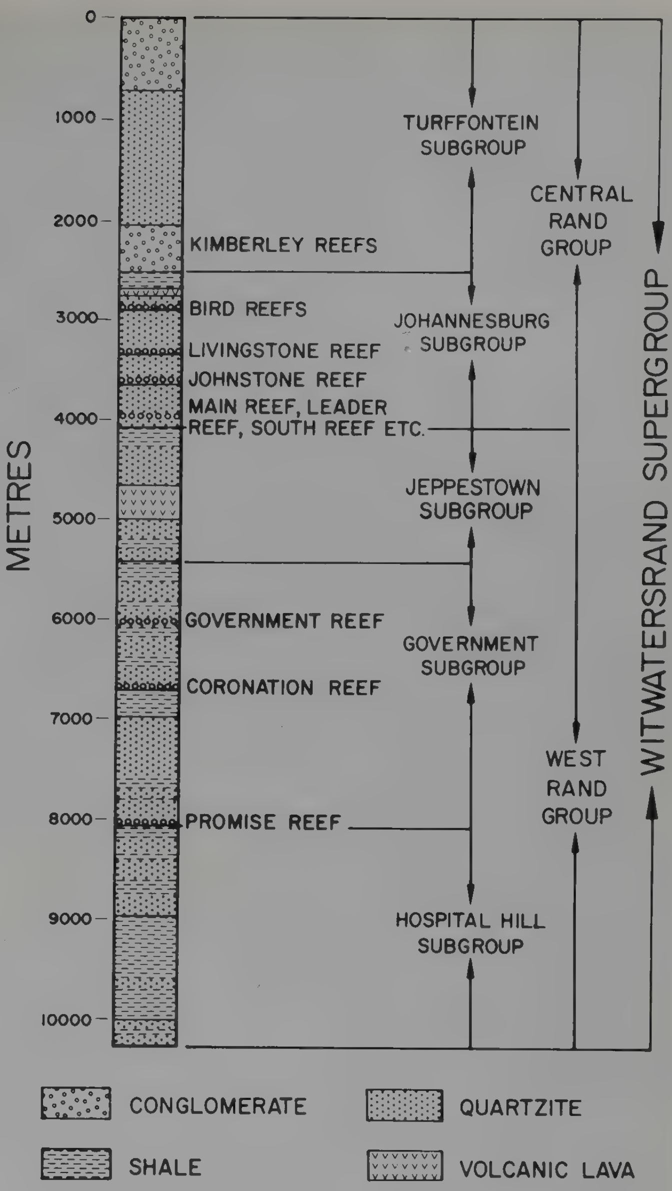


Figure 17. **Generalized stratigraphy of the Witwatersrand Supergroup.**

Zircon, chromite and other "heavy minerals" occur throughout the Witwatersrand strata and would be expected to be derived from a granite-greenstone terrain which is seen as being a possible source of the sediments. An unusual aspect is the almost total absence of the iron oxides ilmenite and magnetite in the basin. Several theories such as sulfidation and pseudomorphic replacement have been proposed to account for this. Leucoxene is commonly present and can be seen to be pseudomorphic in places after primary magnetite and ilmenite.

The most common silicate mineral in the reefs is quartz, followed by muscovite, pyrophyllite, chloritoid and chlorite. Origins suggested for the pyrophyllite are that the mineral is a primary detrital component, or that it formed by metamorphism of primary kaolinite. A third possibility is that the pyrophyllite originated during greenschist-facies metamorphism, an interpretation which may be supported by the presence of other metamorphic minerals such as tourmaline, rutile, paragonite and titanite.

The sulfides form the most abundant suite of minerals, second only in volume to quartz. A wide variety of nickel-cobalt-platinum sulfoarsenides, as well as copper sulfosalts and antimony-bearing minerals, are present (Table 4). Included in these groups of minerals are

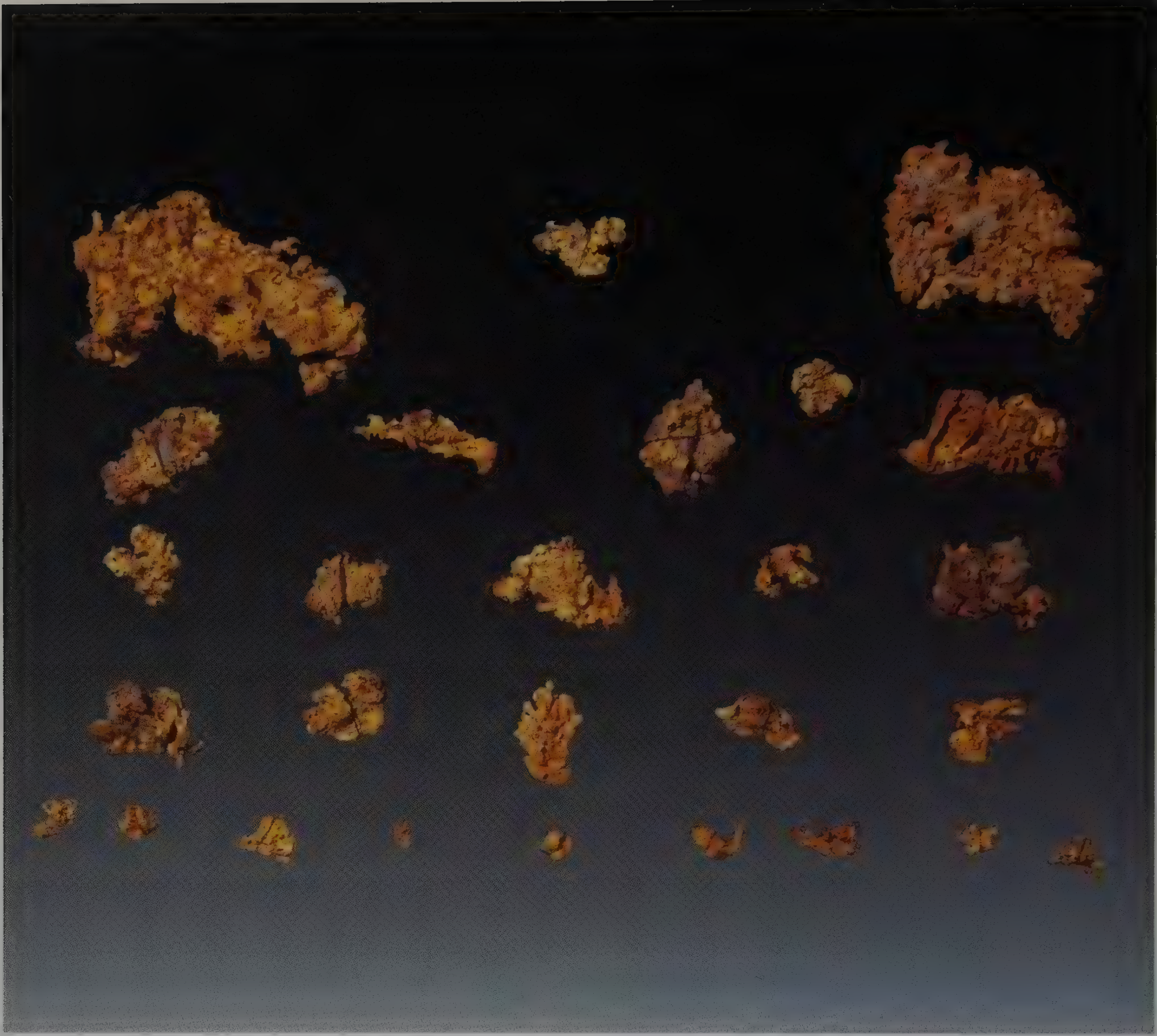


Figure 18. A collection of alluvial gold nuggets from Theta Hill in the Pilgrim's Rest area, collected from 1952–1954. Transvaal Gold Mining Company. The top left specimen is 11 cm. Johannesburg Geological Museum collection. Photo by Mark Hudson.

Figure 19. A unique specimen of skeletal octahedral gold crystals from the Van Dyk mine, Witwatersrand goldfields. The gold crystals are perched on vein quartz. The crystal is 1.7 cm on edge. Geology Department, University of the Witwatersrand. Photo by Mark Hudson.

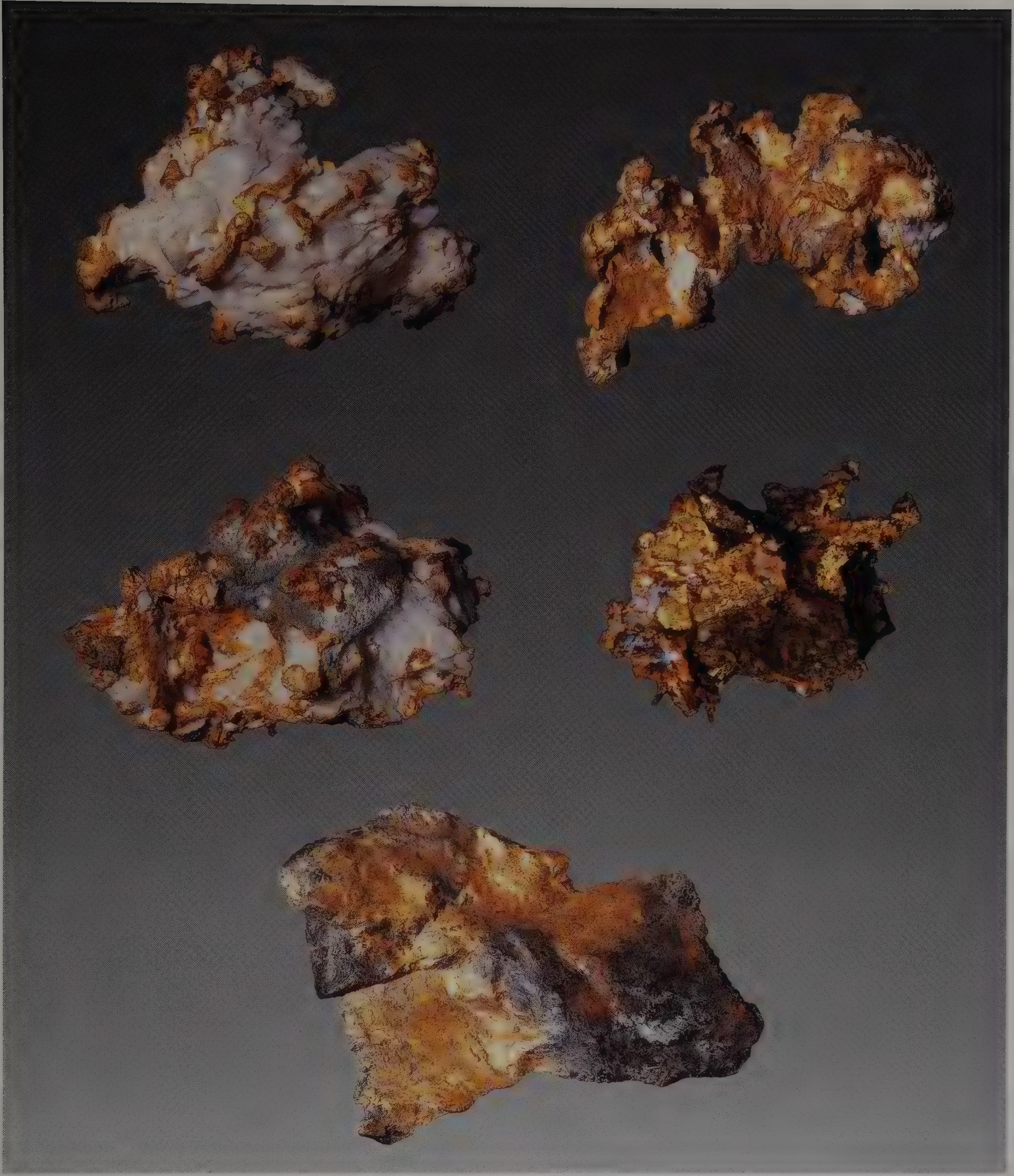


Figure 20. (clockwise from top-left) **Gold with quartz and chlorite, Vogelstruisbult East mine, Witwatersrand goldfields; 16 cm. Gold with quartz, Vogelstruisbult East mine, Witwatersrand goldfields; 10 cm. Gold and quartz, Brakpan mines, Witwatersrand goldfields; 5.5 cm. "Paint gold" in schist matrix, New Consort mine, Barberton Mountain Land; 17 cm. Gold with quartz and chlorite, Vogelstruisbult East mine, Witwatersrand goldfields; 10 cm. Johannesburg Geological Museum collection. Photo by Mark Hudson.**

Table 4. **Witwatersrand goldfield mineralogy: minerals reported from Reef Horizons since 1917.**

Anatase
Apatite
Arsenopyrite
Betafite
Biotite
Bornite
Braggite
Brannerite
Brookite
Calaverite
Calcite
"Carbon"
Cassiterite
Chalcocite
Chalcopyrite
Chlorite
Chloritoid
Chromite
Cobaltite
Coffinite
Columbite
Cooperite
Corundum
Covellite
Cubanite
Diamond
Digenite
Dolomite
Dycrasite
Epidote
Erlichmanite
Euxenite
Feldspar
"Ferrianthorite"
Galena
Garnet
Gersdorffite
Geversite
Glaucodot
Gold
Graphite
Hematite
Hollingworthite
Ilmenite
Irarsite
Iridarsenite
Iridium
Iridosmine
Isoferroplatinum
Kaolinite
Kyanite
Laurite
Linnaeite
Löllingite
Mackinawite
Magnetite
Marcasite
Michenerite
Millerite
Molybdenite
Monazite
Moncheite
Muscovite
Nickeline
"Osarite"
Osmiridium
Osmium
Pentlandite
Platiniridium
Proustite
Pyrrhotite
Pyrite
Pyrophyllite
Pyroxene
Quartz
Ruthenarsenite
Ruthenosmiridium
Rutile
Safflorite
Silver
Skutterudite
Sperrylite
Sphalerite
Stibiopalladinite
Stibnite
Stromeyerite
Sudburyite
Tellurium
Tennantite
Tetrahedrite
Thorite
Titanite
Tourmaline
Troilite
Tucekite
Uraninite
Uranothorite
Xenotime

After Phillips and Myers (1987). The table was compiled by these authors from Young (1917), Ramdohr (1958), Viljoen (1963), Feather and Koen (1975) and Hallbauer (1986).

species such as cobalt-rich arsenopyrite, gersdorffite and cobaltite, and the platinum group minerals geversite, sperrylite, braggite and cooperite. Pyrite is present in a variety of habits and forms (Ramdohr, 1958), and this ore mineral has itself been the subject of debate with respect to its mode of formation.

The main uranium-bearing minerals are uraninite and brannerite with minor amounts of coffinite and uraniferous thorite. Uranium (and gold) tend to be enriched when found in association with carbon.

Carbon is present in many reefs and has been referred to as kerogen, thucolite or simply carbon (Hallbauer, 1986). Carbon is commonly present as laminae up to 1 mm thick, but can reach several centimeters in thickness. In some places a "reef," the Carbon Leader, is developed and mined because the gold content is exceptionally high in association with the carbon. A biological origin has been proposed for the presence of the carbon (Schidlowski, 1965; Snyman, 1965; Hallbauer, 1975; Hallbauer *et al.*, 1977) although a detrital origin has also been put forward. Gold is intimately associated with the carbon and is present as fine filaments 1–2 microns in diameter and also as tangled aggregates (Hallbauer, 1986).

A further intriguing mineral associated with the Witwatersrand reef is diamond. In 1889, two diamonds were found at the Wolhuter and Percy gold mines, and in 1913 a three-quarter carat hexoctahedron was found at the Modderfontein "B" gold mine (Young, 1917). Since then other diamonds have been found. During the early mining days in the Klerksdorp area (Fig. 12), the Klerksdorp Gold and Diamond Company Ltd. was founded which simultaneously mined diamonds and gold. Most of the stones averaged 1–2 carats although one of 8 carats was recorded (Denny, 1897). A feature of all of the diamonds is their green coloration, ranging from a barely perceptible pale green tinge to bottle green and almost black; it is confined to an outer rind on the stones and does not penetrate into the interior. In a study of 38 diamonds recovered from the reefs, and ranging in size from 0.08 to 1.53 carats, Raal (1969) established that the color was induced by natural radiation from associated uranium in the host conglomerates. The presence of diamonds in the gold-bearing reefs indicates that a source for these gemstones already existed in the Early or Middle Archean prior to the deposition of the sediments.

Most of the gold in the Witwatersrand is present as native gold. This occurs in a variety of habits including microscopic veinlets in older minerals and overgrowths on younger minerals. It often has an idiomorphic habit (Phillips and Myers, 1987). Gold of this habit is usually only visible under the microscope, but in some instances, the metal may be seen with the naked eye. Most of the larger gold specimens were formed by remobilization of existing finely disseminated gold and precipitation along fault planes, in secondary veins and (in rare instances) in vugs associated with post-depositional faulting and intrusives. For the most part, the gold particles range in size from 0.005 mm to 0.5 mm in diameter, although both larger and smaller grain sizes are also known (Hallbauer and Joughlin, 1973). The size frequency distribution of these gold particles varies considerably from reef to reef and also within any specific reef. The following varieties and shapes have been recorded: (1) Composite gold-pyrite grains, 1.2–2.4 mm in size. The gold forms a thin film on the pyrite surface or is present as solid features projecting out from the pyrite (Feather and Koen, 1975). Gold of this particular size can also form the matrix between adjacent small pyrite grains. (2) Free gold grains, 0.3–1.2 mm, occur as plate-like particles or euhedral elongated octahedrons often containing attached dendritic extensions. (3) The 0.075–0.3 mm size range consists almost exclusively of plate-like gold particles. And (4) smaller than 0.075-mm particles which are plate-like and dendritic. Porous, or spongy gold grains are also recorded.

Hallbauer and Joughlin (1973) describe several mineralogical associations of the various gold particles. These include: (1) Quartz and phyllosilicates associated with gold, which usually forms platy, euhedral (sometimes a filigree of several small crystals) and porous grains. The bulk of gold in the reefs is associated with these silicates. (2) Gold associated with carbon is often nugget-shaped and shows a wide range of sizes from 0.05 mm to greater than 2.0 mm. Large particles formed by aggregation of the smaller grains are also present. And (3) pyrite associated with gold which shows evidence of remobilization and redeposition caused by metamorphism. This gold coats the pyrite grains and fills interstices between them.

Feather (1975) reported that gold forms intergrowths and spongy grains in association with gersdorffite, galena and tucekite. These minerals frequently enclose gold. A detailed summary of the chemistry and other associations of gold and reef constituents is provided by Feather and Koen (1975).

The larger, spectacular gold specimens are known to post-date the enclosing sediments; they are found in features such as structures formed by later faulting and intrusion. At the Randfontein Estates gold mine, gold occurred in an area where a dolerite dike had transgressed the strata, and gold was "found smeared on fault planes" (Kransdorff, 1937). Crystalline gold was also reported from a nearby fault surface which contained gold-bearing secondary quartz veins. Reports of some spectacular finds of native gold were made in the underground workings of the City Deep mine (Keep, 1934). One of these finds consisted of a limited amount of interwoven gold crystals forming small mats which were found between the walls of a fissure in the Main Reef Leader. This fissure was associated with a dolerite sill. Close to the fissure, a large vug contained clear, rhombohedral calcite crystals 15 to 20 cm in size. In the same area of the mine, a 10-meter dolerite dike had intruded the Main Reef Leader and produced a series of fissures and vugs lined with a mass of beautiful clear quartz crystals up to 10 cm long, together with smaller calcite crystals. Native gold was found in association with these vugs and the secondary minerals.

Conclusion

Many workers have remarked that the data amassed on the Witwatersrand gold, the structure, the mineralogy and the geology can be used to support both the placer as well as the hydrothermal origin of the gold in the reefs. Both of these models provide some answers to the many and varied problems encountered in the Witwatersrand goldfields. During 1986 when the centenary of Johannesburg and the discovery of the goldfields were celebrated, Skinner and Merewether (1986) had this to say about the Witwatersrand gold:

> *We still fight over the origin of the deposit that was found a century ago on the farm Langlaagte, and it is likely that we will still be fighting long after the last grain of gold has been dug from the basin.*

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Finally, we should mention that it is an offense punishable by law to possess any unwrought gold in South Africa unless one has the necessary permits. The authors have no gold specimens in their possession for the purpose of selling or trading.

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MINERALS OF THE LINWOOD MINE SCOTT COUNTY, IOWA

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Iowa is not considered a "mecca" for mineral collectors. Take away Pint's quarry and the famous Keokuk geode belt and there is not much left. The Linwood mine has produced excellent quality calcite, barite and marcasite specimens. The calcite and barite are unusual in that they occur in a wide variety of crystal forms and habits. Though the mine is not accessible to collectors, the information presented herewith may stimulate investigation of above-ground quarries in the vicinity.

INTRODUCTION

The Linwood mine, owned and operated by Linwood Mining and Minerals Corporation, is located along the northern side of the Mississippi River just east of the town of Buffalo in Scott County, Iowa. The mine's beginnings can be traced back at least to 1897. Linwood began operations on the site in 1918, producing limestone from an open-cut quarry. Around 1956, due to an increased demand for high-purity limestone and calcium carbonate, the quarry was abandoned (because excessive overburden covered the favorable rock units) and underground mining was begun. Workings extend in a generally northward direction from portals set in the face of limestone ledges, which are prominent along the Mississippi River in this area. Mining extends over 1200 meters from the portals, and working levels are from 18 to 40 meters vertically below the surface. Mining is by the room and pillar method, with 9-meter pillars on 21-meter centers, and the underground workings now cover several hundred acres. Employees number about 100, with 16 assigned to work underground. The major product line includes: calcium oxide, calcium hydroxide, calcium carbonate, crushed stone aggregates, fillers and extenders. Current production is about 1,400,000 tons per year. Given the identified reserves, at the current rate of production the mine should continue operations for at least 100 years. In addition, mined-out areas are currently being considered for use as cold storage and other commercial warehouses.

GEOLOGY

The mineral deposits at the Linwood mine are contained within carbonate rocks of the Wapsipinicon Group (middle Devonian age). The rock units, in ascending order, are the Otis Formation, the Kenwood, Spring Grove and Davenport members of the Pinicon Ridge Formation, and the Solon and Rapid members of the Little Cedar Formation. A brief description of these units follows. More detailed descriptions are given in Witzke *et al.* (1985).

The Otis Formation is the lowest unit exposed in the mine. It is a thin to medium-bedded, very fine to medium-grained, sparsely fossiliferous limestone containing dolomitic horizons in the lower part. The Otis is typically quite dense, but locally may be soft and porous. It is locally cavernous and brecciated.

The Kenwood member of the Pinicon Ridge Formation is a dense, fine-grained argillaceous dolostone which is locally fractured and brecciated. Commercial gypsum deposits occur within the Kenwood in the southeast part of Iowa.

The Spring Grove Member consists of dense, faintly laminated limestone. Rocks of the lower part exhibit a petroliferous odor when broken. The Spring Grove is notably less argillaceous than the Kenwood and typically coarser grained than the overlying Davenport.

The Davenport Member, the uppermost unit of the Pinicon Ridge Formation, is characteristically a fine-grained to sublithographic limestone. The upper part is extensively brecciated with breccia clasts

Figure 1. **Linwood quarry and mine today. Photo by Bob Welch.**

ranging from a few millimeters to more than half a meter across. Brecciated areas grade into beds which are highly fractured, but continuous; unfractured beds occur locally. The brecciation, which is widespread in eastern Iowa, is thought to be a result of the dissolutional removal of evaporite beds.

The Solon Member of the Little Cedar Formation overlies the Davenport. It is characteristically a medium-grained irregularly bedded limestone, which is sandy at the base. Unlike the underlying units, the Solon contains an abundance of marine invertebrate fossils, notably corals and brachiopods. It is highly fractured in the lower part, probably a result of collapse into the underlying brecciated Davenport.

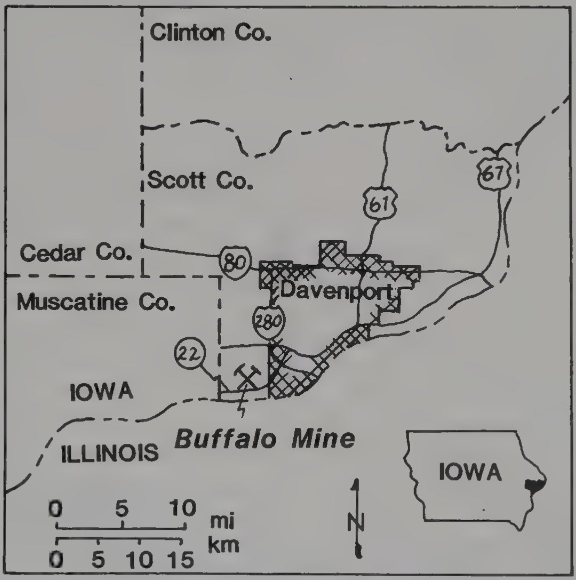

Figure 2. **Location map.**

The Rapid Member is typically a fine-grained argillaceous limestone. Fossils, primarily brachiopods, are abundant in some horizons.

The Coralville Formation is the uppermost unit exposed in the Buffalo mine area. A prominent discontinuity separates the Coralville from the underlying Little Cedar Formation. It is a fossiliferous limestone, differing from the underlying Rapid by a low clay content and by the presence of abundant colonial rugose and tabulate corals.

Following the deposition of the Devonian marine carbonate rocks, the shallow seas withdrew and the rocks were exposed to the agents of subaerial weathering. Important among these agents was underground water, which dissolved substantial amounts of calcium carbonate from the limestone. Bedding plane and transverse fractures were solution-enlarged, some to cavern-sized openings. Collapse of the roofs of shallow caverns allowed entrance of surface waters. The water washed clay and sand-sized sediments into the caverns and these materials gradually worked their way downward into deeper openings. Substantial filling of shallow karst openings in the Davenport occurred, but openings in the deeper, more isolated Otis were only partially filled. Karst-filling sands in the mine are generally clean and white. The clays are light to dark gray and contain varying amounts of organic matter. Locally, they are very organic-rich. Although karst-filling sediments at the Linwood mine have not been studied in detail, they are likely of Pennsylvanian age. Verified Pennsylvanian karst-filling sediments are widespread in Silurian and Devonian carbonate rocks in eastern Iowa and western Illinois (Witzke, 1984; Bunker *et al.*, 1985; Garvin and Ludvigson, 1988).

MINERALS

Mineralization at the Linwood mine is contained principally in the cavernous, brecciated areas of the Otis Formation. Openings range from a few centimeters to several meters across. These are lined with crystal crusts and scattered individual crystals. Minerals also coat and cement breccia clasts. Some mineralization also occurs in bedding

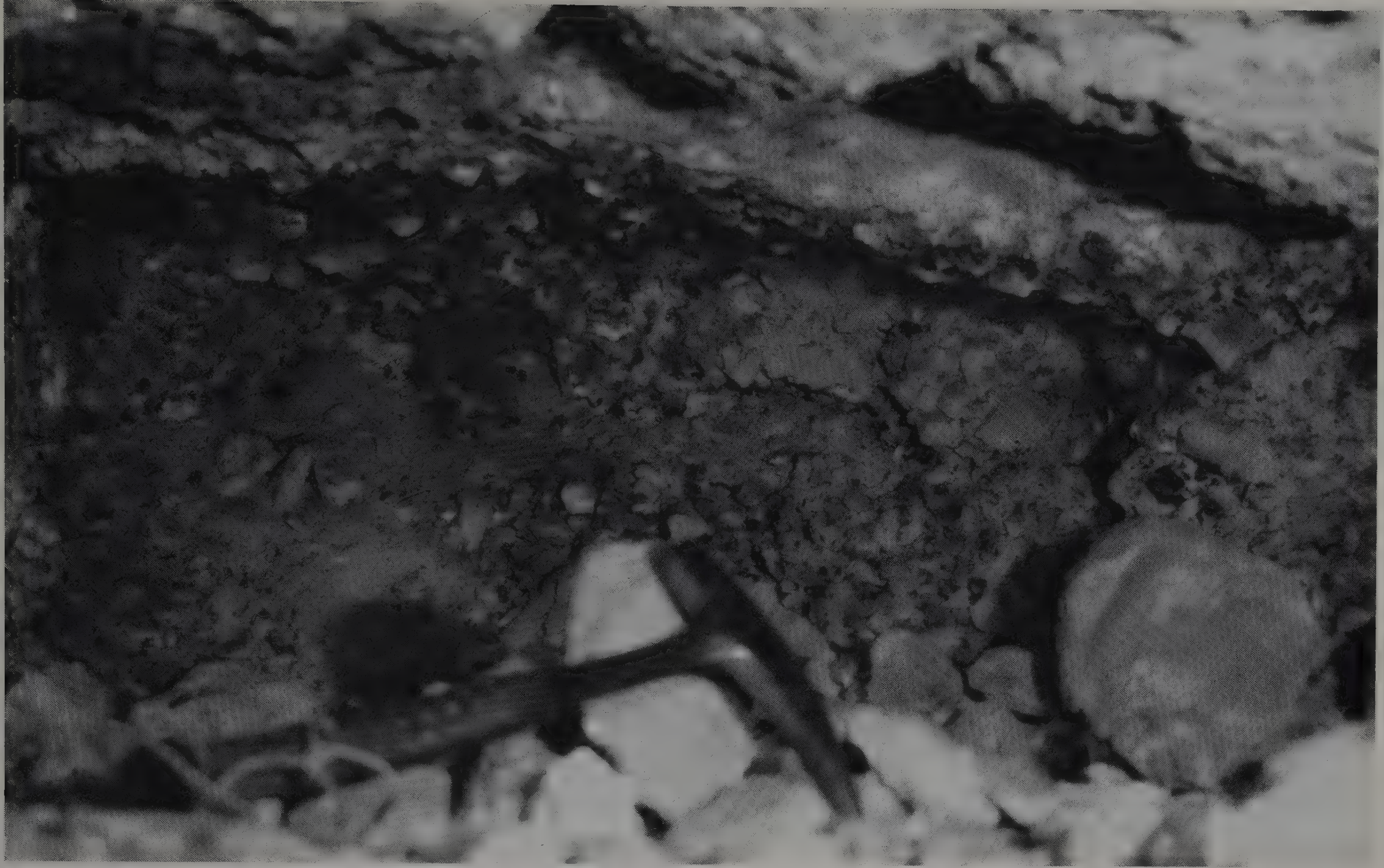

Figure 3. **Large mineralized cavity, west area of the mine; rock pick for scale. Photo by Bob Welch.**

plane fractures adjacent to caverns. Differential dissolution of the Otis locally produced highly irregular bedrock surfaces upon which the minerals were deposited. As a result, unusual fin-shaped and "swiss cheese-like" encrustations of minerals can be observed.

The mineralogy at the Linwood mine is similar to that of several other localities in eastern Iowa and western Illinois (Heyl and West, 1982; Ludvigson and Mullen, 1988; Spry and Kutz, 1988; Garvin, 1984a, 1984b; Garvin *et al.*, 1987; Garvin and Ludvigson, 1988). The minerals, in order of decreasing abundance, are calcite, marcasite, barite, pyrite and chalcopyrite. The Linwood minerals are unique in Iowa because the crystals are of excellent quality, and because of the wide variety of crystal forms exhibited by both calcite and barite.

Barite $BaSO_4$

Barite is abundant in the western part of the mine, but sparse to absent elsewhere. It ranges from colorless to milky white to amber. All varieties fluoresce bright white in longwave ultraviolet light. It occurs in a variety of crystal forms and habits: (1) as wafer-thin plates less than 1 cm across, which are aggregated in subparallel intergrowths, (2) cream-colored to amber-colored radiating groups and rosettes composed of wafers similar to (1), (3) amber-colored blocky prismatic crystals a centimeter or so across, (4) cream-colored feathery dendritic masses 3 or more centimeters in longest dimension, and (5) cream-colored stalactitic masses. The dendritic and stalactitic forms are observed on cavern ceilings. Stalactites are small (2 cm maximum length) and are hollow. One specimen found contains a complex barite crystal; the crystal is transparent yellow and consists of prisms, pinacoids and dipyramids in combination. Typical barite crystal forms are illustrated in Figure 8.

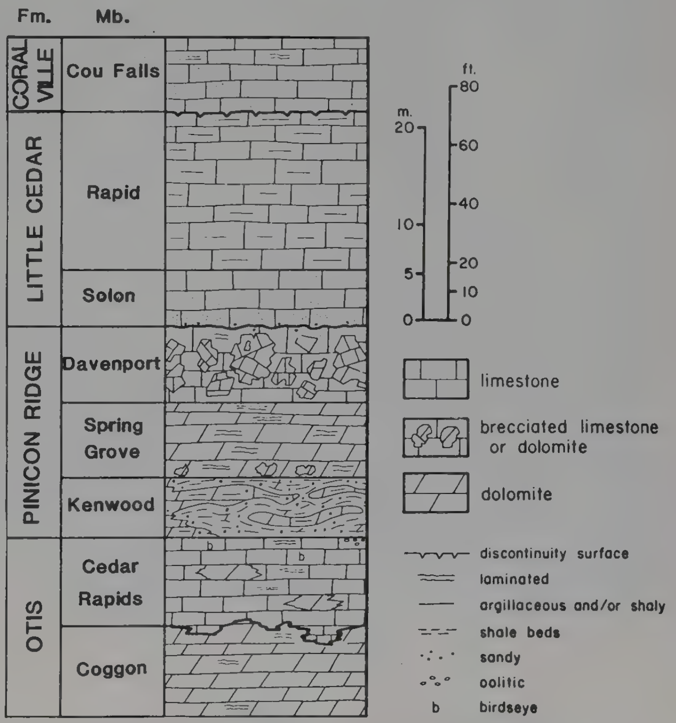

Figure 4. **Generalized stratigraphic section of Devonian rocks in east-central Iowa. (Modified from Witzke *et al.*, 1985).**

Calcite $CaCO_3$

Calcite is by far the most abundant mineral at the mine. It is typically translucent to transparent and colorless, milky white or pale yellow.

Figure 5. Golden barite (5.5 cm across). Paul Garvin specimen.

Figure 6. Barite rosettes (1 cm across) scattered on marcasite. Paul Garvin specimen.

Figure 7. Dendritic barite (9 cm long). Paul Garvin specimen.

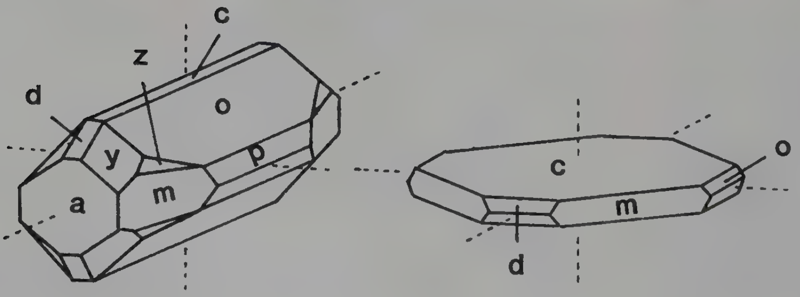

Figure 8. Individual crystal forms of barite: a = pinacoid {100}, c = pinacoid {001}, d = prism {h0l}, m = prism {hk0}, o = prism {okl}, p = prism {okl}, y = dipyramid {hkl}, z = dipyramid {hkl}.

Figure 9. **Calcite crystal group, 10.5 cm, from the Linwood mine. Paul Garvin collection.**

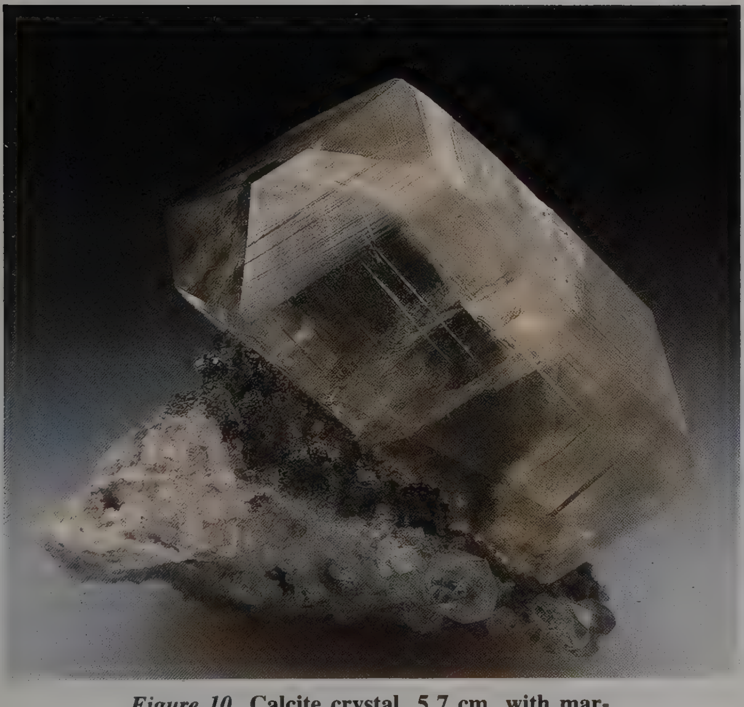

Figure 10. **Calcite crystal, 5.7 cm, with marcasite, from the Linwood mine. Paul Garvin collection.**

Figure 11. **Calcite crystal, 1.9 cm, with marcasite inclusions, from the Linwood mine. Paul Garvin collection.**

Locally, it is iridescent brown due to coating by a film of organic matter. In longwave ultraviolet light (356 nm) early calcite druses fluoresce creamy white, and some white varieties fluoresce pale pink. Colorless calcite is non-fluorescent. Etching of crystal faces is common in the western part of the mine, but generally absent in the north. Typically, some faces of a given crystal are etched, while others are not. The degree of etching appears to be controlled by the orientation of the crystals within the cavity. Crystals growing from ceilings and on the bottom sides of horizontal bedding plane slabs are unetched; crystals on floors and on the top sides of slabs are etched. Crystals found locally in small, isolated pockets tend to be unetched, presumably because they were protected from the action of corrosive fluids.

Calcite occurs in a wide variety of crystal forms. Simple "dogtooth" scalenohedra and rhombohedra occur locally. A scalenohedral druse

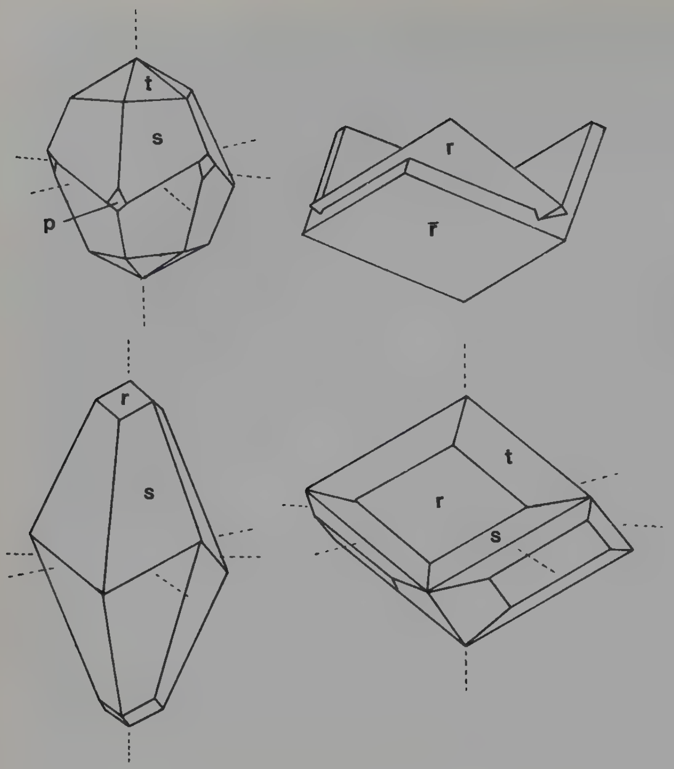

Figure 12. **Crystal forms of calcite. D is a {0001} penetration twin, s = acute scalenohedron $\{hk\bar{i}l\}$, t = obtuse scalenohedron $\{hk\bar{i}l\}$, r = obtuse rhombohedron $\{h0\bar{h}l\}$, p = acute rhombohedron $\{h0\bar{h}1\}$. A and D from Palache *et al.* (1951); B and C modified from Palache *et al.* (1951).**

commonly coats cavity walls. Individual crystals are less than a centimeter in length and are etched. Rhombohedra with a coating of iridescent brown organic matter occur locally. More common at Linwood are complex combinations of scalenohedron and rhombohedron. Acute scalenohedra are modified by either obtuse scalenohedra or rhombohedra. Obtuse rhombohedra are modified by both acute and obtuse scalenohedra. Rhombohedral crystals as much as 8 cm across have been observed on cavern floors, and crystals 2 to 3 cm across are common. Scalenohedral crystals 15 cm or more in length have also been observed. Phantom acute scalenohedra within modified rhombohedra, and phantom obtuse rhombohedra within acute scalenohedra are common. The phantoms are accentuated by dustings of iron sulfide microcrystals on interior zones. As many as four sulfide microcrystal zones can be observed in the larger calcite crystals. Some calcites are gray to black because of abundant microscopic iron sulfide inclusions. One calcite specimen found exhibits a {0001} penetration twin. Illustrations of typical calcite crystal forms are shown in Figure 12.

Chalcopyrite $CuFeS_2$

Chalcopyrite is very rare at the Linwood mine. It occurs as microscopic tetrahedral crystals perched on and within calcite scalenohedra.

Marcasite FeS_2

Marcasite is often deposited directly upon the limestone host. Crystals are typically 5 mm or less in length. They appear as blades and as aggregates of wedge-shaped crystals which exhibit complex twinning. Some crystals are acicular. Incipient oxidation has produced iridescent coloration on some crystal surfaces. Marcasite also occurs as microscopic inclusions in calcite crystals, and as a microscopic dusting on earlier marcasite.

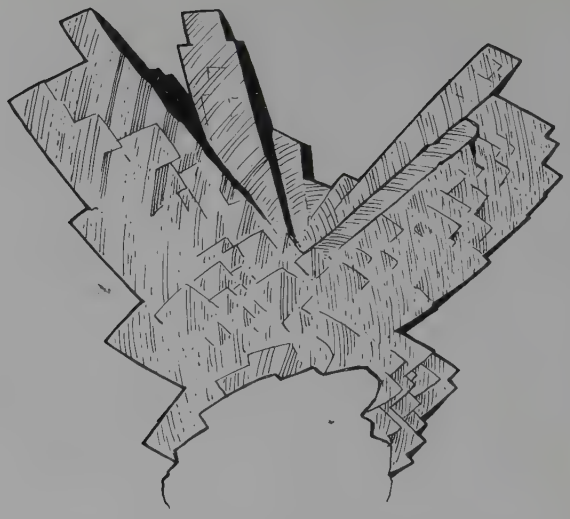

Figure 13. **Butterfly-shaped marcasite, subparallel aggregate, tarnished yellow and magenta (4 mm across).**

Pyrite FeS_2

Pyrite is a minor mineral at the Linwood mine. It occurs as scattered microscopic cubic or octahedral inclusions in calcite, and locally as small (a few millimeters across) cuboctahedral crystals lining fracture walls. It is not readily identifiable without a microscope.

PARAGENESIS

Unraveling the paragenetic sequence of mineralization at the Linwood mine is a difficult task for two reasons. First, calcite and barite both occur in several different forms. Although all barite appears to be late, widely differing crystal habits suggest at least two generations. Second, specimens collected from widely separated areas of the mine exhibit somewhat different calcite and barite habits. Specimens exist in collections for which the exact source within the mine is not known. More systematic sampling is needed to establish relationships among minerals from different areas.

On the basis of similarities and differences in crystal colors and habits, and spatial relationships between calcites and iron sulfide minerals, the following tentative sequence is presented. The first mineral to form was scalenohedral calcite druse (C1). This early calcite is observed in specimens from both east and west sections of the mine. Following this deposition (C1) the first generation of marcasite, consisting of macroscopic blades and wedges, was deposited. Early marcasite was followed by cuboctahedral pyrite. Simple rhombohedral calcite (C2) is next in the sequence. It occurs most commonly as phantoms in scalenohedral calcite. Rhombohedra were dusted by microscopic crystals of pyrite and marcasite, which accentuate the phantoms. Scalenohedral calcite was deposited next (C3). Simple acute scalenohedra are perched on earlier C2 crystals, and are present as phantoms within later rhombohedral calcite. Calcite scalenohedra modified by obtuse rhombohedra overgrow earlier rhombohedra. Acute scalenohedra modified by obtuse scalenohedra overgrow bladed marcasite. The final stage of calcite deposition followed; crystals are obtuse rhombohedra modified by both acute and obtuse scalenohedra (C4). Throughout the depositional history of calcite, intermittent deposition of marcasite, pyrite and chalcopyrite occurred. Sulfide deposition ended near the termination of the C4 stage. Barite was the last mineral deposited. Plates, rosettes, dendrites and stalactites were all collected from the same area in the western part of the mine, and, based on spatial relations with other minerals, are probably synchro-

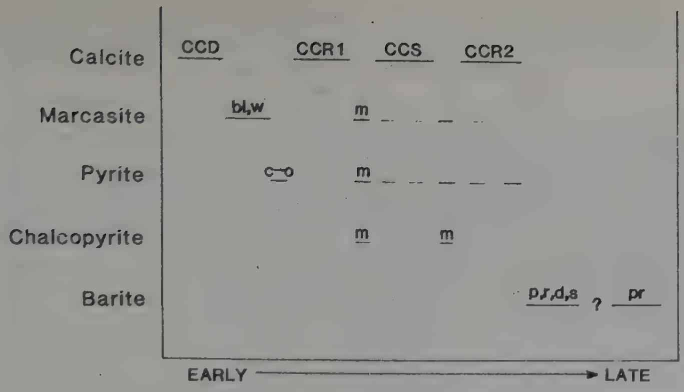

Figure 14. **Paragenetic sequence of mineralization at the Buffalo mine. CCD = scalenohedral druse, CCR1 = simple rhombohedra, CCS = modified scalenohedra, CCR2 = modified rhombohedra, bl = blades, w = wedges, m = microcrystalline, c-o = cuboctahedral, p = plates, r = rosettes, d = dendrites, s = stalactites, pr = prismatic crystals.**

nous. The prismatic barites, collected from the more central and eastern areas of the mine, may represent a different generation. Composite paragenetic relations are illustrated in Figure 14.

Origin of the Minerals

Sulfide-bearing, open-space-filling mineral deposits are widespread in eastern Iowa and in adjacent Wisconsin and Illinois. The most noteworthy of these are the formerly commercial lead-zinc deposits of southwestern Wisconsin and northwestern Illinois. Although mined for zinc and lead, these deposits of the upper Mississippi Valley also contain substantial marcasite, pyrite, barite and calcite. Numerous minor mineral occurrences which fringe the main commercial district have been studied in some detail, in order to assess their genetic relationship to the main-district deposits (Heyl and West, 1982; Coveney and Goebel, 1983; Ludvigson and Mullen, 1988; Spry and Kutz, 1988; Garvin, 1982, 1984b; Garvin *et al.*, 1987; Garvin and Ludvigson, 1988). Comparisons have been made on the basis of structure, mineralogy, paragenesis and stable-isotope geochemistry. Some of these deposits are spatially related to paleokarst. Several in Linn and Johnson counties in Iowa have been studied in detail (Garvin, 1984a; Garvin and Ludvigson, 1988). In all of these deposits minerals were precipitated from aqueous fluids at some time after filling of karst openings by Pennsylvanian sediments. At the Linwood mine the chronology is the same. Minerals can be observed on and enclosing Pennsylvanian shale clasts. As with the other paleokarst deposits, most of the minerals at Linwood were deposited on limestone cavity walls and breccia clasts, where these are in close proximity to Pennsylvanian sediments. Concentration of minerals in this paleokarst environment may have occurred for several reasons: (1) paleokarst openings allowed movement of mineral-bearing aqueous fluids, (2) organic-rich shale (which characteristically contains abundant sulfur) may have provided sulfur needed to form marcasite, pyrite, chalcopyrite and barite, (3) bacteria present in the shales may have chemically reduced sulfur in the fluid, causing precipitation of sulfide minerals (alternatively, organic carbon in shales may have served as a reductant), and (4) interaction of the fluids with limestone may have increased the pH, causing precipitation. The presence of abundant marcasite in the deposits indicates that the aqueous fluids were acidic, thus subject to neutralization by interaction with limestone (Murowchick and Barnes, 1986).

Comparison of mineralogy and paragenesis between the Linwood and upper Mississippi Valley minerals reveals similarities and differences. In both deposits sulfides are early and calcite is late. In both there is more than one generation of calcite, with scalenohedral forms early and rhombohedral forms late. However, at Linwood all calcite precedes barite, whereas in the upper Mississippi Valley deposits barite precedes calcite. Planned geochemical investigations of the Linwood minerals (e.g., stable-isotope analysis, fluid-inclusion research) will help clarify the genetic relationship between these mineral deposits.

CONCLUSIONS

Without question, some of the finest mineral specimens to be found in the state of Iowa occur at the Linwood mine. In addition, calcite and barite each occur in several interesting crystal forms and habits. Mineral collecting is strictly forbidden because of the hazards and liabilities attendant to underground mining. Permission to enter the mine was granted by Linwood Mining and Minerals Corporation only for the purposes of research and for the preparation of this paper.

ACKNOWLEDGMENTS

We express our sincere appreciation to Gaillard Krewer, Robert Niemela and the staff at Linwood Mining and Minerals Corporation for permission to enter the Linwood mine, and for important information about the nature of the mineral deposits and the history of mining. We thank Robert Welch for providing additional mineral specimens for study. We are grateful to Dr. Wendell Wilson and Robert Welch for photographic work.

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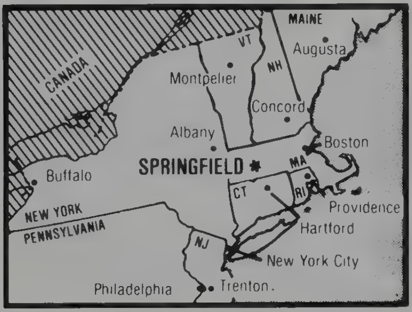

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HIENDELAENCINA, SPAIN

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The silver deposits of Hiendelaencina, Spain, were discovered in 1843 and worked until 1866. During that time many silver sulfosalt specimens, including the world's best freieslebenite, were recovered and distributed to museums and private collections worldwide.

INTRODUCTION

The small town of Hiendelaencina is located in Guadalajara province, about 55 km north of the city of Guadalajara and about 100 km northeast of Madrid in central Spain. The district was an important silver producer during the last half of the 19th century. During the first 25 years of exploitation, well over 10 million troy ounces of silver were produced (Mallada, 1927), the equivalent of about 300 metric tons. This equals nearly 25% of the total production of Kongsberg, Norway, over its 330-year history (Johnsen, 1986). Targhetta (1959), less conservative in his estimate, suggests the total may have been as high as 1,000 metric tons. Most of the silver from Hiendelaencina was shipped to the Banco Español de San Fernando, where it was processed into silver coinage.

In addition to the huge quantity of silver produced, many fine specimens of silver-bearing minerals (especially freieslebenite) were recovered. Fortunately there was a renewed interest in Spanish geology at the time; the minister Francisco Romero Robledo had enlisted the help of Lastenet and Verneuil, two French geologists, for the purpose of assembling a geologic map of the country. Because of this scientific interest, many fine mineral specimens escaped the smelter to enrich public and private collections in Spain and around the world.

HISTORY

In late 1843 an outcrop of silver minerals was discovered by a surveyor, Pedro Esteban Gorriz, about 1 km north of the town of Hiendelaencina (the Santa Cecilia mine was later opened near the discovery site; Ezquerra, 1851). The discovery sparked a silver rush to the area; more than ten mines were opened on the *Filón Rico* ("rich vein") during the following year. Mining was facilitated by the narrowness of the vein (usually less than 1 meter in width) which, combined with the hardness of the wall rock, made timbering unnecessary. To ventilate the 400-meter-deep workings, towers were raised over the shafts which acted like chimneys, inducing passive ventilation. The very minor flow of water was hoisted out in barrels (Ezquerra, 1851).

In 1847 a British company under the direction of Sir William Pollard built the "La Constante" smelter. This was the earliest amalgamating facility built in Spain. It was at first powered by a waterwheel, but two steam engines were later installed. At its peak the facility resembled a small British town of about 100 families in permanent residence (Contreras, 1905).

The boom year of 1858 saw the production of about 800,000 Castilian ounces of silver, but a steep decline soon followed. The Filón Rico was found to have been offset by a major fault, and the continuation of the vein could not be located. Exploration shafts to a depth of 520 meters failed to locate it, and were abandoned in 1866. For a few years following 1868 some silver was produced by extracting and processing backfill and vein walls, and by gleaning the dumps, but from 1871 onwards the mines closed, one by one. By 1900 only the Nueva Santa Cecilia mine was still in operation, yielding about 100 kg per month. By 1924 all of the mine properties had been abandoned except the Nueva Santa Cecilia and the Santa Teresa mines, which remained open for maintenance work only. In that year the dumps were reworked for the third time, stone by stone (Royo and García, 1924). Minor work was done in 1947 in mines on the western side of the Filón Rico, primarily the Santa Teresa mine.

In 1980 a flotation mill was constructed for processing the old dumps, and in 1984 some clean-up work and exploration was undertaken in the Santa Catalina mine to a depth of 900 meters. But the low market value of silver has prevented any renewed mining since then.

Geophysical studies combined with drilling have delineated the Filón Rico horizontally for at least 700 meters and to a depth of 500 meters. Geochemical analyses of stream sediments in the district point to the existence of other, as yet undiscovered, veins in the district (De Vos and Viaenne, 1981); consequently the district cannot yet be definitively proclaimed exhausted. Known reserves currently total about 300 tons of silver, equivalent to all that has already been mined, but of lower grade (I.G.M.E., 1975).

Figure 1. **A view of the La Constante smelter in 1924. Photo by J. Royo. Reprinted from the *Boletín de la Real Sociedad Española de Historia Natural.***

GEOLOGY

The geology and mineralization of the Hiendelaencina district have been reported in detail by Mallada (1927), Soers (1972), Navidad (1975) and De Vos and Viaenne (1981), among others.

The Hiendelaencina massif is part of the Central Spain System; it consists mainly of the Congostrina and Hiendelaencina Formations. The latter (which hosts the silver deposits) is a gneissic volcano-sedimentary rock in places containing orthoclase crystals to 10 cm inherited from an extrusive igneous source (Fernandez and Capote, 1971). It varies in thickness from 1,300 to 1,600 meters. Principal deformations are associated with the Hercynian orogeny (Late Paleozoic). In the eastern part of the district overlying Pliocene-Quaternary sediments reach a maximum thickness of about 200 meters (I.G.M.E., 1975). The hydrothermal veins, dated as late Hercynian, are probably genetically related to plutonic rocks occurring northeast of Hiendelaencina (Targhetta, 1959).

The silver lodes can be divided into three major groups according to their relative age, mineralization and orientation. The first and most important group includes the Filón Rico, exploited over a distance of about 3 km by the Verdad de los Artistas mine and the Santa Cecilia mine, among others. A smaller vein is encountered in the Fuerza mine. The gangue in these veins consists mainly of barite and siderite, with subordinate calcite and quartz. Silver occurs mainly in sulfosalts. The veins have been affected by extensive faulting.

A second group of veins, seen mainly in the Coto San Ignacio mine, carries milky quartz gangue without siderite or barite. In the veins of a third group silver occurs mainly as the native metal and in argentiferous galena, with only a sparse scattering of sulfosalts. Nearly all of the historically most productive mines are located on veins of the first group.

Figure 2. **Location map.**

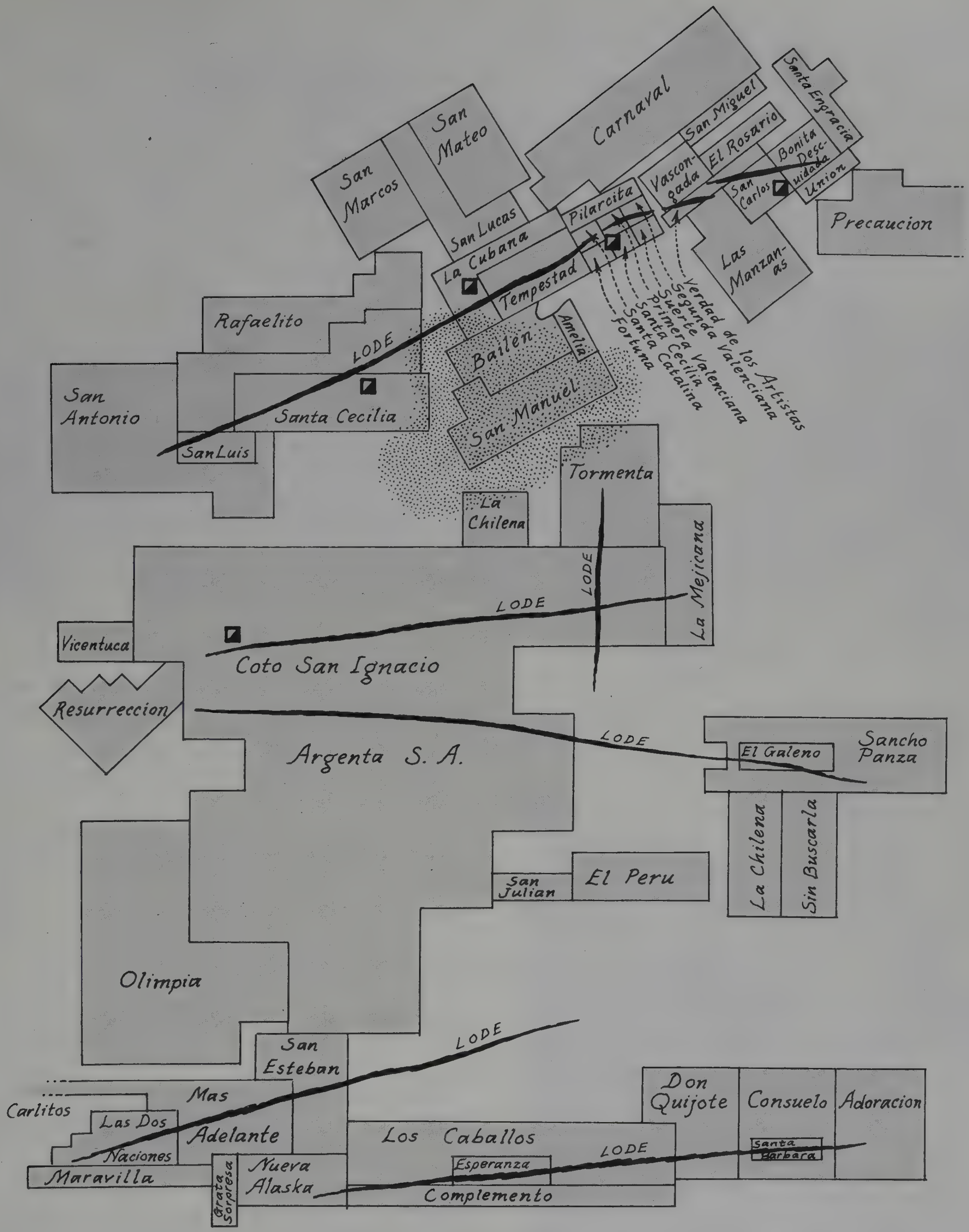


Figure 3. **Simplified mining claim map of the Hiendelaencina district in the 1850's, indicating the location of the principal veins and shafts. Many other unproductive or unworked claims are situated in the northeastern part of the district. The "Coto San Ignacio" also includes many individual claims, and some claim names were changed with time. Stipled area is the Hiendelaencina townsite.**

Figure 4. **Remains of buildings at the San Carlos mine in 1989.**

Figure 5. **A view (1989) of the Santa Catalina mine, the earliest mine in the district and the last to close.**

MINERALOGY

The economically most important silver minerals at Hiendelaencina are all sulfosalts. Conspicuously absent are nickel and cobalt minerals typical of many other silver sulfosalt occurrences.

Only those species of some collector interest are described below; all species known from the district are listed on Table 1.

Acanthite Ag_2S

Acanthite is relatively abundant in the district, mainly at the Santa Cecilia mine (Calderón, 1910). It occurs as small masses and arborescent growths on barite and siderite, and as intergrowths in galena.

Argyrodite Ag_8GeS_6

Argyrodite occurs sparingly as small pseudo-octahedral crystals and as botryoidal concretions (Bareche, 1984).

Arsenic As

Native arsenic occurs as small masses and intergrowths with stibarsen, in some cases associated with barite (Naranjo, 1862).

Arsenopyrite FeAsS

Small amounts of massive arsenopyrite occur throughout the district, but not in fine specimens or mineable quantities. Some crude crystals have been found in altered gneiss between the La Constante smelter and the town of Villares.

Barite $BaSO_4$

Barite, in association with lesser quantities of quartz and siderite, is the principal gangue mineral in the district. Groups of parallel, tabular, colorless crystals to 7 x 13 cm have been found. The main crystal forms are {110}, {010} and {011}. Less commonly, thick honey-yellow crystals to 2 cm have also been found. Barite crystals, in some cases covered by a quartz druse, are the typical associates of freieslebenite crystals. Some barite crystals carry minute inclusions of silver sulfosalts.

Table 1. **Minerals reported from the Hiendelaencina district, compiled from Calderón (1910), Royo and García (1924), Mallada (1927), Bareche (1984) and personal observations of the authors.**

Acanthite
Altaite
Alunite
Ankerite
Argyrodite
Arsenic
Arsenopyrite
Azurite
Barite
Bindheimite
Biotite
Bournonite
Bromargyrite
Calcite
Chalcopyrite
Chlorargyrite
Copper
Cordierite
Diaphorite
Dolomite
Dyscrasite
Fluorite
Freibergite
Freieslebenite
Galena
Goethite
Gold
Gypsum
Hematite
Iodargyrite
Jarosite
Malachite
Marcasite
Melanterite
Miargyrite
Microcline
Muscovite
Orthoclase
Polybasite
Proustite
Pyrargyrite
Pyrite
Pyrolusite
Pyrrhotite
Quartz
Siderite
Silver
Sphalerite
Stephanite
Sternbergite
Stibarsen
Stibnite
Tetrahedrite
Tourmaline

Bournonite $PbCuSbS_3$

Bournonite occurs as small masses and occasional fine crystals, mainly in the Verdad de los Artistas mine, associated with galena, siderite, pyrite and in some cases chlorargyrite. The best of these specimens are in the British Museum (Natural History) in London and the Museo de Ciencias Naturales in Madrid (Calderón, 1905).

Bromargyrite $AgBr$

Known to the miners as *plata verde* ("green silver"), bromargyrite occurs in the district mainly at the Verdad de los Artistas mine. It forms small masses of greenish yellow color. Lesser amounts have been identified from the Santa Cecilia and La Suerte mines; at the latter minute crystals have been found.

Chlorargyrite $AgCl$

Known to the miners as *plata córnea* ("horn silver"), chlorargyrite is relatively common in the Hiendelaencina mines, principally at the Verdad de los Artistas mine where it occurs as large, compact masses and botryoidal crusts (Mallada, 1927). Chlorargyrite has a characteristically waxy consistency and gray color. It has also been found at the Vapor, Fortuna and Santa Cecilia mines, and (with iron oxides) at the Villares mine about 3 km east of Hiendelaencina.

The mixture of chlorargyrite and halite once known as *huantajaite* has been reported in association with silver halides (Galan and Mirete, 1979; Bareche, 1984).

Copper Cu

Native copper is very rare in the Hiendelaencina district, but patches and crude crystals have occasionally been found associated with barite and native silver (Fernandez, 1900).

Diaphorite $Pb_2Ag_3Sb_3S_8$

Diaphorite from Hiendelaencina has been identified on two specimens in the Canadian Museum of Nature, Ottawa (G. Robinson, personal communication, 1990). It occurs as striated, metallic black crystals to 8 mm, associated with siderite, barite, pyrargyrite, tetrahedrite and myargyrite.

Dyscrasite Ag_3Sb

Dyscrasite has been found only occasionally, as fine crystals associated with barite and chalcedony in the Santa Cecilia and San Carlos mines. A fine specimen is preserved in the Museo Don Felipe de Borbon (School of Mines, Madrid).

Fluorite CaF_2

Fluorite is a major constituent of the gangue only at the Tirolesa mine, and in a vein near the Bodera River in Robledo. The latter occurrence has produced large, colorless to violet cubic crystals.

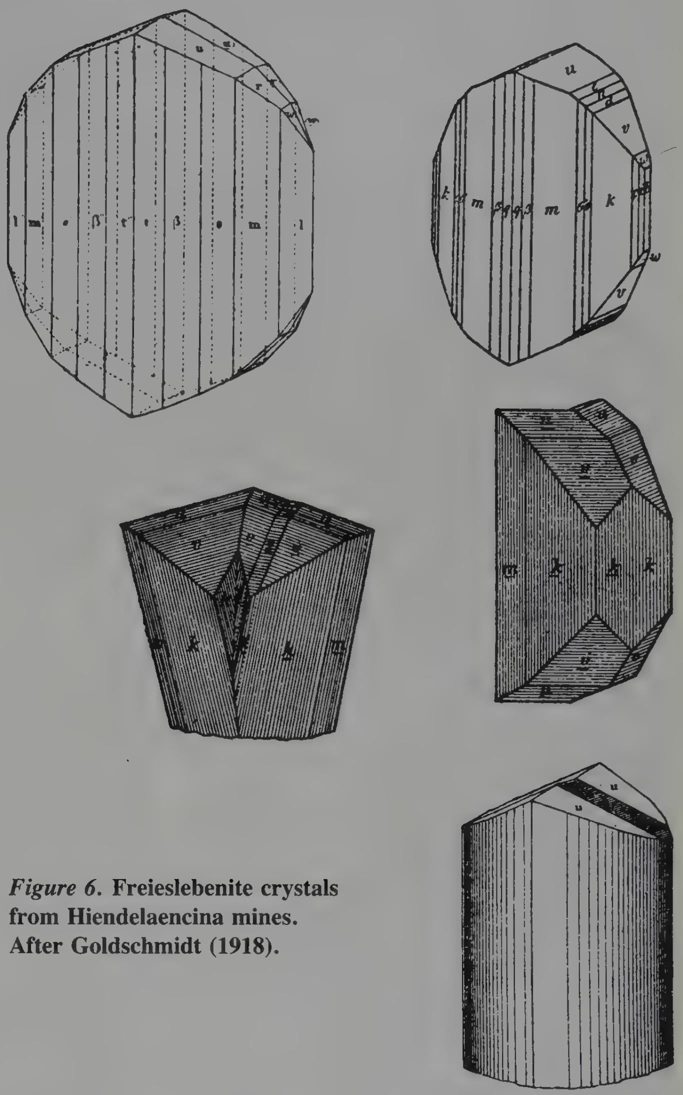


Figure 6. **Freieslebenite crystals from Hiendelaencina mines. After Goldschmidt (1918).**

Freieslebenite $AgPbSbS_3$

Freieslebenite as a species was not well characterized until the Hiendelaencina specimens were discovered. In fact, the mineral from the original type locality may actually be diaphorite, a closely related mineral difficult to distinguish without detailed crystallographic studies (Palache *et al.*, 1944). The Spanish miners called it *plata agria* ("brittle silver") or *plata estriada* ("striated silver"). Specimens were first found at the Verdad de los Artistas mine (Mallada, 1927), but freieslebenite was eventually recognized at most mines in the district, as massive material and somewhat crude crystals to 3 cm. In such crystals the dominant forms are {011}, {021} and {110}. Twins on (100) have also been found.

The best specimens in the district (and in the world) came from the Verdad de los Artistas and Santa Cecilia mines. The finest specimen of all was found in the Santa Cecilia mine, and is now in the Museo Don Felipe de Borbon (School of Mines, Madrid). It is a 25-cm matrix piece covered with many crystals up to 2 cm. A larger, detached crystal is also preserved there.

Freieslebenite occurs massive in the gneiss, but more commonly

Figure 7. Freieslebenite crystals to 2 cm from Hiendelaencina. Collection of the Mining Academy in Madrid; photo by Rainer Bode.

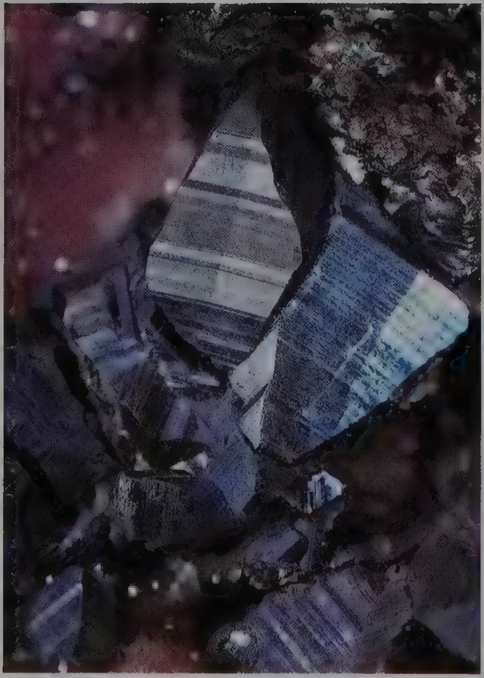
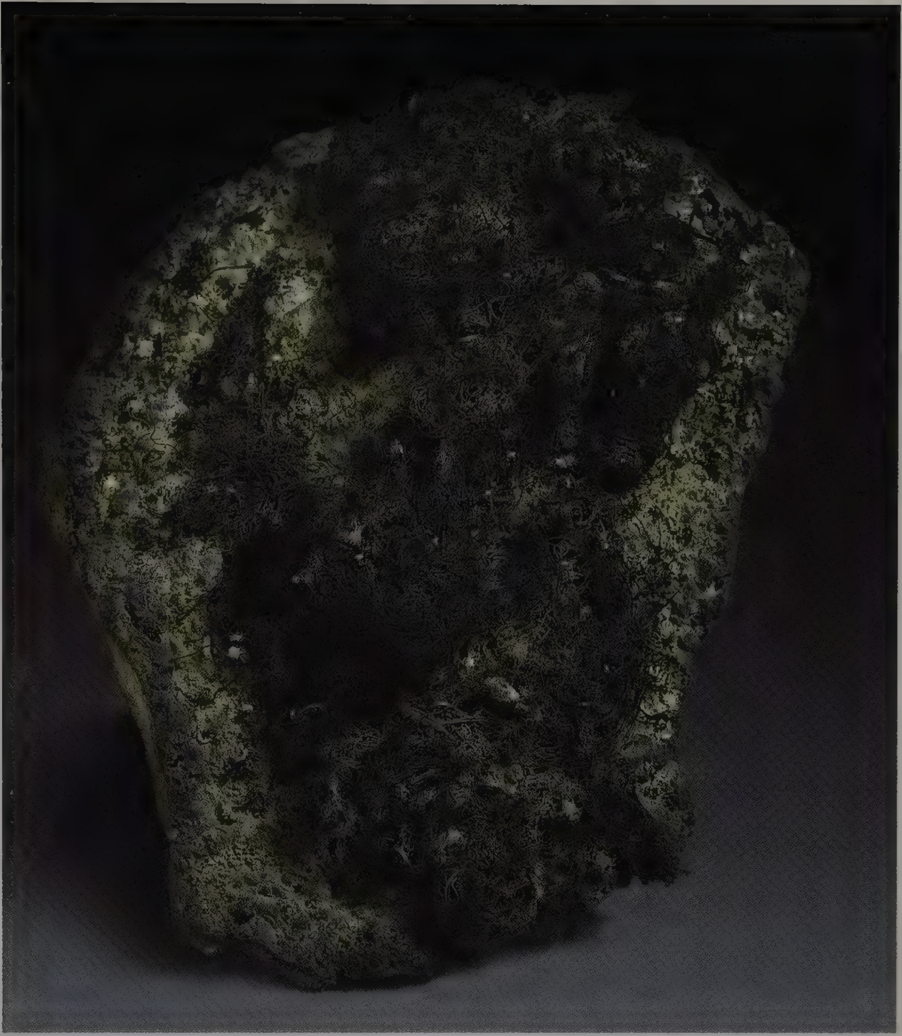


Figure 8. Freieslebenite crystals to 5 mm from Hiendelaencina. Collection of the Mining Academy in Madrid; photo by Rainer Bode.

Figure 9. Freieslebenite crystal group on quartz, 10 cm across, with crystals up to 1.5 cm, from Hiendelaencina. Museo Geominero specimen #4880. Photo by J. Gonzalez.

Figure 10. Native silver wires on galena, 9 cm across, from Hiendelaencina. Museo Geominero specimen #4709. Photo by J. Gonzalez.



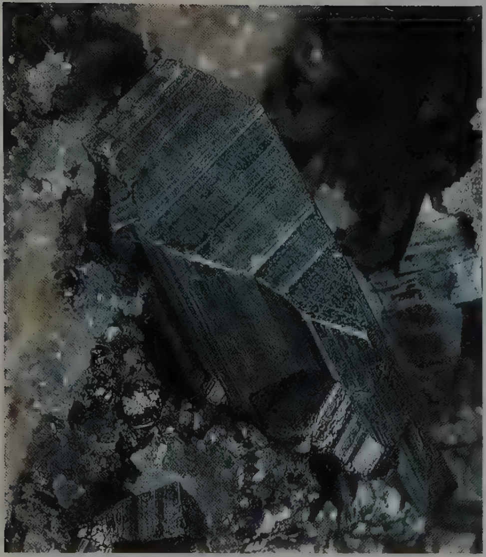


Figure 11. Freieslebenite crystal, 1.5 cm, from Hiendelaencina. Canadian Museum of Nature specimen #56537 (Pinch collection); photo by George Robinson.

Figure 12. (left) Pyrargyrite crystals to 2 cm, from Hiendelaencina. Museo Geominero specimen #4343. *(right)* Pyrargyrite crystal group, 5 cm across, from Hiendelaencina. Museo Geominero specimen #5600. Photo by J. Gonzalez.

in the veins with barite and siderite. Associated minerals include mainly pyrargyrite, and also a little dolomite (which is of sparse occurrence in the district). Freieslebenite is also reported to have been found in the Santa Maria pit just before it was closed at the beginning of this century (Galan and Mirete, 1979).

Galena PbS
Argentiferous galena (called *polvorilla* by the local miners) is the principal ore mineral in the mines at La Bodera, near Hiendelaencina. however, at Hiendelaencina it is generally only an accessory mineral, found as veins in siderite and as minute octahedral crystals in fissures.

Goethite $Fe^{+3}O(OH)$
Veinlets of iron oxides, mainly goethite and hematite, served as indicators for ascertaining the presence of offset portions of the silver-bearing veins (Mallada, 1927). Some crystals of hematite have reportedly been recovered (Fernandez, 1900).

Gold Au
Gold occurs very sparsely in the gneiss surrounding the silver veins. In nearby Navas de Jadraque some gold mines were worked during the 1800's.

Iodargyrite AgI
Iodargyrite occurs very sparsely at Hiendelaencina as small, yellow crusts. Only a few specimens are known; the best are in the Instituto Geominero de España in Madrid.

Miargyrite $AgSbS_2$
Miargyrite was found in the Suerte mine, mainly as masses in barite but also as small crystals striated on {100}. The forms {210}, {110}, {101}, {012} and {212} have also been observed (Bareche, 1984).

Polybasite $(Ag,Cu)_{16}Sb_2S_{11}$
Massive veins of polybasite have been noted, in association with other silver sulfosalts.

Proustite Ag_3AsS_3
Proustite is relatively abundant in the district, mainly as massive material but also as small, rounded, prismatic crystals of predominantly rhombohedral habit in fissures.

Pyrargyrite Ag_3SbS_3
Pyrargyrite is quantitatively the most important ore mineral in the district. It occurs as fine, large crystals to 5 cm, dark and opaque, at the San Carlos mine, and as fine, smaller specimens at the Verdad de los Artistas mine and the Santa Cecilia mine. The crystals at Santa Cecilia are of two principal habits. One is a combination of $\{10\bar{1}0\}$, $\{10\bar{1}1\}$, $\{01\bar{1}2\}$ and {0001} (rare for pyrargyrite), and the other, more unusual habit is a combination of the prism $\{11\bar{2}0\}$ and the rhombohedrons $\{01\bar{1}2\}$ and $\{21\bar{3}4\}$, unequally developed.

Pyrrhotite $Fe_{1-x}S$
Pyrrhotite has been reported by Royo and Garcia (1924) in the waste rock from the Santa Teresa mine, as squamous masses with quartz and barite.

Quartz SiO_2
Quartz, in crystals up to 2 cm, is widespread throughout the district. It occurs in barite-siderite veins, and also more commonly as massive vein fillings and as chalcedony.

Siderite $Fe^{+2}CO_3$
Siderite is one of the most prominent gangue minerals, mainly in the Filón Rico and associated veins. It occurs as large masses of lenticular crystals and also as free-growing rhombohedral crystals to 2 cm in fissures. The color ranges from yellow (unweathered) to brown-black (weathered).

Figure 13. **Silver wire 5 mm thick, from Hiendelaencina. M. Calvo collection and photo.**

Silver Ag
Native silver was generally found as filaments and wires to 1 cm (Galan and Mirete, 1979), mainly in veins of the third group (as at the San Juan mine). Silver has also been found at the Verdad de los Artistas mine, with chlorargyrite, and as thin sheets at the La Suerte mine.

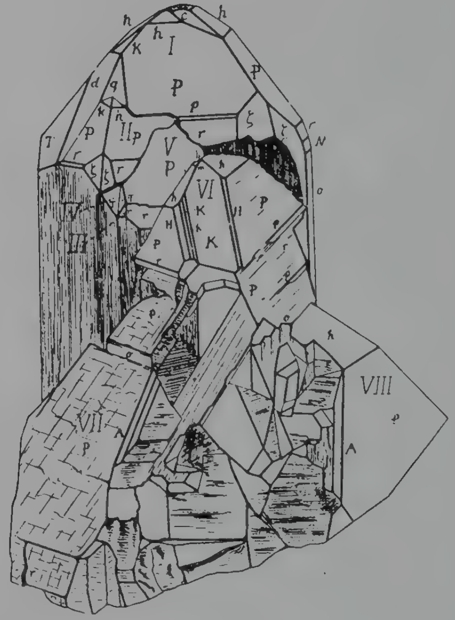


Figure 14. **Stephanite crystals from Hiendelaencina. J. Folch collection, Barcelona (Soriano, 1931).**

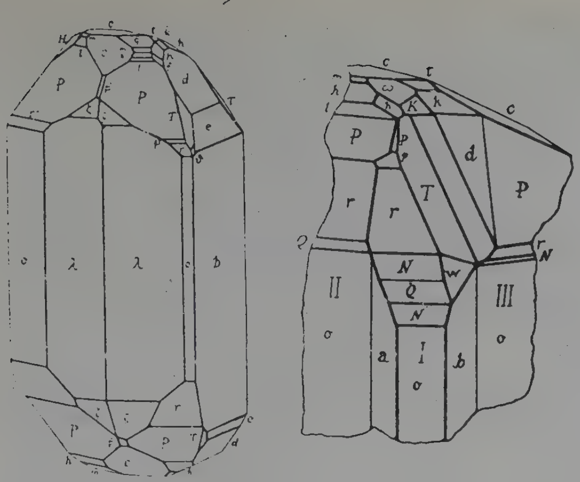


Figure 15. **Idealized stephanite crystals from Hiendelaencina. Note the hemimorphic appearance of the first crystal. From Soriano (1931).**

Stephanite Ag_5SbS_4

Stephanite, like freieslebenite, was grouped by the miners under the term *plata agria*. It is sometimes found as large crystals, up to 5 cm, with dominant {110}, {102} and {011}. The most complete crystals show a hemimorphic appearance (Soriano, 1931). It has also been found as tabular, pseudohexagonal twins on (110), mainly in the Verdad de los Artistas mine, where it is associated with pyrargyrite in a gangue of siderite, quartz or calcite.

Sternbergite $AgFe_2S_3$

A few specimens of sternbergite showing groups of very thin, tabular, pseudo-hexagonal plates have been reported, mainly from the Verdad de los Artistas mine (Bareche, 1984; Galan and Mirete, 1979).

Stibarsen $SbAs$

Small amounts of massive stibarsen mixed with native arsenic have been found, usually with barite (Naranjo, 1862).

Stibnite Sb_2S_3

Stibnite is not abundant in the district, but has been found as fibrous masses in some of the mines and at La Bodera.

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

Tetrahedrite has been found, usually as small crystals, associated with freieslebenite. The best specimens came from the Malanoche mine. Freibergite, the silver analog of tetrahedrite, has also been found in the district.

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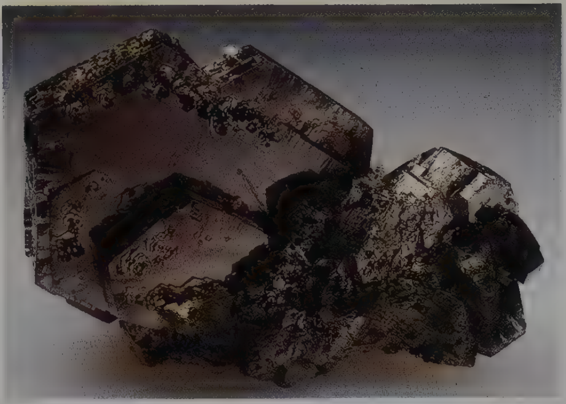

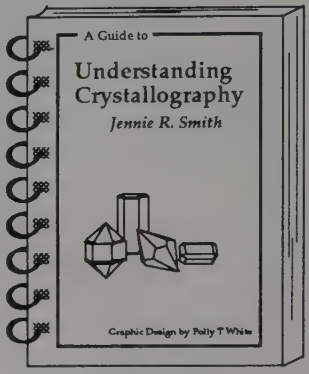
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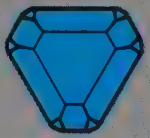

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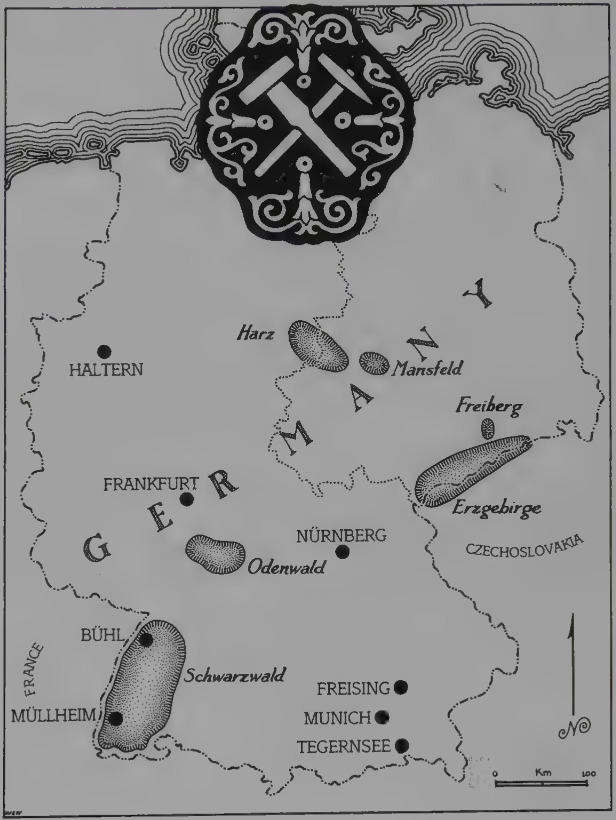

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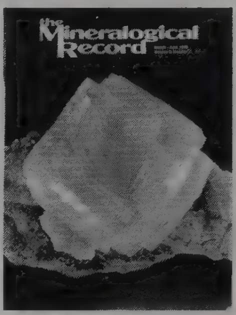

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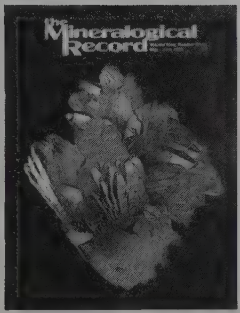

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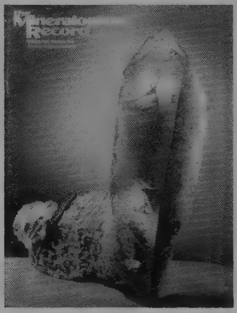
v.9/#6 Libethenite (Zambia), Quartz & Pyrite (WA), Hydroboracite (CA) **$5**



v.10/#1 Hydroxylherderite (Brazil), Books on U.S. minerals **$5**

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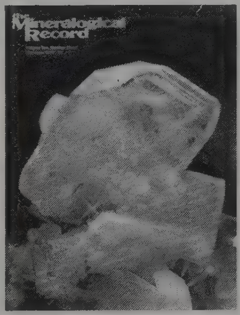

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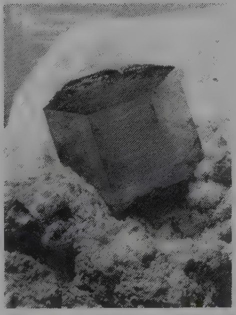

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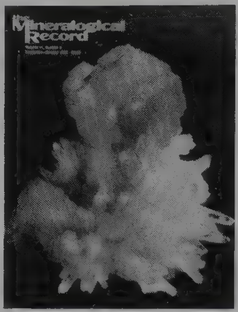

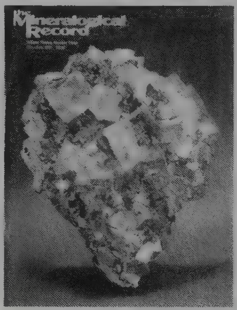

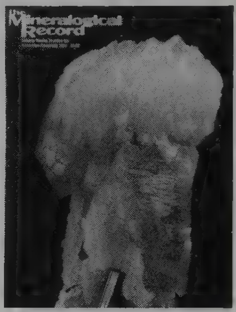

THE GEOSCIENCE COLLECTIONS OF THE FREIBERG MINING ACADEMY

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The Freiberg Mining Academy, founded in 1765, is among the oldest and most illustrious such institutions in the world. Its extraordinary mineral and rock collections have been growing for well over two centuries.

INTRODUCTION

In the year 1168 silver ore was discovered in the Freiberg area. The mining town of Freiberg developed rapidly, and served as the administrative, economic and scientific center of the Saxon Erzgebirge district for centuries.

In 1765 the Mining Academy was founded in Freiberg. This was the first specialized institution in the world for the academic study of mining, the geosciences and metallurgy. Its principle objective was to train specialists in these fields. The Mining Academy, during the course of its 226-year history, has been responsible for many leading contributions to the development of mineralogy and economic geology. Today, the Geosciences Department of the Mining Academy continues to be an important center in eastern Germany for teaching and research in these fields.

When the Mining Academy was founded, special geological, metallurgical and technical collections were also established to provide a sound practical basis for the education of students. The geoscience collections have been systematically improved and enlarged ever since. They contain material relevant to mineralogy, petrology, economic geology, paleontology, historical geology and the geology of fuels. These collections are comparable, in terms of both quality and quantity, to those in Leningrad, London, Paris and Washington.

The Freiberg collections are among the oldest great collections in the world, ranking in historical significance with the university collections of Padua, Lund, Uppsala and Madrid, and the natural history museum collections in Dresden, Moscow, Paris, Vienna and London.

ORIGIN AND DEVELOPMENT

The first samples were contributed by C. E. Gellert (1713–1795), the Saxon General Mining Commissioner Friedrich Anton von Heynitz (1725–1802), and the Head Mining Officer, Friedrich Wilhelm von Oppel (1720–1769). Heynitz and Oppel were the founders of the Academy. The samples were first displayed in Oppel's own house, which today is the Academy's main administrative building. Here were given practical demonstrations and explanations for both students

Figure 1. **General Mining Commissioner of Saxony Friedrich Anton von Heynitz (1725–1802).**

Figure 2. **View of the Mineralogical Collection exhibit hall in the A. G. Werner Building, Brennhausgasse 14, Freiberg. Photo by M. Knopfe.**

and visitors. J. F. W. von Charpentier (1738–1805), a very able and versatile teacher at the Mining Academy, expanded the collection to include representative minerals and ores from the entire Saxon Erzgebirge area. Charpentier was also the author of the first scientific Regional Mineralogy/Geology of Saxony and Thuringia, published in 1778.

Abraham Gottlob Werner (1749–1817) became an inspector and professor at the Academy in 1775. He is today regarded as the founder of the modern science of mineralogy. In 1778 he published advice for the establishment of geoscience collections, and recommended systematic organization based on the following:

(1) The external distinguishing features (such as shape, surface characteristics, luster, fracture, transparency and optical refraction, streak, color, hardness, flexibility, solubility, specific gravity, taste, odor) (Werner, 1774).
(2) The natural order (class, genus, tribe, species), and the four classes: (I) *Erdiche Fossilien* ("earthy minerals"), (II) *Salzische Fossilien* ("salty minerals"), (III) *Brennliche Fossilien* ("combustible minerals"), (IV) *Metallische Fossilien* ("metallic minerals").
(3) The system of his "theory of rock formation" (primary mountains, seam formation, accretioned formation) (Werner, 1786).
(4) The principles of geography (geographical collection).
(5) The principles of use (economic collection).

Werner assembled his own special collection for teaching and research purposes, which he subsequently sold to the Academy for 40,000 Talers in 1814. Werner subsequently bequeathed most of this money to the Academy, and it was later used to finance scholarships. Werner's natural history collections included:

(1) The Oryctognostic Collection (Systematic mineralogical collection) with 8043 samples,
(2) The Kennzeichen Collection (Outer distinguishing features collection) with 309 samples,
(3) The Precious Stone Collection with 1368 samples,
(4) The "Schaustufen" Collection (Big and beautiful samples collection) with 108 samples
(5) The Geognostic Collection (Rocks) with 1045 samples
(6) The Geographic Collection (Regional mineralogy, geology) in 24 boxes
(7) The Petrifact Collection in 22 boxes
(8) The Conchylia Collection (snails, shells) in 22 boxes
(9) The Zoophyta Collection (Herbarium etc.).

The first four of these collections were revised by the custodian L. G. F. Köhler (1795–1820). They have been preserved essentially unaltered, and are known today as the Werner Museum, one of the historical sections in the Academy Geoscience Collections. The other five of Werner's collections were later integrated into other collections of the Mining Academy.

After Werner's death the geosciences were divided into mineralogy and geology/economic geology. The collections of the Academy were similarly divided, and thereafter followed their own separate lines of development.

THE MINERALOGICAL COLLECTION

Friedrich Mohs (1773–1839) was the next curator of the mineralogical collection. Mohs was Professor of Mineralogy in Freiberg from 1818 until 1826, and was the inventor of the "Mohs hardness scale" for minerals. Mohs attempted to introduce Linneaus's system of binary nomenclature (with Latin genus and species names) into mineralogy, a system which was further developed by J. F. A. Breithaupt. Under Breithaupt (1791–1873) the collection was enlarged to about 20,000 specimens by purchases, donations and through his own collecting activities. Furthermore, Breithaupt discovered 46 new minerals, and was the first to use the term "Paragenesis" (Breithaupt, 1849).

Julius Albin Weisbach (1833–1901) enlarged the collection to around 30,000 specimens, and converted the Latin and German mineral names into the internationally recognized names. At the beginning of the 20th century, the mineralogical collection was regarded as one of the best researched and scientifically arranged collections in the world. Its prestige was further enhanced by Weisbach's discovery of the mineral *argyrodite*. After this, C. Winkler, Freiberg's Professor of Chemistry, discovered the new element *germanium* (the Eka-Silicium predicted theoretically by Mendeleev) in argyrodite.

Under F. Kolbeck (1869–1943) the collections moved to their present location in the Geological-Mineralogical Institute, Brennhausgasse 14, which was inaugurated in 1916. In 1929 H. von Philipsborn took over the directorship of the mineralogical collection. Unfortunately, at this time the inflow of new material from other countries decreased because of the consequences of Nazi fascism and the resultant world war.

After the reopening of the Mining Academy in 1946, F. Leutwein (1911–1974), Professor of Mineralogy, became also the head curator. He hired custodians for the mineralogical collection (A. Bernstein, 1952–1964; H. Thiergärtner, 1964–1965; M. Guntau 1965–1970; F. Hofmann since 1970). In the last decades a world-wide network for the exchange of samples was established. Today the mineralogical collection contains roughly 74,000 specimens. The original specimens and type specimens of Breithaupt, Weisbach and Kolbeck are among the most historically important.

Minerals of extraordinary quality from the Freiberg mining district form an important part of the collection. Excellent specimens acquired relatively recently include proustites from Niederschlema, crystallized native bismuth from Schlema and first-rate whewellite specimens from Burgk, Schlema, Ronneburg.

THE ORE DEPOSITS COLLECTION

C. A. Kühn (1783–1848) began the geological collection in 1818. The main part was derived from Kühn's private collection, which he donated to the Academy. The geologists C. F. Naumann (1797–1873), inventor of the Naumann crystallographic indices, and B. von Cotta (1808–1879) continued building the geological collection. Apart from the latter, which was largely used as an important resource for teaching, they also established and developed the so-called "Geographical Collection" as a specimen archive. By 1850 the geological collection consisted of three main parts: the Ore Collection, the Geographical Collection of Saxony and the Geographical Collection from foreign countries. After 1866, A. W. Stelzner (1840–1895) reorganized the collection into a single Ore Deposits Collection. Stelzner was regarded as one of the leading scientists of his time in the fields of petrography, geology and especially economic geology. Important people in the scientific development of Economic Geology at that time in foreign countries were alumni of the Freiberg Mining Academy and disciples of Stelzner (Waldemar Lindgren), of v. Cotta (S. F. Emmons), and of v. Cotta and Breithaupt (Raphael Pumpelly).

Stelzner's successor was R. Beck (1858–1919). Beck was a pioneer in the field of Economic Geology. Former students of Beck supported the collection by sending excellent material from all over the world. He himself brought back valuable suites of specimens from his travels in Europe, South Africa and Canada.

O. Stutzer (1881–1936), Professor of Economic Geology of nonmetallic materials, also brought rich material to the collection from his travels in Europe, the United States and Africa. Stutzer wrote a famous article dealing with the creation and organization of ore collections, which is still an important reference work (Stutzer, 1911).

After Beck, F. Schumacher (1884–1975) systematized the Ore Deposit Collection, which contained specimens from more than 1000 metallic ore deposits and about 100 deposits of nonmetallic ores in the 1920's. Under Schumacher, the Academy's Ore Deposits Collection became the most comprehensive and most scientifically respected ore collection in the world and, consequently, a unique teaching resource.

In the closing years of the second World War, the Academy's collections were seriously endangered. However, thanks to the efforts of the Soviet Army, which protected the Academy's buildings and collections, there was no loss of material.

During the 1950's the Ore Deposits Collection greatly expanded by incorporating the collections of former mining and research institutions such as the famous Freiberg Mining District Collection and collections from the Schneeberg, Annaberg and Marienberg mining districts. The Freiberg Mining District Collection contains a complete documentation of all the ore veins of the Freiberg district which were worked between the years 1820 and 1911. The efforts of C. H. Müller (1823–1907) were largely responsible for the completion of this collection. During recent decades, the Professors of Economic Geology, O. W. Oelsner (1907–1963) and L. Baumann made significant contributions to the Ore Deposits Collection.

Since 1966 there have been custodians specifically assigned to the Ore Deposits Collection (G. Weinhold, 1966–1974; Wolfgang Weber since 1974, and also K. Rank since 1986).

The Ore Deposits Collection consists now of around 70,000 specimens from approximately 2,600 mining sites and localities around the world.

THE PETROLOGY COLLECTION

Geological education at the Mining Academy was oriented toward Economic Geology from its very beginning. Consequently, petrological material has always been included within the Ore Deposits Collection. During the 1920's, the geologist M. R. Schreiter (1885–1948) began to establish a separate Petrology Collection, but only since 1958 has this collection begun to assume something of its present form. Today's collection includes some 11,000 specimens.

Other Geoscience Collections of the Freiberg Mining Academy include: The Paleontological Collection, with more than 150,000 inventoried macrofossils and microfossils; the Stratigraphic Collection, with about 15,000 specimens; and the Collection of Fuels (Coals and Petroleums) with about 6,000 specimens.

OBJECTIVES OF THE COLLECTIONS

The chief purpose of the Geoscience Collections of the Mining Academy is to provide essential support for teaching and research at the Academy. Since their establishment they have come to be regarded as a unique teaching resource. In this sense they form the specimen equivalent of a series of textbooks for the guidance of those studying the geosciences. In other words, they are an illustration of the subjects dealt with by lectures given at the Academy. At the same time, because of the present extent and range of the collections, they have also assumed other functions in addition to their primary pedagogic purpose.

Figure 3. **Wolframite, 7 cm, from Zinnwald in the Erzgebirge; August Breithaupt specimen, ca. 1832. Mineralogical Collection.**

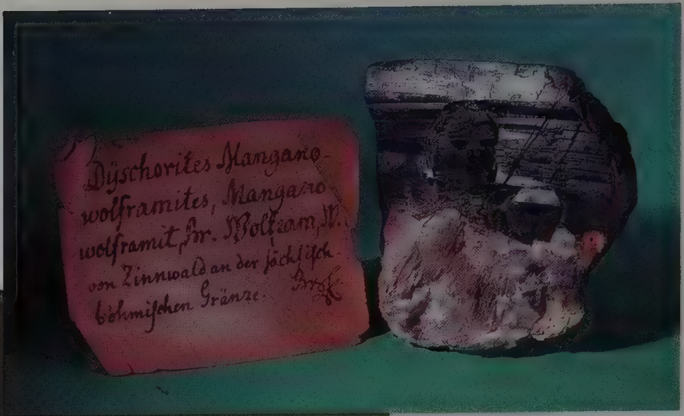

Figure 4. **Native bismuth with dolomite, 12 cm, from Schlema in the Erzgebirge. Mineralogical Collection.**

Photos by M. Knopfe.

Figure 5. **Whewellite with chalcopyrite, 7 cm, from Schlema, Erzgebirge. Mineralogical Collection.**

Figure 6. **Barite, 12 cm, from the Pöhla mine, Erzgebirge. Mineralogical Collection.**

Figure 7. **Native silver on calcite, 12 cm, from Freiberg.**

Figure 8. **Celestite, 10 cm, from the Güte Gottes und König David mine, Scharfenberg near Meissen, Saxony; Oryctognostic Collection of Werner.**

Figure 9. **Erythrite (crystal size 3 cm) on quartz, from Schneeberg.**

A further function of the collections is the storage and provision of material for scientific research. This function has increased in importance as the extent of the collections has grown. Furthermore, research is facilitated by ready access to specimens for both students and researchers. Every effort is made to keep the collections relevant and up-to-date by a constant influx of new specimens from all over the world.

Another function of the collections is the documentation of important historical mining sites and localities (many of course now closed or abandoned). This is based on their unique assemblage of material, built up during more than 225 years of involvement with mines and mining. Such documentary evidence is an invaluable historical and scientific legacy. The collection specimens are also available for study to other scientific institutions, both in Germany and in other countries. Although the education of the general public is not a major activity, the interested visitor is welcome to study the materials on display in the exhibition rooms. Both our permanent and temporary exhibitions are frequently visited by interested members of the public, amateur mineralogists, mineral collectors, and school classes.

SPECIMEN ACQUISITION

An important measure of the scale and value of a collection such as that at Freiberg is not only the volume and quality of the samples, but also the extent to which they are continuously updated, and the principles used for ordering and arranging them. Thus not only material of proven historical significance should be available but also, for example, material derived from new outcrops and mines. Only in this way is it possible to support teaching, and to promote research that remains rigorous, valid and practical. This emphasis on scientific and educational aims distinguishes our collections from those of the more traditional museums. The Academy's collaborators and students collect new material during field trips, expeditions and other research work. New material is also obtained by means of donations, exchanges and special purchases. Until recently, donations were the main source of new specimens. Both German and foreign students regarded it as a great honor (as well as a duty) to donate exceptional specimens from their working sites. These donors found reward enough in having their names inscribed in the catalogs. Nowadays, however, the exchange of specimens has become more important. By means of exchange, necessary specimens can be obtained without relying upon the more haphazard nature of donation. The Academy has special voluminous collections and search lists for exchange. The purchase of single items and even whole collections is made possible by funds supplied to the Mining Academy. In this way several excellent private collections have been purchased in recent years.

EXHIBITS

Only a small portion of the entire collection is exhibited in display cases.

Mineral Collection

The three mineral exhibits have different themes. The "Systematic Mineralogy" display is arranged chemically as follows:

Elements
Sulfides
Oxides
Halides
Quartz and Silicates
Borates and Nitrates
Phosphates, Arsenates, Vanadates
Sulfates, Tungstates, Molybdates, Chromates
Carbonates

This exhibit also includes meteorites and tektites, and a representative collection of larger specimens.

The "Minerals from eastern Germany" exhibit is arranged according to source areas, and contains samples from:

Eastern Erzgebirge
Middle Erzgebirge
Freiberg mining district
Western Erzgebirge
Vogtland
Thuringia
Harz Mountains
Other areas

Other exhibits include "Crystallography" and "Precious Stones."

The mineralogical collection is undoubtedly the chief attraction for the visitor, because the bright colors, shapes and rarity of the specimens are most attractive and interesting.

Ore Deposits Collection

There are three economic geology exhibitions. "Ore Generating Processes" complements the lecture program on "General Economic Geology." It consists of:

Characteristics of Ore Deposits
Genesis of Ore Deposits
Metallogeny

The "Types of Ore Deposits" exhibit is arranged according to the lecture program on "Special Economic Geology." The exhibit illustrates the following themes:

Metallic Raw Materials
Metallurgical and Thermal Insulation Raw Materials
Chemical and Agricultural Raw Materials
Technical Materials and Precious Stones

The exhibition on "Ore Deposits of Eastern Germany" serves to illustrate the lecture series on "Regional Economic Geology," and presents material from the following geotectonic-lithogenetic epochs and regional provinces:

Pre-Hercynian Mineralization and Ore Deposits
Hercynian Mineralization and Ore Deposits
Post-Hercynian Mineralization and Ore Deposits
Deposits of Economically Valuable Rocks

Petrology Collection

The petrological exhibits are arranged according to the three-fold Classification of Rocks:

- Igneous
  - intrusive rocks
  - extrusive rocks
- Sedimentary
  - clastic rocks
  - chemical and biogenic rocks
  - coals
- Metamorphic
  - contact-metamorphic rocks
  - regional-metamorphic rocks

There are also exhibits devoted to the "Historic Werner Museum," the "Historic Freiberg Mining District Collection," "Paleontology," "Earth's History," and "Geology of Coals and Hydrocarbons."

The conglomeration of Geoscience Collections at the Freiberg Mining Academy is, in view of its scientific profile, quantity and quality, unique in the German-speaking countries, and it ranks high on the list of geoscience museums world-wide.

The curatorial staff is happy to welcome visitors to the museum, and to entertain offers for the exchange of specimens.

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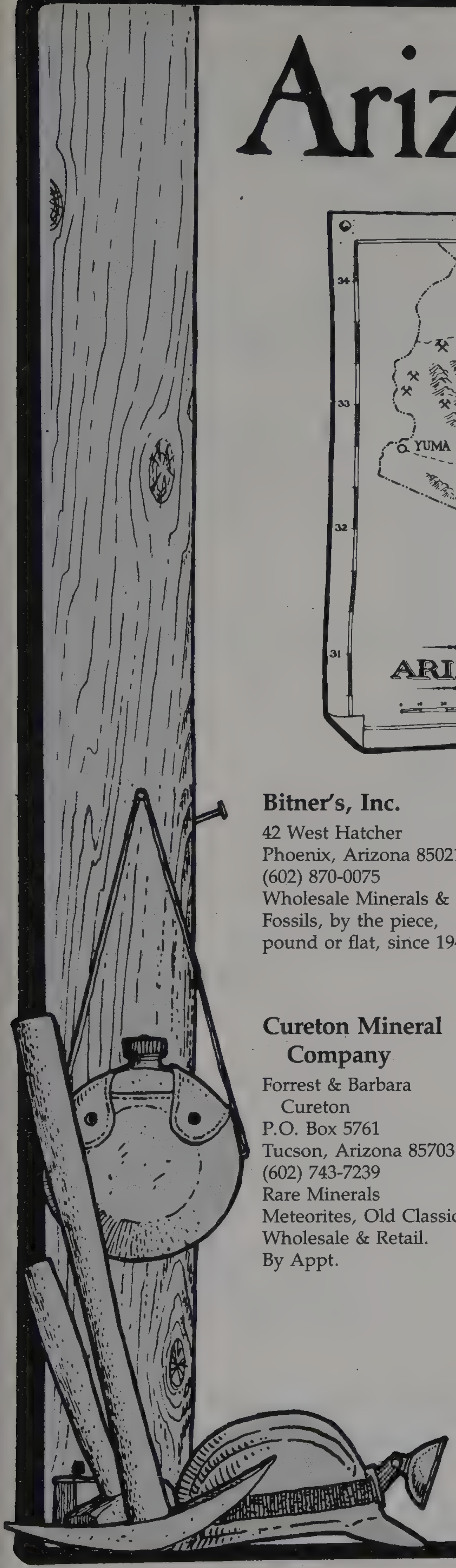

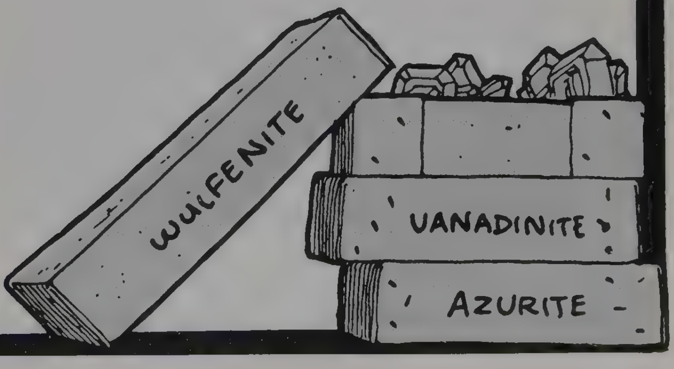

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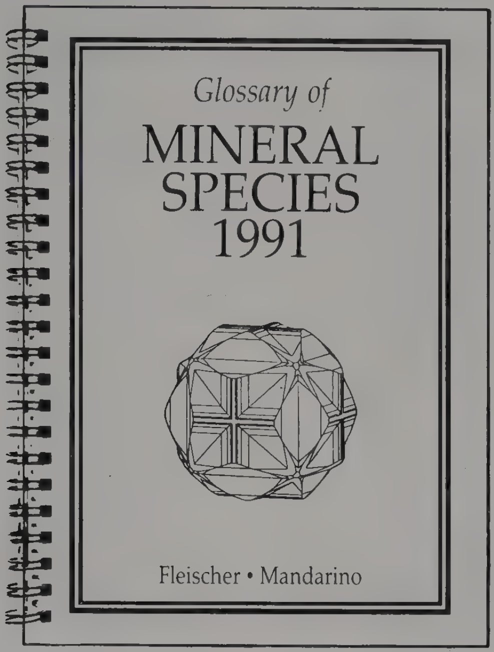

Glossary of
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1991

Fleischer • Mandarino

by **Michael Fleischer** and **J. A. Mandarino**

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In the fifteen months since the Sixth Edition went to press, nearly 50 new mineral names have been published and new data have appeared for many minerals. This list covers the literature from Aug. 15, 1990 to Nov. 15, 1991. The page numbers listed are those of the Sixth Edition.

We are deeply indebted to many persons for helpful data and suggestions, and especially to John S. White, Bowie, Md.; Pete Dunn and Brian Mason, Smithsonian Institution; John L. Jambor, Ottawa; and G. W. Shokal, San Carlos, Calif.

Page

1 (to follow **Abhurite**), **Abswurmbachite**, $Cu^{+2}Mn_6^{+3}(SiO_4)O_8$, tet., dark brown, compare **braunite**, **neltnerite**, Neues Jahrb. Mineral., Monatsh. 1991, p. 117-143 (Eng.)

2 **Aerugite**, $Ni_{17}As_6O_{32}$, trig., green, **50**, 2108 (1965), Min. Abs. **42**, no. 1, p. 23 (1991)

3 **Akaganeite**, beta-$Fe^{+3}(O,OH,Cl)$, mon., ps. tet., compare **Feroxyhyte**, **Goethite**, and **Lepidocrocite**, **48**, 711 (1963), **56**, 659 (1971), **76**, 272–277 (1991)

4 **Alluaivite**, add **76**, 1728 (1991)

5 **Aluminium**, Al, cub., **65**, 205 (1980)

5 Aluminum, see **Aluminium**

6 **Alvanite**, change the formula to $(Zn,Ni)Al_4(VO_3)_2(OH)_{12}\cdot 2H_2O$, add Min. Mag. **54**, 609–611 (1990)

7 Andrewsite, a mixt. of **hentschelite**, **rockbridgeite**, and **chalcosiderite**, **75**, 1197–1199 (1990)

7 (to follow **Anilite**), **Ankangite**, $Ba(Ti,V^{+3},Cr^{+3})_8O_{16}$, tet., black, *Cryptomelane* group

8 **Anorthite**, $Ca_2Al_2Si_2O_8$, tric., trimorph. with **Dmisteinbergite** and **Svyatoslavite**, see **Plagioclase**, *Feldspar* group

8 (to follow **Antlerite**), **Anyuiite**, $Au(Pb,Sb)_2$, tet., lead- to silver-gray, **76**, 299 (1991)

9 **Aravaipaite**, change 1988 to 1989

10 **Argentotennantite**, change the formula to $(Ag,Cu)_{10}(Zn,Fe)_2(As,Sb)_4S_{13}$

11 **Arseniosiderite**, in the formula, change Ca to Ca_2

12 (to follow **Ashanite**), **Ashburtonite**, $Pb_4Cu_4^{+2}Si_4HO_{12}(HCO_3)_4(OH)_9Cl$, tet., blue, **76**, 1701–1707 (1991)
12 **Ashcroftine-(Y)**, in the formula, change $3H_2O$ to $8H_2O$
12 **Astrocyanite-(Ce)**, add **76**, 665 (1991)
13 **Attakolite**, change the formula to $(Ca,Sr)Mn^{+2}(Al,Fe^{+3})_4[(Si,P)O_4]H(PO_4)_3(OH)_4$, change orth. to mon., **51**, 534 (1966)
15 **Balangeroite**, change "compare **Gageite-2M**" to "compare **Gageite-1Tc, Gageite-2M**"
15 **Balkanite**, add "compare **Danielsite**"
16 **Bannisterite**, change ref. to **66**, 1063–1067 (1981)
16 Barium pharmacosiderite should not be in bold face
17 (to follow **Barroisite**), **Barstowite**, $3PbCl_2 \cdot PbCO_3 \cdot H_2O$, mon., Min. Mag. **55**, 121–125 (1991)
18 (to follow **Bearsite**), **Bearthite**, $Ca_2Al(PO_4)_2(OH)$, mon., *Brackebuschite* group
18 **Beaverite**, change the formula to $PbCu^{+2}(Fe^{+3},Al)_2(SO_4)_2(OH)_6$
18 (to follow **Beidellite**), **Belkovite**, $Ba_3(Nb,Ti)_6(Si_2O_7)_2O_{12}$, hex., brown, **76**, 1723 (1991)
19 **Bellingerite**, change the formula to $Cu_3^{+2}(IO_3)_6 \cdot 2H_2O$
19 Belorussite-(Ce), see **Byelorussite-(Ce)**
19 **Berborite**, after trig., add "polytypes **-1T**, **-2T**, and **3H**, Min. Abs. **42**, no. 2, p. 153 (1991); **76**, 1734 (1991)
19 **Bergslagite**, add **74**, 901 (1989)
20 **Bernardite**, replace Min. Mag. **53**, 531–538 (1989) by **75**, 1209 (1990)
21 **Bezsmertnovite**, change the reference to **66**, 878 (1981)
22 **Bismoclite**, change the reference to (1935)
23 (to follow **Boggsite**), **Bøgvadite**, $Na_2SrBa_2Al_4F_2O$, orth., **76**, 1728–1729 (1991)
24 **Bornite**, change cub. to orth., ps. cub., add **63**, 1–16 (1978)
25 **Bracewellite**, after compare, add **Akaganeite**
26 **Braunite**, change to "compare **Abswurmbachite** and **Neltnerite**"
27 **Brownmillerite**, **Srebrodolskite** is misspelled
28 **Burpalite**, add Eur. Jour. Min. **2**, 413–418 (1990)
28 **Butlerite**, formula should be $Fe^{+3}(SO_4)(OH) \cdot 2H_2O$
28 **Byelorussite-(Ce)**, add **76**, 665–666 (1991)
29 **Calcio-ancylite-(Nd)**, add **76**, 1729 (1991)
29 **Calcioferrite**, change (1964) to (1969)
30 (to follow **Cameronite**), **Camgasite**, $CaMg(AsO_4)(OH) \cdot 5H_2O$, mon.
34 **Cerite-(Ce)**, $Ce_9^{+3}Fe^{+3}(SiO_4)_6[(SiO_3)(OH)](OH)_3$, trig., isostructural with the phosphates **Whitlockite** and **Strontiowhitlockite**, **43**, 460–475 (1958)
35 **Cetineite**, change $(K,Na)_{3-x}$ to $(K,Na)_{3+x}$, change (1983) to (1988)
35 (to follow **Chalcophanite**), **Chalcophyllite**, $Cu_{18}^{+2}Al_2(AsO_4)_3(SO_4)_3(OH)_{27} \cdot 3H_2O$, trig., green
36 **Chayesite**, change (1988) to (1989)
37 (to follow **Cheralite**), **Cheremnykhite**, $Pb_3Zn_3Te^{+4}O_6(VO_4)_2$, orth.
37 (to follow Chile saltpeter), **Chiluite**, $Bi_6Te_2^{+6}Mo_2^{+6}O_{21}$, hex., yellow, **76**, 666 (1991)
40 **Clinobehoite**, add **76**, 666–667 (1991)
41 (to follow **Clinokurchatovite**), **Clinomimetite**, $Pb_5(AsO_4)_3Cl$, mon., dimorph. with **Mimetite**, *Apatite* group, Can. Min. **29**, 369–376 (1991)
41 **Cobaltite**, change "orth., ps. cub." to cub., add Can. Min. **28**, 719–723 (1990), change **Cobaltite** group to *Cobaltite* group
43 **Cookeite**, add compare **Lunijianlaite**
43 (to follow **Cookeite**), **Coombsite**, $K(Mn^{+2},Fe^{+2},Mg)_{13}(Si,Al)_{18}O_{42}(OH)_{14}$, trig., brown, compare **Zussmanite**
45 **Criddleite**, after mon., insert ps. tet.
45 Csiklovaite, a mixt. of **tetradymite**, **galenobismutite**, and **bismuthinite**, **76**, 257–265 (1991)
48 (to follow **Dalyite**), **Damaraite**, $3PbO \cdot PbCl_2$, orth., Min. Mag. **55**, 593–602 (1991)
48 **Danielsite**, add "compare **Balkanite**"
50 **Dewindtite**, add **76**, 1734 (1991)
51 (to follow **Dimorphite**), Dinite, $C_{20}H_{36}$, orth.
51 **Dmisteinbergite**, $CaAl_2Si_2O_8$, hex., trimorph. with **Anorthite** and **Svyatoslavite**, *Feldspar* group
53 **Durangite**, add "forms a series with **Maxwellite**"
54 **Edgarbaileyite**, add **75**, 1192–1196 (1990)
54 **Efremovite**, add **76**, 299–300 (1991)
57 **Euchlorin**, $KNaCu_3^{+2}(SO_4)_3O$, mon., emerald-green, Min. Abs. **42**, p. 22 (1991)
59 Falkmanite should not be in bold face
61 Fernandinite should not be in bold face
61 **Feroxyhyte**, delta-$Fe^{+3}O(OH)$, hex., trimorph. with **Goethite** and **Lepidocrocite**, compare **Akaganeite**, **62**, 1057 (1977)
61 **Ferrikatophorite**, after **Aluminokatophorite**, insert "compare **Magnesio-aluminokatophorite**"
66 **Florensovite**, add **75**, 1209–1210 (1990)
71 **Gartrellite**, $Pb(Cu^{+2},Fe^{+2})_2(AsO_4,SO_4)_2(CO_3,H_2O)_{0.7}$, tric., bright yellow to greenish-yellow, **75**, 932 (1990)
72 (to follow **Geikielite**), **Geminite**, $Cu_2^{+2}As_2^{+5}O_7 \cdot 3H_2O$, tric., bright green to sea-green
73 **Gersdorffite**, add "compare **Jolliffeite**"
73 **Geversite**, change the formula to $Pt(Sb,Bi)_2$
73 **Giessenite**, change orth. to mon., add **72**, 229 (1987)
73 (to follow **Gillespite**), **Gillulyite**, $Tl_2(As,Sb)_8S_{13}$, mon., deep red, **76**, 653–655 (1991)
74 (to follow **Girdite**), **Girvasite**, $NaCa_2Mg_3(PO_4)_2[PO_2(OH)_2](CO_3)(OH)_2 \cdot 4H_2O$, mon., **76**, 669 (1991)
75 **Goethite**, alpha-$Fe^{+3}O(OH)$, orth., trimorph. with **Feroxyhyte** and Lepidocrocite, compare **Akaganeite**, **Bracewellite**, **Diaspore**
75 **Gordonite**, add "compare **Mangangordonite**"
76 **Götzenite**, change (1953) to (1958)
76 **Grandreefite**, change orth. to mon., add **76**, 278–282 (1991)
76 (to follow **Graphite**), **Gravegliaite**, $Mn^{+2}(SO_3) \cdot 3H_2O$ (a sulfite), orth., Zeit. Krist. **197**, 97–106 (1991) (Eng.)
76 (to follow **Grayite**), **Grechishchevite**, $Hg_3S_2(Br,Cl,I)_2$, tet., reddish orange, turning black on exposure, **76**, 1729–1730 (1991)
77 Grünlingite should not be in bold face
78 **Gyrolite**, add "compare **Orlymannite**"
81 (to follow **Haycockite**), **Haynesite**, $(UO_2)_3(SeO_3)_2(OH)_2 \cdot 5H_2O$, orth., amber yellow, Can. Min. **29**, 561–564 (1991)
83 change Heterogenite (= **Heterogenite-3R**) to **Heterogenite-3R**
83 **Heterogenite-2H**, change **Heterogenite** to **Heterogenite-3R**
85 **Holtite**, $Al_6(Al,Ta)(Si,Sb)_3BO_{15}(O,OH)_2$, orth., related to **Dumortierite**, **57**, 1556 (1972), **75**, 937 (1990)
86 **Hotsonite**, change the formula to $Al_5(PO_4)(SO_4)(OH)_{10}$, add **76**, 1734 (1991)
88 Hydromolysite should not be in bold face
91 **Ingodite**, $Bi(S,Te)$, **76**, 257–265 (1991)
93 **Izoklakeite**, change the formula to $Pb_{27}(Cu,Fe)_2(Sb,Bi)_{19}S_{57}$, add **72**, 821–831 (1987)
96 **Jinshajiangite**, (after golden-red) add "compare **Perraultite**"
96 (to follow **Joliotite**), **Jolliffeite**, NiAsSe, cub., *Cobaltite*

group, compare **Gersdorffite**, Can. Min. **29**, 411–418 (1991)

97 change **Joseite** (Joseite-A) to **Joseite-(A)**

100 **Kassite**, add **76**, 283–287 (1991)

100 Katophorite, add **Magnesio-alumino-katophorite**

100 **Kazakhstanite**, add **76**, 667 (1991)

102 **Khatyrkite**, change orth. to tet.

103 Kitaibelite should not be in bold face

103 Kivuite should not be in bold face

104 (to follow **Kobellite**), **Kochkarite**, $PbBi_4Te_7$, hex.

105 (to follow **Kombatite**), **Komkovite**, $BaZrSi_3O_9 \cdot 3H_2O$, trig.

105 **Kostovite**, change mon. to orth.

106 (to follow **Ktenasite**), **Kukisvumite**, $Na_6ZnTi_4Si_8O_{20} \cdot 4H_2O$, orth.

106 (to follow **Kukisvumite**), **Kuksite**, $Pb_3Zn_3Te^{+6}O_6(PO_4)_3$, orth.

109 **Laitakarite**, add **76**, 257–265 (1991)

109 **Langbanite**, after trig., insert "and mon."

110 (to follow **Latrappite**), Laubmannite, a mixt. of **dufrenite**, **kidwellite**, and **beraunite**, **75**, 1197–1199 (1990)

111 **Leadhillite**, after mon., add "ps. trig."

112 **Lepidocrocite**, change to "trimorph. with **Feroxyhyte** and **Goethite**, compare **Akaganeite**"

114 (to follow **Linnaeite**), **Lintisite**, $Na_3LiTi_2Si_4O_{14} \cdot 2H_2O$, mon., **76**, 1730 (1991)

114 (to follow **Lisetite**), **Lishizhenite**, $ZnFe_2^{+3}(SO_4)_4 \cdot 14H_2O$, tric., pale violet

115 **Lithiowodginite**, add **76**, 667–668 (1991)

116 **Lovdarite**, change formula to $K_2Na_6Ba_4Si_{14}O_{36} \cdot 9H_2O$

117 (to follow **Lüneburgite**), **Lunijianlaite**, a regular 1:1 interstratification of **Cookeite** and **Pyrophyllite**, mon.

118 **Magnesio-aluminokatophorite**, after **Aluminokatophorite**, add "compare **Ferrikatophorite**"

121 (to follow **Majorite**), **Makarochkinite**, $(Ca,Na)_2(Fe^{+2},Fe^{+3},Ti,Mg)_6(Si,Al,Be)_6O_{20}$, tric., *Aenigmatite* group

121 **Malachite**, delete "dimorph. with **Georgeite**"

121 **Malanite**, delete **Dayingite**

122 (to follow **Manganese-shadlunite**), **Mangangordonite**, $(Mn^{+2},Fe^{+2})Al_2(PO_4)_2(OH)_2 \cdot 8H_2O$, tric., cols. to yellow, compare **Gordonite**

123 (to follow **Manganotapiolite**), **Manganotychite**, $Na_6Mn_2^{+2}(SO_4)(CO_3)_4$, cub., pale role to green, compare **Tychite**

123 **Mannardite**, add "compare **Ankangite**," change (1968) to (1988)

124 **Maricopaite**, add "*Zeolite* group (?)"

124 **Marsturite**, change to "compare **Lithiomarsturite**, **Nambulite**, **Natronambulite**"

124 **Mascagnite**, Taylorite should not be in bold face

125 (to follow **Mawsonite**), **Maxwellite**, $NaFe^{+3}(AsO_4)F$, mon., medium to dark red, forms series with **Durangite** and with **Tilasite**, Neues Jahrb. Mineral., Monatsh. 1991, 363–384 (Eng.)

126 **Mcbirneyite**, add **73**, 1495 (1988)

127 **Melilite**, change to bold face, $(Ca,Na)_2(Al,Mg)(Si,Al)_2O_7$, tet., a mineral of the series **Akermanite-Gehlenite,** *Melilite* group

127 **Mellite**, change $18H_2O$ to $16H_2O$

127 **Mendozavilite**, change **73**, 192 to **73**, 193

127 **Meneghinite**, change 393, 395 to 393–395

128 **Merenskyite**, change the formula to $(Pd,Pt)(Te,Bi)_2$

129 Metahaiweeite should not be in bold face

129 Merrilite, change to **Merrillite**. **Whitlockite** should be in bold face

131 **Mimetite**, change "mon., ps. hex." to "hex., dimorph. with **Clinomimetite**"

132 (to follow **Mixite**), Mizzonite, a member of the *Scapolite* group, intermediate between **Marialite** and **Meionite**

132 **Modderite**, after the formula, add "orth. (?)"

132 **Moissanite**, change to **Moissanite-6H**

133 change **Molybdenite** (Molybdenite-2H) to **Molybdenite-2H**

135 **Motukoreaite**, add **74**, 1054–1058 (1989)

136 **Mummeite** should be in bold face

138 (to follow **Na-komarovite**), **Nalipoite**, $NaLi_2PO_4$, orth., Can. Min. **29**, 565–573 (1991)

138 **Nambulite**, change "compare **Marsturite**" to "compare **Lithiomarsturite**, **Marsturite**"

141 **Nevskite**, after trig., add "compare **Platynite**"

142 delete the hyphen in **Nickelhexahydrite**

142 **Nickel-skutterudite**, change the formula to $(Ni,Co)As_{2-3}$

144 **Norrishite**, add **76**, 255–271 (1991)

144 **Nsutite**, change to "compare **Akhtenskite**, **Pyrolusite**, **Ramsdellite**, **Vernadite**"

145 **O'Danielite**, change to **O'danielite**

146 Oligonite, delete "*Calcite* group"

147 **Orlymanite**, change trig. to hex., add "compare **Gyrolite**"

147 **Osarizawaite**, change (1972) to (1962)

148 **Osumilite**, delete "$\cdot H_2O$" from the formula

150 **Paracelsian**, $BaAl_2Si_2O_8$, mon., dimorph. with **Celsian**, *Feldspar* group

152 **Paratacamite**, change the formula to $Cu_2^{+2}Cl(OH)_3$

153 **Pearceite**, change the formula to $(Ag,Cu)_{16}As_2S_{11}$

154 (to follow Penginite), **Pengzhizhongite-6H**, $(Mg,Zn,Al,Fe^{+3})_4(Sn^{+4},Fe_2^{+3}Al_{10}O_{22}(OH)_2$, trig., yellow to yellow-brown, **76**, 1730–1731 (1991)

155 (to follow **Perovskite**), **Perraultite**, $KBaNa_2(Mn^{+2},Fe^{+2})_8(Ti,Nb)_4Si_8O_{32}(OH,F,H_2O)_7$, mon., orange-brown, compare **Jinshajiangite**, **76**, 307 (1991)

155 **Perryite**, change formula to $(Ni,Fe)_8(Si,P)_3$, add "trig., Acta Cryst. C47, 1358–1361 (1991)"

157 **Phosphuranylite**, change the formula to $Ca(UO_2)_7(PO_4)_4(OH)_4 \cdot 12H_2O$, add **76**, 307 (1991)

158 **Platynite**, add "compare **Nevskite**"

160 **Potosiite**, change the formula to $Pb_8Sn_2^{+4}Fe^{+2}Sb_2^{+3}S_{14}$

166 **Rancieite**, after hex., delete the ?, add "forms a series with **Takanelite**"

166 (to follow **Radhakrishnaite**), **Radtkeite**, Hg_2S_2ClI, orth., yellow-orange, **76**, 1715–1721 (1991)

170 **Robinsonite**, change tric. to mon., add "Min. Abs. **42**, 152 (1991)"

171 **Roggianite**, change the formula to $Ca_2Be(OH)_2Al_2Si_4O_{11} \cdot 2.5H_2O$, Neues Jahrb. Mineral., Monatsh. 1991, 307–314

171 (to follow **Romanechite**), Romanite, $(U,Pb)(Ti,Fe^{+2},Fe^{+3})_2O_{38}$, trig., related to the *Crichtonite* group

171 (to follow **Roquesite**), **Rorisite**, CaFCl, tet., **76**, 1771 (1991)

171 (to follow **Roscherite**), **Roshchinite**, $Ag_{19}Pb_{10}Sb_{51}S_{96}$, orth.

172 **Routhierite**, change the formula to $(Tl,Cu)Hg(As,Sb)S_3$

172 (to follow **Routhierite**), **Rouvilleite**, $Na_3Ca_2(CO_3)_3F$, mon., Can. Min. **29**, 107–111 (1991)

172 **Rucklidgeite**, add **76**, 257–265 (1991)

174 **Sadanagaite**, delete the hyphen in **Magnesiosadanagaite**

174 **Safflorite**, change the formula to $(Co,Fe)As_2$

174 **Sakharovaite**, change orth. to mon.

176 **Sapphirine**, change "**Sapphirine** (= Sapphirine-2M) to **Sapphirine-2M**

180 Selen-tellurium, a mixt. of **selenium** and **tellurium**, **76**, 257–265 (1991)

183 (to follow **Silhydrite**), **Silicon**, Si, cub., **76**, 668 (1991)

183 (to follow **Silicon**), **Silinaite**, $NaLiSi_2O_5 \cdot 2H_2O$, mon., Can. Min. **29**, 359–367 (1991)

183 change **Silver** (Silver-3C) to **Silver-3C**

184 **Sobolevskite**, after hex., add "dimorph. with **Polarite** (?)"

185 (to follow **Sodium-zippeite**), **Sofiite**, $Zn_2(Se^{+4}O_3)Cl_2$, orth., **75**, 1211–1212 (1990)

185 Sodium phlogopite should not be in bold face

186 Sophiite, see **Sofiite**

187 (to follow **Spurrite**), **Squawcreekite**, $(Fe^{+3},Sb^{+5},Sn^{+4},Ti)O_2$, tet., yellow-brown, *Rutile* group, compare **Tripuhyite**

189 **Stibarsen**, add **76**, 257–265 (1991)

189 **Stibivanite-2O**, add **75**, 937 (1990)

190 **Strätlingite**, change the formula to $Ca_8Al_4(Al_4Si_4)O_8(OH)_{40}\cdot 10H_2O$, add Eur. J. Min. **2**, 841–849 (1990)

191 (to follow **Strontiopyrochlore**), **Strontiowhitlockite**, $Sr_9Mg(PO_4)_6[(PO_3(OH))]$, trig., compare **Whitlockite**, isostructural with the silicate **Cerite-(Ce)**, Can. Min. **29**, 82–93 (1991)

192 **Sulphotsumoite**, add **76**, 257–265 (1991)

192 **Sundiusite** should be in bold face

193 **Svyatoslavite**, $CaAl_2Si_2O_8$, orth., trimorph. with **Anorthite** and **Dmisteinbergite**, *Feldspar* group, **76**, 300–301 (1991)

194 (to follow **Sztrokayite**), **Szymanskiite**, $Hg_{16}^{+1}(Ni,Mg)_6(H_3O)_8(CO_3)_{12}\cdot 3H_2O$, hex., blue-gray, Can. Min. **28**, 703–718 (1990), **76**, 1731 (1991)

195 **Takanelite**, $(Mn^{+2},Co)Mn_4^{+4}O_8\cdot H_2O$, hex., forms a series with **Rancieite**, **56**, 1487 (1971)

197 **Tengchongite** should be in bold face

198 (to follow **Terskite**), **Tertschite**, $Ca_4B_{10}O_{19}\cdot 20H_2O$, mon. (?), **39**, 849 (1954)

198 **Testibiopalladite**, change the formula to PdBiTe, add Can. Min. **29**, 481–489 (1991)

200 **Tilasite**, add "forms a series with **Maxwellite**"

200 (to follow **Tincalconite**), Tinnunkulite, $C_{10}H_{12}N_6O_8$, Chem. Abstracts **114**, no. 16, 147109 (1991)

203 **Triplite**, change **Magnotriplite** to **Magniotriplite**

203 **Tripuhyite**, add "compare **Squawcreekite**"

204 **Tsumoite**, add **76**, 257–265 (1991)

205 (to follow **Tulameenite**), **Tuliokite**, $BaNa_6Th(CO_3)_6$, trig., pale yellow, **76**, 668 (1991)

205 change **Tungstenite**, WS_2 (Tungstenite-2H) to **Tungstenite-2H**, WS_2

205 **Tungstenite-3R** is misspelled

211 (to follow **Vashegyite**), **Vasilite**, $(Pd,Cu)_{16}(S,Te)_7$, cub., Can. Min. **28**, 687–689 (1990)

211 **Vernadite**, after compare, insert **Akhtenskite**

212 **Vincentite** should be in bold face

212 **Vertumnite**, change the formula to $Ca_8Al_4(Al_4Si_5)O_{12}(OH)_{36}\cdot 10H_2O$, add Eur. Jour. Mineral. **2**, 841–849 (1990)

212 **Vincentite** should be in bold face

213 **Vochtenite**, add **75**, 1212 (1990)

216 (to follow **Watkinsonite**), **Wattersite**, $Hg_4^{+1}Hg^{+2}Cr^{+6}O_6$, mon., dark reddish-brown, Min. Record **22**, 269–272 (1991)

216 (to follow **Weilite**), Weinebeneite, $CaBe_3(PO_4)_2(OH)_2\cdot 4H_2O$, mon.

216 **Weissite**, CuTe, Hex., ps. cub., bluish-black, **34**, 357–358 (1949)

216 **Welinite**, add "compare **Franciscanite, Örebroite**"

217 **Werdingite**, add **76**, 246–251 (1991)

217 **Wermlandite**, change the formula to $(Ca,Mg)Mg_7(Al,Fe^{+3})_2(SO_4)_2(OH)_{18}\cdot 12H_2O$

217 **Westerveldite**, change the formula to (Fe,Ni)As

218 **Whitlockite**, $Ca_9(Mg,Fe^{+2})(PO_4)_6[(PO_3(OH)]$, trig., compare **Strontiowhitlockite**, isostructural with the silicate **Cerite-(Ce)**, **26**, 145–152 (1941)

218 **Willyamite**, change orth. (?) to "mon. or tric."

219 **Wittite**, change the formula to $Pb_3Bi_4(S,Se)_9$

221 (to follow Xinganite-(Y), Xingsaoite = cobaltoan **Willemite**, $(Zn,Co^{+2})_2SiO_4$, trig., **76**, 669 (1991)

222 **Yafsoanite**, add **75**, 937 (1990)

222 (to follow **Yimengite**), **Yingjiangite**, $(K,Ca)(UO_2)_3(PO_4)_2(OH)\cdot 4H_2O$, orth., golden-yellow to yellow, **76**, 1731–1732 (1991)

222 **Yoderite**, change the formula to $(Mg,Al,Fe^{+3})_8Si_4(O,OH)_{20}$, add **76**, 1052–1060 (1991)

222 **Yofortierite**, correct the spelling, change "compare **Palygorskite**" to "compare **Palygorskite**, **Tuperssuatsiaite**"

224 (to follow **Zemkorite**), **Zenzenite**, $Pb_3(Fe^{+3},Mn^{+3})_4Mn_3^{+4}O_{15}$, hex., black, Can. Min. **29**, 347–354 (1991)

226 (to follow **Zirsinalite**), **Znucalite**, $Zn_{12}(UO_2)Ca(CO_3)_3(OH)_{12}\cdot 4H_2O$, tric., yellow, **76**, 1732–1733 (1991)

227 **Zussmanite**, add "compare **Coombsite**"

228 *Adelite* Group, center the heading

228 *Aenigmatite* Group, add Makarochkinite

228 *Alluaudite* Group

Monoclinic phosphates and arsenates of general formula $NaACD_2(XO_4)_3$; A = Ca, Mg, Pb; C = Ca, Fe^{+2}, Fe^{+3}, Mg, Mn^{+2}; X = P, As.

Alluaudite
Arseniopleite
Caryinite
Ferro-alluaudite
Hagendorfite
Maghagendorfite
Varulite

229 *Apatite* Group, Carbonate-fluorapatite and carbonate-hydroxylapatite are misspelled; add Clinomimetite

231 *Brackebuschite* Group, add Bearthite

232 *Calcite* Group, Gaspeite is misspelled

232 *Crichtonite* Group, add "Romanite is a related mineral"; after Ti, insert U

233 *Cryptomelane* Group, in the list of A elements, add Mn^{+4}; add Ankangite

234 *Epidote* Group, Hancockite and Strontiopiemontite are misspelled

235 *Feldspar* Group, add Dmisteinbergite; Svyatoslavite is misspelled

235 *Gadolinite* Group, change the last sentence to: "The phosphates Drugmanite, Herderite, and Hydroxylherderite and the arsenate Bergslagite are structurally related to the silicates of this group"

236 *Hexahydrite* Group, delete the hypen in Nickelhexahydrite

237 *Joaquinite* Group, change Belorussite to Byelorussite-(Ce)

238 *Lovozerite* Group, in the general formula change Si_5 to Si_6

241 *Olivine* Group, change formula to $A_2^{+2}SiO_4$

244 *Rutile* Group, add Squawcreekite

252 Erythrite, change arsenite to arsenate

256 Vesuvianite, change valcium to calcium

NOTE: *The Glossary of Mineral Species*, sixth edition (1991) is still in print, and is available for $16 postpaid. A booklet-size reprint of the above additions and corrections, sized to fit within the *Glossary* in a map-pocket, is available for $2 postpaid. Order from the Circulation Manager, Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740.

Letter from Europe

by **Michael P. Cooper**

In this issue we are pleased to introduce our new European Correspondent, Michael P. Cooper, who will be stepping into Tom Moore's well-worn hiking shoes to report on European shows and museums. Mick has been a regular writer for the UK Journal of Mines and Minerals, *and is now its Managing Editor.* Mineralogical Record *readers will also remember his excellent article and photographs on Caldbeck Fells in the March-April 1991 issue. He'll be receiving occasional assistance from other correspondents from time to time, as from Miguel Calvo in this installment. The repatriated Tom Moore is not lost to us, however; his report on the 1992 Tucson Show (it was his* first year *at that event!) appears elsewhere in this issue.Ed.*

Paris Show 1991

Fourteen hours is a long time to spend in an airport departure lounge, especially when you've dragged yourself out of bed at 5 am to get there in time for your 7 am flight to Paris; especially when the Paris mineral show which opened that afternoon was your first assignment as the *Mineralogical Record*'s new European Correspondent. An inauspicious beginning. At least, in contrast to outgoing correspondent Thomas Moore, I didn't have the responsibility of a carful of offspring to placate. Every half an hour the departure board helpfully announced that there would be more information in 30 minutes. Finally a reason was announced: fog in Paris meant our aircraft (which didn't have the relevant fog-landing equipment or crew) couldn't land. Fog in November; whatever next? Somehow this reminded me of British Rail's recent excuse for delayed trains: tree leaves on the track. Leaves! In Autumn!

At midday, my planned lunch—talking minerals in a French *bistro*—was replaced by drinking over-priced coffee in an airport lounge listening to stories of Great Airport Delays I Have Known. Not a worthy substitute. At 8:15 pm, thirteen hours after our scheduled time, our flight—still cynically referred to as the *07.00hrs to Paris*—left the ground to spontaneous applause from its already weary passengers. In Paris, I was one of the lucky ones whose luggage had also been sent to Paris. More delays followed while the less fortunate filled out reams of lost luggage claims. High on coffee I got to bed at about 1 am.

On Saturday morning I found time to savour my morning *croissants* (why don't they taste so good in England?) before rushing off to the *Métro*. The autumn Paris show (or *bourse*) is easy to find; it is held in the large Hotel Pullman Saint Jacques (popularly referred to as the PLM), on the Boulevard St. Jacques a few hundred meters downhill of the Métro St. Jacques, and not far from the center of Paris. On arrival I sought out show organizer Roger Pelloux (9 Square Rouget de Lisle, 95140 Garges-Les-Gonesse, France) who made me very welcome. He had arranged a room for me to use as a photographic studio—a spacious conference room that a whole troop of photographers could have fitted into—where I dropped off my gear before making my way back to the show. This is held twice a year in several upstairs rooms in the hotel: the large main exhibition hall, and several smaller adjoining rooms. The *bourse* was already thronged with visitors. Roger was hoping for 8–10,000 visitors over the two-and-a-half day event, a target I think that was easily achieved. There were 200 exhibitors at this 20th anniversary show, most with well-displayed and well-lit exhibits on glass shelving units. The heat from the lamps and visiting bodies was thankfully dissipated under the high ceiling, otherwise the contrast between the show and the bitter weather outside might have been overpowering.

My first call was French mineral collector Frédéric Escaut (*Ostrea Locations,* Route des Huitres, 17550 Dolus, France), a specialist in Chinese minerals. I had first met Frédéric at the London show many years before when he was studying English over there. He has a refined taste in minerals and usually has something good to see. At the last *bourse* in Sainte-Marie-aux-Mines (France's largest and longest-running show) he unveiled a new find of superb **orpiment** from Hunan. Further specimens had arrived in time for the Paris show: rich orange-brown prisms, some over 10 cm long, in sprays and groups with or without the contrast of lustrous creamy-white scalenohedral calcite crystals to over 7 cm long. The luster and clarity of this orpiment is quite remarkable, and most pieces are surprisingly free from damage considering the fragility and softness of the species. Prices started at about $70 for a small spray to over $3,600* for a large radiating mass of 10-cm crystals about 15 cm across. Not bad for world-class specimens.

Precise locality data for this find is hard to come by. At first thought to be a different mine from that producing the recent fine realgar specimens, latest word is that both minerals are coming from the same place. Fine orpiment from China has been known for decades, and there is even a Chinese postage stamp illustrating a group of orpiment and calcite crystals strikingly similar to these new pieces, but I've not been able to find out much hard data about the source. It is usually known simply as "the arsenic mine."

A conversation developed which was to be repeated throughout the day: I recounted my Great Airport Delay Story and Frédéric responded by telling me about the specimens that had been sold yesterday. Best among these, judging by the number of people who told me about it, was a Chinese **fluorite** in large, flawless, glassy cubes the color of Wagholi cavansite. This, and the many other fine fluorites on the stand, were labeled Fujan, Hunan. We assume, from the variety of material produced, that this is an area rather than a specific mine. The common run of this fluorite consists of two types: large (to 5 cm) glassy cubes with pronounced but frosty dodecahedron faces, either in loose groups or scattered on "saddles" of peach-tinted creamy dolomite; or masses of composite crystals composed of small, stacked cubes. The latter comes in shades of pale to dark sea-green. Matrix pieces reach 30 cm across and prices varied from about $60 for small cabinet pieces to about $900 for the best. The dodecahedrally modified crystals are essentially colorless or bluish with bright purple patches or zones floating inside them. One attractive piece shows a sharp octahedrally modified purple phantom in a large colorless cube. The remaining blue specimens (reminiscent of the classic English specimens from the Florence mine, Cumbria) are rather pale but nonetheless very nice. A further batch of these specimens arrived just after the show, but I had to decline an invitation to assist at the opening of the package.

Fluorite was also available in association with some fine **ferberite** specimens from Gejiu, Hunan. These show lustrous, striated black blades of ferberite up to 3 x 6 cm, some on quartz crystals; they vary in size from attractive miniatures to cabinet groups. One nice small piece consists of a ferberite blade embedded in sharp purple fluorite cubes, as if pushed there by some powerful thumb. Gejui also produces some good **scheelite.** Frédéric had a few miniatures showing very sharp, transparent, pale brown bipyramids 1.5 cm on edge, perched on quartz and colorless fluorite.

The market in Russian minerals is understandably quiet, mineral

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* Originally priced in French francs, at about 5.5 to the dollar.

dealing being so trivial in the face of the massive social and political upheaval in what used to be the USSR. But, nonetheless, some good specimens are still available. A popular and prolific source is Dal'negorsk in Primorsky Krai on the eastern seaboard of Russia. The magnificent, lustrous **pyrrhotite** crystals from there reach over 10 cm across and are commonly associated with shiny black sphalerite, galena (some of which has a curious "melted" look), dolomite, and needles of pink-tinted **quartz.** All the big pyrrhotite crystals I have seen have been loose crystals, some of whose goethite(?)-coated broken bases suggest that they were found loose in the vein. François Lietard (*Minerive,* Au Bois, 42520 Roisey, France), one of France's most knowledgeable and well-traveled dealers, has handled some very fine specimens from this site. François's stand is always very colorful, mainly because of his current specialty in pegmatite minerals (kunzite, tourmaline, beryl etc.) especially those from Pakistan and Afghanistan, but also from Africa and Russia. (He also attends Tucson.) Just in from a locality "near Lake Baikal" (well, that cuts it down a bit) were some doubly terminated **tourmalines** (elbaite?) to about 7 cm long, each of a dark smoky gray color with rich purple terminations; small reflective areas within the body of these crystals scatter vivid highlights in blue and purple. At first appearing rather dull, these pieces repay continued viewing. Prices ranged from $540. Another new group of specimens, these from Dzhezkazgan in Kazakhstan, consist of nice singles and tangled groups of wire silver, all off matrix. One piece is somewhat flattened, as if having formed as part of a filling in a narrow vein. Prices started at about $45.

A recent consignment of **tourmaline** from Pakistan was also on display. These are all loose crystals with broken bases but perfect terminations. "Watermelon" color-zoning is their principal feature: a purplish core overgrown by pale to dark green (that shade called "actinic green" which is used for poison bottles). The terminal planes are a deep smoky purple, a very attractive shade that proved difficult to capture on film. Most crystals are about 10 cm long. François also had some fine African material, including a selection of beautiful, transparent single crystals of **scapolite** from Mpwa-Mpwa, Tanzania, at $180–$333. They are 2 to 3 cm long.

My day was already dwindling. I had a lot of catching up to do, and the Saturday crowd didn't help. Progress must be slow and careful when you're ferrying tens of thousands of francs worth of other people's minerals back and forth to an *ad hoc* photographic studio! Conversing in French slows me down too, although many of my French friends would rather use and practice my language than let me stumble on in theirs. But there's no real barrier, and the casual visitor shouldn't feel daunted. When push comes to shove, everybody speaks pocket calculator, so if all you want to do is look or buy there's nothing to stop you. I really enjoy the French collecting scene. It's very vigorous, and much biased in favor of the aesthetic. Systematic mineralogy is eschewed by many private collectors, as one told me: if you can't see it with the naked eye and you can't do anything else with it (like your own analysis) then why collect it? "Chemical curiosity" is regarded by many as the province of the Germans and the British. This bias is much of the attraction of Continental shows for me. Generally much finer material is offered than back home and, although systematic mineralogy is a part of a British collector's make-up (mine included), the unique sculptural beauty of fine minerals is a pleasure as well. But, of course, the predominance of fine display-quality material in Continental European shows is not merely a reflection of the taste of collectors; money enters into the equation too, and there seems to be plenty of it in Paris.

Speaking of money, the most expensive—and one of the most beautiful—pieces I saw in the show was part of the select display of Phillipe Rodier (21 Bis, rue de Toul, 75012 Paris, France), a specialist in gem minerals and spectacular cut stones. Among the former was a small group of excellent Nigerian **emerald** crystals. The best of these, serious money at half a million francs, was a luminous green, doubly terminated, gemmy prism about 5 cm long. It was complemented by a smaller, apparently sceptered, crystal, the head and shaft of which are different shades of green. On the same stand there was also some exceptional pink **apatite** from Stak Nala, Gilgit, Pakistan, fine **spessartine** from Shengus (also in Gilgit), and some large **lazurite** crystals on matrix from Badakhshan, Afghanistan. One of the lazurite specimens seems to consist of a thick hexagonal crystal of mica (phlogopite?), the sides of which are encrusted in bright lazurite while the basal plane is untouched.

Pink **apatite** from Gilgit could be found scattered in small groups of specimens throughout the show. I have a fondness for these pieces, and noticed quite a range of types on different stands. Although one of Rodier's specimens got my vote for the glassiest, pinkest, sharpest crystal, it was difficult to say which was the best specimen. Other contenders included an interesting, loose, milky-pink prism with a doubly terminated **phenacite** embedded in it (Gilles and Françoise Barras-Gauthier, Le Besset, 63880 Olliergues, France), and some glassy prisms implanted in beds of lustrous scales of pearly brown muscovite (Jean-Pierre and Nicole Voilhes, *La Pierrerie,* Rue du Foirail, Plauzat, 63730 Les Martes de Veyre, France). Both of these stands are run by husband-and-wife teams with excellent taste in specimens. But I was disappointed to note that François Lietard had no more of the apatite-sheathed stacks of spessartine crystals that he had shown at Ste-Marie-aux-Mines.

The collector of sulfides and sulfosalts was well served in Paris. From the exotic orpiment and realgar of China already mentioned to humbler central European galena and pyrrhotite. Almost a regular feature of the present collecting scene, **stibnite** specimens were displayed by several dealers. Chinese stibnite graced Frédéric Escaut's stand; clean, bright, striated prisms in singles or small clusters, they reach over 30 cm long, but most are between 5 and 20 cm. They were priced at $90–$400 for good single crystals, often with the added charm of text-book bends and creases. Similar pieces were also available from Kirgizia, but the widest range of material came from various mines in Transylvania, Roumania. Lucien Jean (15 rue Colonel-Roux, 05000 Gap, France), who deals exclusively in Romanian minerals, had a fine display of these stibnites, including specimens from three major finds, two at Herja and one at Suior. From Herja he had a group of specimens collected some 12 years ago that consist of radiating masses of gray blades 2 to 10 cm long, with a stoss-side coating of tiny pinkish barite plates. A 10-cm specimen would set you back $180, and pieces were available in all sizes up to about 30 cm across. From Suior (Sujorbanya) there was a new find of lustrous bladed crystals to 1 x 5 cm, but usually smaller, on matrix. These cost from $270 to $400 for a piece 30 cm across. In common with several other dealers, Lucien also carried stibnite from a relatively new find at Herja. These specimens (also seen at Ste-Marie-aux-Mines in the summer) have small but brilliant stibnite blades intergrown in plumose groups with fibrous **berthierite.** A partial overgrowth of minute, sparkling dolomite (?) crystals gives a perfect finishing touch to some pieces; in the best specimens the stibnite bursts through clouds of dolomite like volcanic eruptions. Almost all the pieces I saw were undamaged and many are very aesthetic, the sprays reaching 15 cm across. Other notable Romanian species included galena, pyrrhotite, sphalerite, and chalcopyrite. Some of the **galenas** form bright, tabular, spinel-law twins 3 to 5 cm across (a habit that is more common in European localities than American and is a particular favorite of mine). Others, having superficially the same appearance, show only cube faces on the flattened face, whereas the true twins show triangular octahedron faces. This second type seems to consist of epitaxial growths of galena on tabular pyrrhotite. Solid plates of both types were available from Lucien Jean priced at $100–$150. The large octahedral galenas from Mistrubanya, Herja, reached 4 cm on edge (a good size for this relatively unusual habit) and cost up to $80. Lustrous **chalcopyrite** in excellent, sharp, striated, 3-cm crystals was available in groups about 10 cm across ($150) and there was plenty of pyrrhotite in books of thin plates 3–4 cm in diameter and as thicker, tabular hexagonal crystals up to 11 cm across from Kapnic. Pierre and Martine Clavel (4 chemin Vie Borgne, 38460 Crémieu, France) had the larger sizes of pyrrhotite, and some excellent examples of stibnite and berthierite from the new Herja find, left over from the selection they had displayed at Ste-Marie. Pierre and Martine also had a few curious "window **quartz**" crystals from Kapnic. These white prisms are up to 10 cm long and form attractive groups. Other quartz prisms are accompanied by small amounts of bright red powdery cinnabar, an unusual occurrence for the locality.

A note on European specialities shouldn't omit the famous Panasqueira mine in Portugal, still producing superb specimen material: **wolframite** blades, groups of lenticular buff-colored **siderite,** glassy green and purple **apatite** crystals, and large brilliantly lustrous **arsenopyrite.** A limited number of collectible species, it's true, but combined with such style that there is always something new to see. René Daulon (20 rue de Bezou '2161', 92400 Lourbevoie, France) deals exclusively in Panasqueira minerals, a passion he has had for several decades, and had a fine selection available in Paris.

There was much else to be seen in addition to minerals, from gems and jewelry to the huge slabs and table tops of petrified wood and fossil-crammed limestones displayed in a back room. If I may be spared an aside on the subject of fossils, I was excited to note a display of fine *Arucaria* pine cones on one stand. Not just any cones—these were the remarkable agatized cones from Patagonia in which the minutest detail of the external and internal structures has been faithfully preserved by multicolored silica. Unavailable for many years, these amazing fossils were on sale in Paris in sizes up to about 7 cm high, either as complete cones or as polished sections. This deposit was once worked by Franz Mansfeld, a German entrepreneur whose other claim to local fame was for the original (1940's) exploitation of the well-known rhodocrosite deposit as Las Capillitas, also in Argentine. By coincidence, a fine selection of polished rhodocrosite stalactites from this locality has been available on the European market for some months, again after being in short supply for many years. And still on the subject of fossils I should mention the fossil bivalve shells from Kertch in the Crimea, Ukraine. Several dealers carried good specimens of this material, each one broken open to reveal the clusters of superb, transparent **vivianite** blades within. Kertch also produces vivianite sprays on a peculiar brown pisolitic matrix which collectors should be wary of when lifting specimens: it is so lightweight that the force expected to be necessary to lift the piece can easily drive it upwards into any overhanging shelf!

Still in short supply on the European market is **wulfenite.** This is a big problem for a self-confessed wulfenitophile like myself. When I began collecting over 30 years ago it was a plentiful species, but the masses of material from mines in Mexico and Arizona declined along with the flowerings from Tsumeb and Morocco. Now there is almost nothing notable in wulfenite coming from Morocco (the most recent substantial source) except a few high-priced, though nonetheless pretty, orange blades from Mibladen (where it carries a premium for its rarity in the mines) and a few generally unexciting remnants of the great Touissit material. American collectors are probably much better served than their European counterparts; good finds are still being made in old Arizona occurrences, for instance, but only a handful of such pieces finds its way over here (it's nice to see such pieces illustrated in the *Mineralogical Record* from time to time). But in Paris I could at least admire a group of old pieces from Los Lamentos exhibited by *La Pierrerie*. These solid masses of orange cuboids were collected around 1980; they are almost floaters, and very attractive.

Barras-Gauthier Minéraux, whom I mentioned above under apatite, included some good examples of the Kertch vivianites on their stand, and also had some relatively new **azurite** from Touissit. These are not the spectacularly large crystals for which the site is justly famous, but are nonetheless noteworthy for showing encrustations of small, lustrous crystals associated with lustrous, globular aggregates of smithsonite. Several other dealers had similar material. Alongside were a couple of unusual floater groups of snow-white crystals from Gilgit, Pakistan. These were labeled calcite, but look more monoclinic than trigonal, and consist of sheaf-like sprays of blocky crystals with a pronounced "waist" in the center. A scattering of small globular masses of brown siderite enhanced the whiteness of the pieces.

There were many dealers whom I had little or no chance to talk to, no matter how interesting their specimens. I could have spent longer, for instance, over the colorful displays of Gilbert Gauthier and Christian Gobin, both well-known on the international circuit and both of whom specialize in central African copper minerals and their associations. I was very impressed with the huge African malachite crystals shown by Christian. And Gilbert showed me a few English curiosities he had acquired, several with interesting old labels. These included some pieces (caledonite and linarite for instance) which really needed a closer look than I could give them at the time, caledonite especially being not only nice in itself but a good indicator of rare associated species. And for those wanting to buy into one of the most remarkable European finds of recent years, Gilbert also had a couple of loose plates—I could almost say slabs—of **stolzite** from the Ste. Lucie mine, Lozère, France, reported in the *Mineralogical Record* recently (vol. 21, p. 489; vol. 22, p. 214 and 216). These unprecedented specimens reach over 5 cm on edge and make up in importance what they lack in attractiveness. Work proceeds to obtain more, I'm told.

After spending most of Saturday borrowing and photographing specimens and most of Sunday taking backup notes and discussing minerals, collectors, and collections, I made my way out of the *bourse* on Sunday evening to stroll 'round Paris. I got cold and damp but the fresh air was nice and my voice got a rest. I hope to catch up with further dealers and their specimens at next year's shows: Ste-Marie-aux-Mines and Munich are musts, and Lyon and Torino are pencilled in.

As well as the annual *bourses* (there is another in March), Paris is home to three of the best mineral exhibits in Europe: the Natural History Museum, the School of Mines, and the Sorbonne collection, all of which demand to be seen over and over. During the show I met up with Henri-Jean Schubnel, curator of minerals at the Natural History Museum, and was invited over on the Monday after the show to see a new exhibition which had been opened the previous week. I hoped I would also have the opportunity to do a little research in the Museum's archives as part of my project on the history of British mineral dealers.

The **Muséum d'Histoire Naturelle** is the oldest museum in Paris (opened to the public in 1745), and houses the oldest of today's great mineral collections. It began in 1626 as part of a collection of pharmaceutical materials gathered by Guy de la Brosse, the physician to Louis XIII. It was reorganized as a Cabinet of Natural History on the death of Louis XIV in 1715. In its early years the collection was augmented by gifts from many of the Royal Houses in Europe, mineralogy being quite the done thing among the aristocracy at the time. 18th-century specimens from Germany, Austria and Russia still survive in the collection complete with their original labels from the Imperial Cabinet in Austria or the collection of the Empress Catherine of Russia. A particularly spectacular gift was a suite of wire silver from the mines at Kongsberg, given by King Christian VII of Denmark to Louis XVI in 1770. Among these is one of the greatest Kongsberg wires known—a thick hoop of wire rope with calcite. Important collections acquired in the 19th and 20th centuries include tens of thousands of specimens from Louis Vesignié (one of Europe's greatest mineral collectors) and a suite of 610 American minerals gathered together for the Pan American Exhibition in Buffalo in 1901 by Frederick Kunz of Tiffany & Company, New York. This wonderful collection, containing some of the best Californian pegmatite minerals and Arizona azurite specimens ever seen, was donated to the Museum by J. Pierpont Morgan. A relatively recent acquisition is the Ilia Deleff collection of giant crystals. Dramatically displayed in a spotlit but

Figure 1. Orpiment crystals to 3 cm, on calcite, from Hunan, China.

Figure 2. Orpiment crystal group, 9.5 cm, from Hunan, China.

Figure 3. Fluorite from Fuyan, Hunan, in pale purple dodecahedrally modified crystals to 2.2 cm on edge, on dolomite-covered matrix. Frédéric Escaut specimen.

Figure 4. Scheelite from Gejui, China, in pale brown, transparent crystals on quartz and fluorite. The largest crystal is 1.4 cm on edge; the specimen on the right measures 3 cm. Frédéric Escaut specimens.

Figure 6. **Tourmaline from "near Lake Baikal," Russia; a double terminated, smoky purple, 7-cm prism. François Lietard specimen.**

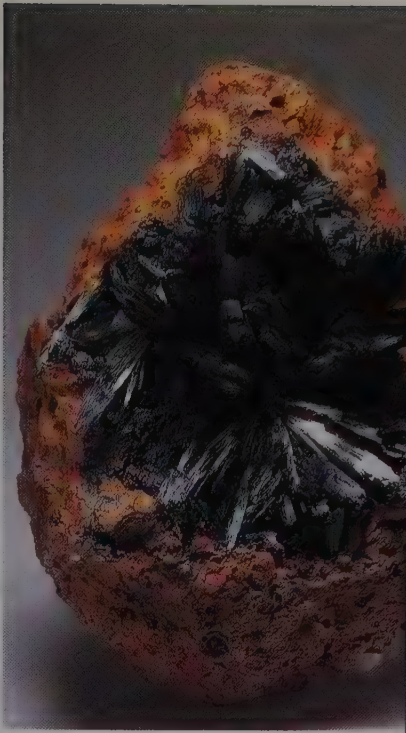

Figure 5. **Vivianite from Kertch, Crimea, Ukraine; a spray of dark green crystals about 5 cm across on a light, pisolitic matrix. Barras-Gauthier Minéraux specimen.**

Figure 7. **Scapolite from Mpwa-Mpwa, Tanzania, 3.5 cm. François Lietard specimen.**

otherwise darkened gallery, these huge crystals of quartz, geodes of amethyst, blocky amazonites and other unique specimens are much admired by visitors to the museum. Deleff had rescued many of these crystals from miners who saw in them only their potential for yielding lumps of clear crystal for cutting for the jewelry or electronics industries. Most of the monster crystals discovered are smashed to pieces where they are found. This group of specimens was acquired for the Museum by Schubnel.

The Museum also houses the working collections of many of its past curators; its inventory—which contains some 200,000 entries—reads like a roll-call of the history of European mineralogy: Romé de l'Isle, Haüy, Gillet de Laumont, de Bournon, Dufrénoy, Delafosse, Descloizeaux; their collections contain many early chemical and crystallographical types (characterized long before the advent of X-ray and electron beam techniques); their names are known even to the least historically minded mineral collector through the species named after them.

Since 1837 the collection has been housed in the specially built Museum in the Botanical Gardens in Jussieu in east-central Paris. Access is easy via the Métro at Jussieu (which also serves the Sorbonne collection) or Gare d'Austerlitz. A good time to visit is in the spring or early summer when the gardens are at their loveliest, but even on a bleak winter's day it's a nice setting. Hard by the museum is an excellent bookshop which deals in all manner of natural history books, many on mineralogical subjects. Interested readers are encouraged to buy and read Henri-Jean Schubnel's *Giant Crystals, Precious Minerals,* which describes the collection's history and is illustrated with superb color photographs of many of its treasures. It was published by the Museum in 1987, and is still available in an English edition. (See the review in vol. 20, p. 149–150.)

The latest display in the Museum is *Silicium* ("Silicon"), a demonstration of the vital importance of this element in the history of man, and especially to our modern civilization, truly the silicon age. The display runs from the birth of silicon in stellar fusion reactions to its present dominance of our lives in the microchip. In between, the exhibit shows us flints, stained glass, ceramics, jewelry and other items worked by man; the fragile silica skeletons built by diatoms, and, of course, natural crystals. A special display shows the vital role of silicon in the modern house. Interpretation is good and children and handicapped visitors are well cared for—this is the first display I have seen that incorporates Braille catalogs and information boards, magnifying glasses, and telescopes for the visually handicapped.

Strongly criticized back in 1971 by Paul Desautels and John White (vol. 2, p. 239, 274–275) for their neglected appearance, the museum's mineral displays are today in good repair and well worth seeing, whether the visitor is inclined to systematics, aesthetics, history or, in the case of the giant crystals, just plain spectacle. The main mineral exhibit is housed in a darkened basement in large, spot-lit, wall showcases. It is a systematic arrangement, mixing the spectacular with the historically and scientifically important. Specimens once belonging to the famous mineralogists who studied them (including many type specimens) are displayed. It's marvellous to be able to see the actual specimens of species like liroconite, olivenite, chalcophyllite and other Cornish specialities once held and characterized by de Bournon and others. Among the spectacular pieces are so many fine specimens that it is difficult to restrict a brief commentary such as this. Of course, as a British collector I recall well such English specimens as a large, doubly terminated Cumbrian barite on matrix (a rich brown, tabular crystal with colorless tips) and a large pyromorphite of a wonderful green from the famous occurrence at Roughton Gill, in the Caldbeck Fells. There are superb morganites from Consilheiro Pena, Brazil; rubellites from California; and superb crystals of Pike's Peak amazonite. Less well-known to me were some remarkable French specimens including superb stibnite (La Lucette, Mayenne; and Le Dahu, Haute-Loire); a huge, almost complete tetrahedrite crystal (over 15 cm!) from Irazein, Ariege; and one cannot ignore the French fluorites, autunites and pyromorphites or, as my guide pointed out, the pretty good schubnelite from Mouanana, Gabon.

Time passed by too quickly. After the tour of the mineral gallery there was just time for a brief examination of the archive—which turned up an 1825 catalog of a Parisian mineral sale by the celebrated English mineral dealer Henry Heuland (a great find!)—before lunch and a hurried return to my hotel for the airport shuttle.

It was a breathless trip, not only because of time lost at the beginning but because French really is a breakneck language! On the flight back I read my Heuland catalog, and Henri-Jean Schubnel's history of the Museum against a background of stories of getting lost on the *Métro,* of being spurned by waiters impatient of *Les Anglais* and their lack of French, or of being stunned by the treasures of the Louvre or by the overindulgence in *Beaujolais nouveau*. High on minerals I got to bed about 1 am.

I'll be back with a review of the British collecting scene in my next letter. Until then, sharing Thomas Moore's lack of a good standard exit line, I'll say Good bye and Happy New Year.

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Bilbao, Spain, Show 1991

[The following report was provided by Miguel Calvo, Zaragoza, Spain. Ed.]

Bilbao, a large city in the Basque country of northern Spain, has a long history of mining. Its extensive iron mines, most of them now closed, were the basis for the industrialization of the area in the 19th and 20th centuries. The Bilbao mineral and fossil show (*XIV Bolsa-Exposición Internacional de Minerales y Fósiles*), on October 4–6, is one of the largest in Spain. It is organized by the *Sección de Mineralogía y Paleontología de Iberdrola* (P.O. Box 119, Bilbao 48008, Spain). The show this year filled the main hall of the Feria de Bilbao (Bilbao Fairgrounds), at only a token cost to the dealers, and with free admission for the public, thanks to the sponsorship of the Iberdrola power company. A dozen museums and institutions also have exhibits at the show. The attendance this year was about 35,000 people, including about 15,000 school children guided by their teachers.

Most of the full-time Spanish mineral dealers, as well as dealers from Morocco, France, Portugal, Italy, Austria, Hungary, Poland, Uruguay and the U.S. have booths at the show. In addition are many local part-time dealers and field collectors. The show presents a good opportunity to obtain relatively fine specimens from obscure localities, and to buy from the primary sources.

The most interesting new specimens from Spain are the **datolite** groups from a quarry near Rigoitia, Vizcaya. Iñigo Beascoechea (from Getxo, Vizcaya) had matrix specimens to 15 cm, with individual crystals to 4 cm. The crystals are very lustrous, complex, and colorless to pale yellow-green. The smaller crystals (1 cm) are transparent, and the larger crystals translucent. Associated species include prehnite, pumpellyite and laumontite. Alberto Alvarez, manager of the quarry, is now collaborating with the *Sección de Mineralogía y Paleontología de Iberdrola* to help preserve any additional specimens that might be encountered there.

Several dealers (including Jose Miguel Cavia of Mondragón, Guipuzcoa, among others) had specimens from the Troya mine, Mutiloa, Guipuzcoa. This mine has been worked only in the last few years, producing **dolomite, sphalerite, galena, chalcopyrite** and **siderite** crystals all to about 1 cm. The small, gemmy orange sphalerite crystals are especially nice for micromounting. Fine but rare crystals of colorless **barite** have also come from the mine; an outstanding example owned by the *Sección* won the award for the finest specimen from the Basque country.

Augustín Fernandez, owner of the Aliva mine at Espinama, Santander, had a large lot of the well-known **sphalerite** from that locality. The crystal groups are up to 30 cm in size, with crude, translucent individuals to 10 cm, some with associated small dolomite crystals. Unfortunately the Aliva mine is soon to close, due in part to the high altitude which limits mechanized work. The specimens offered at the show were found last summer by Fernandez and Santiago Jimenez.

I stated in a recent article on the Navajún **pyrite** occurrences (vol. 20, p. 451) that Navajún pyrite is almost exclusively cubic in habit. Well . . . Mother Nature has a sense of humor. Pedro Ansorena, owner of the Navajún mine, recently found a number of pyrite crystals, 2 to 4 cm in size, that show cube and octahedron faces in approximately equal development. The crystals occur isolated in marl, and the faces are less lustrous than the classic cubes from this locality. At the Bilbao show Ansorena was offering these along with the usual pyrites, some in large crystal groups.

Manuel Mesa from Oviedo had some emerald-green **beryl** crystals collected from a roadcut near Franqueira, in Pontevedra. This small mica schist outcrop has been known for several years as a source of fine, translucent green crystals to 5 cm, although none have thus far been gem-grade.

Luis Miguel Fernandez of Zaragoza had a fine selection of **gypsum** crystals from the now-famous Fuentes de Ebro alabaster quarries near Zaragoza. He discovered the specimen potential of these quarries some years ago, and has since recovered many fine specimens. At his booth there was also a 10-cm yellow-orange **anglesite** from Morocco, and a selection of uncommon secondary uranium minerals from Zaire.

The most outstanding specimens to be imported lately into Spain are the Mexican **amethyst** groups being sold by Enrique Kucera (Comte d'Urgell 171, Barcelona 08036). The specimens come from Amatitlan, Zumapango del Río, in Guerrero state. The finest are large, cabinet-size groups with dark purple crystals to 20 cm, priced in the thousands of dollars. (The equivalent in Spanish pesetas is terrifying!) However, these are the finest amethyst specimens ever seen at a Spanish mineral show.

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What's New in Minerals?

by **Tom Moore**

Tucson Show 1992

Since I'd never before seen the Tucson Show, or even visited Tucson, it was with much excitement that I welcomed the opportunity to come out here at last (for I write this from my Tucson motel room, the show still in progress all around me). At long last I got to see the brown rocky hills that encircle the city, the mile-high cacti and palms, the garishness and the beauty of capitalism glinting amid desert dawns, and the endless straight thorough fares which, more than the negligible downtown area, seem to represent Tucson's true being. It was good to feel the old, moist, European fogs dissipate from me, vanishing into this fresh, clear, wonderfully soft Western air. And—to get to business—I was happy, amused and intimidated finally to get to check out the American mineral scene at its most concentrated and headiest, here at what is, of course, the greatest mineral show in the world.

Fairly to survey and then report on this show turns out to be as daunting a task as I'd expected, this not only because I am rusty on American minerals and mineral people, but also because of the show's complex logistics. After many days of motel-hallway trudging and room visiting and revisiting I could wish nostalgically for the relative convenience of *any* European show (even Munich) where one can reasonably hope to see more or less everything in more or less one place, at one time. Here, not only are dealers frequently "out" and their rooms closed, but you may visit a room, absorb what's there, leave, then look in again two days later only to find that half the stock is different, so that you must begin the learning process all over again. And, in addition to the Executive Inn (where most of the mineral dealers hung out this year), there are the Desert Inn and Travelodge, with their ringers of isolated fine dealers disseminated among the lapidarists and fossil merchants. Anyway, pity the lapidary and gem folk who, to admire *their* kinds of jewels, must visit the *fifteen* other motels and hotels around Tucson which are crammed full of such things. To complete the strategic confusion there is the "main show" at the Convention Center, where new minerals one hasn't seen are likely to surface a full ten days after the first hotel dealers have opened their doors to hall-creepers; a sort of Puritan watchword for buyers, I learned, is "save some money for the Main Show." No studies presently are available on how widely this prudent but un-fun advice gets followed.

Like Tucson itself, this mammoth show sprawls good-naturedly over space and time, all overloaded with energy, money, obsessiveness, spontaneity, scholarship, schmoozing, honor and greed and good times. There is here a fairly stark contrast with any major European show, which will be energetic and schmoozy enough, to be sure, but which will breathe a relatively well-ordered and genteel cloisteredness. On a European show's fringes there will generally be just mild picnicking and cafe-hopping, a politeness of neat streets, spa gardens, and quaint, static scenery. But in Tucson, podner, with those mountains and cacti and general Western ambiance for backdrop, there is a certain funkiness. Observe, for example, the tall, mangy, lovable neo-counterculturalists, healthful mystics and blessers of strangers, who sell their handcrafted jewelry, Native American art and ambiguous little peace pipes from stands out along the freeway near the Travelodge. And even among the respectable there is *partying,* as typified, say, by the big barbecue at the Executive Inn one night for "international guests," and countless impromptu invasions of the local Western steakhouses and ethnic restaurants by crowds of boistrous, multinational mineral folk.

There were indeed international guests in plenty: it is necessary to speak, not only of contrasts between the U.S. and European show scenes, but also of the very free flow of enthusiasm, people and minerals between them. Munich properly bills itself as an "international" show, as do at least a dozen others in Europe, and if you don't pick up that special Australian piece from that Australian dealer in Tucson, well, you might get to have another go at it, and him, when you visit Munich. In Tucson the conversations overheard in hotel hallways are often in German, French, Italian, Spanish, Portuguese, Catalan, Norwegian, Hindustani, or (for that matter) British, Australian, South African, Texan or New Yorkish English. The questions that kept being directed to me about price-scaling differences between the U.S. and Europe are, I decided at last, largely anachronistic, largely based on forgetting the smallness, commercially, of the present world. I think I heard about as many dealers in Tucson observe that specimen prices generally are much higher in Europe, as I heard observe that they are much lower. Setting the tangential question of currency fluctuations aside, one can look meaningfully only at very local differences. Idaho pyromorphite, for example, is more abundant and cheaper here than in Europe, the reverse for French and Bad Ems pyromorphite; what *else* is new (in minerals)? And price and supply differences as functions of what might be called spheres of influence turn out to be just as predictable: Brazilian and Mexican minerals are commoner and cheaper in the U.S., Zaire and Moroccan ones are so in Europe. Nor did I notice *any* significant differences for things from really recent specimen provenances, like the Himalayas and former Soviet Union. This is One World, especially with regard to our little world of mineral collecting and selling.

It is hard to know where to begin discussing "what's new"—or even to know how to weigh the complaints of some dealers that very little was *really* new this year, as against the exultations of others that this was a *great* Tucson show—and I think and hope that they didn't mean this exclusively in a cash-flow sense. Yes indeed it was "great," assuredly so at least to the Tucson-virgin's eye, but there was also a general impression that much of the really fine material here had hit the show scene before, in earlier incarnations. And I'll also mention, since it's psychologically interesting, the slightly guilty jadedness that sets in when one sees room after room, ton after ton, thousands of really dramatic specimens, of things that, if in shorter supply, would be real show-stoppers for beauty and crystal sizes: Pakistani aquamarine, Spanish pyrite, Illinois fluorite, Indian apophyllite and zeolites. But even so, and for the last of these in particular, there's always that tiny group of pieces so marvelous as to excel all others definitively, and overcome jadedness with brute wonder: witness the two small cabinet specimens of apophyllite from Jalgaon, Aurangabad district, India (being shown by Ken and Rosemary Roberts, *Roberts Minerals,* Box 1267, Twain Harte, CA 95383), which were practically unbelievable, with 10-cm pale green crystals standing straight up like surreal skyscrapers from park-prospects of stilbite/laumontite canopy.

Besides, there's another and cheerier category I would reserve (call it "refreshing abundance") for other superlative mineralizations now coming on strong, without being sense-dulling drugs, at very reasonable prices. These include Touissit and Tsumeb azurite, of which magnificent small specimens could be had for under $200 in many rooms; Mexican hemimorphite (of which more later); Idaho pyro-

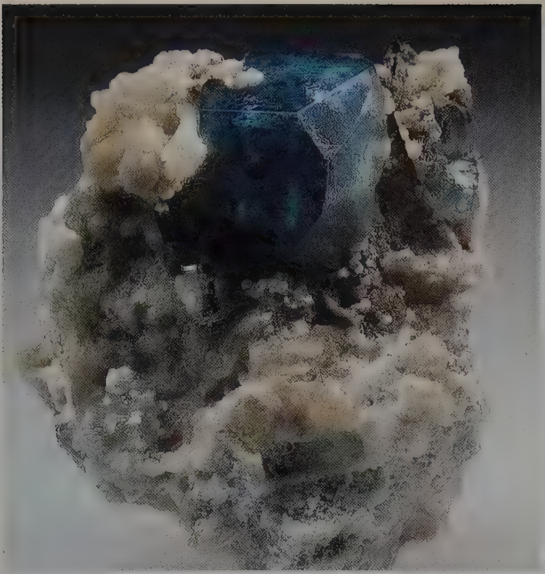


Figure 1. Blue fluorapatite crystal, 1.7 cm, from near Governador Valadares, Minas Gerais, Brazil. Roberts Minerals specimen.

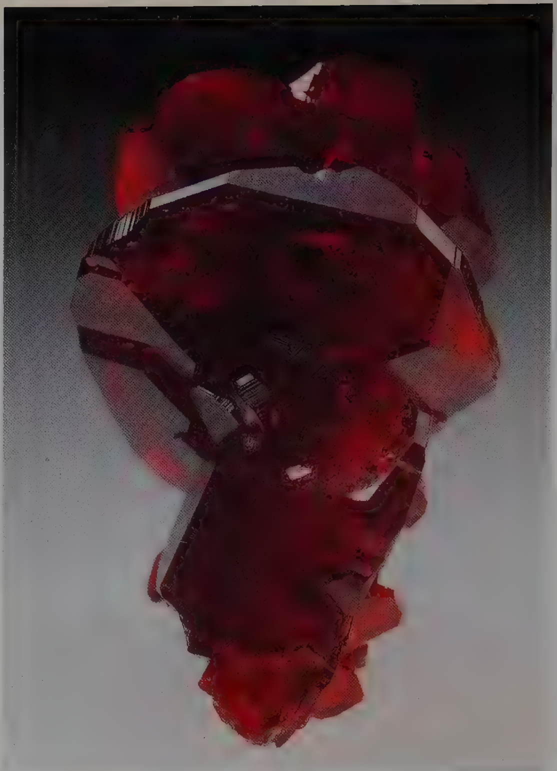


Figure 2. Uvite crystal group to 2.5 cm, from the Brumado mine, Bahia, Brazil. Roberts Minerals specimens.

Figure 3. Beryl crystal, pink and blue, measuring 18 cm across, from Laghman, Nuristan, Afghanistan. Kristallkeller Nürnberg specimen.

Figure 4. Vivianite crystal, 6.5 cm, on matrix with brown siderite microcrystals, from Morococala, Oruro, Bolivia. Gary Nagin specimen, now in the Martin Zinn collection.

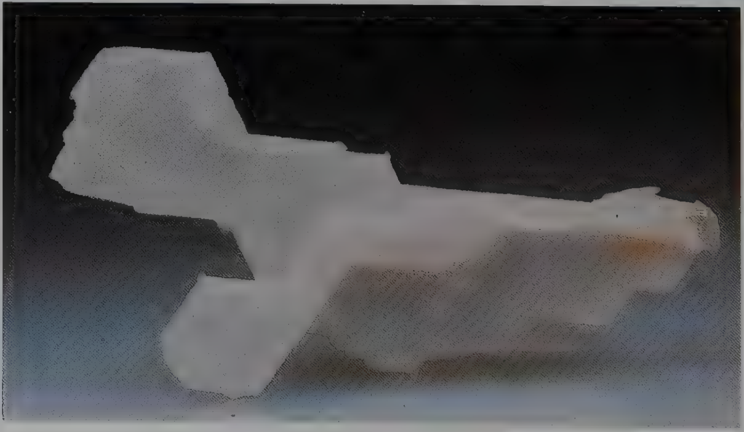


Figure 5. *(right)* Talc crystal coated by a thin layer of very fine-grained drusy quartz. Brumado mine, Bahia, Brazil. Carlos Barbosa specimen.

Figure 6. (above) Dioptase crystal group with blackish malachite crystal, 9.5 cm, from the Ray mine, Arizona. John Mediz specimen, now in the Dick Morris collection.

Figure 7. (above) Hemimorphite, 3.8 cm, from the 79 mine, Arizona. George Godas specimen.

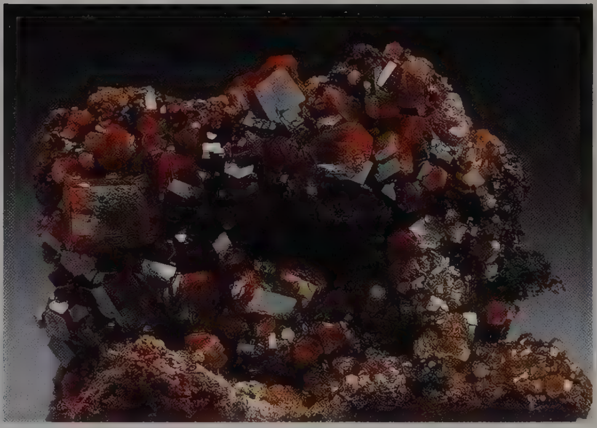


Figure 8. Vanadinite crystals to 5 mm from the 400 level of the Ramsey mine, 20 miles east of Quartzsite in La Paz County, Arizona. Mark Hay specimen.

Figure 9. (left) Allanite-(Ce) crystal, 1.8 cm, on dolomite, from the "Cerium level" of the Trimouns mine, Luzenac, France. Fabre Minerals specimen, collected in 1990.

Figure 10. (right) Stolzite crystals, 1.1 cm, on smoky quartz from the Fat Jack mine, Arizona. George Godas specimen.

morphite of the orange globular kind; Spanish and Manitoba gypsum; and Australian crocoite. There has probably not been, within most of our lifetimes anyway, a better time to pick up a top-quality specimen of these.

To business, then . . .

The Brumado mine in Bahia, Brazil, is being very busy these days, and feeling generous to collectors. Kicking around at the show were a few "killer" specimens (as they say) of well-formed ice-clear **sellaite** crystals on and off matrix. **Magnesite** in large rhombs of a comparable pellucid iciness was also moderately plentiful among the Brazilian dealers and a few gringos. Luis Leite (Av. 25 de Abril, No. 50, 3. Esq. 2800 Almada, Portugal) had **hematite** from Brumado in two interestingly different habits: fine miniatures and small cabinet specimens of very thin, very bright and sometimes rutiliferous plates resembling crystals from the Alps, and groups of frosty-lustered pseudocubes with individuals 2 cm across, these found last June. Carlos Barbosa (Rua Cel. Roberto Soares Ferreira, 586 Villa Bretas, 35030 Governador Valadares, Minas Gerais, Brazil) had gemmy red, cinnamon-brown and dark green flattened rhombs of **uvite** in fine thumbnail groups, and even a single superb thumbnail of zeunerite. And Roberts Minerals had Brumado thumbnails and miniatures of hematite, magnesite, uvite *et al.* that could make one stand in awe of this mine. Among the truly unusual new things from Brumado were some **talc** crystals, very flat and several centimeters across. They would probably have fallen apart in the pocket and been lost, but a thin coating of white drusy quartz on each side has preserved their shape, like little talc "sandwiches." Barbosa also offered, from Ibitiara, Minas Gerais, some glassy, yellow-brown, well-terminated **xenotime** crystals in loose sprays and singles to 3 cm.

Terminal Ltda. (Rua Pedro 1, N. 7-Gr. 607, Rio de Janeiro, Brazil) had some **aquamarine** of very peculiar aspect on show on the Desert Inn. The locality is Mimoso do Sul, Espirito Santo, Brazil—a 1990 find in a pegmatite prospect. The crystals range in color from a typical aquamarine-blue to pale green, not brightly lustrous on faces but clean and gemmy inside. The odd thing is the form: they are tapered hexagonal prisms three times as wide at the bases as at the tips, where, nevertheless, steep terminations are present; i.e. they come to a point like pencils. Specimens are either jackstraw scatterings on a microcline/quartz matrix or loose groups of two to five individuals. A range of sizes was available.

Tom Wolfe Minerals (P.O. Box 9791, Fountain Valley, CA) was selling some lovely thumbnails of **barite** from João Pessoa, Paraiba, Brazil: thin brownish-gray plates arranged in rosettes on a gray earthy matrix with drusy quartz. Tom also had, I might mention, a roomfull of very nice, very inexpensive fluorite thumbnails from a variety of well-known American occurrences: the Elmwood mine, Tennessee (slightly rough purple cubes with sphalerite); the Felix mine, Los Angeles County, California (pale green octahedrons); Bingham, New Mexico (pale blue cubes); and the Pine Canyon deposit, Grant County, New Mexico (rich purple octahedrons, slightly rounded, on remnants of etched quartz). The lover of limpid, small fluorites could have done no better than to stop at this room.

Over in the Travelodge, Thomas Gary Nagin of Crystal Springs Mining (Rt. 2, Box 1077, Royal, AZ) and Tony Jones (California Mineral Supply) were proudly showing the results of an importing coup scored just a week before the show—the best strike of **vivianite** from Morococala, Oruro, Bolivia since the great one of 1983 (see *Mineralogical Record* cover photo, Vol. 15, No. 3). These new ones are gorgeous, transparent, sea-green to greenish bluish black individuals, parallel growths and fans to 15 cm, very sharp and lustrous, with not too many cleavages or other wounds; some of the groups are on a glittery honeycombed matrix of brown siderite impregnated with pyrite and (probably) some rare phosphates.

Moving north in Latin America, some of Mexico's riches were at their best in the room of Peter Megaw (*Imdex, Inc.*, P.O. Box 40756, Tucson, AZ 85717). Indeed, one of the show's few *truly* new finds, seen here in about a dozen miniature and cabinet specimens, was **jarosite** from a "sensitive" and as yet undisclosed locality in Chihuahua. Considering that this is probably the world's best jarosite, its relative undazzlingness might easily be forgiven: dark reddish brown, sub-resinous crystals in thin aggregated plates standing on edge, in form vaguely resembling mica books. These were found solidly filling open seams and cavities in 3 to 5-cm vein fillings of massive jarosite in a light brown weathered volcanic rock. The largest cabinet piece I saw is about 12 x 12 cm, and reasonably attractive. A much bigger crowd-pleaser in Megaw's room (for a day or so, before they all got bought up) were some new **ludlamites** from the San Antonio mine, Santa Eulalia, Chihuahua, Mexico. About 35 absolutely top-notch miniatures and thumbnails were taken from a pocket entered just three weeks before the show; they are vividly glassy, pale green sprays and subparallel bundles of crystals to 5 cm, on matrixes of pale brown siderite sometimes showing small rhombs. A typical fine thumbnail would go for about $200. Finally, Megaw offered some wonderfully clean, bright, shapely Santa Eulalia **hemimorphites** of the familiar "wheatsheaf" habit on dark brown iron oxide matrix, and thumbnails from a now 4-year-old strike of nice yellow-brown **mimetite** in solid groups consisting of little round, slightly rough-edged bouquets of columnar crystals without matrix. The mimetites and new/old hemimorphites were fairly widely available in other dealers' rooms too.

Now for several nice new Arizona discoveries. In early January of this year, Dave Shannon, Dave Smith and Dave Lare hit an old adit in the old Planet mine, La Paz County, Arizona, full of dramatic and *natural* (though perhaps post-mining) **chalcanthite** of vivid "laboratory" blue color, occurring as brittle twists and ram's-horn curls, sometimes densely matted in bundles and forests, on a chalky, friable matrix of altered copper ore. "These specimens have been dipped in mineral oil to help retard dehydration," the labels forthrightly admitted. Cabinet pieces in Lare's room (*Jeffrey Mining Company,* Rt. 1 Box C-20-A1, Saulsbury, TN 38067) ran up to $300, but small specimens, here and elsewhere, were very cheap, and these brightly idiosyncratic specimens are most desirable—good for wowing your non-mineralogical neighbors and great aunts.

Last fall John Mediz brought out of the famous Ray mine at least 10 flats of specimens, all sizes, of extraordinary **dioptase**. One 8-cm piece, for example, shows good, deep green, 5-mm crystals underlain by a drusy dioptase crust, filling, in turn, an irregular cavity in chrysocolla-stained rock. This would be good dioptase for almost *any* locality, and may be, some say, the best ever dug in Arizona. The specimens are presently being sold by the "Arizona Minerals" field-collecting team of George Godas, Mark Hay and Dick Morris.

Mark Hay and Dick Morris have been working two new Arizona localities. The Ramsey mine, east of Quartzsite in La Paz County, has been yielding fine **vanadinite** in mottled brown-green crystals with high luster. And an undisclosed locality near Kingman in Mohave County has been producing excellent cabinet specimens and miniatures of lustrous white to transparent **calcite**. The crystals, in hexagonal prisms and steep scalenohedron/prism combinations, are reminiscent of old Cumberland and St. Andreasberg specimens.

George Godas has been having good luck at the famous 79 mine. He recently collected several hundred specimens of attractive, blue botryoidal hemimorphite there. These differ somewhat from the earlier specimens known from there, in that they are on a blackish oxide matrix rather than a pale limestone matrix.

David Bunk (9240 W. 49th Ave., #317, Wheat Ridge, CO 80033) had a variety of interesting Colorado material. Prominently attractive were some very sharp **rhodochrosite** rhombs (mostly thumbnails) from the American Tunnel, Silverton; good **barites** from almost everywhere in Colorado, though the lovely transparent colorless singles on matrix from Book Cliffs, Grand Junction, deserve special notice; and much Eagle mine material, including excellent thumbnails of **polybasite** in bright metallic black clusters of sharp hexagonal plates. These last were a real surprise for me, accustomed as I am to seeing such polybasites from old German and Czech localities—the Eagle mine examples are said to have been found in the 1970's, in a small feeder tube of silver-enriched ore leading into the main orebody, and thus are likely to be a one-time thing.

Mike Haritos (*S.T.D. Mineral Company,* 22 Spring Hill Rd., Hyde Park, MA 02136-4013) enjoyed a good day recently in the classic old Lane quarry near West Springfield, Massachusetts, taking from a brecciated zone in the quarry floor about 100 fair to excellent small specimens of bright black wedge-shaped **babingtonites** to 1.5 cm, nestled in crannies between lime-green prehnite spheres.

And—last stop in the U.S.—Dick and Joyce Willis (*Willis Earth Treasures,* 116 Prospect St., Stewartsville, NJ 08886) had some huge groups of Sterling Hill **franklinite**, brought out last summer just ahead of a flood on the lower levels of the great mine. The groups, as etched free of the enclosing calcite, feature solid crusts of quite sharp (i.e. only slightly rounded) franklinite octahedrons averaging 2 cm, largely free of damage. The largest specimen ($2500) is about 25 cm long by 6 cm high and has a single 8 cm octahedron sitting up nicely on it; they had about 12 other large cabinet pieces.

It was good to see many European people of my acquaintance here, but European *minerals* were, on the whole, sparsely represented (except for super one-of-a-kinders scattered about, of course). Perhaps the most notable European entries were those brought from Scandinavia by Peter Lyckberg (Box 31042, 40032 Goteborg, Sweden). Here were loose Norwegian **anatases** to 4 cm long, a few fine, small Kongsberg wire **silvers**, and a handful of brilliant sharp floater pyritohedrons of **cobaltite** from the Håkansboda mine, Sweden. Also, a 1989 pocket at Malmberget, Sweden (see my Scandinavian report, Vol. 22, p. 43) yielded some spectacular large specimens of glowing orange, transparent **calcite** dogteeth (and an occasional butterfly twin), in 10-cm clusters; only about 10 really good ones were available, although winning little **stilbite** thumbnails from Malmberget were more abundant, and less expensive.

Jordi Fabre (*Fabre Minerals*) in the Executive in had some excellent **allanite-(Ce)** to a centimeter or so from a find at the Trimouns mine, Luzenac, France in 1990. The crystals are a peculiar brown-green-pink, in flat blades on white dolomitic matrix. Alain Carion, at the Convention Center, had more of the **parisite** and **bastnaesite** from the same discovery.

Giuseppe Agozzino (Via Porta Soprana 13/3, Genova, Italy) had some flats of very appealing **amethyst** from a roadfill quarry near the village of Osilo, near Sassari, Sardinia. The prismatic form is that of typical quartz and the amethystine color is pale to medium, but the transparent crystals sit up pertly, alone or in parallel "cathedral" groups, on drusy quartz. They are very beautiful, and do not really resemble Mexican or any other amethysts I have seen; they were available in a range of sizes.

And now to Africa. I have already mentioned the "refreshing abundance" of good Tsumeb azurite at this show, and will add that much other classic Tsumeb material was also round. Don Olson (P.O. Box 858, Bonsall, CA 92003) had some intriguing *new* things from what is reported to be a *third* oxidized zone, down around the 44th level of the mine; minerals from these depths include superb dodecahedral **cuprite** crystals to 2 cm; and blocky, bright yellow **legrandite** crystals to 1 or 2 cm growing in micaceous 5-cm crystals of white **leiteite**, some with included yellow **renierite** blebs to 2 or 3 mm. It is quite likely that yet more Tsumeb surprises await us, as the mine goes into its very last years.

Several dealers had some excellent things from the Wessels and N'Chwaning mines near Kuruman, Black Rock District, South Africa. Calm yourselves, now: **rhodochrosite** from N'Chwaning is still lying low: there were only some pretty, milky pink Coloradoesque groups of 5-mm rhombs. But two recent pockets play rather remarkably in other keys. In one, at the Wessels mine, the by now familiar small pale yellow, sharp hexagonal prisms of **thaumasite** occur with white fibrous-radial balls of **xonotlite**, and with coarser fibrous crystals, also in radiated spheres, of a pinkish-orange **inesite** which, for general attractiveness, easily matches the gray-pink inesite of California. In the other pocket, at the N'Chwaning mine, wall linings of white glassy calcite crystals nicely set off brilliant metallic black **hematite** and **hausmannite** and the rare **todorokite**, the two H minerals in really splendid crystallizations. The hausmannites are sharp stepped pyramids to 2 cm, sometimes lightly frosted with calcite, while the hematites appear as pencil-point-tapered hexagons (hard to orient), of highest luster. From N'Chwaning also comes glassy bright yellow **charlesite** (a member of the sturmanite/ettringite group) which looks like sulfur, feels just as greasy and has just as low a specific gravity (being, the knowledgeable say, almost half water by weight). The most prolific supplier of these South African goodies was the team of Clive Queit, Bruce Cairncross, Ludi von Bezing and John Glidden, all of Johannesburg; but Don Olson had superlative hausmannites, inesites, and charlesites, and Mike Haritos was flashing around a knockout xonotlite specimen, with about 15 3-cm white silky spheres lining a cavity in matrix.

Roberts minerals had some of the best new "primary" **malachite** crystal groups from the Mashamba West mine in Zaire. These are wonderfully sharp, with gleaming, lustrous prism faces, at least as attractive as the older classics from the Onganja mine in Namibia. (Incidentally, the Lidstrom Trophy this year went to Al Partee for a Mashamba malachite.)

Back in the mega-specimen category, Wayne Thompson (1723 E. Winter Dr., Phoenix, AZ 85020) had a showcase-full of gigantic red **elbaite** crystals from the Otjua mine near Karibib, Namibia—this is a pegmatite that has been sporadically productive for years, but the super pocket was hit in November 1991. We are talking prisms 20 cm long and 8 cm thick, with flat basal terminations, and of a deep blackish red, approaching transparent gemminess near the tips. There are about 10 of the huge singles, including one specimen with the tourmaline resting flat on a blocky quartz crystal, as in classic California pieces. Best of all, large areas of some prism faces are solidly encrusted with sharp plates of blue **apatite** to 1 cm across.

Bryan Lees (*Collector's Edge*), at the Convention Center, had a large number of green **elbaite** crystals, 2 to 10 cm or so, from the same location in Namibia (the Otjua mine near Karibib) as produced the beautiful, dark red crystals in Wayne Thompson's room. Bryan also had Russian minerals, including a superb **sperrylite** from the Talnach deposit near Norilsk, Krasnojarskij Kraj region, northern Russia. Van Scriver/Plajskov minerals had a similar sperrylite.

Experienced China hand Doug Parsons (1119 S. Mission Rd., Suite 243, Fallbrook, CA 92028) had about half a cliffside's worth of variously sized specimens of what are still fairly exotic-seeming **stibnites** from the Xikuangshan antimony mine near Lengshuijiang, Shaoyang County, Hunan Province, China. Doug assures us that this orebody is so vast that the mine will keep going for a long time to come. New to me, though, were the loose, thin, terminated shafts of **valentinite/cervantite** (X-ray confirmed) pseudomorphs after stibnite from Xikuangshan: earthy brown, sharp and very clean, and at least as good as any stibiconite pseudomorphs from Mexico I've seen; the longest crystal is 22 cm and sold for $450. And center-stage in Doug's room were what have to be the two finest **orpiment** specimens anywhere: amazing plates 40 and 30 cm in widest dimension respectively, with brilliant deep orange crystals to 3 cm poking into the cavity from calcite and massive orpiment matrix. The locality for these is the one already famous for world-class realgar/calcite specimens: the Hunan realgar mine, Shimen, Hunan. In Doug's room also, of course, were nice sideshows: Chinese **bournonites**, **wolframites**, **scheelites**, **fluorites** and others, mostly in the smaller sizes. Imagine what might

Figure 11. Legrandite crystal, 1.3 cm, in leiteite from the 44 level of the Tsumeb mine, Namibia. Don Olson specimen.

Figure 12. Leiteite crystal, 6.3 cm, with small, embedded, yellow renierite crystals from the 44 level of the Tsumeb mine, Namibia. Don Olson specimen.

Figure 13. "Primary" (i.e. non-pseudomorphous) malachite from the Mashamba West mine, 4.9 cm, Zaire. Roberts Minerals specimen.

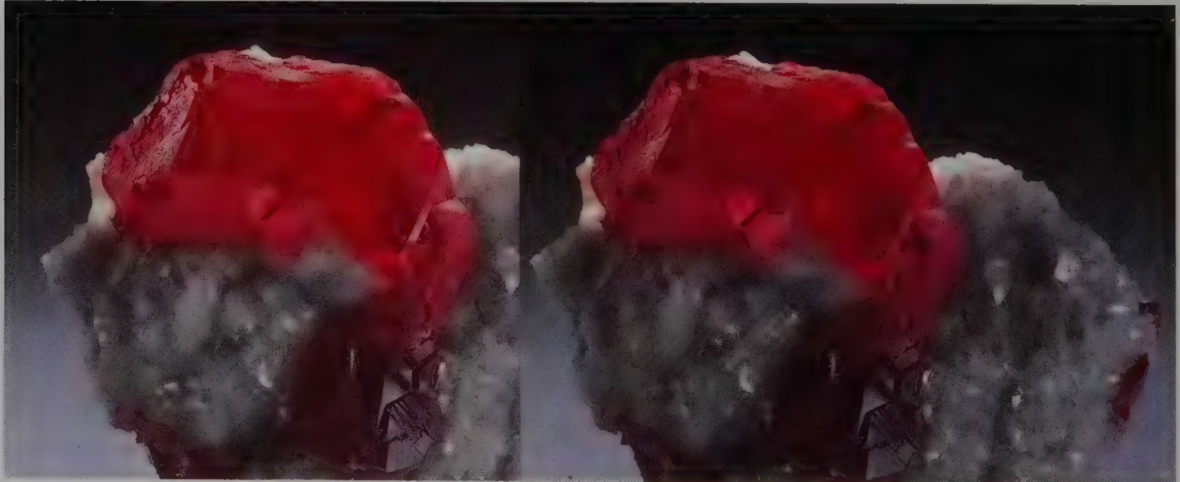


Figure 14. Cuprite crystal, 1.9 cm across, from the 44 level of the Tsumeb mine, Namibia. Don Olson specimen. (Stereopair)

Figure 15. (far left) **Sperrylite crystal, 1.7 cm, in sulfide matrix from the Talnach deposit near Norilsk, Krasnojarskij Kraj region, northern Russia. Bryan Lees specimen, now in the Carnegie Museum collection, Pittsburgh.**

Figure 16. (left) **Sperrylite crystal group, 2.4 cm, in sulfide matrix from Talnach near Norilsk, Krasnojarskij Kraj region, northern Russia. Van Scriver/Pljaskov specimen, now in the William Pinch collection.**

Figure 17. **Scheelite crystal, 4.5 cm, from the Tenkerchin mine, Chukotka region Magadan Oblast, northeastern Russia. Van Scriver/Pljaskov specimen.**

Figure 18. **Betekhtinite crystal groups on matrix, 10 cm, from Dzezkazgan, Kazachstan. Alexander "Slash" Agafonoff specimen, collected several years ago.**

Figure 19. **Ferroaxinite crystal, 3.8 cm, from Paiva, in the Polar Urals, Russia. Hans-Jurgen Wilke specimen.**

appear when and if China, too, de-communizes, and mineral export channels widen still further.

I can't think of a better lead-in than that for what has to be the climax of this survey: what's new in former-Soviet-Union minerals. While still not exactly abundant, Russian minerals old and bewilderingly new were fairly easy to find around the Executive Inn, as were folks with Russian-mineral-related stories to tell, many of these stories a little paranoiac around the edges, and some quite true and some quite false and most in-between; who knows? The Fersman Museum of Moscow had an Executive Inn room where mostly non-executive-quality Russian things were available; but they were *interesting* things for mineral devotees, for how often has one seen whole large flats of loose, crude, 5-cm **phenacites**, with mica schist adhering as if to prove that the crystals indeed are from the classic old Sverdlovsk, Urals locality? And from the Fersman people one could pick up a really good thumbnail of Dalnegorsk **pyrrhotite** for only $10.

Ben de Wit (Burg. Bloemerstraat 1, 7271 Da Borculo, Netherlands) bears tales of having lived for some months in a Ural village very near the Sverdlovsk mines, and he has minerals from all over Russia to show for it, too. Then there are Forrest and Barbara Cureton (*Cureton Mineral Company,* P.O. Box 5761, Tucson, AZ 85703-0761), with a few gorgeous miniatures of **gypsum** from Gaurdak, Turkmenia: absolutely transparent, colorless, well terminated thick prisms. And Dr. Hans-Jurgen Wilke (D-6116 Eppertshausen/Hessen, Germany) tells us that limited groups of German collectors are now being escorted into the Kola Peninsula to dig for the many exotic minerals there. With one-sixth of the earth's land surface, how can the former Soviet Union *not* keep laying new and fine things before us, through whatever channels, for decades to come—barring political catastrophes.

Let's look at some single-piece show-stoppers now, all of these having passed through the capable hands of Brad and Star Van Scriver and Jevgenij Pljaskov (12700 N. Bandanna Way, Tucson, AZ 85737), also veterans of Russian travel. The huge and beautiful **scheelite** crystal pictured here is from the Chukotka Peninsula, Magadan Oblast, northeastern Russia; the astonishing **creedite** was collected in 1977 at Mine #2, Akchatau, East Kazachstan. There were also large specimens of the rare sulfosalts **freieslebenite** and **betekhtinite**, both of which far excel any earlier specimens of these minerals from old European localities. *Their* locality is Dzezkazgan, Dzezkazgan Region, Republic of Kazachstan—already a classic, I'd say, among major world localities, as it is also the source of the wonderful wire **silvers** which have been showing up here and in Europe for the past couple of years. This 20-year-old copper mine is the source, too, of what are probably the world's best **bornite** crystals: sharp, tarnished isometric form-combinations to 2 cm sitting singly on matrix. And some superb, transparent yellow cassiterite crystals to 2 cm, on matrix, were available from Merek, Chabarovskij, Kraj.

Dr. Wilke of Eppertshausen, already mentioned, was showing off some unusual, and occasionally even pretty, specimens of rare minerals from the Kola Peninsula, Russia. From Lovozero comes **villiaumite** in mostly thumbnail specimens showing small cubic crystals and cleavages comprising most of the mass, and with a beautiful red-purple color. From the Afrikanda Massif on the Kola come excellent submetallic black octahedrons and cuboctahedrons of **perovskite**, with individuals to 2 cm across, loose or in matrix groups (average price $50). From the Chibiny Massif, Kola Peninsula, comes **loparite** in black penetration-twin cubes (like English fluorite), very sharp, in matrix, to 1.5 cm. The Chibiny Massif also gives up glassy opaque to translucent terminated thick prisms of **natrolite** to 5 cm in handsome cabinet and miniature clusters.

But when I first entered Wilke's room I was riveted, not by any of these, but by his exquisite thumbnail and miniature-seized loose crystals of **ferroaxinite**—almost true floaters, with nearly invisible points of attachment, since, as I later learned upon seeing a matrix piece, the axinite blades hang very tenuously onto their dolomite moorings. The locality was given only as Paiva in the "Polar Urals" of Russia. These crystals, even when they reach 6 cm long, are razor-sharp, of ideal triclinic ax-blade form, brightly glassy, and quite transparent except at the thickest central parts; their color is a rich, slightly purplish brown, much like that of French axinite. Word is that these axinites come from a 50-meter walk-in pocket discovered last year at a quartz mine which, alas, is quite inaccessible to Western collectors and, as a matter of fact, inaccessible to any humans except for maybe three months of the year, as it gets mighty wintry at that latitude. The occurrence is an Alpine-type skarn; associated minerals are quartz, dolomite and palygorskite, none of which make independently interesting crystal specimens. As for the future, well, there are probably going to be more fine axinites coming out, but supply routes, naturally, are variable, unreliable, even byzantine . . . stay tuned.

On Wednesday, February 12th, the Main Show triumphantly opened at the Convention Center. Purely for my own convenience I'll give my once-over-lightly (for this has already gone on long enough) survey of the minerals which appeared there, rather than try to fold everything into the rough geographical tour of localities above.

George Witters (7347 Crannell St., Boulder, CO 80239) had some first-rate specimens of dendritic **silver** from the 2500-ft. level of the White Pine mine, Ontonagon County, Michigan; the best piece is a 9-cm specimen of irreproachable aesthetics. These silvers show white calcite, not in the usual formless etched remnants but as clean transparent crystals to 1 cm nestled amid the branchings and forks of the bright silver crystals. Witters, as well as Richard Whiteman (*Red Metal Minerals,* Hwy. 203, P.O. Box 45, Hancock, Michigan 49930), had some delicately beautiful, tin-white thumbnails of the same stuff.

Chuck Turley (*Silver Scepter Minerals,* P.O. Box 1382, Richland, WA 99352) was the proud proprietor of a large lot of fine **epidote** from the Green Monster deposit, Prince of Wales Island, Alaska, taken out last summer by Arctic collecting ace Doug Toland of Juneau. Quartz crystals, some of them colored pleasantly green by byssolite or chlorite inclusions, liberally accompany the clean, bright, blocky chevron epidote twins characteristic of this famous locality; sizes for these crystals and for those of the longer, just as attractive, parallel-columnar groups, reached 5 cm. This, by the way, is still an actively productive locality, although access, of course, is limited, lest it become *too* active.

Bellavista Minerals Ltd. (Grossackerstr. 100, 8041 Zürich, Switzerland) put out a pristinely twinkling tablefull of the Alpine *Nadelquarz* ("needle **quartz**") much loved in Europe, and deserving of wider fame here, I'd say. These are icy sprays of very thin, delicate crystals in flat plates from the Bedretto Valley, Tessin, Switzerland (though the same stuff also occurs, just a valley or two away, over the border in Italy).

Not to be outdone, Arizona, too, has very recently produced some wonderful **quartz** from Scepter Hill, Santa Cruz County. Yes, these are winsome little scepters, some of them very faintly amethystine, some with small clay inclusions, of which a whole showcase-full formed one of the exhibits at the main show, courtesy of Bill Hefferan and Byron van Tassell of Tucson. After getting a first whiff, Hefferan searched in the field for seven years before finally locating and exploiting the pocket, and now several flats, mostly of thumbnails, were being very quickly sold off by Em and Ogle Love (*Em's Gems,* 8846 E. 35th Circle, Tucson, AZ 85710). While at this stand I was also shown a single small flat of old Bisbee specimens of auriferous **copper**: good bright specimens with visible dodecahedrons of copper, visibly filmed with native gold, forming sparkling dense branching aggregates. They are old Bisbee treasures brought back into circulation by Dick Graeme; $250 would buy a superlative miniature.

In the wholesale section, Hilde Sclar (*Oceanside Gem Imports*) had many interesting Brazilian minerals as usual. Among her stock were some new chrysoberyl twins from Teixeira de Freitas in Bahia. The crystals are typically sixlings, but in a more flattened habit than the famous Itaguaçu specimens. The largest is about 4 cm across and 1 cm thick, with a rather muted grayish green color.

Herb Obodda (Box 51, Short Hills, NJ 07078) had a stupefying array of great old classics of highest quality: large cabinet specimens were the biggest crowd-pleasers but I lingered long over his side-tablefull of thumbnails too. To give just a random survey, there were Cornwall bournonite, Japanese stibnite, Bad Ems pyromorphite, Neudorf galena and siderite, Schneeberg silver, Jachymov proustite . . . and so on.

And one of my old acquaintances from Europe, François Lietard (*Minerive,* Au Bois, 42520 Roisey, France), had fine large cabinet specimens of the "Polar Urals" axinite; aesthetic prize-winners of the Kazachstan wire silver; wonderful sharp green-brown "toenails" of **vesuvianite** from Bellecombe, Aosta Valley, Italy, with blocky striated crystals to 3 cm; gem-quality single crystals of orange and *purple* **scapolite** from Morogoro, Tanzania; some fine large Swiss "gwindels" of smoky **quartz**; and dramatic spiky orange 20-cm groups of **barite** with **celestite** and sulfur from the Machow mine, Tarnobrzeg, Poland.

Regular show-goers here and in Europe have grown accustomed—remarkably—to the great lodes of California crystallized **gold** at Wayne and Dona Leicht's booths (*Kristalle,* 332 Forest Ave., #8, Laguna Beach, CA 92651), and of course these cropped out once again here, but I'll close, sort of by way of saluting the future, by wishing luck to the Leichts' son David in his new mineral-selling venture—for what hotel-hallway creeper could wish otherwise for the dealership in the Executive Inn called "Fledgeling Minerals?"

I could go on for quite a while more in describing the *exhibits* at the main show, but will content myself with the briefest of respectful glances at a few of them.

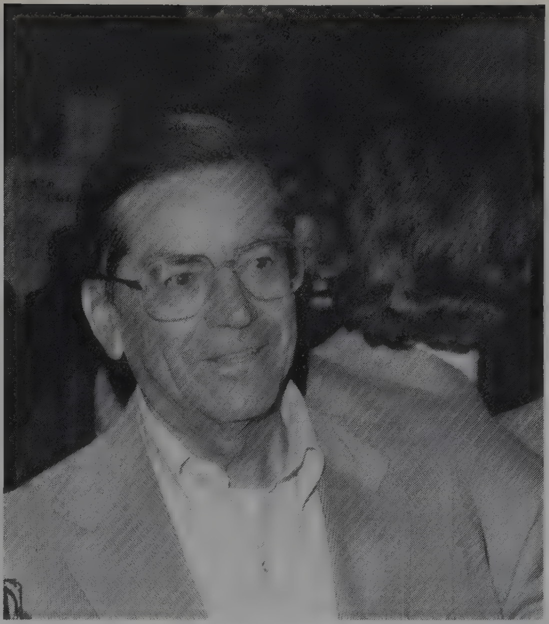
Since pyromorphite was the theme species this year, several cases were full of wonderful specimens (of course) of the mineral, the centerpiece being a single boulder-sized Bunker Hill mine, Idaho pyromorphite, billed as the best in the world, put out by the Houston Museum of Natural History. The Smithsonian also had an all-pyromorphite case, showing the ultimate standards for specimens from Bunker Hill, Bad Ems, Phoenixville, Correzé, Broken Hill, etc. Several other exhibits played around the same theme, e.g. the University of Arizona Mineralogical Museum's case of secondary lead minerals. The Narodní Museum of Prague brought over 20 of the finest pieces from that great collection, almost all old venerables from Central Europe. The Geological Museum of Copenhagen displayed some of the fine minerals of Greenland, with chatty, informative English labels, a geologic map of the island, and a big photo of barren moraines in the background, as in the effective cases I saw at the Museum in Copenhagen. Then there were the dazzling worldwide pieces from Miguel Romero's collection; Kay Robertson's Cornwall case; Robert Whitmore's New England minerals; the Geo-Literary Society's case in celebration of, and displaying rare old editions of books by, the great mineralogist Karl Friedrich Rammelsberg (1813–1899). The Desautels Trophy for "best rocks in the show" went to Bill Moller's extraordinary case.

But I must catch my plane back to Connecticut now, and begin trying, somehow, partly to de-mineralize my mind and sensibilities; it won't be easy. But show manager Marty Zinn says (and he is right) that I, and everyone mineralogical, *must* get to Tucson next year.

Thomas P. Moore
15 Lakeview Drive
Niantic, CT 06357

MIGUEL ROMERO RECEIVES CARNEGIE AWARD

Dr. Miguel A. Romero Sanchez, founder and director of the Museo Mineralogico de Romero (Romero Mineralogical Museum) in Tehuacan, Puebla, Mexico and "the man who singlehandedly saved his country's mineralogical patrimony," has won The Carnegie Mineralogical Award for 1991. The award was presented to Dr. Romero at the Tucson Gem and Mineral Show by Dr. James E. King, Director of The Carnegie Museum of Natural History.



Kent England 1985

Miguel Romero

In addition to discovering several new minerals, including mapimite and ojuelaite, Dr. Romero has amassed one of the world's best private mineral collections containing about 8,500 specimens, most of which are Mexican minerals and meteorites. Had he not acquired these specimens, they would have been sent to the United States or Europe for study and exhibition. Dr. Romero exhibits this collection, which is continuously upgraded by a team of trained mineralogists, in his museum. The museum is open to the public at no charge and is visited by scientists, tourists and thousands of Mexican children and students each year.

Dr. Romero's interest in minerals was sparked as an undergraduate at the Universidad Nacional Autonoma de Mexico (National University of Mexico) where he studied under Dr. Eduardo Schmitter at the Institute of Geology. Now he provides financial support and study specimens to Mexican college students pursuing degrees in geology or mineralogy today. He also operates an exchange program that enables students in Russia, France, Denmark and the United States to study Mexican mineralogy in his museum's fully-equipped research laboratory.

Dr. Romero was a founding member and first president of Sociedad Mexicana de Mineralogia (Mineralogical Society of Mexico), a group devoted to the scientific study and preservation of Mexican minerals; founded the Boletin de Mineralogia (Mineralogical Bulletin) which publishes articles on the mineralogy, petrology and geology of Mexico; and organized and raised funds for the First Mexican Mineralogical Congress held in June 1991. In the United States he has for many years exhibited Mexican minerals at the Tucson Gem and Mineral Show and served on the International Board of Directors of the Arizona-Sonora Desert Museum where he helped develop the museum's Earth Science Department.

Dr. Romero earned advanced degrees in organic chemistry and biochemistry from Harvard University and completed post-graduate studies in chemistry at the Imperial College in London. He is the director general of Desarrolo Technologico Division of Groupo Romero, which is world famous in the field of poultry raising for its methods and quality-control standards.

Nominations for the 1992 award should be submitted to the Mineral Museums Advisory Council Selection Committee, c/o Dr. George Robinson, Mineral Sciences Department, Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario, Canada K1P 6P4 or to Dr. James E. King, Director, The Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, PA 15213-4080.

Letters

BRAZILIAN AMETHYST

I returned yesterday (12 October 1991) from Rio Grande do Sul. There was some talk about the largest amethyst geode ever found having just been sold to a Japanese individual for approximately $100,000. I arrived a few days too late to see the piece, but was shown pictures of it and even managed to get a copy for myself. While attempting to determine the facts I spoke with Genesio Piouesan, one of the principals in the firm Legep Mineracão Ltd., who related the particulars concerning the geode.

It was found in one of the mines that Legep was operating in partnership with another individual around May 1991. There was some trouble agreeing on a price for the geode, so the partner sold his 50% interest in the geode to another individual, and after about six months a sale was effected. The mine is located about 4 km east of the small town of São Gabrial, which is not far from Frederico Westfallen and Irai.

The weight of the geode is 2,040 kg. The geode is 1.9 meters wide, 1.3 meters high, and roughly oval in shape, somewhat taller on the right than on the left, with a heavy, thick base. The individual amethyst terminations in the geode range from 3 to 12 cm in diameter, and are of the finest color. The "door" or "window" to this geode, which was removed so the interior of the geode could be viewed, was hammered down into faceting rough which was sold for $20,000. My photo shows at least one calcite crystal (10 cm?) growing in the geode. I did get to see—small consolation—the giant wooden box that it had been packed in for shipment to Japan. It was unusual in that it was somewhat trapezoidal in shape rather than the more standard rectangular boxes, and was studded with heavy iron straps over the edges.

Discussion soon got around to what was historically the biggest amethyst geode ever found in Rio Grande do Sul. Information about *this* giant was a little less precise because of the amount of time that had passed since its discovery in approximately 1978. It was found in the Demetrio mining area near the small town of Nonoai, which is about 20 km east of Planalto. Planalto is also not far from Frederico Westfallen and Irai. This monster was 1.5 meters deep, 3 meters wide and 2 meters high (approximately) and weighed 3,750 kg. The amethyst was, however, of a light color. It was sold by the firm of Iramos Lodi Ltd. to a Japanese client and is thought to be in Tokyo.

The above descriptions may give the impression that the maximum dimension of any big geode is 3 meters, but that is not so. Many geodes are long and skinny, and are found standing like trees or cone heads in the basalt deposits. I have seen one geode approaching four meters in length but not of very good color and this is probably not the record.

Most mining for amethyst in Rio Grande do Sul is now down underground. Ten years ago much of the mining was still conducted in open cuts, but now most mining is done by driving tunnels as far as 150 meters into the richest (for amethyst) basalt flows. The tunnels run approximately parallel to each other, leaving only enough rock between to support the overburden. These tunnels follow almost perfectly horizontal basalt flows which are exceptionally rich in mineralized amygdaloidal cavities sometimes less than a meter apart. The limiting factors are apparently ventilation and, to a lesser extent, the haulage of waste rock. Apparently 150 meters is about the limit for sufficient natural circulation of the air, and beyond that point powered ventilation would be required. The broken rock is removed by jeeps that have been converted into little dump trucks powered by small diesel engines.

Rock H. Currier
Jewel Tunnel Imports

Typical examples of faked (cast) octahedral gold "crystals" to 2.5 cm. Photo by P. Vollenweider.

FAKE VENEZUELAN GOLD CRYSTALS

Well-crystallized gold from Santa Elena, Venezuela, has been known for several years (see W. E. Wilson, *Mineralogical Record,* **18**, p. 89). Most of these gold crystals are hoppered or dendritic and, although exceptional in their own way, do not exhibit the perfection of octahedral development common to minerals such as pyrite and fluorite. Since early in 1990, however, nearly perfect octahedral gold specimens in the 1 to 30-gram range have been turning up on the mineral market. These specimens are purported to have also come from Santa Elena.

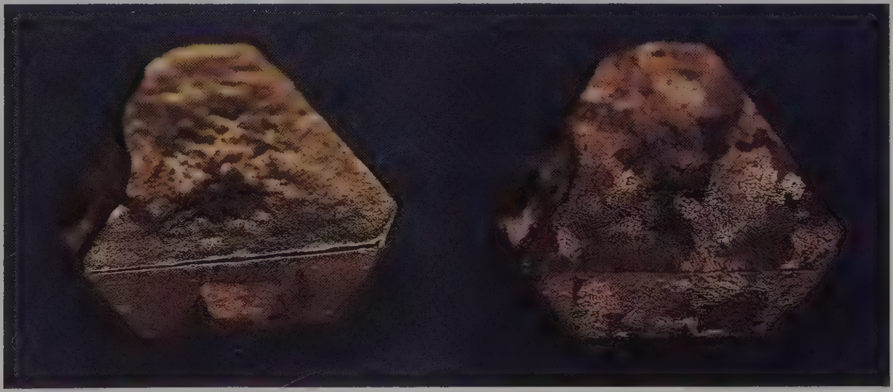
The unexpected perfection of these crystals is so striking that I began an investigation to determine whether or not they are genuine. Suspicions regarding gold specimens of this type seen at the 1990 Denver Show have already been expressed by Wilson (*Mineralogical Record,* **22**, p. 53). Recent analyses have now confirmed that all apparently perfectly formed, non-dendritic and non-hoppered octahedral "crystals" of purported Santa Elena gold which have been examined are man-made. They are, at least, made from real gold, as shown by microprobe analysis and a measured density of 15.8 to 18.4 grams/cm^3.

The faked gold crystals are always nearly perfect octahedrons modified by smaller cube faces. Some specimens are flattened on a three-fold axis, with two opposing octahedron faces much larger than the other six. The specimens show absolutely no sign of macroscopic dendritic growth. Inclusions of quartz or other gangue minerals are lacking, as are any indentations or imprints of attached or intergrown minerals which are typical of natural vein gold specimens.

How can these faked golds be distinguished from natural crystals? The best evidence is their polycrystalline nature, which is typical of specimens cast from molten metal; although having the external shape of single crystals, etching and X-ray tests clearly show that they are not. Etching the "crystals" in aqua regia (followed by a rinse in sodium thiosulfate to remove silver chloride) makes the polycrystalline structure stand out plainly, showing dendritic intergrowth of crystal domains which is characteristic of cast metal. Laue backscatter photographs and X-ray diffraction patterns obtained on single "faces" also demonstrate polycrystallinity.

Unfortunately, X-ray facilities are not usually available to the average mineral collector, and etching is destructive to the specimens. Therefore, most collectors will have to rely on purely morphological criteria, although these do not provide absolute proof, and should be confirmed by etching or X-ray tests whenever possible.

Faked "crystals" have an unnatural appear-



Faked 1-cm gold "crystal" shown before *(left)* and after *(right)* etching in aqua regia. Note dendritic intergrowth pattern of crystal domains visible after etching. Photos by P. Vollenweider.

ance because of the perfection of the "faces," the lack of inclusions or contact points, the featureless surfaces, and the slight rounding of "crystal" edges. Usually at least one face is slightly concave, as would be expected from cast metal which contracts upon solidification. In some cases the edges are accentuated somewhat because of the concave faces. Microscopic bubbles on the "crystal" surfaces are also clear evidence of casting rather than natural crystal growth.

The chemical composition of faked and natural Santa Elena gold was compared using qualitative microprobe analysis. The natural crystals consist of nearly pure gold alloyed with a small amount (<1%) of palladium. The faked crystals are rich in silver, and contain a considerable amount of copper as well. Due to the silver content, the faked specimens are of a lighter yellow color than the natural crystals.

Although the fakes are obviously castings, each specimen is different in shape. It is most likely, therefore, that some variant of the "lost wax" casting technique was employed. Judging from the habit, as Wilson (1991) observed, it appears quite possible that artificially grown alum crystals were the basis for the replications. Embedded in a molding compound, alum crystals could easily be dissolved out with hot water, and molten gold then poured in.

These gold specimens are insidious fakes which are difficult to distinguish with certainty from natural gold crystals. Collectors and curators are advised to exercise caution and to carefully investigate suspicious specimens.

Beda Hofmann
Natural History Museum
Bern, Switzerland

MISORIENTED CRYSTAL DRAWINGS

Having had occasion to make a number of crystal drawings for my books, I offer this advice to those who expect to use such drawings in the future: you must never assume that the graphic designer responsible for inserting illustrations in the text knows how crystal drawings must be oriented in accordance with existing conventions. On the contrary, you must assume just the opposite: that the drawings may be oriented according to the artistic sensibilities of the designer, or, lacking any clue whatsoever, by sheer guesswork.

If you believe misorientations are uncommon, consider these few examples that I have noted over the past few years. They occurred in all types of literature and in various countries. The splendid color-plate *Atlas Mineralu* (Prague, 1907) shows misoriented crystal drawings in figures 7, 10, 11, 32, 70, 72 and 73. William P. Blake's "The various forms in which gold occurs in nature," in *Report of the Director of the Mint* (1885), most valuable for its otherwise splendid collection of crystal drawings of gold, unfortunately has eight out of 17 in error! Bolman's *Handboek voor Edelsteenkunde* (1950) contains many drawings in error, e.g., figures 21, 22, 64–66, 93, 94, etc., and many others crudely and inaccurately drawn. Almost unbelievable are the three out of four misoriented gold crystal forms on the corners of the fancy cover of Harry Emanuel's book, *Diamonds and Precious Stones* (1867)! Just recently, Torgier T. Garmo of Norway must have been annoyed to discover that several figures of zircon and garnet, among others, in his *Norsk Steinbok* (Oslo, 1983) were misoriented. Augustus C. Hamlin's fine *Leisure Hours Among the Gems* (1884) contains two errors involving the same doubly terminated Ceylon sapphire crystal, one printed inverted in gold upon the spine, and the same, in color, upon the plate facing page 367. George P. Merrill's *Non-Metallic Minerals* (1904) has two misoriented garnet crystals on page 194. Yuri Orlov's *Mineralogiya Almaza* (Moscow, 1973) has a blue diamond crystal to the right of the silver cover title that is upside down. William D. Panczner's *Minerals of Mexico* (1987) is unfortunately rich in misorientations, probably due to the lack of clues upon the drawings; I counted 16 between pages 86 and 394. Jay Ellis Ransom's *Gems and Minerals of America* (1974) has many errors in the drawings on pages 124–125.

In all fairness to book designers, the mistakes noted herein are most likely to occur when drawings lack any letter or symbol clues such as axial letters or plane symbols, or ragged bottom "break-off" places. Lacking such clues, graphic designers uneducated in crystallography tend to orient drawings to suit their own esthetic tastes or to conserve page space. An example of the last is placing an elongated crystal on its side instead of erect. Particularly confusing to designers are all of the more complex crystals of the isometric system. Poor garnet!—it is liable to appear in every attitude except the correct one.

Most authors assume that they will be permitted to see the final proofs prior to printing but this is all too often not the case and that's where so many glaring errors occur. In fact, most publishers that I have had experience with consider that the author should see only the words and only the captions to the illustrations. Unless an author requests page proofs that include illustrations, he or she may be embarrassed by the printed work when it appears.

John Sinkankas
San Diego, California

[Ed. note: Authors of articles in the Mineralogical Record *always receive full page proofs showing crystal drawings in place.]*

SPANISH MINERALS

In your annual review of the year's mineral discoveries, there is a common mistake in the section on Spanish minerals: The source for the fine, well-known sphalerite specimens is not the Reocin mine, but rather the Aliva mine. It is located about 75 km to the west, near Espinama, Cantabria province (formerly Santander province), Spain. This small mine, situated in the Picos de Europe range, is an underground operation worked on a small scale only during the summer months because of heavy winter snowfall at that altitude. Sphalerite is the major species of collector interest. But galena crystals, dolomite, calcite and scarce dolomite pseudomorphs after calcite are found there as well.

The Reocin mine is actually the marcasite occurrence at Reocin near Torrelavega in Cantabria province. This mine is a large open-cut operation owned by "Asturiana del Zinc." The Pb-Zn-Fe orebody is the largest of its type in Europe. The sphalerite at this locality is massive only; and, although the marcasite specimens are relatively fine they are somewhat unstable.

Miguel Calvo
Zaragoza, Spain

UNASSISTED STEREO

With regard to the excellent stereopairs in the recent issues of the *Mineralogical Record,* some of your readers may be interested in attempting to view them in 3-D without the aid of a stereoscopic instrument. A simple method is to hold an index card vertically on the "seam" between the two photographs and view the left photograph with the left eye and the right photograph with the right eye. The key is in forcing the eyes to maintain parallel lines of vision and then trying to merge the two images. This merging is the most difficult part and may require some practice. Once mastered, the index card will no longer be necessary.

G. S. K. Rao
University of Manitoba

ABOUT OLD LABELS

I read with great interest your recent editorial note on old labels (vol. 22, no. 4, p. 250). I couldn't agree with you more, and cannot imagine why some collectors throw away the provenance of their specimens. In fact, I will sometimes buy a piece just for the old label, and on occasion will regard the label as more valuable than the specimen. As an example, last November in Munich I found an average pyromorphite from Dognacska, Hungary, with three labels (see photo). The second label was of A. Berger, Vienna, ex sammlung Dr. Lechner. That was enough for me to snatch up the piece; you can imagine my excitement when back at the hotel I found the third label, most probably in Lechner's own hand.

One point that you did not mention was that some dealers retain the old label, but mutilate same, I guess because they do not want their customers to know the old price, or do not want anyone to know the name of the original dealer.

This brings me to a similar subject which I have been thinking about for quite some time. I am sure that many collectors, as I do, have a few excellent specimens that came with no label at all. I am not one to just attribute a locality because the piece "looks like" it is from such and such. However, I do know that certain pieces are very obvious as to their origin, and can be attributed correctly. Perhaps there could be a case at the Tucson show devoted to nice specimens for which the localities are not known. This would probably have to be on a reservation basis, limited to two or three pieces per collector, or first-come-first-served. Each piece would be numbered, with a notebook near the case for knowledgeable viewers to give their opinion on origin. I have two great pyromorphites that have been sitting in my cabinet for years; I have never seen any similar specimens. Perhaps with the huge fund of experience passing through the exhibits, somebody would know where my specimens, and others, were found.

John Marshall
Dedham, Massachusetts

You make an excellent point about the mutilation of old labels to disguise original source and price. I hope collectors have matured beyond the point where an old (low) price on an old label causes them to think the modern price is out of line. Those old price notations are valuable historical data, and will become ever more interesting as the years pass. All we could ask in addition would be that the year of sale had also been marked, but unfortunately that was almost never done. For modern first-purchase specimen labels, however, the buyer can write the purchase date in under the price, and thereby create a small historical document of lasting value and interest, to be handed down to all subsequent owners of the specimen.

As to cutting off the parts of labels which would divulge a dealer's proprietary information regarding source, that practice totally destroys the historic value of the old labels. There is no point in doing so; it would be better to simply write out a new label and donate the old one to the Record Archive.

Your idea of creating a show exhibit of specimens which have lost their locality data, and asking for attributions from the public, is excellent and I hope some show will adopt it. Ed.

I have some 19th and early 20th century mineral specimens which are badly in need of cleaning. The problem is that they have equally old paper labels or "tickets" affixed to them. Can anyone in the museum community suggest how the labels can be safely waterproofed, and conserved, so that the specimens can be washed?

Peter Tarassoff
Beaconsfield, Quebec

I used to affix small labels like that to my own specimens, after coating the labels front and back with Duco cement as a sealer. It worked perfectly. Perhaps the best approach would be to soak off or carefully peel off your old labels, wash them gently, dry them, and then coat them in this manner before gluing them back on to the specimens. Do readers have any other suggestions? Ed.

LOCALITY NOTATIONS

In response to the guest editorial by Pete Dunn in the September-October, 1991 issue of the *Mineralogical Record,* there is another logical method of locating mineral localities—the state topographic grid.

In Tennessee, the state Division of Geology for many years has published the locations of quarries, mines and prospects referenced to the state topographic grid. These coordinates consist of a northing and easting pair, measured in feet. This coordinate grid can be found marked along the edges of any recent 7½-minute topographic map issued for the state (many maps issued before 1950 usually do not have this grid).

Even here in the well-vegetated east, coordinates can be measured from the map if one pays attention to where they are. A few good compass bearing intersections, where feasible, definitely help. Surveying is an excellent, but expensive way of gaining coordinates, but I doubt such accuracy is needed, unless you're trying to recover the location of a drill hole.

As a practicing economic geologist, I can assert through experience that many old, abandoned prospects and mines do not have grid maps available. Those that may exist at operating mines may or may not be available for "public consumption" and may not be tied into a state grid but rather a locally derived grid. Using a mine's locally derived grid would cause tremendous confusion because of the plethora of such grids that may exist.

Property survey maps are available at the courthouse only if the plat has been registered (not always required). Even if a plat is registered, it may not be tied into a grid. In some counties, property tax maps may have the state grid along the edge of the map. In this case these maps may be more useful than a topo map in that they are usually at a scale of 1 inch = 400 feet. The drawback is that the county clerk may not be able to readily furnish you with a map copy.

I agree that using U.T.M. coordinates is a possible solution, but many American collectors, and even professionals, do not use the metric system. Even when doing work for a Canadian client on a prospect in the southeastern U.S., I was instructed to give all dimensions in my reports in feet, inches, acres and tons (not meters, centimeters, hectares, kilograms or tonnes).

In summary, I would argue that use of state grid coordinates is an excellent way to provide "permanent" coordinates for mineral localities, far more useful than the range and township designation, although that system should be used in addition when it is available.

Incidentally, the new portable satellite positioning units should make locating surface sites far easier than contracting with a surveyor. A local surveying/mapping firm tells me that they use large portable units to get the coordinates of control points for preparing maps from an aerial survey. Reported accuracy is one one-hundredth of an inch while that for hand held portables is 15 meters.

Travis A. Paris
Knoxville, Tennessee

ANTIQUARIAN REPRINTS

Yesterday I received your latest reprint, *Museum Regalis Societatis.* I like it very much because it is very well done. Not only is the quality of the reprint very good, but also the binding, in my opinion, is excellent.

I own a substantial collection of old books about mineralogy and mining myself, and enjoy it very much. So I really know how difficult it is to get hands on certain books. That is why I think it is a very good idea to reprint some old and scarce ones in high quality. I can only guess how much work it must be to do this, but I would like to encourage you to continue this series.

Thank you for all your efforts and keep on going.

Heinz A. Rieckert
Seeheim-Jugenheim, Germany

SMOKEY BEAR QUARTZ

After reading the article about the Smokey Bear quartz claims in New Mexico, I am concerned and revolted by the action of the U.S. Forest Service. Beside the recent action in the Sawtooth Mountains of Idaho, I am distressed by the attitude of some local Forest Service officials. I am alarmed at the apparent loss of our basic mining rights. Do we have to sit still or lay down dead while the Forest Service bureaucrats impose on us the concept of stealing government property, in the process of mining or prospecting? If the statute 18, U.S. Code 641, applies to the removal of mineral and rock specimens, we collectors are reduced to the status of plain vandals.

Should we ask who owns the rocks and minerals in the forest reserves? What was the original concept or mandate for the Forest Service? (From the U.S. Congress?) I had thought that serving as custodian of the timber resources in the National Forests would have been the primary objective or mandate. But as I see the destruction currently involved in the clear-cutting of ancient forests in order to sell the logs to Japan for a profit, I am thinking that they have strayed a long way from their original purpose.

As to Forest Service jurisdiction over rocks and minerals, why aren't the U.S. Bureau of Mines or even the U.S. Geological Survey empowered to decide about mining rights in U.S. forests?

Must we docilely accept the status quo, or can we by concerted action and a very loud howl in Congress reclaim our rights?

Norman Balcom
Garden Valley, California

COMMENTS ON "DIVERSITY"

Regarding Bill Smith's November-December guest editorial on "Diversity": The idea behind the Desautels Trophy seems very clear: to encourage exhibits of specimens that will excite and impress *everyone* (or at least the maximum percentage of people) attending the Tucson Show. All other factors including diversity have been declared secondary, for the purposes of this particular competition, by the Show Committee.

A person entering such a competition knows that he or she is obliged to select specimens *not* solely for *personal* satisfaction but to satisfy the judging criteria that will be employed by the judges (in this case, crowd-pleasing power). Personally, I have a large, systematic collection specializing in strange, unusual and scientifically interesting crystals, built over about 40 years. I could easily have displayed a good representation of many rare and exotic minerals perhaps exhibiting little aesthetic appeal but much scientific interest. However, the point of entering a competition is to win, so I selected aesthetic, crowd-pleasing specimens, according to the requirements, even though they do not necessarily reflect my overall collecting philosophy or personal taste.

It is true that an overriding emphasis on aesthetics limits the species list. But even in an exhibit where high specimen aesthetics is a requirement, scientific interest and diversity of species can be discerned. In my display last year, interest could be found in seeing (1) differences between specimens of the same species from different localities; (2) similarities in specimens of the same species coming from widely separated localities; (3) similarities in form and habit between native gold, silver and copper (all of which have the same crystal structure); (4) similar habits in crystals of widely differing sizes; (5) differences among specimens from the same locality or general area; (6) specimens of species having some commonality, such as a particular metallic constituent, e.g. copper, and so on. With characteristics such as colors, habit, size, composition and origin for comparison, each specimen, even a most aesthetic one of a common species, shows interesting relationships if a person will only look for them. Aesthetics and scientific interest value are not mutually exclusive, and, indeed, I find the scientific attraction of aesthetic specimens of a small number of species to be an equally valid criterion as having a larger number of species represented.

Gene Meieran
Phoenix, Arizona
1991 Desautels Trophy Winner

I read the recent guest editorial on diversity by Mr. Bill Smith with great interest. However, the further I read, the more of a discordant note it seemed to strike. I am a relative newcomer to this hobby and science, and certainly do not consider myself more than a very enthusiastic neophyte when compared to the old guard. I too have entered the McDole competition at the annual Tucson Show and was the fortunate (if undeserved in some eyes) winner in 1990.

Early in my collecting, I was in Colorado with Keith Proctor and several other collectors on the way to Mt. Antero for a week. I asked Keith what made a great mineral display. Keith proceeded to list twenty species on a napkin, beginning with tourmaline and beryl, gold, silver, azurite and wulfenite and ending with several choices in the phosphate group. Keith has sometimes been a controversial personality over the last 20 years in the hobby, but he has never been accused of not having a great display, often with significant duplication. These species are the same mineral species which seem to be in prominent display positions in many of the museums and large private collections I have observed over the last seven years.

The large number of gem crystals in Mr. Meieran's case was certainly evident to me as well, and I too would have preferred more diversity. However, the stated "reason for being" of the McDole Trophy and its successor, the Desautels Trophy, was to give recognition to the case with "the best rocks." This concept of recognizing the case with "the best rocks" is a unique award in the mineral world. An even more important function in my eyes was to bring the very best private collections out on public display to dazzle the audience at the annual Tucson extravaganza. Certainly, it accomplished the latter goal with collections such as Bill Larson's, Peter Bancroft's, Ed Swoboda's, John Barlow's, Steve Smale's, Dave Wilber's, Bill Moller's, Jim Bleess's, Julius Zweibel's, Les Presmyk's, Tom McKee's and the many other venerable participants. The public, as well as the mineralogical world, is often awe-struck by these sensational collections. Many of these collections are now residing in museums and require a specific trip to a far away location to be seen and appreciated.

The reasons for attendance at mineral shows are many. I believe that many amateur hobbyists and the general public attend and spend their recreation dollars to have a good time in a pleasant atmosphere with friendly people. A few may feel the need to expand their minds and choose the local mineral show, because of its educational exhibits. These are available from the various museums. For example, look at the great display on quartz by a Canadian museum at the recent Denver show. Certainly, this was worth photographing and studying in leisure hours, if one desired to understand and learn the concepts. When galena was the theme mineral at Tucson several years ago, the Smithsonian had a great display showing clearly the paragenesis of the secondary lead minerals.

However, even with a graduate degree in biochemistry, when I try to visualize that case, I keep seeing the great green Les Farges pyromorphite and not the clear depiction of chemical changes involved in the paragenetic sequence. The enjoyment of the aesthetic beauty of the minerals, and their ability to illustrate scientific information are not mutually exclusive; it is very much a personal choice and neither choice makes the lack of the other a tragedy. Either the appreciation of the aesthetics or scientific value are certainly acceptable expressions of mineral appreciation. Again I must state that the two concepts are not mutually exclusive and at least in my collection one seems to foster the other.

There are certain categories for competition in the AFMS which require diversity and which award points for variety as well as quality. If a collector desires to use his specimens of dickite and hanksite, these categories and classes of competition exist and can be utilized. However, the McDole and Desautels Trophies were created with essentially no rules, to be awarded to the most spectacular display of minerals of any kind. No further "reason for being" is necessary in my eyes.

As I continued to read the same issue of the *Mineralogical Record* I came upon Mr. Smith's excellent article on the Lechner mineral collection. The specimen photographs seem to tell a story in themselves. The museum-owned specimens pictured are all of dazzling pieces of both common and rare minerals from classic localities. The pieces chosen by Mr. Smith from this collection (which one might assume are his favorites) include a very dazzling garnet group from an old locality. I am sure that any of the listed McDole/Desautels participants would love to show this specimens in their display cases. But he also included several excellent but not quite so showy specimens from old European localities. The gentleman obviously practices what he preaches.

The concatenation between pleasant emotions and beautiful mineral specimens is enough in my eyes to justify competitions such as the McDole and Desautels Trophies. We all love to see great mineral specimens and often stand in awe in front of cases, such as the Kongsberg Museum case in Tucson. In the McDole competition, a great Kongsberg silver seems more appropriate, to me, than a dickite. These exhibits can exist side by side with educational exhibits, mining exhibits, geological technology and lapidary materials. This adds to the breadth and enjoyment of the hobby and hopefully will do its part in promoting the growth and appreciation of the earth sciences that we all desire. This diversity allows each viewer to find his own favorites and provides a niche for the observer in search of pleasant emotions, but who does not want a deep educational experience on Saturday afternoon. Hopefully, if one's interest in the scientific aspects of minerals is kindled at the local mineral show, Neal Yedlin's dictum "buy and use a good mineral book" is certainly available to all.

The above is only one collector's opinion. Perhaps my perspective is not shared by others but I believe there is room in our hobby for everyone, no matter what particular needs the hobby fills for each individual. It is certainly not intended to infer that Mr. Smith's ideas are wrong, only to give another perspective.

Stephen Neely, MD
Lebanon, TN

I would like to comment on Bill Smith's November-December guest editorial on "Diversity." I was the Competitive Exhibits Chairman for the 1992 Tucson Show and have served in that capacity for six years. My responsibilities include selecting the judges for all of the various categories of competitive exhibits, including the Desautels Trophy, and overseeing the judging process. For those of you who are unfamiliar with the Desautels Trophy, it is a special award presented at the Tucson Gem & Mineral Show for the finest case of minerals entered in that competition. The rules and judging criteria are as follows:

(1) The competition is open to any individual and the exhibitor must be the owner of the specimens.
(2) Specimens must be labeled correctly with species name and location. A minimum of twelve (12) specimens are required.
(3) The principal judging criteria will be the quality and aesthetics of the specimens. Showmanship, rarity and variety will also influence the judging.
(4) There will be no point score given and the decision of the judges will be final.

Three judges are used to select the winner. They are chosen for their knowledge, experience and strong egos. Each judge makes his decision, the votes are tallied, and any necessary discussion follows. The choice for the 1991 Desautels Trophy was not a unanimous decision, but that is not an uncommon occurrence.

I have had the privilege of knowing Bill and Carol Smith for the past five years. In fact, we met as the result of Bill entering the McDole Trophy competition several years ago. (The McDole Trophy preceded and was similar to the Desautels competition but was retired due to the passing of Al McGuinness.) I am familiar with Bill's collection and know it to encompass specimens all the way from the aesthetic to the scientific, as does Gene Meieran's.

Thank goodness for the diverse interests within the hobby. However, it is not the purpose of the Desautels Trophy to address all facets of specimen collecting. Its primary purpose is to reward the finest case of minerals, regardless of the diversity or "scientific" value. Bill has already done a fine job of arguing my case. The Desautels Trophy honors a man synonymous with high quality and aesthetics in mineral specimens. Therefore, judging is based almost entirely on those two criteria. While variety is a consideration, it is certainly possible that an exhibit containing one species could win the trophy.

Bill assumes only the most valuable collection will be the one to win. Just because someone has a lot of money to spend does not automatically mean they have the eye and experience to assemble a fine collection. Having the money helps, but I would rather have the "eye." There are many collectors who have amassed trophy-winning collections by being patient and building their knowledge and their collections over a period of many years. I agree that a collection worthy of taking the Desautels Trophy will have to be a valuable one. Does that mean that large sums of money must be spent in assembling such a collection? Possibly, but some of that is a function of when one has entered the hobby and how quickly the urge to compete infects the collector.

It is just a fact of nature, both human and mineral, that not all mineral species can compete on an equal basis. The Desautels Trophy is not intended to reward all species equally. Also, how is one species to be judged mineralogically more interesting than another? For example, one of the judges has a fine collection of high-quality and very beautiful thumbnail minerals. A person looking at his collection would be struck by the multitude of colorful and aesthetic specimens. He has a fine catapleiite and a fine beryllonite as well, despite the fact that neither is colorful. In fact, he won the McDole Trophy twice and has built the collection on a fireman's salary.

For those of us fortunate to have known Dave Wilbur during the heyday of his collection, it was truly a sight to behold. He represented the epitome of collecting at the time. And for those who are quick to point out he only collected "pretty" specimens with no scientific value, I wish to disagree. I remember one of the finest Chino mine, New Mexico, cuprites I have ever seen in his collection, as well as the finest zincite crystal in existence. Neither one was particularly attractive but both were great specimens in their own right.

Now let us delve into the philosophy of mineral collecting versus the science of mineralogy. First and foremost, the professional mineralogist could not survive save for the interest of the amateur mineralogist, the mineral hobbyist and the commercial specimen market. For all of the posturing about how selling minerals and crystals somehow demeans mineralogy, I say bunk. It is the commercial portion that supports everything else.

In the period of time I have been collecting (since 1963), the mineral world has grown from around 2,000 species to nearly twice that. Some of these new species are the result of newer and better methods available to differentiate minute chemical and structural differences of existing species. However, a large portion of new species discovered and described over the last 30 years are the result of the great increase in value and interest in the amateur end of the hobby.

One case comes to mind. In 1981 or so, a commercial specimen recovery project was initiated at the Grand Reef mine in Arizona. The sole purpose was to mine and extract crystals (mainly linarite) for profit. During the mining operation, one vug of a white acicular mineral was discovered. The larger half is in my collection and the lesser half found its way to Dr. Tony Kampf; from it he subsequently described four new mineral species, all lead fluorides. The two specimens are the only two known examples of these minerals and they would not have been discovered except for the commercial field collector.

Arthur Montgomery has been quoted within the body of the editorial to support Bill's position. I have never met Mr. Montgomery but I have a great deal of respect for him. When he decided to dispose of his collection, he apparently followed his convictions and basically gave it away. One of his comrades in arms against the evil of paying money for specimens was the recipient of some of this largesse. Ironically, after having also extolled the virtues of a pure science, this same person sold a portion of that gift when money was needed for other purposes. For that matter, I also believe that even Mr. Montgomery has been known to sell a specimen or two in order to further his collecting goals. What right does he have to tell me that I cannot do the same or that he is my moral superior because he no longer has to sell minerals to further his interests? He is entitled to his opinion but that does not make him right.

I also take exception to Bill's argument comparing beauty to something that can be manmade of glass, plastic, or whatever. Man has never been able to come close to the beauty contained in most mineral specimens. Man's attempts at imitation fall drastically short of anything found in nature. If we felt otherwise, the Corning Glass Company would be a lot richer today. I just do not see anything wrong with enjoying the beauty of minerals for its own sake, although certainly, the hobby becomes significantly more interesting the more one delves into the science behind it.

The subjects broached by Bill's letter should provide some food for thought. I, for one, applaud the efforts of all the field collectors who are digging not only for the joy of discovery but also to make a buck, to all the collectors who are advancing the enjoyment of one part of nature's bounty, and the existence of the *Mineralogical Record* (and similar magazines) where discussions of this type can take place.

Les Presmyk
Gilbert, Arizona

Bill's guest editorial certainly stirred up an interesting range of comment from our readers. Some time has elapsed since its publication, however, and I would urge people to give it a fresh reading, particularly where Bill says:

> *I will not defend the thesis that my outlook on collecting is the [only] right one, only that some room, and some recognition, should be made for those of us who believe that there is more to collecting than the 100 "worthy" [i.e. most aesthetic] species.*
>
> *Though I urge opening competition, as well as contemplation, to more than "aesthetics," I don't intend that there be no "beauty contests." . . . Collecting solely on the grounds of beauty is surely legitimate. . . . There should be many rooms in our mineralogical mansion. What I complain of is the propensity for* all *of mineral collecting to be reduced to such narrow [i.e. purely aesthetic] terms.*

Ed.

BACK ISSUES WANTED

The U.S. Bureau of Mines would like to complete its collection of the *Mineralogical Record*. Library funds are extremely limited, and the Bureau Library is in need of volumes 1 through 12. If anyone would wish to donate these back issues to the Bureau, your gift would be very much appreciated and it would be tax deductible. Please contact Ann E. Chapel, Librarian, U.S. Bureau of Mines, P.O. Box 25086, Denver Federal Center, Denver, Colorado 80225.

Steven Tuftin
Library Committee

ERRATA

The size notations for the hedenbergite and andradite specimens shown on page 307 (1991) are incorrect. The hedenbergite is 2.5 cm (not 25 cm), and the andradite-hedenbergite is 7.5 x 10 cm.

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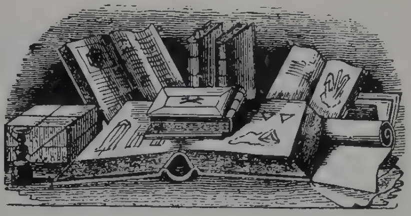

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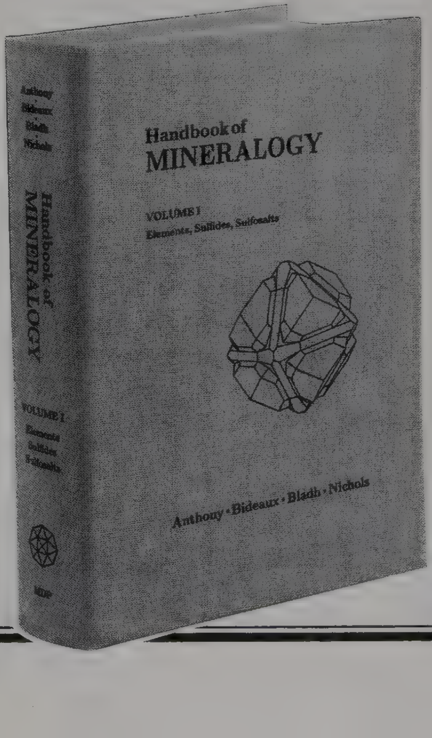

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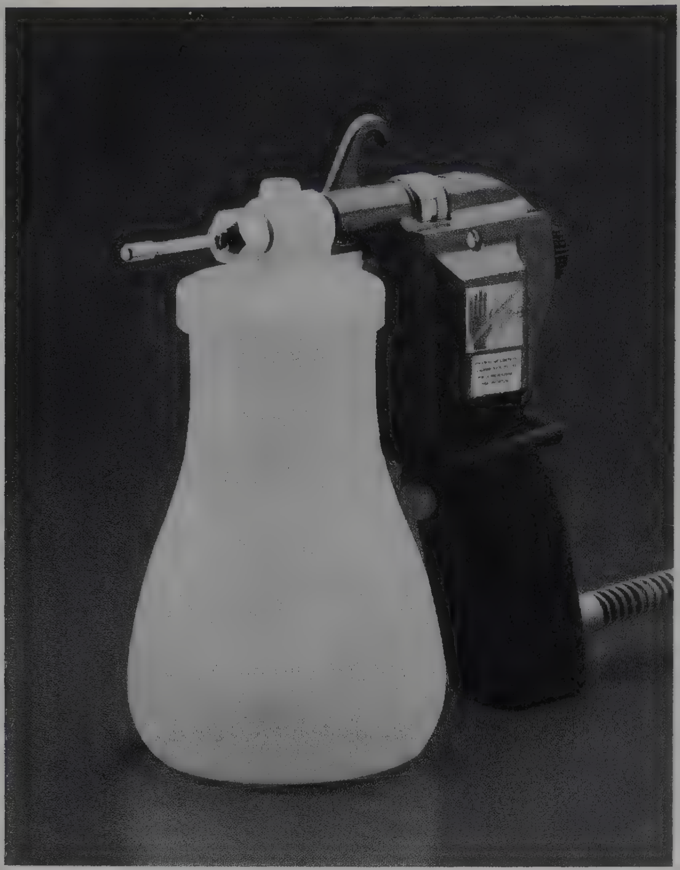

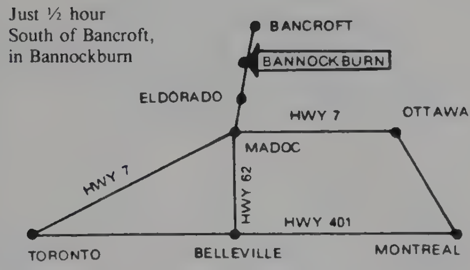

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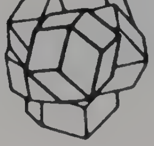

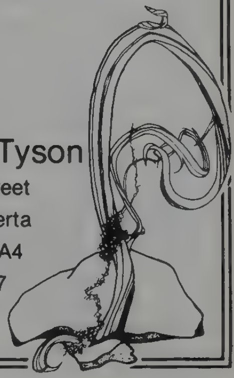

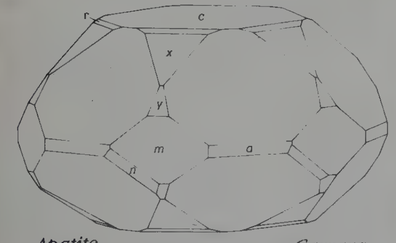
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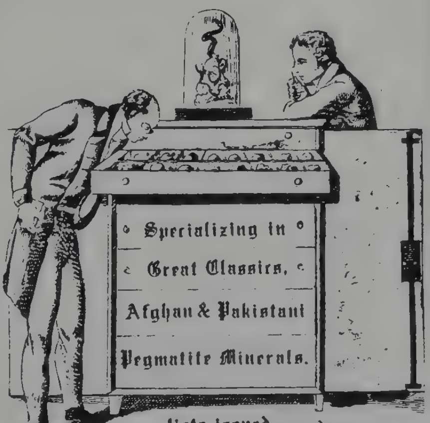
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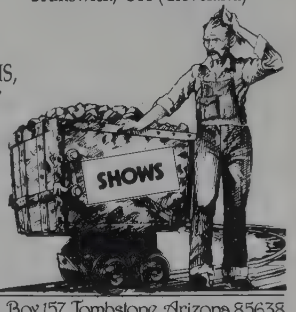
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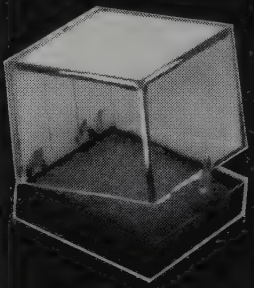

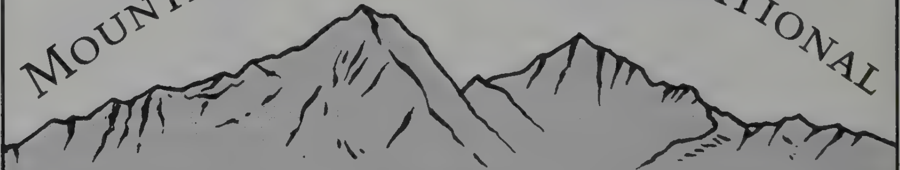

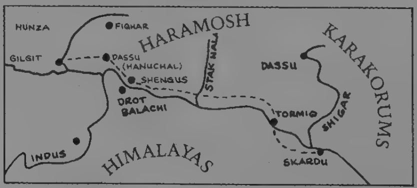
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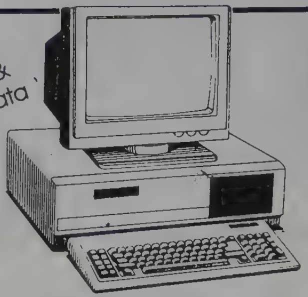
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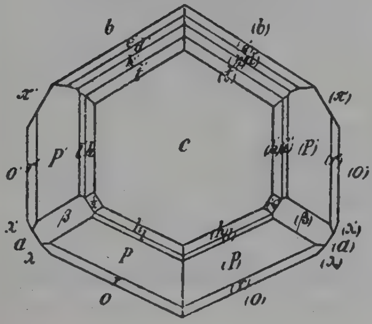

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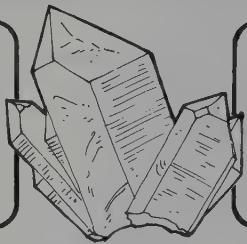

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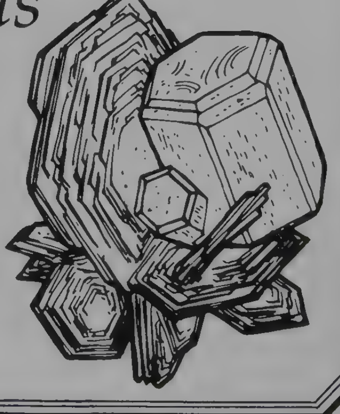

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