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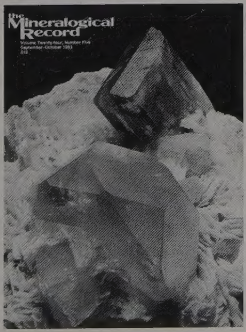
What's new in minerals?



COVER: SPODUMENE (purple) and BERYL (pink) on albite and quartz, from the Guskak mine, Pedch, Kunar, Afghanistan. The beryl crystal is 14.5 cm across. Wayne Thompson and Gene Meieran specimen; photo by Jeffrey A. Scovil.

notes from the EDITOR

BACK ISSUE FACSIMILES

Judging by the contact we have with our subscribers, many people are currently trying to build complete sets of back issues. Some simply enjoy the quest for rare collectibles; others want to complete their already substantial investment to help protect its value; and still others (especially libraries) want the back issues for the information they contain.

We encourage the assembly of complete sets because (a) it is our mission to disseminate mineralogical information, and (b) completed sets are often hardbound and thereby better preserved and protected for future generations.

Unfortunately there are just not enough copies of the early issues to go around, particularly in volume 2 (1971). In those days the *Mineralogical Record* was struggling to survive, paying no salaries, losing money, and making ends meet only through cash donations from Arthur Montgomery. To minimize expenses, the press run was limited to 3,000 to 4,000 copies, many of which were lost or damaged in production, or have since then been worn out, damaged or discarded. Consequently, it is likely that fewer than half of our current readers have any chance of building a complete set of original issues. When rare individual copies do come on the market, they generally fetch $75 or more, a sum which people interested only in the data have a hard time justifying to themselves.

We have always* maintained a policy of not going back to the printing press on out-of-print back issues because doing so is very expensive (thousands of dollars), and we prefer to spend the money producing *new* pages and *new* photography rather than replicating already published materials.

Recently, however, we have developed a new alternative. Using a high-tech Xerox 5775 Digital Color Copier set on black-only mode, we have been able to produce some superb facsimile reprints in small numbers and at relatively low cost. The paper is not quite as glossy as the originals, and of course the covers are rendered in black and white instead of color. But they are folded and saddle-stitched exactly like the originals (11 x 17-inch paper, with heavier stock for the covers, folded once and stapled in the fold, then edge-trimmed), and the reproduction of the black and white photos inside is excellent.

As a service to our readers, we have decided to make a test-offering of facsimile reprints of the issues in volumes 1 and 2, at $10 per copy (plus $1 postage). So, if you are missing any of these and do not require an investment-grade original, here is your chance.

One other reason why we would not want to go back to the color press, and print hundreds or thousands more copies indistinguishable from the originals, is that we would not want to injure the value of the existing originals. People have paid good money for these, and it would be unfair to them if we flooded the market at this late stage. However, the facsimiles we are now offering are in fact only photocopies (albeit superb ones) which, in theory, anyone could produce on his own if he had an original available to disbind and copy, if he had state-of-the-art equipment available, and if he wanted to go to all that work. So I don't think these facsimiles should have much impact on the collector value of originals.

Journals such as *American Mineralogist* and *Mineralogical Magazine* still offer their entire runs in facsimile, back to volume 1, number 1, because people want to have the information they contain. Perhaps some day we can offer all of *our* out-of-print issues in facsimile. That will depend upon how this initial offering is received.

Order from the Circulation Manager, P.O. Box 35565, Tucson, AZ 85740. [There are four issues only in vol. 1; six issues per volume thereafter.]

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*Actually, in the early days before I became editor, a few reprints were indeed run off: 600 copies in black ink of vol. 1, no. 1 (originals were printed in a very dark blue ink), and 500 copies of vol. 2, no. 1, characterized by a black-and-white cover. Less than 3,000 color-cover copies of vol. 2, no. 1 were printed.

HISTORY AND MINERALS OF THE GEYSERS SONOMA COUNTY, CALIFORNIA

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From the time of its discovery in 1847 until the mid-1960's, The Geysers geothermal area in California produced an extensive suite of sulfate minerals. Unusual species such as mascagnite, boussingaultite, tschermigite, ammonioalunite (type locality) and letovicite (the only natural occurrence) could be collected freshly formed each year from the many fumaroles, hot springs and steam jets in the area.

INTRODUCTION

The Geysers, a popular health resort from 1852 to the 1920's, is located in northern Sonoma County about 145 km north of San Francisco, California. The Geysers can be reached by taking Alexander Valley Road off the Redwood Highway (U.S. 101) about 1.6 km north of Healdsburg, or by taking Geysers Road, which leads in a southeasterly direction along Big Sulfur Creek from Cloverdale.

The name "geysers" is a misnomer, as there are no geysers in the area but only fumaroles, small steam jets and hot springs where water quietly boils, all producing large volumes of steam which in the early morning or on a cool day, presents a scene that reminds one of Dante's Inferno (Vonsen, 1946). This widely known locality was visited by many people from this country and abroad who partook of the various natural mineral waters and hot baths which had become known for their curative properties.

The geothermal steam source is believed to date back to late Tertiary volcanic activity and faulting in the area (Switzer, 1951; McNitt, 1963). Since 1955, deep wells in the underlying Franciscan rocks have harnessed the steam, which has been used to operate several steam-driven electrical generators. From a geothermal perspective, this is the only steam field outside of Italy which produces dry steam. It is also the first field to produce electrical power from a natural steam source in the United States.

For the mineralogist, this area is unique in that it has been the source of a large suite of sulfate minerals, most of which contain ammonia. Unfortunately, in the early 1970's, wells were drilled to divert the subterranean steam to the generation of electrical power. In doing this, the ascending steam and water were reduced significantly and the formation of sulfate minerals has virtually ceased.

EARLY HISTORICAL DESCRIPTIONS

Local tradition credits the first use of The Geysers to the local Indians, who bathed in them for curative purposes before the arrival of the white man. From the discovery of The Geysers in 1847 by a party of hunters, until the 1920's when the resort spa went out of style, a great variety of colorful descriptions of the area's escaping-steam vents and mineral waters was written. As second in command of the California Geological Survey, author and geologist Professor W. H. Brewer, writing in his journal during his November 1861 visit, starts his description of the area by describing the landscape of the mountains and valleys in all directions. In picking up with his journal entry of what a geyser is, please note the intense on-site description of the boiling springs (Brewer, 1865):

> The Geysers are not *geysers* at all, in the sense in which that word is used in Iceland—they are merely hot springs. Their appearance has been greatly exaggerated, hence many visitors come away disappointed. The springs cover a number of acres, but the principal ones are in a very narrow canyon with very steep sides. They break out on the bottom and along the sides up to the height of 150 or 200 feet, and on a little flat nearby. There are hundreds of springs (boiling water) boiling, hissing, roaring. The whole ground is scorched and seared, strewn with slag and cinders, or with sulfur and various salts that have either come up in the steam or have been crystallized from the waters.
>
> Passing over the flat we saw several of these—many in fact—here a boiling spring, there a hole in the ground from which steam issues, sometimes as quietly as from the spout of a tea kettle simmering over the fire, but at others rushing out as if

Figure 1. **View of The Geysers steam field in 1963, looking east. Photo courtesy of Pacific Gas and Electric Company.**

> it came from the escape pipe of some huge engine. The ground is so hot as to be painful to the feet through thick boots, and so abounds in sulfuric acid and acid salts as to quickly destroy thin leather—it even chars and blackens the fragments of wood that get into it.
>
> Near some of the springs a treacherous crust covers a soft, sticky, viscous, scalding mud; one may easily break in, and several accidents more or less serious have thus occurred. Quite recently a miner was so badly scalded as to be crippled, probably for life. Sulfur often issues with the steam and condenses in the most beautiful crystallizations on the cooler surface. Specimens of sulfur frostwork are of the most exquisite beauty, but too frail to be removed. We crossed this table and descended into the canyon above the geysers and followed it down.
>
> One can descend into the canyon and follow it down with safety, a feat that seems utterly impossible before the trail. Here is the grand part of the spectacle. Here are the most copious streams, the largest and loudest steam jets, the most energetic forces, and the most terrific looking places. Standing part way down the bank at the upper end of the active part, where the canyon curves so that all its most active parts are seen at a glance, the scene is truly impressive. It seems an enormous, seething, steaming cauldron. Steam or hot water issuing from hundreds of vents, the white and ashy appearance of the banks, the smell of sulfur and hot steam in our faces, combined to produce an entirely novel effect.
>
> We descended and followed down the canyon, threading our way on the secure spots. Hot water or steam issued on all sides—under us, by our side, over us, around us. In one place a rocky pool of black rock several feet in diameter, filled with thick, black water—black from sulphuret of iron, black as ink—was in the most violent agitation. It is the most peculiar feature of all the geysers and is well called the Witches' Cauldron. The water, black and mysterious, boils so violently that it spouts up two or three feet from the surface, enclosed in this rocky wall.

Figure 2. **Portrait of Professor William H. Brewer. Photo courtesy of the University of California.**

Another early historical account of The Geysers was written by Winslow Anderson, M.D., who received the 1889 prize of the Medical Society of the State of California for the book in which his article appeared. The book, *Mineral Springs and Health Resorts of California, with a Complete Chemical Analyses of Every Important Mineral Water in the World,* has served as a basic source for information on California springs since that time. Although his account was no doubt useful medically, Dr. Anderson was not a geologist. Despite this, it is one of the most interesting of the "travelogs" of the day. However, to fully appreciate his description, one must have personally explored The Geysers and collected the abundant sulfate minerals which were continually forming from the boiling water pools and scorching soil:

> This marvelous region (Plutonian realm) was discovered in 1847 by Mr. William B. Elliot one day while out hunting. Imagine his fear and astonishment at beholding for the first time The Geysers! He remained awestruck for a few moments, and then hastened away to inform his companions that he had discovered the very mouth of the infernal regions!
>
> Since that time to the present, these famous springs have been the objects of wonder and admiration to all the many thousands who visit them yearly. Formerly tourists rode on horseback for many miles up the narrow mountain trails to visit this natural wonderland, which is situated about 1,700 feet about the sea level, but thanks to the push and enterprise of Western civilization, we now travel in comfortable six-horse stages from the terminal of the Cloverdale and Calistoga railroads over excellent mountain roads to The Geysers. It is a good plan to go by way of Cloverdale and return by way of Calistoga, as you then see all the grandeur and beauty of the surrounding country.
>
> Before you reach The Geysers, your attention is called to the large white or yellowish white banks across the canyon. They are known as "sulfur" banks and consist of deposits of sulfur and cinnabar with incrustations of salts of sodium, potassium, magnesium, sulfur, etc. They are extinct craters, or the deposits of geysers and fumaroles which have died out, leaving evidences of volcanic action behind.
>
> As we drew nearer and nearer the sylvan resort our ears were greeted with sounds like those of a steamboat or locomotive—puff—puff—at regular intervals. These, we were told, and as we ascertained afterwards, came from the "steamboat" springs.
>
> The Geysers resort with its many cozy cottages, hotel and grounds, are situated in a leafy dell on the side of the mountain opposite Geyser Cañon. Having indulged in one of those splendid sulfur Hammam baths, where the skin is rendered soft, white and pliable owing to the medicinal effects of the mineral ingredients, you are ready for dinner, and a good one it was during our visit to The Geysers in 1888.
>
> ### A Trip Through Geyser Cañon
>
> Bright and early next morning we set out for our trip "over the river" to his majesty's Plutonian shores. In the summer season, the best time to start out is from 4:30 to 5:00 a.m., in order that you may perceive the full volume of the steam and sulfurous vapors as they rise several hundred feet into the air. Later in the morning, the sun's rays condense the vapors so that they are not visible as far above the ground.
>
> You are now armed with a long staff, like the pilgrims of old, and with your guide you set out to cross the Pluton River—this time on a bridge. Before doing so, however, your attention is called to a cool, clear spring, known as the "iron" spring. It is located near the edge of the Pluton River, on the same side as the hotel. This iron spring, on analysis, is found to contain valuable salino-chalybeate (iron) mineral ingredients.
>
> Immediately after crossing the Pluton River, a change in the atmosphere becomes noticeable. On the side where the hotel and resort with the many picturesque and cozy cottages are built, the air is pure, dry and invigorating; on the side where Geyser Cañon is located, the atmosphere is mixed with the perfumes from the interior realm.
>
> Near the path on the bank of the river, as you proceed up the cañon, is situated quite a remarkable spring, containing large quantities of aluminum, sulfate, magnesia and silicic acid. It is known as the "Alum Spring."
>
> Following your guide, you soon realize that you are nearing the brink of eternity. You now cross "Devil's" or Geyser Cañon and come to the "alum and sulfur" spring, having a temperature of 160° F. Proceeding farther on you next see the "black sulfur" springs, in which we find sulfide of iron. The ground is now getting warm under your feet, and the fumes from the "lower regions" make you think of the hereafter, and as you push on, a deep and steep ravine is entered, from which boiling hot steam and gases escape in every direction until you feel awestruck in this strange place! Passing along through the ravine, with the boiling water running at your feet, you enter "Proserpine's Grotto," in which is placed the "Devil's Armchair." This latter is a huge boulder which nature has hollowed out in the shape and form of a large parlor chair. In this you sit with great solemnity, to make sure of the benevolent friendship of his Satanic majesty.
>
> The next point of interest is the "Devil's Kitchen," with warning signs of "danger" stuck up in every direction. The country rock is serpentine, sandstone and limestone with igneous deposits and incrustations of sulfur, soda, cinnabar, etc., and as the fumaroles, cracks and fissures emit their boiling waters and vapors saturated with free sulfurous, sulfuric, hydrochloric acids and carbonic anhydrite, all having strong disintegrating action on the formation, everything is, in consequence, soft and yielding. The banks and rocks are like clay and sand, easily dislodged upon the slightest touch—hence the signs of danger.
>
> You are now fairly in the mouth of a boiling, seething, trembling and smoking Plutonian realm. The ground under your feet is becoming hotter and hotter, and the sulfurous fumes and vaporous steam are nearly suffocating. Early in the morning these vapors rise to a height of 300 to 500 feet. It is also observed that these wonderful subterranean forces exhibit more activity at or near the full moon.

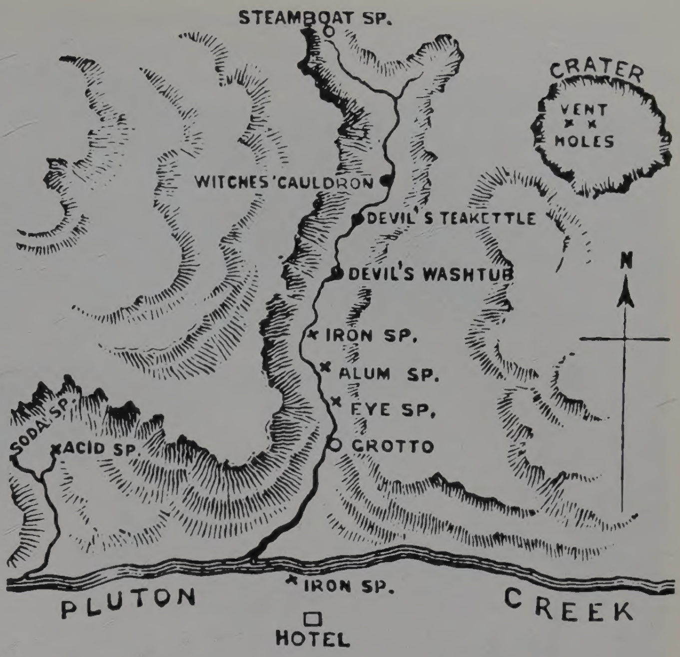


***Figure 3.* Area map of The Geysers showing the location of important mineral springs along Geyser Creek Canyon in 1881 (Anderson, 1892).**

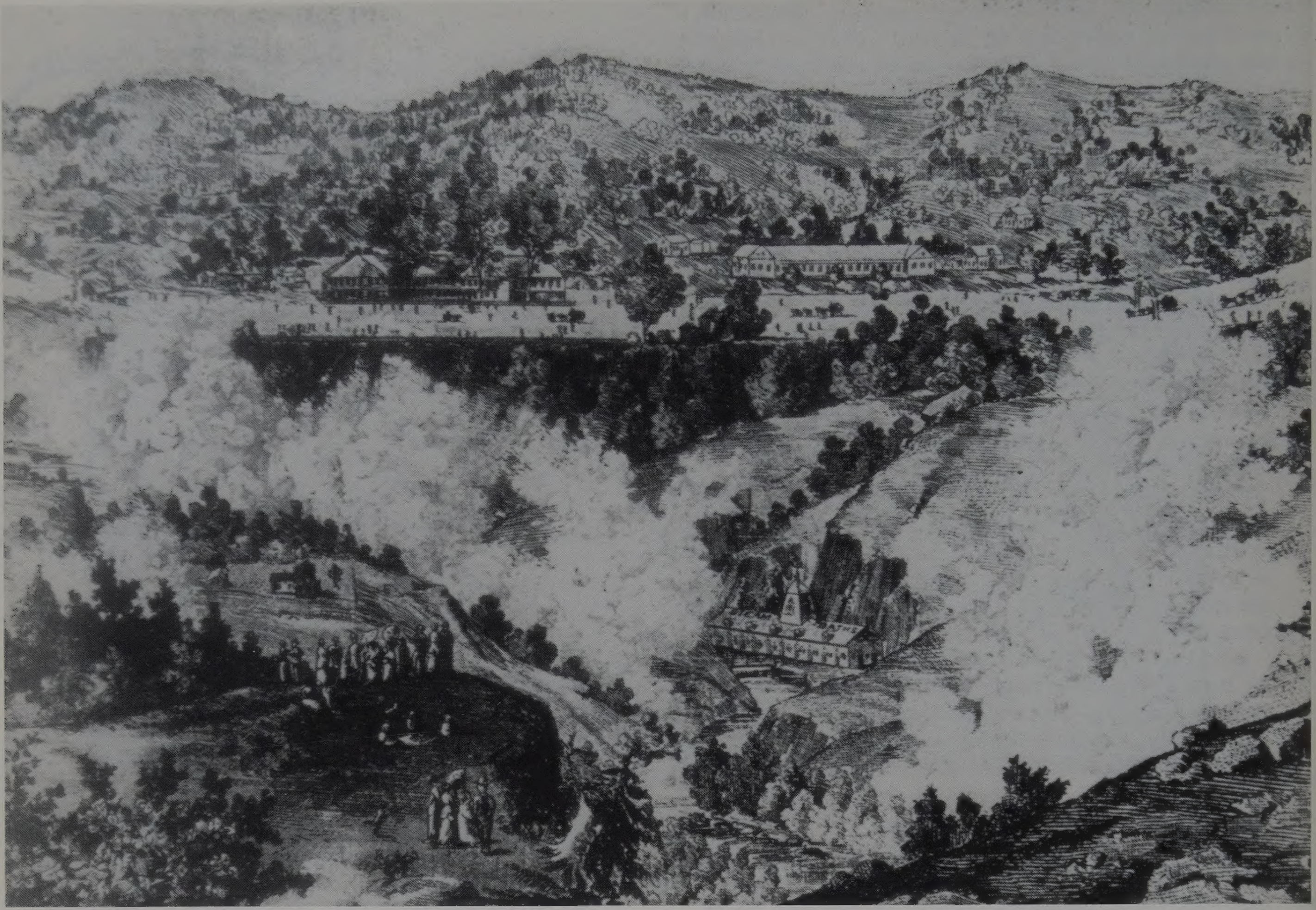


Figure 4. **Sketch view of The Geysers showing hotel and cottages (Anderson, 1892).**

In this *olla podrida* of Hadean liquids are several interesting points and springs to be observed. Near at hand is a hot "Epsom salt" spring, having a temperature of 150° F., and over 140 grains of magnesium sulfate to the gallon of water. Another boiling spring of "iron and sulfur" has a temperature of 208° F. On the right side of the path is a large, black, sulfurous spring continually boiling and rumbling as the black, inky fluid reaches the bright dawn of day at a temperature of 162° F. It is the "Devil's Inkstand," a hot sulfurous iron and alum sulfide and sulfate water which makes very fair writing fluid. For this purpose it is used at the Geyser hotel, where the visitor inscribes his name on the register His Majesty's ink.

You next come to the "hot alum" spring, containing, as will be seen from the following analysis, over 60 grains of aluminum sulfate to the gallon. It is an alumino-ferruginous sulfurous water.

As you proceed along the not overly "straight and narrow path," it is literally and practically important that you follow your guide and the "narrow path" here, lest one misstep hurl you into that "undiscovered country, from whose bourn no traveler returns." Innumerable springs and vents and subterranean outlets spurt and spout in every direction. "Pluto's Punch Bowl" is a large spring of hot lemonade, containing sulfuric acid and sulfates. The "Geyser Smokestack" is a large opening from which issue volumes of sulfur-laden fumes, which rise into the air for several hundred feet, where it condenses and deposits again on the ground as water and sulfur, etc.

One of the most interesting springs in Geyser Cañon is the "Witches' Cauldron," a large, boiling, circular spring of over seven feet in diameter and of unfathomable depth. The water has a temperature of 212° F., and is unceasingly boiling and bubbling. The spring is a black, sulfurous fluid as black as the inky cloak of Hamlet. As the awestruck tourists, "round about the cauldron go" they see, in their imagination, the solemn ghost of Banquo rising and materializing in the fumes of the "charmed pot," and with a small stretch of the imagination you once more see the three witches and hear their husky voices chanting a solemn incantation.

On analysis this remarkable fumarole, having its source probably hundreds of feet below the surface, yields water rich in sodium, calcium and magnesium sulfates.

Next comes the "Devil's Canopy" and the "Geyser Safety-valve," an intermittent, scalding spring, which ejects streams of boiling water to the height of 15 feet; then the "Devil's Pulpit," a little elevation where His Satanic Majesty (presumably) goes to direct the workings of his laboratory.

A little farther up and to the left are the wonderful "Steamboat Geysers," which can be heard a mile or more away, blowing and snorting intermittently at high pressure. This is seemingly a true geyser. The steam is so hot that it does not begin to condense until it is ten or fifteen feet from the surface. Tourists are very apt to burn their fingers trying to find out what makes the noise, as the steam is not visible. The temperature here is 214° F.

Around these hundreds of springs are incrusted deposits of crystallized sulfur, magnesium, alum, etc., etc. In many places

Along the hogback.

Figure 5. **Sketch view of the road along the hogback approaching The Geysers (Anderson, 1892).**

one can stick his alpenstock into the sides of the banks, and immediately hot steam and vapors will issue.

You then pass on to the "Devil's Gristmill," where a large column of steam escapes from a hole in a rock with so much force that stones and sticks placed at the orifice are blown away like bits of paper. Loud subterranean noises are heard within resembling those of a gristmill, hence its name.

Going still farther up, the ravine is found to bifurcate. The left fork is still active, having dozens of springs, with temperatures ranging from 100° F. to 210° F. The right fork is cool and pleasant, with several pure water springs. Ascending at the bifurcation some 160 feet you come to an elevation—a plateau of smooth, plastic clay stained with iron and sulfur. This clay has a temperature of 170° F. A long pole is introduced into the yielding clay and forthwith issue hot, smoking vapors. The edge of this plateau is called "Lover's Leap." Here the view of the boiling, seething, roaring, steaming, groaning and bubbling springs below is one of unrivaled grandeur. 160 feet below you and all along the "Devil's" Cañon is one mass of smoking fury, shrill whistles, regularly intermittent puffs and groans, issuing from the interior of the earth. This sight alone is worth the whole trip.

To the eastward is "Lover's Retreat," a pleasant oasis in this wilderness of sulfurous clouds. Here also is the "Temperance Spring,"—of clear cold water. Near it is a large fallen oak, which serves at once for a seat, and a knot hole in one of its huge branches is known as the "Post-office." Here we leave our cards in case civilization is never reached again.

Going along the usual route, we pass over the "Fire Mountain" with its hundreds of small orifices through which miniature geysers issue. The temperature of this ocherous clay is 175° F. A little east of this is located "Alkali Lake" and the "Lava Beds." Here the crust is so thin that stamping hard on it produces a hollow sound. This is evidently an extinct volcanic crater on a small scale. We now pass the "Indian sweat bath" and come to another remarkable spring known as the "Devil's Tea Kettle." This is one of the strongest vapor springs on the coast. The orifice is three feet in diameter, opening out of the side of the mountain with a huge boulder overhanging it. The "Tea Kettle" spring is about half a mile from the active springs in Geyser Cañon. The vapor is emitted with such force that a large bunch of brush placed in front of it is instantly swept away for many feet. This steam is above the boiling point and is sulfurous in character, and contains a large quantity of free sulfuric acid. Formerly a huge cone with a steam whistle attached to it was constructed over the orifice, but it made such a noise as to keep the guests awake at night, and was therefore taken down.

Your route now lies along the side of a mountain where a narrow path has been cut out of solid igneous rock. Below you is the Pluton River, and above you the snorting geysers. Issuing from the side of the solid glass mountain are two remarkable springs—the "Hot Acid" and the "Lemonade," whose waters are rich in the potassium salts so valuable in many conditions and diseases. The acid spring is remarkable for the fact of its having 154 grains of free sulfuric acid to the gallon, and the lemonade spring from the fact that it is one of the few springs in California which has free muriatic acid.

The water is pleasantly sour, and with sugar or syrup, makes one of the nicest of lemonades.

The next place of interest is the "Devil's Oven," a large excavation in this silicon oxide mountain where in years gone by this igneous rock was at a white heat. All over this realm of subterranean outlets the crust of the earth is covered with the products of the Plutonean shores—sulfur, iron, magnesia, nitre, alum, etc., etc. On again reaching Pluton River, several more cold and hot springs are seen. Some are sulfureted and others are ferruginous, magnesic and aluminic.

The Geyser Springs, hot and cold, flow daily about 100,000 gallons. The area covered is about 400 acres. Most of the activity, however, is confined to the "Devil's" or Geyser Cañon, and comprises about 60 acres.

Many of the springs resemble *true* geysers, such as we have

The witches' cauldron.

Figure 6. **Sketch view of the Witches' Cauldron (Anderson, 1892).**

in the "wonderland of America"—Yellowstone Park—and in Iceland; but scientific authorities classify our California geysers as fumaroles or openings and outlets in a volcanic district.

As the first visitors at this California Hecla were at a loss for motive power to produce all these boiling, steaming and spouting Stygian sluices, they naturally turned to their early teachings for a solution of the phenomena. As they were all good people and had early been taught the power of His Satanic Majesty located—well he used to reside in the infernal regions, presumably in the center of the earth—why they most naturally gave him the credit and named the springs with their present euphonious names of "Devil's" this and "Devil's" that, a process of reasoning that has been applied to names given at a more recent date. In order to be true to nature we have described the springs with their names as we found them.

The Geysers are wonderful and picturesque exhibitions of the nearly extinct volcanic forces slumbering beneath the romantic "Devil's Cañon," and the resort is one of the pleasantest and most salubrious watering places we find on the coast, and destined to become one of the world's greatest sanitariums.

GEOLOGY

The geological features of The Geysers Geothermal Resources Area have been studied and mapped extensively by many investigators including Bacon *et al.* (1976), Bailey *et al.* (1964), Bedrossian (1980), Black *et al.* (1971), Brice (1953), Chapman and Bishop (1970), Donnelly *et al.* (1976), Gealy (1951), Hannah (1975), Higgins (1980), Isherwood (1975), Hsu (1968), Koenig (1963), Lang and Westphal (1968), Majmundar (1984), McNitt (1963, 1968), McLaughlin (1974, 1975a, 1975b, 1976, 1977), and Swé and Dickinson (1970).

The Mayacmas Mountains of northern Sonoma County are underlain by rocks of the Jurassic-Cretaceous Franciscan Formation and Great Valley sequence. These consist primarily of marine sedimentary and volcanic rocks and include graywackes, shales, spilitic basalt and serpentine; they have been folded and faulted into a series of rugged, northwest-trending ridges and valleys.

The oldest unit in this sequence is a massive graywacke with a very minor amount of shale. The graywacke is overlain by several tens of meters of spilitic basalt and associated chert beds. The basalt is, in turn, overlain by a sequence of poorly bedded graywacke and shale. Conformable bodies of serpentinized peridotite in places over 70 meters thick, occur at the upper and lower contacts of the basalt. Bodies of hornblende and glaucophane schist occur near basalt-serpentine contacts, and are thought to be the product of contact metamorphism of basalt by ultrabasic intrusions. The original schist contact, however, has been obscured by complex faulting (McNitt, 1963).

Geosynclinal deposition ceased in early Tertiary time when the Mesozoic rocks were uplifted and gently folded. No record of the Oligocene and Miocene epochs was found in this area, but by Pliocene time the uplifted rocks had been truncated by erosion. During Pleistocene time, volcanic rocks, including rhyolitic flows and tuffs, obsidian, basaltic lavas, and lavas of dacitic and andesitic composition, were erupted onto the eroded surface. These Pleistocene volcanic rocks principally occupied the Clear Lake Basin, which borders the Mayacmas Mountains on the northeast. This basin is a northwest-trending structural depression 49 km long by 24 km wide. Chapman (1975) cites an area of unusually low gravity centered near the Clear Lake volcanic rocks and indicates the presence of a hot, intrusive magma chamber at depth.

During the time of the Clear Lake Basin development, the Mesozoic rocks of the Mayacmas Mountains were uplifted and complexly faulted into a series of northwest-trending horsts and grabens. These individual horsts and grabens range between 1.6 and 3.2 km in width and extend for lengths up to 16 km while maintaining their identity as structural units. The grabens have not subsided on distinct major faults, but some movement has occurred along numerous interrelated normal faults, which dip between 60° and 80°. Fault lengths rarely exceed 1.6 km. The grabens are also cross-faulted by arcuate faults which define several downdropped units within the individual grabens. McNitt (1963) states that it is difficult to measure accurately the amount of vertical displacement because of the complexity of the faulting, the lack of clearly recognizable datum planes, and the variable thickness of the faults. However, the order of magnitude of this movement can be estimated from one of the grabens in which Tertiary gravels have been downdropped into the underlying Mesozoic rocks. This vertical displacement of the grabens was found to be a minimum of 73 meters, with the movement distributed among two or three normal faults.

Figure 7. **Index map of The Geysers Geothermal Resources Area (GRA) showing the steam field, the Mayacmas Mountains and the Clear Lake physiographic area (Bedrossian, 1980).**

The Geysers thermal area is located at the west end of a northwest-trending graben 9 km long by 1.6 km wide, which is 8 km southeast of the Clear Lake Basin. Numerous thermal areas, of which The Geysers is the largest, occur within the graben. Cobb Mountain, a horst block capped by a rhyolite extrusion, is northeast of The Geysers graben and represents the culminating uplift of the Mayacmas range. McNitt (1963) states that because this uplift corresponds with a volcanic extrusion center and is spatially associated with the thermal areas, it is possible that forceful magmatic intrusion is responsible for the uplift of Cobb Mountain, and that the flanking grabens were formed due to horizontal extension of the crusts across the arched area.

The Geysers graben is within an area of Franciscan graywacke which is overlain by basalt, which in turn is overlain by a body of serpentine along the canyon of Big Sulfur Creek. Both the serpentine

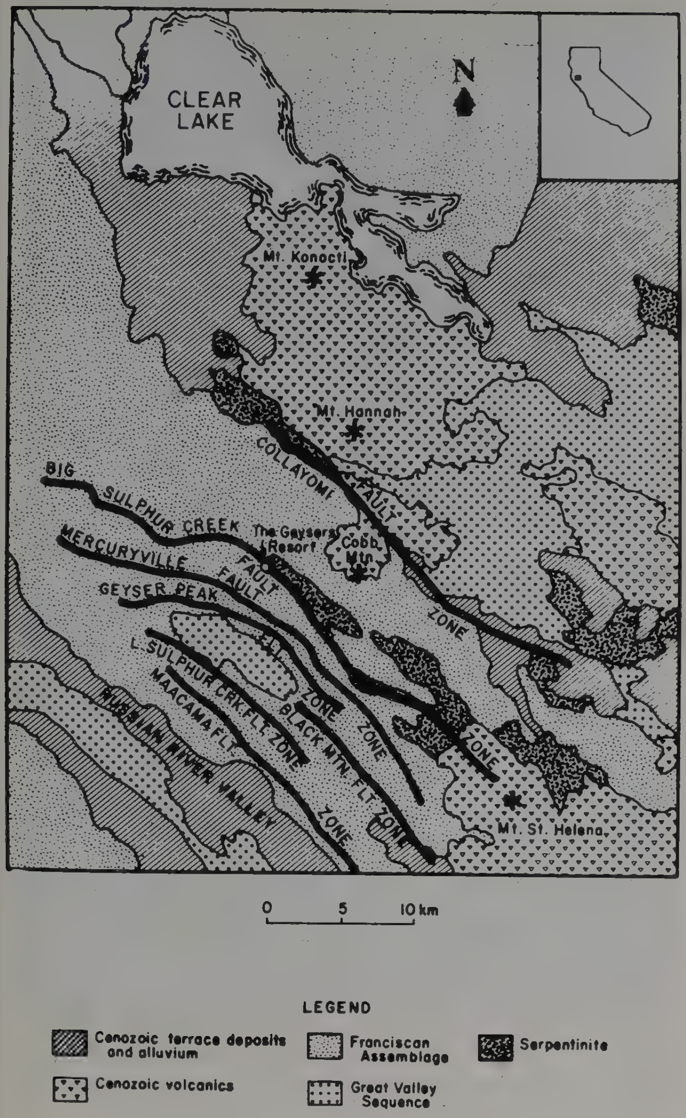


Figure 8. **Map showing the major fault zones associated with the Franciscan assemblage in The Geysers area (Bedrossian, 1980).**

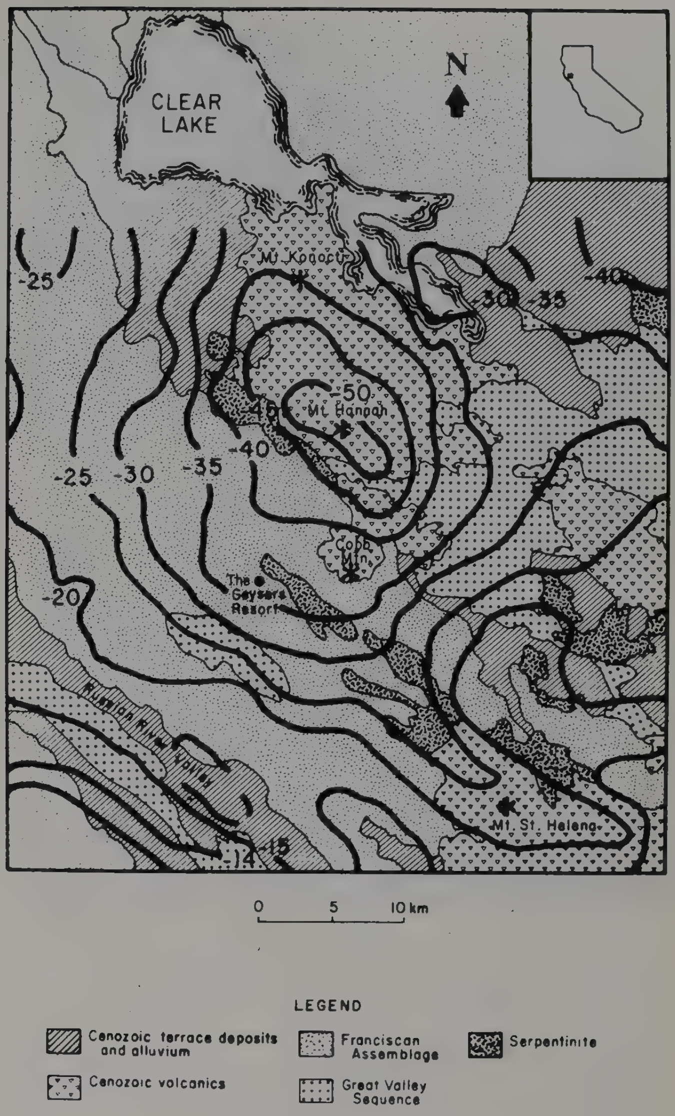


Figure 9. **Map showing the generalized geology and location of the negative gravity anomaly that indicates a still-heated magma chamber at depth (Bedrossian, 1980).**

and the basalt have been downfaulted into the underlying graywacke, with the serpentine body marking the axis of the graben. The geometry of the faults and the relative stratigraphic position of the faulted units indicate that the thermal areas are located on the fissures closest to the serpentine body. In the vicinity of The Geysers resort, slopes on both sides of Big Sulfur Creek are characterized by massive landslides. Smaller landslides upstream toward the "Little Geysers" area have been mapped by Bailey (1946), McLaughlin (1975a, 1975b), and McNitt (1968a). The slope stability in the area of The Geysers has been studied by Bedrossian (1980).

GEOTHERMAL DEVELOPMENT

Over the years a number of geothermal development studies have been done by interested people such as Allan and Day (1927), Bradley (1946), McNitt (1963), Koenig (1969), Higgins (1980), and Majmundar (1984). A summary of the activity of the steam field in the development of electrical power use through 1969 has been described by Koenig (1969).

Plans to use the steam for agricultural and industrial processes were discussed repeatedly in the early days of this century. In 1904, after the successful generation of electric power from natural steam at Larderello, Italy, plans were made to drill for additional steam at The Geysers. Eight wells were drilled between 1921 and 1925, but the project failed for lack of adequate local demand for electric power. The deepest of these wells went down to 213 meters. Only one is still capable of producing steam. Currently, none of the wells is in use and several have been plugged.

In the 1950's, interest was renewed in geothermal power generation. In 1955, Magma Power Company obtained a 99-year lease for thermally active lands along Big Sulfur Creek. With its partner, Thermal Power Company, six wells (Magma 1, Thermal 1 through 5) were drilled between 1955 and 1957. The deepest of these, Thermal 3, went to a depth of 468 meters. One well, Thermal 4, blew out, and despite subsequent attempts over the years to seal the blowout, to quench it, and to relieve steam pressure by drilling additional wells nearby, it was still out of control in August of 1962.

Flow tests were made by Thermal Power Company in December of 1957, which indicated total steam flow at the wellhead of about 660,000 kg per hour at a gage pressure of 40 kg/cm² for four wells. Pacific Gas and Electric Company ran additional pumping tests in August of 1958, and upon satisfactory completion, signed a contract for the purchase of steam on October 30, 1958. Additional wells (Thermal 6 through 11) were drilled from 1959 to 1962. Thermal 11 became one of the attempts to seal the blowout of Thermal 4. It was

Figure 10. **View of The Geysers geothermal field, with power generating station and condensing units in the foreground (Koenig, 1969).**

drilled directionally to intersect the blowout of Thermal 4. Over 700,000 liters of cool water was injected to quench the blowout. This effort failed but Thermal 11 was completed as a steam producing well.

Geothermal power generation became a reality in June 1960, when a 12,500 kw plant began generating electricity from some 550,000 kg of steam per hour supplied by four wells including Thermal 11.

Since 1960, when the first area to be drilled was on the north bank of Big Sulfur Creek opposite The Geysers resort, drilling has been going to greater depths. Thermal 12, completed to a depth of 650 meters in October of 1961, is now considered to be a "shallow" well. In September of 1961, the first of the Sulfur Bank series was drilled to 1,760 meters, 1.6 km northwest of the original site on Big Sulfur Creek.

The early wells of the Sulfur Bank series were not very successful. Most were comparatively shallow, with the exception of Sulfur Bank 4, which was deepened to 1,772 meters in 1965, and then abandoned. The 2 km of terrain between the Thermal and early Sulfur Bank series, however, has been drilled successfully. These include 19 Sulfur Bank and 9 Happy Jack series wells. The deepest, Happy Jack 9, reached 2,030 meters.

Partially to satisfy lease requirements, Thermal Power Company drilled and completed two wells in 1964 at "Little Geysers," an area of fumarolic and hot springs activity some 8 km southeast of the initial site of exploration. This area is part of the structural and thermal "trend" on Big Sulfur Creek. A few years later, the focus of geothermal activity returned to the "Little Geysers" with the completion of three additional wells capable of producing over 550,000 kg of steam per hour.

So great is the steam potential at The Geysers that a number of companies have drilled wells in the area, including Union Oil, Geothermal Resources International, Signal Oil, Sun Oil, and Worldwide Geothermal Exploration. The greatest depth reached so far has been 2,725 meters.

Figure 11. **Aerial view of The Geysers geothermal field. Geyser Canyon is to the left of the steam vents; the first power plant under construction is in the lower right corner. Photo courtesy of Pacific Gas and Electric Company.**

COLLECTING HISTORY

Due to the popularity both as a health resort and a geological curiosity, The Geysers has been studied extensively. As early as 1877, many of the mineral salts had already been identified. Allan and Day (1927) reported additional sulfates from the many fumaroles and hot springs in the area. Although no record was found describing mineral collecting in the area before 1940, no doubt several of the local collectors must have recognized the abundance of sulfate minerals which were continually forming in the moist, hot canyon.

The most extensive collecting was done by Magnus Vonsen of Petaluma, California, whose interest in minerals and their properties is widely known in California. During the summer and fall months of 1939 and 1940, Vonsen, together with Dr. John Peoples of Petaluma, made many trips to the area for the purpose of collecting and studying the abundant sulfates which were found there, especially along Geyser Creek Canyon. During this study, the area was mapped and as each mineral was identified, its location was placed on the map. During this collecting adventure (and it was an adventure collecting in an environment of 100° C. water, scalding steam and acid ground waters) more than 100 samples were collected. Those samples which were affected by climatic conditions, particularly during the damp winter months, were placed in airtight containers for preservation. Because of the widespread contamination of ammonia, iron, nickel, copper and chromium, identification often became quite difficult. Many of the ammonium sulfates formed simultaneously from the hot water pools, resulting in fine-grained mixtures. Due to the

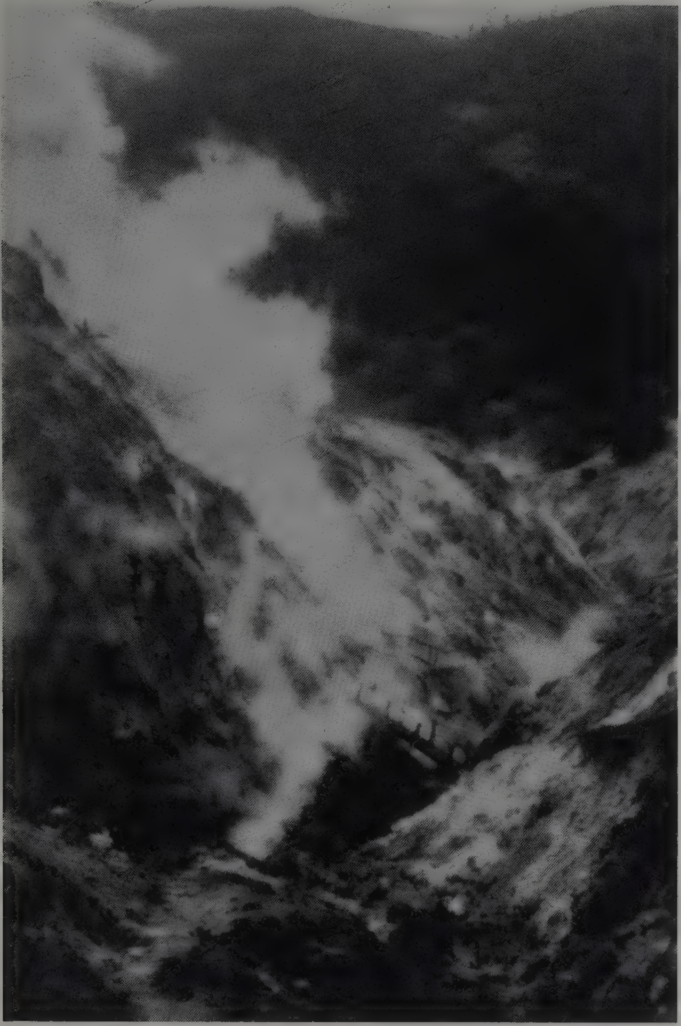


Figure 12. **View looking down Geyser Creek Canyon in the early 1940's (Bradley, 1946).**

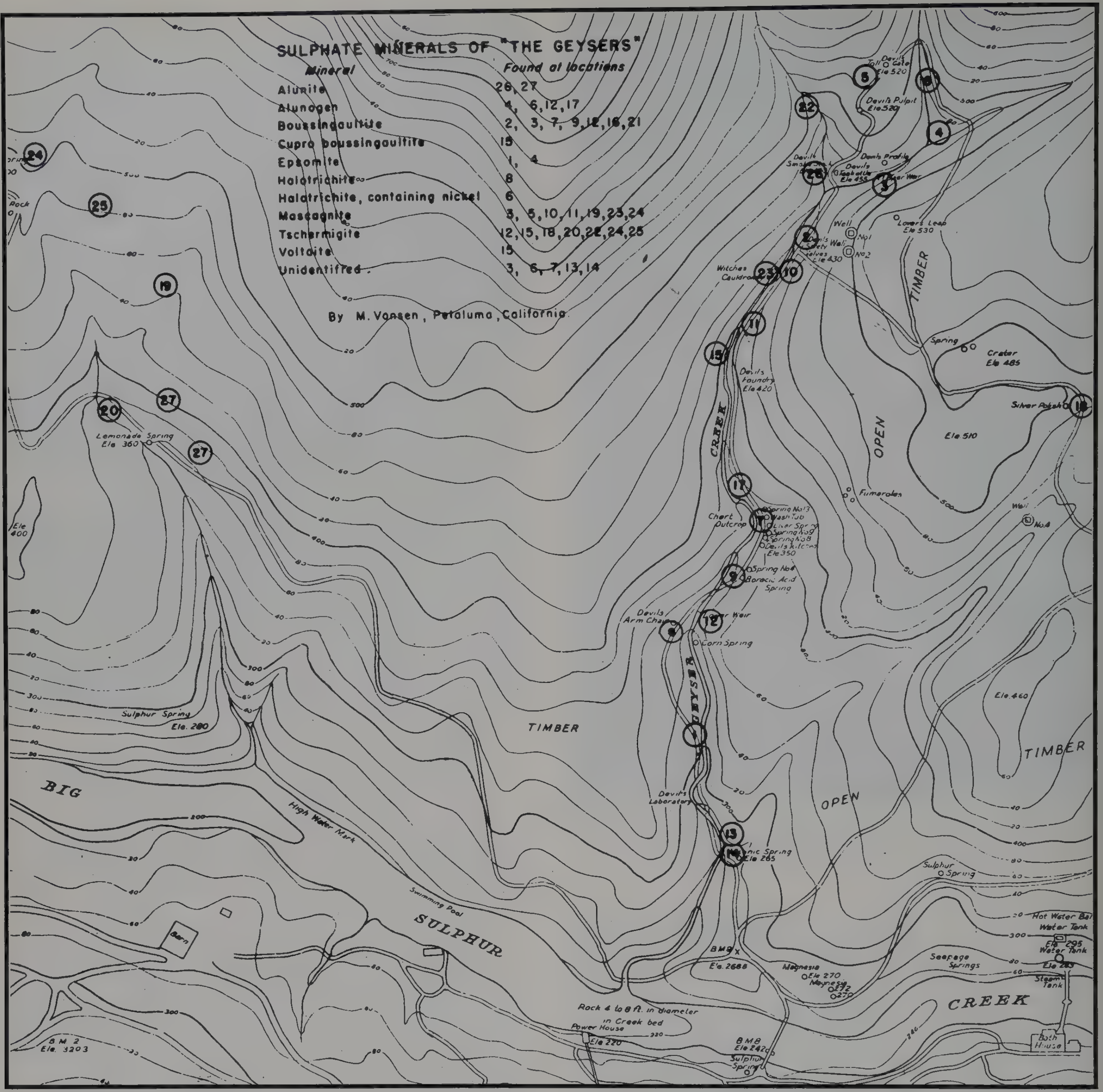
lack of sophisticated equipment to tell the difference between old mineral contamination or a new species, Vonsen submitted a number of these minerals to Dr. George Switzer of Yale University for further study.

In 1949, as part of this continuing study, Switzer spent a part of the summer at The Geysers studying the thermal activity and collecting samples of the salts that crystallized around the fumaroles and hot springs. In addition, while researching the early history of The Geysers, he learned from the owners of the resort that the natural site was discovered by William B. Elliot, who coincidentally was the grandfather of Dr. Switzer's uncle (Switzer, 1951). Some of his adventures during that summer are recounted here, and illustrate the conditions of collecting sulfate minerals in an active steam and boiling water environment:

> The principal area of thermal activity at "The Geysers" is along Geyser Creek, a minor tributary of Big Sulfur Creek, which joins Big Sulfur Creek across from the resort buildings. Beginning at Big Sulfur Creek, where several hot springs are found, the hot ground extends east-west for a distance of about 400 meters, and stretches up the steep slope along and on either side of Geyser Creek for distances varying from 200 to 500 meters. The boundaries of the hot ground are sharply defined for it is almost devoid of vegetation.
>
> From a distance on a hot day at noon, the area looks little different from the surrounding country. Early on a cool morning, however, the principal area of activity, Geyser Creek Canyon, is filled with a huge cloud of steam, while the steam wells send dense white plumes high into the air.
>
> A walk along the trail up Geyser Creek soon brings one to a fascinating area of intense thermal activity. Boiling hot springs are everywhere and the very ground under one's feet in places is simmering with boiling water and steam, so there are short stretches along the trail where it is much too hot to stand in one place for more than a few seconds. The normal air temperature during July and August in these deep Coast Range valleys commonly rises above the 100° F. mark. Thus Geyser Canyon may become a veritable inferno on a hot day. The strong odor of hydrogen sulfide adds further reality to this allusion.
>
> In addition to the boiling hot springs, there are numerous steam jets along the canyon walls, the orifices of which are commonly lined with beautiful, bright yellow needles of sulfur, but so fragile and delicate as to almost defy collection. In other places are areas where the steam just "oozes" forth from hot, soft, highly decomposed rock. The Smokestack, near the head of Geyser Creek and just to the west of the Devil's Pulpit, is the largest fumarole, and pours forth the largest volume of steam.
>
> Collecting samples of the salts that encrust the ground near the hot springs and fumaroles can be hazardous. On hot days, when the steam is invisible, I had the frequent experience of sticking my hand into a jet of live steam, and on other occasions very inopportunely stood so that a jet of steam shot up my pants leg. The ground everywhere is saturated with a rather strong solution of sulfuric acid, which can completely ruin the clothing of a mineral collector, who unlike the average sightseer, will soon be lying prone in various out of the way places trying to reach an especially attractive specimen.
>
> Temperature measurements of the hot springs showed them to range from just slightly warm to a maximum equal to boiling water, at that altitude about 97.5° C. The temperature of any particular spring will vary somewhat with the season of the year due to varying amounts of dilution with rain water.
>
> Acidity measurements show a range from just about neutral in the cool springs to rather strong acid with a pH of 2.5. No alkaline springs were found.
>
> A complete suite of minerals, mostly sulfates, are constantly forming about the various hot springs and fumaroles. Mineral collecting here is seasonal, since the salts, most of which are water soluble, are largely washed away during the rainy season, which usually lasts from October to April. The best time for collecting is early summer, especially after a dry winter, when a new crop has accumulated. However, at any time of the year good specimens of many minerals may be collected by working in protected places, such as under overhanging rocks.
>
> Many of the salts are highly deliquescent or efflorescent, and if they are to be preserved must be tightly sealed in jars at the time they are collected.

Our own interest in The Geysers started with our first trip in the summer of 1962 and extended until the early 1970's when the thermal action near the surface became so diminished that mineral precipitation had ceased. After arriving at the area via Healdsburg, we began walking along the narrow trail through the clouds of steam up Geyser Creek Canyon. The noise of the open steam vents and wells just above us was deafening (you can hear this roar of escaping steam for several km before arriving at the site). Pools of water appeared to be everywhere, and each seemed to contain better specimens than the previous one. Often the best specimens were found near the back of the hot water pools which form part of a cave in hydrothermally altered rock.

After a few encounters with invisible steam jets and boiling water, we managed to quickly pick up several samples and hastily placed



SULPHATE MINERALS OF "THE GEYSERS"

Mineral	*Found at locations*
Alunite	26, 27
Alunogen	4, 6, 12, 17
Boussingaultite	2, 3, 7, 9, 12, 16, 21
Cupro boussingaultite	15
Epsomite	1, 4
Holotrichite	8
Halotrichite, containing nickel	6
Mascagnite	3, 5, 10, 11, 19, 23, 24
Tschermigite	12, 15, 18, 20, 22, 24, 25
Voltaite	15
Unidentified.	3, 6, 7, 13, 14

By M. Vonsen, Petaluma, California.

Figure 13. **Location map showing the various mineral locations along Geyser Creek Canyon and vicinity (Vonsen, 1946).**

them in jars before being burned. It was a matter of who was faster, the collector's hand or the steam jet. Recalling Dr. Switzer's advice that in order to obtain good samples, one had to lie prone on the hot, steamy ground and reach for a sample, we found this method worked well for us except that most of the ground was saturated with sulfuric acid which usually was not kind to our clothing.

Feeling somewhat dehydrated, we rested near the head of the canyon where the only shade was found next to a stream of somewhat cooler water. In this area, we found good specimens of melanterite and epsomite in long, thin fibers. We also found a few nice examples of pentahydrite attached to an overhanging cliff.

Field identification of several ammonia-bearing sulfates was possible by placing a tiny piece on the tongue and noting its taste. Mascagnite is recognized by its sharp, bitter taste while boussingaultite has a saline and astringent taste. Tschermigite has a somewhat sweetish and astringent taste.

Our most treasured find was not recognized until several years later when some of the mascagnite specimens were examined using a binocular microscope. One sample, which we had labeled from Boric Acid Spring, was observed to contain a fine-grained mass of platy, colorless, pseudohexagonal crystals. This crystal habit did not correspond to any of the other ammonium sulfate minerals reported from The Geysers. Several small samples were submitted to John Sampson White of the Smithsonian Institution who, on the basis of X-ray tests, determined the colorless crystals to be the rare mineral letovicite. This is the first occurrence in the United States for letovicite and also the first occurrence of this rare mineral in a natural geothermal environment. Subsequent trips to the original spring where we first found the letovicite revealed no further samples there or at any other springs along the canyon.

MINERALS

From its discovery in 1847 until the mid 1960's when mineral formation was drastically reduced by steam diversion to generate electrical power, the fumaroles, hot springs and steam jets of The Geysers along Geyser Creek were a constant source for a large number of sulfate minerals. These minerals usually were found around the rims of the hot water pools or attached to the low roofs above the hot mineral saturated water that was being forced through the fractured underlying rocks by a hot magma body at depth. Sulfates of potassium, aluminum, ammonia, magnesium, calcium and iron are among the most common of the minerals found at The Geysers.

Alunite $KAl_3(SO_4)_2(OH)_6$

Near Lemonade Spring, Vonsen found alunite in decomposed volcanic rocks which had been altered by hot water (Vonsen, 1946). In veins 3 to 9 cm thick, the mineral appeared hard and porcelaneous with a smooth fracture, while in veins of greater width nearby, it was quite soft and resembled white clay. Alunite was noticeable in many places along the west bank of Geyser Creek up to Devil's Smoke Stack, as well as on the north bank of Big Sulfur Creek a few hundred meters below The Geysers resort.

Alunogen $Al_2(SO_4)_3 \cdot 17H_2O$

Fine, fibrous, silky tufts of alunogen occur in many places along Geyser Creek Canyon, as well as along the banks of a small creek flowing down a canyon below Lemonade Spring. It was found as a thick incrustation of rather striking appearance, with dark, almost black or greenish rough surfaces. The green crust unusually tests strongly for nickel (Vonsen 1946).

Ammonioalunite $(NH_4)Al_3(SO_4)_2(OH)_6$

Ammonioalunite occurs closely associated with ammoniojarosite and amorphous silica along Geyser Creek Canyon at one or more of the springs high in ammonium sulfate. The mineral was discovered and described by Altaner *et al.* (1988) in a single specimen from the Smithsonian Institution (NMNH 145596) collection. (Although the exact location by hot spring name is not known, it was most probably recovered from one of the hot springs containing high concentrations of ammonium and sulfate under very acid conditions and temperatures below 100° C.) The mineral is grayish white in color with a vitreous luster and white streak. Crystals, generally smaller than 20 μm, are euhedral rhombohedra.

Ammoniojarosite $(NH_4)Fe^{3+}_3(SO_4)_2(OH)_6$

Although ammoniojarosite is difficult to recognize in the field, we identified a few small brownish orange crystals using EDS and X-ray analysis on wall rock from Devil's Pulpit.

Boussingaultite $(NH_4)_2Mg(SO_4)_2 \cdot 6H_2O$

This mineral, described by Goldsmith (1877) and later by Allan and Day (1927), was confined almost entirely to Geyser Creek Canyon. It is particularly abundant under the overhanging rock in the main creek about 70 meters south of Devil's Pulpit, below a point known as Lovers Leap. Here, many square meters are crusted over with boussingaultite, and in certain places small stalactites 15 to 20 cm in length hang from the ceiling.

Across from the Devil's Arm Chair on the east bank of Geyser Creek and at several other places further up the canyon, a pale purplish colored mineral was found which was determined to be a chromian boussingaultite. At Witches' Cauldron on the west bank of Geyser Creek, crusts of boussingaultite containing copper (which produces a bluish black color on the surface and a pale greenish color in the interior) were found in thicknesses 3 to 6 cm (Vonsen 1941, 1946). Larsen and Shannon (1920) have described the only other California locality for boussingaultite at South Mountain near Santa Paula, California.


Figure 14. **Boussingaultite specimen, 10 cm, showing a stalactite and porous habit. G. Dunning specimen and photo.**

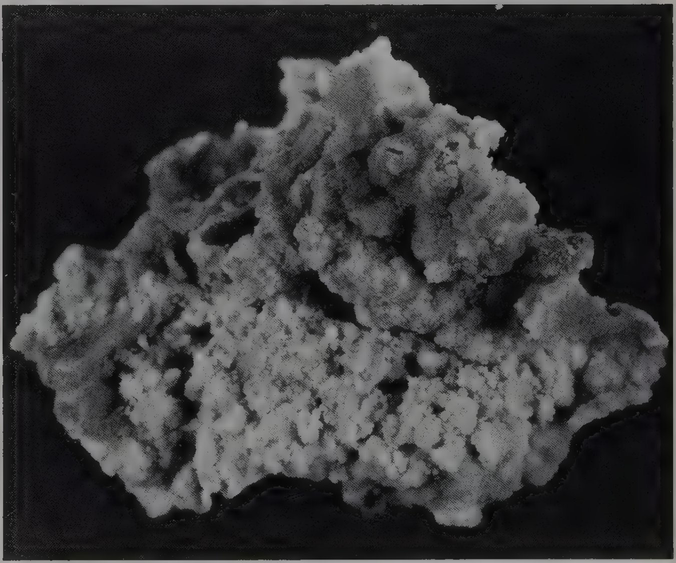


Figure 15. **Boussingaultite with a massive crust of mascagnite. G. Dunning specimen and photo.**

Cinnabar HgS

Vonsen (1946) reported cinnabar associated with mascagnite near Lemonade Spring and also in sulfur nearby. The loose, white, decomposed siliceous earth and dark decomposed volcanic rock at this locality also contained some cinnabar. In Geyser Creek Canyon about 50 meters upstream from the Devil's Kitchen, along the south bank, cinnabar was noted in a weathered opalized rock as reddish seams, and in the white earth as a delicate pink stain. It is not surprising to find cinnabar at The Geysers, since there are several mercury mines west of The Geysers (Davis 1976).

Epsomite $MgSO_4 \cdot 7H_2O$

Epsomite is found near the upper and lower margin of the hot zone in Geyser Creek Canyon, and in places along the south bank of Big Sulfur Creek. At the point where the trail enters Geyser Creek Canyon, the west wall is composed of highly altered serpentine rock with many large cavities and pockets that have resulted from the less resistant material being dissolved. These cavities are often coated with white powdery epsomite, which in places fills a considerable portion of the cavity. A crust of pale green epsomite 5 to 10 cm in thickness and made up of compact fibers was found on the floor of two of the larger cavities. In addition to the pale green epsomite, long, white, silky masses were also found at Geyser Creek Canyon as well as at Lovers Leap.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum was found only once in Geyser Creek Canyon, at an open fissure with opal, cinnabar and a yellow iron sulfate. It occurs sparingly in long fibers and small, poorly terminated crystals.

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

Yellowish white halotrichite was found near Witches' Cauldron and sparingly at other places in Geyser Creek Canyon, including Lemonade Spring (Vonsen, 1946).

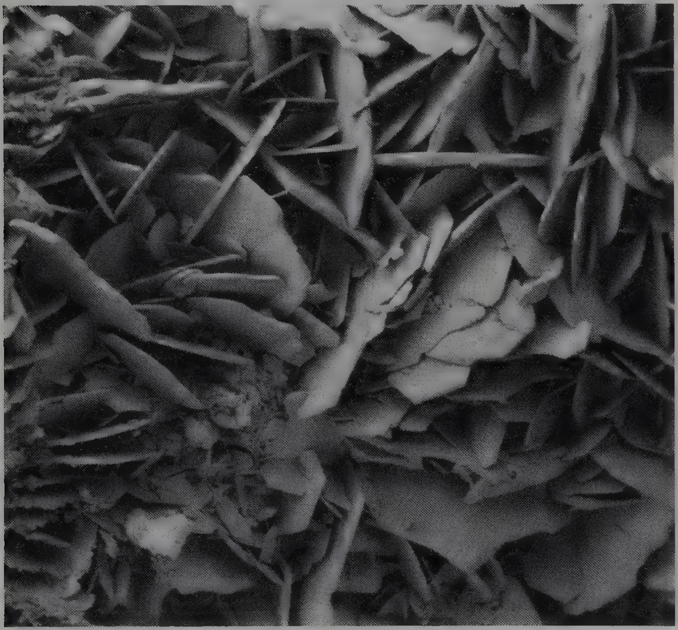


Figure 16. **Delicate, intergrown letovicite crystals to 0.05 mm, covering mascagnite (SEM photograph). G. Dunning specimen and photo.**

Letovicite $(NH_4)_3H(SO_4)_2$

The rare ammonium hydrogen sulfate, letovicite, was discovered by Dunning and Cooper (1969) on samples of massive mascagnite from Boric Acid Springs along Geyser Creek Canyon. Massive boussingaultite also occurs with letovicite. The mineral was initially collected during the summer of 1962 and was observed as masses of colorless, pseudohexagonal crystals, 0.03 by 0.05 mm and 0.005 mm thick. John Sampson White, then of the Smithsonian Institute, identified the mineral.

Letovicite was first described by Sekanina in 1932 from Letovice, Moravia, where it was found with sulfur as a result of burning the waste heaps from a coal mine. A second, similar occurrence was discovered at a coal mine near Kladno, Bohemia in 1937 (Rost, 1937).

A visit in 1972 to the original locality at The Geysers revealed no further samples of letovicite. It would appear that the acidity of the fumarolic waters necessary for the formation of letovicite had decreased gradually during the years with the diversion of steam for geothermal power.

The occurrence of letovicite at The Geysers is the third verified locality for this rare sulfate mineral and the first for California. It is also the first occurrence of letovicite in a natural, geothermal environment.

Personal communication with Dr. George Switzer in 1968 revealed that the crystallographic date of "letovicite" listed by Palache *et al.* (1951) was for the compound $(NH_4)H(SO_4)$ and not letovicite. Recently Davis and Johnson (1984) have presented the true unit cell data for letovicite. It is triclinic, $P1$ or $P\bar{1}$ with $a = 5.87(1)$, $b = 10.17(3)$, $c = 8.27(1)$Å, $\alpha = 101.1(4)$, $\beta = 111.1(1)$, $\gamma = 89.9(2)°$. Pseudohexagonal symmetry is present along [001].

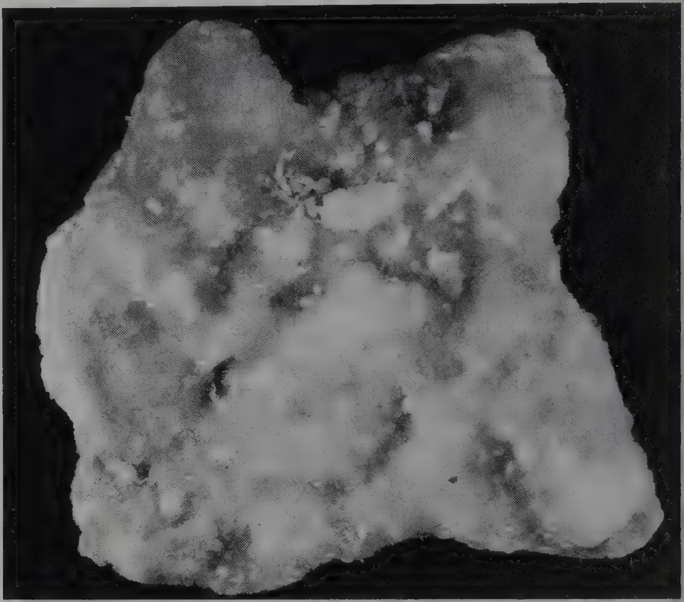


Figure 17. **Crystalline mascagnite, 7 cm, covered with minute letovicite crystals. G. Dunning specimen and photo.**

Mascagnite $(NH_4)_2SO_4$

This ammonium sulfate is quite common. It occurs at a high point near the Devil's Pulpit in the upper half of Geyser Creek Canyon, where the ground is hot as incrustations and nodules form, some with a coarse, fibrous interior. Mascagnite is particularly noticeable in the early summer months but in late summer and fall it disappears with the first rains, leaving a dark brownish residue. Its greatest development is in large, firm, crystalline masses near Lemonade Spring, where it is especially noticeable on the east bank of a small wash where the removal of specimens is difficult due to the intense heat of the ground. Sulfur forms freely with it, and in one spot cinnabar was found attached to the underside of the specimens.

Melanterite $Fe_2SO_4 \cdot 7H_2O$

Melanterite occurs along the upper area of Geyser Creek Canyon as pale green stalactites in protected areas such as rock overhangs. When associated with boussingaultite the two minerals are not easily distinguished.

Metastibnite Sb_2S_3

Brookins (1970) has identified metastibnite from samples collected during the years 1957 to 1958 from an area near the eastern edge of the geothermal area. It occurs as red coatings in cracks in siliceous sinter, but nowhere was it observed to form a complete vein. The mineral is apparently restricted to an area known as "The Big Geysers," approximately 50 meters north of Big Sulfur Creek.

The conditions necessary for the formation of metastibnite are not clear. Clark (1970) attributes formation of metastibnite at Mina Alacran, Copiapo, Chile, to oxidation from stibnite, but the metastibnite found at The Geysers and at Steamboat Springs, Nevada, may be primary in its formation (White, 1967). Sulfur isotope analyses of sulfur-bearing species from the metastibnite location at The Geysers suggest that a gas phase, probably H_2S was involved in the formation of primary metastibnite because its sulfur is isotopically lighter than that of the other species. This might also account for its occurring as coatings in cracks but not as complete veins.

Opal $SiO_2\cdot nH_2O$

Delicate capillary fibers of opal, sometimes branching out in radiating tufts resembling small cotton balls, occur in small open fissures near the surface in Geyser Creek Canyon at Lemonade Spring. Sometimes it forms reticulated masses in the depressions of the fissures, resembling delicate, interlaced, loose fibers of mesolite. Gypsum was found coating the fibers, resulting in anomalous optical properties. Removal of the gypsum revealed the fibers to be isotropic (Vonsen, 1946).

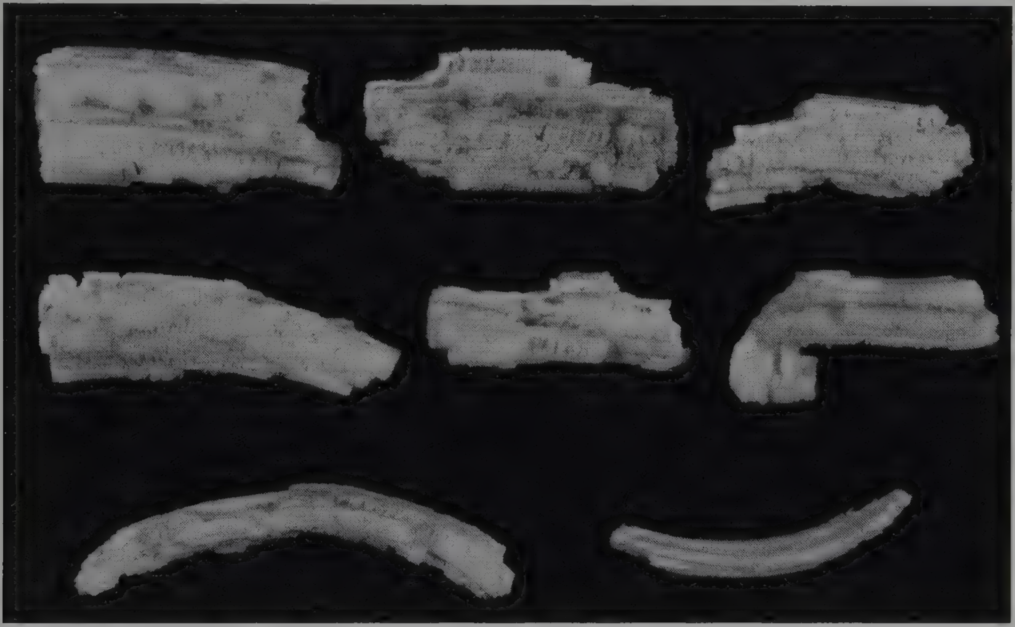


***Figure 18.* Pentahydrite after epsomite, to 3 cm long, showing typical curved habit. G. Dunning specimen and photo.**

Pentahydrite $MgSO_4\cdot 5H_2O$

Granular pseudomorphs of pentahydrite after epsomite were identified by Allen and Day (1927). These pseudomorphs are somewhat harder than the epsomite from which it was derived. During our visits to the area in the 1960's only a few of these pseudomorphs were found, attached to the walls of several small cavities along the canyon.

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

Allen and Day (1927) reported pickeringite from an area along Geyser Creek Canyon but Vonsen (1946) could not verify the occurrence. Pickeringite was reported to be rich in nickel.

Pyrite FeS_2

Pyrite occurs as crystalline, brass-yellow smears on lumps of black earth along several locations in Geyser Creek Canyon (Vonsen, 1946).

Sassolite H_3BO_3

Smith (1958) identified and reported sassolite in samples collected by J. B. Nichols of Sacramento and M. Vonsen of Petaluma, California. The specimen consisted of a matte of tiny transparent flakes that had the same optical properties as the Steamboat Springs, Nevada, sassolite. The Geysers sassolite was found associated with both boussingaultite and mascagnite.

Sulfur S

Vonsen (1946) reported large quantities of sulfur at Lemonade Spring and at the Sulfur Bank. On the hot ground in Geyser Creek Canyon, earthy looking crusts displayed countless brilliant, sharply terminated sulfur crystals when overturned. Crystals surrounded the vents of many small steam jets and lined small fissures where vapors were constantly escaping.

Tschermigite $(NH_4)Al(SO_4)_2\cdot 12H_2O$

Crusts and crystalline masses of tschermigite occur in several places in upper Geyser Creek Canyon near Lemonade Spring. In this locality, as well as in several other places in Geyser Creek Canyon, fine crystallized tschermigite was found after the first rain. The formation of this mineral resulted when dissolved material from a clay bank was redeposited by a slower than usual flow of water, to more level ground and evaporation occurred. This mineral was also identified along the south bank of Big Sulfur Creek as small, glassy, octahedral crystals attached to the hard rock.

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

Vonsen (1946) reported black crusts of voltaite at Witches' Cauldron along Geyser Creek Canyon. The interiors of these crusts are crystalline.

Silicate Minerals

Silicates are rather limited in occurrence at The Geysers, but can be found in the surrounding hills. The most common of these is tremolite which occurs in fibrous aggregates and prismatic crystals. Pectolite is generally distributed throughout the area, filling small veins, although in limited amounts. Perhaps the most interesting silicate noted by Vonsen (1946) is stellerite. It occurs in small tabular crystals, sharply developed, ranging in size from 2 to 4 mm. A few actinolite masses were noted in the washes above Geyser Canyon. A chromium-bearing kaolinite occurs as bright bluish green, fine-grained masses near Devil's Pulpit. Brookins (1973) made a study of this chromian kaolinite from The Geysers.

DISCUSSION

As a geologic curiosity, the geothermal area known as The Geysers has been the subject of many investigations dealing with its geology and the source of the steam. The early theory on the source has been confirmed by a number of investigators who agree that the heat source is deep-seated and magmatic in origin. Groundwater turned to steam is continually being channeled to the surface along a fault which courses northwestward along a ridge on the southern side of the Mount St. Helena range (Allen and Day, 1927; Switzer, 1951; McNitt, 1963). Areas of hot spring and fumarole activity are common around volcanoes such as Mt. Lassen, in California, and in areas of more recent volcanic activity, such as Yellowstone Geyser Basin, Wyoming. In these two locations, the evidence is clear that hot springs and fumaroles are caused by bodies of molten rock, or lava which have been pushed up to the surface from an unknown depth below. At The Geysers, there are no volcanic rocks exposed at the surface, only old Franciscan rocks, which certainly have no bearing on the origin of the thermal activity. However, the fact that there is evidence of fairly recent volcanic activity only a few km away makes it almost certain that the heat in the form of escaping steam and hot water is supplied by a body of hot rock at an unknown depth which, for some reason, was never able to force its way to the surface. It has, however, been steadily releasing its heat through cracks and fissures in the overlying rocks.

Switzer (1951) considers the source of the water which issues from the fumaroles and steam wells to be mostly meteoric in nature, since magmas contain only a small percentage of water. Even a large magma chamber could not give off the quantity of water that has passed into the atmosphere as steam, or run off from the discharge of the numerous hot springs during the untold number of years that this area has been active.

From the observations of Allen and Day (1927) it is known that a body of ground-water overlies the superheated steam zone and is the principal supply of water. It has been suggested (McNitt, 1963) that the base of the constant temperature zone corresponds to a steam-water interface at the bottom of the groundwater body.

The question arises whether the steam reservoir is confined by overlying impermeable beds or by a body of groundwater in hydrostatic equilibrium with the steam reservoir such that the expansive pressure of the steam equals the hydrostatic pressure of the water body which confines it. McNitt (1963) has tested this latter hypothesis and has found that there is in fact a body of groundwater above the steam reservoir. This was deduced from static wellhead pressure data by calculating the height of a column of water which would produce the static wellhead pressure observed during field tests. This calculated height was then added to the elevation of the temperature "break" observed near the bottom of the constant temperature interval recorded in the well logs. This height is thought to represent the top of the groundwater body overlying the steam.

Two surface features noted in the study by McNitt (1963) support the validity of these calculations. First, there is a general similarity in configuration between the topography of The Geysers area and the configuration of the upper boundary of the proposed groundwater body; and second, the elevation of the surface ranges between 500 and 533 meters, which corresponds to the range in elevation of the principal natural springs in Geyser Canyon.

McNitt (1963) argues that the static pressure of the steam is dependent upon the hydrostatic head above the steam, and that the height of this water is principally determined by the rate of heat flow into and out of the overlying water body. This water body is a mixture of meteoric water originating in the immediate vicinity of The Geysers, and condensed steam from below. Under natural conditions, heat is released from this groundwater body by the flow of hot water from the springs in Geyser Canyon; this rate of water flow is determined by the permeability of the fracture zone above the water body.

In order to maintain the density inversion of the two phases in the underground system McNitt (1963) states that there must be a balance of heat flow into and out of the groundwater body. Under static conditions, it would not be possible for a steam phase to be in mechanical equilibrium with an overlying liquid phase due to their difference in density. In the case of The Geysers steam system, a density inversion is made possible by the movement of both phases through the system, not only by their density difference but also by the thermodynamic equilibrium existing between the two phases in an open and flowing system.

Switzer (1951) suggests that the mineral salts which continually form along Geyser Canyon, especially during the warm, dry summer months, have been transported upward by the escaping steam and hot condensed water. Analysis of the gases making up the steam is given by Bradley (1946) and shows 67.3% CO_2, 12.9% H_2, 11.7% CH_4 and 2.7% H_2S in the non-condensible phase. The soluble gases include 15.0% NH_3, 3.9% H_2S, and 5.1% CO_2. Switzer (1951) also suggests that the soluble mineral matter originated in part from emanations of the underlying hot rock and by partial solution of the overlying Franciscan rocks. For a thermal area associated with dying volcanism, it is unusual that no significant chloride has been detected in either the steam or the hot waters.

White (1957) has classified the hot springs at The Geysers as belonging to the sodium bicarbonate type.

CONCLUSIONS

The Geysers geothermal area has been an active producer of steam and hot water since the late Tertiary or early Quaternary time. The source of the energy supplying this geothermal area is thought to be a hot rock mass at some unknown depth below the underlying Franciscan rocks. The primary source of water in this natural steam generator is considered to be a combination of meteoric water and condensed underground steam in equilibrium with the loss of energy to the atmosphere.

This escaping steam and hot water, channeled upward along faults and fractures in the underlying rocks, has provided scientists, mineral collectors, and curious visitors with a natural energy source and a chemical laboratory capable of forming a variety of interesting minerals, whose elements have been released from both the hot rock mass and the Franciscan rocks through which the steam is channeled.

These minerals, most of which are sulfates containing ammonia, have been quite abundant until the 1970's. Since then they have decreased in quantity due to the increased diversion of the steam for electrical generation. Today there are no water-soluble sulfate minerals forming in this once popular fumarolic area of Geyser Canyon, although samples of sulfur, cinnabar and other insoluble minerals may still be found. At present, the area surrounding the old resort and Geyser Canyon is closed to the public.

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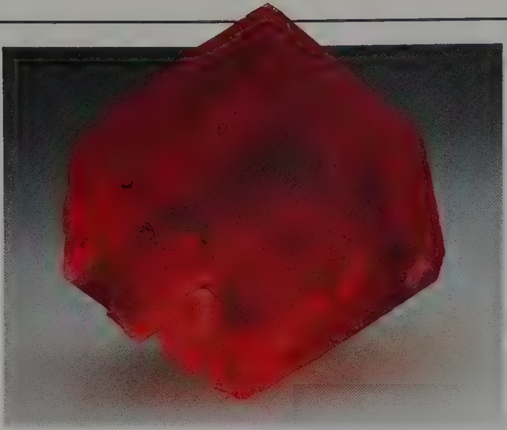

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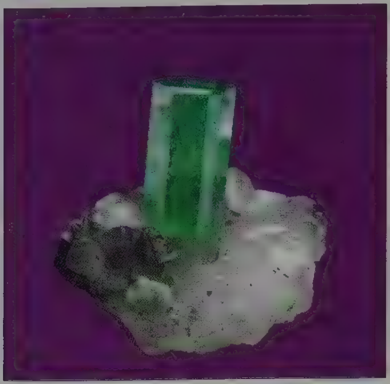

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INTRODUCTION

The vesuvianite deposit, located off lower School Street in the town of Sanford, Maine, is a classic example of the mineralized calc-silicates commonly encountered in northern New England. Variously known as the Goodall quarry, Goodall Farm mine, and Webster quarry, the deposit consists of one primary and two smaller shallow pits. This locality has been a producer of collector-quality specimens of vesuvianite, grossular, scapolite and other species for almost 150 years. It still offers promise to diligent collectors today.

HISTORY

The first recorded reference to this location was by Harvard University Professor John H. Webster (1848), who described idocrase (vesuvianite) from the Sanford deposit as follows:

> The crystals of idocrase uncovered present brilliant planes, and stand out in bold relief. The crystals are often finely terminated and present the usual modifications of form; they vary in size from a tenth of an inch in diameter to an inch and a half.

Similar references to vesuvianite from this location can be found in the works of James D. Dana, George F. Kunz and other authors.

Serious (for the times) developmental work on the deposit was undertaken by Thomas Goodall, a local entrepreneur and industrialist, who eventually founded the Goodall-Sanford textile mills. The extent of Goodall's operations in the latter half of the 1800's, and the quantity of his finds, seem to have gone unrecorded but by the early 1900's fine specimens of Sanford vesuvianite were in the collections of at least 16 museums and colleges around the country including Brown, Yale, Colby and Harvard (Emery, 1901; Haven, 1934).

The activity of the two world wars focused mineralogical attention away from the economically insignificant calc-silicate deposits; the Sanford location, like many others, lay idle with only sporadic visits by collectors during the first half of the 20th century. In the early 1950's the Maine Geological Society leased the locale and did some drilling and blasting for specimen recovery in the main pit. After their activities they had several adjacent stone walls bulldozed up to the working face so that a mere four to five feet of ledge was left exposed and the previously existing 12 plus feet of exposed vertical face was effectively sealed off. Some claimed this was a safety precaution requested by the landowner (Mr. Frank Clark); others of a more cynical bent said it was to cover up the deposit to keep other collectors from obtaining good specimens. The net result was to create what seems to be a dump composed about equally of angular masses of calc-silicate rock and rounded glacial boulders. This had led a number of recent collectors to the incorrect assumption that this deposit is merely glacial "float" and not an *in situ* occurrence.

Field collecting has continued to date, with frequent finds being made by hard-working individuals. Local legend is persistent in the rumor of at least one large pocket being broken into by intrepid collectors in the early 1960's. I can attest to a large number of especially clear, well-terminated crystals being available at local swap meets circa 1964. Recent finds of powellite, meionite, scheelite and grossular have been made.

GEOLOGY

The Sanford deposit is essentially a calc-silicate granofels with minor marble and, as such, is one of five distinct lithological units associated with the Lower Member of the Rindgemere Formation. The Rindgemere Formation is a sequence of variably bedded metasediments derived from pelitic shale, argillaceous sandstone and calcareous sediments (Hussey, 1985).

The calc-silicate unit appears to be bounded on all sides by the Lyman Pluton, an acidic non-foliated biotite granite. This suggests that the deposit is a roof pendant; faulting and brecciation of some mineralized portions of the outcrop (600 meter pit; see map) are also visible. The granite crops out locally in several places adjacent to the deposit; in addition, small basaltic dikes crop out in contact with the calc-silicate unit. The well-mineralized portion of this unit is exposed at several places along a surface strike of N 15° W over a distance of 600 meters. These are locally referred to as the "main pit," the "200 meter ledge," and the "600 meter pit." While there are minor

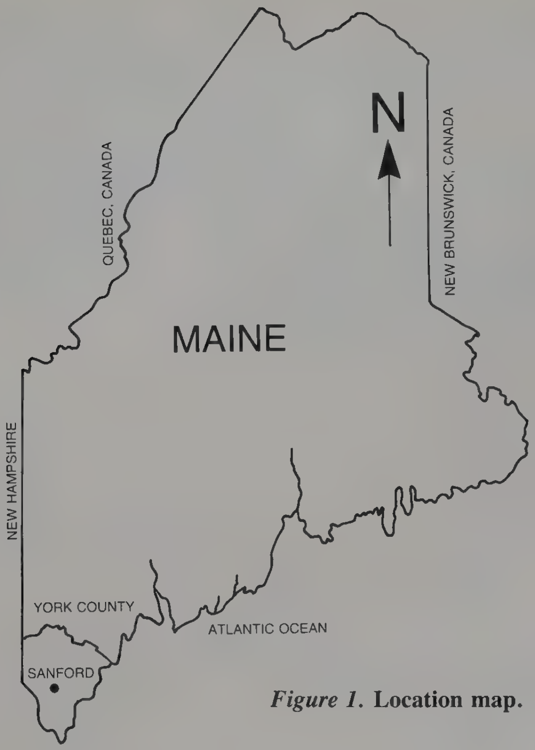

Figure 1. **Location map.**

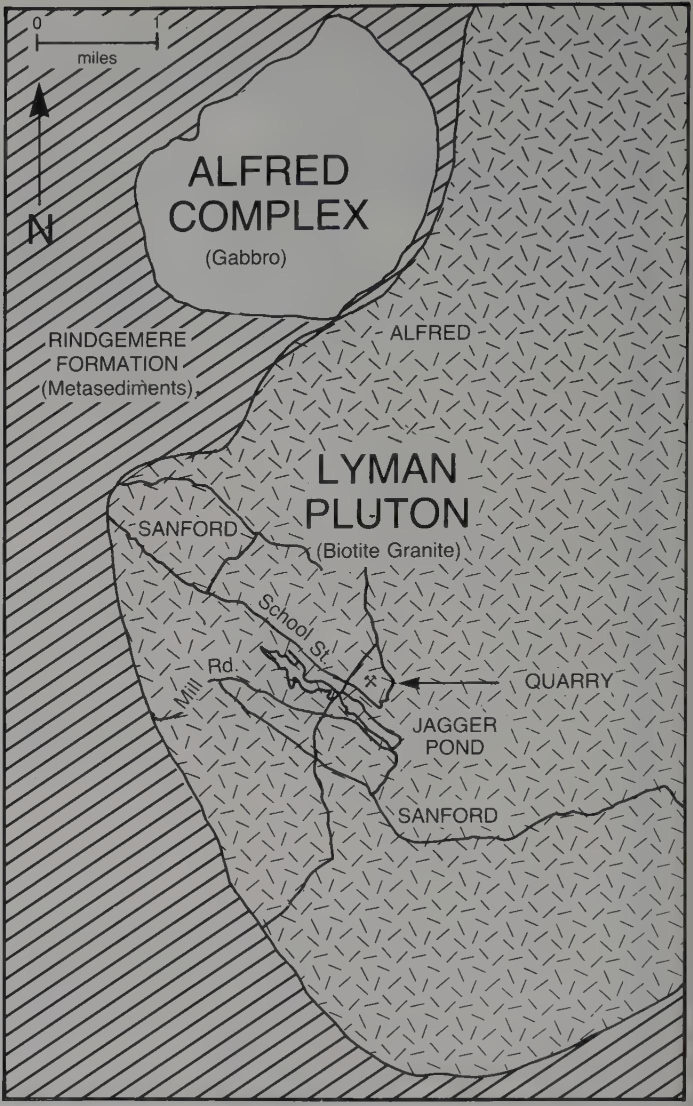

Figure 2. **General geology of the Sanford vesuvianite occurrence (after Hussey, 1985).**

Figure 3. **The Main pit; seams of quartz and calcite are visible in the calc-silicate matrix.**

Figure 4. The 200-meter location. The shallow depression was originally a ledge standing 60 or 70 cm above ground level, which has been broken down by collectors. Collectable material can still be found here.

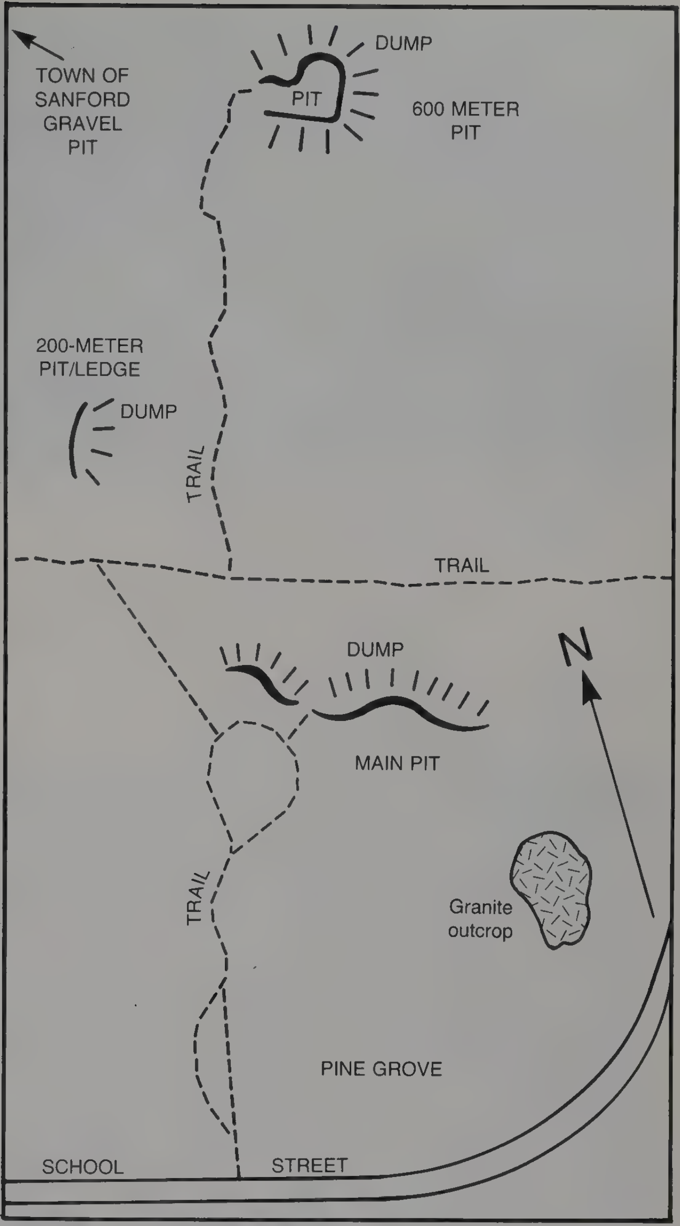

Figure 5. Sketch map of the pit areas (not to scale). Heavy lines show calc-silicate outcrops in the pits.

Figure 6. The 600-meter location, showing the exposed ledge in the pit.

differences in species distribution between these three areas, they all contain the same major minerals (see Table 1) and do not seem to represent zones of any type. Jackson (1970) indicates that a completely random pattern of mineralization is common for this type of deposit.

Hussey (1985) suggests the possibility that this calc-silicate may in fact represent a single stratigraphic sub-unit in the Lower Member of the Rindgemere Formation. Mineralogically similar Rindgemere Formation rocks crop out in the nearby towns of Kezar Falls, Cornish and Parsonfield. Radiometric dating places the age of the Lyman pluton at 322 ± 12 Ma (Gaudette *et al.*, 1982).

MINERALOGY

Table 1 lists the species positively identified from the Sanford deposit to date. Many species are only exposed by etching them out of the enclosing calcite with hydrochloric acid. Pods and seams of calcite are found more or less at random in massive vesuvianite, and range in size from 2 or 3 cm up to 1 meter. When etched, these pods may reveal a single species or two, or a whole assemblage of species intergrown in jackstraw profusion. The following species descriptions are limited to those that afford attractive specimens to the collector.

Actinolite $Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$

Dark green to near-black acicular actinolite crystals to 1 cm are found growing in felted masses from the walls of the host rock into pods of calcite and meionite. Almost invariably exposed only by acid treatment, they are most common in the 200 meter pit.

Andesine $(Na,Ca)Al(Al,Si)Si_2O_8$

Off-white to greenish white crystals of andesine are found throughout the deposit, but seem most common in the main pit. Crystals range in size from microscopic to 4 by 6 cm. While anorthite is listed in the early literature, all recent specimen analyses indicate a calcium content equivalent to that of andesine.

Clinozoisite $Ca_2Al_3(SiO_4)_3(OH)$

Clinozoisite occurs as crude single crystals to 4 cm in calcite pods associated with meionite, titanite and diopside. It is not commonly encountered in all parts of the deposit.

Diopside $CaMgSi_2O_6$

Diopside is ubiquitous to all parts of the deposit. It usually occurs as euhedral crystals of dull brown to bright green in the microscopic to 5-mm size range, although larger crystals are known. Floater groups of microscopic crystals can be removed from the calcite, providing superb microspecimens of translucent green crystals.

Fluorite CaF

The occurrence of flourite seems to be limited to the 600 meter pit, where it occurs as massive veins and blebs in a mixture of scheelite, sphalerite, altered vesuvianite and granular calcite. It occurs in masses up to 4 cm and veinlets up to 1 meter in blue-purple, white and pink colors. There is a faint blue fluorescence under shortwave ultraviolet light. No crystals have been observed.

Grossular $Ca_3Al_2(SiO_4)_3$

While grossular has been reported from all portions of the deposit it is most common at the 600 meter pit. Here it is common to find masses of bright garnet disseminated through the host rock. Where these masses intersect calcite pods, etching reveals deep red crystals 5 mm to 5 cm in size, though most fall in the 2-cm range. The habit of these crystals is about equally divided between simple dodecahedrons and dodecahedrons modified by trapezohedrons. While single crystals are found, an inordinate number of "twosomes" have been recovered. Common associates are meionite and vesuvianite. A number of excellent specimens have been recovered in recent years. Many specimens from the 600 meter pit show brecciation of the massive vesuvianite host rock, with garnets occurring along the length of the fractures.

WEW

Figure 7. **Meionite crystals to 2.5 cm, in calcite with dark green actinolite, from the 200-meter pit at the Sanford deposit. Duane Leavitt collection.**

Meionite $Ca_4Al_6(SiO_4)_6(CO_3)$

Meionite is common to all areas of the deposit. It occurs as microcrystals up to crystals 10 cm long by 2 cm in diameter. Masses of jackstraw crystal aggregates and plates up to 25 cm by 34 cm have been recovered. The color of these specimens ranges from yellow-brown to ivory to bone-white. The crystals are elongated tetragonal prisms with seemingly flat terminations. Some specimens show bent crystals with deformation fractures; others are very straight and slender. Jackstraw clusters and intergrowths are common, often providing the surfaces upon which other species have grown. Response under longwave ultraviolet light is strongest in the whiter crystals. This locality is the premier location for scapolite in Maine.

Molybdenite MoS_2

Molybdenite occurs sparingly throughout the entire deposit. The usual mode of occurrence is in isolated patches and crude masses to 1 cm in the massive vesuvianite host rock. At the main pit it has been found in superb, splendent, thin, free-standing hexagonal crystals to 1.5 cm uncovered by leaching away calcite.

Powellite $CaMO_4$

Powellite occurs as disseminated grains and small masses in massive vesuvianite. It fluoresces a bright yellow under shortwave ultraviolet light. A significant find at the main pit in 1983 produced masses and crude crystals to 1 cm. These were uncovered by extensive digging parallel to the backfilled face of the main pit, at a point where the calc-silicate unit is in close contact with the local pegmatite body. Any molybdenite samples from this area should be checked carefully under ultraviolet light for the presence of powellite. [Ed. note: The test is not foolproof, however. A minor amount of molybdenum can cause scheelite to fluoresce a cream to yellow color as well.]

Figure 8. **Colorless scheelite octahedron, 1.7 cm, from the 600-meter pit, Sanford deposit. Duane Leavitt collection.**

Figure 9. **Vesuvianite crystals to 5.5 cm from the Sanford deposit. Duane Leavitt collection.**

Figure 10. **Red grossular crystals to 1.3 cm on vesuvianite crystals, from the Sanford deposit. Duane Leavitt collection.**

Figure 11. **Titanite crystal, 1.5 cm, with clinozoisite from the Sanford deposit. Duane Leavitt collection.**

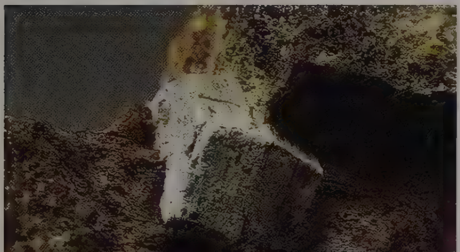

Figure 12. **Powellite pseudomorph, 2 mm, after molybdenite, from the Main pit at the Sanford deposit. Duane Leavitt collection.**

Scheelite $CaWO_4$

Although present in all parts of the deposit, the greatest concentration of scheelite is in the 600 meter pit. Here it occurs as blebs, masses and crystals in a highly altered mixture of vesuvianite, fluorite, sphalerite and granular calcite. Masses of pure scheelite to 5 by 8 cm are common. Crystals are quite rare, although a number have been recovered. The best of these is a sharp, 1.6-cm tetragonal dipyramid on a matrix of brecciated vesuvianite. The crystals have glassy faces and are a uniform gray-white in color, as are the masses. All scheelite from the deposit fluoresces a brilliant bluish white under ultraviolet light.

Sphalerite $(Zn,Fe)S$

Discovered only recently at the 600 meter pit, sphalerite exists as crystalline grains and masses from microscopic size up to 4 cm. It is almost always found admixed with granular calcite, scheelite, fluorite and altered vesuvianite. In some specimens sphalerite makes up to 8% of the total volume of rock. No crystals have been observed.

Titanite $CaTiSiO_5$

Titanite occurs in two distinct habits. One consists of highly curved clusters of small, straw-yellow to tan crystals in sheaf-like aggregates. The other habit consists of light brown, almost perfect monoclinic tabular prisms with some interpenetration twinning on (110). Crystal sizes range from microscopic to 1.5 cm. Both habits have caused considerable confusion in recent years; both fluoresce a medium yellow to golden color under shortwave ultraviolet. This has led some collectors to the conclusion that this material is maganaxinite. Axinite is listed for this location in Morrill's 1959 guide book (the only comprehensive Maine mineralogy prior to 1988) while titanite is not. X-ray diffraction analysis of a sample at the Harvard Mineralogical Museum in 1989 produced a pattern identical with titanite (personal

Table 1. **Minerals reported from the Sanford, Maine, location.**

Species	Main Pit	200 Meter Pit/Ledge	600 Meter Pit
Actinolite		X	X
Andesine	X		
Calcite	X	X	X
Clinozoisite	X	X	
Diopside	X	X	X
Fluorite	X	X	X
Grossular	X	X	X
Meionite	X	X	X
Molybdenite	X		X
Powellite	X		X
Pyrite			X
Quartz	X	X	X
Scheelite	X		X
Sphalerite			X
Titanite		X	X
Vesuvianite	X	X	X

communication, G. Bearss). Pending future discoveries, the Sanford titanites are probably the best from the state. The species is most common at the 200 meter and 600 meter exposures, and is commonly associated with meionite and altered vesuvianite.

Vesuvianite $Ca_{10}Mg_2Al_4(SiO_4)_5(Si_2O_7)_2(OH)_4$

Vesuvianite is common in all areas of the deposit, in a variety of habits. Sinkankas (1966) states that matrix specimens of vesuvianite are rare; but they tend to be more common than single crystals at Sanford. In the main pit large masses of glassy, columnar prisms with few exposed terminations are the norm. The exceptions come when the vesuvianite intersects the calcite, or more rarely quartz-filled seams in the host rock. Etching or careful tapping often reveals perfect tetragonal first-order prisms with flat pinacoidal terminations; second-order prisms and dipyramidal terminations are also known. Specimens from the main pit were used as the basis for some of the crystal drawings found in the third and some subsequent editions of Dana's *Textbook of Mineralogy* (Dana, 1926). Crystal size ranges from microscopic to single crystals 7 cm in length. Aggregate masses of intergrown crystals and massive vesuvianite to 27 kg have been recorded. Superb microcrystal specimens, translucent to transparent, have been obtained by etching small calcite-filled interstices in massive material. The specimens from the main pit are dark brownish green in color.

The vesuvianite crystals from the 200 meter pit are generally smaller and less attractive than those at the main pit, occurring as gray-green crystals in the 1-cm or less size range. Much material from this pit tends to be corroded, naturally etched or decomposed, breaking apart very easily.

Vesuvianite from the 600 meter pit tends to be similar to that of the main pit but with some exceptions; some specimens with pyramidal terminations have been recovered, and there are more floater crystals of considerable size in the calcite pods. Often these crystals will show fractures and healing or regrowth resulting in curved or kinked specimens; this is the probable result of faulting and brecciation at the northern end of the deposit. Colors range from dark brown to lighter green. Etched "pocket groups" to 20 by 40 cm with tens of crystals from 2 to 7 cm in length are not uncommon. In the early 1960's a very large calcite pod was recovered with superb, sharp, single crystals to 8 cm in diameter. This material was absorbed into private collections almost within a season.

Other Species

A number of other species have been reported from the Sanford vesuvianite deposit. These include pyrite, hydrozincite, manganoan axinite, anorthite, (which eventually proved to be andesine) and clinochlore. Additional specimens for analysis are needed to validate these species. To date none have been found in desirable, collector-quality specimens.

DISCUSSION

Jackson (1970) cites brown, blocky vesuvianite as being typical of regional metamorphic environs. The small size and apparently shallow depth of the Sanford deposit, less than 100 meters (Hussey 1985), argue for classification as a contact metamorphic deposit. Yardley (1989) indicates that grossular and diopside are only stable in metamorphic environs where the fluid phase is rich in water and correspondingly poor in carbon dioxide. External buffering of the fluid phase by water from a local pluton is suggested as a mechanism by which this phenomenon may occur. Minerals such as scheelite, fluorite, molybdenite and sphalerite are common in metasomatized deposits. The species in the assemblage, coupled with brecciation in the deeper portions of this deposit, suggest that circulating fluids from the granite pluton reacted preferentially with the calcium-rich rocks in the sequence. Given the number of igneous plutons in southern Maine, this would lead to the assumption that additional, as yet undocumented similar deposits may exist.

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RECENT DISCOVERIES
from the
WESSELS MINE SOUTH AFRICA

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INTRODUCTION

During the last week of April and the first week of May, 1992, a new find of inesite and several associated minerals was made at the Wessels mine north of the town of Kuruman in the Kalahari Manganese Field. The specimens were found near a dike (P. de Bruyn, personal communication, 1992) and had crystallized in altered portions of the wall rock that had been in contact with the intrusion. Specimens from a few museum-sized pieces to cabinet, miniature and thumbnail specimens were collected, although high-quality, undamaged specimens probably number less than 30. The inesite was associated with other minerals, two of which are zeolites, and these are reported here for the first time.

MINERALS

The minerals found include inesite, datolite, natrolite, tobermorite, thomsonite, rhodonite and hydroxyl-apophyllite. All specimens were positively identified using X-ray diffraction, and the identification of tobermorite was further substantiated by wet chemical analysis. The minerals are listed in sequence according to their structural classification as described by Strunz (1970).

Datolite $CaBSiO_4(OH)$

Flesh pink datolite occurs as a basal crust on many of the specimens upon which inesite has crystallized. The color may originate from the darkly colored matrix considering that isolated pieces of the datolite are relatively translucent and colorless. These encrustations appear to be botryoidal, but under the microscope, complex aggregates of microcrystal faces are evident.

There are two generations of datolite. The earlier formed material is that described above. A second, later generation occurs as small, less than 0.5 mm globules randomly and sparsely scattered on the inesite.

Tobermorite $Ca_9Si_{12}O_{30}(OH)_6\cdot 4H_2O$

White amorphous spherules 1–2 mm in diameter, and aggregates of these spherules, partially coat inesite. X-ray diffraction analysis suggested that this mineral is probably tobermorite, but the X-ray pattern closely resembled that of oyelite (see Table 1). On a macroscopic scale it resembles oyelite described from other specimens where oyelite is associated with bultfonteinite (Von Bezing *et al.*, 1991). However, we conducted chemical analyses to determine whether boron, the element distinguishing oyelite (Kusachi, *et al.*, 1984) from tobermorite, is present. The weight percentage of B_2O_3 in oyelite is 5.21% and the results of our analyses show no detectable boron in the Wessels material. The sample analyzed was small, but even with a dilution factor, some boron should have been detected had the mineral been oyelite.

Rhodonite $(Mn^{2+},Fe^{2+},Mg,Ca)SiO_3$

Up until now, crystalline rhodonite has not been reported from the Kalahari Manganese Field (Von Bezing *et al.*, 1991). However, subhedral and euhedral (rare) crystals of rhodonite occur dispersed in the matrix of the recently found inesite specimens. These reach 5 mm in length, although most are 2–3 mm in size. The crystals are opaque and rose-pink in color.

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

The best specimens removed from this find must rank with the best inesite known. The mineral is well crystallized with individual crystals reaching dimensions of 2 cm in length, 1 cm in width and 1 mm thick. They are chisel-shaped and occur in stacked, fan-shaped parallel groups and aggregates. Individually, the crystals are completely transparent and pale red in color. When stacked together, the crystals appear a deeper red, reminiscent of the color of the rhodochrosite from the region. A few tightly packed sprays are a deep wine red color. The crystal aggregates are grouped in radiating fans, either lying flat on the matrix or, more rarely and spectacularly, as free standing groups on the matrix. The number of these deeper red specimens recovered is small; in many specimens the inesite is instead a "bleached" paler pink color.

In addition to the well crystallized specimens, botryoidal groups of inesite were also found. These probably predated the specimens described above and are similar to those pictured in Figure 20 of Von Bezing *et al.* (1991). However, some of the recent spherules are more vivid pink in color, even wine red, and reached the size of golf balls.

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Figure 1. Inesite ball on matrix, 5 cm, from the Wessels mine near Kuruman, South Africa. S.T.D. Minerals specimen; photo by Jeff Scovil.

Figure 2. Inesite crystal group, 1.7 cm, from the Wessels mine near Kuruman, South Africa. Bob Guyon collection; photo by Jeff Scovil.

Figure 3. Inesite from the Wessels mine, 3.5 cm. Bruce Cairncross specimen; photo by David Minster.

Figure 4. Inesite (red), natrolite (white sprays), and tobermorite (small white spherules) on a crust of datolite. This specimen was the largest removed from the Wessels mine. It measures 20 x 24 cm (portion shown = 5 x 7 cm). The natrolite is radiating out of cores of thomsonite. Clive Queit specimen (now in the collection of the Transvaal Museum); photo by Verni Naidoo.

Figure 5. Inesite, xonotlite, calcite from the Wessels mine: 5 cm. Bruce Cairncross specimen; photo by David Minster.

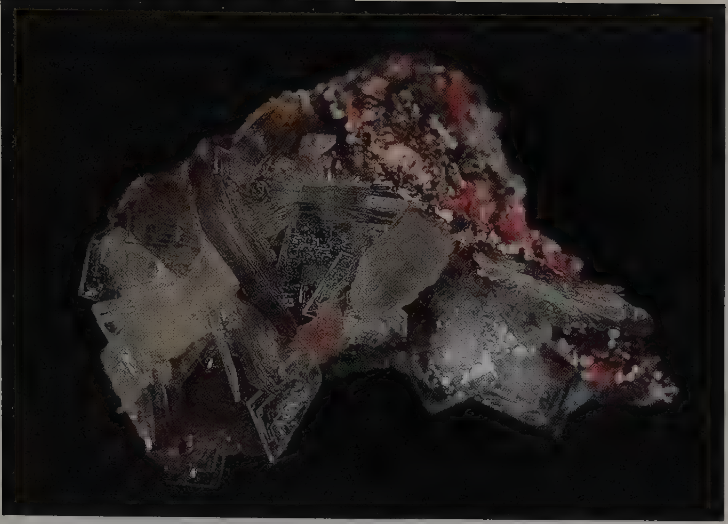

Figure 6. **Hydroxylapophyllite on datolite on a matrix of soft, granular rhodonite and tobermorite from the Wessels mine; 7 cm. Bruce Cairncross specimen; photo by Verni Naidoo.**

Figure 7. **Inesite crystal group, 6.7 cm, from the Wessels mine near Kuruman, South Africa. S.T.D. Minerals specimen; photo by Jeff Scovil.**

Figure 8. **Spray of natrolite on datolite (pink) partially coated by tobermorite; Wessels mine, 3.5 cm. Bruce Cairncross specimen; photo by Verni Naidoo.**

Natrolite $Na_2Al_2Si_3O_{10}\cdot 2H_2O$

Well crystallized sprays of natrolite were found in association with some inesite, but also with hydroxylapophyllite and datolite. Prismatic crystals, elongate along the *c*-axis and displaying {111} terminations were found as radiating groups. The best of these, with individual crystals up to 5 cm long closely resembles those pictured by Tschernich (1992), his Figure 44-5. The natrolite is colorless to white; some crystals are opaque near the base becoming transparent closer to the termination. When the sprays occur on an inesite matrix, the crystals exhibit a pleasing pale pink translucency caused by the transmittence of the inesite's color through the natrolite crystals. The natrolite was at first thought to be afwillite and created a flurry of interest, but the crystal morphology, together with X-ray diffraction analysis, showed the mineral to be natrolite. This is the first reported occurrence of well crystallized specimens from the region although the mineral has been observed as massive bodies from core samples (A. Kleyenstüber, personal communication, 1992). Only a handful of specimens have the combination of well crystallized, red inesite associated with sprays of vitreous white natrolite, an aesthetically striking combination.

Figure 9. **Natrolite from the Wessels mine; 3 cm. Bruce Cairncross specimen; photo by Verni Naidoo.**

Table 1. **Comparison of patterns (strongest lines, intensities from tobermorite-11Å (synthetic, PDF file 19-1364), oyelite and small, white amorphous spherules (<2 mm) from the Wessels mine.**

Tobermorite-11Å, ICPDS 19-364	*Oyelite, Japan*	*White, amorphous spherules, Wessels mine*
11.30 (80)	10.23 (100)	11.20 (100)
5.38 (25)		5.41 (20)
3.78 (6)	3.78 (10)	3.77 (6)
3.53 (20)		3.51 (15)
	3.41 (25)	
3.31 (28)		3.30 (9)
3.08 (100)		3.07 (51)
		3.01 (11)
2.98 (65)	3.00 (60)	2.97 (37)
2.82 (40)		2.82 (12)
2.53 (12)	2.56 (15)	2.53 (20)
2.15 (16)		2.13 (9)
2.08 (10)	2.05 (13)	2.08 (7)
2.00 (20)		1.99 (8)
1.84 (40)		1.84 (14)
1.67 (20)		1.67 (9)

Thomsonite $NaCa_2Al_5Si_5O_{20}\cdot 6H_2O$

Some of the natrolite sprays are seen to radiate out from a core of a different, opaque white mineral. On examination, this core mineral was found to be thomsonite, also reported here for the first time from the area. The characteristic 9.2Å peak distinguishes thomsonite from natrolite. The crystals are thin, rectangular blades stacked together in spherical aggregates (similar to Fig. 581 of Tschernich, 1992). Some of these cores are associated with a pale canary-yellow mineral which X-ray diffraction has failed to identify (R. Dixon, personal communication, 1992).

Hydroxylapophyllite $K(Ca,Mn)_4Si_8O_{20}(OH,F)\cdot 8H_2O$

Tabular, euhedral white to cream or colorless hydroxylapophyllite crystals up to 6 cm on edge occur together with the natrolite and inesite. These typically display a pearly luster. A few specimens have water-clear hydroxylapophyllite crystals up to 1 cm perched upright on the inesite sprays.

PARAGENESIS

The matrix of the minerals described above is composed of two types of material: an inner hard core surrounded by an outer, soft granular matrix. The latter contains scattered subhedral rhodonite crystals and disseminated tobermorite. The succession of mineral assemblages grades from the euhedral crystallized inesite assemblage lining the inner surfaces, through the earthy matrix containing tobermorite, datolite, inesite and (rare) rhodonite. This soft matrix is followed by a very dense, hard matrix. The latter was examined petrographically and chemically and was found to contain a mixture of thomsonite, albite, aegerine-augite and minor rhodonite. The sequence of crystallization is as follows: (rhodonite matrix), datolite (1st generation), inesite, datolite (2nd generation), tobermorite, thomsonite and natrolite.

ACKNOWLEDGMENTS

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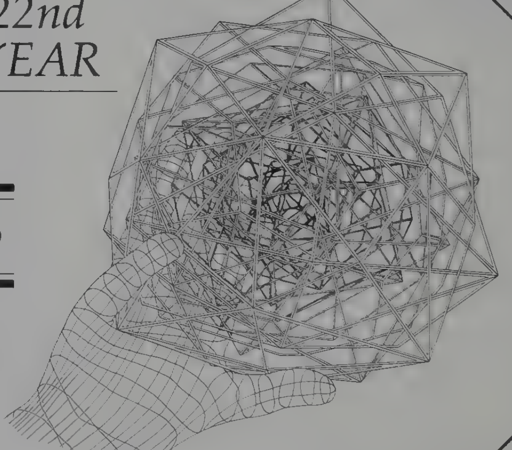

THE PARKER MINE, NOTRE DAME DU LAUS, QUEBEC

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The Parker mine ranks as one of Quebec's classic localities. It has yielded large, euhedral crystals of altered forsterite to 30 cm in size, and fine ferroan spinel crystals to 6 cm.

INTRODUCTION

The Parker mine is one of several classic mineral localities located within a 100-km radius of Ottawa, Ontario (Gault *et al*. 1980; Hogarth 1972, 1974). Mineral specimens from localities in this region of the Grenville, a geological subprovince of the Canadian shield, may be viewed in mineral collections around the world.

Of note is the abundance of exceptionally large, well-formed crystals of various rock-forming minerals commonly found in the carbonate vein-dike systems (Ellsworth 1932). Crystals of remarkable proportions have been unearthed in the past; notably a 300-kg crystal of fluorapatite, 1-meter-wide phlogopite crystals, and a 2-meter diopside crystal to name a few. The Parker mine is such an occurrence; a euhedral crystal of forsterite approximately 6 x 20 x 30 cm was unearthed there in 1984. (Unfortunately the crystal's proximity to the surface resulted in its prior deterioration.) Exceptional ferroan spinel crystals from 1 to 6 cm were found associated with the forsterite crystals.

Recently the government of Quebec instituted a number of restoration programs including a program to backfill old and dangerous mine workings using existing dumps and overburden. As a result, a number of localities of mineralogical interest have been covered over, including the Parker mine. Extreme caution is necessary when collecting in the pit area because infill consisting of trees and loose rock may cave into old pits when walked on.

The Parker mine is located approximately 3 km west-northwest of the town of Notre Dame du Laus on Lot 52, Range V, Bigelow Township, Labelle County, Quebec. Flat ground in the immediate vicinity of the occurrence is covered with mixed dense bush and surrounded by hills which attain heights of 300 meters.

HISTORY

The occurrence was originally discovered, owned and operated for mica during the summer of 1910 by Mr. W. Parker of Buckingham, Quebec. Mr. parker and his partner, Mr. W. Cameron, worked the property intermittently during the summer months of 1910 to 1913, employing three men who mined mica without the aid of machinery.

In 1914 possession of the workings was taken over by Cameron, who apparently did little more than prospect for new occurrences on the west end of Lot 52, bordering Lac Poisson Blanc. There followed a 28-year period of inactivity until 1942, when the Micabia Prospecting syndicate took possession of the property. Production records are lost or nonexistent; however, it is likely that little of any mica produced was of good grade due to partial alteration, inclusions, brittle ribbon texture, and the mode of occurrence of phlogopite there. The deposit is of the pocket and fissure type (Spence, 1929). The phlogopite mined was brought by horse cart to a storage shed on the present grounds of the high school in Notre Dame du Laus, where it was hand-trimmed, packed into barrels and stored.

An overgrown exploration trench measuring 2 x 3 x 4 meters hosted the best specimens. It was rediscovered by staff members of the National Museums of Canada, Mineral Sciences Division in the early spring of 1984. Several hundred excellent specimens were found by screening disintegrated carbonate vein material. Subsequent collector activity quickly filled in the small pit.

In late spring of 1987 the main spinel-bearing and forsterite-bearing carbonate vein was re-excavated with the aid of heavy equipment. Light blasting was conducted in a highly mineralized section of the main vein, and two fractures were excavated which yielded many fine specimens. Excellent specimens are preserved in the (Canadian) National Mineral Collection; associated rock types are preserved in the Mineral Occurrence Collection, National Museum of Natural Sciences, Ottawa. The property is located on federal crown land, and the mining rights are currently owned by Mr. M. Perrault of Wilsons Corners, Quebec.

GEOLOGY

This area of regionally metamorphosed, Precambrian sediments is host to a variety of rock types. The principal occurrence lies within the green rock complex (metagabbro, calcsilicate, amphibolite rock types) which may have formed as a result of igneous activity (R. Herd, G. Robinson, L. Moyd, personal communications, 1987). Anorthositic lenses and narrow pegmatites are randomly oriented throughout the green rock complex. Most contacts are obscure; however,

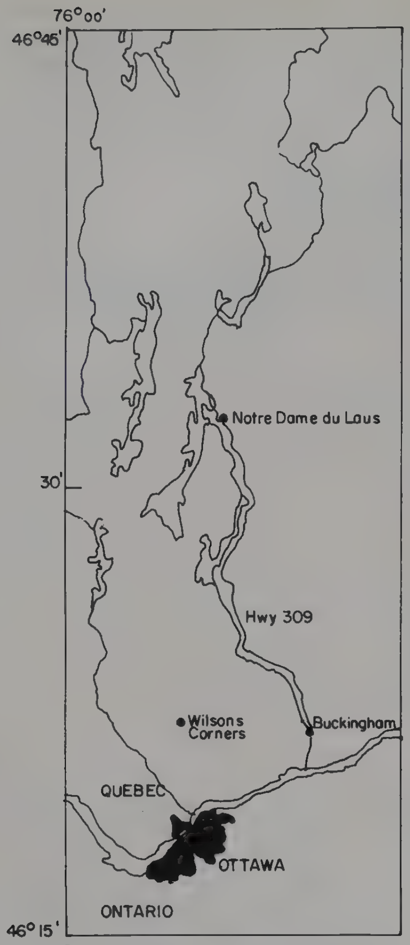

Figure 1. **Location map.**

contact between calcitic marble and the green rock complex is marked by a near-vertical slope in places along Lac Poisson Blanc on the west and south side of Lot 52. This contact is host to several zoned, lithologically similar units of small size. These are located on Lots 51, 53 and 54, and include anorthositic lenses and pyroxenite.

Gray-violet to gray-blue anorthositic lenses of varying size host accessory titanite and euhedral zircon, and are dispersed throughout the metagabbro. A large 1.5 x 5 x 5-meter anorthositic xenolith is located between the main vertical mica lead and the spinel-forsterite-bearing pit. A vertical vein composed of altered forsterite, phlogopite and minor spinel traverses this xenolith. A pockety vein of similar composition with accessory fluorapatite was observed *in situ* on the underside of this xenolith. Metagabbro in contact with carbonate veins and fractures is host to several different species including diopside-hedenbergite of intermediate composition, anorthite, augite and pargasite. Of interest are several exsolved phases in the augite which were initially observed optically and later characterized by semi-quantitative electron microprobe analysis. Meionite occurs surrounding subhedral grains of pargasite. Magnetite is noticeably apparent in thin section as flattened elipsoids in the form of exsolution trains in augite and anorthite.

The formation of the species of interest to collectors was facilitated by extensive fracturing. These fractures trend approximately east-west and north-south, pinching and welling over a distance of more than 30 meters. Shearing is evidenced by the presence of slickensided rock in the main occurrence. Mineralization in fractures and veins was sporadic over a distance; however, where two vertical fractures intersected, or where a fracture swelled, many excellent specimens have been collected.

One narrow vertical vein (oriented perpendicular to the main vein) which pinched and swelled over a 10-meter distance, showed the following zones: Metagabbro → ribbon or crushed phlogopite oriented perpendicular to the contact ± fine-grained massive forsterite → eu-

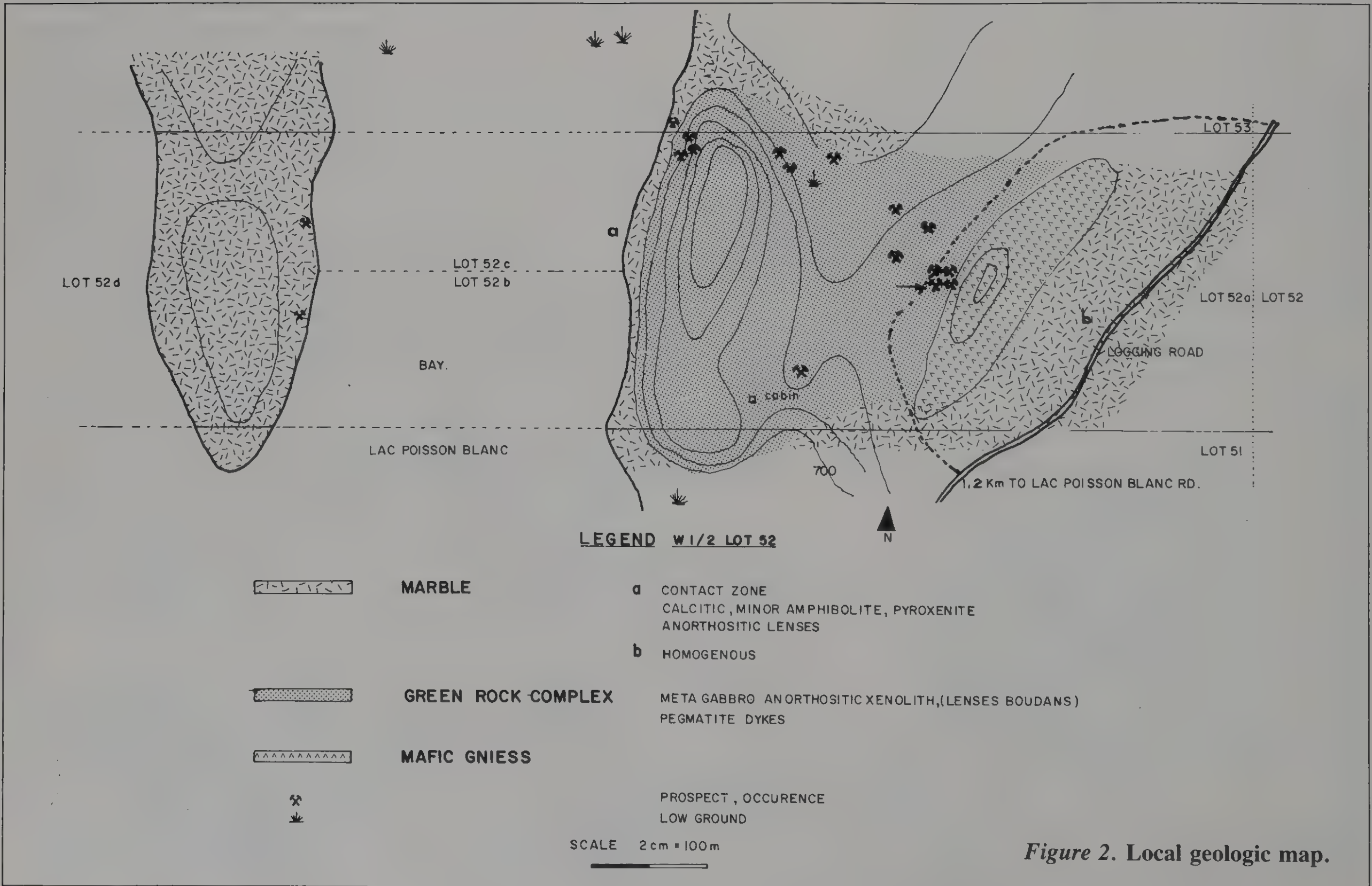

Figure 2. **Local geologic map.**

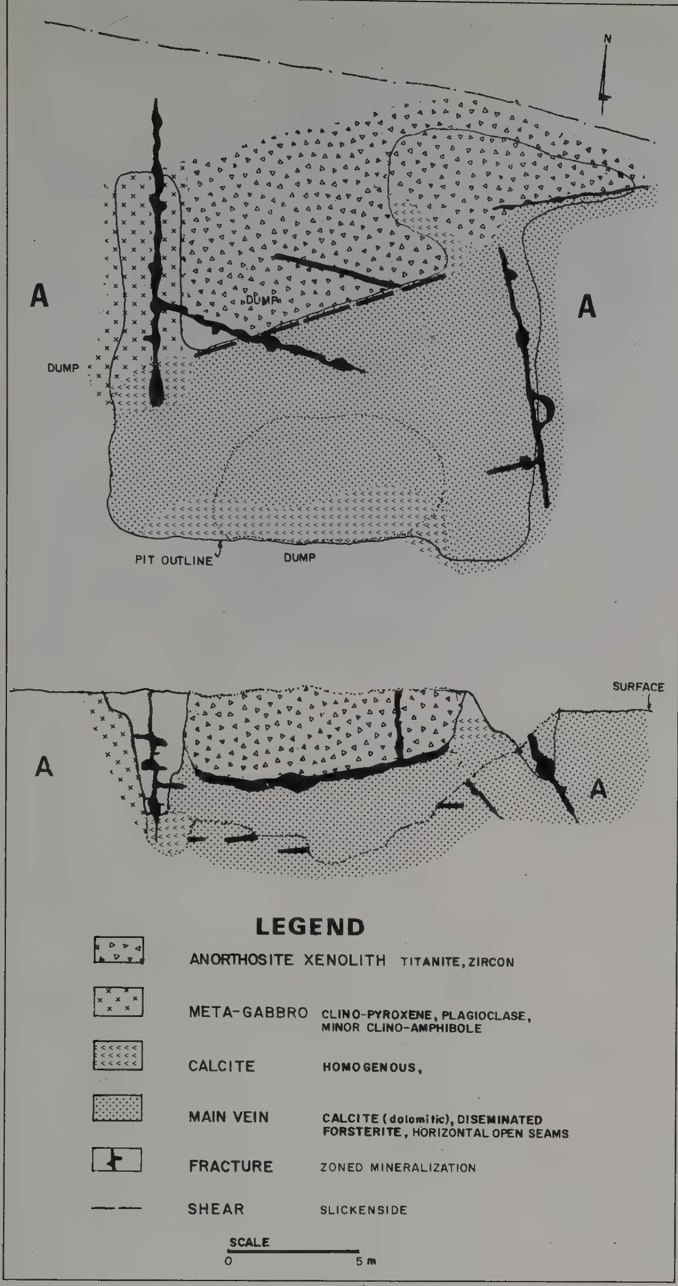

Figure 3. **Geology of the Parker mine.**

hedral phlogopite crystals to 10 cm → euhedral forsterite crystals to 6 cm → ferroan spinel ± phlogopite overgrowth → carbonate core. These zones appeared symmetrically disposed with the exception of the presence of xenolithic anorthosite instead of metagabbro bounding its opposite side.

The main calcite vein, which is actually dolomitic in part, is oriented parallel to the principal producing vertical mica vein. In this vein, 5 meters wide in places, phlogopite was conspicuously rare and apatite was not observed.

FERROAN SPINEL

Ferroan spinel has been observed in several modes of occurrence which include: euhedral crystals on the periphery of and in forsteritic inclusions; isolated euhedral crystals suspended in massive carbonate; in horizontal and near-vertical, narrow eliptical shaped pockets; on euhedral forsterite crystals; and loose in disintegrated carbonate vein rock.

Excellent ferroan spinel crystals to 6 cm in size were found, though the typical size averages 1 cm. The crystals display a simple morphology, the two most commonly observed forms being the octahedron {111}, and dodecahedron {110}. Occurring less frequently is the trapezahedron {211} and possibly the trisoctahedron {321}. No twinned crystals were observed, but parallel and stacked growth is common. A few crystals are skeletal in their growth and rare flattened crystals were also observed. Two partially altered pseudomorphs of lizardite with magnetite after spinel were found.

In one fracture oriented perpendicular to the main carbonate vein in metagabbro, morphological development of the ferroan spinel was simple whereas in another fracture octahedral, dodecahedral and trapezohedral forms were observed. All crystals are black. Optical examination revealed the presence of magnetite as inclusions in the ferroan spinel. Table 1 gives the electron microprobe analysis. From this analysis the empirical formula is $[Mg_{.811}Fe_{.165}Zn_{.019}]_{\Sigma=0.995}$ $[Al_{1.898}Cr_{.001}Fe_{.100}Mn_{.004}]_{\Sigma=2.003}O_4$ which is reasonably close to end-member $MgAl_2O_4$ spinel. The unit cell refined from the powder data is d = 8.0975 Å, V = 530.963 Å^3.

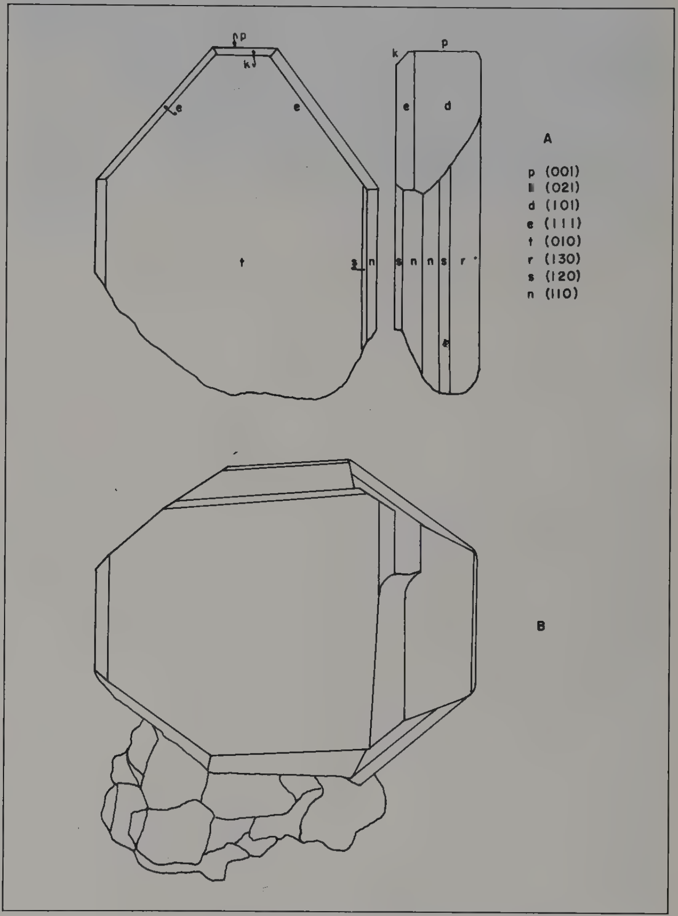

Figure 4. **Forsterite crystals from the Parker mine. A = CMN specimen number 49144, 8 cm. B = CMN specimen number 49004, 4 cm (now lost?).**

FORSTERITE

This species, although not of gem quality, forms excellent crystals up to 10 cm in size (averaging 2 cm). These are light brown yellow to drab olive-green in color. The best-formed specimens are found near the surface, where the host carbonate has partially disintegrated, or in fractures in massive medium-grained forsterite.

All specimens observed are partially altered. X-ray and optical examination of a partially altered forsterite crystal revealed the presence of a kaolinite-serpentine group mixture. Lizardite 1T, magnetite and possibly lizardite 6T formed along fractures and the imperfect cleavage planes {010} and {100} of forsterite. Crystals found near the

Figure 5. **Spinel specimen with crystals to 1 cm, from the Parker mine. CMN specimen.**

Figure 6. **Spinel crystals to 1 cm on forsterite from the Parker mine. CMN specimen.**

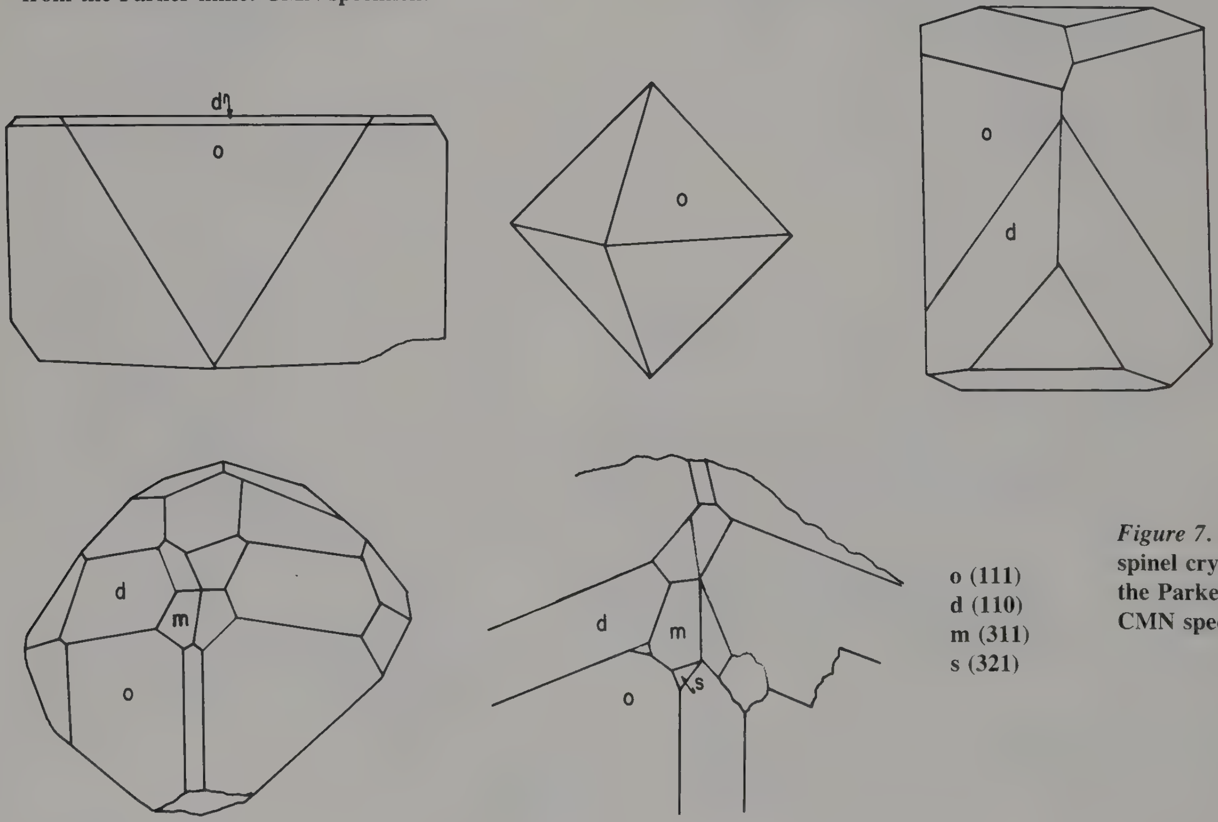

Figure 7. **Ferroan spinel crystals from the Parker mine. CMN specimens.**

surface are highly friable and altered whereas specimens found at depth in the main carbonate vein are less altered. Alteration of this species may have been caused by circulating ground water in near-surface conditions or by retrograde metamorphic processes.

The X-ray powder data using the graphical method of Dunn (1946) indicated a nearly pure end member, forsterite Fo = >95%, which was confirmed by quantitative electron microprobe analysis (Table 1) as $(Mg_{1.817}Fe_{.187})\Sigma_{2.00}Si_{.997}O_4$ or ideally Mg_2SiO_4. The unit cell dimensions refined from the powder data are a = 4.749, b = 10.199, c = 5.993, V = 290.384. The commonly observed forms are {010}, {101}, {001}, {130} and {110}.

DISCUSSION

Many detailed studies exist of similar occurrences located elsewhere; however, well-crystallized specimens of interest to collectors from the majority of these occurrences are rare, whereas the Parker

Table 2. **Chemical analysis of minerals of the Parker mine area.**

Species		MgO	ZnO	Al_2O_3	Cr_2O_3	FeO	Fe_2O_3	MnO	SiO_2	CaO	Na_2O	TiO_2	K_2O	SO_3	Cl	F	Total
Ferroan Spinel	1	21.81	1.13	64.84	.05	7.80	4.80	.18									100.61
	2	21.35	.94	63.19	.04	7.99	5.62	.19									99.32
	3	21.93	1.13	65.25	.04	7.47	3.87	.18									99.87
	4	21.85	1.00	63.31	.03	7.32	5.99	.19									96.68
	5	21.35	.98	62.98	.06	8.13	6.29	.17									99.96
	6	21.11	1.03	63.42	.05	8.41	5.31	.15									99.48
	Note	Analysis 1–5 towards core, analysis 6, rim of crystal															
Forsterite		49.33				9.39		.27	40.86	.04							99.89 Core
		50.08				9.19		.24	40.60	.02							100.13 Mid
		50.23				8.99		.08	40.88	.02							100.20 Rim
Augite		10.50		11.48		2.56	5.55	.08	44.65	23.67	.64	1.04					100.17
	Note	Average of 3 analysis															
Diopside Inter. Hedenbergite		12.43		7.40			5.33	.19	48.32	22.37	.92	.40					97.35
Pargasite (K, Rich)		13.34		16.93		5.11	6.10	.11	39.42	12.51	1.62	1.37	2.28				98.81
Magnetite		.41		.25		30.43	68.87										99.96
Meionite				28.10			.20	.04	42.80	19.95	1.84		.10	1.24	.10		98.20
Phlogopite		24.81		17.54		3.30			37.94		.61	.53	9.50			1.67	95.89
Labradorite				28.45					54.14	10.23	5.29		.08				98.17
				28.04		.09			53.14	10.49	5.00		.07				96.83

Table 1. **Minerals of the Parker mine area.**

Species	Occurrence
Anorthite	Anorthositic xenolith
Augite	Metagabbro
Calcite	Main vein
Clinohumite	Marble, contact zone
Diopside/Hedenbergite	Metagabbro
Dolomite	Main vein
Enstatite	Metagabbro
Fluorapatite	Vein, contact, anorthositic xenolith
Forsterite	Fracture, main vein
Garnet group	Marble, contact zone
Graphite	Marble, contact zone
Hypersthene	Metagabbro
Lizardite 1T	Fracture
Lizardite 6T	Fracture
Labradorite	Anorthositic xenolith
Magnetite	Inclusions in fassaite
Meionite	Inclusions in fassaite
Pargasite	Metagabbro
Quartz	Amphibolite boudan contact zone
Phlogopite	Fracture
Pyrite	Anorthositic lens
Pyroaurite	Marble
Spinel, ferroan	Fracture
Titanite	Anorthositic xenolith
Tremolite	Contact zone
Zircon	Anorthositic xenolith

mine is unique for the size and development of the forsterite crystals.

Many questions remain concerning the origin of this deposit. Moyd (1990) gives a comprehensive summary concerning the possible origin of the calcite-cored vein dike system; however, to compose a chronological sequence of geological events leading to the formation of the principal species at the Parker mine is difficult. It is likely these minerals formed, in part, as fracture-filling minerals as a result of igneous activity and subsequent contact metamorphism, perhaps occurring later than the main regional metamorphic event. This is evidenced by the presence of pegmatites, diabase dikes and a vein composed of spinel, forsterite and phlogopite which traversed a large anorthositic xenolith.

The origin of the anorthositic lenses in the green rock complex is uncertain. Contact between these units and surrounding rock is sharp, suggesting that the formation of these xenoliths predates or formed early in the Grenville orogeny. Age dating of zircon present in anorthositic inclusions, fluid inclusions studies, and other determinative means will provide additional information.

ACKNOWLEDGMENTS

The author would like to thank the staff of Mineral Sciences Division, National Museum of Natural Sciences, in particular Dr. T. S. Ercit and R. A. Gault, for electron microprobe analysis and Dr. G. W. Robinson for many helpful suggestions. Dr. Richard Herd of the Geological Survey of Canada and L. Moyd offered helpful suggestions concerning the possible origin of this unique occurrence. Claude Lupien of the National Art Gallery of Canada and Ken Barkman assisted in the photography. Michel Perreault of Wilsons Corners, Quebec, allowed staff from the Mineral Sciences Division access to his claim. Ruth Dinn typed the manuscript.

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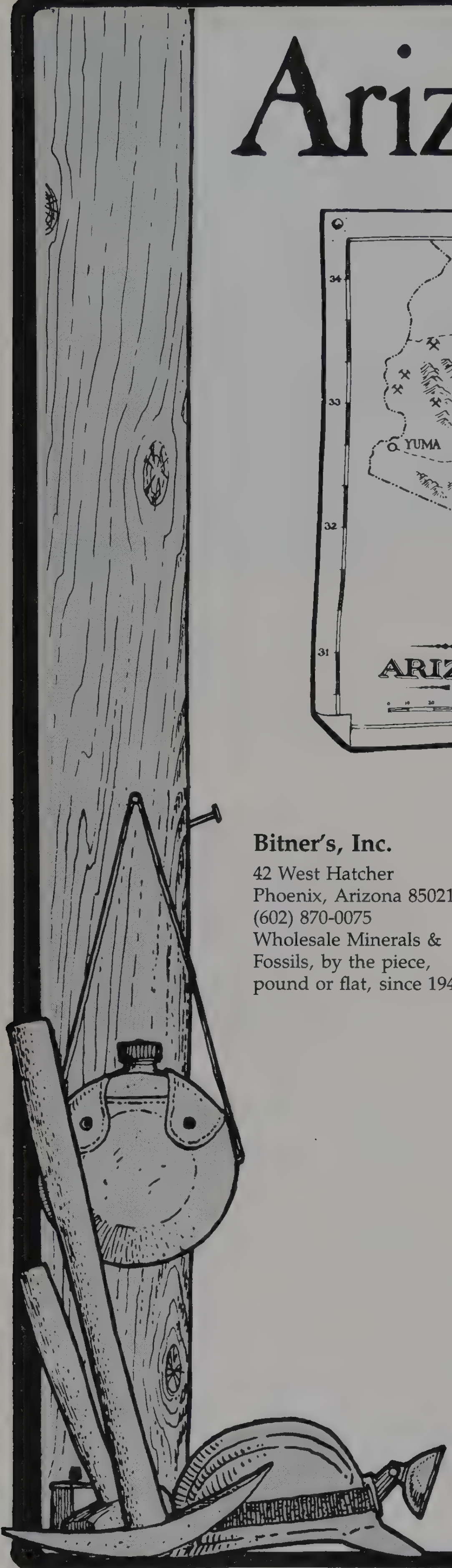

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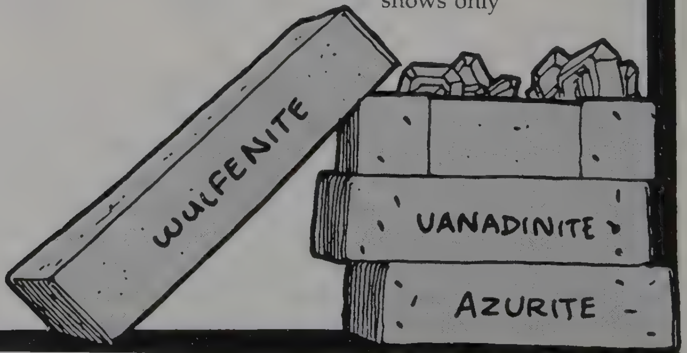

DRAWING MICROMINERALS

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Pen and ink drawings are nothing new to readers of the Mineralogical Record, *as evidenced by the number of authors and advertisers who have utilized this form of artwork. Line drawings have a distinct and honorable history in the sciences, one that developed well before the invention of photography.*

INTRODUCTION

Remarkably realistic examples of line drawings can be found in many early works going back to the 16th century, not only in mineralogy, but perhaps to an even greater degree in the biological and medical fields. In many cases this form of representation is still preferred, because selected aspects can be emphasized for the observer.

Our particular field of interest, and one that we have pursued extensively (resulting in the publication of a book of line drawings illustrating the microminerals of Mont Saint-Hilaire, Quebec), is that of rendering minerals as they are observed under the microscope. Unlike larger mineral specimens, micromounts are not easily viewed by large numbers of people; consequently, for purposes of exhibit and discussion, many collectors have resorted to photomicrography as a secondary hobby. The perfect photomicrograph is, however, a very difficult achievement, and though many very beautiful pictures are produced, many of those illustrating articles in books and periodicals are vague or poor in detail because of the unavoidable limitations of optical systems. However, when a writer is able to accompany his work with a few good line drawings, the educational value of the article can often be greatly enhanced.

Line drawings offer a number of distinct advantages over photographs. The first, and most obvious, is that the artist has infinite depth of field. Furthermore he is in complete control of the representation; able to add, delete or rearrange the material (though this should be done with discretion) so as to present a unified, meaningful image to the observer. "Busy" samples, in which the species of interest becomes lost in the general confusion, are easily handled either by eliminating the distracting material or by reducing its dominance with fainter lines, less shading or ghosted images.

Difficulties that plague photography, such as the representation of small but necessary faces, may be solved by the artist by rotating the specimens and observing them in the light to understand their true shape and position, and then mentally repositioning them on the drawing. Similarly, surface features and textures can be implied with various techniques of shading. Likewise, colorless on white, or black on black specimens which are also frustrating to photograph present no difficulties to the artist.

Finally, it is relatively easy and inexpensive to reproduce line drawings for publication, whether by formal printing procedures for texts and magazines, or just as photocopies to enhance society bulletins.

Of course there are some drawbacks. It is impractical in most cases to include color. And it is also necessary to have some artistic talent. But, of course, not everyone takes a good photograph either.

The technical aspects of reproducing suitable mineral sketches are covered in the drawings that follow.

EQUIPMENT

(1) Good quality, smooth drawing paper so ink will not "bleed."
(2) Good quality HB (medium hardness) pencils.
(3) Vinyl eraser.
(4) Rapidograph (or equivalent) pens in sizes 0.18 to 0.35 mm.
(5) "Stick-tac" to hold the specimen while drawing.

PROCEDURE

Sketching can be done in a number of ways, including the projecting of slides onto paper, the use of optical projection devices, sighting one eye on the scope and one on the paper, or simply by looking into the scope and then reproducing the relative position of lines on the paper. The latter method is the simplest and most natural.

The initial sketch is done in pencil, creating a preliminary outline

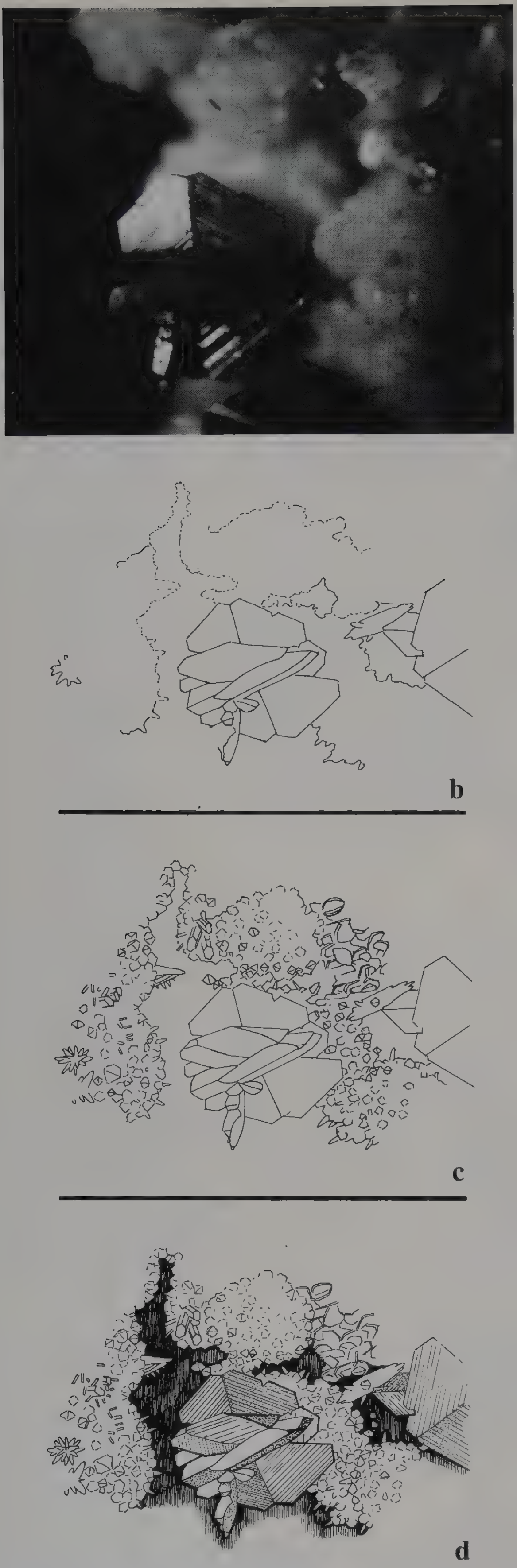

Figure 1. **Illustrations (a) through (d) illustrate the sequence of development of a drawing. The specimen (a) shows marcasite, fluorite, quartz, albite and dawsonite. Drawings by Fisher; width, 5 mm.**

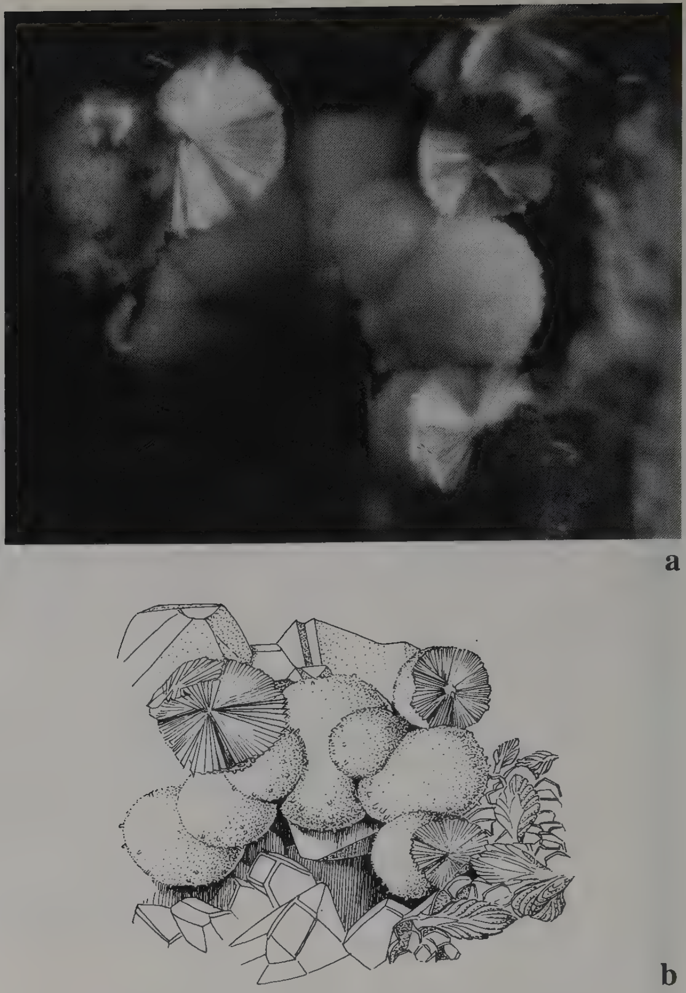

Figure 2. **Figures (a) and (b) show a photograph and the corresponding fully developed drawing of dresserite/hydrodresserite balls with albite, siderite and quartz, by Fisher; width, 6 mm.**

to relate the masses and placement of the crystals and matrix. Selected components of the picture can be eliminated or moved closer together at this point to achieve a satisfactory image of the original sample.

Details are added in pencil to give crystal faces the desired perspective, being careful to note sets of parallel edges and intersections of lines. A lighting direction is selected and shadow areas indicated accordingly.

With ink and a short plastic rule, all of the crystal edges are then drawn in. This is necessary to indicate the crisp sharpness of crystals. Freehand will generally not do. Next, the matrix and associated crystals are drawn in either freehand or with the ruler, depending on the sharpness required. Broken or dotted lines are used to subdue the less important accessory material (Fig. 1b).

Surface features such as lines or pits are drawn in, giving just enough detail to achieve the desired effect. The pencil lines are then erased. Shading begins with the blocking out of the major shadow areas using an assortment of lines, hatches and stipples as required (Fig. 1c).

Final shading is added to indicate slight differences in angle of crystal faces and to give life and depth to the specimen. With a coarser pen and the ruler, bottom edges and edges in shadow are thickened to give weight and density (Fig. 1d).

EXAMPLES from the FRANCON QUARRY

The specimens drawn for this article are from the Francon quarry, Francon Division de Canfarge Limitee, Boulevard Pie IX, Montreal,

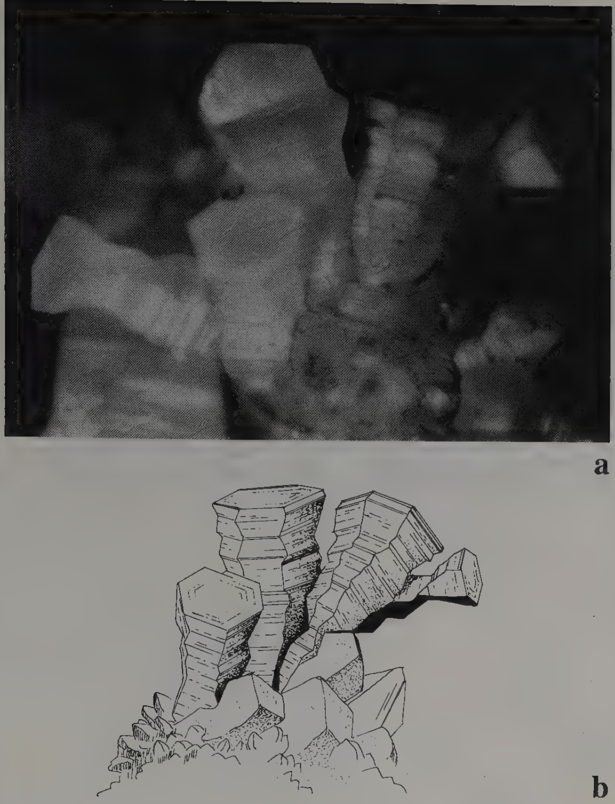

Figure 3. **Figures (a) and (b) illustrate typical weloganite crystals with quartz and calcite; by Glenn; width, 5 mm.**

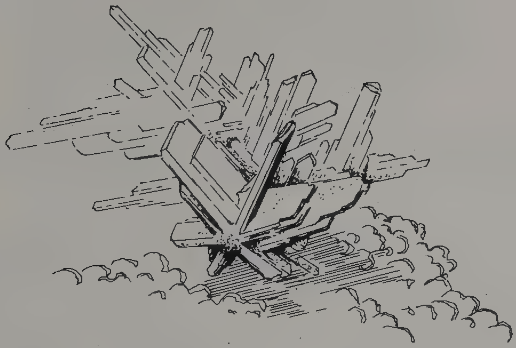

Figure 6. **One of a number of interesting habits of strontianite twinning, on albite; by Glenn; width, 4 mm.**

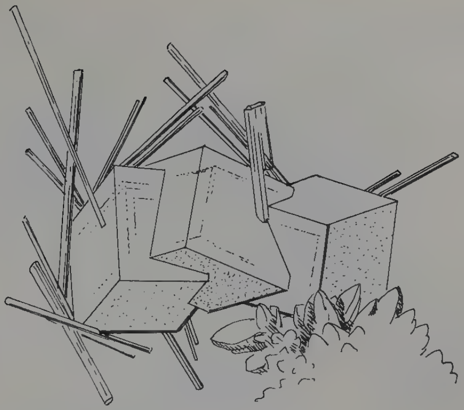

Figure 4. **Clear to pale purple fluorite with phantoms, dawsonite and calcite; by Glenn; width, 3 mm.**

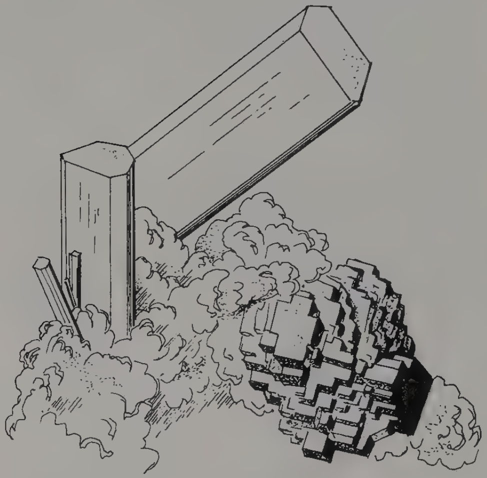

Figure 5. **A stepped habit of pale purple fluorite and large, colorless dawsonite; by Glenn; width, 3 mm.**

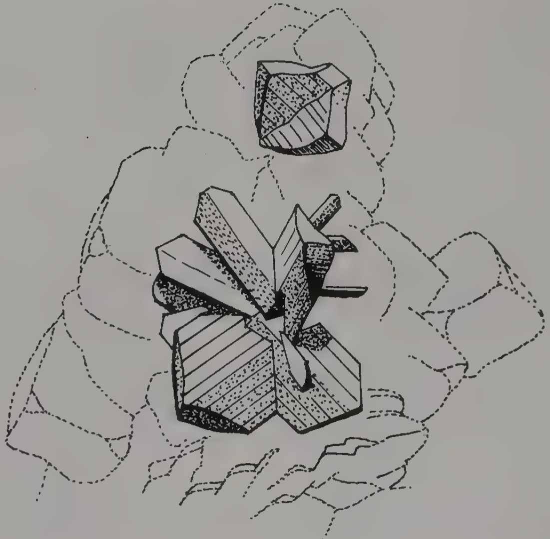

Figure 7. **Typical of the marcasite on calcite from the Francon quarry; by Fisher; width, 3 mm.**

Quebec, Canada. This is a well-known quarry which in its heyday rivaled Mont Saint-Hilaire (30 km to the south) for diversity and abundance of specimens. It has been closed for some years now, and collecting is no longer possible. However, large quantities of material were removed and are still occasionally available from old stocks.

The quarry was developed in middle Odovician limestones, and the collecting material was produced mainly from two intrusive dawsonite-rich silico-carbonatite sills. Approximately 60 species are reported from this deposit; Francon is the type locality for weloganite, dresserite, hydrodresserite, strontiodresserite, franconite and, most recently, voggite.

The sill material consists principally of potassium feldspar and dawsonite with variable amounts of quartz, analcime, aegirine-augite, dolomite, siderite and albite (Jambor *et al.*, 1976), and a significant zirconium and niobium content (Steacy and Jambor, 1969). The collectable material was largely of microscopic size with cavities ranging

Figure 8. **This drawing illustrates a complex assemblage of species, as is typical of many Francon samples. It consists of a large white calcite, crested white barite, small fluorite, numerous dawsonites and bladed albite; by Fisher; width, 5 mm.**

Table 1. **Species occurring at Francon quarry (from Sabina, 1979).**

Acmite
Albite
Almandine
Analcime
Anatase
Ankerite
Baddeleyite
Barite
Brookite
Calcite
Celestine
Cristobalite
Crocoite
Cryolite
Dachiardite
Dawsonite
Dolomite
Dresserite
Elpidite
Fluorapatite
Fluorite
Galena
Goethite
Graphite
Gypsum
Halite
Harmotome
Hematite
Hydrocarbon
Hydrocerussite
Hydrodresserite
"Ilmenorutile"
Kaolinite
K-Feldspar
Magnetite
Marcasite
Molybdenite
Montmorillonite
Mordenite
Nahcolite
Natrojarosite
"Pseudorutile"
Pyrite
Pyrochlore
Pyrrhotite
Quartz
Rozenite
Siderite
Smythite
Sphalerite
Strontianite
Strontiodresserite
Sulfur
Synchysite
Thenardite
Thorbastnaesite
Voggite
Weloganite
Zircon

from a few millimeters to several centimeters.

Minerals in the two sills have been designated by Ann Sabina of the Geological Survey of Canada (1979), as assemblages A and B. Assemblage A (the upper sill) is dominated by albite, quartz, dawsonite and calcite with less abundant strontianite, barite, cryolite, fluorite and pyrite. The lower sill, assemblage B, consists chiefly of calcite, dawsonite, fluorite, quartz, analcime and albite with less abundant strontianite, celestite, barite, montmorillonite, marcasite and hematite.

Probably the most dramatic of the rare species that occur here is weloganite, named in honor of Sir William Logan, founder of the Geological Survey of Canada. This is the type locality for this species, and the crystals occur in dramatic pagoda-like growths to several centimeters. After this, dawsonite provides some of the most delicate and attractive material from the deposit. It forms sprays of colorless, transparent crystals from fine needles to short prismatic crystals that approach the diameter of a wooden match. An equally exciting, though much rarer find, is white balls of radiating crystals of dresserite and hydrodresserite as illustrated in the drawings (Fig. 2).

Figure 9. **Rosettes of flat, white barite plates in a habit typical for this locality, with colorless dawsonite; by Glenn; width, 3 mm.**

Figure 10. **Quartz in a habit locally known as "pineapple quartz," with dawsonite; by Fisher; width, 1 mm.**

Most of the other rare species from Francon are extremely difficult to find. A number of them occur only in the surrounding rock, and are often massive rather than in euhedral crystals. The more common species occur in attractive and complex suites, often with well-formed dawsonite. Specimens typically have six or more species present on a single micromount.

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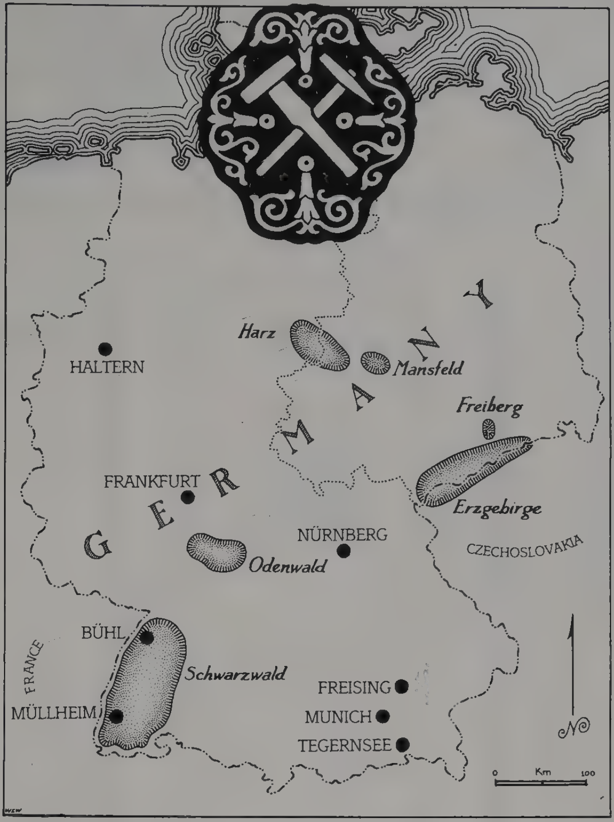
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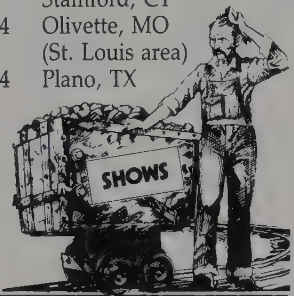
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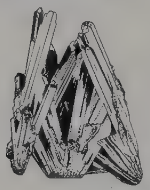

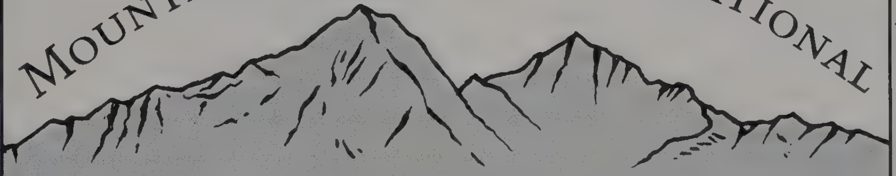

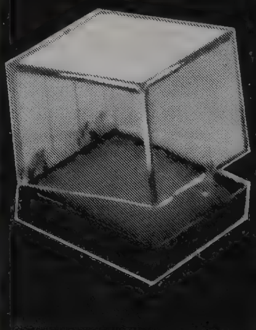

What's New in Minerals?

ANNUAL WORLD SUMMARY OF MINERAL DISCOVERIES
Covering April 1992 through April 1993

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The following report is a summary of the *What's New in Minerals* program presented at the twentieth Annual Rochester Mineralogical Symposium last April. In general, only discoveries made since the previous year's symposium are discussed. For the sake of a complete summary, even those occurrences which have already been described in earlier issues of the *Mineralogical Record* are recapped here. As in past years, the information is presented geographically, with emphasis placed on truly new finds rather than continuing supplies of previously known materials. Addresses are given for most of the dealers who are not advertisers in the *Mineralogical Record*.

As usual, there has been a significant number of new mineral discoveries made since last year's symposium, with a correspondingly large number of people to thank for bringing them to our attention, providing information and photographs. While we cannot list all those who have helped here, we would like to especially thank Forrest and Barbara Cureton, Torgeir Garmo, Robert Gault, Gilles Haineault, László Horváth, Pierre Laville, Ross Lillie, Mark Mauthner, William Pinch, Jeffrey Scovil and Wendell Wilson for their continued support.

Part I: United States

ALASKA

Gary McWilliams (5314 2nd Ave. NW, Seattle, WA 98107-2052) collected a sizeable lot of some unusual quartz "fingers" with stilbite at Rocky Pass near Kuiu and Kupreanof Islands, southeast Alaska, last summer. The quartz is stark white, and occurs in interesting shapes. Other zeolites, quartz, calcite and fluorite occur nearby. Gary has described the find in *Mineral News,* **8** (11), p. 8–9, and **9** (1), p. 1 and 4.

ARIZONA

A large quantity of azurite and malachite has been recovered from the 4900-foot level of the northwest extension of the Morenci pit at Morenci. Matrix specimens up to 50 cm and consisting of bright green botryoidal malachite with blue, bladed crystal aggregates of azurite from 5 mm to 3 cm have been found. Also recovered were fine malachite pseudomorphs after azurite crystals (to 2.5 cm) in bladed aggregates to 10 by 12 cm. Specimens are available from *Bitner's* (42 W. Hatcher, Phoenix, AZ 85021), *De Natura* (P.O. Box 1273), Gilbert, AZ 85234), Stan Esbenshade (1501 W. Kilburn, Tucson, AZ 85705), Wayne and Laura Thompson (1723 E. Winter Dr., Phoenix, AZ 85020), and a number of other dealers.

David Lewis (*Diversified Minerals,* 1955 N. Redwood Rd., Salt Lake City, UT 84116) had a large selection of some old-time Bisbee specimens at last year's Denver show. For the most part, these consist of velvety brown, iridescent siderite from the Junction shaft and native copper from the Campbell shaft. The specimens were collected in the 1950's, but only recently brought to market through the sale of a collection.

Scott Lewis of *Redmac Minerals* (5640 N. Chieftan Trail, Tucson, AZ 85715) has successfully mined a number of good wulfenite specimens from the Silver Bill and Defiance mines near Gleeson. A quantity of specimens with thin, tabular butterscotch-yellow crystals to 2 cm has been recovered, along with good specimens of rosasite, smithsonite and calcite.

Barlow's (P.O. Box 54327, Phoenix, AZ 85078) and several other dealers had some polished specimens of chrysocolla with azurite and malachite at last year's Denver show. These very colorful specimens range in size from 10 to 40 cm, and come from the Ray mine at Ray.

Dauphiné-twinned amethyst crystals to 1 cm as well as acicular chrysocolla "crystals" to 3 mm in amethyst matrix have been found at the Mammoth open pit, Tiger, by Vandall King.

A number of rarer species have also been found in Arizona over the past year. Patrick Haynes (*Virgin Mining Co.,* P.O. Box 1531, Cortez, CO 81321) has bokite with rauvite and fervanite from the Monument No. 2 mine, Apache County, while Graham Sutton (1851 So. Emerson, Mesa, AZ 85210), Les and Paula Presmyk (*De Natura,* P.O. Box 1273, Gilbert, AZ 85234) and David Shannon (6649 E. Rustic Dr., Mesa, AZ 85205) obtained a small but excellent lot of the rare species aravaipaite and laurelite from the Grand Reef mine in Graham County.

ARKANSAS

Quartz from Arkansas is certainly nothing new, but large Japan-law twins have hardly ever been found until recent years, and now only at one principal locality. According to Art Smith (who supplied all of the following information), the Collier Creek quartz mine, Montgomery County, Arkansas has been worked by Don Burrow since 1980. The deposit was originally found by the Graber brothers, who owned it until late 1979. It was tested in the 1940's as a source of quartz for oscillators but, though it had an abundance of clear quartz, it was not mined because much of it has internal twinning. The bright, clear, long slender crystals of this mine have caused it to be called the "miner's dream." Japan-law twinned quartz crystals are quite rare in most Arkansas deposits though a few may be seen in some collections. However, since 1980 the Collier Creek mine has eclipsed all other mines in the production of these crystals though the total number is still quite small. In the first two and a half years it produced 12 crystals and, since then, Don Burrow estimates the total number to be about 200. Most of these were kept in his private collection until he started selling them in the fall of 1992.

CALIFORNIA

Good specimens of clinoclase as drusy crusts and spherical clusters to 1 cm have been collected at the Antelope mine, near Loyalton, California. Other species found include alumopharmacosiderite, barium-pharmacosiderite, cornwallite, olivenite and a number of other minerals. The occurrence has been described by Jensen (*Mineral News,* **8** (6), p. 8).

COLORADO

The Sweet Home mine at Alma has been worked for rhodochrosite and other minerals over the past year with incredible success. The venture has been possible through a consortium of investors and a good deal of perseverance and hard work, particularly by Bryan and Kathryn Lees (*Collectors Edge,* 402 Gladiola St., Golden, CO 80401), who are marketing the specimens. Literally thousands of fine specimens have been recovered. The rhodochrosite is nothing less than world-class, and generally of two types: large, translucent cherry-red rhombohedrons up to nearly 15 cm, and smaller (1–2 cm), more opaque, dark pink crystals. Associated species include quartz, calcite and pyrite. One of the finest large specimens recovered is pictured in the *Mineralogical Record* (Vol. 24, p. 46), and two others, even larger and of equal quality were exhibited at the Tucson show (vol. 24, p. 228). Other minerals from the mining operation available in collector-quality specimens include pale purple fluorite, calcite, tetrahedrite, galena and hübnerite. To many collectors, this discovery is arguably one of the most significant in the past several decades. For more information see Cook (*Rocks and Minerals,* **68** (1), p. 40–43) or Bode (*Mineralien Welt,* **3** (6), p. 43–45) (in German).

Don Knowles (*Golden Minerals,* 13030 W. 6th Place, Golden, CO 80401) recently obtained a large quantity of specimens from the Eagle mine near Gilman. These consist of well-crystallized pyrite in addition to galena, sphalerite, rhodochrosite, barite, dolomite, siderite and chalcopyrite in all sizes and combinations.

The "K.D." pocket which was found in a surface outcrop in Ouray County, has produced hundreds of good specimens of tapered milky quartz crystals. The crystals average 8–10 cm, and occur in groups nearly a half meter across. Specimens are available from *Mike Madson Minerals* (3201 Snowberry Court, Grand Junction, CO 81506). Also new from Ouray County are some hollow, drusy, milky quartz pseudomorphs after barite crystals to 7 x 10 cm from the O.S. prospect, Uncomphaghre mining district. These were collected by Larry and Carmen Piekenbrock (P.O. Box 1758, Boulder, CO).

Doug Perry (P.O. Box 4985, Boulder CO 80306) has worked the Black and Blue prospect at Harris Park, where he has found large smoky quartz crystals (to 20 cm) which occasionally contain near-surface inclusions of black hematite crystals to several mm.

Dave Bunk Minerals (9240 W. 49th Ave., #317, Wheat Ridge, CO 80033) had some unusual Colorado specimens at last year's Denver show consisting of brown prismatic crystals of brannerite to 1.5 cm from Mount Antero, Chaffee County, and microscopic red-brown crystals of mcgovernite on quartz from the Idarado mine, near Telluride.

GEORGIA

Beau Gordon (*Jendon Minerals,* P.O. Box 6214, Rome, GA 30162-6214), recently collected some rather nice groups of amethyst crystals from Cold Water Creek, Rock Branch, in Elbert County. The groups consist of doubly terminated crystals of medium purple color up to 4 cm, and occur in clay-filled seams in weathered granite.

Beau also reports that collecting by organized groups (clubs, schools, etc.) is once again being permitted at Graves Mountain, and good specimens of rutile, kyanite and other minerals are being recovered. Interested parties should contact the owners (Combustion Engineering) in advance.

ILLINOIS

The southern Illinois fluorite districts are once again producing some top-notch fluorites. Perhaps some of the most notable ones have come from the Minerva No. 1 mine, near Cave-in-Rock, where lustrous sky-blue crystals to 3 cm associated with sphalerite have been found. Some show purple or yellow phantoms, and others appear dark brown to black due to a thin layer of hydrocarbon just beneath their surfaces. Other excellent fluorites and calcites have also been coming out of the Annabell Lee mine. Details of these discoveries have been summarized in the *Mineralogical Record* (**24**, p. 48) by Ross Lillie (*North Star Minerals,* P.O. Box 46212, Mt. Clemens, MI 48046-6212) who has specimens available. John and Pat Carlon (*Maple Hill Studio,* 1110 E. Emerson, Bloomington, IL 61701), *Wright's Rock Shop* (Route 4, Box 462, Hot Springs, AR 71913) and a number of other dealers are also carrying these.

MAINE

Perhaps inspired by the mining activities at Mount Mica and the Bennett quarry, there has been a flurry of specimen mining activity at a great number of Maine's pegmatites over the past year. So much so, that it is becoming very difficult for the casual or visiting collector to find a place to collect anymore. Nonetheless, there have been a number of exciting new finds, and eventually specimens should find their way into a large number of collections. A complete account has been given by King (*Rocks and Minerals,* **68** (1), p. 49–53), so only the highlights and new additions are mentioned here.

Duddie Groves, of Poland, Maine, and Dick Dionne, of Erroll, New Hampshire, have reopened a prospect west of the Wade quarry, near Auburn. Several world-class purple fluorapatite crystals to 3 cm have been found, along with one unterminated elbaite crystal (approximately 5 cm) with facetable pink, blue and red zones. Excellent transparent, red garnets (micromount to 1 cm) have been found embedded in blocky albite, along with some world-class, green-to-black gahnite crystals to 4 cm, with sections to 10 cm. Fragments of the new purple fluorapatite and gahnite have been cut into gemstones. Also near Auburn, Ben Ashley, of South Paris, Maine, uncovered a 1 x 1 x 2-meter crystal pocket at the Maine Feldspar quarry, that yielded over a hundred unusual, multiply terminated muscovite crystals.

Ron and Dennis Holden of Norway, Maine, had a good year at the Bennett quarry, near Buckfield. In addition to many interesting finds, some very good, black manganotantalite crystals were found. Though most of these consist of tightly corrugated clusters, several single crystals to 5 cm on cleavelandite have been recovered.

Cal and Maureen Burdick of Pawtucket, Rhode Island, and Nestor Tamminen, of Greenwood, Maine, have been mining the Tamminen quarry near Greenwood, and have found some outstanding groups of parallel growth quartz crystals to 30 x 60 cm. A specimen of transparent petalite was also recovered, and has subsequently yielded several 1-carat to 2-carat faceted gemstones. These were cut by Art Grant, of Martville, New York. As far as is known, the Tamminen quarry has produced the only facetable petalite known from North America.

Ray Sprague and Tony Wielkewicz, of Andover, Massachusetts, have been working the Emmons quarry, near Greenwood. In addition to finding some rare phosphates, which included some excellent perhamite crystals, a series of branching pockets (to several meters) yielded some exceptional muscovite crystal clusters to 10 x 10 cm.

Joey Martin, of Rumford, Maine, has been working the Martin prospect at Newry, on behalf of the American Tourmaline Fields Company. The prospect has a simpler exposed mineralogy than most of the nearby quarries, but certainly does not lack for large crystals: the discovery of a spodumene crystal measuring 6.34 meters long and 30 x 80 cm across set a new state record for that species! Of perhaps greater interest to collectors, however, are the many small to medium-sized pockets that have been uncovered, which have yielded milky blue fluorapatite crystals to 4 x 8 cm and gem-quality indicolite, including a flawless crystal with an etched termination of 1150+ carats and a 10-cm, 155-carat well-terminated crystal. Additionally, an exceptional cluster of brilliant cassiterite crystals, approximately 3 x 5 cm, was found which ranks among the best known from the United States.

Frank Perham, of West Paris, Maine, has reopened the Whispering Pines quarry near Paris. Several excellent schorl crystals to 8 cm and about 20 kg of first class, deep-colored rose quartz have been recovered along with several hundred kg of lesser quality rose quartz.

Jan Brownstein, of Portland, Maine, briefly prospected at the Ridge pegmatite #1 prospect of the Red Hill quarry group, near Rumford, and found a complex, and highly unusual, dark brown siderite crystal (1 x 1 cm); and Robyn Green, of Attleboro, Massachusetts, found a partially terminated crystal of triphylite over 5 cm long at the same locality.

The Swamp #1 quarry, just north of the Consolidated #1 & 2 quarry complex, near Topsham, has produced some excellent, small, brilliant, cuboctahedral uraninite crystals in matrix, associated with monazite-(Ce) crystals to 1 cm. New finds of anatase and brookite crystals (as microcrystals) have been made at the Consolidated #2 quarry. Cliff Trebilcock of Topsham found yellow grains of rhabdophane to 2 mm in smoky quartz and microcline at the Havey quarry (just west of the Garland quarry), Schoolhouse Road, Topsham; and Zakk Duffany of Litchfield, Maine, found some large milky green beryl crystals (to 12 x 30 cm) at the William Willes #1 quarry, also near Topsham.

MICHIGAN

There has been a recent discovery of native copper from a new locality in the Keweenaw peninsula, near Copper Harbor. The specimens consist of dodecahedral crystals up to 5 cm which were collected from a surface vein cutting the Portage Lake basalt last summer. Associated species include prehnite, datolite, analcime, laumontite, epidote and calcite. Specimens were available at last year's Detroit show from *North American Minerals* of Baraga, Michigan.

The White Pine mine in Ontonagan County has continued to produce well-crystallized dendritic native copper and silver specimens. Specimens are available from *Precious Earth, Red Metal Minerals* (P.O. Box 45, Hancock, MI 49930), *Trap Hill Mining and Minerals* (P.O. Box 247, Bergland, MI 49910) and others.

MISSOURI

Dan and Jill Weinrich (16216 Copperwood Lane, Grover, MO 63040) recently obtained some sharp pyrite pseudomorphs after anhydrite (?) from the Miliken (Sweetwater) mine, near Sweetwater, Reynolds County. These range in size from 2 to 5 cm. In addition to the pyrite pseudomorphs, some unusual golden calcite crystal "caps" to 4 cm have also been found. These are predominantly scalenohedral with sharp rhombohedral indentations at their bases, suggesting they probably originally formed as sceptered overgrowths on rhombohedral crystals. However, perhaps the most exciting find at the Miliken mine in recent years was made in early December, when a huge pocket with doubly terminated golden calcite crystals was encountered. Some of the crystals were over half a meter long! Recognizing the significance of the find, permission was given to the miners to collect, so a number of fine specimens have been preserved. Additional information on the find is given by Weinrich (*Mineral News,* **9** (1), p. 6–7).

NEVADA

Good specimens of arborescent native copper have been found at the Carissa pit in Lander County. Overall, they resemble many of those from Arizona and New Mexico, and are available from Jim McGlasson (*Collector's Stope,* 7387 S. Flower St., Littleton, CO 80123). Jim also reported that some very rich native gold specimens have recently been found at Echo Bay's mine at Round Mountain, but few, if any, are well-crystallized, which means they probably won't make it to the marketplace, since it is of little advantage to the mining company to dispose of them in that manner.

Martin Jensen recently described the rediscovery of an old locality for aurichalcite at the Grand Deposit mine, White Pine County (*Mineral News,* **9** (1), p. 1–2). Other species found include calcite, hemimorphite, aragonite, plattnerite, scrutinyite, cerussite and malachite.

NEW MEXICO

Rich specimens of spangolite were collected last year by Ray DeMark (6509 Dodd Place NE, Albuquerque, NM 87110) at the Buckhorn mine, Red Cloud district, Gallinas Mountains, Lincoln County. The individual crystals are generally up to 1 mm, and make very attractive micromounts, though they are easily visible for those who prefer larger specimens.

NEW JERSEY

The Millington quarry, near Millington, has been the source of very interesting pectolite crystals and recently has produced some highly unusual datolite crystals. These are milky white, rounded in habit and form spiked clusters to 15 cm, resembling a pineapple. The Chimney Rock quarry, near Bound Brook, has produced some specimens of botryoidal chalcopyrite ("blister copper") on calcite up to 7 x 7 cm.

NEW YORK

Last year we reported the discovery of some unusual cubic magnetite crystals with tetrahexahedral faces from the 2500 foot level of the Z.C.A. (Zinc Corporation of America) No. 4 mine near Balmat, St. Lawrence County, New York. Since then there have been many more, better and larger crystals found as a result of continued mining in the same area. The associated species are as unusual for magnetite as is the crystal habit: anhydrite, halite, colorless sphalerite, calcite and talc! The crystals appear to have formed by hydrothermal deposition in gash veins in an unusual spherulitic sphalerite-magnetite ore. Also associated with the ore were pods of chalcopyrite rimmed by bornite with and without chalcocite. Some of the chalcocite is stained green by paratacamite, admixed rarely with botallackite, nantokite and namuwite, all of which appear to be of post-mining origin. Additional information on the find has been provided by Hollmann (*Mineral News,* **8** (8)) and a complete mineralogical study of the occurrence is currently in progress. A number of dealers now have these for sale, though perhaps the best and largest selection we have seen recently is that of Gary Stacy (*The Lone Prospector,* 148 Rowley St., Gouverneur, NY 13642).

The Gouverneur Talc Company No. 4 Wollastonite quarry near Harrisville, Lewis County, has recently yielded some interesting microcrystal material including prehnite crystals (5–10 mm), sprays of acicular, white wollastonite crystals to 2 mm, and pale yellow aggregates of sub-parallel, tabular, barium-dominant brewsterite crystals to 3 mm. The latter has in fact been shown to be the barium analog of brewsterite and has been fully described by Robinson and Grice (*Canadian Mineralogist,* in press). These minerals occur in cavities in a massive prehnite/wollastonite rock. A description of the occurrence is in progress (King *et al.*, in preparation).

OREGON

There have been some superb opal specimens recently mined at Opal Butte, Morrow County. The best of these rival gem-quality fire opal from anywhere. Excellent specimens of common opal, jelly opal and fire opal are currently available from *West Coast Gemstones, Inc.* (P.O. Box 133, College Place, WA 99324).

TEXAS

Fine, twinned crystals of marcasite have been found near Temple, Bell County, and are available from Al and Betty Tlush (*Carousel Gems and Minerals,* 1202 Perion Dr., Belen, NM 87002). The Folkstone-habit twinned crystals are up to 3 cm and have been partially etched from their limestone matrix, but still have brilliant faces and make very attractive specimens.

Jendon Minerals has obtained a large lot of pale blue-gray celestine crystals from Adamsville, Lampasas County. These consist of lustrous single crystals up to 5 x 8 cm and groups to several times that size. Overall, the specimens resemble those from Clay Center, Ohio.

UTAH

There were a number of interesting new mineral discoveries from Utah evident at last year's Denver show. Both Jim McGlasson and Phil Richardson (1599 E. Evergreen Lane, Salt Lake City, UT 84106-3313) had good specimens of aurichalcite, hemimorphite and rosasite from the Hidden Treasure mine in Tooele County. Some are associated with azurite microcrystals on a gossan matrix, and resemble similar specimens from Durango, Mexico. Jim also had fluellite microcrystals from the Tuscarora mine near Randolph, in the Crawford Mountains, Rich County, while Phil offered good microcrystals of philipsburgite on mixite from the Gold Hill glory hole, Clifton district, Tooele County. Both Phil and Richard Meiners, who was with Harvey Gordon (*Sierra Nevada Minerals,* 1002 S. Wells Ave., Reno, NM 89502) had large (up to 50 cm) groups of bladed white barite crystals from Buckhorn Canyon in the Dugway Mountains, Tooele County. Some are associated with minor purple fluorite and make attractive specimens. Some of the largest groups were collected last March by Richard Meiners, Tom Nannini and Lane Johnson.

Both *Diversified Minerals* and Robert Johansing (*Global Subsurface Products, Inc.,* 13523 W. 24th Pl., Golden, CO 80401) had excellent selections of sceptered quartz crystals from the Pine Grove district, Beaver County. Some crystals reach 10 cm in length and show interesting combinations of sceptered and hopper growth, in addition to large, visible fluid inclusions. Most are colorless to white, though a number show a pale smoky to amethystine color. The crystals reportedly occur in cavities in a Cambrian quartzite.

For those interested in the more uncommon species, Mike Madson had a good selection of coquimbite, römerite and other sulfate minerals from the Dexter No. 7 mine, San Raphael Swell, Emery County, and Patrick Haynes had specimens of ferroselite with haynesite from the Repete mine, San Juan County.

Jeff Scovil reports that some unusual, tabular, cinnamon-red beryl crystals have been found in Searle Canyon, Thomas Range by John Holfert, who may allow collecting on a fee basis, if contacted ahead of time. The crystals are up to a centimeter in diameter, and sometimes occur in rosette-like aggregates. Holfert also recovered some very fine durangite crystals up to a centimeter from another (presently undisclosed) locality.

VERMONT

Small crystals of quartz, fluorite and calcite have been found in veins in phyllite near Putney. A description of the locality has been given by Robinson (*Mineral News,* **8** (12), p. 1, 4–5).

Part II: Other World Occurrences

AFGHANISTAN

As in years past, there has been a continuing supply of fine specimens from the Afghanistan-Pakistan deposits, and it's difficult to know what is really new. At last year's Denver show Dudley Blauwet (*Mountain Minerals International,* P.O. Box 302, Louisville, CO 80027-0302) had several large (up to 40 cm), well-terminated, gem kunzite crystals from Mawi, near Nuristan, Logham province, Afghanistan, among his stock, along with some new color-zoned fluorapatite crystals from the Panzher Valley. *Blal's Gems and Minerals* (12400 Eucalyptus, #18, Hawthorne, CA 90250) had a number of gem-quality dark green and pink bicolored elbaite crystals from Kuhnar, Afghanistan, to 3 x 8 cm.

There has also been a continuing supply of very fine Afghan lazurite crystals available from dealers too numerous to mention. A particularly interesting specimen was recently obtained by Richard Herd of the Geological Survey of Canada, who noticed it had a particularly unusual morphology for lazurite. Subsequent examination revealed that its glassy gray core is the rare mineral afghanite, and its external morphology suggests the whole is a pseudomorph after quartz! Additional unusual specimens consisting of white mica crystals (phlogopite?) rimmed by dark blue lazurite in marble were available at the Tucson show from François Lietard (*Minerive,* Au Bourg, 42800 Tartaras, France).

AUSTRALIA

Attractive colorless, tapered, doubly terminated quartz crystals from the White Rocky quarry, approximately 30 km east of Adelaide, South Australia, were available from Robert Sielecki (*Ausrox,* 42 Hex St., Tottenham, Melbourne, Victoria 3012, Australia) at last year's Denver show. Most of these were single crystals 8–10 cm in length, but crystals to 25 cm and a few Japan-law twins have reportedly been found. Rob also had a fine crystallized nissonite with glassy blue-green crystals to 2 mm on quartz, and a specimen of the very rare sieleckiite, with turquoise and libethenite from Mt. Oxide, Queensland.

BOLIVIA

There have been more of the superb large vivianite crystals found at Morococala, and available from *Crystal Springs Mining and Jewelry Co.* (P.O. Box 40, Royal, AR 71968), *Wright's Rock Shop* and several others. The crystals are complexly terminated, transparent, blue-green individuals up to about 4 x 10 cm on a matrix of pyrite.

BRAZIL

While there may not have been quantities of fine gem crystals found in Brazil over the past year, there have been a number of other new materials produced from the pegmatites of Minas Gerais, and seen at both the Denver and Tucson shows. Miriam and Julius Zweibel (*Mineral Kingdom,* 812 N. Ocean Blvd., Suite 204, Pompano Beach, FL 33062) had a very fine group of bicolored elbaite crystals from Lavra da Pederneira, as well as bicolored scepters from Barra de Salinas. Luís Leite (Ave. 25 de Abril, #50 3.° Esq., 2800 Almada, Portugal) also had bicolored elbaite from Lavra da Pederneira along with a good selection of new brazilianite, stokesite and specimens of crystallized rose quartz with etched schorl from Galileia. The brazilianites consist of sharp yellow-green crystals to 7 cm in groups several times that size. Frank and Wendy Melanson (*Hawthorneden,* P.O. Box 100, L'Amable, Ontario K0L 2L0) also had an excellent selection of these. Luis Menezes had green elbaite crystals with fibrous terminations from Resplendor, in addition to bright green variscite microcrystals in quartz from a graphite deposit near Hapecerica, twinned muscovite crystals from a new find at Divino das Laranjeiras and some exceptional cleavelandite rosettes (to 50 cm!) from Mina Pederneiras, São Jose da Safira.

Perhaps one of Brazil's more mineralogically significant finds was the new lot of bertrandite crystals, labeled as coming from Conselheiro Pena, Minas Gerais, though it is also rumored the actual locality is the Pedeneira mine, near São Jose da Safira. These bertrandites are certainly among the finest large crystals ever found, forming platy, radial aggregates of sharp, white crystals to 5 cm! Specimens were available from Carlos Barbos (Rua Cel. Roberto Soares Ferreira 586, Bairro Vila Bretas, 35030 Governador Valaderes, Minas Gerais, Brazil), *Hawthorneden* and others at the Tucson shows.

Carlos Barbosa also had a large selection of specimens from Brumado, Bahia. The most unusual of these was a new find of very elongated chernovite-(Y) crystals to 5 mm associated with magnesite and uvite crystals. Also evident were some new, brilliant hematite crystals to 6 x 6 cm with mirror-finish faces, in addition to similar but smaller crystals on magnesite, associated with clear to white talc crystals. Carlos also had a good selection of phosphate species from two new occurrences worthy of mention. The first of these is the beryllonite crystals from the Almerindo mine, Linopolis, Minas Gerais; they consist of etched, tabular crystals to 3 cm on limonite-stained cleavelandite, associated with complex, blocky, dark green fluorapatite crystals to 1 cm. The entire surface of the beryllonite and its matrix may be coated with a continuous layer of lightly stained, tan botryoidal moraesite. The beryllonite crystals frequently show a reticulated fracture pattern in-filled with moraesite. The second find of phosphates consists of small nodules from Conselheira Pena, Minas Gerais. The nodules, which occur up to about 6 x 6 cm, predominantly contain tan acicular strunzite with frequent clove-brown to red-brown bermanite crystals. The bermanite may overgrow the strunzite or occur as irregular, subparallel scales or infrequent blocky crystals to 1 mm. Lilac phosphosiderite and pink strengite in granular clusters are common. A few specimens contain pale yellow stewartite, yellow-orange laueite and orange, acicular beraunite (which has been erroneously called "cacoxenite"). A few specimens show black, intergrown sprays of massive rockbridgeite and some dark green, free-standing crystals to 3 mm of a presently unidentified mineral, which may be a member of the alluaudite group.

Renewed collecting has yielded some very attractive blue, terminated crystals of kyanite to 15 cm in quartz (available from *Valadares Minerals,* Rua Capote Valente, 513, Ap. 133 CEP 05409 Pinheiros, São Paulo, S.P., Brazil), in addition to plumose fans of black kyanite crystals to 12 cm, both from Barra de Salinas, Minas Gerais. Also available were good "ball" lepidolite groups to 15 x 25 cm from Taquaral, some new pale purple to blue fluorapatite crystals to 1 cm coating quartz crystals from the Golconda mine, and a quantity of large (up to 25 cm), very well formed, doubly terminated schorl/dravite crystals from Rio Grande do Norte.

The São Pedro mine near Suacui (Malacacheta district, near Teofilo Otoni), has recently produced some excellent uranocircite crystals that greatly resemble autunite specimens from the Daybreak mine, near Spokane, Washington. In fact, some are even calling them autunite, though to our knowledge, no one has actually analyzed them to establish their Ba:Ca ratio. Regardless of which is correct, the crystals are spectacular for either species and are available from Luiz Menezes, *Valaderes Minerals, Wright's Rock Shop, Hawthorneden* and a number of others.

Carter Rich (P.O. Box 91, Aldie, VA 22001) recently obtained some interesting tapered schorl crystals with negative rhombohedral terminations from Galileia. These appear to have formed by repeated dissolution and regrowth, and were available in single crystals up to 10 cm.

Other interesting new Brazilian specimens we have seen include two very fine, twinned chrysoberyl crystals to 5 cm (one perched on a quartz crystal matrix) from Medeiros Neto, Bahia, offered by Russ Behnke (161 Sherman Ave., Meriden, CT 06450); purplish red dodecahedral almandine crystals to 3 cm in pegmatite matrix from Carnaúba dos Dantas, Rio Grande do Norte, available from Reinhard Wegner (Dep. Geologia, Cidade Universitaria, C.P. 10094, 58.100 Campina Grande, Paraiba); and some interesting and very colorful iridescent, schistose, specular hematite from an iron mine near Belo Horizonte, Minas Gerais, available from Rock Currier (*Jewel Tunnel Imports,* 13100 Spring St., Baldwin Park, CA 91706-2283). The cause of the iridescence is presently unknown, although two specimens examined by SEM at the Canadian Museum of Nature showed anomalous Al and P peaks in the EDS X-ray spectrum obtained from the surfaces of the iridescent microcrystals. The hematite is reported to occur in a 1.5-meter wide vertical vein.

BULGARIA

The mines near Madan, in the eastern Rhodope Mountains, continue to produce superb specimens of galena, sphalerite, quartz and calcite. Some of the galenas are especially interesting, forming flattened, distorted cubes and octahedrons. Excellent specimens have been available from Brad and Star Van Scriver (12700 N. Bandanna Way, Tucson, AZ 85737) and Ernesto Ossola (8, Rue du Luxembourg, 30140 Anduze, France).

BURMA

William Pinch reports that there were some spectacular gem-quality, red, octahedral spinel crystals in white quartz (!) from Burma seen at this year's Tucson show. (See Costa Mesa Show report in this issue.)

CANADA

Rod and Helen Tyson (*Tysons' Minerals,* 10549 133rd St., Edmonton, Alberta, Canada T5N 2A4) have been actively acquiring a number of new Canadian minerals. Among the past year's new finds are some very fine transparent crystals of gypsum from Willow Creek, near Nanton, Alberta; some interesting skeletal galena crystals and dark, frosted crystals of sphalerite up to 4 cm from a relatively new find at Mount Hundere, near Watson Lake, in the southern Yukon Territory; an excellent selection of lazulite and other phosphate minerals from the Rapid Creek area in the northern Yukon; some spectacular pieces of the new millerite reported here last year from Thompson, Manitoba; an excellent lot of manganite with quartz from the Caland pit at Atikokan, Ontario; chalcopyrite with tennantite from the H-W mine on Vancouver Island, British Columbia; some new (but relatively few) scalenohedral (?) hematite crystals from a skarn deposit near Hadley Bay, Victoria Island, Northwest Territories; some large, glassy, colorless-to-white, twinned dolomite crystals that resemble those from Eugui, Navarra, Spain, associated with magnesite and quartz from the Mount Brussilhof mine, near Radium, British Columbia; and some very aesthetic groups of cubic white halite crystals from the P.C.S. (Potash Corporation of Saskatchewan) mine near Rocanville, Saskatchewan. The latter are post-mining crystallization products that occur in some of the drifts of the mine along with colorless carnallite crystals to 3 cm, flat prismatic bischofite crystals to 10 cm, and other evaporite species.

Mark Mauthner of the University of British Columbia had some unusual gold nuggets with tetradymite at the Tucson show. The nuggets, which range from 2 mm to 1.5 cm, are from Sonora Gulch on Hayes Creek, Yukon. No lode deposit of this material has been found to date, but considering the softness of the tetradymite, these nuggets could not have traveled far. Mark also reports that the Engineer mine on Tagish Lake, near Atlin, British Columbia, is being mined for gold and collector specimens by Warren Arnholtz and Jan (Swede) Martensson of Ampex Mining. The Engineer mine is a Dana locality for "allemontite" (a mixture of stibarsen and native arsenic) in addition to good specimens of arsenic, electrum and roscoelite. Work is currently underway at the University of British Columbia to confirm additional species. Specimens are being marketed through the *Collectable Earth* shop at UBC's M.Y. Williams Geological Museum (6339 Stores Rd., Vancouver, B.C. V6T 1Z4).

Elsewhere in British Columbia, Bob Jackson (P.O. Box 2652, Renton, WA 96056) collected some very fine, large barite specimens at the Rock Candy mine near Grand Forks, and Brad Wilson (*Alpine Gems,* P.O. Box 352, Kingston, Ontario, Canada K7L 4W2) collected what may well be the world's finest malayaite crystals at a tin-bearing skarn near Ash Mountain, in the Tuya Range, northern British Columbia. The yellow crystals, which resemble titanite, occur in calcite-filled seams in an andradite-pyroxene skarn, and have been found up to 3 cm, though most are 3–5 mm. The finest large specimen recovered is now in the collection of the Canadian Museum of Nature in Ottawa, thanks to the continuing generosity of Teck Corporation. Microprobe analyses done at the Canadian Museum of Nature have shown the crystals to be zoned with respect to Ti and Sn, with compositions ranging from end-member malayaite to 30 mole % titanite in apparent solid solution.

Mont Saint-Hilaire, Québec, has been unusually quiet over the past year, with relatively few significant new finds. The better of these includes ashcroftine-(Y) as dense and radiating aggregates of acicular pinkish purple crystals to 5 cm in fractures in hornfels. Individual crystals up to 0.6 x 15 mm were found. Associated species include lemon-yellow, transparent narsarsukite, lorenzenite, gray rosettes of steacyite and excellent, blue leucosphenite crystals to 1 cm. A large pocket containing a number of single, colorless, transparent catapleiite

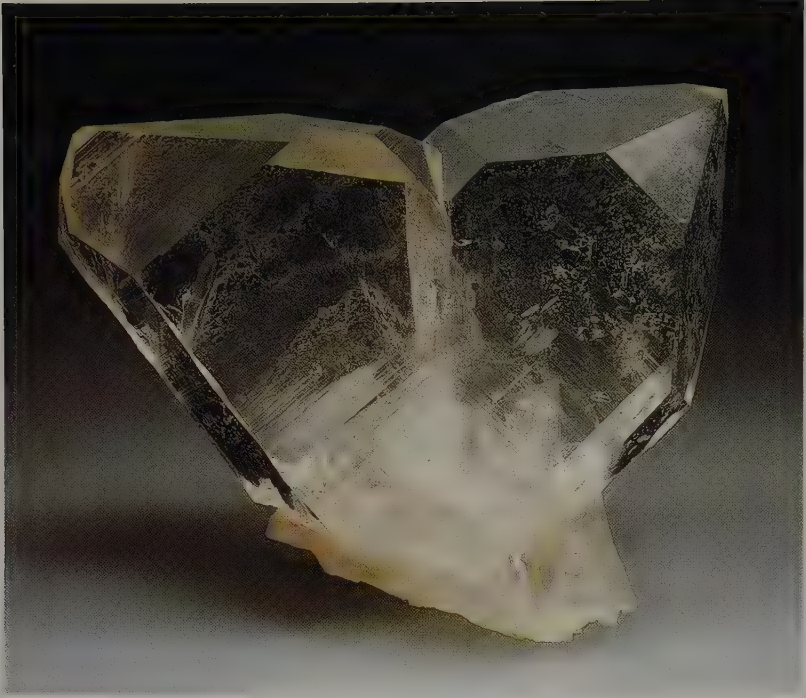


Figure 1. Quartz, a Japan-law twin 10.5 cm across, from the Collier Creek mine, Montgomery County, Arkansas. Art Smith collection; photo by Jeff Scovil.

Figure 4. Platinum crystals (cubic penetration twins) to 1.5 cm, from Konder, near Nelkan, Ajano-Maiskiy region, Khabarovsk Kraj Oblast, Russia. The specimen on the left has native gold partially covering its surface. Van Scriver-Pliaskov specimens.

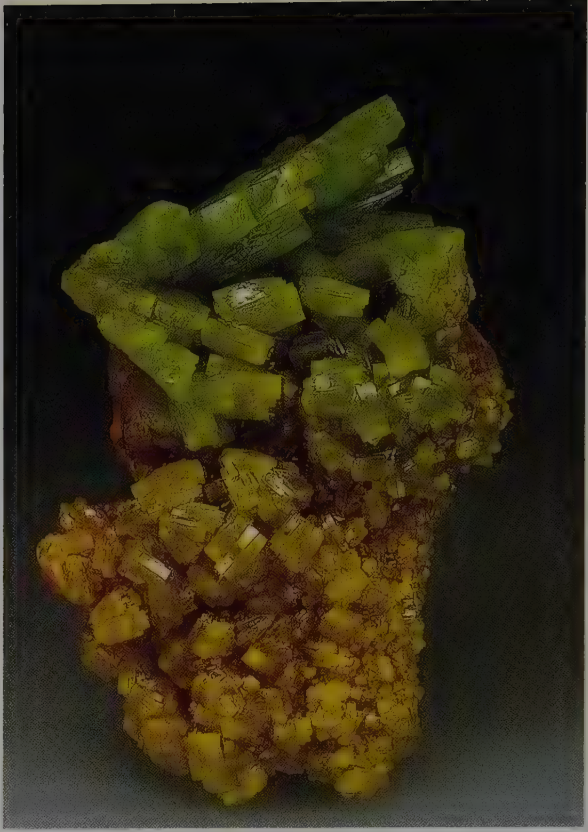
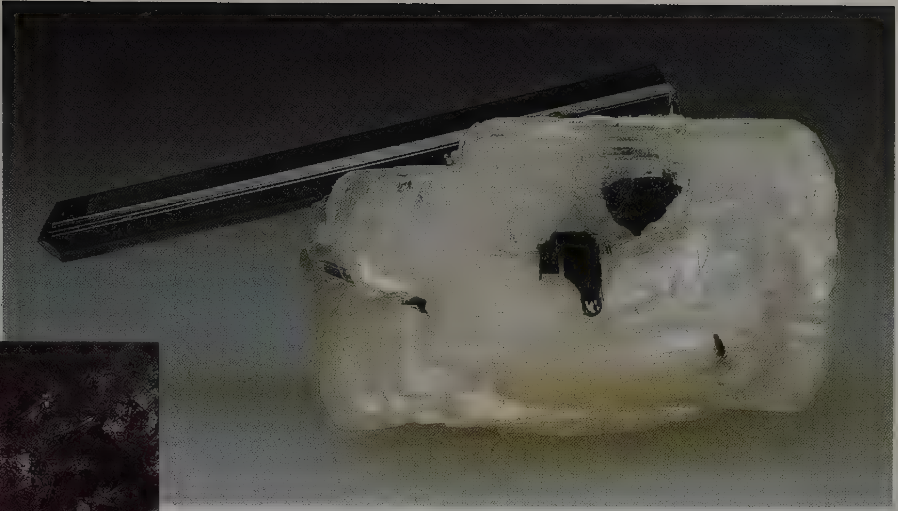


Figure 2. Pyromorphite from the 9 Level, Jersey Vein, Bunker Hill mine, Kellogg, Idaho; 6.7 cm high. *Dave Bunk Minerals* specimen; photo by Jeff Scovil.

Figure 3. Pyromorphite from the Bunker Hill mine, Kellogg, Idaho; 15.6 cm wide. *Wayne Thompson Minerals* specimen; photo by Jeff Scovil.

Figure 5. Red spinel crystal, 1 cm, from Mogok, Burma. William Larson specimen; photo by Harold and Erica Van Pelt.

Figure 6. Bertrandite, in a sub-parallel crystal aggregate 4 cm across, with dark green elbaite, from Conselheiro Pena, Minas Gerais, Brazil. Carlos Barbosa specimen (obtained subsequently by Chris Wright).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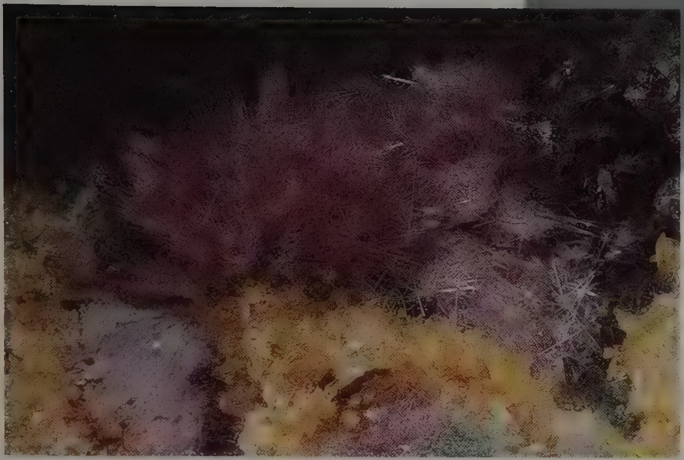


Figure 7. Ashcroftine-(Y), acicular tuft 2 cm across, on matrix, from Mont Saint-Hilaire, Quebec. Canadian Museum of Nature specimen; photo by G. Robinson.

Figure 8. Diopside and grossular crystal group, 4 cm, from Asbest, Ural Mountains, Russia. Lance T. Hampel collection; photo by G. Robinson.

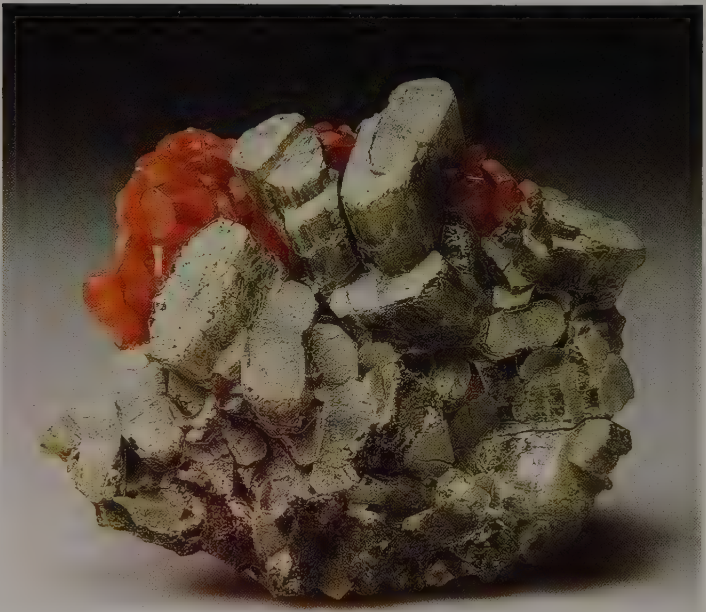


Figure 9. Stibnite crystal group with cinnabar crystals, 10 cm, from the Nikitova mine, Ukraine. Canadian Museum of Nature specimen; photo by G. Robinson.

crystals was also found. Though most of the specimens recovered are not particularly attractive, a few are large enough to allow a number of gemstones to be faceted from them. Some of the best and richest specimens of lintisite and silinaite found to date were collected last year, as were good specimens of makatite, searlesite, normandite, erdite, cryolite and garronite, mostly as microcrystals.

In the meantime, continuing research at the Canadian Museum of Nature and Carleton University has added a significant number of species to the ever-growing Mont Saint-Hilaire list, including several newly described ones (UK numbers are those of Chao *et al.*, *Mineralogical Record*, **21**, p. 363–368). Among these were brochantite, found in a reddish, altered looking mass in a sodalite xenolith; shomyokite-(Y), as transparent, colorless, elongated prismatic crystal to 2 mm, associated with UK 100, galena and albite in a sodalite xenolith; schairerite, as colorless, blocky, etched, poorly formed crystals to 1 mm with aggregates to 3 mm, in marble xenoliths associated with pectolite, shortite, kogarkoite, phlogopite, arfvedsonite, leucophanite, leucosphenite and UK 90a; UK 84, as colorless to mauve, vitreous, equant, pseudohexagonal crystals to 1 mm, found in a sodalite xenolith associated with ussingite, sodalite, makatite, etc.; pirssonite, as off-white, slightly prismatic crystals with diamond-shaped cross-sections to 1 mm associated with kogarkoite, feldspar, analcime, etc.; wadeite, as white, hexagonal, tabular crystals 3 x 5 mm associated with albite; zakharovite (formerly UK 38), found in sodalite xenoliths as canary-yellow patches of minute flakes, rarely as tiny, tabular, hexagonal crystals, or as pseudomorphs after a pseudo-octahedral mineral, and associated with terskite, lovozerite, ussingite, natrolite, microcline, etc., and in silicate cavities with yofortierite, analcime, albite, natrolite, polylithionite, etc.; magnesiohornblende, as dark green phenocrysts to 1 cm in hornfels; sazykinaite-(Y) (formerly UK 88), as yellow rhombohedral crystals in sodalite xenoliths associated with ussingite, sazhinite, UK 53, zakharovite, tugtupite, halite and lintisite; manganotychite, as a yellowish brown, blocky crystal 5 cm across imbedded in trona and associated with UK 100, in a sodalite xenolith; natrosilite, as white, elongated crystals to 0.5 mm with good cleavage, associated with revdite in sodalite xenoliths; neptunite, as zones several microns across in a crystal of mangan-neptunite; and four new species, formerly members of the UK 58 "group" of unknowns.

The Bear Lake Road (Gibson Road) titanite locality near Tory Hill, Ontario, produced a large number of very fine titanite crystals last September. These were collected on land adjacent to the Harper claim, which has been recently described by Harper in *Mineral News* (**8** (6), p. 1–2). The better specimens consist of aggregates of sharp, bladed, dark brown 8-cm crystals associated with microcline and fluorapatite. Elsewhere in the Grenville province, collectors have been finding small but gemmy pink zircon crystals at the McLaren mine near Perth, Ontario, while the roadcut at Matilda Lake, Québec, has continued to provide larger, but more opaque crystals. Canadian Museum of Nature staff collected excellent twinned crystals of xenotime to 3 cm at the Gunter quarry near McKenzie Lake, Ontario, sharp crystals of monazite to 5 cm at the Carey quarry near Mackey, Ontario, colorless, transparent diopside crystals to 3 cm near Cawood, Québec, and some interesting stilbite in a skarn outcrop at a construction site near Maniwaki, Québec.

A number of very fine, but small crystals of gemmy green titanite were collected at a magnetite prospect near Chibougamau, Québec, last summer by both the Canadian Museum of Nature and several Montreal area collectors. The best of these are only 1–2 cm, but are lustrous, and of excellent grass-green color. They occur in lenticular pockets in a sheared, chloritized, layered magnetite anorthosite host rock. Microprobe analysis of the titanite suggests its color is due to vanadium, which, along with titanium, is also reported present in the host magnetite. This, together with field evidence, suggests the occurrence is analogous to an alpine cleft deposit, with the essential components of the cleft minerals being derived from the host rock through metamorphic means. Associated species include epidote, albite, and a dark green to black chlorite group mineral (probably chamosite).

Probably few people know that howlite was first described from Nova Scotia, and named for a Canadian mineralogist. Some of the best crystals of this mineral occur in massive anhydrite and gypsum along the shore of Bras D'Or Lake, approximately 2.5 km southwest of Iona, Cape Breton Island, and are still collectable today. Last summer Toronto collector David Joyce found sharp, colorless to white, centimeter-sized crystals in rosette-like aggregates to nearly 3 cm.

Fred Bailey of Nanisivik Mines reports that in addition to more of the normal pyrite crystals (if there is a "normal" pyrite at Nanisivik!) there have been found some rather unusual pseudomorphs of pyrite after dolomite crystals up to several centimeters across.

CHILE

Specimens of the rare sodium iodate-sulfate species, hectorfloresite, were available from Jim McGlasson at last year's Denver show. These occur as sharp, glassy, terminated microcrystals on thenardite from Pampa Rica, Antofagasta.

CHINA

There has been a continuing supply of excellent Chinese minerals on the market. Some of the more memorable ones we have noted over the past year would have to include the blue-green fluorite crystals from Shang Bao, Leiyang County, Hunan, available from Martin Rosser (P.O. Box 13, Mooloolah, 4553 Queensland, Australia) and others; prismatic crystals of cinnabar to 1.5 cm on Herkimer diamond-like crystals of quartz from Kweichow province, available from *Wright's Rock Shop*; large, well-formed crystals of scheelite up to 10 cm from Sichuang province, available from Miriam and Julius Zweibel and others; yellow-green and pink bicolored tourmaline crystals from Yunnan province, near the Burma border, some very rich, crystallized galenobismutite (resembling Mexican boulangerite) with quartz and chalcopyrite from Chenzhou, southern Hunan province, and an exceptional 7.5-carat twinned diamond crystal from an alluvial deposit in northwestern Hunan, all of which were available from Doug Parsons (1119 S. Mission Rd., Suite 243, Fallbrook, CA 92028) at the Tucson show.

COLOMBIA

There have been some very fine Colombian emerald crystals seen over the past year. Most are single, well-terminated, gemmy crystals from 3 to 5 cm, though a number of fine matrix specimens were also seen. Undoubtedly the finest large crystal was the 5 x 10 cm "Angel of the Andes," displayed at the Denver show, where there was also seen a fine selection of gem crystals from the Coscuoz mine, Boyacá, at *Delta Bravo Gemstones* (P.O. Box 3609, Evergreen, CO 80439). Additional fine emeralds were available from the *Crystal Springs Mining and Jewelry Co.*, Harvey Gordon, and others, and at the Tucson show, Herb Obodda (Box 51, Short Hills, NJ 07078) had a superb doubly terminated 5-cm parisite crystal (on matrix!) from Muzo.

COMMONWEALTH OF INDEPENDENT STATES

Perhaps the most mineralogically significant and diverse lots of new minerals to appear on the market in the past year are those from the former Soviet Union. There is an overwhelming amount of new and extremely fine specimens available from an equally overwhelming number of localities new to Western collectors. Some of these have recently been described by Hamet and Stedrá in *Mineralien Welt* (**3** (6); in German). The following paragraphs only highlight some of the things that caught our attention, and is by no means an exhaustive account of what is available.

Certainly one of the new items deserving attention is the pyrochlore specimens from Veshnovogorsk (Cherry Mountain), Middle Ural Mountains, Chelabinsk Oblast. Most of these are being supplied by

Brad and Star Van Scriver, and consist of extremely sharp, lustrous, red-brown octahedrons up to about 1.5 cm on matrix up to 15 x 20 cm. These apparently occur in carbonatite veins and have been developed by the selective removal of calcite by acid. The same locality also produces lustrous, doubly terminated gray-white crystals of zircon up to 7 cm. These are reported to occur in alkalic pegmatite veins. Other new materials available from the Van Scrivers (and others) include sharp brown cubes of perovskite to 1.2 cm on clinochlore from the Zelenzowskaja mine, as well as 2.5-cm octahedrons of magnetite with dodecahedral modifications in calcite from Kashkanar, both near Zlatoust, Chelabinsk Oblast, Ural Mountains; large betekhtinite crystals from Dzezkazgan Region, Kazakhstan; fine cinnabar crystals up to 1 cm, some with stibnite crystals from the Nikitova mine, Gorlovka, Donetzk Oblast, Ukraine (these were also available from Alexander Dikov, P.O. Box 66, 1404 Sofia, Bulgaria); terminated hambergite crystals to 3 cm from the Malkhane pegmatite field, Transbaikal, Chita Region, Russia; huge görgeyite crystals (to 8 cm!) and inderborite crystals (groups of terminated 4-cm crystals) from the Inderskoje mine, near Inderskoje, Gurijev Oblast, Kazakhstan; twinned, yellow-brown titanite crystals to 3 cm with chlorite from the Saranay area, Polar Urals; 1.5-cm platy bertrandite crystals with rhodochrosite from Kounrad, Kazakhstan; and a large selection of fine minerals from the Nicolaj mine, near Dal'negorsk (approximately 400 km northeast of Vladivostok), Primorskij Kraj, in eastern Russia. These include many fine transparent blue fluorite cubes to 6 cm, 5-cm sphalerite crystals on quartz, superb pale green datolite crystals to 6 cm, manganocalcite, and exceptionally lustrous, well-crystallized ilvaite specimens to several cm.

Among the most remarkable new finds in Russia are the superb penetration-twinned cubic platinum crystals to 1.5 cm. The three examples that Brad Van Scriver brought to the Tucson Show, may well not be the last; the Russian manager of the mining operation reportedly remarked that many such crystals have been found there but all were melted down because their value as crystals was unsuspected. The locality has been given as Konder, near Nelkan, Anjano-Maiskiy Region, Kharbarovsk Kraj Oblast.

Western Minerals (P.O. Box 43603, Tucson, AZ 85733) has fine specimens of lustrous, green-brown andradite crystals up to 3 cm in groups to 15 cm. The crystals are predominantly dodecahedrons modified by trapezohedral faces, and are from Dal'negorsk. Other high-quality specimens from Dal'negorsk are also available from *Mineralien and Fossilien Galerie* (Fahrgasse 88, 6 Frankfurt, Germany), as are good specimens of wolframite and quartz from Kara-oba, Kazakhistan, axinites as well as brookite crystals on quartz (resembling those from Prenteg, Tremadog, Wales) from Sarnapaul, Polar Urals, and purplish pink rubellite crystals from the Pamirs, Tajikistan. *Wright's Rock Shop* and *Western Minerals* also have good Kara-oba wolframites and fluorites as well as other Russian minerals. Interesting specimens of acicular cosalite crystals in quartz crystals from Kara-oba were also seen. Christian Weise (*Kristalldruse München*, Oberanger 6, D-8000 München, Germany) has very fine orange scheelite crystals to 3 cm on quartz from Iultin, northern Siberia. Also worthy of mention are the excellent large (up to 25 cm!) groups of dioptase from the type locality at Altyne-Tyube, Karaganda, Kazakhstan, that have been available from *Wright's*, the *Tideswell Dale Rock Shop* (Commercial Road, Tideswell, Derbyshire, England), Lance Hampel (*Precious Earth Co.*, P.O. Box 39, Germantown, WI 53022) and others. The crystals on these specimens average 1 to 1.5 cm and generally resemble those from Reneville or Tsumeb.

Lance Hampel also has a good selection of minerals from the world's largest asbestos mine at Asbest, Ekaterinburg, Central Urals. These are remarkably like the minerals from Asbestos, Québec, (or Eden Mills, Vermont), and include grossular, diopside, clinochlore, vesuvianite and other minerals. Certainly deserving of special mention among these "other minerals" are the world-class crystals of transparent brucite to 5 cm! Another striking "look alike" offered by Lance was blue fluorapatite in pink calcite from Slyudyanka, Siberia—a dead ringer for the Canadian Grenville deposits.

Bryan and Kathryn Lees have also been importing good Russian minerals including some new fluorapatite crystals from Puj Va, Samgorodoh, Urals, and some new fluorite and calcite specimens from Tetjuche-Pristan, Primorskij. Dave Bunk had similar material at the Denver show, and Ben DeWitt had a small lot of systematic minerals documented by chemical analyses and X-ray films. Among the species offered were niobo-aeschynite-(Ce), hingganite-(Ce), tantite, ferrotantalite and landauite. Forrest and Barbara Cureton (*Cureton Mineral Company*, P.O. Box 5761, Tucson, AZ 85703) again had a number of rare and new minerals from the Kola Peninsula, including belkovite, bystrite, imandrite, koukovite, olympite and zakharovite.

The *Fersman Museum* (Moscow) attended both the Denver and Tucson shows with a large selection of Russian material, especially rich in the rare species from the Kola Peninsula. One particularly exciting new item was offered by the Fersman Museum: huge native tellurium crystal sections from a gold mining district at Kochoulak, Ubekistan. The locality has produced about 75 species, including a number of rare sulfosalts and tellurium minerals (altaite, goldfieldite, hessite, calaverite, etc.) in addition to remarkably large, pure cleavage masses and crystals of native tellurium to 6 cm! Other new materials included well crystallized pinnoite from Inder, Kazakhstan; complex calcite crystals and overgrowths, sometimes associated with tan stilbite and white laumontite from Sargai, Ural, Kazakhstan; excellent, delicate moss agate slabs from Pstan, Kazakhstan; bright green fuchsite (chromian muscovite) crystals to 1 cm with black tourmaline and rutile lining fractures in hornfels from the Pamir Mountains, Tadzhikistan; smoky Baveno and Manebach combination twinned microcline/orthoclase crystals to 4 x 10 cm from Udacha, Chabarovsk region, Chutkotka peninsula, Russia; rich, splintery holtite in pegmatite matrix from Mount Ploskaja, Kola peninsula, Russia; and sharp, pointed, dark green clinochlore crystals with "chromian" titanite from Sarany, Urals. Also attending the Tucson show for the first time was the *St. Petersburg Mining Institute* which provided both a fabulous exhibit and a good selection of rare minerals for sale, including the new species tsaregorodtsevite, from Mun-Hambo, Hanty-Mausiiky district, Polar Urals, Russia.

Of course there have been more of the superb gem heliodore crystals from Wolodarsk-Wolynski, Wolhynien, Ukraine, in addition to an number of gem aquamarine crystals from the same locality. All of the latter, however, were reported to have been treated by heating and/or radiation to give the blue color. Once again, buyers beware! There were also numerous classic emeralds, elbaites, aquamarines and topaz specimens from the Urals. Some of these are reported to have been recently mined, such as the 25-cm doubly terminated aquamarine crystal from Alabashka, or the 8-cm amethyst crystals from Mursinka, Urals, seen at Peter Lyckberg's booth (P.O. Box 31042, S-40032 Gothenburg, Sweden).

FINLAND

Oftentimes as mineral collectors, we tend to shun lapidary materials as a source of good mineral specimens. As a result, the beautiful labradorite from near Ylamaa, known for years as "spectrolite" to gem cutters, is almost never seen on the north American mineral market. However, Peter Lyckberg provided a literal "eye-opener" with this material at the Tucson show with polished slabs of Ylamaa labradorite to 20 x 30 cm whose color could be seen from across the room. The combination of intense golden yellow, royal blue and copper-red play of colors shown by these specimens is indeed memorable!

GERMANY

Last year we reported the discovery of superb nickeline crystals at the Pöhla mine, Erzgebirge, Saxony. A very few more of these were seen at this year's Tucson show, including one large group, approx-

WEW

Figure 10. Unknown mineral crystal group, 1.8 cm across, on matrix, from Dzezkazgan, Kazakhstan. Van Scriver-Pliaskov specimen.

Figure 11. Vesuvianite crystals to 2 cm, from Asbest, Ural Mountains, Russia. Lance T. Hampel collection; photo by G. Robinson.

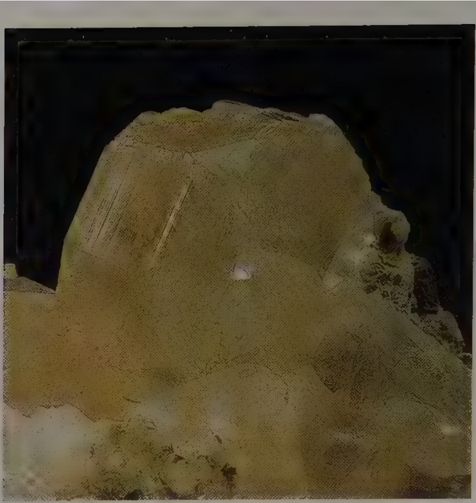


Figure 12. Brucite crystals to 4 cm, from Asbest, Ural Mountains, Russia. Canadian Museum of Nature specimen; photo by G. Robinson.

Figure 13. Fluorite and fluorapatite from Aktsche Tau (Akschatau, Akcetao), Kazakstan; 20 cm long. *Mineralien & Fossilien Galerie* specimen; photo by Jeff Scovil.

Figure 14. Titanite crystal group, 12 cm, from the Polar Urals, Russia. Canadian Museum of Nature collection; photo by G. Robinson.

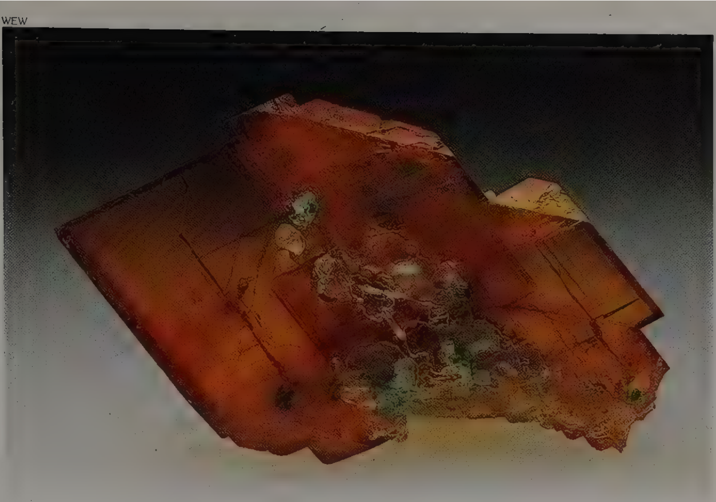


Figure 15. Barite, a golden orange-yellow crystal 3.1 cm across, from the Mashamba West mine, Zaire. Roberts Minerals specimen.

Figure 17. Cinnabar crystal group, 7 cm, from the Nikitova mine, Ukraine. Canadian Museum of Nature specimen; photo by G. Robinson.

Figure 16. Magnetite crystal group, 11 cm, from Kashkanar, Ural Mountains, Russia. Canadian Museum of Nature collection; photo by G. Robinson.

Figure 18. Iowaite crystals on matrix, 1.5 cm, from Phalaborwa, South Africa. Canadian Museum of Nature specimen; photo by G. Robinson.

imately 20 cm across, that has to be a contender for the world's best. These were once again available from Manfred Schwarz (*Saxonia Minerals*, Bründelasberg 19, 0-9400 Aue, Germany).

GREAT BRITAIN

Neil Hubbard (122 Cordery Rd., Evington, Leicester, England LE5 6DF) has continued to obtain an interesting and diverse lot of microminerals from the British Isles, some of which include: clear to pale milky orange hilgardite crystals and clusters to 2 mm on clear, pale blue, cubic boracite crystals from the Boulby mine, Loftus, Cleaveland, Yorkshire; well-defined, lustrous, dark green crystals of (beta-?) duftite on quartz from Penberthy Croft, St. Hilary, Cornwall; cumengeite, as green to bluish green, bipyramidal crystals less than 1 mm, associated with etched masses of cerussite from Gunver Head, Padstow, Cornwall; phosgenite, as tabular, complex, tan crystals to 3 mm on drusy quartz from Bounds Cliff, Daymer Bay, St. Minver Cornwall, as more simple tabular crystals to 3 mm in vuggy quartz with pyrite at Tregardock, St. Teath, Cornwall, as clear, complex crystals to several mm in corroded galena from Wheal Penrose, Porthleven, Cornwall, as bright, clear crystals to 5 mm with etched, milky, cerussite and limonite in corroded galena from Lossiemouth, Elgin, Grampian, Scotland, and as smoky to milky, simple, columnar crystals to several mm with barite and limonite in galena from Clevedon, Avon; pyrolusite, as lustrous, irregular crystals to several mm on wad from the Fullabrook mine, Ilfracombe, Devon; vesignieite, as yellow-green, irregular, platy crystals to several mm in a friable volcanic rock from the Bardon quarry, Coalville, Leicestershire; edingtonite, as both twinned and individual crystals to several mm from the Squilver quarry, Disgwylva Hill, Shropshire; offretite that resembles shredded coconut, lining vugs in basalt and associated with clusters of salmon-pink albite to several mm from the Loanhead quarry, Beith, Strathclyde, Argyll, Scotland (other finds at this quarry include stellate clusters of thomsonite and gemmy, pale yellow-green titanite); corundum, as gemmy, sapphire blue crystals to 3 mm from Port na Cloidheig, Loch Scridain, Island of Mull, Argyll, Scotland; and transparent, cruciform, twinned crystals of harmotone to several mm, sometimes coated with drusy, clear to milky barite(?) from the Cwm Orog mine, Llangynog, Powys, Wales.

INDIA

There is a continuing supply of fine zeolite specimens from the Deccan basalts. Hundreds of very fine apophyllite, stilbite and heulandite specimens from Jalgaon have been available from the Zweibels, *Crystal Springs Mining and Jewelry, Mountain Minerals International,* Rustam Kothavala (1345 W. Clausen Circle, Tucson, AZ 85745), *Zeolites India* (D-311 Manju Mahal, 35 Nargis Dutt Rd., Bandra West, Bombay 400 050, India) and others. *Mountain Minerals* also had some new mesolite specimens from Lonavla, consisting of frosted white sprays of crystals to 10 cm on pale green apophyllite crystals.

IRELAND

Neil Hubbard has recently obtained some rather remarkable crystals of crandallite. Though a mineral of fairly widespread distribution, genuine and visible crystals are scarce. These specimens consist of milky, steep rhombohedral crystals to 0.5 mm, sparsely scattered on botryoidal turquoise from Fort Lismeenagh, Shenagolden, County Limerick.

ITALY

Forrest Cureton reported that some extremely fine specimens of lustrous brown grossular crystals to 1.5 x 2 cm with green diopside crystals to 1.2 x 4.5 cm in undamaged groups to 6 x 7 cm were seen at the Torino show last year. These were collected over the summer by A. Filipao, T. Guiseppe and N. Giantiero in the Susa Valley, Alpe Delle Frasse, Piemont. Also seen at the show were specimens of the very rare mineral cascandite from a new find at the original locality, Cava Diverio, Baveno.

MADAGASCAR

Ernesto Ossola has an interesting new suite of specimens from Androy. Among these are dark blue, rounded crystals of sapphirine to 1.5 cm associated with phlogopite in coarsely crystallized calcite, and a number of zircon, titanite, pyroxene and scapolite specimens that are virtually indistinguishable from those from the Canadian Grenville deposits.

Denis Gravier (Chemin de Ronde, 01500 Ambronay, France) has obtained a large selection of new rhodizite crystals (to 5 mm) from a kaolin quarry near Sahanivotry, Sahatany Valley, Mount Bity district. The pale yellow crystals consist of simple dodecahedrons with small octahedral modifications.

MEXICO

At last year's Denver show Steve Green (*Rough and Ready Gems,* P.O. Box 10404, Denver, CO 80210) had a lot of yellow-green vesuvianite crystals from a presently undisclosed new locality in Veracruz. The crystals are sharp, equant, bipyramidal individuals with short prism faces up to about 2 cm; overall they resemble those from the Lake Jaco area in Chihuahua.

Bob and Vera Turner (*Natural Connection,* 520 Marthmont Way, El Paso, TX 79912) had an impressive selection of Mexican minerals at last year's Denver show, including lustrous cuboctahedral galena crystals associated with calcite and fluorite from Naica, Chihuahua; delicate, stark white calcite helictites up to 15 cm from Santa Eulalia, Chihuahua; some excellent, large, arsenopyrite crystals to 3 cm on dark sphalerite crystals, also from Santa Eulalia; and a good selection of danburite specimens from Charcas, San Luis Potosí. Benny Fenn (P.O. Box 16285, Las Cruces, NM 88004) and several other dealers also carried similar selections of fine Charcas danburites. The best of these are perhaps among the best ever produced, consisting of exceptionally sharp, lustrous, transparent crystals up to 10 cm.

Some very unusual grossular-andradite crystals occur at the Rainbow garnet mine (rumored to be near Hermosillo) in Sonora. The crystals are centimeter-sized green-brown dodecahedrons, somewhat resembling those from Stanley Butte, Arizona, except for one dramatic feature—they have a brilliant opalescent play of color! The opalescence is particularly evident along the edges of the dodecahedral faces, and cut stones resemble opal or fire agate much more than they do garnet. A few of these unusual specimens were available from Gerald and Jeannine Clark (*International Mineral Exchange,* P.O. Box 11090, Costa Mesa, CA 92627) at the Tucson show.

A few very fine azurite specimens have recently been available from Rancho Santa Rosa, Concepcion del Oro, Zacatecas. The crystals are unusually large compared to most Mexican azurites, and of a bright blue color. These were available at the Tucson show from Brad and Star Van Scriver.

NAMIBIA

There has been a significant number of large elbaite specimens recovered from the Otjua mine near Karibib. Some of these consist of large purplish red crystals to 18 cm on plates of albite crystals with smoky quartz and lepidolite over half a meter across. Specimens are available from *XTAL* (20 N. Iowa St., Colorado Springs, CO 80909).

Among the new finds from Namibia were some incredible, nearly flawless, subhedral to euhedral crystals of bright orange spessartine found in a mica-quartz schist reportedly near Marienflüss. The color and clarity of these crystals is superb, and the paragenesis unusual. Only a few specimens were seen at the Tucson show (*Pala International,* 912 So. Live Oak Park Rd., Fallbrook, CA 92028), but hopefully more will surface.

There were a fair number of very good green fluorite specimens from the Okarusa mine seen at the Tucson show. A number of pieces had sharp, 5-cm crystals in clusters to 25 cm and were available from *Harvey Gordon Minerals* (1002 S. Wells Ave., Reno, NV 89502), Mel and Pam Bersch (*Genesis Epoch*, 2417 Sandridge Ct., Grand Junction, CO 81503) and others.

Lastly, there have been some very good centimeter-size sprays of stout, terminated uranophane crystals on calcite found at Rössing, as well as some extremely fine specimens of prehnite found in a basalt quarry on the Brandberg Plateau. The latter typically consist of green, coarsely crystallized spherical aggregates of crystals from 3 to 5 cm associated with quartz, analcime and calcite. Victor Yount (Route 3, Box 250, Warrenton, VA 22186) and a number of the European dealers had specimens available at the Tucson show. Details of the find have been given by Enterich (*Lapis*, **17** (10), 45–46) (in German).

NEPAL

Rubens de Vasconcelos (Rua Afonso Pena 3053, 35.100 Governador Valadares, Minas Gerais, Brazil) had some new clear to milky white hambergite crystals to 1.5 x 6 cm at this year's Tucson show. The locality for these specimens was given as the Hyakule mine, Sankhuwa Sabha.

NORTHERN IRELAND

While Northern Ireland is a classic locality for zeolites, specimens are rarely seen on the North American market. Good, representative specimens of gmelinite, stilbite, thomsonite, levyne and gobbinsite from various localities in County Antrim, were available from Patrick Haynes at last year's Denver show.

NORWAY

For the first time in a number of years, the silver mines at Kongsberg have once again produced some classic specimens of wire silver and acanthite through the efforts of local collectors. While most of these probably never reached the North American market, a few good specimens up to 8 x 10 cm were seen at the Tucson Show and were available from Miriam and Julius Zweibel and Peter Lyckberg, who reported that a single, sharp 4-cm crystal was also found.

Torgeir Garmo (*Fossheim Steinsenter*, N-2686 Lom, Norway) reports that there have been a number of interesting new mineral discoveries made elsewhere in Norway, too. The Kjøholt limestone mine near Porsgrunn, Telemark, is producing very good specimens of calcite with marcasite and pyrite. Some of the calcites show well-developed dark-colored scalenohedral phantoms, overgrown by a later generation of transparent calcite, which make quite attractive specimens. Clusters of crystals up to 40 kg are relatively common, as some of the pockets are quite large; one is reported to be 28 meters long! There have also been a number of new quartz localities found, some of which may become significant specimen producers. In Valdres, Oppland, approximately 150 km north of the Hardangervidda anatase locality, a quartz vein in mica schist has produced water-clear crystals, some associated with well-crystallized anatase. Other good quartz specimens have been found in the area of Namdalen–Nord Trøndelag, approximately 250 km north of Trondheim, and in the adjacent areas near Børgefjelt and Hattfjelldal in Nordland, and small sceptered amethyst crystals with calcite have been collected in the Kirstiandsund area. Other finds include pale pink to blue corundum crystals to 12 cm in biotite schist from a small island outside Sandressjøen; barrerite crystals in seams in an altered calc-silicate rock from Tosenvegen, Vefsn, Nordland; black, lustrous augite crystals to 2 cm from Skarnebergbukta, Seiland, Alta, Finnmark; hematite with epitactic rutile crystals to 8 mm from Kongsli, Vinstra, Oppland (these greatly resemble the larger ones that have been available from Brazil, over the past few years); smoky quartz crystals to 10 cm from Sætre, Hurum, Buskerud; and two new occurrences for prehnite: one at Valldal, Møre og Romsdal, as sharp translucent crystal aggregates on epidote fans with feldspar and quartz crystals, and another at Hurum, Buskerud, that produces darker green specimens associated with calcite and apophyllite, similar to those from Paterson, New Jersey.

PAKISTAN

Sharp, gemmy, prismatic crystals of green zoisite to 6 cm, labeled as coming from both "near Skardu" and "Alchuri village," between Shigar and Dassu, Baltistan, Northern Areas, were seen at both the Denver and Tucson shows over the past year. Wayne Thompson, François Lietard and *Mountain Minerals International* all had fine specimens available. *Mountain Minerals* also had etched topaz crystals from Apaligun, above Nyet, Baltistan, Northern Areas, some rather complex, flattened, pink fluorite crystals from Chumar, Bakhoor Nala, above Sumayar village, Nagar, Northern Areas, schorl crystals from Machara Nala, above Hassanabad, Hunza, and a nice lot of epidote crystals up to 5 cm from Tormiq, above Baghicha, on the Gilgit-Skardu road.

PERU

Both Harvey Gordon and Gerald and Jeannine Clark had a small number of wire silver specimens from Uchuchaqua, at the Tucson show. A few gemmy, dark red rhodochrosite crystals of scalenohedral habit have been coming from the same locality.

PORTUGAL

Sebastian Rodriguez (Av. Nossa Senhora do Rosário 1042, 2750 Cascais, Portugal) had one of the best selections of Panasqueira minerals we have seen in a long time at the Tucson show. These included gemmy green fluorapatite crystals to 8 cm in diameter on large quartz crystals, in addition to excellent cabinet-sized specimens of wolframite, arsenopyrite, siderite and other species.

ROMANIA

Christian Weise had an excellent selection of crystallized and leaf gold from Roşia Montana (the old classic locality of Verespatak), Transylvania at the Tucson show. These are very rich specimens, averaging 3 to 8 cm across, reportedly obtained from a private collector in Romania.

SOUTH AFRICA

What are probably the world's finest inesite crystals were found last summer at the Wessel's mine in the Kuruman district. These form aggregates of sharp, red, radiating tabular crystals to 1 cm as well as more dense spherical aggregates to 2 cm, occasionally associated with brown orlymanite, oyelite, thomsonite, natrolite or datolite. Most are in the thumbnail to miniature size range, and very colorful. Excellent specimens have been available from Charles Key (P.O. Box 56, Peaks Island, ME 04108), Mike Haritos (*S.T.D. Mineral Co.*, 22 Spring Hill Rd., Hyde Park, MA 02136), and Clive Queit (Box 1014, Fourways 2055, Sandton, Johannesburg, South Africa). Specimens of well-crystallized tephroite (crystals to 1.5 cm) and jacobsite (lustrous black octahedrons to 3 mm) have been found at Wessel's mine, and the rare manganese mica, norrishite, has been tentatively identified in mm-sized platy crystals in massive sugilite on a specimen submitted for identification to the Canadian Museum of Nature by Don and Gloria Olson (P.O. Box 858, Bonsall, CA 92003). The occurrence of "leucophoenicite" reported here last year has subsequently been proven to be caryopilite.

Superb crystals to 1 cm of the rare mineral iowaite have recently been found at the Palabora open pit, at Phalaborwa, Transvaal. Good specimens have been available from both Mike Haritos, Clive Queit and Dr. Georg Gebhard (D-5226 Reichshof, Oberwehnrath, Germany). Some of these greatly resemble the pyroaurite crystals found several years ago, though a re-examination of one such specimen at the Canadian Museum of Nature confirmed the earlier identification as correct.

SPAIN

Victor Yount had an excellent selection of blue to purple fluorite crystals associated with calcite from La Collada, Asturias, at last year's Denver show. Some of the fluorites show phantoms and occur in cubic crystals up to about 10 cm (see *Mineralogical Record,* **23**, p. 69–76).

UGANDA

Sharp, well-formed, 1.5-cm gray-brown octahedral crystals of northupite from Katwe Lake, Uganda, were available from Gilbert Gauthier (7 Ave. Alexandra III, Maisons-Laffitte 78600, France) at last year's Denver show.

ZAIRE

In addition to the northupite, Gilbert of course had an excellent selection of fine and colorful copper and uranium minerals and associated species from Shaba, at both the Denver and Tucson shows, including excellent cuprite, malachite, malachite pseudomorphs after barite, and golden barite from the Mashamba West mine, some exceptionally fine dark green crystal groups of torbernite from the Musonoi extension, large selections of cobaltoan dolomite from Kakanda, and stalctitic malachite from Kamoto, free-standing mm-sized crystals of cornetite from the Star of the Congo mine at Lubumbashi, and attractive crystallized libethenite on pseudomalachite from M'sesa, near Kambove. Gilbert also had some very rare uranium minerals, including well-crystallized specimens of francoisite-(Nd) and wyartite.

Costa Mesa Show

by Bob Jones & Jeffrey A. Scovil

[May 14-16, 1993]

The second annual *West Coast Gem and Mineral Show* was held again at the Holiday Inn, Costa Mesa. The location is ideally situated near John Wayne Airport and at the confluence of two major freeways. Just as in 1992, the attendance was excellent. The parking lot filled up before lunch Saturday and the hallways were crowded. Spending was off this year but the quality of minerals and fossils, including some new arrivals, made for a good show.

This show has no special exhibits or mineral theme but it does boast a lively museum benefit auction held on Saturday night, preceded by food and snacks. This year's beneficiary, the San Bernadino County Museum, received about $1500.

It's not surprising that some of the new material is from Russia, the stunner being a monster **emerald** crystal shown by *Kristalle*. They also had some of that Christmas Day find of crystallized **gold** from the Jamestown mine, Tuolomne County, California, first seen at Tucson. The emerald is very clean for one occurring in schist. The color is a dark blue-green, and the size is about 15 cm long and close to 10 cm across, a sharp and exceptional piece.

Stone Flower (B. Kommunisticheskaya, 48, Moscow, Russia) a dealership operated by Nickolai Kuznetsov and Alexander Agafonoff, had some very colorful octahedral **fluorites**. The crystals reach 2.5 cm or more, and are a deep, rich purple and showing slightly concave faces. Along with the fluorites are fine, blue, doubly terminated **fluorapatites**. The apatite crystals served as matrix, in some cases, while others stand as descrete crystals along with the fluorite on a white matrix. These from Akschatau, Kazakhstan, are reported to be a limited find of perhaps 100 specimens. *Ken Roberts Minerals* had some of the Russian purple fluorites, superb large octahedrons on matrix. The locality given is Kara Oba, Kazachstan.

Stone Flower had an exceptional specimen with gray-black acicular crystals (to 5 cm) of the rare copper-iron-lead sulfide **betekhtinite** from Kazakhstan. The overall specimen is 15 by 20 cm with the needles radiating flat on a quartz matrix.

Stone Flower also had some monster **datolites** from Dal'negorsk, Russia. The crystals are quite lustrous, pale green and associated with white quartz crystals to 5 cm in length. One specimen consists of two intergrown crystals 18 cm across.

Roberts Minerals also had several really fine Russian **stibnites**, blades to 15 cm, with sharp, water-clear tabular barites. Some are paper thin, others more sturdy. The locality was given as Akcetao, Russia (Akschatau, Kazakhstan?).

Of interest to fossil collectors, Roberts had a half dozen unusually shaped dinosaur eggs just in from China. The exact species is still being identified. The eggs were in good condition, showing a decidedly flattened but almost round shape as opposed to the typical oval shaped eggs from the Gobi Desert.

I was particularly attracted to several classic minerals from England offered by *Scott Williams Mineral Company*. Two of the species are pseudomorphs, **calcite** after witherite from the Higgs mine, Netsherry, Northumberland, and **barite** after alstonite from the Bromley Hill mine, Nenthead, Cumberland. Each shows very sharp, distinct crystals to 2.5 cm. Scott did not know if these were a new find or old stock, but both are classic localities!

Scott Williams also had some new tetrahedral **boracite** crystals from England. The crystals are small, to several millimeters long. But such crystals are quite rare. These are from the Boulby mine, Boulby, Cleveland, Yorkshire, England. Along with the boracites, Scott also offered rare **hilgardite** from the same locality.

To close out the book on England, Scott also had classic, half-inch, penetration-twin **fluorites**, purple in color, from Frazer's Hush mine, Rookhope, Durham, as well as green penetration twinned fluorite from a new locality, the Blue Circle cement quarry, close by the classic Heights mine, Weardale, England.

Cavansite is back on the shelves. *Zeolites-India* had two stunning specimens of deep blue radiating crystals of this rare mineral. The sprays are about 2.5 cm across, very lustrous, and stand close to 1.3 cm off the white heulandite matrix. These are much larger, a much deeper blue, and more lustrous than the earlier material.

Zeolites-India also had a nearly 2.5-cm doubly terminated **powellite** crystal on matrix showing an odd (from India) green color. It's from a new locality about 112 km north of Nasik.

Dave Bunk (9240 W. 49th Ave., #317, Wheat Ridge, Colorado 80033) has bought out the stock of Russian minerals of the *Collector's Edge*, balancing nicely his fine stock of Colorado minerals. What caught our eye, though, were his **pyromorphites** from the Bunker Hill mine, Kellogg, Idaho. Most of the specimens are typical barrel-shaped crystals, from green to orange in color and could be had for $30 to $2,000.

Dave was not the only one to have material from the famous Bunker Hill mine. *Wayne Thompson Minerals* (1723 E. Winter, Phoenix, Arizona 85020) was turning heads with his material. According to Wayne, exploratory work is going on at the mine, and that chances are good that more material will be forthcoming. Most of Wayne's stock consisted of bright orange, lustrous botryoidal groups on matrix. The very attractive specimens were as much as 15 cm across.

Tom Wolfe Minerals (P.O. Box 9791 Fountain Valley, California 92728) had a good selection of the **creedite** specimens mentioned in the May-June issue of the *Mineralogical Record*. The samples are from the Hall mine, Nye County, Nevada. According to Tom, they were mined back in 1984, but only just now have surfaced. The pale purple matrix groups could be had as large as 18 cm across and up to $340. Average crystal size was about .5 cm.

John Siebel (P.O. Box 95, Tehachapi, CA 93561) always seems to find something new. This time he had some very interesting prismatic **dioptase** from the Sanda mine, Mindouli region, Congo. Collectors of dioptase will recognize the Mindouli label as being one of the classics for this mineral. These specimens are unusual in that they are associated with twinned **cerussite**, much of which is coated with some unidentified pale blue copper mineral, possibly plancheite. A few specimens also have tiny orange **wulfenites** attached!

A variety of **quartz** was in evidence. *Mark Rogers* had a superb

Japan-law twin about 13 cm long with siderite from Governor Valadares, Minas Gerais, Brazil. *Blal's* of Hawthorne, California, had a very nice Afghanistan Japan-law twinned quartz. *Baron and Beale,* Morgan Hill, California, had a fine selection of Patagonia Mountains, Arizona, Japan-law quartz twins. And *Jendon* had some very nice Elbert County, Georgia, amethysts.

Another common mineral in fine form at the show was **calcite** in snow-white groups to 15 cm offered by *Tana and Lois,* Claremont, California. The calcites are from Tsumeb, and show a habit distinctly different from the stair-step variety of years ago.

Benny Fenn, Las Cruces, New Mexico, had a couple of nice Mexican minerals. The **danburite** that has been coming from San Luis Potosi is still coming out. Benny had one with crystals to 5 cm, with a generous sprinkling of pyrite crystals on the clear danburites. From Muzquiz, Mexico, Benny brought complex **fluorite** cubes to 5 cm across that look black but with transmitted light show a strong purple color. Groups to 15 cm and more were offered for sale.

For the gem crystal collector, *The Collector,* Fallbrook, California, had a fine selection of vibrant green chromian **tourmaline** from Burma. Crystals to 4 cm were displayed. They also had fine, 6-mm, red octahedral **spinels** on a white calcite matrix, from Mogok, Burma. The eye-catcher case in their room was *The Collector*'s display of Russian **heliodor**, all sizes to 3 kilograms! These are very gemmy, typically etched, superb crystals. One conversation piece is a large heliodor which had a section split off, probably naturally. This section had later been heat-treated to a delicate blue color and laid back on the original crystal. Great contrast!

Coast to Coast Gems had several very large faceted Oregon **sunstones**, good red color, some showing zoning, in sizes ranging from 12 to 17 carats. They also had a 2.5-carat **benitoite**, a rare size for a rare stone!

Fossil collectors were not left out. *Fossilesource,* Santa Fe, New Mexico, had an exceptional 50-thousand-year-old walrus skull and jaw, perfectly preserved.

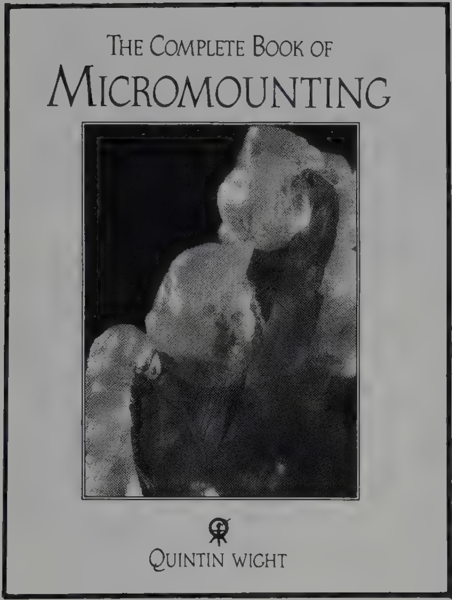
Luiz Menezes (Rua Eng. Agenor Machado, 108, São Paulo 04710 SP Brazil) has some easily overlooked goshenite **beryl** crystals. They are thin tabular, and from 1.5 to 3.5 cm in diameter. Many of the crystals are stacked like poker chips and are accompanied by slender green **elbaite** crystals. Luis had about 35 pieces for sale, very reasonably priced from $1 to $30. The locality was given as Resplendor, Minas Gerais, Brazil.

The well-known California **fluorite** locality, the Felix mine in Azusa, Los Angeles County, is again producing. Older material consists of stepped, bright sea-green octahedra on matrix, while the new material consists of stepped cubes of the same color. *Gochenour's* (phone: 714-832-1214) had numerous loose crystals to 5 cm in diameter as well as matrix pieces for sale. Prices were very reasonable, from $5 to $50.

Todd Schowalter had some very fine turritellas from France. Preparation on these pieces is excellent. And *St. Paul Gems and Minerals,* known for very colorful Condor agates from Argentina, had some great polished slices of Araucaria pine cones from Cerro Cuadraro, Patagonia.

All in all, it was a good show and worthwhile to visit. So put Costa Mesa on your list of 1994 shows!

Book Reviews



The Complete Book of Micromounting

by Quintin Wight. Published (1993) by the Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740. Hardcover with color dust jacket, 283 pages, 21 x 28 cm, 165 color photographs; price: $62 plus $3 shipping (non-U.S. orders add $1).

*This long-awaited book is truly a labor of love. Begun many years ago by "Mr. Micromounter," Neal Yedlin, it was a jumble of manuscript pages, notes, and published micromounting columns from various magazines when Yedlin died in 1977. The torch was then passed on to an equally famous mineral collector and connoisseur, Paul Desautels, founder of the Baltimore Mineral Society and its annual micromount symposium. Desautels worked on the manuscript for several years, adding his own comments and observations. Unknown to him, a book on micromounting was also being prepared by Quintin Wight, a well-known Canadian collector. In 1990, Desautels turned over all his notes and materials to Wight, who finally accomplished the formidable task of turning more than two decades of miscellany into a finished book.

Wight's book is not the first such book on micromounting; several already existed, including a 1965 work by Milton Speckels and several more in German, French, and Italian. But Wight's effort is far more comprehensive, modern, and up-to-date.

This book is not only classy and well produced; it is also well written, accurate, and educational. In a sense it is a distillation of the knowledge, experience, and "folklore" of North American micromounting since the mid-1960's.

Wight has truly done his homework in researching this book. The introduction contains a brief history of microscopic observation of small crystals, starting about two centuries ago. This chapter also traces the origins of micromounting in the United States, beginning with the great collections of Wills, Rakestraw, Bement, Fiss, and Cahn and continuing into the "modern era" and the collections of Boyle, Yedlin, Perloff, Parrish, Hunt, Yost, Desautels, and others.

I have great fondness for this historical material for a variety of reasons. Jack Boyle had been the biggest influence on Lou Perloff's and Yedlin's interest in micromounting. Boyle, a great teacher, had many students at the Brooklyn Children's Museum. His lack of academic credentials led to a fading of support within the museum establishment, a move that eventually broke his heart. Boyle's legacy, however, was revived when, thanks to Yedlin's recommendation, I was hired by the Brooklyn Children's Museum in 1964 to create a new curriculum in geology. There, I found the remains of the once-great mineral collection established at the museum by Boyle, stuffed unceremoniously into a dusty closet! In the late 1960's, I was a regular lecturer at the Baltimore Micromount Symposium, where I got to meet, to know, and to love almost all the "great names" in micromounting who are described in Wight's book.

The chapters on collecting (including a great deal of information on the use of explosives!) and identification are extremely thorough and informative and could be profitably used by anyone interested in field collecting minerals (not just microminerals). But the real heart of this book are the chapters on preparation, mounting, and conservation. A micromounter is *not* just a collector of tiny mineral specimens. The distinction lies in the art of displaying the chosen micromineral in a box that, by accepted convention, is a one-inch cube.

The fun of micromounting is the challenge of trimming a small mineral specimen to the correct size to fit into such a box and then figuring out how to support the specimen within the box in a way that shows off the specimen to its best advantage, while at the same time is also artistic, clever, and unobtrusive.

Two additional chapters, on optics and photography, are virtually unique among gem and mineral books, and their usefulness extends far beyond their specific application to photomicrography. The final sections on micromount symposia and The Micromounters Hall of Fame provide a wonderful means of humanizing this book, by making all aspects of the hobby and its chief protagonists both "real" and accessible.

Wight even provides such elegant finishing touches as appendices that list water-soluble minerals and methods for constructing a micromineral cabinet. A *piece de résistance* is a photo album with 165 high-quality and superbly reproduced micromineral photographs.

The black-and-white photos in *The Complete Book of Micromounting* are well selected and great fun to look at in themselves. Wight has done an amazing job of blending the material assembled by Yedlin and Desautels and merging it with his own observations and ideas in a seamless fashion that does not even hint of multiple authorship.

This book is the definitive English-language work on micromounting and will remain so for the foreseeable future.

Joel E. Arem

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L'Alpe Devero ed i Suoi Minerali

by Claudio Albertini. Published by Crodo, Italy (1991), Centro Studi Piero Ginocchi/Dormelletto: Ediz. Grafica p.g.a., 300 pages (in Italian); price: Italian Lire 49,000, plus 10,000 postage (surface mail). Order from Claudio Albertini, via A. Grandi, 22, I-28026 Omegna (Novara), Italy.

Alpe Devero corresponds to the Italian (southern) side of the same mountains whose richness in minerals renders the Binn Valley world famous. The highest mountain, which dominates both sides, is Cherbadung or Tscherbadung (Pizzo Cervandone in Italian). It has given wonderful specimens for centuries, and even in these last years notable findings have come to light, in contrast to most occurrences of the Alpine region. The mineral specimens from Cherbadung are not only famous for their beauty, but there are several species which are unique in the world, or nearly so, and new minerals are still being discovered. Although many famous occurrences are exclusive of the Swiss side (such as for instance the Lengenbach quarry), even today it is not widely known that many of the most celebrated specimens "from Binntal" have actually come from the Italian side. This has been acknowledged by several authoritative Swiss scientists.

The book here reviewed is the most complete and up-to-date description of the minerals from Alpe Devero, a locality which is also famous for its intrinsic beauty and peace (no cars are admitted). After a brief historic introduction, a detailed description of the various localities is given, including geologic information. The bulk of the book consists of a description of the different mineral species which have been observed in the zone so far. This description is accompanied by a considerable number of crystal drawings and, most of all, by wonderful pictures, which are remarkable also for the quality of their reproduction. The book provides data useful in recognizing the various minerals visually (of course, within the limits of such a procedure).

For its seriousness and the quality of the information, the book can be rightly considered as a masterpiece of its kind, and this especially on considering that the author is not a professional specialist, but just an amateur, who has been driven by his love for nature and culture.

The level of the work, because of its intrinsic value and of the importance of the zone there considered, lies quite above the average for descriptive books concerning local mineralogy; for this reason, the book can be warmly recommended even to those who are not particularly interested in Alpine minerals.

Carlo Gramaccioli

Die Mineralien des Schwarzwaldes und ihre Fundstellen

by Kurt Walenta. Published (1992) by Christian Weise Verlag, Orleansstrasse 69, D-8000 München 80, Germany. Hardcover, 336 pages, 15.7 x 24.5 cm; price: DM 63 postpaid, ISBN 3-921-65624-9.

This book brings up to date the mineralogy of the German Schwarzwald, which includes many of Germany's most famous collecting areas, such as Wolfach and Schauinsland. The mineral data includes work done as recently as the publication year. After an introduction to the geology of the region, the minerals are described in chemical order with a section at the end describing minerals as yet unnamed. Particularly valuable is the 511-entry list of references; there are several lists, one giving species found in the area for the first time during 1991/92 and another listing species by main mining or collecting area. The pictures in the color section at the back of the book are not of the highest quality but, since the price is so reasonable for a large and most useful text, most readers will not be unduly demanding.

Michael O'Donoghue

Die Minerale des Döhlener Beckens

by Klaus Thalheim, Wolfgang Reichel and Thomas Witzke. Published (1991) in Dresden as a "Schriften no. 3 des Staatlichen Museums für Mineralogie und Geologie." Softcover, 131 pages, 17 x 23 cm, no price given; ISBN 3-910006-07-8.

The Döhlener Basin lies to the south of Dresden in the former German Democratic Republic. It has long been famous for calcite and whewellite specimens, which are minutely described in this well-illustrated and informative text covering the geology and mineralogy of most of the mines in the area. Minerals are described in traditional order; there is a useful bibliography and a well-drawn pull-out map at the conclusion of the text, with the individual mines clearly marked. The area has produced coal for much of its productive life, as well as the copper, lead and zinc minerals, many of which are collectible.

M. O'D.

Bergkristall; Stein der Weisen der Wissenschaft

"Rock Crystal; Stone of Teaching and Science"], a collection of essays by various authors. Published (1992) by Christian Weise Verlag, Orleansstr. 69, D-8000 München 80, Germany, as the third issue in the "ExtraLapis" series. Softcover, 21 x 30 cm, 96 pages; price: DM 29.80 excluding shipping; ISBN 3-921656-25-7.

The third in the "ExtraLapis" series deals with the rock crystal variety of quartz. Various authors and photographers collaborate to cover rock crystal from various classic locations including Mount Ida, Arkansas as well as European locations. Left- and right-handedness is discussed as well as form and habit differences. A brief alphabetical country listing with major occurrences concludes an attractively produced book.

M. O'D.

Letters

BROOKITE AND "JURINITE"

The article by Starkey and Robinson on the Prenteg, Wales, brookite deposit (vol. 23, no. 5) contained the following statement: "Haidinger stated in 1825 that the name *jurinite* was given to this species [brookite] by Soret in 1822 and that the original locality was Dauphiné. All record of the original publication (if any) appears to be lost." Here is some further information:

Fréderic Jacob Soret (1795–1865) was born in St. Petersburg in 1795, but he spent his early life in Geneva where his family had its origins. He was a mineralogist (crystallographer) and mathematician, and published a number of papers, in particular on crystallography. He also collected coins. The Soret family had connections to various royal families in Europe, and between 1822 and 1835 Soret was the educator (Erzieher) of the princes of Sachsen-Weimar in Weimar, where he was also an acquaintance of Goethe. Afterwards he returned to Geneva, where he lived from private means. He died in Geneva in 1865. His brother Nicolas's son, Jacques-Louis Soret (born 1827) was a well-known scientist who published numerous papers, in particular on electricity and the atmosphere (ozone) (Poggendorf's *Biographien*; Rillet, 1890; etc.).

In 1821–1822 Fréderic Jacob Soret was apparently engaged in arranging and cataloging the mineral collection of the University of Geneva. This collection had been started in 1818. It contained a large number of specimens from the Alps. Soret was apparently helped in this work by Louis Jurine (1751–1819) a medical doctor in Geneva, who had an interest in geology, and with whom Soret also published a paper ("Sur un phénomène du mirage latéral"; *Bull. Société philomatique de Genève*). It was probably during this cataloging work that Soret first noticed the crystals of the mineral to which he gave the name, "jurinite" (after 1819, to honor his late friend?), and which was later named brookite.

The crystallographic work of Soret is recorded in Franz von Kobell's *Geschichte der Mineralogie* (1864). On page 555, von Kobell also describes the origin of the name, brookite: "Brookite: the mineral was first made known by Soret (1822), the locality was Oisans in Dauphiné," Unfortunately, von Kobell did not give the exact reference! I have been unable to find a copy of von Kobell's earlier work which might contain the reference.

It would certainly seem that Soret had indeed recorded "jurinite" (brookite) from Oisans sometime in the period 1818–1822; that is between the time when the Geneva collection was founded, and the time when Soret left for Weimar. However, the record may have been just an internal report for the University of Geneva, or even just a catalog entry. Alternatively, the reference may have been published by Jurine.

As far as I have been able to ascertain, Soret (and Jurine) published three papers in the period 1818–1822 which might possibly contain a reference to "jurinite" (*Catalogue of Scientific Papers*, The Royal Society, London; Poggendorf's *Biographien*; *The British Library Catalogue of Printed Books*; etc.).

1) SORET, F. J. (1821) Observations sur les rapports qui existent entre les axes de double réfraction et la forme des cristaux. *Mem. Soc. Phys.* I., 1821, p. 33–88.
2) SORET, F. J. (1822) Mémoire sur la Pictite. *Bibl. Univ.*, XIX, 1822, p. 134–147.
3) SORET, F. J. (1822) Rapport sur les minéraux rares on offrant des cristallisations nouvelles, observés dans la Collection du Musée Académique. Genève. *Mem. Soc. Phys.* I., 1822, p. 465–500.

I have read all of these (beginning with the last, the title of which seemed very promising!), but I have not been able to find the required mention of "jurinite." In his paper on "pictite" (titanite), which was read in January, 1822, Soret made the following comments on titanium oxide:

"Dans le genre titane, par exemple, on devroit donner à l'anatase le nom de titane oxidé, mais on a préféré conserver le premier nom, parce qu'il auroit été impossible de distinguer cette espèce du titane oxidé proprement dit, qui en diffère essentiellement quant aux propriétés physiques."

Perhaps a reader near to Geneva could take up the task at the "Section des Sciences de la Terre" of the University of Geneva (13 rue des Maraîchers, CH-1211 Genève 4). I think it very likely that the reference exists, and it would be nice if Soret could have his correct place in the history of mineralogy. The best places to look would be the publications of the "Société philomatique de Genève," and of the "Société de Physique et d'Histoire naturelle de Genève" for the years 1818–1823.

Peter S. Burr
Munich, Germany

BROOKITE STAMP

Regarding the brookite specimen depicted on the Monaco postage stamp (vol. 23, no. 5, p. 446), I ask François Colette, a former field collecting partner of mine in Shaba (now resident in Monaco), to search for more information. He contacted the Secretary of the Postal Administration there. She did not know who the owner of the brookite and anatase specimens might be, but she confirmed the locality stated on the stamps: "Parc National du Mercantour," that is, the Mercantour National Park, specifically the "Vallée de la Tinée, Département des Alpes Maritimes," in the hinterland of Monaco.

Further to Starkey and Robinson's discussion of the cotype localities of brookite in their article on Prenteg (vol. 23, no. 5, p. 391), it should be noted that Dauphiné is the name of a rather large area, not a specific locality. It includes part of the French Alps, a mountain chain spread over nine "Departements" including Isère and Alpes Maritimes. A good source of information on French localities is Eric Asselborn's *Les Minéraux* (Solar Editions, Spain, 1987). He lists three localities for brookite and anatase in different Departements, the most likely cotype locality being Saint-Christophe-en-Oisans, Isère, Dauphiné.

J. Lhoest
Liege, Belgium

BROOKE'S PHOSGENITE

I have recently seen Mr. Burr's article "Notes on the history of phosgenite and matlockite from Matlock, England" and would like to respond to his discussion on page 381 of the provenance of Brooke's specimen of phosgenite.

The specimen which appeared in Brooke's paper of 1837, a crystal from which was figured in Greg and Lettsom (1858), was entered in the register of the Mineralogical Collection as Carbonate 2302 and 2301, a small piece having been broken off. The larger specimen (2302) is extant, though there is so far no sign either of the three crystals of phosgenite which were removed for closer examination or of 2301.

Russell described 2302, with the determination by Hutchinson of the white, bladed mineral as paralaurionite, in 1922/1927. Like Mr. Burr, Russell could not trace Wheal Confidence, though he found a mention of a mine with that name in 1830–1 which gave no locality beyond Cornwall and no indication of what the mine worked, and suggested that it may have been one of the small workings for lead in the cliffs near New Quay. However, Brooke's specimen was so similar to other examples of phosgenite and allied minerals from Cornwall that Russell did not doubt that the attribution was genuine.

BROOKE, H. J. (1837) On Murio-carbonate and Native Muriate of Lead. (London and Edinburgh) *Philosophical Magazine,* Series III, **XI**, 175–176.

BURR, P. S. (1992) Notes on the History of Phosgenite and Matlockite from Matlock, England. *Mineralogical Record,* **23**, 377–386.

GREG, R. P. and LETTSOM, W. G. (1858) (republished in 1977) *Mineralogy of Great Britain and Ireland.*

RUSSELL, A. (Read in 1922, published in 1927) On laurionite and associated minerals from Cornwall. *Mineralogical Magazine,* **XXI**, 221–228 (including Hutchinson, A. on paralaurionite).

Mineralogy and Petrology
Sedgwick Museum
University of Cambridge

[HOME] SWEET HOME MINE

It seems a controversy has arisen concerning the correct name of the [Home] Sweet Home mine (Bill Smith's letter in vol. 24, no. 1, p. 55). Apparently somewhere along the line Leonard Beach's family preferred the name "Home Sweet Home" mine and began using it as what they considered to be the proper name. As owners of the mine, this was their prerogative.

I have enclosed a partial copy of a survey map done by Russell Corn, a professional mining engineer; Corn did the survey of the mine pursuant to a request by Edwin Spray, the mine owner and Leonard Beach's uncle, in order to reopen the mine in search of silver ore. A man named John Soules from Texas, whom I met with in 1976 and 1977, operated the mine for Spray and told me that although some silver ore was found it was still a financial loss. After Edwin Spray died his widow, Ella Spray, gave John Soules 25% ownership of the mine as partial compensation for work that he had done. This survey map was given to me by Leonard Beach. It is clearly entitled: "Geologic Map of the Home Sweet Home mine, Park County, Colorado . . . R. Corn, August 1956."

The few documents in Mrs. Spray's home that I looked at in the 1970's, prior to leasing the mine, referred to it as the "Home Sweet Home" mine. Recently Marvin Rausch at Amherst University gave a talk on the Sweet Home in Tucson. He has in his possession a photograph from 1921, which clearly shows the mine owner at that time standing beside a sign which reads, "Home Sweet Home Mine." This man in the photograph is Edwin Spray.

I received all my information, including the map by Russell Corn, from Leonard Beach who also at the time told me a bit of the history of the mine, including how the "original" name of the mine was the "Home Sweet Home" mine, the name his family had used since acquiring it in the early 1900's, and how it had mistakingly been shortened to "Sweet Home" by various people. When I wrote my article about the Home Sweet Home mine in vol. 10, no. 6 of the *Mineralogical Record* in 1979, I again conferred with Leonard Beach regarding the name I should use. At the time, he was quite adamant that the correct name should be the "Home Sweet Home" mine. Therefore, Bill Smith's assertion that "it was known as the 'Sweet Home' both popularly and correctly through its entire life, except perhaps during the Kosnar-Saul lease [1977]" is incorrect.

Richard A. Kosnar
Golden, Colorado

Bill Smith's letter about the "Sweet Home" mine caught my attention. Here is some additional information.

Kosnar was not the sole nor first user of the "Home Sweet Home" name. Both variants are found in H. B. Patton's (1912) "Geology and ore deposits of the Alma district, Park County, Colorado." *Colorado State Geological Survey Bulletin* **3**.

However, I have located the original patent papers for the mine. The survey (no. 106) was approved September 10, 1873, and patent no. 2043 was granted November 28, 1876. The property is referred to as the "Sweet Home Lode," owned by Samuel B. Morgan and Edward W. Henderson. Two old maps in the Colorado School of Mines Library, and a fraction survey for a mill site also use the "Sweet Home" name. So it is clear that, although both names have long been used, "Sweet Home" has historical precedence.

Roland B. Fischer
Lakewood, Colorado

VALENCE SUPERSCRIPTS

Readers, authors of articles in preparation, and other users of the *Glossary of Mineral Species,* may wish to take note of a decision made by the Commission on Nomenclature of Inorganic Chemistry. Superscripts indicating charge values in mineral formulas are henceforth to be written with the plus or minus symbol *following* the numeral, rather than preceding it as in the *Glossary.* Therefore, a formula such as $Co^{+2}Co_2^{+3}S_4$, should be changed to $Co^{2+}Co_2^{3+}S_4$. The *Mineralogical Record,* and future editions of the *Glossary of Mineral Species,* will comply with this ruling.

Ed.

ERRATA

In the article by Boggs and Menzies on the Sawtooth Batholith (vol. 24, no. 3, p. 185), the names *potassium carpholite* (p. 188) and *kalicarpholite* (p. 199, Table 4) were used. Neither of these are currently valid species names; they should have been indicated as an unnamed "carpholite-like mineral" containing essential potassium and lithium. We regret the oversight. Readers should consult the definitive paper on this species from this locality (Ghose *et al.*, 1989, *American Mineralogist,* **74**, 1084–1090), which describes the material as an unnamed "new member of the carpholite family."

Ed.

ALAIN CARION

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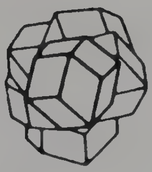

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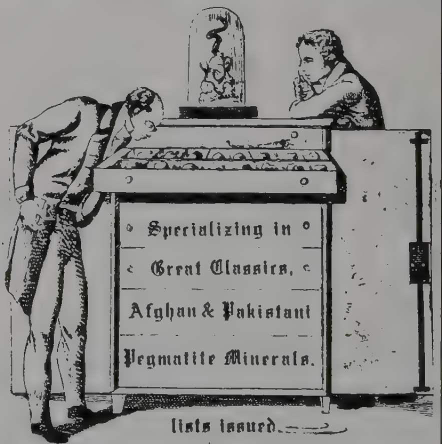

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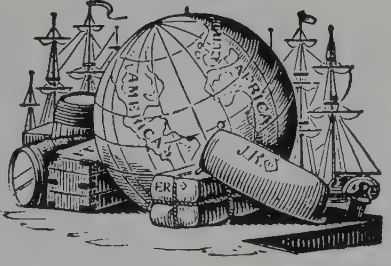

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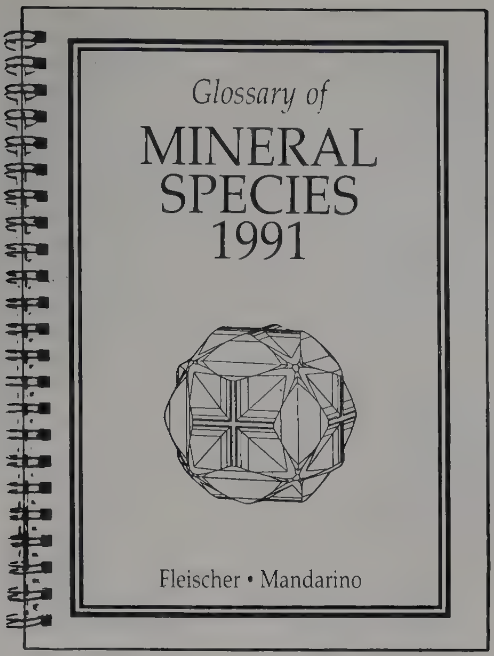

The Second List of Additions and Corrections to the Glossary of Mineral Species, 6th Edition (1991)

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

Since the preparation of the first list of additions and corrections to the Sixth Edition of the *Glossary of Mineral Species 1991,* almost 70 new mineral names have been published and new data have appeared for many minerals. This list covers the period from November 15, 1991 to May 24, 1993. The page numbers listed are those of the Sixth edition. New entries *not* in boldface have not been approved by the IMA Commission on New Minerals and Mineral Names.

We are deeply indebted to many persons for helpful data and suggestions, and especially to Dr. Pete J. Dunn, Smithsonian Institution, Washington, D.C.; Dr. J. L. Jambor, CANMET, Ottawa, Ontario; Mr. A. C. Roberts, Geological Survey of Canada, Ottawa, Ontario; Mr. M. E. Back and Mr. H. Dales, Royal Ontario Museum, Toronto, Ontario; and Mr. J. Ferraiolo, Bowie, Maryland.

Page

1 **Abhurite**, change the formula to $Sn^{2+}_{21}Cl_{16}(OH)_{14}O_6$, add **78**, 235–236 (1993)

4 (to follow **Allanite-(Ce)**), Allanite-(La), $(La,Ce,Ca)_2(Al,Fe^{2+},Fe^{3+})_3(SiO_4)_3(OH)$, mon., *Epidote* group, *Min. Mag.* **55**, 497–508 (1991)

6 Alushtite, a dioctahedral chlorite, **77**, 1619 (1992)

6 **Amarillite**, add **77**, 212 (1992)

7 **Ankangite**, add **76**, 2020 (1991), **77**, 1119 (1992)

9 **Arcanite**, add Taylorite

10 Arizonite, a mixt., should not be in bold face

10 **Armenite**, change hex. to orth., ps. hex., add **77**, 1119 (1992)

11 **Arsenoclasite**, add "isostructural with **Reppiaite**"

11 (to follow **Arsenoflorencite-(Ce)**), Arsenoflorencite-(La), $LaAl_3(AsO_4)_2(OH)_6$, trig., *Crandallite* group

11 (to follow Arsenoflorencite-(La)), Arsenoflorencite-(Nd), $NdAl_3(AsO_4)_2(OH)_6$, trig., *Crandallite* group

13 **Attakolite**, add **77**, 1285–1291 (1992)

15 **Bafertisite**, add "compare **Hejtmanite**"

15 Baiyuneboite-(Ce), should not be in bold face

16 **Bannisterite**, change formula to $KCa(Fe^{2+},Mn^{2+},Zn,Mg)_{20}(Si,Al)_{32}O_{76}(OH)_{16}\cdot 4\text{–}12H_2O$, add **78**, 236 (1993)

19 (to follow **Beidellite**), **Belendorffite**, Cu_7Hg_6, trig., ps. cub., **77**, 1305 (1992)

20 (to follow **Bermanite**), **Bernalite**, $Fe(OH)_3$, orth., ps. cub., dark bottle green

21 **Billingsleyite**, change the formula to Ag_7AsS_6

22 (to follow **Bismutite**), **Bismutocolumbite**, $Bi(Nb,Ta)O_4$, orth., black, isostructural with **Bismutotantalite**

23 **Bogdanovite**, $(Au,Te,Pb)_3(Cu,Fe)$, cub., rose-brown to bronze, possibly isostructural with isoferroplatinum, **64**, 1329 (1979), **76**, 2025–2026 (1991)

23 **Bøgvadite**, change the formula to $Na_2SrBa_2Al_4F_{20}$

24 **Boracite**, after cub., insert "dimorph. with **Trembathite**"; after **Chambersite**, add **Congolite**

24 (to follow **Bornite**), **Boromuscovite**, $KAl_2BSi_3O_{10}(OH,F)_2$, mon., *Mica* group, **76**, 1998–2002 (1991)

25 (to follow **Botryogen**), **Bottinoite**, $Ni[Sb^{5+}(OH)_6]_2\cdot 6H_2O$, trig., light blue-green, **77**, 1301–1304 (1992)
27 (to follow **Buchwaldite**), **Buckhornite**, $AuPb_2BiTe_2S_3$, orth., compare **Nagyagite**, *Can. Min.* **30**, 1039–1047 (1992)
27 **Buddingtonite**, delete "$\cdot 0.5H_2O$" from the formula; add **78**, 204–209 (1993)
28 (to follow **Byelorussite-(Ce)**), **Bystrite**, $Ca(Na,K)_4Si_6Al_6O_{34}(S^{2-})_{1.5}\cdot H_2O$, hex., *Cancrinite* group, **78**, 450 (1993)
30 (to follow **Calzirtite**), **Camerolaite**, $Cu_4^{2+}Al_2(HSbO_4,SO_4)(CO_3)(OH)_{10}\cdot 2H_2O$, mon., blue-green, **77**, 1116 (1992)
30 **Camgasite**, add **76**, 2021 (1991)
31 (to follow **Cancrinite**), **Cancrisilite**, $Na_7Al_5Si_7O_{24}(CO_3)\cdot 3H_2O$, hex., dark to light lilac, *Cancrinite* group
31 (to follow **Cannizzarite**), **Cannonite**, $Bi_2O(OH)_2(SO_4)$, mon., *Min. Mag.* **56**, 603–609 (1992)
31 (to follow **Cannonite**), **Capgarronite**, $HgS\cdot Ag(Cl,Br,I)$, orth., black, **77**, 197–200 (1992), compare **Perroudite**
34 **Cervelleite**, add **75**, 1431 (1990)
35 **Chalcophanite**, change the formula to $(Zn,Fe^{2+},Mn^{2+})Mn_3^{4+}O_7\cdot 3H_2O$
37 **Cheremnykhite**, in the formula, change Te^{+4} to Te^{6+}, add **77**, 446 (1992)
37 **Cherepanovite**, add **71**, 1544 (1986)
38 (to follow **Chlormanganokalite**), **Chlorocalcite**, $KCaCl_2$, orth., *Dana 7th ed.* **II**, 91–92 (1951)
39 (to follow **Chvilevaite**), **Cianciulliite**, $Mn^{2+}(Mg,Mn^{2+})_2Zn_2(OH)_{10}\cdot 2–4H_2O$, dark reddish-brown, **76**, 1708–1710 and 1711–1714 (1991)
41 **Clinomimetite**, add **76**, 2031 (1991)
41 (to follow **Clinosafflorite**), **Clinotobermorite**, $Ca_5Si_6(O,OH)_{18}\cdot 5H_2O$, mon., dimorph. with **Tobermorite**, *Min. Mag.* **56**, 353–356 (1992)
42 **Colusite**, after **Nekrasovite**, add **Stibiocolusite**
43 **Congolite**, add "compare **Trembathite**"
43 **Coombsite**, add **77**, 671 (1992)
43 (to follow Copperas), **Coquandite**, $Sb_6^{3+}O_8(SO_4)\cdot H_2O$, tric., *Min. Mag.* **56**, 599–603 (1992)
44 **Corvusite**, in the formula change O_{26} to O_{20}
46 **Cuprosklodowskite**, replace reference with **66**, 610–625 (1981)
48 **Damaraite**, add **77**, 671 (1992)
49 (to follow **Dellaite**), **Deloryite**, $Cu_4^{2+}(UO_2)(MoO_4)_2(OH)_6$, mon., dark green to black, *Neues Jahrb. Mineral. Monatsh.* **1993**, 58–64 (Eng.)
51 Dinite, add **77**, 674 (1992)
51 (to follow **Dioptase**), **Dissakisite-(Ce)**, $Ca(Ce,La)MgAl_2Si_3O_{12}(OH)$, mon., yellow-brown, *Epidote* group, **76**, 1990–1997
52 Donathite, a mixt. of **Magnetite** and **Chromite**, **77**, 1120–1121 (1992)
54 (to follow **Eclarite**), **Edenharterite**, $PbTlAs_3S_6$, orth., brownish-black, streak red, *Eur. J. Mineral.* **4**, 1265–1270 (1992)
57 (to follow **Erlichmanite**), **Erniggliite**, $Tl_2SnAs_2S_6$, hex.
60 **Fenaksite**, add "compare **Manaksite**"
61 **Ferridravite**, delete the entry
61 (to follow **Ferrikatophorite**), **Ferrilotharmeyerite**, $Ca(Zn,Cu)(Fe^{3+},Zn)(AsO_3OH)_2(OH)_3$, mon., brownish-yellow, compare **Lotharmeyerite**, **77**, 1305–1306 (1992)
61 (to follow **Ferristrunzite**), **Ferrisurite**, $(Pb,Ca)_{2-3}(CO_3)_{1.5-2}(OH,F)_{0.5-1}[(Fe^{3+},Al)_2Si_4O_{10}(OH)_2]\cdot nH_2O$, mon., yellow-green, compare **Surite**, **77**, 1107–1111 (1992)
62 (to follow **Ferritungstite**), **Ferri-winchite**, $CaNaMg_4Fe^{3+}Si_8O_{22}(OH)_2$, mon., *Amphibole* group, **63**, 1023–1052 (1978)
62 **Ferrocarpholite**, change orth. to "orth. or mon.", add **78**, 453–454 (1993)
64 (to follow **Ferrowinchite**), **Ferrowodginite**, $Fe^{2+}Sn^{4+}Ta_2O_8$, mon., dark brown to black, compare **Wodginite**, **Lithiowodginite**, **Titanowodginite**, *Can. Min.* **30**, 633–638
65 Delete the entry for **Fiedlerite**, replace it by
Fiedlerite-*1A*, $Pb_3Cl_4F(OH)\cdot H_2O$, tric.
Fiedlerite-*2M*, $Pb_3Cl_4F(OH)\cdot H_2O$, mon.
66 **Fluorapophyllite**, change tet. to orth., ps. tet., add **77**, 1119 (1992)
66 (to follow **Foggite**), **Fontanite**, $Ca(UO_2)_3(CO_3)_4\cdot 3H_2O$, orth., bright yellow, *Eur. J. Min.* **4**, 1271–1274 (1992)
67 (to follow **Franciscanite**), **Francisite**, $Cu_3^{2+}Bi^{3+}(SeO_3)_2O_2Cl$, orth., bright green, **75**, 1421–1425 (1990)
67 (to follow **Franklinite**), **Franklinphilite**, $(K,Na)_4(Mn^{2+},Zn,Mg,Fe^{3+})_{48}(Si,Al)_{72}(O,OH)_{216}\cdot 6H_2O$, tric., dark brown, isostructural with **Stilpnomelane**, *Min. Rec.* **23**, 465–468 (1992)
69 **Fukuchilite**, after the formula insert "cub."
72 **Geminite**, add **77**, 671 (1992)
73 **Germanite**, change the formula to $Cu_{13}Fe_2Ge_2S_{16}$. After **Nekrasovite**, insert **Stibiocolusite**
76 **Gravegliaite**, add **77**, 672 (1992)
81 (to follow **Heinrichite**), **Hejtmanite**, $Ba(Mn^{2+},Fe^{2+})_2TiO(Si_2O_7)(OH,F)_2$, mon., brownish- to golden-yellow, compare **Bafertisite**, **77**, 1306 (1992)
83 **Hexatestibiopanickelite**, change formula to Ni(Te,Sb), add **76**, 2025–2026 (1991)
83 **Heyrovskite**, change the formula to $(Pb,Ag)_5Bi_3S_8$, add *Can. Min.* **29**, 553–559 (1992)
86 (to follow **Huanghoite-(Ce)**), **Huangite**, $CaAl_6(SO_4)_4(OH)_{12}$, trig., *Alunite* group, **77**, 1275–1284 (1992)
87 (to follow **Hummerite**), **Hunchunite**, Au_2Pb, cub.
89 (to follow **Hydroxyapophyllite**), **Hydroxycancrinite**, $Na_8Al_6Si_6O_{24}(OH)_2\cdot 2H_2O$, hex., light blue to cols., *Cancrinite* group
92 **Iridium**, (Ir,Os,Ru) with Ir dominant, cub., *Can. Min.* **29**, 231–237 (1991)
92 Iridosmine = **Osmium**, *Can. Min.* **29**, 231–237 (1991)
92 Iridosmium, change to " = **Osmium**"
99 **Kamchatkite**, add **77**, 212 (1992)
100 **Kashinite**, add "compare **Bowieite**"
100 Katayamalite = **Baratovite**
100 **Kegelite**, add *Min. Mag.* **55**, 127–134 (1991)
100 Kehoite, a mixt. of several phases, **78**, 238 (1993)
102 **Kharaelakhite**, after the formula, insert "orth.(?)"
103 **Klyuchevskite**, change formula to $K_3Cu_3^{2+}(Fe^{3+},Al)O_2(SO_4)_4$, add **78**, 454 (1993)
105 **Komkovite**, add "brown, **77**, 207–208 (1992), **78**, 454 (1993)"
106 **Krennerite**, change formula to $(Au,Ag)Te_2$
106 **Kukisvumite**, in the formula, change the subscript for O from 20 to 28
107 (to follow Kurgantaite), Kurilite, $Ag_2(Te,Se)$, cub., **77**, 208 (1992)
111 **Lazurite**, after cub., insert "(also mon., tric.)", add **76**, 1734 (1991)
111 (to follow **Leadhillite**), **Leakeite**, $NaNa_2(Mg_2Fe_2^{2+}Li)Si_8O_{22}(F,OH)_2$, mon., deep red, *Amphibole* group, **77**, 1112–1115 (1992)
113 (to follow **Liddicoatite**), **Liebauite**, $Ca_3Cu_5^{2+}Si_9O_{26}$, mon., greenish blue, *Zeit. Krist.* **200**, 115–126 (1991)
115 **Lithiowodginite**, before **Wodginite**, add "**Ferrowodginite**, **Titanowodginite**, and"
115 **Lomonosovite**, add "compare **Polyphite**"

116 **Lotharmeyerite**, after reddish-orange, insert "compare **Ferrilotharmeyerite**"

116 (to follow **Luanheite**), **Luberoite**, Pt_5Se_4, mon., **78**, 450–451 (1993)

120 Magnesiokatophorite, **Magnesioferrikatophorite** should be in bold face

121 (to follow **Magnussonite**), **Mahlmoodite**, $Fe^{2+}Zr(PO_4)_2\cdot 4H_2O$, mon., creamy white, **78**, 437–440 (1993)

122 (to follow **Mammothite**), **Manaksite**, $KNaMn^{2+}Si_4O_{10}$, tric., colorless to cream to light rose, compare **Fenaksite**

123 (to follow Manganophyllite), **Manganosegelerite**, $(Mn^{2+},Ca)(Mn^{2+},Fe^{2+},Mg)Fe^{3+}(PO_4)_2(OH)\cdot 4H_2O$, orth., *Overite* group

123 **Manganotychite**, change pale role to pale rose

125 **Mattheddleite**, after **Chlorellestadite**, insert "**Fluorellestadite**, **Hydroxylellestadite**"

125 **Maxwellite**, add **77**, 449 (1992)

126 (to follow **Mcguinnessite**), Mckelveyite-(Nd), $(Ba,Sr)(Nd,Ce,La)(CO_3)_2\cdot 4\text{–}10H_2O$, tric., yellow-brown, **78**, 237 (1993)

128 change Merrilite to Merrillite

129 (to follow **Metalodevite**), **Metamunirite**, $\beta\text{-}NaV^{5+}O_3$, orth., **77**, 1116–1117 (1992)

131 **Michenerite**, change the formula to PdBiTe

131 **Microsommite**, add "compare **Pitiglianoite**"

132 **Moissanite-**_6H_ and **Moissanite-**_5H_, replace with: **Moissanite** (Carborundum), SiC, including the hexagonal and trigonal polytypes *-5H, -6H, -10R, -15R, -33R*, **61**, 1054 (1976), **77**, 208 (1992)

133 **Molybdenite-**_3R_, change **Molybdenite** to **Molybdenite-**_2H_

134 (to follow Montesite), **Montesommaite**, $(K,Na)_9Al_9Si_{23}O_{64}\cdot 10H_2O$, orth., ps. tet., *Zeolite* group, **75**, 1415–1420 (1990)

136 (to follow **Mpororoite**), **Mrazekite**, $Bi_2Cu^{2+}_3(PO_4)_2O_2(OH)_2\cdot 2H_2O$, mon., blue, **77**, 1306 (1992)

136 **Mummeite**, $Ag_2CuPbBi_6S_{13}$, mon., compare **Pavonite**, **Cupropavonite**

138 **Nagyagite**, add "compare **Buckhornite**"

138 **Nalipoite**, add **77**, 449 (1992)

138 (to follow **Nalipoite**), **Namansilite**, $NaMn^{3+}Si_2O_6$, mon., dark red, *Pyroxene* group

138 **Nambulite**, add **58**, 162 (1973)

140 **Natronambulite**, add **58**, 162 (1973)

140 **Nekrasovite**, after **Germanite**, add **Stibiocolusite**

141 **Neptunite**, add **78**, 237 (1993)

145 **Odinite**, change *Chlorite* group to *Kaolinite-Serpentine* group

145 (to follow **Oldhamite**), **Olekminskite**, $Sr(Sr,Ba)(CO_3)_2$, trig., forms a series with **Paralstonite**, **78**, 451 (1993)

148 Osmiridium = **Iridium**, *Can. Min.* **29**, 231–237 (1991)

148 **Osmium**, (Os,Ir,Ru) with Os dominant, hex., *Can. Min.* **29**, 231–237 (1991)

148 **Ourayite**, change the formula to $Ag_3Pb_4Bi_5S_{13}$ (?)

149 (to follow **Paderaite**), **Padmaite**, PdBiSe, cub., compare **Ullmannite**, *Cobaltite* group, **78**, 451–452 (1993)

150 (to follow **Paradocrasite**), **Parafransoletite**, $Ca_3Be_2(PO_4)_2(PO_3OH)_2\cdot 4H_2O$, tric., dimorph. with **Fransoletite**, **77**, 843–847 (1992)

151 **Paralstonite**, after **Barytocalcite**, add "forms a series with **Olekminskite**"

151 (to follow **Paranatrolite**), **Paranite-(Y)**, $Ca_2Y(AsO_4)(WO_4)_2$, tet., compare **Scheelite**, **78**, 452 (1993)

153 **Pavonite**, after **Mummeite**, insert **Cupropavonite**

154 (to follow **Penzhinite**), **Peprossiite-(Ce)**, $(Ce,La)Al_2B_3O_9$, hex., light yellow, *Eur. J. Min.* **5**, 53–58 (1993)

155 **Perlialite**, add **76**, 1734 (1991)

155 **Perraultite**, change **76**, 307 to **76**, 300, 2023 (1991)

155 **Perroudite**, add "compare **Capgarronite**"

157 **Phosphuranylite**, change the formula to $KCa(H_3O)_3(UO_2)_7(PO_4)_4O_4\cdot 8H_2O$, add **77**, 1119–1120 (1992)

157 **Phurcalite**, change the formula to $Ca_2(UO_2)_3O_2(PO_4)_2\cdot 7H_2O$, add **77**, 213 (1992)

158 (to follow Pitchblende), **Pitaglianoite**, $K_2Na_6Si_6Al_6O_{24}(SO_4)\cdot 2H_2O$, hex., *Cancrinite* group, **76**, 2003–2008 (1991)

158 **Plagioclase**, delete the ☐

158 Platiniridium = platinian **Iridium**, *Can. Min.* **29**, 231–237 (1991)

160 (to follow **Polymignite**), **Polyphite**, $Na_{17}Ca_3Mg(Ti,Mn)_4(Si_2O_7)_2(PO_4)_6O_3F_5$, tric., light brown, compare **Quadruphite**, **Sobolevite**, and **Lomonosovite**

160 (to follow Potassium feldspar), **Potassium-fluor-richterite**, $KNaCaMg_5Si_8O_{22}(F,OH)_2$, mon., *Amphibole* group

160 **Potosiite**, change the formula to $Pb_6Sn^{4+}_2Fe^{2+}Sb^{5+}_2S_{16}$

161 (to follow P-ourayite), **Povondraite**, $NaFe^{3+}_3Fe^{3+}_6(BO_3)_3(Si_6O_{18})(OH,O)_4$, trig., black, *Tourmaline* group, **78**, 433–436 (1993)

161 (to follow Prassoite), Pravdite = **Britholite**

162 **Pseudoboleite**, change the formula to $Pb_{31}Cu^{2+}_{24}Cl_{62}(OH)_{48}$, add **77**, 1308 (1992)

162 **Pumpellyite-(Mg)**, add **77**, 1307–1308 (1992)

164 **Pyrrhotite**, add "7 polytypes"

165 (to follow **Qitianlingite**), **Quadruphite**, $Na_{14}CaMgTi_4(Si_2O_7)_2(PO_4)_4O_4F_2$, tric., light brown, compare **Polyphite**, **Sobolevite**, and **Lomonosovite**

166 **Ramdohrite**, change the formula to $Ag_3Pb_6Sb_{11}S_{24}$, add **76**, 2020 (1991)

168 (to follow **Renierite**), **Reppiaite**, $Mn^{2+}_5(OH)_4(VO_4)_2$, mon., orange-red, isostructural with **Arsenoclasite**, *Zeit. Krist.* **201**, 223–234 (1992) (Eng.)

168 Rezbanyite, a mixt. of **Hammarite**, **Krupkaite**, and **Cosalite**, **77**, 1308–1309 (1992)

168 **Rhodesite**, change the formula to $KHCa_2Si_8O_{19}\cdot 5H_2O$, **77**, 1308 (1992)

169 **Rhodostannite**, change "hex. or tet." to tet., add "compare **Toyohaite**"

169 **Ribbeite**, add **78**, 190–194 (1993)

170 **Rinkite**, change the formula to $(Ca,Ce)_4Na(Na,Ca)_2Ti(Si_2O_7)_2F_2(O,F)_2$, add **77**, 674 (1992)

171 **Roggianite**, change the formula to $Ca_2Be(OH)_2Al_2Si_4O_{13}\cdot 2.5H_2O$, add **77**, 452 (1992)

171 **Rorisite**, change reference to **76**, 1731 (1991)

171 **Roshchinite** should follow **Rosenhahnite** not **Roscherite** as given in the previous list

172 **Rouvilleite**, after mon., add cols. to brown, **76**, 2023 (1991)

172 **Russellite**, change tet. to orth., add **78**, 454 (1993)

172 **Rustenburgite**, add "compare **Atokite**"

173 **Rutheniridosmine**, (Ir,Os,Ru) with Ir dominant, hex., *Can. Min.* **29**, 231–237 (1991)

173 Ruthenosmiridium = **Iridium**, *Can. Min.* **29**, 231–237 (1991)

174 **Sabatierite**, change tet. (?) to orth.

176 Replace **Sapphirine-**_2M_ and **Sapphirine-**_1Tc_ with **Sapphirine**, add polytypes *-1A, -1Tc, -2A, -2M, -4M, -5A*, **75**, 937 (1990)

177 **Scheelite**, add "compare **Paranite-(Y)**"

180 (to follow **Segelerite**), **Segnitite**, $PbFe^{3+}_3H(AsO_4)_2(OH)_6$, trig., greenish- to yellowish-brown, **77**, 656–659 (1992)

183 (to follow **Silver-**_4H_), **Simferite**, $Li(Mg,Fe^{3+},Mn^{3+})_2(PO_4)_2$, orth., red, **78**, 452 (1993)

183 (to follow **Sinoite**), **Sitinakite**, $KNa_2Ti_4Si_2O_{13}(OH)\cdot 2H_2O$,

tet., light brown to pale rose
186 **Spertiniite**, add **78**, 237–238 (1993)
187 **Squawcreekite**, change formula to $Fe^{3+}Sb^{5+}O_4$, add **77**, 449 (1992)
187 (to follow **Srilankite**), **Stalderite**, $(Tl,Cu)(Zn,Fe,Hg)AsS_3$, tet., black
189 (to follow **Stibiocolumbite**), **Stibiocolusite**, $Cu_{13}V_4(Sb,Sn,As)_3S_{16}$, cub., compare **Colusite**, **Germanite**, **Nekrasovite**
189 **Stillwellite-(Ce)**, add **77**, 1308 (1992)
189 **Stilpnomelane**, add "**Franklinphilite**"
190 **Strätlingite**, add **77**, 674–675 (1992)
191 **Strontiopiemontite**, add **76**, 668 (1991)
191 **Strontiowhitlockite**, change formula to $Sr_9Mg(PO_4)_6(PO_3OH)$, add **76**, 2024 (1991)
192 **Surite**, add "compare **Ferrisurite**"
194 **Szymanskiite**, change formula to $Hg^{1+}_{16}(Ni,Mg)_6(CO_3)_{12}(OH)_{12}(H_3O)^{1+}_8\cdot 3H_2O$
195 **Tadzhikite-(Y)**, change name to **Tadzhikite-(Ce)** and change formula to $Ca_3(Ce,Nd,La)_2(Ti,Al,Fe^{3+})B_4Si_4O_{22}$
195 **Takanelite**, in the formula change the subscript for O from 8 to 9
196 (to follow **Taneyamalite**), Tangeite = **Calciovolborthite**
197 **Tengerite-(Y)**, change the formula to $Y_2(CO_3)_3\cdot 2–3H_2O$, add **78**, 425–432 (1993)
197 **Tennantite**, change the formula to $(Cu,Ag,Fe,Zn)_{12}As_4S_{13}$
198 **Testibiopalladite**, PdTe(Sb,Te), cub., *Pyrite* group, compare **Maslovite**, **Michenerite**, **61**, 182 (1976), **77**, 675 (1992)
198 **Tetrahedrite**, change the formula to $(Cu,Fe,Ag,Zn)_{12}Sb_4S_{13}$
200 (to follow **Tincalconite**), Tinnunculite, $C_{10}H_{12}N_6O_8$, *Chem. Abst.*, **114**, 147109 (1991)
201 (to follow **Titanite**), **Titanowodginite**, $Mn^{2+}TiTa_2O_8$, mon., dark brown to black, compare **Ferrowodginite**, **Lithiowodginite**, and **Wodginite**, *Can. Min.* **30**, 633–638 (1992)
201 **Tobermorite**, change the formula to $Ca_5Si_6(O,OH)_{18}\cdot 5H_2O$
201 **Tochilinite**, change tric. to mon. or tric., add **71**, 1201–1209 (1986)
202 (to follow **Tongbaite**), **Tooeleite**, $Fe^{3+}_8(AsO_4)_6(OH)_6\cdot 5H_2O$, orth., cadmium-orange, **77**, 1306–1307 (1992)
202 (to follow **Tosudite**), **Tounkite**, $(Na,Ca,K)_8(Si_6Al_6O_{24})(SO_4)_2Cl\cdot H_2O$, hex., green to yellowish-green
202 (to follow Tourmaline), **Toyohaite**, $Ag_2FeSn_3S_8$, tet., compare **Rhodostannite**, **77**, 1117 (1992)
203 (to follow **Trechmannite**), **Trembathite**, $(Mg,Fe^{2+})_3B_7O_{13}Cl$, trig., dimorph. with **Boracite**, compare **Congolite**, **78**, 233 (1993)
203 **Trimounsite-(Y)**, add **76**, 2024 (1991)
205 **Tuliokite**, change color to light or dark gray, add **77**, 209 (1992)
205 **Tuperssuatsiaite**, change the formula to $Na_2Fe^{3+}_3Si_8O_{20}(OH)_2\cdot 4H_2O$, add **77**, 1308 (1992)
206 **Tvalchrelidzeite**, change tric. to mon.
206 (to follow **Tvalchrelidzeite**), **Tvedalite**, $(Ca,Mn^{2+})_4Be_3Si_6O_{17}(OH)_4\cdot 3H_2O$, orth., **77**, 438–443 (1992)
206 **Twinnite**, change orth. to tric., ps. orth.
206 **Tychite**, add **Manganotychite**
207 **Ullmannite**, change tric. ps. cub. to cub., add *Can. Min.* **24**, 27–33 (1986)
209 **Urvantsevite**, change hex. to tet., add **76**, 2025–2026 (1991)
211 **Vermiculite**, change the formula to $(Mg,Fe^{2+},Al)_3(Si,Al)_4O_{10}(OH)_2\cdot 4H_2O$
214 (to follow **Volynskite**), **Vonbezingite**, $Ca_6Cu^{2+}_3(SO_4)_3(OH)_{12}\cdot 2H_2O$, mon., deep azure blue, **77**, 1292–1300 (1992)
214 (to follow **Vyacheslavite**), **Vyalsovite**, $FeS\cdot Ca(OH)_2\cdot Al(OH)_3$, orth., **77**, 201–206 (1992)
215 (to follow Wad), **Wadalite**, $(Ca,Mg)_6(Al,Fe^{3+})_5Si_2O_{16}Cl_3$, cub., black to dark gray, *Acta Cryst.* **C49**, 205–207 (1993)
215 (to follow **Walstromite**), **Walthierite**, $BaAl_6(SO_4)_4(OH)_{12}$, trig., *Alunite* group, **77**, 1275–1284 (1992)
216 **Wattersite**, add **77**, 672 (1992)
216 **Weinebenite**, add *Eur. J. Mineral.* **4**, 1275–1283 (1992)
219 **Wodginite**, change the formula to $Mn^{2+}(Sn^{4+},Ta)Ta_2O_8$, after compare, add "**Ferrowodginite**, **Lithiowodginite**, and **Titanowodginite**"
220 **Wurtzite**, after polytypes, insert *-2H, -4H, -6H, -8H, -15R, -18R, -21R*
221 (to follow **Xilingolite**), **Ximengite**, $BiPO_4$, trig., *Min. Abst.* **41**, 472 (1990)
224 **Zenzenite**, add **76**, 2024–2025 (1991)
226 (to follow **Zircon**), **Zirconolite**, $CaZrTi_2O_7$, orth., mon., trig. and metamict, polytypes *-3O, -3T, -2M*, black to brown, **68**, 262 (1983)
226 **Znucalite**, in the formula change $(OH)_{12}$ to $(OH)_{22}$

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228 *Alluaudite* Group, change general formula to $NaACD_2(XO_4)_3$, A = Ca, Mg, Pb; C = Ca, Fe^{2+}; D = Mn^{2+}, Fe^{2+}, Fe^{3+}, Mg; X = P, As
228 *Alunite* Group, add **Huangite** and **Walthierite**
229 *Amphibole* Group, add **Ferri-winchite**, **Leakeite**, and **Potassium-fluor-richterite**
232 *Cancrinite* Group, add **Bystrite**, **Cancrisilite**, **Hydroxycancrinite**, and **Pitaglianoite**
232 *Chlorite* Group, delete **Odinite**
233 *Cobaltite* Group, change to B = As, Sb, Bi; add **Padmaite**
233 *Crandallite* Group, add Arsenoflorencite-(La) and Arsenoflorencite-(Nd)
234 *Epidote* Group, add Allanite-(La) and **Dissakisite-(Ce)**
237 *Kaolinite-Serpentine* Group, add **Odinite**
239 *Melonite* Group, change **Berndtite-C6** to **Berndtite-***2T*, add **Berndtite-***4H*
240 *Mica* Group, add **Boromuscovite**, delete Montdorite
241 *Overite* Group, add **Manganosegelerite**
243 *Pyroxene* group, add **Namansilite**
247 *Tourmaline* group, delete **Ferridravite**, add **Povondraite**
248 *Zeolite* Group, add **Montesommaite**

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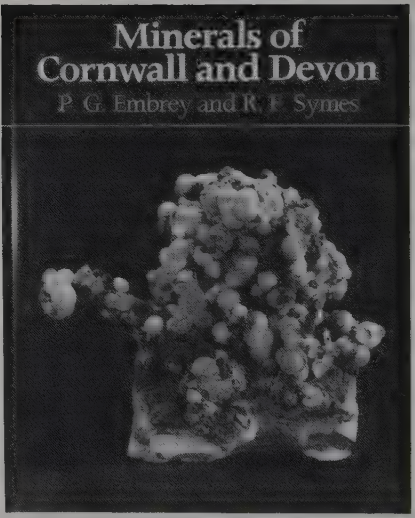
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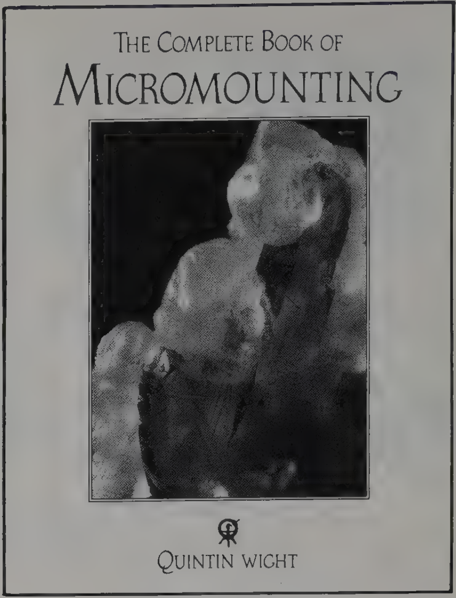

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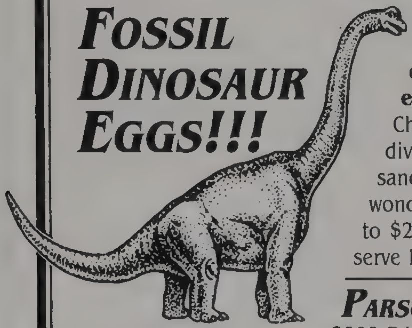

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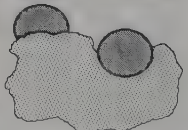

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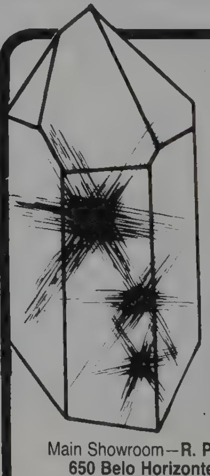

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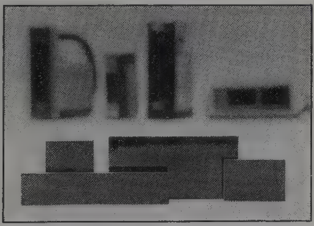

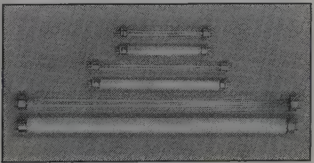

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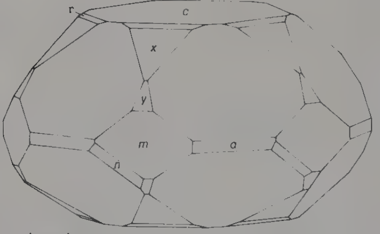

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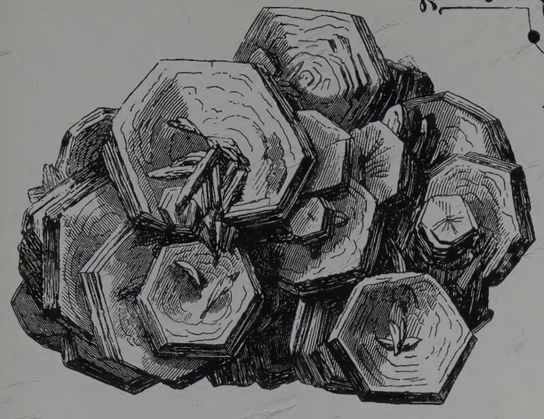

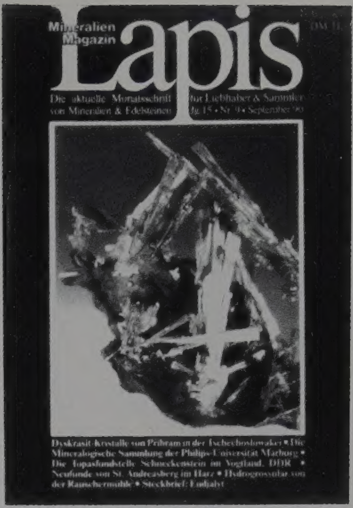

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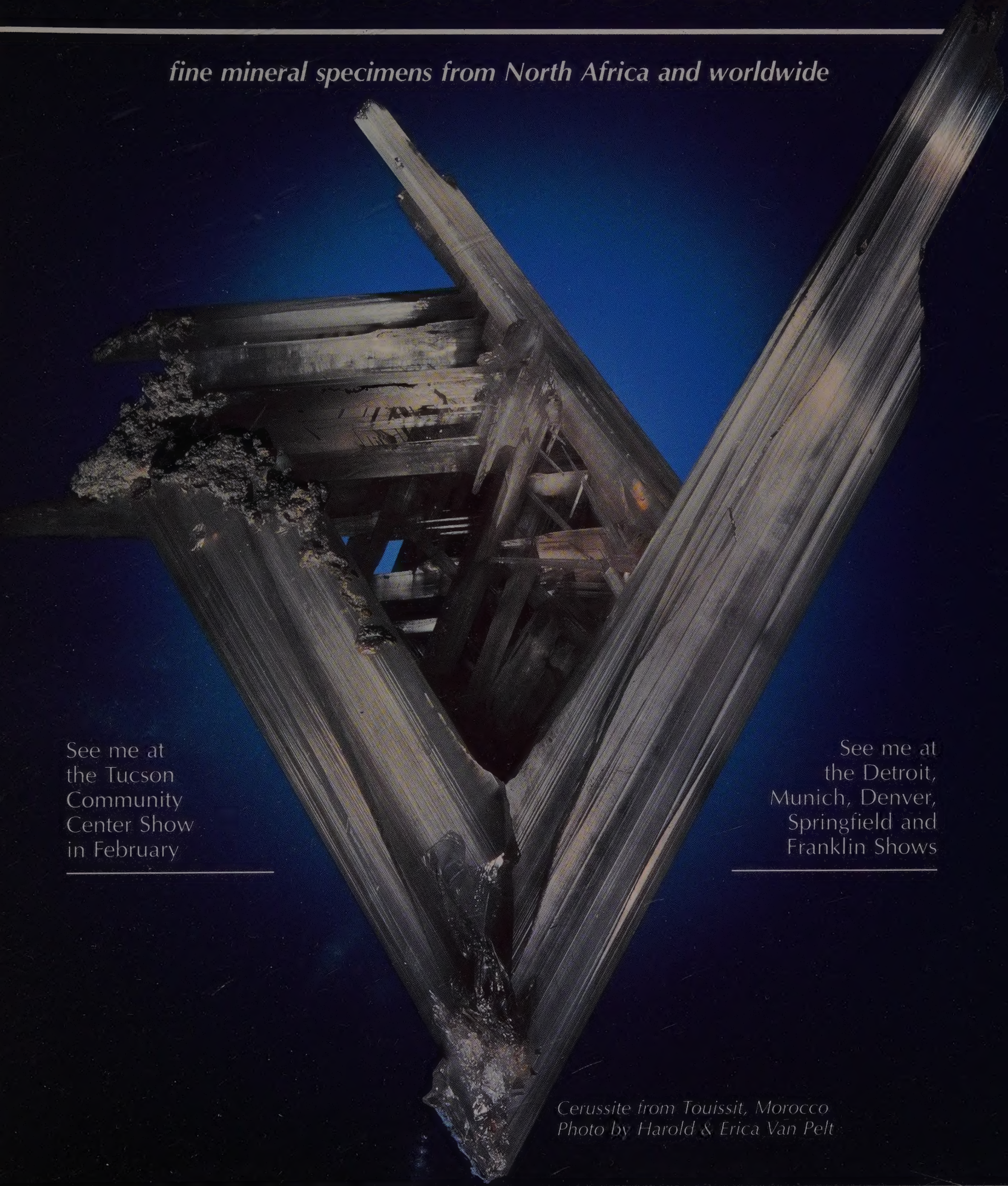

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