Northwest
Micro Mineral
Study Group

MICRO PROBE

Spring, 2019 VOLUME XII, Number 9

SPRING MEETING . . . . . .CAMAS, WASHINGTON

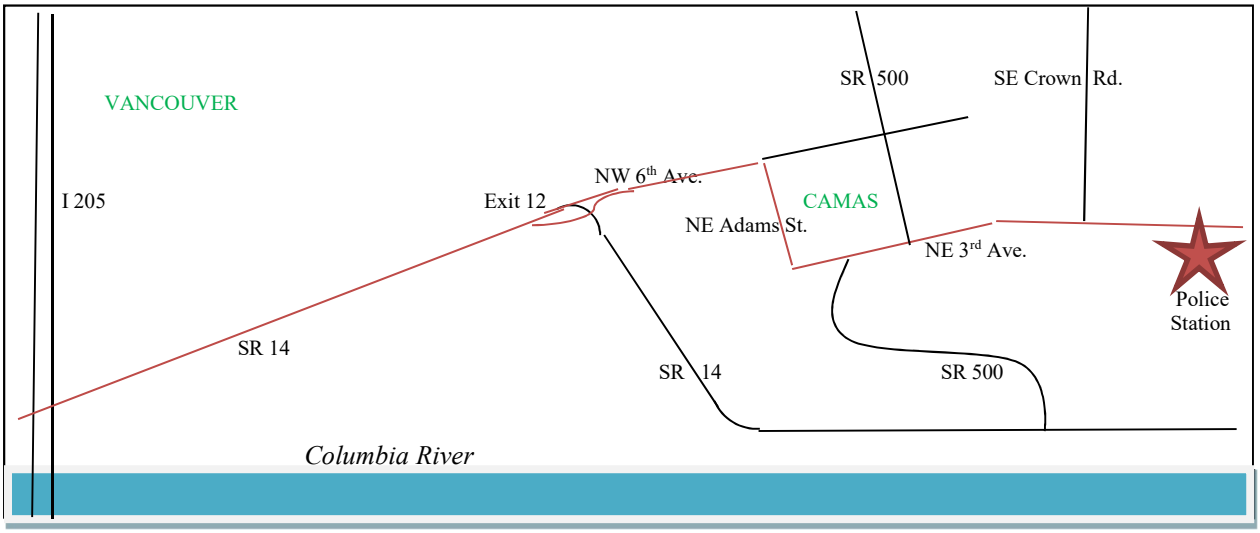
May 11, 2019 9:30 am to 4:30 pm

Camas Police Station
2100 NE 3rd Avenue
Camas, Washington

This time the Fire Station is in use for training purposes, so we have been referred to the Police Station in downtown Camas. To get there, continue about 2 miles farther east on SR14 to the next exit (12) and follow down 6th Avenue. The main traffic flow jogs down Adams Street to 3rd Avenue and on through town. If you goof and go down the hill on the bypass, a left turn at SR500 will get you back up to 3rd Avenue. Continue through downtown and out about a mile, on past the light at Crown Road. The Police Station is on the south side of the street and there is plenty of parking in front of the building.

Bring microscopes and things for the give-away tables as usual. We will have the Club provide sandwich makings (bread, meat, lettuce, cheese, dressings, and coffee, tea, cocoa) for our lunch potluck: Please bring salads, chips, pop, nuts, chili, cookies, pie, or cake to add to the lunch.

After lunch, we will again try to have a picture-sharing time**.** Do bring the pictures you have to add to the presentation. We would love to see them. We will have the computer-projector set up.



What is a mineral?

Steve Ullrich

That's a good question…and the attempted answer to that question is full of unexpected twists and turns. A number of the oddities are caused because it is a bureaucracy that determines what a mineral is. The International Mineralogical Association (IMA) has a Commission on New Minerals and Mineral Names (CNMMN) which assumes responsibility for officially determining what a mineral is and what it is not. (1)

Alas, but the IMA was really needed when it was formed in 1959. It was a Wild Wild West in the mineral world before there were rules governing what should be recognized as a mineral. Fleischer (1961) estimated that, of the 583 minerals proposed between 1940 and 1959, 46% were of doubtful validity. The development of a process laying out what information needs to be known about a specimen before it can be accepted as a new mineral was a step in the right direction. It would be beyond the scope of this article to detail the need for all of the rules and tests required for acceptance – thermogravimetric behavior, birefringence, or calculated density, for example, will not be mentioned. This essay can only scratch the surface of the complicated subject of mineral acceptance. The present list of rules was developed over the years, and presumably will evolve further as the need arises. Mineralogists from 29 countries assist the IMA in making its decisions. So scholars with a variety of different kinds of expertise and international points of view are available to help make the best collective decisions possible. (2)

The first demand ordinarily asked is that the specimen be "solid". (3) However, liquid elemental mercury (Hg) is accepted as a mineral. It can be found as droplets associated with cinnabar on specimens from volcanic rocks or hot springs. So why is mercury accepted? It was "grandfathered" in, since it was received as a part of the mineral kingdom before IMA's founding in 1959. The IMA has a tendency not to question the validity of these grandfathers. Whether some of these decisions of hallowed pre-1959 antiquity are similar to accepting the existence of dragons and unicorns because our ancestors believed in them has to be asked from time to time. Since mercury can form naturally, it can be accepted as a mineral.

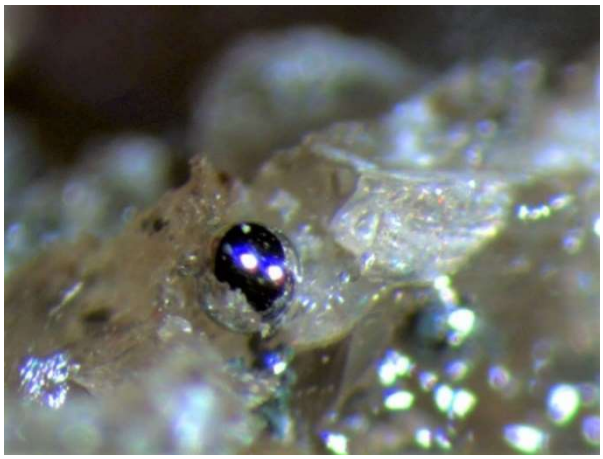


Fig. 1 *Droplet of Native Mercury on Calomel*
Red Bird Mine, Churchill Co. Nevada

Another counterintuitive selection is the most common mineral of them all: ice. It's hard to keep a piece in your collection at home, because it has the unfortunate habit of melting at room temperature. Although water and ice are contained in a single heading in Dana, 7th edition (4), suggesting that they are a single mineral, only ice now has IMA approval. Perhaps one liquid mineral was enough.

Another usual demand is that the specimen be "inorganic". (5) Let's be clear about what this word means as it's used here. The word can be taken to mean that the specimen is not produced entirely by biological processes, or it can be taken to mean that the specimen does not contain any of the majority of compounds of carbon which the chemist classifies as organic. It is the first of these definitions that the IMA has in mind. There are many minerals acknowledged to contain these carbon compounds. (6) Among these are the mineral urea ($CO[NH_2]_2$), containing a major component found in the urine of mammals and fish (7); uricite (2,6,8-trihydroxypurine) and tinnunculite (2,6,8-trihydroxypurine

Fig. 2 *Carpathite Crystals of the compound Coronene derived from petroleum sources by geologic processes. Pichaco Mine, San Benito Co., California*

Fig. 3 *Weddellite* $Ca[COO]_2 \cdot 2H_2O$ *Fulton Canyon Quarry, Biggs, Oregon*

Fig. 4 *Melanophlogite, silica with a tetragonal crystal structure requiring a small amount of an organic compound to provide stability. Agoura Hills, Los Angeles Co., California*

dihydrate), containing uric acid, a compound excreted from birds and most reptiles (8); and the mineral guanine (2-aminohypoxanthine), made of an important component of the DNA and RNA that make heredity possible. (9)

Two other minerals containing organic radicals are whewellite and weddellite, which contain calcium oxalate ($Ca[COO]_2$), better known to most people as the main component of kidney stones. At a local occurrence near Biggs, OR (10), there are jasper nodules containing these oxalates. Some Biggs nodules have also been found containing fish scales and bones, which are thought to be the source for the organic material that ultimately became the two organic minerals. Geologic processes changed these organic ingredients into minerals; the whewellite and weddellite today did not arise by biological processes alone.

Unique in the world is the set of minerals found at Pabellon de Pica in Chile (11). Here Guanay cormorants dropped their poop on chalcopyrite-containing gabbro which generated copper-containing crystals, many of them deep blue. The bird's organic guano was necessary to supply a portion of each of these minerals: the isocyanurato ion (johanneumite), the triazolate ion (triazolite, chanabayaite), and the ammine group (ammineite, triazolite, chanabayaite, shilovite, johanneumite,).

It's helpful to have a sample of a mineral-to-be that's crystalline. X-rays can be aimed at a mineral crystal to reveal the pattern created by the atoms of which the crystal is made. (12) Each kind of crystal is unique, so each pattern created by the x-rays on that kind of crystal is unique as well. X-ray diffraction, as the process is called, can therefore be used to show that the sample is not a mixture of several components.

As powerful a method as x-ray diffraction may be, there are some crystals that do not respond well to being x-rayed. There are other specimens that are amorphous, and therefore must be subjected to a battery of tests that will help to confirm that the specimen is not a mixture. This helps to explain why so

many different kinds of analysis are now required with a modern IMA application (13); in the bad old days, many of the "minerals" that were trumpeted as new turned out to be mixtures of already known minerals.

Radioactivity can damage crystal structure. (14) Suppose we have a radioactive element X that is part of a crystal lattice at the time that lattice first forms. When X undergoes radioactive decay to Z, not only does Z have a different set of chemical bonding properties than X did, but the radiation released in the decay may well be enough to break other bonds in the crystal lattice. Radioactivity can therefore ruin x-ray studies of crystals. Here again, the full set of tests gives evidence that may allow for the acceptance of a radioactive mineral.

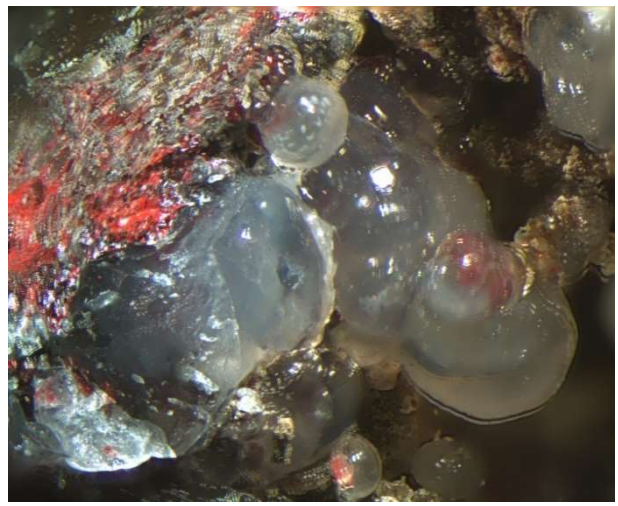


Fig. 5 *Opal and Cinnabar*
Opal, hydrated silica, is more like a glass than a crystalline material.
Red Bird Mine, Churchill Co., Nevada

From time to time people have wondered about the legitimacy of minerals from outer space. Examination of materials that have fallen onto the earth in meteorites (15), materials that have been collected on the moon (16), and spectroscopic evidence obtained from heavenly bodies show that outer space is formed from the same elements we have here on earth. (17) Meteorites contain minerals also found on the earth, such as plagioclase feldspars, pyroxenes, olivine, amphiboles, magnetite and serpentine. (18) Meteorites also contain unique minerals not found on earth like troilite (FeS), schreibersite ($[Fe,Ni,Co]_3P$) and cohenite ($[Ni, Fe,Co]_3C$). Likewise, the astronauts who visited the moon brought back minerals like tranquillityite ($[Fe^{+2},Ca]_8[Zr,Y]_2Ti_3[SiO_4]_3O_{12}$) collected from the moon's Sea of Tranquillity, armalcolite ($[Mg,Fe^{+2}]Ti_2O_5$), named after the three astronauts who visited the moon Neil ARMstrong, Buzz ALdrin, and Michael COLlins, and pyroxferroite, ($[Fe^{+2}, Mn^{+2},Ca]SiO_3$). When first discovered, these three minerals seemed unique to the moon, but later they were found on earth as well. Minerals like tholins, compounds containing carbon, hydrogen and nitrogen, are found on the outer solar system's gas giants and have a strong reddish color. Further exploration of the planets and their moons can only reveal more strange and wonderful minerals.

Fig. 6 *Holfertite, and Hematite*
Though clearly crystalline, the mineral holtfertite, $(H_2O)_3Ca_{0.25}(UO_2)_{1.75}TiO_4$, is so metamict due to radiation damage that it gives poor x-ray diffraction
Thomas Range, Juab Co., Utah

A great concern of the IMA is the rejection of "minerals" that were not produced by natural processes but were made by humans. (19) Crystals that were grown in a laboratory under carefully controlled conditions would be one example. A beautiful crystal of dyed ammonium nitrate, flawless and golden yellow, labeled "blastite" and also, in smaller print, "lab produced" was offered for sale. Ammonium nitrate ($[NH_4\}\ [NO_3]$) is an infamous explosive, which explains the name it was given. The

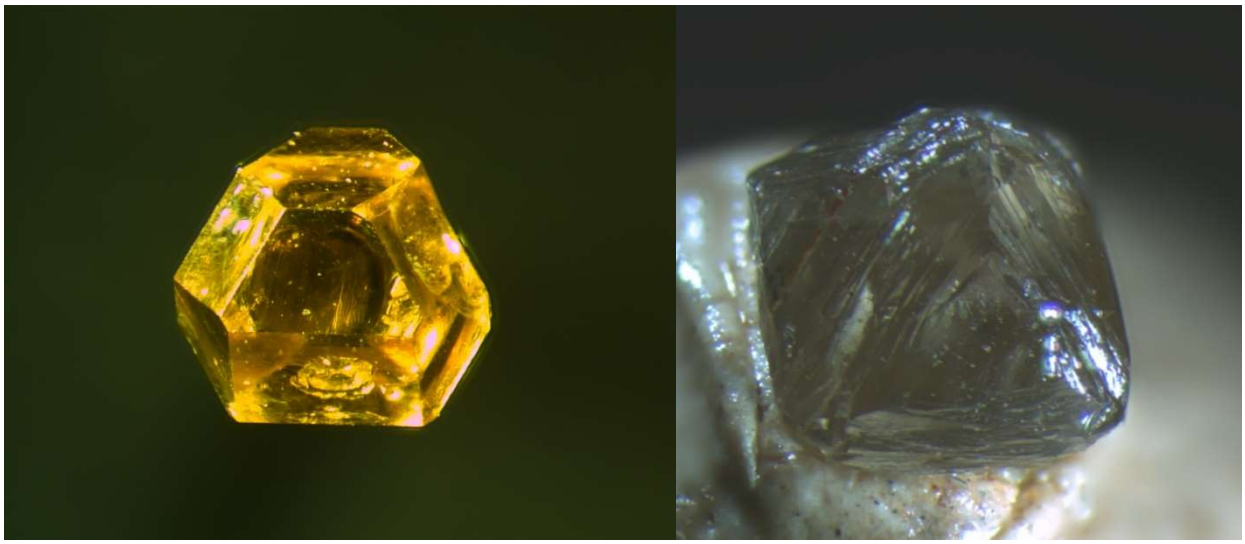


Fig. 7 *Diamond* *Manufactured in Switzerland* *Natural from Kimberley, South Africa*

mineral name for ammonium nitrate is "ammonia-niter"; no example of its occurrence in nature has yet been found. Undyed ammonium nitrate would be colorless and not nearly as pretty.

Then there is schutteite ($Hg_3[SO_4]O_2$), which can be either man-made or the result of natural processes. Natural processes will form this material through the reaction of small amounts of water with cinnabar in the presence of sunlight, and man-made processes will form it by the action of sulfuric acid with metallic mercury in chimneys and retorts. So the IMA would identify the first of these two possibilities as "mineral" and the second as "non-mineral".

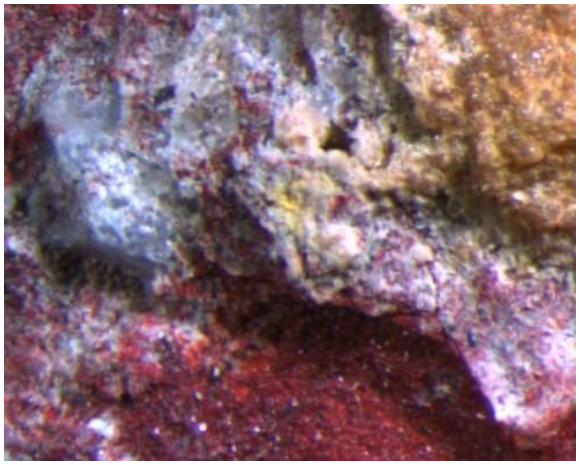


Fig. 8 *Schuetteite (yellow patch) on Cinnabar*
From an ore pile near
Battle Mountain, Lander Co. Nevada

A number of minerals might conceivably arise from the human occupation of mining, from ore dumps, slag weathering, mine fires, or mine water. (20) The IMA does not like to accept minerals from slag remaining from old mining operations, but it did accept thorikosite (Pb_3Cl_2 [OH] [SbO_3, AsO_3]) in 1984. (21) Thorikosite is found only in classic Greek and Roman mining areas, forming because of the action of sea water on old lead containing slag. Perhaps the factor of intentionality (22) has come into play with the decision about thorikosite. Surely the last thing in the world the ancient Greek and Roman miners had in mind for their slag heaps was to create new minerals in them. The IMA will sometimes allow authorization as a mineral if those responsible for the formation of a new material did not intend to create a new mineral. Possibly this was the guiding principle behind the IMA's decree about thorikosite.

The mineral calclacite (Ca Cl [CH_3COO]. $5H_2O$) is a strange grandfather of a mineral. It was declared a mineral in 1945, before the IMA existed, and was therefore grandfathered in. The name arises because it is made of CALcium, ChLoride and ACetate. It is a "mineral" that forms only on calcium-containing rocks, fossils and even pieces of pottery that are kept in oak museum cases, which furnish the acetate! Calclacite has never been found in nature, but it is a mineral anyway – in spite of IMA rules to the contrary! Have we found a dragon or a unicorn here?

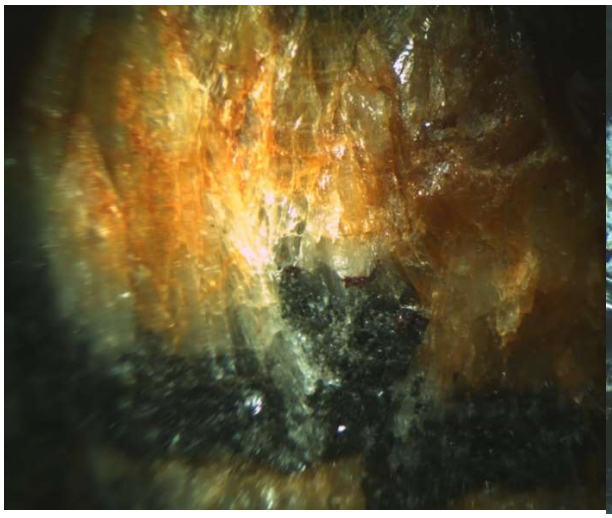


Fig. 9 *Jordisite in Stilbite*
Jordisite is the amorphous phase of MoS_2
Nisbitt Mine, Lake Hariett, Oregon

Fig. 10 *Ilsemannite and halotrichite on Jordisite*
(See the following article for an explanation.)
found growing in my basement (DGH)

The calclacite example points out an IMA safeguard for the integrity of a new mineral sample, a safeguard not yet mentioned: the sample must be conserved in a recognized location that will provide a safer home for the new mineral (23) than an oak museum case. If any questions arise about the sample, the mineral community needs to remain assured that the conserved sample will be in the same condition it was in when it was installed in its new home.

Since the present author is not privy to the deliberations of the IMA, the decisions made in individual cases may not seem to be understandable to him. What surely has to be clear is that there are no easy answers to the question, "**What is a mineral?**".

Fig. 11 *Mellite* $Al_2C_6[COO]_6$
Csordakuti Lignite Deposit, Fejer, Hungary

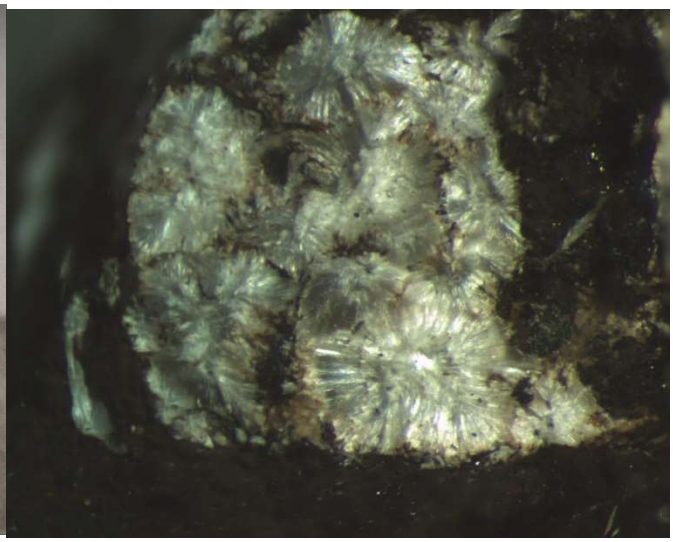


Fig. 12 *Kochsandorite* $CaAl_2[CO_3]_2[OH]_4 \cdot n[H_2O]$
Many Coal Deposit, Fejer, Hungary

Two examples of organic acids interacting with masses of bauxite.

Footnotes and References:

To save the need for a lot of pesky footnotes, assume that every time you come to a mineral name, the footnote you should envision is: MINDAT, "mineral name", s.v.

The other footnotes for this article are given explicitly.

*The excellent *The Definition of a Mineral* by Ernest H. Nickel from The Canadian Mineralogist Vol. 33, pp.689-690 (1995) formed the template for this article.*

(1 The Commission on New Minerals and Mineral Names (CNMMN) of the International Mineralogical Association (IMA) http://euromin.w3sites.net/Nouveau_site/mineralogiste/IMA/IMAe.htm, p.1
(2) The Commission..., op. cit., pp. 1,2
(3) The Commission ... op.cit., p.2
*(4) Palache, Charles, Berman, Harry, Frondel, Clifford, *Dana's System of Mineralogy*, 7th edition, vol.I (New York: John Wiley and Sons, 1944), p. 494*
(5) The Commission…op. cit., p.2
*(6) Stefan WeiB *Mineral Register for Collectors*, IX. Organic Compounds (Munich: Christian Weise Verlag GmbH, 2015) of the Lapis, *The Complete Mineral Index for Collectors**
*(7) Knut Schmidt-Nielsen, *Animal Physiology* (Englewood Cliffs, New Jersey: Prentice-Hall,1960) p.59*
(8) Schmidt-Nielsen, op. cit., p.59
*(9) Lubert Stryer, *Biochemistry*, 4th edition, (New York: Freeman, 1995) pp.76,96*
(10) MINDAT Biggs, Sherman Co., Oregon, USA
(11) MINDAT Pabellon de Pica ,Chanabaya, Iquique Province, Tarapaca, Chile
(12) Nickel, op. cit., p.689
(13) Nickel, op.cit., p.689
(14) Nickel, op.cit., p.689
*(15) Paul Henderson, *Inorganic Geochemistry* (Oxford: Pergamon Press, 1982) Chapter 1: Meteorites, pp.3-22*
(16) Paul Henderson, op. cit., Chapter 3, The Moon pp.42-58
(17) Paul Henderson, op. cit., Chapter 2, 'Cosmic' Abundances and Nucleosynthesis, pp.23-41
*(18) O. Richard Norton, *Rocks From Space*, 2nd edition, (Missoula : Mountain Press, 1998), p. 177*
(19) Nickel. op. cit., p.690
(20) Carnegie Institution for Science; Explore Our Science " Catalog of 208 Human Caused Minerals Bolsters the Argument for 'Anthropocene' Epoch"
(21) The Mineralogical Society Handbook, thorikosite.pdf
(22) Nickel, op. cit., p.690
(23) The Commission… op. cit., pp. 1,4

Photo Credits:

Fig. 2 Doug Merson
Fig. 3 Saul Krotki
All other figures: Donald Howard

Basement Minerals

Don Howard

I learned early on that some mineral specimens can be bad news in a collection. While I was still in college, I went out and collected some laumontite from a pillow basalt location on Nicasio Creek, Marin Co., California. The little clusters of crystals were white and shiny and very pretty. I put them in my mineral case and when I looked at them a week or so later they were nothing but white powder. It thoroughly dampened my enthusiasm for zeolites for a number of years, until I had come to Oregon and run across other zeolites in the Wallowas that were far more stable.

But at least the laumontite was not about to ruin my mineral case. I was less lucky with a different collecting experience. As a teen-ager I had gone on a field trip with the East Bay Mineral Society to the Manhattan Mine in Napa Co., California. The mine tunnels were in a very dark gray rock that had beautiful wheels of marcasite along with spots of bright red cinnabar and little silvery spheres of native mercury. I came back with several very pretty hand-sized specimens that I put into the wooden drawers of my mineral collection case. Nothing happened right away, but I noticed some years later that the pieces were beginning to fall apart. When I tried to clean up the fragments, I discovered that the wood underneath had blackened. I was not very pleased to have the drawer bottoms being eaten up by those pieces. The whole batch got relegated to a plastic tray in the basement.

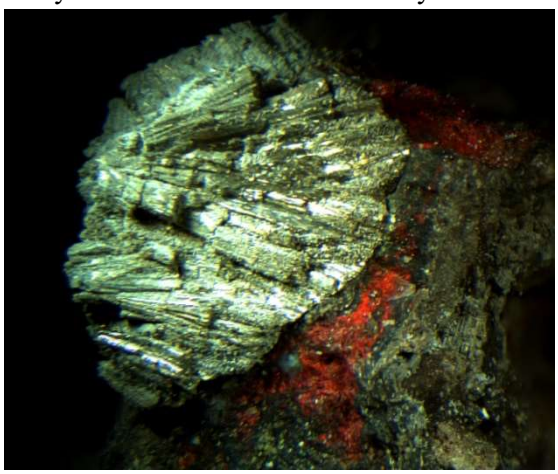


Fig. 1 *Marcasite and cinnabar*
Manhattan Mine, Napa Co., Calif.
This piece at least has proven to be stable.

So that is how I learned that marcasite is another mineral that does not keep well. Some pyrite, especially if it is finely divided in the matrix, will do the same thing as the marcasite. It seems that in both crystal forms, iron disulfide is a rather easily oxidized material. The sulfur is rather oddly bonded chemically, receiving one electron ionically from the ferrous iron and sharing the second covalently with a neighboring sulfur. The result of this is that the sulfur can be slowly oxidized to form sulfuric acid in the presence of moisture. And sulfuric acid is not kind to wooden shelves!

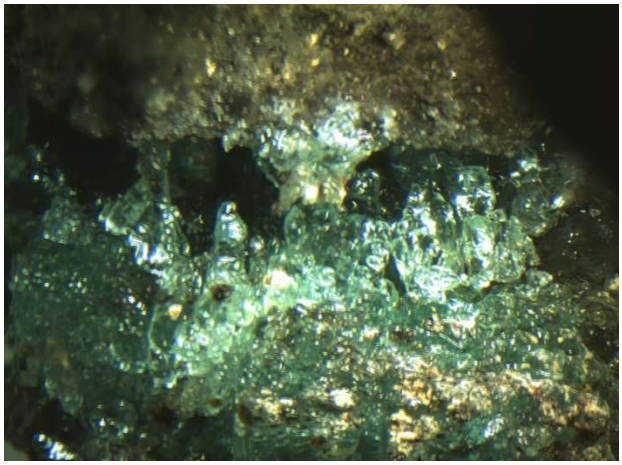


Fig 2 *Melanterite* *10mm FS*
Manhattan Mine, Napa Co., Calif.
Material from the mine floor

Now I should have realized this. The floor of the Manhattan Mine had a thick deposit along the walls of melanterite, which is ferrous sulfate, $Fe\ SO_4 \cdot 7\ H_2O$. The sulfuric acid formed digested the ferrous iron

from the marcasite to form melanterite. Hydrated sulfates like this can dehydrate rather easily, but over 60 years later the green crystals, kept in a closed tube, are still pretty much as they have always been.

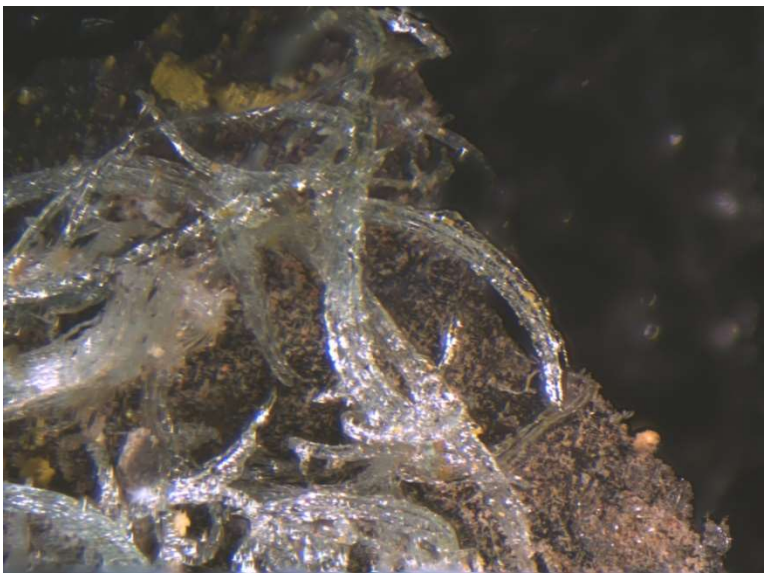


Fig. 3 *4mm FS*
Melanterite growing on the debris of material originally from the Manhattan Mine stowed away in my basement.

But that finally brings me to the story that I wanted to tell. Those fragments in the plastic tray sat in my basement for several years, and they too grew melanterite all over the surface. This material, as shown in Fig. 3, is of the "ram's horn" variety as seen in some gypsum, and often the form of chalcanthite that grows on the walls of copper mines. It is rather pretty under the microscope. It is also quite fragile. However, I have mounted up the piece seen in the micrograph and have decided to keep it in my collection. Is it a valid mineral? I am not sure I care. I know the story that goes with it. Now you do too. It is much too sensitive to vibrations to take the piece to a meeting, but at least I have the micrograph to show.

Other minerals can form in the same way. If there are aluminum compounds that can be easily digested by the sulfuric acid, then the needles may be halotrichite instead, ferrous aluminum sulfate, $Fe\ Al_2\ (SO_4)_4 \cdot 22\ H_2O$. Halotrichite forms as fine white hairlike needles all over specimens, both in the field and in the collection cabinet. I have pieces from the Morning Star and Leviathan Mines in Alpine Co., California which originally had nice little micro crystals of baryte and enargite that have been covered with a growth of fuzzy halotrichite. The resulting specimens are not attractive, and washing them off only provides more moisture to hasten the deterioration process.

Closer to home, the calcite vein at the Kiggins Mine in Clackamas Co., Oregon has patches where finely divided bits of iron and molybdenum disulfides make black bands and spots. Both the jordisite and the pyrite oxidize easily to form sulfuric acid. There is also plenty of aluminum present in the form of zeolites. Squirrelled away in my basement, those pieces grow little tufts of halotrichite. The molybdenum released makes ilsemannite which colors the fuzz a dark blue. In the field, of course, the perpetual rains in Oregon dissolve both ilsemannite and halotrichite, so they are rarely seen on freshly collected material. At least the calcite base to the vein material is not susceptible to being broken down and caused to crumble by the acid generated, so the basic specimens are still intact. (See Fig. 9 & 10 in the preceding article.)

So I guess the moral of this story is, if you have specimens that persist in growing fuzz that ruins the appearance of the original mineral, try stowing it in a quiet, damp corner of your basement. You may come out with some new species.

Filiform Pyrite
Starvation Creek State Park

Don Howard

Most people are familiar with the fine filiform pyrite crystals, with their right-angle bends, that have come from the cliffs along the Clackamas River. What you may not be so familiar with are the filiform pyrite crystals that have come from the boulders at the wayside at Starvation Creek.

Starvation Creek State Park is a wayside and trailhead along the Columbia River Highway (I-84) about half way between Cascade Locks and Hood River. At exit 55, it is only accessible to east-bound traffic. The site consists of a few dozen parking places and restroom facilities. The south bank of the Columbia River is a rather narrow strip backed to the south with very high, steep basalt cliffs that in the past dropped considerable material onto scree piles. Since it is a State Park, picking up rocks is frowned upon, and indeed, most of the scree is now gone. Only small fragments of material with little to no cavities remain. But collecting was possible before park designation, so there are boxes and buckets of the material that was easily picked up from the rock pile in former times. One such bucket found its way into my basement a couple of decades ago, and I admit I have been ignoring it for a long time. The pieces were rather large, and I was concerned that the process of breaking them down would ruin whatever was in them. Not so, I learned when I took to breaking one piece and looking at what was inside.

The filiform pyrite from Starvation Creek has a reputation for being very fine and very long, often over an inch long while being much finer than a human hair. I discovered that this reputation has been earned by uncoated crystals, which are very flexible and therefore able to withstand the breaking of the matrix. There are coated crystals as well, and these are much more brittle and therefore very fragile. Both types are shown in the micrograph below. As is also evident, both types possess right angle bends.

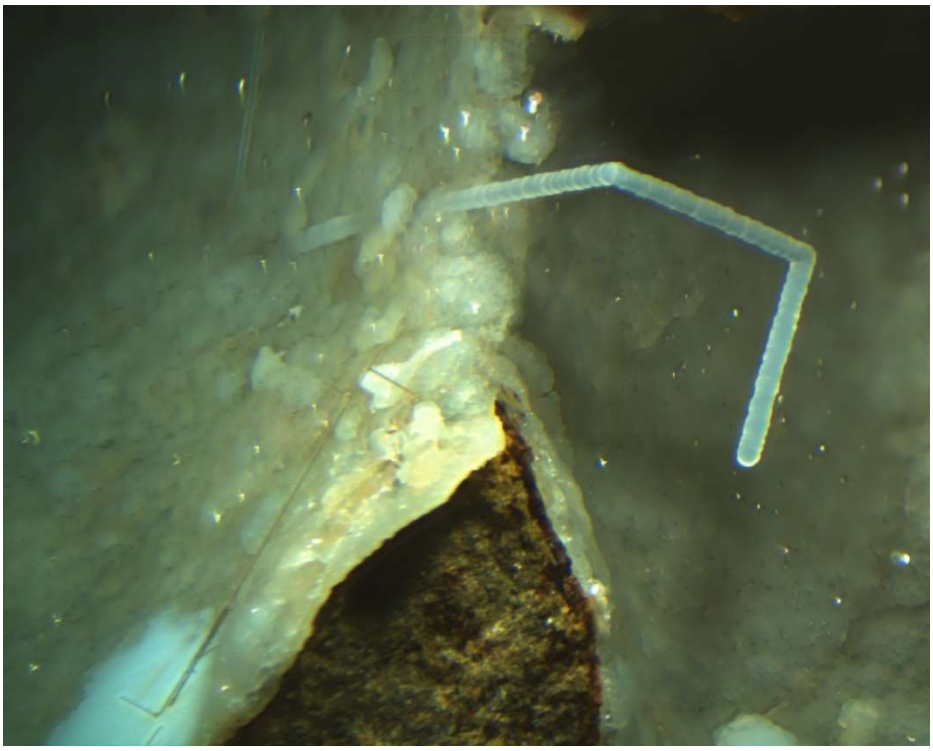


Fig. 1 *Pyrite and heulandite* *Starvation Creek, Hood River Co., Oregon*

Examination of this material suggests the following paragenesis: The original basalt was very full of holes up to an inch or more in size. These were originally coated with a layer of dark clay. Filliform pyrites grew on this clay layer, complete with right angle bends. At some point, solutions rich in zeolite saturated the system, coating clay and filiforms with a thin layer of heulandite that was still much thicker than the filiforms themselves. Following this, filiform pyrite again grew on the zeolite base. The coated filiform in Fig. 1 is very prominent; the uncoated filiform in the lower left quadrant is much harder to see, but it also possesses several right-angle bends.

Unfortunately, the brittle nature of the coated filiform caused it to shatter during the process of photography, but one section was salvaged and is shown in Fig. 2. The micrograph is 2mm full scale. That makes the heulandite cylinder amount 0.3mm in diameter. The filiform running through the center is, in contrast, only about 20 μm in diameter. That is probably typical of both generations of filiforms at this location.

Fig. 2 *The filiform coated in heulandite in fig. 1 Scale is 2mm.*

In looking through the other cavities present on the piece, I ran across one that really brought me up short. The filiform was way down in the bottom of the vug very near the wall, and it was not easy to photograph, but I did manage the picture shown in Fig. 3. Again, the scale is only about 2mm. The cavity is lined with drusy heulandite on which small equant crystal of pyrite are scattered. The small crystals are formed of cubes with the corners strongly modified by octahedral bevels on the corners. The filiform was located close enough the drusy lining to ***pass through*** the equant crystal!

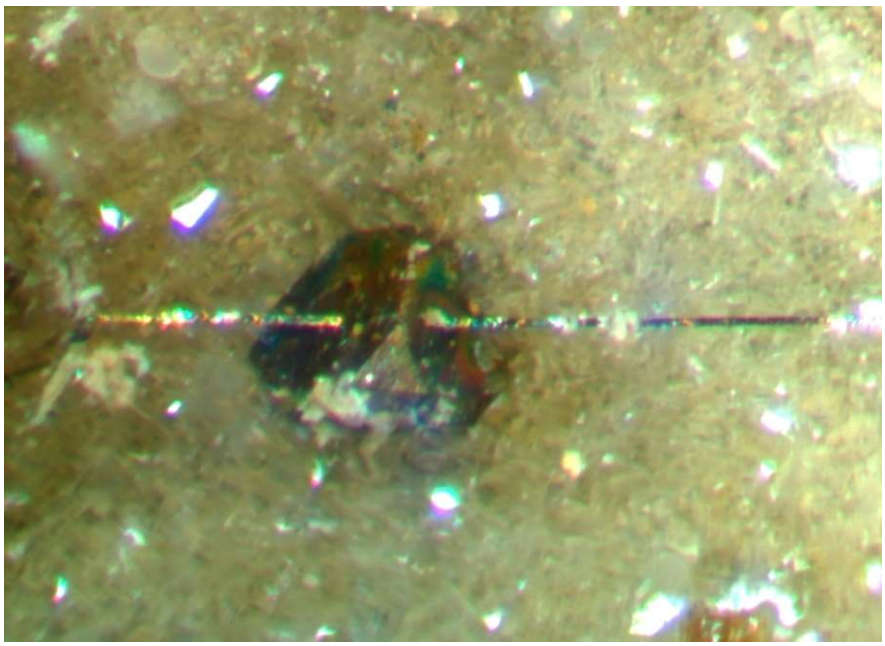


Fig. 3 *An equant pyrite crystal growing around a filiform pyrite*
Starvation Creek, Hood River Co., Oregon

Now the first thing to realize is that both crystals have the same composition: pyrite. The second thing is that the filiform cannot have pierced the equant crystal, so that it must have existed before the equant crystal grew around it. The question therefore becomes: how could that possibly happen?

I believe that the answer to this question lies in understanding the dynamics of crystal growth. Normally, there are atoms of iron and sulfur diffusing around on the surface of a crystal. These attach most easily to places where there are steps, so that the steps grow out, leaving behind flat planes. The formation of a cluster on one of those planes generally takes a higher surface density than the process of growing out the step and is therefore the limiting process governing how fast the crystal will grow. The exceptions to this limit are two: the presence of a catalyst to aid formation, and the existence of screw dislocations to provide steps that grow like a spiral staircase and therefore never 'grow out'.

Filiform growth is governed by the presence of a catalyst particle on the tip of the needle. Growth therefore proceeds without the generation of dislocations. The sides of the filiform are dislocation-free, and therefore the growth rate is greatly curtailed if the surface concentration of new material is not high. The filiform accumulates new material on the end where the catalyst particle is located but only very slowly on the sides, and therefore becomes long and slender.

The equant crystals growing on the heulandite lining, on the other hand, are created around points that provide a source of screw dislocations, which then allow them to accumulate material at a somewhat lower surface concentration. The equant crystal can therefore grow up and around the filiform, adding material at a concentration that does not allow the filiform to grow laterally. That is what I believe has happened in this case.

Each new location provides specimens that illustrate different new aspects of the world of minerals, and understanding them can give us fresh insights into the mechanisms of crystal formation

and growth. It is a joy to discover something that you have never seen before, and puzzling out what new message it has to shed light on the details of the fascinating mineral world.

Heulandite and pyrite are the primary minerals present at Starvation Creek. I have observed minor amounts of celandonite, calcite, levyne and apophyllite in a few of the cavities. It is unfortunate that the site is currently off limits for collecting. Perhaps others of you have some squirreled away from previous collecting time; if so, I think it is well worth going back through it to see if it has more surprises to show us.

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