MASCOT MUSINGS

By Bob Janules

In Gorham, New Hampshire there is an old lead mine named the Mascot Mine that recently has gotten a lot of attention from micromounters. In addition to lead mineralization in the form of galena; copper, zinc, and iron minerals are present and abundant as primary phases (chalcopyrite, sphalerite, and pyrite). When these metal sulfides oxidize from weathering, an impressive suite of secondary minerals can form. This is the case here.

The Mascot mine satisfies three criteria for making it an important locality for micromounters. First, a large number of minerals can be found there in attractive microcrystals. Secondly, they often present challenges in identification. (If identification were easy, we would never learn much about minerals.) And finally, the Mascot suite of minerals raises interesting questions about how minerals form.

Included among the mineral species identified from the Mascot mine are uncommon to rare minerals such as schulenbergite, posnjakite, serpierite and ramsbeckite. With this assemblage the locality takes on a European flavor. These minerals are rare in the United States but occur at several localities in Europe, a number of these being slag localities. The best example is at Laurium, Greece where ancient miners threw processed ore slags into the ocean. When these boulders wash up on the beaches they often feature microcrystals of exotic secondary minerals. Mineralogists have long disagreed as to whether these can actually be called minerals. In the definition of a mineral is the phrase "naturally occurring". There is nothing natural about processing metal ores and throwing them into the ocean, a foreign environment. The hand of man clearly is involved. At the Mascot mine the situation may not be that extreme; however, much of the mineralization is post-mining in origin, occurring on the surface of dump rocks that were placed in a pile by man and allowed to weather. There is also the question of whether the pond contributed to mineral formation. The most productive dump at the locality is at the edge of Mascot Pond. Perhaps it was at that spot that the miners cobbed the ore. At its deepest spot the dump is more than five feet deep. Water is hit at the bottom, yet, the dump rocks are wet by capillary attraction two to three feet above this. Maybe constant moisture helped solutions supersaturate with metal ions for at this deepest part of the dump, solution driven surface mineralization is widespread.

As a contributor to Van King's upcoming book "The Mineralogy of New Hampshire" I will at some point in time have to wrestle with the post- mining question. In the introduction to Van's "The Mineralogy of Maine" it is clear that he doesn't feel that minerals formed on the dumps reflect the geological and chemical processes of the state and are not suitable for inclusion in the book. For example, if the mined Mascot material were moved to the edge of a pond in Vermont, we would be talking about schulenbergite from Vermont. In the case of the Mascot minerals some may have formed both in place within the ore vein and also as a post-mining druse. It will be difficult to sort this out.

A bizarre twist occurred regarding the mineral acanthite, a silver sulfide that forms as flat bristles upon wire silver on some Mascot specimens. Scott Whittemore approached

me one day and he said "I think my acanthites are growing." He looked in all directions before stating this to make sure no one else heard such crazy talk. Later I checked my own acanthite specimen and found the crystals to be about three times larger than before. I also found acanthites starting to grow on silver wires that previously showed no acanthite. Post mining is one thing, but post-collecting mineralization brings this thorny problem to a level of absurdity.

THE MASCOT MINERALS

There are two types of rock in the Mascot dumps that are productive for the finding of secondary minerals. The first rock type is a mix of massive sulfide ore minerals cemented together by quartz, the second is siderite. Siderite is abundant upon the Mascot dumps and some of it features cavities lined with siderite rhombs. Within these cavities other minerals can be found. It is this author's opinion that the minerals within the siderite vugs are not post-mining in origin. The Mascot minerals identified to date are :

Acanthite – Ag2S -Acanthite forms splendent black flat bladed crystals that resemble feathers or leaves. This mineral forms exclusively on or near wire silver within the siderite vugs.

Anglesite – PbSO4 - Anglesite at the Mascot typically occurs as lustrous colorless short or elongated prismatic crystals with a rhombic cross-section. Equant anglesite crystals of complex crystal morphology have been found less frequently. Typically, anglesite is found within rusty patches in the mixed sulfide assemblage. It also has been observed within the siderite vugs growing upon chalcopyrite crystals. Mascot anglesite crystals are usually quite small, less than .5mm in length.

Aragonite (?) – CaCO3 - Chalky-white tapering prismatic crystals to .5cm growing in jack-straw fashion upon the surface of dump rocks are believed to be aragonite. These effervesce strongly in acid confirming the mineral is a carbonate.

Arsenopyrite – FeAsS - Arsenopyrite crystals are rare at the Mascot. They have been found as diamond-shaped striated crystals to 1mm within the mixed sulfides. It is possible that massive arsenopyrite occurs more commonly, as it may be difficult to distinguish it from massive pyrite.

Aurichalcite (?) – (Zn,Cu)5(CO3)2(OH)6 - An acicular mineral that forms as tufts of needles and as fibrous mats is believed to be aurichalcite. An SEM EDS trace does show copper with some zinc. The color of the mineral is a robin's egg blue to a pastel blue-green or green. It is uncommon at the Mascot.

Brochantite – CuSO4(OH)6 - Brochantite is moderately abundant, usually as a druse of minute crystals often associated with chalcopyrite- bearing ore. Previous versions of this article described blocky and diamond- shaped medium to emerald green crystals from this locality as brochantite. EDS analysis revealed this mineral to be ramsbeckite. EDS analysis

did find brochantite as well, but no characteristic crystal forms emerged from this study. Crystal shapes of confirmed brochantite from single specimens include: elongated tapering prisms, single and clustered bladed crystals and barrel-shaped crystals. Perhaps the most common crystal habit of Mascot brochantite is of single crystals with the edges of the crystal faces rounded, giving the appearance of "blebs".

Cerussite – $PbCO_3$ - Cerussite displays a number of habits at the Mascot. Opaque white thin prismatic crystals are sometimes found, usually associated with malachite. Cerussite can also be in the form of very thin tabular plates. Bladed cerussite is perhaps the most common habit at this locality especially within the siderite vugs where it often is found associated with chalcopyrite. The cerussite is white to yellow in color usually with a characteristic oily luster. Twinning is common. Very clear lustrous prismatic cerussite is sometimes noted within the siderite matrix. These crystals,at quick glance, can resemble quartz crystals. Mascot cerussite crystals are usually less than 1mm in size.

Chalcopyrite – $CuFeS_2$ - Primary chalcopyrite is common and is usually associated with other sulfides in massive form. Within the siderite vugs, however, sharp sphenoidal crystals of secondary chalcopyrite to .5cm are commonly found. These crystals are sometimes a clean brassy color, but usually they are tarnished or coated. Associated minerals include silver, cerussite and rarely anglesite. This author is not aware of a better locality in New Hampshire to find chalcopyrite crystals.

Chamosite / Ortho-chamosite- $(Fe,Mg,Al)_6(Si,Al)_4O_{10}(OH,O)_8$ - SEM EDS analysis of a mineral that forms olive-green botryoidal crystals shows it is an iron-rich member of the chlorite group of minerals. The individual botryoidal crystals are under .5mm across, but they sometimes form into dense mats that line seams in fine-grained siderite.

Cuprite – Cu_3O - Cuprite crystals usually are found within rusty patches of the mixed sulfide assemblage. The cuprite is a deep ruby red in color with the most common crystal habit being the octahedron. The crystals are usually very tiny, perhaps .1mm in size. A few larger ones have been found, but even these are smaller than .5mm. Chalcopyrite is the most common associated mineral. Cuprite has not been found to date within the siderite cavities.

Galena – PbS - Galena is common as embedded crystals, veins and stringers. Free growing crystals are rare at this locality.

Goethite – a-FeO(OH) - Goethite is a common alteration product formed by the weathering of the Mascot vein material. It is found as earthy or velvety brown patches in pieces rich with primary sulfides. Goethite has also been noted as shiny black or ochre-yellow crusts with a smooth outer surface.

Gypsum- $CaSO_4.2H_2O$ - Colorless gypsum crystals to 2mm were found on one occasion growing on a dump boulder. The gypsum crystals were clearly post-mining in origin.

Hydrozincite (?) – $Zn_5(CO_3)_2(OH)_6$ - A mineral that forms as a white chalky crust is believed to be hydrozincite largely because it is fluorescent. It hasn't been otherwise tested.

Linarite- $CuPbSO_4(OH)_2$ - Gorgeous microcrystals of linarite have been found at the Mascot where it forms as distinct tabular or bladed crystals, either as individuals or as groups of subparallel plates resembling an open book. Stout crystals are a deep azure blue, while extremely thin blades are a pale blue. The crystals are transparent, but become an opaque blue-gray when weathered. Although crystals average only .5mm across, their sharpness and vivid color make them one of the most sought after Mascot mineral species. Linarite is relatively common, occurring on the surface of dump material and also within the sulfide and quartz matrix. It has not been found in the siderite vugs.

Malachite – $Cu_2CO_3(OH)_2$ - Malachite is common as green botryoidal crystals and crusts that have an earthy surface appearance. Acicular malachite has not been identified from this locality. Malachite will effervesce in acid, a property that will help distinguish it from brochantite and ramsbeckite.

Metazeunerite –$Cu(UO_2)_2(AsO_4)_2.8H_2O$ Metazeunerite is known from a single find where it forms tiny clusters of yellow-green tetragonal plates on sphalerite. It is, thus far, the only secondary mineral at this locality containing arsenic. The source of uranium likely came from the granite country rock that hosted the Mascot vein.

Posnjakite – $Cu_4SO_4(OH)_6.H_2O$ - Posnjakite crystals at the Mascot are a distinct aqua blue, a different shade of blue than linarite. The crystals (about 1mm. or smaller) tend to be rounded without sharp crystal angles. Often they appear as stubby pseudo-hexagonal barrels. Rarely elongated crystals are encountered. Posnjakite is moderately common and is often associated with schulenbergite. The "barrel-shaped" crystals were confirmed to be posnjakite by x-ray analysis. It is possible that Mascot specimens with crystals of the same distinct color as the posnjakite but that display a different habit than the pseudo-hexagonal barrels may, in fact, be other species. Other copper sulfates like langite and wroewolfeite are possible here, but they have not been confirmed.

Pyrite – FeS_2 - Pyrite is common in the mixed sulfide assemblage in massive form and also as inter-grown cubic crystals. It also is found within seams of a very fine- grained siderite matrix. Here other crystal forms are noted besides the cube including octahedrons, pyritohedrons, and elongated crystals.

Quartz- SiO_2 - Quartz is common in massive form. Some plates of crystals have been found, but usually the crystals (to 3cm) are rather dull in luster. In contrast, clear and lustrous microcrystals of quartz are commonly found within the siderite vugs.

Ramsbeckite – $(Cu,Zn)_{15}(SO_4)_4(OH)_{22}. 6H_2O$ - It was once thought that all green microcrystals from Mascot that don't fizz in acid were brochantite. EDS analysis confirmed the presence of brochantite at this locality, but ramsbeckite was found as well.

The ramsbeckite forms as blocky crystals resembling cubes, as well as flat crystals with a diamond shape. The color is a medium to emerald green with a vitreous luster.

Rosasite (?) – (Cu,Zn)2CO3(OH)2 - A mineral that forms as blue to blue-green botryoidal crystals with a very smooth outer surface was thought to be smithsonite. Analysis showed it to be a carbonate of both copper and zinc. The appearance of the botryoids resembles rosasite. It is uncommon at this locality. Rounded smooth spheroids of a deep green color may be this mineral as well.

Schulenbergite- (Cu,Zn)7(SO4,CO3)2(OH)10 Schulenbergite forms on the surface of the dump rocks as a flaky crust that is a lively sky blue color with a pearly luster. Individual crystal aggregates are composed of curved foliated sheets that overlap into crude hemispheres and rosettes. Posnjakite and linarite are often associated.

Serpierite- Ca(Cu,Zn)4(SO4)2(OH)6.3H2O Serpierite is rather uncommon, forming as crusts upon the dump material. The crusts are made up of individual flat needles of a light to medium blue color. This mineral can easily be mistaken for blue Mascot aurichalcite. If large enough individual blades are present, an examination of the terminations will distinguish the minerals. Aurichalcite with its' orthorhombic symmetry features "picket fence" terminal ends, while the serpierite shows the oblique angle characteristic of monoclinic minerals. Aurichalcite will fizz when exposed to acid, while serpierite will not.

Siderite – FeCO3 - Siderite is an abundant gangue mineral and is present in large blocks within the Mascot dumps. When fresh it is tan in color, but when weathered it is brown. Some siderite chunks contain cavities lined with euhedral rhombs of siderite to 2cm in maximum dimension. Quartz, silver, chalcopyrite, sphalerite, cerussite, chamosite and anglesite have all been found within these siderite vugs

Silver – Ag - Silver occurs as thin to stout wires to several mm in length. The silver wires are often branched and coiled into intricate nests. Some specimens have been found where the wires are uncoated with a metallic luster. More often, however, they are tarnished or have a rusty brown growth on the surface. Gold and copper colored wires are likely tarnished silver specimens. The matrix in which the silver is found is that of vuggy siderite with abundant chalcopyrite.

Smithsonite – ZnCO3 - Smithsonite forms as a crust with white, yellow or pale green rounded crystals with a frosted outer appearance. It is found usually on the surface of massive sphalerite.
Sharp individual crystals are rare. In one specimen smithsonite crystals have a tapering pinecone shape, in another they show a crude prism with a sharp trigonal termination.

Sphalerite – ZnS - Sphalerite is common in massive form. It is dark brown, nearly black in color with prominent cleavage. Good crystals are sometimes found within the siderite vugs. Single tetrahedra are rare, usually Mascot sphalerite forms as composite crystals.

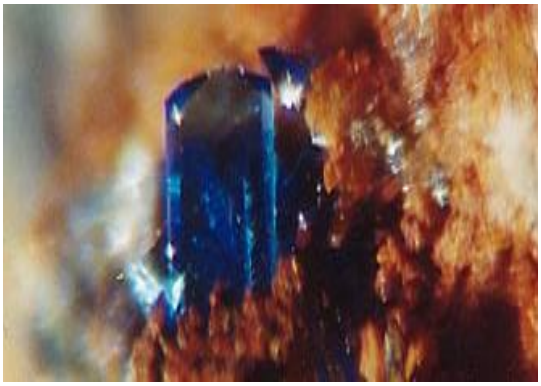
Crystals of **Calcite** and **Fluorite** from the Mascot have been reported by reliable sources. I haven't seen the specimens and don't want to comment on them here. A manganese oxide of undetermined species coats the surface of dump boulders.

There are also several Mascot unknowns that may prove interesting. One forms as lemon yellow platy crystal crusts. SEM EDS analysis shows only lead and sulfur. It doesn't look like anglesite; other possibilities with that chemistry would include **Lanarkite** and **Scotlandite**. One specimen has been found featuring colorless tabular plates.This mineral may be **Leadhillite**, but it has not been tested. Another Mascot unknown forms as sky-blue to greenish flat disks with a pearly luster and a crudely hexagonal form. Analysis shows it to be a copper-zinc carbonate. The rare mineral **Claraite** is a distant possibility.

Just as ramsbeckite emerged as a separate species from the green Mascot specimens thought to be brochantite, new species may someday emerge from some Mascot specimens now thought to be either linarite or posnjakite. Some specimens that are either medium or azure blue show different crystal form than the crystals that were used to confirm posnjakite and linarite. These could be other species. EDS analysis most likely will not be enough to make a positive identification. I believe that the potential for there to be other minerals in addition to those described here far exceeds my ability to determine it to be so.

The study of the Mascot minerals is not a solitary endeavor on my part. I thank other members of the Mascot team for their help. They include Gene Bearss, Ed Hakesly, Gordon Jackson, Tom Mortimer, Jim Nizamoff, Al Plante, Art Smith, Vince Valade, Scott Whittemore, and Bob and Anna Wilken.

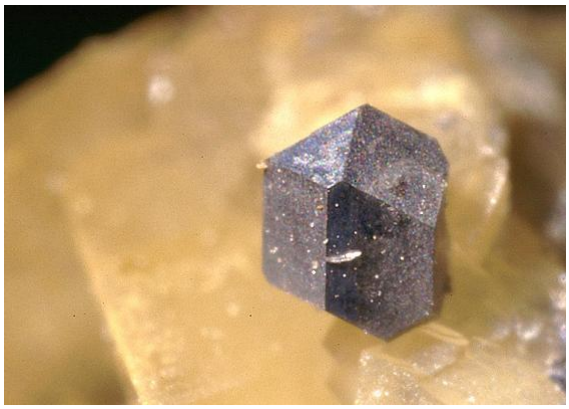
Anglesite



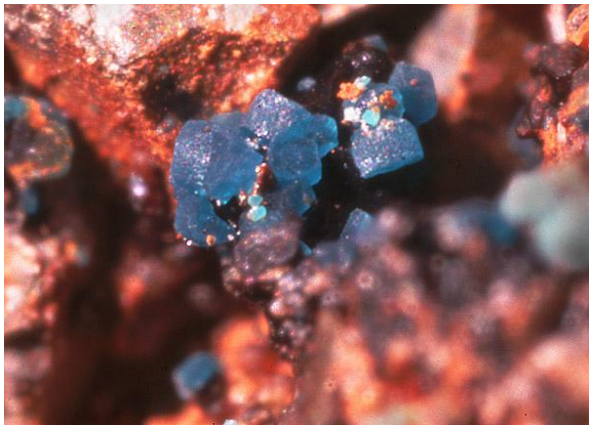
Linarite

Chalcopyrite

Smithsonite

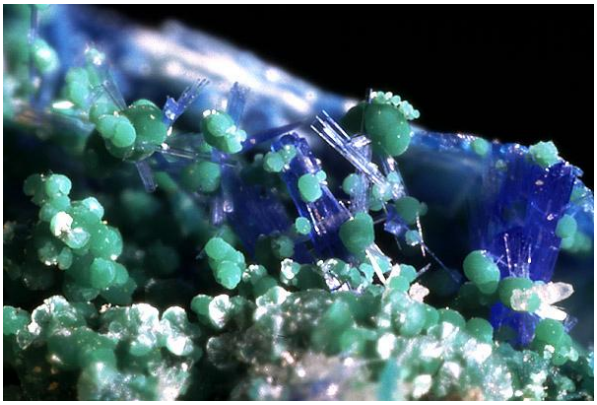


Sphalerite

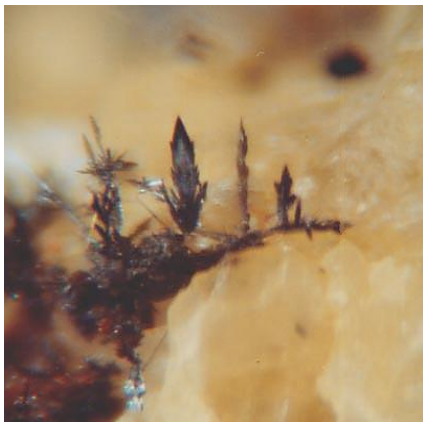


Posnjkite

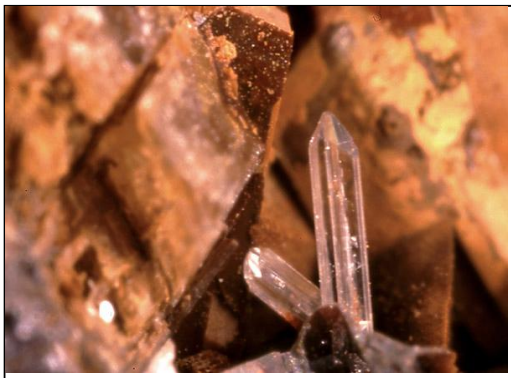
Linarite



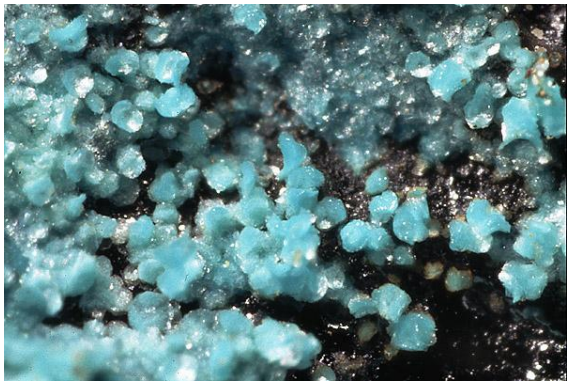
Malachite, Linarite



Acanthite



Cerussite



Posnjkite