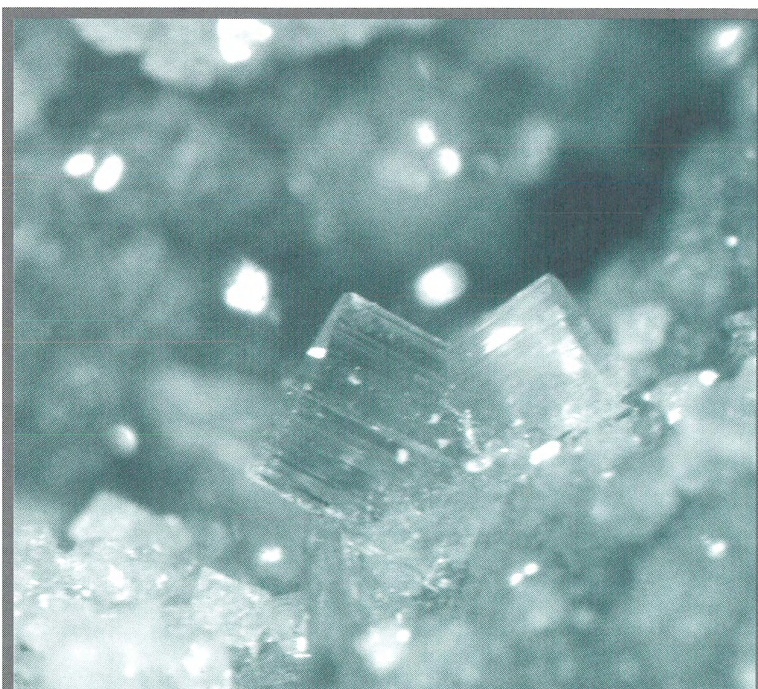
Minerals of the Utahlite Claim

Lucin, Box Elder County, Utah



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Cover photo: Metavariscite twin from Utahlite Claim

Photographs by Joe Marty; SEM microphotographs by Donald G. Howard.

Book design by Vicky Clarke.

Introduction

Phosphate minerals in northwestern Utah have been known since 1905. In 1909, Frank Edison and Edward Bird located claims on Utahlite Hill and produced variscite until 1910. Now the location is known as the Utahlite claim. This locality is important as a source of lapidary-grade variscite and well-formed microcrystals of metavariscite and variscite. Reports of wulfenite crystals occurring on variscite (personal communication, Richard W. Thomssen) enticed Joe Marty to explore the location together with Jim McGlasson in March, 1993. The number of mineral species occurring at this location is limited, but interesting. Currently, one small oval open pit has been developed for mining lapidary material. North of this pit is a small variscite prospect, the Alice claim.

The claim is located on Utahlite Hill, in Box Elder County, Utah, about a 90 minute drive north of Wendover, Utah. From Wendover, you travel west on Interstate 80 for 32 miles to Oasis and exit north on Nevada State Highway 233 (in Utah, State Highway 30). After crossing the Utah-Nevada border you travel an additional 8.7 miles toward Grouse Creek Junction. Next, travel 1.9 miles south on the gravel road to Lucin. On the west side of the road there is a gate. Proceed through the gate and take the road west for 1.1 miles. The claim is on top of the hill in the NE ¼ of section 21 in Township 8 North and Range 18 West, with longitude 113.904722 and latitude 41.403611.

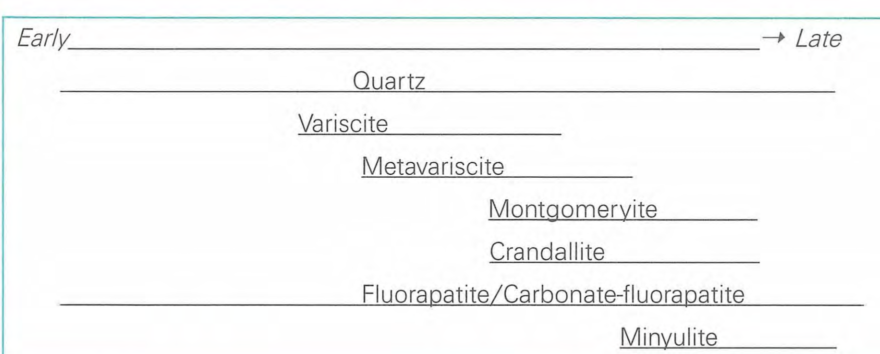
Photograph of open pit at the Utahlite Claim, Box Elder County, Utah, looking south.

Geology

The Utahlite claim is situated on the Permian Rex Chert Member of the Phosphoria Formation which consists of dolomite, limestone, quartzite, chert, and siltstone (Doelling, 1980; Miller, 1985). The host rock is heavily brecciated in the vicinity of the mineral occurrence. In addition, prominent northwest-striking, high-angle faulting is evident in the open pit. These structural events provided good permeability for fluids carrying phosphate and other ions from the underlying Meade Peak Member of the Phosphoria Formation. Although the exact mode of mineral deposition is uncertain, nearby igneous bodies may have provided the heat and solutions necessary for mineral deposition (typical of epithermal systems). These solutions cemented and replaced brecciated rocks with phosphates and silica. Landforms in this area show evidence of wave-cut terraces formed by ancient Lake Bonneville.

Mineralogy

The hydrothermal solutions that produced the mineral species initially were probably acidic and rich in aluminum, calcium, and phosphate. The source of the phosphate was the underlying phosphate beds while aluminum and calcium may have come from the wall rocks. As the solutions traveled closer to the surface they cooled and the first crystals to form were variscite and metavariscite. During the initial phases of crystallization, aluminum concentrations decreased and then carbonate-fluorapatite crystals formed. As phosphate continued to replace limestone, the pH increased and became less acidic. In some open spaces, cementing or filling was incomplete, allowing the formation of euhedral crystals of metavariscite, variscite, carbonate-fluorapatite, minyulite, quartz, and several unknowns. Minyulite, a potassium aluminum phosphate, appears to have formed coincident with the final phases of carbonate-fluorapatite formation. Vivianite was probably very late in formation. Below is the proposed paragenesis of the major mineral species at the Utahlite Claim. These minerals have been identified at the Utahlite Claim.



Paragenesis of major mineral species at the Utahlite Claim, Box Elder County, Utah.

Carbonate-fluorapatite, $Ca_5(PO_4,CO_3)_3F$, occurs as white, opaque, prismatic, euhedral to subhedral crystals up to 3 mm long. Many of the crystals coalesce to form botryoidal masses and rarely crystals are attached to the surface of variscite crystals. Some of the crystals form as small acicular bundles and powdery masses. In addition, carbonate-fluorapatite may be seen delicately perched on montgomeryite crystals. Small 2 mm tabular crystals of carbonate-fluorapatite occur north of the Utahlite claim in a small variscite prospect, the Alice claim. Analysis of a specimen of complex crystals and fibrous white carbonate-fluorapatite from the Utahlite Claim pit shows a fairly typical composition for this mineral.

Carbonate-fluorapatite, $Ca_5(PO_4, CO_3)_3F$, Lucin, Utah

P_2O_5	SO_2	ThO_2	Al_2O_3	Y_2O_3	La_2O_3	Ce_2O_3	MgO	CaO	FeO	SrO	BaO	F
40.34	0.79	0.04	0.1	0	0.27	0.02	0	57.6	0.01	0	0.04	2.52

Crandallite, $CaAl_3(PO_4)_2(OH)_5 \cdot H_2O$, Lucin, Utah

P_2O_5	SO_2	ThO_2	Al_2O_3	Y_2O_3	La_2O_3	Ce_2O_3	MgO	CaO	FeO	SrO	BaO	F
31.18	0.19	0.06	33.91	0	0.01	0	0.07	13.72	0.02	0.15	0.03	0.54

Metavariscite, $AlPO_4 \cdot 2H_2O$, Lucin, Utah

P_2O_5	SiO_2	Al_2O_3	V_2O_3	MgO	CaO	MnO	FeO	ZnO	Na_2O	K_2O	F
48.34	0.02	33.73	0.22	0.01	0.01	0.0	0.34	0.0	0.02	0.0	0.16

Minyulite, $KAl_2(PO_4)_2(OH,F) \cdot 4H_2O$, Lucin, Utah

P_2O_5	SiO_2	Al_2O_3	V_2O_3	As_2O_3	MgO	CaO	MnO	FeO	CuO	ZnO	Na_2O	K_2O	F
41.21	0.01	29.04	0.03	0.06	0.02	0.03	0.03	0.02	0.04	0.0	0.05	10.68	4.7

Mitridatite, $Ca_3Fe_4^{+3}(PO_4)4(OH)_6 \cdot 3H_2O$, Lucin, Utah

P_2O_5	SiO_2	Al_2O_3	V_2O_3	MgO	CaO	MnO	FeO	ZnO	Na_2O	K_2O	F
32.92	0.47	2.84	0.36	0	18.38	0	30.43	0.04	0.07	0.02	0.11

Montgomeryite, $Ca_4MgAl_4(PO_4)_6(OH)_4 \cdot 12H_2O$, Lucin, Utah

P_2O_5	SiO_2	Al_2O_3	V_2O_3	MgO	CaO	MnO	FeO	ZnO	Na_2O	K_2O	F
37.36	0.03	17.22	0.01	3.11	19.4	0	0.25	0.09	0	0.02	0.04

Variscite, $AlPO_4 \cdot 2H_2O$, Lucin, Utah

P_2O_5	SiO_2	Al_2O_3	V_2O_3	As_2O_3	MgO	CaO	MnO	FeO	CuO	ZnO	Na_2O	K_2O	F
48.09	0.05	32.14	0.29	0.16	0.0	0.05	0.02	0.08	0.04	0.06	0.07	0.01	00.5

Analyses of Lucin minerals. Composite of multiple points analyzed by microprobe.

Crandallite, $CaAl_3(PO_4)_2(OH)_5 \cdot H_2O$, is rare and occurs as powdery yellow masses which rim nodules of variscite/metavariscite and may represent a late-stage alteration product of metavariscite. Brown veining in a nodule of very compact, bright green metavariscite is also crandallite. One spot on the east wall produces small crandallite crystals, 0.2 mm long, and are pseudomorphs after twinned metavariscite crystals. Crandallite also occurs on the west wall as small isolated crystalline aggregates on white druses of carbonate-fluorapatite. Analysis of the yellow and brown crandallite shows it to be nearly pure end-member crandallite (page 3).

Jarosite, $KFe_3(SO_4)_2(OH)_6$, occurs in an outcrop a short distance northeast of the main pit as yellow, translucent, platy crystals up to 0.6 mm, associated with small, clear carbonate-fluorapatite crystals (personal communication, Mel Cannon).

Lipscombite, $(Fe^{+2},Mn)Fe_2^{+3}(PO_4)_2(OH)_2$, occurs as translucent, green, dipyramidal crystals up to 0.2 mm in length. The crystals were found in association with unknowns 1 and 2 (below), mitridatite, and montgomeryite in very small vugs in massive metavariscite. The crystals were found in one small zone near a fracture. The few samples that were found were collected by looking for macroscopic coatings of mitridatite on fracture surfaces. Some of the lipscombite crystals are intimately intergrown with mitridatite and strengite. At this time, since material is limited, positive identification with XRD has not been accomplished.

A cluster of lipscombite crystals 0.2 mm in diameter (240x).

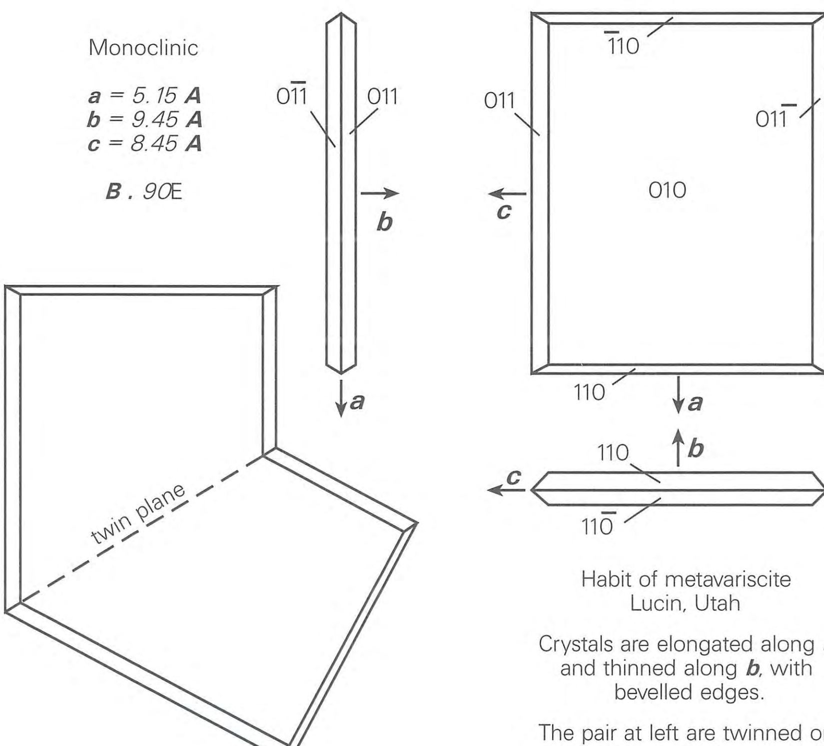
"Lucinite" was shown to be identical with variscite and was discredited as a mineral species (Larsen, 1925).

Metavariscite, $AlPO_4 \cdot 2H_2O$, is abundant and forms colorless to light green, euhedral, bladed crystals to 2.0 mm.

Analysis of the deep green tabular and prismatic metavariscite is compositionally within limits reported previously for the species (page 3). Metavariscite may be perched on massive variscite or with variscite crystals attached to its prism faces, and frequently forms flat prisms and less commonly V-shaped twins. This location is the type locality for metavariscite. Larsen and Schaller showed that the mineral previously called variscite from Lucin was actually metavariscite (Larsen, 1925).

Metavariscite is monoclinic, but the angle is so close to 90° that, for the purposes of discussing habit, it may be considered orthorhombic (below). The crystals tend to be thin in the b direction and elongated in the a direction, with striations on the (010) face parallel to the a axis. The blades have beveled edges formed by (110) and (011). Twinning occurs as contact twins on the (101) plane. The double twin shown on page 6 (photomicrograph) appears to be a penetration twin, since there is no prominent plane perpendicular to (101). The (301) is about 3° off, too far to explain the near-perfect parallel orientation.

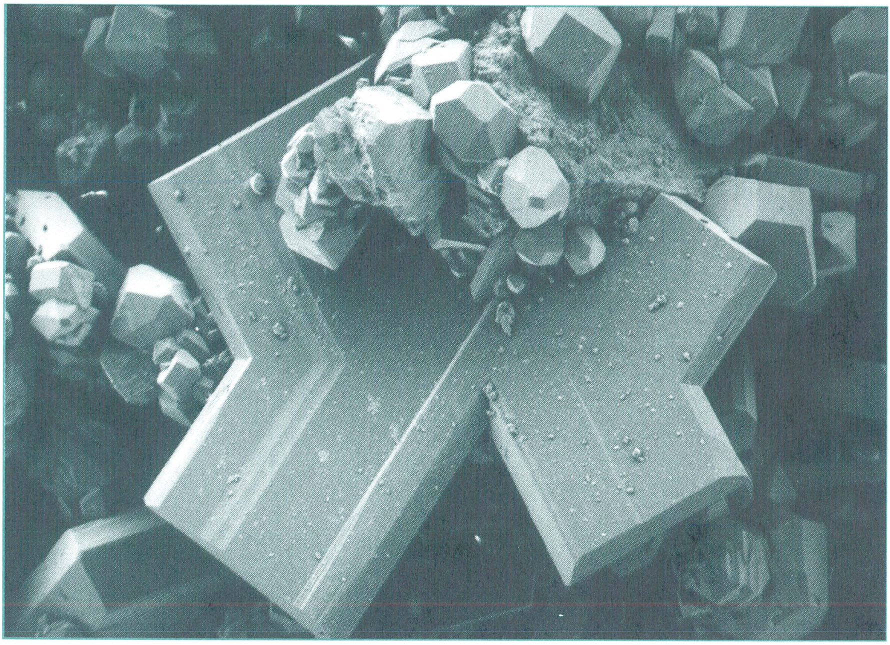
The green material used for lapidary purposes has been called "variscite." Recent x-ray powder diffraction studies reveal that most of this is actually metavariscite. The lapidary jewelry on page 6 was made with metavariscite from the Utahlite Claim. Much of the massive metavariscite has a concentric structure and is therefore desirable for lapidary purposes. No production figures for the lapidary-grade metavariscite are available. However, total production of about 2,000 pounds is a reasonable estimate.



Habit of metavariscite
Lucin, Utah

Crystals are elongated along ***a*** and thinned along ***b***, with bevelled edges.

The pair at left are twinned on the (101) plane. See page 6.

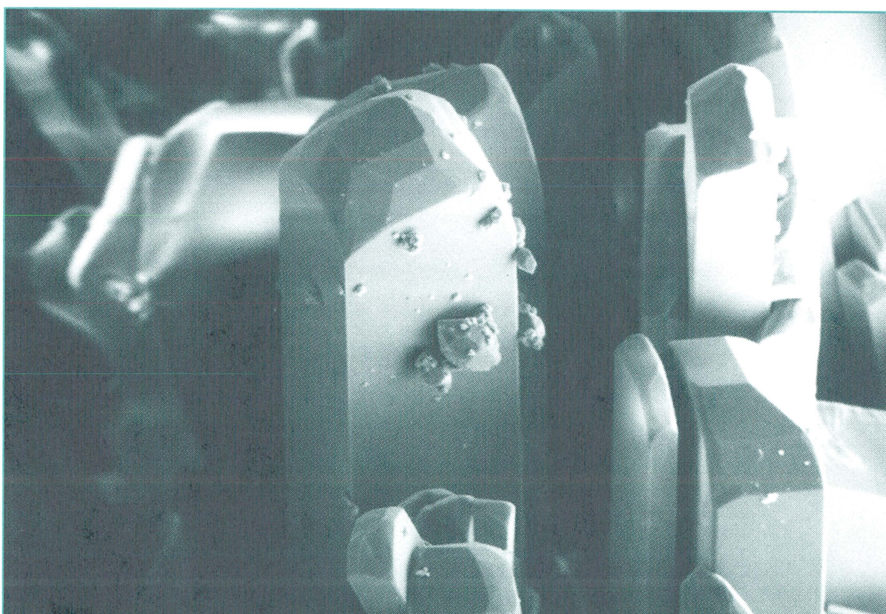


Metavariscite with variscite, Utahlite claim, Box Elder County, Utah. Penetration twins on the (101) plane (see page 5). Notice the striation lines parallel to the a axis. The small equant crystals on and around the metavariscite are variscite. (55X)

Lapidary jewelry with metavariscite from the Utahlite Claim, Box Elder County, Utah.

Minyulite, $KAl_2(PO_4)_2(OH,F) \cdot H_2O$, occurs as translucent, colorless to faintly yellow, prismatic crystals up to 2 mm in length. Several very attractive aggregates of prismatic crystals were found. The crystals were limited to one small pocket or zone in an area that is now inaccessible. It was identified by x-ray diffraction and SEM-EDS methods by the late Eugene Foord, U.S. Geological Survey. This is thought to be the eighth known occurrence of minyulite.

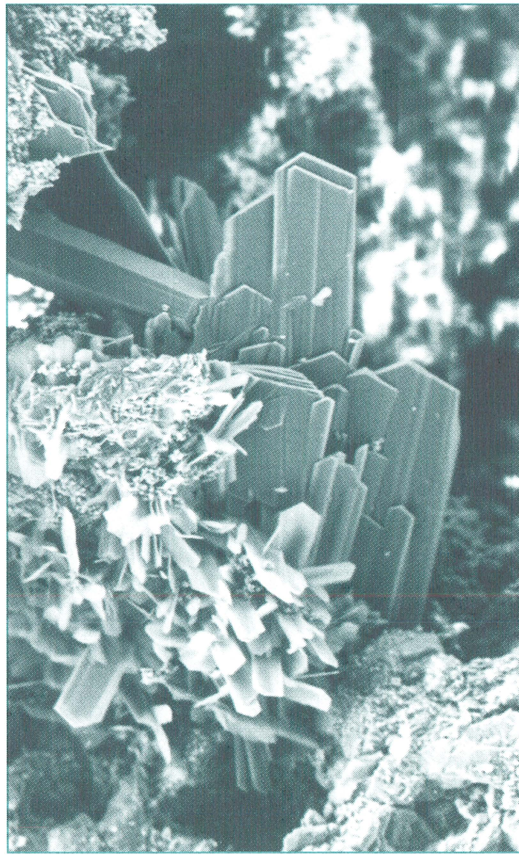
Minyulite is orthorhombic. Crystals are acicular and elongated parallel to the c direction. The terminations, as shown in the photomicrograph below, are quite complex. Most of the published structural work has been done on material from the original occurrence in Western Australia where the mineral occurred mainly in fibrous arrays. No later work appears to have been done on the morphology of this mineral. Further examination of the crystal forms of minyulite is warranted on these specimens.



Minyulite, Utahlite Claim, Box Elder County, Utah. The terminations of these acicular orthorhombic crystals are quite complex. Notice the very small attached quartz crystals. (450X)

Mitridatite, $Ca_3Fe_4^{+3}(PO_4)_4(OH)_6 \cdot 3H_2O$, is relatively common and occurs on iron-stained blocks of quartzite, closely associated with carbonate-fluorapatite. The small, less than 0.3 mm, green to brown, platy crystals have a resinous luster. Individual crystals are difficult to distinguish and most of the material is composed of subhedral coatings. In one small fracture zone, mitridatite is intimately associated with lipscombite, montgomeryite, and unknowns 1 and 2. Page 12 photomicrograph shows oval discs of mitridatite on bipyramids of lipscombite (560x). Analysis of a specimen of the dark brown, massive mitridatite was consistent with the analyses on page 3.

Montgomeryite, $Ca_4MgAl_4(PO_4)_6(OH)_4 \cdot 12H_2O$, is very rare at the Utahlite claim and only occurs at a few locations in the world. The flat, chisel-shaped, prismatic crystals are translucent, colorless to light green, and up to 1 mm in length. The photomicrograph to the right shows montgomeryite with perched carbonate-fluorapatite crystals. Analysis of a prismatic montgomeryite specimen gave results that are similar to reported values, but enriched in magnesium and deficient in aluminum. Little analytical data exist with which to compare montgomeryite; page 3 indicates unreported chemical variability within the species.



Montgomeryite, Utahlite Claim, Box Elder County, Utah. A cluster of terminated montgomeryite crystals seen edge on, with smaller crystals in all orientations above and to the left. One carbonate-fluorapatite prism is seen behind the blades with no termination. (100X)

"Peganite" is no longer a valid mineral species. It was originally described by Breithhaupt as a new mineral species from material at Striegis in 1830 but was shown by Moschetti in 1918 and confirmed by Larsen to be identical to variscite (Larsen, 1925).

Perhamite, $Ca_3Al_7(SiO_4)_3(PO_4)_4(OH)_3 \cdot 16.5H_2O$, occurs in one small zone as fracture coatings. The white, platy, crystals have a pearly luster and form balls up to 0.3 mm in diameter. Some of the crystal balls show a hexagonal outline.

Phosphosiderite has been reported to occur at this locality but was not confirmed.

Quartz, SiO_2, occurs as many late-developing crystals, up to 3 mm in length in cavities with variscite and metavariscite crystals; but the majority of quartz is cryptocrystalline.

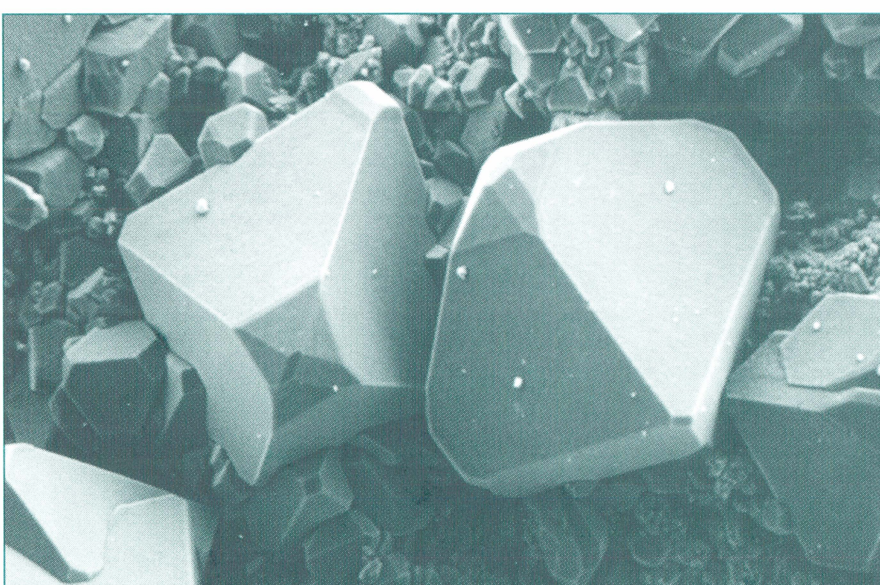
Strengite, $FePO_4 \cdot 2H_2O$, occurs as very small colorless crystals, less than 0.5 mm in length, in small vugs in metavariscite associated with mitridatite, lipscombite, and montgomeryite. Larger strengite crystals up to 2 mm have been reported to occur in a small outcrop to the northeast of the claim (personal communication, Mel Cannon).

Unknown # 1 is very rare and occurs as yellow rosettes of platy crystals up to 0.3 mm in length in small vugs in metavariscite. Unknown # 1 was found in association with lipscombite, montgomeryite, mitridatite, and unknown # 2.

Unknown # 2 is also very rare and occurs as white rosettes of platy crystals up to 0.3 mm in length in association with unknown # 1, montgomeryite, mitridatite, and lipscombite in very small vugs in metavariscite.

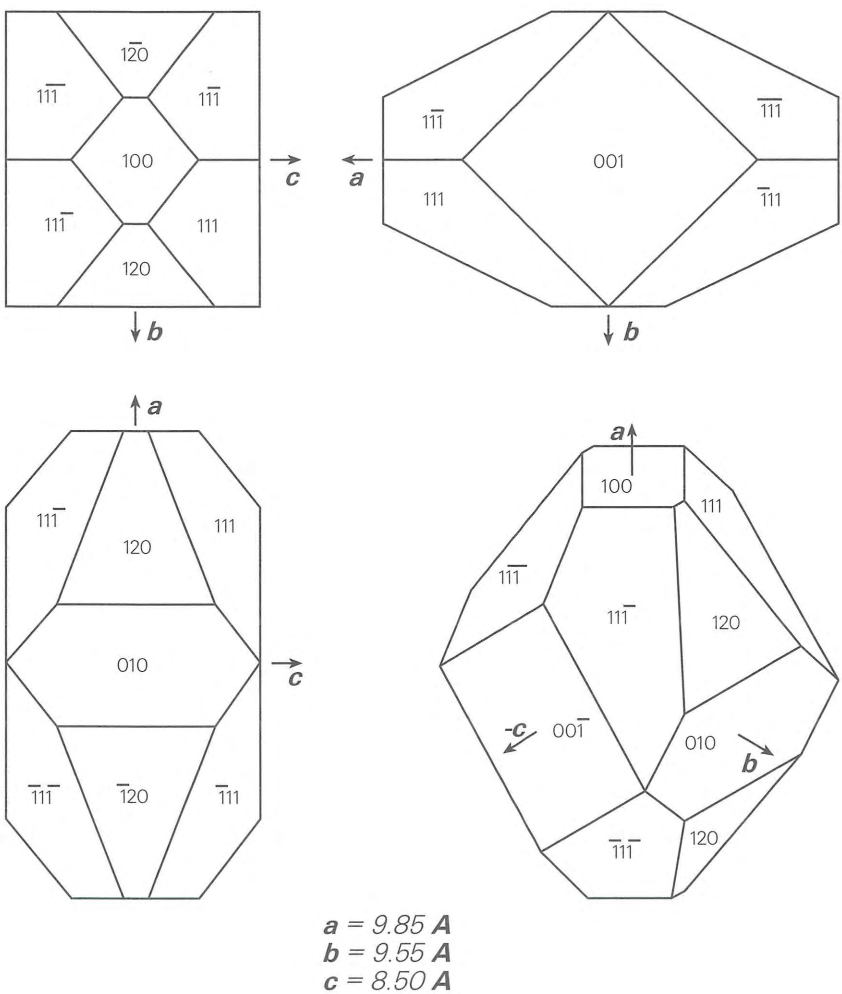
Variscite, $AlPO_4 \cdot 2H_2O$, is very abundant and occurs principally as massive material with local colorless to green, equant, dipyramidal crystals up to 0.5 mm. Very well-formed crystals are present, some of which are perched on metavariscite crystals. In one area of the pit numerous green balls or spheres of variscite occur up to 3 mm in diameter. The green coloration is likely due to small amounts of vanadium and chromium (Foster and Schaller, 1966); however, the exact mechanism of coloration is still poorly understood. SEM-EDS examination by the late Eugene Foord, U.S. Geological Survey, of similar material from Clay Canyon showed the presence of trace amounts of vanadium and chromium. Schaller (Schaller, 1912; 1916) also found vanadium and chromium traces to be present.

The nomenclature for variscite has changed since the original description. The material that was originally called variscite has now been shown to be metavariscite. Also, the material that was originally called "lucinite" has been



Variscite, Utahlite Claim, Box Elder County, Utah. A pair of octahedrons with complex modifications (125).

definitively shown to be variscite (Schaller, 1912; 1916). In addition, "peganite" was shown to be the same species as variscite and thus the name "peganite" has been discredited. Much of the lapidary material that has been called "variscite" is actually metavariscite.



Habit of variscite crystals, Utahlite Claim, Box Elder County, Utah. Equant orthorhombic prism and dome, with modifying faces.

Variscite is orthorhombic. At Lucin, the crystals are equant (see page 9), as opposed to the bladed metavariscite. They are primarily dipyramidal in habit; the (111) faces being best developed in all the crystals. Corners are truncated with pinacoidal faces, with the (001) best developed. The presence of (120) faces on each side limits the development of the (010) faces. A small (100) face is usually present. Page 6 shows a number of such crystals clustered about the base of the metavariscite blade. The habit of variscite crystals is illustrated on page 10.

Vivianite, $Fe_3^{+4}(PO_4)_2{\cdot}8H_2O$. One small iron-stained block was found on the dump which contained dark blue vivianite crystals to 2.0 mm long.

Wardite, $NaAl_3(PO_4)2(OH)_4{\cdot}2H_2O$, has been reported to occur (K. Bullock, 1981) at this locality but was not confirmed. Wardite that was previously described may have been variscite.

Wavellite, $Al_3(PO_4)_2(OH),F)_3{\cdot}5H_2O$, is very rare and is closely associated with carbonate-fluorapatite and minyulite. Crystals occur as balls of white, acicular, bladed needles to 1.0 mm, often perched on druses of carbonate-fluorapatite crystals. Visually, with smaller crystals, it may be difficult to distinguish bladed crystals of wavellite from hexagonal terminations of the more common fibrous carbonate-fluorapatite.

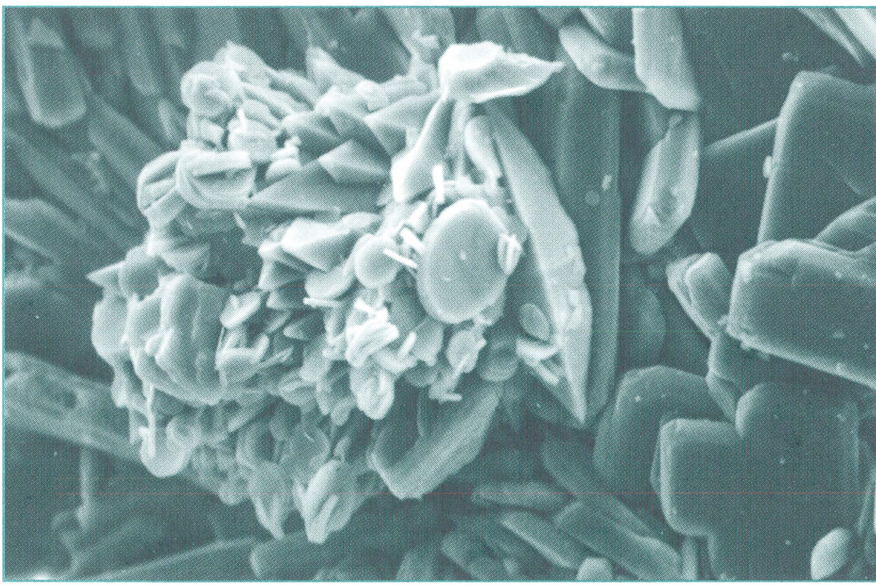
Wulfenite, $PbMoO_4$, has also been reported to occur at this locality but this would be a very unlikely occurrence in this particular mineralogical environment. Wulfenite may have occurred on variscite at the Empire mine (Tecoma Hill #18 mine) below Tecoma Hill in Regulator Canyon which is just a short distance to the east of the Tecoma Hill mine #11 mine. This district is about 10 miles southwest of the Utahlite Claim on the Utah-Nevada border.

Discussion

With additional mining, the potential exists for other species to be found and described. However, the economic future for continued mining of variscite for lapidary purposes is uncertain. The claim lessor is considering filling in the open pit because of regulatory and liability issues. At present, access to the bottom of the small open pit with equipment is difficult and this may limit future mining and diminish the potential for mineral collecting. The open pit is approximately 30′ wide, 40′ long and 45′ deep. Including the dumps there is about one acre of disturbance (see page 1).

Other similar phosphate deposits include Clay Canyon, Utah (Larsen and Montgomery, 1940; Larsen and Shannon, 1930; Thomssen, 1991); Amatrice Hill, Utah; unspecified localities between Park Valley and Snowville, Utah (Hansel Mountains); St. George, Utah; and Island Park, Idaho. Variscite is known to occur at all of the above localities in or near Mississippian or Permian phosphatic limestones. Metavariscite crystals have been found at the Utahlite Claim and at Island Park.

The Utah variscite deposits have been investigated by the Utah Geological Survey for scandium potential (Shubat, 1988) because some of the variscite occurrences are rich in scandium and other cations. Scandium is roughly equal in value to gold and United States supplies are nearly non-existent. Scandium is a trivalent element that is a minor constituent present in hundreds of minerals, especially aluminum phosphate minerals where it forms complexes with the phosphate ion (PO_4) (Frondel and others, 1968). At Clay Canyon, Utah, the very rare mineral kolbeckite contains scandium as the sole cation.



Oval discs of mitridatite on bipyramids of lipscombite (560x).

Claim Status

The mineral and surface rights originally belonged to the Union Pacific Railroad. Santa Fe Gold/Newmont recently acquired the mineral rights. The property is presently under lease to Dave Penney and because of liability issues and other concerns, collecting is not being allowed. Surface weathering has caused the pit walls to become very unstable and dangerous.

Acknowledgments

We wish to thank Dave Penney, who allowed us access for this study and Richard Thomssen who reviewed the manuscript.

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1999
Miscellaneous Publication 99-6

ISBN 1-55791-639-X