

Northwest
Micro Mineral
Study Group



MICRO PROBE

FALL, 2005

VOLUME X, Number 2

FALL MEETINGHILLSBORO, OREGON

Saturday, November 5, 2005

9:30 am to 5:00 pm

Rice NW Museum of Rocks and Minerals
26385 NW Groveland Drive
Hillsboro, Oregon

Once again we will be meeting in the NW Gallery at the Rice Museum and be able to enjoy the displays as they are being developed. Bring your microscopes and new finds for the summer to share with others and plan to spend the day looking at and talking about minerals. We will have space for trading, selling, and microscopes. And do bring along plenty of labeled material for the free tables. We might be short of tables, so if you have some please bring them to the meeting.

PROGRAM:

Morning: 11 am Doug Merson now has the software and hardware to do *Multi focus photography through the scope*. He will present that technique with examples showing how it works.

At the last meeting, we agreed that the club would no longer supply food for the lunch pot-luck table, so bring enough to eat (and share if you like) for lunch. There are no longer kitchen facilities at the museum.

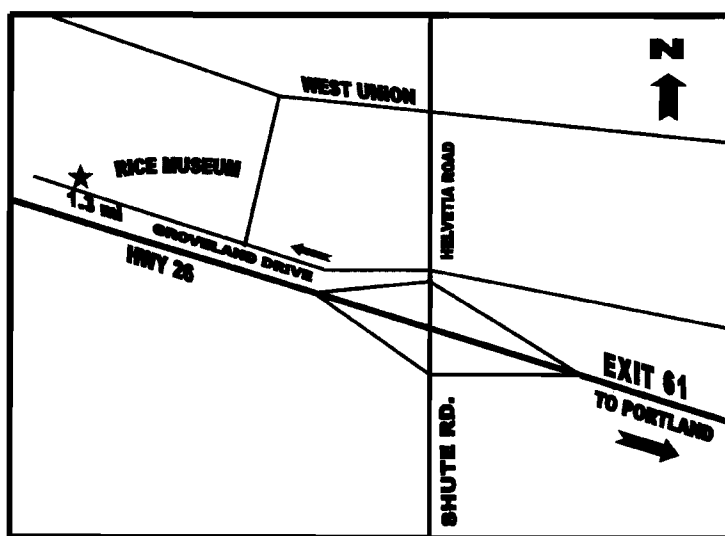
Afternoon: 2 pm Don Howard will talk on *Catalyzed crystal growth and its application to filiform minerals*. This will be followed by our usual short business meeting and review of the collecting status of locations in the Northwest.

* * *

Restaurants are available in the local area. Some of us will get together after the meeting for dinner, so please plan to join us if at all possible.

* * *

To reach the Rice Museum, take the Sunset Highway (US 26) west from Portland. Exit at Helvetia Road (exit 61). Jog right 100 feet, then left onto Groveland Drive. The museum is in the trees 1.3 miles to the west.



**Stilbite-Ca and Associated Minerals from the Bald Mountain Skarn,
Jefferson County, Montana**

Larry B. French
HC 46, Box 7204
Miles City, MT 59301

East of Butte, Montana, the Continental divide is spanned by rocks of the Boulder Batholith. The batholith is composed of a series of Cretaceous-Tertiary intrusions that were emplaced into Paleozoic sedimentary rocks. The lower to middle Paleozoic rocks in the area are rich in carbonate rocks, and extensive skarn development occurs in the contact zone between these rocks and the igneous rocks of the batholith. The contact zone is particularly rich and relatively well exposed in the area of Bald Mountain, east of Pipestone Pass.

Bald Mountain is located in sections 34 & 35, T. 2 N., R. 6 W. Section 34 is located within the Deer Lodge National Forest; Section 35 is administered by the Bureau of Land Management. The area is shown on the 7.5 minute Delmoe Lake quadrangle produced by the U. S. Geological Survey. The original collecting sites were hand-dug pits near the contact between massive calc-silicates and a marble unit. At the northeastern end of Bald Mountain two quarries and a tunnel have been opened. This claim is owned by Mel Rowling of Butte, Montana and collecting in the quarries should not be done without his permission.

The author is primarily interested in micro minerals and the following are descriptions of specimens in this size range. For descriptions of larger specimens, recovered from this location, readers are referred to the paper by Reuss (1976).

Apatite is not common from this location. The mineral is represented by a single specimen with multiple colorless hexagonal crystals up to 1 mm long.

Calcite forms the matrix enclosing all the other minerals. The original limestone has been recrystallized into pale to medium blue coarse cleavages. Individual calcite crystals were not found.

Diopside is the most abundant mineral at the Bald Mountain skarn. Euhedral crystals are common, pale apple to dark green, and translucent to transparent. Twinning is common along various crystallographic planes, producing a variety of geometric shapes.

Epidote is not common in the skarn. A single massive specimen composed of radiating yellow green crystals was recovered. The radiating mass was 3 mm across and associated with massive iron-oxides minerals, quartz, and garnet.

Grossular is the second most common mineral in the skarn. Well formed, typical cinnamon brown dodecahedral crystals were recovered. Grossular was found intimately associated with diopside.

Iron oxide minerals are not common in the carbonate rocks. A few reddish brown masses are present in a few of the rocks, especially associated with epidote.

Manganese oxide dendrites occur on the surfaces of a few of the stilbite crystals. The dendrites are yellowish brown to dark brown in color and are less than 0.5 mm long.

Stilbite-Ca was recovered while dissolving blocks of calcite matrix to expose garnets and other minerals. The stilbite was found as well formed, colorless or very pale yellow crystals up to 2 mm in length. The crystals are common and modified flat-topped forms (Tschernich, 1992, p. 449, fig. 534 & 535). Lanny Ream (2004) tentatively identified stilbite from this location. Stilbite identification was confirmed by Excalibur Mineral Company using energy dispersive spectroscopy and SEM images.

Wollastonite was tentatively identified by Ream (2004), but was not found by the author.

References:

Ream, L., 2004, *The skarns of Montana*: Pacific Northwest Chapter Friends of Mineralogy, June Bulletin, pp. 4-5 & 8.

Reuss, R. L., 1976, *Minerals of the Bald Mountain skarn, Pipestone Pass area, Montana*: The Mineralogical Record v. 7, n. 1, p. 18-24.

Tschernich, R. W., 1992, *Zeolites of the world*: Geoscience Press Inc., Phoenix, Arizona, 563 p.

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EDAX, the Physicists' Way of Doing Chemistry

Donald G. Howard

In former times, the only way to determine the elements present in a mineral was through the use of wet chemistry. This consisted of the following procedures:

- Separate a sizeable amount, say at least several hundred milligrams, of the pure material from the matrix and intergrown other minerals.
- Find some way (acids, fusion in some compound, etc.) to get the material to dissolve in water.
- Test for each element present individually, by precipitation and weighing, titration, or some colorimetric technique, whichever was appropriate for that particular element.

The first step was labor intensive, and often there was insufficient material to carry out a satisfactory analysis. Since most minerals are not water soluble, the second step required a lot of ingenuity. On silicates, hydrofluoric acid was often employed, and this is a nasty material to handle, plus it removes the silicon so that it could not be included. In the third step, one constituent often interfered with the analysis of another, and required that they be separated by precipitation and resolution or some clever fractionation of a complex ion in an organic solvent.

Needless to say, in general, this required a large amount of sample and a lot of time. Nowadays, these sorts of techniques are seldom employed. Spectroscopy (that is, using electromagnetic emissions) has pretty well replaced such procedures. Sometimes this is done with visible light, where the sample is vaporized and the absorption lines of each element are detected in a spectrometer. Sometimes the scans are done in the infrared, where certain bond energies absorb radiation that gives a characteristic pattern. But by far the most employed technique involves x-rays.

All spectroscopic methods depend on the fact that the energy levels in each atom are quantized – that is, there are only specific energies at which the electrons can exist. As a result, when an electron makes a transition to a higher level by absorbing energy, it can only do so in certain sized increments. And when an electron drops down into an unoccupied lower level, it can emit that energy as a photon of specific energy and therefore specific wavelength. Optical spectroscopy depends on the transitions of the least tightly bound of all the electrons in an atom, which usually takes place at wavelengths in or near the visible part of the spectrum. X-rays, however, have much higher energies, and therefore involved the more tightly bound electrons.

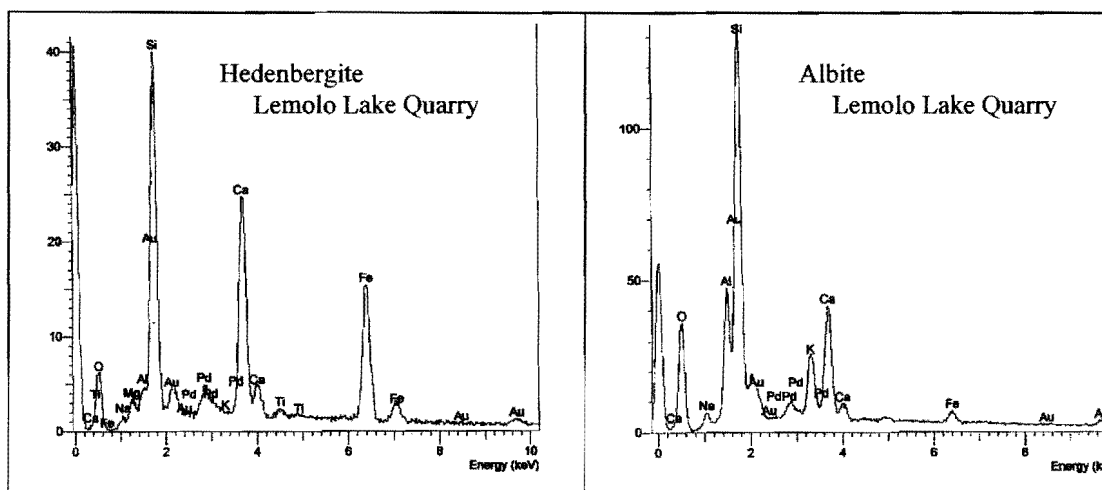
The two most tightly bound electrons – the so-called K-shell electrons – have binding energies that depend on the electrical forces between nucleus and electron cloud. Therefore they depend on the atomic number, Z , the number of protons in the nucleus. Given in electron-volts (eV), the value is roughly given by $11 \cdot Z^2$. Thus, each element, corresponding to each Z value, has a different value of the binding energy of the K-shell.

An electron microscope uses a beam of electrons accelerated to a fairly high energy, generally up to 20 to 30 thousand electron-volts (keV). A quick calculation will show that such electrons are capable of knocking the innermost K-shell electrons out of any element with a Z value somewhere in the 40's. When this occurs, a hole is left in the

innermost shell of the atom that will quickly be refilled by another of the atom's electrons. When this happens, energy is released. If it takes the form of a photon, then that photon will have a characteristic value for each element. Since the energies involved are much larger than those of visible photons, they lie in the x-ray region, and are called characteristic K x-rays.

Typically, an electron microscope is equipped with two kinds of detectors. The usual one records the *intensity* of x-rays being generated as the electron beam sweeps over the sample in a pattern of lines, and the output is put on a monitor to form a picture, what we usually call a micrograph when it is recorded and printed. The Microprobe has prints many of these black-and-white photos over the years to show the details of tiny crystals. They depend on the fact that the emission of x-rays depends on the composition and orientation of each surface, so that we get enough contrast to show fine details. And by scanning the original electron beam over smaller and smaller regions, we can achieve fantastic detail.

The second type of detector measures the specific *energy* of the emitted x-rays. So instead of a picture of the shape of the sample, it gives a graph of the number of x-rays detected as a function of their energy. The emission from each element occurs at a different energy, and therefore we have a "count" of the number of atoms of each element doing the emitting – in other words, an analysis of the abundance of each element in the sample, a chemical fingerprint. Two such graphs of the minerals described in the article about the spring field trip to Lemolo Lake are shown below.



Sounds too good to be true? Well, there are a few complications. And as always, the complications limit the usefulness of the technique. So, having described in simple terms how the method works, let us look at some of the details.

In practice, detectors work best in the range of 0 to about 10 keV, so elements above about arsenic and selenium have characteristic K x-rays above the working range. The good news is that this does not limit the application, because here there are plenty of inner electrons and the bombarding electrons can knock bound ones out of the next higher L-shell. Again, these fill rapidly with still higher energy electrons and emit characteristic L x-rays of their own. The bad news is that these lie on top of the K x-rays in energy, so they are superimposed over the same region. You may notice in the above

graphs notation of palladium (Pd) around 3 keV and gold (Au) in the 8 to 10 keV region. These are L x-rays generated by the conductive coating needed to drain the spent electron beam off of the sample. For elements above gold, the third shell is driven off and M-shell x-rays result. The notation of Au on each side the silicon peak is an example of characteristic M-shell x-rays.

And herein lies one of the major difficulties. While the emission lines are very narrow in energy, the detectors are not so precise and yield broadened peaks. Several elements can give lines at nearly the same position, making it difficult to distinguish the contribution of one element in the presence of another. For gold and aluminum, this is not a real problem, since the two elements seldom occur together in nature. But lead, molybdenum, and sulfur are an example of elements that do occur together that lie at the same position. A similar problem occurred in working with the wakefieldite from Yellow Lake, British Columbia because the vanadium and lanthanum peaks were on top of each other. Lead containing sulfosalts are a particular pain in the neck.

Another problem is encountered with the lightest elements. Here, there are no electrons to repopulate the K-shell with hydrogen and lithium. For beryllium and boron, the energies involved are so low that even if x-rays are produced, they are absorbed in the top layers of the sample, detector, or along the path in between (after all, a "good" vacuum still has a lot of atoms floating around in it). In practice, it takes special equipment to reliably detect elements lighter than carbon. Lithium is a good candidate for conventional light spectroscopy, since it has a strong emission line in the red. Boron and beryllium are hard to detect and often get overlooked.

Ideally, we would expect the intensities of the lines to be proportional to the relative abundance of atoms of each element present. Unfortunately, another complication confuses such a simple interpretation. Once excited, an atom *may* emit a photon when it relaxes but it does not have to. There is another process (called the Auger Effect) where when one electron drops into the created hole, another loosely bound electron accepts the energy instead and uses it to escape the atom (ie, ionization, leaving behind an atom that is still missing electrons, but all in the highest energy levels). For a number of atoms, this turns out to be the preferred method of relaxing, and they give out few x-rays. The halides (fluorine, chlorine, bromine, etc.) are examples of such cases, and these become hard to detect. Emission probabilities therefore vary widely from element to element, and must be taken into consideration. The incident angle of the beam onto the crystal surface also affects intensities (otherwise we would not get such good pictures of crystal faces). And finally, detector efficiency is also energy dependent and contributes to varying peak heights

So we are left with a partial method that is most useful for qualitative analysis. It works particularly well for the elements between potassium and zinc (K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn). Since these are the ingredients of some of our most colorful minerals, this method gets a lot of use in identifying unknown minerals.

And what do we do when we actually come across a new mineral and need to determine the composition quantitatively? Then we need to resort to more sophisticated techniques. Such devices are usually referred to as microprobes rather than electron microscopes. They employ much more sophisticated detector systems that are better suited to separating between nearly overlapping x-ray emission wavelengths. Of course, such systems drastically reduce the rate at which data accumulates, so much longer count

times are required. And since only one wavelength at a time can be measured, long term beam intensity stability has to be built into the machine.

To combat the problems of differing emission rates for various elements, several things are done. Sample preparation is one; the sample is embedded in epoxy and polished flat before coating to eliminate questions of surface angles. But the most important is the use of standard samples – ones whose composition has been carefully measured beforehand and is kept for the purpose of calibration. An unknown and one or more standards are compared so that the intensity can be converted to actual atomic percentages. The standard is best if it most closely resembles the composition of the unknown. At the end of an analysis, percentages are added to make sure that the total is near 100%.

The advantages? Much smaller samples are required, often only a tiny fraction of the amount required by even the most sophisticated wet-chemistry methods. One of the things that has come out of studies is that many crystals are zoned – that is they have one composition on the outer rim and a different one in the interior. In earlier times, wet chemistry could only give the average composition of the crystals.

And the disadvantages? The time required per sample is considerable and therefore the procedure is costly. Oxidation states (ie, ferrous or ferric) are not obvious and must be inferred to get the totals to give 100%. Lithium, beryllium and boron are still a detection problem. Water must be determined from the oxygen emission alone, and it is never very clear whether the “missing” part added in this way should be determined as water, H_2O , or as hydroxide (OH).

Microprobe methods are powerful, but not sufficient in and of themselves. They only determine composition, not structure. Coupled with x-ray diffraction, particularly of single crystal fragments rather than powders, they can pin down the probable location of the atoms in a unit cell and clarify questions of valence and the nature of hydroxyl versus water content. Both types of studies have to be successful before a new mineral can be proposed and accepted.

Meanwhile, we have an exceptionally useful tool in having the EDAX system attached to the electron microscope. By suitably twisting and turning the sample, we can get an idea of what faces are present on the crystals and their approximate orientation. The element scan gives a qualitative idea of the composition of the crystals. Knowing what is *not* in the crystal eliminates a lot of possibilities that we do not need to consider. From the choices that are left, hopefully we can identify what mineral we are looking at. Of course, if the chemistry tells use that we are looking at a calcium aluminum silicate, there are still an amazing number of possibilities to eliminate to get a positive identification.

Update on Minerals from Lemolo Lake, Douglas Co., Oregon

Donald G. Howard

For those of you that were a party to our plans to take the Speaker to Summit Rock after the Spring meeting, and elected not to go, my hearty congratulations! To say that the trip was not a warm success would be an understatement. We should have been clued in when we found a couple of feet of snow still on the feeder road into Summit Rock, enough to preclude trying to get in there. But there is always Lemolo Lake, right?

The campground at Diamond Lake was open – that is, they had scraped enough snow off some of the campsites to make them useable. So we (Doug and Beckie Merson, Joe Marty, and I) settle into campsites Sunday afternoon. (Joe insisted that I only pay for one night – brilliant thinking.) The sun was out, for a while, and then the misty clouds blew in and the hail came down and It was a cold night, but we survived.

Next morning, in a light, very cold drizzle, we went down to Lemolo Lake, which is about 1000 feet lower in elevation, and began to putter around. We started along the spillway, which is where most of the more interesting minerals had been found. I wanted to verify in particular that the large boulders we had been collecting from had originated in the very prominent flow visible across the spillway.

Indeed, this is the origin of the rock in which most of the pseudobrookite has been found. This is the uppermost flow in this area, forming the southern shoreline to the lake and extending west beyond the point at which the spillway trench ends and the water runs down over scattered rocks to the bed of the river below. As can be seen in the photo at right, the flow is 20 or more feet thick in this area, gradually thinning toward the western end of the spillway. It probably also forms the base on the north side of the spillway that the short spur road is built on, though trees and undergrowth cover it pretty effectively.



The spillway at Lemolo Lake

The reddish, scoria-like flow directly beneath has poor integrity and weathers to a gritty reddish soil much more rapidly, leaving the edge undercut. Clearly, the scoria layer had a wider variety of elements than the big flow that covered it. Diffusing and minor mixing into the bottom centimeter or two of the harder rock allowed a wider variety of minerals to form. The thick flow has only a few cavities, and these are mostly lined with tridymite, enstatite crystals, and very tiny flakes of ilmenite. The latter two are ferrous minerals, indicating very little oxidation present. At the interface, more oxygen was introduced, resulting in some ferric minerals such as hematite, magnetite, and

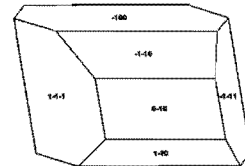
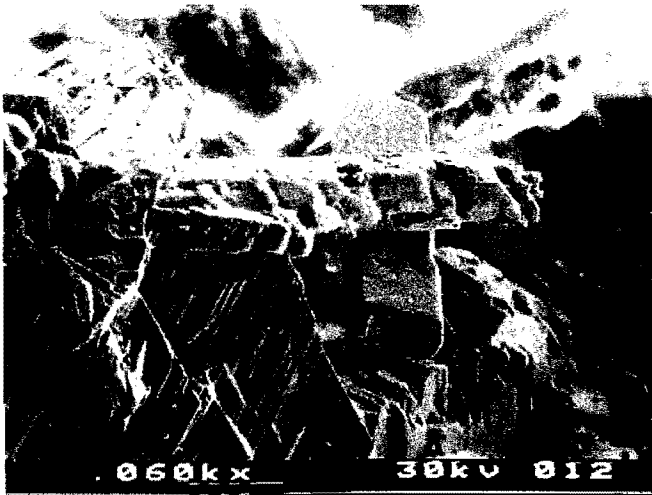
pseudobrookite. Small amounts of sodium, magnesium, calcium, zirconium, etc. allowed the formation of magnesiohornblende, aegirine, apatite, and zircon.

Other than proving a point, going to the other side of the spillway, while possible around the west end, was not very productive for minerals. The rocks there are weathered and do not promise fresh material. Hammering on the large boulders that line the north side of the spillway is far more productive, and should be for quite a while to come, as many big boulders remain that show the punky, reddish contact that signals possible interesting mineralization.

On this particular Monday, however, the drizzle quickly produced numb finger, even inside gloves. By midmorning, Joe announce he had had it (and I think he was beginning to question the sanity of Northwest collectors) and he took off to meet someone in Nevada, where I am sure it was warmer. The three of us that remained decided to switch our attention to the large quarry down the hill to the west of the spillway. Over several collecting trips, the quarry had produced a few odd pieces and we wanted to try to find enough to analyze.

The drizzle continued in the quarry, and it was just as cold. Doug did manage to locate a stool-sized boulder of the sort of rock we were looking for, and with sledge hammer and numb fingers we proceeded to reduce it to liftable size chunks, which we divided to bring home.

This rock is clearly from a separate flow, as the chemistry of the minerals it contains is completely different. The texture and color of the rock is similar, but the cavities are throughout the rock rather than limited to a thin rind, and they tend to be cluttered with a tangle of poorly formed crystals, some clear blades, and some black or reddish irregular needles. Cavities vary from a few millimeters to 2 centimeters or more. Some are completely filled with a jumble of loosely associated crystals in one big cluster. Typical crystals from a more open pocket are shown in the micrograph below.



Albite on Hedenbergite
Lemolo Lake Quarry

The inset above is of a typical
Pyroxene crystal form.

The horizontal crystal in the above micrograph is one of the irregular dark rods. When “fresh”, I believe they are black. Oxidation often has given them a red coating on the surface. EDAX analysis shows this one to be a calcium iron silicate with only traces of sodium, magnesium and aluminum. This is the correct composition for hedenbergite.

Moreover, the section of the crystal just to the right of center has the classic shape of a pyroxene, as shown in the diagram above in the same perspective.

Hedenbergite – $\text{Ca Fe}^{+2} \text{Si}_2\text{O}_6$ – is currently the proper name to be applied to a ferrous calcium pyroxene low in aluminum, magnesium, and ferric iron. Though this mineral is often found in metamorphic rocks, it is also formed in igneous environments. The skeletal form of these crystals makes it very difficult to find terminations as a method of identification. Moreover, the needles often have black, metallic crystals of octahedral **Magnetite** and rhombohedral **Ilmenite** or Hematite adhering to their surfaces, and a ruddy coating (hematite?) covering the exposed areas.

In the micrograph above, one can also see a second crystal attached to the far side of the needle. This colorless-to-white blade is an aluminum silicate of sodium, calcium and potassium that I believe could best be described as **Albite**. Albite is a plagioclase feldspar rich in sodium – $(\text{Na,Ca}) \text{Al} (\text{Si,Al})_3\text{O}_8$. It forms clear “flakes” with many fracture and striations marking them. The flakes seldom have a regular outline. They stand up among the hedenbergite needles and are often attached to them.

In addition to the albite flakes, there are also clear feldspar crystals growing flat against the walls of the cavities. These are low in calcium and contain considerable potassium, which would probably make them **Sanidine** – $(\text{K,Na}) \text{Al Si}_3\text{O}_8$.

Small tufts of very tiny yellowish hairs resemble the **Aegirine** – $\text{Na Fe}^{+3} \text{Si}_2\text{O}_6$ – that is found on some of the specimens at Summit Rock. These tend to be scattered on the sanidine and hedenbergite base material.

Some cavities show scattered white balls of **Cristobalite** – SiO_2 -. Most of the cavities have mats and individual crystals of **Apatite** – $\text{Ca}_5 (\text{PO}_4)_3 (\text{F,OH})$. These are colorless needles usually fairly long but too fine to be able to make out the hexagonal cross-section under normal magnification.

In other cavities from other rocks that appear to be from the same flow, the needles are translucent brown and appear to be magnesian hornblende, often with magnetite growing on them. These cavities also show abundant blades of albite along with large blades of ilmenite.

Thus we see a flow fairly rich in aluminum, calcium, potassium, titanium, and sodium with minerals forming readily in its interior. Since these pieces of this flow have only been found as loose rocks in the quarry, it is not yet clear just exactly where on the hillside they originated. Several flows, including the one exposed along the spillway, are present in the quarry area.

By the time we had dismantled the boulder and loaded its pieces into our pickups, it was mid-afternoon and we were pretty thoroughly chilled and ready to go back to camp. By the time we drove back up the hill to Diamond Lake, the drizzly rain had mixed snow in it. That was when I decided I had had it and packed up my things to head back to Portland. Doug and Becky decided to stay one more night. They said the four inches of snow that covered everything by the next morning was really pretty. Then they headed up into John Day country where it was considerably warmer.

Update on Zeolite Species

Donald G. Howard

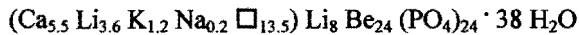
As I am sure you are all aware by now, the Zeolite Group has recently been expanded to include a number of additional minerals. Rudy Tschernich summarized the new rules for zeolite nomenclature shortly after their adoption by an article in the *Microprobe*, Vol. VIII, #7, pg 2-5, with a list of the newly added and rearranged members included on page 6. Naturally, the newly included minerals, as well as some of the recently described minerals, are not a part of Rudy's "Zeolites of the World". They are also probably not minerals many of us are familiar with. So beginning with this issue, I intend to review the new additions a few at a time so you can update your references.

I hope you find this information useful to you. You might discover, as I did, that you already have some of these minerals in your collection.

For openers in this issue, I have elected to introduce two minerals that are perhaps the most controversial of the list in that they are a real departure from the traditional definition of a zeolite as an aluminum silicate. These are instead beryllium phosphates. Chemists working to synthesize zeolites have recognized similar structures in the phosphates for many years now. The PO_4 are tetrahedral and therefore now qualify if they form a spatially linked network. In the two minerals that follow, the beryllium and phosphorus are both tetrahedral and link in such a way that a spatial network with channels is formed. In fact, both minerals have structures closely related to existing materials, natural or artificial, that have been recognized as zeolites by the old definition that limited the group to aluminum silicates.

NOTE: There is a new convention that is appearing in the writing of chemical formulas for minerals. You will note that in the formula for pahasapaite, the symbol \square appears. This symbol is used to indicate a vacant site. The first parenthesis represents a site in the unit cell of that mineral that by symmetry has 24 equivalent locations. Of those, only 10.5 are occupied (5.5 by calcium, 3.6 by lithium, 1.2 by potassium, and 0.2 by sodium). Like in many zeolites, this represents an easily exchangeable set of ions, so this part of the formula could contain a variety of ions, depending on the environment. Presumably, if all such ions were monovalent, half the sites would be filled, probably in a random way. Introducing divalent calcium increases the number of sites that are vacant in order to maintain charge neutrality. This scheme of writing a formula takes symmetry into account by including site occupancy. It probably makes a difference only to structural chemists, but it is now appearing in the literature, so we include it with this explanation so that when you run across it, it won't throw you.

Pahasapaite



Named in 1987 for the Lakota Sioux word *pahasapa*, their name for the Black Hills.

Type locality: Tip Top Mine, Custer Co., South Dakota, U.S.A.

Structure

Crystal System: Cubic

Space Group: I23

Crystal axes: $a=13.781 \text{ \AA}$

Type of Structure: Ordered PO_4 and BeO_4 tetrahedra are formed into a spatial framework similar to that of the synthetic zeolite rho. In zeolite rho ($\text{Na}_9 \text{Cs}_3 \text{Al}_{12} \text{Si}_{36} \text{O}_{96} \cdot 73 \text{H}_2\text{O}$), there is a body-centered cubic array of cages whose shape is that of an octahedron truncated by a cube and dodecahedron in such a way that the cube faces are octahedral. These are connected together by octagonal prisms along the crystallographic axes in such a way as to make two sets of channels. In pahasapaite, the cages are distorted diagonally in opposite directions in each channel system. The Li ions and their associated water molecules are located in the octahedral "faces" of the cages. The remaining ions (represented by the first parenthesis in the formula above) are located in the octagonal prisms that join the cages and are probably readily exchangeable.

Physical Properties

Color: colorless, light pink, transparent

Streak: white

Luster: vitreous

Hardness: 4.5

Density: 2.28 g/cm^3

Cleavage: none

Optical Properties

Refractive Index:

$n = 1.523$

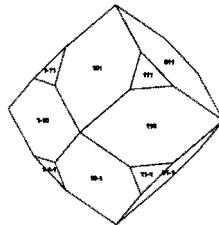
isotropic

no twinning

Morphology

Euhedral crystals up to 1 mm

Forms: $\{110\}$ and $\{111\}$



Occurrence

Pahasapaite is a pegmatite mineral that occurs with other beryllophosphates in fractured beryl crystals.

United States

South Dakota: Tip Top Mine, Custer Co., associated with montgomeryite, tiptopite, eosphoite-childrenite and roscherite.

References:

1. Rouse, R.C., Peacor, D.R., Dunn, P.J., Campbell, T.J., Roberts, W.L., Wicks, F.J., and Newbury, D. (1987) *Pahasapaite, a beryllophosphate zeolite related to zeolite rho, from the Tip Top Pegmatite of South Dakota*. Neues Jahrbuch für Mineralogie Monatshefte, 433-440.
2. Rouse, R.C., Peacor, D.R., and Merlino, S. (1989) *Crystal structure of pahasapaite, a beryllophosphate mineral with a distorted zeolite rho framework*. Am. Min. 74, 1195-1202.

Weinebeneite

$\text{Ca Be}_3 (\text{PO}_4)_2 (\text{OH})_2 \cdot 4 \text{H}_2\text{O}$, $Z = 4$

Named in 1992 by Franz Walter for the type locality.

Type locality: The dump of an exploration adit about 2 km west of Weinebene Pass, Koralpe, Carinthia, Austria

Structure

Crystal System: Monoclinic

Space Group: Cc

Crystal axes: $a=11.897 \text{ \AA}$

$b=9.707 \text{ \AA}$

$c=9.633 \text{ \AA}$

$\beta=95.76^\circ$

Type of Structure: PO_4 and BeO_4 tetrahedra form sheets of alternating 8-member and 4-member rings in the bc plane, the sheets being offset from each other. Additional beryllium tetrahedra connect the sheets in such a way as to form 3-membered rings. This makes a series of channels along [001]. The Ca atoms and water molecules are located in the channels. The structure is related to that of the mineral lovdarite and to the structure of gismondine.

Physical Properties

Color: colorless

Streak: white

Luster: vitreous

Hardness: 3-4

Density: 2.15 g/cm^3

Fracture: irregular, splintery

Cleavage: none

Twinning: none

Optical Properties

Refractive Index:

$\alpha = 1.520$

$\beta = 1.520$

$\gamma = 1.530$

biaxial positive

$2V < 10^\circ$

$Z^c = 42^\circ$

Morphology

Xenomorphic rosettes of crystals up to 20mm in diameter. Individual crystals on their periphery are platy on {001} and elongated parallel to [100], with sizes up to $0.1 \times 0.3 \times 0.5 \text{ mm}$.

Forms: Dominant forms are {001}, {110}, {-110} and {010}.

Rare forms include {100}, {111}, {-111}, {113} and {-113}.

Chemical Composition

$\text{Ca}_{0.99} \text{Be}_{3.02} \text{P}_{1.97} \text{O}_{7.88} (\text{OH})_{2.11} \cdot 4 \text{H}_2\text{O}$

Occurrence

Weinebeneite occurs in narrow fractures in a fine-grained spodumene pegmatite hosted by kyanite-bearing mica schists. The fractures are filled with rare secondary phosphates, including weinebeneite, fairfieldite, roscherite, and uralolite.

Austria

From the dump of an exploration adit about 2 km west of Weinebene Pass, Koralpe, Carinthia.

References:

1. Walter, F., (1992) *Weinebeneite*, $\text{Ca Be}_3 (\text{PO}_4)_2 (\text{OH})_2 \cdot 4 \text{H}_2\text{O}$, a new mineral species: mineral data and crystal structure, Eur. J. Min. 4, 1275-1283.

Micromineral Meeting November 5th

The Northwest Mineral Gallery at the Rice Museum will be completed for the November micro meeting. Excellent displays of quartz, calcite, barite, zeolites, gold, sunstones, agate, thundereggs, and some of the finest specimens of general minerals from the Northwest will be present. The finest specimens from the collections of Lew Landers, Bart Cannon, Randy Becker, and John Cornish will be on loan for this special opening. We will meet similar to the way we did at the last meeting. Please bring extra tables. Some tables can be used outside next to the building for free minerals leaving us more room inside for members, microscopes, and viewing the new displays.

There is a weeklong ½ price OPAL SALE going on in the lecture room of the main building from 1 to 5 p.m. Micro members are welcome to attend the sale. We have added a large gravel parking area next to and behind the metal storage buildings behind the Northwest Gallery. We ask the Micro members to park in this area after unloading so that there will be space for the general public attending the opal sale.

Come to the Micro meeting and have fun.

Rudy Tschernich
Curator

Micro Probe Format

At the spring meeting we had a discussion of the format that the Micro Probe should be available in. The options run from a paper format as we currently have, publishing it on CD, or providing it on a website. The advantages of the CD and website format would be the ability to provide more color photographs per issue without much added expense. I would like to solicit feedback from the membership on how we present the Micro Probe in the future. For those who do not use a computer we will continue to provide the Micro Probe in the present format.

Please contact me and let me know your preference. If you are not at the fall meeting I may be contacted at

dmerson@wavecable.com

Douglas Merson
2807 Fircrest Drive SE
Port Orchard, WA 98366-5701

Or by phone at 360-871-4061 after 5 PM Pacific time.