Northwest
Micro Mineral
Study Group

MICRO PROBE

SPRING, 2012 **VOLUME XI, Number 5**

SPRING MEETING . . . . .VANCOUVER, WASHINGTON

May 5, 2012 9:00 am to 5:00 pm

Clark County P. U. D. Building
1200 Fort Vancouver Way
Vancouver, Washington

Time once again to spend the day together. We will be talking more about the minerals from the Golden Horn. Please read the President's Message on the next page, and make contact in advance if you wish to order a copy of the new Unknown List.

Spring meeting agenda:

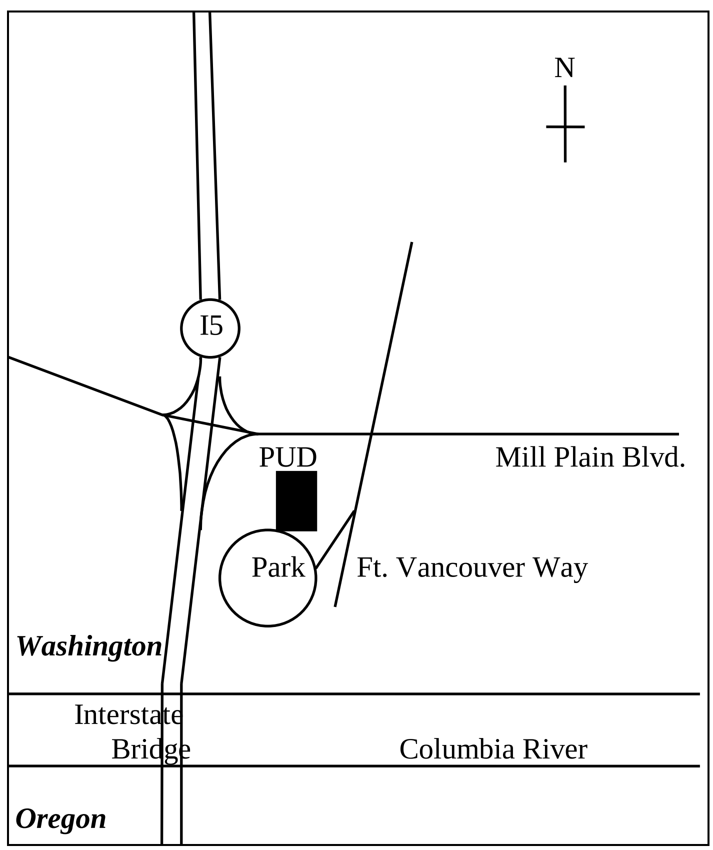
9:00 am: The doors will open and tables will be set up. Bring minerals for the free mineral tables. Exchange specimens, discuss minerals, and have a good time.

10:00 am: General meeting
11:00 am: Program on **Known Minerals from the Golden Horn Batholith** by Rudy Tschernich

Noon: Pot Luck Lunch: sandwich fixings and coffee will be provided by the club. Please bring something to add to the selection.

1:00 pm: Program **Unknown Minerals from the Golden Horn Batholith** by Randy Becker

2-4:30 pm: study minerals
4:30pm: clean up
5:00 pm Dinner will be at the County Buffet in Vancouver. Please join us if you can.



Presidents Page

by Rudy Tschernich

The Spring 2012 meeting is soon approaching and now is the time to gather things together to share with the group. The Northwest Micromineral Study Group's mission is to study minerals. The current area of study is the minerals from the Golden Horn Batholith. This is a very complex area and it will take some time before it is somewhat understood. Expect a lot of time, discussion, and programs on the minerals from the Golden Horn Batholith at the Micro meetings. Expect many of the papers presented in the Micro Probe Newsletter to be devoted to the Golden Horn Batholith.

Some of the membership has been working on the Golden Horn Batholith Project this winter. I have been working all winter with Randy Becker, photographing his Golden Horn Batholith specimens for the unknown list and for programs to be presented at the micro meetings. I have taken over 600 photos to represent the species found in the Golden Horn Batholith and will take many more. A small Research Group consisting of Saul Krotki, Don Howard, Bob Meyer, Lanny Ream, Randy Becker, and Rudy Tschernich have met at my home and Randy Becker's home in Yakima to discuss research on unknowns from the Golden Horn Batholith. We talked about what kind of research is needed on each of the unknowns and who will do the work. Twelve rock specimens from important boulders in the Golden Horn Batholith have been sent out for thin section work. They should be back soon. I will study the thin sections and write a paper on the results for the Fall 2012 newsletter.

Since digital images are easily copied without authorization and put on the internet or Mindat, I have decided not to publish the digital images of the unknown minerals I have taken of Golden Horn minerals in the Microprobe Newsletter, since we do not have control over them. Many tentative species-like names on samples will change as research is completed and we find out what they really are. Too often incorrect information or names followed by a ? is placed on the internet without the ?, which makes it very difficult to correct. For this reason the 47 page Unknown List compiled by Randy Becker will not be put on the internet. We will provide printed color copies of the Unknown List at the spring micro meeting for the cost of printing ($10. to $20. depending on number printed). If you are interested in a copy email Don Howard at **pogodh@hei.net** soon enough in advance so that sufficient copies will be available. These copies are a "work in progress" and will be constantly changed as new unknowns are added and new information or positive identification is achieved.

In order to organize the unknown minerals from the Golden Horn Batholith, bring your unknown specimens from the Golden Horn Batholith and present them to Randy Becker at the meeting for identification or addition to the unknown list. If the specimen is to be added to the unknown list, you will have to either provide a photograph of the unknown or loan the specimen to Rudy Tschernich to be photographed and returned at the next meeting.

IN MEMORY OF ELSIE BOGGS

1920 – 2012

It is with great sadness that we must report the passing of Elsie on the day after New Years at the age of 91. She has been ailing for nearly a decade now with problems in her back that made it very difficult to be up and around at all. Bob has been faithfully taking care of her, most recently with the aid of his son.

We remember Elsie as someone who always had a smile on her face and a cherry word for everyone. She and Bob were some of the original members of our group and participated actively in our meetings and collecting trips for many years before it became too difficult to travel to meetings. They were also long-time members of the Northern California Mineralogical Association.

Elsie truly loved nature, and she loved being surrounded by it. She loved the wildlife, particularly the birds, and could wax enthusiastic when she talked about them or helped you identify them. She equally well knew the trees and wildflowers. Being in the field with her made every experience doubly enjoyable.

She also loved people and being with them. Elsie and Bob have made a loving team of encouragers for some 62 years. We will certainly miss her, and our hearts go out to Bob in his time of mourning.

Donald Howard

THE MICROPROBE

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Minerals of the Golden Horn Batholith

by Rudy Tschernich

Alkaline Granite

Allanite
Aegirine (acmite)
Aenigmatite
Agardite-(Y)
Albite
Anatase
Annite (biotite)
Arfvedsonite
Astrophyllite
Bastnäsite-(Ce)
Calciocatapleiite
Calcite
Cerussite
Chalcocite
Chevkinite
Chlorite Group
Chrysocolla
Elpidite
Euxenite-(Y)
Fayolite
Fluorite
Gadolinite-(Y)
Gagarinite-(Y)
Galena
Goethite
Hematite
Ilmenite?
Kaolinite
Linarite (Henrik Friis)
Löllingite
Magnetite
Microcline
Molybdenite
Monazite-(Ce)
Okanoganite-(Y)
Opal
Orthoclase
Pharmacosiderite
Polylithionite
Pyrite
Pyrochlore Group
Quartz
Riebeckite
Scorodite
Siderite
Sogdianite
Sphalerite
Spionkopite
Synchysite-(Ce)
Synchysite-(Y) (Stein Rorvik)
Thorianite
Titanite
Wulfenite
Yarrowite
Zektzerite
Xenotime-(Y) Micro Probe V6 #8 by Boggs. Not listed in thesis.
Zircon

Listed in Mindat but in question

Biotite var. Oxybiotite (Van King)

Clinochlore? (Howard)

Masutomilite (Mica Group) www.minsocam.org (Am. Min.)

Hisingerite? $Fe_2^3(Si_2O_5)(OH)_4 \cdot 2H_20$ alteration of biotite, brown to black resinous mica ID at Mont. St Hilaire determined by EDX

Hastingsite var. Alkali-ferrohastingsite amphibole classification used by Stull. Not used by Boggs.

Annite Granite

Albite
Anatase
Annite (biotite)
Apatite
Bastnäsite
Calcite
Chamosite
Chlorite
Fayalite
Ferro-hornblende
Fluorite
Gadolinite-(Ce) (Saul Krotki)
Gadolinite-(Y)
Genthelvite (Saul Krotki)
Goethite
Ilmenite ?
Laumontite
Kaolinite
Magnetite
Microcline
Opal
Orthoclase
Plagioclase
Prehnite
Pyrite
Quartz
Siderite
Titanite
Zircon

Bold species listed in Russell Boggs thesis

Border Granite

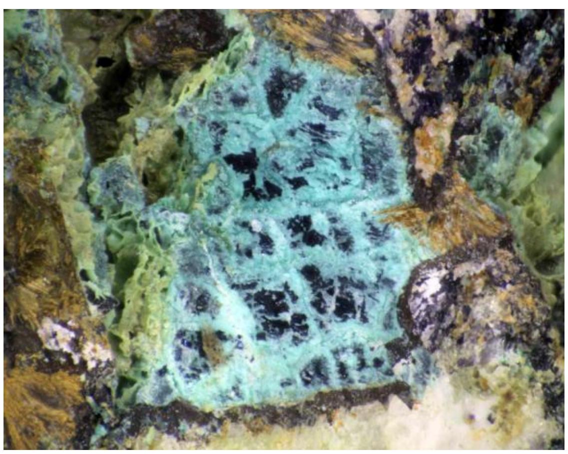
Aegirine (acmite)
Albite
Allanite-(Ce)
Annite (biotite)
Arfvedsonite
Bastnäsite
Calciohilairite
Calcite
Chlorite
β-Fergusonite-(Y)
Fayalite
Ferrokatophorite
Ferrorichterite
Ferrowinchite
Fluorite
Gadolinite-(Y)
Goethite
Hematite
Ilmenite
Kaolinite
Katophorite
Kainosite-(Y)
Magnetite
Malachite
Microcline
Opal
Pyrite
Quartz
Riebeckite
Siderite
Synchysite (Don Howard)
Titanite
Zircon

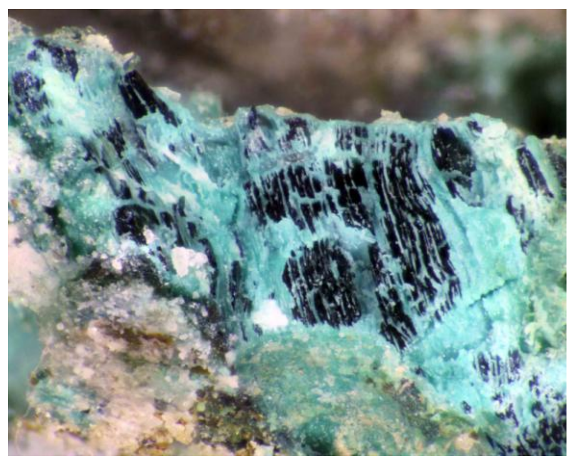
Yarrowite from the Golden Horn Batholith, Okanogan County, Washington

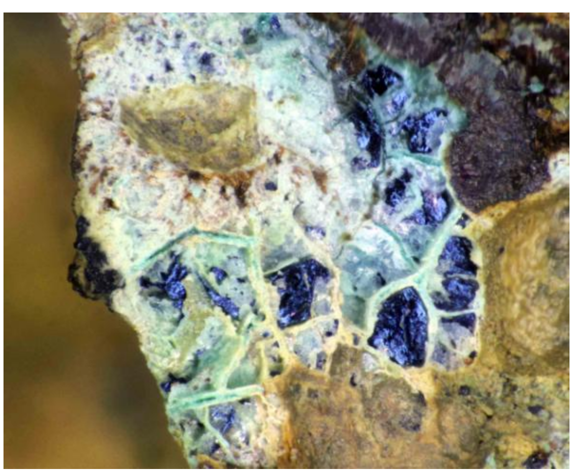
by
Rudy Tschernich
300 Alps Road Unit 1007
Moxee, WA 98936

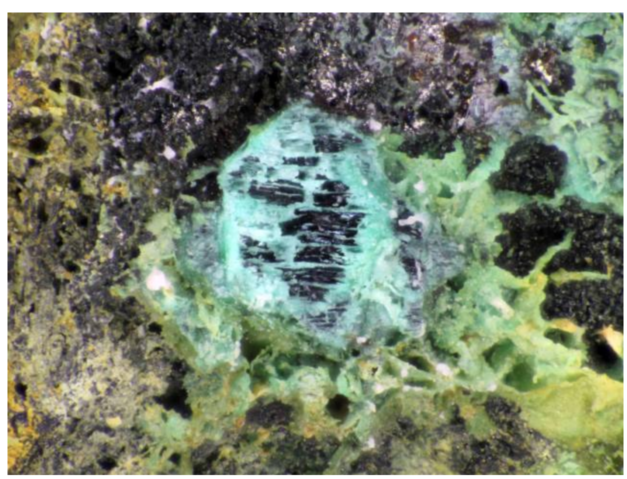
Russell Boggs (1984) described two unusual sulfides, yarrowite and spionkopite, in the sulfide-bearing arfvedsonite granite in the Golden Horn Batholith. These two species are closely related to covellite (CuS) which they resemble. They form peacock-blue cleavages and black stacks of plates associated with galena, sphalerite, löllingite, chalcocite, linarite, chrysocolla, and a green unknown that resembles malachite. Fe-arsenates occur along cleavage planes and light blue chrysocolla cuts across the blue yarrowite/spionkopite plates. Boggs (1984) lists micro probe chemical analysis of 40 points on this material and found that the majority of the samples had a Cu/S ratio between 1.035 to 1.265 making most of the material yarrowite (Cu_9S_8) Cu/S=1.13 with the remainder being closer to spionkopite ($Cu_{39}S_{28}$) Cu/S=1.39. Since these two species are always intergrown, you will not expect to find individual crystals of each species separately.

During photographing of Randy Becker's Golden Horn Batholith mineral collection, I discovered the specimens of yarrowite/spionkopite (RB211 and RB212) seen below that he collected in the 1980's on the Liberty Bell talus.









Genthelvite Crystals
Along the North Cascade Highway,
Okanogan County, Washington

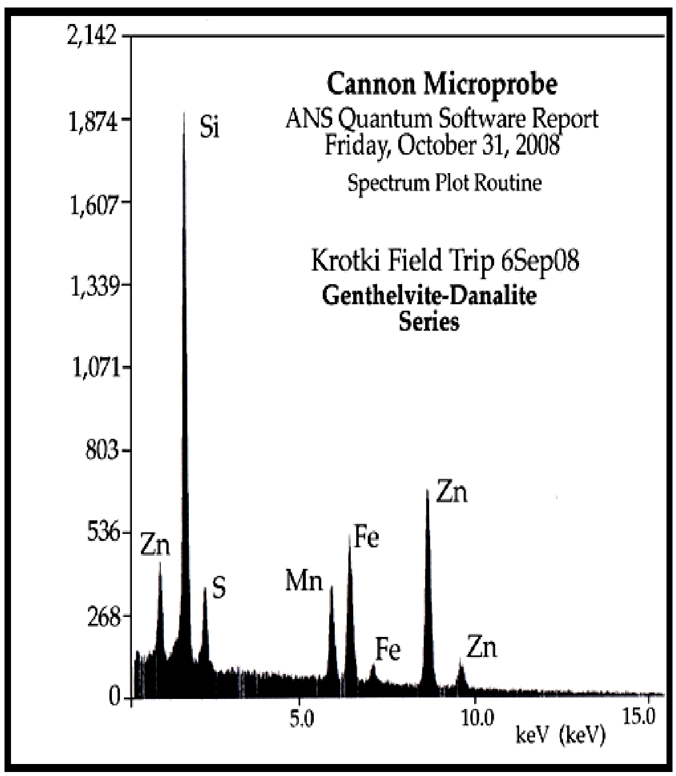
Saul Krotki February 2012

While breaking up some annite granite that I brought home from the North Cascade Highway, milepost 165, I came across a solitary crystal, tetrahedral in form, sporting a translucent pink glow. The material was collected during the summer of 2008.


Genthelvite FOV 3.0 mm wide

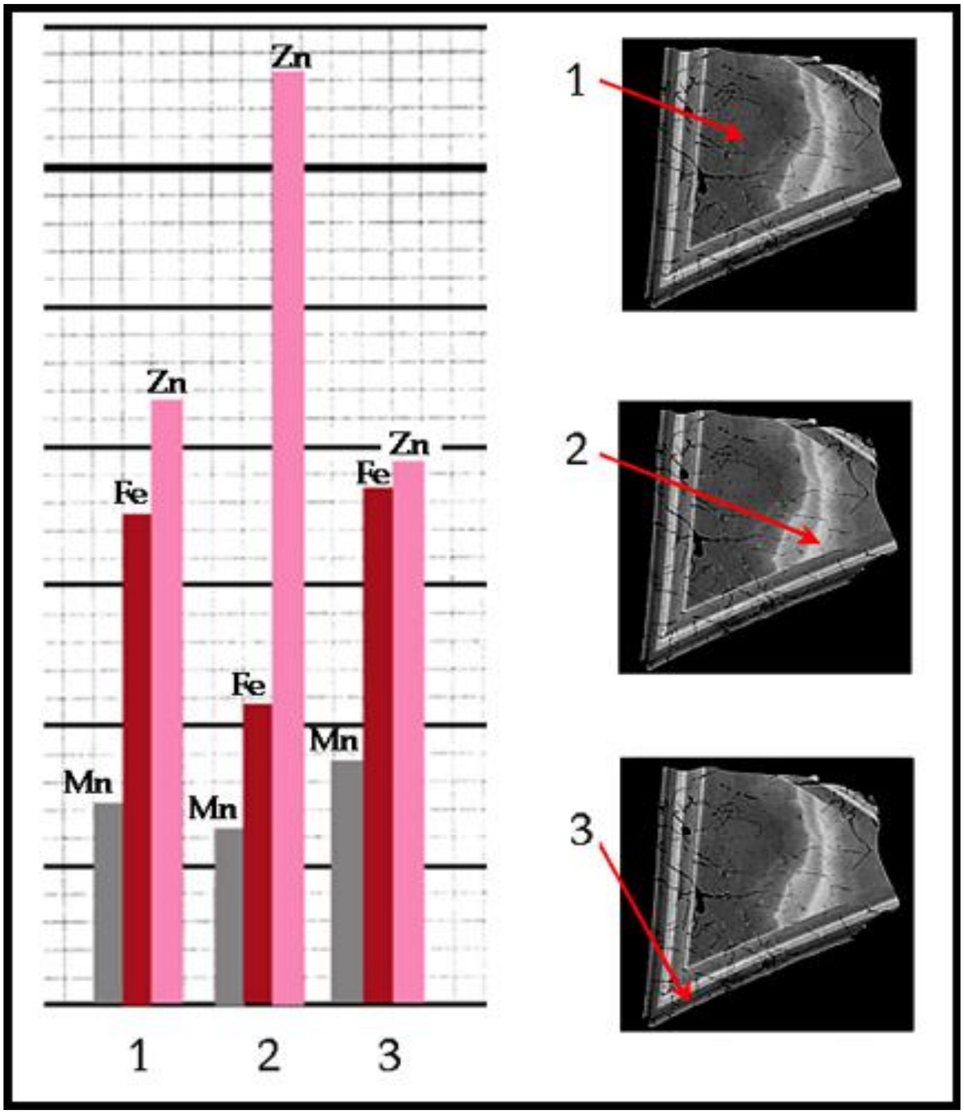

Okanoganite-(Y) FOV 4.4 mm wide

I had recently been very fortunate in collecting along a rusty fracture in an arfvedsonite granite boulder at milepost 166, from which I reaped a dozen cleanly-formed, but crusty crystals of okanoganite-(Y) (right above). Okanoganite crystals, as we know, are actually exotic twins of trigonal symmetry, which resemble isometric tetrahedrons. It was these pseudo-tetrahedral crystals that were on my mind when I found the pink crystal (left above). I fantasized that I had captured a gem-quality okanoganite — at last, I would be able to derive a fine, representative EDS spectrum for future comparisons!



I sent a fragment to Cannon Microprobe for spectral analysis. Bart Cannon called almost immediately to inform me that my pure crystal of okanoganite was, in fact, genthelvite! EDS spectral analysis is not sensitive to the beryllium content of genthelvite ($Zn_8Si_6Be_6O_{24}S_2$), but the spectrum does provide a good comparative match to standards for the Genthelvite-Danalite series. Genthelvite is therefore the species indicated, since it is the zinc-dominant member of the series, but iron-dominant, danalite, is also a possibility. With the results in hand, I immediately launched an investigation concerning the distribution of elements in different zones within the crystals. I searched for, and found some more fragments that would allow me to proceed.

The WA Pass genthlevites form twins in various parallel arrangements.
Collected and photographed by the author, August 2009. FOV 4.5 mm wide.
These are associated with annite books coated with chlorite.



Genthelvite Zone Study

The zone study was accomplished by John Attard, San Diego, California, in October 2009. The graph has been derived by the author, from detailed software- enhanced data, which John provided. No additional trace elements were found to be present. The Back Scatter Electron Images are 1.2 mm wide. Here you see iron approximating the zinc compositional proportion only in the outer-most zone of the crystal. In the core zones, zinc is distinctly dominant, therefore the crystals examined are clearly genthelvite.

Of the various species collected in the vicinity of milepost 165, genthelvite is among the most uncommon. Other associated species include anatase, bastnäsite-(Ce), fluorite, zircon, and gadolinite, which the author previously reported ("A New Find of Gadolinite-(Ce), Washington Pass, Okanogan Co., WA" *MICRO PROBE,* Vol. X, #10, Fall 2009).

The area of milepost 165 invites continued examination. The steep avalanche chutes continually supply fresh material, all within easy reach from the ample parking area. This is a truly wheelchair-accessible mineral collecting locality! Watch for the rock that has a hint of blue-gray color when wet. If you bring home a truck full and spend your winter breaking up the rock, you will surely uncover some surprises under the microscope!

Kainosite from the Liberty Bell Talus

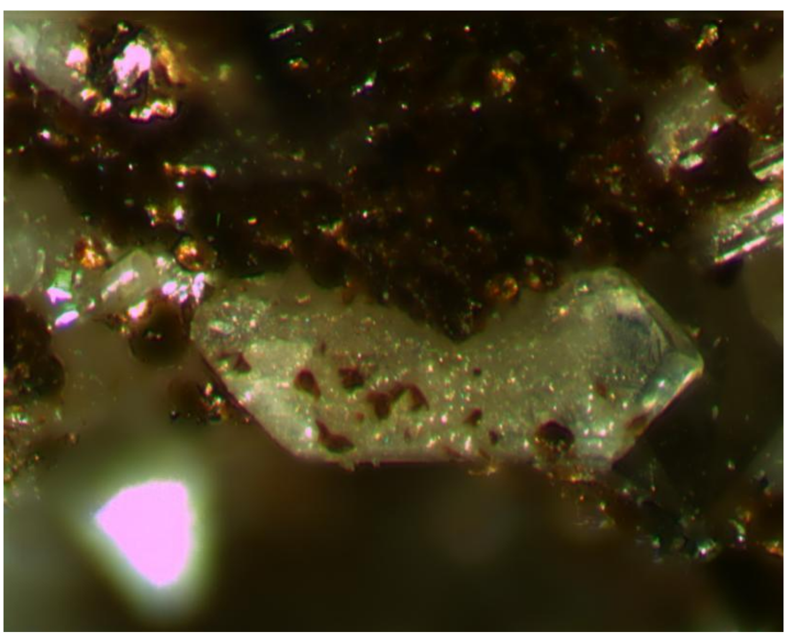
By Don Howard

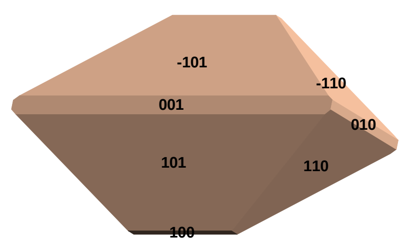
One of the medium-sized rocks in the pile beneath Liberty Bell has produced a fair number of very nice kainosite crystals. Actually, it is two halves of what was once a larger rock that must have split on contact, with the pieces ending up several dozen yards apart. Structure in the face of each of them caused me to associate them, and Bob Boggs, who was with me at the time, confirmed my suspicion. Later examination of the minerals they contain added further evidence that we were indeed working with two halves of the same boulder.

This particular rock has a great many small vesicles, and as a result is rather easy to chisel fragments off of its surface. So far, the following minerals have been identified.

Matrix minerals	Cavity minerals
Annite	Allanite-(Y)
Microcline	Fluorite
Quartz	Kainosite-(Y)
	Riebeckite
	Titanite
	Zircon
	Chamosite(?)

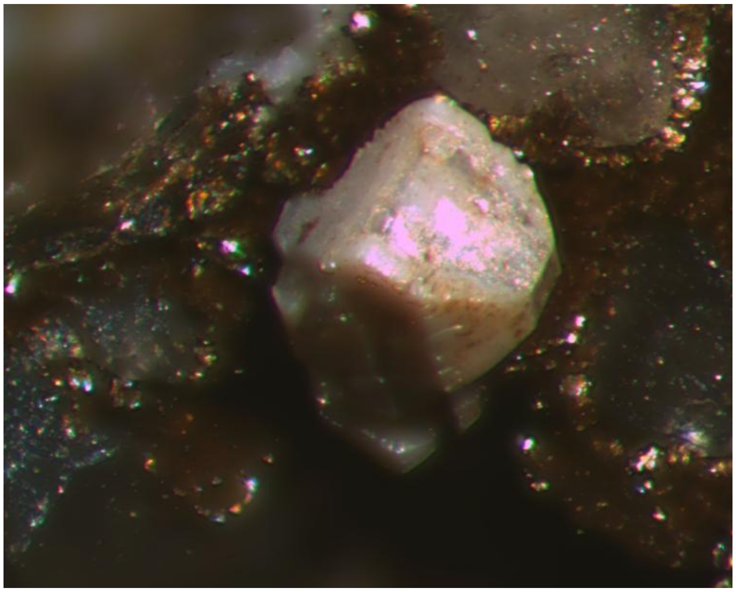
Kainosite-(Y) is a carbonate silicate of calcium and yttrium: $Ca_2Y_2Si_4O_{12}(CO_3)\cdot H_2O$ X-ray fluorescence show no cerium or other rare earth elements, though there is a small amount of iron present that may be responsible for the very pale yellow color of some of the crystals. The crystals are orthorhombic and are usually embedded in the fuzzy brown material lining the cavities, which is often referred to as chamosite. The picture and diagram below show the most common form: clear, pale yellow prisms elongated along the b-direction.

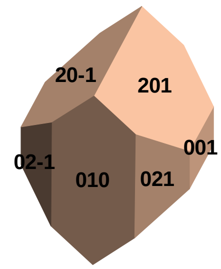




Kainosite-(Y) from the boulder located on Liberty Bell, Washington Pass, Okanogan Co., Washington. The diagram at right shows the orientation and the faces present, (100), (010), (001), [101], and [110].

However, another form has also been identified from the same boulder. These crystals are more equant, and only the (001) appears as glassy. The little crystals overall look very white and opaque. Moreover, the faces present are different. The X-ray fluorescence spectrum looks very much the same for both forms of crystals.

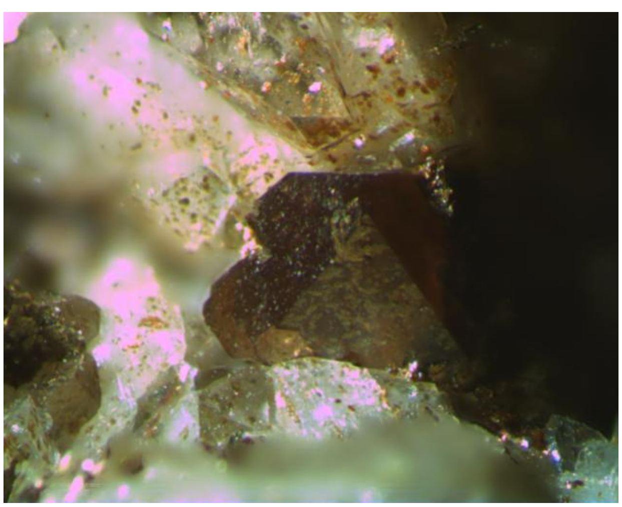


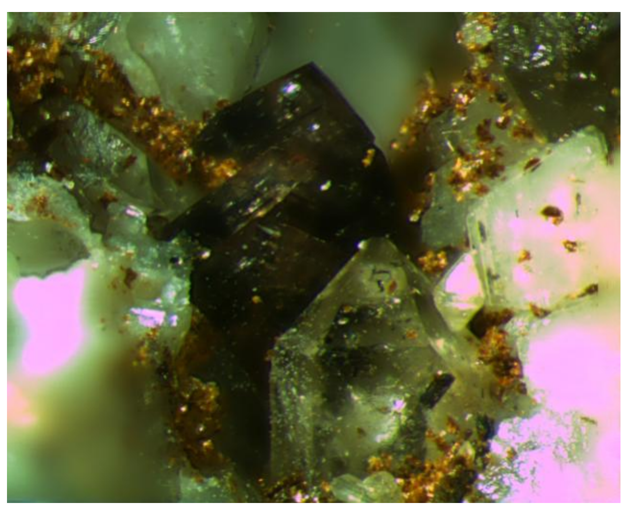


A second form of Kainosite-(Y) from the same boulder. Notice the small clear (001) face on the right side. The diagram at right shows the orientation and the faces present, (010), (001), [201], and [021].

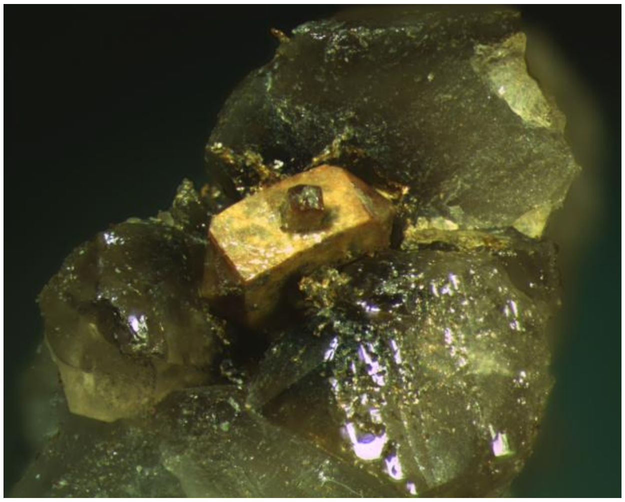
One possible clue about the differences might come from the positioning of the crystals. The clear, elongated form is normally found well embedded in the brown "chamosite", while the white opaque form is usually very much on the surface. We could be looking at crystals that formed at different times and therefore under different conditions.

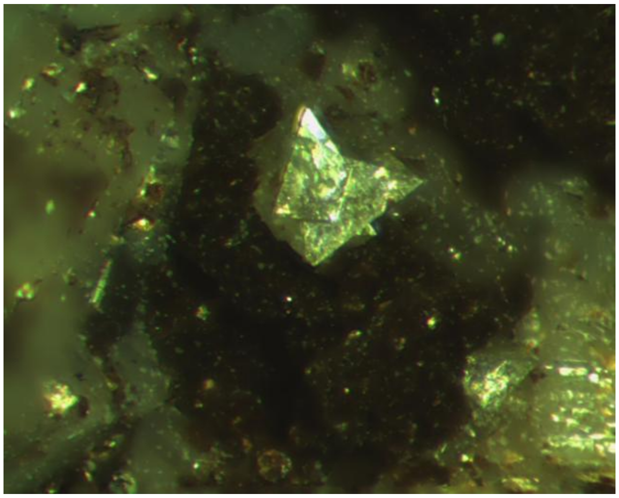
Other minerals in this boulder also show more than one crystal habit. Titanite usually forms as thin, sharp blades that are clear and somewhat smoky in color. But there is also a bipyramidal form that is orangy brown and much more opaque. This latter blocky form is usually much more embedded in the surrounding quartz-microcline matrix, so is probably the earlier to form.





Two forms of titanite, bipyramidal on the left, sharply bladed on the right.





Two forms of zircon from the kainosite boulder on Liberty Bell, Washington Pass

Another mineral that comes in a variety of forms and colors is zircon. All crystals show the typical pyramidal termination, but there is a range from no prism at all to greatly elongated prisms. Shown above is an opaque crystal with a tan colored prism and reddish brown termination, and a much glassier form that is greenish in color and shows only double pyramids with no prism at all between. The left micrograph shows two crystals in a penetration twin. Intermediate examples, of brown bipyramids with no prism, are also seen in some of the cavities.

All of this comes from studying the minerals in one boulder. Think of how many boulder's worth of granite are waiting up at Washington pass.

The Rare Earth Carbonates

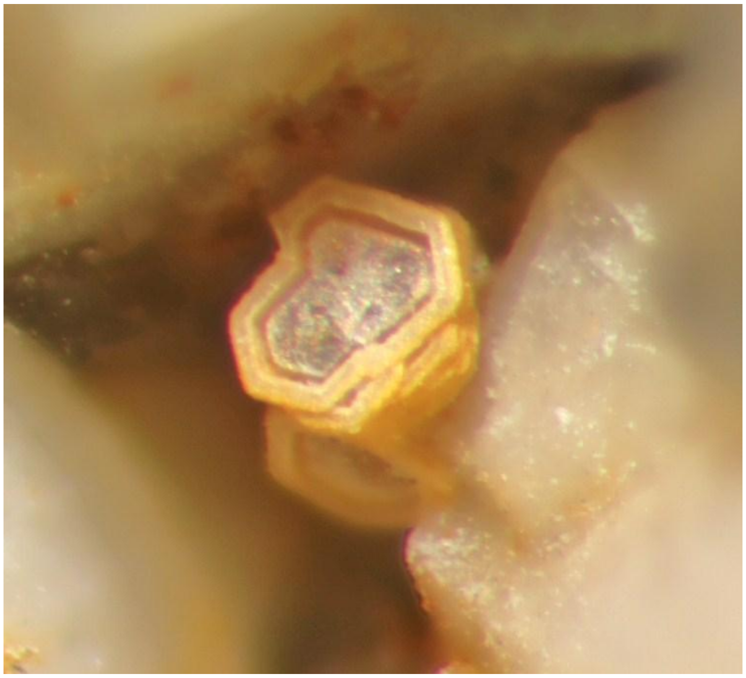
By Don Howard

There is a group of minerals, present in many of the rock environments of the Golden Horn Batholith, that are very difficult to tell apart. These are the group of carbonates best known from the mineral group Bastnaesite. Six minerals have so far been recognized in this group. The set can be represented chemically by the formula: (Ce,La,Y) (CO_3) (F,OH)
At Washington Pass, the mineral thus far identified is Bastnaesite-(Ce), the fluorocarbonate of cerium. Like all the members of this group, it forms layers with a hexagonal arrangement of atoms.

A closely related group of minerals are the Synchysites, whose chemical composition can be represented as: (Ce,Nd,Y) (CO_3) (F,OH) · Ca (CO_3)
In it, crystals possess layers identical to bastnaesite that alternate with layers of calcium carbonate. The structure of synchysite is very nearly the same as bastnaesite, but with a slight distortion, making it either orthorhombic or monoclinic, but it is said to be pseudohexagonal. The crystal form is still that of a hexagonal prism with flat ends. In principle, in spite of similar crystal habit, it should be possible to differentiate between the two minerals by detecting the presence of calcium.

But in nature, things are seldom that simple. It turns out that, since these are alternating layers, one can have other intermediate stackings. Two have been recognized and approved. Parisite has one layer of calcium carbonate to every two layers of REE fluorocarbonate. Roentgenite has two layers of calcium carbonate to every three layers of REE fluorocarbonate. By this point, you are probably beginning to suspect that you can have just about any ratio of layers, depending on the relative concentrations of calcium and rare earth element. And that is very probably true. What may very well occur is a random stacking of layers, which *average* out to some intermediate value. This makes the job of identifying these intermediate arrangements almost impossible, even using x-ray diffraction.

Notice that all the named intermediate phases are on the rare-earth-rich side. Why don't we have phases with more layers of calcium carbonate than rare earth fluorocarbonate? Interestingly, I think nature has shown us what happens to those phases. Consider the crystal shown in the micrograph on the next page. These crystals from the Okanoganite Boulder have been analyzed as synchysite-(Ce) in the center and bastnaesite-(Ce) on the outside. They usually have a hollow gap between phases. What I would propose is the following: In the mineral-forming solutions, the cerium and calcium were reasonably balanced originally, forming synchysite. Then the calcium became more abundant, making more layers of calcium carbonate than the cerium fluorocarbonate. Finally, the calcium concentration dropped until only the cerium layers formed. Now calcium carbonate is a trimorph, meaning that there are three atomic arrangements yielding three minerals: calcite, aragonite, and vaterite. The form that is consistent with the layers in synchysite is vaterite, the least stable of the three. Therefore, those layers of vaterite were subsequently easily dissolved by ground waters, leaving a void between the more stable minerals. One of the frustrations, of course, is that we cannot analyze the layer that is no longer present, so there is no real way to prove that the grove was originally calcium carbonate layers, but this is at least a plausible explanation for the structure of these crystals.

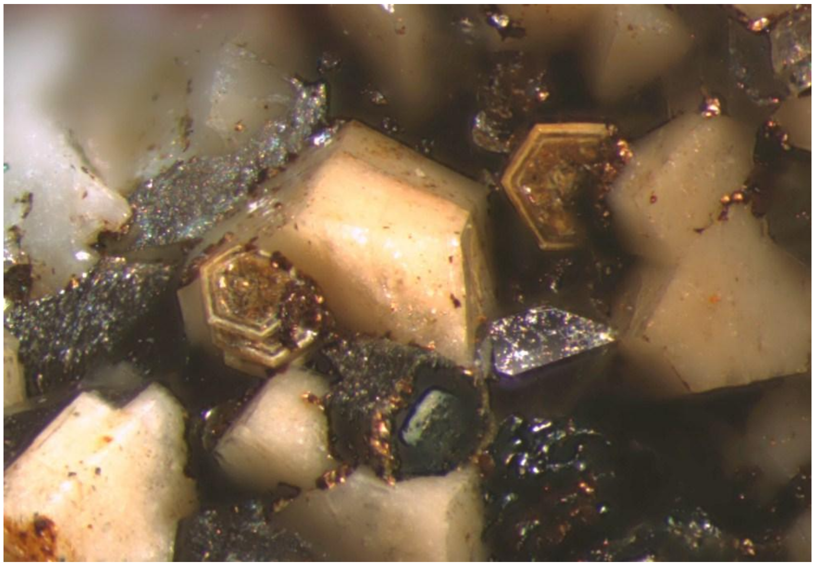


Bastnaesite / Synchysite
From the Okanoganite Boulder

I think we are going to have to adopt an identification scheme something like this: If there is very little calcium detected in XRF, we call it bastnaesite. If the calcium is substantial, we call it synchysite. The names parisite and roentgenite are going to be just too hard to establish, and should probably not be used without positive XRD identification.

That does not completely solve the nomenclature problem, because of the added complication of the suffix for the rare earth element in highest concentration. Preliminary results run on a crystal from the copper-containing Calciohilairite Boulder indicate that some crystals may be zoned as to the rare earth they contain. Surface XRF scans in the SEM suggest that the crystal is ytterim-rich in the interior and cerium-rich on the rim. Since a fairly large calcium peak is also observed, this would most likely be synchysite-(Ce) / synchysite-(Y). So even this simplified identification scheme is going to get messy.

As a final complication, surface scans of some crystals also show a considerable concentration of iron (substituting for calcium?). This has been discussed previously (Microprobe X-9 pg 8-11). Clearly a lot more work needs to be done to sort out the REE Carbonates.



Zoned REE Carbonates with Microcline, Annite and Quartz, from the Calciohilairite Boulder, Liberty Bell

Making Crystal Measurements

By Don Howard

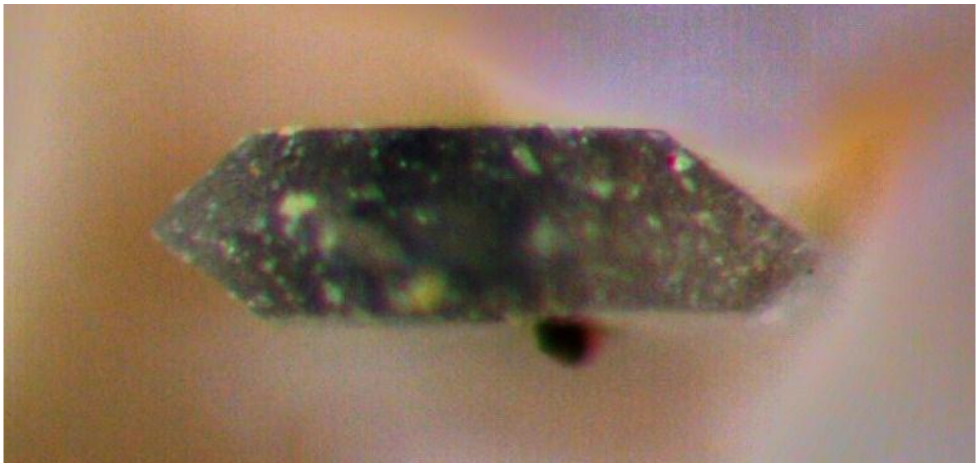
Seeing something in your microscope, and actually being able to make quantitative measurements of what you are seeing, has gotten a lot easier with the advent of digital microscope cameras. Now, what we are seeing can be captured into a computer and printed out onto paper, suitably magnified and ready to apply a ruler and protractor. Let me explain the procedure I use to obtain some of the details of the structure of a crystal. I am going to assume that the crystal I am looking at is not monoclinic or triclinic, since that greatly complicates the analysis phase.

First, if I have a choice, I am going to pick a well-formed crystal that I can see from several angles. I want a crystal with sloping faces. I will take the time necessary to orient it with one of the crystal axes pointing directly at the camera. This means I will tip it this way and that until faces parallel to the crystal axis in question just disappear. Then I take a picture from this view. It may not be a very attractive picture for ascetic reasons, but my purpose is diagnostic rather than artistic. I am going to take a single frame rather than make a composite (stacked) picture because I want to introduce as little distortion as possible. I am focusing on making the edges as sharp as I can.

If practical, I will repeat this procedure for another crystal axis. For cubic, tetragonal, or orthorhombic crystals this means orienting at 90^o with respect to the first picture. If I am really lucky, I may be able to take a picture down each one of the three crystallographic axes.

Having taken the pictures, processed them on my computer, and printed them, I now can move to the analysis phase. Consider the picture below:

Unknown mineral
Top view



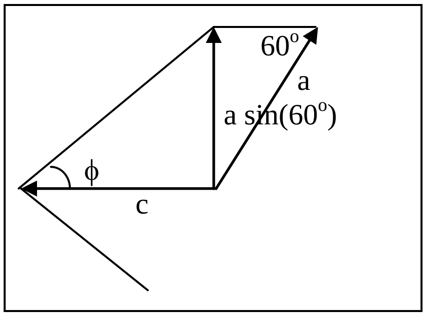
This picture represents a top view looking down on a single blade of an unknown mineral (WP-112) found in the rock on Liberty Bell often referred to as the ‘Parisite’ Boulder (though it is questionable whether the small orange-brown prisms are indeed parasite). The X-ray fluorescence data shows silicon, oxygen, and very little else. That result would say that this is just a flattened quartz crystal. However, look closely at the angle on the right and left edges. If this were quartz, which is hexagonal, and we were looking down the c-axis, those angles should be 120^o. I think you can see that they are less than 90^o – I actually measure very close to 80^o.

Randy Becker suggested the way out of this seeming contradiction: this view is not looking down the c-axis, but rather down one of the a-axes. The c-axis is actually oriented in the plane of the picture from left to right! In a hexagonal crystal, the direction perpendicular to both the a-axis and the c-axis is midway between the other two a-axes. So we can check to see if this will explain the roughly 40^{o} angle observed.

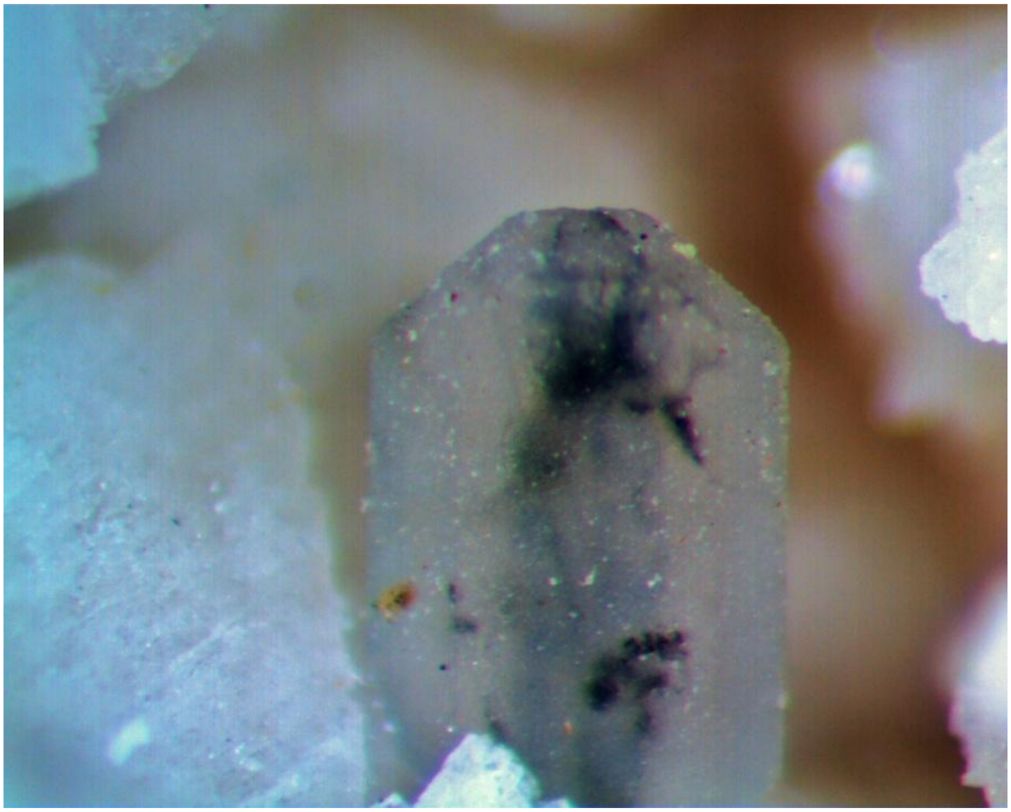
Using for quartz: a = 5.00A
c = 5.46A

$\tan(\phi) = a \sin(60^{o})/c$
$= 5.00 * 0.866 / 5.46 = .793$
$\phi = 38.4^{o}$

This is indeed just about the observed angle.



Below we show a side view of the same blade:



Unknown mineral (quartz) Side view

Bear in mind that the c-axis is horizontal, not vertical. What a strange shaped crystal of quartz: flattened, with the length along the c-axis shorter than the width. The identification only raises more questions. What could possibly have caused such a distorted shape for an isolated quartz crystal? Why is it so thin and short?

Washington Pass offers lots of puzzles for us to grapple with.

The Washington Pass Unknown List Project

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Thirty five years of collecting Washington Pass micro minerals has resulted in finding a lot of "what is this? " mineral specimens. These are known as "unknowns". In the early years of my Washington Pass collecting, many of my unknowns were put on Bob Boggs' handwritten unknown list. Some of the specimens on Bob's list were identified by work done by Russ Boggs but many stayed unknowns. During later years, my organizing and placing of specimens on any unknown list has languished. The finding of an unknown mineral has resulted in the specimen being labeled as unknown (UK), boxed, and placed with the known Washington Pass specimens in my collection. This resulted in my not knowing how many of a particular unknown I have, where they were located in the collection, and the inability to compare them. All of this resulted in additional barriers to the already difficult process of trying to get an unknown micro mineral specimen reliably identified.

Recent life changes (retirement and moving) have freed up time to ponder the state of my Washington Pass unknown collection. With the encouragement and unbridled enthusiasm of Rudy Tschernich, I have created a new up-to-date Washington Pass Unknown list. This list has been started with specimens from my collection, but it is intended to be a list for anyone who has Washington Pass unknowns that defy identification by visual or simple physical methods. The value of this list is greatly enhanced over prior attempts by the inclusion of high quality micro photographs of each unknown. The photographs of my unknowns have been taken by Rudy Tschernich using an automatic StackShot camera control system and Zerene Stacker software. Even when the photographs are not of "first rate" quality, they have great value in that they are able to depict features of the unknown that are only observable at magnifications greater than 30X. These photographs also give the reader of the list much greater understanding of what the unknown looks like than just the traditional written description which may be very subjective.

Generating this list was and is more challenging than it was initially thought. Unknown specimens had to be dug out of packed boxes, organized, and then pondered over for hours. Is it unknown or just another zircon? What software and formatting was debated. Finally the issues of how the information in the unknown list would be used, disseminated and protected are still being discussed.

This unknown list was originally conceived of as a simple list. For that reason, and common usage of software, it was decided to make the list as a MSWORD table. All known pertinent information on an unknown would be put in the list as well as at least one photograph. The following are the information fields that are being used and the rationale behind the fields.

1) **NO.** The format for the unknown number is "WP-X". The WP is for Washington Pass. The intent is this is not just Randy Becker's UK list , but a list for collectors that have unknowns that they may want to have added to the list. Thus the generic WP for the unknown number.

2) **I.D.** Usually blank. Names without "?" indicate a high confidence species ID based upon analytic data. Names (and data throughout the list) with "?" represents information that is questionable and needs further verification

3) **LOC. / ROCK TYP.** Gives information as to where the unknown was found at Washington Pass and if known, what type of granite the unknown is found in.

4) **COL.** (Collector) Gives the name of the first discover, if known,(first listed), other specimen owners, how many specimens have been found and the date found in the field if known. The number of specimens available for analysis can be a critical determining factor in getting an unknown identified.

5) **REF.** This field, so far, has just two references; a) if unknown was listed on Bob Boggs UK list, Bob's UK number is given when known. This was done since a number of my unknowns (and possibly other collectors) have Bob's number on the specimens. B) Multiple unknowns were discussed in Russ Boggs PhD dissertation Mineralogy and Geochemistry of the Golden Horn Batholith, Northern Cascades Washington but were not completely identified. This page reference points to that discussion in this thesis.

6) **DESC. / DATA** This field has brief description of physical characteristics, associations where significant, and brief description of results of any analysis.

7) **PHOTO** This section contains the photograph with information on the photographed specimen including brief description, where from, who collected it, date and photographer. In WORD the whole document can be magnified up to 5 times which enlarges the photo.

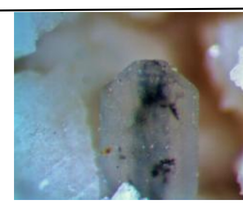
The intended use of this list is to get the unknown mineral specimens from Washington Pass organized in order to facilitate their identification. By other collectors having their specimens placed on the list, my single unknown specimen could turn into multiple specimens of the same unknown spread over several collectors, which enlarges the pool of specimens available for potential analysis.

One of the difficulties in making this list is deciding what to consider unknown. For example, bastnaesite is found at the MP166 road cut and has been analyzed (Boggs and others). It was also found and analyzed as bastnaesite / synchysite from the Sogdianite Pegmatite, and as predominantly bastnaesite with minor amounts of synchysite from the Okanoganite Boulder. Most Washington Pass collectors label the hexagonal tablets to elongated prisms that are frequently found in other locations at Washington Pass as bastnaesite. These specimens have not been fully analyzed and it is not known which member of the REE Carbonates the specimen is since they cannot be visually distinguished between the species. Parasite is speculated to be from the Liberty Bell talus but it has not been completely analyzed or verified. To date, the unknown list does not attempt to list every REE Carbonate mineral I have found from different locations but does list ones that seem to be different in some way from the more "average" ones.

Another aspect of the unknown list is that I have tried to minimize duplication as much as possible, but I am sure it exists. An example is Zircon. Zircon is common in most rock types at Washington Pass and displays a mind-boggling array of morphologies and distortions. As a result, the beginning collector's first unknown from Washington Pass is likely to be zircon. I am sure there are zircons in the unknown list, but a lot of effort has been made to try to not include too many at the risk of rejecting zircon look-alikes that might represent a new to Washington Pass species.

One issue with this unknown list is how to disseminate this information. A lot of effort and dollars has gone into generating the photographs and the text. This list, basically all new information, is considered a living document. It is constantly being updated, with more material being added. The date on the list reflects the version of the list on that particular date. It is to be considered outdated after that date. There is a large concern about unauthorized release of this list and / or the photos to the internet. The problem is that this would likely result in errors and incorrect information on the internet, which becomes very difficult to impossible to correct. This issue is currently still being discussed.

The following is an excerpt from the Unknown list to give an idea as to what the list looks like.

NO.	I.D.	LOCATION / GRANITE TYPE	DISCOVER / OWNERS	REF.	DESCRIPTION / DATA	PHOTO
WP-6		MP 164, MP 165 Fine grained Arfvedsonite (?) granite	B. Boggs? R. Becker 6/2/1995		White to off white to reddish pseudomorph after gadolinite (?). Often small bladed xls on surface	 RB 168 WP-6 UK pseudomorph after gadolinite ? From Amazonite boulder, MP164. Col. By Randy Becker 6/2/1995.
WP-7	REE Carbonate ?	MP 164 MP 165 Fine grained Arfvedsonite (?) Granite	B. Boggs R. Becker	B. Boggs # 63	Orange to Red opaque rounded hexagonal xls	 **Specimen WP7** unknown orange-red hexagonal **bastnasite?** plates with zircon , chamosite, and albite/microcline from MP 164 collected by Randy Becker.
WP-112	Quartz	"Parisite" Boulder Liberty Bell talus One feldspar Annite granite (Border granite)	D. Howard R. Becker (multiple?)	MicroProbe Vol. XI #5 Pg.14	Flattened xl. Luster etched Colorless with gray blotches D. Howard EDX Si, O	 D. Howard photo. WP-112 flattened blade, translucent colorless to gray, on microcline with REE Carbonate. Collected by D. Howard from 'Parisite' boulder, liberty Bell talus.