Northwest
Micro Mineral
Study Group

# MICRO PROBE

SPRING, 1992 VOLUME VII Number 5

## SPRING MEETING ------------------------ VANCOUVER, WASHINGTON

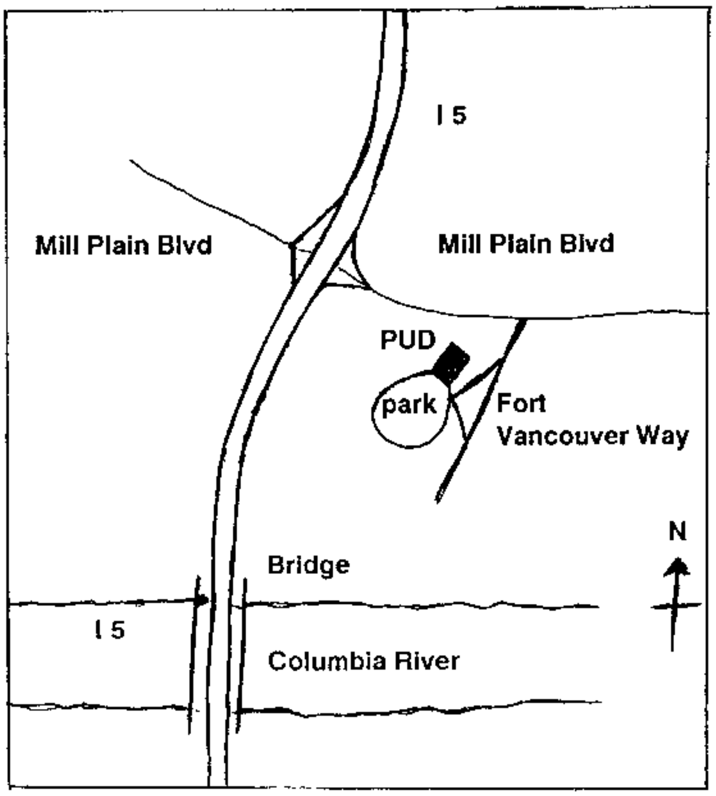
MAY 2, 1992 9:30 am to 9 pm

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

Don Howard and Genie are currently in New Zealand for 6 months. Rudy Tschernich is filling in as president at the May meeting and as editor of this issue of the newsletter.

The Northwest Micro Mineral Study Group (NWMMSG) is a group of mineral collectors interested in collecting and studying minerals of all sizes including those requiring magnification. Many of the members do not consider themselves micromounters for they do not mount tiny crystals in standard micromount boxes. Larger plastic boxes "Perky boxes" are generally used so that larger matrix specimens covered with crystals can be kept clean and studied. Even large crystals can be more fully studied and associated minerals found on them by using a microscope. We do not consider ourselves to be micromineralogists since none of us is so small that we need magnification to be seen. A title of mineral collector or mineralogist (one who studies minerals) is more exact. Members vary from those just beginning the hobby to those with over 40 years experience. Some of the members collect minerals just for the enjoyment of getting out in the great outdoors. Others are obsessed with the collecting and study of what is found to great depth. Many of our members hold degrees in mineralogy or geology. Some of these members have access to X-ray diffraction equipment, scanning electron microscopes, electron microprobes, and polarizing microscopes that enable precise determination of unknown or unusual minerals. Members are encouraged to bring unknown minerals to the meetings. The material may be easily identified by one of the members or if additional work is needed for identification someone can be suggested to work on it.

The NWMMSG is a very low keyed organization because most of the members are tired of long business meetings, planning of shows, and reading of minutes that take up nearly all the time at other clubs.



Our meetings are the first Saturday of May and November with a field trip generally planned on Sunday of the meeting weekend. Other field trips that take place during the year are planned at the May meeting. The Micro Probe is our main method of transfering information to the membership. Many of our out of state and out of country members have never actually attended a meeting but pay dues in order to receive the Micro Probe. The content of the Micro Probe is determined by the type of articles that are submitted by the members. We always have articles on zeolites since they are abundant in the Pacific Northwest and are a subject that Don Howard and myself are studying. Articles from other members are very much welcomed and needed by the editor. Some back issues of the Micro Probe are available at the meetings. SEM photographs that Don Howard usually makes for the Micro Probe are available as the supply lasts.

**Dues for the NWMMSG are due at the May meeting.** Please pay at the meeting or send $10.00 per member or couple to Evelyn Sweany, 1125 SE 52nd Ave, Portland, Oregon 97215.

Our business meetings are very short and informal. Planning of field trips and talking about collecting sites are the main business. Informal programs and slide shows of collecting trips or minerals are generally presented. The main purpose of our group is to bring together mineral collectors to talk, trade, and learn about minerals. Everyone is asked to wear a name tag at our meetings so that we can all learn each others names. If you do not have your own name tag, we will provide you with one at the meeting.

It is the policy of the NWMMSG to encourage the exchange of information and minerals. Please bring minerals to the meeting to be given away on the free table. Be sure to label the minerals given away and most important give the locality. Trading and selling of minerals has always been encouraged at the meetings. Many members do not have material to exchange, but would like specimens that are available; therefore, the intermediate exchange material (money) can be used. We require that anyone selling minerals at our meetings must be a member of the NWMMSG. The building where we meet has a limited number of tables that are needed for members to set up microscopes and for a limited amount of trading material. If you bring more than 4 flats of minerals for trading or selling, please bring tables to accommodate them.

With the exceptionally good weather this winter? and spring many of the members have been collecting nearly every weekend. Please plan to tell us of your exploits at the meeting. We are all interested in what areas are producing minerals and those that are not. If you have color slides of your collecting trips or minerals please bring them along for viewing.

It is a tradition of the NWMMSG to have a pot luck dinner in the evening (around 5:30). The club provides ham, scalloped potatoes, and coffee. It is also a tradition that I bring baked beans. Please stay for the pot luck. Bring either a hot dish, salad, or desert plus equipment to eat with. If you do not bring any food, you can make a donation to the treasurer towards the cost of the ham. A complete kitchen is present in the building with refrigerators, ovens, stoves, and sinks to prepare and heat up your creation.

## SCHEDULE FOR THE MAY 2nd (SATURDAY) MEETING.

| | |
|---|---|
| 9:30 | Doors open (please come early to help set up table and chairs |
| 10:00 | Trading, talking, identification of specimens |
| 12:00 | Lunch (bring your own or go to a local establishment) |
| 1:00 | Short business meeting and plans for Field Trips |
| 1:30 | Members report on collecting activities |
| 2:30 | Discussion of my book Zeolites of the World |
| 3:30 | Sides of minerals or trips |
| 4:30 | Visit and trade |
| 5:30 | Pot Luck Dinner |
| 7:00 | Clean up and visit |
| 8:00 | End of the meeting and prepare for field trip the next day |

## FIELD TRIP FOR MAY 3rd (SUNDAY)

A field trip is planned to the Four Mile and Five Mile Quarries, near Porter, Washington the Sunday of the NWMMSG meeting. (Porter is located between Aberdeen and Olympia). See the description of the minerals at this locality in an article in this issue of the Micro Probe. The drive is easy, lots of parking is available, and good micro minerals are present. This is a new locality that has not been heavily worked. Bring 4 and 8 lb. hammers, chisels, bars, boxes, wrapping material, and lunch. We will meet along the main street at Oakville at 9:00 am and proceed to the collecting site.

Other field trips will be planned at our May meeting.

The following is part of a letter Don Howard sent from New Zealand February 15, 1992.

Greetings from a fair distance away. You would really like collecting here. For one thing, getting into quarries, even while they are operating, does not seem to be a problem. Everyone we asked so far has said "Yes and welcome." And I think I know the reason for the difference. It has to do with liability insurance. In New Zealand, you don't need it, because it is covered by the government. There is no suing for personal injury. Car insurance rates are therefore marvelously low because all that has to be covered is property damage, theft, etc. And quarry operators are therefore very open to collectors.

If you think weather in the Northwest is changeable, you should see this place. Yesterday was cloudy and drizzled a bit in the morning. When I came home around 4 the wind was rather cold. By 6 the sun was out and the temperature has shot up into the 80's and it was stiffy. Two hours later it was cold and windy again. That may be a bit of an extreme, but suffice it to say that they give a separate weather forecast for mornings and for afternoons (which by the way seem to bear little resemblance to what actually happens the next day).

We're having a grand time, seeing lots of things and making many new friends. This is a great place to spend leave time. We have bought a little red '82 Mitsubishi Mirage and are getting used to driving on the wrong side of the road. When I say road, I do NOT mean freeway. Roads are two-lane affairs like they used to be in the "good" old days.

## Aranga Quarry, Northland, New Zealand

by
Donald G. Howard
356 SE 44th Avenue
Portland, Oregon 97215

A few miles north of the city of Dargaville in the extreme northern part of the North Island of New Zealand, a long ridge runs out slightly south of west to meet the Tasman sea. Its rocky end, where land meets sea, is called Maunganui Bluff. Here the rocks are dark and pierced with holes. If a fresh fall has occurred, zeolites will line some of the holes. On the day we visited there, only a piece or two showed levyne blades worth keeping.

Farther east along the ridge, a large quarry is currently providing "road-metal" (crushed rock for paving). The wall of the rock on the western end provides some protection from the stiff west wind blowing in from the sea, and numerous ponds on the quarry floor stand filled from the rain of the day before. As we drive up, the floor of the quarry is filled with a herd of cows, and as we collect, they wander around to see what we are doing.

The rock here is light in color, grayish to reddish, and rather coarse-grained. Very little clay is present in any of the cavities. The mineral assemblage is reminiscent of the Oak Grove Fork of the Clackamas River, but with a few additions and alterations in relative abundances. Paragenesis seems to be as follows:

**NATIVE COPPER** occurs as tiny plates in some of the rock. Where not covered by other minerals, it has weathered away. Green stains on some of the block faces attest to its former presence.

**CHABAZITE** lines most of the pockets with small, clear, rhombohedral crystals up to a few millimeters across. Where native copper is embedded in them, they have an iridescent appearance. No clay is present, so the crystals are well fastened to the base rock.

**CALCITE** commonly formed crystals on the chabazite. These are clear, colorless, elongated, six-sided prisms with three-sided rhombohedral terminations. A few are still present, but most have been completely dissolved away after being coated by subsequent mineralization. The calcite crystals are typically up to an inch or more in length and one quarter inch in diameter.

**GISMONDINE** formed next as mounds of multiply-twinned crystals. These are often milky white in color, as if altered. Clearer crystals tops sometimes cover milky interiors. The gismondine preferred to form on the calcite, often covering and enclosing it. Hollow crystal casts are common. Even where the gismondine clusters are thick and fresh, broken mounds show a small calcite at their heart. Smaller gismondine groups which formed directly on the chabazite are often poorly attached and pop off before the rock can be broken.

**THOMSONITE** appear to be the last mineral to form. Several different forms are present. Calcite crystals were covered by deposits of up to a millimeter of white, granular-appearing thomsonite, after which the calcite almost always dissolved away completely. The casts and surrounding chabazite are often covered by a thin layer of the fine, tortuous form of thomsonite as a very late crystallization.

There is also present the type of thomsonite that forms glassy, nearly smooth balls. Under the microscope, these show a surface pattern of the blockier individual crystals than is usually seen. The balls are also unusually clear, so that you can see deep into the interior. Larger balls (2 mm diameter) are found sitting directly on the chabazite, but tiny clear globs adhere to the clear calcite crystals, and tiny cloudy masses perch upon the chalky white gismondine. Thomsonite is much more abundant at Aranga than it is on the upper Clackamas River.

**LEVYNE** is also present, but like at the Oregon site it always seems to keep to itself in cavities without the other zeolites listed above, so it place in the sequence is difficult to establish. It is usually found in the quarry as individual, paper-thin blades with just a hint of white offretite coating set on a very thin background of jet black clay. On the beach below cavities with thin, interlocking hexagonal blades occur. These too are clear with a thin coating of offretite, and are often stained orange by the iron in the decomposing clay still visible beneath.

**HEULANDITE** forms tiny sprays in the rock at the base of Maunganui Bluff containing the levyne. The sprays are flat-ended in slightly spreading sheafs similar to the form of the heulandite seen with cowlesite, such as at Yacolt. Again, the heulandite is in cavities where no other zeolite has formed, though they may be only a few millimeters from cavities of levyne. They too have orange surface stains coloring them.

In summary, this gismondine location is New Zealand is strikingly similar to the one on the Clackamas River in Oregon with the exception that thomsonite is much more abundant. The thomsonite is obviously a very late mineral. Also, there is little clay present, so the crusts of gismondine in partially filled cavities are absent at Aranga. It is therefore not clear that the generation of thomsonite that forms tiny balls in the clay layers in Oregon is of the same late origin as the thomsonite in New Zealand.

We are deeply indebted to Jocelyn Thornton and Matthew Singleton for arranging our visit to Aranga as well as to numerous other quarries, and to their wonderful hospitality upon our arrival in New Zealand.

## Zeolites along the South Fork of the Toutle River, Cowlitz County, Washington

by
Rudy W. Tschernich
526 Avenue A
Snohomish, Washington 98290

Zeolites are abundant east of Trouble Creek Canyon, along the ridge on the south side of the South Fork of the Toutle River, Cowlitz County, just a few miles west of Mount Saint Helens. The main deposit is found near the end of Weyerhaeuser logging road 5700. Smaller occurrences of zeolites are also found at the end of road 5500 and along roads 5712, 5670a, 5710h, and 5635.

The 5700 site can be reached from road 4100 on the floor of the South Fork of the Toutle River valley by following the steep four-wheeled drive road 5700 or the slightly more passable road 5710 which turns into road 5712 and intersects road 5700 on the ridge. Another route from Cougar is also possible. Follow road 5700 west until you pass through a narrow double-sided road cut that is at the highest point on the ridge. Zeolites are found from the double-sided road cut to the end of the road, with the best collecting about 100 yards from the cut. When traveling in this area be sure to have a map that indicates logging road numbers. The elevation at the 5700 site is 4400 feet; therefore, snow usually covers the collecting areas until late July.

The rock is mapped as Oligocene andesite flows on the Washington State Geologic Map GM-34 (Southwest Quadrant) and overlies the older Eocene andesite flows found around Elk Mountain to the west. The volcanic rocks that make up Mount Saint Helens are much younger Quaternary to Recent age andesite and basalt. The flows dip to the northeast and are part of the eastern limb of an anticline whose axis runs northwest to southeast through Elk Mountain.

Exceptional specimens of scolecite, stilbite, and heulandite are found in large cavities, some reaching nearly 1.75 meters (5 feet) in diameter. The large cavities are elliptical or egg-shaped rather than stretched or flattened. Small vesicles are present in some areas.

This locality produces the finest scolecite in North America. It is the third best scolecite locality in the world only behind those in India and Brazil. Although the size of the scolecite crystals is impressive, very few display quality specimens survive because of the extensive weathering and staining at this locality. The potential for great specimens is present but nearly all large pockets are altered from iron-rich water that follows joints in the rock and when it intersects zeolite-lined cavities deposits orange to brown iron oxides (limonite) on the crystals. A thin coating of iron oxide can be successfully removed with vitamin C (ascorbic acid) but thicker coatings require oxalic or hydrochloric acid. These acids etch the scolecite and turn it into an ugly chalky white mass. Furthermore, the deposit is near the surface and freezing of water-filled cavities in the winter breaks many of the scolecite prisms. Stilbite and heulandite crystals coated with iron oxides clean a little better because they have a higher silica content which resists the affect of acids. It is better to use oxalic acid to clean stilbite and heulandite than hydrochloric acid. Prolonged soaking in oxalic or hydrochloric acids produces a white coating on stilbite. The cleanest specimens are found in the center of the joint blocks where the staining has not reached.

Minerals observed:

**SCOLECITE** is one of the most spectacular minerals at the 5700 and 5500 sites. It forms radiating groups of colorless to white prisms, 0.2 to 3 cm wide and up to 18 cm (7 inches) long, nearly filling some of the cavities, 30 cm (12 inches) or more across. The larger scolecite crystals are terminated with thin parallel needles that form crude multiple terminations. Most scolecite-lined cavities contain only scolecite. A few cavities, up to 60 cm in diameter, were found with scolecite prisms, 3 mm wide and 8 cm (3 inches) long, on stilbite or heulandite.

**STILBITE** commonly forms colorless to white pointed blades, 4 mm to 8 cm (3 inches) long and 1 to 3 cm thick. Some of the finest stilbite specimens found in the Northwest come from this locality. Stilbite is often found on a white mordenite-quartz cavity lining or on drusy heulandite. In some cavities decomposition of the mordenite hair detaches the stilbite plates from the cavity walls and produces loose plates of stilbite. Very rarely flat topped stilbite has been found. In some cavities tiny chabazite rhombohedra are scattered on the stilbite. Stilbite-lined cavities 30 to 60 cm in diameter are common. During the summer of 1991 a pocket 1.75 meters (5 feet) in diameter was uncovered that was lined with exceptional stilbite crystals up to 8 cm long.

**HEULANDITE** commonly forms a colorless, white, cream-colored, or red drusy cavity lining that is covered by stilbite, scolecite, thomsonite, levyne, phillipsite, laumontite, or calcite. A few exceptionally nice heulandite crystals, up to 4 cm (1.5 inches) long, have been found. Heulandite is commonly covered by stilbite.

**QUARTZ** commonly forms tiny, colorless, doubly terminated, rice-grain-like crystals, up to 2 mm long, on thin white mordenite needles or forms a hard mass of intergrown quartz and mordenite, up to 15 mm thick. The quartz-mordenite layer lines many of the larger cavities, some up to 60 cm (two feet) in diameter. The white rice-grain quartz, can be seen as inclusions at the base of many stilbite crystals. Other zeolites are generally not found on the quartz-mordenite lining.

Rarely, banded chalcedony or white cave-like growths coat or fill some cavities. A few large quartz geodes, up to 60 cm in diameter, were found lined with short colorless quartz crystals, up to 3 cm in diameter, on a 10 cm thick massive quartz shell.

**MORDENITE** forms thin colorless to white needles and white masses generally so intergrown with rice-grain quartz that it is not obvious that mordenite is present. Large white cavities, up to 60 cm (2 feet) in diameter are lined with mordenite-quartz and are rarely covered with a few scattered small stilbite crystals.

Mordenite was present in most of the cavities that contain loose plates of stilbite. The mordenite in those cavities, on which the stilbite grew, was removed by water that flowed through the cavities.

**THOMSONITE** rarely forms tiny, colorless to gray spheres, up to 2 mm in diameter, scattered on the tips of thin, colorless, pointed heulandite crystals in the small cavities. The thomsonite spheres are often covered with levyne and phillipsite.

**LEVYNE** rarely forms tiny, thin, transparent, colorless, hexagonal plates, up to 2 mm in diameter, on thomsonite spheres and drusy heulandite and is covered by white pseudo-octahedra of phillipsite.

**PHILLIPSITE** rarely forms white, crude, pseudo-octahedral aggregates, up to 4 mm across, on thomsonite, levyne, and drusy heulandite in the small cavities.

**LAUMONTITE** rarely forms 4 mm long, colorless to white prisms terminated by a single sloping face in the small cavities.

**APOPHYLLITE** very rarely forms light-green masses and crystals, up to 2 cm long, with stilbite.

**CHABAZITE** rarely forms tiny, transparent, colorless to white rhombohedra, up to 3 mm across, on heulandite and stilbite in the larger cavities.

**CLAY** lines most of the cavities. The clay forms a thin green layer preceding crystallization of the zeolites.

**ARAGONITE** prisms are rarely present. Evidence of aragonite having been present is provided by a drusy heulandite shell covering partially etched aragonite prisms or radiating hollow cavities, up to 2 cm long.

**CALCITE** was also rarely present. Rhombohedral cavities found under the mordenite-quartz layers were calcite crystals that preceded zeolite crystallization and have been removed by later alteration. Small colorless calcite crystals are found on other zeolites in the small cavities.

Observed sequence of crystallization:

Clay > calcite-aragonite > mordenite > quartz > heulandite > stilbite > scolecite > thomsonite > levyne > phillipsite > ? (chabazite-apophyllite-laumontite) ? > calcite

The sequence of crystallization appears to be controlled by a progressive decrease in the silica content of the solution as the temperature dropped. The high silica zeolite mordenite and quartz are the first to crystallize, followed by zeolites of moderately high silica content, heulandite and stilbite. The low silica zeolites scolecite, levyne, thomsonite, and chabazite were the last to crystallize.

The 5700 site has excellent potential for producing more spectacular display specimens and micro crystals. The site has been heavily worked but more rock can be barred loose to expose large cavities. Large boulders can be broken down to expose cleaner cavities inside and boulders dumped over the bank when the road was made should be carefully checked for cavities. Most collectors at this site are intent on looking for the large crystals and overlook the interesting microminerals that are in the smaller cavities.

## Zeolites from the former Soviet Union

by
Rudy W. Tschernich
526 Avenue A
Snohomish, Washington 98290-2414

With the break up of the Soviet Union and introduction of the free market, new independent Soviet mineral companies and collector's cooperatives have imerged that are bringing minerals to the Western mineral market. This year two groups from Moscow were selling minerals at the Tucson and many other dealers had minerals from the former Soviet Union. Minerals are now becoming available from one seventh of the worlds surface that had previous been closed to mineral collectors. Zeolites from four important zeolite localities were available this year.

Outstanding display specimens stilbite, heulandite, and thomsonite have been found in large cavities in volcanics at **KRASNOYARSKY KRAI, YAKUTIA, south-central SIBERIA, RUSSIA**. Observation of the minerals are as follows in the order in which they crystallized.

**CLAY** forms a black lining in the cavities preceding zeolite crystallization.

**MORDENITE** was the first zeolite to crystallize. It formed long, white, needles up to 2 cm long. Most of the mordenite formed radiating groups 1 to 2 cm in diameter but after cleaning the long delicate needles are reduced to compact white mounds 1 cm in diameter. Inclusions of long mordenite needles are seen in transparent calcite crystals. Amber colored stilbite and reddish heulandite are attractively scattered on the mordenite mounds.

**HEULANDITE** forms very attractive zoned red to colorless crystals, commonly up to 2 cm long, with some reaching 6 cm long, on white mordenite mounds and covered with chabazite, stilbite, analcime, and thomsonite.

**STILBITE** is one of the most spectactular zeolites from this occurrence. It forms light golden to amber colored, lustrous, compound blades and bow ties up to 10 cm long. The crystals all have flat tops and are found on mordenite and heulandite.

**ANALCIME** is rather scarce but forms white trapezohedra, up to 4 cm in diameter, and are commonly covered with thomsonite or calcite.

**THOMSONITE** forms some of the finest bladed thomsonite specimens I have ever seen. It forms very thick colorless, light yellow, or pink blades. The smallest crystals are the size of the largest from Drain, Oregon and the largest are 3 cm long and 3 mm thick. Specimens ranged from 3x3 cm to 14x10 cm. Some are associated with stilbite, heulandite, analcime, and calcite.

**CHABAZITE** rarely forms colorless to light yellow, simple, smooth-surfaced rhombohedra, up to 10 mm across, scattered on heulandite.

**CALCITE** forms large colorless complex crystals, up to 14 cm long, on mordenite, heulandite, stilbite, and thomsonite.

**LAUMONTITE** rarely forms tiny white prisms, up to 3 mm long, scattered on some specimens of thomsonite.

The minerals crystallized in the order: clay > mordenite > heulandite > stilbite > analcime > thomsonite > chabazite > calcite > laumontite

Fine zeolite specimens are found in a skarn zone in near the main magnetite ore body in the **SARBAI IRON ORE MINE, in the southern URAL MOUNTAINS, near RUDNYI, KAZAKHSTAN.** These include:

**CHABAZITE** forms simple colorless, light brown, and orange smooth-surfaced rhombohedra, up to 1 cm wide, on calcite and chalopyrite-rich rock and is associated with yellow-green stilbite. Gmelinite commonly overgrows these rhombohedra.

**GMELINITE** form a thin lustrous orange epitaxial overgrowth on the surface of chabazite rhombohedra that produce exceptional specimens, up to 10 by 14 cm, composed of 12 mm crystals.

**STILBITE** forms small pointed greenish-yellow groups up to 5 mm long on orange chabazite-gmelinite crystals. The orthorhombic stilbite variety stellerite forms dark brown to reddish-brown flat-topped radial hemispheres, up to 2 cm in diameter.

**CALCITE** forms white masses and intergrown crystals that is covered by chabazite-gmelinite and stilbite.

Exceptional specimens of white trapezohedra of analcime, commonly up to 8 cm, in diameter, and a few up to 22 cm across are found in volcanics at **TUNGUSKA, TURA, central SIBERIA.** No associated minerals have been observed.

Colorless to opaque white natrolite prisms, 15 to 25 mm in diameter, and up to 8 cm long are found **MOUNT YUKSPOR and EVESLOGCHORR, KHIBINA (= CHIBINY) MASSIF, in the KOLA PENINSULA, northern RUSSIA.** Some of the crystals contain a gray phantom from clay overgrowth during crystallization. No associated minerals have been observed.

---

## NOTICE:

The **MOUNT SAINT HELENS INTERPRETIVE CENTER** at Silver Lake, Washington has requested our help in obtaining mineral specimens (massive or crystals) that represent the minerals found in the Mount Saint Helens area. These specimens are intended to be put on display at the center. For more information contact: Gloria Cook, 3027 Pennsylvania, Longview, WA 98632 (telephone 206-425-4016).

---

## Zeolites from Porter, Grays Harbor County, Washington

by
Rudy W. Tschernich
526 Avenue A
Snohomish, Washington 98290-2414

Zeolites are found in two quarries containing Eocene basalt of the Cresent Formation in the Black Hills, near Porter, Grays Harbor County, western Washington. The first quarry was found by Ray Claude and named the Four Mile Quarry because of a mileage marker painted on a rock right at the quarry. This quarry produces an abundance of the cowlesite associated with other zeolites and is one of the best cowlesite localities in Washington state. The second quarry, one mile further up the road, was found this year by Randy Becker and myself. We named it the Five Mile Quarry for obvious reasons. It is a new operating quarry that contains fewer zeolites but deserves more attention.

Zeolites are abundant in a vesicular zone, 12 feet thick, in the lower level of the Four Mile Quarry and the floor of the Five Mile Quarry. The upper level of both quarries is composed of columnar basalt that is devoid of cavities and zeolites. Very little loose rock remains in the Four Mile Quarry; therefore, rock needs to be barred loose from the quarry face and broken down. Fresh broken rock is abundant at the Five Mile Quarry. Zeolites are also found in a few of the large boulders piled along the perimeter of a large flat clearing across the road and southwest of the Four Mile Quarry.

Chunks of rock barred loose show very few cavities on the joint surfaces but when broken they are filled with small vesicles. Most of the zeolites are concentrated along the outer edges of the joint blocks. The center of the blocks often contain vesicles only lined with clay.

The cavities are generally 0.5 to 2 cm in diameter. Display specimens are not present but excellent micro-sized crystals are abundant. Although cowlesite alone in the cavities makes good specimens, its association with heulandite, levyne, thomsonite, and chabazite is more desirable.

The minerals are described in the order that they crystallized in the cavities. Most of the observations are from the Four Mile Quarry since material collected from the Five Mile Quarry has not been fully studied. Both sites are very similar. At this time cowlesite and phillipsite have not been found at the Five Mile Quarry, although thomsonite, chabazite, levyne, pyrite, and heulandite are present.

**CLAY** forms a black lining in all the cavities and precedes the crystallization of the zeolites. In some of the cavities a second generation of clay, colored a brownish-green, is observed on the black clay. Some cavities appear bicolored from the two generations of clay. The darker colored clay often forms a platform at the base of the cavities due to settling of clay by gravity during its crystallization. In the cavities with platforms, the upper 2/3 of the walls of the cavity is either barren of clay or has a thin brown clay covering. The different colored clay is important since it imparts coloration to the transparent heulandite and analcime that formed on top of it. In some of the cavities clay formed twisted rootlike growths on which the zeolites crystallized.

**PYRITE** rarely forms bright shiny spherical aggregates, up to 3 mm in diameter, that are composed of tiny cubes and are surrounded by black clay. Tiny octahedra of pyrite are found on some of the zeolites in the Five Mile Quarry.

**HEULANDITE** commonly forms colorless, transparent, unusual prisms elongated along the b-axis. Heulandite normally is flattened on the b-axis. For some unknown reason, heulandite that crystallizes with cowlesite at Goble, Spray, and Beech Creek in Oregon and Yacolt, Washington is elongated along the b-axis. Chemical composition of the heulandite at these localities is unknown but would be worth study. At Porter heulandite is the first zeolite to crystallize and is commonly covered with cowlesite, levyne, analcime, or thomsonite. The color of the clay beneath the heulandite is transmitted through the heulandite and imparts an attractive amber, brown, or black color to the heulandite crystals.

**ANALCIME** commonly forms tiny, transparent, colorless trapezohedra, 0.5 to 3 mm in diameter, that appear black when scattered on the black clay lining or are surrounded by light gray cowlesite. In a few cavities the analcime trapezohedra appear to have been partly dissolved to produce unusual rounded crystals. Most of the analcime crystals formed before the crystallization of cowlesite. A few tiny analcime crystals have been found perched on the top of the cowlesite blades indicating that these two zeolites co-crystallized.

**COWLESITE** commonly forms a gray-appearing cavity linings. At most localities, cowlesite linings are of uniform thickness and size of crystals. At the Four Mile Quarry cowlesite forms a variety of sizes ranging from minute radiating fanlike groups, under 0.5 mm in diameter, that are widely scattered on black clay and complete linings that vary from 0.5 to 3 mm thick in different cavities. Attractive twisted rootlike groups of cowlesite aggregates formed on very thin clay filiments. Cowlesite commonly is found alone in the cavities. The most interesting specimens are when smooth balls of thomsonite, rhombohedra of chabazite, levyne, and phillipsite are found on top of the cowlesite. Tiny radiating groups of cowlesite scattered on black or amber-appearing heulandite prisms or between black-appearing analcime crystals are exceptionally nice. Cowlesite is the only bladed mineral at the Four Mile Quarry. It forms very tiny pointed blades. All the thomsonite found at this locality forms smooth surfaced hemispheres or linings. The two minerals can also be differentiated by hardness (cowlesite 2, thomsonite 5).

**THOMSONITE** commonly forms attractive, blue or gray, smooth-surfaced hemispheres, up to 5 mm in diameter, and botryoidal linings in many of the cavities. The smooth blue thomsonite hemispheres are quite attractive when perched upon a light gray rough-surfaced cowlesite lining or are scattered on black rootlike clay growths. The smooth thomsonite aggregates are composed of minute blades so closely packed that only the {001} pinacoid is exposed on the surface. This type of thomsonite have been shown at other localities to have crystallized very rapidly from a single point.

At the Five Mile Quarry blue-gray, smooth thomsonite hemispheres reach 10 mm in diameter with only one hemisphere per cavity.

**LEVYNE** commonly forms colorless, transparent, hexagonal plates. The plates are 0.5 to 3 mm in diameter and are very thin and flat. A few larger thicker crystals are up to 8 mm across and have a concave curved pinacoidal surface. Some of the levyne crystals show unequal development of faces that produce an unusual triangular-shaped crystals.

**OFFRETITE** forms an extremely thin, faint, milky-white overgrowth on the {0001} pinacoid of only a few levyne crystals.

**PHILLIPSITE** very rarely forms colorless to slightly white, curved prisms elongated along the a-axis, and commonly terminated by only two faces. Cross twins produced from these curved crystals form unusual radiating aggregates. Blocky phillipsite crystals terminated with the more common four faces are also rarely found.

**CHABAZITE** is the most abundant mineral in the quarry. It forms colorless, transparent, simple rhombohedra and penetration twins, generally up to 3 mm across, although a few reach 8 mm across. The faces of the rhombohedra have a very high luster and an abundance of intersecting striations. Chabazite is the last zeolite to crystallize at the Four Mile Quarry; therefore, it is found on all of the other minerals. Some areas of the quarry chabazite is nearly the only zeolite present. A greater variety of minerals can be collected if rock rich in chabazite is avoided.

**CALCITE** is very rare in the cavities.

Observed sequences include each of the zeolites alone on the clay and less commonly the following combinations:

clay > heulandite > cowlesite
clay > heulandite > analcime
clay > heulandite > chabazite
clay > analcime > cowlesite > analcime
clay > analcime > levyne > offretite
clay > analcime > thomsonite
clay > analcime > chabazite
clay > cowlesite > levyne
clay > thomsonite > phillipsite
clay > thomsonite > chabazite
clay > cowlesite > levyne > thomsonite > chabazite

Generalized sequence of crystallization:
clay > pyrite > heulandite > analcime > cowlesite > analcime > levyne > offretite > thomsonite > phillipsite > chabazite

From this sequence of crystallization a general decrease in Si/Al ratio is seen. Heulandite is the only zeolite in this group of zeolites with a rather high silicon content, although its exact chemical composition has not been determined. It may be a low silica variety.

The zeolites appear to have formed in a stagnate situation where the hot water altered the rock and produced a simple progressive drop in silica content that is reflected in the minerals that crystallized. The crystallization of clay reduced the iron, magnesium, and aluminum in the solution and produced a solution rich in calcium, sodium, and silicon along with small amounts of aluminium and potassium. The ratio of silicon to aluminium determines which zeolite framework will crystallize while sufficient amounts of Ca, Na, and K are only need to electrically balance the structure. The amount of calcium and sodium does not effect which zeolite will crystallize. The co-crystallization analcime (containing only the exchangable sodium cation) and cowlesite (containing only the calcium cation) shows that sufficient amounts of both of these ions were present in the solution. The rarity of phillipsite (a potassium-bearing zeolite) in the cavities indicates that the amount of potassium was very low in the solution. The low potassium concentration is also reflected by the small amount of offretite and erionite found on the levyne. Potassium is required for the framework of offretite to nucleate. No needlelike zeolites (natrolite-mesolite-scolecite) are have been found.

## Zeolites from Mount Solo, Longview, Cowlitz County, Washington

by
Rudy W. Tschernich
526 Avenue A
Snohomish, Washington 98290-2414

Zeolites were first found at Mount Solo in the earily 1960s by John Cowles when the quarry was first opened. During the late 1969s the quarry became inactive, was used for target practice, and a garbage dump. At that time good specimens were still found in the large boulders between the road and the quarry. In the earily 1970s the quarry reopened and was work for a few years. Rock in the quarry consists of columnar Eocene basalt, flow breccia, and pillow lava that formed in a marine enviornment. The columnar basalt produced good hard rock for crushing but the pillow basalt and breccia (where all the zeolite are found) was highly altered and soft. As excavation of the quarry proceeded, a large area of pillow and breccia was exposed in the center of the quarry overlayen by pillow basalt. Although this area produced most of the good zeolite specimens from this site, it also signaled the demise of commerical activity for too much waste rock was present. After 1976 the quarry became inactive and has been barricated from the road. Other quarries further along the road are completely in columnar basalt and do not contain zeolites.

The quarry is reached by turning west (down river) at the stop light at the north end of the Lewis and Clark Bridge that goes over the Columbia River from Oregon to Longview, Washington. Travel on the long straight road for two miles. The road will fork when it reachs a small hill (Mount Solo). Park at the fork in the road and walk along the left fork for 200 feet, climb over the bouders along the road, and you will be in the old quarry. There is no place to park next to the quarry. Collecting was good when the quarry was operating but is now not considered very productive. Careful search of the boulders for veins and cavities might produce specimens. Rock can be loosened from the quarry face and broken up.

Recently a book of maps to mineral localities has directed people to the wrong quarry at Mount Solo. Those directions are to a barren columanr basalt quarry, a half mile west of the zeolite producing pillow basalt quarry mentioned in this paper. That quarry is posted no trespassing and people have been arrested for entering.

Mount Solo never produced display sized crystals. Cavities commonly ranged from a few millimeters to a maximum of 8 cm in diameter. All of the crystals are small but very attractive and interesting when viewed with a microscope at 10 to 20 magnification. This locality is important because specimens from it played an important place in explaining how chabazite and gmelinite intergrow. This locality shows selective dissolution of chabazite in the interior of gmelinite/chabazite crystals and leaves the shape of the twinned chabazite variety phacolite as a mold inside the gmelinite shell.

**NATROLITE** forms colorless, transparent, thick prisms with pyramidal terminations and less commonly thin hairlike needles, up to 1 cm long. The base of some natrolite needles are white but still appear to be natrolite. Natrolite was one of the first zeolites to crystallize and often was covered with chabazite, gmelinite, calcite, and analcime. In a few cavities thin needles of natrolite extended from radial bladed thomsonite groups.

**ANALCIME** is the most common zeolite in the cavities at Mount Solo and is associated with all the other minerals. Analcime forms small, colorless, transparent trapezohedra, 1 to 3 mm in diameter, with a few reaching 8 mm across. Rarely, golden pyrite cubes were seen under the transparent analcime crystals. Two generations of analcime are present. The first generation of analcime formed earily in the crystallization sequence and is covered by a second generation, that was much later in the sequence which enlarged existing analcime crystals and formed tiny trapezohedra on other zeolites.

**CHABAZITE** formed colorless to white twinned chabazite variety phacolite crystals, 2 to 4 mm in diameter. Rhombohedra of chabazite are not present. Analcime, natrolite, and thomsonite were commonly associated with the chabazite. Individual crystals of chabazite and gmelinite were never seen in the same cavity. Gmelinite formed an epitaxial overgrowth on the phacolite crystals in some of the cavities.

**GMELINITE** formed colorless to light yellow hexagonal prisms with hexagonal pyramid and small {0001} pinacoid (a few crystals also display a second order pyramid). The crystals were small, commonly only a few millimeters in diameter with some reaching 8 mm in diameter. Although some of the smaller crystals were pure gmelinite most of the gmelinite crystals were a composite overgrowth on chabazite variety phacolite. The amount of gmelinite deposited on the chabazite was not uniform on all faces of the phacolite crystals. The thickest overgrowth developed on the pyramidal faces with only a thin overgrowth or absence of gmelinite on the prism faces. After the chabazite-gmelinite crystals had formed, chemical conditions changed and the chabazite portions of the composite crystals were totally disolved away, leaving hollow gmelinite shells (when the gmelinite completely covered the chabazite crystal). When composite crystals (covered by gmelinite only on the pyramidal faces) were selectely dissolved, open clam-shaped shells of gmelinite remained. Still other crystals where the amount of gmelinite was very thinly deposited on the phacolite were dissolved, only shards of gmelinite remained attached to natrolite needles.

**THOMSONITE** is found in only a few of the cavities. It formed tiny radiating bladed aggregates on colorless analcime and often was covered with scattered thin needles of natrolite. Chabazite commonly covered the thomsonite but gmelinite was never present.

**CALCITE** formed colorless to light yellow rhombohedra in many of the cavities.

**PYRITE** rarely formed bright golden-colored cubes on the black clay cavity lining and was covered by transparent analcime.

**CLAY** is present in all the cavities, preceding the zeolites.

**STILBITE** is found in only a few cavities. It formed colorless to pale beige, pointed blades and was covered by natrolite, chabazite-gmelinite, and analcime.

The minerals crystallized in the order: calcite > clay > pyrite > stilbite > analcime 1 > thomsonite > natrolite > chabazite variety phacolite > gmelinite > dessolving of the chabazite > gmelinite > analcime 2 > calcite

From the observed sequence of crystallization, the chemical history of the minerals in the cavities can be interepcted. Since the rock is a pillow and breccia the formed in a marine enviornment and overlayen by columnar basalt, this area probably represents an island, similar to Hawaii, where surface flows extend to the edge of the island and flow into the salt water to form pillow lava and breccia. The hot rock flowing into the sea water is quenched to form a black glass that is rich in calcium, sodium, magnesium, iron, aluminum, and silicon from the rock plus additonal sodium, chlorine, and potassium from the sea water. Much later when hydrothermal solutions alter the glass and the minerals in the rock (feldspars, olivine, pyroxene, magnetite) the trapped elements were released into the cavities in the rock. Clays rich in Mg, Fe, Ca, Al, Si and Fe or carbonates are the first minerals to form. Crystallization of the clay reduces the amount of Mg, Fe, Al in the solution; therefore, increasing the Si/Al ratio of the solution to a point favorable to zeolite crystallization. The Si/Al ratio of the solution determines which zeolite framework will crystallize. If that ratio is low, as is the case at Mount Solo, low-silica zeolites are the only ones that crystallize. The exact chemical composition of all the minerals present in the cavities (which we do not have) is needed to interpet why the minerals crystallized in the order they did. We do have several knowns. Analcime can vary widely in its chemical composition but nearly all the analcime found in basaltic cavities has a pure sodium content. Natrolite does not vary from its ideal composition; therefore, it also contains only sodium as its exchangeable cation. Gmelinite is fairly consistant in its chemical composition with nearly equal amounts of Ca and Na or is richer in Na. Thomsonite although very scare at Mount Solo, it is quite consistant in composition with near equal amounts of Na and Ca. The abundance of sodium-rich zeolites at this locality is due to the rock having formed in seawater which provided the extra sodium to the glass and later to the solution what altered the rock and formed the zeolites.

# Natrolite Arches And Associated Minerals From The Rainier Quarry, Rainier, Columbia County, Oregon

by
Rudy W. Tschernich
526 Avenue A
Snohomish, Washington 98290-2414

Zeolites were rarely found in veins crossing Eocene basalt in the Rainier Quarry, at the south end of the Lewis and Clark Bridge along highway 30, east of Rainier, Columbia County, Oregon when the quarry was in operation in the 1960s and 1970s. Collecting in the quarry was generally not allowed when the quarry was active, although John Cowles, who lived near the quarry, was able to collect in there several times and preserved the specimens studied in this paper. The labels with the specimens were dated 1967, 1968, and 1973. The quarry is now abandoned and the gate is open but a search of the rock this year found only two zeolite-calcite-bearing veins in the whole quarry. Most of the rock is non-zeolite bearing columnar basalt with areas of soft massive basalt that is cut by zeolite-bearing veins. Calcite, chabazite, stilbite, and pyrite were commonly in the veins while natrolite, apophyllite, and heulandite were scarce. The best specimens were those associated with a very attractive amber calcite or covered by pyrite. Only recently was the significance of the very unusual curved and arched natrolite realized.

The minerals from the Rainier Quarry are described in the order in which they first crystallized in the veins.

**CALCITE** forms a variety of rhombohedra and scalenohedra, many with phantoms. Calcite crystallized before the zeolites and is the first mineral in the veins. It also is the last mineral formed and is found on all of the zeolites. The first generation of calcite is beautiful transparent golden to deep amber colored rhombohedra, up to 8 mm across, many with creamy phantom centers. Colorless rhombohedra of chabazite and blades of stilbite commonly scattered on the colored calcite make attractive specimens. The late generation of calcite is colorless or milky-white and forms both rhombohedra and scalenohedra that are commonly coated with a dusting of pyrite or contain pyrite inclusions. This late generation of calcite is found on the colored calcite and on all of the zeolites.

**HEULANDITE** forms a colorless, transparent drusy lining in only some of the veins. Rarely, crystals up to 4 mm across were found.

**STILBITE** forms transparent, colorless pointed blades, up to 8 mm long, with small flat faces on the terminations. Stilbite is found on amber calcite and heulandite and commonly covered by chabazite, apophyllite, pyrite, and calcite. Needles of natrolite are seen penetrating through the outer 0.5 mm of the stilbite crystals. Rarely, 1 mm long, colorless stilbite blades are seen on chabazite rhombohedra. From these observations stilbite appears to have had its major crystallization period after heulandite and before chabazite and natrolite but continued slightly after those minerals in order in be found upon them or enclose them.

**CHABAZITE** forms transparent colorless rhombohedra, up to 12 mm across. Some rhombohedra have complex, deeply striated surface, others are deeply etched or hollow. Heavy coatings of pyrite crystals on the chabazite make exceptional specimens. Most chabazite rhombohedra are found on stilbite, heulandite, and calcite. Apophyllite is generally found on top of chabazite. One specimen contained tiny chabazite crystals on calcite and apophyllite in the order apophyllite > calcite > pyrite > chabazite. Natrolite needles are generally found on top chabazite rhombohedra. Some specimens indicate that the natrolite started crystallization just before chabazite crystallization ceased and was enclosed in the very thin outer edge of the chabazite crystals.

**NATROLITE** forms colorless to white straight needles, up to 8 mm long, with stilbite, chabazite, and pyrite in only a few veins. Some cavities contain numerous curved, bent, and arched natrolite crystals similar to those from Flinders, Australia described by William Henderson Jr. and Carol Garland (1986) in the *Mineralogical Record*, V 17, Nov-Dec, pp 377 to 379. That paper is recommended reading. The base of the natrolite needles are opaque white becoming colorless and transparent towards the termination. Natrolite needles are observed passing through the outer edges of stilbite blades and chabazite rhombohedra; therefore, it formed before those two minerals had finished crystallization. The natrolite first formed extremely thin, long needles. In most of the cavities, continued growth produced a wider crystal and some increase in length. In a few cavities movement of the solution along the fracture disturbed the very thin needles causing them to bend, brake, or become attached to other needles. As continued growth proceeded in these cavities, lateral growth of the natrolite structure produced stress in framework of the curved needles that straightened some of the needles. Many other natrolite needles could not continue to grow a curved crystal and developed numerous straight crystals tangentially to the curved crystal. These crystals formed arches with numerious straight crystals on the surfaces.

**APOPHYLLITE** forms colorless to milky white prisms with doubly terminated dipyramids, up to 6 mm long, on chabazite and stilbite. The apophyllite crystals are commonly etched or corroded producing hollow crystals or only shards of apophyllite remaining on unaffected chabazite and stilbite.

**PYRITE** forms tiny cubes or cubo-octahedra, less than 0.5 mm in diameter, on all of the minerals in the Rainier Quarry. The present of the pyrite adds an extra touch to the specimens when small pyrite crystals are attached to natrolite needles, form a thin dusting on calcite crystals, stilbite blades, and chabazite rhombohedra. Rarely cubo-octrahedra of pyrite, up to 2 mm across, are found on the zeolites.

The sequence of crystallization in the veins at the Rainier Quarry is not a simple progressive sequence of one mineral after another. There is evidence that several minerals (ones in parenthesis below) were crystallizing at the same time. The observed sequence of crystallization is: Milky calcite > amber calcite > heulandite > (stilbite > chabazite > natrolite > chabazite > stilbite) > apophyllite > (colorless calcite-pyrite-calcite)

# MICRO MINERALS OF THE KING COUNTY QUARTZ LOCALITIES

by
Randy Becker
14415 Sleepy Hollow Road
Lake Stevens, Washington 98258

There are many quartz localities in King County, Washington, Some of these are well known and have produced world class quartz specimens. Denny Mountain has produced some exceptional quartz scepter specimens and the Spruce claim is continually producing top quality quartz pyrite specimens. Other localities that are not as well known also produce good to excellent quartz specimens. There probably isn't a northwest mineral collector that doesn't have multiple King county quartz specimens in their collections yet many collectors do not realize that these localities produce more that just quartz and pyrite. Many of these localities produce a variety of micro species that most collectors do not realize exist, possibly on specimens sitting on their shelf. This article will briefly explore the species found by the author at localities known mainly for quartz and ignored for their micro potential. Unless otherwise noted identifications are visual. Also it must be noted that these lists are not complete.. They represent species that the author has observed while examining quartz specimens under the microscope.

## BALD HORNET CLAIM (BLUE MTN. SADDLE)

The Bald Hornet claim is a small breccia zone that has seen limited commercial production of quartz Japan Law twins associated with dravite (Rock and Minerals, Vol. 66, Nov. / Dec., 1991, pg. 469).

DRAVITE is commonly found as radiating aggregates of acicular needles. Almost all cavities contain dravite. Some of the aggregates form interesting thumbnails and micro specimens. Frequently the tourmaline is found included in the quartz.

PYRITE is occasionally found as micro crystals included in quartz crystals.

## MT. TENERIFF

A quartz breccia outcropping in a cliff, this deposit is well known to local field collectors for producing a lot of small stubby brilliant quartz crystals and Japan Law twins to 10 cm across.

GOETHITE pseudomorphs after octahedral pyrite crystals are infrequently encountered. These range in size from about 5 mm to 2.5 cm.

HEMATITE forms hexagonal platelets, about 1 mm in diameter, in included in one quartz crystal.

**RUTILE** is found in a small zone within the breccia, where two generations of quartz occur. The first generation produces barrel shaped etched cloudy quartz crystals. The second generation quartz formed brilliant clear overgrowths and rarely well developed scepters. Occasionally found on the surface of the first generation quartz are rounded lustrous crystals of rutile to 1 mm. These crystals are brilliant black with some showing twining. Occasionally found included in the second generation quartz are very fine wisps and curved elongated colorless to white acicular crystals that are possibly rutile. One Japan Law twin was found with a fur ball like aggregate, 1 mm in diameter, of these elongated crystals included in one ear of the twin.

**TOURMALINE** is occasionally seen as olive green to black fibrous aggregates. Tourmaline is also infrequently found included quartz crystals. It is not known if the tourmaline occurring at Mt. Teneriff is dravite or schorl.

**AN UNKNOWN** mineral is frequently found included in the second generation quartz overgrowths forming rectangular casts to 1 cm long. Most of these casts breach the surface of the crystals. The original mineral has yet to be found.

## HANSEN CREEK

There are four separate quartz crystal producing areas in the Hansen Creek drainage. One hard rock road cut is well known to local micro collectors for producing anatase, apatite, brookite, quartz, yellow titanite and other species. The other 3 quartz localities produce amethyst scepters, Japan Law twins and single quartz crystals in disintegrating breccia zones. Since most of these specimens are found as single crystals dug out of the dirt, micro crystals are not encountered or found. Occasionally some of the amethyst scepters have hematite inclusions similar to the ones found in the Denny Mountain scepters. Other inclusions periodically seen are microscopic movable bubbles, chlorite and actinolite needles.

## DENNY MOUNTAIN

The cavities found in the skarn zone on Denny Mountain have produced some of the most spectacular amethyst scepter specimens found.

DIOPSIDE is occasionally found as blocky green crystals to 1 cm long in pockets in the skarn usually associated with grossular garnet. Many of these skarn pockets are filled with calcite.

HEMATITE commonly forms red delta shaped inclusions in scepters from Denny Mountain. (These inclusions have been previously been visually identified as lepidocrocite. Recent work has identified the red inclusions as hematite in the samples studied.) Frequently associated with the red platelet inclusions are silvery elongated needles, goethite (?) and small platelets of dark gray to black hematite.

MAGNETITE has been found as brilliant octahedrons to 2 mm long associated with chlorite, grossular garnet, hematite, pyrite, and quartz in calcite filled cavities.

QUARTZ frequently forms masses of interlocking Japan Law twins in the open spaces in a small, punky, porous quartz lens cutting the skarn. Larger pockets have been found in this zone where a high percentage of the quartz has been Japan Law twins. One of these pockets had Japan Law twins forming a second generation growth of quartz with the twins growing on the sides of larger milky quartz crystals. These twins have been found from 1 mm to 5 cm across but for the micro collector the punky quartz masses composed completely of interlocking and intergrown Japan Law twins to 1 cm are unique. Occasionally complex multiple twins are found.

SCHEELITE is found as white to colorless etched distorted octahedrons to 5 mm. These are occasionally encountered in the calcite filled vugs from one small area in the skarn. Larger scheelites have been found in open cavities associated with larger milky quartz crystals.

TITANITE has been found recently forming highly flattened titanite crystals to 3 mm long. These crystals are either a translucent bright olive green or coated with white clay. They were found on the back of a couple non sceptered quartz matrix specimens from the scepter zone. The back of these specimens have been altered to spongy mass of clay, chlorite and mica crystals.

RAINY MINE (QUARTZ CREEK)

Though not a quartz locality, Rainy Mine is in a breccia zone where most of the open space has been filled with sulphides. The locality has produced unusual talc and limonite pseudomorphs after twined anthophyllite crystals.

**RUTILE** forms rounded black crystals, up to 1 mm, rarely occurring on the anthophyllite pseudomorphs.

**TOURMALINE** forms black intergrown radiating masses. Two specimens of transparent tourmaline crystals were found. One specimen is a 5 mm long transparent light blue tourmaline with a 1 mm doubly terminated quartz crystal. impaled on it. The other specimen of this light blue tourmaline was found associated with 1 mm calcite crystals and 1 mm cubic pyrite crystals. These two specimens came from the same small vuggy area in a piece of massive quartz and are the only ones seen or heard of.

GREEN RIDGE

Green Ridge is a deposit well known to local collectors for its large pockets (up to 42 feet long) that produce large Japan Law twins and good quality large amethyst crystals and amethyst scepters.

**PYRITE** forms cubic and octahedral pyrite crystals to 2 mm occasionally included in quartz crystals. Occasionally a pocket will be found where almost every crystal will have phantom made up of micro pyrite crystals.

**AN UNKNOWN** mineral forming brownish acicular crystals to about 1 mm long are rarely found included in quartz crystals usually growing out of the surface outlined by a phantom.

SPRUCE CLAIM

The Spruce claim is a world famous locality known for its spectacular quartz and pyrite specimens that usually won't fit under the microscope.

**ACTINOLITE** has been found as acicular green needles to 1 cm long included in a few quartz crystals.

**CHALCOPYRITE** is rarely found as crude to sharp brassy tetrahedrons to 1 cm.

**GOLD** forms crude crystals to 1 mm diameter included at the base of a few quartz crystals from the west fault breccia (personnel observation).

**PYRITE** commonly form 5 to 15 cm crystals at the Spruce claim and occasionally produces micro crystals. A few specimens have been seen of secondary pyrite octahedrons to 1 mm growing on quartz crystals. Good micro pyrites are frequently encountered included in quartz crystals. In the west fault breccia the pyrite inclusions are almost always seen occurring at the base of the quartz crystals in contrast to the main breccia where the inclusions are located near the upper portions of the quartz crystal.

**SPHALERITE** is infrequently found as crude rounded black crystals up to 1 cm growing on quartz and pyrite.

**AN UNKNOWN** light pink crudely crystalized mineral is occasionally found. This mineral resembles a carbonate whose coloration could be the result of hematite staining.

CLIPPER

The Clipper claim is a seldom collected quartz breccia. Its lack of popularity can be attributed to its close proximity to the Spruce claim and the lack of large pockets and crystals.

**QUARTZ** crystals to 2.5 cm with inclusions of micro actinolite, chalcopyrite, chlorite, galena (?), pyrite, siderite, have been found.

**CONDOR (Pegasus, Needles, Ox,)**

A quartz breccia zone that has produced excellent quality quartz crystals many of which are lightly to heavily included with green actinolite needles. Many of the species found in this deposit are the result of the alteration of the country rock.

**ACTINOLITE** commonly occurs as green needles to 1 cm long included in quartz crystals. They frequently occur in the lower portions of the quartz crystal crudely outlining a phantom. These inclusions are some time so dense that they color the quartz green.

**ADULARIA** are found infrequently in typical wedge shaped white crystals to 5 mm associated with chlorite and titanite.

**ANATASE** have been found as octahedral crystals to 1 mm long with a prominent c face. These have been found only in a couple of pockets as isolated crystals associated with small chlorite and mica crystals selectively growing on 3 prism faces of quartz crystals. These quartz crystals are in turn lightly to heavily included with actinolite needles.

**BROOKITE** forms a few orange blades to 1 mm long associated with chlorite and mica crystals.

**EPIDOTE** occurs infrequently as radiating sprays to 1 cm growing on chlorite.

**MONAZITE** has been found as small isolated pinkish crystals to 2 mm growing on fine grained chlorite, mica matrix in between quartz crystals which may be up to 10 cm long.

**PREHNITE** has been found as 5 mm diameter white blocky crystals growing on chlorite in a few small pockets associated with adularia and titanite.

**RUTILE** has been found included in the quartz crystals as elongated black rod like crystals. Some of these crystals are twined. One specimen has been found of a 5 mm network of reticulated rutile crystals included in quartz.

**TITANITE** occurs infrequently as the typical flattened crystals orange brown color to 3 mm long growing on chlorite associated with prehnite.

**BIG CHIEF**

This breccia zone about a mile east of the Spruce claim is little known and not visited by many collectors. This is partially due to the very steep cliffs that are part of the deposit and its uneconomic nature. The following species have only been found on a few specimens.

**ANATASE** is found on fine grained mica matrix interspersed between quartz crystals on a couple of specimens. They occur as typical bluish gray octahedrons less than 1 mm long.

**ANTHOPHYLLITE** forms small crude prismatic, anthophyllite (?) crystals to 5 mm long, similar to the ones found at Rainy mine. They have been found growing on the sides of several quartz crystals.

**BROOKITE** forms orange brown blades to 1 mm long on a single specimen associated with anatase.

**SULFUR** forms minute sulfur crystals encrusting cavernous corroded remnants of pyrite crystals. Instead of the normal oxidation of pyrite these crystals were corroded in a oxygen deficient environment reducing the pyrite, removing the iron and leaving the sulfur. Only 2 specimens have been seen.

## PEDRO CLAIM

The Pedro claim is a seldom visited breccia that has seen commercial core drilling and several commercial mineral specimens mining ventures. Specimens bear a superficial resemblance to the Spruce claim but Pedro produces a greater variety of sulphides and also has produced a limited amount of secondary minerals formed from the alteration of the primary sulphides. Pedro has the most complex mineralogy of any of the Middle fork of the Snoqualmie river quartz localities

**CERUSSITE (?)** forms colorless needles to 1 mm long and white scales occasionally on corroded galena crystals.

**CHALCOPYRITE** occurs as single tetrahedrons or intergrown tetrahedrons from 1 mm to 4 cm across. The smaller crystals are usually the best quality. Many of the Chalcopyrites are have an attractive iridescent surface luster.

**CUPRITE** forms minute (less than 0.5 mm) octahedral crystals in a thin film on portions of quartz crystals. They have been observed to date, in only one pocket. A layer of limonite about 1 mm thick was then deposited over this cuprite film. By flaking off the limonite film one could expose the cuprite. Associated with the cuprite were chalcopyrite crystals to 2.5 cm across growing on the quartz crystals. The chalcopyrite was also coated with the limonite film. These chalcopyrite crystals were partially altered and the copper released from this alteration formed the secondary cuprite.

**GALENA** occurs as modified flattened cubic crystals to 1 cm growing on pyrite crystals and as unusual stalactitic growths from 1 to 3 cm long. Most of the galena crystals are partially altered on the surface.

**MALACHITE** forms acicular crystals to 2 mm long infrequently growing on quartz and within fractures in chalcopyrite crystals.

**PYRITE** can be found in a wide range of crystal sizes from 1 mm to 10 cm diameter. The micro crystals are infrequently found as sharp octahedrons while the larger crystals are usually cubic with step growths common. The luster of the pyrite ranges from brilliant to totally altered. The luster depends upon the level of oxidation in the pocket. Some pyrites that are heavily encrusted with limonite may have excellent luster. Quartz crystals containing pyrite inclusions are occasionally found though the inclusions are frequently smears of the sulfide instead of sharp crystals.

**SCHEELITE** occurs as crude colorless octahedrons to 2 mm growing on quartz and has been reported included in quartz crystals forming a florescent phantom. It has also been reported that blue scheelite crystals were found in a single pocket.

**SPHALERITE** is occasionally found as crude rounded crystals to 1 cm diameter.

**STIBNITE (?)** is found in a single quartz crystal 3 cm long. It forms elongated brilliant black crystals to 5 mm long included near the termination. The striations and bends in a few of the crystals lead to the tentative identification of stibnite. No other specimens are known.

**SEVERAL UNKNOWN** microminerals have been found. Frequently only a single specimen is found. A number of unknown inclusions in quartz are also found. One that is frequently encountered are brownish acicular needles. A black powder like mineral has been seen associated with a corroded portion of a scheelite crystal.

**WULFENITE (?)** forms a single, tabular, orange colored crystal less than 0.5 mm across on a piece of corroded galena.

## KATIE BELLE

The Breccia located on the top of the very precipitous Katie Belle ridge has not been visited by many collectors. It has seen limited commercial collecting for quartz scepters. These scepters are typically about 2.5 cm long and can be frequently found attached to matrix.

**MALACHITE** forms tufts of acicular crystals to 3 mm long in a pocket attached to a small scepter matrix specimens.

As stated at the beginning of this article this listing of micro species found at these localities only represent what the author has observed. No serious micros mineral study has been done at any of these localities.

It has been observed that these localities are mostly breccia zones and that the open spaces are commonly filled from the introduction of hydrothermal fluids. In many cases the hydrothermal solutions altered the wall rock and leached the wall rock elements into cavities where minerals were deposited. Fine grained chlorite and mica is usually formed from this alteration. The titanium which formed the scarce but wide spread occurrences of anatase, brookite, rutile and titanite were also derived from the alteration of the country rock. Where fine grained chlorite and mica matrix is found these four titanium minerals may be found as isolated crystals. Thus these minerals can be expected to be found in minute amounts from any of these deposits Morale of the story, put all specimens under the scope. The back side of matrix specimens often contain interesting micro crystals.

## MINERALS AND UNKNOWNS: WASHINGTON PASS, OKANOGAN COUNTY, WASHINGTON

by
Bob Boggs
10434 22 Avenue S.W.
Seattle, Washington 98146-1333

In September of 1989 a different type of rock in the form of a dull blue-gray dikes (up to four inches wide, but mostly one inch or less) were found running through a few normal pale tan-colored border granite boulders at Washington Pass. The minerals found on this first trip proved so interesting that more of the same or similar material was looked for and found in 1990 and 1991.

Most of the open vugs in this material tends to be in flattened seams and run in the direction of the dike. Most pockets are very clean, up to 1 x 1.5 centimeters in size, with well formed clear crystals of quartz and albite being very abundant. The microcline is very small and doesn't dominate the scene. In much border granite the amphibole (arfvedsonite and others) tends to be somewhat fibrous, but in these dikes the arfvedsonite is very solid lustrous terminated prisms.

Orange to brown (possibly pink) hexagonal prisms and tabular crystals of the parisite (group) minerals are common. Some are zoned, some prism faces are irregular poorly stacked plates (all have flat "C" faces). In August of 1990 at Eastern Washington University, with the micro probe analyzer that was out of kilter and not able to "see" elements lighter than calcium, Russell Boggs was able to get a rare earth, calcium, yttrium chemistry on these, but no proportions. They dissolve in cold dilute (1 acid to 5 parts of water) hydrochloric acid and bubble away so they are a carbonate. Of the bastnaesite-parisite-synchysite group, synchysite is the only one that is supposed to dissolve that easily.

Many of the unknowns in this dike rock are very tiny crystals in small vugs and in small amounts. One of these found in 1989 (Unk-65) is in 0.10 mm isometric octahedrons, is a calcium, iron silicate (tested with conditions as above), and Russ said a garnet wouldn't form an octahedron. Only three crystals were found originally and no more were found in 1990 and 1991.

In working eight pounds of this rock and trimming out 75 specimens, two crystals of galena were found, both with an alteration coating on the crystal faces.

Etched calcite is fairly common and hardly ever found in the normal arfvedsonite granite phase at all, so could possibly be what held these spaces open during formation of the dike.

Pale to deep purple sharp full octahedrons of fluorite are gemmy, usually less than 0.50 mm, and not common. Transparent green aegirine, pale yellow thin wedges of titanite and dark brown dipyramids of zircon are all fairly abundant.

In specimens from three major and a few minor pieces of this dike rock, there are over a dozen unknowns.

I'll have slides and colored prints of most of these at the May meeting in Vancouver, along with a similar "run down" on some of the older unknowns. Anyone of you out there that may have Washington Pass unknowns in your collections, bring them to the meeting and we can compare specimens and notes.

I also have devised a very sensitive and simple device to detect magnetism in very small crystals (at least down to 0.25 mm for magnetite) and it detects the weak magnetic "tug" of franklinite (at least in large crystals) and it is small enough to use under the microscope so you can see which crystals it "grabs"!