Northwest

Micro Mineral

Study Group

MICRO PROBE

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INTERESTING MINERALS IDENTIFIED FROM SHELLROCK MOUNTAIN, HOOD RIVER COUNTY, OREGON

Donald Howard

Zeolite and silicate minerals have been collected recently in the vicinity of Shellrock Mountain, near milepost 53 on Interstate 84 between Cascade Locks and Hood River. The end of this mountain has been cut and terraced to prevent rockfall onto the freeway. Some mineralization is to be found on the terrace, but in general the cut face is very steep and dangerous. Most of the collecting has been done in the loose rock that was removed and pilled in the draw at the west side of the mountain. The rock is basalt in several different textures and colors, containing cavities up to several centimeters in diameter. There is no room to park along the freeway at that spot; there are wide spots on both sides from which it is possible to walk into the area. A frontage road (Closed off) gives access onto the terrace from the east side.

The minerals so far identified, in the approximate order of formation, are as follows:

PYRITE a few cubes with tarnished surfaces, have been found. These seem to be located on the basalt itself, under all other mineralization. The basalt shows some spots of primary pyrite located away from the cavities as well.

CHALCEDONY much of this is a white, porcelain-like material (perhaps better called white chert), sometimes interlayered with more glassy bands of chalcedony. Chalcedony is by far the most common cavity-filling mineral, often completely filling the cavities. In open cavities, it appears to form a base layer.

SMECTITE a clay come next, generally colored grayish to golden brown. The tiny flakes are often rather shiny.

DIOPSIDE occurs occassionally as very fine white needles or as a white, cotteny mass. This is a rather unusual form for diopside. The material looks as if it should be a zeolite, possibly mordenite, but it is not. Its exact place in the order of crystalization is uncertain. It certainly preceeds the calcite and zeolites.

QUARTZ a later formation of silica than the chalcedony. The quartz is usually in well-formed crystals, usually clear, often tinted a delicate color of violet (amethyst).

CALCITE though occassionally forming chunky, angular crystals, most of the calcite is in very thin plates with a hexagonal outline. They are easily confused for levyne, which has not been found at this location. Most of the calcite is covered with a layer of stilbite. Long, tapered terminated crystals of calcite (a more normal form) are probably a later generation that followed zeolite formation.

HEULANDITE occurs as small, perfectly clear, simple crystals of the normal "coffin" shape. These are occassional and usually isolated, often upon the clay layer.

STILBITE this is the most common zeolite, often covering other minerals, particularly the calcite, with many small, clear, rectangular crystals of the variety "epidesmine". These are often in rounded groups of nearly parallel crystals.

CHABAZITE this is the last zeolite to form, making the usual "pseudo-cubes" that would be clear except for internal cracking.

MINERALS OCCURING AT HANSEN CREEK, KING COUNTY, WASHINGTON

Gerald Klein & Donald Howard

An interesting mineral deposit occurs near Hansen Creek, King Co., Washington. The area is about 12 miles east of North Bend and about 2 miles south of Interstate 90 (see Fieldtrip map). Other collecting sites in the area are well known. One claim sponsored by the Washington State Mineral Council has been set aside for collecting unusual quartz crystals: sceptors, amethyst and Japan law twins. These are found by digging in a weathered, decomposed granitic soil. Quartz crystal sites are located on the east side of Hansen Creek; some are posted No Tresspassing.

The deposit described here is located further up the mountain and on the west side of the creek. It is exposed as a road cut along forest service road #FR 55 . It appears to be an isolated event, as none of the other exposures or outcrops in the area show similar minerals or appearance. Since the area has been extensively logged, much of the rock is exposed and accessible.

The general appearance of the exposure and its mineralization suggests a hydrothermal alteration of the Snoqualmie granodiorite country rock of the area. One can observe sharp boundaries between the altered zone and the country rock surrounding.

Following along the road cut one can observe three distinct zones within the alteration aureole. Zone 1, the easternmost zone, is exposed for about 125 feet by the road cut. The dip suggests that this zone may extend quite a bit further into the hill towards the east. This zone is characterized by numerous limonite-filled miarolytic cavities. Pyrite cubes can be collected here, up to 2 inches across a face, most of which are altered, either completely or on the surface with an unaltered core.

Zone 2, the middle zone, is characterized by a grey porphyritic microdiorite. Cavities in this rock are lined with a dark green chlorite and quartz. In and around the cavities are sprays of pistaccio-green epidote. Some of the cavities are partially or completely filled with calcite, which protects other minerals, especially titanite and apatite. Unfilled cavities have a powdery layer of limonite that is difficult to remove and generally spoils specimens. Zone 2 extends about 60 feet along the cut from the boundary with zone 1 on the western side. The exposure disappears for about 40 feet along an uncut section and reappears until terminated by a sharp contact boundary with zone 3. The cavities and the epidote in this zone is primarily confined to the rock within 12 feet of zone 1.

Zone 3 extends for about 45 feet towards the west beyond the boundary with zone 2. It ends abruptly along a sharp contact with the granodiorite country rock at the west end. This zone is characterized by numerous miarolytic cavities, many completely filled with calcite. This zone yields the greatest variety of mineral species, including small Titanite crystals, many of which have altered to the titanium oxides Brookite and Anatase. Surface outcroppings of this zone extend about 90 feet up the hill from the cut, and 60 feet down the hill below the road. Most of the rubble from the road cutting was dumped directly down the hill below the road. Good collecting is possible here although a bit dangerous due to the steep grade. The rock is quite hard, so heavy breaking tools are necessary.

Most of the minerals occuring at this location are small in size. They appeal to both serious mineral students and to the micromounter. The calcite fillings serve to protect the delicate material during collecting and transport. Acid leaching reveals many attractive micro specimens.Either hydrochloric or acetic acid can be used for this purpose. Hydrochloric acid is much faster, but some of the minerals (particularly the apatite) may be attacked and severely corroded or completely disolved. The acetic acid treatment requires more patience but the results are often worth the waiting. Glacial acetic acid can be purchased from chemical supply houses, and should be used diluted one part acid to one or two parts water. It works best if kept warm, such as on a hot plate. Since the fumes are strong, it is best to do the leaching out-of-doors. Specimens often need to be soaked several days to disolve the calcite. Some of the calcite fillings are a more of less dirty brown color due to included iron oxide. When these are leached with acetic acid. a yellow brown stain remains. This can be further cleaned away with a short soak in oxalic acid (a few minutes is usually sufficient).

The presence of calcite presents a small geologic problem, since none of the basic minerals of either the country rock or the altered zone contain enough calcium to account for the amount of calcite present. There are skarn zones in nearby rock formations along Denny Creek to the north and over the ridge of Humpback Mountain to the east. Calcite-rich solutions could have been derived from these formations during the hydrothermal alteration sequence.

Due to extensive corrosion of the sulfides one may conclude that the sulfide emplacements probably occurred first, to be further altered during the hydrothermal process. Many of the calcite fillings contain fine iron oxide inclusions, imparting a more or less brown color. All of the calcite is opaque, so that it is not possible to see what minerals lie underneath until after leaching.

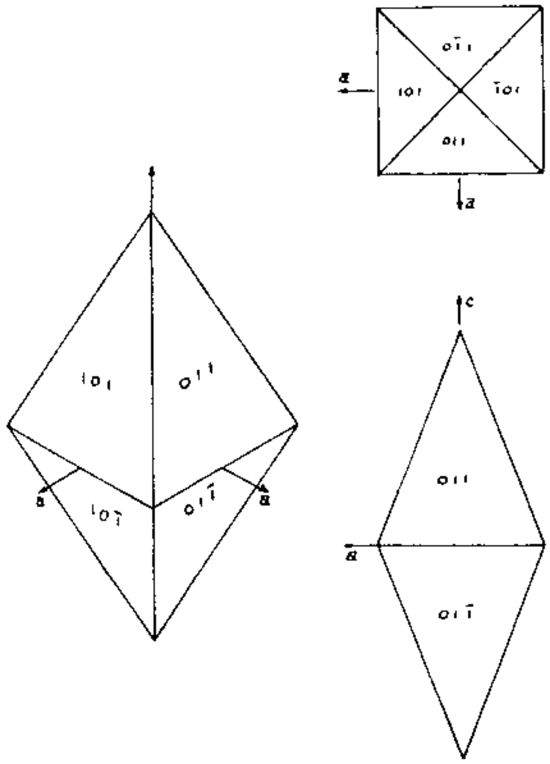
At present, 18 different species have been at least tentatively identified from this location (including the usual species which form the unaltered country rock). Most have been identified using a polarizing microscope. A description of these species follows. More work is planned to confirm these and other species and to determine the sequence of mineralization.

ADULARIA It occurs as rhombohedral micro-crystals in some of the cavities in zone 3. The simple form suggests a lower temperature of formation. Perhaps it is a result of recrystalization of orthoclase during hydrothermal action.

ALBITE These are found as skeletal crystal groups in the cavities of zone 3. Some of these crystals show characteristic forms. None so far studied exhibit any twinning.

ANATASE This occurs as small crystals (up to 2 mm) in zone 3. The form is the characteristic stepped tetragonal bipyramids. (See diagram.) The color ranges from a pale honey yellow to an oragne amber. Although isolated crystals can be found, they are usually found in partially to totally altered titanite crystals, frequently mixed with blades of brookite. (See micrograph #134.)

BIOTITE This occurs as disseminated small books in the country rock adjacent to zone 3. The books range in size to ½ inch in diameter by 1/8 inch thick.

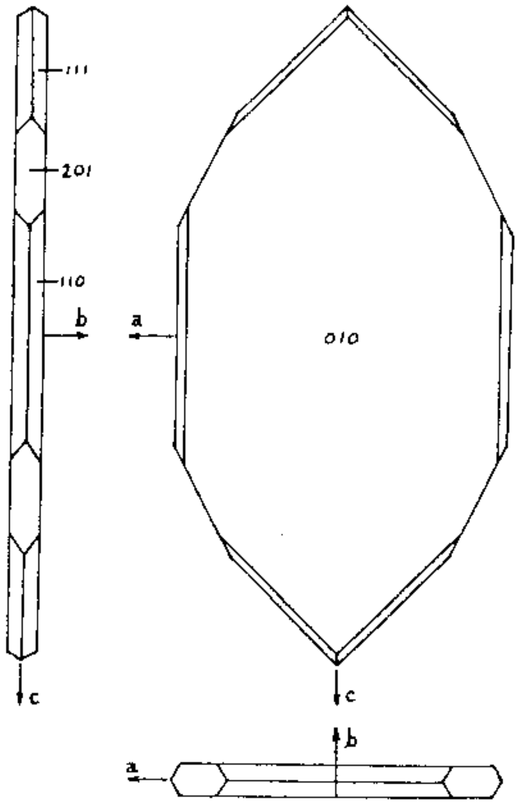


ANATASE

Idealized shape of the tetragonal bipyramid. Actual crystals show repeated steps due to twinning.

BROOKITE This occurs as reticulated groups of thin plates in zone 3 as an alteration of titanite crystals. The wedge-shaped outline of the replaced titanite is easily recognized, with brookite plates growing into the space once occupied by the titanite. The color of the plates is a brilliant orange-red. Frequently, anatase and brookite occur together. (See micrograph #134.) Brookite is an orthorhombic mineral with crystals flattened along the b axis (see diagram). The decomposition of titanite by CO_2 in solution is shown in the reaction:

$$CaTiSiO_5+CO_2 \text{ -- } CaCO_3+SiO_2+TiO_2$$



BROOKITE

Orthorhombic crystal typically flattened along the b-axis. Crystals would show the 010 face to be striated vertically. This drawing represents the brookite blade shown in the micrograph #134.

CALCITE This occurs as a filling material in the miarolytic cavities of zones 2 and 3. On occassion a cavity will be incompletely filled revealing primative rhombohedral faces. The crystals in such cases show considerable surface etching. The calcite varies in color from a creamy white to a dirty brown, the latter caused by submicroscopic inclusions of iron oxide.

CHALCOPYRITE This occurs as brassy yellow masses in the matrix of zone 3. No distinct crystals have been found. Often the masses are rimmed with a blue secondary alteration rind, probably chrysocolla although a positive identification for this has not been made. Acid leaching often destroys both the rind and the chalcopyrite (because of multiple cracking?).

EPIDOTE In zone 2 it occurs as typical pistaccio-green sprays in and around the cavities, which are lined with chlorite and quartz. It also grades into larger crystals that are a very dark green, almost black. The alteration of the microdiorite, evidenced by the presence of epidote, is limited to the rock within a few feet of the boundary with zone 1. In zone 3, epidote occurs less frequently as small parallel and divergent sprays of dull green micro-crystals in some of the cavities.

FERROAN-CLINOCHLORE Although the nomenclature for the chlorite series is changing, the measurable optical properties are distinct. Former names for this phase were rippidolite and prochlorite. It occurs as dark green micaceous groups disseminated throughout the rock in all three zones. It forms attractive micro specimens of spherulitic and vermiform groups in the cavities. It is the secondmost abundant mineral in the location (after quartz). The vermiform groups and some smaller groups are paler green in color but optically appear to be the same material.

FLUORAPATITE Small, clear to white, hexagonal crystals are common in some of the cavities of zone 3 and occassionally in the ones of zone 2. A few of the crystals show distient pyramidal terminations, though most are terminated primarily by a basal face. Most crystals have traces of basal parting. If the cavity has been leached with hydrochloric acid. the apatite will be severely corroded or may completely disolve.

HYDROMUSCOVITE This occurs as silvery, divergent, micaceous plates intermixed with chlorite in the cavities and as a significant constituent of the matrix in zones 1 and 3. Another name frequently used for hydrated mica of this type is sericite.

ORTHOCLASE This occurs as small poorly-formed crystals in a few cavities, and also as the major feldspar of the matrix in all three zones. It is also the principal feldspar of the country rock. Interestingly, in zone 3, the matrix contains very little feldspar, being composed mainly of quartz and chlorite.

PIEMONTITE This occurs as violet brown colored, parallel and divergent crystal groups in some cavities in zone 3. It is very fragile, with nice groups surviving only where encased in protecting calcite. They are exposed as free-standing groups by acid leaching. It is the only species from this location identified so far containing manganese.

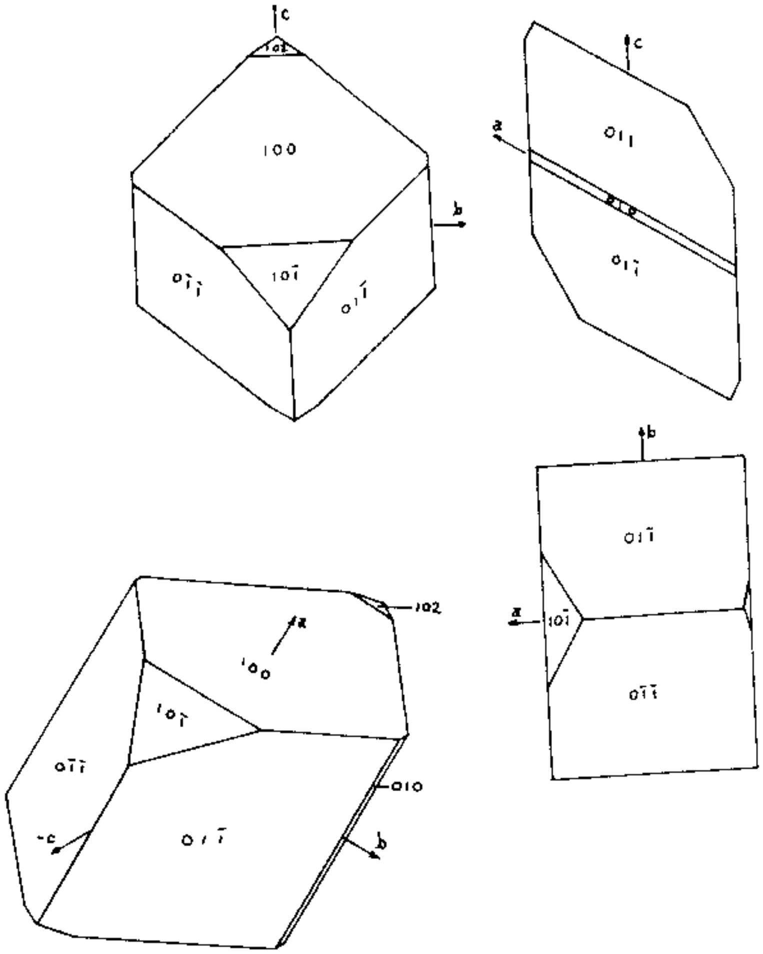
PYRITE In zone 1 pyrite can be found as cubes up to 2 inches on a side. All show extensive surface alteration to limonite (goethite and lepidochroite). Many smaller samples are completely altered. Skeletal samples of altered material can also be found. In zone 3, small micro cubes and pyritohedrons can be found as scarce individuals in some cavities. These also have dull, altered surfaces.

QUARTZ This is the major constituent of the rocks in zones 1 and 3 and a minor constituent of zone 2. Sharp, clear crystals line the miarolytic cavities in all zones. Many of the quartz crystals are flattened.

RUTILE Some tiny, very dark red grains with complex, striated surfaces are thought to be rutile. These are usually associated with the clinochlore rather than the groups of other titanium oxides remaining from the alteration of titanite.

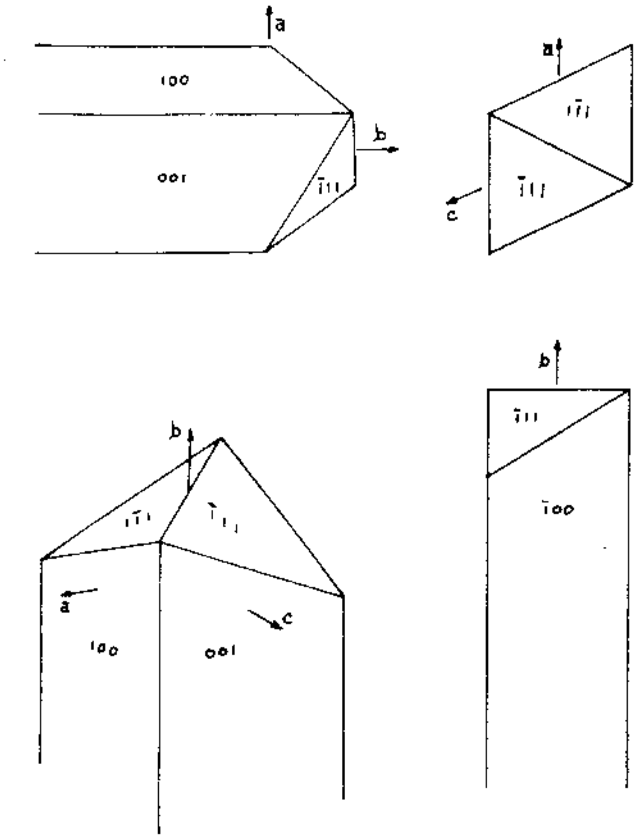
SCHORL One cavity in zone 2 showed a small black crystal with characteristic striated prism faces and a conchoidal basal fracture. Optical examination showed this to be the black variety of tourmaline, schorl. Schorl has been collected from other cuts further up the hill.

TITANITE (Sphene) This is disseminated as a trace species throughout the rock in zone 3. Sharp, pale yellow crystals can be found at the periphry of many cavities as well as in the matrix. (See diagram and micrograph #133.) Many of the titanites in the cavities will show various stages of alteration to brookite and anatase, with many being complet-ly altered. Titanite is also found in calcite-filled cavities of zone 2 as fresher, yellow-green crystals.



TITANITE (Sphene)

Crystal of the shape as shown in micrograph #133. The crystal system is monoclinic, with an oblique angle of about 60^{0}. Most crystals found at Hansen Creek are fairly simple "wedges" of this type.



EPIDOTE

Very simple, untwinned, monoclinic crystals elongated parallel to the b-axis, that usually occur in parallel groups. This material, pistaccio-green in color, is found primarily in zone 2 at Hansen Creek.

F I E L D   T R I P

Date: July 8 & 9, 1989

Place: Hansen Creek (between North Bend and Snoqualmie Pass)

Take exit #47 off I-90 , cross bridge to the south and turn left. Road branches at about 1.5 miles; take left (main) road, go under railroad trestle and keep to main road up the hill. It will cross the creek at about 3.8 miles. Continue another 0.7 miles to the outcrop.

There is limited parking along the dirt road, so plan to go up in groups whenever possible.

The rock is quite hard so take heavy hammers and chissles for breaking. Since cavities are filled with calcite, there is little need for any special packing materials. Bring rock home, finish breaking it up, and use acetic acid to leach out the calcite to reveal the minerals.

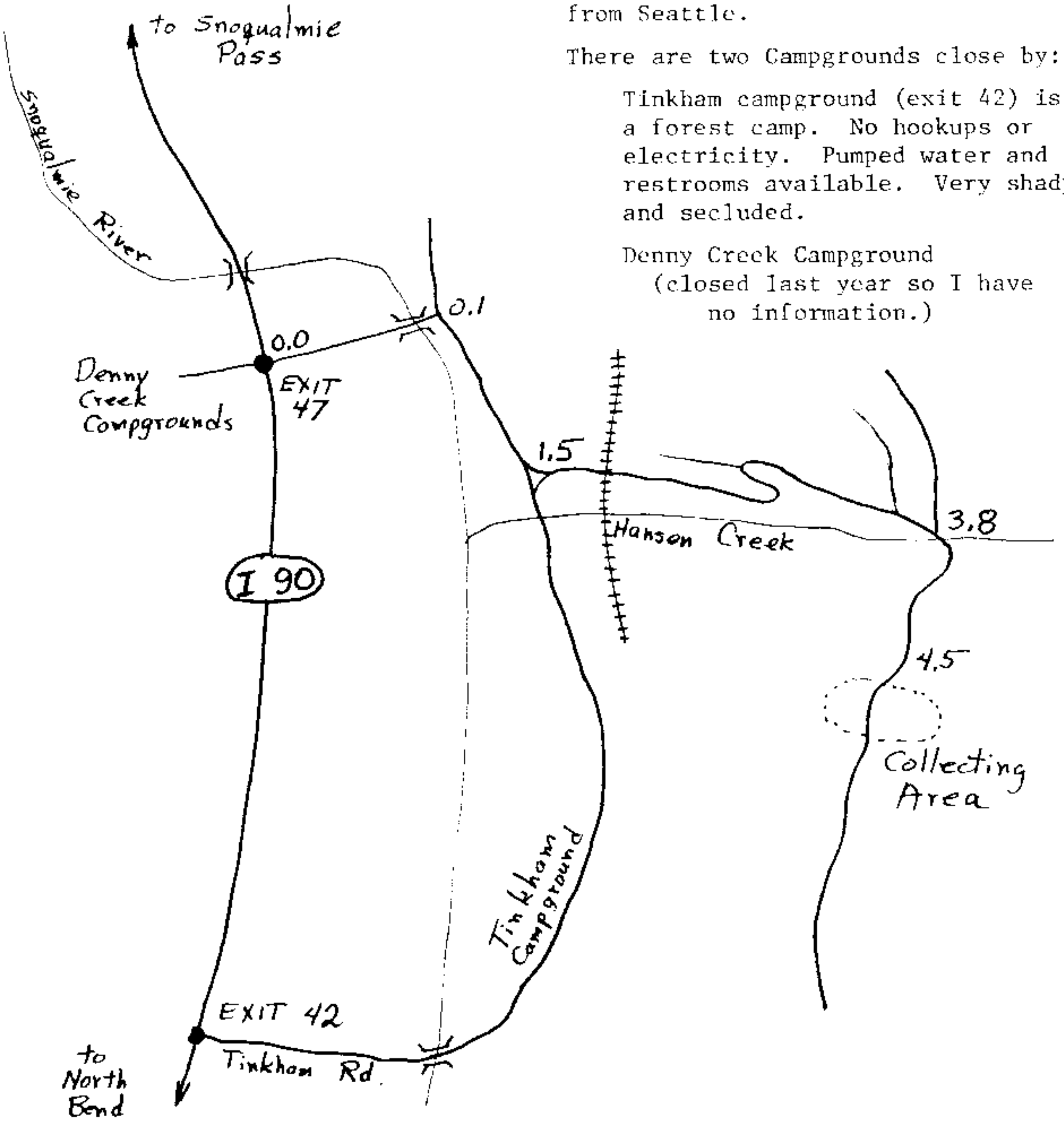
Facilities:

There are motels, etc. in North Bend The location is only about 50 miles from Seattle.

There are two Campgrounds close by:

Tinkham campground (exit 42) is a forest camp. No hookups or electricity. Pumped water and restrooms available. Very shady and secluded.

Denny Creek Campground (closed last year so I have no information.)



S E M MICROGRAPHS accompanying this issue.

(Photo number appears at lower right on the front.)

Donald Howard

#133 Titanite on Clinochlore and Quartz (x25)
The clinochlore are the small dark "booklets" of parallel plates. See the diagram of this crystal at the end of the article in this issue.

#134 Anatase and Brookite (x150)
Brookite forms thin plates. The anatase, whose basic form is a bipyramid, form tall structures through repeated twinning on the 001 plane.

from Hansen Creek, King County, Washington

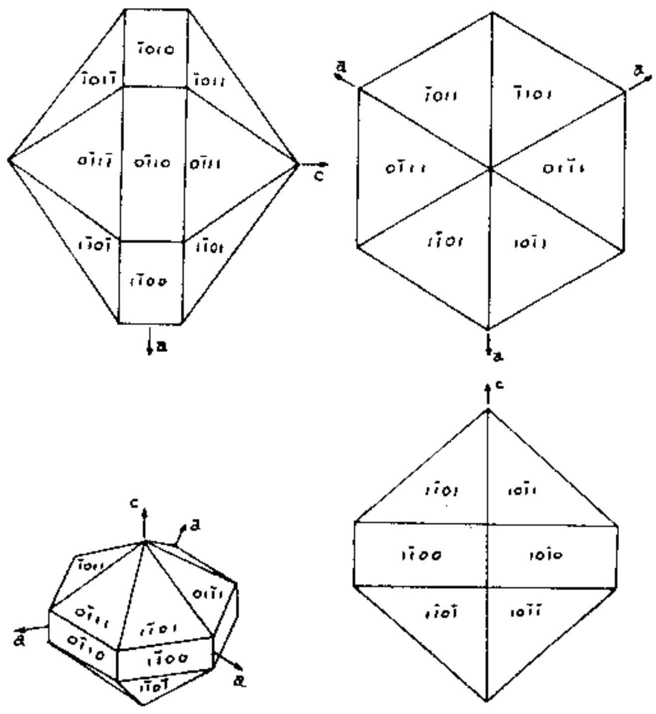
#136 Gmelinite on Phillipsite (x27)
A crystal showing the entire pyramidal termination.

#139 Chabazite on Gmelinite on Phillipsite (x30)
Here both terminations have oriented Chabazite crystals overgrowing the gmelinite, so that only the prism faces of the latter remain visible.

from Stony Creek, North Fork John Day River, Grant Co., Oregon

#678 Malachite on Wad (x250)
This unusual short, chunky shape of the malachite crystals is probably associated with the fact that approximately 10% of the copper has been replaced by manganese. The base material is wad, a dark gray amorphous manganese oxide which contains considerable copper replacing the manganese.

from Highland Valley Mine, Logan Lake, British Columbia
(Specimen courtesy of Ty Balacko)



GMELINITE

Simple crystal of the type found at Hansen Creek. The system is Hexagonal, with the crystal formed of prism and pyramids.

ZEOLITES ALONG THE NORTH FORK OF THE JOHN DAY RIVER, GRANT COUNTY, OREGON

by Rudy W. Tschernich

Several locations for zeolites exist in vesicular Miocene basalt and pillow lava found along the scenic North Fork of the John Day River, Grant County. Although the names of creeks and ridges used in this paper appear on USGS topographic and US Forest Service maps, rarely are any signs present telling where you are at. Mileage will be given first from the main bridge crossing the North Fork northwest of Threemile Creek and secondly from the black top road (Highway 395) at Camas Creek Bridge.

Very little collecting has been done along the North Fork due to the terrible road that follows the river. It is in horrendous condition. Bridges which cross the small creeks are partially or totally collapsed or have been washed away, cattle guards have sections missing, and very deep ruts are present in the road from 4-wheel drive vehicles during the wet season. The road is fairly level but is not recommended for normal low built cars or trucks especially when loaded with rock, tools, and people. Although the condition of the road changes from the amount of misuse, neglect, and recent weather conditions, the better route is from Ritter to Threemile Creek and across the bridge north of the paulingite location. Under no conditions should this road be attempted while it is wet for it turns to deep mud and rolls up on the wheels until you cannot proceed.

The first location from the bridge, northwest of the Threemile Creek, is just west of Deer Creek (4.1 miles; 14.9 miles). Zeolites are scarce in the vesicular basalt flows along the road. Zeolites present include levyne plates with a white offretite-erionite overgrowth, blue smooth surfaced thomsonite hemispheres, chabazite, and rarely cowlesite.

Further along the road, pillow basalt is found just east of Monkey Creek (5.3 miles; 13.7 miles). Small chabazite rhombohedra, under 5 mm across, abundantly line large cavities, up to 60 cm in diameter, which are found between pillows. Occasionally, very attractive golden calcite crystals up to 4 cm long are present on the chabazite lining. Very rarely thin scattered mesolite needles are found among chabazite crystals. This pillow basalt formed by lava flowing into a fresh water lake with the zeolites resulting from alteration of the glass and feldspar at a much later time. The resulting zeolites are all calcium rich. In contrast, pillow basalt which flowed in marine water, at locations like Robertson Pit, Dayton, Washington and Wren, Oregon incorporates sodium from the seawater into the glass and when altered produces the sodium-rich minerals natrolite and analcime.

The main collecting site is in the steep cliffs, 50 meters long and 15 meters high, located (12.5 miles; 6.5 miles) along the road at southern end of Devils Backbone, just west of Stony Creek. The rock is composed of a fine-grained, hard, dense basalt with widely scattered vesicles, 1 to 8 cm in diameter, which are found uniformly throughout the cliff area. Zeolites are abundant, especially phillipsite and gyrolite. The main collecting area is partially in the shade in the afternoon which is very nice on hot summer days.

The following is a description of the minerals found at Devils Backbone. On first appearance, the mineralogy appears rather simple, but most of the minerals crystallized at several different times in a complicated alternating sequence of crystallization.

PHILLIPSITE: Phillipsite is usually the first mineral which forms in cavities ranging from 1 to 10 cm in diameter. It is not preceded by clay. Phillipsite forms a radiating drusy lining in cavities, some crystals 1 to 4 mm long which are later followed by larger blocky phillipsite crystals, 4 to 10 mm long. The crystals are colorless to milky-white, blocky, pseudo-orthorhombic prisms, elongated along the a-axis. They usually display the forms {010}, {001}, {100} and {110}, often twinned around the a-axis with small reentrants. Very rarely, phillipsite is preceded by chabazite variety phacolite. A white parallel fibrous hydrous calcium silicate rarely occurs between the radial phillipsite and the blocky generation. All of the other minerals are found on top of phillipsite.

GMELINITE: Gmelinite is the most desirable mineral present at Devils Backbone. It forms interesting epitaxial intergrowths with chabazite. Gmelinite and chabazite have been found to intergrow in crystals which are often called gmelinite in Northern Ireland, Finders, Australia; Mt. Solo, Longview, Washington and others, yet, these intergrowths are usually only detected by XRD, optics, or chemical analysis. The gmelinite and chabazite crystals found at Devils Backbone are unusual in that the external morphology clearly displays these epitaxial intergrowths. Several alternating generations of chabazite and gmelinite are present.

Gmelinite commonly forms colorless to milky simple hexagonal prisms with dipyramid and {0001} usually ranging from 0.5 mm to 8 mmm in diameter with a few reaching 10 mmm. Horizontal striations are usually on the prism faces. Rarely, second order prism faces are also present which produce vertical striations on the prism faces.

A complex intergrowing of chabazite and gmelinite is observed in the cavities at Devils Backbone in following phases.

Phase 1: Rarely, a very early generation of chabazite variety phacolite is found, some covered by tiny gmelinite crystals, under 1 mm in diameter, composed of a simple hexagonal prism, with large {0001} and tiny pyramidal faces, which grow epitaxially on the sides of chabazite. Other crystals which appear to be gmelinite crystals are internally composed of alternating epitaxial intergrowths of chabazite and gmelinite with the external morphology of gmelinite (similar to gmelinite found in Australia and Northern Ireland).

Phase 2: Etching or dissolution of the gmelinite-chabazite intergrowth occurred, producing deep cavities in the crystals. Usually dissolution starts a cavity by removing the {0001} and nearby parts of the pyramidal faces, leaving a cavity with the the appearance of an inverted cone which projects down the c-axis. Prism faces of the gmelinite-chabazite intergrowth are left intact.

Phase 3: Regrowth of gmelinite forms small colorless dipyramids with horizontal striations, enlarging existing intact or etched gmelinite-chabazite crystals. Small white gyrolite hemispheres formed during this period, often inside the etched cone-shaped cavity of the gmelinite-chabazite crystals.

Phase 4: Regrowth of tiny, colorless, rhombohedral chabazite crystals forms epitaxially in rows on the horizontal striations on the gmelinite prism faces and on the pryamid of the gmelinite.

Some gmelinite crystals show three clear rhombohedrons growing on alternating pryamidal faces at each end of the gmelinite while the prism faces of the gmelinite are not covered. Enlargement of these chabazite rhombs produces a single large clear rhombohedron on both ends of the gmelinite while the prism faces of the small gmelinite crystal is still exposed. Continued chabazite growth completely covers the gmelinite but still displays a milky-white gmelinite-chabazite core or phantom deep inside the composite crystal.

GYROLITE: Two generations of gyrolite have been observed. The earliest generation forms thin, white, hexagonal mica-like plates usually forming into hemispherical aggregates, under 1 mm in diameter. A later generation of gyrolite forms thicker colorless transparent plates which form into hemispherical aggregates, 2 to 5 mm in diameter. Often the second generation gyrolite overgrows portions of the first generation resulting in bicolored (colorless and white) hemispherical aggregates.

CA-SILICATES: White, chalky, hydrous calcium-silicates are found at several different positions in the crystallization sequence. One forms parallel white fibrous linings, predating all the zeolites, even phillipsite. More massive non-fibrous layers or mounds with rough irregular surfaces and porcelain-like interiors are found on phillipsite and gmelinite and other zeolites. The massive porcelain-like material has been checked with X-ray diffraction by several different people with differing results ranging from "tacharanite" to a "Ca-silicate which is distinctly different from tacharanite". Often, hydrous calcium-silicates are poorly crystallized or have become partially dehydrated and therefore yield conflicting XRD patterns. Several different hydrous Ca-silicates may be present or all the different white chalky material might just be different degrees of crystallization and dehydration of tacharanite.

TACHARANITE: A late generation of small, white, furry mounds of tacharanite, 1 to 2 mm in diameter, identified with XRD by Don Howard, is commonly found on many of the zeolites.

THOMSONITE: Two generations of thomsonite are present. The first forms clear colorless fan-like blades, 2 to 4 mm long, scattered on phillipsite. Natrolite-mesolite needles often extend from or radiate from first generation thomsonite. A later generation of tiny white bladed thomsonite is found coating mesolite needles, often filling the area between the needles. Rarely, bundles of long, needle-like, white blades of thomsonite, up to 10 mm long, form sheaves which are pinched in the middle.

NATROLITE: Natrolite needles form compact white radiating masses, up to 10 mm in diameter, often on thomsonite and nearly always epitaxially overgrown by long separated mesolite needles which extend from the natrolite.

MESOLITE: Mesolite forms attractive, colorless, separated needles, up to 3 cm long, extending from compact white natrolite-thomsonite base.

ANALCIME: Water-clear colorless trapezohedrons of analcime often cover black clay linings and projections. White, first-generation gyrolite hemispheres on a black clay are quite striking when covered by transparent analcime. Colorless 2nd generation gyrolite is found on top of analcime.

CHABAZITE: Colorless to frosted-appearing gray, twinned chabazite with a phacolite habit is found in crystals, up to 1 cm in diameter. The phacolite appears to have formed very early in the sequence, even before phillipsite.

A much later and more widespread generation of chabazite forms colorless rhombohedrons, often epitaxially oriented on the pyramidal faces or prism faces of the gmelinite.

APOPHYLLITE: Apophyllite in colorless, transparent, square flat tablets with beveled corners is found on most of the other minerals.

CALCITE: Rarely, golden-colored crystals of calcite are found on the zeolites.

CLAY: Clay, which is usually common at most zeolite locations is rare at Devils Backbone. Clay is usually not found in phillipsite lined cavities but is found in cavities preceding white gyrolite and analcime. The black clay forms a lining in these few cavites or makes stalactite-like growths which are always covered by analcime.

The following complex sequence of crystallization is made from observation of hundreds of specimens:

Chabazite var. phacolite > radial phillipsite > Ca-silicate > blocky phillipsite > gmelinite-chabazite > etching > massive mounds of Ca-silicate > white gyrolite > thomsonite > natrolite > mesolite > thomsonite > analcime > tacharandite > clear gyrolite > chabazite > Ca-silicate > apophyllite > calcite

ORIGIN: Chabazite has been found in experimental studies to crystallize over a wide range of temperature and solutions rich in Ca or Na, while gmelinite is very restricted to a narrow range where Ca and Na ions are in nearly equal amounts. Conditions must have oscillated between a solution composition with equal amounts of Na and Ca which favored gmelinite to those which favored the closely related chabazite structure. Potassium-calcium rich phillipsite only forms early in the sequence. Ca-rich minerals dominate at Devils Backbone with small amounts of Na-rich minerals occurring in some cavities. Vertical zonation in the flow must be studied further. The dense basalt which makes up the Devils Backbone is covered by the pillow basalt seen at Monkey Creek.

MINERAL SPECIES FOUND IN THE ALKALINE GRANITE OF THE GOLDEN HORN BATHOLITH, LOCALLY REFERRED TO AS THE "WASHINGTON PASS AREA". ALL SPECIES ARE FOUND AS FREE GROWING CRYSTALS IN MIAROLITIC CAVITIES EXCEPT THOSE MARKED <>, AND THOSE MARKED ** ARE ENDEMIC TO WASHINGTON PASS AND FOUND NOWHERE ELSE. SPECIES MARKED # ARE FOUND AS POLY-CRYSTALS INTERGROWN WITH ANOTHER SPECIES.

ACMITE	AENIGMATITE	AGARDITE-(Y)	ALBITE
ALLANITE-(Ce)	ANATASE	APATITE <>	ARFVEDSONITE
ASTROPHYLLITE	BASTNAESITE-(Ce)	BIOTITE	CALCIOHILAIRITE **
CALCITE	CALCIUM CATAPLEIITE	CERUSSITE	CHEVKINITE-(Ce)
CHLORITE (GROUP)	CHRYSOCOLLA <>	ELPIDITE	EPIDOTE
EUXENITE-(Y)	FAYALITE <>	FERGUSONITE-BETA(Y)	FERROFERRIWINCHITE
FERROHORNBLEND	FERRO-KATAPHORITE	FERRO-RICHTERITE	FLUORITE
GADOLINITE-(Y)	GAGARINITE-(Y)	GALENA	GOETHITE
HEMATITE	KAINOSITE	KAOLINITE <>	LAUMONTITE
LOELLINGITE	MAGNETITE	MALACHITE	MICROCLINE
MOLYBDENITE	MONAZITE-(Ce)	OKANOGANITE-(Y)**	OPAL <>
ORTHOCLASE	PARISITE-(Ce)	PHARMACOSIDERITE<>	PLAGIOCLACE
POLYLITHIONITE	PREHNITE	PYRITE	PYROCHLORE (GROUP)
QUARTZ	SCORODITE <>	SIDERITE	SOGDIANITE #
SPHALERITE <>	SPOINKOPITE <>	SYNCHYSITE-(Ce)#	THORIANITE
TITANITE	WULFENITE	XENOTIME-(Y)	ZEKTZERITE **
ZIRCON			

Unknowns: Either need more work or more and better material to classify.
3=Yellow hexagonal prism (possibly bastnaesite).
11=Dark blue tabular crystal, copper mineral?
13=Brown hexagonal, Amorphous (contains titanium and iron).
17=Tan blocky crystal (one only) Synchysite?
31=Dark brown lusterous needles.
36=White discs.
44=Yttium Calcium Silicate, Hellandite?
46=Pyrochlore group member.
47=White plates.
48=Diamond shaped cross section (blades).
49=Rosette of hexagonal plates.
52=Carbonate coating, fluorescent bright green.
55=Copper Sulfide?
57=Salmon colored plates, (zirconium silicate).
60=Minute black prisms, Thorite?
61=(Zirconium Silicate) near Wadeite but not the same.

LIST BY RUSS AND BOB BOGGS MARCH 25,1988

NOTES ON THE ZEOLITES FROM THE ROBERTSON PIT, DAYTON, MASON COUNTY, WASHINGTON

by Rudy W. Tschernich

Minerals of the Robertson Pit are described by Ray Lasmanis in Rocks and Minerals magazine, V 63, pp 24-28 (1988).

Further study of the zeolites in the Robertson Pit has shown that mesolite is often found on last 2 to 3 mm of the tips of the natrolite needles, although many specimens are pure natrolite.

Twinned rhombohedrons described as secondary natrolite are tiny colorless chabazite crystals.

A second generation of analcime is often present forming milky-white highly skeletal or hollow trapezohedrons enclosing natrolite needles and is found clearly on top of intact colorless transparent earlier formed analcime.

The sequence of crystallization appears to be: chlorite > pyrite > clear analcime > natrolite > milky analcime > mesolite > chabazite > calcite > clay.

The glass in the marine pillow basalt was probably enriched with Na from the salt water during cooling of the basalt. Alteration of the Na-rich glass produced Na-rich zeolites (analcime and Natrolite) but later in the sequence small amounts of calcium-rich minerals (mesolite-chabazite-calcite) crystallized. Why only the second generation of analcime became unstable and etched is unclear.

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Please send all inquiries and comments to:

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356 S.E. 44 th Avenue
Portland, Oregon 97215

President and editor

NOTICE OF SPRING MEETING

DATE	Saturady, May 6, 1989
PLACE	"The HEILMANS", Raymond, Washington
TIME	10:00 am
PROGRAM	Ample time to trade and to look at the new material others have collected. Samples of the minerals from Hansen Creek will be available for examination.

Business meeting will discuss:

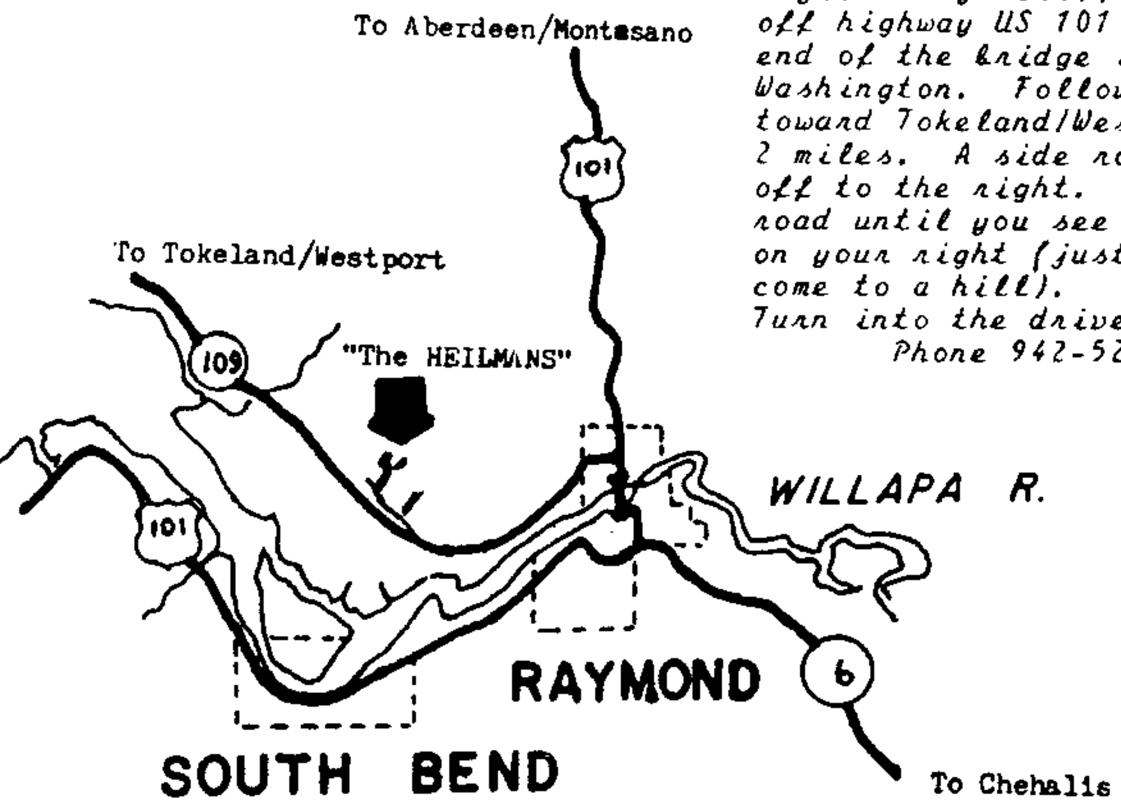
- Date, time and place of our Fall meeting
- Plans for our summer fieldtrip
- Update on the status of new minerals
- Reports on the status of collecting areas in the Northwest.

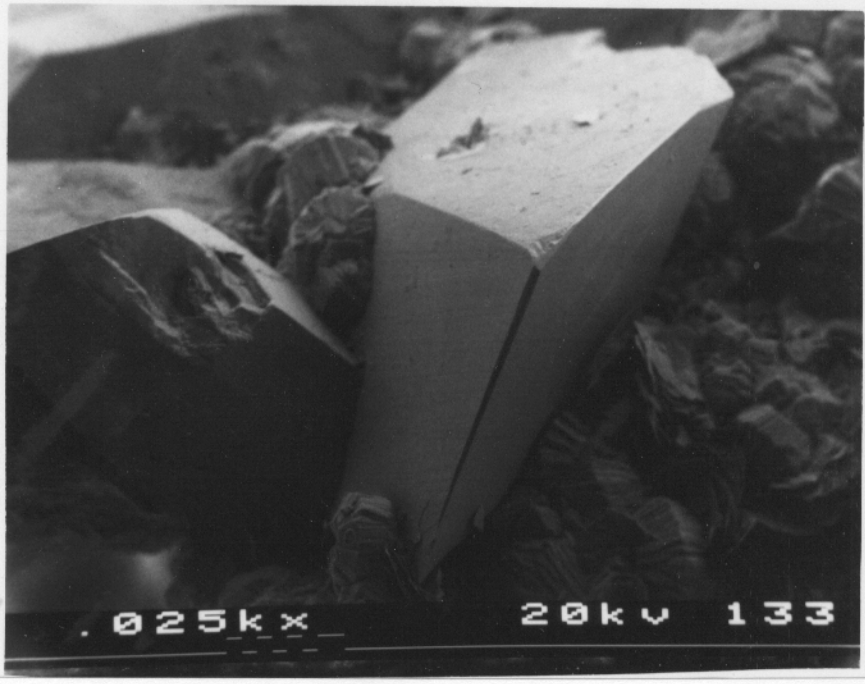
Potluck Dinner -- in the evening
Bring a hot dish, salad, or dessert.

Slide show after dinner -- bring slides of minerals and collecting areas to share.

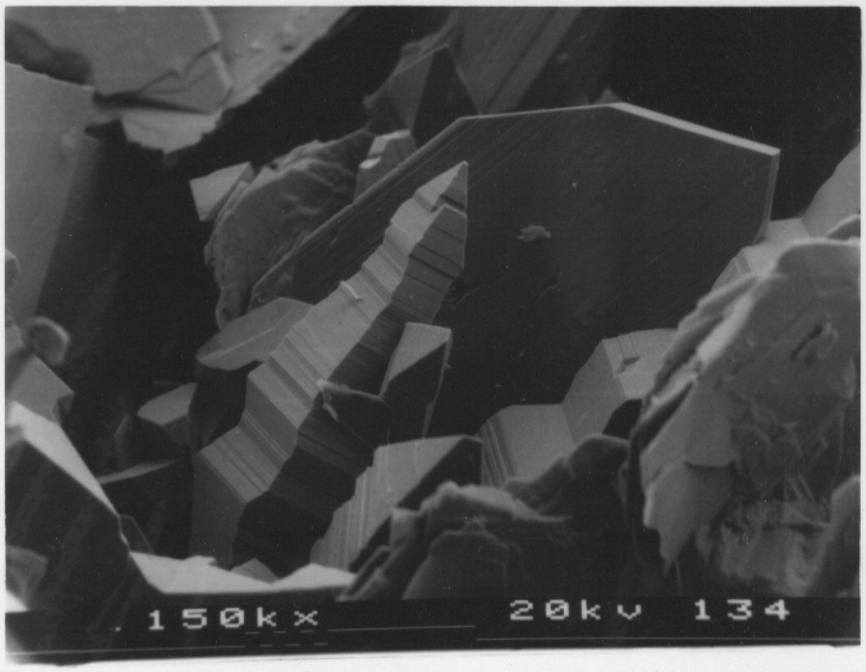
NOTE: Those who can come on Friday and help ready the facilities for our meeting will be greatly appreciated.

To reach the HEILMANS (former Bayles Army Post), turn west off highway US 101 at the north end of the bridge in Raymond, Washington. Follow highway toward Tokeland/Westport about 2 miles. A side road angles off to the right. Follow this road until you see the buildings on your right (just before you come to a hill).
Turn into the driveway ....
Phone 942-5231

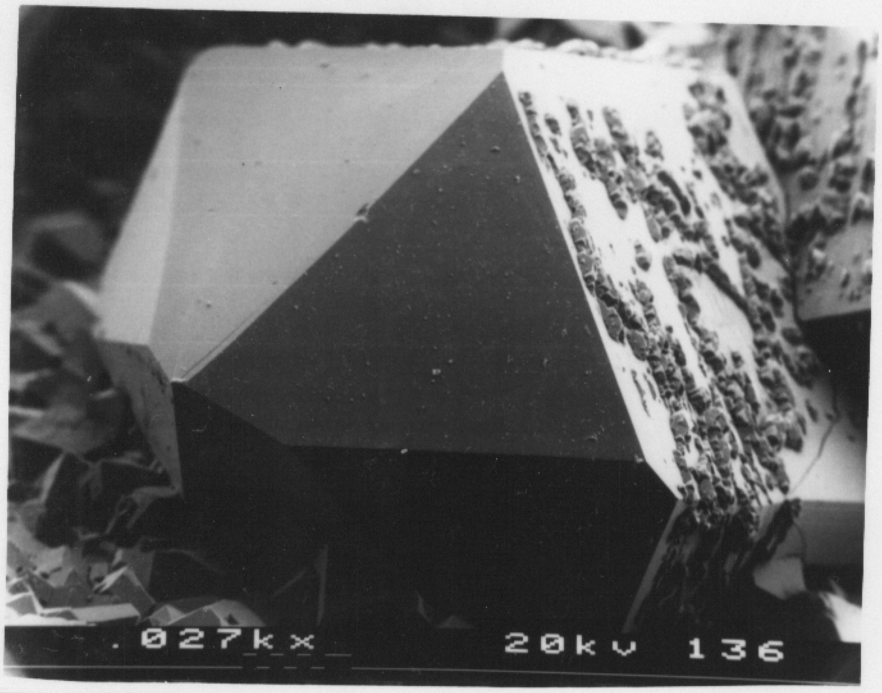




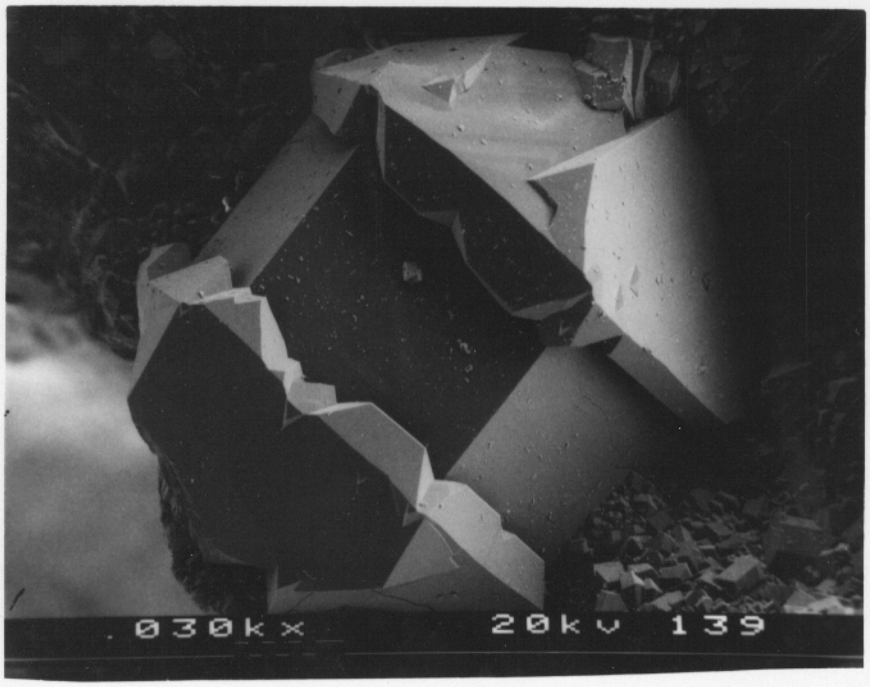
#133 – TITANITE – HANSEN CREEK, KING COUNTY, WASHINGTON – 25X



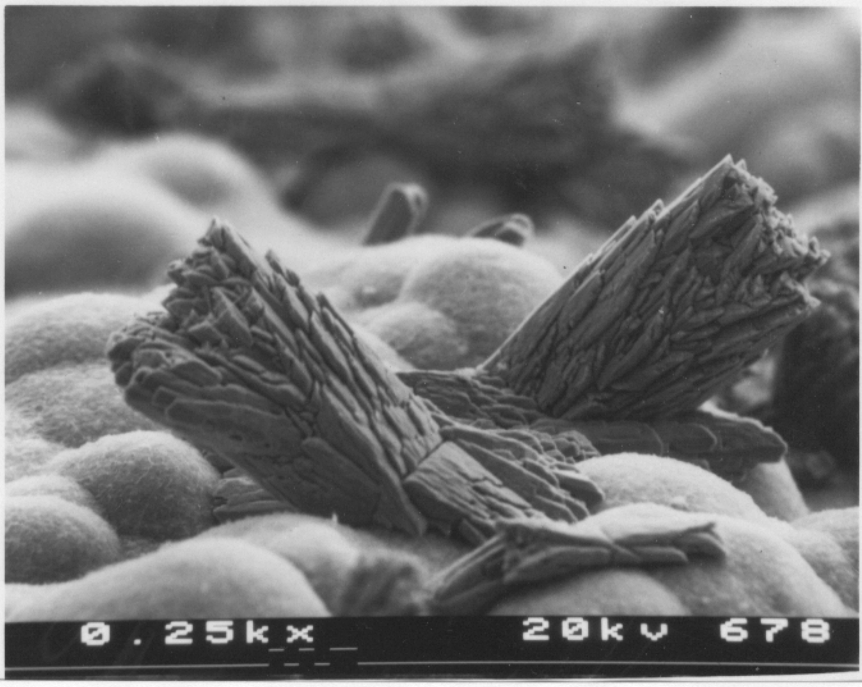
#134 – ANATASE, BROOKITE – HANSEN CREEK, KING COUNTY, WASHINGTON – 150X



#136 – GMELINITE, PHILLIPSITE – STONY CREEK, NORTH FORK JOHN DAY, GRANT COUNTY, OREGON – 27X



#139 – CHABAZITE, GMELINITE – STONY CREEK, NORTH FORK JOHN DAY, GRANT COUNTY, OREGON – 30X



#678 – MALACHITE – HIGHLAND VALLEY MINE, LOGAN LAKE, BRITISH COLUMBIA, CANADA – 250X