Northwest

Micro Mineral

Study Group

MICRO PROBE

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WELCOME TO A NEW DECADE

With this issue of the Microprobe, we begin the 90's, and as you can see above, Volume VII. Northwest Micromineral Study Group has grown through the last decade, both in numbers and in geographic area. But with growth comes change: rather than meeting in Raymond, Washington and Forest Grove, Oregon, our future meetings are to be in Vancouver, Washington, in the facilities of the Clark County Public Utilities District. This year, we will be in the Orchards building on May 5 and at the downtown building again on November 10.

So, too, our newsletter has grown over the decade. I hope that that growth will continue. But again, growth implies changes. Our focus has been mainly on zeolites, and rightly so, since the Northwest is one of the finest areas in the world for collecting zeolite minerals, and since so much of our area is covered with basalts. The last decade has seen the discovery of new zeolites -- tschernichite and boggsite -- and the identification of several species that had not previously been found in the Northwest -- such as gismondine and gonnardite. We will, of course, continue to offer articles on the zeolites minerals.

At the same time, we hope to broaden our scope to include other minerals interesting to Northwest collectors. For that reason, we are beginning what we hope will be a series of articles on the very interesting mineral species to be found in the Golden Horn batholith at Washington Pass. These species are ideally suitable to microscope study, because most are small, and there are a large number of different, rare minerals to sort out. Several new species (zekzterite, okanoganite, calciohilairite) have already been described, and more are undoubtedly present.

THE GOLDEN HORN BATHOLITH -- PART I

Donald G. Howard

The Golden Horn Batholith lies just east of Washington Pass in Okanogan County, Washington. It includes most of the rocks making up the peaks on both side of the highway east of the pass.

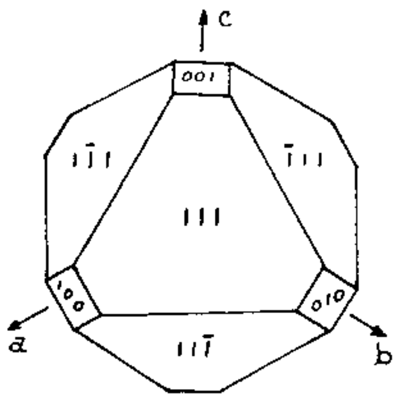
I think collectors have been put off by the stories and slides that have been presented at meetings featuring the ruggedness of the area. It is true that the terrain is impressive, and that to find large, virgin cavities with large, museum-quality specimens, a good deal of hiking and mountain climbing is involved. However, most of the interesting minerals occur in very small miarolitic cavities only a few millimeters in diameter. There is abundant material to collect and study in the rocks below the road, extending from the hair-pin curve about two and a half miles to Silverstar slide. The rock is granite, so that breaking pieces off requires a lot of effort. But each boulder is different, promising a new array of microminerals.

The minerals found at Washington Pass are very different from the ones most of us have become accustomed to collect. Also, many are rare species which are not included in the usual descriptive literature. We hope that by providing descriptions of a number of these minerals, we will stimulate interest. There is no system as to which species are described in this article, or the order in which they appear: the availability of illustrations has largely governed the choice of species included.

One of the common types of rock found at Washington Pass is arfvedsonite granite, a fairly coarse-grained granite composed of white microcline and glassy quartz. The dark mineral present is mostly arfvedsonite. The miarolitic cavities very often contain:

FLUORITE CaF_2

Fluorite is usually pale cream to pink or lavender in color, with a milky appearance. Crystals are basically octahedral in shape with cube faces truncating the corners. The crystals are often rough and irregular, with pitted faces. Small spots of pinkish color are a good thing to look for in this rock, as the fluorite is often associated with chevkinite and bastnäsite.



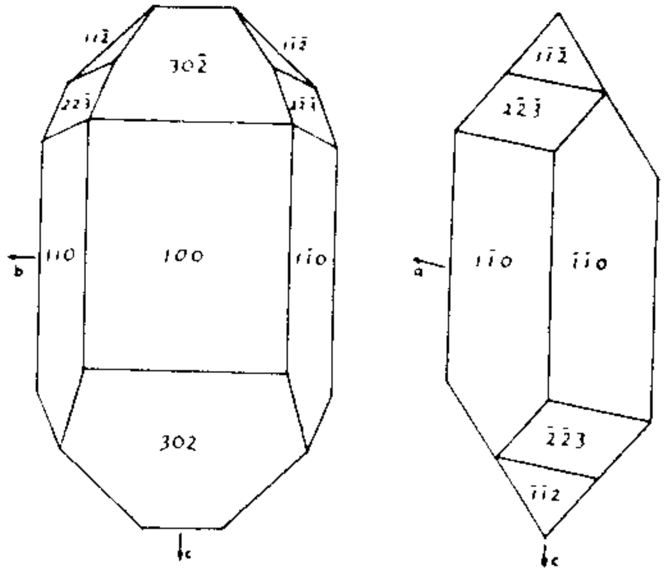
Fluorite crystal habit

CHEVKINITE (Ce) $(Ce,Nd,Ca)_4(Fe,Mg)_2(Ti,Fe)_3Si_4O_{22}$

Chevkinite is a black mineral that forms tiny prisms in and around the fluorite. Crystals are monoclinic and are generally extended along the b-axis. The crystals may be somewhat flattened (as in the micrograph) or multi-sided rods that appear almost round.

The micrograph shows an interesting twinned crystal. Since the twin plane is (001), the angle of the twin (21°44') is closely related to the oblique angle of the monoclinic structure.

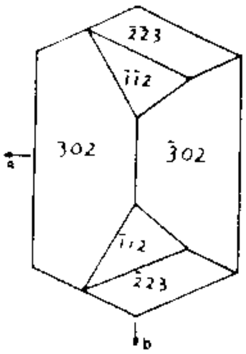
Other associated minerals include bastnäsite-synchysite intergrowths (shown in the micrograph), euxenite, and okanoganite.



Chevkinite

(monoclinic)

a = 13.34 A
b = 5.74 A
c = 11.10 A
= 100°54'



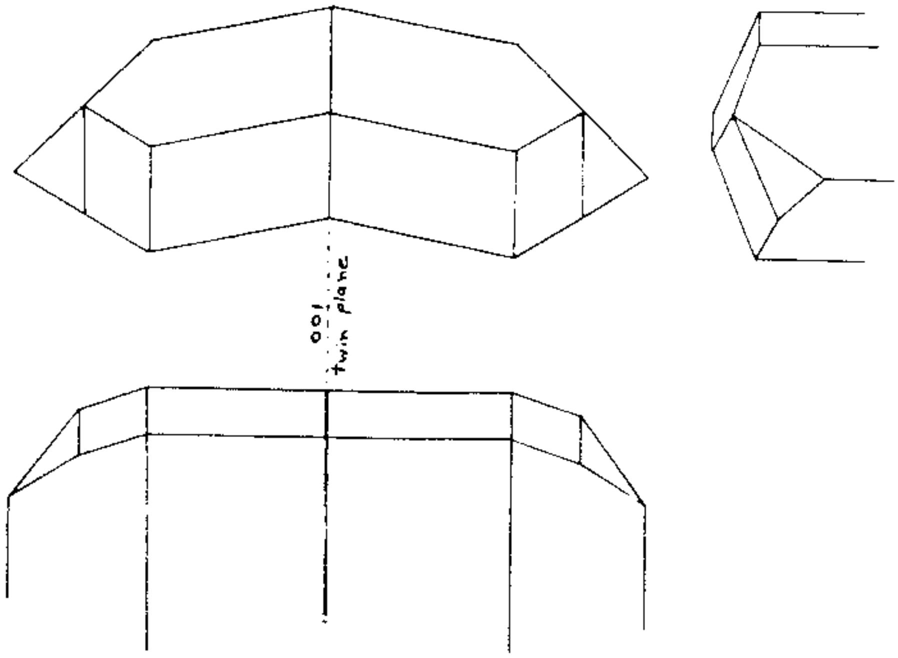


Diagram showing the orientation of the twin crystal appearing at the bottom of Micrograph #037. The faces are the same as those indexed in the diagram above.

Another common type of rock present in the piled boulders along the road fill is referred to as "border granite". This is also composed primarily of light-colored microcline and quartz, but often has a much finer texture. The dark minerals tend to be aegirine rather than arfvedsonite, with books of dark green biotite.

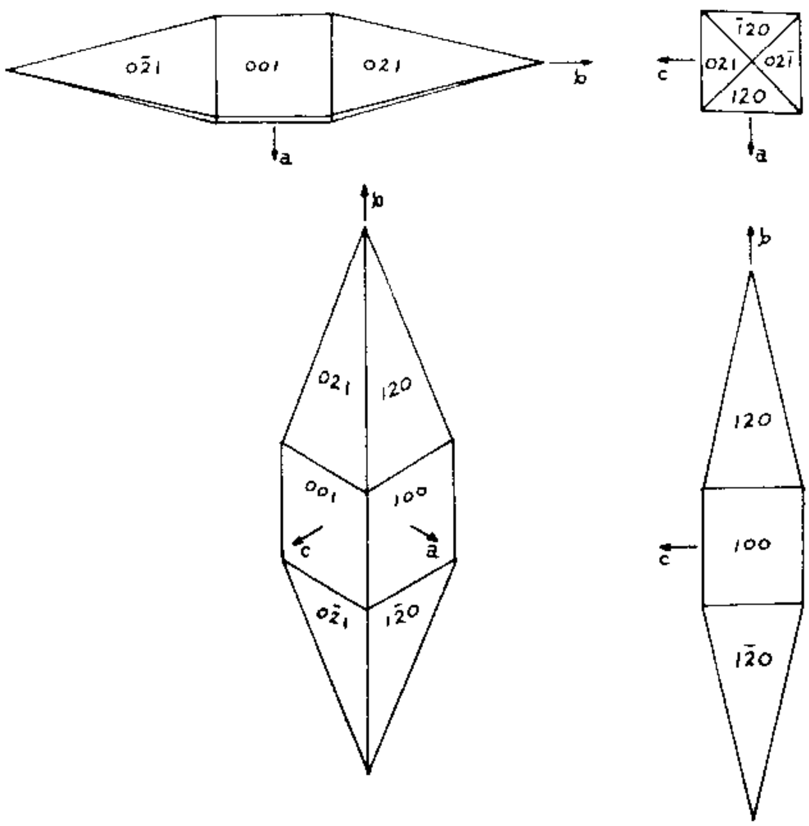
CLINOCHLORE $(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$

Clinochlore is a common mineral in the miarolitic cavities of the border granite, forming small rounded balls of thin blades, dark green in color with a silvery look. In exposed cavities, the color becomes more rusty as the iron oxidizes.

beta-FERGUSONITE (Y) $Y\ Nb\ O_4$

Beta-fergusonite forms in miarolitic cavities of the border granite as slender, needle-like crystals, and is usually associated with clinochlore. Although monoclinic in form, the oblique angle is only a few degrees from a right angle, so that the crystals appear nearly tetragonal. The b dimension of the unit cell is much larger than the other two, and this coupled with a tendency to form higher-order bipyramid ({021} and {120}) give the crystal its characteristic needle-like shape. Occassionally, small {011} and {110} faces tend to somewhat blunt the point.

Crystals of beta-fergusonite are golden to grayish brown in color. Faces tend to be roughened. It is often found in groups growing parallel to the b-axis.

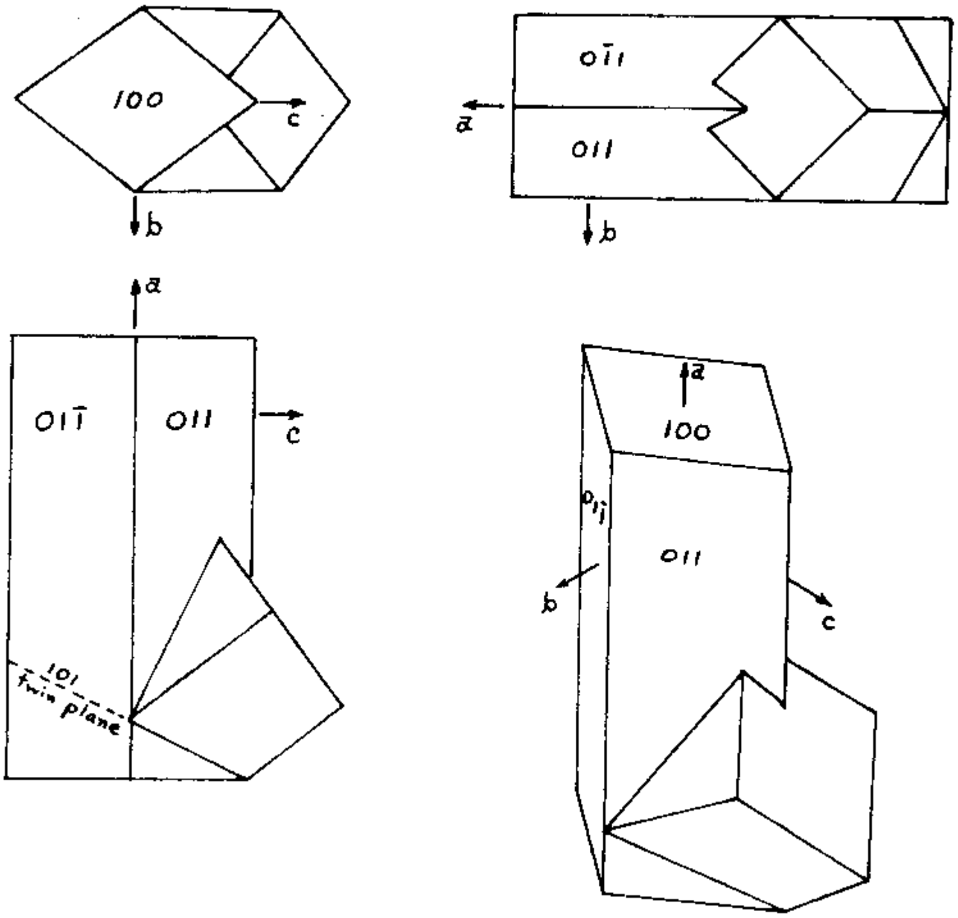


beta-Fergusonite

(monoclinic)

a = 5.236 A
b = 11.037 A
c = 5.092 A

= 92°30'



Gadolinite

(monoclinic)

a = 4.74 A
b = 7.49 A
c = 9.85 A

= $89^{\circ}27'$

GADOLINITE (Y) $(Y,Nd,Ce,Ca)_2FeBe_2Si_2O_{10}$

Another unusual occurrence in the border granite is gadolinite. At most occurrences, this mineral is black and completely embedded in the quartz and feldspar matrix. At Washington Pass it occurs as pale green, simple prisms in miarolitic cavities. Again, although a monoclinic mineral, the oblique angle is so close to 90° that the prisms appear to be orthorhombic.

Gadolinite is often found as clusters of crystals, though it is not normally in close proximity to other minerals. The micrograph illustration shows a pair of intergrown crystals that have resulted from twinning on the (101) plane as diagrammed above.

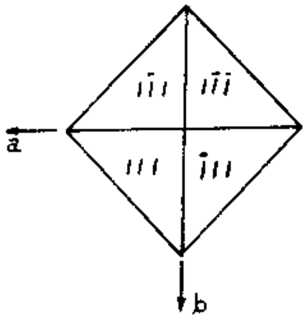
ILMENITE $Fe\ Ti\ O_3$

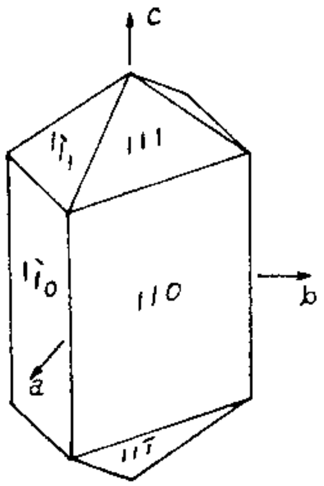
Though a common mineral in general, this seems to be the first verified occurrence of ilmenite from Washington Pass. A very thin bladed crystal about 1 mm across was found in a miarolitic cavity in the border granite associated with magnetite, biotite, clinochlore, and zircon. The large blade appears to be nearly twelve-sided; a number of smaller, oriented, hexagonal plates are growing on the larger crystal.

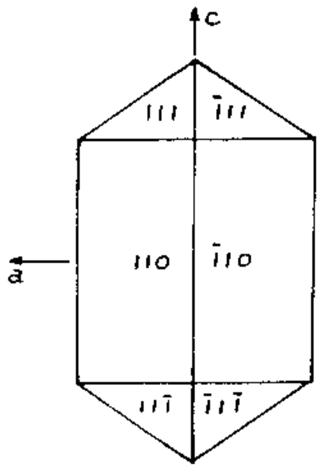
ZIRCON $ZrSiO_4$

Small crystals of zircon occur in all of the granites of the Golden Horn. These are short tetragonal prisms terminated by simple pyramids. The color is reddish to orangish brown. Zircon crystals are often found in clusters associated with magnetite. The prism faces of isolated zircons sometimes have a coating of tiny, black, glittery anatase crystals. The composition of the zircon shows an appreciable concentration of the rare element hafnium substituting for the zirconium.

Zircon
(tetragonal)
a = 6.604
b = 5.979



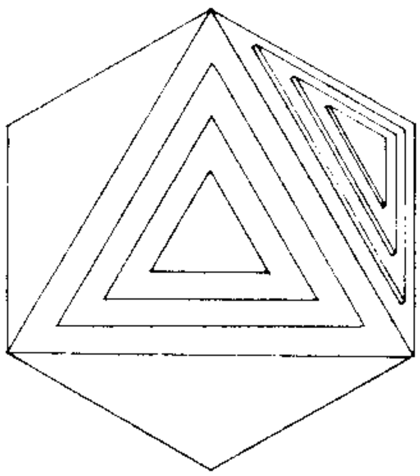




MAGNETITE Fe_3O_4

Magnetite is another mineral widespread in the granites, usually occurring as small, embedded metallic masses. In the border granite it forms crystals in the miarolitic cavities in association with clinochlore, anatase and zircon.

Crystals of magnetite are roughly octahedral in shape. Each face is composed of a number of steps, so that they appear as a set of stacked equilateral triangles. The crystals are black with a shiny, metallic luster.



Perspective drawing of a crystal of magnetite. The triangular "growt-steps" are shown on two of the octahedral faces.

ANATASE TiO_2

The Washington Pass anatase is very different in both color and crystal form from the usual occurrances of this mineral. The color is black with a metallic shine. The shape of the crystals are simple elongated tetragonal prisms with flat terminations. Most of the faces are very smooth. The identification of this material as anatase rather than rutile is based on one of the larger crystals from the border phase that is striated across the prism rather than lengthwise.

Anatase appears to be a late mineral, and has been identified growing on magnetite, zircon, and one of the rare-earth fluorocarbonates. It appears to occur in the cavities of both types of granite.

SIDERITE $FeCO_3$

One of the most common minerals in the cavities throughout all granite phases is siderite. Crystals are usually rather simple rhombohedrons, often grouped together in oriented growths. The color of fresh material is a very pale yellow, but weathering of the rock quickly turns it to orange and finally to rusty brown.

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BOGGSITE

Boggsite is well on its way to becoming an officially accredited species. It has been approved by the C.N.M.M.N. of I.M.A., and the article officially describing it: "BOGGSITE, A NEW HIGH-SILICA ZEOLITE FROM GOBLE, COLUMBIA COUNTY, OREGON" (D.G. Howard, R.W. Tschernich, J.V. Smith, and G.L. Klein) is scheduled to be published in the September/October issue of American Mineralogist. A report of the discovery, determination of structure, and possible significance of the mineral appeared in Science, March 23, 1990, page 1413.

A few of the technical particulars:

Formula:

$(Ca_{7.8}Na_{2.9}K_{0.2}Mg_{0.1})(Fe_{0.1}Al_{18.3}Si_{77.6})O_{192}\cdot 70H_2O$

Density = 1.98 g/cm^3

Hardness = 3.5

Crystal Structure:

Orthorhombic

a = 20.21 A
b = 23 77 A
c = 12.80 A

Habit: in hemispherical aggregates with the b-axis oriented radially outward. Crystals are elongated along b .

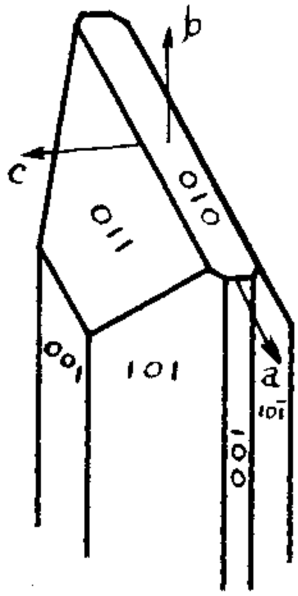

PHOTO CAPTIONS

This issue, we return to a set of micrographs from the Scanning Electron microscope. The number on each print is on the front at lower right. All photos are by D. G. Howard on the microscope facilities at Portland State University. Except where otherwise noted, the specimens are from the collection of D. G. Howard.

Dachiardite

#137 from Altoona, Wahkiakum Co., Washington (x550)
Close-up detail of the terminations of the very thin, bladed crystals making up a spray.

#441 from Opal Hill Mine, Riverside Co., California (x 98)
Face-on and edge-on views of composite individual blades. Specimen courtesy of Violet Frazier.

#437 from San Piero de Campo, Elba, Italy (x 24)
This is an "eightling" twin. Assuming that the inward-sloping faces of the "hopper" are (001), the twinning occurs on the (110) plane. The (110) and $(1\bar{1}0)$ planes are 45.80°apart. Thus, eight such twins make 366.4°, or 6.4° too much to close. The result of this mismatch is the spiral crystal shown, with subsequent "tiers" rotated 6.4° to the one below. Two and one half tiers are shown in this illustration. Speciman courtesy of Rudy Tschernich.

Minerals from the Golden Horn, Washington Pass, Okanogan Co., Washington

#037 Chevkinite, Fluorite and Bastnäsite on Microcline (x100)
A cluster of chevkinite crystals. The lower crystal is a twin on (001). The irregular, pitted crystal at left is fluorite. The crystal at right with the missing hexagonal band is bastnäsite.

#443 Zircon and Magnetite (x 60)
A cluster of five zircon crystals surrounding a magnetite crystal. The zircon crystal at left, in addition to the usual prism {110} and pyramidal {111} faces, shows a small (100) face bevelling the prism edge. Note the triangular "growth steps" on the {111} faces of the magnetite.

#444 Ilmenite and Magnetite on Microcline and Quartz (x 50)
The ilmenite forms as very thin, hexagonal blades. The magnetite crystal sitting on the ilmenite shows the triangular "growth steps" very clearly.

#449 Gadolinite on Microcline (x 90)
Two crystals twinned on (101). The corner of the larger crystal has been broken. Specimen courtesy of Robert Boggs.

#461 beta-Fergusonite on Microcline (x150)
A very small but doubly terminated individual crystal. Note that all faces are very rough.

ZEOLITES OF THE WORLD, section dachiardite, by Rudy W. Tschernich

DACHIARDITE (DAK'E'YAR'DITE)

$(Ca,Na_2,K_2)[Al_4Si_{20}O_{48}]\cdot 14H_2O$ $Z = 1$

Named in 1906 by Giovanni D'Achiardi after his father Antonio D'Achiardi (1839-1902), an Italian mineralogist.

Type location: San Piero di Campo, Elba, Italy.

Obsolete synonyms: d'achiaridite, Na-dachiardite, and svetlozarite.

Nomenclature: Na-dachiardite is incorrectly listed as a species in the Glossary of Mineral Species by Fleischer (1987). Na-dachiardite was submitted to I.M.A but was rejected as a new species on the grounds that it was just a chemical variation of dachiardite (William Wise, pers com).

With the wide variation in Ca, K, and Na found in dachiardite, current usage is to use modifying ajectives, such as Na-rich, Ca-rich, K-rich, sodian, calcian, or potassian to convey compositional variation rather than subdivide a zeolite into seperate species (RWT). The modifying adjective should not be connected to the species name by a hyphen.

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STRUCTURE:

Crystal System: Monoclinic
Space Group: C2/m
Crystal axes: a = 18.65-18.69
b = 7.49-7.52 $\beta = 107^{\circ}\ 54'$ to $108^{\circ}\ 22'$
c = 10.24-10.30

Typical unit cell content: $(Ca,Na_2K_2)[Al_4Si_{20}O_{48}]\cdot 14H_2O$

Type of structure: Dachiardite consists of sheets of 6-rings (which are Al-free) connected with cross-linked 4-rings (which are Al-rich) while the exchangable cations are distributed between the 6-ring sheets (Gottardi and Meier, 1963; Vezzalini, 1983; Gottardi and Galli, 1985). Dachiardite from Elba, Italy is (Si,Al) ordered while bladed dachiardite from most other locations show irregular {001} twinning and {100} stacking faults which indicate disordered (Si,Al) in the framework (Alberti, 1975b; Yoshimura and Wakabayashi, 1977; Gellens et al., 1982). Dachiardite (IUPAC code DAC), a structural member of the mordenite group, is closely related to epistilbite and ferrierite while less so to mordenite and bikitaite.

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PHYSICAL PROPERTIES:

Color: colorless, white, pink, and orange-red
Streak: white
Luster: vitreous to silky
Transparent
Hardness: 4 to 4.5
Fracture: conchoidal, uneven
Cleavage: {100} & {001} perfect
Density: 2.14-2.17 g/cm^3 measured
2.14-2.18 g/cm^3 calculated

OPTICAL PROPERTIES:

Refractive Index:
α = 1.471-1.494*
β = 1.475-1.496*
γ = 1.476-1.500* * = Elba location
Biaxial positive* & negative
2V = 23° to 80°
inclined extinction 2° to 38°*
OP perpendicular to (010) at Altoona
OP parallel to (010) at Elba
X = b at most locations
Z = b at Altoona, Washington

DACHIARDITE

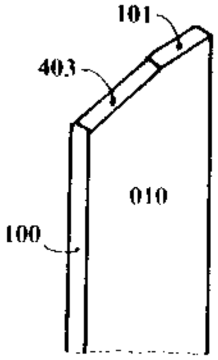

Fig. 1

TERMINATION
OF FIGURE 2

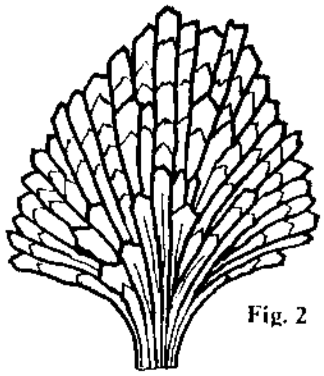
Fig. 2

BUSH-LIKE AGGREGATE
ALTOONA, WA., U.S.A.

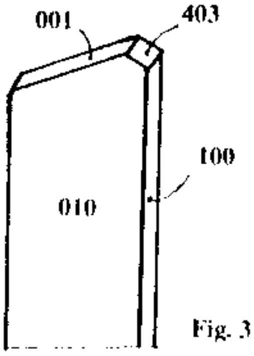

Fig. 3

TERMINATION
OF FIGURE 2

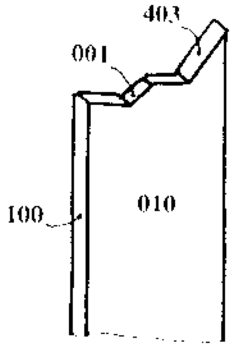

Fig 4

POLYSYNTHETIC TWINNING
ALTOONA, WA., U.S.A.

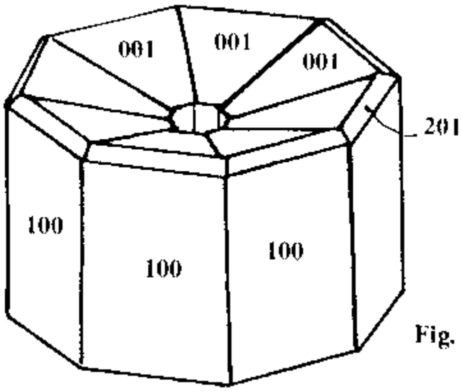

Fig. 5

CYCLIC TWINNING
ELBA, ITALY

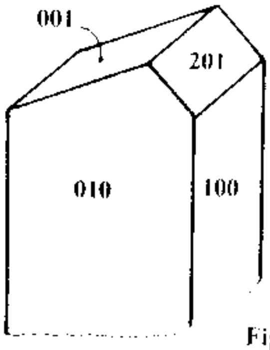

Fig. 6

UNTWINNED PRISM
ELBA, ITALY

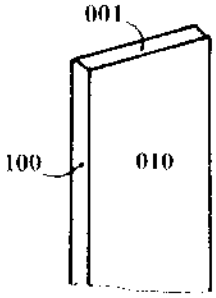

Fig. 7

TERMINATION
OF FIGURE 2

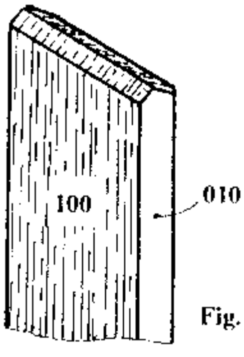

Fig. 8

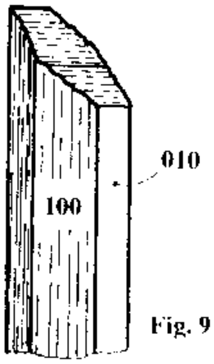

Fig. 9

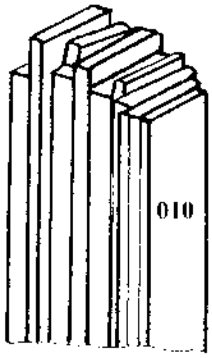

Fig. 10

BLADES FLATTENED ON (100), ALTOONA, WA., U.S.A.

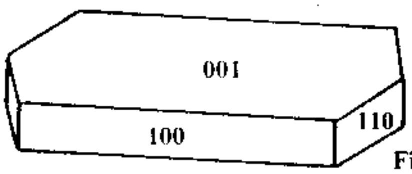

Fig. 11

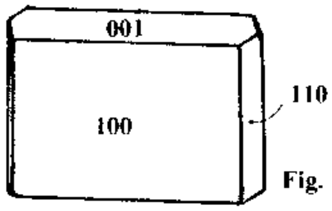

Fig. 12

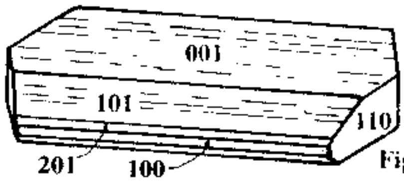

Fig. 13

BLADES ELONGATED WITH THE B-AXIS, YELLOWSTONE NATIONAL PARK, WY., U.S.A.

MORPHOLOGY: Only dachiardite from the type location (Elba, Italy) forms the unusual cyclic-twinned eightlings (Fig. 5), perhaps due to its high cesium content (Gottardi and Galli, 1985). The crystals are blocky, eight-sided twins, up to 5 mm across, composed of sectors repeatedly twinned on {110} at nearly 45^{o} to the next sector which yields with a reentrant toward the center of the eightling (which resembles a shallow octagonal hopper). Rarely a hollow core is present. The forms {001} {100}, {201}, and {110} are reported by Berman (1925). Structural explanation of the {110} twinning is given by Meier (1968). Rarely cyclic twins are produced by a spiral of sectors which curve down into the center of the hopper-shaped twin (RWT). Twinning on {001} is also common (Bonnatti and Gottardi, 1960); rarely on {100} (Bonnatti, 1942). Horizontal striations are present on {100}. Simple untwinned crystals (Fig. 6), elongated with the c-axis and bound by {001}, {100}, {201}, and {010} are also found along with the cyclic-twinned hoppers at Elba (RWT).

Dachiardite from most other locations forms blades, elongated along the b-axis, with tiny irregular terminations or thin fibrous masses due to cleavage in two directions parallel to elongation. These crystals are often flattened on {001}, less commonly on {100}, and have the forms {001}, {100}, {110}, {101}, {201}, $\{\bar{2}01\}$ (Fig. 11-13) with repeated parallel twinning on {001} with {100} as the twin axis, which produces striations parallel to {010} (Bargar et al., 1987).

Bush-like groups of composed of thin dachiardite blades (Fig. 2), up to 4 mm long, elongated parallel to the c-axis, with an inclined {001} cleavage are described by Wise and Tschernich (1978). These blades are usually flattened on {010} with small {100} and terminated by {001}, {101}, and $\{\bar{4}03\}$ (Fig. 1,3,4,7), although some crystals are rarely flattened on {100} with vertical striations due to offsets faces (Fig. 8-10). No evidence of cyclic-twinning has been found, however, polysynthetic twinning (Fig. 4) is commonly developed on the [100] twin planes (seen from numerous re-entrant angles on the terminations and by optics) (Wise and Tschernich, 1978).

FORMS: {001}, {100}, {201}, $\{\bar{2}01\}$, {010}, {110}, {101}, $\{\bar{4}03\}$

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CHEMICAL ANALYSIS:

San Piero di Campo, Elba, Italy (Bonardi, 1979)
$Ca_{1.76}K_{0.73}Na_{0.70}Cs_{0.12}Sr_{0.02}[Al_{5.05}Si_{18.93}O_{48}]\cdot 12.7H_2O$

Alpe di Siussi, Bolzano, Italy (Alberti, 1975)
$Na_{2.59}K_{0.71}Ca_{0.53}Ba_{0.01}[Al_{4.27}Fe_{0.11}Si_{19.61}O_{48}]\cdot 13.4H_2O$

Altoona, Wahkiahum Co., Washington, U.S.A. (base of cluster) (Wise and Tschernich, 1978)
$Na_{2.74}K_{0.60}Ca_{0.09}[Al_{3.38}Fe_{0.02}Si_{20.57}O_{48}]\cdot 14.2H_2O$

Altoona, Wahkiahum Co., Washington, U.S.A. (tip of cluster) (Wise and Tschernich, 1978)
$Ca_{1.01}Na_{0.61}K_{0.34}[Al_{3.43}Fe_{0.02}Si_{20.67}O_{48}]\cdot 14.2H_2O$

Cape Lookout, Tillamook Co, Oregon, U.S.A. (Wise and Tschernich, 1978)
$Ca_{1.14}K_{0.91}Na_{0.61}[Al_{4.02}Si_{20.03}O_{48}]\cdot xH_2O$

Yaquina Head, Agate Beach, Lincoln Co., Oregon, U.S.A. (Wise and Tschernich, 1978)
$Na_{2.12}K_{0.93}Ca_{0.21}[Al_{3.53}Fe_{0.01}Si_{20.48}O_{48}]\cdot xH_2O$

Lower Geyser Basin, Yellowstone National Park, Wyoming, U.S.A. (Bargar and Beeson, 1981)
$K_{1.02}Ca_{0.92}Na_{0.92}[Al_{5.31}Fe_{0.05}Si_{19.15}O_{48}]\cdot xH_2O$

Lower Geyser Basin, Yellowstone National Park, Wyoming, U.S.A. (Bargar et al., 1987)
$Ca_{2.66}Na_{0.05}K_{0.01}[Al_{5.44}Si_{18.58}O_{48}]\cdot xH_2O$

Rhodope Mountains, Zvezdel, Bulgaria (Gellens et al., 1982)
$Ca_{1.28}K_{0.95}Na_{0.36}Mg_{0.09}[Al_{3.66}Si_{20.24}O_{48}]\cdot 13.1H_2O$

Tsugarwa, Niigata Prefecture, Japan (Yoshimura and Wakabayashi, 1977)
$Na_{2.93}K_{0.36}Ca_{0.16}Mg_{0.01}[Al_{4.37}Fe_{0.06}Si_{19.76}O_{48}]\cdot 12.6H_2O$

Hatsuneura, Chichijima Island, Ogosawara Islands, Japan (Nishido and Otsuka, 1981)
$Ca_{1.77}Na_{1.24}K_{0.49}[Al_{4.80}Si_{19.08}O_{48}]\cdot 12.10H_2O$

Francon Quarry, St-Michel, Montreal Island, Quebec, Canada (Bonardi et al., 1981)

$Na_{2.93}K_{0.36}Sr_{0.01}Ca_{0.01}[Al_{3.59}Si_{20.47}O_{48}] \cdot 12.43H_2O$

VARIATION IN COMPOSITION: Dachiardite displays a wide variation in composition in Ca, Na, and K with examples of each cation being dominate. Trace amounts of cesium (under 1% Cs_2O) is found in crystals with an ordered (Si,Al) framework (Gottardi and Galli, 1985; Bargar et al., 1987). Bladed crystals are often heterogenous in composition. Zoned blades which are rich in sodium at the base becoming calcium-rich at the terminations are reported by Wise and Tschernich (1978).

T_{Si} =Si/(Si+Al) = 0.783 to 0.858. Si/Al ratio varies widely from of 3.62 (Elba, Italy) to 6.05 (Altoona, Washington) (Wise and Tschernich, 1978).

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IDENTIFICATION: Eight-sided cyclic-twinned crystals of dachiardite are very distinctive, yet they have been only found at Elba, Italy. Untwinned bladed dachiardite which is found everywhere else is easily confused with many other species, particularly blades and aggregates of thomsonite and calcite. Observation of the terminations is difficult because 50 to 100x magnification or SEM photographs are needed. Dachiardite has an irregular, rough termination from multiple faces while thomsonite generally has a simple single flat (001) termination while calcite aggregates are usually pointed rhombohedra. Calcite is easily confirmed with HCl acid.

Dachiardite is a high-silica zeolite, usually found with the other high-silica zeolites such as ferrierite, mordenite, silica-rich heulandite (=clinoptilolite), epistilbite, and yugawaralite as well as erionite, phillipsite, calcite, and quartz. Low-silica minerals such as thomsonite, levyne, natrolite, mesolite, scolecite, and cowlesite would not be expected to crystallize in this environment. Suspected samples of dachiardite must be confirmed with XRD. Sharp XRD lines are only from samples from Elba, Italy and Yellowstone, Wyoming; all others produce diffuse lines or streaks which indicate some disorder in the structure.

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CLEANING and PRESERVATION: Dachiardite is high-silica zeolite, therefore it is either not effected by HCl or slowly decomposed by it. Removal of calcite should be possible if immersed in HCl for only a few minutes. Maleyev (1977) reports dachiardite (=svetlozarite) is not effected by concentrated HCl, H_2SO_4, or HNO_3 at room temperature after 30 hours with no changes in transparency, luster, or optical properties. In concentrated HF, a gelatinous precipitate was formed.

If dachiardite is associated with minerals which will not tolerate strong acids, remove calcite with the slower acetic acid. Use oxalic acid to remove iron stains.

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ORIGIN: Dachiardite is formed in a silica-rich environment in late-stages of pegmatites and silica-rich volcanics (tholeiitic basalt, rhyolite, and sandstone xenoliths in basalt). Recorded temperatures in drill holes at Yellowstone National Park, Wyoming shows that dachiardite crystallizes between 100^{o} to 200^{o} C at depths from 20 to 152 meters (Bargar and Beeson, 1981; Bargar et al., 1981). Synethic dachiardite is produced from devitrified rhyolite at 250^{o} C (Knass and Beiriger, 1984).

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OCCURRENCE: Dachiardite is a rare zeolite found with high-silica zeolites in volcanics and pegmatites. Specimens of cyclic twins from Elba are very hard to obtain but bladed specimens are available from locations in Washington and Oregon, U.S.A; Germany, Italy, and Japan. Search for additional dachiardite occurrences should be concentrated at locations where high-silica zeolites and quartz are present. Dachiardite has not been reported in sedimentary (diagenetic) deposits.

WORLDWIDE LOCALITIES:

GERMANY: Na-rich dachiardite is found in the Maroldsweisach quarry, near Schweinfurt, Unterfranken, associated with natrolite, silica-rich heulandite, thomsonite, scolecite, stilbite, gmelinite, chabazite, erionite, gismondine, and phillipsite (Toni Wieland, pers com).

Sodian dachiardite is found with silica-rich heulandite and two unknown minerals on apophyllite in sandstone xenoliths in Tertiary basalt at the Zeilberg quarry, near Maroldsweisach, Franconia, Bavaira, with other cavities containing gmelinite, natrolite, analcime, thomsonite, phillipsite, and Ca-silicates (Wolfgang Hampel, pers com).

White tufts of dachiardite needles are rarely found on silica-rich heulandite, lining vesicles in a 10x2 meter sintered sandstone zenolith (composed of quartz, minor cristobalite, and phillipsite), which is embedded in alkaline-olivine basalt and basanite at the Ortenberg quarry, Vogelsberg, Hessen; resulted from high-alkali hydrothermal solutions with the crystallization sequence nontronite-calcite > phillipsite > paulingite > silica-rich heulandite > dachiardite, while nearby cavities contain chabazite, erionite, merlinoite, and apophyllite (Hentschel, 1986). Nearby volcanics contain analcime, gismondine, apophyllite, thomsonite, natrolite, phillipsite, calcite, thaumasite, montmorillonite, and pyrite (Hentschel, 1979).

BULGARIA: Ca-rich dachiardite (=svetlozarite) from Zvezdel in Kurdzhali, Eastern Rhodope Mountains (Maleev, 1976) was found to be disordered with polysynthetic twinning and structural faults (Gellens et al., 1982). The dachiardite forms, 5 to 15 mm, colorless to white spherulites which co-crystallized with mordenite on opal-cristobalite and gray chalcedony after silica-rich heulandite and ferrierite lined veins which cement Oligocene brecciated andesite (Maleev, 1976).

AUSTRIA: Tiny parallel groups of prismatic Na-rich dachiardite crystals, up to 3 mm long, are found covered by blocky silica-rich heulandite (=clinoptilolite), analcime, and thin hair-like mordenite on joints and cavities of chlorite schists and amphibolites in the tunnels, which were constructed in 1980-1981, through Tanzenberg, near Kapfenfberg, Styria (= Steiermark); associated minerals include bladed ferrierite, octahedrons and filiform pyrite, marcasite, quartz, siderite, sphalerite, chalcopyrite, pyrrhotite, millerite, opal, rutile, anatase, goethite, dolomite, calcite, magnesite, ankerite, and barite (Postl and Walter, 1983; Postl et al., 1985).

ITALY: TYPE LOCATION: Dachiardite was first found in late stage hydrothermal cavites in pegmatite veins crossing the Miocene granodiorite stock Monte Capanne near San Piero in Campo, on the island of Elba, in 1905 (D'Achiaardi, 1905; 1906). This Ca-rich dachiardite, with nearly 1% Cs_2O, forms blocky, colorless to white, spectacular eightling twins with hopper-shaped habit which display the forms {001} {100}, {201}, and {110} (Fig. 5) (Berman, 1925). Untwinned prisms are also present bound by the forms {001}, {100}, {201} and {010} (Fig. 6) (RWT). Associated minerals include mordenite, stilbite, heulandite, apatite, pollucite. quartz, feldspar, and tourmaline (RWT). The original dachiardite found in the Speranza vein, formed twinned crystals, up to 5 mm across, but good specimens are also found in the pegmatite veins Fonte del Prete, Masso Foresi, and Grotta d'Oggi, all at San Piero in Campo (Orlandi and Scortecci, 1985).

Dark orange-red masses of thin, radiating fibers of Na-rich dachiardite with (100) and (001) cleavage is covered with pink massive mordenite and rarely silica-rich heulandite in porphyritic basalt at Orli di Fassa, Alpe di Siusi (=Seiser Alpe), Bolzano (Alberti, 1975) and at a nearby location at Val di Fassa (Demartin and Stolcis, 1979).

JAPAN: Ca-rich dachiardite forms slinder, prismatic crystals with mordenite, heulandite, and quartz in hydrothermal veins at the Onoyama gold Mine, Kagoshima Prefecture (Kato, 1973).

White to beige needle-like mats of Na-rich dachiardite is found with mordenite, silica-rich heulandite, barite, and sulfide minerals in veins in altered Miocene rhyolite at Tsugarwa, Niigata Prefecture (Yoshimura and Wakabayashi, 1977).

Na-rich dachiardite forms radiating aggregates of prismatic fibers associated with mordenite and heulandite in amydules of altered andesite pillow lava at Susaki on the west coast of Chichijima

Island in the Ogasawara Islands (Nishido et al., 1979).

A Ca-Na-rich dachiardite forms radiating aggregates of platy, prismatic crystals associated with mordenite in chalcedony veins crossing altered boninite pillow lava at Hatsuneura, on the east coast of Chichijima Island in the Ogasawara Islands (Nishido and Otsuka, 1981).

Dachiardite occurs with mordenite and natrolite at Mt. Hokiidake, Nagano, Honshu (Smithsonian, RWT).

CANADA:

Quebec: Na-rich dachiardite is found in a dawsonite-bearing silicate-carbonate sill at the Francon quarry, St. Michel, Montreal Island, in a single pocket, 23 cm in diameter, lined with colorless to brownish analcime on which is found silky-white bundles of acicular dachiardite crystals, 1 to 2 mm long, some showing a hourglass-like structure, and associated with ankerite, dolomite, calcite, quartz, weloganite, and white matted fibers of mordenite (Bonardi et al., 1981).

UNITED STATES:

Wyoming: Research drill holes in the Lower Geyser Basin and along the Firehole River, in Yellowstone National Park, have uncountered a Ca, Na, and K-rich dachiardite in fractures and cavities in hydrothermally altered Late Pleistocene rhyolite and tuffs at a depth of 20 to 155 meters and temperatures ranging from 100^{o} to 200^{o} C (Bargar et al., 1987). The dachiardite forms colorless, transparent to cloudy, radiating groups of bladed to acicular crystals, elongated along the b-axis and flattened on {001} or less commonly flattened on {100} with the forms {001}, {100}, {110}, {101}, {201}, and {$\bar{2}$01} and striations parallel to {010} from repeated parallel twinning on {001} with {100} as the twin axis (Fig. 11-13) (Bargar et al., 1987). The chemical compositon varies widely from very Ca-rich crystals to those dominate in K or Na along with trace amounts of cesium (0.05 to 0.07% Cs_2O) and forms on quartz, heulandite, mordenite, kaolinite, pyrite, and calcite while followed by mordenite, yugawaralite, epistilbite, and Na-rich smectite; nearby cavities also contain laumontite, fluorite, Ca-rich smectite, Na-rich wairakite, erionite, and truscottite (Bargar and Beeson, 1981; Bargar et al., 1981; Bargar et al., 1987). Ca-rich zones in the rock, with contain dachardite and associated Ca-rich minerals, alternate with Na-K-rich zones, which contain analcime, Na-rich heulandite, Na-rich mordenite, Na-rich smectite, aegirine, and adularia due to alternating aquifers of different chemical composition (Barger et al., 1987).

Arizona: Dachiardite forms in amygdales and matrix of Late-Tertiary basalt breccia and andesite in drill cores extending from surface to the lower levels in the geothermal basin near Hassayampa, in central Arizona (Sheridan and Maisano, 1976).

California: Bush-like groups of dachiardite blades are very rarely found with ferrierite, silica-rich heulandite (=clinoptilolite), calcite, and chalcedony in a brecciated porphyritic andesite at Agoura, Los Angeles County (Wise et al., 1969; (RWT). Excavations at the Canwood Mall, near Agoura, Los Angeles County, produced colorless to white sprays of bladed dachiardite, up to 5 mm long, associated with ferrierite, silica-rich heulandite (=clinoptilolite), mordenite, phillipite, quartz, opal, and calcite (Robert Ray, pers com).

Tiny, individual, colorless to milky dachiardite blades, not over 2 mm long, with stepped terminations are found scattered in red vesicular Tertiary basalt at the Opal Hill Mine, "Coon Hollow", in the Mule Mountains, SW of Blythe, Riverside County, often associated with milky-white to colorless phillipsite and tiny, colorless, blocky silica-rich heulandite in the sequence dachiardite > heulandite > opal-chalcedony balls > phillipsite > fluorapatite needles (Violet Frazer, pers com).

Washington: Dachiardite forms silky-white to colorless bush-like groups (Fig. 2), up to 4 mm long, consisting of well-terminated, tiny, thin crystals which are Ca-rich at the terminations and become Na-rich at the stem or base of the groups, in cavities of Miocene basalt breccia exposed along the Columbia River at Altoona, Wahkiahum County (Wise and Tschernich, 1978). Cavities, up to 1 cm across, are lined with siderite covered by greenish-black nontronitic clay on which small white furryappearing aggregates of mordenite occur followed by either monoclinic or orthorhombic ferrierite > colorless, blocky crystals of silica-rich heulandite > silky bushes of thin-bladed dachiardite > rarely short hexagonal prisms of light yellow apatite > and finally calcite (RWT). Quartz and calcite is very abundant in nearby brecciated rocks, yet chalcedony only rarely forms a thin layer under mordenite or a thin covering on all the zeolites. Obsevation of dachiardite crystal terminations at 25 to 500x magnification shows the crystals are elongated along the c-axis, usually flattened on {010} (Fig. 1,3,4,7), rarely flattened on {100} (Fig. 8-10), with small {100} and terminated by {001}, {101}, and $\{\bar{4}03\}$, and are commonly twinned parallel to {100} (Wise and Tschernich, 1978).

Oregon: Frosted, colorless, transparent, individual blades and radiating hemispherical aggregates of Ca-rich dachiardite, up to 15 mm in diameter, are found, in 1 to 8 cm cavities, in vesicular Miocene tholeiitic basalt north of Cape Lookout, Tillamook County (Wise and Tschernich, 1978). Crystals are elongated along the c-axis, with inclined {001} cleavage across the length of the blades and display the forms {010}, {100}, {001}, {101}, and $\{\bar{4}03\}$ (RWT). Simple-appearing blades with complex terminations are repeatedly twinned on [100]. An iron-rich smectite first formed in the cavities followed by thin hair-like erionite needles which form radiating sprays or linings followed by a porcelaneous mordenite on which dachiardite forms; mordenite then formed a second generation of tiny cotton-ball-like aggregates followed by colorless to pale-green blocky silica-rich heulandite and lastly filiform and cubic pyrite, calcite, and chalcedony while nearby cavities also contain phillipsite (Wise and Tschernich, 1978). Erionite and dachiardite are very rarely present in the same vesicle. Dachiardite is usually found in a 10 to 30 cm thick zone running across the quarry which consists of the assemblage dachiardite-mordenite-silica-rich heulandite (=clinoptilolite) with a noteable absence of hair-like erionite needles. Vesicles above and below the dachiardite zone consist of abundant erionite, mordenite, and silica-rich heulandite without any dachiardite (RWT).

Bush-like groups of terminated Na-K-rich dachiardite with large radiating fan-like extremities and tapering stem-like base are very rarely found in association with silica-rich heulandite and pyrite in the Miocene vesicular basalt at Yaquina Head, Agate Beach, Lincoln County, while nearby rock contains an abundance of erionite, mordenite, phillipsite, calcite, clay, chabazite, and barite (Wise and Tschernich, 1978).

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The MICROPROBE

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Dues for 1990 are now due and payable at the Spring Meeting. Dues for 1990 may also be sent directly to the editor at the above address.

FIELD TRIP to SUNDAY CREEK, NORTH FORK of the SNOQUALMIE RIVER, WASHINGTON

(JULY 28-29, 1990)

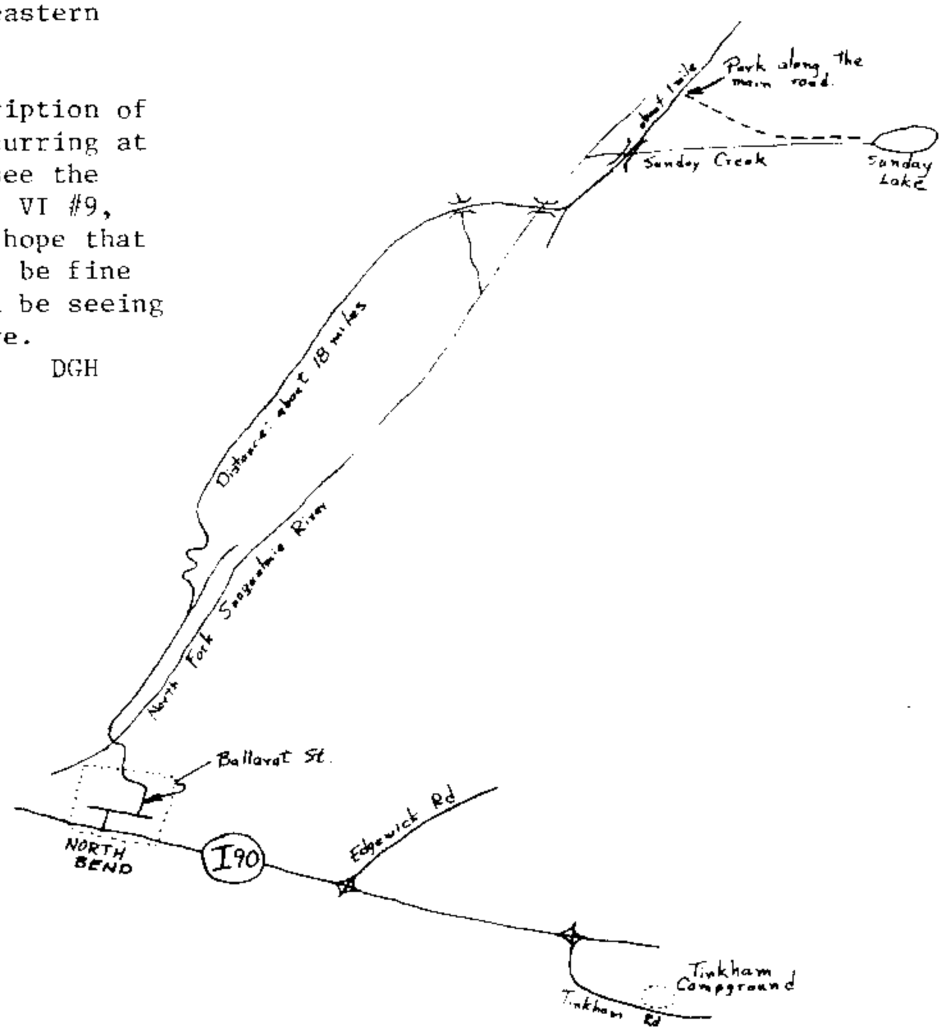
We will be going back to the Sunday Creek location in late July. So far the material collected at that location has been in the form of float boulders along the Creek. We hope to have time to explore the area to see if we can locate where the float is coming from.

We plan to camp at Tinkham Campground, just off I90 at the Tinkham Road exit between North Bend and Snoqualmie Pass. We plan to leave the campground Saturday morning about 8:30 am. It should take a little over an hour to reach Sunday Creek.

Sunday Creek is about 18 miles northeast of North Bend on a road (mostly well-graded gravel) through logging area along the N. Fk. of the Snoqualmie River. Access is from Ballarat St. in North Bend. The road across to the upper part of Sunday Creek has been closed by the Forest Service, so it is necessary to park along the main road. The side road is not marked, but is about 1 mile above the bridge over Sunday Creek. This in turn is the first bridge on the road after recrossing the Snoqualmie River onto the eastern side.

For a description of the minerals occurring at this location, see the Microprobe, Vol. VI #9, pages 9-10. We hope that the weather will be fine and that we will be seeing many of you there.

DGH

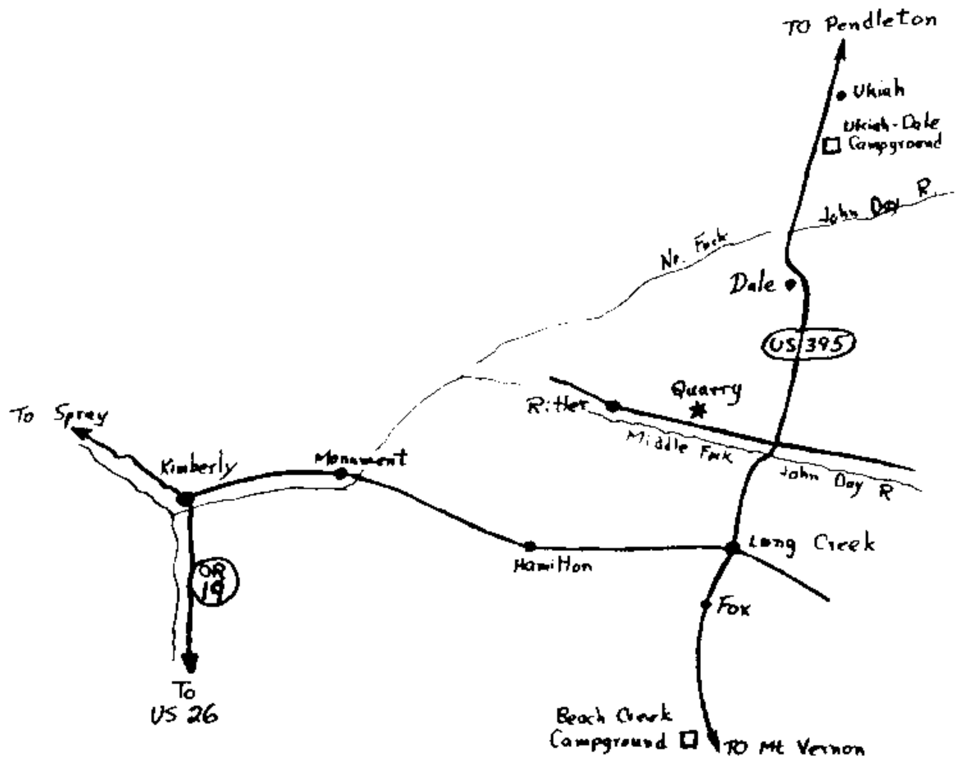


FIELD TRIP to the MIDDLE and NORTH FORK of the JOHN DAY RIVER, OREGON (JUNE 28-30, 1990)

It was agreed at the last meeting that a field trip would be planned to attempt collecting zeolites along the North Fork of the John Day River (see Micro Probe V 6, #8, pp 10-13, 1989 for description of the locality). Since the generally poor condition of the road and creek crossings varies each year, several 4-wheeled drive vehicles will be in the group to shuttle members to the location, in case conventional cars can not make it. Normally, with care, all vehicles should be able to get to the location. Do not attempt it with a trailer.

We will rendezvous on June 28 at the quarry along the Middle Fork of the John Day River (approximately 4.5 miles from Highway 395 towards Ritter). We will collect in the quarry or make short trips to nearby locations during that day and camp in or near the quarry that night so that all members can link up with the group. Early in the morning on June 29 we will caravan to the North Fork locations and may camp in that area if the road is passable or return to the Middle Fork quarry.

Bring 4 to 8 lb hammers, bars, and boxes. Remember both rattle snakes and scorpions have been seen in the collecting and camping areas therefore watch where you walk and put your hands. We can not predict the weather but it should be hot. The collecting area on the North Fork is in a "little" shade in the afternoon and trees for shade are nearby. Naturally water is present, we are right next to the river. Let's have a good time. RWT

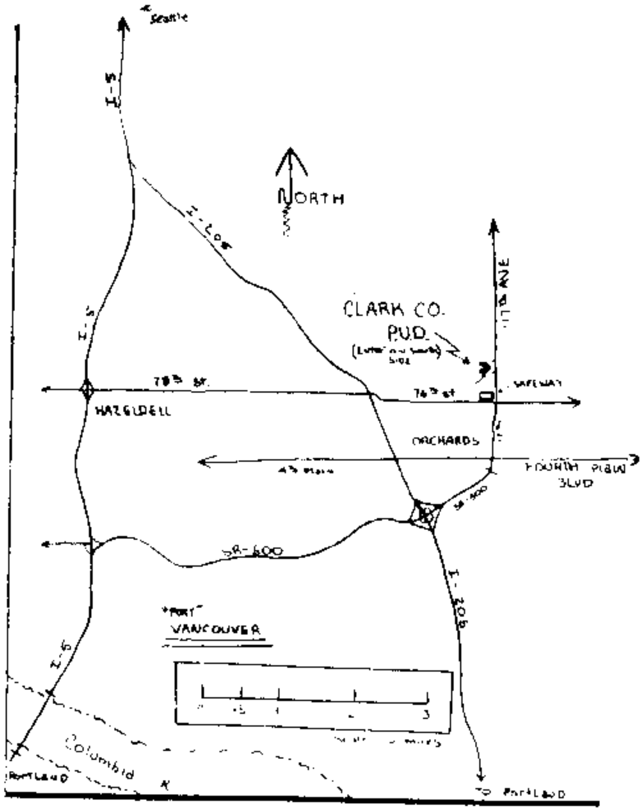


S P R I N G   M E E T I N G

DATE: May 5, 1990

TIME: 9:30 am to 9 pm

PLACE: Orchards Office
Clark County P.U.D.



Come one, come all.
Bring your microscope, your best new specimens, plenty of material to trade. We hope to have another full day of fun and fellowship.

As usual, there will be plenty of informal time to get to visit and inspect each other's material.

Business Meeting at 2 pm
- Election of officers
- Discussion of dues
- Reports on collecting localities
- Further information on upcoming field trips.

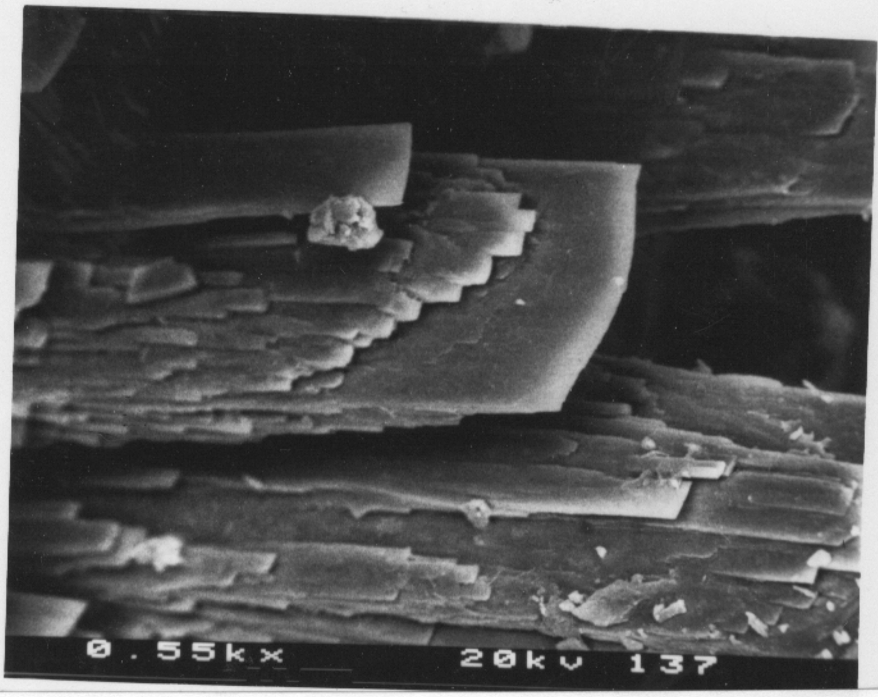
There will be material from both of our summer field trip localities for your inspection.

We hope also to have a discussion group after the business meeting about minerals from the Golden Horn, Washington Pass.

POT LUCK Dinner in the evening.
- Bring a salad or a desert.
- Main course will be provided as usual.
- It is always safest to bring your own plate, cups, and tableware in case we run out.

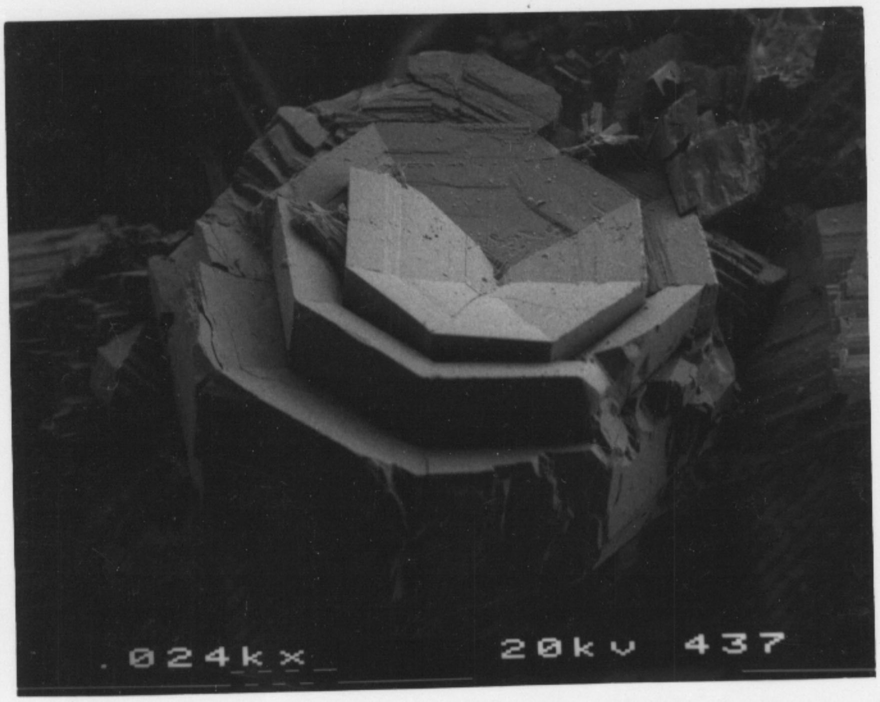
Slides in the evening -- bring any pictures of minerals or collecting localities that you have to share with the group.

Easily reached from I205. State road 500 goes right past the front door. Park on the south end of the building, and enter using the south door.

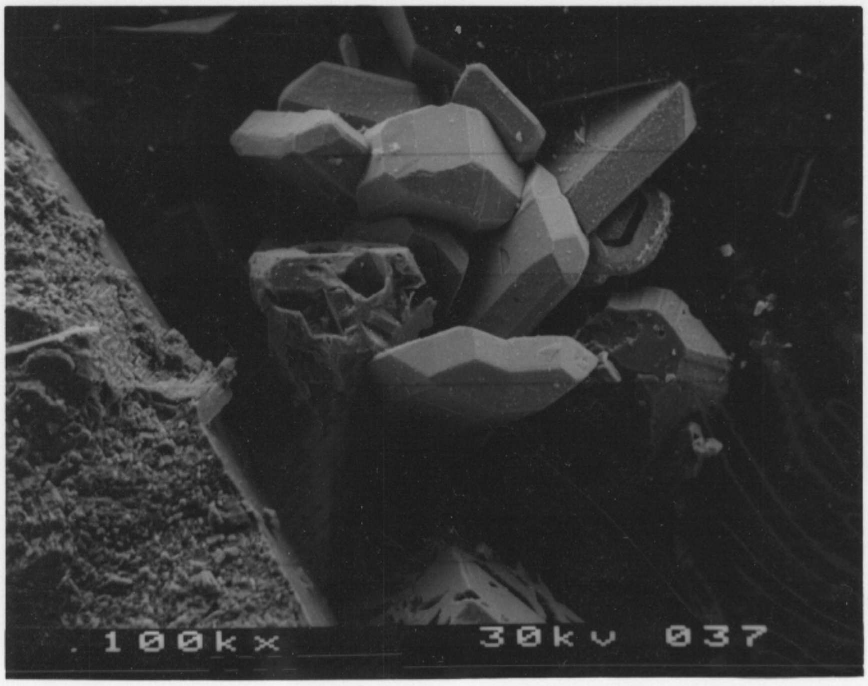


#137 – DACHIARDITE – ALTOONA, WAHKIAKUM COUNTY, WASHINGTON – 550X

#441 – DACHIARDITE – OPAL HILL MINE, RIVERSIDE COUNTY, CALIFORNIA – 98X

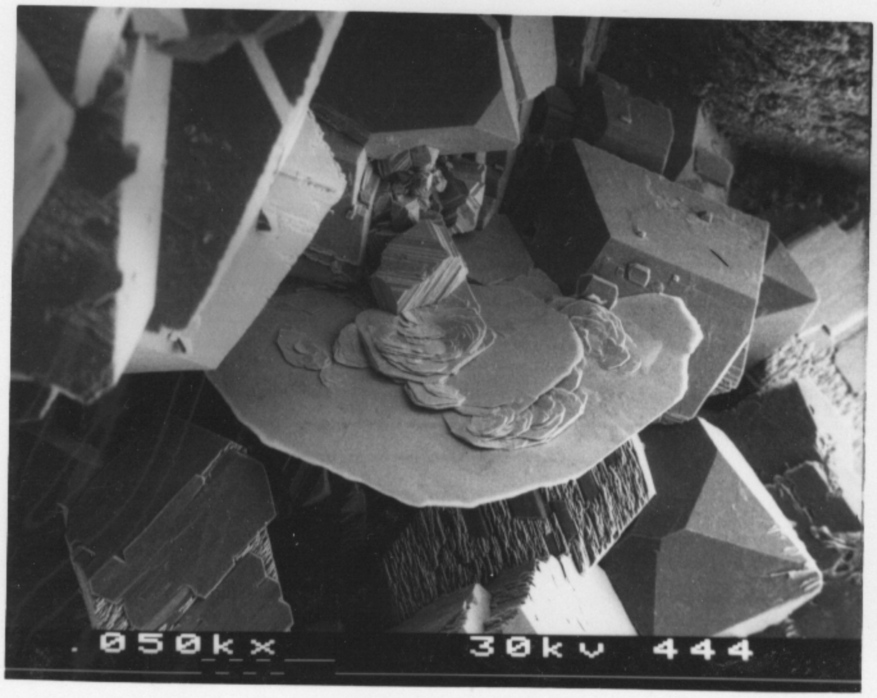


#437 – DACHIARDITE – SAN PIERO de CAMPO, ELBA, ITALY – 24X

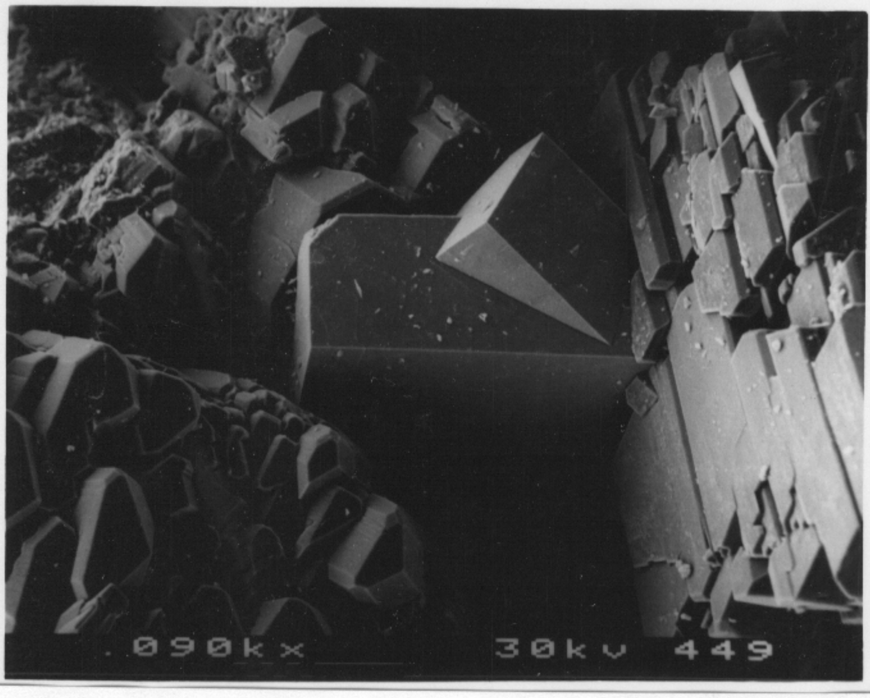


#037 – CHEVKINITE, FLUORITE – GOLDEN HORN BATHOLITH, OKANOGAN COUNTY, WASHINGTON – 100X

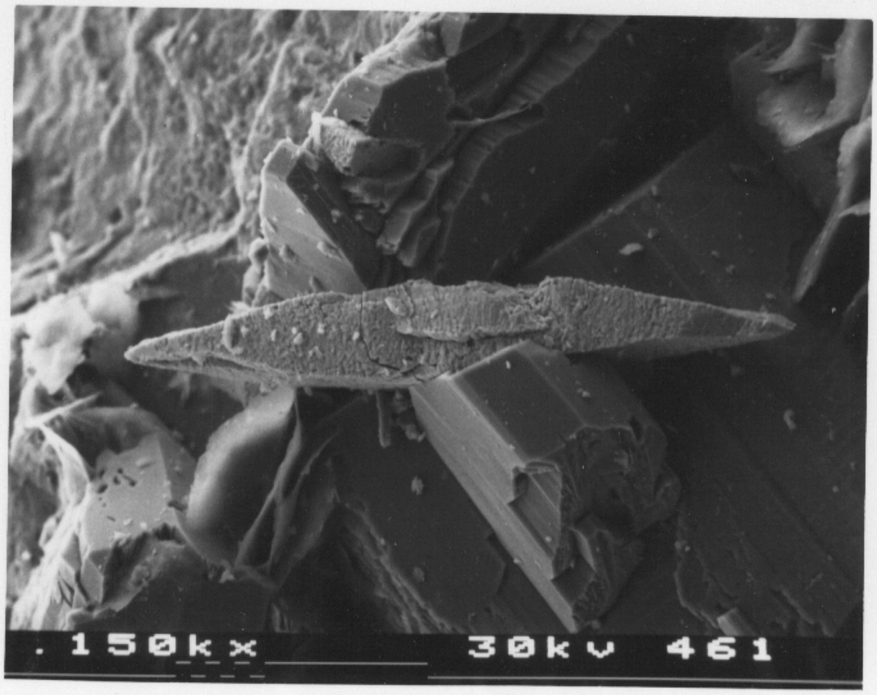
#443 – ZIRCON, MAGNETITE – GOLDEN HORN BATHOLITH, OKANOGAN COUNTY, WASHINGTON – 60X



#444 – ILMENITE, MAGNETITE – GOLDEN HORN BATHOLITH, OKANOGAN COUNTY, WASHINGTON – 50X



#449 – GADOLINITE – GOLDEN HORN BATHOLITH, OKANOGAN COUNTY, WASHINGTON – 90X



#461 – FERGUSONITE – BETA – GOLDEN HORN BATHOLITH, OKANOGAN COUNTY, WASHINGTON – 150X