

Northwest
Micro Mineral
Study Group



MICRO PROBE

FALL, 1993

VOLUME VII, Number 8

FALL MEETINGVANCOUVER, WASHINGTON

November 6, 1993

9:30 am to 9 pm

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

Come join us for a day of good fun and fellowship about mineral collecting. Bring your microscopes and the best of your new finds from this summer's outings. Also be ready to share information about the status of collecting spots in your area. And be sure to bring some pieces for the give-away table so that everyone will come away with new material to study.

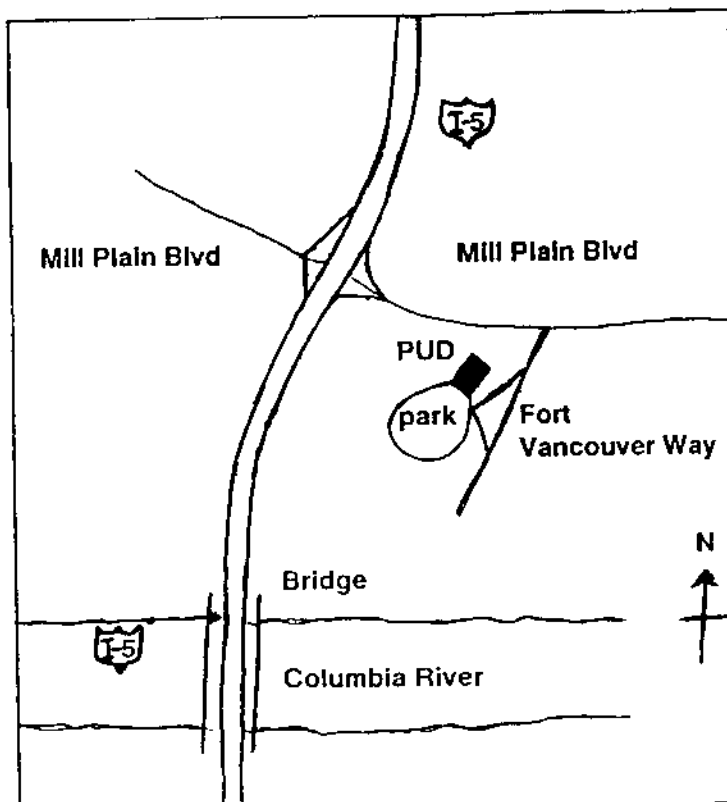
There will be a short business meeting at 1:30 with a chance for everyone to share information about collecting. Possible field trips for Sunday will be discussed, depending on the weather.

Rudy Tschernich will show slides and tell us about his collecting experiences in Victoria, Australia earlier this year.

As usual, we will have specimens from Victoria, and from the locations featured in articles in this issue for you to examine.

Pot Luck Dinner will start around 6 pm. Bring a salad, hot dish, or dessert. We will supply ham, potatoes and coffee.

Bring slides of collecting trips or newly photographed minerals to share in the evening after dinner.



AN UNUSUAL OCCURRENCE OF GARRONITE FARA, VICENZA, ITALY

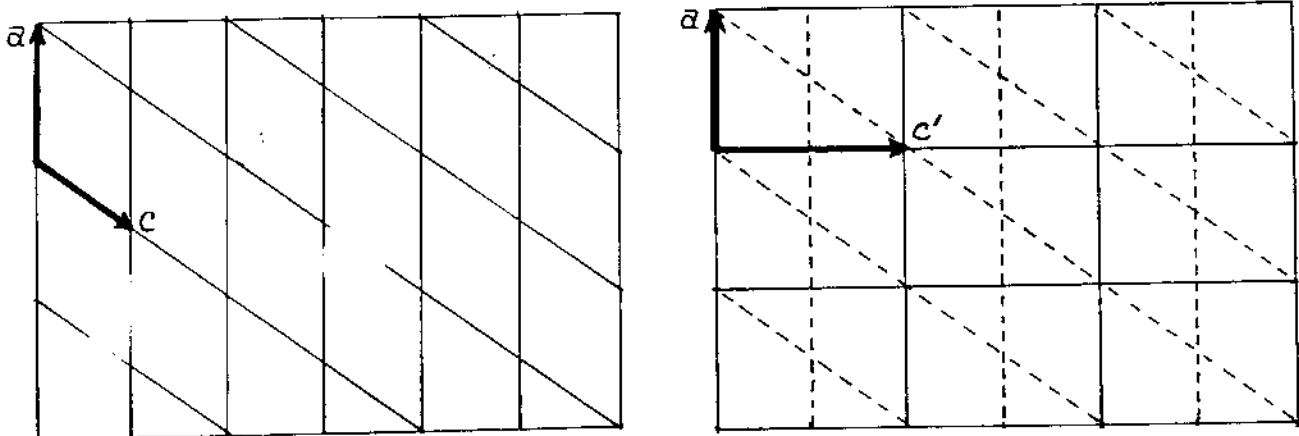
Donald G. Howard

Garronite is not an uncommon member of the zeolite suite occurring at several of our Northwest localities. Normally, garronite forms as completely filled cavities with a very characteristic pattern of cracking. Occasionally, it forms balls that only partially fill the cavity, in which case the ball will be covered with a layer of crystallized phillipsite.

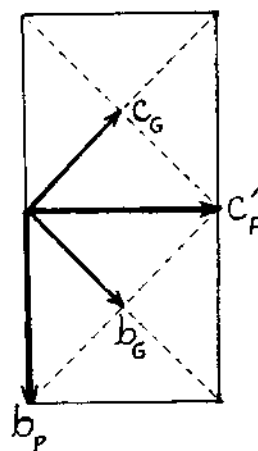
The reason that garronite forms in this manner is that it is a disordered structure, generally resulting from rapid growth. The ordered structure that corresponds to the same composition is gismondine. All of these structures are closely related to that of phillipsite.

Usually, garronite forms in the sequence of crystallization before phillipsite. A recent find in northern Italy, however, shows what can happen if the phillipsite forms first. The zeolite specimens were obtained from a basalt outcrop on a farm near Fara Vicentina, Vicenza, in northern Italy. The most common zeolite present, and earliest to form, is analcime, present in clear trapezohedrons up to several millimeters in diameter. Gonnardite and chabazite (hershellite) are also present. One fracture contained small amounts of phillipsite with associated garronite present as individual crystals rather than as polycrystalline masses. The garronite shows interesting twinning, and epitaxial growth upon the phillipsite.

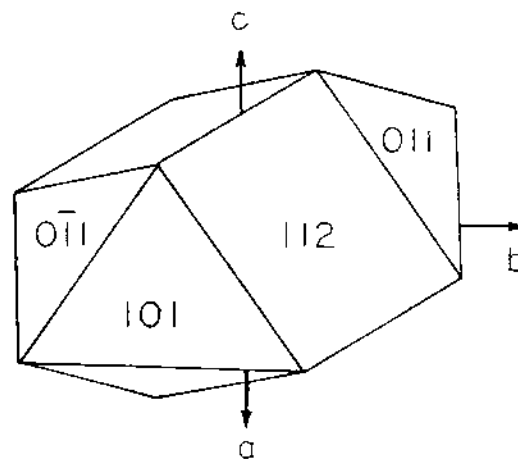
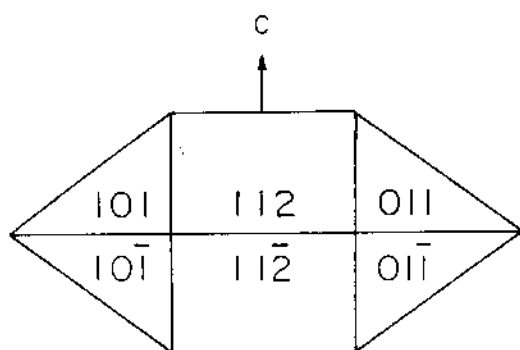
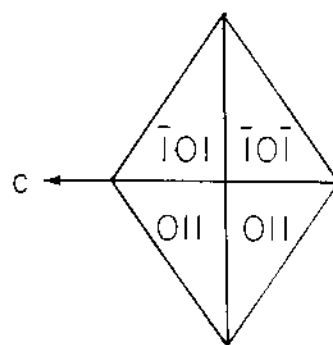
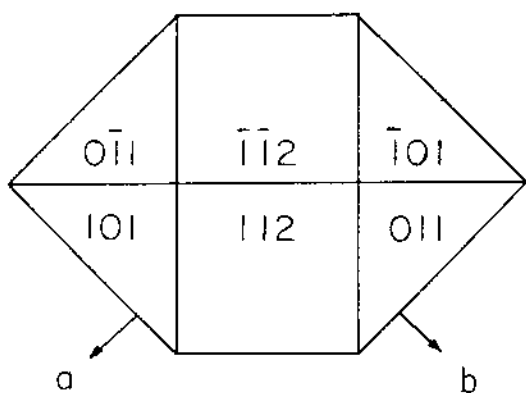
In order to understand the nature of the epitaxial growths, it is necessary to describe the structural relationship between phillipsite and garronite. Phillipsite is a monoclinic mineral that is very nearly tetragonal. To see this, consider the diagram below showing a view perpendicular to the *b* axis. At left is shown the usual monoclinic unit cell, with an oblique angle of about 125° . We show at right how, by picking a cell twice as large, we come up with axes that are very nearly at right angles. In addition, this new longer *c*-axis has an almost identical length to the original *b*-axis, giving very nearly tetragonal symmetry.



Garronite has a structure that is given as orthorhombic, although the three axes differ only slightly in length and it therefore is very nearly cubic. The axial lengths are about the same as the shorter a-axis of phillipsite. In fact, where the garronite is epitaxially related to the phillipsite, the a-axes of each structure are parallel, while the b- and c-axes of garronite are rotated 45° with respect to the tetragonal representation of phillipsite, as shown at right. The resulting unit cell is therefore half the size of the phillipsite tetragonal cell, and the two structures fit together very nicely.



While the lattice parameters for garronite are very nearly cubic, the shape of the resulting crystals do not display cubic symmetry at all. The crystals are composed of $[101]$ and $[011]$ faces, together with $[112]$ faces of varying development. The resulting prism is shown in the diagram below.



The basic crystal form of garronite from Fara, Vicenza, Italy

Because of the close relationship between the lattice structures of the two zeolites oriented as described above, most of the major faces lie parallel to each other.

These parallel equivalents are given in the table at right. Though not obvious from the perspective of the crystal diagram for garronite, the near equality of the axes allow the (011) and (0 $\bar{1}$ 1) faces (and similarly the (101) and (10 $\bar{1}$) faces) to be very nearly perpendicular to each other, as they would be in a truly cubic lattice.

Corresponding faces between orthorhombic garronite and of monoclinic phillipsite.

garronite	phillipsite
011	001
01 $\bar{1}$	010
101	110

The phillipsite at Fara was the first to form, growing slowly enough to make well-ordered, clear crystals. Many are cruciform twins. At some point a change took place that favored fast growth. The reentrant angles of the cruciform twins made ideal nucleation centers for the new crystals of garronite, and the result was epitaxial growth of the type illustrated in micrograph #326. Both the right and the left reentrant angle have garronite crystals growing in them. The visible top faces of the garronite are the [101] faces. The [112] faces in these crystals are not very well developed. Notice that the crystal on the left is twinned on the (10 $\bar{1}$), with the twin clearly showing the striations characteristic to the [112] faces.

Not all the garronite occurs in contact with phillipsite. In some cavities the garronite grew directly on the clay lining, and in these crystals complex twinning occurs. Micrograph #324 shows several such groups. In the upper left, four crystals form a "core-bit" twin by repeated twinning on the [011] faces. The large central group is of similar structure, but is viewed at 45°, looking down on the heavily striated [112] faces of one member of the group. This crystal is actually twinned in the "core-bit" manner about all three axes. The heavy striations on the [112] faces indicates that further twinning is occurring on the [110] planes, so that a complete group of this type would be made up of 24 individuals.

In contrast to the glassy clear phillipsite, the garronite is white and opaque. As can be seen from the many cracks in the two micrographs, garronite is fragile. It does not stand up well to the vacuum preparation necessary for the electron microscope. However, the crystals do seem stable in shipping and should not readily deteriorate in a collection.

This is by far the finest occurrence of garronite found so far, and will be much in demand by zeolite collectors. Though most cavities are small, the clusters of twinned crystals are particularly attractive. Moreover, this occurrence has expanded our understanding of the structure of one of the rarer zeolites. With twinning possible on at least three distinct sets of planes, [110], [101], and [011], it is easy to see how such complex groups of crystals result.

Other interesting zeolites are also present in the Fara material. Based on limited observations of specimens, the following minerals have been observed in order of their sequence of crystallization:

SMECTITE lines most of the cavities with a substantial layer of light greenish-gray clay. These fine-grained deposits tend to be rather bumpy and irregular.

ANALCIME has formed directly on the clay. In many cases, these are tiny crystals whose individual faces are barely discernable at a magnification of 40x. Some individual have grown much larger, forming scattered, water-clear crystals up to several millimeters in diameter. The form is the usual trapezohedron with substantial cube faces often present.

CHABAZITE variety HERSHELLITE also grows on the clay base and over the smaller analcime crystals. Individual crystals are almost circular wedges, without indication of separate faces. (See the accompanying micrograph #264.) The rough surface texture indicates they are very finely and complexly twinned to form these wedges. X-ray diffraction studies show chabazite with a small admixture of gmelinite, which is the characteristic signature of hershellite.

PHILLIPSITE forms small, clear individuals, both simple and cruciform twins.

GARRONITE has formed after the phillipsite, and in cavities where phillipsite is already present, grows as oriented, epitaxial individuals with sharp, often heavily striated faces. Garronite also forms complex twinned groups directly on the clay base. The garronite crystals are white and opaque, and therefore are easily discernable from the clear phillipsite.

GONNARDITE is also present in some cavities, though not in close association with the garronite, so it is difficult to tell which precedes. Since both of these minerals are disordered and therefore undoubtedly grow very rapidly, it is likely that they formed at the same time at the end of the mineralization period. Gonnardite is also white and opaque. It forms in small clumps that have a radial structure and a roughened top. Occasionally, they appear as crude radial rods with very rough terminations.

The conditions that caused such rapid growth, followed by no further mineralization, must have been quite unusual. At most sites, a slowing of formation leaves a layer of phillipsite over free garronite surfaces. This clearly did not happen at Fara.

Interestingly enough, another outcrop only about 400 meters away contains a completely different suite of zeolites, including a potassium-rich gmelinite, natrolite and thomsonite in addition to analcime, phillipsite and chabazite. The author has not yet seen material from this adjacent site.

TIPS ON SOME NEW MOUNTING MATERIALS

Donald G. Howard

One of the most important operations of maintaining our mineral collection is the mounting of specimens for preservation and storage, and we all have slightly different methods for accomplishing this. A majority of us have come to depend on the use of plastic boxes, particularly for zeolite specimens that can be easily ruined by dust that cannot be washed away, or by an accidental brush that can smash delicate crystals. The box provides a place to attach a label or number as well.

Most boxes come with a styrofoam insert (or one can be purchased separately). These inserts form a base for the mineral as well as some stability for the label. Unfortunately, they come in one color -- white. If a black background is more desirable to show off a specimen, the insert needs to be sprayed with black paint. This is often a messy business, and requires a special can of spray paint that does not contain a carrier that dissolves the styrofoam. I have found over the years that the results are often less satisfactory than I would desire. I was therefore interested in exploring other kinds of plastic foam that might take paint better (without dissolving) and thus make better mounts.

The material I have recently come across is "extruded polyethylene plank". Its properties are considerably different than styrofoam, and it therefore involves some different handling techniques. These differences lead to some advantages and some disadvantages, so you will have to weigh the pros and cons to see if this material appeals to you.

One of the major advantages involves coloring: this foam is not attacked by the organic carriers in the spray paint, so any paint can be used. But even better - this foam comes in both white and black, so you have a choice of mounts without having to spray paint.

Cutting of the foam is easily accomplished using a fine-toothed hack-saw blade. Large pieces can be cut down to bars of the correct dimensions for the particular boxes you are using, and then slices can be made of the desired thickness. Trimming to size is easily accomplished using an ordinary pair of scissors.

The texture of the foam is very like that of the styrofoam, so that the appearance of the finished mount is almost indistinguishable from your previous mounts. However, unlike styrofoam, the polyethylene retains a flexibility. This is both an advantage and disadvantage. With this material, you can no longer crush a dent into which you fasten the mineral, since the dent slowly restores itself. It is necessary to trim out a small area with pointed scissors, tailoring it to the shape of the bottom of the specimen, before applying glue. It is still possible to use mineral-tack if that is the way you prefer to fasten down specimens. However, the fact that the foam does not dissolve in solvents allows a much wider range of cements to be used, including acetone-based ones like Duco (model airplane cement) that damage styrofoam. I prefer using rubber cement.

The flexibility, while being a nuisance during mounting, has a real advantage, however. Unlike the styrofoam, this material will not break away easily. Thus, mounts are much more likely to remain intact, even when the box is severely jarred or even dropped. This means that the mounts are much more stable and less likely to be damaged during transit, as for instance while bringing them to a mineral meeting to show off your newest finds. The reason that I prefer rubber cement is that it also retains some flexibility and further increases the stability of the mounts.

Extruded polyethylene plank can be purchased from foam dealers. I buy mine from A-1 FOAM RUBBER, 8040 S.E. Stark St., Portland, Oregon. It comes in 8 by 2 foot pieces about 2.25 inches thick, and costs about \$4 per square foot (the dealer is usually very willing to cut the amount you need). Be sure to specify the UNLAMINATED variety, since the kind that is laminated forms unsightly ridges across the insert.

* * * * *

For those who mount very tiny crystals or tiny specimens, another useful material is 1/16 inch plastic rod, available from a plastic supplier (such as Tap Plastics, Inc., 3818 S.E. Powell Blvd., Portland, Oregon). Since this material is slender and clear, it disappears from view very readily, and therefore does not need to be blackened like cork or wood posts. The rod can be broken or clipped to the desired size and fastened to the back of the specimen with an acetone-based cement such as Duco, which bond to the plastic by partially dissolving the surface layer. By making a tiny hole in the foam liner, the base of the rod can be inserted after dipping in rubber cement. (CAUTION: it is best to cut the rod to length before gluing on the specimen, as the snap can be transmitted up the rod and cause the specimen to fly off.)

MINERALS FROM RITTER, GRANT COUNTY, CENTRAL OREGON

by

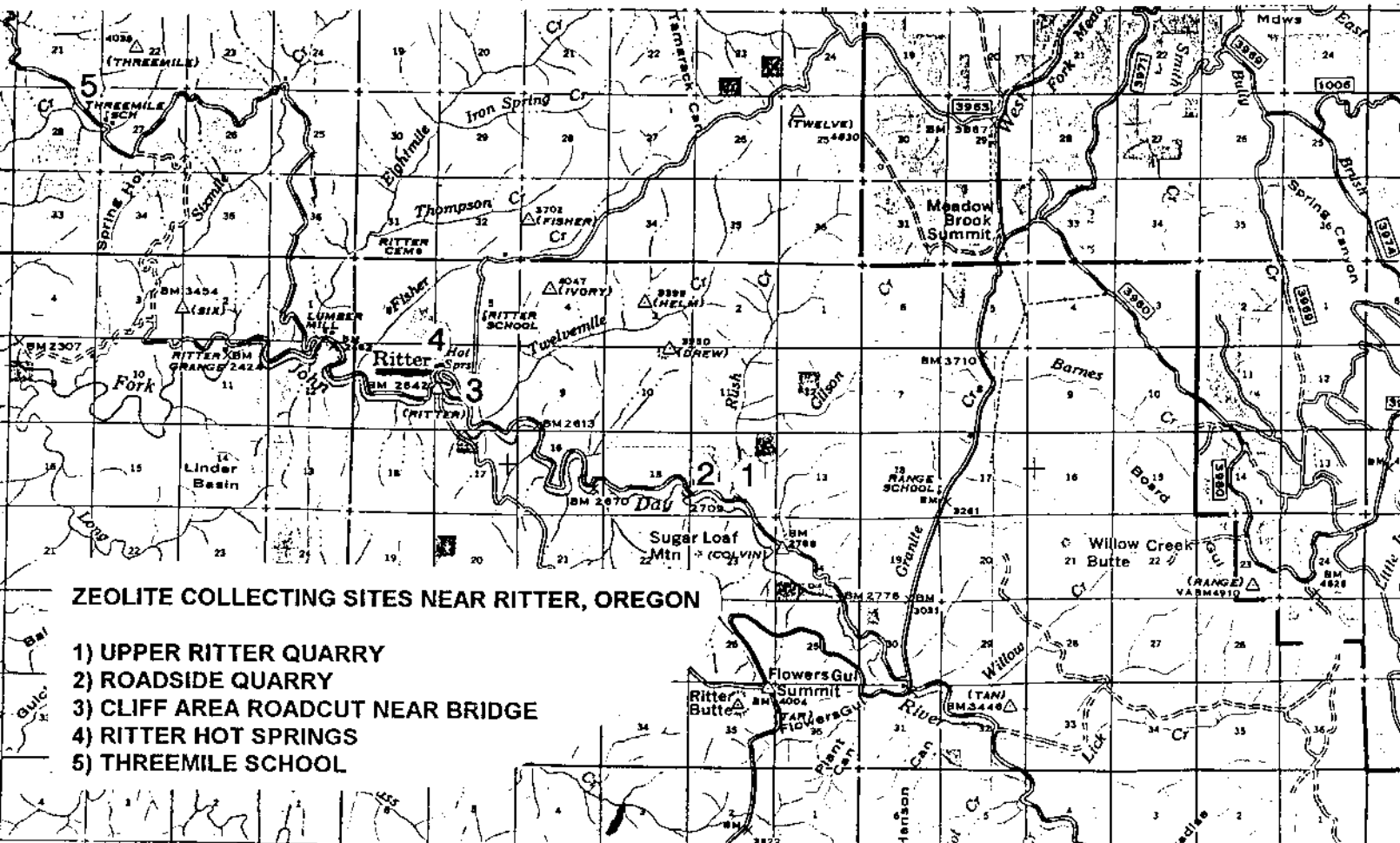
Rudy W Tschernich

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Zeolites have been known in the Ritter area ever since the publication of *Zeolites from Ritter Hot Springs, Grant County, Oregon*, in Proceedings of the U.S. National Museum, V 73, Art. 16 pp 1-19, by Hewett, D.F., Shannon, E.V., and Gonyer, F.A. in 1928. Hewett collected the minerals described in that paper from the basalt cliffs right near the Hot Springs in 1915. They included calcite, chabazite, mesolite, pseudomesolite, analcime, stilbite, diabanite, levyne, thomsonite, heulandite, and opal. They also described a white fibrous overgrowth on levyne which we now know is offretite. Since X-ray identification of minerals was not widely used at that time their identification was based on optics and chemical analysis. Several errors were made. The most important one was in the identification of the fibrous zeolites. They described a compact radiating base of mesolite with long free growing needles of an optical different mineral they called pseudomesolite. It was later found that the base of these groups is natrolite and the long free growing needles is normal mesolite. Although heulandite is rarely found in the area, phillipsite was the cavity lining they were trying to describe.

At Ritter Hot Springs 1,300 feet of basalt flows are exposed. Each flow is composed of a dense dark greenish black columnar phase covering a dark green, gray, or red vesicular or scoria phase (thickest at the base of the flow). Most of the flows range from 50 to 125 feet in thickness. The basalt is Miocene in age and is some of the earliest of the Columbia River Basalt Series to have formed. A just west of Highway 395, granite and other basement rocks are exposed in the



road cuts covered by a thick layer of light colored John Day Formation sediments. The base of the Columbia River Basalt resting on the John Day Formation is only a few hundred feet from floor of the Upper Ritter Quarry. The Ritter localities, like most of the zeolites localities in central Oregon, are at the base of the Columbia River Basalt while basalt higher in the volcanic series is devoid of zeolites.

Several hot springs with a distinctive hydrogen sulfide odor are present at Ritter. The main hot springs, located 32 feet above the river, has been converted into a bath house and supplies water to the swimming pool and toilets. It produces about 35 gallons a minute at 110° F at its outlet with a pH of 9.62 that is ideal for the crystallization of zeolites. A chemical analysis of the water taken in 1955 shows it contains 93 ppm calcium carbonate, 70 ppm silica, 0.6 ppm aluminum, 79 ppm (sodium plus potassium), 35 ppm chlorine, 7 ppm fluorine, and 19 ppm SO₄. Several other smaller hot springs are present on the hillside, along the river, and in the field south of Ritter.

The country store and gift shop now at Ritter were part of an old stage coach stop built in 1894. The rustic hotel was build in 1906. The swimming pool, cabins, and camp sites were added later.

Zeolites and hot springs in the Ritter area are controlled by a series of northwest trending vertical faults. The main hot springs at Ritter lies right on a vertical fault whose south side has dropped 20 feet. The main fault can be directly traced for over 9 miles extending from the Threemile Creek paulingite locality at one end to the Ritter Quarries at the other end. The meandering Middle Fork of the John Day River and its accompanying road cross the fault several times exposing rocks rich in zeolites. The cliffs and adjacent road banks just east of the bridge to Ritter Hot Springs yield many fine specimens of mesolite, thomsonite, analcime, gyrolite, stilbite and rarely laumontite and pyrite/marcasite. The old stage road entering the canyon from the south and leading to Ritter Hot Springs intersects vertical veins lined with small stilbite blades covered by calcite crystals. Near the pump house at Ritter Hot Springs, thomsonite blades abundantly line cavities in the rock and zeolites are scattered in weathered cavities near the hot springs but most of the mineralization occurs along the vertical fault a few hundred feet east of the pump house. Here cream colored, flat-topped stilbite crystals, 1 to 4 cm long, completely line angular breccia cavities and the walls of the fault. This stilbite forms smooth sheets and mounds up to 30 cm across often covered with pale yellow massive calcite. Rarely tiny rhombohedra of chabazite are found on the stilbite. Single crystal X-ray work by W. S. Wise indicates that some of the flat topped stilbite from Ritter is the orthorhombic variety stellerite. Most of the flat topped stilbite from this site contains too much sodium to be considered stellerite; therefore, it is better to label it stilbite. The smooth-surfaced sheets of stilbite are found on the fault surface for several miles although the amount of stilbite in the rocks decrease the further you go from Ritter Hot Springs.

The two main collecting sites in the Ritter area are the Roadside Quarry and the Upper Ritter Quarry that are located 4.5 and 4.7 miles from Highway 395, about half way to Ritter Hot Springs on the road following the Middle Fork of the John Day River. The minerals from the Upper Ritter Quarry (4.5 mile site) are described in an accompanying paper by Howard and Tschernich. The following description is of the small previously unnamed quarry (4.7 miles site) located right along the road. I will refer to this site as the Roadside Quarry to differentiate it from the other quarry (Upper Quarry) that is located several hundred feet up hill from the road. A few zeolites are found in the road cut and pits between the two major sites.

The Roadside quarry is a small pit that was briefly operated in the 1960's for crushed rock. Zeolites are abundant in the quarry and across the road where some of the rock was used to dike the river. Two types of rock are present in the quarry. One is a very fine grained dense basalt with widely scattered cavities, up to 6 cm in diameter, that make up the upper left side of the quarry.

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The other rock is a soft vesicular basalt that forms the lower part of the quarry. These two types of basalt probably represent the dense center and the vesicular base of a single flow. Good specimens can still be found with some effort.

Minerals in the dense hard basalt:

COPPER forms shiny aggregates on the clay lining and is covered by phillipsite.

PHILLIPSITE forms a colorless to milky white drusy linings in most of the cavities in the hard rock. A later generation of phillipsite formed larger colorless to white blocky crystals, up to 8 mm long, on the drusy phillipsite lining.

TACHARANITE has been identified in the hard rock in the Roadside Quarry by W.S. Wise. It forms porcelainlike opaque white mounds, up to 8 mm in diameter, on drusy phillipsite and is covered by colorless gyrolite.

GYROLITE forms colorless to white aggregates composed of thin hexagonal-appearing plates commonly on a drusy phillipsite cavity lining that are covered with apophyllite. The colorless aggregates of gyrolite, up to 10 mm in diameter, appear to have formed early in the crystallization sequence. The large aggregates predate the fibrous minerals natrolite, mesolite, and thomsonite. A later generation of gyrolite forms small white plates that cover the colorless gyrolite and forms tiny groups scattered on mesolite needles. Colorless rhombohedra of chabazite are found covering colorless gyrolite aggregates.

NATROLITE/MESOLITE needles are rarely found on phillipsite in the hard rock. In these cavities white gyrolite, calcite, and apophyllite are found on the needles.

APOPHYLLITE forms colorless to golden transparent and white crystals with numerous crystal forms and habits. Some crystals form thin tablets bound by a large {001} with {111} and {110}. Other crystals are barrel shaped due to 1st, 2nd, and 3rd order prism faces while terminated with a flat {001} pinacoid and small pyramidal {111}. Rarely zoned apophyllite crystals are found with a white central band from which tiny colorless fibrous apophyllite crystals extend parallel to the c-axis.

CHABAZITE commonly forms colorless simple rhombohedra on phillipsite and gyrolite in the hard rock.

CALCITE rarely forms small crystals on all of the other minerals.

Minerals of the soft highly vesicular basalt:

ANALCIME forms transparent colorless trapezohedra, a few millimeters in diameter, on dark long filaments of clay. Milky white trapezohedra of analcime up to 15 mm in diameter have been found.

THOMSONITE forms colorless to white thin rectangular blades and radiating groups with mesolite/natrolite and gyrolite in some of the cavities.

NATROLITE forms radiating compact groups, up to 2 cm in diameter, that are commonly covered by long straight mesolite needles. Under polarizing light and 50 power magnification a pointed phantom termination of the natrolite crystal can be seen in the lower part of a single needle with the upper part of the same needle being mesolite.

MESOLITE forms long, thin, straight, colorless to cream-colored needles, up to 3 cm long, usually extending from a compact natrolite base. Rarely tiny chabazite crystals, white thomsonite blades, white gyrolite clusters, and colorless apophyllite prisms are found on mesolite needles. In the 1960's a spectacular series of interconnected flattened horizontal cavities, 8 to 10 cm high and up to a meter long and deep were found between the hard rock and soft rock in the upper part of the quarry. These cavities were lined with clean undamaged mesolite needles, up to 4 cm long, on a radiating natrolite base. Hundreds of these specimens were recovered from this site and were sold or traded as pseudomesolite. Most of the good mesolite specimens found in private collections and museums from Ritter Hot Springs were derived from this quarry. The mesolite from the weathered surface rock near the hot springs never made good specimens.

HEULANDITE is rather scarce but when present it is alone in the cavity and forms unusual twisted or curved aggregates elongated along the b-axis with a pearly luster on its dominant b {010} face.

COWLESITE forms colorless to gray bladed cavity linings near cavities containing levyne/offretite.

LEVYNE forms colorless hexagonal plates always associated with offretite. Most of the offretite forms a white silky epitaxial overgrowth on the large {0001} face of the levyne but some levyne crystals are a compound series of levyne offretite overgrowths with levyne being the surface mineral.

OFFRETITE forms thin, silky, white needles commonly on the {0001} pinacoid of levyne. When the overgrowth of offretite is very thick, 4 to 20 times the thickness of the levyne, it covers the edges of the levyne and forms a large compound hexagonal crystal of offretite with sloping sides which indicate a pyramidal face rather than a simple hexagonal prism. Some offretite overgrowths form a solid rim around the edge of the levyne plate and more widely spaced fibers in the center portion of the levyne {0001} pinacoid.

CHABAZITE is found in both the hard and soft rocks but is more common in the softer rock. It most commonly forms colorless simple rhombohedra on mesolite in the soft rock. Rarely the twinned variety phacolite forms colorless bean-shaped crystals lining the cavities or on mesolite and thomsonite.

ZEOLITES FROM THE UPPER RITTER QUARRY, GRANT COUNTY, CENTRAL OREGON

by

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The Miocene basalt along the Middle Fork of the John Day River between Ritter Hot Springs and the turnoff from highway 395 has produced many interesting zeolites. Zeolites are found at the hot springs, in road cuts, and along the bank of the roads. Occasionally, boulders drop from the cliffs that would otherwise be unreachable. In the 1960s a small quarry along the road (Roadside Quarry) produced many good specimens but due to a lack of fresh exposures collecting activity has waned. In the early 1980s a new quarry (Upper Ritter Quarry) was started just east of the old quarry area to provide crushed rock for the county roads. A large excavation was made and several huge piles of crushed rock were left between the quarry and the road before the crushing equipment was moved elsewhere. Those piles have been gradually used, until now only a small amount remains. Since the roads need a steady dressing of gravel, at some point soon more rock will be required, and the quarry may be reactivated, since it is rather centrally located. Anyone passing the area should check on the status of this quarry and report signs of new excavation.

The Upper Ritter Quarry has two distinct zones of rock. The upper level, best exposed on the east side of the quarry, consists of a very hard basalt that contains only a few scattered cavities. Mineralization in this rock consists mainly of apophyllite and gyrolite on a drusy phillipsite cavity lining, with few other zeolites present. This type of rock is about twenty meters thick and is preferred for crushing. Below the hard basalt is an area that is considerably blacker and has a tendency to crumble, particularly after exposure. This basalt possesses a much higher density of mineralized cavities. It is in selected boulders of this material, largely left behind and pushed to one side, and in exposures along the north and central parts of the quarry that the wide variety of zeolites have been found. The suite of minerals here often is similar to those found at Burnt Cabin Creek, near Spray and the Beech Creek Quarry, near Mount Vernon, Oregon. The two types of rock found in the quarry probably represent a single flow composed of a hard poorly vesicular columnar central zone and its accompanying highly altered vesicular base.

Listed below, in the approximate order of crystallization, are the minerals that have been identified to date.

Hard basalt, upper level mineralization:

CLAY is not present or rarely forms a very thin layer in the cavities in the hard rock preceding zeolite crystallization.

PHILLIPSITE is the earliest zeolite to crystallize in both the upper and lower zones and lines most of the cavities. It varies from a fine druse to linings of clearly discernible crystals that vary from colorless to white and is commonly covered by gyrolite and apophyllite, rarely by tobermorite.

THOMSONITE rarely occurs in the upper zone material as a hard, clear, crystalline crust with the ends of individual crystals visible as parallel lines on the surface.

TOBERMORITE very rarely forms white porcelain-like mounds on drusy phillipsite and is associated with gyrolite and apophyllite. This material is very similar in appearance to tacharanite identified from Devils Backbone on the North fork of the John Day River, Big Bend, near Kimberly, and the nearby Roadside Quarry. The tobermorite from the Upper Ritter Quarry has been confirmed with X-ray diffraction by Don Howard. Its place in the order of crystallization is not at all certain and it may be different than shown here.

GYROLITE forms white hemispherical groups composed of hexagonal-appearing plates, up to several millimeters in diameter, on drusy phillipsite. Gyrolite is only found in the hard rock.

CHABAZITE rarely occurs as clear colorless rhombohedra on top of phillipsite and mounds of gyrolite.

APOPHYLLITE is another exclusively upper zone mineral. It forms crystals, up to 5 mm across, that are clear, colorless, and tend to be tabular, with extensive c-faces. Edges are primarily {111} faces with only the corners modified by {110} prism faces. Apophyllite is always found on drusy phillipsite and often covers gyrolite.

Vesicular, lower level mineralization:

Mineralization in the lower vesicular rock varies considerably from site to site in the quarry. In much of the rock, chabazite or phillipsite is the only zeolite present. Clay is very abundant and completely fills many of the cavities. The zeolite content can change entirely over the span of a few feet, either vertically or horizontally. Much of the collecting has been done in specific boulders left from the quarry or in selected sites where the vesicular rock is in place. The sites include the northern vesicular area, the central vesicular area, and the west or front boulder area.

1) The lower portion of basalt at the north end of the quarry is highly vesicular and crumbly. It contains an abundance of phillipsite, thomsonite, mesolite, chabazite, calcite, and rarely heulandite and gonnardite. Clay completely fills most of the cavities.

2) A major portion of the lower vesicular basalt is left in the center of the quarry, with a ramp bulldozed up onto its top. Most efforts to collect in this area have yielded numerous cavities, generally filled with chabazite and little else. However, work this summer on the point just to the left of the ramp uncovered a small area of highly vesicular basalt where the base mineral was phillipsite or clay and contained excellent sprays of thomsonite and mesolite as well as considerable gonnardite and cowlesite. The presence of cowlesite and some levyne indicated that there is probably a close relationship to a boulder that was found several years ago laying a few yards away from the central vesicular area that contained the following assemblages of minerals: phillipsite > scolecite > chabazite > thomsonite; clay > copper > gonnardite > levyne > offretite; and cowlesite > heulandite > calcite. Interestingly, this particular part of the rock has a very

definite "grain" to the basalt and tends to split off in sheets rather easily. The heavy dark colored clay is absent in most of the cavities in the central area.

3) A pile of rather large boulders were left just behind the lip of the quarry front or western end of the quarry. One of these boulders produced a fair quantity of specimens that were characterized by drusy phillipsite-lining covered by clay-coated mesolite needles, tiny water-clear prisms of heulandite, and chabazite.

The minerals found in the lower vesicular rock are listed in the approximate order in which they first crystallized.

CLAY is a major component in the lower vesicular part of the quarry. Three distinct generations of clay are recognized. An inconspicuous thin green or blue-gray layer of clay, under 0.2 mm thick, precedes all of the zeolites and is probably an iron-rich smectite. This mineral is common in the upper part of the central vesicular area and is the cavity lining on which cowlesite and levyne are found. A second-generation of clay which might also be a smectite is found throughout the vesicular area forming tiny light cream-colored hemispheres on mesolite, thomsonite, gonnardite, and drusy phillipsite and is commonly covered by chabazite, heulandite, and blocky phillipsite. In the northern vesicular area, extensive crystallization of a gray to greenish-black third-generation of clay completely fills most of the cavities or less commonly just lightly covers the early formed clay and zeolites. This last phase of clay has been identified as montmorillonite with X-ray diffraction by Russell Boggs. Phillipsite and chabazite continued to grow during and after this major clay phase and was rarely accompanied by heulandite and the last generation of calcite. The third-generation of clay appears to be absent from the central vesicular area leaving an abundance of the clean zeolites. The two phases of clay that crystallized midway through the deposition of the zeolites is believed to represent the beginning of a second zeolite crystallization phase either shortly after the first phase or perhaps hundreds or thousands of years later.

CALCITE forms at least two distinct generations. In a few cavities in the northern vesicular area calcite forms dark, reddish, amber-colored, long prisms that preceded all of the zeolites. In the central vesicular area, golden-amber colored calcite rhombohedra are covered with tiny thomsonite crystals and white hemispheres of gonnardite. In the same area colorless to rich golden brown calcite rhombohedra, several centimeters in dimensions, are found on mesolite. Throughout the vesicular areas colorless or light amber-colored calcite crystals are found on top of all the zeolites and is the last mineral to crystallize. Colorless overgrowths of the later generation of calcite is found enlarging the earlier formed amber-colored crystals.

PHILLIPSITE forms two distinct generations. It is the first zeolite to crystallize in the cavities and forms colorless, transparent, radiating groups composed of elongated prisms that combine into a drusy cavity lining in most of the cavities. A later generation of phillipsite is found on the fibrous zeolites thomsonite-gonnardite-mesolite and forms larger, blocky, colorless to cream-colored simple crystals. Actually these two generations are connected since cross sections of these groups reveal that some of the early formed phillipsite crystals continued to grow during thomsonite-gonnardite-mesolite growth. Phillipsite continued to grow after the fibrous zeolites and covered them. Even though phillipsite crystallization appears to have stopped before the third-generation clay forming phase, the clay avoids forming on the phillipsite crystals and leaves them bright and shiny. Some of the larger blocky phillipsite crystals are heavily etched and show partially dissolved surfaces. Though most of the phillipsite crystals are simple, a few cruciform twins have been observed. Blocky phillipsite crystals are rarely found on cowlesite.

THOMSONITE appears to crystallize at several different times in the Upper Ritter Quarry. The first-generation of thomsonite forms compact cavity linings of tiny blades very early in the crystallization sequence. The second-generation forms radiating groups of colorless larger blades some of which are intergrown with white gonnardite that are often overgrown by mesolite. The third-generation of thomsonite crystallized very late in the cavities and makes a white coating on the mesolite needles and gonnardite balls. In the northern vesicular area, first-generation thomsonite commonly forms tiny colorless to blue blades that make a compact cavity lining directly on the cavity wall or on drusy phillipsite. A second-generation thomsonite also forms radiating groups or hemispheres on a phillipsite cavity lining, on the first-generation thomsonite lining, and forms intergrown aggregates with gonnardite and mesolite. Thomsonite and gonnardite can crystallize at several different times within a single radiating group, each growing on each other in concentric layers in the aggregate which usually is followed by mesolite. Clay commonly covers the second-generation thomsonite.

In the central part of the quarry, exceptional specimens of colorless radiating second-generation thomsonite blades, up to 5 mm long, form wheel-like groups, fans, hemispheres, and individual crystals that are associated with chabazite, tufts of mesolite, and are found on a drusy phillipsite cavity lining. This generation of thomsonite also coats golden calcite crystals, especially in cavities where gonnardite is present rather than mesolite. Also in the central vesicular area third-generation of thomsonite crystallized very late in the cavities, covering the gonnardite balls and needles of mesolite, giving them a tufted appearance. Some specimens show groups of single, thin, flat blades of thomsonite covering a very thin mesolite needles along the centerline of the blade. The third-generation of thomsonite surrounds small chabazite rhombohedra found on gonnardite balls but is also found included inside other larger rhombohedra of chabazite. It appears that the chabazite crystallized over a wide period of time, crystallizing before and after the white third-generation thomsonite.

GONNARDITE rarely forms tiny white blades intergrown with colorless thomsonite blades and mesolite needles in the northern vesicular area. The gonnardite is much softer than the thomsonite and often has been dissolved from the thomsonite-gonnardite-mesolite aggregates to leave an open space between the other minerals. Gonnardite can be in the core, middle, or surface of the thomsonite-gonnardite aggregate. In the central vesicular area the best gonnardite specimens are found. Here gonnardite forms white radial balls, often several millimeters in diameter, on first and second-generation of thomsonite that covers calcite crystals and on the drusy phillipsite cavity lining. The gonnardite ball has a fine-grained radial structure and usually is covered by a sprinkling of tiny white third-generation thomsonite blades. One boulder found near the central vesicular area contained a few cavities lined with a pale gray clay on which was found white hemispheres of gonnardite covered with a white earthy mineral, possibly tobermorite and is associated with levyne/offretite.

MESOLITE commonly forms colorless, thin, straight needles, up to 10 mm long, on thomsonite-gonnardite hemispheres and is usually covered with either a thin coating or completely encased in light cream-colored to grayish-green clay. Transparent chabazite crystals often cover some of the clay-covered mesolite needles to produce interesting inclusions. In some cavities the mesolite needles are piled in a jumble of randomly oriented needles on thomsonite-gonnardite mounds and cemented together by cream-colored clay spheres. These needles appear to have been broken loose from the thomsonite-gonnardite aggregate and were reattached by the clay. In the central vesicular area, some of the cavities contain sprays of reasonably sturdy colorless to white mesolite needles. Cavities, up to 6 cm in diameter, completely lined with snowy white mesolite needles

have been observed. Although some of the needles are strong enough to withstand immersion in water, dust seems to cling to them and they are not easy to clean. Care must be taken while collecting to keep dirt from filtering down from the rocks above the collecting site. Mesolite crystallized on drusy phillipsite or thomsonite but before the second-generation of blocky phillipsite. The thin needles of mesolite can be seen passing through the blocky phillipsite crystals but when they extend beyond the phillipsite crystal the mesolite is coated with a heavy white overgrowth of thomsonite. In some cavities groups of long thin colorless thomsonite blades, up to 10 mm long, are found, each with a single white to cream-colored mesolite needle in the center. Other cavities contain thin mesolite needles covered by a fluffy white overgrowth of third-generation thomsonite similar to a late generation of thomsonite found at Goble, Oregon. Natrolite which commonly forms the base under mesolite needles at most of the collecting sites in the Ritter area is not present in the Upper Ritter Quarry.

COPPER forms tiny bright masses or small crystals associated with gonnardite and offretite-coated levyne on clay in the central vesicular area.

LEVYNE very rarely forms thin, glassy, hexagonal plates that are covered with a white overgrowth of offretite and is associated with gonnardite in clay-lined cavities only in the central vesicular area.

OFFRETITE rarely forms an oriented overgrowth on levyne plates that is many times thicker than the levyne itself in a few cavities in the central vesicular area. The composite crystals usually maintain a hexagonal outline. The offretite also rarely forms slender tapered needles on the clay lining. Since levyne/offretite has not been found directly with other minerals, their position in the crystallization sequence is uncertain.

ANALCIME forms tiny, colorless, transparent trapezohedra, a few millimeters in diameter, modified with small {233} trisoctahedron faces (Fig. 34 in *Zeolites of the World*) on a thin coating of blue-gray first-generation clay and is covered by cowlesite in a couple of cavities in the central vesicular area.

COWLESITE forms a grayish lining composed of tiny colorless crystals on a thin, bright, blue-gray, first-generation clay in cavities, up to 2 cm in diameter, the upper part of the central vesicular area. Here cowlesite is usually the only zeolite in the cavity although a few cavities were found that contained cowlesite on analcime or cowlesite covered by blocky phillipsite, coarse bladed thomsonite, and rhombohedra of chabazite. Close observation of the rectangular bladed thomsonite aggregates and the sparkling pointed cowlesite aggregates is required to distinguish these two minerals from each other. Cowlesite is covered with calcite and heulandite prisms that are elongated along the b-axis in a boulder near the central vesicular area.

CHABAZITE very commonly forms colorless transparent rhombohedra {1011} some with small {0112} and {0221} after the cream-colored second-generation clay phase and continued to crystallize after the third-generation clay forming phase. It is found on top of partly clay filled cavities and covers most of the other zeolites in the lower part of the quarry. The rhombohedra of chabazite display a dark center when they crystallized directly on the mesolite (covered by the cream-colored clay) but appear light colored when the same rhombohedra continued to crystallize and become enlarged over the third generation of clay. Rarely the twinned chabazite variety phacolite is found. Chabazite rhombohedra are both surrounded by white third-generation

thomsonite and over grows over the same generation of thomsonite indicating that these two minerals co-crystallized near the end of the sequence.

SCOLECITE rarely forms a white, branching, fluffy growth composed of thin needles on chabazite or phillipsite and rarely is covered with colorless calcite. This material has only been found in a couple cavities in a boulder near the central vesicular area and has been confirmed by X-ray diffraction and optics. Although scolecite is a rather common mineral in the zeolite deposits of southern Washington, this is the only known occurrence in central Oregon.

HEULANDITE rarely forms tiny, colorless, transparent, blocky crystals that are slightly elongated along the b-axis on top of the third-generation clay layer in the northern vesicular area and is abundant in some of the boulders on the western edge of the quarry. There it forms individual clear prisms of the classic shape scattered on clay or clay-covered mesolite needles. A few heulandite crystals have been observed on the surface of clear chabazite rhombohedra indicating that the heulandite crystallized very late in the sequence. Heulandite was found associated with cowlesite in one boulder near the central vesicular area where it forms colorless individual prisms greatly elongated along the b-axis similar to crystals at Yacolt and Porter in Washington.

SUMMARY OF CRYSTALLIZATION

It is difficult to summarize the crystallization sequence in the Upper Ritter Quarry in a single progressive sequence. Many of the minerals appear to have crystallized several times over an extended period of time and have co-crystallized with several other species.

The minerals appear to crystallize in the following order: 1st clay > amber calcite > drusy 1st phillipsite > 1st thomsonite > 2nd thomsonite/gonnardite > mesolite > yellow 2nd clay > analcime > cowlesite > blocky 2nd phillipsite > chabazite > dark 3rd clay > chabazite > white 3rd thomsonite > chabazite > heulandite > colorless calcite. Chabazite appears to have crystallized continuously since it first formed on the second-generation clay to the end of the sequence. The exact position of levyne > offretite is unknown.

NOTICE

Keep open on your calendar our meeting dates for 1994.

May 7

November 5

Both days have been reserved at the Clark County PUD
Building in Vancouver, Washington.

GISMONDINE FROM THE NORTH FORK OF THE JOHN DAY RIVER, GRANT COUNTY, CENTRAL OREGON

by

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Tiny white crystals of gismondine have recently been discovered in the vesicular Miocene basalt at Devils Backbone, west of Stony Creek and 12.5 miles west of Highway 395 (at the Camas Bridge), along the North Fork of the John Day River, Grant County, in central Oregon. The gismondine was discovered in rock collected several years ago from a then existing rubble pile that had developed from years of collecting along a 15 foot wide vesicular area at the base of the columnar basalt cliffs in the Devils Backbone exposure. The gismondine appears to be abundant only in a few rock samples, especially in cavities under 5 mm in diameter. Milky white crystals of gismondine completely line a few cavities up to 8 cm across. Individual crystals are found scattered on the terminations of phillipsite crystals.

The other minerals from this locality are described in the Micro Probe V 6, Number 8 (1989). All of the minerals are either white or colorless; therefore, they are hard to recognize in the field. The cavities contain many different species in a complex crystallization sequence. The following species have been found at the Devils Backbone site in the order of their abundance phillipsite, gyrolite, chabazite, analcime, tacharanite, gmelinite, apophyllite, thomsonite, natrolite, mesolite, calcite, gismondine, levyne, and offretite.

Since members of the gismondine group (amicite, gismondine, garronite, and gobbinsite) all have the same morphology, visual identification of gismondine was confirmed by a X-ray diffraction pattern taken by Don Howard.

The gismondine crystals are cloudy, semi-transparent to chalky white simple-appearing tetragonal dipyrramids, shortened along the c-axis (Fig. 1). The crystals are usually under 0.2 mm on an edge with only a few reaching 0.5 mm. Only the tiny scattered crystals display good morphology. The others are too intergrown and show only the edges of the crystals or reflect only one of the triangular faces that are distinctive of this mineral. Even the best crystals faces appear rough on the surface due to dissolution. The white gismondine can be soft or even crumbles into a white powder. Twinning of the crystals is common although not obvious to casual observation. Careful study of the crystals seen in the SEM photograph that accompanies this paper shows the crystals are stacked with a 90° rotation to each other (Fig. 2). This is commonly seen in members of the gismondine group (see amicite Figs. 25 & 27 and gismondine Fig. 228 in *Zeolites of the World*).

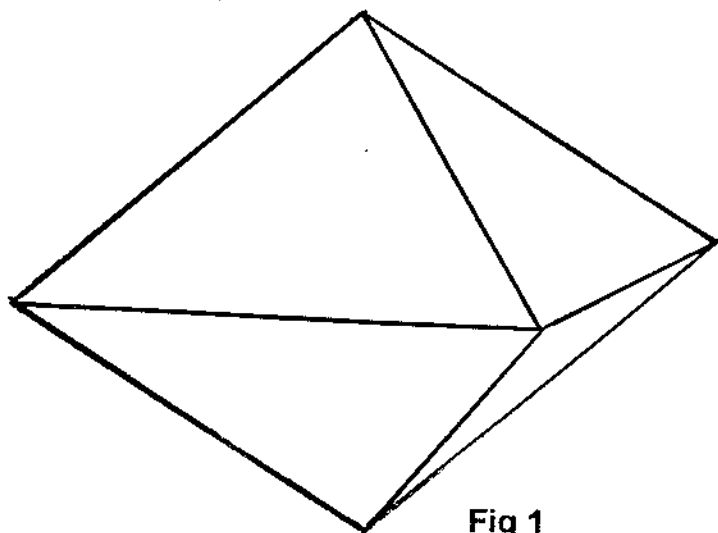


Fig 1

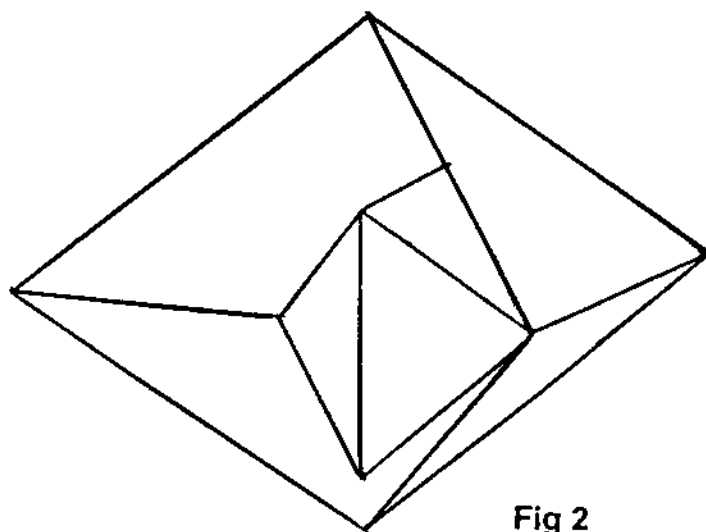


Fig 2

The gismondine crystals are always found covering a drusy colorless phillipsite that extends perpendicular to the cavity wall and are commonly covered by very attractive thin, short, colorless, cruciform twins of phillipsite with deep reentrant angles. Minerals commonly seen on the gismondine include gmelinite/chabazite, gyrolite, clay, and phillipsite while rarely with analcime, mesolite, apophyllite, tacharanite, and the late generation of chabazite.

Close study of cross sections through the phillipsite-gismondine-phillipsite layer shows that the long colorless prisms of phillipsite extend from the lower radial base through the white gismondine and when exposed on the surface, they are the sites for continued growth of larger cruciform twins. When the gismondine is only scattered on the phillipsite, the phillipsite crystals continued growth enlarging the crystals. In cavities that do not contain gismondine, the phillipsite forms a colorless base, a milky phantom, and a colorless outer rim. Gismondine appears to crystallize in place of the milky-colored phillipsite stage.

An early generation of gmelinite formed before the radial phillipsite or the gismondine. This relationship can be seen by the presence of a rectangular shaped black core in the center of the gmelinite crystals because it rests directly on the wall of the cavity and transmits the dark color of the rock through the crystal. Colorless pointed terminations of the gmelinite/chabazite crystals appear white because they cover white gismondine. Further proof of the order of crystallization comes from cross sections through gmelinite-gismondine-phillipsite overgrowths that clearly show the core of gmelinite crystals extend to the wall of the cavity with radial phillipsite covered with gismondine growing up to the sides of the gmelinite core but that the colorless pointed terminal ends of the gmelinite covers both the gismondine and the radial phillipsite.

The initial growth of the gmelinite/chabazite intergrowths developed flattened hexagonal prisms that are twice as wide as they are high and contain numerous milky-white and colorless layers parallel to the {0001} pinacoid of the gmelinite/chabazite intergrowth. These layers represent alternating overgrowths of gmelinite and chabazite. After the radial phillipsite and gismondine crystallized, continued growth of the gmelinite/chabazite grew faster along the c-axis than on the prism faces producing elongated crystals. The colorless overgrowth shows no banding or layering as does the core of the gmelinite/chabazite crystals.

The minerals appear to have crystallized in the following order: (chabazite var. phacolite-gmelinite intergrowth) > radial phillipsite > gismondine > blocky phillipsite > gmelinite > etching of the chabazite/gmelinite > Ca-silicate > white gyrolite > thomsonite > natrolite > mesolite > thomsonite > analcime > tacharanite > clear gyrolite > rhombohedral chabazite > Ca-silicate > apophyllite > calcite with the position of levyne/offretite not known.

BLACKHEAD QUARRY, DUNEDIN, NEW ZEALAND

Donald G. Howard

One of the most consistent producers of quality zeolite specimens in New Zealand over many years has been the quarry at Blackhead, just south of the city of Dunedin on the South Island of New Zealand. It has produced everything from excellent micros to outstanding museum specimens.

Blackhead consists of a point along the seacliffs that thrusts out into the southern Pacific Ocean south of Dunedin. Its use as a quarry was apparently begun by the Maori before the whiteman settled on the island. For many years it was worked by Trevor Gray, producing crushed rock, first for the railway, and in later years for the highways of the area. It is currently owned and operated by Fulton and Hogan, and is operating at a very high volume to supply crushed rock to the area.

The quarry operation is huge, involving the entire top of the headland, which is composed of a very dark basalt. There is a central solid plug with columnar basalts on the seaward side and pillow basalts on the landward side. A limestone cap at one time covered most of the central plug. With so much variety of terrain, there are also a variety of mineralized areas yielding different suites of zeolites.

The columnar region is, as usual, devoid of mineralization. Other regions produce small cavities with bladed thomsonite and clear rhombs of chabazite, some in whites and others in a delicate shade of yellow from iron coloration. Analcime has been obtained at various times. The best material, however, comes from the central plug, especially high up within a few meters of the overlaying limestone. Very little of this region still remains after many years of quarrying activity. The basalt is hard and brittle, splitting off in flakes when struck, like some obsidian. It contains cavities of a wide variety of sizes, from millimeter size up to ones a foot or more in diameter. Oddly, though the large and small cavities are thoroughly intermingled, they seem to contain different mineralization.

The large cavities possess a rim of alteration one or two centimeters thick, composed of a lighter, softer material than the surrounding basalt. Only occasionally will they have a scattering of small phillipsite crystals on their surface. Very little clay is present. A good cavity will contain a lining of balls of gonnardite, from small up to some an inch or more in diameter. These may have a smooth, hard surface, but most are covered with a thick layer of needles of natrolite. These large cavities, filled with varying sized balls of snow-white natrolite-gonnardite make spectacular cabinet specimens. The brittle nature of the basalt, moreover, makes trimming them to a workable size possible as long as there are no fractures through them present in the rock.

What is most interesting about this material involves the small cavities in the rock surrounding the larger ones. These generally are only a few millimeters in diameter, though some are a bit bigger. Invariably, they are completely lined with clear, glassy prisms of phillipsite. Many

of these cavities contain only phillipsite. However, occasionally individual prisms of gismondine can be found growing on this lining. These take the form of distorted octahedra, and show no tendency to twin. As they are also water-clear, they are very hard to see on the background of clear phillipsite. Mostly, they are located by light reflections off of faces that are a different shape (triangular) than that of the drusy phillipsite (parallelogram). These crystals are generally tiny, on the order of a quarter millimeter or less, about the same size as the individual phillipsite crystals that they are perched upon.

The mystery here is why the sodium-rich zeolites -- natrolite and gonnardite -- are restricted to the large cavities, while the potassium-rich and calcium-rich zeolites -- phillipsite and gismondine -- prefer the small cavities, when the two types of cavities are thoroughly intermingled and may be only a few centimeters apart.

This occurrence, coupled with the report of gismondine from the North Fork of the John Day River in another article in this issue, points to an interesting pattern to the form that gismondine takes in a given site. At these two sites, as well as sites in Germany (Zeolites of the World, Rudy Tschernich), the associated mineral is primarily phillipsite. The gismondine is found in crystals of a discernable octahedral form. Though some orientational relationship between individuals may occur, the form of the individual is apparent. At other occurrences (Stone's Quarry, Aranga, Northland, New Zealand; Oak Grove Fork, Clackamas River, Oregon) where the associated mineral that the gismondine grows upon is primarily chabazite, the gismondine is found in complicated groups that show intricate twinning to the point that few faces of each individual remain. Chemistry must play an important role in determining the nature and extent of twinning for gismondine.

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MORDENITE, STILBITE AND ASSOCIATED MINERALS FROM WOODLAND, CLARK COUNTY, WASHINGTON

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This paper deals with zeolites that were collected from a quarry located south of the North Fork of the Lewis River, and approximately 5 miles southeast of Woodland by the late Noble Witt from Vancouver, Washington in the late 1960's. It was his effort that saved the specimens from destruction and his accounts of collecting that are related in this paper. The land on which the small quarry was located was owned by the Girl Scouts and access was difficult to obtain. Only Noble collected at this site. Specimens were abundant when the quarry was in operation but now nature has reclaimed the site. A small creek flows over the quarry wall making a water fall and down what use to be the access road leading to the quarry. Trees, ferns, and moss grow in profusion covering the broken rock. The site was visited by the author and Noble in 1990 but we failed to find any specimens.

The rock is a highly brecciated andesite with numerous angular cavities up to 30 cm across. Many of the cavities were filled with water containing calcium carbonated in solution. The specimens needed to be washed soon after collecting to remove any calcium carbonate film. If the calcium carbonate was allowed to dry it would form a colorless thin white coating on the crystals and cement dirt and rock fragments from collecting onto the specimens. For a considerable length of time Noble identified the minerals from this quarry as natrolite, heulandite, stilbite, aragonite, thomsonite, and calcite. The natrolite has since proven to be mordenite, thomsonite and heulandite are not present, and the tiny pointed aragonite-appearing crystals failed to react to HCl acid and were found to be quartz.

The minerals form interesting mounds, fingers, and plates, on the platy calcite crystals and rock fragments. Stilbite crystals are often concentrated at the protruding portions of the mounds while coloration from hematite inclusions apparently followed solution pathways through the cavities which results in differences of color on the same specimen. The specimens look like coral, with mounds of hard, rough, white quartz-mordenite covered by small colored blades of stilbite.

Some of the cavities show evidence of natural fracturing and rehealing of the rock and cavity-lining minerals. Small filled veins crossing the rock can be traced to the cracks in the mordenite-quartz lining. The cracks, often up to 3 mm across, are sealed with stilbite crystals.

The mineralization in this quarry represents a very simple high silica environment. Calcite, which promotes zeolite crystallization, is commonly the first and last mineral to crystallize. Quartz and mordenite that are abundant at Woodland commonly precede zeolites at other high silica localities. Heulandite which normally follows quartz-mordenite and precedes stilbite at other localities is absent at the Woodland site. The minerals are described in the order that they crystallized.

CALCITE forms two distinct generations. The first generation forms large thin plates, up to 5 mm thick and 15 cm across. These plates crisscross the cavities in a boxwork-like structure and are covered by mordenite, stilbite, quartz, and later formed dogtooth calcite.

MORDENITE forms thin colorless to white stiff needles that are commonly colored pink or maroon from inclusions of hematite. Thin mordenite needles occur up to 3 cm long and less commonly form rather thick, stiff, terminated needles. Mordenite at most localities is so thin that it becomes matted, broken, or has feathered terminations. Scanning electron microscope photographs taken by Milton Speckles show that these mordenite needles are bound by the forms {001}, {010}, {110} and terminated by {101} and {111} (See Figs. 413, 416, 422, 423 in *Zeolites of the World*). A silky-white layer of mordenite, up to 2 cm thick, lines some of the cavities and calcite plates and is covered with stilbite, quartz, and a late generation of calcite.

QUARTZ commonly forms colorless, frosted, doubly terminated, slender, pointed individuals without distinct faces and attractive radiating groups on the mordenite needles. Stilbite often covers the quartz and mordenite. Some of the cavities contain a layer of quartz crystals up to 15 mm thick.

STILBITE commonly forms colorless doubly terminated blades that line the breccia cavities or encrust mordenite fibers. Stilbite crystals are generally, 1 to 5 mm long, with many of them colored pink, maroon, or light yellow from hematite inclusions. The hematite inclusions are usually concentrated near the outer surface on the {010} faces of the stilbite. In some of the cavities the stilbite forms very nice encrustation pseudomorphs over calcite plates.

CLAY does not precede the zeolites as it does at most localities. At the Woodland site a clay mineral rarely forms tiny 0.5 mm diameter aggregates of thin green plates scattered on a few of the stilbite crystals.

The minerals crystallized in the followed order: calcite > mordenite > quartz > fracturing of the rock > stilbite > clay > calcite.

CORRECTION

The mineral described in the last issue of the Microprobe (Vol. VII, #7, page 18) as "twinned mordenite" from Stew Point Station, New Zealand, and illustrated in micrograph #142, was incorrectly identified. Rudy Tschernich has determined from optical studies that the mineral is SCOLECITE. Information about the twin plane, and the diagrams with their labelled faces are all correct, with the exception that the a-axis should be shown sloping downward at an angle of 90.6° with respect to the c-axis (psuedo-orthorhombic representation). Scolecite, as an acknowledged monoclinic mineral, is known to twin in this manner, so the form of the twin is less remarkable. However, these remain fine examples of well-terminated scolecite.

Please correct page 18 of the last issue, together with the caption on page 2, to identify this mineral as SCOLECITE.

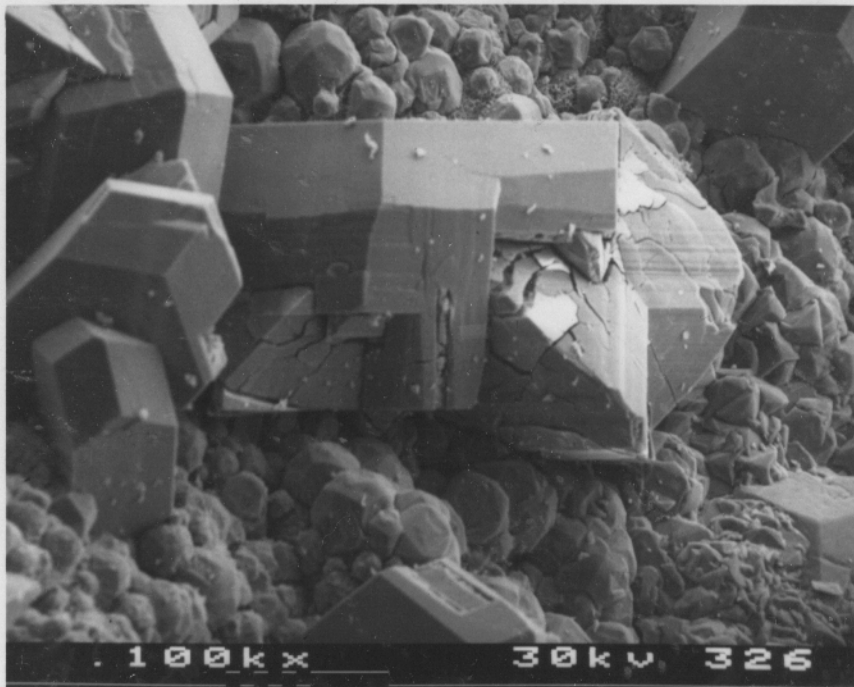
FIGURE CAPTIONS

Scanning Electron Micrographs -- Number in the lower right corner.

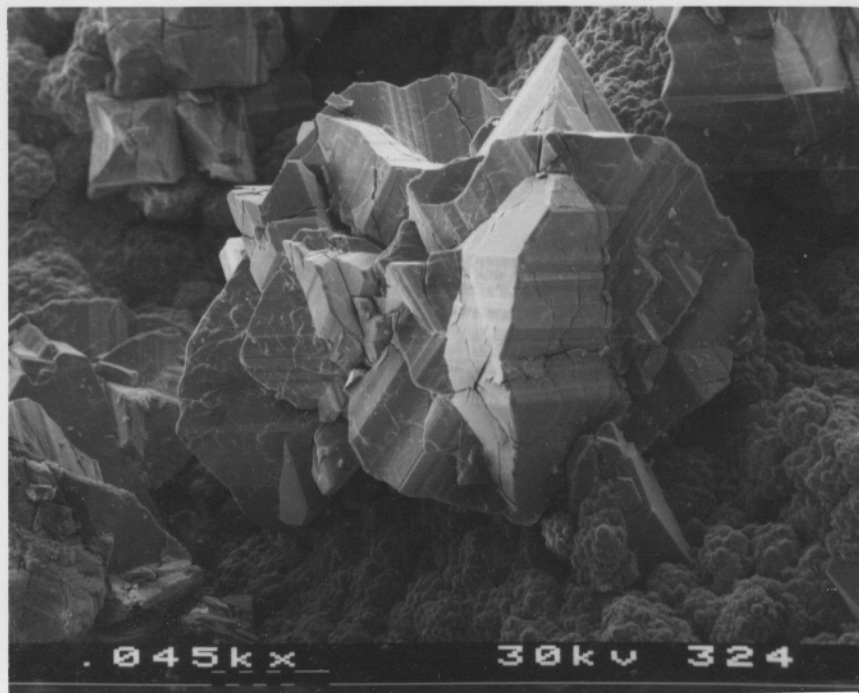
- #326 Garronite on Phillipsite (x100)
 Fara Vicentine, Vicenza, Italy
 Crystals of garronite fitted diagonally into the reentrant angles of a cruciform twin of phillipsite. The garronite crystal to the right is further twinned.
- #324 Garronite (x 45)
 Fara Vicentine, Vicenza, Italy
 A complex twin, looking down on the [110] direction midway between the four-fold twin axes, which appear above and below at 45°. Notice the "core-bit" twin at upper left.
- #264 Chabazite *variety* Hershellite (x 80)
 Fara Vicentine, Vicenza, Italy
 Curved, wedge-shaped blades with roughened surfaces.
- #756 Gismondine (x199)
 Devil's Backbone, N. Fk. John Day River, Grant Co., Oregon
 A crust of crystals, many in twin positions (at right angles to each other).
- #761 Gismondine on Chabazite (x 40)
 Oak Grove Fork, Clackamas River, Oregon
 A group of rough-faced crystals with characteristic 90° twinning. Crystals that have formed on chabazite seem to be more complexly twinned.
- #759 Thomsonite on Phillipsite (x 28)
 Upper Ritter Quarry, Grant Co., Oregon
 Fans of parallel blades, found in place in the center of the quarry.

Color photographs -- Number on the back of print.

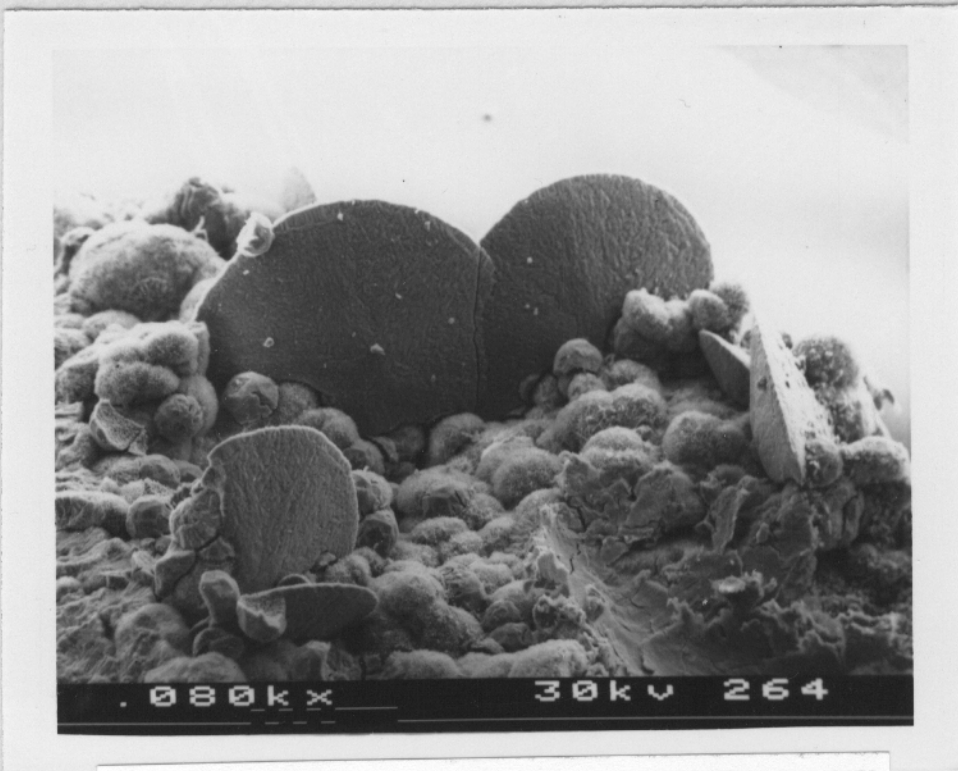
- #5 Scolecite with Chabazite (x 4)
 Upper Ritter Quarry, Grant Co., Oregon
 Tufts of branching, feather-like crystals, from the original boulder found on the floor of the quarry.
- #6 Natrolite on Gonnardite (x 1)
 Blackhead Quarry, Dunedin, New Zealand
 Balls of gonnardite covered with needles of natrolite radiating outward. Notice the oxidation rim around the cavity.



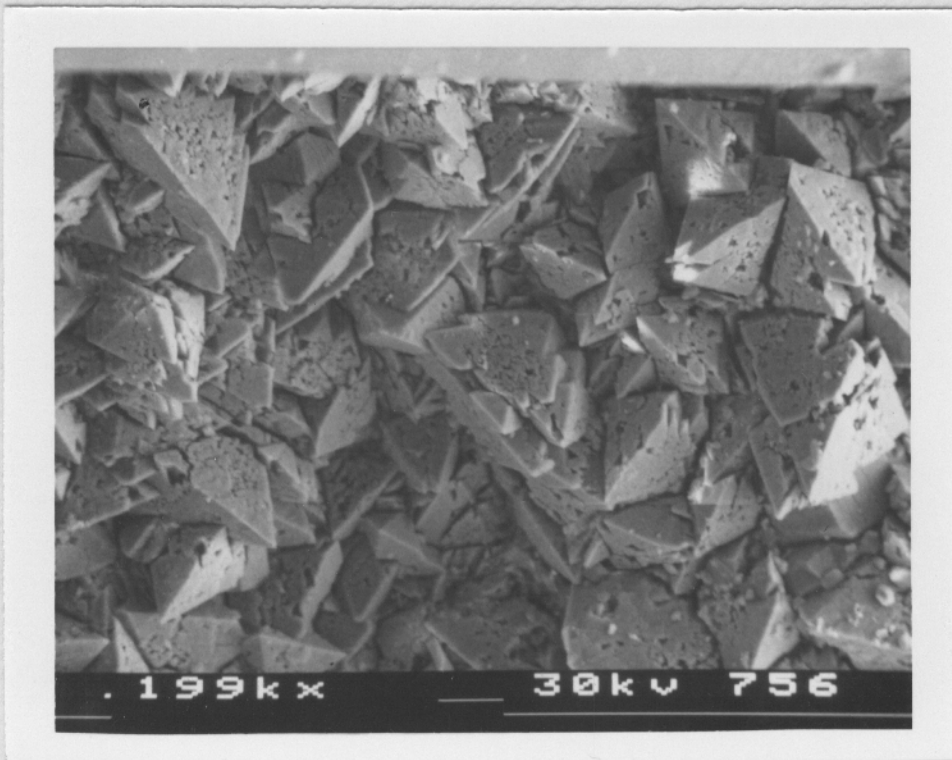
#326 - GARRONITE, PHILLIPSITE - FARA VICENTINE, VICENZA, ITALY - 100X



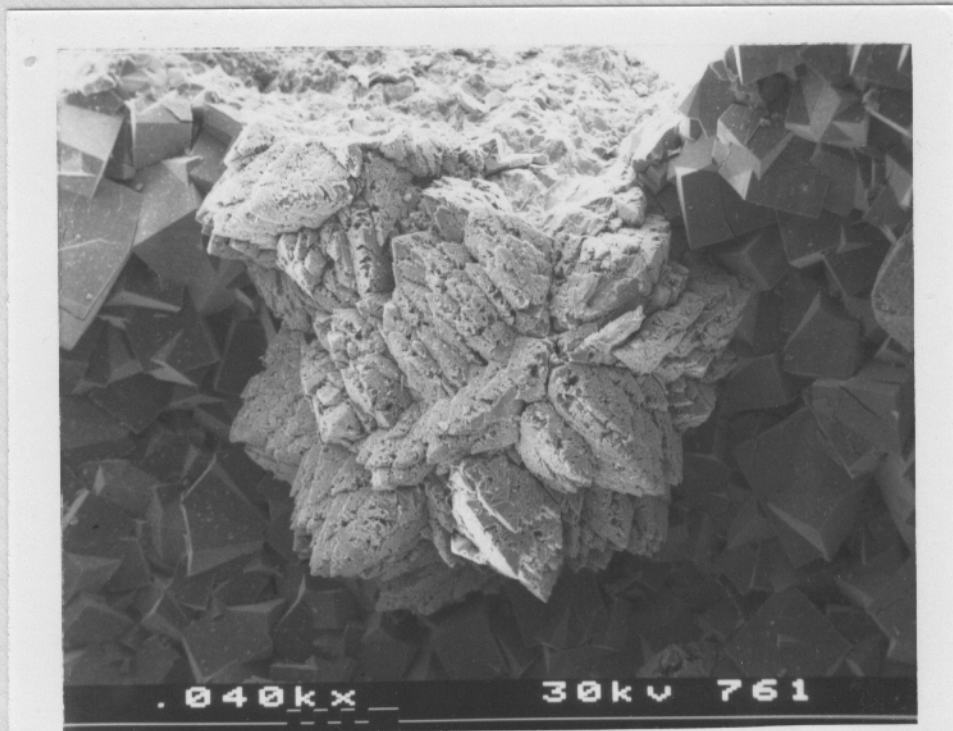
#324 - GARRONITE - FARA VICENTINE, VICENZA, ITALY - 45X



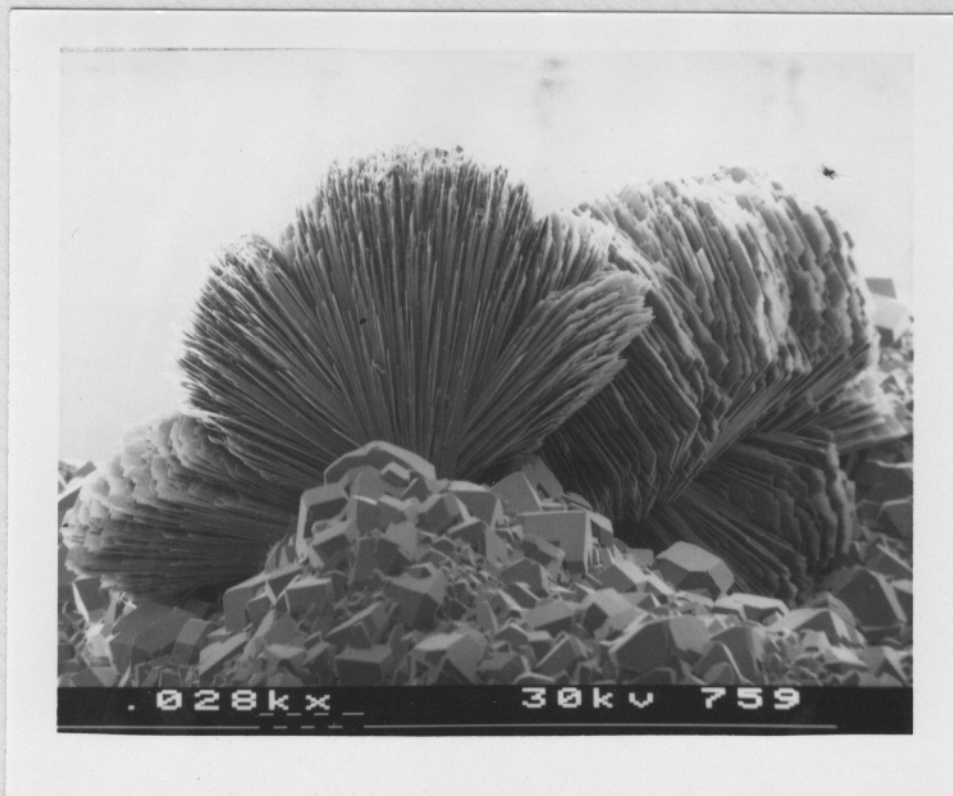
#264 - CHABAZITE - FARA VICENTINE, VICENZA, ITALY - 80X



#756 - GISMONDINE - DEVIL'S BACKBONE, NORTH FORK JOHN DAY, GRANT COUNTY, OREGON - 199X



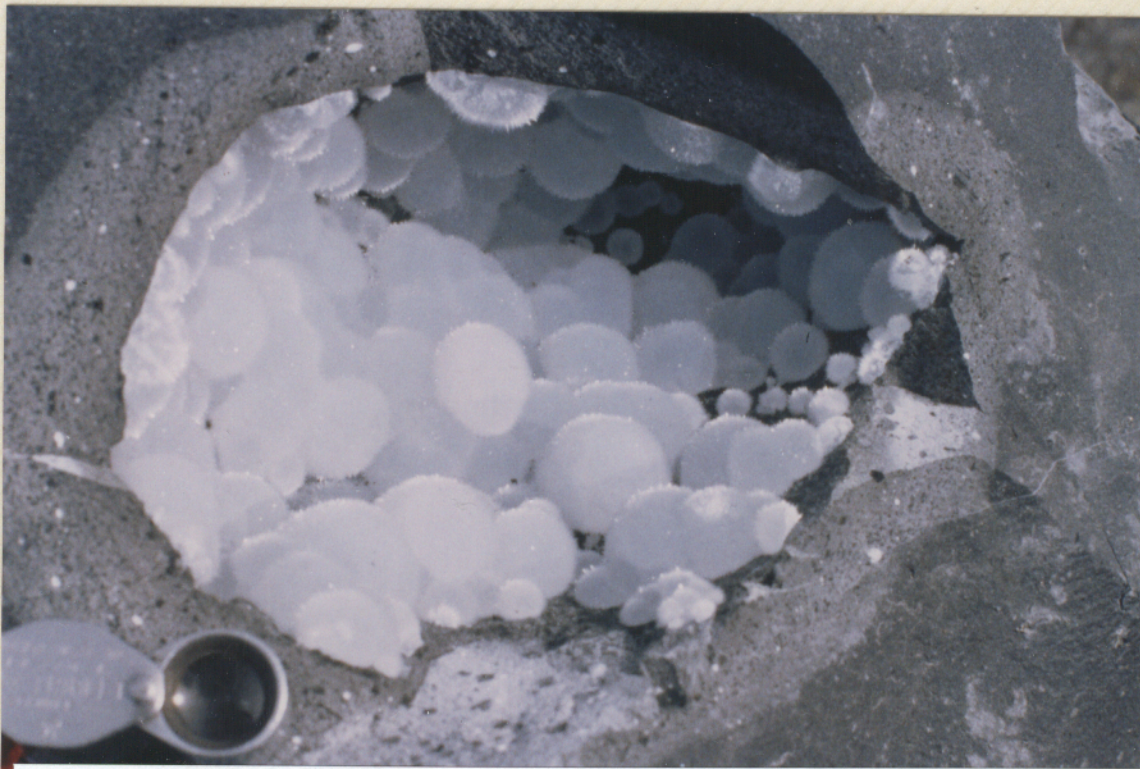
#761 - GISMONDINE, CHABAZITE - OAK FORK GROVE, CLACKAMAS RIVER, OREGON - 40X



#759 - THOMSONITE, PHILLIPSITE - UPPER RITTER QUARRY, GRANT COUNTY, OREGON - 28X



#5 - SCOLECITE, CHABAZITE - UPPER RITTER QUARRY, GRANT COUNTY, OREGON - 4X



#6 - NATROLITE, GONNARDITE - BLACKHEAD QUARRY, DUNEDIN, NEW ZEALAND - 1X