Northwest
Micro Mineral
Study Group

MICRO PROBE

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SPRING MEETING............VANCOUVER, WASHINGTON

May 1, 1993 9:30 am to 9 pm

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

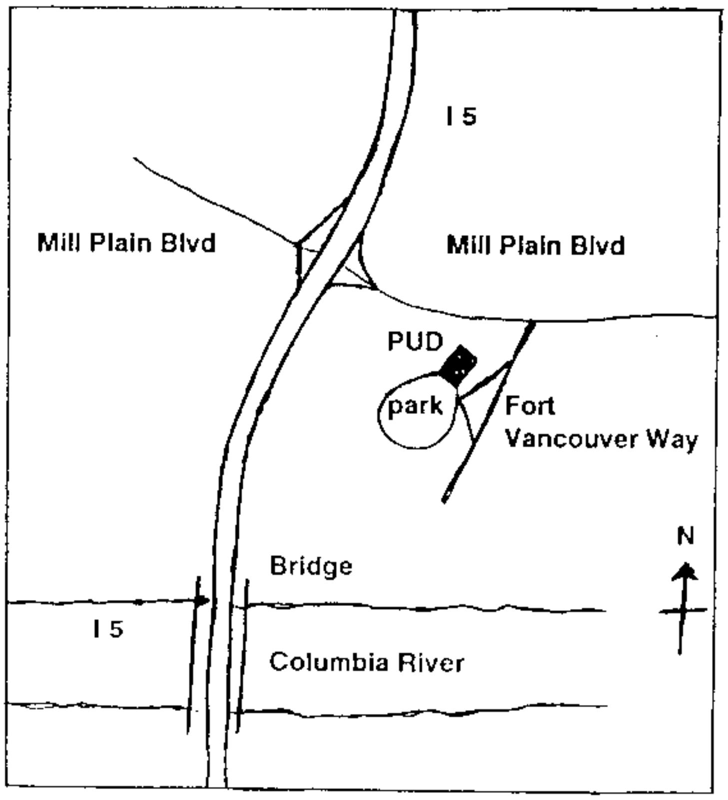
We are planning another full day of fun and sharing our favorite hobby. Bring your microscopes, best new finds, and some things to trade with others. And be sure to bring some pieces for the give-away table so everyone will come away with something new.

Short business meeting at 1:30 pm followed by slides and discussion by Rudy Tschernich on his recent collecting trip to Costa Rica. Rudy will have specimens to examine and for sale as well as pieces on the give-away table.

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

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

See Page 34 for details of a collecting field trip proposed for Sunday.



CAPTIONS TO THE PICTURES ACCOMPANYING THIS ISSUE

Note: For micrographs, the number appears on the front in the lower right corner
For photographs, the number is on the back.

FROM: Pedernal, Costa Rica

#253 Epistilbite (x200)
Elongated prisms showing {110} and {010} with roughened {011} faces as terminations.

#254 Epistilbite (x 90)
Habit showing similar prisms terminated by {112}.

FROM: Stew Point, Rangitata R., South Island, New Zealand

#142 Mordenite (x290)
Group of twinned crystals. See diagram in text.

FROM: Henderson's Quarry, Mt. Ngongotaha, Lake Rotorua, North Island, New Zealand

#146 Mullite on Tridymite (x120)
The spray of acicular crystals is mullite. The bladed hexagonal plates are tridymite.

#177 Hematite and Titanite (x 80)
The hematite crystal is somewhat rounded. A portion is missing where it encounters the titanite below. Other crystals are tridymite.

#251 Titanite on Augite (x240)
Two titanites impalled on an acicular crystal of augite. The augite needle shows interesting parallel growths.

#249 Pseudobrookite (x150)
A group of thin, striated blades on tridymite.

#3 Osumilite-(Mg) with Hematite on Tridymite (x 16)
Three pale green hexagonal prisms. The surfaces are somewhat roughened and the edges bevelled.

FROM: 150 level, Gold Hill Mine, Tooele Co., Utah

#4 Crednerite, Conichalcite, and Cu-Bi Arsenate (x 17)
The new unnamed mineral is the golden-colored drusy. The green translucent balls are conichalcite. The crednerite is the black mass at the extreme left, associated with green malachite.

FROM: Majuba Hill Mine, Imlay, Pershing Co., Nevada

#119 Arthurite and Pharmacosiderite (x250)
A group of upright blades of arthurite. The cubic blocks in the background are pharmacosiderite.

CREDITS:

Specimens #253 & 254	Rudy Tschernich
Specimens #142, 146, 177, 251	Jocelyn Thornton
Micrographs	Don Howard
Color Photographs	Genie & Don Howard

ZEOLITES OF COSTA RICA

by

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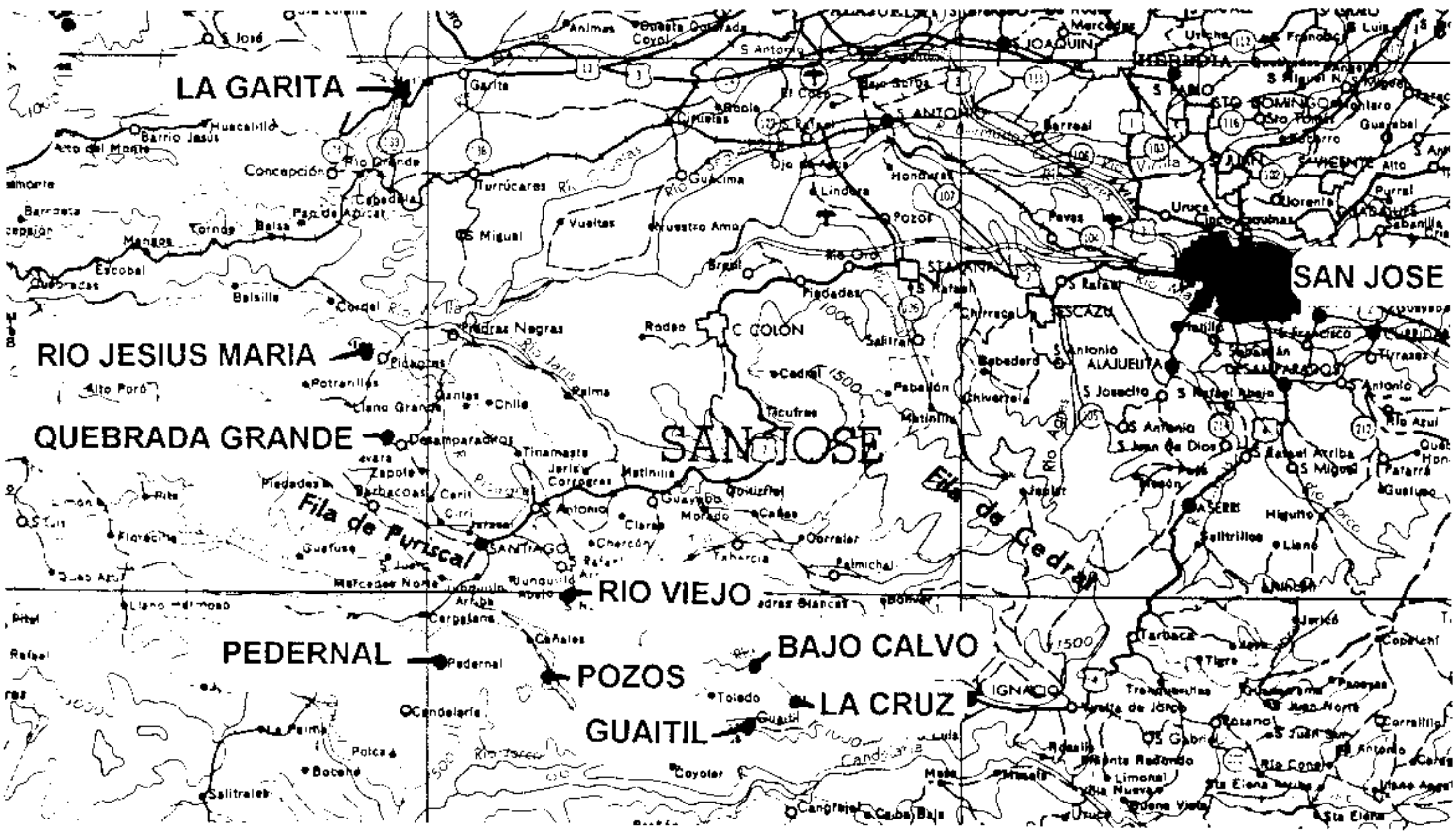
During that last two weeks of January 1993 I had the opportunity to travel to Costa Rica, visit Ronald Boyd in San Jose, and collect at many of the zeolite localities he has discovered in the last few years. Costa Rica borders Panama to the south and Nicaragua to the north, and both the Atlantic and Pacific Oceans. A chain of active volcanoes, up to 10,000 feet high, extend from north to south in the central part of Costa Rica with older volcanic rocks making up the a 3000 to 4000 foot high central plateau. Most of the people live in the higher plateau area because it is cooler and is less humid than the coastal region. Like most volcanic areas, zeolites are not found in the newly formed volcanic peaks but in the older flows. Eocene and Miocene andesite and basalt flows make up much of the region but in general they are devoid of cavities. A region west of San Jose, the capital of Costa Rica, does contain volcanic breccia, tuff, and reworked conglomerates composed of ash and rounded volcanic boulders that contain zeolites.



Hydrothermal alteration is common in the volcanic rocks. Mild hydrothermal alteration converts the tuff into a soft iron stained mud. More intense alteration produces iron stained masses of quartz with minor barite, pyrite, sphalerite, and sulfur. Native copper sheets were deposited between the joints in basalt at one locality. A few flows have vesicular and breccia zones at their bases that contain zeolites. Most of the zeolite-bearing rocks are found in vesicular boulders, ranging from few centimeters to several meters in diameter, that were rounded by streams and buried by volcanic ash flows. Numerous hydrothermal veins crossing tuff beds leading to the zeolite-bearing conglomerates indicate that the zeolites formed in the vesicles after they were buried in the conglomerate and that they did not result from erosion of zeolite-bearing flows. Some of the zeolite-bearing rock is found in conglomerate deposits but most of the boulders have been eroded from the conglomerate and are now found in steams and river beds. The following is a list of all of the known zeolite localities in Costa Rica that have been found to this date.

QUEBRADA GRANDE, near Desamparaditos: Zeolites are found in a slide area along the road and in boulders eroded from conglomerate in the creek. This locality is known for its exceptionally large phillipsite crystals.

PHILLIPSITE forms large, blocky, lustrous prisms, up to 15 mm long, in cavities 2 to 24 cm across. One of the largest pockets was 24 cm deep and 18 cm wide lined with well-formed phillipsite crystals up to 10 mm long. Unfortunately it was in the middle of a 3 meter boulder and was solidly attached. These crystals closely resemble harmotome from Strontian, Scotland. Samples are being tested for barium content.

ANALCIME forms colorless trapezohedra, up to 8 mm in diameter. The analcime crystals line the cavities and are often covered by chabazite, thomsonite, or levyne.

STILBITE rarely forms small colorless pointed crystals.

MESOLITE forms thin colorless needles, up to 5 mm long, on thomsonite and analcime.

HEULANDITE forms small colorless crystals, up to 4 mm long, flatten on the b-axis.

CHABAZITE commonly forms colorless rhombohedra and the variety phacolite, up to 10 mm across. Smaller crystals are found on analcime and thomsonite.

CALCITE forms colorless to milky crystals up to 7 cm long.

THOMSONITE rarely forms thin colorless blades covered by mesolite and brilliant lustrous botroydial mounds associated with chabazite.

LEVYNE forms thin, colorless, hexagonal plates, a few mm in diameter, associated with analcime and cowlesite.

COWLESITE is very scarce but was found with levyne lining a few cavities. The cowlesite forms tiny, colorless, sparkling blades, under 1 mm long.

LA CRUZ: Zeolites are found in vesicular rock in a talus slide along the road and in the adjacent cliffs. Remnants of large pockets are found in the talus containing exceptionally large crystals of stilbite, heulandite, analcime, and mesolite.

ANALCIME forms large colorless trapezohedra up to 2 cm in diameter.

HEULANDITE commonly forms a drusy cavity lining or crystals, up to 2 cm long, covered by stilbite and mesolite.

THOMSONITE forms groups of radiating blades on stilbite and heulandite, and are completely covered by mesolite. In the small cavities colorless blades of thomsonite completely line the cavities and are covered by thin mesolite needles.

MESOLITE forms thin needles, up to 10 mm long, and masses of coarse crystals, up to 6 cm long, on stilbite and heulandite. In the small cavities tiny colorless mesolite needles extend from a compact thomsonite cavity lining.

CHABAZITE forms colorless rhombohedra only a few millimeters across on mesolite needles or lining small vesicles.

STILBITE forms colorless blades, up to 4 cm long, and fanlike aggregates, up to 7 cm long, on heulandite in the larger cavities.

COPPER alteration stains are rarely found on zeolites.

LAUMONTITE forms white prisms up to 5 mm long.

LEVYNE forms very thin colorless hexagonal plates covered with a thin overgrowth of offretite.

OFFRETITE forms a very tiny colorless to white needles on the large {0001} pinacoid of levyne crystals.

CALCITE forms colorless rhombohedra with levyne in some of the small cavities and on mesolite in the larger cavities.

COWLESITE very rarely forms a white cavity lining near cavities containing levyne.

PHILLIPSITE rarely forms small white altered prisms in the tiny cavities.

RIO VIEJO near **SAN RAFAEL** and southwest of **SAN SANTIAGO** is a small creek containing zeolites in boulders at its junction with the RIO MARIN. Nearby hydrothermally altered ash is converted to reddish-yellow iron oxides, sulfides, and some native sulfur. Basalt in the area contains large native copper sheets along the joints. This locality is noted for its exceptionally nice mesolite on analcime specimens.

ANALCIME commonly forms very transparent, lustrous, colorless, trapezohedra with tiny cube faces that line most of the cavities. The crystals are only a few millimeters in diameter but are very attractive. One large cavity, over 60 cm in diameter, contained a intergrowth of black clay, colorless analcime crystals, up to 8 mm in diameter, small stilbite crystals, and barite

MESOLITE forms thin, colorless needles, up to 3 mm long, radiating from thomsonite aggregates on analcime or chabazite in many of the cavities.

THOMSONITE forms thin, colorless, radial groups of blades, up to 8 mm in diameter, on analcime and usually are covered with mesolite needles.

CALCITE forms long pointed crystals on analcime and mesolite in a few of the cavities.

CHABAZITE forms colorless twinned phacolite crystals, up to 5 mm in diameter, commonly associated with thomsonite and mesolite.

PHILLIPSITE forms tiny milky prisms and radial aggregates, up to 2 mm in diameter, that are partially covered with clay aggregates.

STILBITE rarely forms colorless pointed blades, up to 3 mm long, with analcime and clay in one large cavity.

BARITE forms gray blades covered by analcime and clay in one large cavity.

CLAY lines most of the cavities and is covered by analcime, mesolite, thomsonite, and chabazite. Only phillipsite appears to have preceded or cocrystallized with the clay.

LA GARITA: Zeolites are found in a talus slope that is used as quarry rock. Two flows are present. The upper flow is andesite that is brecciated at its base. Most of the zeolites are found in breccia cavities up to 15 cm in diameter. The massive basalt flow that makes up the lower portion of the cliff is the main rock used in the quarry but it contains very few cavities. This locality is noted for its abundance of bladed thomsonite.

CHABAZITE forms colorless twinned phacolite crystals, up to 4 mm in diameter, associated with thomsonite, mesolite, and calcite.

CALCITE commonly forms attractive, colorless, complex crystals, up to 4 mm in diameter, scattered on the thomsonite and chabazite.

THOMSONITE is very common at this locality. It lines nearly all the cavities and forms radial groups of colorless thin blades associated with chabazite, calcite, and rarely mesolite. Many of the cavities contain a white alteration or clay on the sides of the blades but is not on the terminations. The presence of the clay adds contrast between the thomsonite blades and makes them quite attractive. Rarely, thick rectangular thomsonite prisms form attractive, lustrous, radial aggregates scattered on black clay

APOPHYLLITE forms colorless prisms associated with gyrolite on one specimen.

GYROLITE has been found on one specimen. It forms tiny white radial groups covered by a later colorless generation.

MESOLITE very rarely forms tufts of needles, 3 mm long, extending from aggregates of bladed thomsonite.

RIO BARBILLA (not visited): Zeolites are found in boulders in the river on the east side (Atlantic Ocean side) of the country. This locality is noted for unusual levyne/offretite, exceptional thomsonite, and attractive mineral associations.

CHABAZITE forms small colorless twinned phacolite crystals, a few millimeters in diameter, associated with most of the other minerals. Complex rhombohedra of chabazite are also present.

THOMSONITE forms excellent specimens composed of thick bladed aggregates, up to 8 mm in diameter. Smaller aggregates have needles of natrolite/mesolite extending from the surface.

PHILLIPSITE forms tiny colorless to white glassy crystals and radial aggregates, up to 3 mm in diameter, in many of the cavities.

CLAY forms dark green to black spherical aggregated in the cavities and is commonly found on phillipsite.

CALCITE forms two generations. The first generation is colorless to white, long, pointed crystals that are covered by phillipsite and chabazite. The second generation is amber colored rhombohedra on the zeolites.

NATROLITE/MESOLITE needles, up to 5 mm long, radiate from the surface of some thomsonite groups. The needles have a small zone of natrolite at the base of each needle that becomes mesolite for the remainder.

LEVYNE/OFFRETITE aggregates are composed of a very thick overgrowth of offretite on thin levyne plates. The amount of offretite is up to 20 times the thickness of the levyne crystal it has grown on. Some of the offretite overgrowth forms tubelike structures on the levyne. These unusual aggregates consist of a thick compact offretite rim around the edge of the levyne, with only short scattered offretite needles in the center of the aggregate. Some of these aggregates display a beveled edge on the offretite indicating pyramidal faces found on erionite are also possible for offretite .

ANALCIME forms small colorless trapezohedra on clay and phillipsite

GUATIL: Zeolites are found in altered volcanic rock in an inactive quarry along the ridge road. This locality is noted for large cavities containing exceptional specimens of stilbite, heulandite, and mordenite.

HEULANDITE rarely forms colorless crystals up to 3 cm long.

STILBITE forms exceptional specimens of colorless to light pink pointed blades, up to 6 cm long, on rice grain quartz.

LAUMONTITE form tiny white prisms on some of the zeolites.

MORDENITE forms colorless to white needles, up to 2 cm long, often covered with rice grains quartz.

QUARTZ forms rice-grainlike crystals, 1 mm long, on mordenite needles and lines many of the cavities..

CALCITE forms colorless crystals on some of the zeolites

RIO CHILE north of **PURISCAL** contains only a trace of zeolites in boulders found in the creek .

LEVYNE forms complex milky-white twinned crystals, several millimeters across.

NEEDLES found in one boulder have not been tested.

STILBITE forms small pointed crystals in some cavities.

CALCITE covers zeolites in many of the cavities.

TOLEDO contains traces of zeolites in highly weathered volcanic rock nearly turned to soil.

APOPHYLLITE forms block, white, altered crystals, a few millimeters across, on stilbite.

STILBITE forms pointed white blades that are covered with apophyllite.

QUARTZ lines some of the cavities.

NEEDLES that were found are still to be tested.

CERRO ESTAQUERO (not visited) is 84 km south of SAN JOSE. Zeolites are rarely found in a basalt quarry.

HEULANDITE forms colorless to salmon-orange crystals up to 8 mm long.

STILBITE forms colorless pointed blades, up to 2 mm long, on heulandite.

ESTRANQUILLO (not visited)

CHABAZITE forms colorless rhombohedra up to 4 mm across.

THOMSONITE forms radiating aggregates, up to 3 mm in diameter, composed of colorless blades that are covered by chabazite.

PHILLIPSITE rarely forms small white prisms, up to 1 mm long.

NEEDLES that form white aggregates have not been tested.
CALCITE covers some of the zeolites.

TRANQULLERAS (not visited): Zeolites occur on epidote in fractures in andesite.
CHABAZITE forms colorless rhombohedra up to 2 mm across.
LAUMONTITE forms tiny white prisms.

BAJO CALVO north of **GUAITIL** contains an abundance of zeolites in a cliff near the road. The zeolites appear to be concentrated along the contact of two flows. The base of the upper flow contains most of the species but is highly altered and is nearly completely filled with zeolites. The lower flow is much harder, contains larger cavities, but has fewer species, mostly drusy heulandite, stilbite, and mesolite. This locality is noted for fine specimens of complex levyne crystals, mesolite sprays, and the rarer species epistilbite and gonnardite.

EPISTILBITE rarely forms colorless normal crystals and flattened twins, some up to 8 mm long, in a few cavities.

PHILLIPSITE forms white blocky prisms in a few cavities.

LEVYNE forms two types of crystals. The first is the common hexagonal prism with a large {0001} pinacoid. The pinacoid is often frosted but does not contain an offretite overgrowth. The second type of levyne forms the unusually complex milky white lustrous crystals that have no {0001} pinacoid at all. These crystals are often mistaken for penetration twins of chabazite. The levyne crystals occur up to 10 mm in diameter.

ANALCIME forms colorless trapezohedra up to 8 mm in diameter.

GONNARDITE (not tested) forms smooth white balls, up to 15 mm in diameter, and more commonly bluish-gray fine grained masses. Phillipsite and chabazite have been seen on top of the free growing hemispheres.

CHABAZITE forms colorless rhombohedra several millimeters across.

LAUMONTITE forms white prisms, up to 8 mm long, on heulandite.

HEULANDITE forms colorless drusy linings in many of the cavities and colorless to tan blocky crystals up to 3 mm long.

STILBITE forms colorless to beige, pointed blades, up to 5 mm long, commonly on heulandite.

MESOLITE form thin to rather thick needles up to 15 mm long. Some of the needles penetrate levyne crystals.

THOMSONITE very rarely forms thin blades on levyne.

RIO JESIUS MARIA near **PICAGRES** is a small creek that contains boulders eroded from conglomerate beds that commonly contain heulandite, chabazite, and calcite. The other minerals are rare.

HEULANDITE forms 1- to 2-mm colorless crystals on clay or is associated with chabazite in a red highly vesicular volcanic rock.

CALCITE abundantly forms lustrous dog tooth crystals and radial groups in most of the cavities.

CHABAZITE forms colorless twinned phacolite crystals, up to 10 mm in diameter, that are alone or associated with calcite or heulandite.

NEEDLES are present but have not been tested.

LEVYNE rarely forms thin colorless hexagonal plates, up to 2 mm in diameter.

THOMSONITE rarely forms highly lustrous smooth hemispheres.

POZOS is a roadcut or unused narrow quarry along the road that contains an abundance of breccia cavities.

SCOLECITE/MESOLITE abundantly forms white linings, 10 mm thick, in irregular cavities in andesite. The needles are 95% scolecite with an irregular area of mesolite near the termination. Most of the cavities are iron stained although fresh material can be found.

STILBITE rarely forms colorless to milky-white pointed blades, up to 15 mm long. The stilbite has not been found associated with the scolecite/mesolite.

CONCAVAS (not visited)

LAUMONTITE forms jackstrawlike crystals and prisms up to 9 mm wide and 3 cm long.

CALCITE fills many of the cavities covering the laumontite. Cleavages up to 6 cm across have been found.

FILA SAN FRANCISCO (a ridge) on the road to **BAJO CHACONES** (valley) south of **PEDERNAL** contains zeolites in place in the middle of the road and in outcrops next to the road. This locality is noted for complex levyne, scolecite, and gonnardite.

LEVYNE forms milky-white complex twins without the present of the characteristic {0001} pinacoid. Crystals occur up to 6 mm across and are commonly covered with scolecite.

SCOLECITE forms flattened colorless to white blades, up to 10 mm long, on a massive white scolecite or on levyne. Some flattened cavities, up to 30 cm long and 5 cm high, were found. In the smaller cavities tiny fibers of scolecite extend at random angles from the main crystals to form the branches of bushlike groups.

GONNARDITE/THOMSONITE (not confirmed) forms hard, blue-gray, massive nodules. Rarely the masses fill cavities that were first lined with levyne.

LAUMONTITE was found in place in the middle of the road and on top of scolecite.

STILBITE was found on one specimen. It consists of lustrous 10 mm pointed crystals.

CALCITE covers the zeolites in some cavities.

PEDERNAL is a small town southwest of Santiago (locally known as Puriscal). Part of the following minerals have been described in the paper ***Preliminary Report on the Second Occurrence of Tschernichite by Tschernich and Boyd*** in the last issue of the Micro Probe. The other minerals are described in the paper ***Epistilbite and Associated Minerals from Costa Rica by Tschernich*** in this issue and will not be repeated here. Minerals found at Pedernal include tsch ernichite, epistilibite, mordenite, chabazite, stilbite, heulandite, calcite, levyne, offretite, okenite, cowlesite, scolecite, mesolite, garronite, thomsonite, phillipsite, todorokite?, goethite ?, and clay.

EPISTILBITE AND ASSOCIATED MINERALS FROM PEDERNAL, COSTA RICA

by

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In the last issue of the Micro Probe Tschernich and Boyd reported on the second occurrence of tschernichite. That report described tschernichite, epistilbite, mordenite, heulandite, stilbite, levyne, chabazite, calcite, and clay from a locality near Santiago de Puriscal, in central Costa Rica. Since then I have had the opportunity to visit the locality and make further observations on the occurrence and associated minerals. This report deals with these new observations. In addition to those minerals already described okenite, scolecite, mesolite, thomsonite, cowlesite, offretite, garronite, phillipsite, todorokite?, and goethite? have been found.

Zeolites are found in small, clay-lined vesicles in gray-colored, Upper Miocene, andesitic conglomerates in the La Cruz Formation in central Costa Rica near the small town of Pedernal, 27.5 km southwest of San Jose. Tschernich and Boyd reported the locality near Santiago de Puriscal (located on maps as Santiago but known locally simply as Puriscal). The smaller town of Pedernal is less then two kilometers from the locality and is now the preferred locality name. The main site is found in a road bank, 30 meters long and 15 meters high, that has been exposed in the last two years by a land slide due to heavy rain or earthquakes that removed the vegetation and exposed the zeolite-bearing rocks. The exposure consists of a conglomerate composed of rounded chunks and boulders of both vesicular and non-vesicular andesite that range in size from a few centimeters to over 50 cm in diameter that are embedded in volcanic ash or tuff. The conglomerate rests on a bed of fine grained volcanic tuff that is cut by near vertical hydrothermal veins. The smaller fragments of the conglomerate are highly weathered and if they contained zeolites, the minerals in the cavities have since fallen off or been dissolved. The larger chunks have been altered along the edges but are fresh in the centers.

Each chunk has reacted a little differently when the solutions followed pathways through the tuff deposits and penetrated the conglomerate deposit to form the zeolites. The non-vesicular boulders were unable to act as a host to the zeolites. Many boulders were weathered before becoming buried and reacted differently than those that were fresh. The size of the conglomerate chunk and size and amount of cavities also caused changes in the solutions that resulted in different minerals being formed. There are an abundance of small vesicles, a few millimeters in diameter, and only a few reaching 8 cm in diameter.

The same minerals are found throughout the deposit but their proportions in different chunks of rock vary considerably. Tschernichite has been found primarily in only one boulder and a few cavities in two other boulders. Cowlesite is abundant in one boulder but rare in several others. Epistilbite is common in most of the boulders but crystals with the unusual {0$\bar{1}$1} termination has been found only to two boulders. Okenite is widely found but most of it has been altered to a white mass. Fresh undamaged okenite crystals were found in the core of one large unaltered boulder. Since the finding of interesting or rare species in one boulder may not be repeated in any of the others; a quantity of some species is difficult to obtain.

An exposure 200 meters uphill from the main site contains an abundance of bladed thomsonite and colorless rhombohedra of chabazite covered with mesolite needles in highly altered volcanic breccia. The former presence of calcite is indicated by hollow pointed cavities under the thomsonite.

A single rock found along the road one kilometer downhill from the main site contained an abundance of drusy heulandite, calcite, quartz, and long white needles of mordenite.

EPISTILBITE at Pedernal forms some of the most unusual crystals and aggregates found in the world for this mineral. The crystals are not large, they are only 1 to 3 mm long. The crystals are colorless, light yellow, or orange transparent, equant prisms elongated long the c-axis or are blades with a diamond-shaped cross section that form fanlike groups, hemispherical aggregates, and formless mounds. At least two generations of epistilbite are present.

The first generation formed lustrous transparent colorless to light yellow prisms bound by equal sized {110} and {010} and terminated by the rare {011} form that is twinned on [100] to form a pyramid (Fig. 5). This termination has not been seen on epistilbite anywhere else in the world. At other localities the form {011} rarely occurs as small faces accompanying the characteristic {001} form (see Fig. 165 in Zeolites of the World). The commonly {001} is not present on the prismatic epistilbite crystals at Pedernal. Most of the prismatic epistilbite crystals have a lustrous {011} termination although in one boulder the terminations were frosted while the prism faces remained bright and lustrous. The large lustrous faces on most of the prismatic epistilbite crystals (Figs. 5,6,8,9) indicates a rather slow growth rate that allowed the crystal to complete growth of the {011} faces.

The second generation of epistilbite has the characteristics of rapid growth. The crystals are smaller, have more common faces, and form an abundance of drusy aggregates. The beginning of the second generation is see on some of the terminations of the prismatic crystals of the first generation. The once smooth {011} faces become frosted as a result of numerous small parallel growth :{011} faces which enlarge into thin blades with the more common {-112}, {-102}, {001}termination (Figs.1-3,7). These blades grow only on the terminations of the prismatic crystals while the {110} and {010} prisms remain bright and lustrous. Only a trace of the {011} form is seen on these blades (Fig. 4).

In cavities where the prismatic epistilbite of the first generation never grew, the second generation of epistilbite formed an abundance of small blades (Figs. 1-3, 7) and twins (see Fig. 173 in Zeolites of the World). Tiny {011} faces are rarely seen in combination with other faces on these crystals. In many of the cavities the epistilbite grew so fast that it only had time to form bundles of minute crystals, radiating fans, hemispheres, or botroydial linings that are devoid of faces even with the aid of the SEM.

COWLESITE commonly forms white, tiny blades, up to 0.1 mm long, that line cavities and form radial groups, up to 0.25 mm in diameter, or are scattered on epistilibite in a few

EPISTILBITE FROM PEDERNAL, COSTA RICA

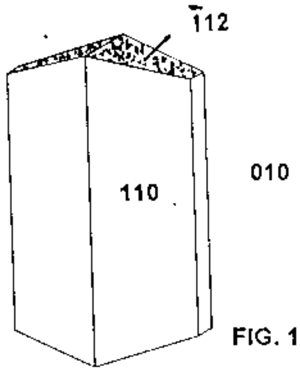


FIG. 1

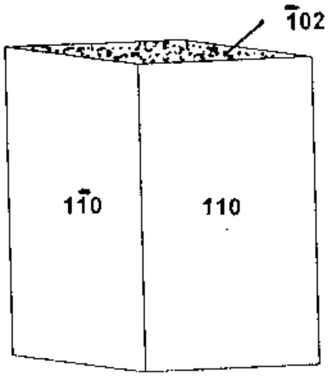


FIG. 2

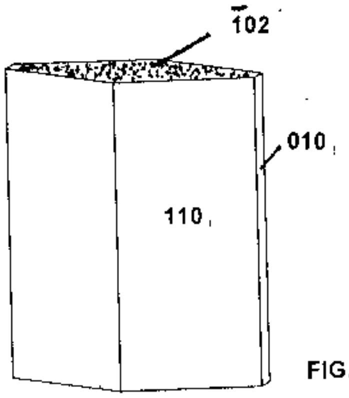


FIG. 3

ROUGH TERMINAL FACES ON MANY OF THE AGGREGATES

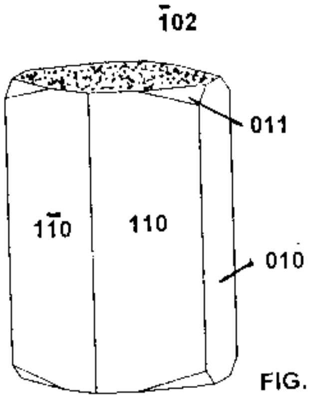


FIG. 4

UNUSUAL {011} FACE WITH ROUGH TERMINAL FACES

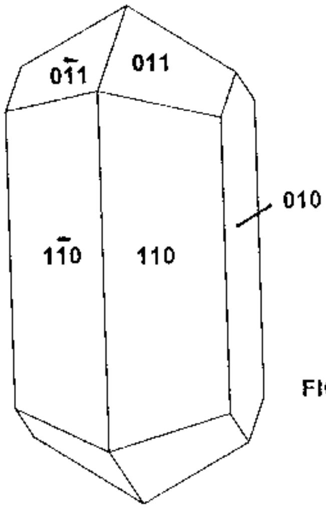


FIG. 5

UNUSUAL {011} TERMINATION

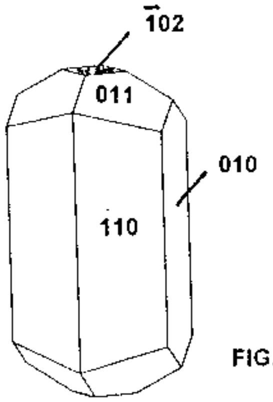


FIG. 6

ROUGH TERMINAL FACE COMBINED WITH {011}

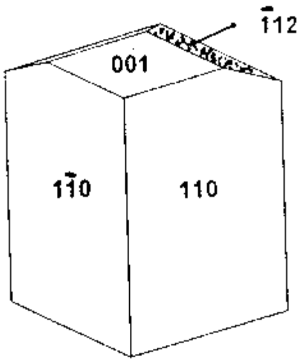


FIG. 7

COMMON {001} FACE

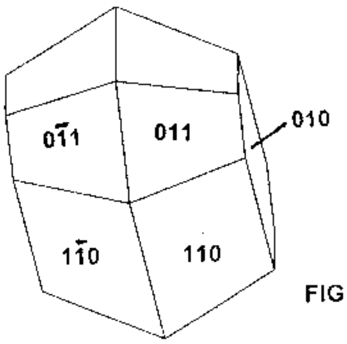


FIG 8

TOP VIEW OF FIG. 5

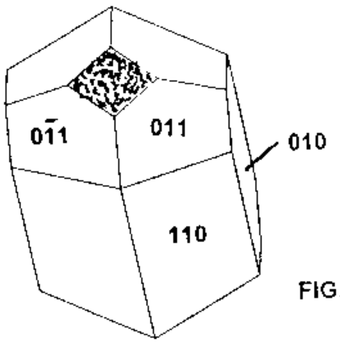


FIG. 9

TOP VIEW OF FIG. 6

of the boulders. Cowlesite is very soft, has a lustrous cleavage, and some samples are concentrically zoned transparent to white. Levyne commonly covers some of the cowlesite.

GARRONITE rarely forms white grainy masses completely filling a few small 2- to 3-mm vesicles in one boulder. No associated minerals have been observed.

THOMSONITE rarely forms compact blue cavity linings, a few millimeters thick, that are often covered by thin white needles of mesolite. Rarely tiny hour glasslike groups of thomsonite blades are found on epistilbite and levyne. In one boulder thomsonite formed fine-grained radiating hemispheres with a frosted rough surface scattered on the clay cavity lining.

At the site 200 meters uphill from the main locality thomsonite forms an abundance of small blades with chabazite and mesolite.

MESOLITE very rarely forms thin colorless to white needles, under 1 mm long, on a botryoidal cavity lining of thomsonite in a few tiny 1- to 2-mm cavities at the main site.

Mesolite is common at a site 200 meters uphill from the main site. At this site it forms thin hairlike needles, up to 15 mm long, on bladed thomsonite, chabazite, and calcite.

SCOLECITE rarely forms colorless to white, thin needles and coarser prisms, up to 10 mm long, on stilbite. In one cavity the coarser scolecite prisms are covered with soft white needles of okenite.

PHILLIPSITE very rarely forms milky-white blocky prisms and aggregates alone or on epistilbite and levyne-offretite. Some aggregates form Stemple twins along all three axes. One cavity contained phillipsite that formed unusual prisms elongated along the b-axis with highly striated faces, a habit seen only on harmotome.

OKENITE forms tiny, chalky, white needles and attractive white ball-like aggregates on heulandite and stilbite and rarely on cowlesite, levyne, and scolecite. Milky-white rubbery fibers and masses commonly found on heulandite, epistilbite, and stilbite are altered okenite.

TODOROKITE ? forms metallic red or maroon colored, foil-like masses on many of the zeolites. Some specimens display groups of tiny, thin, plates on the zeolites.

GOETHITE ? very rarely form black needles on stilbite and associated the metallic red todorokite plates.

CRYSTALLIZATION SEQUENCE:

Observed sequences:

Clay > tschernichite > levyne

Clay > tschernichite > epistilbite

Clay > mordenite (inclusions) > heulandite

Clay > mordenite (inclusions) > chabazite
Clay > calcite > epistilbite
Clay > epistilbite-1 > epistilbite-2
Clay > epistilbite > heulandite > epistilbite
Clay > epistilbite > stilbite
Clay > epistilbite > chabazite
Clay > epistilbite > levyne > offretite > chabazite
Clay > epistilbite > cowlesite > chabazite
Clay > epistilbite > levyne > thomsonite
Clay > epistilbite > phillipsite
Clay > heulandite > stilbite
Clay > heulandite > okenite
Clay > heulandite > stilbite > levyne > chabazite
Clay > heulandite > levyne
Clay > heulandite > stilbite > chabazite
Clay > stilbite > levyne
Clay > stilbite > okenite
Clay > stilbite > scolecite > okenite
Clay > levyne > chabazite
Clay > epistilbite > levyne > offretite > thomsonite
Clay > garronite
Clay > thomsonite > mesolite
Clay > calcite > cowlesite
Clay > cowlesite > levyne
Clay > cowlesite > okenite
Clay > cowlesite > chabazite
Clay > epistilbite > cowlesite
Clay > levyne > offretite > phillipsite
Clay > levyne > offretite > okenite
Clay > levyne > thomsonite

Generalized sequence:

Clay > calcite > tschernichite > epistilbite-1> mordenite > heulandite > epistilbite-2 > stilbite > scolecite ? > cowlesite > levyne > offretite > thomsonite > mesolite ? > okenite > chabazite.

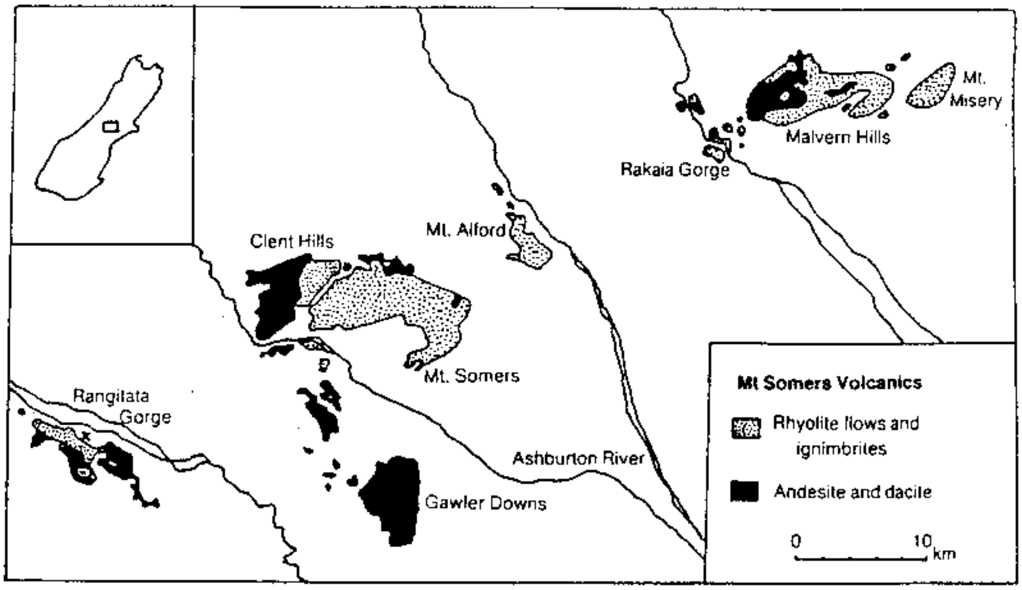
Most of the zeolites at Pedernal are dominant in calcium. Sodium is common only in mesolite, thomsonite, and mordenite which are all very scarce at the main site. The most abundant zeolites are high in silica and appear to have crystallized due to a progressive decrease of silica in the solution. Tschernichite, with the highest silica content, crystallized first, followed by the high-silica zeolites epistilbite, mordenite, heulandite, and stilbite while cowlesite, levyne, thomsonite, mesolite, scolecite, and chabazite, with the lowest silica content, crystallized last.

Micro-minerals from Stew Point Station, Rangitata Valley

Jocelyn Thornton (reprinted from the Newsletter for the micromineral collectors of New Zealand)

The cliffs above Stew Point Station on the Rangitata River are part of the Mt Somers Volcanics, a group of volcanic rocks which outcrop in a belt about 50 km long from the Rangitata River to the Malvern Hills in the foothills of the Southern Alps.

These volcanics are domes, flows, tuffs and ignimbrites ranging from high-alumina basalt to rhyolite, erupted on to an eroded land of greywacke, and in places they are overlain by coal measures, silica sands, marl and limestone. Three main eruptive centres occur; the northern Rakaia Gorge-Malvern Hills-Mt Misery area, the central Mt Somers-Clent Hills-Mt Alford-Gawler Downs, and the Rangitata Gorge.



At Mt Somers at least 3 phases of rhyolite eruptions have been recognised, layered with at least 5 phases of andesite. At Malvern Hills andesite overlies ignimbrite and the rhyolites may also be earlier than the andesite, but at Rangitata Gorge one phase of andesite was followed by rhyolite.

The rhyolite rocks are composed of quartz, sanidine and plagioclase feldspar crystals, minor to rare almandine garnet, and biotite, and a fine-grained felsitic groundmass. Secondary hemetite occurs in some of the rhyolites. The dacite, andesite and high-alumina basalt consist of plagioclase and hypersthene crystals, minor ilmenite, magnetite and clinopyroxene, in a groundmass. All the volcanic rocks are chemically interrelated and form a sequence that erupted over a geologically short period of time, less than 5 million years from about 95 million years ago.

Banded agate amygdules in the andesite and dacite flows were formed when the flows were cooling or very soon after, and the parallel bands were esed to measure the amount of tilt for the rocks since the agates formed.

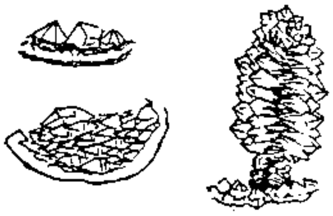
Most collectors seek the agates as lapidary material, regretting the areas of calcite and zeolites that also fill the amygdules. In the Rangitata Gorge agates, quartz and heulandite have been collected east of the homestead and waterfall.

Detailed observations and microminerals are from material collected in boulders at the base of talus slopes slightly south-west of the Stew Point Station woolshed, and from material collected further east behind the homestead.

Many of the vesicles had a green skin of iron-clay, celadonite, or a thin green layer of siliceous material, chert or opalite. Most of the interesting vesicles had a pink skin, which was often very thin, but could be found in thicker layers grading up to 2 mm or more, when it had pearly cleavages and where coarser and uncovered it showed heulandite terminations. Where the skin was thinnest it was most often covered with either a fine chalcedony layer or the bases of minute quartz crystals; in the table the pink skin is not counted, unless it is coarse and terminated crystals.

Many vesicles were solidly filled with chalcedony, quartz, a mordenite/quartz mix, or chlorite, and these were discarded uncounted. The nodules that failed to split easily in the breaker were also discarded unexamined.

<u>Mineral desciptions.</u>



Quartz - as primary coating, rising in balls and columns, occasionally parallel.
- as parallel flat growths on surfaces.
- as white balls on heulandite.
- as sugary fine crystals, late stage.
- less often as central crystals.
- less often as amethyst.

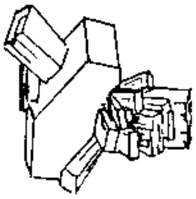
Heulandite - background layer, random terminations.
- large pink or white coffin shapes.
- clear wedges, usually singles.

Calcite with epistilbite

Calcite - creamy corroded crystals.
- thin coatings, rarely stalactitic.

Chlorite (clinochlore?) - in balls
- filling vesicles

Chlorite on quartz



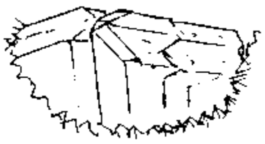
Stilbite with heulandite

with quartz

Stilbite - clear flat-topped crystals

Scolecite - radiating needles

Scolecite with epistilbite



Twinned

Epistilbite - yellowish singles, upright
- colourless, repeated, twinned

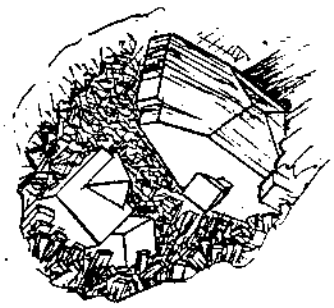
Chabazite - blocky, intergrown or twinned, not phacolites.

There are also amygdules filled solid with a pink or white fibrous mineral, which on XRD testing is closest to mordenite, but very near also to dachiardite. One vesicle had coarser structure and flattened terminations - I thought it could be scolecite but the XRD was nowhere near. We are waiting for further tests.

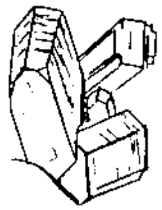
Mineral Associations

Chlorite	- solid	
	- heulandite	
	- mordenite - dachiardite?	
Heulandite	- solid	
	- quartz	
	- q + chlorite	
	- q	- calcite
	- calcite	
	- stilbite	
	- chlorite	
	- laumontite	
	- heulandite (second generation)	
Quartz	- heulandite	
	- h + calcite	
	- h + calcite	- quartz
	- h	- quartz
	- h + epistilbite(rare)	- quartz
	- h + stilbite	
	- h + stilbite	- quartz
	- h + stilbite + chlorite	
	- h + chlorite	- quartz
	- h + scolecite	
	- h + scolecite	- calcite
	- h + scolecite	- quartz
	- h + laumontite	
	- scolecite	- quartz
	- epistilbite	- quartz
	- e + calcite	- quartz
	- e + calcite	- fibrous ?
	- stilbite	
	- st	- quartz
	- st	- scolecite
	- st + chabazite	- heulandite
	- chlorite	- quartz
	- ch + heulandite + stilbite	
	- mordenite	- quartz
	- chabazite	- quartz
Chalcedony	- quartz	
Calcite	- calcite	

Quartz ball and singles in vug lined with heulandite



Quartz-lined vug with stilbite, chabazite and heulandite.



Heulandite + stilbite

Our thanks to Ruth Jacobsen who supplied lists of mineral associations and some specimens for drawing.

Reference -Adams,C.J.D. and Oliver, P.J. "Potassium-argon dating of Mt Somers Volcanics, South Island, New Zealand", N.Z. Journal of Geology and Geophysics Vol 22, No 4. (1979).

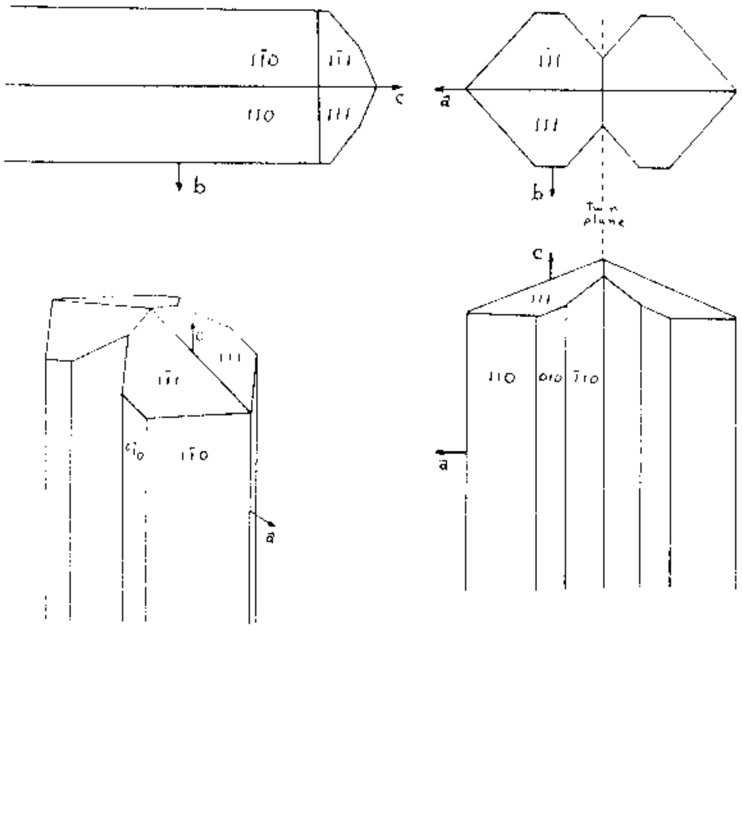
Twinned Mordenite from Stew Point Station, New Zealand

Donald G. Howard

The preceeding article by Jocelyn Thornton is an excellent example of the fine work being done by advanced collectors in other parts of the world. In it, she mentions the possible occurrence of mordenite in some of the vessicles. Many of these are fibrous-appearing, and when x-rayed show only quartz -- presumably the mordenite is responsible for the fibers but makes up too small a percentage of the total volume to register in x-ray diffraction. Some cavities are solidly filled with mordenite. The one sample with coarser crystals with odd terminations Jocelyn sent to me for further investigation.

This vessicle has a black rim (due to the clay lining) and is an orangy brown color. It is about 5 mm in diameter. Most of it shows a fibrous texture, but there is a region near the center of about 2 mm where the terminations of the crystals clearly show. Micrograph #142 (included in the illustrations to this issue) shows the nature of these terminations: the individual crystals are in pairs that are clearly twinned. Detailed examination shows the twinning to be on the [100] crystal plane, as shown in the diagram below. To our knowledge, these are the first twinned mordenite crystals that have been observed.

Why are these crystals so unusual? Mordenite is normally an orthorhombic mineral, and in the orthorhombic system the [100] plane is a mirror plane and therefore cannot be a twin plane. Rudy Tschernich in his book mentions that some mordenite has been observed optically to have an inclined optic axis and therefore must actually possess monoclinic symmetry. To be twinned on [100], these crystals must be the monoclinic type, and with the b-axis in the same orientation as the b-axis for orthorhombic mordenite. If more material can be found, this mineral warrents further study, both optically and crystallographically through detailed x-ray diffraction measurements.



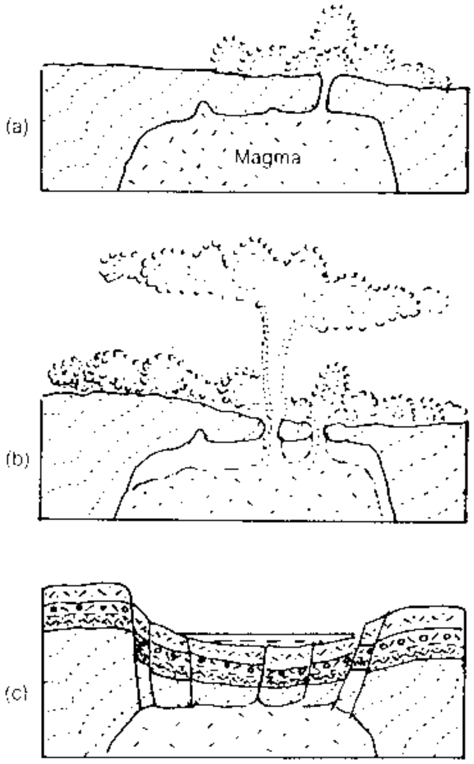
Habit of twinned mordenite, showing twinning on [100]

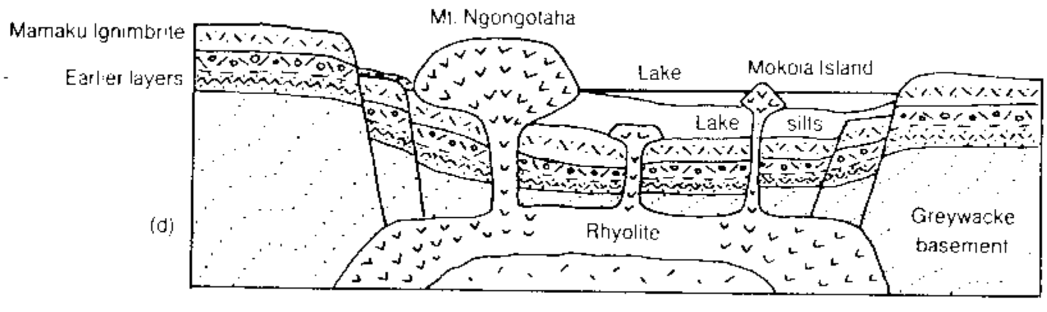
The Minerals of Henderson's Quarry, Mt. Ngongotaha, Bay of Plenty, New Zealand

Donald G. Howard

Lake Rotorua is a prominent feature in the central region of the North Island of New Zealand. Beautifully set and surrounded by areas of hot springs, steaming pools and geysers, it is a popular resort area and tourist attraction. The lake itself is round and blue with a pointed island near its center -- that is, it is a filled caldera. Its formation, however, is somewhat different than the collapsed volcanic cones with which we are familiar here on the West Coast. Jocelyn Thornton describes its formation (1):

> "The formation of the Rotorua Cauldera illustrates the sequence of events in an ignimbrite vent.
>
> "First, a mass of melted rock gathered in a magma chamber underground and small amounts of lava escaped to form some pumice beds (fig. a). Gas pressure built up and enormous amounts of ash and pumice burst out in explosive eruptions, some in the form of burning clouds (nuees ardentes) which formed ignimbrites, some as towering clouds of ash which spread far across the land downwind of the vent (fig. b).
>
> "As the shallow reservoir became partially emptied, the roof collapsed to form a circular basin, the caldera (fig. c). The remaining lava rose up the cracks caused by the collapse on the floor of the caldera and around the rim (fig. d). A lake filled the centre part of the caldera, but its level fluctuated as other eruptions sometimes blocked the outlet. The rim towards Lake Rotoiti was covered by a much younger ignimbrite from the Okataina Centre."





Mt. Ngongotaha is a prominent feature on the south shore of Lake Rotorua. As described above, it is composed of rhyolite extruded during the later stages of formation of the caldera. Henderson's Quarry is a major excavation on the side of the mountain facing the lake, exposing several thousand square meters of rock surface at several levels. The uppermost zone is composed of finely vesicular pumice, and the lowermost zone of obsidian, some of it brecciated. Between these lies an extensive zone of flow-banded rhyolite. Layering is defined by both textural and chemical variations, with bands varying from less than 1 millimeter to several centimeters in thickness. The color of the material is in various shades of gray. This zone is filled with lithophysal cavities, mostly flattened and distorted by the flow, from a few millimteres in size up to large openings several centimeters high and extending many tens of centimeters in length. The cavities often show very contorted structure along the walls, and are complexly interconnected. They are lined with a drusy of bladed tridymite crystals. The overall appearance of the pale gray rock and the snowy surfaces of the cavity lining give a very light appearance to the rock face.

Interesting mineralization occurs within the lithophysal cavities, which have resulted from the high content of volatile material in the original magma chamber. Tridymite is the stable form of silica in the temperature range between 870^{o} and 1470^{o} C, with quartz being the stable form below this range and cristobalite above this range. Thus, the array of minerals formed in and on the tridymite have been deposited directly from the gas phase rather than from the action of hydrothermal solutions. This leads to a rather interesting and different suite of minerals.

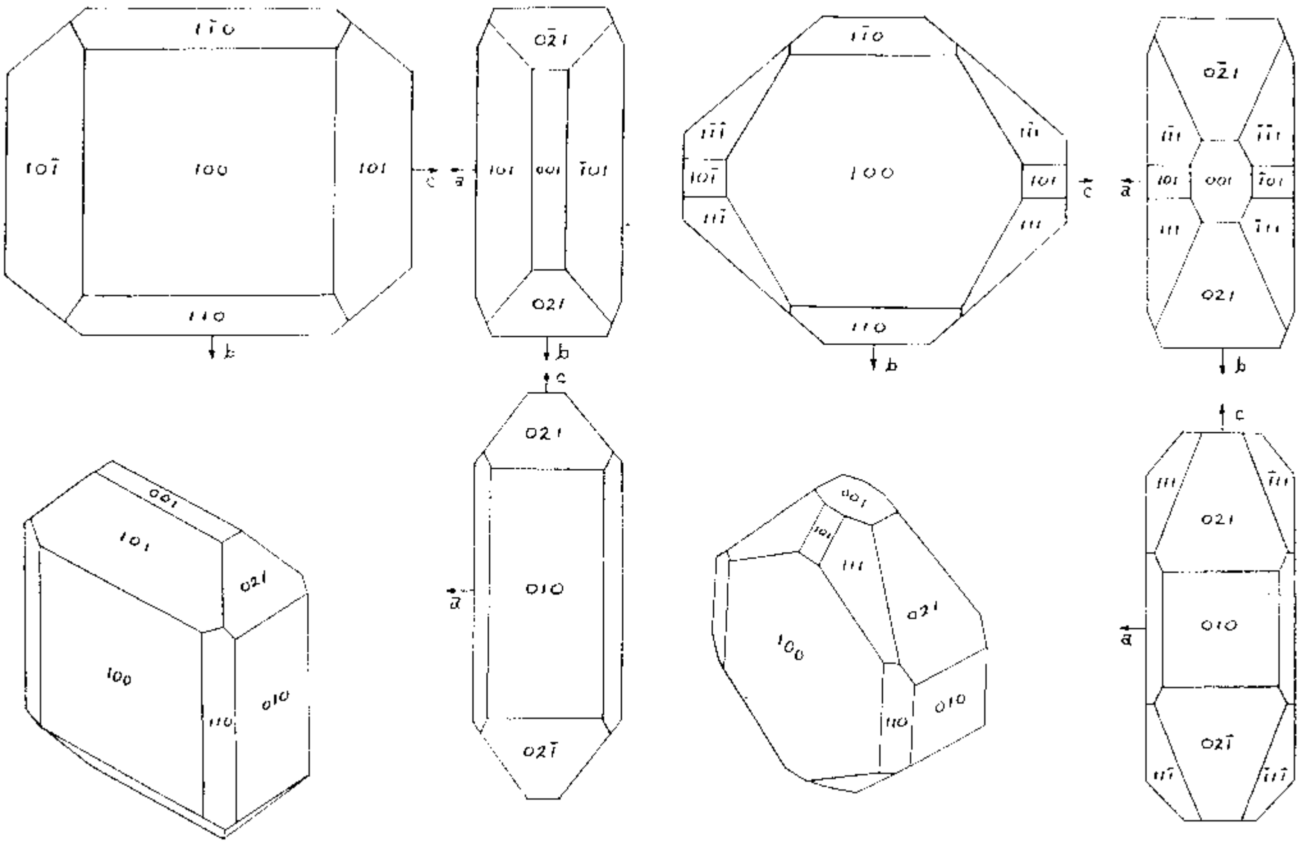
TRIDYMITE SiO_2

is abundant as cavity linings. It forms tiny, very thin hexagonal plates that are very clear. These would usually be formed of extensive c-faces with a-faces defining the hexagon. The crystals are so thin, however, that the shapes are often irregular due to shattering. Tridymite forms a white background for the other, darker minerals that occur.

FAYALITE $(Fe,Mg)_2SiO_4$

is the iron-rich end-member of the olivine group. Fayalite crystals are probably the most common mineral present on the tridymite linings. The crystals are orthorhombic, more or less equant and often up to several millimeters in size. All show well developed [100] and [010] prism faces, with some bevelling on the edges by [110]. Terminations are formed from [101] and [021] faces topped by a small [001] face. Some crystals show well-developed [111] faces, which give them a rather rounded appearance. The crystals are considerably altered, opaque rather than clear brown in color and with considerable iridescence. Most are scattered singly on the tridymite substrate, though some multiples are occassionally present.

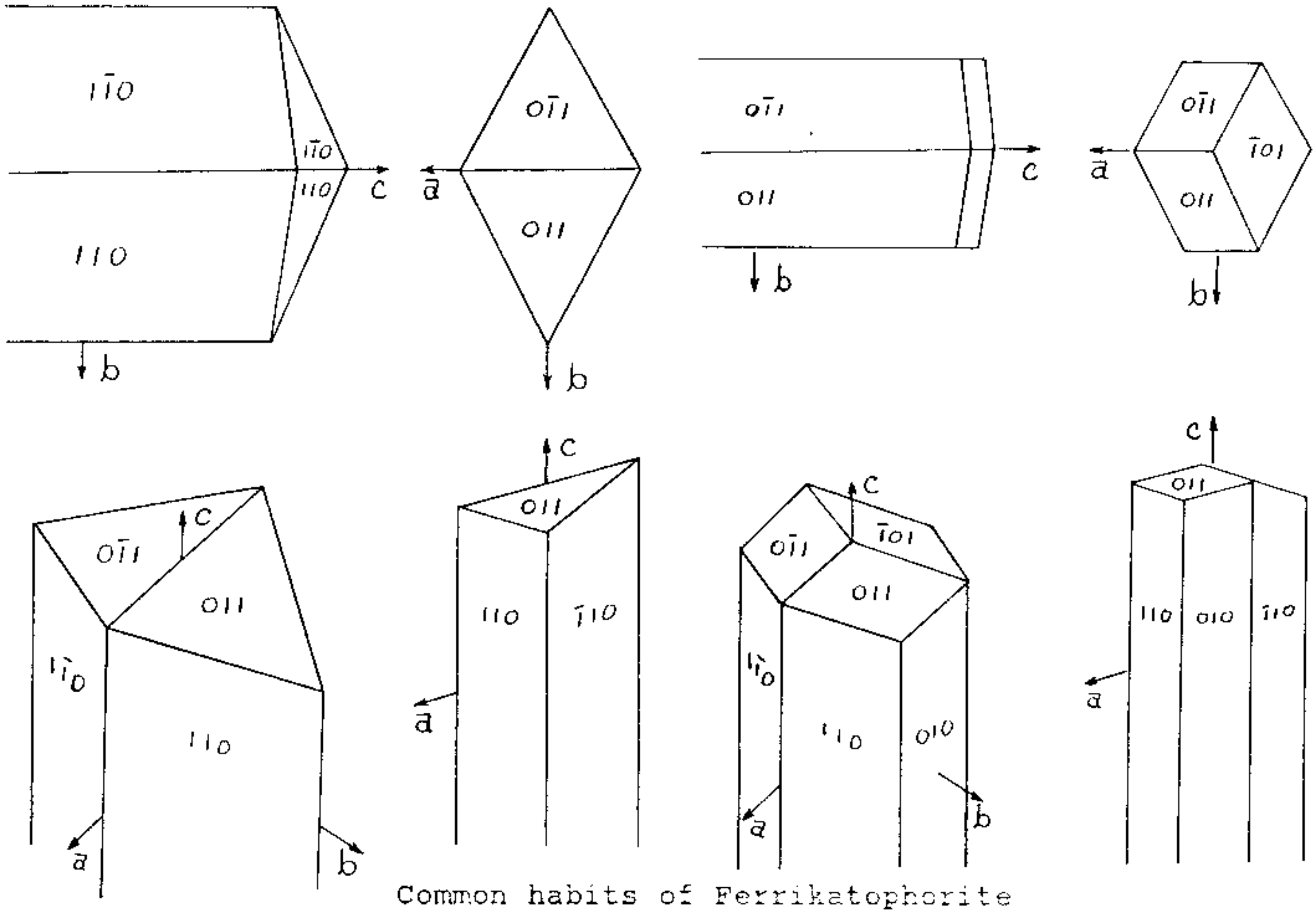
Chemically, they are ferrous silicate with about 13% of the iron replaced by magnesium. Cavities containing fayalite generally do not also contain other minerals except for needles of amphiboles.



Typical crystal habits of Fayalite

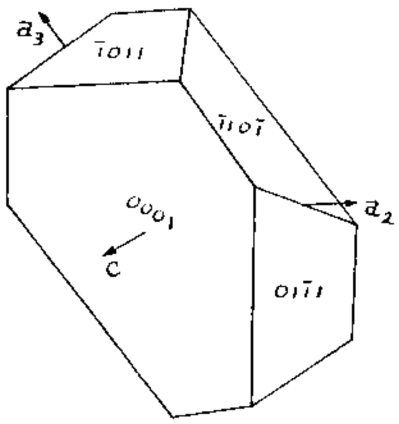
FERRIKATOPHORITE $Na_2Ca(Fe^{++},Mn)_4Fe^{+++}Si_7(Si,Al,Ti)O_{22}(OH)_2$ is an iron-rich amphibole that occurs as slender needles embedded in tridymite, often in cavities with associated fayalite. The needles may be several millimeters long but are very thin. They appear black in color, but the very thinnest are a beer-bottle brown color from transmitted light. Most of the crystals are very simple monoclinic prisms, with a diamond-shaped cross-section formed by [110] faces and a sloping termination formed by two [011] faces. In slightly thicker crystals, the acute edges of the diamond are truncated by [010] faces to make a nearly hexagonal cross-section. This pseudohexagonal habit is accentuated by the addition of a $[\bar{1}01]$ face to the termination. Both habits are shown in the diagram below. A second, iron poor amphibole has also been identified, but it is associated with a different suite of minerals.

HEMATITE Fe_2O_3 is another constituent of the tridymite-lined cavities, though it is not generally seen in association with the fayalite.



Common habits of Ferrikatophorite

Rather, it is commonly associated with phlogopite, titanite, pseudobrookite, augite, mullite, pargasite, and osumilite. Hematite forms as lustrous, black hexagonal plates. These are often scattered singly about on the tridymite, but on occassion form as rosettes of very thin blades with complicated edges. Hematite is basically a rhombohedral mineral, so that the hexagonal, plate-like crystals usually show the alternately sloping [01$\bar{1}$1] edges as shown in the diagram. Occassionally, the crystals of hematite are elongated along the c-axis, taking the form of simple hexagonal prisms [01$\bar{1}$0]. Chemically, up to about 10% of the iron oxide has been substituted, primarily by titanium oxide, but with some aluminum oxide also present. An interesting feature is that when the hematite grows in close proximity to a titanite crystal, it avoids the surface of the titanite, as if a "bite" had been removed from its side, leaving it arched over the crystal below.



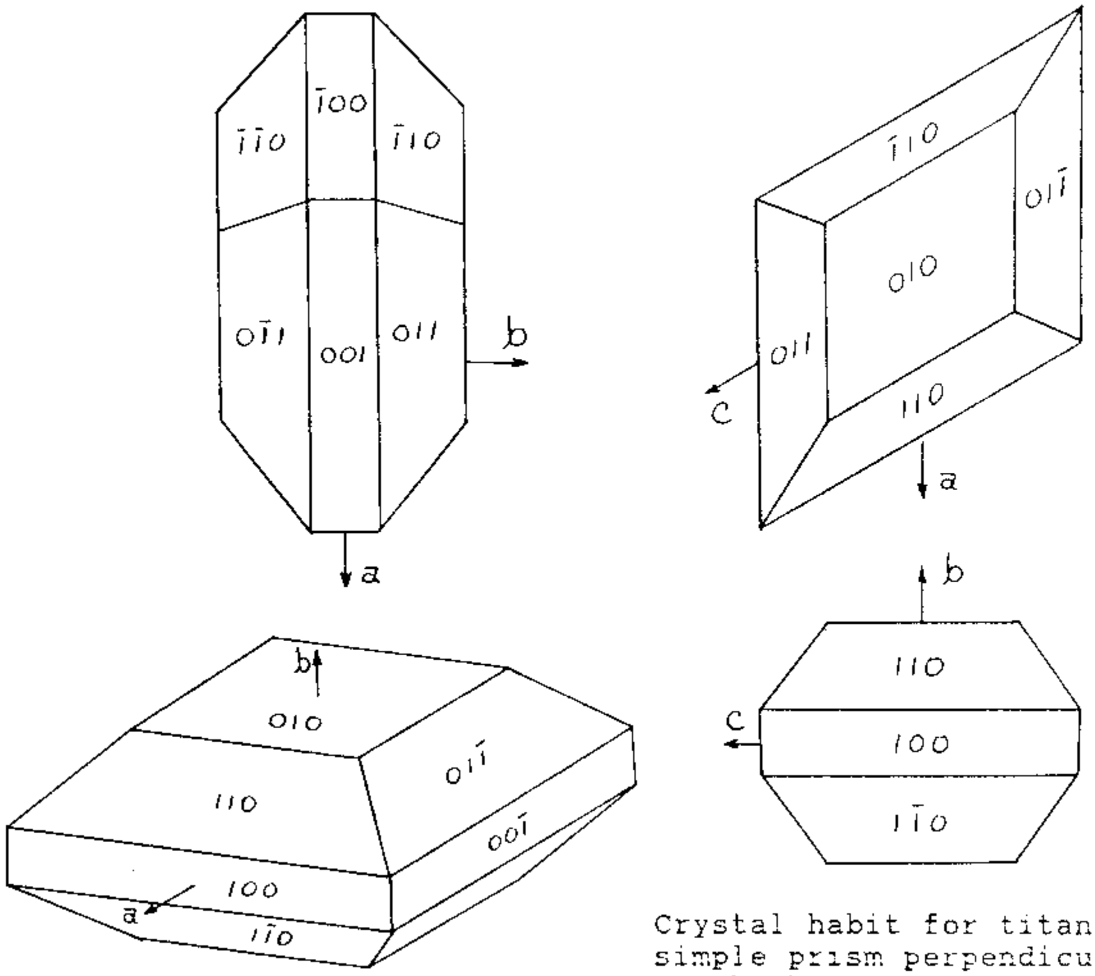
Hematite....hexagonal plate with alternate rhombohedral edges.

PHLOGOPITE $K_2(Mg,Fe,Ti,Al)_3Si_3AlO_{10}(OH)_2$

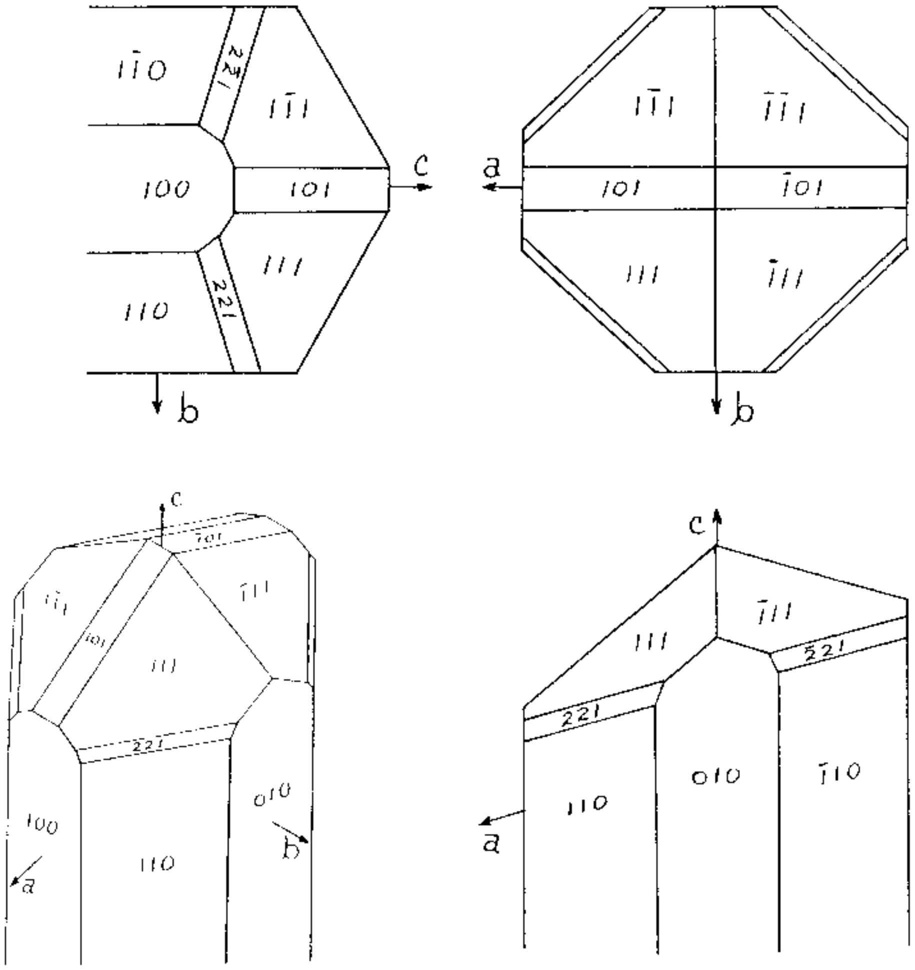
is a magnesium mica with a small amount of iron substituting in place of the magnesium. It forms very thin hexagonal plates that normally stand on edge. Like the hematite, they do not seems to cluster or form groups. Basically, the mineral is white, but the iron often gives it an orange tint. Phlogopite is a common associate of hematite in the tridymite-lined cavities.

TITANITE $Ca(Ti,Fe,Al)SiO_5$

forms tiny yellow-orange crystals scattered on the tridymite linings of some cavities, or occassionally impaled on slender augite needles (see micrograph #251). The crystals are simple and prismatic, composed of a well-developed b-face [010] and prism faces [100] and [001]. Edges are often bevelled by [110] and [011] faces. Though this is a very simple habit for a monoclinic crystal, it is a very unusual form for titanite, which is very variable in habit and noted for a variety of complex faces. Chemically, about one quarter of the titanium has been replaces by iron and aluminum.



Crystal habit for titanite: simple prism perpendicular to the b-axis, often with bevelled edges.



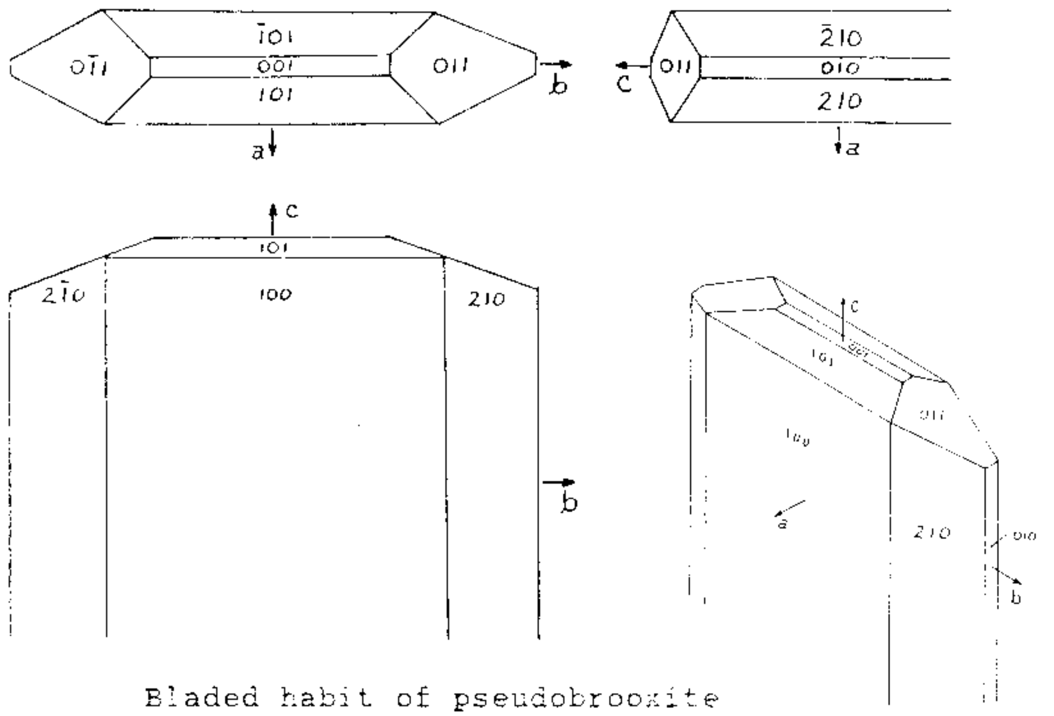
Termination on augite crystals

AUGITE $Ca(Mg,Fe,Mn)Si_2O_6$

forms as tiny golden yellow needles scattered individually on the tridymite. The crystals are elongated parallel to the c-axis. With both first-order [110] and second-order [100],[010] prisms about equally developed, they are eight-sided and therefore appear almost round. Terminations are primarily [111] faces with small additional [101] and [221] faces some-times present. The crystal faces often show etching and regrowth, such as that depicted in micrograph #251. Chemically, they are a calcium magnesium silicate with about 20% iron and 2% manganese replacing the magnesium.

MULLITE $Al_6Si_2O_{13}$

forms tiny sprays of white acicular needles. The individual crystals appear as nearly square rods with flat terminations, about 0.01 millimeters in diameter and several millimeters in length. Chemically, a little iron replaces the aluminum, but not enough to impart any color. Mullite is not common in this quarry.



Bladed habit of pseudobrookite

PSEUDOBROOKITE Fe_2TiO_5

forms as small groups of bladed crystals. In color they are black and shiny; only the very thinnest blades will transmit light, and these are beer-bottle brown in color. Pseudobrookite crystals are always elongated in the c-direction and very thin in the a-direction. The crystals therefore tend to have large [100] faces, but these are usually striated parallel to the c-axis because of repeated appearances of [210] faces, and the result is often rather curved or wavey. The terminations are primarily a flat wedge formed by [101] faces. The crystals from this quarry often show corner bevelling by [011], and small prism faces [010] and [001] are sometimes present as well. The crystals are generally 1 millimeter or less in width and up to a few millimeters long. They occur in clusters, but with little tendency to form parallel growths. Chemically, they are nearly pure ferric titanate with a little aluminum and manganese replacing iron. Like most pseudobrookite, they contain an access of titanium over the formula listed above. They are usually associated with hematite, and have been observed growing out of hematite crystals.

EDENITE $(Na,K)Ca_2Mg_5(Al,Fe,Ti)Si_7O_{22}(OH)_2$

is a second amphibole occurring in the cavities. The most common form present is as thin white flexible hairs. These are often a centimeter or more long, and though several are often present in a single cavity, they are never crowded or matted. This form is very low in iron -- generally less than 2% of the total weight. A second form, slightly richer in iron, is present as scattered brownish or reddish crystals, whose surface appears somewhat etched or oxidized.

OSUMILITE - (Mg) $K(Mg,Mn,Fe)_2Al_3(Si_{10}Al_2)O_{30}$ is perhaps the most unusual mineral present in the quarry. Unlike the iron-rich variety of osumilite, which appears black and glossy, this osumilite is very low in iron, with about one third of the magnesium being replaced by nearly equal parts of manganese and iron. The mineral therefore is very light in color, forming as pale green hexagonal prisms. Crystals are up to about 1 millimeter in length and are nearly equant. Most crystals are simple prisms with flat terminations, perhaps with just a hint of bevel on the edges. Surfaces are somewhat rough and rounded, but the crystals themselves are translucent and unaltered. Osumilite is very scarce in the quarry, and only a few cavities have been found which contain it, though when it occurs, numerous crystals are scattered about on the tridymite.

All of these minerals appear to have been deposited from high-temperature vapors in the rhyolite during the period of its formation. Such vapors clearly carried oxides of silicon, aluminum, iron, magnesium, calcium, titanium, potassium, sodium, and manganese, and these segregated into the variety of minerals present.

Silica was obviously the most abundant material, and most went into the formation of the tridymite. Sufficient was present to facilitate the crystalization of a number of silicates.

Iron was probably next most abundant, forming as the silicate fayalite and as the oxide hematite, and lending small amounts to several of the other minerals.

With the exception of tridymite, fayalite and hematite, most of the other minerals are very scattered and occassional, and correspond to only trace amounts.

Magnesium tended to form augite, phlogopite, edenite and osumilite.

Titanium formed as titanite where calcium was available and as pseudobrookite where iron was available.

In the absence of titanium, calcium went mostly into forming augite.

Sodium was primarily incorporated into the amphiboles.

Potassium primarily was incorporated into the phlogopite. Osumilite is also a potassium mineral

Manganese prefered incorporation into osumilite , although it is present as trace amounts in several other minerals.

Aluminum was necessary to the formation of edenite, phlogopite, and osumilite, and is present replacing silica in smaller amounts in several of the other minerals. Where aluminum was locally abundant, mullite formed as the only aluminum-rich mineral.

References:

Jocelyn Thornton, "Field Guide to New Zealand Geology" (Heinemann Reed, Aukland, New Zealand) 1985.

Andrew Shepard, "Volcanology and Petrology of the Post-caldera Ryolitic Domes, Rotorua Volcanic Centre, New Zealand (Thesis -- Victoria Univ., Wellington) 1991.

Some Rare Minerals from the Dara-I-Pioz Massif, Tadzhikistan

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Introduction:

The collapse of the communist strangle-hold over eastern Europe has permitted collector-mineralogists to obtain specimens from a number of localities which were formerly "off limits" (such as Russia's Kola Peninsula), or almost entirely unknown outside of the scientific fraternity. Dara-I-Pioz is one of the latter. Specimens from this locality, situated in the western Tien Shan mountains of Tadzhikistan, first began to appear in mineral price lists during the latter half of 1990, and some thirteen species, some very rare, have been offered thus far. It is difficult to determine whether the appearance of Dara-I-Pioz specimens is the result of the opening up of international frontiers, or the result of new mineralogical discoveries. Certainly, Tadzhikistan is a region seldom heard from by Westerners; being situated, as it is, on the northern and north-eastern borders of Afghanistan and the extreme north-western border of China. To the north-east, Tadzhikistan is bordered by Kirgizia, and its other border is with Uzbekistan. Its capital, Dushanbe, is located nearly 3000 km south-east of Moscow. The region is very rugged; the famous Pamir knot with its lofty peaks and precipitous valleys, dominates the eastern area and, although a well developed textile industry has been established there, the native Tadzhiks seem to prefer the traditional nomadic way of life where possible.

The range of mineral species currently in circulation from the Dara-I-Pioz alkalic massif is reminiscent of the many rare species found at such other alkali deposits as the Kola Peninsula, Ilimaussaq in Greenland, and our own Pilanesberg Complex in Bophuthatswana.

Minerals from Dara-I-Pioz include the following:

aegirine	polylithionite
albite	quartz
baratovite	reedmergnerite
cesium kupletskite	sogdianite
hetjmanite	steacyite
leucosphenite	stillwellite-(Ce)
microcline	tadzhikite-(Ce)
miserite	titanite
neptunite	zektzerite

What follows below are brief descriptions of some of the rarer and more interesting species that occur in and around Dara-I-Pioz:

BARATOVITE $KCa_7(Ti,Zr)_2Li_3Si_{12}O_{36}F_2$

This phyllosilicate species was first described in 1975 and, to date, Dara-I-Pioz remains the only locality from which it is known. It forms platy masses and aggregates with a perfect basal cleavage and a pearly white to pinkish-white colour. Aggregates to 50x20x5 mm were described in association with ekanite (=steacyite?), miserite, titanite and tadzhikite-(Ce) in albitites and in quartz-albite-aegirine veinlets. Under SW UV, it exhibits a brilliant white fluorescence. The writer's small specimen exhibits the typical pearly micaceous cleavage surface and measures 12x9 mm (4 mm thick). The presence of much aegirine has imparted a green-grey colour to some of the baratovite. The petrographer Baratov, of Tadzhikistan, was honored in the naming of the species.

CESIUM KUPLETSKITE $(Cs,K,Na)_3(Mn,Fe)_7(Ti,Nb)_2Si_8O_{24}(O,OH,F)$

Aegirine-microcline-quartz pegmatites, and polylithionite-quartz complexes in pegmatites "of the massif" (Fleischer, 1972) of the Altai alkalic province in southern Tien Shan were found to host this species. The unnamed massif in the province may possibly have been Dara-I-Pioz (this interpretation is open to correction), in which case, this is the type locality for cesium kupletskite. The species was first described in 1971 as rosette-like intergrowths of curved platy crystals in association with pyrochlore, stillwellite-(Ce), tienshanite, sogdianite and thorite. The writer's specimen consists of incomplete parallel-growth clove-brown platy crystal aggregates with individual incomplete crystals measuring 2x1 mm embedded in a white sugary matrix (=quartz?) and associated with a micaceous brown tadzhikite-(Ce) aggregate.

HEJTMANITE

This mineral was mentioned in the Spring 1992 price list issued by Albert Schrander in Breau, France. The description was of an orange-brown platy species but little else is known of it.

LEUCOSPHENITE $BaNa_4Ti_2B_2Si_{10}O_{30}$

An uncommon species known from several localities including the Inaglia massif in southern Yukutia, and from Turkestan (both CIS) and Mont Saint-Hilaire where single crystals to 25 mm have been recovered. Dara-I-Pioz specimens form translucent to opaque crystalline aggregates of a yellowish colour, as well as individual crystal sections in quartz-microcline matrix. Unlike leucosphenite from elsewhere, material from Tadzhikistan exhibits a pale orange fluorescence under SW UV.

MISERITE $K(Ca,Ce)_6Si_8O_{22}(OH,F)_2$

Magnet Cove, Arkansas, is perhaps the best known locality for this species, which also has been recorded from the Kipawa Lake area in Quebec, Canada. Also from Mont Saint Hilaire. Miserite from Dara-I-Pioz forms pale pink, compact, bladed fan-like aggregates in association with aegirine, microcline and quartz. A dull pinkish fluorescence is visible under SW UV.

NEPTUNITE $KNa_2LiFe_2Ti_2Si_8O_{24}$

The superbly crystallized specimens found in quantity at the Benitoite Gem Mine and Mina Numero Uno, both in San Benito County, California, may lead many to believe that this scarce species usually forms fine crystals. This is not so, and material from Dara-I-Pioz has only been found as brown masses to date.

POLYLITHIONITE $KLi_2AlSi_4O_{10}(F,OH)_2$

This scarce mica occurs, together with quartz, as replacement complexes in the Tien Shan pegmatites. Specimens of interest from Dara-I-Pioz occur as micaceous platy greenish-brown to golden greenish-brown aggregates and crystal sections in matrix. The hexagonal form may be clearly visible; some to 20 mm across. Specimens exhibit a light orange SW fluorescence.

REEDMERGNERITE $NaBSi_3O_8$

This rare feldspar was first described as colourless transparent stubby prismatic crystals, exhibiting chisel-like terminations, to 2 mm long and associated with such rare species as eitelite, shortite, leucosphenite and nahcolite from oil wells in the Green River Formation, Utah. Reedmergnerite from Dara-I-Pioz formed pale orange crystaline aggregates and masses exhibiting a well developed cleavage. Associated species include quartz, polylithionite, aegirine, microcline, steacyite and stillwellite-(Ce). A red-brown micro-crystalline mineral was recorded with reedmergnerite in a mineral list issued by Sharon Cisneros (Mineralogical Research Company): could this have been the new species hejtmanite? The writer's specimen consists of very pale orange cleaved aggregates in a whitish (quartz?) matrix. The largest cleavage face measures 4x6 mm.

SOGDIANITE $(K,Na)_2(Li,Fe)_3(Zr,Ti,Fe)Si_{12}O_{30}$

Sogdianite was described in 1968 (and incorrectly abstracted as "sogdianovite" in Am. Min. 54, 1221: 1969) from a pegmatoidal body in the Altai Range which is situated to the north-east of the Tien Shan mountains, some 1600 km from the closest Tadzhikistan border. It brackets the Russo-Mongolian border in the extreme eastern area of Kazakhstan. The writer is left wondering whether the locality should not read "Tien

Shan mountains", in which case Dara-I-Pioz might well prove to be, if not the type locality, then fairly close to it. In the original description, sogdianite formed violet-pinkish platy masses to 10x7x4 cm in association with such rare-earth species as thorite and stillwellite-(Ce). Dara-I-Pioz material forms similar platy masses in granular quartz in association with tadzhikite-(Ce) and aegirine. The list from Sharon Cisneros also noted an unidentified reddish-black cubo-octahedral mineral forming crystals to 1.5 mm in size

The writer's specimen, measuring 13x10x11 mm, consists of anhedral violet-pink sogdianite with micaeous tadzhikite-(Ce) and minor dull grey-green aegirine masses. At present, Tadzhikistan is the only known locality for sogdianite and references to the species occurring in South Africa's Kalahiri Manganese Field are in error: that material is sugilite (Dunn et. al., 1980). (Editors note: Washington Pass was omitted but later acknowledged by the author.)

STEACYITE $Th(Ca,Na)_2K_{1-x}Si_8O_{20}$ $(x = 0.2 - 0.4)$

Mont Saint Hilaire, Canada, is the principal and type locality for this very rare mineral which forms blocky tetragonal prisms to 3 mm which occasionally form cruciform twins. The color ranges from pale beige to off-white, through greenish-brown, to dark grey. Dara-I-Pioz is the second known locality for steacyite (references to ekanite are almost certainly this species) where it forms yellowish-green blocky to elongated tetragonal crystals and crystal sections embedded in quartz in association with microcline, leucosphenite, polylithionite, and others. These specimens exhibit a red fluorescence under SW UV.

STILLWELLITE-(Ce) $(Ce,La,Ca)BSiO_3$

A rare mineral which here forms pinkish- to yellowish-tan crystalline aggregates or crudely formed crystal sections in quartz and microcline. Some of the crude crystal sections have been measured at 9x15 mm. Polylithionite and baratovite have been recorded as associated species.

TADZHIKITE-(Ce) $Ca_3(Ce,Y)_2(Ti,Al,FE)B_4Si_4O_{22}$

This mineral poses an interesting nomenclature problem. Tadzhikite was originally described in 1970 from pegmatite dikes in the "Turkestan-Altai alkaline province" in Tadzhikistan and, since the dominant rare-earth element was yttrium, was given the name tadzhikite-(Y) when the Levinson suffix system for REE minerals was adopted in Fleischer's Glossary of Mineral Species, fifth edition. Nevertheless, in Roberts et. al. (1990) the formula given has (Ce,Y) and all tadzhikite specimens listed from Dara-I-Pioz are named tadzhikite-(Ce), implying Ce>Y. If this is correct, then this is a new species which has yet, to the writer's knowledge, to be published, and Dara-I-Pioz will probably be the type locality. Specimens consist of light tan-brown to dark brown elongated and flattened non-terminated crystals to 6 mm in sugary quartz and are associated with aegirine, baratovite, sogdianite, and others. Larger crystals exhibit a curved morphology. Somewhat micaeous dark brown aggregates with minor quartz are associated with the writer's sogdianite specimen described above. En passant, it is perhaps worth noting that tadzhikite described as tadzhikite-(Y) has been found as micro-bladed crystal clusters with sanidine at Tre Croci, Viterbo, Lazio, Italy. Fine micro stillwellite-(Ce) has also been found there, as also has the species hellandite. Whether hellandite has been mistaken for tadzhikite-(Y) or vica verse (or whether both species occur there) is a problem that requires clarification.

ZEKZTERITE $NaLiZrSi_6O_{15}$

A very rare species originally described as well formed crystals from miarolitic cavities in the Golden Horn Batholith at Washington Pass in the North Cascade Range, Washington, U.S.A. in 1977. Associated minerals there include arfvedsonite, aegirine, okanoganite, elpidite and astrophyllite. Dara-I-Pioz specimens forms small crystalline masses in rock matrix which are readily recognized by their brilliant bluish-white fluorescence.

Dara-I-Pioz is a locality worth watching. This short introductory note has served principally to draw together species descriptions found scattered through several recent mineral lists and the literature and it is hoped that it may give a prompt to someone knowledgeable about the deposit (and its very confusing locality nomenclature - especially the mountain ranges) and its minerals to put together a more systematic and comprehensive report. The matter of tadzhikite-(Ce) and hejtmanite, two possible new species, also requires greater clarification.

References;

Amin, M, Willetts, D and Tetley, B. (1989) The roof of the World. Camerapix Publishers International: Nairobi

Cisneros, S. (1990) November/December price list of the Mineralogical Research Company, San Jose, California

Dunn, P.J., Brummer, J.J., and Belsky, H. (1980) Sugalite, a Second Occurrence: Wessels Mine, Kalamiri Manganese Field, Republic of South Africa. Canadian Mineralogist, 18, p 37-39

Dunn, P.S., Rouse, R.C., Cannon, B. and Nelen, J.A. (1977) Zekzterite, a new Sodium Zirconium Silicate Related to Tuhualite and the Osumilite Group. Am. Min. 62, p 416-420

Fleischer, M. and Mandarino< J.A. (1991) Glossary of Mineral Species, 1991, Mineralogical Record Inc.: Tuscon

Fleischer, M. the following abstracts from Am. Min.:
54, p 1221 (1969) Sogdianite
56, p 1838 (1971) Tadzhikite-(Y)
57, p 328 (1972) Cesium Kupletskite
61, p 1053 (1976) Baratovite

Horvath, L. and Gualt, R.A. (1990) The Mineralogy of Mont Saint-Hilaire, Quebec. Min. Record, 21, p 284-368

Roberts, W.L., Campbell, T.J. and Rapp, G.R. (1990) Encylopedia of Minerals, van Nostrand Reinhold: New York

Schrander, A. & M. (1992) Spring and summer price lists: Breau, France

Time-Life Editors (1984) The Soviet Union, Time-Life Books: Amsterdam.

CREDNERITE, Another Unusual Mineral from Gold Hill, Utah

Donald G. Howard

Our congratulations to Mike Kokinos and Bill Wise for the excellent article and photographs of the minerals from Gold Hill that appeared in the January/February, 1993 issue of Mineralogical Record. The list of minerals present at Gold Hill is impressive and contains some rare and unusual species. One species that has been verified but not included in their list is crednerite.

Crednerite is a copper manganate: $Cu Mn O_2$. In appearance, it is lusterous and very black. Although at some European locations it forms groupings of platelets, its usual mode of occurrence is as fine-grained black coatings, and this is the way it appears at Gold Hill. Crednerite is an "old" mineral, dating back to 1847, when it was first reported from Thuringia, Germany.

Samples of crednerite have been taken from the 150 level tunnel of the Gold Hill Mine. The area represents a contact between quartz-rich rocks and bordering carbonates. The crednerite comes from the quartz phase, and is usually in intimate association with crusts and sometimes needles of malachite. Azurite is often present as well. It is also commonly associated with the unnamed copper bismuth arsenate mentioned in the article in Mineralogical Record (see photograph #4). Other associated minerals include conichalcite, connellite, tyrolite and mixite. Some of the primary tennantite-chalcopyrite is present embedded in the quartz matrix.

As a black coating, crednerite is an easy mineral to overlook. It resembles a number of other manganese oxide minerals that are difficult to separate. The presence of a high copper content makes identification somewhat easier, but still requires chemical or x-ray fluorescent analysis to confirm it. For this reason, it may be more common than the reported occurrences would indicate. Black manganese "stains" in close proximity to green malachite "stains" should probably be tested to see if crednerite is present.

The Crystal Habit of ARTHURITE

Donald G. Howard

Arthurite $Cu Fe_2 (AsO_4)_2 (OH)_2 \cdot 4 H_2O$ is an unusual arsenate of copper and ferric iron. It was originally described in 1965 from Cornwall, England, where it occurs as apple-green crusts intimately mixed with pharmacosiderite. It was later found to occur in Atacama Province, Chile as very thin, sporatic coatings on fracture surfaces of the malachite shells surrounding the djurleite masses that were the copper ore body. Only one small crystal fragment was found, and that was used to do single-crystal x-ray work to establish the crystal structure, which is monoclinic. To date, the morphology of the mineral has not been discussed.

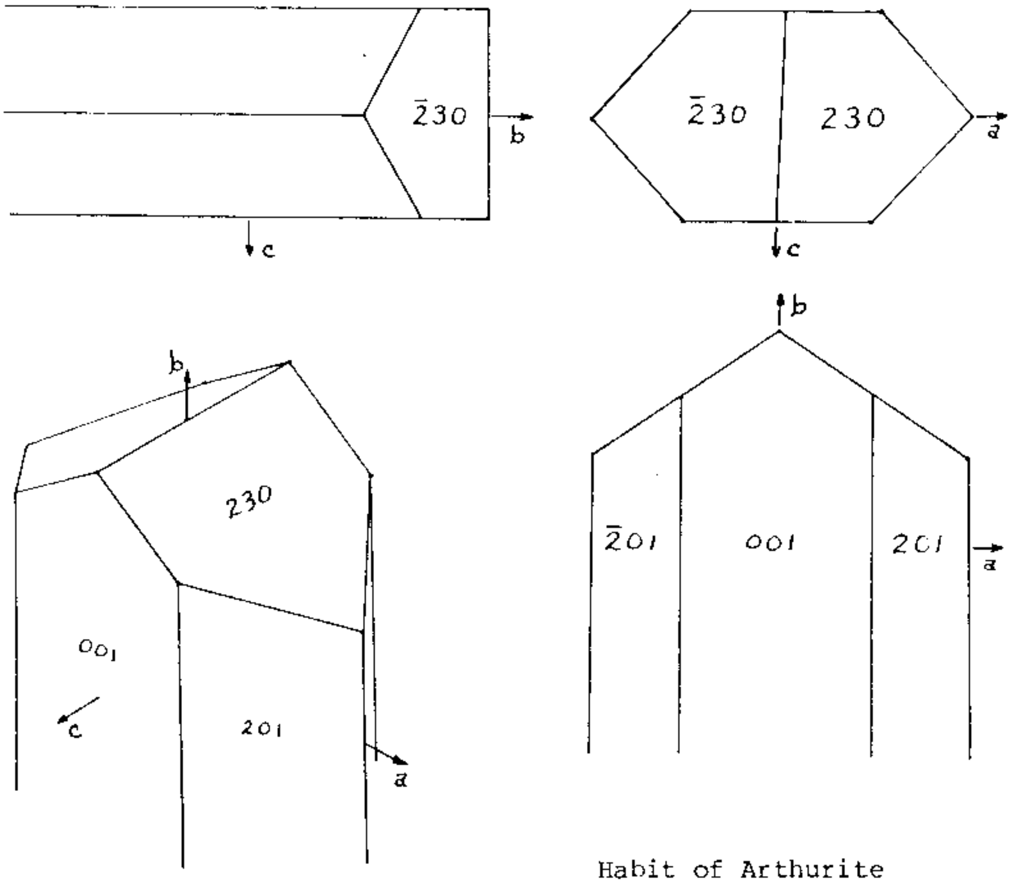
The world's best specimens of arthurite have been found at the Majuba Hill Mine. Majuba Hill is in Pershing Co., Nevada, about 30 miles northwest of the town of Imlay. Over the years, it has been a consistent producer of excellent specimens of a number of the more unusual secondary copper arsenate minerals. The minerals are formed from the decomposition of arsenopyrite, which was the primary ore body in the mine with which the gold was associated. An article by Martin Jensen on the geology and mineralogy of the Majuba Hill Mine is scheduled for the May/June issue of Mineralogical Record.

Arthurite at Majuba Hill occurs in the lower portion of the copper stope, where it forms radiating tufts of crystals in small pockets and along cracks in a very light-colored rock. The feathery groups of crystals are a vivid yellow-green color. Some sturdier clusters are a darker, apple-green. Individual clusters are small, generally less than 1 millimeter in diameter. All the crystals show terminations under sufficient magnification. In most samples, the arthurite is closely associated with clear, colorless to pale green cubic crystals of pharmacosiderite. Some sprays of clear, colorless scorodite are also present. Traces of arsenopyrite, and occassionally small crystals, can be seen in the matrix. Acicular crystals of tourmaline are also present as a part of the matrix. Twisted efflorescent growths of chalcanthite, often several millimeters in length, are found growing on the exposed surfaces, and often cover the arthurite.

X-ray studies of arthurite show it to be a monoclinic mineral with the oblique angle only a slightly different from a right angle.

$a = 10.09$ A
$b = 9.62$ A
$c = 5.55$ A
$\beta = 92.2^{\circ}$

The individual crystals are elongated parallel to the b-axis and appear to be untwinned. The major prism faces are [201] with the [001] face often present in varying degrees of development. The [201] faces are striated parallel to the b-axis. Terminations are formed by two equally-developed [230] faces. The form is shown diagramatically below, and in situa in micrograph #119.



Habit of Arthurite

FIELD TRIP for SUNDAY MAY 2nd

We are planning a collecting trip to the Elk Mountain, near Mount Saint Helens, Cowlitz County, Washington the day after the micro meeting. The locality is on the north side of the mountain and has produced an abundance of scolecite specimens in large pockets and fine micro minerals in the smaller cavities. Very little collecting has been done in this area due to the difficulty in finding your way through the maze of unmarked logging roads, the short collecting period between snow melt (4,000 foot elevation) and closure for fire season, and the poor condition of the roads. We will meet in front of the Mount Saint Helens Motel, at Castle Rock **exit 49** at 8:00 am and proceed to the collecting site (about 1.5 hours drive). Only four-wheeled drive or trucks with good clearance should try this trip. The first and best locality produces cabinet sized specimens of white scolecite and micro sized stilbite, levyne, chabazite, calcite, and rarely okenite, gyrolite, and thomsonite. The remainder of the trip can only be tried with a 4-wheeled drive, if the road is still there. A very bad washout and slide area that can easily take out the road during the winter blocks the only entry to the other sites. Members that do not have a four-wheeled drive vehicle and want to make this trip can ride with someone that does have one.

THE MICROPROBE .... Donald G. Howard, Editor
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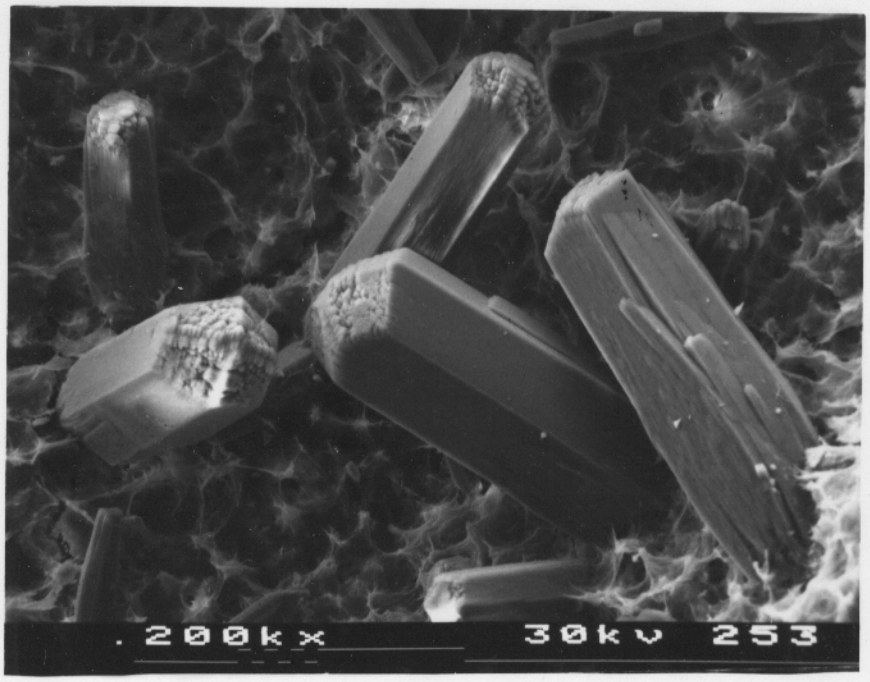
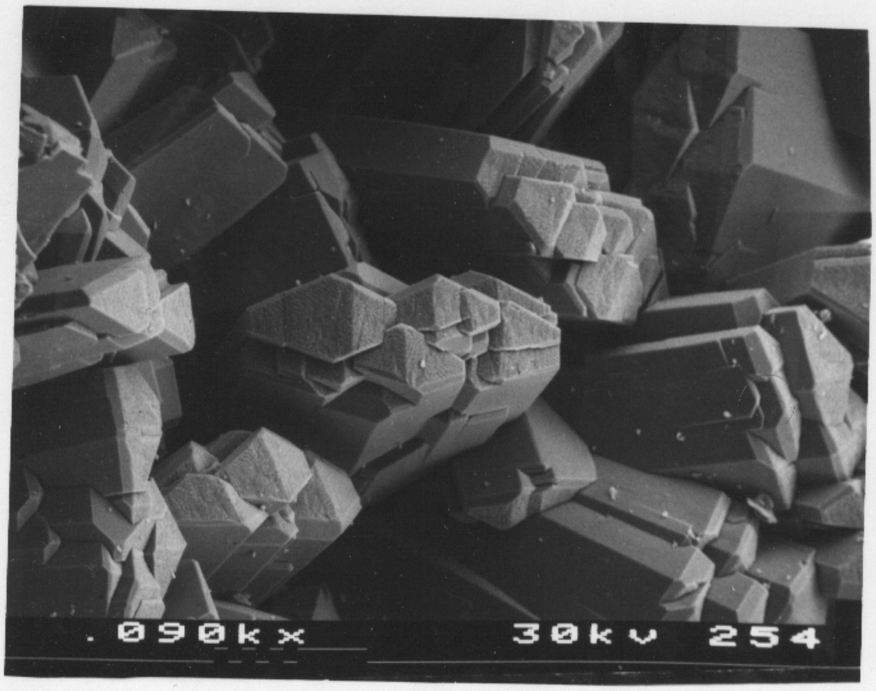
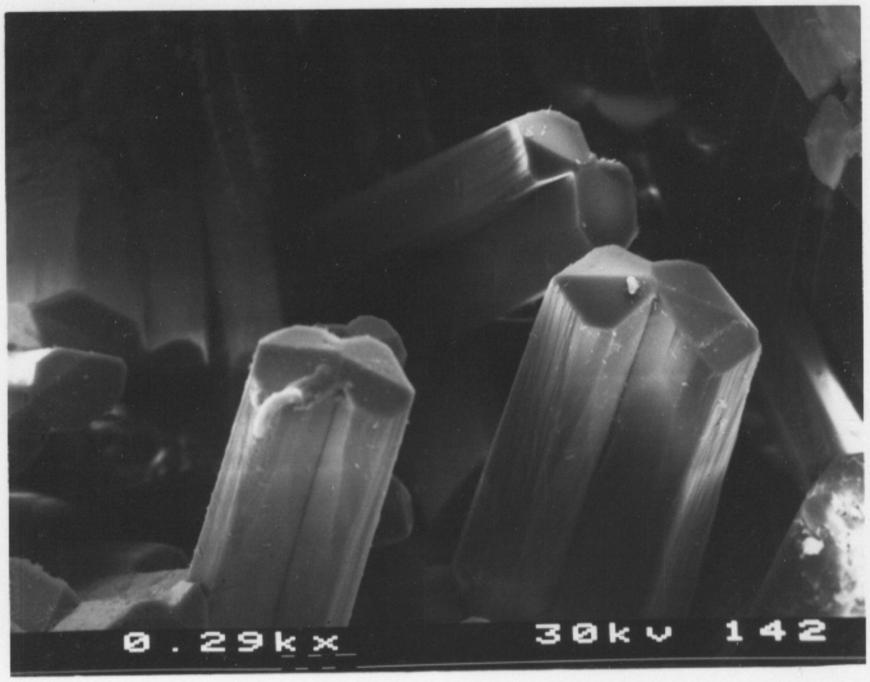
Portland, Oregon 97215



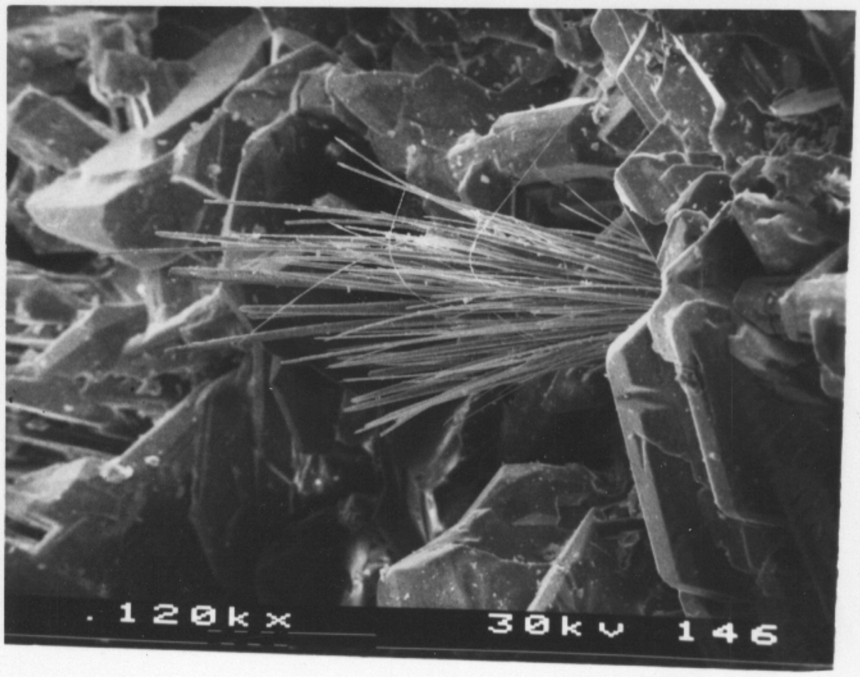
#253 – EPISTILBITE – PEDERNAL, COSTA RICA – 200X



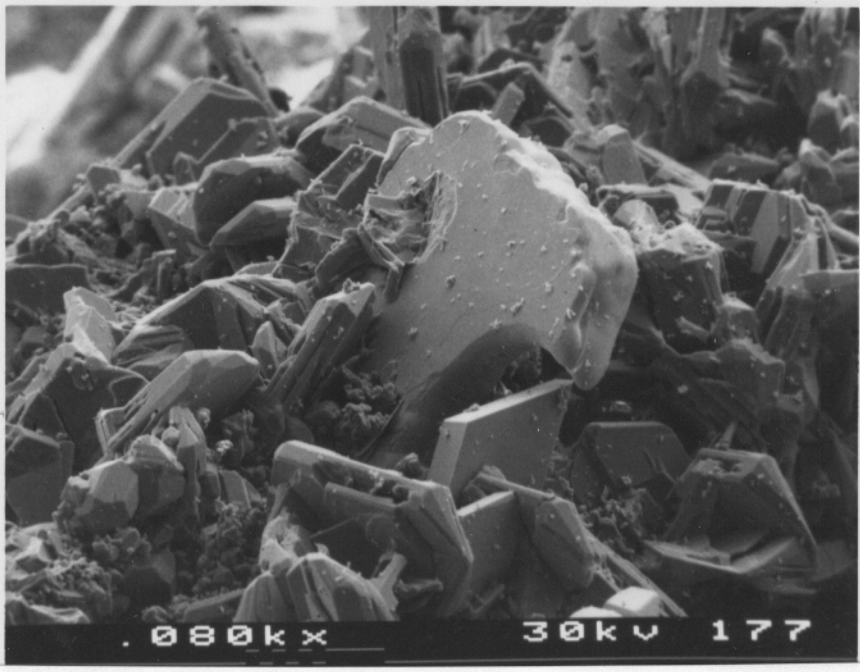
#254 – EPISTILBITE – PEDERNAL, COSTA RICA – 90X



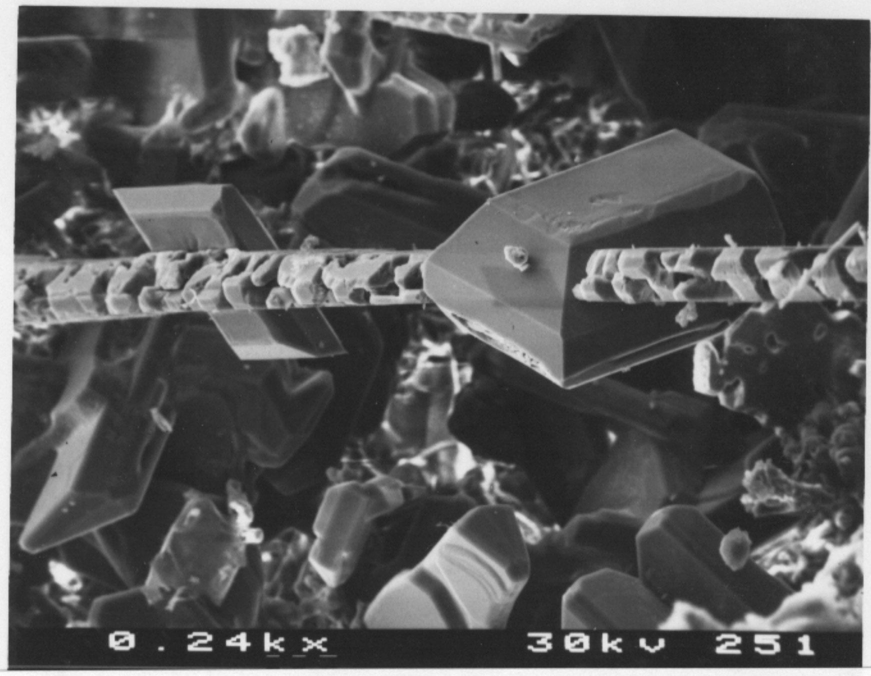
#142 – MORDENITE – STEW POINT, RANGITATA RIVER, SOUTH ISLAND, NEW ZEALAND – 290X



#146 – MULLITE, TRIDYMITE – HENDERSON'S QUARRY, MT. NGONGOTAHA, LAKE ROTORUA, NEW ZEALAND – 120X

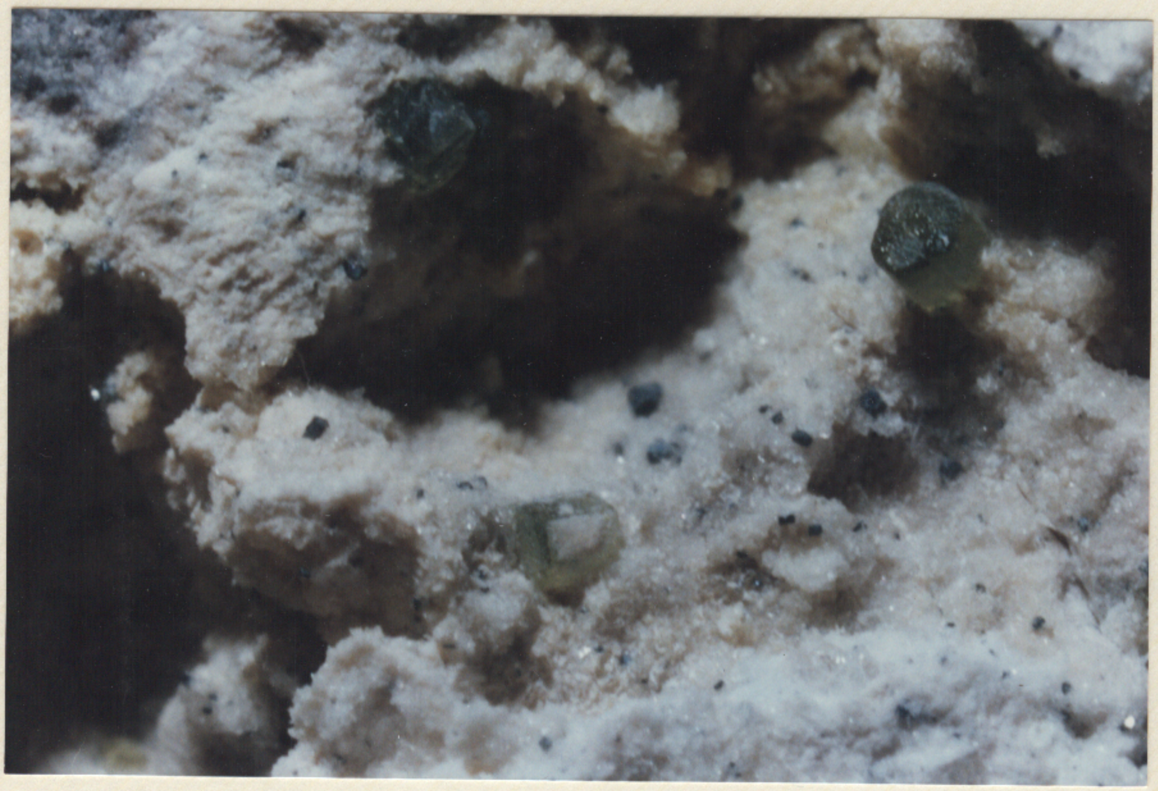


#177 – HEMATITE, TITANITE – HENDERSON'S QUARRY, MT. NGONGOTAHA, LAKE ROTORUA, NEW ZEALAND – 80X

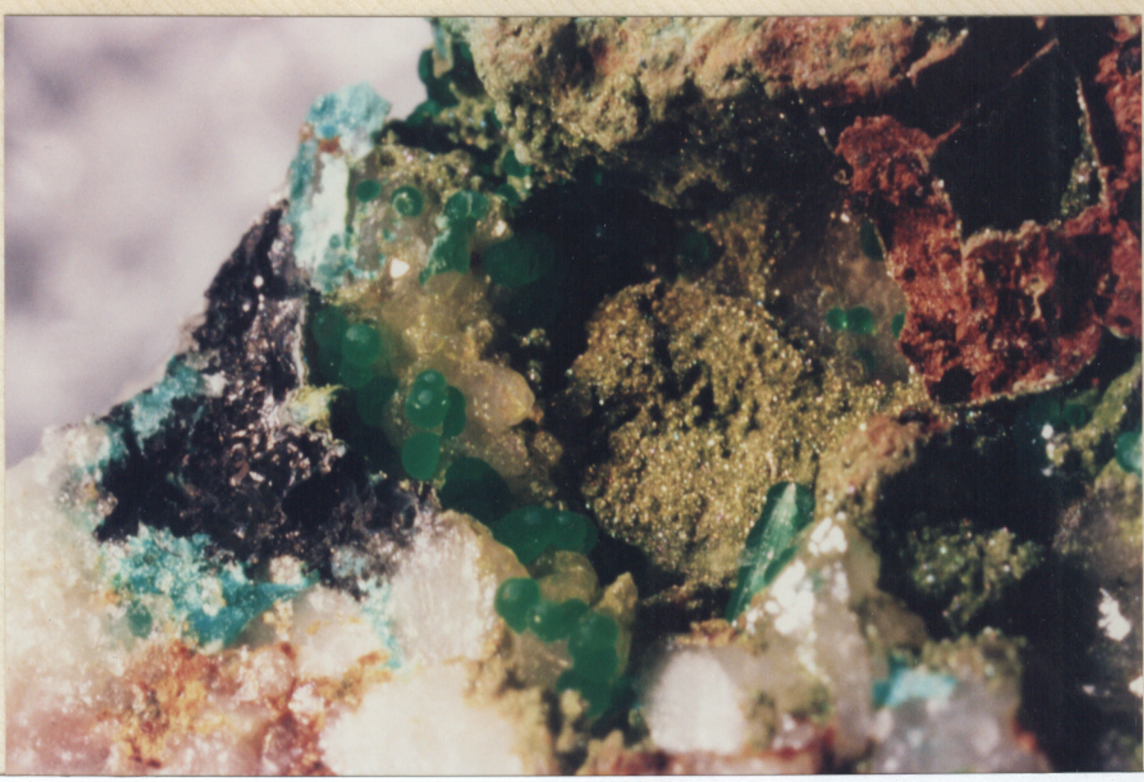


#251 – TITANITE, AUGITE – HENDERSON'S QUARRY, MT. NGONGOTAHA, LAKE ROTORUA, NEW ZEALAND – 240X

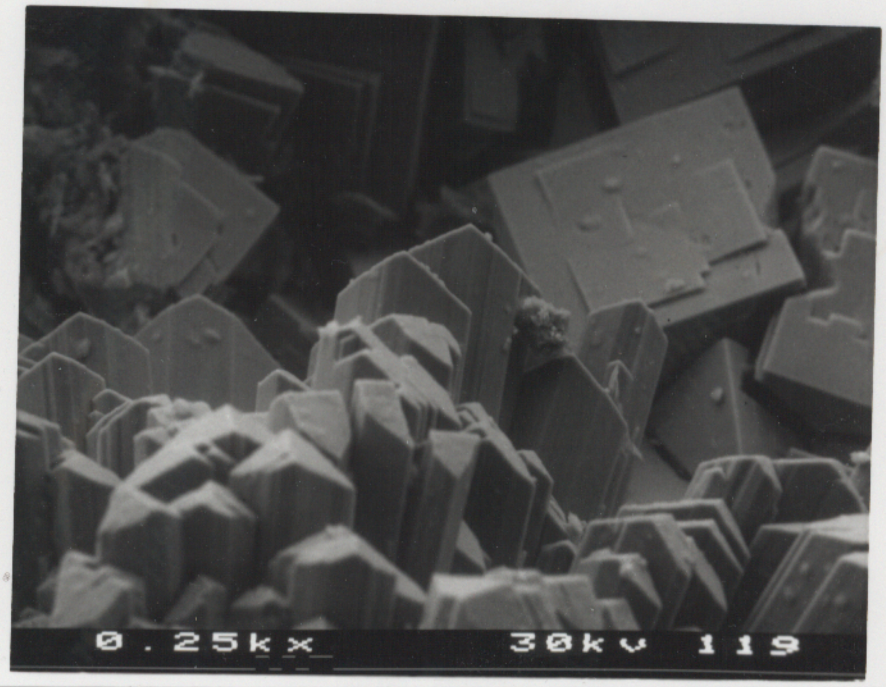
#249 – PSEUDOBROOKITE – HENDERSON'S QUARRY, MT. NGONGOTAHA, LAKE ROTORUA, NEW ZEALAND – 150X



#3 – OSUMILITE-(Mg), HEMATITE – HENDERSON'S QUARRY, MT. NGONGOTAHA, LAKE ROTORUA, NEW ZEALAND – 16X



#4 – CREDNERITE, CONICHALCITE, Cu-Bi ARSENATE – GOLD HILL MINE, TOOLE COUNTY, UTAH – 17X



#119 – ARTHURITE, PHARMACOSIDERITE – MAJUBA HILL MINE, IMLAY, PERSHING COUNTY, NEVADA – 250X