

# **THE GEOLOGY OF THE FRANCISCAN COMPLEX IN THE WARD CREEK-CAZADERO AREA, SONOMA COUNTY, CALIFORNIA**

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## **Introduction**

Coleman and Lee in 1963 published their classic study of the glaucophane-bearing metamorphic rocks exposed in a narrow strip about 300 m long by 10 m wide in the bottom of Ward Creek, about 2 km west of the village of Cazadero, in Sonoma County, California. Since that time, at least 25 studies have been made of this exceptional sequence (Erickson, 1992). The units exposed in this small outcrop may be the most intensely studied body of metamorphic rocks in the world.

In contrast to the rocks of the classic sequence, the geology of the surrounding area has been poorly known. A small-scale map based on a reconnaissance study by Edgar Bailey of the U.S.G.S. was included in Coleman and Lee (1963), and Bailey's work was incorporated into a later U.S.G.S. reconnaissance study of western Sonoma County (Blake et al, 1971). To improve knowledge of the area, the author made, in 1975, a detailed map of approximately 14 square miles around the Ward Creek location at 1:12000 scale, published here as a companion document. No cross-sections are provided because they would be very speculative. A brief summary of this work, without a detailed map or block descriptions, was earlier published (Erickson, 1978a, 1978b).

The primary purpose of this report is to present a data base for the area, consisting of the 1:12000 map and accompanying petrographic information. Most of the petrographic information is contained in the descriptions of 557 exotic blocks in Appendix A, but reconnaissance petrographic information is also presented in the text on the melange matrices and other bedrock units. A secondary purpose of the paper is to present brief descriptions of the major map units, and to provide hypotheses for their origin where appropriate.

The map shows all observed outcrops of bedrock units as well as all of the 741 exotic blocks greater than approximately 3m in maximum dimension. ( Note that there are innumerable smaller blocks and weathering fragments of blocks in block-rich areas). The only units not mapped were about 50 out of place exotic blocks which have slid downslope and lie in the bed of Ward Creek in the last three kilometers of its course.

The major map units have been given informal names where the unit was large enough and distinctive enough to warrant it.

The original base maps for the project were the USGS 7.5' Cazadero and Fort Ross quadrangles. Both of these were done by field topographic parties in the early days of World War II, and they contain many errors and distortions. The final base for this map is the superior new edition of the same pair of quadrangles done from air photos in 1978. Transferring data from one set to another is often difficult and was done by referring points to the grid system described below, with some adjustment for topography.

Mapping was largely done by pace and compass traverses, tied into known points by Brunton triangulation where possible. Exposures are fairly abundant in the Cazadero area on natural slopes, stream bottoms, and road cuts, especially along the many logging roads. Future workers are warned that the magnetic declination in the Cazadero area locally varies by several degrees, perhaps due to buried serpentinites.

In the following text, locations on the map are referred to its grid reference system with decimal subdivisions. X units are B through Q and Y units are 2 through 14. A typical reference might read D.4 - 7.8; this means 0.4 between D and E, and 0.8 between 7 and 8. Note that in Appendix A the grid system is used more informally to locate individual exotic blocks on the map.

### **Brief Outline of the Geology**

The geology of the Cazadero-Ward Creek area is quite complex. A number of separate units are present, joined along probable fault contacts. In a few places these faults are visible. Each of the major units will be described in turn.

#### **I. Hell Hole conglomerate.**

This unit is named after its excellent exposures in the portion of the Ward Creek drainage called the Hell Hole. It is the sort of unit usually referred to as "Great Valley type". It underlies several square kilometers of the central western map area, in one main body and several smaller ones. The smaller exposures, easily missed on the uncolored map, are at grid coordinates E.5 - 9.7, J.0 - 8.5, K.3 - 7.7, and M.0 - 8.5. The dominant rock is pebble to cobble conglomerate characterized by well-rounded round to elliptical pebbles and cobbles to ~10 cm, with rare larger clasts, of very many rock types. The fabric is usually clast-supported and elliptical clasts show a marked planar parallelism but no imbrication. Strike and dip symbols in the conglomerate outcrop area on the map marks this plane defined by elliptical clast parallelism. No petrographic information was gathered on clast types; many silicic volcanic types were observed.

The clasts lie in a matrix of coarse-grained sandstone. Rare sandstone lenses are present; these are up to a few m long by 10-30 cm wide, lack internal bedding, and are often deformed.

The conglomerate is massive. It has no bedding and neither normal nor reverse grading. Top indicators are very rare. No turbidite textures are present. No traction structures such as ripple marks are found. The conglomerate is probably a resedimented mass, but it is not exactly like any other such conglomerate described in the literature (Walker, 1975) so far as I am aware. It is closest to sandstones in the Matilja sandstone described by Stauffer (1967). The unit was probably emplaced as a sediment flow (Middleton and Hampton, 1973). This suggests deposition on a fairly steep slope, probably on the forearc of the Mesozoic trench. The conglomerate mass extends to the west beyond the map area for about 2 km (Blake et al, 1971).

The conglomerate in the main body is quite deformed, in what appear to be large-scale complex folds, perhaps suggesting more than one period of deformation.

Along Ward Creek from coordinates D.0 - 7.4 to C.2 - 5.8, the conglomerate grades downsection into sandstone, siltstone, and rare shale displaying good sorting and thin beds. These locally display shallow-angle cross-bedding but no traction or turbidity current structures, and are tentatively interpreted as resedimented sandstone and siltstone reworked by contour currents (Bouma and Hollister, 1973) before deposition of the overlying conglomerate by sediment flow. A conglomerate-sandstone transition also shows up where the Fort Ross road crosses the main conglomerate exposure from F.0 - 8.2 to G.5- 7.4. Here some of the sandstone bodies in the transition zone are internally unbedded and quite irregular in shape, suggesting slump after deposition.

The rocks are unmetamorphosed. Bailey (1976, pers. comm.) reported Valanginian fossils in the unit (location unknown). The unit contains no exotic blocks, although 43 are found in its various outcrop areas, no doubt due to landsliding from topographically higher exposures of melange units.

## **II. Kings Ridge Road melange.**

This unit underlies slightly more than half the map area, in three separate exposures. It is named after the road running north from Cazadero, which crosses the largest exposure area. It is interpreted as a sandstone-matrix olistostrome melange, containing 249 mapped exotic blocks within the map area.

Over 95% of matrix outcrops are of massive unbedded medium-grained very well-sorted sandstone. These exposures contain no turbidity flow textures, no cross-bedding, and no fossils. It is a remarkably homogenous unit. The very well-sorted nature of the sand, together with the absence of shale or pebbles, suggests initial deposition in a beach or bar system. The general absence of bedding structures suggests subsequent resedimentation on the forearc as a sediment flow (Middleton and Hampton, 1973). Common marked subparallel orientation of shale chips and phyllosilicate grains in the megascopically unbedded sandstone suggests the strength of the flows was too low for debris flows, and the absence of fluid escape pipes, dish structures, flame structures, and coarse-tail grading suggests the sand was not fluidized during its last emplacement. Grain flow seems the most likely mechanism of emplacement.

The gross features of the depositional system are unclear since only a small part of the unit has been mapped, and no depositional model is proposed.

Local outcrops do show megascopic bedding, usually marked by shale interlayers. These areas are rarely extensive. The exposures are located on the map . by their strike and dip symbol, marked with a lower-case **m**, symbolizing megascopic bedding.

Megascopically massive sandstone generally contains abundant to sparse phyllosilicate grains, generally biotite, and rarely contains dark shale chips. These planar clasts are usually subparallel and define a plane within the rock, presumably parallel to original horizontality. This plane is parallel to megascopic bedding where the two coexist.

In the field, this plane was measured by carefully removing a hand-specimen of the sandstone from the outcrop, estimating the position of this plane by eye, and drawing a line around the specimen, locating this plane with a pen. The specimen was then carefully placed back on the outcrop in its original position and the strike and dip of the plane measured. Strike and dip determined in this way is probably not better than + or -

20°. Strikes and dips of the plane in these exposures are shown by strike and dip symbols without lower-case m's, on the map. They account for the majority of measurements.

The sandstone has been very complexly deformed. This is shown by an overview of just the megascopically bedded outcrops; addition of data from the outcrops showing only phyllosilicate layering confirms this impression. The almost random character of bedding attitudes suggests that much of the variation is due to soft-sediment deformation due to slump. Local outcrops, however, do show apparent tectonic folds, and megascopic folding has also affected the unit. In some shale-sandstone sequences disruption of competent beds by extension has occurred. No detailed structural analysis of the layering attitude data has been made.

A reconnaissance petrographic study suggests that the sandstone is dominantly feldspathic litharenite in Folk's (1968) classification. Local veinlets and patches of probable laumontite suggest that the unit has undergone burial metamorphism. In one outcrop at K.8 - 9.2, the sandstone contains asphalt veins.

### **Exotic blocks of the Kings Ridge Road melange**

The map outcrop area for the Kings Ridge Road melange contains 249 exotic blocks greater than ~3m in size. Most of these are fully described in Appendix A; almost all the others are labelled with a petrographic acronym on the map. One of the blocks, a ~100 m chert clast, has a visible unfaulted contact with its sandstone matrix along the Cazadero road at coordinates N.8 - 11.0 on the map. This is the only contact between a block and its matrix observed in the map area.

The blocks exhibit great petrographic variety. Most are greenstones, greenschists, or simple glaucophane-bearing schists, phyllites, hornfelses, or felses, but many are of uncommon petrographies, such as the several blocks of non-plagiogranite arc-type felsic plutonic rocks (Erickson, 1992), or are unique, such as block #1254. This is a 10 m block of garnet + epidote + hornblende fels with small patches of glaucophane in the hornblende. Perhaps 80 blocks are radiolarian chert of several colors. The exotic blocks range from 3m to a kilometer in size; most are 5-20 m in maximum dimension. Note that sizes given here or in Appendix A are visual estimates. The abundant chert blocks and the felsic plutonic blocks are only found in this melange unit. There are no conglomerate, sandstone, or shale blocks in this melange, and no blocks of pink Laytonville-type limestone.

The blocks which can be observed in three dimensions are generally equant and often rounded. They seldom show much weathering, and rounding seems to have occurred by abrasion in some earlier environment. The blocks are not uniformly distributed by any means, and are often widely separated. Large areas of the melange are nearly devoid of blocks, while others contain dozens of blocks in a small area, as in area M - 11 on the map on the east side of St. Elmo creek.

The great petrographic variety and presence of so many unique types and the wide spacing of blocks in many areas, coupled with the contact evidence mentioned above, and the generally unshaped matrix, makes it very unlikely that the blocks are phacoids produced by shearing or extension of competent units. Rather, it is clear that the blocks are weathering out of the sandstone and that the sandstone and blocks together constitute an olistostrome melange with a sandstone matrix.

The blocks of all sizes are interpreted here as giant clasts, which presumably came down the paleoslope into the depositional setting by individually sliding or rolling or by riding sediment flows.

### **III. Cazadero phyllite melange**

This unit underlies the central part of the map area, and extends beyond it to the east and south an unknown distance. The unit is named for the village of Cazadero, which is built on it. Surface exposures are dominantly of a very diverse population of exotic blocks, but exposures in stream bottoms and road cuts are almost wholly of sericite phyllite or rarer muscovite schist or chlorite phyllite. Typical sericite phyllite is composed of alternating quartz-rich and sericite-rich laminae 1-2 mm wide; in outcrop small quartz veinlets parallel to foliation are ubiquitous. Local glaucophane and lawsonite are present in the unit. The protolith was probably a shale. Map data show that the phyllite is strongly deformed in complex patterns, which have not been analyzed.

The unit's outcrop area contains 341 exotic blocks up to 60 m in long dimension. No contacts of these with the surrounding phyllite have been observed, but the great number of blocks on the phyllite outcrop compared with the number on the surrounding units and the markedly different proportions of block types compared to the population sitting on the Kings Ridge Road melange strongly suggest that the phyllite is the source of the blocks, which in turn suggests that they are clasts in the phyllite terrain and that the phyllite - clast assemblage is a metamorphosed olistostrome melange.

A simple model for formation of the protolith melange is that shale depositing in the Mesozoic trench periodically received clasts of various lithologies rolling or sliding individually down the paleoslope. The mechanism is the same as that proposed for the Kings Ridge Road melange, except that the matrix for the blocks is mud rather than sand.

The metamorphic mineralogy suggests initial formation of a relatively mature sericite + chlorite + quartz mineralogy followed by the very unequilibrated development of local glaucophane and/or lawsonite during a brief episode of subduction into a high-pressure environment, followed by rapid uplift to low pressures and temperatures.

### **Exotic blocks of the Cazadero phyllite melange**

Exotic blocks are abundant on/in the phyllite. 341 are present, and their lithologies are described in Appendix A below. Blocks are typically equant, rounded, and separated from one another by tens to hundreds of meters. They are in general little weathered. Many glaucophane-bearing ones have local patchy actinolite-rich rinds or rims a few cm thick. These may have developed during the initial low-grade metamorphism of their host shale.

The block population is different from that in the Kings Ridge Road melange. Only three chert blocks were found, and no blocks of felsic plutonic rocks. The melange also contains unique clasts, such as # 131, a 5 m block of metamorphosed silicic lava with albite and clinopyroxene phenocrysts in a very fine-grained quartzofeldspathic ground mass, now containing glaucophane, lawsonite, and green stilpnomelane in patches in the ground mass. Another unique block, # 270, is a 1 m clast of chlorite + quartz +

carbonate fels with zoned idiomorphic carbonate crystals. Blocks of breccias are not uncommon, such as # 380, which contains varied clasts of (a) glaucophane hornfels, (b) lawsonite metabasalt, and (c) clinozoisite metabasalt, all in a quartz matrix. Relict igneous textures survive in these metabasalt clasts.

As with the Kings Ridge Road melange, this unit has no conglomerate, sandstone, or shale blocks, and no blocks of pink Laytonville-type limestone.

#### **IV. The Ward Creek and Blue Jay Ridge blocks**

The classical work of Coleman and Lee (1963) described in detail the glaucophane-bearing metamorphic rocks in the small exposure in Ward Creek. These are mostly glaucophane, lawsonite, and jadeitic clinopyroxene bearing metamaifites, with an associated stilpnomelane metachert unit. Veins of aragonite cut the sequence, and in fact metamorphic aragonite was first discovered here by Coleman and Lee (1962). At least 25 published mineralogical studies have been carried out on these rocks (Erickson, 1992) and they may be, again, the best studied metamorphic rocks in the world. Anyone wishing to examine the rocks should be sure to get permission from the property owners and should not plan on collecting specimens; the classic exposures partly line their swimming hole and they have seen too much damage to the rocks over the years.

I interpret the Ward Creek sequence as composing a small fault block along the major fault separating the Big Oat Creek metapillow basalt to the north from the Cazadero phyllite melange to the south. A similar block, not studied in any detail yet by anyone, lies in and east of Blue Jay Ridge at E.5 - 6.0 on the map, about 2 km west of the Ward Creek locality; it also contains stilpnomelane metachert and coarse-grained glaucophane schist.

#### **V. Big Oat Creek metabasalt.**

This distinctive unit has a protolith of pillow basalt with minor interlayered sediments. It is named after the excellent exposures in Big Oat Creek. Texturally, the pillow structure has undergone marked flattening and the pillow ellipsoids define a flattening plane shown on the map. Foliation is not common. Relict vesicles/amygdules are commonly preserved. The original pillow outlines have been deformed enough so that no tops could be determined.

The metamorphic mineralogy is complex. Maruyama and Liou (1988) studied this unit and defined two major isograds within it. Many of the major minerals are green and the pillows are generally green, of course. The margins of the pillows, however, typically have a zone of purple glaucophane one to two cm thick which effectively outlines the pillow forms in the rock. From a distance the pattern of purple ovoids in stream exposures is quite striking.

In exposures in Blue Jay Creek at E - 5 on the map, masses of aragonite between the relict pillows may represent metamorphosed calcareous ooze in the protolith.

Unlike the other units so far described, this metabasalt has a simple structure. The flattening plane of the relict pillows is roughly parallel to the long axis of the metabasalt exposure and no folds are visible. The unit extends to the west some km beyond the map area (Blake, et al, 1971)

## **VI. Massive greenstone**

A large body of unfoliated greenstone, exposed from F - 9 to J - 10 on the map and a smaller body at M.5 - 7.2, lie entirely surrounded by the Cazadero phyllite melange. They have simple epidote-chlorite mineralogies and contain no visible glaucophane. They lack penetrative foliation, and are texturally best described as hornfelses. They are interpreted as masses faulted into the Cazadero phyllite and not as blocks in the phyllite.

Another large greenstone mass, clearly fault-bounded, outcrops from C - 8 to I - 13 on figure 1. This is also an epidote-chlorite hornfels in texture, and additionally contains very sparse local veins and patches of glaucophane; it is a classic Type II unit of Coleman and Lee (1963).

## **VII. Chlorite-epidote phyllite**

The unit outcropping from C.5 - 11.5 to F - 13 on the map is a well-foliated chlorite-epidote phyllite. It locally contains veins and patches of glaucophane. It joins the epidote-chlorite hornfels described in the last paragraph along an obscure contact and is most likely just a unit in a metamafite assemblage composed of both. This phyllite protolith was probably mafic tuff, perhaps hyaloclastite, intercalated with the lavas from which the hornfelses came.

## **IX. Serpentinite**

There are a number of small serpentinite bodies in the map area. All but two of them lie well within the Cazadero phyllite, centering on map coordinates H.5 - 8.5 and L - 8.5. Two very small exposures lie in the Kings Ridge Road melange at L.0 - 9.0. It is obvious that in this area, exotic blocks have **not** been brought to the surface in serpentinite diapirs.

## **X. Felsic pluton of Little Black Mountain**

Centered on coordinates H - 12 on the map is a polylobate body of meta-trachyte to meta-rhyolite porphyry, the eastern half of which underlies Little Black Mountain (Stuart, 1992). In hand specimen, the rock is composed of 0 - 20% 1-5 mm blocky pink to gray feldspar and rare blue amphibole phenocrysts in a medium green aphanitic ground mass. In thin section, most of the ground mass is indeterminate. Probe analysis shows these feldspars to be nearly pure red albite. Probe data also shows that the blue amphibole

is the alkali amphibole **arfvedsonite**, a primary igneous phenocryst phase, and not metamorphic glaucophane. Chemical data in Stuart (1992) show the rock to be a trachyte or a rhyolite. The rock is an arfvedsonite albite phyric trachyte porphyry. The trachyte has a whole-rock K-Ar date of 100 Ma (Stuart, 1992), and is part of the Franciscan assemblage; it is a type I unit in the sense of Coleman and Lee (1963). It is the first felsic pluton to be described from the Franciscan complex.

Two 5 m blocks of this unit lie in Blue Jay Creek at D.9 - 3.6, some 3 miles NNW of Little Black Mountain on the map. No in-place source for them was located, but a second intrusion of this trachyte porphyry is probably present in the area; it is probably quite small.

### **Acknowledgements**

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### **Note Added in 2007 as document was placed in the digital archive at SSU**

This article, first written in 1975 at the time the accompanying map was made, was never published. I have added material intermittently since, so some references are as young as 1992. The Fort Ross Road was dug deeper into its cutbank by Caltrans (?) in that interval, exposing more of the matrix of the Cazadero melange and removing at least one plutonic exotic block in the process.

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## **APPENDIX A: PETROGRAPHIC DESCRIPTIONS OF EXOTIC BLOCKS**

This Appendix contains available information on the numbered exotic blocks located on the map. The amount of information is variable, but often includes an estimate of size and usually includes a petrographic description, variably taken from field notes, hand specimens, or thin sections. 130 thin sections were prepared, dominately of the texturally and/or mineralogically unusual looking specimens. In the original field study, hand samples of all the numbered exotic blocks were collected for petrographic study, but samples of many blocks were discarded by the department technician; the data here presented are what was left after that unpleasant incident.

In addition to the numbered blocks, 161 were not given numbers, generally because their petrography was obvious. These are dominately 40 chert blocks and 45 greenstone blocks in the Kings Ridge Road melange; they also include 31 whose labels have been lost in the Cazadero melange.

Every numbered exotic block in the Appendix has the same number on the map, and has a location given keyed to the coordinate grid on the map. The coordinate system for block location is more general than that for other map feature locations in the preceding text; here a coordinate, such as SW B-4, means that the block will be one-half grid interval or less to the SW of the intersection of coordinate grid lines B and 4.

All exotic block locations have been crosschecked between the map and this Appendix. Every block is plotted and labelled on the map where the coordinate system of the Appendix says it should be, and every numbered block on the map is described in this Appendix at those coordinates.

The map doesn't show about 50 loose exotic blocks lying in the bed of Ward Creek for the first three miles west of its confluence with Austin Creek. These were initially not mapped because they weren't in place; I now feel a petrographic survey should have been made and regret the oversight.

Note that the petrographic descriptions of the blocks on the map are a shorthand acronym only, and the descriptions in the Appendix take precedence.

Mineral abbreviations are as follows: glau=glaucophane; gar=garnet; carb=carbonate; alb=albite; qtz=quartz; stilp=stilpnomelane; trem=tremolite; chlor=chlorite; sph=sphene; rut=rutile; op=opaque; jcp= jadeitic clinopyroxene (pleochroic in green); cpx=nonjadeitic clinopyroxene; czt=clinozoisite; ep=epidote; actin=actinolite; hb=hornblende; law=lawsonite; x=unknown phase. Hornblende and actinolite are differentiated by extinction angle. Epidote and clinozoisite are differentiated by birefringence.

Minerals are given for a rock in order of increasing abundance. Given the volume of petrographic information, descriptions of any one rock are abbreviated and limited to the mineralogy and a general textural label, plus a short description of any unusual features. **Sec.** is used to indicate thin section descriptions. Descriptions of unique one-of-a-kind rocks are so labelled.

Rock name abbreviations are: gstm=greenstone; hnfls=hornfels; phyll=phyllite. If the description says petrography n.a. , it means the sample was one of those discarded and no petrographic data exist in the field notes.

Texture abbreviations are: amyg=amygdaloidal; aph=aphanitic; leuco=leucocratic; pleo=pleochroic; retro=retrograde; frags=fragments. The dominant texture of the rock is described by the terms slate, phyllite, schist, or gneiss for foliated rocks, and hornfels or fels for unfoliated rocks. Rocks are assumed to have a uniform, homogenous character of their type unless otherwise specified.

### Block List

#23, NNE H-7, size x, glau hornfels w. carb veins.

#24, NNE H-7, size x, Type IV glau gneiss. **Sec.** of alb cut by brecciated zones with ragged crystals of glau.; probably a vein.

#25, NE F-8, size x, blasted complex block; **Sec.** shows idioblastic sph + musc glau schist w. jcpx band w. minor glau and musc; coarse law and qtz veins/patches.

#29, W F- 8, size x but big, glau schist.

#31, WNW F-8, 40 m, glau schist, locally brecciated, other mins.

#34, WSW F-8, big, glau schist w. actin rim, veins of x.

#35, WSW F-8, 20 m, glau hornfels w. carb veins; **Sec.** shows ep + glau hornfels w. a few idioblastic gar to 1 mm + a few small xenoblastic sph.

#36, SW F-8, 20 m, glau rock, texture x, green vein

#37, SW F-8, 7 m, glau fels; **Sec.** sph + law + glau fels w. acicular to ragged to subidioblastic glau varying greatly in average size, to ~ 1mm.

#41, SSE E-8, 10 m, glau schist.

#42, ENE E-8, 25 x 10 m, greenschist w. veins; **Sec.** of sph + musc + actin + alb schist w. vein of alb containing sparse coarse sph and large idioblastic crystals of apatite (?). sph occasionally has rut cores.

#45, WNW F-8, muscovite schist

#46, NW F-8, 4m block, green fels. Petrography x.

#47, SE E-7, 10 m, glau schist/phyllite.

#48, SE E-7, 5 m, serpentinite hornfels with talc porphyroblasts to 3 mm. **Sec.** shows carb + talc + serpentine hornfels with ~5% phase x; subidioblastic brown high-relief xtls to 3 mm, possible early carbonate. **Unique.**

#58, W F-6, 10 m, glau + actin phyllite

#59, SSE E-6, 10x10 m, mica (musc ?) schist, poss. chlor or glau.

#60, SSE E-6, size x, chl phyllite; shows crenulation

#67, S G-7, big, chl slate w. very rare law (?).

#68, S G-7, greenstone

#70, NE G-7, 5m, greenstone w. glau veins

#73, NE G-7, 5m, gar glau schist.

#74, NNW H-7, 10 m, chl + musc + glau schist.

#75, NNW H-7, 5 m, glau + musc schist. **Sec** hem(?) + sph + glau + ep + chl + musc + alb schist.

#76, NNW H-7, 3 m, green granofels/schist, mineralogy x.

#77, N H-7, 6 m, musc schist w. green veins.

#80, ENE H-7, 3 x 7 m, glau fels.

#81, ENE H-7, 20 m, glau phyllite.

#82, E H-7, "big", biotite(?) schist with white blasts of mineral x.

#83, SE H-7, 3 small blocks, 3 m, chl phyllite.

#84, SE H-7, 15 m, cpx + glau + musc schist

#85, SE H-7, "very large", glau + musc schist.

#86, SW I-7, 20 m, serpentinite(?)

#88, NNW I-8, 30 m, musc + chl schist.

#89, NW I-8, 5 m, glau + cpx + musc, texture x.

#90, NNE I-8, petrog. n.a.

#91, NNE I-8, "big", **Sec** sph + stilp + actin + albite fels  
w. choritized garnets + 2nd generation gar; v. small % glau in actin. **Unique.**

#92, NNE I-8, same large block as #91, **Sec** ep + actin + chlor + albite schist.

#94, NE I-8, 30 m equant, chl + musc schist.

#96, SW J-7, 20 m, musc + glau schist.

#97, SW J-7, 15 m, chl phyllite.

#99, NNW J-8, 8x4 m, chl schist.

#100, NNW J-8, size x, chl + qtz schist; contorted foliation.

#101, N J-8, 20 m equant, qtz + chl schist; **Sec** ap(?) + stilp + rut + chl + musc + actin + albite schist.

#103, N J-8, size x, glau schist; **Sec** sph + chl + musc + glau schist.

#105, NE J-8, 3 m, gar + musc + glau fels.

#110, WSW I-7, 15x10 m, chl schist.

#113, SSW H-8, size x, glau phyllite.

#114, SSW H-8, size x, jcpX + carb fels; **Sec.** sph + chl + jcpX + albite fels; law tablets in coarser plag.

#116, SW H-8, size x, biotite (?) + unk gneiss.

#117, S H-8, size x, biotite (?) + chl schist

#118, E H-8, size x, musc + chl schist.

#120, NE H-10, "small", glau + chlor hornfels.

#124, SE H-10, 2 x 2 m, glau fels; **Sec.** albite + law + glau fels.

#126, SE H-10, "big", glau phyllite; **Sec.** hem + alb + musc + glau phyllite w. chloritized gar w. musc + apatite (?) rims.

#127, S I-10, size x, gar + musc + glau, texture x.

#131, NNE E-9, 5 m, **Sec.** meta-felsic flow; albite + cpx pheno in fg quartzofeldspathic gmass, w. green radiating stilp (?) + chlor + glau + law. **Unique.**

#133, E-9, 3 m, hornfels, petrog. n.a.

#134, N E-9, 15 m, black phyllite w. green pods; **Sec.** of pod shows monomineralic fels of stubby radiating to equant min. with anomalous purple IFC, hi ext. ang., no pleo, biax. w.  $2V=90^{\circ}$ ; low biref.; poss. clear pumepelleyite or cpx. **Unique.**

#137, ENE E-10, 8 m, gar + glau schist; **Sec.** musc + chl + actin + glau schist; most actin partly converted to glau. One zone of relict jcpX + chloritized gar; retro eclogite.

#138, NW F-10, 20 m, gar + glau schist.

#139, ENE E-10, 10 m, glau phyllite.

#146, WSW G-11, "big", red chert.

#154, NNE D-11, 7 m, chert block.

#155, NNW I-13, 15x7 m, glau phyllite.

#202, WSW F13, "big" gstn block; may be basement gstn in unusual expo.

#203, W I-13, 10 m, glau phyllite.

#221, SE H-11, size x, glau schist.

#239, NE G-10, 40x30 m, glau phyllite.

#240, NE G-10, 10 m, glau phyllite.

#244, E I-11, 50 m equant, musc + glau schist. Larger of "Two Rocks" on topo map.

#247, SE I-11, 40x20 m slab, glau fels. Smaller western of "Two Rocks".

#252, SW I-11, 5 m, jcp<sub>x</sub> + musc + glau schist; **Sec.** sph + musc + ep + actin + glau schist; glau partially replacing actin.

#253, SW I-11, 5 m, petrog. n.a.

#254, I-11, 5 m, glau phyllite.

#256, NW I-11, glau fels.

#262, S I-10, petrog. n.a.

#266, SE H-10, size x, glau fels.

#267, SE H-10, 8 m, chl schist.

#268, SE H-10, 5 m, musc + glau schist.

#269, SSE H-10, size x, glau phyllite.

#270, S H-10, 1 m, qtz + carb fels; **Sec.** chlor + carb + qtz fels. Carb xtls oft idioblastic, w. growth zones. **Unique.** Block too small for normal sampling but sampled due to unusual petrography.

#274, NNE G-9, 15 m, glau hornfels.

#275, WSW G-8, size x, glau phyllite.

#313, E F-10, petrog. n.a.

#314, ESE F-10, size x, vesicular gstrn.

#315, E F-10, 5 m, hornfels; many qtz. veins.

#324, NW F-10, 7 m, petrog. n.a.

#325, NW F-10, 7 m, greenschist.

#326, NW F-10, 5 m, petrog. n.a.

#327, NW F-10, 10 m, **Sec.** sph + musc + actin + glau + ep phyllite; glau forming from actin, ep stable.

#328, WNW F-10, size x, gstrn.

#329, NE F-10, petrog. n.a.

#330, NNE F-10, 5 m, **Sec.** glau + jcpX + clear amph (tremolite ?) fels. JcpX & amph stable, glau alt amph. **Unique.**

#332, NW F-10, 5 m, jcpX + gar + glau fels.

#334, NNE F-10, 7x3 m, glau phyllite.

#335, NNE F-10, 5 m, glau phyllite.

#336, NNE F-10, 10 m, glau phyllite.

#337, N F-10, 5 m, greenstone

#338, N F-10, (4) 2x2 blocks, petrog. n.a.

#339, N F-10, 10 m, glau + musc schist.

#342, SE F-9, 4 m, chl phyllite.

#343, SE F-9, 5 m, jcpX fels.

#344, SSE F-9, size x, musc + glau schist.

#345, SSE F-9, 10x20 m, **Sec.** sph + law + glau schist.

#346, SSE F-9, size x, **Sec.** of sph + musc + jcpX + czT + chl + glau schist.

#347, SSW F-9, 5 m, glau phyllite.

#348, SSW F-9, 5x5x2 m, glau schist.

#349, S F-9, 5x5x3 m, chl fels.

#351, NE F-10, 5 m, glau phyllite w. qtz veins.

#352, NE F-10, 4 m equant, breccia; **Sec.** metabasalt frags with glau + alb + czr mineralogy in vfg brown matrix.

#353, NE F-10, 3x5 m, **Sec.** musc + sph + glau + alb + law schist.

#354, NE F-10, block field; law + glau schist.

#355, ENE F-10, 3 m equant, **Sec.** sph + glau + qtz gneiss; ~85% qtz.; poss. jcpv needles. **Unique.**

#356, NW G-10, 3x5 m, petrog. n.a.

#358, NW G-10, 5 m, **Sec.** hem + sph + musc + glau + gar + jcpv fels; hem attacking garnet rims. Retro eclogite.

#359, NW G-10, 3 m, gar + glau hornfels.

#360, NW G-10, 7 m, gar + glau fels.

#370, SW G-8, 3 m, chl schist; **Sec.** sph + chl + actin + glau + jcpv fels; jcpv retro to others. Many law + arag veins.

#371, SW G-8, 1x3 m, glau phyllite.

#374, SE F-8, 4 m, musc + glau schist.

#375, SE F-8, 2 m, law + glau fels; **Sec.** of sph + chl + musc + carb + glau fels.

#377, SE F-8, 10x30 m, glau schist.

#380, N F-9, 3 m, **Sec.** of breccia of clasts of (a) glau hornfels; (b) law bearing metabasalt; (c) czr bearing metabasalt, all in a qtz matrix. Law and czr appear to replace protolith plag; relict ig textures survive. **Unique.**

#383, SW F-9, 5 m, glau schist.

#384, SW F-9, size x, plutonic block.

#385, SW F-9, petrog. n.a.

#386, N F-9, 4 m, **Sec.** of chl + ep(?) + glau hornfels.

#388, SE F-9, 10 m, glau schist.

#390, S F-9, 4 m, glau phyllite

#393, WSW F-9, 10x15 m, petrog. n.a., notes say "odd".

#395, NW F-9, 15 m, glau phyllite.

#396, SW F-8, 5 m, gar + musc + glau schist.

#398, SSW H-7, 10m, serpentinite.

#399, S H-7, 10 m, glau fels; **Sec.** sph + musc + chl + ep + glau + relict jcpix hornfels.

#400, SSE H-7, 5 m, glau hornfels; **Sec.** metabasalt greenstone w. veins of glau, stilp, and qtz.

#401; SSE H-7, 5 m, mica (musc?) schist.

#402; SSE H-7, 10x10 m group of frags, glau schist + green patches; **Sec.** hem + op + sph + gar + actin + alb + ep + glau gneiss; has ep rich bands.

#403, SE H-7, 2x5 m, aphanitic hornfels, petrography n.a.

#404, SE H-7, 5x7x5 m, glau phyllite; **Sec.** sph + czt? + glau phyllite.

#405, NNE H-8, several 2-3 m blocks, petrography n.a.

#406, SE H-7, musc. schist.

#407, NE H-8, 10 m equant, petrog. n.a.

#408, NE H-8, size x, chl schist.

#409, ENE H-8, 30x10x10 m; glau schist; **Sec.** rut + stilp + musc + ep + actin + alb schist; actin has blue-green patches; prob. mistaken for glau on outcrop.

#410, WNW I-8, 8 m equant, glau schist.

#412, ENE H-8, 30x30 m area of blocks; **Sec.** sph + ep + actin + alb fels.

#413, ESE H-8, 5 m equant, green x; **Sec.** hem + chl + musc + jcp + glau schist; musc random orient.

#423, I-8, 5x3x4 m, talc schist; **Sec.** <1% talc + <1% op + serp; serpentinite block.

#424, I-8, 10x10x5 glau schist.

#426, ESE I-8, 2x7x3 m, serp + talc hornfels.

#427, WSW J-8, size x, **Sec.** of sph + musc + alb + ep + chl + act fels.

#429, SW J-8, 30x50x20 m, serpentinite; **Sec** <% talc + <1% op + serpentine.

#430, SW J-8, 8x8x5 m, **Sec.** law + jcp<sup>?</sup>/cpx metabasalt hornfels w. relict basalt texture; cut by veins of glau, arag, and qtz.

#432, SSE I-8, 40x40 block field; **Sec.** musc + chlor + sph + gar + glau + law + ep fels.

#435, SE I-9, several small blocks; glau hornfels.

#442, SSE J-8, 3 m equant, glau phyllite.

#443, SW K-8, 5x7x3 m, chl schist.

#444, SW K-8, 10x10x5 m, chl phyllite.

#445, WSW K-8, size x, **Sec.** sph + gar + glau + alb schist; highly crenulated; myriad of minute gar.

#446, WSW K-8, 7x7x2 m, chl phyllite.

#447, SW K-8, 30x50 m, petrog. n.a.

#448, WSW K-8, 20x20 block field, glau + musc schist.

#449, W K-8, 8x8x5 m, glau phyllite.

#450, W K-8, 5x5x2 m, blastic green hornfels; petrog. n.a.

#451, W K-8, 5x8x3 m, chl phyllite.

#452, ESE J-8, 3x3x1 m, "odd type", petrog. n.a.

#453, SW J-8, 15x10x5 m, musc + gar schist.

#454, WSW J-8, 5 m equant, grnstn.

#455, NW J-8, 10x10x5 m, chl phyllite.

#457, W J-8, 25x25x20 m, **Sec.** musc + trem schist.

#458, N J-8, size x, glau phyllite.

#459, J-8, 20x20x5 block field; serpentinite.

#460, S J-8, 25x25x15 m expo, not sure if block; chl phyllite.

#462, NNW H-9, 5 m equant, glau schist.

#464, H-9, 5 m equant, glau + jcp<sub>x</sub> + musc + x schist.

#465, S H-9, 30x30x15 m tower of blocks; **Sec.** sph + rut + musc + chlorite rep. garnet (50%) + chl + law + jcp<sub>x</sub>? + actin w. glau margins fels. Retrograded eclogite?

#474, NNE I-9, 20x50x40 m, **Sec.** law blasts in ep + sph + chlor + glau hornfels w. relict glau fol.

#479, SW J-8, petrog. n.a.

#480, NW J-9, petrog. n.a.

#481, I-9, 2x2x0.5 m, "odd" petrography n.a.

#482, SE I-9, 10x10x2 m, green aphanite x, petrog. n.a.

#483, SSE I-9, small block field, "odd fragmental rock", petrog. n.a.

#485, SSW I-9, "small", glau schist.

#486, SSW I-9, "big", chl phyllite.

#487, SW I-9, 4 m, chl phyllite.

#489, NE H-9, 10x15x10 m block pile; glau schist.

#490, SSE K-8, 10x30x20 m, glau schist w. calcite veins.

#491, SSE K-8, 5 m equant, glau + musc schist.

#493, SE K-8, 30x30 m tower, serpentinite?

#496, SW L-8, 3 m equant, glau phyllite.

#498, SSW L-8, 5 m equant, petrog. n.a.

#499, SSW L-8, 5 m equant, chlor phyllite.

#506, SE L-8, 10x10x5 m, musc + gar + glau schist.

#507, S L-8, 4 m equant, glau phyllite.

#508, E L-8, 5 m equant, glau + qtz gneiss.

#510, NE L-8, 20x20x5 m block pile, musc + glau schist.

#511, S L-8, 5 m equant, chlor fels.

#512, S L-8, 10x5x5 m, **Sec.** musc + trem fels.

#514, ESE K-8, 15x15x5 m, chlor phyllite.

#516, ENE K-8, 3 m, serpentinite.

#517, N K-8, 5x4x2 m, petrography n.a.

#518, NW K-8, 10x10x5 m, musc schist w. green x.

#521, NE K-8, 10x10 m, fels, petrog. n.a.

#522, NE K-8, 10x10x5 m, fels, petrog. n.a.

#524, SE K-7, 4x4x2 m, glau phyllite.

#525, E K-7, 10x10x1 m, glau hornfels; **Sec.** sph + jcp + ep + glau hornfels w. abundant veins of pumpellyite?

#527, W K-7, 6x4x3 m, glau gneiss.

#561, NE K-7, 5 m equant, serpentinite.

#562, ENE K-7, 10 m equant, petrog. n.a.

#564, WNW L-7, size x, musc + glau schist.

#565, WNW L-7, 10x8x3 m, chlor phyllite.

#567, L-7, 7x7 m block field, glau schist w. foliated qtz body. Vein (**sec**) is gar + musc + glau + qtz fels; has 2 generations of gar.

#568, E L-7, 20x20x15 m, petrography n.a.

#569, SE L-7, 8x8x5 m, glau phyllite w. green bands mineral x.

#572, WSW M-7, 10x5x7 m, greenstone.

#574, NNE L-8, 10x10 m block field; glau + musc + green x gneiss.

#575, NW L-8, 5 m equant, green fels, petrography n.a.

#590, SE M-8, "big" block field; petrography n.a.

#591, SE M-8, serpentinite schist; **Sec.** of breccia of frags of serp + carb + op in a foliated serpentine matrix.

#592, ESE M-8, serpentinite fels.

#593, ESE M-8, **Sec.** of sph + chl + stilp + glau + alb fels; >80% alb; spaced radiating clusters of stilp and glau. **Unique.**

#596, E M-8, "small block", **Sec.** of ep + chl + glau/actin + alb schist; glau has actin borders.

#599, SE M-7, size x, **Sec.** of breccia of gstn frags and one frag of glau-bearing qtzt or qtz vein; local small patches of glau in several gstn frags.

#620, S N-7, 3x5x4 m, **Sec.** sph + actin + glau + chlor + ep schist; glau replacing actin on rims.

#622; N N-8, 5 m equant, phyllite, petrography n.a.

#623, NE N-8, 1x3x3 m, glau + musc + blast phase x schist.

#624, NNW N-8, 20x20x10 m, gneiss, petrography n.a.

#626, SW N-8, 5 m equant, petrography n.a.

#629, NNE M-9, 15x15 m expo buried block, glau schist.

#631, SSE M-7, petrog. n.a.

#632, SE N-7, 15x15x10 m; **Sec.** sph + law + glau phyllite.

#634, E N-8, 15x15x20 m, eclogite; **Sec.** sph + glau + jcp + gar fels.

#636, SE N-8, 7x5x3 m, garnet glau schist.

#638, SE N-8, 8x8x3 m, **Sec.** ep + actin fels w. one garnet + glau.

#643, E N-9, 10x7x7 m, chlor fels.

#644, E N-9, "small", glau + ep gneiss.

#646, SE N-9, 8 m equant, petrography n.a.

#650, WSW O11, >100 m, red and green chert.

#651, SE N-9, 10x10x3 m, glau phyllite.

#652, SE N-9, 20x15x10 m, actinolite fels.

#660, S M-6, 20 m equant, petrography n.a.

#661, S M-6, 10x15x10 m, **Sec.** sph + jcpx + chloritized gar + ep + glau fels. Retro eclogite.

#662, S M-6, 15x5x5 m, petrography n.a.

#664, S M-6, 5 m equant, "marble" ?

#665, SW M-6, 20x15x10 m, petrography n.a.

#666, ESE L-6, 5x3x3 m, chlor phyllite.

#667, SSW L-6, 10 m equant, greenstone.

#669, E K-6, 5 m equant, glau schist.

#673, W K-6, 5 m equant, gar + musc + glau schist.

#677, SSW J-6, 8x5x3 m, glau schist.

#679, NNW J-7, 15 m equant, chlor phyllite.

#685, NNW E-6, 5 m equant, glau(?) + chl + musc schist.

#687, NNW E-6, petrog. n.a.

#697, S E-5, "big", glau fels.

#702, S E-7, petrog. n.a.

#704, SW E-7, 10x5x5 m, glau phyllite; **Sec.** musc + sph + glau phyllite w. abundant law porphyroblasts.

#705, SSE D-7, 5 m equant, petrography n.a.

#708, S E-7, 25x25x5 m, **Sec.** sph + op + jcpX + ep + law + chlor + glau.

#811, SW J-6, size x, petrography n.a.

#812, SW J-6, size x, petrography n.a.

#822, SW J-6, 10 m equant, actin schist.

#832, NW K-6, 5 m equant, **Sec.** mus + sph + jcpX + chlor + alb + glau schist.

#841, SE M-6, 7 m equant, **Sec.** gar + sph + law + musc + chlor + glau + jcpX; retro eclogite.

#843, SSE M-6, 7 m equant, actin + musc gneiss/schist.

#847, SW M-6, 20x7x5 m, gar + glau schist.

#871, SE M-6, 5x5x7 m, musc + glau schist.

#873, SE M-6, 5 m equant, glau schist.

#887, NW N5, size x, pale aph gstn w. carb and qtz veins.

#888, N N6, size x, pillow-structured aphanitic gstn.

#891, NW O-9, petrog. n.a.

#892, WSW O-9, petrog. n.a.

#893, SE N-9, 20x10x10 m, **Sec.** op + stilp + carb + qtz fels with swirl-textured frags of trem(?) + chlor hornfels. Local zones have pleo like jcpX; others have matted needles like fibrolite in appearance (?). **Unique.** Calcite + albite vein.

#894, SE N-9, 20x20x10 m, glau hornfels.

#896, SE M-6, 10x10x5 m, gneiss, petrography n.a.

#897, SE M-6, 10x7x5 m, gar + glau gneiss.

#898, SE M-6, 7x7x5 m , **Sec.** sph + chl + gar + jcpX + czT + glau phyllite. Block has actinolite rind.

#899, SE M-6, 5x5x7 m, glau schist.

#900, SE M-6, 10x10x5 m, **Sec.** sph + rut + law + musc + chloritized gar + jcpX; retro eclogite.

#903, SSW M-6, 30x30x40 m, gar + glau schist.

#913, SW L5, size x, extremely aph gstn.

#917, SW L4, size x, glau hnfls.

#922, W K-5, size x, metabasalt greenstone w. jackstraw text and czT and qtz veins.

#931, NNW E-4, size x, gstn.

#937, NNE L-5, size x, glau-bearing breccia.

#938, NE L-5, 10x10 m, greenstone.

#939, S L-4, 10x10 m, semischist.

#941, NE K-4, 1 m, aph greenstone.

#942, NE K-4, 15 m, felsic pluton.

#943, N K-4, "massive", greenstone.

#980, NE I3, size x, aph gstn.

#1012, NNE K4, size x, gstn.

#1014, E J4, 1x5 m, glau+law fels.

#1016, SSE J-4, size x, pale banded aph gstn.

#1018, SE I3, 50 x 30 m, pillowed gstn.

#1026, S H-3, size x, greenstone.

#1030, SE G-3, 20x20 m, **Sec.** fine-grained hornblende gabbro, with local brecciated zones.

#1031, SE G-3, 5 m, glaucophane phyllite, metasedimentary appearance.

#1070, SE G-2, 30x30x10 m, greenstone.

#1072, NW H-3, "massive", greenstone.

#1075, NE E-4, 3x5x0.5 m, **Sec.** semischist sandstone cut by quartz vein; prob. matrix outcrop, not a block.

#1078, ESE B-4, 2x1x3 m, **Sec.** czt + sph + rut + musc + chl + gar + jcpix + glau; very high gar %; retro eclogite.

#1091, NW D-3, 5x5x2 m, gar + musc + glau schist; **Sec.** czt + gar + sph + glau fels w. retro musc + chlor & relict jcpix. Very retro eclogite.

#1092, SE C-2, 10x10x5 m, **Sec.** sph + musc + chl + czt + amphibole occ. pleo in blue; glaucophanic; texturally hornfels.

#1093, S D-3, size x, greenstone.

#1094, SSW D-3, 20x20x15 m, greenstone.

#1096, SW D-3, size x, greenstone.

#1098, W D-5, 25x15x15 m, glau phyllite, **Sec.** sph + musc + czt + chl + glau phyllite. UnID phase.

#1099, NW D-5, size x, glau phyllite.

#1100, NW D-5, 8x5x3 m, eclogite; **Sec.** of retrograded zone sph + musc + chlor after gar and nonpleochroic tabular zoned cpx w. local weak jcpix rims.

#1106, NE C4, size x, gstn.

#1109, NNE C-4, 15x15 m, red chert.

#1116, SW D-11, size x, green chert.

#1126, SE E-12, size x, finely laminated chert. **Sec.** shows matrix between bands full of sprays of glau; rock glau metachert. **Unique.**

#1127, SSE E-12, size x, vesicular greenstone, chlorite veins.

#1128, SE E-12, size x, sheared red schist.

#1129, W F-12, size x, fels w. sparse spherical bodies.

#1132, N E-10, size x, gabbro block from greenstone breccia.

#1145, NW E-9, 10x10x7 m, glau phyllite.

#1148, N C-8, 10x10x3 m, glau phyllite.

#1149, SW D-8, 10x5x5 m, greenstone.

#1150, SW D-8, 25x20x15 m, glau phyllite.

#1151, SSW D-8, 30x30x20 m, glau phyllite. Not sure if block, maybe matrix.

#1152, SSE D-8, 7x3x3 m, glau schist.

#1153, N D-8, size x, meta-granulite; **Sec.** shows abundant ~ An<sub>60</sub> plag and nonpleochroic cpx with patchy actin and chlor replacing cpx in many places; clear relict granulitic texture. **Unique.**

#1159, NE L-6, 30x30x15 m, gneiss, petrography n.a.

#1164, SE L-5, 7x7x3 m, glau schist.

#1165, SE L-5, 5x5x1 m, glau phyllite.

#1169, NW N-5, 30x30x15 m, greenstone.

#1170, SW N-4, 20 m equant, greenstone; **Sec.** very slightly met. basalt, Type I of Coleman and Lee. Some chlor in plag.

#1174, N M-4, 50x30 m, diorite plutonic block; **Sec.** brecciated hornblende diorite, hb color mottled, plag all but one sericitized; that andesine by Ab-twins. No glau, no czt.

#1181, NNW M-3, 5x5 m, amygdaloidal greenstone. **Sec.** chlor + carb amygdules in slightly metamorphosed basalt w. fresh cpx, sericitized plag, glass (?) to chlorite.

#1182, SSW L-3, 7x7 m, diorite plutonic; **Sec.** meta-hornblende diorite; green pleo primary hb altered to fibrous clear amphibole (trem/actin) + coarse czt in plag and hb, relict plag twins are An<sub>35</sub> by Ab twin method. Brecciated veins cut rock.

#1184, NE L-4, size x, serpentinite.

#1187, SW M-3, "huge", greenstone.

#1188, SW L-2, 5x5 m, greenstone w. white blasts; **Sec.** chlor greenstone frags in carb and qtz veins & dark matrix. Large plag frags wholly/partly alt to carb. No glau visible but some frags purple.

#1190, W L-2, 1x3 m, greenstone.

#1191, L-3, vesicular gstrn.

#1192, SW K-2, 20x20x5 m, chlor phyllite.

#1193, SW K-2, size x, purple locally vesicular metabasalt.

#1194, SSW K-2, size x, greenstone breccia. **Sec.** of breccia of sand to granule size clasts of felsic volcanic rocks and rarer mafic volc rocks; coarse czt in clasts. Matrix v. sparse. **Unique.**

#1196, SE K-3, 15x15x3 m, greenstone.

#1198, E N-6, size x, greenstone.

#1199, SW O-6, 3x3x1 m, hb diorite plutonic.

#1202, O-5, size x, biotite diorite plutonic.

#1203, NE O-5, 30x5 m, **Sec.** vesicular metabasalt only weakly met.; plag alt but cpx mostly OK; orig. glass to chlorite.

#1205, SE N-5, 50x20 m, **Sec.** qtz + actin schist; actin has local glau margins.

#1206, SSW P-8, 40 m equant, greenstone.

#1207, S P-9, 5x5x4 m, glau phyllite.

#1208, SSE P-9, 5x5x3 m, **Sec.** minor law + relict jcpw w. sph + chl + gar + czt + glau schist. Highly retro eclogite.

#1209, ENE P-10, 5x5 m, glau schist.

#1210, ENE P-10, 20x5 m, **Sec.** microgneiss with glau and qtz+law laminae

#1211, ENE P-10, size x, glau + gar schist.

#1212, NW Q-10, 5 m equant, chlor phyllite.

#1214, NW Q-11, 200x200 m, **Sec.** coarse sph + czt + actin + alb schist. Actin somewhat color mottled, unusually pleo from yellow tan to medium leaf green. Cut by alb veins.

#1215, Q-10, 5x20 m, coarse-grained serpentinite.

#1216, SSE Q-10, 30x30x5 m, glau schist.

#1217, NW Q-11, giant block, petrog. n.a.

#1219, W Q-11, size x, **Sec.** Qtz + cpx fels; >90% cpx; has radiating habit. **Unique.**

#1220, E P-11, size x, greenstone.

#1222, NNE P-11, 10x5x5 m, chlor phyllite.

#1223, SW Q-10, 20x10x10 m, **Sec.** musc + chlor + cpx? hornfels; cpx just assembling; no pleo., 45° extinc.; l-f. **Unique.**

#1224, SE P-10, 15x15x5 m, **Sec.** ap + sph + czt? + law + chlor fels; chlor grey, +; relict foliation in chlor overgrown by law. **Unique.**

#1228, NW O-10, " odd dark unfol. rock with scattered round white bodies, 1 mm."

#1230, NW O-10, 5x5x3 m, glau patches in greenstone.

#1231, NNW O-10, 15x15x10 m, glau + law schist w. retro zones of chlor schist.

#1232, NW O-10, 15x15x5 m, pale greenstone.

#1233, SSE O-11, 8 m equant, glau schist w. bands of chl schist.

#1234, ESE O-11, 20x20 m, **Sec.** sph + czt + Qtz + alb? + actin hornfels. A small amount of biotite/stilp present.

#1235, NW P-10, 20x20x15 m, greenstone.

#1237, NW P-10, 5x5x3 m, glau schist.

#1238, W P-10, 50x50x15 m, greenstone?

#1239, N P-10, size x, glau phyllite + white blasts.

#1240, NE P-10, 25x25 m pile of blocks, glau schist.

#1241, N P-10, 30x30 m, chlor phyllites.

#1242, N P-10, 20x20 m pile of blocks, glau schist.

#1243, E P-10, 15x15x5 m, chlorite schist.

#1244, SSW P-10, 40x40x30 m, musc greenschist.

#1245, SE O-9, 25x25x3 m slab, chlor schist.

#1247, NE O-10, size x, "odd layered rock".

#1250, ESE O-9, **Sec.** hornblendite w. plagioclase veins. No glau. local breccia dikelets of hornblende fragments.

#1252, ESE O-9, 40x40x30 m, pillowed greenstone.

#1253, NE O-11, 15x15 m, musc + gar + glau + qtz schist.

#1254, SSE O-10, 3x3x10 m, **Sec.** sph + rut + gar + zoned ep + hb fels w. minor retro chlor + musc. Hb has max ext angle of 34°. Small patches of glau common in hb.  
**Unique.**

#1258, E N-4, 10x10x7 m, chlor schist.

#1260, NW P-5, size x, glau hnfls.

#1265, NW N-4, 30x15 m, **Sec.** medium-grained gabbro; cpx and plag. About 30% is finer-grained very platy plag. Innumerable local crystals of brown pleo stilpnomelane (?); veins of aphanitic green x cut specimen.

#1266, WSW N-3, "big", greenstone.

#1267, WSW N-3, **Sec.** meta-quartz gabbro w. relict cpx and plag, abundantly replaced by multiple layers of radiating chlorite (?). ~15% qtz; one local granophyric-textured quartzofeldspathic vein 2mm wide cuts it.

#1269, NNW N-2, giant block one kilometer, amygdaloidal vesicular greenstone.

#1270, ESE N-7, 7x7 m, glau hornfels.

#1271, WNW N-10, 5 m equant, actin + musc + czt + glau phyllite; one quartz vein.

#1272, SSW M-11, 20x20x5 m, gar + glau schist.

#1273, NW M-11, 7x5x3 m, gar + glau schist.

#1274, N M-11, 7x4x5 m, gar + glau phyllite.

#1275, N M-11, 15x30x5 m, **Sec.** sph + musc + czt + glau schist, w. many highly retro gar w. thick musc rims.

#1276, NNE L-12, 7x5x3 m, musc + glau schist.

#1277, NW L-12, 15x25x10 m, **Sec.** op + sph + chl + law + jcp + glau schist. Glau and jcp show strong color zoning. Law + chlor vein.

#1278, WNW L-12, 25x25x15 m, glau phyllite.

#1279, N M-11, 10x10x7 m, **Sec.** sph + musc + czt + glau schist, w. very retro gar w. law and chl coronas.

#1280, SE M-10, 7x7x3 m, **Sec.** sph + rut + czt + alb + trem + chl schist.

#1282, NW M-10, 3x5 m, "igneous rock".

#1283, NW M-10, 5x5x3 m, "igneous rock"

#1284, L-10, 50x20x15 m, **Sec.** rut + czt + alb + actin schist. Locally brecciated in veins and patches.

#1285, L-10, 15x15x5 m, **Sec.** sph + czt + actin + alb microbreccia.

#1286, NE L-10, 10x10 m, **Sec.** sph + czt + actin/hb + alb fels; amph ext ang 20°, plag An<sub>10</sub>, ~5% relict nonpleo cpx; original text granulitic; rock a metagranulite. **Unique.**

#1287, N L-10, 5x10 m, **Sec.** fine-grained meta-hornblende gabbro. Hornblende deformed but stable; some relict Ab twins in plag; other large xtls of plag full of lawsonite. Many quartz patches. Local breccia veins, one pump (?) vein.

#1288, NW L-10, 40x40x40 m; **Sec.** czt + actin/hb + plag fels; amph ext ang 18°, plag v. altered to law tabs + sericite.

#1289, S L-10, 15x15x5 m, "igneous rock".

#1300, NNE J-10, size x, glau fels; **Sec.** striped op + law + chlor + carb + glau + 50% minutely felted mass of pale tan chlor? as matrix; text a fels. **Unique.**

#1301, SW J-10, size x, gar + glau rock, texture x.

#1303, WSW J-11, 15x15x5 m, chlor schist.

#1304, SW J-11, 20x20 m, chlor schist.

#1305, SE I-11, 8x8x3 m, glau rock, texture x.

#1312, SE J-10, size x, musc + glau schist.

#1314, SE J-10, size x, lith x.

#1315, NE J-11, size x, **Sec.** pump? + cpx? + law + glau fels.  
Possible clear pump ~ 30%; radiating xtlx poss cpx rep. by glau. **Unique.**

#1316, NE J-11, size x, glau phyllite.

#1317, W K-11, size x, gar + glau schist.

#1318, W K-11, size x, glau phyllite.

#1319, W K-11, size x, glau schist.

#1320, ESE, J-11, size x, white chert.

#1321, SE J-11, size x, **Sec.** hem + sph + rut + law + glau phyllite.

#1322, NE J-12, size x, musc + glau schist.

#1323, NE J-12, size x, glau fels.

#1325, SE K-11, size x, greenstone; **Sec.** extreme aphanitic;  
veins of chlor + carb + alb.

#1326, SE K-11, size x, eclogite.

#1327, K-11, size x, **Sec.** sph + chl + jcpX? fels. cpx has no pleo, otherwise OK. Sphene  
to 3 mm. Retro eclogite.

#1328, WNW K-11, 10x10x5 m, glau phyllite.

#1329, WNW K-11, 15x10x5 m, glau schist.

#1331, M-9, **Sec.** sph + glau + ep + actin + chl + alb phyllite w. local late brown  
pleochroic anhedral to feathery stilpnomelane (?). Actinolite >> glau. Abundant parallel  
needles of phase x in albite.

#1332, NW M-9, 5x7x4 m, musc schist.

#1333, NW M-9, size x, musc schist.

#1334, NW M-9, size x, glau schist.

#1335, NE L-9, size x, glau and qtz fels.

#1336, NE L-9, size x, **Sec.** sph + musc + chlor + law + glau + czT + gar + jcpX; musc +  
chlor mostly attack gar; retro eclogite.

#1337, NE L-9, "big", glau phyllite.

#1338, NE L-9, size x, chlor schist.

#1339, NE L-9, size x, chlor phyllite

#1339a, NE L-9, size x, hb schist.

#1339', NW L-11, size x, **Sec.** op + sph + cpx? + law + glau hornfels; Contains several blasts of x phase; ~1mm, hi-relief, clear idioblastic square, biaxial, mostly altered to chlor or glau. **Unique.**

#1340, NE L-9, **Sec.** glau + law hornfels; a few % of czt or zoisite with anomalous purple interference colors. A small amount of feathery stilpnomelane (?).

#1340', NW L-11, size x, **Sec.** shows stilp + nonpleo cpx + law + fibrous glau fels, w. law vein.

#1341, NNW M-9, size x, chlor schist.

#1342, WSW M-8, size x, chlor schist.

#1342', NNW K-11, size x, greenstone breccia.

#1343, WSW M-8, size x, glau phyllite.

#1344, SW M-8, size x, chlor fels.

#1345, WSW M-8, size x, **Sec.** sph + carb + ser + stilp + chlor + law + glau + cpx; porphyroclasts of yellow-tan cpx lie in matrix of fibrous glau, chlor and tiny law tablets. **A meta-clinopyroxenite. Unique.**

#1345', S L-11, size x, "odd gray rock".

#1346, ESE L-8, size x, serpentinite.

#1346', NNE L-12, size x, glau + czt schist w. czt vein.

#1347', S L-11, size x, glau hornfels.

#1348, SSE M-8, size x, glau + phase x gneiss.

#1348', S L-11, size x, chlor hornfels.

#1349, ESE M-9, size x, chlor schist.

#1349a', SE M-10, 40x40x15 m, **Sec.** hemi + musc + chlor + carb + sph + czt + glau + jcp schist; band in glau schist block.

#1350, S L-9, size x, greenstone.

#1350', SE M-10, 10x10x2 m slab, green fels.

#1351', S M-10, 5x7 m, glau fels w. white blast x.

#1352', SW M-10, 5x5x3 m, musc + gar + glau schist.

#1353, SW L-9, "small", greenstone.

#1353', S M-10, 10x10x3 m, **Sec.** very coarse musc + sph + chlor + gar + glau fels; deeply corroded gar w. chlor rims.

#1354, SW L-9, size x, greenstone.

#1354', S M-10, 7x4x3 m, gar + glau schist.

#1355', S M-10, 7x7x5 m, chl + gar + glau + jcp? fels.

#1356, NNE K-10, size x, amygdaloidal greenstone.

#1356', S M-10, 10x7x5 m, glau schist.

#1357, NW K-10, "big", glau + chlor phyllite.

#1357', SSW M-10, 5 m equant, **Sec.** sph + czt + jcp schist w. jcp trans to glau; retro musc + chlor.

#1358, SW M-10, 7x7x5 m, musc + glau schist.

#1359, SW M-10, 5x5x4 m, **Sec.** mus + chlor + sph + czt + glau hornfels.

#1360, NNW M-11, 20x20x15 m, **Sec.** hem + musc + chlor + czt + sph all retro after tremolite schist.

#1361, WNW M-11, 7x7x3 m, **Sec.** hem + musc + chlor retro of actin + czt + alb schist.

#1362, WSW M-11, 15x15x7 m, **Sec.** musc + sph + jcp + actin + chlor + alb schist, w. abundant mineral x, perhaps colorless pump.

#1363, SE L-11, 15x15x15 m, glau hornfels w. veins of alb or law.

#1364, SW M-10, 20x20 m, **Sec.** sph + rut + czt + chlor + glau retro of gar + jcp; retro eclogite.

#1365, N M-11, 7x7x4 m, musc + chlor + gar + glau fels; retro eclogite.

#1366, N M-11, 7 m equant, **Sec.** op + sph + czt + actin + alb banded fels.

#1368, SSE L-10, 10x10x7 m, **Sec.** musc + chlor + sph + hb + czt + jcp schist. Unident <1% phase; low IFC, relief, equant, has parallel dark linear inclusions prominent. Hb has bluish tinges locally, one small glau seen.

#1369, SE L-10, 8 m equant, greenstone.

#1370, SE L-10, 10x10x5 m, gar + chlor fels, retro eclogite.

#1371, SE L-10, 7 m equant, **Sec.** of glau + sph phyllite retro after massive coarse clear pumpellyite? fels. About 30% still pump.

#1372, SE L-10, 15x15 m, **Sec.** of glau + law + sph + jcp after monomineralic prehnite? fels.

#1373, SE L-10, 10x7x7 m, chlor fels.

#1374, SE L-10, 7x5x5 m, glau phyllite.

#1375, SE L-10, size x, **Sec.** of breccia of alb frags with law + unresolvable others; HS color sugg glau present. Cut by alb veins. **Unique.**

#1377, NE L-11, 7x10 m, **Sec.** of breccia of glau + sph + musc + law fels.

#1378a, NE L-11, 7x7x5 m, **Sec.** of sph + law + glau hornfels. Cut by law veins.

#1379, NE L-11, 5x5x3 m, **Sec.** of hem + sph + czt + actin + musc + alb + chlor schist. Amph only faintly green pleo.

#1380, NE L-11, 8x8 m, **Sec.** of musc + glau + czt + act + chl + gar + qtz schist; a glau quartzite with profoundly poikiloblastic garnets; **Unique.**

#1381, NE L-11, size x, **Sec.** of very crenulated jcp + sph + glau/act + alb schist; amph has patchy purple and green/blue coloring.

#1382, SE N-10, 30 m equant, **Sec.** of sph + glau + jcp hornfels w. local law blasts. Jcp has local grass-green pleo, v. patchy. A 3 mm vein of law + carb with a small mass of bluish green pleo needles of pump (?) cuts the section.

#1383, SE G-7, 5x10x5 m, lith x.

#1384, SE G-7, 5x10x5 m, chlor schist.

#1385, ESE G-7, 7x10x5 m, gar + glau schist.

#1386, E G-7, 10x20x3 m, **Sec.** of glau-bearing jcp<sub>x</sub> fels w. minor retro musc + sph.

#1387, E G-7, 5 m equant, serpentinite.

#1388, SE G-7, size x, glau phyllite.

#1389, SE G-7, 5x7x4 m, musc + chlor schist.

#1391, S G-7, 4x7x2 m, glau phyllite.

#1392, S G-7, 20x20x15 m, chlor phyllite.

#1394, NW G-7, 30x30x20 m, lith x.

#1395, SE J-6, size x, greenstone.

#1396, SE J-6, "big", glau schist.

#1397, NW K-7, size x, glau fels.

#1398, ENE J-7, size x, **Sec.** of op + stilp + sph + law + glau schist, w. pods and veins of law.

#1401, SW K-7, size x, chlor + qtz, texture x.

#1402, W K-7, size x, glau schist.

#1403, SSW K-6, size x, gar + glau schist.

#1404, SSW K-6, size x, glau schist.

#1405, SSW K-6, size x, glau schist.

#1407, SW M-6, size x, glau fels/schist.

#1420, NW J-7, 15x15x10 m, musc + chlor schist.

#1421, NW J-7, 10x15x5 m block pile, glau phyllite.

#1422, NNE J-7, 40x20x20 m, **Sec.** actin + carb + sph + musc + czt + jcp<sub>x</sub> + law fels.

#1423, E J-7, 15 m equant, chlor schist.

#1424, E J-7, 5 m equant, glau schist.

#1426, SW J-7, size x (buried), czt fels w. qtz + carb veins.

#1428, WSW J-7, 40x20 m, stilp + glau schist.

#1429, E I-7, 30x15x30 tower, **Sec.** stilp + musc + chlor + sph + law + czt + glau phyllite.

#1430, W I-7, size x, gstn.

#1431, W I-7, 20x30x10 m, "qtz and gar veins".

#1432, W I-7, 15x15x10 m, musc + chlor schist.

#1433, N H-8, 10x10x7 m, "heavily retrograded".

#1434, NW H-8, 8x8x4 m, glau schist w. chlorite knots.

#1435, NW H-8, 5x3x4 m, **Sec.** sph + musc + chlor after jcpX fels w. several former gar changed to stilp? or chlor and musc. One glau vein. Retro eclogite.

#1436, NW H-8, 7x7x5 m, gar + glau fels.

#1437, SE G-7, 7x7x4 m, glau schist.

#1438, WSW H-8, 7x5x3 m, gar + glau schist.

#1439, NE G-8, 5x5x3 m, **Sec.** glau + musc + chlor + sph fels.

#1440, W H-7, 10x5x3 m, musc + glau rock w. green retro mins.

#1442, ENE G-7, 10x5x5 m, glau + jcpX? gneiss.

#1443, NE G-7, 10 m equant, "green and white gneiss".

#1444, NE G-7, 10x15x10 m, qtz + glau gneiss.

#1445, NE G-7, 10 m equant, blotchy jcpX? w. retro chlor schist.

#1446, NW H-7, 10x5x5 m, lith x.

#1447, NW H-7, 10 m equant, **Sec.** stilp + glau/actin bearing plagigranite/qtz diorite. Patchy actin has glau margins. **Unique.**

#1448, NNW H-7, 8x8x5 m, musc + jcp<sub>x</sub>, texture x.

#1449, NNW H-7, 7x7x5 m, glau schist.

#1450, N H-7, 5x5x3 m, glau phyllite.

#1453, NE G-8, 7x7x4 m, glau schist w. retro chlor.

#1454, NE G-8, 3x3x5 m, gar + glau schist.

#1455, ESE G-8, 6 m equant, glau schist w. jcp<sub>x</sub> + chlor + musc schist.

#1456, ESE G-8, 5 m equant, lith x.

#1457, SE G-8, 10x10x7 m, greenstone w. pink xt<sub>ls</sub> in vugs.

#1458, SE G-8, 40x30x20 m, chlor phyllite w. white x bands.

#1459, SE G-8, size x, stilp + qtz metachert.

#1461, SW G-8, 8x8x3 m, qtz + musc schist.

#1462, NE F-8, 5 m equant, musc + glau schist, bit actin rim.

#1463, NW F-8, 7x5x4 m, **Sec.** hem + sph + law + pump? + glau phyllite. Pump? clear to faint leaf green, variable elong.

#1464, NW G-8, 5 m equant, gar + glau schist.

#1465, NW G-8, 20x20x15 m block field, glau schist.

#1466, NW G-8, 7x7x5 m, gar + glau + law, texture x.

#1468, S G-3, 15x15x10 m, greenstone.

#1472, NW G-3, 5 m equant, greenstone.

#1474, NE J-3, "large", greenstone.

#1475, NW F-10, size x, glau + phase x gneiss.

#1500, E F-13, 5 m equant, glau fels breccia w. new glau in matrix.

#1501, E F-13, 5 m equant, reddish greenstone.

#1502, E F-13, 5 m equant, glau phyllite.

#1503, SE F-12, 50 m equant, hornblende quartz diorite. Has small regions of glau in hb.

#1504, E G-13, 5 m equant, felsic plutonic.

**End Petrographic Descriptions**