A RE-EVALUATION OF THE MINERALOGY OF THE MINDY TIN PROSPECT, THIRTYMILE RANGE BY PETROGRAPHY / MINERAGRAPHY

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Claims: Min 1-4

YB84647-YB84650

Map sheet 105C-9, 60° 37’N, 132° 20’W

Watson Lake Mining Recorder’s district

CONTENTS

CLAIMS p. 5

LOCATION AND ACCESS p. 5

INTRODUCTION p. 6

DISCOVERY OF THE PROSPECT AND PREVIOUS WORK p. 7

REGIONAL GEOLOGY:

- Lithologies p. 7
- Structure p. 8
- Granite Intrusions p. 8

ORK AND MINDY PROSPECTS: GEOLOGY:

ORK p. 12

MINDY p. 13

MINERALOGY AND CHEMISTRY:

- Upper skarn p. 14
- Lower skarn p. 14
- Skarn chemistry p. 16
- Tin mineralization p. 20
- Skarn type p. 20
- Faulting and fracturing p. 20

2015 WORK:

METHODS p. 21

PETROGRAPHY AND MINERAGRAPHY p. 21

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS p. 36

REFERENCES p. 38

COST STATEMENT p. 39

STATEMENT OF QUALIFICATIONS p. 40

FIGURES: DRAWINGS AND PHOTOGRAPHS

Figure 1. Location of the Mindy prospect. p. 5

Figure 2. Geology of the Thirtymile Range. pocket

Figure 3. Trace element discriminant diagram of Eby (1992). p. 10

Figure 4. Thirtymile granite compositions as proportions of albite-quartz-orthoclase, showing the effect of fluorine content. p. 11

Figure 5. Mica compositions in the Thirtymile – Ork granites p. 11

Figure 6. The Ork granite contact p. 12

Figure 7. Geology of the Mindy prospect. pocket

Figure 8. Cross section of the Mindy prospect. pocket

Figure 9. Drill section DDH 81-1 pocket

Figure 10. Drill section DDH 81-2 pocket

Figure 11. Drill section DDH 81-3 pocket

Figure 12. Drill section DDH 81-4a pocket

Figure 13. Drill section DDH 81-4b pocket

Figure 14. Drill section DDH 81-5B pocket

Figure 15. Drill section DDH 81-8 pocket

Figure 16. Skarn pyroxene compositions as proportions of diopside-johannsenite-hedenbergite for DDH 81-3. p. 17

FIGURES: PHOTOMICROGRAPHS

Figure 17.	Primary skarn	p. 24
Figure 18.	Fracturing & alteration	p. 25-26
Figure 19.	Alteration	p. 27
Figure 20.	Magnetite-borate-fluoride mineralization	p. 28-29
Figure 21.	Mineralization	p. 30
Figure 22.	Wrigglite	p. 31
Figure 23.	Bandylite, phengite, borates	p. 32
Figure 24.	High temperature skarn, shearing and tin mineralization	p. 33

TABLES

Table 1:	Microprobe analyses of vesuvianite from DDH 81-3.	p. 18
Table 2:	Analysis of ferrophengite by electron microprobe	p. 19
Table 3.	Mineralogy of the skarns	p. 22-23
Table 4.	Tin mineralization in the specimens examined	p. 34

APPENDIX

Photomicrographs in individual full-page format. Some are full resolution copies of those used in the figures. Digital format only on DVD included with hard copy report.

CLAIMS

The Mindy property consists of four claims, Min 1- 4, with grant numbers YB84647 to YB84650.

LOCATION AND ACCESS

The property is located at 60° 37'N, 132° 20'W in the centre of the Thirtymile Range between the Nisutlin and Wolf rivers, some 57km north-north-east of Teslin (see Minfile map 105C-9 038). It is only easily accessible by helicopter, although that part of the Range has been reached by use of canoe on the Nisutlin river followed by a two-day walk into the area.

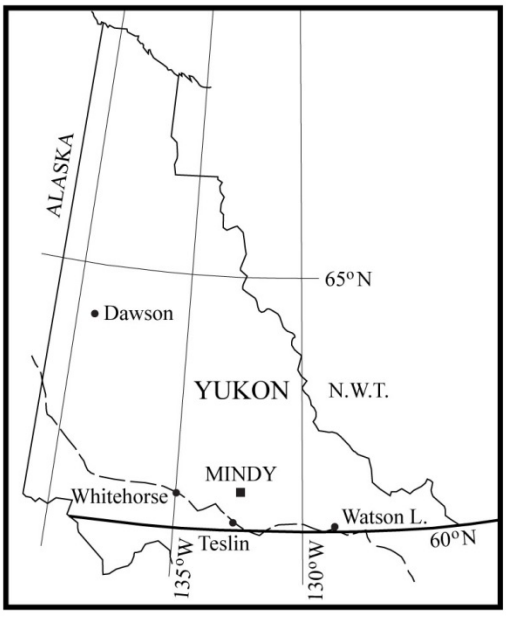


Fig. 1. Location of the Mindy prospect.

The Mindy and Ork prospects on either side of the range are just above tree line and the alpine tundra provides easy walking, apart from vertical relief. Over a kilometre of relief exposes much of the stratigraphy of the Thirtymile Range about the highest peak of 1992m elevation. The Mindy prospect is at around 1560m elevation and the ground immediately above the outcropping skarns where drill holes were collared forms a small plateau that is devoid of much vegetation i.e., it is horizontal felsenmeer.

INTRODUCTION

This present work on the Mindy prospect consisted of re-sampling of diamond drill core held in the Bostock Core Library to allow thin and polished section preparation. These sections were examined to (i) investigate the sequence of skarn mineral formation and relative timing of tin mineralization and (ii) to allow some estimate of relative proportions of oxide versus fluoride / borate tin minerals present at the prospect since cassiterite is the only mineral of economic interest, the borates being “metallurgically refractory”.

A very detailed description of the geology of the Thirtymile Range and Mindy prospect is given by way of introduction, since this has not been included in any previous report. Also a brief description of the Ork prospect to the west of Mindy is included since it indicates the composition of the nearest outcropping granite and the metallogeny. It is considered that a similar leucogranite to that of the Ork immediately underlies the Mindy prospect.

DISCOVERY OF THE PROSPECT AND PREVIOUS WORK

The Mindy prospect was discovered during regional exploration for tungsten and tin by Newmont. Stream sediment sampling for heavy minerals had revealed scheelite in the Mindy valley. The property was prospected, geologically mapped, covered by ground magnetic and E.M. surveys and then drilled with eight BQ sized diamond drill holes (Limion, 1979, Nebocat, 1981, 1982). No further exploration was carried out and the original claim block expired in 1989. In 1987 Terry Macauley, manager of Newmont, offered the portions of drill core that had been transported to Vancouver for study by the present author. Investigation of the mineralogy and chemistry of the skarns was used as part of a PhD thesis (Liverton, 1992). Drill core of the skarn intervals and some of the marble is stored in the H.S. Bostock core library in Whitehorse.

REGIONAL GEOLOGY

LITHOLOGIES

The Thirtymile Range consists of a sequence of strata that had been assigned to the enigmatic "Dorsey terrane" (Wheeler et al., 1991), much of which is now recognized as being Yukon-Tanana. The immediate Thirtymile Range, however, contains imbricated strata lithologically similar to North American Proterozoic to lower Paleozoic sequences. The topographically lowest unit is of grit, arkose and quartzite which is overlain by marble, fine-grained siliciclastics of slaty appearance (i.e., they have been sheared), then a thick sequence of cherts. Thin units of sheared greenstone and basalt are found at several localities at the top of the quartzite or within the slaty unit. The overall attitude of the major units is near horizontal to moderately east dipping. No fossils have been reported from these rocks. It is possible that this sequence is part of the rifted portion of the continental margin that formed the basement for the Yukon-Tanana terrane.

STRUCTURE

Many outcrops display a metre-scale (and smaller) fabric of phacoidal, anastomosing pressure solution cleavages with an asymmetry consistent with regional top to the east shear. Examination of the largest cliff face in the range {644,000E, 6,725,500N} indicates that the phacoidal structure may also be on a $\geq$ 500 m scale. Repetition of the stratigraphy by thrusting is likely. One occurrence of a fault-bounded slice of marble, some 5m thick, within the slaty metasediments immediately north of peak 1997 at the top of that cliff face indicates that large-scale faulting has occurred: that locality is some 400 m vertically above the main outcrop of the marble. The upper surface of the marble unit was considered to be a thrust fault by Liverton (1992). Projection of that surface around the Range (Fig. 2) would take it to the top of the thin marble exposure west of the Mindy prospect, immediately above the Mindy 'mini-plateau'and NE to exposures of the grit / quartzite unit {approximately 648,400E, 6724,500N} where a high-strain zone containing stretched conglomerates was identified (S. Gordey, pers. comm.) with similar appearance to those reported from the Moine Thrust, Scotland.

The Mindy prospect contains two marble / calc-silicate hornfels and skarn horizons that overly the chert unit.

GRANITE INTRUSIONS

The Thirtymile Range contains mid Cretaceous (100 Ma) stocks of monzogranite to alkali feldspar granite according to the Streckeisen classification (Le Maitre, 1989). Two lithofacies of biotite-only granite make up the bulk of the outcropping Thirtymile Stock to the NW of the Mindy prospect. A volumetrically minor hornblende-bearing 'porphyry' forms a disaggregated syn-plutonic dyke within that stock and is the only amphibole-bearing lithofacies seen in the pluton and indeed the Seagull suite. A lithium mica topaz leucogranite crops out at its SE corner which also forms ladder dykes in the biotite-bearing 'even-grained' lithofacies. The leucogranite also forms 1-5m scale dykes and three sills in the aureole that contain spectacular concentrations of topaz. It may be classified as an alkali feldspar granite sensu stricto. A similar lithofacies forms the just-exposed Ork stock and adjacent dykes that are 2.5 km west of the Mindy prospect. Those Thirtymile and Ork leucogranites consist of a quartz-albite-

orthoclase-zinnwaldite-topaz-fluorite mineral assemblage that also has accessory fergusonite. Very small (≤ 20 mm thick) lepidolite-topaz greisen or beryl dykes are found within the Thirtymile stock leucogranite.

These two Thirtymile plutons, together with the Seagull and Hake batholiths were considered as a sub-suite of the Cassiar intrusions by Liverton (1992) and called the Seagull-Thirtymile suite. They were identified as having A-type affinity (Liverton and Alderton 1994, Liverton and Botelho, 2001) Subsequent work on the Cretaceous granites of the Northern Cordillera has added a further pluton to the NW as being part of this suite and renamed them as simply the Seagull suite, which is distinct from the Cassiar intrusions and confirmed their anorogenic nature (Rasmussen, 2013). They are metaluminous to weakly peraluminous (Liverton & Botelho 2001 Fig. 7) and conform to the type A1 of Eby (1992): Fig. 3, which are attributed to a continental rift setting i.e, this type is indicative of an extensional setting rather than subduction.

The Thirtymile and Ork leucogranites are the most chemically evolved, i.e., fractionated, granites in the Northern Cordillera (Rasmussen 2013), with Rb/Sr contents exceeding 3000. They might be considered the plutonic analogue to the topaz rhyolites, such as found from Colorado to New Mexico (Christianson, 1986). They form the apical portion of the batholiths, which were emplaced at shallow depth (< 2 km) as indicated by common miarolitic cavities and pod pegmatites. These magmas were highly enriched in alkalis Rb and Li and anions F, Cl and B. Those anions would allow a granitic magma to remain as a melt to < 650° C and produce a compositional trend that is different to the 'normal' quartz enrichment process (Fig. 4). The halogen-enriched granites fractionate to albite-enriched compositions and due to protracted melt / aqueous fluid and fluid / vapour fractionation (and their reduced nature) are able to concentrate the high field strength elements into the hydrothermal phase: notably Sn, Nb, Ta (c.f., Lehman & Harmanto, 1990). Shallow depth of emplacement of the pluton (the apical part of a batholith) is essential for the development of the F-B mineralization. In the anorogenic granites an 'inheritance' of those metals is possible (e.g., see discussion in Lehmann, 1990) but fractionation processes in low-temperature reduced melts will be most important. The halogen enrichment of the granite is reflected in the unusual mineralogy at the Mindy and Ork prospects: the Mindy skarns are 'greisenized skarn' in the classification of Kwak, (1987).

Analysis of biotite to zinnwaldite mica from the granites indicates a continuous sequence of iron enrichment in the micas with progressive fractionation from the least evolved lithofacies in the whole Seagull granite suite (as shown in the Thirtymile porphyry) through the Hake granite to Seagull granite and the Thirtymile biotite granites to the zinnwaldite of the leucogranites (Fig. 4). The biotite compositions indicate that these granites were distinctly reduced (Fig. 5): biotite $\{Fe^{2+} / (Fe^{2+}+Fe^{3+})\}$ = 0.811-0.965 and magma fO_2 = < the NNO buffer (Liverton & Botelho, 2001, Fig. 12). The progression to extremely Fe-enriched micas (trioctahedral 1M zinnwaldite) may be a trait of the anorogenic granites (Gary Lowell, pers. comm. 1997).

The Li-mica leucogranite of the Mindy stock exhibits three forms of hydrothermal mineralization at its southern contact: rare cm-scale beryl pegmatite, cm-scale lepidolite-topaz greisen veins and, presumably the last event, mm-scale joints that carry haematite. It is remarkable that a granite that carries very little total iron is capable of exsolving iron-rich hydrothermal fluid, but this is also evident in the retrograde / greisen stage skarn mineralization.

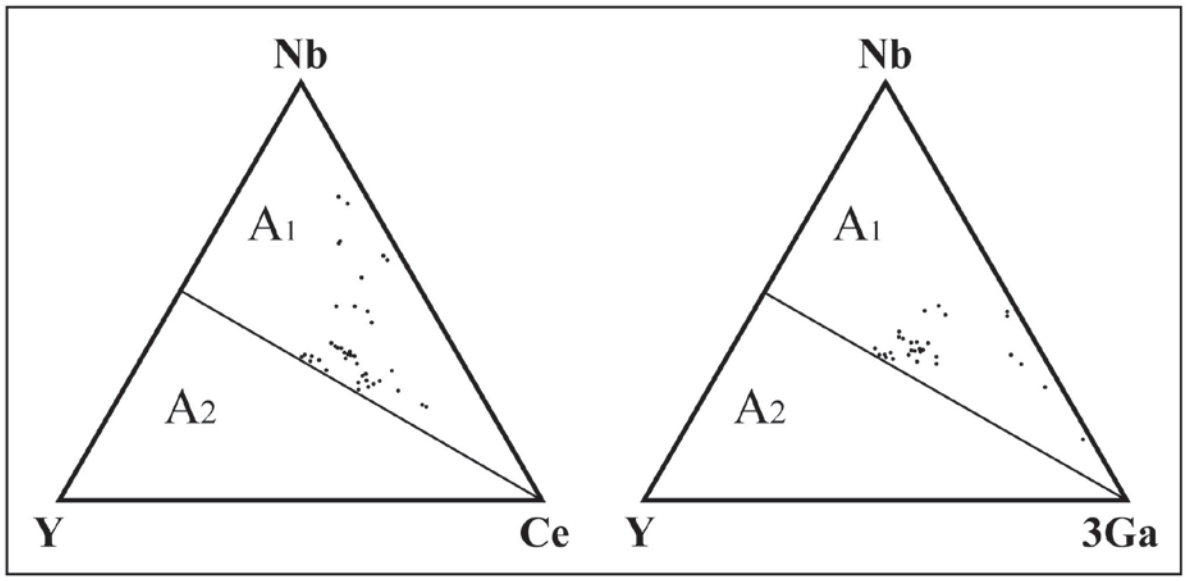


Figure 3. Eby (1992) discriminant diagrams for the Thirtymile intrusions.

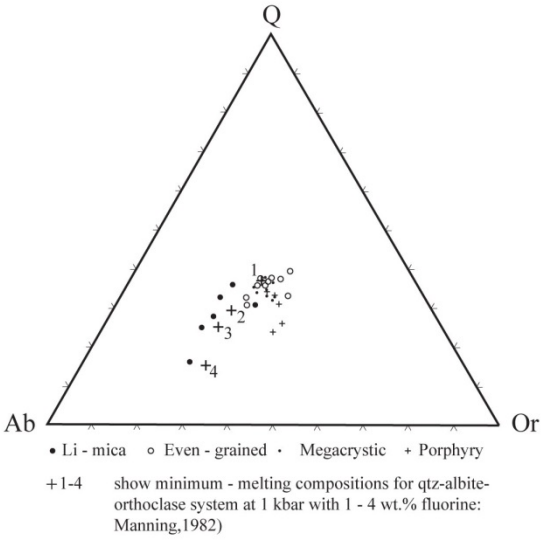
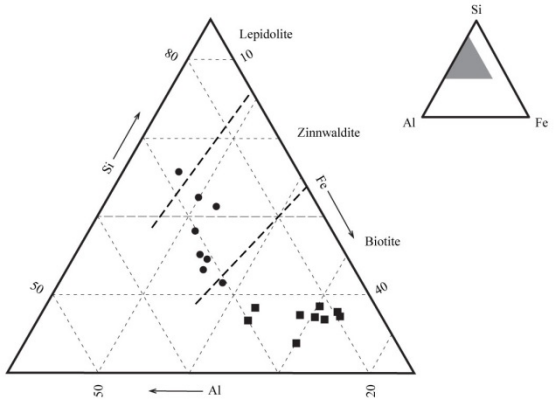
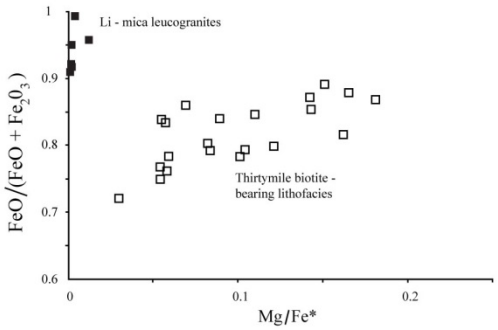


Figure 4. Proportions of quartz - albite - orthoclase for the various lithofacies of the Thirtymile and Ork stocks compared to experimental data for a fluorine - bearing system.



Cation proportions of Al-Si-Fe in micas from Thirtymile & Ork granites



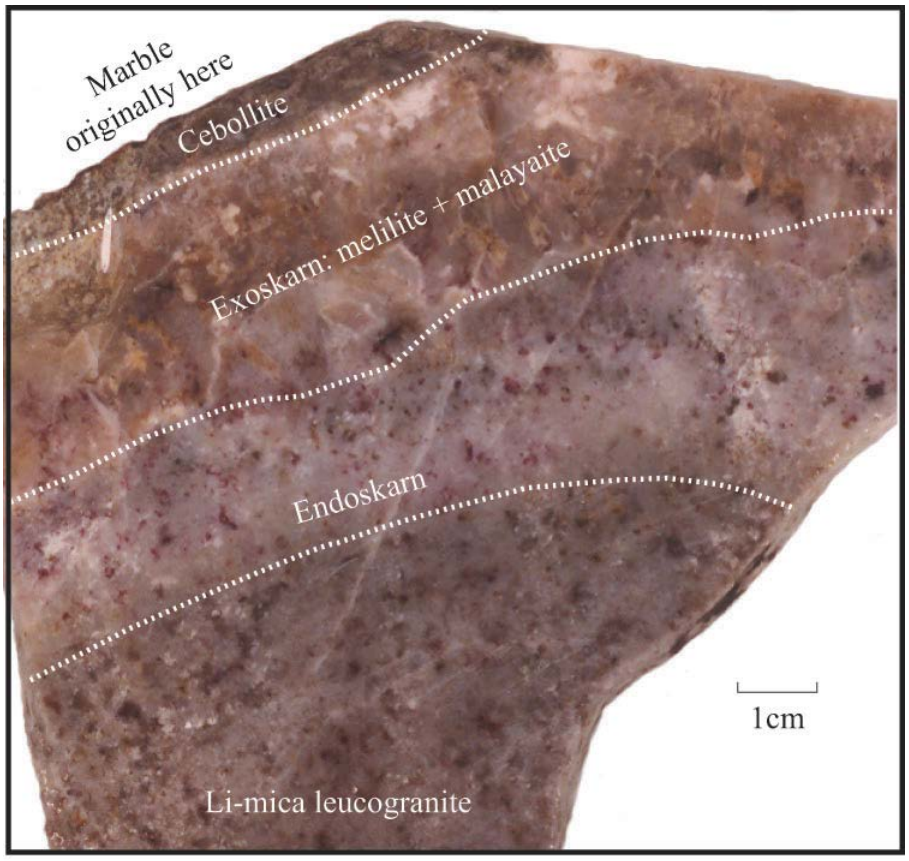
Ferrous iron proportion to Mg/Fe ratio of micas

Figure 5. Chemical data for Thirtymile - Ork micas

ORK AND MINDY PROSPECTS: GEOLOGY

ORK

The Ork prospect {Minfile 105C-9 054B} shows excellent exposure of the contact of the Li-mica topaz leucogranite stock with the marble unit in the creek that drains northward. The mineralogy at the Ork reflects the chemistry of the intrusion. At this locality the marble is of predominantly calcite and the skarns are of very small scale, the whole endoskarn-exoskarn-marble sequence being on the scale of one hand specimen (Fig. 5). The leucogranite has calcic plagioclase for a few centimetres (endoskarn), then an exoskarn of melilite ± malayaite for ≈ 6 cm, a final 5 mm 'rind' of cebollite and a sharp contact to white calcite marble



Ork contact. Endoskarn is plagioclase & fluorite, exoskarn predominantly melilite, with a layer of cebollite originally in contact with marble

Figure 6: Ork granite contact (sawn slab)

. Two 1 metre thick amazonite-zinnwaldite bearing pegmatite dykes are found within 15 metres of the contact in the creek. Some 300 metres west, where a (?) 10 metre thick bed of carbonate consists of dolomite with decimetre-scale lenses of calcite marble, the contact metamorphism is seen as zoning of diopside at the lens contact with axinite crystals in the carbonate indicating the boron content of the granite. To the east of the Ork creek the marbles contain centimetre-scale fluorite veins. Pod pegmatites are found in the stock, some 100 metres north of the contact.

MINDY

The Mindy prospect consists of sparse exposure and frequent float of two marble-skarn horizons within the siliciclastic rocks. The property was mapped in detail during the 1988 season (Fig. 2). The regional mapping (Liverton, 1992) indicated the presence of at least three E-W striking extensional faults that transect the property and which have been interpreted to be the principal 'plumbing' for the introduction of hydrothermal fluids into the carbonates. These faults have little displacement and likely were associated with the granite intrusion. This is particularly indicated to the west of Mindy where scheelite-bearing diopside skarn is developed alongside one such fault (see green skarn band marked on Fig. 2) which also projects through the mineralized portion of the Mindy prospect. An interpretation of diamond drill sections indicated that the lower carbonate-skarn unit, the only potentially economic horizon, is boudinaged (Fig. 8). Away from the extensional faults (Fig. 7) it consists of pure calcite marble. On the Mindy property the carbonates locally dip at from 9° to 25° to the east. Skarns containing tin minerals, which show evidence of much greisen alteration, are developed adjacent to the extensional faults.

MINERALOGY AND CHEMISTRY OF THE MINDY SKARN

Core from the 1981 diamond drill holes was made available by Terry Macauley of Newmont for the original research into the Mindy skarn (1988-1992). This material was logged and sampled for petrography-mineragraphy and electron microprobe / SEM analysis in 1988. The core is now stored in the Yukon Geological Survey Core Library. This present work is based on a re-sampling of those core intervals that showed significant tin assays from the Newmont work.

UPPER SKARN

The upper skarn consists predominantly of vesuvianite-grossular-calcite skarn with acicular vesuvianite crystals up to 40 mm long. No tin mineralization has been noted from this unit. The margins of the coarse skarn grade into aphanitic 'calc-silicate hornfels' (diopside-hedenbergite), with siliciclastic metsediments above. This hornfels would correspond to the bimetasomatic skarn type of Kwak (1987). The garnet of this horizon (≈ 21% andradite) is significantly more aluminous than that of the main horizon, presumably reflecting the protolith chemistry.

LOWER SKARN

The skarns of the lower horizon are best developed at the north and south extremities of the surface exposures of the marble unit. Textural evidence suggests that the original protolith controlled much of the skarn mineralogy and that migration of many chemical components during contact metamorphism and metasomatism was on a small scale. In the fine-grained hornfelses C-S fabric that developed during thrusting is preserved in calc-silicate mineralogies. Some original porphyroclasts are scapolite and diopside and the matrix is diopside-hedenbergite. Near the base of the lower skarn (DDH 81-8, 87.78m) a chert clast in brecciated calcite marble has a 7mm thick 'bimetasomatic' amphibole skarn rim developed, but the original cataclastic texture of the rock is preserved. At the northern limit of surface exposure (900N, 160W) epidote-chlorite-magnetite marble at the base of the unit also retains the pressure-solution fabric of the protolith.

The process of skarn formation has had an obvious structural control. Development of successive retrograde and greisen skarn assemblages has each accompanied a separate episode of fracturing of earlier skarn.

The primary skarn consists predominantly of nearly pure larnite+diopside or coarse garnet-vesuvianite skarn (Figs. 17, 24A). Successive alteration has produced increasingly Fe-rich pyroxene to nearly pure hedenbergite at the southernmost surface exposures. Diopside predominates after the high-temperature garnet-rich skarn. These skarns were obviously developed during active movement on the extensional faults (some of which are seen in outcrop at the upper skarn horizon). Cataclasis of the diopside pyroxene seen in thin sections that has a range of compositions from salite to ferrosalite indicates continued brecciation. Disequilibrium in composition over the scale of a thin section is quite usual in the central mineralized part of the skarns.

Chondrodite, recognisable by its lamellar twinning, is occasionally found in the pyroxene skarn, but is more commonly seen associated with actinolite amphibole (as at the southermost surface exposures in massive ferroactinolite-chondrodite-fluorite-pyrrhotite skarn) or as relicts in the phlogopite-magnetite-fluorite wrigglite that is interpreted to be a later greisen-skarn overprint that has largely replaced the chondrodite.

Amphibole alteration of the pyroxene and less commonly garnet, is most obvious in sheared skarn (Figs. 18, 19A, 24B), giving rise to the complete compositional range of the tremolite-ferroactinolite series. Tremolite-actinolite in the northern part of the prospect (drillholes 1 to 3) is found in fracture zones that cut the pyroxene or garnet-vesuvianite skarn (Fig. 24B). Clearly movement continued on the minor extensional faults during retrograde metamorphism/metasomatism. Further retrograde alteration also appears as ferrophengite in the greisen-skarn. Massive magnetite-pyrrhotite-borate-fluoride mineralization has replaced chondrodite as the first fluorine-bearing phase.

The most striking texture of this phase of metasomatism is the intricately banded 'wrigglite' (c.f. Kwak and Askins, 1981; Kwak, 1987). The wrigglite consists mostly of contorted layers of magnetite and sulphides (pyrrhotite with minor pyrite, arsenopyrite and chalcopyrite) with phengite or occasionally talc, with lesser amounts of fluorite, fluoborite and corroded relicts of chondrodite and vesuvianite. The zones of wrigglite are obviously discordant to bedding of the host rock, hence representing fracture systems and the wrigglite veins

themselves may be cut by several generations of microfractures < 1mm to 3mm wide that carry phengite, talc and scarcer ferrophengite or serpentine.

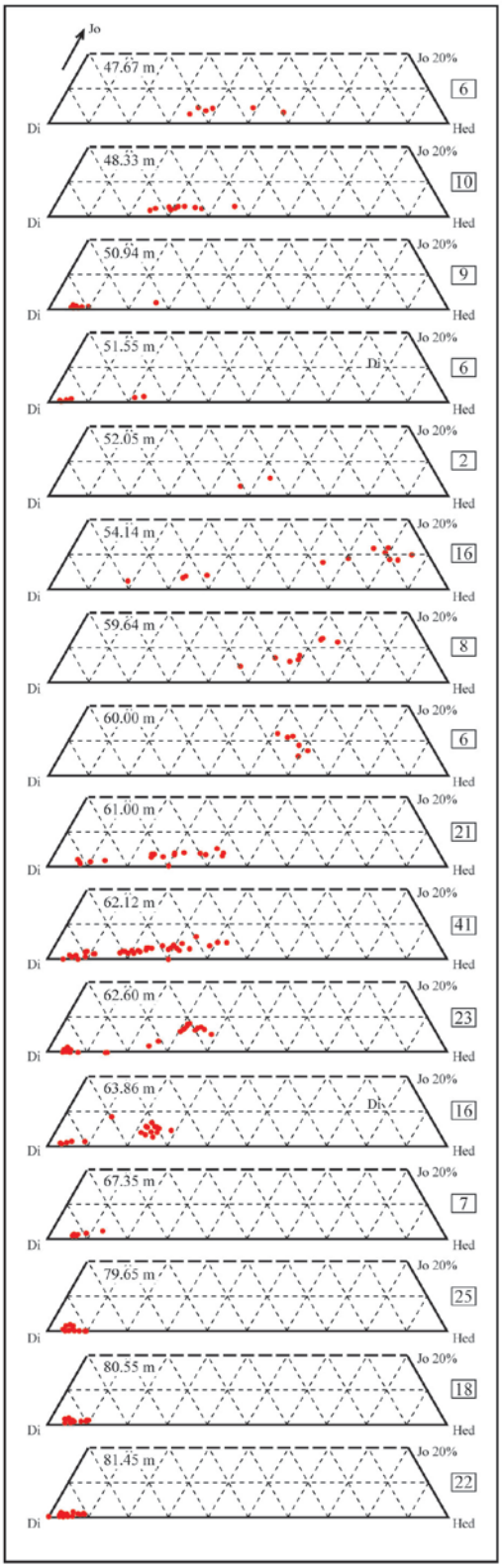
Peripheral alteration of diopside-hedenbergite skarn to fluoborite and serpentine is also observed, coarse euhedral fluoborite possibly representing replacement of remnant carbonates as the earliest F-B mineralization. Massive replacement of early skarn by magnetite and the vonsenite-ludwigite series minerals with hülsite occurs along with the wrigglite skarns. The F-bearing mineral assemblages represent greisen alteration of the main skarns. It is likely that the wrigglite texture was developed by direct replacement of remnant carbonate during the greisen stage of mineralization and the more massive mineralization was introduced along fracture systems and it altered existing skarn silicates.

Discordant vein skarns in marble are of andradite-arsenopyrite (the garnet varying from honey-brown to deep green andradite) to approximately 1 metre thickness, or tiny stockworks of finer (5mm) vonsenite veins with clinohumite-group minerals as a selvedge. Occasional wollastonite primary vein skarns are found in white calcite marble sections. At most stages of retrograde skarn formation a fracture control is obvious.

SKARN CHEMISTRY

Compositions of pyroxenes, amphiboles, garnets and vesuvianite were determined using energy dispersive X-ray analysis with a Jeol electron microprobe on polished thin sections and blocks of specimens taken from diamond drill core. The most complete section of pyroxene analyses through the lower (main) skarn was obtained from core of DDH 3. In compositional plots two populations of pyroxene are evident: a tight group of 0-12% hedenbergite (interpreted as being the 'primary' pyroxene) and then a wide variation in compositions from the same stratigraphic interval (interpreted as being formed by successively iron-rich metasomatic fluids).

(Figure 16 follows)



Proportions of diopside-johannsenite-hedenbergite in skarn pyroxenes from drill core. Drill hole 81-3. Electron microprobe analyses.

Each diagram shows the range of compositions across one thin section. Numbers of analyses are shown in the boxes.

The range of compositions (Fig. 16) from each interval analysed emphasises this relationship. The broad range in pyroxene composition is mirrored by the scapolite: a range from 79.1-100% meionite being analysed in one thin section from DDH 3: 47.67m. Fewer analyses of amphiboles were obtained from the same specimens, but at least for DDH 3 it may be stated that a wide range in Fe contents were observed ({Fe/(Fe+Mg+Mn} varies from 0.061 to 0.773).

Vesuvianite is an occasional component of the main skarn horizon, notably in nine decimetre-scale magnetite-garnet-vesuvianite bands in diopside skarn within the 4.4m interval below 70.8m in DDH1 and from 81.45-81.53m in DDH 3, where it is found in 10mm crystals with garnet. Analyses from one specimen are shown in the following table.

SiO_2	CaO	FeO	MgO	Al_2O_3	MnO_2	TiO_2	Total	DDH 81-3
38.66	36.43	3.34	1.94	17.24	0.26	1.26	99.77	81.45m
37.78	36.36	4.22	2.77	13.31	0.49	3.76	99.38	81.45m
38.10	37.37	3.47	1.88	16.35	0.16	1.13	99.10	81.45m
38.59	37.03	4.29	1.44	16.53	0.04	1.44	100.09	81.45m
37.95	36.89	3.33	1.90	17.00	0.42	1.17	99.40	81.45m
38.76	36.89	3.73	1.72	16.81	0.39	1.36	100.38	81.45m

Table 1 Microprobe analyses of vesuvianite from DDH 81-3.

As is usual in skarn there is some variation in chemical composition even over the scale of a thin section.

The garnet of the main skarn horizon is andradite-grossular, with < 4% spessartine or < 6% almandine components (using the method of Droop, 1987 to estimate Fe^{3+}). It varies from 58-99% andradite, with the exception of the garnet found with the vesuvianite of DDH 3, 81.45m (andradite ≈18%). The phlogopite or talc of the 'wrigglite' greisenised skarn was not analysed but deep green, strikingly-zoned ferrophengite (Figs. 21A, 23A) associated with the other phyllosilicates was analysed by the microprobe, as well as being identified by X-ray powder diffraction. The ferrophengite is a particularly Fe-rich and Si poor variety in comparison to the analyses quoted in Fleet (2003).

SiO_2	CaO	FeO	MnO	Al_2O_3	K_2O	Na_2O	Total	
37.21	0.13	29.37	2.17	18.39	9.09	0.29	96.64	81-5B, 106.75; mean of 8 analyses

Table 2. Analysis of ferrophengite by electron microprobe

Chemical evolution of the skarn metsomatism would have been from high temperature alteration of the carbonate with mostly silica introduction to produce the larnite high temperature (800°C) calcic skarn, subsequent garnet-vesuvianite skarns, then diopside-rich primary skarn, followed by successive Fe-enrichment of the hydrothermal fluid to produce the range of salite to hedenbergite pyroxene, then retrograde alteration to produce amphibole assemblages. Late introduction of HF to produce fluorite / chondrodite assemblages was followed by the magnetite – phengite 'wrigglite' greisenized skarns that carried the bulk of the tin. Cassiterite was probably earliest in the fluorine-rich stage and the borate-fluoride minerals accompanied the latest greisen alteration. The latest vein retrograde stage is represented by serpentine with occasional bandylite $\{CuB(OH)_4Cl\}$. Prominent bleached zones as selvedges to fractures in the siliciclastics above the lower skarn, which have been attributed elsewhere to $CaCl_2$ 'exhaust solutions' from the metasomatism indicate that abundant chloride was present with the B to form this unusual mineral.

TIN MINERALIZATION

Although no quantitative analysis for tin was performed on the silicate phases, the spectra from electron microprobe energy-dispersive analyses were frequently examined qualitatively for tin peaks. No discernable peaks were found, so tin levels in the garnet, pyroxene, amphiboles and vesuvianite are expected to be << 0.5%. Tin mineralization does not obviously occur until the early greisen-skarn stage, appearing first as cassiterite in magnetite-phlogopite altered marble and as possibly later fluoride-borate minerals accompanying magnetite-fluorite-fluoborite in wrigglite. The visible tin mineralization as either cassiterite, vonsenite-ludwigite or hülsite phases accompanies a massive introduction of iron as magnetite and often lesser amounts of pyrrhotite and pyrite into the skarn. In just one specimen the pyrite has been observed to form wrigglite texture with the fluorides and phengite (Fig. 22C). Nordenskiöldine is a rare mineral indicated by SEM scan from surface specimen {685N, 290W}.

SKARN TYPE

Kwak (1987) has elaborated the classification of skarns proposed by Einaudi and given general paragenetic mineral sequences for both calcic and magnesian protoliths. Although no intrusion was intersected in the drilling of the Mindy prospect, it is reasonable to infer the existence of a stock immediately below the skarns (skarn mineralogy is of the proximal type and a biotite-cordierite aureole is obvious in the more pelitic siliciclasic sediments surrounding the marble/skarn units). In particular, the presence of larnite in relict carbonate indicates possible initial fluid temperatures of 800°C. Most of the lower primary skarn conforms to Kwak's ‘Proximal high-T, non-greisen, reduced Sn-skarn’ type, but the local subsequent development of 'wrigglite' zones are of the ‘greisenised skarn’ type rather than greisen-skarn directly formed from carbonate (c.f. Kwak, 1987). The latter type occurs only as occasional 10 cm thick veins in the marble.

FAULTING AND FRACTURING

Early fracturing of primary skarn appears to have occurred as single discrete events: a particular alteration is associated with each. The last stage of fracturing, where serpentine

alteration abounds, may have involved several individual events of lesser energy. In 81-4, 149.72 (Fig. 18) the latest developed fracture system is an en-echelon array of serpentine-quartz veins at 75° to the common fracturing and alteration of the skarn. That last vein system shows textural evidence of a least six crack-seal events.

THE 2014-2015 WORK

METHODS

Those intervals of drill core that had yielded significant tin values in the 1981 assay work of Newmont were re-sampled by sawing the minimum thickness slices useful for thin section preparation from the remaining half of the material at the Core Library. Thin and polished thin sections of 'standard' 25x50mm or 50x75mm size were prepared by Vancouver Petrographics Ltd. Initially 17 specimens were chosen from the 2014 sampling, then six more from material remaining from the original 1992 work. The aim of the work was to better understand the skarn-forming events and to make an attempt at estimation of the relative proportion of oxide (cassiterite) to borate-fluoride tin minerals.

PETROGRAPHY / MINERAGRAPHY

The specimens prepared are shown in Table 3 below. Indicated in blue are those remaining from the 1992 work which have been re-examined. Twenty-three new standard thin, polished thin or large sections were prepared. ('pts' refers to polished thin section, LTS, large thin section and LPTS, large polished thin section.) Tin-bearing minerals are shown in red, borates in green. The borate-fluoride minerals seen are: fluoborite [$Mg_3(F,OH)_3BO_3$] (Winchell), vonsenite [$3(Fe,Mg)O.2Fe_2O_3.SnO_2.3B_2O_3$] (Dana) and hulsite [$(Fe^{2+},Mg)2.(Fe^{3+},Sn)BO_5$] (Mineralienatlas). Nordenskïoldine [$CaSn(BO_3)_2$] was identified in one specimen (surface {685N, 290W}) by SEM in the 1992 work. The thin and polished thin sections were examined under the petrographic/mineragraphic microscope and appropriate photomicrographs taken to illustrate mineralogy and textures. The mineralogy shown in photomicrographs is also given in the tables and on the graphic logs (Figs. 9 to 15). Brief

petrographic descriptions are appended and additional photomicrographs appended on DVD disk.

DRILL HOLE & INTERVAL	MINERALOGY
81-1 65.2-65.3	Quartzite: diopside, actinolite
81-1 67.0-67.08	Diopside, carbonate, serpentine
81-1 69.55-69.62	Diopside, actinolite, serpentine
81-1 73.4-73.49	Cassiterite, magnetite, talc
81-1 75.42-75.49 *M1*	Wollastonite, fluoborite, vonsenite
81-1 76.52-76.56 *pts*	Diopside, hulsite, pyrrhotite. magnetite
81-1 76.60-76.67	Diopside, carbonate, scapolite, magnetite, cassiterite, sulphide, phengite.
77.88-77.92 M2 *pts*	Magnetite, wollastonite, fluoborite, cassiterite.
81-1 88.0-88.90	Vesuvianite, diopside, serpentine
81-1 83.9-84.02 *M3*	Vesuvianite, diopside
81-1, 88.4-88.61	Quartzite with biotite, cordierite
81-2, 89.87 *LTS*	Chondrodite, vonsenite, magnetite, pyrite, fluoborite, talc, serpentine
81-2 86.66-86.74 *M4 pts*	Diopside, actinolite, pyrrhotite, fluorite, ferrophengite, pyrite, chalcopyrite
81-2 86.82-86.89 *M5 LTS*	Pyrrhotite, ferrophengite, talc, fluoborite, bandylite arsenopyrite
81-2, 89.87 *LTS*	Chondrodite, vonsenite, magnetite, pyrite, fluoborite, talc, serpentine
81-2 92.45-92.49 *M6 pts*	Pyrrhotite, arsenopyrite, chalcopyrite chondrodite, wollastonite, diopside, talc
81-2 93.66-93.71 *M7 pts*	Fluoborite, fluorite, pyrrhotite, arsenopyrite
81-2 96.10-96.18 *M8*	Pyrrhotite, phengite, fluoborite, serpentine.
81-4 70.17-70.25 *M9 pts*	Diopside, magnetite, pyrrhotite, arsenopyrite, garnet
81-4 142.50m	Magnetite, sphalerite, talc, fluoborite, bandylite, phengite
81-4, 148.30 *M18 pts*	Magnetite, pyrrhotite, fluoborite, fluorite, arsenopyrite
81-4 148.40-148.5 *M10 pts*	Ferrophengite, magnetite, pyrrhotite, arsenopyrite, chalcopyrite, bandylite, serpentine
81-4 149.72-149.82 *M11 LPTS*	Garnet, salite, ferroactinolite, pyrrhotite, fluorite
81-4 150.00 *M19 pts*	Garnet, hedenbergite, actinolite, pyrrhotite
81-4 151.15-151.23 *M12 pts*	Diopside, pyrrhotite
81-5B 66.72 *M20 pts*	Garnet, salite, actinolite, pyrite

81-5B 103.47-103.51 *M13*	Andradite, diopside
81-5B 104.85-104.92 *M14 pts*	Actinolite, fluorite, cassiterite, ferrophengite
81-5B 105.08 *M21*	Garnet, vesuvianite, actinolite
81-5B 106.75 *M22 pts*	Magnetite, pyrrhotite, chalcopyrite, ferrophengite, cassiterite
81-5B 108.87 *M23 pts*	Magnetite, pyrrhotite, arsenopyrite, fluorite, talc, cassiterite
81-5B 109.06-109.11 *M15*	Cassiterite, phengite, quartz, pyrrhotite
81-5B 111.25-111.34 *M16 pts*	Fluorite, phengite, fluoborite, quartz, amphibole, pyrrhotite, cassiterite
81-8 48.92-49.0m *M17 LPTS*	Magnetite, hulsite, vonsenite
81-8 49.00 *pts*	Pyrrhotite, vonsenite, hulsite, fluoborite, serpentine
81-8 66.8 *pts*	Garnet, diopside

SURFACE SPECIMENS

Coordinates refer to the original Newmont grid (Fig.6). Distances (e.g., 1½m) give depth from top of a near vertical face.

125N 110W - 1½m	Diopside, larnite, actinolite, fluorite
125N 110W – 4m	Diopside, serpentine, fluorite, actinolite, carbonate
125N 119W - 1½m	Diopside, larnite, calcite, actinolite
660N 180W	Quartzite: phacoidal garnet and diopside
660N 180W (second slide)	Diopside, vesuvianite, garnet.
670N 285W	Diopside, magnetite, garnet, vesuvianite, epidote, borates
685N 240W	Quartzite with a little plagioclase, carbonate layers
690N 270W	Chlorite, carbonate in siliciclastics, diopside, epidote
690N 285W	Garnet, vesuvianite, carbonate, pyroxene, sphene, epidote
695N 280W	Vonsenite

Table 3. Mineralogy of the skarns

Figures 17 to 24 illustrate the various skarn types, as follows:

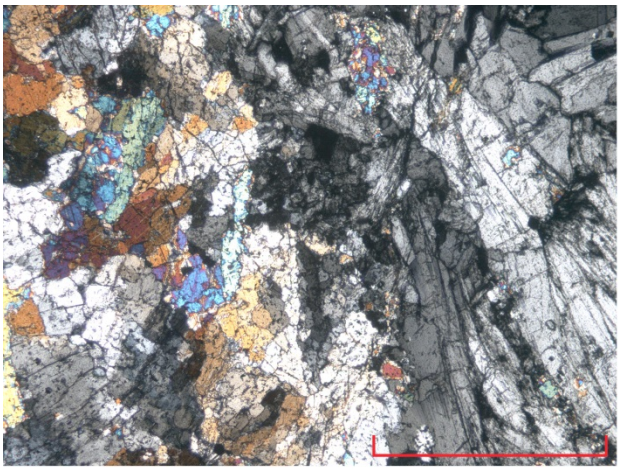
Primary skarn

Figure 17A. Primary skarn: vesuvianite and diopside. Crossed polarizers. Scale bar 1mm.

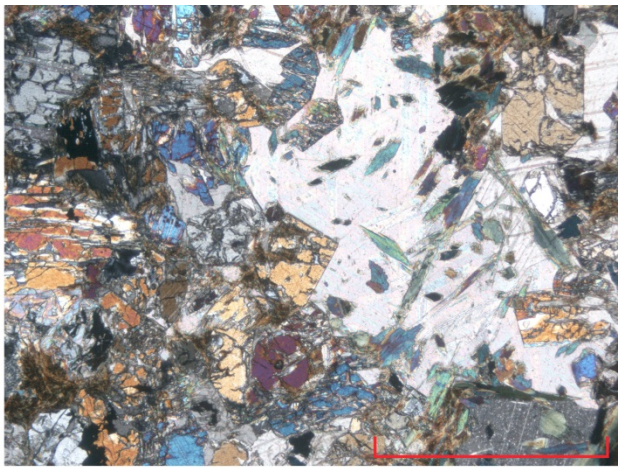
B. Remnant larnite in carbonate, diopside, actinolite. Crossed polarizers. Scale bar 1mm.

C. Diopside altered to actinolite. Crossed polarizers. Scale bar 1mm.

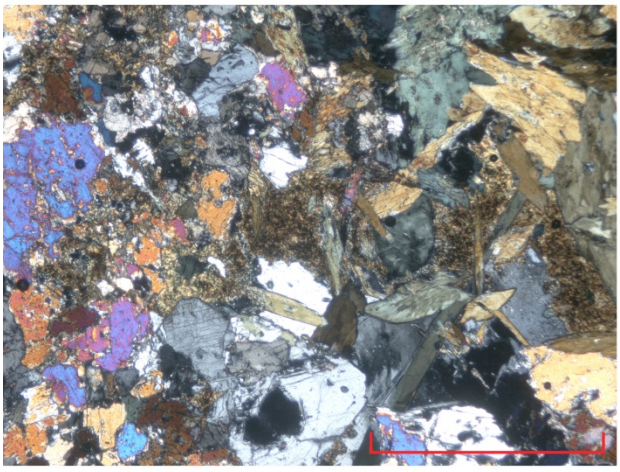
D. Chondrodite showing twinning (lowest interference colours). Crossed polarizers. Scale bar 1mm.



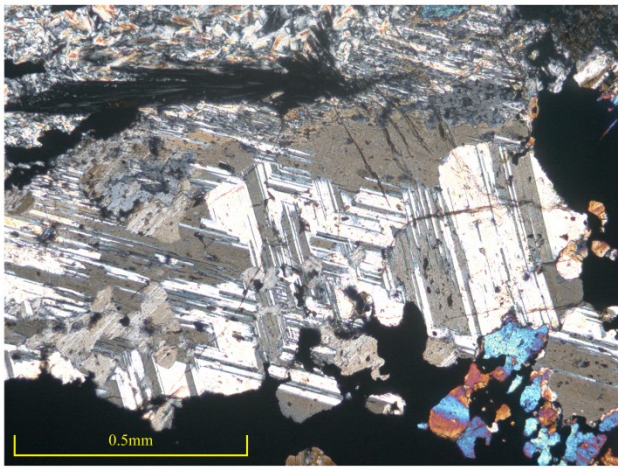
A: DDH 81-2, 83.80m



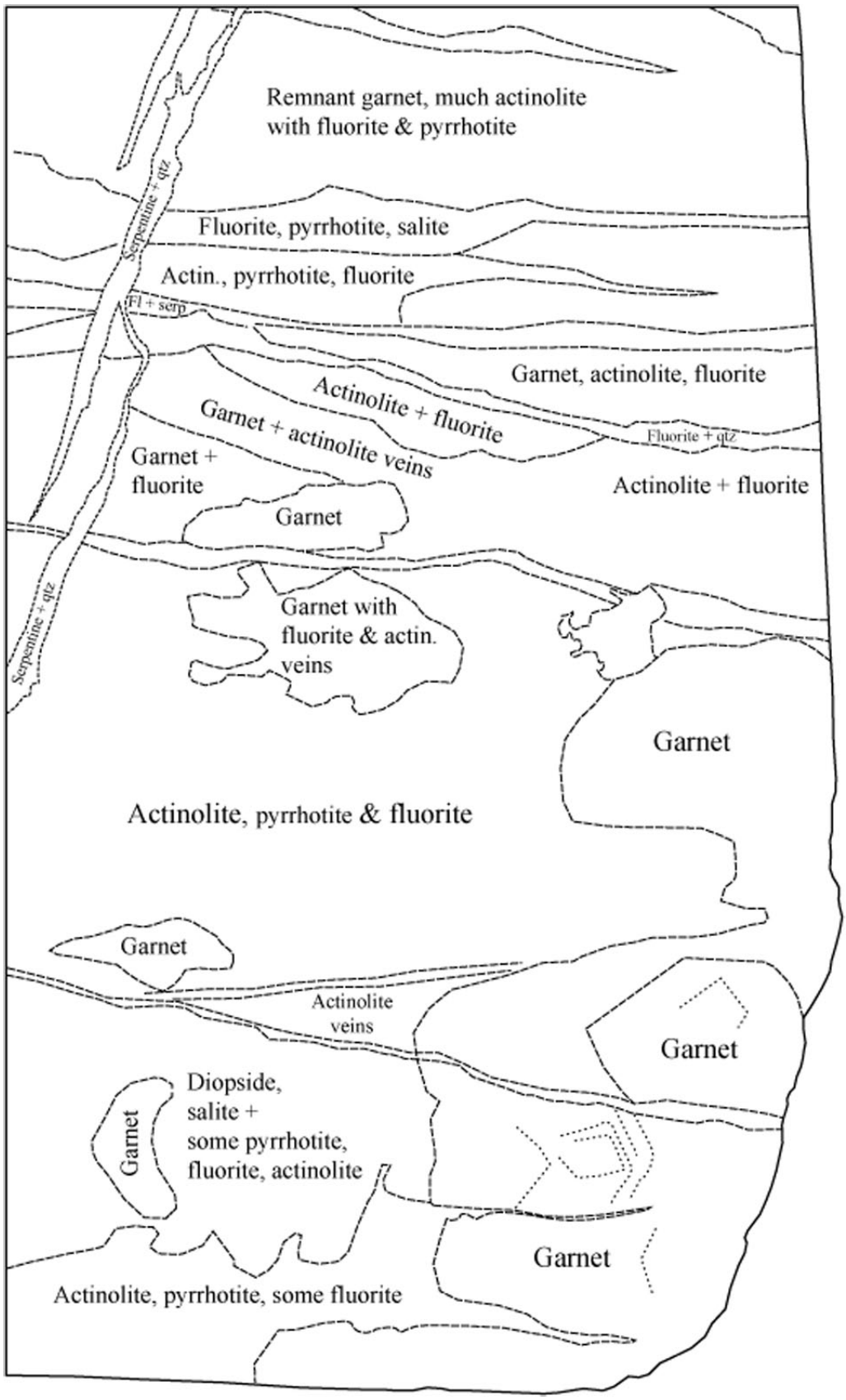
B: Surface 125N, 119W



C: DDH 81-2, 69.55m

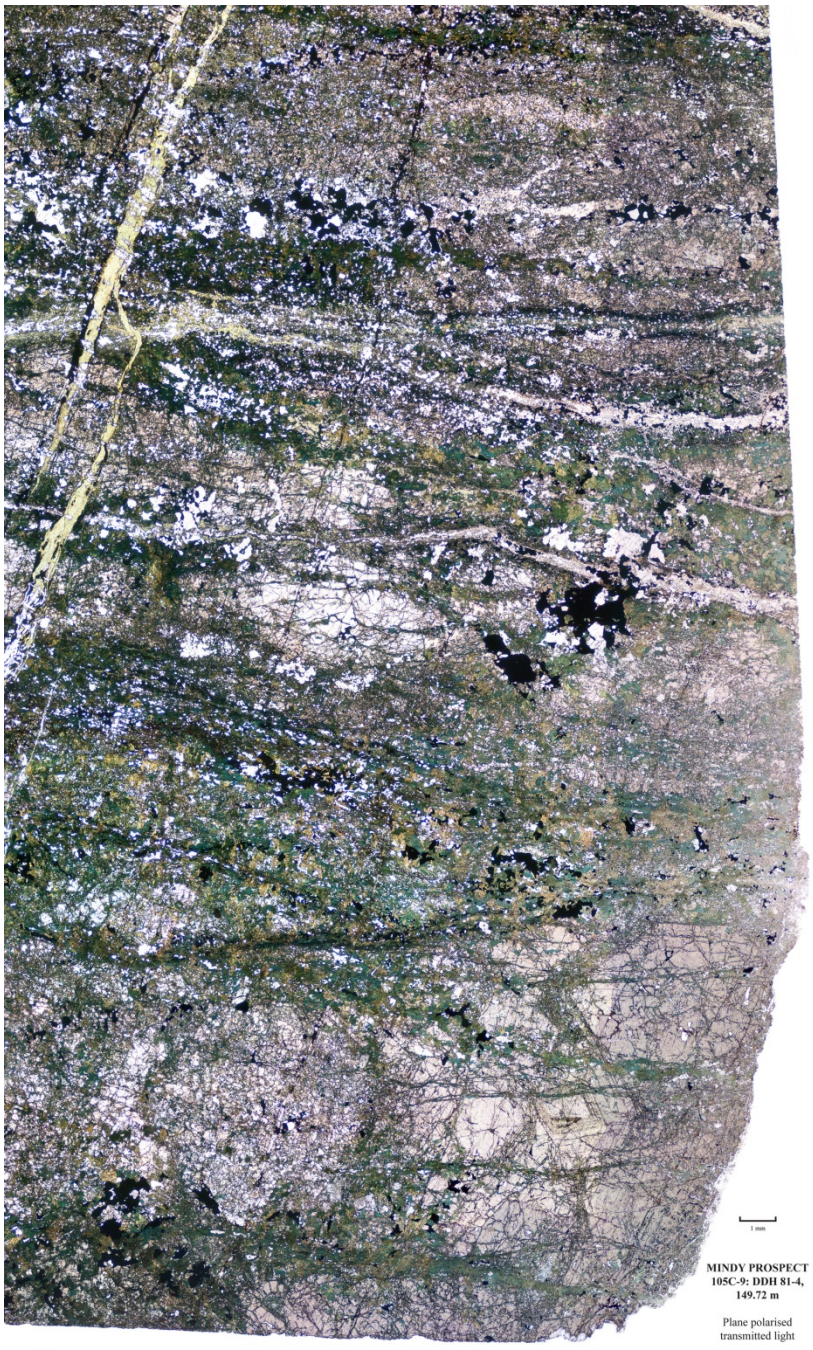


D: DDH 81-2, 92.45


Remnant garnet, much actinolite with fluorite & pyrrhotite
Serpentine + qtz
Fluorite, pyrrhotite, salite
Actin., pyrrhotite, fluorite
Fl + serp
Garnet, actinolite, fluorite
Actinolite + fluorite
Garnet + actinolite veins
Fluorite + qtz
Garnet + fluorite
Actinolite + fluorite
Garnet
Garnet with fluorite & actin. veins
Serpentine + qtz
Garnet
Actinolite, pyrrhotite & fluorite
Garnet
Actinolite veins
Garnet
Garnet
Diopside, salite + some pyrrhotite, fluorite, actinolite
Garnet
Actinolite, pyrrhotite, some fluorite

Fracturing & alteration: Figure 18.

Garnet-diopside-salite skarn altered to actinolite and mineralized with pyrrhotite and fluorite along fractures. The three en-echelon serpentine-quartz veins show evidence of 7 crack-seal events. Plane polarized transmitted light. Scale bar 1mm. 'Stitched' mosaic of 60 photomicrographs. See sketch alongside for mineralogy.



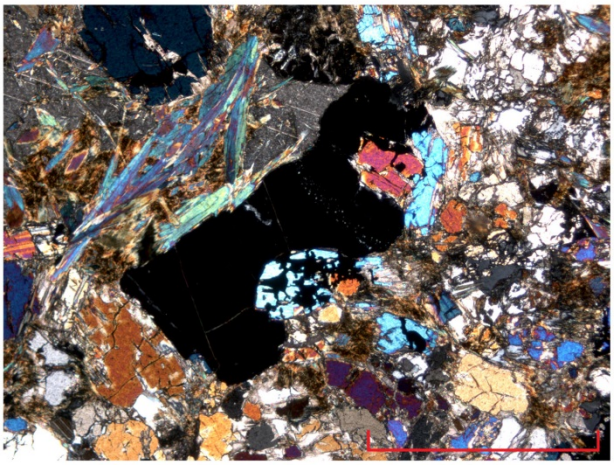
Alteration

Figure 19 A. Diopside altered to actinolite with fluorite and some serpentine. Crossed polarizers. Scale bar 1mm.

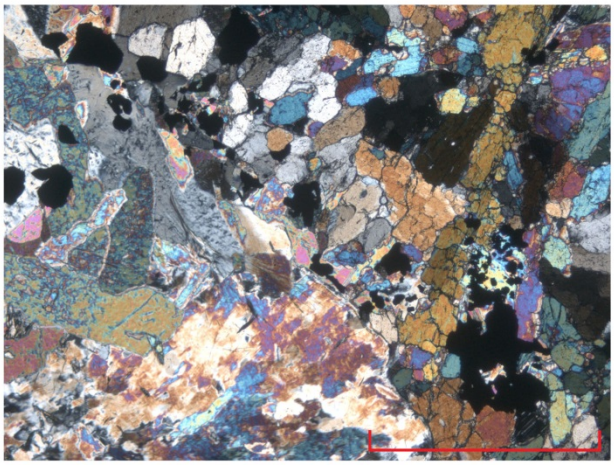
B. Diopside replaced by fluoborite (SW corner). Crossed polarizers. Scale bar 1mm.

C. Detail of fluoborite above showing tiny acicular vonsenite crystals. Plane polarized light. Scale bar 0.5mm.

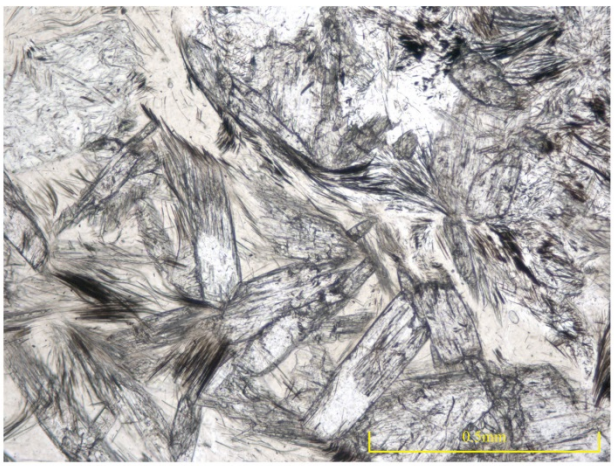
D. Euhedral diopside in hülsite and magnetite. Plane polarized reflected light. Scale bar 1mm.



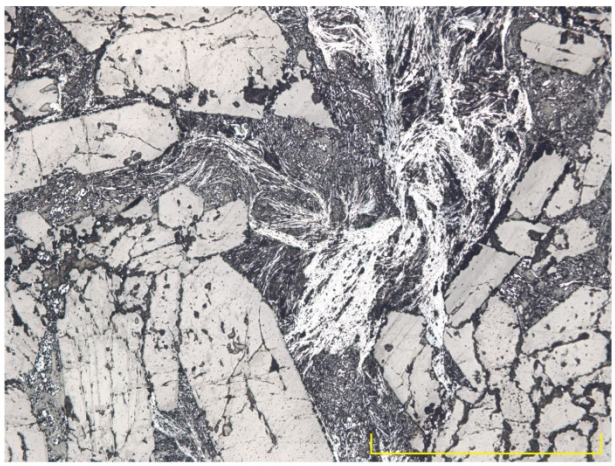
A. Surface 125N 110W



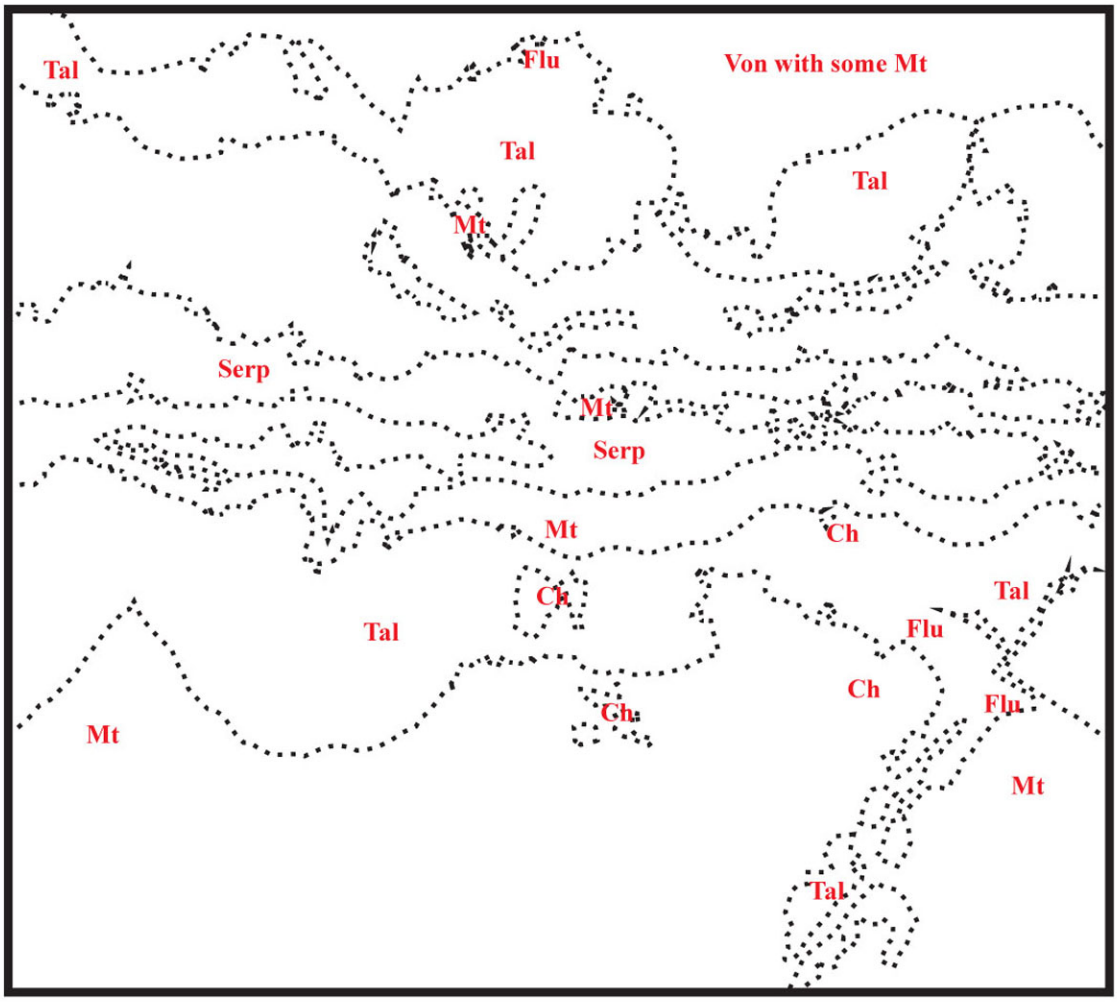
B. Surface 670N 285W



C. Surface 670N 285W



D. DDH 81-1. 76.52



MINDY DDH 81-2, 89.87m

Mineralogy.

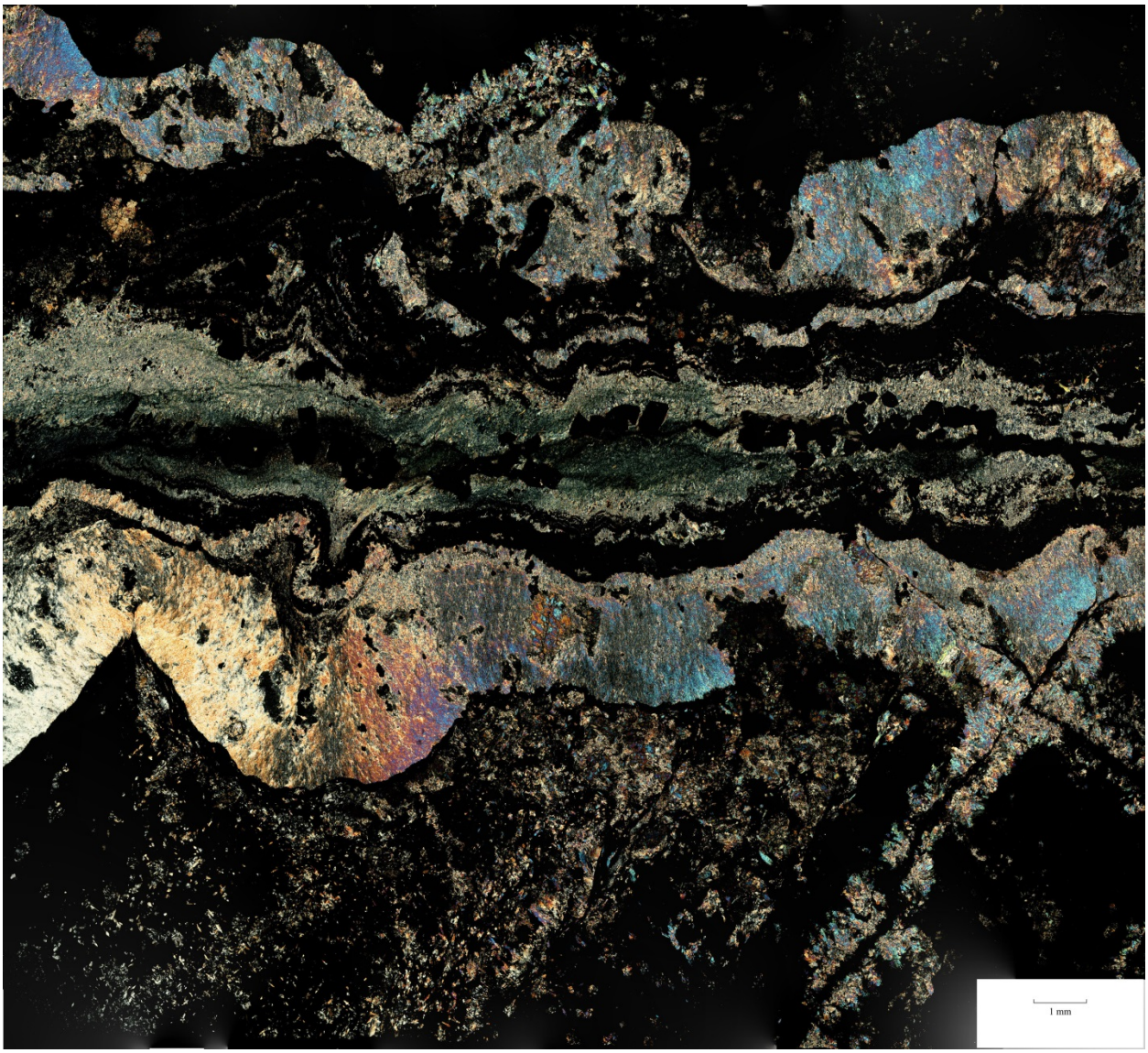
Ch = chondrodite relicts, Mt = magnetite, Tal = talc +/- phengite, Serp = serpentine, Von = vonsenite, Flu = fluoborite.

Figure 20a: Mineralogy shown in the following figure.

Magnetite-borate-fluoride mineralization

Figure 20.

Transmitted light with crossed polarizers. The opaque field is pyrrhotite and vonsenite, which contains relict chondrodite. The E-W vein has a selvedge of talc, with magnetite and serpentine (the green body colour predominates) in the core. 'Stitched' mosaic of 160 photomicrographs. Scale bar 1mm. See sketch alongside for mineralogy.



Mineralization

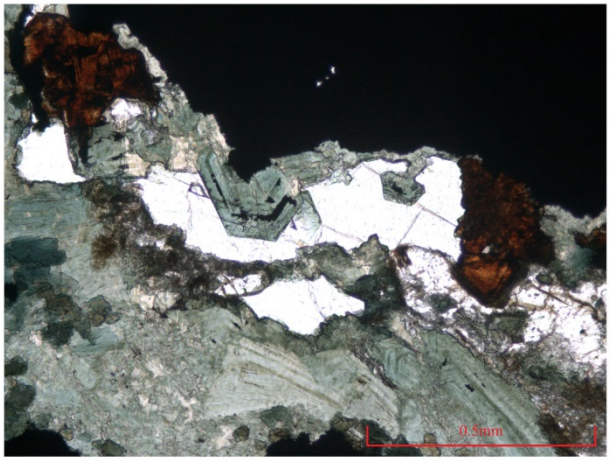
Figure 21 A. Cassiterite (perhaps 'wood tin') in fluorite with strikingly zoned ferrophengite and pyrrhotite. Plane polarized light. Scale bar 0.5mm.

B. Cassiterite containing inclusions (magnetite?) in carbonate with phengite and pyrrhotite. Crossed polarizers, scale bar 0.1mm.

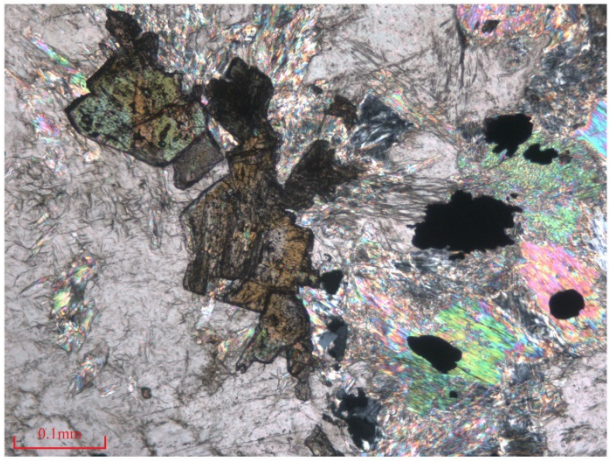
C. Radiating acicular vonsenite (with cores of magnetite to each cluster) in carbonate with remnant wollastonite and magnetite. Plane polarized light, scale bar 1mm.

D. Hülsite in fluorite. Plane polarized reflected light, polarizers at 85°.

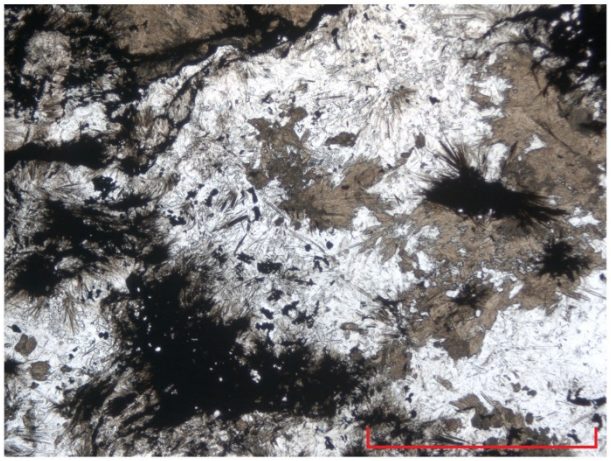
Scale bar 0.1mm.



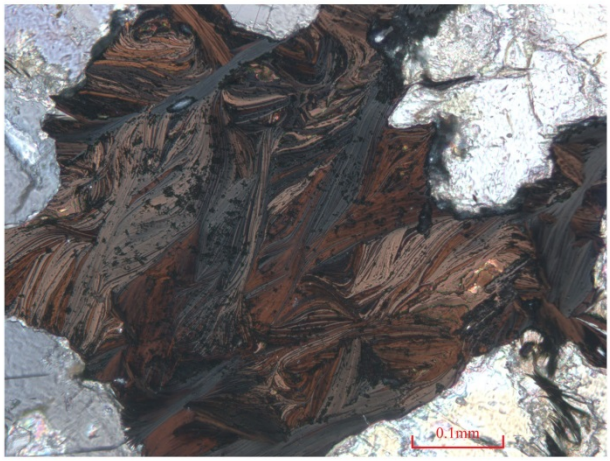
A. DDH 81-5B, 104.85m



B. DDH 81-2, 73.4m



C. DDH 81-1, 75.42m



D. DDH 81-2, 76.52

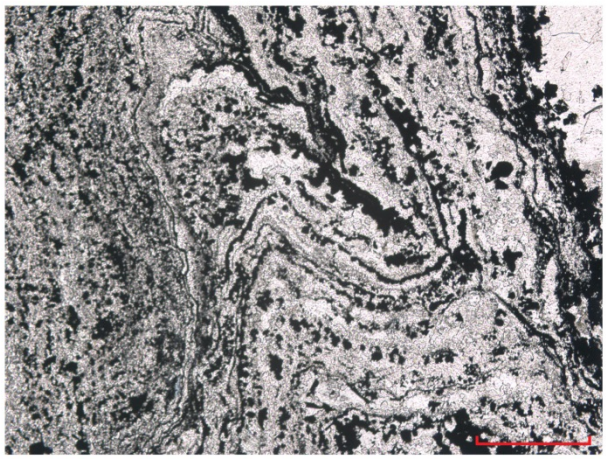
Wrigglite

Figure 22 A. Typical ‘wrigglite’ texture. Plane polarized light, scale bar 1mm.

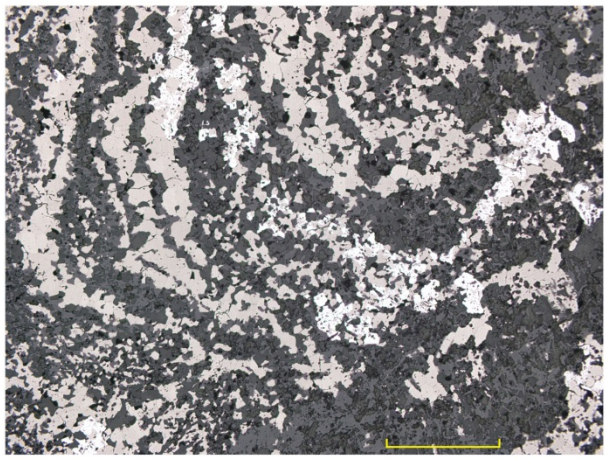
B. Detail of wrigglite: magnetite (mid grey) and pyrrhotite. Plane polarized reflected light. Scale bar 1mm.

C. Sulphide wrigglite: cassiterite in phengite with pyrite. Crossed polarizers. Scale bar 1mm.

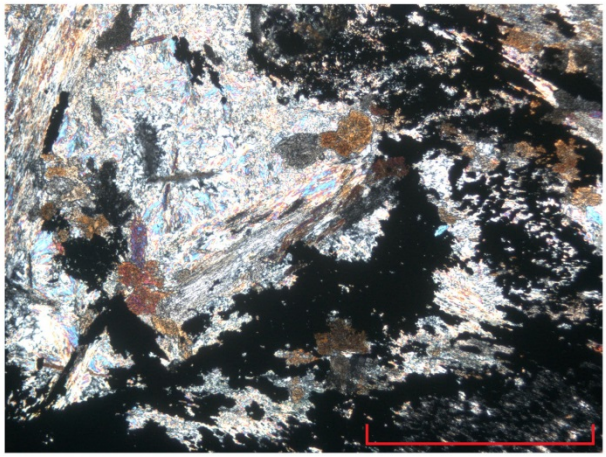
D. Wrigglite: magnetite, pyrrhotite and chalcopyrite (dull yellow, SW corner). Plane polarized reflected light. Scale bar 0.5mm.



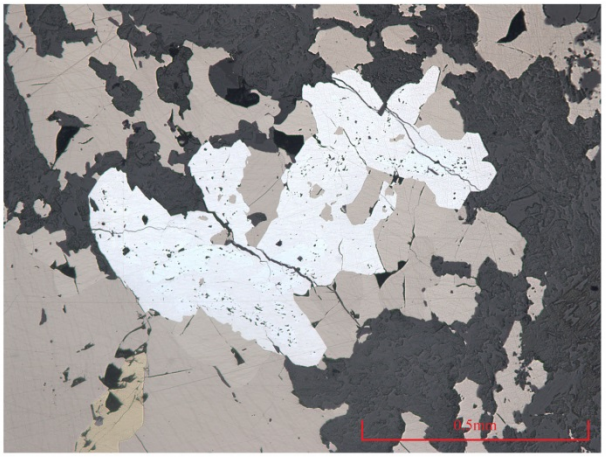
A. DDH 81-4, 148.40m



B. DDH 81-2, 86.66



C. DDH 81-8, 49.0m



D. DDH 81-2, 92.45

Bandylite, phengite, borates

Figure 23 A. Ferrophengite in fluorite. Plane polarized light, scale bar 1mm.

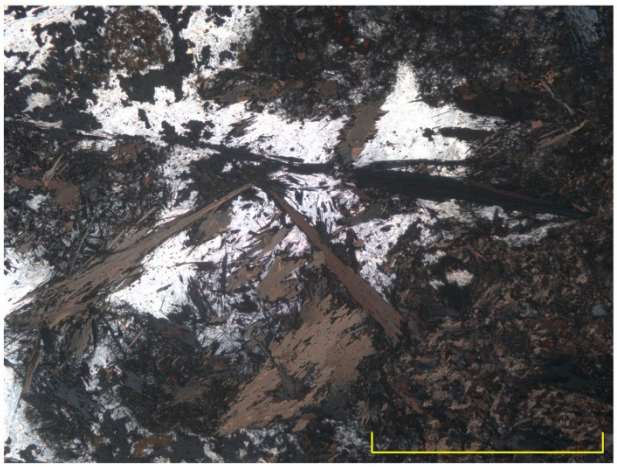
B. Vonsenite (acicular), hülsite ('wavy') in fluorite. Reflected light, polarizers at 85°. Scale bar 1mm.

C. Bandylite with some serpentine in fluorite. Plane polarized light, scale bar 0.5mm.

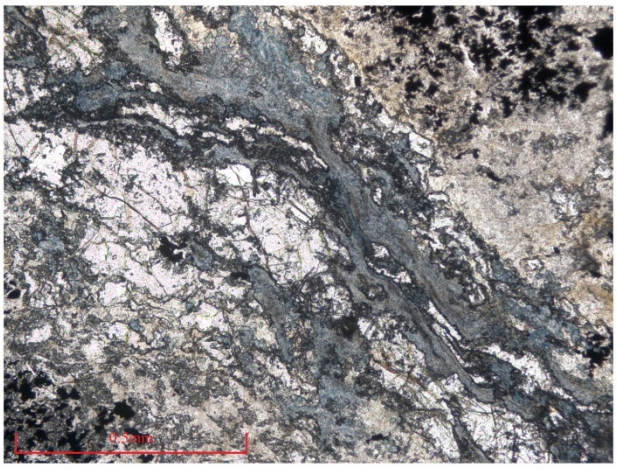
D. Bandylite with magnetite in fluorite, phengite and serpentine. Plane polarized light. Scale bar 0.1mm.



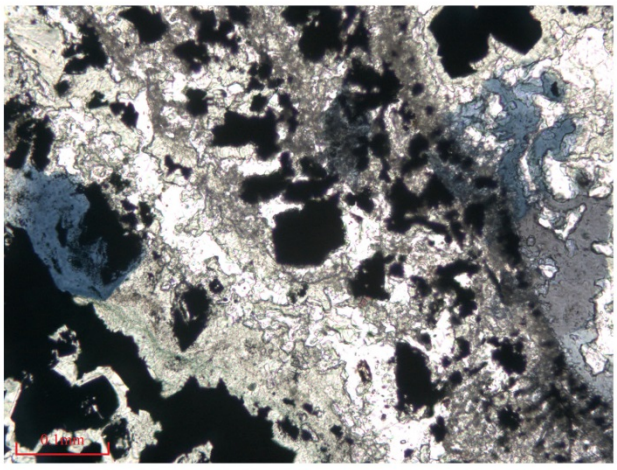
A. DDH 81-5B, 104.85m



B. DDH 81-8, 48.92m



C. DDH 81-2, 86.82m



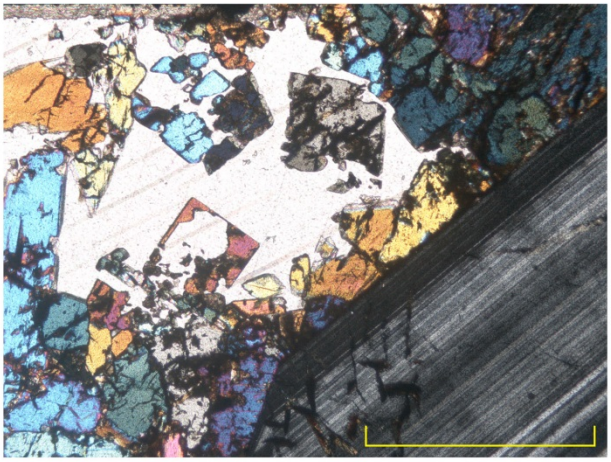
D. DDH 81-4, 148.40m

High temperature skarn, shearing and mineralization

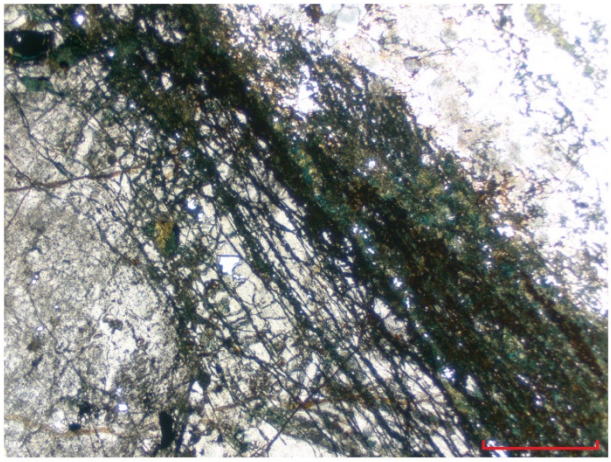
Figure 24 A. Primary skarn: zoned anisotropic garnet, diopside, carbonate and one skeletal larnite crystal. Transmitted light, crossed polarizers. Scale bar 1mm.

B. Shearing and retrograde alteration. Garnet (SW corner, sheared) is in fault contact with vesuvianite. Actinolite alteration has followed the shear zone. Transmitted plane polarized light. Scale bar 1mm.

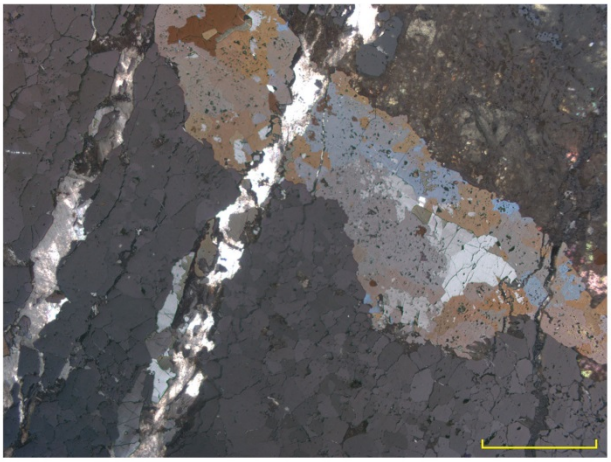
C. Two generations of vein mineralization: arsenopyrite and pyrrhotite cut by pyrrhotite-calcite in diopside skarn. Reflected light, polarizers at 85°. Scale bar 1mm



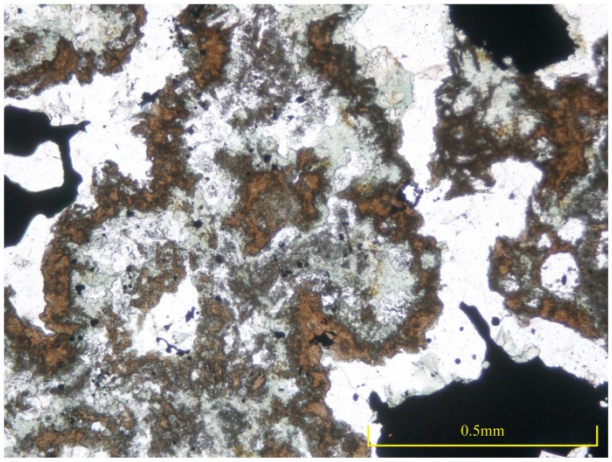
A. DDH 81-5B, 66.72m



B. DDH 81-5B, 105.08m



C. DDH 81-4, 70.17m



D. DDH 81-5B, 106.75m

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D. Wrigglite texture. This image shows cassiterite in wrigglite textured mineralization (uncommon in the Mindy prospect). Rings of cassiterite crystals are included in fluorite with cores of phengite, fluorite and very fine-grained cassiterite. The opaque mineral is entirely pyrrhotite. Transmitted plane polarized light. Scale bar 0.5mm.

Table 4, following, summarizes which specimens contain either massive magnetite-pyrrhotite or wrigglite mineralization and which have tin minerals present.

DDH	INTERVAL	SPECIMEN	MINERALIZATION	TIN
81-1	73.4-73.49		Mag repl marble	Cassiterite
81-1	75.42-75.49	M1	Massive mag	none
81-1	76.52-76.56		Borate repl diopside skarn	Hulsite, vonsenite
81-1	76.60-76.67		Po repl. diopside skarn	none
81-1	77.88-77.92	M2	Mag / cass. replaced marble	Cassiterite 1%
81-1	86.82-86.89	M5	Mag / Po wrigglite	none
81-2	89.87		Massive mag-Po	Vonsenite
81-2	92.45-92.49	M6	Po replaced chond	none
81-2	93.66-93.71	M7	Po / mag wrigglite	none
81-2	96.10-96.18	M8	Po wrigglite	none
81-4	70.17-70.25	M9	Massive mag / Po	none
81-4	142.50		Magnetite wrigglite	none
81-4	148.30	M18	Magnetite + Po wrigglite	none
81-4	148.4-148.5	M10	Po wrigglite	none
81-4	151.15-151.23	M12	Skarn / Po wrigglite	none
81-5B	104.85-104.92	M14	Magnetite replacement	Cassiterite
81-5B	106.75	M22	Magnetite-Po wrigglite	Cassiterite 2%?
81-5B	108.87	M23	Magnetite-Po wrigglite	Cassiterite 1%
81-5B	109.06-109.11	M15	Massive mag / Po	Cassiterite 1%
81-5B	111.25-111.34	M16	Po replaced skarn	Some cassiterite
81-8	48.92-49.00	M17	Massive borate	Cass. 2% + vonsenite
81-8	49.00		Po wrigglite / massive mag-borate	Vonsenite, hulsite

Table 4. Tin mineralization in the specimens examined.

It may be noted (see particularly the logs: Figs. 7 to 13 as well as the table above) that not all of the wrigglite carries obvious tin mineralization:

a) In DDH 81-1, the high Sn assay correlates with vonsenite / hulsite mineralization; cassiterite with a separate moderate grade interval.
b) In DDH 81-2, both cassiterite around 86.8m and vonsenite at 89.87m give grade.
c) DDH3 has low grades of tin and both borates and cassiterite were noted (1992 work).
d) In DDH 4, hulsite was identified in the tin zone at 69.96m, but in the mineralized zone from 148.3-150.0m the one specimen available did not display tin minerals.
e) DDH 81-5B shows cassiterite correlating with high assays and,
f) DDH 81-8 shows both the borates and cassiterite (the latter to 20% volume locally in the specimen) in the 1% assay interval on the graphical log (Fig. 13) at 49m. No specimen was available for the 93m zone.

Surface material from 695N, 280W, the northern part of the skarn outcrop, consists entirely of the borates.

As noted earlier, the distribution of skarn within the marble horizon, apart from possible 'bimetasomatic' skarns along the upper and lower contacts, is influenced by cross-cutting extensional faults that provided pathways for hydrothermal and meteoric fluids. Continued fault movement brecciated early-formed primary skarn and allowed retrograde assemblages to form. The obvious concentration of tin mineralization is in the northern part of the property, although this conclusion is partly influenced by the distribution of drill holes. The drilling was, however, guided by magnetic and EM surveys by Newmont that would have identified the magnetite-pyrrhotite mineralization that accompanied tin.

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

The mineralogy and chemistry of shallow-emplaced tin skarns is particularly variable, even over a scale of millimetres, in comparison with deeper-formed (6km +) tungsten skarns which might remain uniform over vertical kilometres (e.g., the Pine Creek deposit, California). Tin mineralization has accompanied the earliest massive introduction of iron as magnetite and lesser amounts of pyrrhotite. 'Wrigglite' the rhythmically banded iron / borate-fluoride replacement of skarn can carry appreciable amounts of tin minerals, but they are not universally present with this stage of mineralization. Both oxide and borate tin minerals are present in the Mindy skarn. From petrographic observations (without point counting) it is obvious that the borates form locally an appreciable amount of the tin. It is estimated, however, that more than half the tin is in oxide form, but judging from the total tin assays reported by Newmont the grades are low: up to 1.00% is reported. It is uncertain whether that value might have represented an upper detection limit for the technique used by the laboratory i.e., that a 'geochemical' analysis programme was selected. Whether economic or not, the property has however provided some excellent research material.

The greatest potential economic target for the property has not yet been investigated. The mineralogy of the fluorine-rich skarns indicates that they are 'greisenized skarn'. This indicates that there is potential for greisens to have been developed in the apical part of the underlying granite intrusion. Depth to the granite contact may be quite shallow. The presence of high-temperature primary skarn minerals (especially larnite) indicates that initial metamorphism / metasomatism was at a temperature of perhaps 800°C, which is around the temperature to be expected for a B-F rich granitic magma, so no great vertical separation from the granite contact is expected. None of the 1981 drill holes penetrated more than a few metres into the siliciclastics that underly the marble/skarn horizon. Future drilling to test greisen could be a valid exploration target.

In the Yukon tin skarns are found in several localities associated with the Seagull suite granites, mostly peripheral to the Seagull batholith: the J.C property (Minfile 105B-3 040) having the largest inferred tonnage and the Val, formerly Partridge, (Minfile 105B-3 030) being another example well known to the author. The latter two prospects have both cassiterite and either borate, sulphide or silicate tin. Seven other tin skarns are listed in the Minfile for sheet 105B-3. In investigating skarns as potential tin prospects it is advisable to assay for both total tin and oxide tin to determine the cassiterite content. Stannite is not particularly desirable as a tin ore and vonsenite, hulsite, nordenskiöldine and malayaite are completely metallurgically refractory.



Timothy Liverton, March 2015

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COST STATEMENT

3/2/15	Vancouver Petrographics: preparation	$ 955.50
11/3/15	Vancouver Petrographics: preparation	$ 311.85
	T. Liverton, petrography, report preparation	
	5 days @ $500.00	$ 2500.00
	TOTAL:	$ 3767.35

STATEMENT OF QUALIFICATIONS

TIMOTHY LIVERTON, PH.D., C.GEOL., F.G.S.

BOX 393, WATSON LAKE, YUKON, Y0A 1C0

1. I am a Graduate of the University of Sydney 1964 (B.Sc. in Geology and Geophysics), the University of Adelaide 1967 (B.Sc. Hons. Economic Geology) and Royal Holloway, University of London 1992 (Ph.D. in Structural Geology, Petrology & Metallogeny)
2. I am a Fellow of the Geological Society, London and am validated as a Chartered Geologist.
3. I have worked in the mineral exploration industry since 1965.
4. I hold a 50% interest in the Mindy property

APPENDIX 1: MINDY PETROGRAPHY

SURFACE SPECIMENS

660N 180W face (25 x 75mm slide)

This is a quartzite with 2mm pelite layers that contain biotite and other boudinaged, phacoidal layers of calc-silicates 2-4mm thick. The quartzite layers contain some individual diopside grains and carbonate masses to 0.5mm. A few 0.08mm plagioclase grains and a trace of chlorite are found in the quartzite. The calc-silicate layers have massive birefringent garnet that includes diopside grains and also epidote.

660N 180W second slide (25 x 75mm slide)

This is a coarse-grained vesuvianite diopside garnet skarn. Vesuvianite crystals are subhedral and up to 8mm long. Anhedral and rarely subhedral diopside is found within the coarser vesuvianite, along with some <2mm interstitial carbonate masses. Across half the section the diopside is fine-grained (0.1-0.2mm), appears brecciated and has been replaced by an anastomosing network of birefringent garnet, itself partly chloritized.

690N 270W (25 x 75mm slide)

This varies across the slide from a carbonate-bearing siliciclastic (quartzite) to coarse diopside-epidote-calcite skarn. Carbonate masses (> 5mm) in the quartzite have anhedral diopside (0.5mm) and some coarser epidote. Chlorite is common in the calc-quartzite. The coarser skarn shows diopside and epidote common to 3mm grain size and interstitial serpentine is common.

690N 285W (25 x 75mm slide)

Coarse-grained garnet-epidote skarn with minor diopside. The garnet forms a mass that covers the whole section. It includes acicular vesuvianite, subhedral epidote to 2mm and remnant carbonate with granular 0.05-0.2mm diopside.

670N 285W (25 x 75mm slide)

Coarse grained diopside skarn containing sulphides to 1.5mm, about 10% overall. Replaced by

two roughly circular masses of fluoborite 2mm and 7mm across. The fluoborite contains tiny acicular vonsenite crystals and has a little serpentine alteration.

125N 110 W 1.5m (25 x 75mm slide)

Granular diopside skarn, mostly < 0.5mm grain size with remnant calcite masses to 4mm which have been replaced by a little anhedral actinolite. A few sulphides (< 5% overall, to 0.5mm) are present and fluorite to 2mm also replaces carbonate. Slight interstitial alteration to serpentine has affected both the pyroxene and amphibole.

125N 110W 4m (25 x 75mm slide)

Coarse diopside skarn to 2mm grain size with masses of calcite remaining. The diopside is anhedral except at the margins of the calcite masses where some euhedral forms are developed. Slight serpentine alteration is found along grain boundaries.

685N 290W

Quartzite with boudinaged carbonate layers to 5mm thick. The carbonates have been recrystallized and at one end of the slide actinolite and a little diopside have replaced the carbonates. Grains of (?) sphene (subhedral to euhedral 0.01mm grainsize) are disseminated throughout the quartzite. A little chlorite is also found with the carbonate

695N 280W

This is a mass of acicular vonsenite with intervening layers where the minerals have plucked out or dissolved during slide preparation. They may have been bandylite.

DRILL CORE

81-1, 65.2 - 65.3m (Std TS)

Quartzite with boudinaged calc-silicate layers. The quartzite (grainsize approximately 0.05mm with occasional coarser feldspars to 0.3mm and fairly angular) has layers of calc-silicates up to 1.5mm thick. These are of 0.1-0.2mm grainsize diopside with a few masses of actinolite to 1.5mm across as subhedral crystals to 0.8mm long. Cross-cutting veins at 70 degrees to

foliation carry actinolite or epidote.

81-1, 67.0 - 67.08m (Std TS)

Diopside skarn. A granular aggregate of 0.5-1mm anhedral pyroxene grains. A few 1mm carbonate masses remain and there the pyroxenes show some euhedral forms. No mineralization was noted.

81-1, 69.55 - 69.62m

Diopside skarn containing a few actinolite masses and with slight seropentine alteration. Diopside grains are from 0.1-1.5mm and are anhedral except where a few 2mm calcite masses are found. On the margins of those carbonates euhedral pyroxene is formed. There is no obvious structure to finer-grained pyroxene zones. Serpentine occurs as occasional 0.5mm sized masses interstitial to the pyroxene.

81-1, 73.4 -73.49m (PTS)

Marble, replaced by phengite and magnetite (with just one 3mm crystal of pyrrhotite). Coarse yellow unzoned cassiterite is present. Round structures as 'ghosts' in the marble are interpreted to have been oolites. Cassiterite, as subhedral to euhedral crystals, is found both within the massive magnetite and with phengite in the carbonate. Some crystals contain tiny acicular inclusions (? tourmaline).

{73.4-73.49-20xp} shows cassiterite with inclusions contained in phengite and carbonate.

81-1, 75.42-75.49m M1 (Std TS)

Fine-grained wollastonite (< 0.5mm crystals) have been heavily mineralized with magnetite (10-20%, 0.04-0.12mm crystals) with 2mm layers of talc containing fluoborite. A few masses of radiating crystal chains of magnetite to 0.5mm long are also present.

81-1, 76.52 - 76.56m (PTS)

Coarse euhedral pyroxene is enclosed in pyrrhotite and borates. Diopside forms mostly 0.5-2mm long euhedral crystals, except for one 6mm mass of 0.1-0.2mm grains, and shows very

slight serpentine alteration along cracks in the crystals. About 40% volume is the sulphide-borate 'matrix'. This matrix is either pyrrhotite alone or pyrrhotite with hulsite or less commonly, vonsenite. Approximately half the opaques are the borates.

81-1, 76.60 - 76.67m (Std TS)

Coarse diopside skarn with a little sulphide mineralization. Diopside is up to 2mm long and anhedral except at the margins of occasional carbonate masses (to 2mm across), where euhedral forms are found. Fine-grained aggregates of 0.1mm grains form 1-2mm zones with no particular orientation. Sulphides (no magnetite) occur as aggregates of mineral interstital to the pyroxene in two areas -up to 12mm across. Where the pyroxene impinges on the (?) pyrrhotite euhedral crystals are formed, in similar fashion to carbonates in the other specimens. This is interpreted to indicate that the sulphide has replaced carbonate

81-1, 77.88-77.92m M2 (PTS)

Magnetite and cassiterite replacement of marble. Magnetite, in radiating crystal aggregates to 1mm long and individual 0.05mm crystals (no sulphides) are in talc and fluoborite. Cassiterite is as 'dirty' brown subhedral crystals to 0.3mm (about 1% overall).

81-1, 83.80 - 83.90m (Std TS)

Vesuvianite-diopside skarn. It consists largely of 1-1.5mm long vesuvianite crystals with a few 0.2-0.3mm anhedral diopside inclusions. Some coarser pyroxene is in 4mm masses of 0.5-1mm anhedral grains. A few 0.5mm interstitial carbonate masses are present.

81-1, 83.9-84.02m M3 (Std TS)

Vesuvianite-diopside skarn. Vesuvianite forms subhedral crystals to 8mm long. Diopside is in anhedral grains 0.15-0.8mm long, with only a few 1.5mm euhedral garnets.

81-2, 86.82-86.89m M5 (LPTS)

Wrigglite: euhedral to subhedral magnetite as 0.08-0.12mm crystals with roughly equal amounts of pyrrhotite form contorted layers up to 1.5mm thick, alternating with talc that contains phengite remnants and a little fluoborite with fluorite (2mm mass). One 1.5mm wide layer of

the wrigglite is composed of anastomosing bandylite and serpentine in fluorite that includes acicular 0.2mm long fluoborite crystals.

81-2, 86.66-86.74m M4 (PTS)

Diopside-epidote skarn with much replacement by pyrrhotite with minor chalcopyrite and fluorite. The diopside varies from 3mm euhedral forms in the pyrrhotite to granular, anhedral 0.2-0.4mm grains. One 7mm wide vein has actinolite at its margin with a core of quartz and fluorite plus some pyrrhotite and ferrophengite. A little talc is in the actinolite selvedge.

81-2, 92.45-92.49m M6 (PTS)

This specimen is composed of chondrodite that has been replaced by pyrrhotite. Chondrodite is in 0.1-1mm subhedral crystals. Pyrrhotite (with only rare chalcopyrite inclusions) forms up to 60% of the volume and includes the smaller chondrodite crystals, as well as being in core of a 2mm wide talc vein, accompanied by arsenopyrite.

81-2, 93.66-93.71m M7 (PTS)

Pyrrhotite wrigglite. The pyrrhotite layers are up to 5mm thick (and the thickest does contain 20% arsenopyrite and a little chalcopyrite). Magnetite (1mm) forms occasional layers and also thicker bands (15mm) mixed with 40% pyrrhotite. Massive fluorite (5mm) with fluoborite forms one layer, the rest of the transparent layers being talc and some serpentine.

81-2, 96.10-96.18m M8 (Std TS)

Opaque layers 0.2-1mm thick in fluoborite / talc. A little fluorite is present. *No* cassiterite was noted.

81-4, 70.17-70.25m M9 (PTS)

Coarse subhedral magnetite in 0.5-0.8mm crystals with a little interstitial (5%) pyrrhotite. Has one vein (1mm thick) of pyrrhotite, chalcopyrite and pyrite in carbonate. Some masses of diopside to 10mm across remain and the pyroxene is interstitial to the magnetite adjacent to the larger magnetite masses.

81-4, 148.00m

A wrigglite. (?) Magnetite with fluorite-talc layers that contain a few crystals of bandylite. One red-brown mass of sphalerite is found with the magnetite.

81-4, 148.30 M18 pts

Wrigglite. Magnetite is predominant with occasional pyrrhotite layers and one 1.5mm mass that includes chalcopyrite. Arsenopyrite is prominent in only one 0.2mm thick layer: elsewhere it is occasionally included in the pyrrhotite. Fluorite and occasional ferrophengite form the other layers. No cassiterite was noted. [M18-5,0pp] shows green phengite in fluorite, part of the wrigglite. The opaquesin this image are entirely magnetite. [M18-2,5ppin] shows wrigglite texture, with a little pyrrhotite present.

81-4, 148.40-148.5m M10 (PTS)

Fine grained wrigglite with bands of ferrophengite and bandylite. Pyrrhotite with about 5% euhedral arsenopyrite forms the opaque layers with the ferrophengite and fluorite as transparent layers. Some relict chondrodite (one 6mm mass of subhedral crystals < 0.5mm with some interstitial pyrrhotite) is present. Bandylite (subhedral crystals to 0.2mm) is scattered throughout the phengite layers.

81-4, 150.00 M19 pts

This is a pyrrhotite mineralized garnet-hedenbergite skarn with some actinolite alteration. The section is entirely of anisotropic pink garnet that shows zoning and sector-twinning in 1mm crystals. It has been irregularly brecciated and contains some replacements of green pyroxene and actinolite (occasionally as 1mm subhedral crystals. Pyrrhotite, in masses to 5mm is interstitial to the garnets. The brecciated regions show up to 10% chlorite along irregular, cross-cutting fractures which are <0.02mm wide. Red iron hydroxides are also common along the fractures. These might be due to weathering during the 27 years at the core library. [M19-5,0xp] shows anisotropic sector-twinned and zoned garnet.

81-4, 151.15-151.23m M12 (PTS)

Diopside skarn, in part brecciated, has been heavily pyrrhotite mineralized and cut by a 2mm vein of garnet which has also been fractured, pyrrhotite mineralized and altered to serpentine. Chalcopyrite accompanies the vein pyrrhotite. Coarser pyroxene is up to 4mm long, and subhedral. Finer grained, probably brecciated, sections have been heavily invaded by the pyrrhotite (to 60% sulphides). The edge of the specimen has 0.2mm thick bands of pyrrhotite wrigglite. Much of the transparent layers are fine-grained pyroxene, with considerable (?) gahnite in 0.02mm grains. Some fluorite is found with the fine-grained diopside.

81-5B, 66.72 M20 pts

Garnet pyroxene skarn. Pink to yellow zoned and sector-twinned garnet is in crystals to 17mm and contains some pale green (salite) pyroxene in fields to 4x10mm plus chains of euhedral, skeletal magnetite crystals 0.2-0.5mm. The cores of the skeletal crystals are filled with an uncertain mineral, possibly fluoborite. The pyroxene is extensively altered along cleavages and cracks to very fine-grained amphibole. Pyrite (to 1.5mm) also repaces the pyroxene. [M20-2,5pp] shows colour-zoned garnet with magnetite. [M20-5,0xp] shows pyroxene in calcite with garnet in the SE corner. The skeletal crystal may be larnite.

81-5B, 103.47-103.51m M13 (Std TS)

Garnet skarn: yellow, zoned and sector-twinned andradite includes some anhedral 'ragged' diopside grains.

81-5B, 104.85-104.92m M14 (PTS)

Massive magnetite replacement of an actinolite skarn. Masses of magnetite up to half the slide show outlines of euhedral crystals. The mass is cut by irregular-branching 0.03mm wide fractures that carry pyrrhotite. Some fractures also carry ferrophengite and fluorite. Actinolite, in the larger mass is in subhedral crystals to 1mm long. Brown cassiterite as 0.1mm subhedral crystals is included in the the actinolite and more commonly in the phengite.

81-5B, 105.08 M21 std ts

Sheared garnet skarn / vesuvianite-actinolite skarn. The garnet, which is anisotropic, sector-twinned and finely zoned is cut by many irregular fractures, some of which are filled with sulphide. A shear zone, 4mm wide separates the garnet from a 4mm wide band of vesuvianite. Sub-parallel fractures along the shear are chlorite filled. Actinolite (0.2mm subhedral forms) with 25% fluorite as 0.1-0.2mm grains orms the remainder (2/3) of the section and grades to coarser (0.8mm) actinolite with fluorite to 0.5mm. [M21-2,5pp] shows sheared garnet in the SW corner, a band of vesuvianite then actinolite in the NE corner. [M21-2,5pp2] is another view.

81-5B, 106.75 M22 pts

Coarse-textured wrigglite: magnetite-pyrrhotite. The pyrrhotite contains frequent chalcopyrite inclusions to 1mm and rarer arsenopyrite. Magnetite varies from massive to subhedral crystals to 1mm. Some spectacular zoned ferrophengite is found with these subhedral crystals along with fluorite and 0.5mm anhedral dark red-brown cassiterite. Locally it forms 20% of some fields, in others it is absent. Some finer-grained cassiterite crystals, 0.02mm form "atols" that contain fluorite and phengite. Some remaining masses of calcite contain 2mm acicular wollastonite crystals. A tiny remnant of vesuvianite is found at one end of the slide. [M22-5,0pp] shows the 'atoll' habit of cassiterite; [M22-10pp2] shows better detail. [M22-10pp] shows the zoned ferrophengite with pyrrhotite; [M22-10ppin] the same field with the pyrrhotite; [M22-10xpin] the anisotropy of the pyrrhotite. [M22-10ppin2] shows pyrrhotite, chalcopyrite and arsenopyrite (note the kalb line). [M22-5,0pp2] shows cassiterite (red-brown0 with mostly pyrrhotite in phengite. [M22-10pp3] shows rings of cassiterite in fluorite with phengite centres that contain very fine-grained cassiterite. Opaques are entirely pyrrhotite.

M23 pts 81-5B, 108.87

Coarse-textured magnetite-pyrrhotite wrigglite with considerable amounts of arsenopyrite. There are approximately equal amounts of magnetite and sulphides. The pyrrhotite contains up to 10% arsenopyrite. Magnetite is often subhedral to euhedral and to 2mm grainsize. The pyrrhotite and included arsenopyrite are irrregularly distributed: the wrigglite texture is only really siscernable in hand specimen. Fluorite, talc and some phengite form the transparent

layers that include cassiterite in 0.02-0.12mm subhedral crystals that vary from almost colourless to brown. A few deep red-brown clusters of sphalerite crystals are up to 0.5mm across. Cassiterite grades perhaps 1% overall. Chalcopyrite appears as a 1mm wide layer at the very end of the slide. [M23-10ppin2] shows euhedral arsenopyrite, the chalcopyrite, pyrrhotite (pinkish) and magnetite at the end of the slide.

[M23-10ppin] shows cassiterite (centred, mid grey slightly darker than magnetite), pyrrhotite, arsenopyrite and magnetite. [M23-5,0ppin] shows euhedral magnetite with pyrrhotite. The small mid-grey ctystals in the NE corner are cassiterite. [M23-5,0pp] shows the same field. Cassiterite is brown, fluorite and phengite colourless. [M23-20xp] shows a twinned, zoned cassiterite crystal in talc and magnetite with a little pyrrhotite at the S edge.

81-5B, 109.06-109.11m M15 (PTS)

Massive magnetite and pyrrhotite with fluorite, coarse ferrophengite and also coarse, zoned brown cassiterite to 1mm in quartz. Magnetite and pyrrhotite are in equal quantity as masses to 5mm across. The quartz, fluorite and cassiterite with lesser amounts of ferrophengite are interstitial to the magnetite. The cassiterite crystals are euhedral, zoned and locally constitute 25% volume, but the average grade for the whole specimen is probably 1%. The coarsest cassiterite includes magnetite.

{M15-5,0pp} shows cassiterite, magnetite in fluorite with a vein of ferrophengite.

81-5B, 111.25-111.34m M16 (PTS)

Diopside skarn heavily replaced either by fluorite and pyrrhotite or fluorite and ferrophengite. Has one 6mm wide quartz-fluorite vein. Elongate, embayed pyrrhotite masses to 6mm long have rims of fluorite (i.e., this is a coarse wrigglite texture). These are surrounded by talc at one end of the specimen. Further across the specimen, ferrophengite and fluorite predominate. At one end fine grained diopside remnants are contined in either talc or the phengite. Some of the phengite is particularly dark green. Only a few 0.3mm cassiterite crystals are included in the pyrrhotite.

81-8, 48.92-49.00m M17 (LPTS)

Massive borate mineralization. It is coarsely banded (2-4mm), acicular vonsenite, sometimes radiating spherical masses to 2mm diameter, with alternating fluoborite layers containing some acicular vonsenite and common disseminated light brown cassiterite with occasional sphalerite with pyrite inclusions. The cassiterite is locally up to 20% of any field, but the whole specimen likely runs < 2%. Serpentine-filled veins 1mm wide cut the borates.

81-8, 49.00m (PTS)

Pyrrhotite wrigglite / massive vonsenite-magnetite minerealization. One corner of the specimen shows relict diopside in talc with a little serpentine, surrounded by finely layered (0.1mm) pyrrhotite wrigglite that has mostly fluoborite in its transparent layers. The heavily mineralized portion of the slide has a coarse masses of vonsenite 1-2mm across with slightly curved aggregates of 1mm long acicular vonsenite accompanied by massive magnetite. Pyrrhotite content increases towards the wrigglite. Several 1mm euhedral arsenopyrite crystals are contained within the pyrrhotite. A few 0.1mm chalcopyrite 'blebs' are found within the pyrrhotite. Brown cassiterite crystals to 0.5mm long are found within the pyrrhotite wrigglite, locally up to 5%, but none were noted within the massive borate mineralization. One 1.5mm wide pyrrhotite-arsenopyrite-phengite-fluorite veins cuts the wrigglite.

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APPENDIX A: SURFACE SPECIMENS

A1 125N, 110W 1.5m 5.0xp

Diopside, somewhat corroded and replaced by actinolite and fluorite (in extinction). Has a little interstitial serpentine alteration.

A2 125N, 119W 5m 5.0xp

A relict carbonate mass contains one larnite crystal at its periphery and has been replaced by a few euhdral actinolite crystals. The remaining material is diopside with serpentine alteration.

A3 660N, 180W 2.5xp

A fine-grained quartzite contains boudinaged layers of calc-silicate minerals. The central boudin has diopside and possibly some scapolite and the right-hand layer is birefringent garnet.

A4 670N, 285W 2.5xp

Skarn: birefringent garnet includes acicular vesuvianite. Epidote is in the NE corner. Much of the fine-grained material is diopside.

A5 670N, 285W 5.0xp

Skarn. Chondrodite with magnetite.

A6 670N, 285W 5.0xp (2)

Primary skarn with borate alteration. Anhedral, granular diopside skarn has been replaced by fluoborite (SW part of the image, showing 3rd. order colours).

A7 670N, 285W 10pp

The same section as above. Detail of the fluoborite in plane polarized light showing tiny acicular vonsenite inclusions.

A8 690N, 270W 10xp

Epidote-vesuvianite skarn. The two nearly rectangular crystals showing first-order grey may be

larnite.

A9 690N, 285W 2.5xp

Garnet-vesuvianite with epidote in fine-grained diopside.

A10 690N, 285W 5.0xp

Acicular vesuvianite in birefringent garnet. Calcite with diopside in NW corner.

APPENDIX B: DDH 81-1

B1 65.2-65.3m 5.0xp

Quartzite containing phacoids of diopside.

B2 69.55-69.62m 2.5pp

Primary skarn with retrograde alteration. Garnet (pink) and salitic pyroxene (slightly green) with euhedral actinolite.

B3 69.55-69.62m 5.0xp

Retrograde alteration: diopside skarn (some euhedral crystals) altered to actinolite and some interstitial serpentine.

B4 73.4-74.49m 5.0xp

Magnetite with cassiterite in talc.

B5 73.4-74.49m 5.0xp (2)

Cassiterite in talc with magnetite.

B6 73.4-74.49m 10xp

Detail of cassiterite with phengite in carbonate.

B7 73.4-74.49m 10xp (2)

Magnetite, cassiterite and phengite in carbonate.

B8 73.4-74.49m 20pp

Detail of cassiterite showing acicular inclusions (? tourmaline).

B9 73.4-74.49m 20pp (2)

Further detail of cassiterite crystals.

B10 75.42-75.49m 5.0pp

Acicular crystals of vonsenite (with magnetite at their core) with wollastonite in carbonate.

B11 75.42-75.49m 5.0pp (blue)

As above, the unpolished section has been illuminated with oblique blue light from a fibre-optic lamp. The magnetite shows a metallic lustre, the borates remain black.

B12 76.52-76.56m (5.0) xpin

Borate replacement of primary skarn. Reflected light with polarizers at 85 degrees. This image shows euhedral pyroxene with interstitial hulsite (curved, acicular) and pyrrhotite (dark). The likely explanation for this texture is that pyroxene formed in carbonate and that the remaining carbonate was later replaced by the borate / sulphide mineralization.

B13 76.52-76.56m 10xpin

Detail of hulsite in pyroxene. Reflected light with polarizers at 85 degrees.

B14 76.52-76.56m 5.0ppin

Hulsite (bright) and pyrrhotite in pyroxene. Plane polarized reflected light.

B15 76.60-76.67m 5.0xp

Pyroxene skarn showing evidence of brecciation.

B16 76.60-76.67m 10pp

Magnetite, pyrrhotite and diopside with phengite and cassiterite (circled).

B17 77.88-77.92m 20pp

Magnetite and cassiterite with fluorite and phengite.

B18 88.80-88.90m 5.0xp

Vesuvianite diopside skarn.

APPENDIX C: DDH 81-2

C1 86.66-86.74m 2.5pp

Wrigglite: magnetite and phengite layers.

C2 86.66-86.74m 2.5ppin

Wrigglite: same field asa move under plane polarized reflected light showing magnetite and silicates (light and dark grey) with pyrrhotite (pink) and arsenopyrite (white).

C3 86.66-86.74m 5.0pp

Diopside with a rim of actinolite.

C4 86.66-86.74m 5.0xp

Pyroxene skarn replaced by pyrrhotite with a vein of ferrophengite.

C5 86.66-86.74m 5.0xp (2)

Fluorite (in extinction) and phengite.

C6 86.66-86.74m 10pp

Shows serpentine and bandylite in the core of a fluorite-fluoborite vein.

C7 86.66-86.74m 10ppin

Plane polarized reflected light. Pyrrhotite and arsenopyrite.

C8 86.66-86.74m 20pp (2)

Detail of bandylite-serpentine veining with acicular fluoborite crystals along the margins and some pyrrhotite.

C9 89.87m 2.5xp

Euhedral magnetite forms the core of a serpentine vein. Talc and magnetite form successive layers after the texture of wriggle.

C10 89.87m 2.5xp (2) annotated

Veins of talc (Tal) with fluoborite (Fb), rimmed by magnetite (Mt) show offset.

C11 89.87m (b) 2.5xp annotated

Shows magnetite, relict chondrodite (Ch) fluoborite and talc veins with serpentine cores.

C12 92.45-92.49m 10xp

Shows chondrodite in pyrrhotite. A similar explanation as in {B12} for the texture applies.

C13 92.45-92.49m 10xp (2)

Shows detail of chondrodite in pyrrhotite.

C14 92.45-92.49m 10ppin

Chalcopyrite in pyrrhotite (showing bireflectance).

C15 92.45-92.49m 10ppin (2)

Pyrrhotite, arsenopyrite and chalcopyrite (dull yellow).

C16 93.66-93.71m 2.5pp

Wrigglite texture. Fluorite, fluoborite and pyrrhotite in coarse crystals.

C17 93.66-93.71m 5.0xp

Two veins: pyrrhotite - fluoborite and phengite.

C18 93.66-93.71m 5.0ppin (2)

Same field as above in plane polarized reflected light.

C19 96.10-96.18m 2.5xp

Fluoborite-serpentine vein in wrigglite.

APPENDIX D: DDH 81-4

D1 70.17-70.25m 2.5ppin

Two veins: arsenopyrite-pyrrhotite cut by pyrrhotite-chalcopyrite.

D2 70.17-70.25m 2.5xpin

Same field as above, polarizers at 85 degrees.

D3 148.40-148.5m 2.5pp

Wrigglite texture.

D4 148.40-148.5m 5.0pp

Wrigglite texture.

D5 148.40-148.5m 10pp

Wrigglite with crystals of bandylite.

D6 148.40-148.5m 20pp

Detail of wriggle showing bandylite, fluorite, serpentine and magnetite.

D7 148.40-148.5m 10pp (3)

Garnet, salitic pyroxene and actinolite. Some interstitial fluorite.

D8 148.40-148.5m 10xp

Birefringent garnet sheared and replaced by actinolite with some Fe oxides.

D9 148.40-148.5m 10xp (2)

Serpentine-quartz vein showing evidence of multiple crack-seal events.

D10 149.72-149.82m 10pp

Actinolite and fluorite.

D11 151.15-151.23m 10xp

diopside in pyrrhotite.

APPENDIX E: DDH 81-5B

E1 103.47-103.51m 2.5xp

Birefringent, sector-twinned and zoned andradite with diopside inclusions.

E2 104.85-104.92m 10pp

Cassiterite (? 'wood tin'), in fluorite with euhedral, zoned ferrophengite crystals.

E3 104.85-104.92m 20pp (2)

Detail of zoned cassiterite crystals in ferrophengite and fluorite.

E4 104.85-104.92m 5.0pp

Cassiterite in fluorite with actinolite and opaques.

E5 104.85-104.92m 20pppin

Pyrrhotite and chalcopyrite.

E6 109.06-109.11m 10pp

Cassiterite, ferrophengite (euhedral crystals in NW corner), fluorite and pyrrhotite.

E7 109.06-109.11m 10ppin

Same field as above. Cassiterite appears as light grey crystals.

APPENDIX F: DDH 81-8

F1 49.00m 20pp

Cassiterite, magnetite and fluoborite.

F2 49.00m 5.0xp (pyrite)

Pyrite wrigglite: pyrite, cassiterite and talc.

F3 49.00m 10ppin

Pyrrhotite, hulsite and vonsenite (acicular) with silicates.

F4 49.00m 5,0xpin

Vonsenite crystals.

F5 49.00m 20xp

Wrigglite: magnetite, phengite and serpentine.

F6 49.00m 5.0xpin

Vonsenite (acicular), hulsite ('wavy') and silicates.

F7 49.00m 10xpin

Vonsenite (acicular), hulsite ('wavy') and silicates.

LEGEND

10	Quaternary	Glacial till, alluvium
9	Cretaceous	Li-mica topaz - bearing leucogranite. Exposed as a facies marginal to the main stock, as sills and as a separate stock and dykes at the Ork prospect.
8		Megacrystic biotite granite } Form the main stock
7		Biotite microgranite } Form the main stock
6		Porphyry: small E-W trending bodies and large xenoliths of granite to diorite composition.
	U. Proterozoic to Mississippian:	Englishmans Group: cataclasites
5		Highly foliated, fine-grained "slaty" cataclasite. Includes thin sheared volcanics =
4		Massive to banded chert. May include some quartz-ribbon mylonite.
3		Quartzite: brecciated and sheared: sometimes as phacoids in a slaty mylonitic matrix. Some arkosic material present.
2		Marble: brecciated and recrystallized. Includes skarn and hornfels =
1		Phyllonite: crenulated

Contact: dashed where approximate. Dots indicate a thin marble or sill.

Fault: thrust

Fault: moderate angle (45° to 60°) extensional

Fault: high angle

Foliation: slaty cleavage in cataclasite, enveloping surface of folds in phyllonite

Foliation: pressure solution cleavage, attitude of lithologic contact

Lineation: plunge of small-scale folds, crenulation

Attitude of jointing in the intrusives. Min= mineralized (sulphide), alt= altered
Prominent jointing in metasediments
Abbreviations: volcs. = (intermediate) volcanics; qtzte = quartzite; HF = hornfels
La = lamprophyre, MC = miarolitic cavities

TRUE MAGNETIC

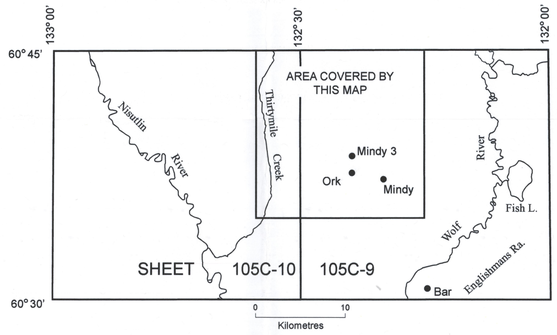
UTM grid shown is for NAD 27

Magnetic variation (1989) assumed to be 29° 48' east of true.

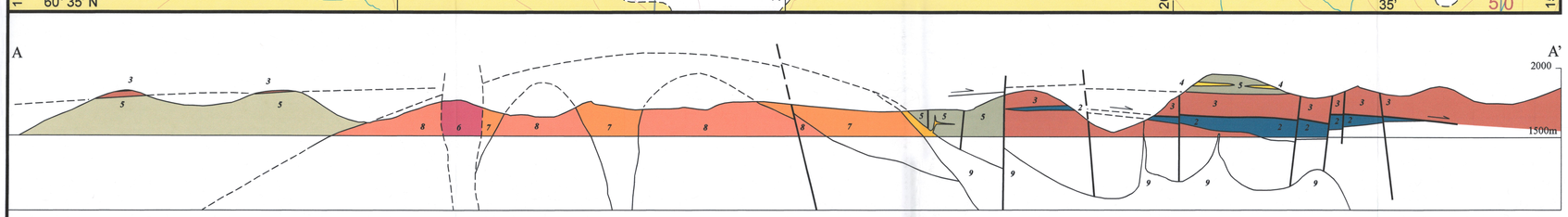
Geology: T. Liverton 1987 to 1989

Digital version: January 2009

1 0 1 2 3 4
Kilometres



INDEX TO 1:50,000 SCALE TOPOGRAPHIC MAP SHEETS 105C-9, 10

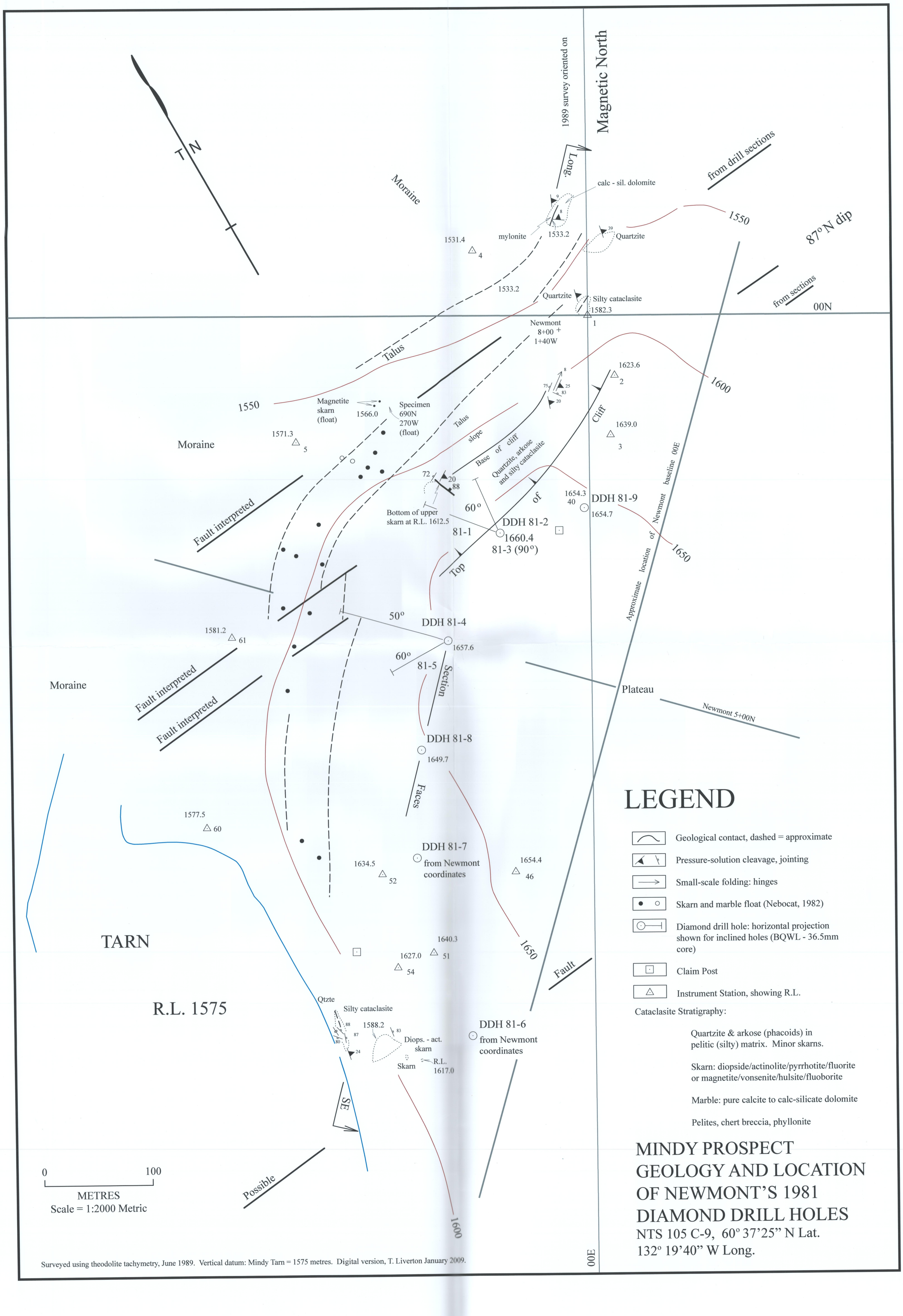


LONGITUDINAL SECTION THROUGH THE THIRTYMILE RANGE: Section A-A'

GEOLOGY OF THE THIRTYMILE RANGE

YUKON TERRITORY: NTS 105C 9 & 10

096740



LEGEND

- Geological contact, dashed = approximate
- Pressure-solution cleavage, jointing
- Small-scale folding: hinges
- Skarn and marble float (Nebocat, 1982)
- Diamond drill hole: horizontal projection shown for inclined holes (BQWL - 36.5mm core)
- Claim Post
- Instrument Station, showing R.L.

Cataclasite Stratigraphy:

Quartzite & arkose (phacoids) in pelitic (silty) matrix. Minor skarns.

Skarn: diopside/actinolite/pyrrhotite/fluorite or magnetite/vonsenite/hulsite/fluoborite

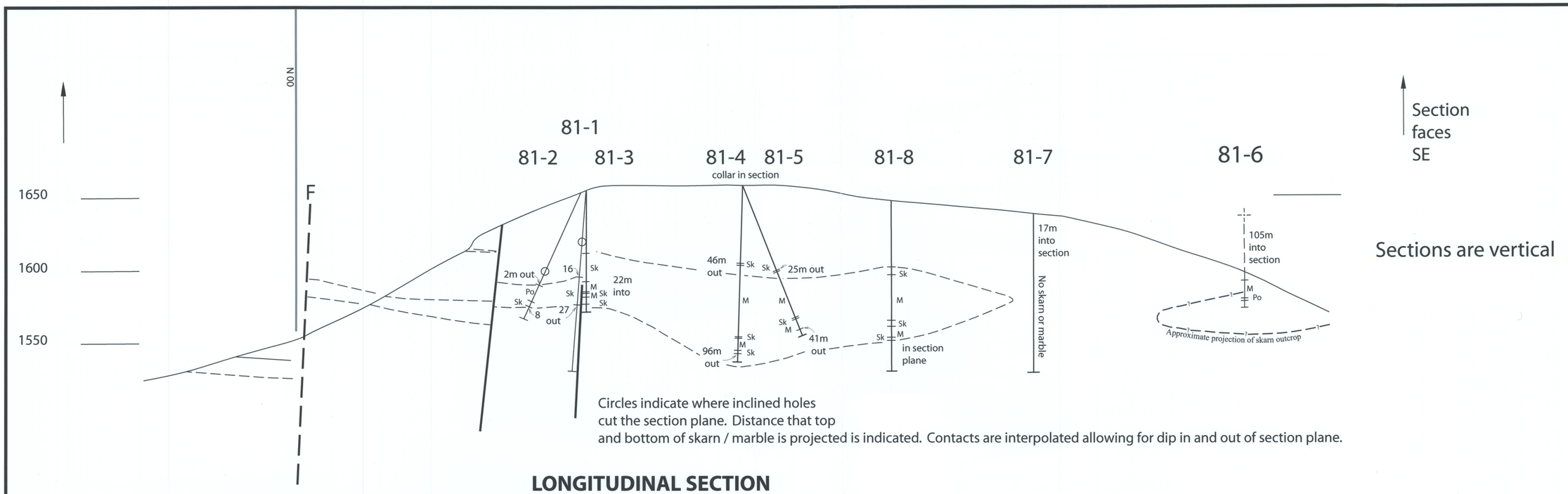
Marble: pure calcite to calc-silicate dolomite

Pelites, chert breccia, phyllonite

MINDY PROSPECT GEOLOGY AND LOCATION OF NEWMONT'S 1981 DIAMOND DRILL HOLES

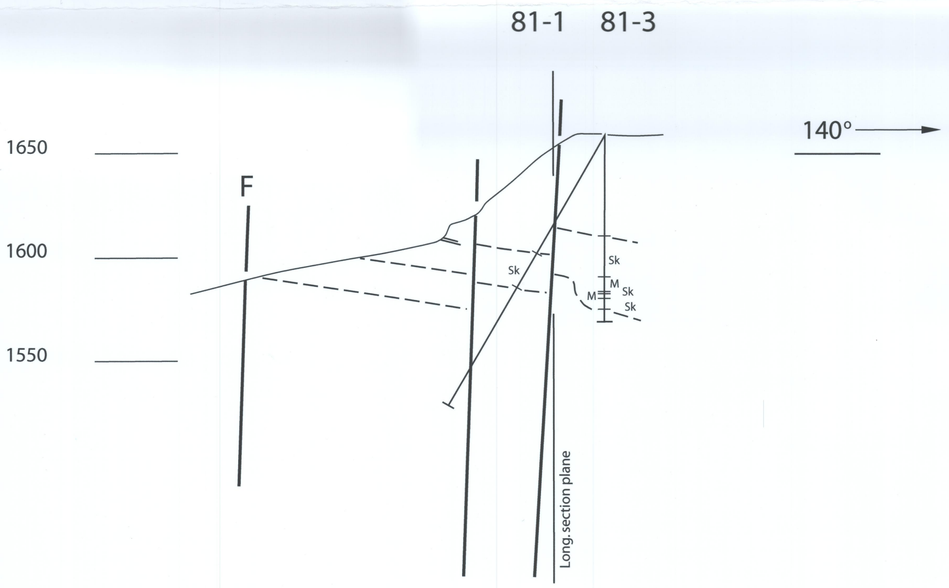
NTS 105 C-9, 60° 37'25" N Lat.
132° 19'40" W Long.

Surveyed using theodolite tachymetry, June 1989. Vertical datum: Mindy Tarn = 1575 metres. Digital version, T. Liverton January 2009.



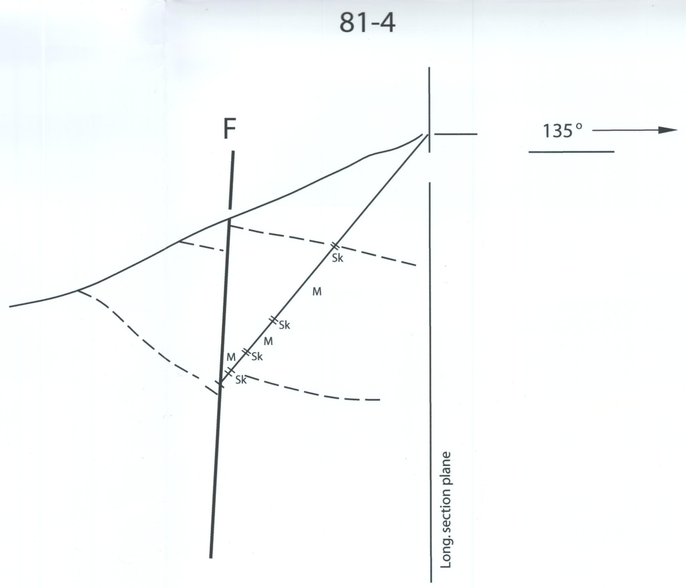
Circles indicate where inclined holes cut the section plane. Distance that top and bottom of skarn / marble is projected is indicated. Contacts are interpolated allowing for dip in and out of section plane.

LONGITUDINAL SECTION



SECTION THROUGH DRILLHOLES 1 AND 3

FACING NE



SECTION THROUGH DRILLHOLE 4

FACING NE

LITHOLOGIES

Sk = skarn (scale does not permit mineralogy to be shown)

Po = pyrrhotite rich sections

M = marble

0 — 100

METRES

V /H = 1

MINDY PROSPECT SECTIONS THROUGH DRILLHOLES 81-1 to 8

Scale = 1:2000

T. Liverton, Digital version Jan. 2009

FIELD LOG

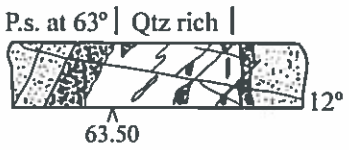
MINERALOGY

BQ CORE = 36.5 mm DIAMETER

59.9 Metres

Dark grey, silty cataclasite - foliation defined by lenticular quartz: 1-2 mm x 50 mm. Fracturing at 63.46 & 63.72

P.s. at 63° | Qtz rich |



Fractures

Pressure-solution cleavage

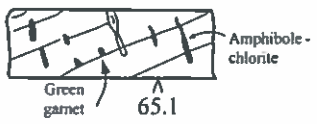
Pale green & pink CSHF breccia with amphibole - chlorite masses

65.0

65.62

= 65.2 - 65.3

Px - plagioclase in layers and clast in chert. Actinolite veins at 70 deg. to core



Pale green, massive diopside skarn. Mostly > 0.2mm grainsize. Contains some irregular, 20 mm thick garnet bands with vesuvianite. Rare fluorite - amphibole sections.

80°

= 67.0 -67.08

Pyroxene - chondrodite skarn

= 69.06 - 69.12

Diopside to salite, calcite, minor fluoborite

69.55

= 69.55 - 69.62

Px skarn with actinolite - quartz masses, some chlorite & occasional cassiterite

Increasingly darker garnet - diopside with vonsenite

70.70

= 70.63 - 70.70

Px - scapolite hornfels, Px - actinolite - calcite skarn

Pale green diopside skarn with magnetite bands containing some garnet & vesuvianite: at 70.80, 71.20, 72.10, 72.40, 73.00, 73.30, 74.30, 74.73, 75.22 to 75.74

Fractures

Magnetite & hulsite

= 73.4 - 73.49

Marble replaced by magnetite, fluoborite, cassiterite (3% in section)

Massive borates

Black borates 75.22 - 75.74

= 75.3 - 75.38

75.42 - 75.49

Wollastonite heavily replaced by fluoborite and vonsenite, magnetite

76.24

Magnetite (40%) - talc - diopside

= 76.24 - 76.30

— 76.54

Euhedral diopside enclosed in pyrrhotite & vonsenite. Some replacement of diopside by hulsite. Much talc at 76.24

76.30

Diopside skarn with frequent magnetite - rich bands. Pyrrhotite from 76.45 - 76.67

76.60 - 76.66

Px skarn with a little interstitial pyrrhotite

= 77.92 - 77.99

Brucite, magnetite, wollastonite, cassiterite

78.40

Coarse (2mm) diopside with pyrrhotite / borate rich sections

= 78.40 - 78.48

Px - chondrodite with Po. Some phengite, fluoborite replacement

79.10

= 78.86 - 78.92

Diopside in pyrrhotite, irregular serpentine masses

77.88 - 77.92 Massive magnetite replacement of wollastonite. A little fluoborite present, but no vonsenite. Cassiterite with the magnetite

Pale green diopside skarn: finely banded to 81.3 with pyrrhotite - chalcopyrite (1 mm)

= 81.32 - 81.40

Diopside, calcite, quartz

Faulted against massive skarn

83.0

= 83.21 - 83.28

= 83.34 - 83.40

Diopside-vesuvianite-garnet skarn, some chlorite

Alternating layers of diopside and vesuvianite / pink garnet / arsenopyrite

84.15

= 83.80 -83.90

8mm vesuvianite crystals with pyroxene

83.9-84.02

Vesuvianite-diopside skarn, a few garnets

Black chert - cataclasite. Upper contact is an irregular 7cm CSHF.
Brecciated: 10mm clasts. Pressure - solution fabric abounds

= 87.74 - 87.88

88.8

Note: 76.60 - 76.67 is sheared skarn.
78.40 - 78.45 is cataclasite - skarn: diopside is replaced by fluoborite & opaques in crush zones & microfractures

ASSAY, Sn%
NEWMONT

0.1 0.2 0.3

0.54%

1.00%

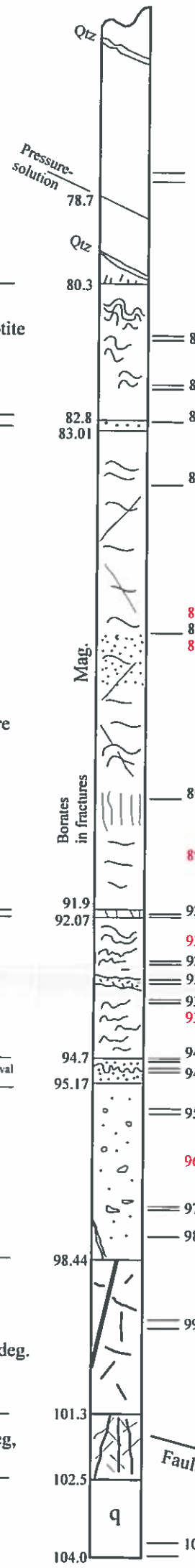
0.52%

MINDY DDH 81-1

Dip - 60°, Az = 321°, Collar R.L. = 1660.4 m

LOG

MINERALOGY



Grey to purple pelitic metasediment - shows quartz layers of irregular thickness, often in S-folds. Has occasional 0.5 - 1.5mm thick pyrrhotite - filled fractures at 0 - 30 degrees. Much pyrrhotite veining from 80.2 - 80.3

Banded pyrrhotite - diopside skarn. Pyrrhotite (with minor chalcopyrite) up to 50%. Disharmonic folding (wrigglite)

Pale green diopside skarn with pyrrhotite blebs.

Chondrodite in fluorite, mostly banded pyrrhotite in fluorite.

Fractured pyroxene skarn: actinolite - fluorite - phlogopite - chlorite replacement

Relict chondrodite in magnetite and serpentine with fluoborite. Bands of fluoborite and pyrrhotite

Dark Grey, pyrrhotite - rich skarn. silicate matrix varies from white to green (very fine grained). Foliation is lenticular or disharmonically folded (wrigglite). Common 0.5mm wide pyrrhotite - filled fractures ar at 45 deg. to core axis. Fine magnetite from 86.8 - 87.7. Fractures // core axis contain fine-grained magnetite-hulsite-arsenopyrite from 89.7 - 90.3.

Wrigglite: relict diopside, rimmed by actinolite. Pyrrhotite, fluorite, ferrophengite, arsenopyrite

Brecciated wrigglite. Brucite - phlogopite - magnetite. Zoned cassiterite

Pyrrhotite-magnetite skarn: garnet replaced by ferrophengite: has talc, fluoborite, phengite. One sinuous fluorite-fluoborite-phengite/bandylite vein. Arsenopyrite with the pyrrhotite

Relict chondrodite and diopside. Veins have fluoborite selvedges that replace the silicates and contain some pyrrhotite. Centres are fluorite and magnetite with phengite rim and serpentine core.

Chondrodite-vonsenite-magnetite-pyrite-fluoborite-talc-serpentine

White, fine-grained marble

Ludwigite - mineralized fractures 0 - 10 deg.

Calcite with veins of ludwigite. Contact with hulsite - phlogopite / magnetite-fluoborite wrigglite

Massive pyrrhotite with minor arsenopyrite and chalcopyrite replacement. Chondrodite in pyrrhotite, relict wollastonite and talc

Banded pyrrhotite skarn with irregular magnetite masses. Borates from 93.24 - 93.45

V. little remnant ? chondrodite, skeletal pyrrhotite, in 50% wrigglite

Wrigglite: chondrodite - magnetite - vonsenite - hulsite - fluoborite

Pyrrhotite, arsenopyrite, chalcopyrite replacement. Chondrodite in pyrrhotite, relict wollastonite

Grey magnetite - fluoborite: ptygmatic pyrrhotite bands at centre of interval

Banded magnetite - diopside skarn with fluoborite replacement

Coarse chondrodite relicts with magnetite and diopside. Heavy fluoborite replacement

Diopside replaced by fluoborite. a few scheelite crystals. Veins of fluorite and phlogopite cut the fluoborite. Late brucite veins.

Pale green diopside skarn. 3mm fluorite masses and pyrrhotite blebs. Some deep green amphibole masses to 15 mm long. Veins at 98.04

Wrigglite: opaques (probably largely pyrrhotite) with phengite and fluoborite

Coarse (to 5mm) pyroxene with actinolite and ? wollastonite. Hydrochlorborite

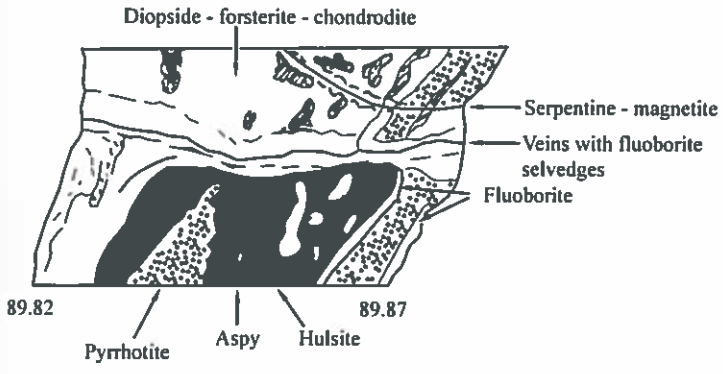
Pyroxene skarn: 2mm wide fluorite - hydrochlorborite vein at 32 deg. to core axis

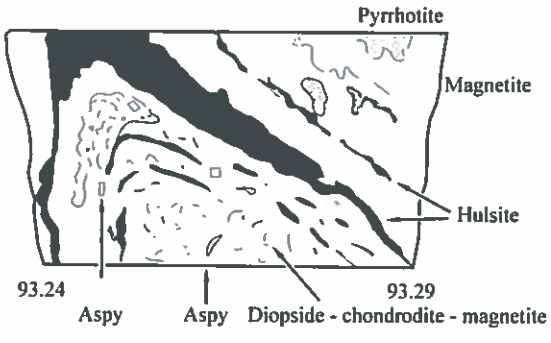
Dark grey, slightly brecciated chert. P.s. cleavage developed from 99.9 - 100.45 36 deg. 1mm quartz veins at 13 deg. and 0 deg.

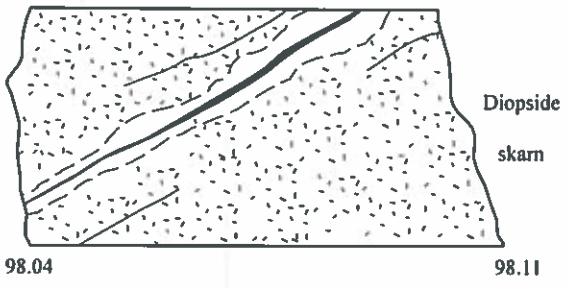
Very brecciated chert. Fractures at 0 - 15 deg, some bearing pyrite. Chloritic sections.

White quartz upper contact with chert at 75 deg. Tiny fractures at all angles from 0 - 60 deg.









MINDY DDH 81-2

Dip - 60°, Az = 006°, Collar R.L. 1660.4m

FIELD LOG

MINERALOGY

Cataclasite: ptygmatic quartz layers

47.6

Pink & green CSHF — 48.05
Fractured CSHF — 48.42

Diopside skarn - some actinolite rich sections. Disseminated arsenopyrite from 48.73 - 48.79

50.82

White CSHF - opaques in tiny fractures, pyrrhotite in 5 - 30mm selvedges. Some diopside skarn bands

53.45

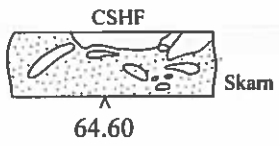
Diopside - actinolite - calcite skarn with irregular garnet masses over 15cm intevals. Some 4mm pyrrhotite 'blebs'

60.20

Pale green diopside skarn - 0.5 - 1mm grainsize. Some 1cm garnet bands

62.20

Diopside skarn to 8mm grainsize, some zoned 8mm garnets



Brecciated

BQWL core: 36.5mm diameter

67.35
67.83

Pure white, massive marble
0.5mm grainsize

74.65

White to green CSHF
haematite veins, hulsite & magnetite

75.65

Marble

78.28

Magnetite veining
pale green CSHF

79.25

Diopside - calcite skarn with garnet masses to 10mm. Vesuvianite (10mm crystals from 81.75-82.40

83.66

Chert cataclasite

Dip -90°, collar R.L. 1660.4m

47.07 - 47.60	
47.67 - 47.74	Scapolite, salite, chlorite, epidote
48.33	Salite
48.73 - 48.79	
50.24 - 50.30	Pyroxene & fluorite, tremolite
50.94- 51.10	Diopside, chondrodite, tremolite
51.55 - 51.62	Diopside /salite - chondrodite. Tremolite - magnetite - brucite along fractures.
52.05	Brecciated diopside skarn: tremolite, quartz, manetite & pyrrhotite in fractures
54.14 - 54.20	Brecciated salite to ferrosalite - calcite skarn. Coarse colourless tremolite developed along zones of cataclasis
	Coarse skarn:
59.64 59.71	Ferrosalite, andradite, calcite
60.00 - 60.08	Pyroxene, andradite, szaibelyite
60.50 - 60.57	Pyroxene, ? chondrodite, szaibelyite
61.00 - 61.05	Diopside to salite, calcite
62.12 - 62.18	Diopside to ferrosalite, calcite
62.60 - 62.70	Diopside to salite, andradite
63.86 - 63.93	Diopside to salite, andradite, calcite (breccia)
64.07 - 64.11	
64.70 - 64.79	
66.80 - 66.87	
67.35 - 67.46	Diopside skarn, diopside - magnetite- ? hulsite
74.5	Talc - szaibelyite - brucite marble with veins of magnetite & hulsite
75.07 - 75.14	
77.20 - 77.30	
78.28 - 78.32	Marble with vonsenite - cassiterite - brucite veins
79.66 - 79.70	Diopside skarn breccia. Szaibelyite replacement
80.55 - 80.64	Diopside, calcite & quartz with interstitial replacement by chlorite
81.45 - 81.53	Brecciated vesuvianite -diopside skarn
83.90 - 84.02	

PYROXENE COMPOSITION

Diopside 90 - 100
Salite 50 - 90
Ferrosalite 10 - 50
Hedenbergite 0 - 10

Dots indicate average values

100 50 0

ASSAY, Sn (Newmont)

0.1 0.2

Sn, %

MINDY DDH 81-3

FIELD LOG

63.4

Chert cataclasite

63.9

Arkosic quartzite: 10% feldspar as 2-6mm angular grains, brecciated

64.7

Chert catalasite with pelitic sections. Cordierite (2-3mm grains) is developed from 68.44 - 68.50 & 68.57 - 68.85

62.20 - 64.34

68.61 -68.79

68.98 - 69.20

69.35

Pelite containing 1% pyrrhotite

69.90

Magnetite - andradite skarn. A 1cm sphalerite vein at 70.2m (at 55°)

69.92 - 69.96

70.50

White marble with a 12mm magnetite-andradite vein at 70.60

70.90

70.68 - 70.74

70.17 - 70.25

70.90 - 78.49: massive white marble, grainsize 1 - 3mm

78.49

78.49 - 99.52: drill core not preserved.

99.52

Newmont logs indicate marble throughout

Massive white marble: 0.5mm grainsize

100.50

Wollastonite skarn. Upper contact 90°, P.s. 45°

100.82

100.47 - 100.61

White marble

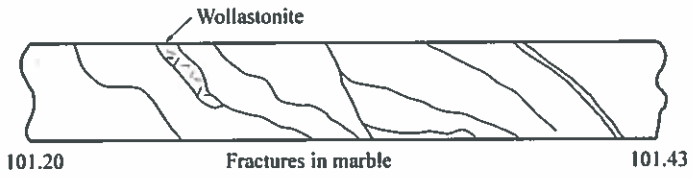
Wollastonite following 45 deg. fractures

Marble with irregular fractures 20 - 45°

Wollastonite: 8mm crystals, contacts at 60 degrees

101.75

Marble with frequent grey fractures and irregular banding



106.68

106.68 - 113.9: drill core not preserved,

Newmont logs indicate marble and wollastonite skarn

113.9

Massive white marble, 0.5mm grainsize

114.68

Wollastonite - calcite skarn: 30% calcite

115.60

Andradite -vesuvianite skarn

Wollastonite - calcite skarn

116.40

Massive andradite garnet zoned brown to green

Wollastonite - calcite skarn

Marble: calcite. Brecciated 117.32 - 118.57

Stained with alizarin / ferricyanide solution during logging

Dolomitic from 118.57 - 120.09

Calcite marble from 120.09 - 121.5

121.5

121.5 - 131.9: drill core not preserved. Newmont logs indicate marble with patches of wollastonite - garnet - quartz skarn from 124.2 - 124.9 and from 131.6 - 135.9, vesuvianite - garnet skarn is indicated

Dip -50 , Az = 316°T, collar R.L. 1657.6

MINERALOGY

Assay, Sn% (Newmont)

0.1 0.2

0.02% Sn

0.55% Sn
0.78% Zn

Andradite - magnetite (& hulsite?) - pyroxene. Fractures at 70 degrees

Carbonate with andradite, a little diopside, a few laths of (?) szaibelyite in the marble

A few diopside remnants are found within massive magnetite and lesser pyrrhotite mineralization. Minor arsenopyrite and chalcopyrite are present. Magnetite cut by two generations of veins: pyrrhotite and arsenopyrite then pyrrhotite and chalcopyrite

MINDY DDH 81-4

FIELD LOG

135.9

Skarn - grading from massive diopside to a central calcite - diopside - actinolite zone containing epidote masses, then calcite - brucite — 137.18

White marble, 1mm grainsize.
Very brecciated - fractures every cm or so at all angles

140.95

Grey dolomitic marble, banding at 55°

White marble 1.5 - 2 mm grainsize, few fractures — 141.10

141.88

Grey dolomitic marble - irregularly mottled

143.23

Pure white, massive marble. Grainsize up to 1mm. A few 0.5mm wide magnetite veins cut the interval 147.8 - 148.2. Angles from 30° to 38°

148.20

Skarn - finely banded magnetite to 148.95, pyrrhotite predominant by 149.0. Fractured. Actinolite occurs with the sulphide. Massive magnetite 149.25 - 149.60

150.27

Pink chert cataclasite

Light grey chert cataclasite — 151.03

Dark grey pelite alternating with 5mm siliceous layers. P.s. at 60°to 73° — 151.76

Brown biotite - bearing siliceous (?) mylonite with 3 - 5mm wide quartz bands — 152.84

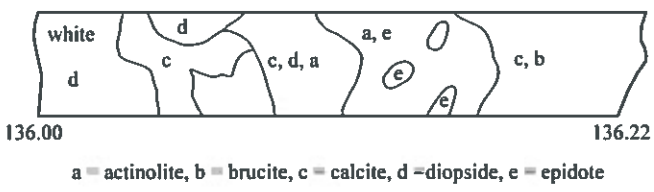
Dark grey pelitic (?) mylonite. Some 1 x 15mm quartz clasts visible. P.s. 55°at 154.5

155.02

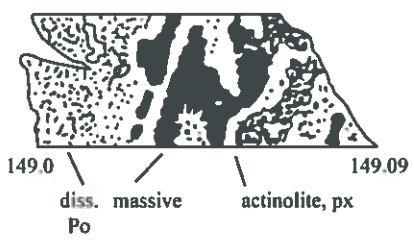
Sheared quartzite. P.s. seams are from 3 to 8mm apart. Clasts 5 x 15mm — 155.78

Dark grey pelite

157.0



a = actinolite, b = brucite, c = calcite, d =diopside, e = epidote



MINERALOGY

136.01 - 136.25
136.64 - 136.74
137.47 - 137.56 — Carbonates and brucite

142.5 — Wrigglite: magnetite with a little sphalerite in talc and fluoborite with bandylite and a little phengite.

148.30 - 148.36
148.50 - 148.56
148.73 - 148.79
149.00 - 149.09
149.35 - 149.42
150.00 - 150.07
Magnetite - fluoborite wrigglite with fluorite and some sphalerite
Ferrophengite & bandylite in one layer
see below

152.65 - 152.72

155.31 - 155.40

148.30 = coarse vesuvianite (4mm laths) cut by magnetite - fluorite - phlogopite wrigglite. Massive opaques may include hulsite

148.30 = wrigglite: predominantly magnetite with pyrrhotite, arsenopyrite and a little chalcopyrite with fluorite, fluoborite & ferrophengite

148.40 = wrigglite: ferrophengite, magnetite, pyrrhotite & fluorite, relicts of chondrodite

148.73 = garnet and magnetite replaced along fractures by actinolite and fluorite

149.00 = remnant diopside and garnet replaced by actinolite - 50% of rock is pyrrhotite and fluorite. Tiny phengite veins

149.35 = a little ragged diopside in actinolite - coarse magnetite - fluorite

149.72 = banded skarn: garnet, salite, ferroactinolite, pyrrhotite, fluorite. Late serpentine veins

150.0 = pyrrhotite-mineralized garnet-hedenbergite skarn with actinolite alteration

151.15 = Salite skarn with massive pyrrhotite. Coarse green pyroxene 3mm long and finer (0.1mm). Granular pyroxene along fracture zones carries pyrrhotite and chalcopyrite

152.65 = biotite - quartz pelite with actinolite - calcite layers. Quartz - scheelite veins at 60°- 75° to core



Dip -50 , Az = 316° T, collar R.L. 1657.6

MINDY 81-4 (cont.)

FIELD LOG

MINERALOGY

BQWL core
36.5mm diameter

61.66

Protomylonite ? 5-25 mm quartz layers with disjointed fold hinges. Pelite from 61.6 - 62.1, 62.4 - 63.6, 63.64 - 66.53 with arkose clasts (1-2mm feldspar grains, 20% of volume) in intercalated intervals. Cordierite developed at 64.15, 65.0 & 65.70m

62.26 - 62.48

63.79 - 63.95

65.07 - 65.14

Quartz layers & clasts in biotite / muscovite rich pelite. A few cordierite patches to 5mm

66.53

66.72

Brown garnet to 10mm in calcite.
Coarse calcite 66.84 - 66.89

66.72 - 66.79

Garnet-salite skarn, magnetite
Yellow - green zoned garnet & coarse pyroxene with interstitial concentric zones of magnetite in carbonate with cassiterite & (?) szaibelyite

67.20

Banding at 80°

White marble: 0.2 - 1mm grainsize

68.87

Diopside skarn (< 0.5mm g/s), calcite veining

69.20

Calcite marble: mostly 0.5mm grainsize.
Some coarser sections

72.10

Diopside marble. Lower contact is faulted. (Marble breccia, calcite veining)

72.50

Massive calcite marble. Grainsize 0.5 - 2mm

81.03

Brecciated diopside marble. Calcite veins at 22°

81.78

Calcite marble: grainsize to 2mm

89.99

Calc-silicate marble: 0.1m of andradite (30mm crystals), 0.5m of quartz-diopside-feldspar breccia skarn, 0.05m of garnet & feldspar / diopside

91.50

Calcite marble: grainsize to 2mm. Shows some irregular anastomosing dolomite layers to 10mm thick

98.30

White, massive marble: grainsize up to 1mm

102.98

102.63 - 102.70

Yellow andradite

Euhedral dark green andradite (15mm, zoned crystals) in fine-grained lighter garnet, containing masses of fine-grained yellow-green garnet.

103.90

103.65 - 103.69

Massive white marble

104.30

104.40 - 104.45

Pale green garnet & buff-coloured garnet

104.45

104.68 - 104.75

Carbonate with diopside. 18mm magnetite - sphalerite - serpentine band.

Massive magnetite, pyrrhotite, disseminate hulsite.

105.15

105.08 - 105.12

Garnet: fractured & replaced by ferroactinolite which is serpentinized. Sheared contact with coarse actinolite - fluorite skarn

Deep green, fine-grained garnet. Magnetite present after 106.35m

105.08

Sheared garnet-vesuvianite-actinolite skarn

106.48

106.35 - 106.41

Fine-grained magnetite skarn. 50% magnetite with green silicates & 2-3mm pyrrhotite.

106.75 - 106.83

Magnetite fluorite - ferrophengite wrigglite with cassiterite

107.35

106.75

Wrigglite: magnetite-pyrrhotite-chalcopyrite-ferrophengite. Cassiterite in atoll-like texture.

Deep green garnet with 4cm magnetite masses

108.40

108.10 - 108.18

Green pyroxene altered along fractures & cleavages to ferroactinolite with coarse anhedral garnet & much fluorite. Cassiterite in veins.

108.87 - 108.94

70% euhedral magnetite with vonsenite alternating with phengite, fluorite & fluoborite containing cassiterite

108.87

Coarse-textured wrigglite: magnetite-pyrrhotite-arsenopyrite-fluorite-talc-phengite with cassiterite.

Deep green, fine-grained skarn. Contains up to 30% pyrrhotite. Cut by 5mm light yellow garnet veins every 5cm or so at 45° to core

109.06 - 109.11

Massive magnetite-pyrrhotite, fluorite, ferrophengite & cassiterite

110.93 - 111.00

50% subhedral magnetite with pyroxene & fluorite. Bands of vesuvianite - pyroxene - fluorite 4mm wide

111.90

111.79 - 111.84

Black, massive chert with quartz veins 1-3mm wide every 20 - 50mm at 70-80 degrees. Rare veins at 55 degrees

111.25 - 111.34

Pyrrhotite-fluorite-ferrophengite replaced diopside skarn. Some cassiterite

113.00

112.88 - 113.00

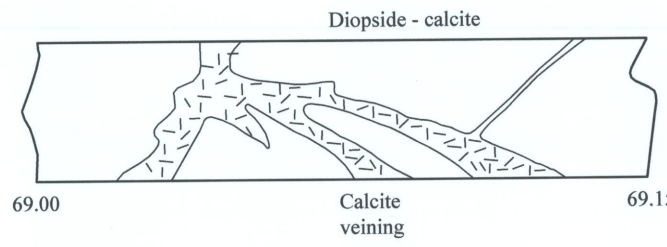
Newmont log indicates some fluorite, pyrrhotite and arsenopyrite in quartz veins to the end of the hole at 118m (core not preserved)

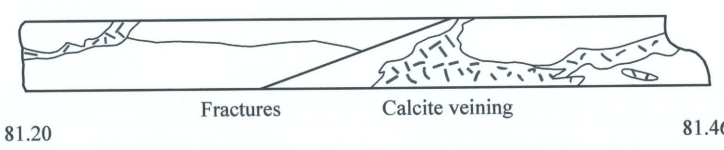
Assay, Sn%
(Newmont)

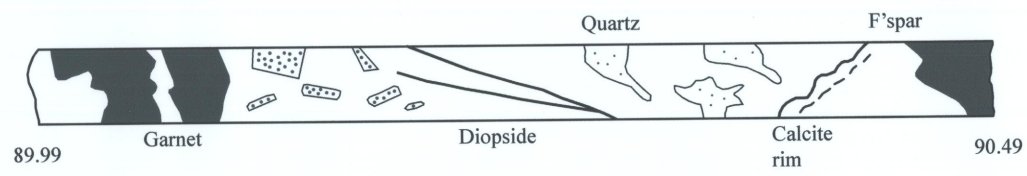
0.1 0.2 0.3 0.4 0.5

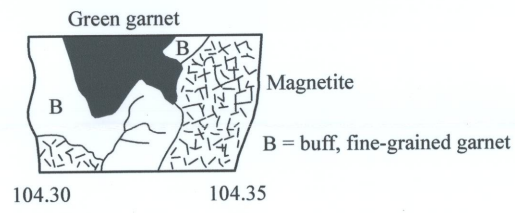
0.4% Sn

Not assayed









0.54% Sn

0.69% Sn

0.68% Sn

0.81% Sn

Not assayed

Dip -60°, Az = 271°, collar R.L. 1657.6

MINDY DDH 81-5B

FIELD LOG

MINERALOGY

44.00

Protomylonite, lenticular quartz clasts to 30 mm long in a dark grey pelitic matrix

45.50

Deep green skarn. Fine-grained amphibole is obvious to 47.8m, where frequent pyrrhotite veins show dark alteration zones up to 4mm wide (veins at 15°- 60°).

Finely banded pyrrhotite cut by irregular arsenopyrite masses to 8mm) from 46.3 - 46.6. By 48.4m, magnetite with fluoborite is predominant.
49.0 - 49.07: hulsite & pyrrhotite
50.5: magnetite - garnet with 15mm sphalerite

Contact with marble (50.60m) at 90 degrees

50.60

51.05

45.80 - 45.85 White tremolite (confirmed by XRD) fluorite-fluoborite vein

46.31 - 46.36 Quartz, fluorite, fluoborite, pyrrhotite & pyrite

46.95 - 47.01

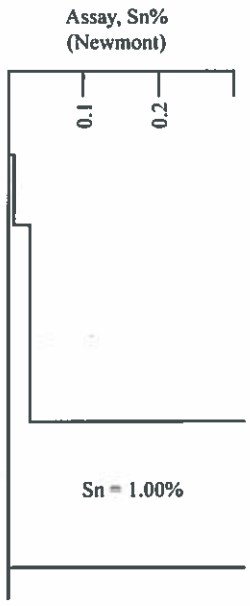
48.38 - 48.43

48.92 - 49.0 Magnetite-borate skarn, not wrigglite textured, vonsenite & cassiterite (locally to 20%).

49.00 - 49.06 Sulphide wrigglite: pyrrhotite-vonsenite±hülsite with interstitial fluoborite, serpentine & fluorite.

50.47 - 50.51

50.81 - 50.90



51.05 - 80.62: core not preserved. Newmont log indicates marble with magnetite - andradite skarn bands from 0.3 to 1.8m thick (6 bands). At 57.30m, one piece of core was alvaged from the site = coarse, deep green andradite (microprobe analysis obtained) with fine-grained yellow andradite (XRD powder pattern obtained)

80.62

White marble, under 0.5mm grainsize

81.38

Hard white marble - probably containing diopside

81.50

Diopside marble with 20mm wollastonite vein

81.75

Green garnet, calcite veins, arsenopyrite, vesuvianite.

81.98

Marble with fractures at low angle to core.

82.70

Very fine grained diopside

Zoned andradite, calcite, diopside

82.85

83.44

83.36 Andradite (deep green), some included pyroxene, arsenopyrite

Yellow-brown garnet, arsenopyrite

84.35

Andradite-siderite masses veined by calcite

Diopside-siderite skarn

84.67

Pale green actinolite-diopside skarn

84.90

84.35 - 84.45

84.77 - 84.83

Brown-green-white mottled quartz-siderite-diopside skarn

85.87

Green garnet-feldspar-brown garnet skarn

85.60

85.04 - 85.17

Not assayed

White marble. Actinolite-brucite vein (40mm) at 87.78

87.78 - 87.95

87.95 - 88.09

Large biotite-quartz pelite clast in marble. Pyroxene-fluorite-vesuvianite-actinolite bimetasomatic skarn rim around clast

88.3

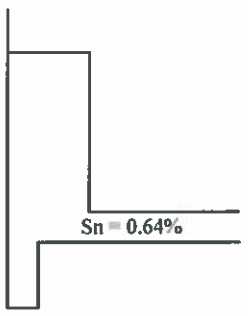
White marble, 0.5-1mm grainsize. Fracturing at 12°- 40°common, 0.2-1mm wide with vonsenite filling

89.45

90.02

Carbonates with zoned veins at 0 - 30 degrees to core = finely banded magnetite-vonsenite with a core of phengite, fluorite & brucite. Possibly a little fine-grained fluoborite. Carbonate replaced up to 2mm out from the veins by either wollastonite or szaibelyite

White marble with many anastomosing fractures, subparallel to core & mineralized with vonsenite. Wider veins (5mm) have pyrrhotite cores



Grey & green, v. fine grained skarn.

93.13

Magnetite-hulsite with phengite veins

Finely banded magnetite-pyrrhotite skarn

93.21 - 93.30

93.35

Grey, finely banded pyrrhotite-diopside skarn

94.00 - 94.09

Brecciated skarn: pyroxene in 2mm crystals & finer grains heavily replaced by actinolite (0.2mm). Coarser actinolite replaced by fluorite & fluoborite

94.50

Dark grey, massive chert. Shows a few quartz veins up to 2mm thick at all angles from 30°- 75°

95.10

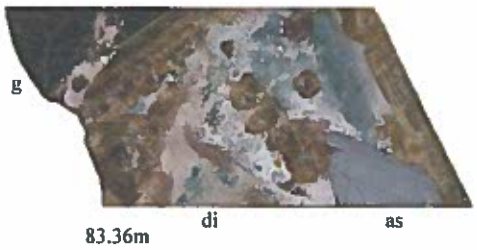
94.40 - 94.47 Wrigglite: v. finely banded magnetite-fluorite, quartz, minor phengite in layers. Some remnant pyroxene.

BQWL core = 365.5mm diameter



.50 81.98

m = calcite marble, w = wollastonite, g = garnet, v = vesuvianite, as = arsenopyrite



83.36m

Dip = -90°, collar R.L. 1649.7m

MINDY DDH 81-8