An Update on the Mineralization of the Nootka Sound Region, Vancouver Island, British Columbia

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Abstract

The Nootka Sound region is host to a few small ore deposits. 2005 & 2006 summer's mapping, a part of a Geoscience BC project, was focused on improving the bed rock mapping in the Nootka Sound area. Preliminary results of this mapping provide an update on geology, mineralogy, chemistry and mineral potential.

Rocks of the study region host the following mineralization types: 1/ Porphyry Copper mineralization 2/ potential for PGE mineralization 3/ Intrusion related gold mineralization 4/ Sulphide vein mineralization 5/ VMS mineralization and 6/ Skarn mineralization (see the geological map below for mineralization locations).

Work continues on completion of a lithogeochemistry study of the various rock types and on a revised metallogenic interpretation of the area, based on new mapping, geochemistry and geochronology.

Regional Geology

The Nootka Sound region occupies a large portion of the west-central half of Vancouver Island.

The study area is part of the Insular belt of the Canadian Cordillera, comprising a number of accreted volcanic terranes (Jones et al. 1977; Muller et al. 1981). Thus the area consists mostly of meta-volcanic rocks and their plutonic counterparts.

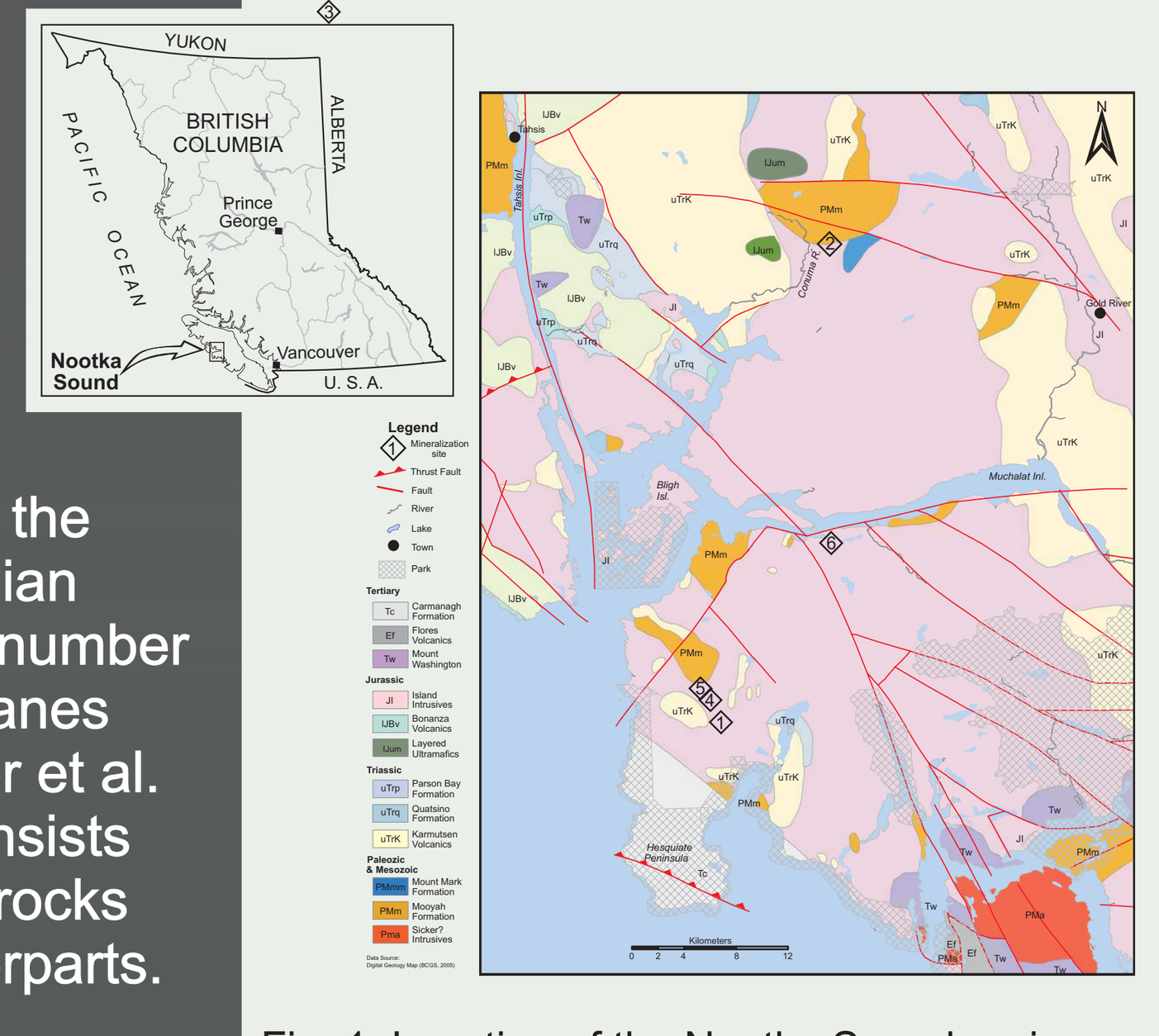

Fig. 1. Location of the Nootka Sound region on the west coast of Vancouver Island and updated geological map of the Nootka Sound study area (modified after *Muller et al. 1981*).

Regional metamorphic grade in the area ranges up to middle greenschist facies. Local contact-metamorphism around the intrusive rocks ranges from greenschist to migmatite, with many examples of partially melted inclusions of country rock. There are abundant brittle faults in the area ranging from local to grand scale.

The intrusive rocks are typical of the Jurassic Island Intrusive and the Tertiary Mount Washington suites. Some of the more altered intrusive rocks may also be related to Sicker volcanism.

A preliminary geology map (Fig. 1) and stratigraphic column (Fig. 2) for the rocks of the Muchalat Inlet area have been derived based on field observations, air photos, previously published reports and maps.

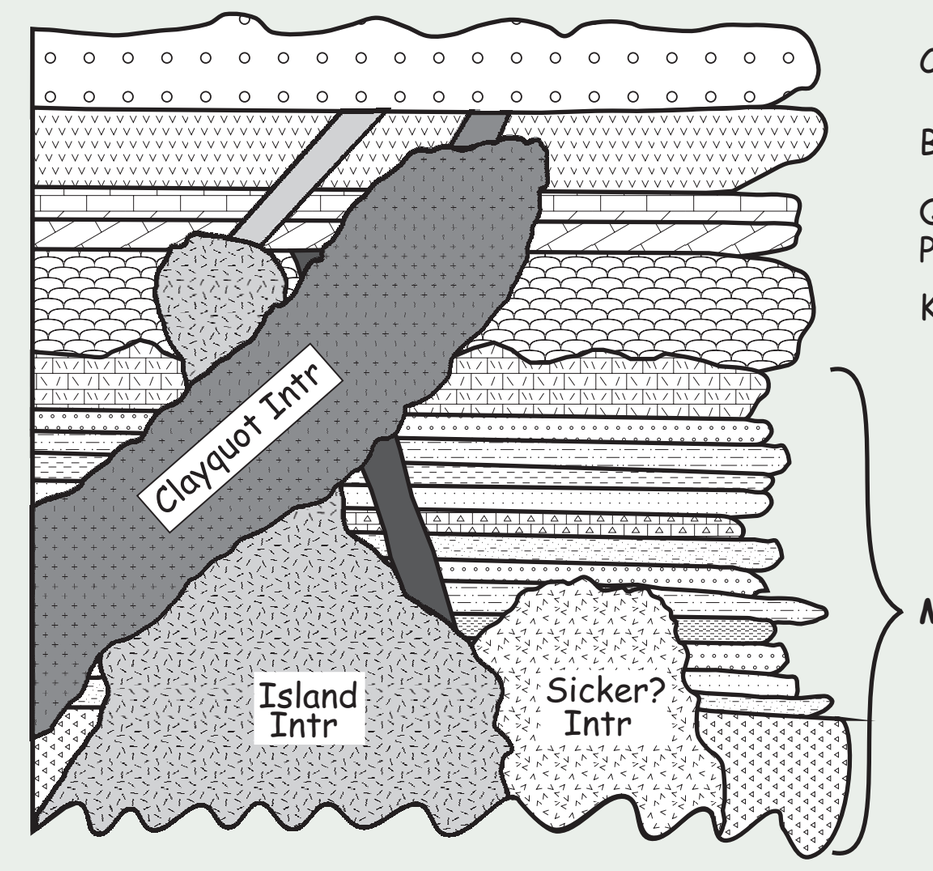

Fig. 2. Idealized stratigraphic column. Unit thicknesses are not to scale. The base of the newly named Mooyah Fm is potentially equivalent to the McLaughlin Ridge Fm and the lower parts Mooyah Fr are possibly correlative with the Fourth Lake Fm (Yorath et al. 1999). The upper calcareous units of the Mooyah Fm may be possible correlatives with the Mt. Mark Fm. Note the intrusive rocks labeled as Sicker intrusive rocks are not dated and no contact relationships have been established in the field. Thus these rocks may possibly be old as upper Paleozoic.

Mineralization potential

Porphyry Copper Mineralization

The Island intrusive suite has been an exploration target for porphyry Cu mineralization since the mid 1900s (Leitch et al. 1995). A float and an outcrop found along recently constructed road bed was chrysocolla stained and contained visible chalcopyrite and bornite (Fig. 3).

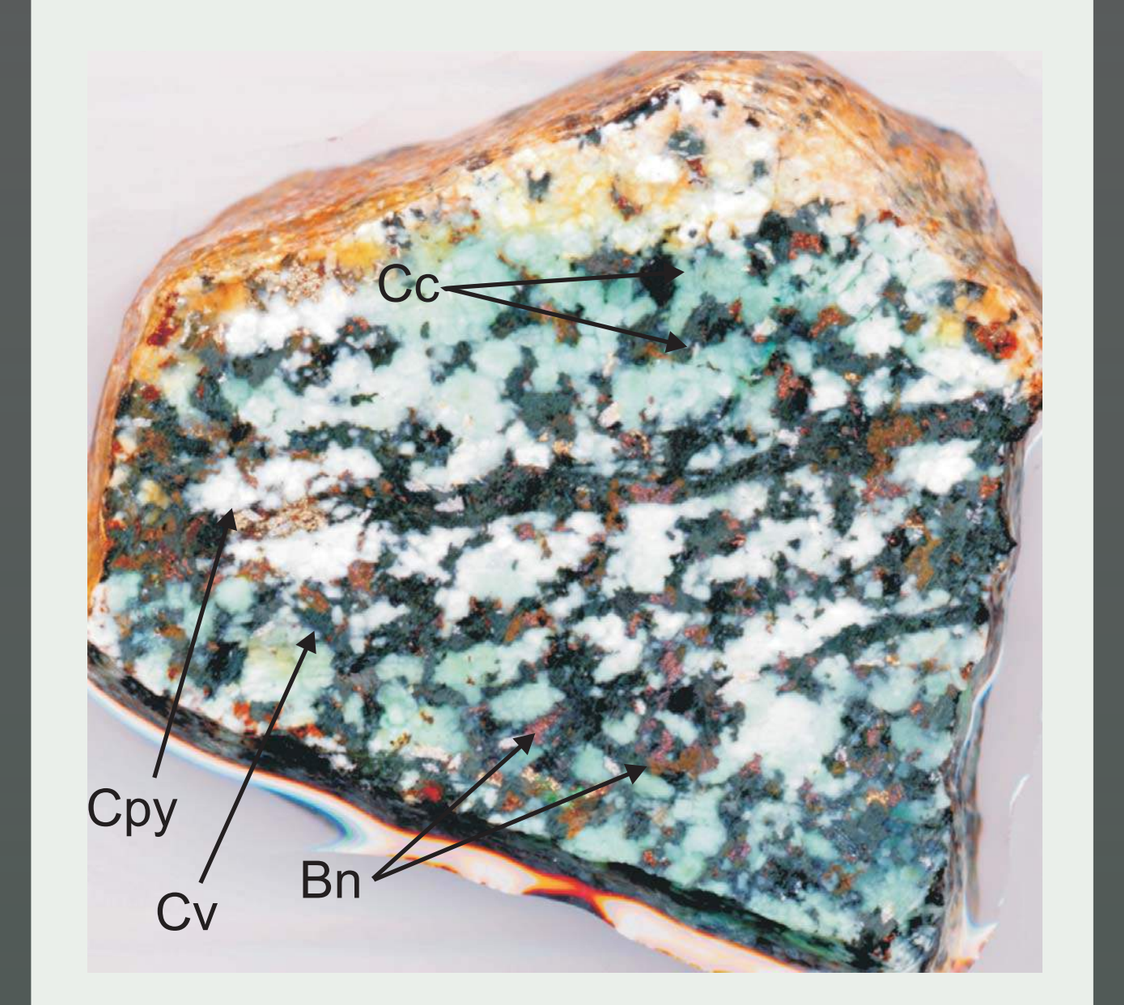

Fig. 3. A sample from Island Intrusives is chrysocolla (Cc) stained and contains visible chalcopyrite (Cpy), covellite (Cv) and bornite (Bn).

The copper minerals are hosted within a hornblende-diorite of the Island Intrusive suite. Superimposed on the primary igneous mineralogy is a hydrothermal overprint resulting in anastomosing veins containing amphibole, chlorite and Cu-bearing minerals. Chalcopyrite, bornite, covellite, chrysocolla and malachite are visible on cut slabs in the veins and disseminated throughout the rock (Fig. 4).

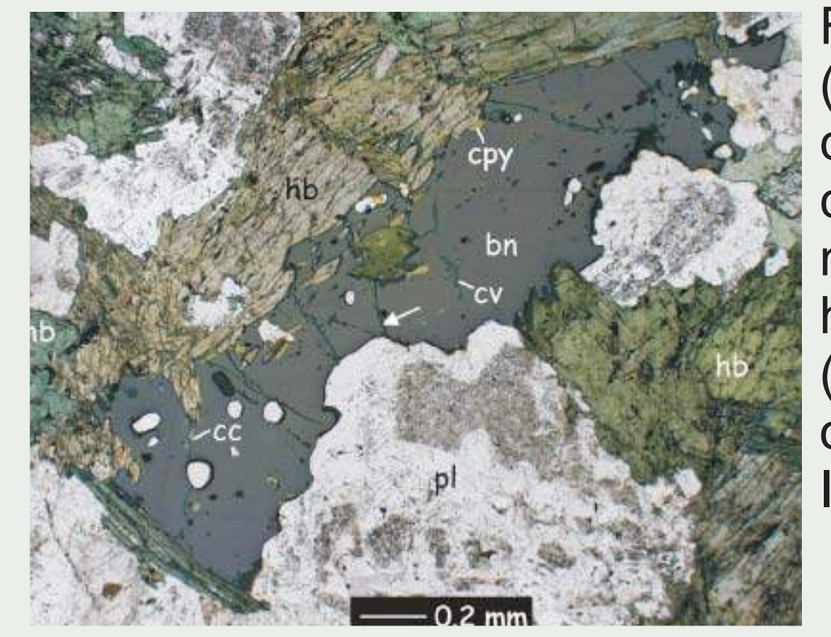

Fig. 4. Chalcopyrite (cpy),bornite (bn), covellite (cv), chrysocolla (cc) and malachite in a hornblende-diorite (pl for plagioclase) of the Island Intrusive suite.

PGE Mineralization

The layered ultramafic rocks occur sporadically within the Island Intrusive suite (Muller et al. 1981; De Bari et al. 1999). These rocks outcrop mostly in the drainages flowing into the Conuma River and were named the Conuma phase of the Island Intrusive suite. The Conuma phase is comprised of two main lithologies (Fig. 5).

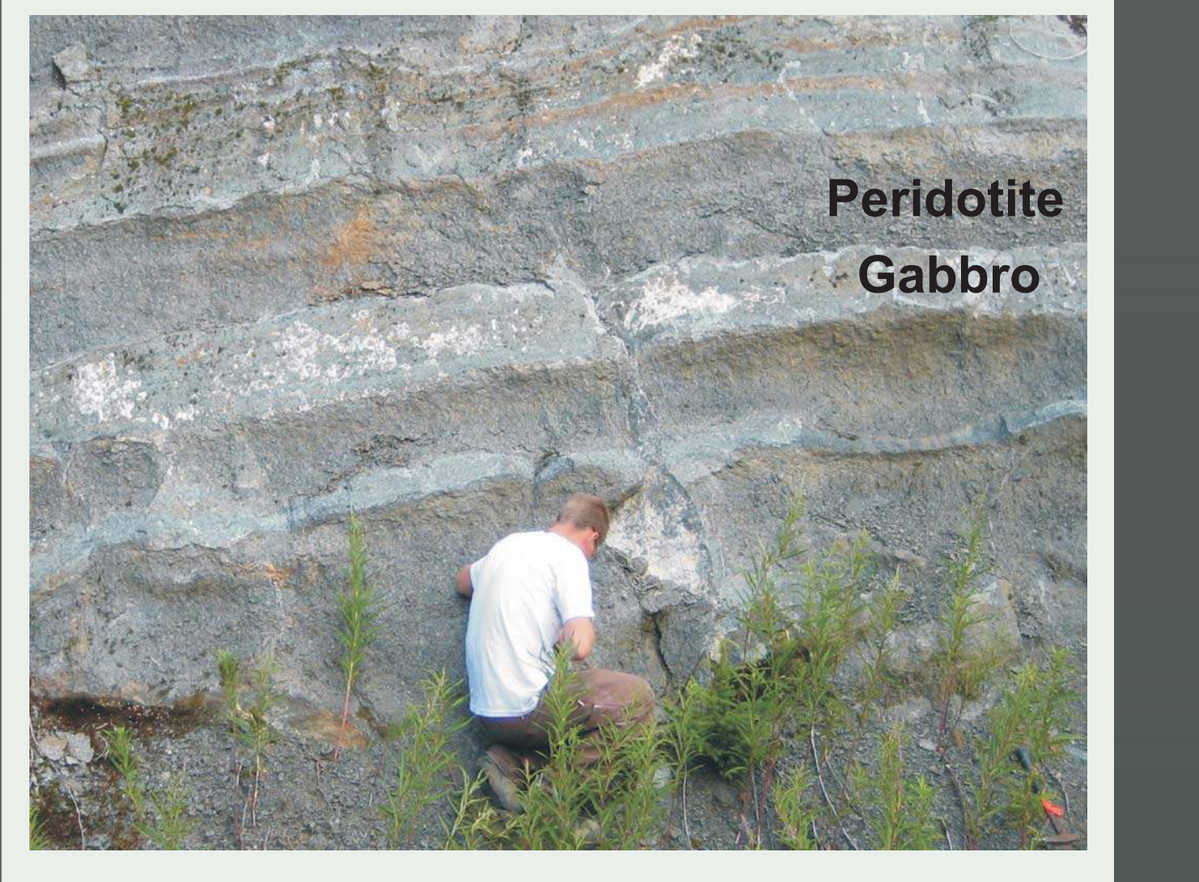

Fig. 5. Two lithologies gabbro and peridotite were identified as the Conuma phase of the Island Intrusives.

The first is a gabbro to hornblende-diorite. This lithology varies locally but in general is comprised of 60% hornblende, 40% plagioclase And minor phlogopite. Most of the pyroxene within these rocks has been metamorphosed to hornblende and phlogopite.

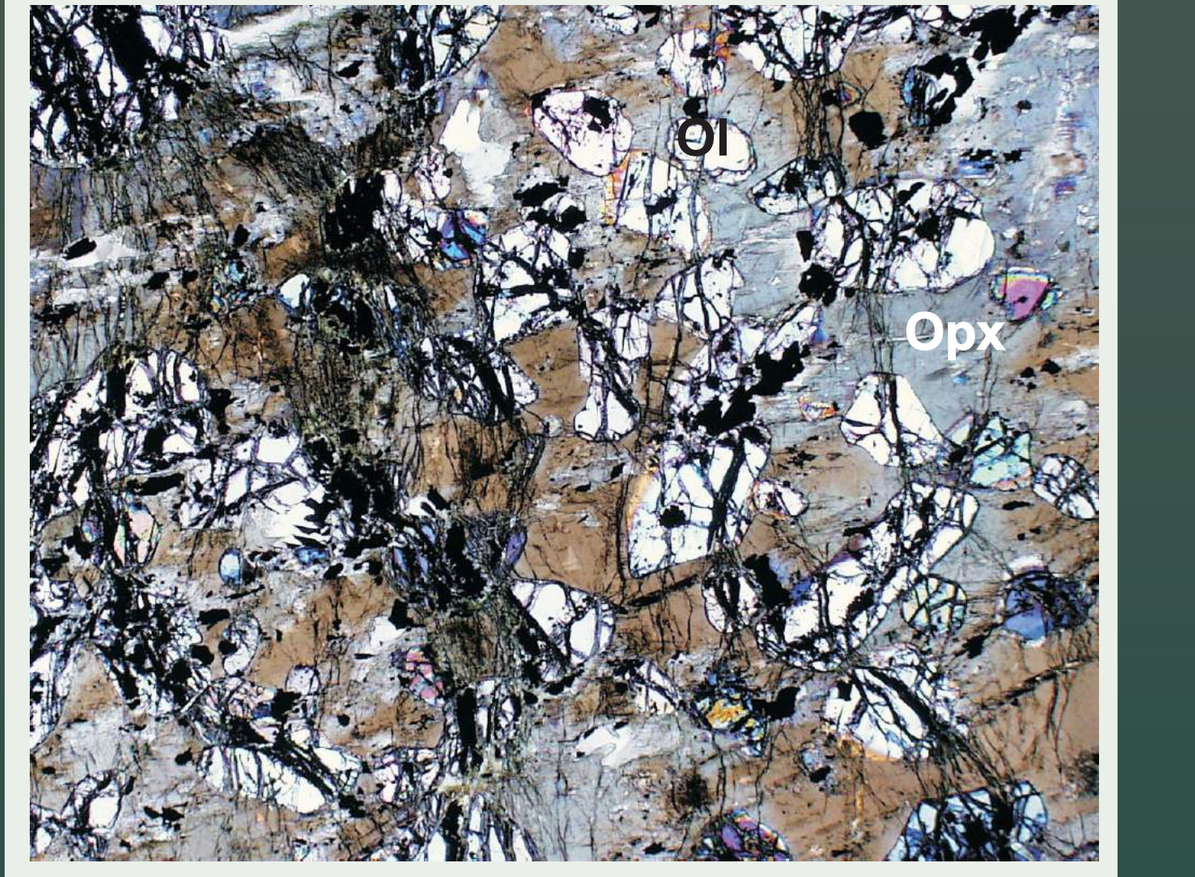

Fig. 6. A thin section of the peridotite with olivine (Ol) slightly altered to serpentine and relatively fresh orthopyroxene (Opx).

The second lithology is a meta-peridotite.

The rock is comprised of approximately 40% olivine, 45% orthopyroxene, 10% hornblende and 5% plagioclase feldspar (Fig. 6). Assuming all the hornblende is retrograded from pyroxene, the rock was probably a olivine-websterite prior to metamorphism. Magnetite (Fig. 7) is common within these rocks with magnetite abundances varying locally up to 5%. Melt inclusions within the olivine generally host small magnetite crystals indicating that magnetite was present and in equilibrium with the olivine during crystallization. Thus there is potential for magnetitite layers within the Conuma phase.

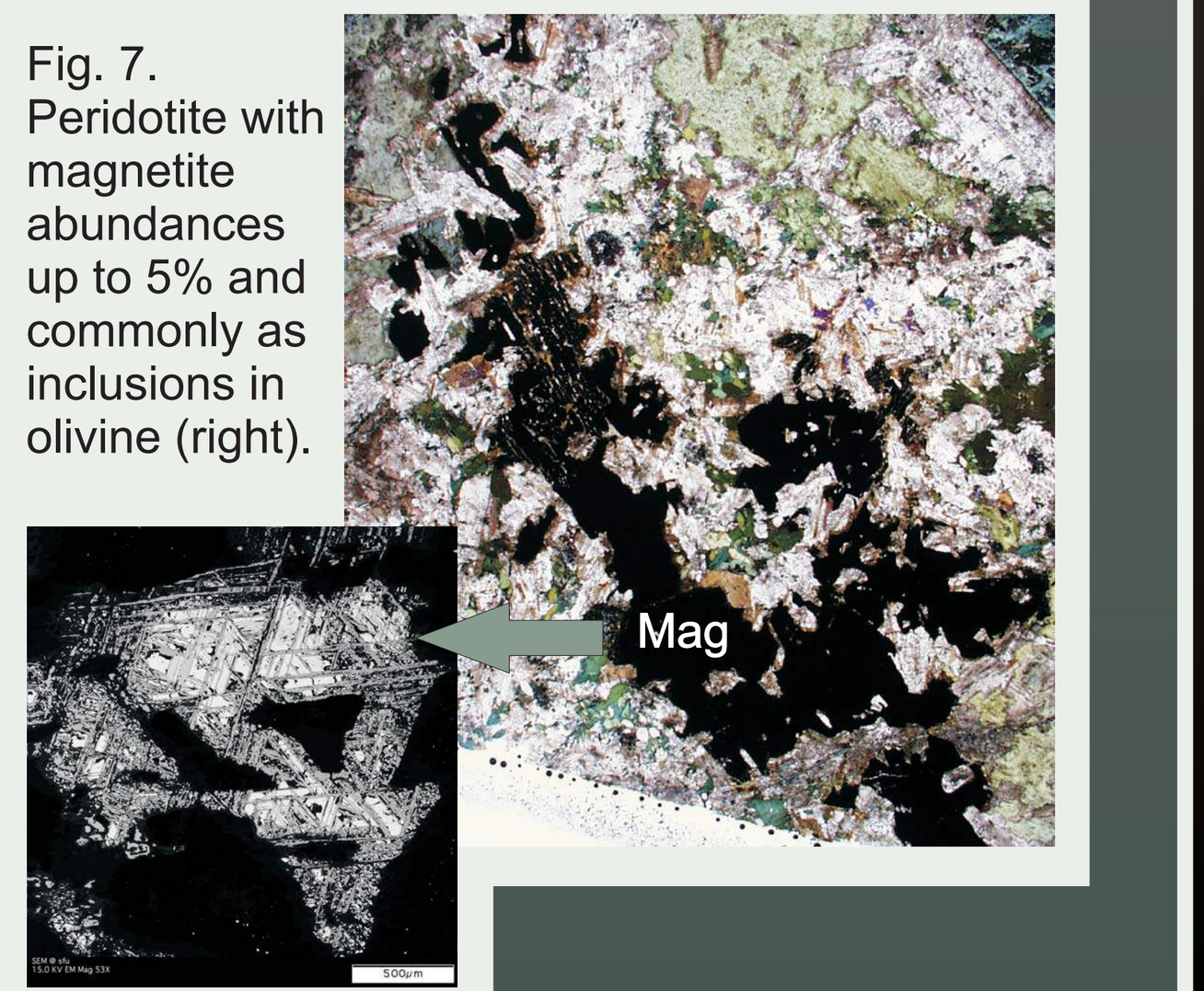

Fig. 7. Peridotite with magnetite abundances up to 5% and commonly as inclusions in olivine (right).

Hornblende from the Conuma phase has been dated by Ar-Ar geochronology. The primary igneous hornblende yields an excellent lower-Jurassic plateau age of 189.9 ± 2.1 Ma comprising 85% of the ^{39}Ar (Fig. 8). A second amphibole from the same lithology yielded a similar age.

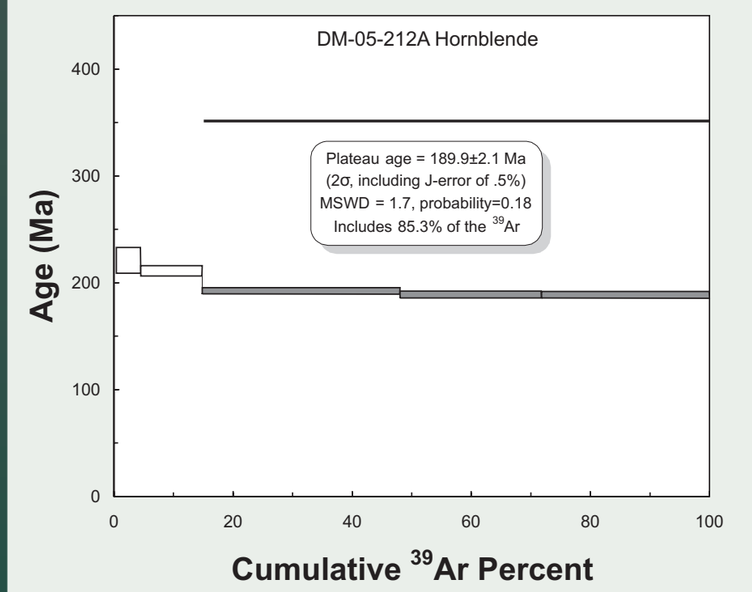

Fig. 8. Hornblende from the Conuma phase, dated by Ar-Ar geochronology, yields lower Jurassic age (189.9 ± 2.1 Ma).

Intrusion-Related Gold Mineralization

The study area has potential for Au mineralization similar to the Intrusion-related deposits in the Zeballos camp. The Zeballos mineralization (Figs. 9, 10, 11) is related to the emplacement of the Tertiary Mt. Washington intrusive rocks. This study has tentatively identified another large intrusion of this type in Shelter Inlet. The occurrence of the Mt. Washington in general proximity to volcanic rocks and Mooyah sediments is prospective. Another earmark of the Zeballos type mineralization is the presence of carbonate. No carbonate or mineralization was observed during this summer's field work. However there is much unexplored ground in the area.

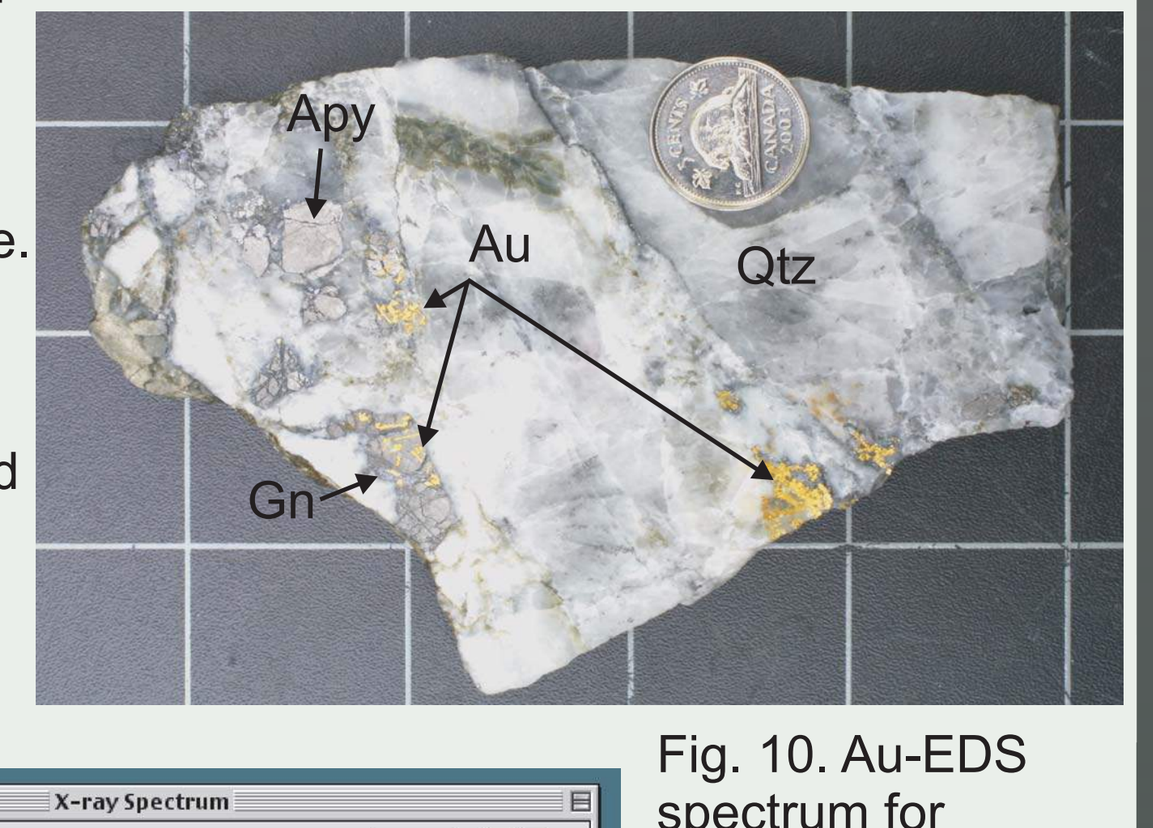

Fig. 9. Slab of gold bearing quartz (Qtz) vein from the Privateer Mine. Minor galena (Gn) replaces arsenopyrite (Apy) and gold (Au), which cuts both the arsenopyrite and galena.

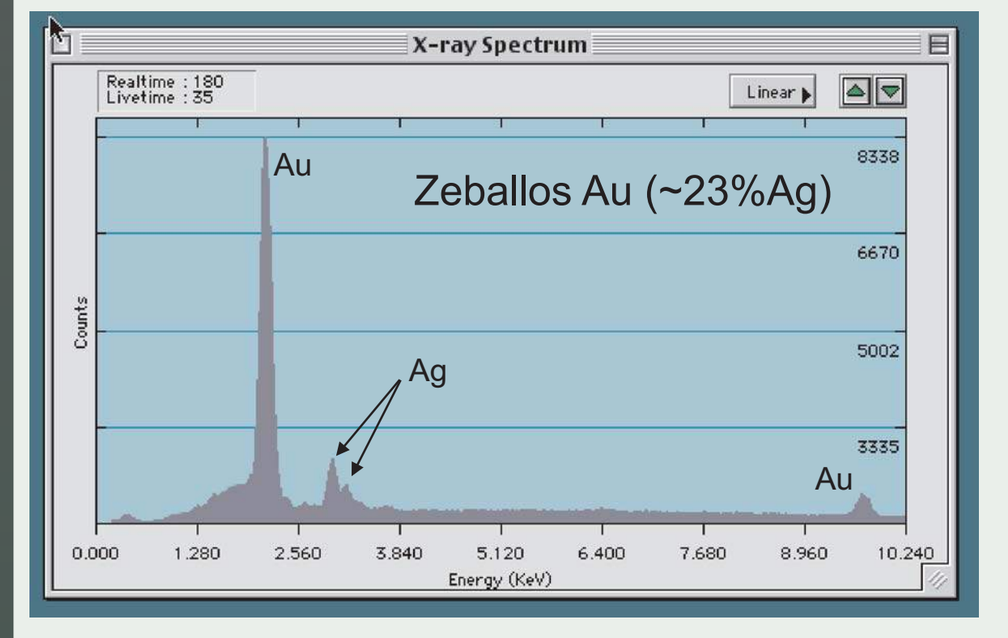

Fig. 10. Au-EDS spectrum for Privateer Mine sample. This is consistent with the gold containing 23 wt% silver, which is generally thought to represent gold precipitation in the epithermal environment.

Fig. 11. Photograph showing the back of 2-3A vein (Privateer Mine). Some deformation is brittle (pink arrow) as evidenced by the splays coming off the main vein; some deformation within the vein is ductile (hammer for scale).

Sulphide vein - Type Mineralization

The sulphide vein type mineralization found on the H7000 spur north of Stewardson Main Line (Fig. 12) is similar to the mineralization at the Beano near the mouth of the Little Zeballos River. The mineralization at Beano consisted of quartz-calcite-pyrrhotite stringers, disseminated pyrrhotite and lenses of massive pyrrhotite. The H7000 mineralization resembles the lenses of massive pyrrhotite from Beano consisting of a vein of massive pyrrhotite with blebs and veinlets of chalcopyrite, and inclusions of altered host rock. A gossanous region can be seen on the other side of the valley directly along strike from the vein.

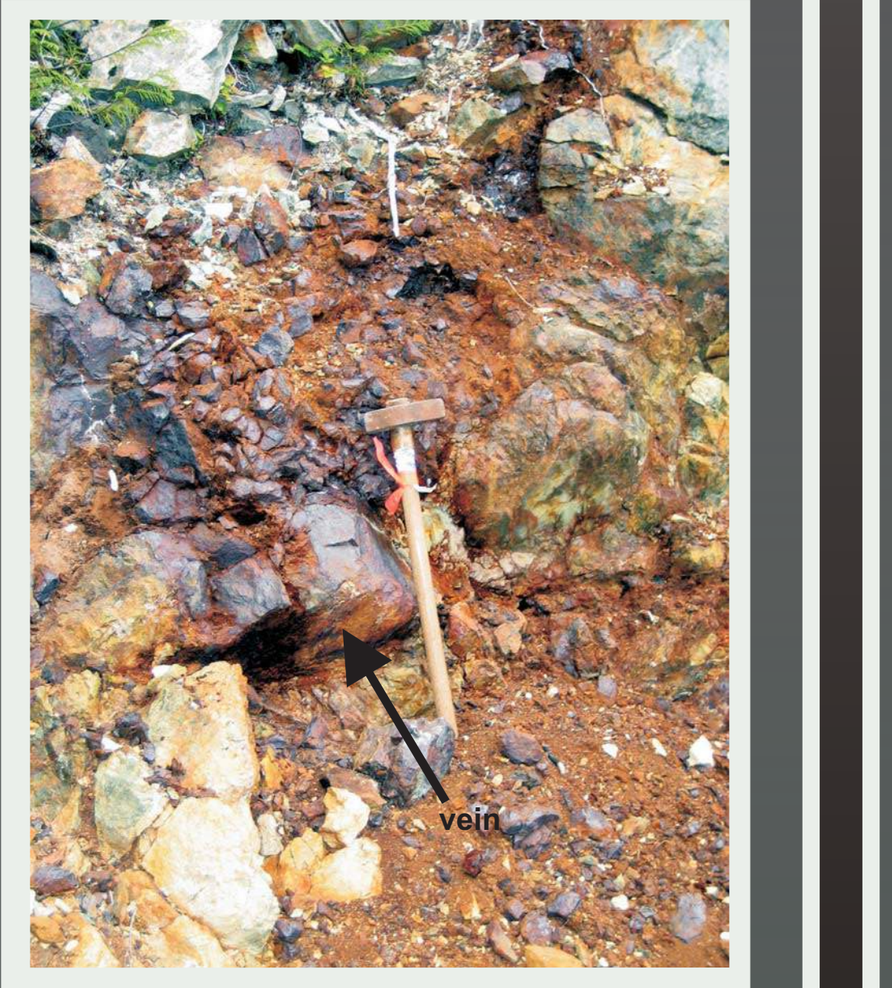

Fig. 12. Gossanous zone with a pyrrhotite vein cutting Mooyah Fm from the H7000 spur of the Stewardson Main Line.

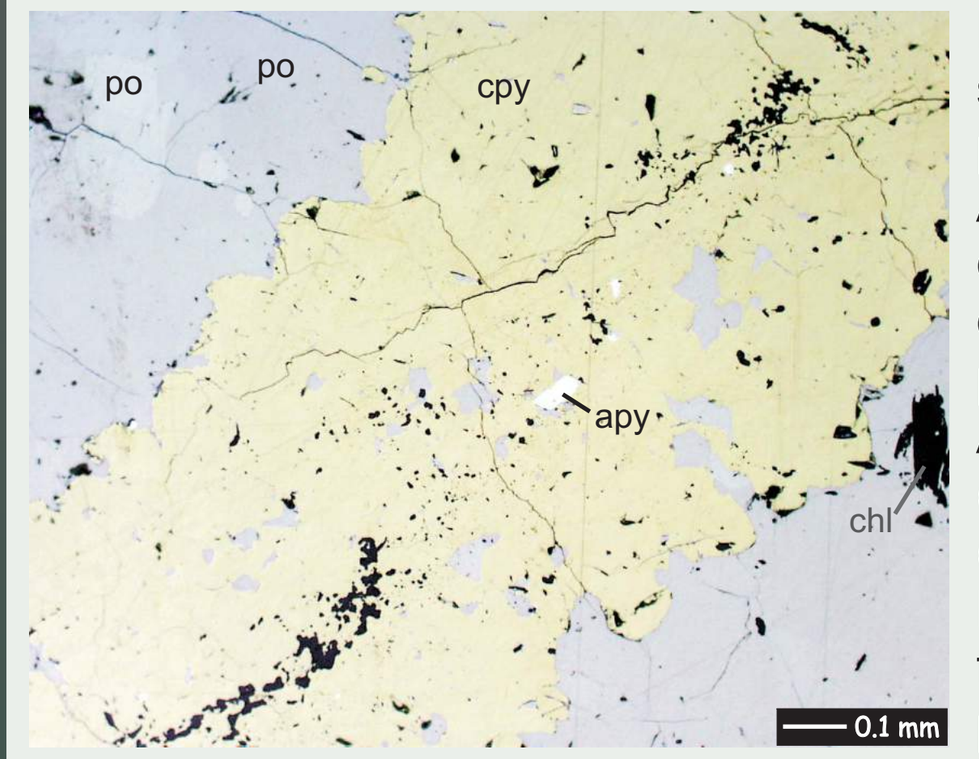

Fig. 13. Thin section of the pyrrhotite vein. A veinlet of chalcopyrite (cpy) cuts massive pyrrhotite (po). Arsenopyrite (apy) and chlorite (chl) are present. Photograph taken under partly XPL.

VMS - Type Mineralization

The study area is host to some metavolcanic rocks. Preliminary geochemistry and the presence of the overlying Mooyah Fm indicate that some of the volcanic rocks are most likely Sicker Group volcanic rock equivalents and correlative to the rocks hosting the Myra Falls mine as described by Barrett and Sherlock (1996). The rocks at one locality (Fig. 14) are highly gossanous and contain abundant mineralized veins up to 15 cm wide comparable to typical VMS stockwork mineralization. The host rocks are massive flows and volcaniclastic rocks with abundant chlorite-epidote alteration. The gossanous zones extend up to 10 m in width and a grab sample from one of the highly weathered sulphide veins returned 2.5 % Cu.

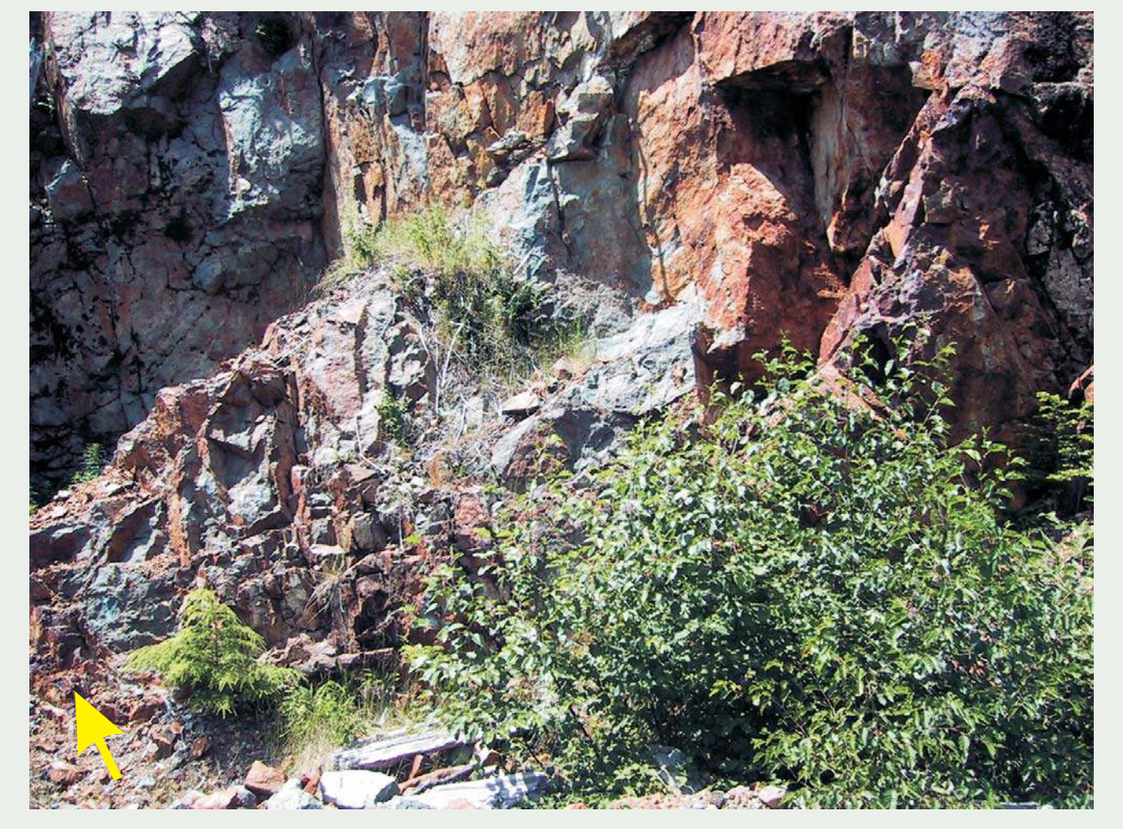

Fig. 14. Gossanous zone within altered mafic volcanic rocks, containing dispersed sulphide veins similar to a typical VMS stockwork zone. The vein on the extreme left (arrow) contains 2.5 % Cu. The photograph is ~ 10 m in width.

Sample	Description	Au (ppm)	Cu (ppm)	Ni (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppm)	As (ppm)	S (wt%)	Co (ppm)	Cr (ppm)	Pt (ppm)	Pd (ppm)	Bi (ppm)
DM 05-13	VMS	NA	24700	69	11	217	17.6	6	6.7	155	24	NA	NA	6
DM 05-11	Po vein	0.005	4900	260	59	5	0.5	45	37.4	462	<1	NA	NA	7
DM 06-32A	U-mafic	<0.03	168	16	2	48	0.1	5	0.04	17	20	<0.03	0.3	<2
DM 06-56	Porph-Cu	NA	31800	2	11	102	113	4	0.92	3	4	NA	NA	397
DM 06-57	Porph-Cu	NA	9040	7	2	65	4	2	0.57	10	11	NA	NA	5
DM 06-99	Porph-Cu	2.55	49800	3	44	100	182	< 2	1.68	16.5	20	<0.03	<0.03	922

Table of geochemical results of rock samples of different mineralization types (VMS = Volcanogenic massive sulphides; Po = Pyrrhotite; U-mafic = Layered Ultramafic; Porph-Cu = Porphyry Copper).UTM locations are 0685370, 5491269; 0685184, 5490654; 0687700, 5529264; 0689503, 5491595; 0688639, 5491593 and 0689503, 5491595 respectively.

Skarn - Type Mineralization

Skarn mineralization has been reported at Silverado within the study area and nearby at a number of locations, most notably the Ford Fe-skarn north of Zeballos. The Silverado is hosted within limestone of uncertain age near the flanks of a large Jurassic Island Intrusion. It is predominantly a Zn-skarn with minor Ag, Au and Cu mineralization. The Ford skarn is hosted within Triassic carbonates. It is a magnetite skarn and is associated with the emplacement of Jurassic Island Intrusions. There were two localities found this summer that have similar geological settings of calcareous rocks intruded by Jurassic Island intrusions. The exposed areas of carbonates were limited and there was abundant evidence of calc-silicate skarn minerals with sulphide mineralization. However, due to limited access, there still remains abundant unprospected area.

Conclusion

2005 & 2006 field work has identified some exploration targets:

1) At least one new occurrence of the Mt. Washington Intrusive Suite, which is associated with Au-mineralization in the neighbouring Zeballos Gold Camp.

2) A previously undocumented occurrence of layered mafic rocks near the contact between Jurassic and Triassic rocks has a potential for Ni- and PGE-rich magmatic sulphide mineralization.

3) Encouraging Cu numbers (2.5% Cu) are from complex vein networks and possible stockwork mineralization from the altered volcanics near Stewardson Inlet.

4) Potential for skarn mineralization in the area is similar to the neighbouring Silverado and Ford Skarns.

5) Massive pyrrhotite veins with minor chalcopyrite mineralization are similar to the veins described from the nearby Beano Au deposit on the Little Zeballos River.

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