Geology and Mineral Potential Update for the Muchalat-Hesquiat Region (NTS 092E, F, K, I), Vancouver Island[1]

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INTRODUCTION

This report provides an update on results previously reported (Marshall *et al*., 2006) and is based on fieldwork undertaken during the summer of 2006. The overall study area comprises the Nootka Sound region (Fig 1). This report provides an updated geological map (Fig 2) and details on the mineralogy and chemistry of two specific rock units within the area and their mineral potential: copper-porphyry potential within the Jurassic Island intrusive suite (JI) and platinum group metals (PGM) potential within a newly discovered magnetite-rich layer within the lower Jurassic, layered ultramafic phase (lJum) of the JI. The regional and detailed geology are described in Muller *et al*. (1981) and Marshall *et al*. (2006). The regional tectonic setting is described in Yorath *et al*. (1999).

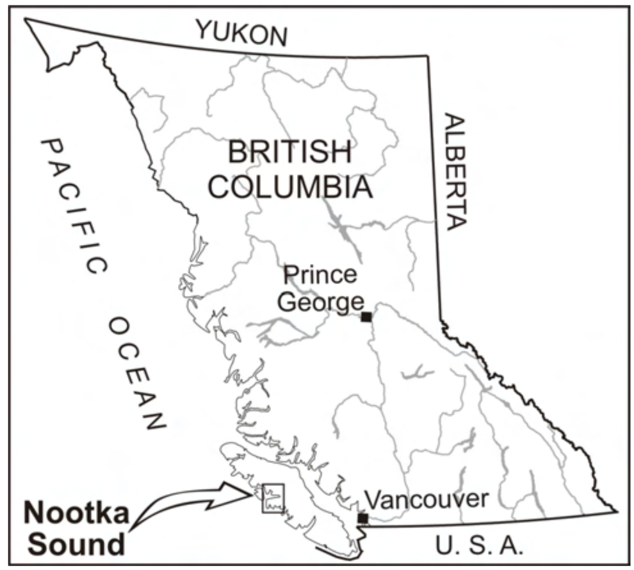

Figure 1. Location map of the study area, Vancouver Island, BC.

LOWER JURASSIC LAYERED ULTRAMAFIC ROCKS

The layered ultramafic rocks occur sporadically within the Island intrusive suite (Muller *et al*., 1981; DeBari *et al.*, 1999). These rocks outcrop mostly in the drainage courses flowing into the Conuma River and it seems appropriate that these layered rocks should be named the Conuma phase of the Island intrusive suite. The best exposures of these rocks are at the top of the Conuma Main Forestry Road and along Norwood Creek. In some cases, the unit can be traced over a few hundred metres. The unit weathers somewhat recessively compared to the main diorite-granodiorite phases of the Island intrusive suite, and thus it is best exposed in roadcuts.

The Conuma phase comprises two main rock types (Fig 3). The first is a gabbro to hornblende-diorite. This rock type varies locally but in general is composed of 60% hornblende, 40% plagioclase and minor phlogopite. Most of the pyroxene within these rocks has been metamorphosed to hornblende and phlogopite. It weathers light brown and is altered locally to epidote and serpentine along fractures. Some zones of intense alteration have malachite staining. The second rock type is metaperidotite. The metaperidotite weathers the typical tan colour of ultramafic rocks. In general, the pyroxenite shows slight alteration but most of the primary mineralogy is preserved. There are minor amounts of igneous hornblende, although some hornblende appears to be metasomatic or metamorphic in origin. Orthopyroxene and olivine are easily visible in thin section (Fig 4) and are relatively fresh. The olivine in these rocks is slightly altered to serpentine along fractures but is generally quite well preserved. The rock is composed of approximately 40% olivine, 45% orthopyroxene, 10% hornblende and 5% plagioclase feldspar. Assuming all the hornblende is retrograded from pyroxene, the rock was probably an olivine-websterite prior to metamorphism. Magnetite (Fig 5, 6) 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.

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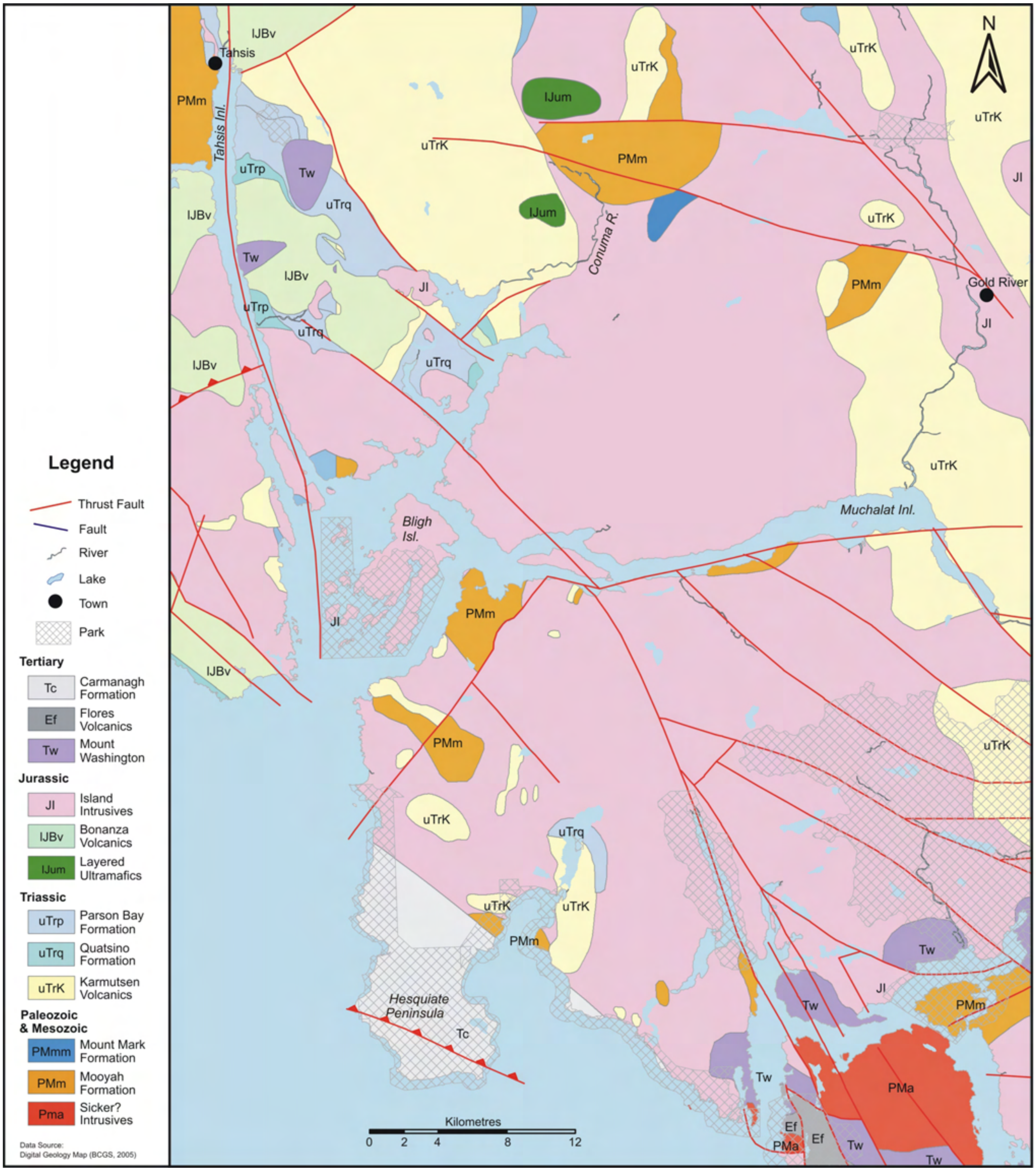

Figure 2. Preliminary geological map for the study area, Vancouver Island, BC (*after* Muller *et al.*, 1981; Marshall *et al.*, 2006).

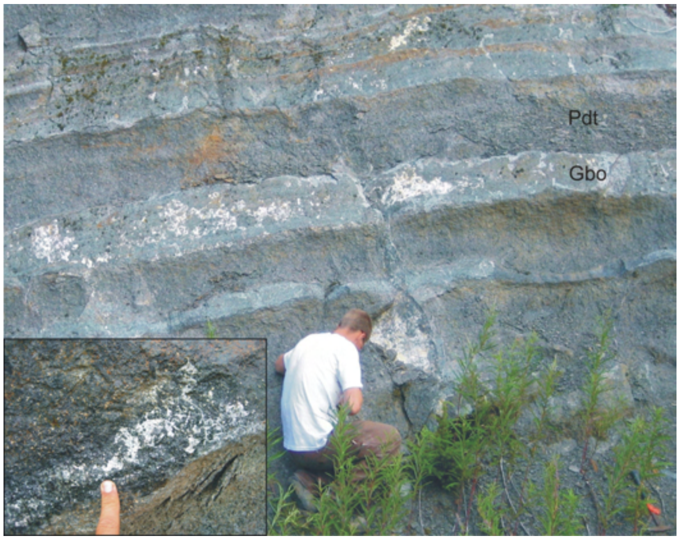

Figure 3. Outcrop photograph of the layered ultramafic rocks of the Conuma phase, showing dark green metagabbro (Gbo) and recessive-weathering black to rusty tan metaperidotite (Pdt) layers, Vancouver Island, BC. Inset photo: close-up of the layering from the same phase at a different locality. Also note the small amount of ductile deformation in the metaperidotite layer and the lack of deformation in the more competent metagabbro layers.

Figure 5. Photomicrograph showing a magnetite (mag)–rich portion within the Conuma phase. Photograph taken in plane-polarized transmitted light.

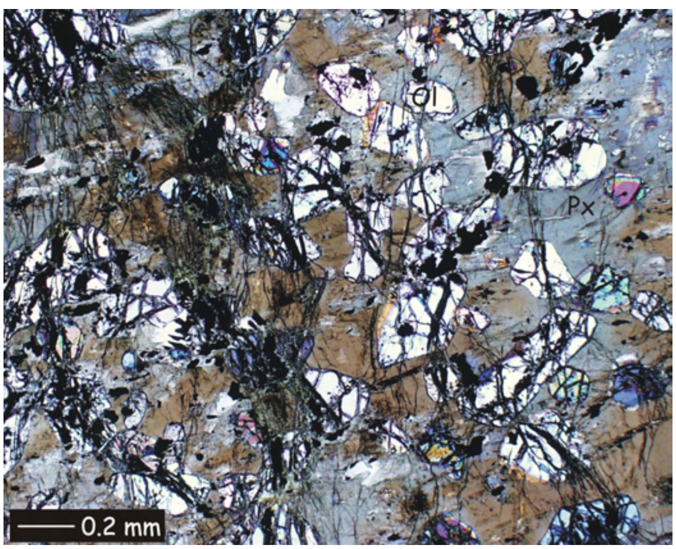

Figure 4. Photomicrograph showing the relatively fresh orthopyroxene (Px) and olivine (Ol) within the metaperidotite. The high-relief highly birefringent olivine displays minor alteration to serpentine along fractures. The pleochroic brown to grey orthopyroxene is relatively fresh but may be slightly altered to amphibole locally. Photograph taken in plane-polarized transmitted light. Sample DM05-212A.

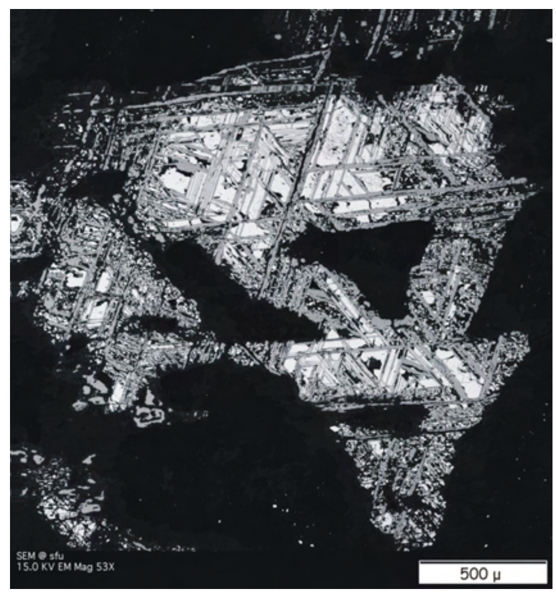

Figure 6. Backscattered electron image of the intergrown magnetite and ilmenite from the magnetite-rich layers of the Conuma phase of the Island intrusive suite.

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 7). A second amphibole from this same rock unit yielded a similar age. Plagioclase grains yielded a very disturbed Ar-Ar spectrum with no interpretable age data.

Although the preliminary platinum group elements (PGE) analyses results (Table 1) are less than exciting, the potential remains for PGE mineralization associated with magnetite in layered intrusions, such as those documented by Sá *et al*. (2005) and Maier *et al*. (2003) in Brazil and South Africa, respectively.

PORPHYRY-STYLE MINERALIZATION WITHIN THE ISLAND INTRUSIVE SUITE

The Island intrusive suite has been an exploration target for porphyry copper mineralization since the mid 1900s

TABLE 1. REPRESENTATIVE GEOCHEMICAL VALUES FROM GRAB SAMPLES OF THE PORPHYRY-STYLE AND LAYERED ULTRAMAFIC MINERALIZATION TARGETS.

Sample no.	Lithology	Au (ppm)	Pt (ppm)	Pd (ppm)	Cu (ppm)	Ni (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppm)	As (ppm)	S (wt.%)	Co (ppm)	Cr (ppm)
DM06-32A	Ultramafic	<0.3	<0.3	**0.3**	168	16	2	48	0.1	5	0.04	17	20
DM06-56	Porphyry copper	-	-	-	**31800**	2	11	102	**113**	4	0.92	3	4
DM06-57	Porphyry copper	-	-	-	**9040**	7	2	65	4	2	0.57	10	11

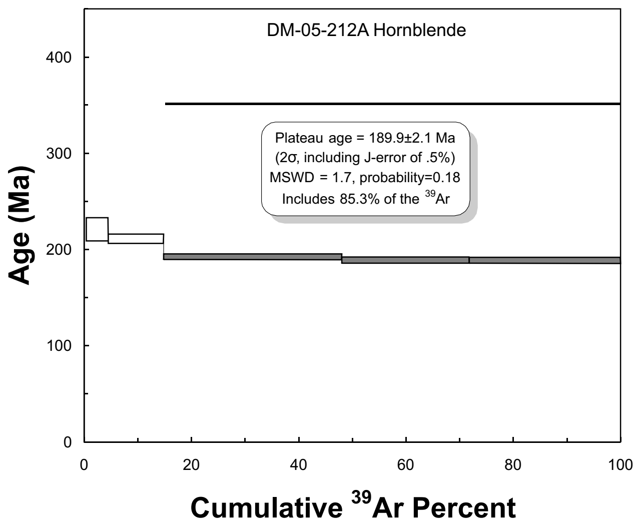

Figure 7. Ar-Ar spectrum for hornblende from the amphibole of the lower Jurassic ultramafic phase (lJum). Filled steps were used for the plateau calculations, open steps were rejected. Step heights are reported at the 2σ level.

(*cf.* Northcote and Robinson, 1972; Leitch *et al.*,1995). This summer a float, found in a recently constructed roadbed, had chrysocolla stain. In addition to chrysocolla, the sample also contained visible chalcopyrite and bornite (Fig 8). The outcrop at this locality was the same rock type but did not have the same copper stain. Samples were taken from the roadbed and a search was initiated to find the outcrop. Another outcrop of the same rock type with copper stain was found further along the road.

The copper minerals are hosted within a hornblende-diorite of the Island intrusive suite. The diorite is fairly typical of the large batholithic intrusions in the area, displaying an equigranular texture and a composition of approximately 80% plagioclase feldspar and 20% amphibole. Superimposed on the primary igneous mineralogy is a hydrothermal overprint resulting in anastomosing veins containing amphibole, chlorite and copper-bearing minerals. Chalcopyrite, bornite, covellite, chrysocolla and malachite are visible on cut slabs of the vein material and disseminated throughout the rock (Fig 9).

OTHER POTENTIAL MINERALIZATION STYLES

The Nootka region is host to some arc-type volcanic rocks. Preliminary geochemistry and the presence of the overlying Mooyah Formation indicate that some of the

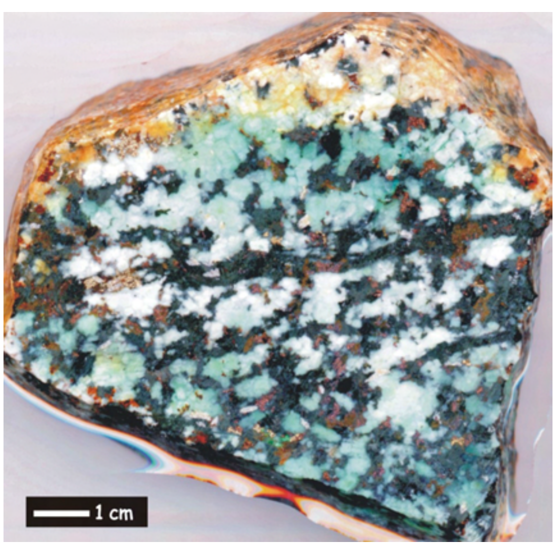

Figure 8. Scanned slab of copper-rich diorite. The original diorite of the Island intrusive suite is cut and altered by stockwork-like veins of amphibole, bornite and chalcopyrite. There is also abundant disseminated bornite and chalcopyrite. The light green stain in this sample is chrysocolla. Bulk rock analysis of this sample returned 2.5 ppm Au, 182 ppm Ag and 5% Cu.

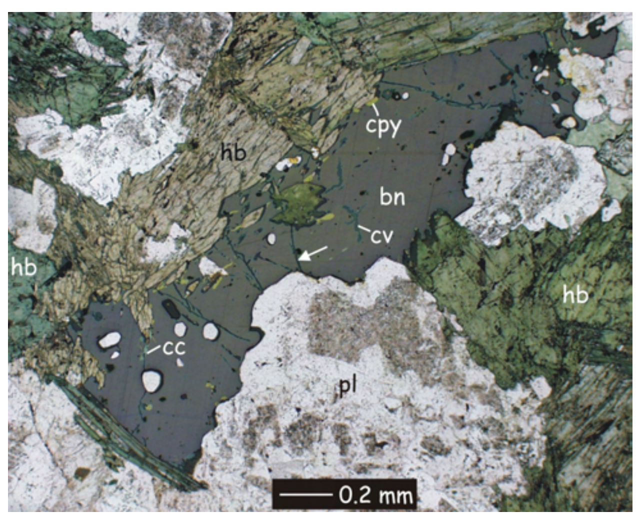

Figure 9. Photomicrograph of the copper-rich samples shown in Figure 8. Bornite (bn) is the most abundant copper-bearing mineral. Chalcopyrite (cpy) is in equilibrium with the bornite, both of which are being replaced by covellite (cv) and chalcocite (cc). Silicate matrix comprises plagioclase feldspar (pl) and hornblende (hb). Also note the late veinlets (arrow) of hematite and silicates. Photograph taken in plane-polarized reflected light.

subsurface 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) and Jones *et al*. (2005). The volcanic rocks at one locality (Marshall *et al*., 2006) are highly gossanous and contain abundant mineralized veins up to 15 cm wide comparable to typical volcanogenic massive sulphide (VMS) stockwork mineralization.

The area is also prospective for gold mineralization similar to the intrusion-related deposits in the Zeballos camp (Stevenson, 1938, 1939, 1950; Hansen and Sinclair, 1984; Marshall *et al*., 2005). The Zeballos mineralization is related to the emplacement of the Tertiary Mount Washington intrusive rocks. A large intrusion of this type has been identified in Shelter Inlet (Marshall *et al*., 2006) and there is still much unexplored ground in the region.

The Silverado and Indian Chief mines within the study area are reported as having skarn-type mineralization. The Silverado is predominantly a Zn skarn with minor Ag, Au and Cu mineralization. Preliminary conodont studies indicate that the carbonate rocks at the Silverado are Triassic (M. Orchard, pers comm, 2006) Additionally, the Ford Fe skarn north of Zeballos is hosted within Triassic carbonate rocks. This is a magnetite skarn and is related to the emplacement of Jurassic Island intrusions. There are some localities in the study area that have similar geology, most notably in the area around Hesquiat Lake (MINFILE 092E 013; MINFILE, 2006).

PRE-TERTIARY FAULTS

A focus of mapping in the Muchalat-Hesquiat region is placing the Westcoast Crystalline Complex (WCC) within the context of the existing Vancouver Island stratigraphy (Yorath *et al*., 1999) and setting this part of Vancouver Island in a more modern plate-tectonic framework. To this end, some time was devoted to documenting major vertical and/or lateral movement on some of the large north-trending faults. The most remarkable of these is the Tahsis fault that runs all the way down Tahsis Inlet and separates the eastern coast of Nootka Island from Vancouver Island. In the area around Tahsis, the entire sequence of Triassic Karmutsen volcanic rocks is missing on the west side of the fault. This corresponds to a vertical offset in excess of 6 km (Surdam, 1968). This is also evidenced by an abrupt change in grade from upper greenschist in the Nootka Island rocks (Close, 2006) to lower or sub-greenschist on the east side of the fault (Marshall *et al*., 2006). Movement on these faults must have occurred prior to the Tertiary as the Tertiary Carmanah sedimentary rocks are observed on both sides of the southern trace of the Tahsis fault.

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