NORTHERN VANCOUVER ISLAND INTEGRATED PROJECT

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INTRODUCTION

The Northern Vancouver Island integrated project (Figure 1) was initiated in 1993 as part of an effort by the Ministry to revitalize base metal exploration in the province. This "targeted" geoscience program (Panteleyev et al., 1994) includes bedrock and surficial geological mapping; water, till and bedrock geochemistry; and alteration and mineral deposits studies. A major focus is to provide a clearer understanding of the nature of the Bonanza volcanics, their geochemical expression and their mineral potential. The original plan was to have a two-year program ending in 1994; the regional bedrock mapping component was extended in 1995 for one additional year. The program is jointly funded by the Canada/British Columbia Mineral Development Agreement (MDA). Results of the most recent studies are described below. A final report summarizing the various component studies and specialized stratigraphic, geochronological, remote sensing, paleontological, geophysical, and other support investigations, will be made ready in 1996.

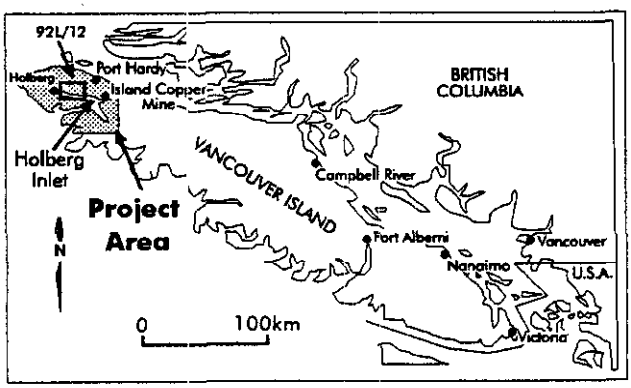

Figure 1. Location map.

REGIONAL BEDROCK MAPPING

Mapping in the 1995 field season covered the Alice Lake map sheet (92L/6) which extends from the southeastern extremity of Quatsino Sound (Neroutsos Inlet) eastward to the northwestern shore of Nimpkish Lake. The northeastern part of the map area is underlain extensively by subaerial flood basalts of the Upper Triassic Karmutsen Formation; the southern and western parts of the area by northwesterly striking, southwesterly dipping units of the overlying Upper Triassic Quatsino and Parson Bay formations and Lower to Middle Jurassic Bonanza group volcanic and sedimentary sequences. The area is intruded by granitoids of the Island Plutonic Suite, the most important of which, the Coast Copper stock, is exposed south of Benson Lake and is genetically related to past-producing copper-iron-gold skarn deposits in the vicinity of Merry Widow Mountain. The most significant results of the 1995 field program are summarized below. Previous project work has been described by Hammack *et al.* (1994), Nixon *et al.* (1994; 1995) and Archibald and Nixon (1995).

Major mafic to intermediate pyroclastic and proximal epiclastic deposits are intercalated with typical Parson Bay lithologies, namely dark to medium grey, thin to medium-bedded, locally coralline, carbonaceous lime mudstone, and argillaceous to silty limestone. The volcanic rocks are dark grey-green, thin to thick bedded, predominantly laharic breccias and lapilli tuffs of probable phreatomagmatic origin, containing clinopyroxene and sparse amphibole phenocrysts and commonly clasts of Quatsino limestone. The lowest pyroclastic horizons occur within the upper few metres of the Quatsino limestone that is locally rich in corals, bivalves and ammonoids. The stratigraphic position of the volcanic rocks implies that they are Upper Triassic, which makes them the only volcanics of this age presently known on Vancouver Island. This conclusion is presently being tested in the laboratories of M.J. Orchard of the Geological Survey of Canada by the processing of samples collected for conodonts, and by laser Ar^{40}/Ar^{39} dating of amphiboles separated from the tuffs by D.A. Archibald of Queen's University.

Metasomatism at the periphery of epidote and garnet-bearing skarns in the Merry Widow area preferentially affects the upper parts of the Quatsino limestone and lowermost Parson Bay sediments, especially the coarser volcaniclastic sequences which are more permeable. Such controls on magnetite-rich

skarns and associated sulphide ore deposits were noted by previous workers.

Major sequences of subaerial aphyric to plagioclase-phyric basalt of probable tholeiitic affinity characterize Bonanza volcanic stratigraphy around the shores of Victoria Lake and south of the Benson River. These flows may be genetically linked to the younger Coast Copper stock, a composite hornblende-bearing gabbroic to monzonitic intrusion. Lithogeochemical studies of the Bonanza volcanic rocks and Island Plutonic Suite are currently in progress.

SURFICIAL GEOLOGY

Surficial geological investigations on Northern Vancouver Island have stressed three components during the life of the project: Quaternary geologic history, till geochemistry and new geophysical applications. To date, preliminary and/or final results of all three elements have been addressed in a series of reports and maps presented elsewhere (Bobrowsky and Meldrum, 1994; Bobrowsky *et al.* 1995; Huntley and Bobrowsky, 1995).

Fieldwork in 1995 consisted of follow-up studies in geophysical applications. A max-min frequency-domain electromagnetic survey was completed at site 2, Mine View Road, near Island Copper mine, to improve the interpretation of bedrock lithology and shear zone location under the monotonous drift cover. Detailed magnetic measurements were also taken at site 3, near the Red Dog property, to complete the "frontier studies" aspect of the project. Interpretive papers on the geophysical studies are in progress to complement a recently released open file (Lowe *et al.* 1995). The till geochemistry data will be published in a separate open file (Bobrowsky and Sibbick, 1996). The latter provides a documentation and synthesis of the till geochemistry samples collected in NTS sheets 92L/5,6,11 and 12 over the past several years by the Geological Survey Branch.

MINERAL DEPOSITS STUDIES

The mineral deposits component of the integrated project investigated porphyry copper, and other intrusion-related mineralization, in a belt of mainly Bonanza volcanics and Island intrusions west of Island Copper mine. The study focused on the potential for additional types of copper-gold-silver mineralization in both "transitional" and epithermal high-sulphidation environments. The transitional hydrothermal environment can be considered to occur between the tops of porphyry copper deposits, and their uppermost expressions at ground surface, as acidic crater lakes or solfateras.

The study of intrusion-related transitional hydrothermal environments is provincial in scope. It was initiated in 1991 in northern Vancouver Island and continued in 1992 in the well exposed high-level, siliceous, advanced argillic alteration zone at Mount McIntosh, its underlying porphyry copper deposit, the Hushamu prospect, and elsewhere in the province. In 1993 the study concentrated on northern Vancouver Island and was incorporated into the integrated project. In 1994, fieldwork was limited, but core from a number of diamond-drill holes on the Hushamu deposit was examined and representative samples selected; additional drill core from Hushamu/Mount McIntosh was examined in 1995. Summaries of previous work are given in Panteleyev and Koyanagi (1993, 1994).

The current project's field component is now concluded. A mineral occurrence model can be formulated. Much of the present interpretation is based on comparisons with circum-Pacific mineral deposits, active volcanoes and geothermal systems in the Philippines, Japan, Chile, and elsewhere, that are described in the scientific literature. The key issue in this study is to determine whether the extensive advanced argillic alteration zones, and their contained acid-leached rocks, are parts of productive, magmatically influenced hydrothermal systems, and can be mineralized or, alternatively, are products of boiling, vapour-dominated acid-leaching systems, which are barren. We cannot, nor can anybody else without much additional expenditure and exploration effort, provide a conclusive and definitive answer for the northern Vancouver Island study area. Certainly the Mount McIntosh/Hushamu example testifies that rocks in high-level, advanced argillic, acid sulphate hydrothermal systems contain (weakly developed) high-sulphidation mineralization. Based on this example, other zones in the belt appear to be permissive for transitional to high-sulphidation epithermal precious and base metal mineralizaton.

The geochemical expression of the porphyry copper, and related high-sulphidation mineralization and advanced argillic/acid sulphate alteration in acidic waters derived from the weathered (oxidized and leached) hostrocks is summarized elsewhere (Panteleyev *et al.* 1996, this volume).

EXPLORATION GEOCHEMISTRY

Fieldwork was conducted during 1995 on the exploration geochemistry component of the project. A small number of water, moss sediment and stream sediment samples were collected in the Macjack River area and from Hepler Creek, which drains the Hushamu deposit. Data from these samples will be incorporated into the final Northern Vancouver Island project report. The geochemistry section of the report will focus on two main topics:

- The application of catchment basin GIS analysis to RGS data.
- The mineral concentration properties of moss mats.

Preliminary results from these studies are already published. Open File 1995-12 (Sibbick and Laurus, 1995a) reports on the integration of geological and RGS data to predict potential areas for intrusion-related mineralization. Initial work on the concentration of heavy minerals by moss-mats was published in the journal Explore (Sibbick and Laurus, 1995b).

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