BC Ministry of Energy, Mines and Petroleum Resources

Geological Survey Branch

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GEOLOGY OF THE MINERAL HILL - WORMY LAKE AREA, SECHELT, BRITISH COLUMBIA

NTS 92G/12W

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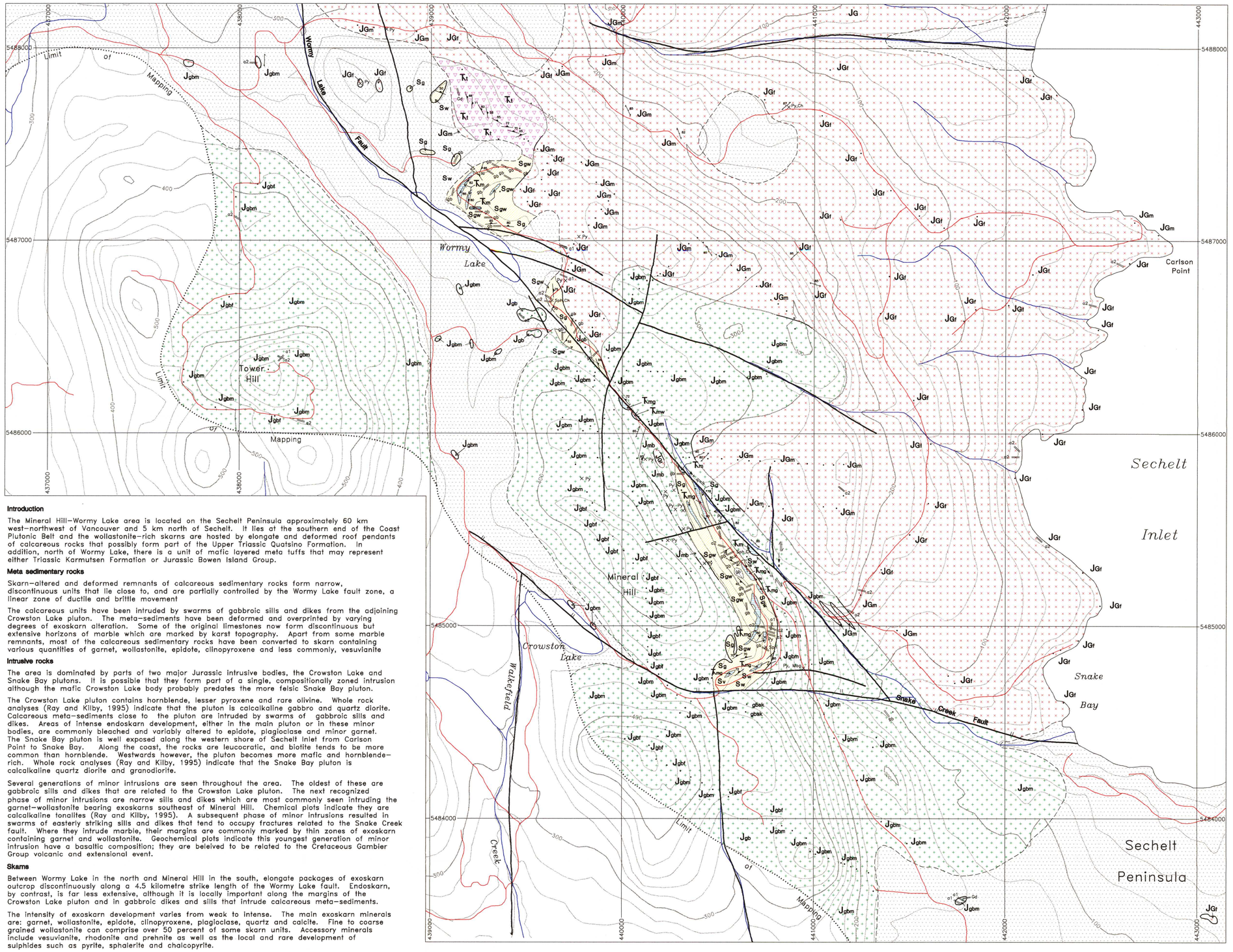
Scale 1:10,000

250 0 250 500 750 1,000

metres



LEGEND

Areas of extensive cover (no exposure)

Minor Intrusions

- gb — Gabbro (Probably related to the Crowston Lake Pluton)
- a — Undiferentiated gabbro–andesite dikes and sills.
- a1 — 1st generation tonalite dikes (age unknown).
- a2 — 2nd generation basaltic dikes (probably Early Cretaceous).
- Gd — Granodiorite dikes and sills (age unknown).

Major Intrusions

Snake Bay Pluton (Jurassic)
Coarse grained, massive to weekly foliated.

- JG — Undiferentiated quartz diorite to granodiorite
- JGr — Quartz diorite to granodiorite with <10% biotite and hornblende (hornblende generally subordinate to biotite).
- JGm — Quartz diorite to granodiorite with >10% biotite and hornblende (biotite generally subordinate to hornblende).

Crowston Lake Pluton (Jurassic)
Coarse to medium grained, generally massive.

- Jgbf — Quartz diorite to gabbro with <15% mafics (hornblende, clino and orthopyroxene, and biotite).
- Jgbm — Quartz diorite to gabbro with >15% mafics (hornblende, clino and orthopyroxene with local olivine).
- gbak — Skarn–altered gabbro (endoskarn).
- Jmb — Mafic, fine to medium grained, generally pyritic rocks. Marginal phase of the Crowston Lake Pluton.

Supracrustal Rocks (possibly Triassic)

- Tt — Layered to massive, medium to fine grained mafic rocks. Possibly Karmutsen Formation or Bowen Island Group metatuffs with minor metabasalts.
- Tm — Marble (possibly Quatsino Formation).
- Tmg — Marble with garnet skarn (possible Quatsino Formation).
- Tmw — Marble with wollastonite skarn (possible Quatsino Formation).

Exoskarn (possibly Triassic Quatsino Formation)

- S — Undiferentiated.
- Sg — Garnet–dominant skarn.
- Sw — Wollastonite–dominant skarn.
- Sgw — Garnet–wollastonite skarn.
- Sv — Vesuvianite–bearing skarn.

Symbol Descriptions and Mineralization

- × — Py = Pyrite, Sph = Sphalerite, Ch = Chalcopyrite, Mag = Magnetite.
- Foliation in plutons.
- Layering in supacrustal rocks: possibly bedding.
- Plunge of slickensiding.
- Subhorizontal movement on fault planes.
- Small scale fold.
- Fault with downthrown side.
- Geological contact; defined, assumed.
- Massive, unfoliated or non–bedded outcrop.
- Road.
- River.
- Contour interval = 20 metres.

Introduction

The Mineral Hill–Wormy Lake area is located on the Sechelt Peninsula approximately 60 km west–northwest of Vancouver and 5 km north of Sechelt. It lies at the southern end of the Coast Plutonic Belt and the wollastonite–rich skarns are hosted by elongate and deformed roof pendants of calcareous rocks that possibly form part of the Upper Triassic Quatsino Formation. In addition, north of Wormy Lake, there is a unit of mafic layered meta tuffs that may represent either Triassic Karmutsen Formation or Jurassic Bowen Island Group.

Meta sedimentary rocks

Skarn–altered and deformed remnants of calcareous sedimentary rocks form narrow, discontinuous units that lie close to, and are partially controlled by the Wormy Lake fault zone, a linear zone of ductile and brittle movement

The calcareous units have been intruded by swarms of gabbroic sills and dikes from the adjoining Crowston Lake pluton. The meta–sediments have been deformed and overprinted by varying degrees of exoskarn alteration. Some of the original limestones now form discontinuous but extensive horizons of marble which are marked by karst topography. Apart from some marble remnants, most of the calcareous sedimentary rocks have been converted to skarn containing various quantities of garnet, wollastonite, epidote, clinopyroxene and less commonly, vesuvianite

Intrusive rocks

The area is dominated by parts of two major Jurassic intrusive bodies, the Crowston Lake and Snake Bay plutons. It is possible that they form part of a single, compositionally zoned intrusion although the mafic Crowston Lake body probably predates the more felsic Snake Bay pluton.

The Crowston Lake pluton contains hornblende, lesser pyroxene and rare olivine. Whole rock analyses (Ray and Kilby, 1995) indicate that the pluton is calcalkaline gabbro and quartz diorite. Calcareous meta–sediments close to the pluton are intruded by swarms of gabbroic sills and dikes. Areas of intense endoskarn development, either in the main pluton or in these minor bodies, are commonly bleached and variably altered to epidote, plagioclase and minor garnet. The Snake Bay pluton is well exposed along the western shore of Sechelt Inlet from Carlson Point to Snake Bay. Along the coast, the rocks are leucocratic, and biotite tends to be more common than hornblende. Westwards however, the pluton becomes more mafic and hornblende–rich. Whole rock analyses (Ray and Kilby, 1995) indicate that the Snake Bay pluton is calcalkaline quartz diorite and granodiorite.

Several generations of minor intrusions are seen throughout the area. The oldest of these are gabbroic sills and dikes that are related to the Crowston Lake pluton. The next recognized phase of minor intrusions are narrow sills and dikes which are most commonly seen intruding the garnet–wollastonite bearing exoskarns southeast of Mineral Hill. Chemical plots indicate they are calcalkaline tonalites (Ray and Kilby, 1995). A subsequent phase of minor intrusions resulted in swarms of easterly striking sills and dikes that tend to occupy fractures related to the Snake Creek fault. Where they intrude marble, their margins are commonly marked by thin zones of exoskarn containing garnet and wollastonite. Geochemical plots indicate this youngest generation of minor intrusion have a basaltic composition; they are beleived to be related to the Cretaceous Gambier Group volcanic and extensional event.

Skarns

Between Wormy Lake in the north and Mineral Hill in the south, elongate packages of exoskarn outcrop discontinuously along a 4.5 kilometre strike length of the Wormy Lake fault. Endoskarn, by contrast, is far less extensive, although it is locally important along the margins of the Crowston Lake pluton and in gabbroic dikes and sills that intrude calcareous meta–sediments.

The intensity of exoskarn development varies from weak to intense. The main exoskarn minerals are: garnet, wollastonite, epidote, clinopyroxene, plagioclase, quartz and calcite. Fine to coarse grained wollastonite can comprise over 50 percent of some skarn units. Accessory minerals include vesuvianite, rhodonite and prehnite as well as the local and rare development of sulphides such as pyrite, sphalerite and chalcopyrite.

Generally, exoskarns throughout the area are characterized by high garnet:pyroxene ratios (approximately 10:1 to 2:1). Massive garnetite is developed locally, particularly in limestone protoliths or in areas proximal to the Crowston Lake plutonic rocks.

Three episodes of exoskarn formation are recognised, all of which resulted in garnet–epidote assemblages; wollastonite however, was only developed in the first and third of these skarn episodes.

The first episode was the dominant skarn–forming event. It was spatially and genetically related to the syntectonic emplacement of the Crowston Lake pluton and its gabbroic sill–dike swarm. It resulted in the pervasive and widespread wollastonite–garnet–pyroxene–vesuvianite assemblages that are of economic industrial mineral interest. Accompanying movements along the precursor structure of the Wormy Lake fault zone resulted in ductile deformation fabrics in the exoskarns as well as boudin structures in the gabbro sills and dikes. Microprobe analyses indicate that the garnets are grossularitic (Ray and Kilby, 1995) with an average composition of $Gr^{67}–Ad^{29}–Pyral^{4}$. The diopsidic pyroxenes average $Di^{85}–Hd^{12}–Jo^{3}$. Comparative analyses of Mineral Hill wollastonite and wollastonite from elsewhere indicate that the Mineral Hill wollastonite have a very low iron content but are comparatively enriched in manganese (up to 1.13% MnO).

Subsequently, a second and minor garnet–epidote skarn forming event accompanied the intrusion of the tonalitic dikes. No wollastonite was produced during this second skarn–forming event. The third skarn episode was related to the young swarm of basaltic dikes and sills. Thin zones of garnet and wollastonite are developed immediately adjacent to the minor bodies.

Wollastonite Mineralization

Wollastonite–bearing skarn is located in two main zones; (1) south of the Wormy Lake fault, along the southeastern slope of Mineral Hill, and (2) north of Wormy Lake, where it is irregularly exposed and open to the north. The southern and northern zones reach maximum outcrop widths of 250 metres and 400 metres respectively.

In 1987 and 1988, Tri–Sil Minerals Inc. conducted an exploration program on the southern half of zone 1. Twenty–four drill holes, totalling 1719 metres in length, were put down to test the grade and continuity of the wollastinite–rich skarns southeast of Mineral Hill. This work has been described by Goldsmith and Logan (1987) and Goldsmith and Kallock (1988). A program of road building and trenching was undertaken on the skarn (zone 2) north of Wormy Lake during the period 1989 to 1990 by Performance Minerals of Canada Ltd.

Wollastonite is widespread throughout the skarn rocks in both zones. Grain size and mode of occurrence vary widely between outcrops and as reported in drill holes. Visually estimated grades in outcrops range up to 80% wollastonite. Massive 2 to 3–centimetre thick layers of wollastonite with fibres up to 0.5 centimetre in length are common. Wollastonite may also occur closely intergrown with grossular garnet and pyroxene over greater widths. In veins and porphyroblasts, wollastonite is much coarser grained, reaching 3 centimetres in length.

Goldsmith and Kallock made preliminary estimates of drill–indicated possible and probable reserves for their "central" section southeast of Mineral Hill. They determined that approximately 196,000 cubic metres of material grading 52% wollastonite is present.

Sulphide mineralization

Minor amounts of sulphide are locally present in the area. The following four types are recognized:

(1) pyrite ± chalcopyrite veinlets in fractures cutting the Snake Bay pluton,
(2) pyrite ± magnetite ± chalcopyrite as disseminations or veinlets in the Crowston Lake pluton.
(3) disseminations, layers and deformed pods and lenses of pyrite ± sphalerite ± chalcopyrite hosted by garnet–wollastonite exoskarn.
(4) pyrite ± pyrrhotite pods and lenses in marble.

Assays on mineralized grab samples representative of all four types of mineralization are presented by Ray and Kilby (1995). Gold values for all samples in the district are generally low. Some of the exoskarns contain thin layers or small tectonized lenses of sphalerite with lesser pyrite and chalcopyrite. Some of this mineralization contain anomalous quantities of zinc, cadmium, copper and cobalt. In addition, they can be highly anomalous in mercury which suggests that the zinc mineralization is not related to any skarn–forming hydrothermal event.

Acknowledgement

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