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GEOLOGY OF NICKEL MOUNTAIN AND THE E&L NICKEL-COPPER PROSPECT (104B/10E)

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KEYWORDS: Economic geology, Nickel Mountain, Iskut River, Hazelton Group, gabbro, pentlandite.

INTRODUCTION

The E&L deposit, the second largest known nickel resource in British Columbia, is located on Nickel Mountain in the Iskut River district north of Stewart. The deposit consists of pyrrhotite, pentlandite and chalcopyrite hosted in an olivine gabbro stock that intrudes Lower Jurassic sediments and volcanics. Exploration has identified 2.9 million tonnes grading 0.80 per cent nickel and 0.62 per cent copper with anomalous values in gold, silver and platinum group elements (Quartermain, 1987; Sharp, 1968). Fieldwork for the present study was carried out in 1988 and 1989 as part of an ongoing regional mapping project in the Iskut-Sulphurets area.

Nickel Mountain is situated in the headwaters of Snippaker Creek (Figure 2-13-1), 27 kilometres east-southeast of the Bronson Creek airstrip and 5 kilometres east of the 950-metre Snippaker Creek airstrip. Access to the property is either by helicopter or on foot.

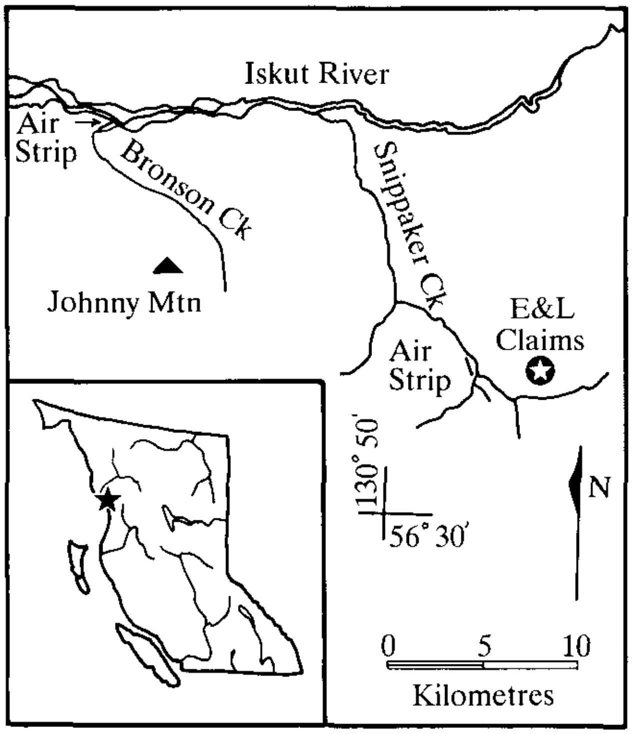

Figure 2-13-1. Location of Nickel Mountain and the E&L claims.

The Nickel Mountain stock crops out at 1850 metres elevation along the crest of a steep ridge which slopes south toward Snippaker Creek and continues northward as a series of razorback ridges separating glaciers and snowfields. A large ice-filled cirque abuts the northeast edge of the showings. The upper slopes are generally talus fans free of vegetation, slopes below 1100 metres are well timbered.

EXPLORATION HISTORY

Nickel Mountain was initially prospected in 1958 by Ed and Lela Freeze for the BIK syndicate (Silver Standard Mines Limited, Kerr-Addison Gold Mines Limited and McIntyre Porcupine Mines Limited.) The E&L 1 and 2 claims were staked at that time followed by the E&L 3 to 28 claims in the winter of 1964-65. Geological mapping, geochemical sampling, hand trenching and x-ray drilling were carried out in 1965 (Hedley, 1965). Further mapping, trenching and drilling were done in 1966 and a small airstrip was built 5 kilometres downstream on Snippaker Creek (Jeffery 1966). A tote road provides access to the property.

Sumitomo Metal Mining Corporation optioned the E&L claims in 1970 and began an underground exploration program. A 450-metre adit was collared 390 metres below the surface showings and driven toward the mineralized zone (Hirata, 1972). Nine underground diamond-drill holes tested the downward extent of mineralization.

Subsequent activity on the property has been minor. In 1986 and 1987 ground magnetometer as well as airborne magnetic and VLF electromagnetic surveys were conducted by Western Geophysical Aero Data Ltd. to outline mineralization beneath the cirque to the northeast (Hermany and White, 1988). In 1986 selected grab samples were analyzed for platinum group elements.

Work on the E&L claims has identified three zones of nickel-copper mineralization exposed at surface and three additional zones underground. Published reserves (Anonymous, 1976; Quartermain, 1987; Sharp, 1968) are presented in Table 2-13-1.

Platinum group element values ranging from less than 50 to 400 ppb platinum and from less than 5 to 415 ppb

TABLE 2-13-1
INDICATED AND INFERRED RESERVES

Category	Tonnes (000's)	Ni %	Cu %	Au g/t	Ag g/t
Trench and drill-					
Indicated	1734	0.80	0.62	0.34	6.8
Inferred	1194	0.80	0.62	0.34	6.8

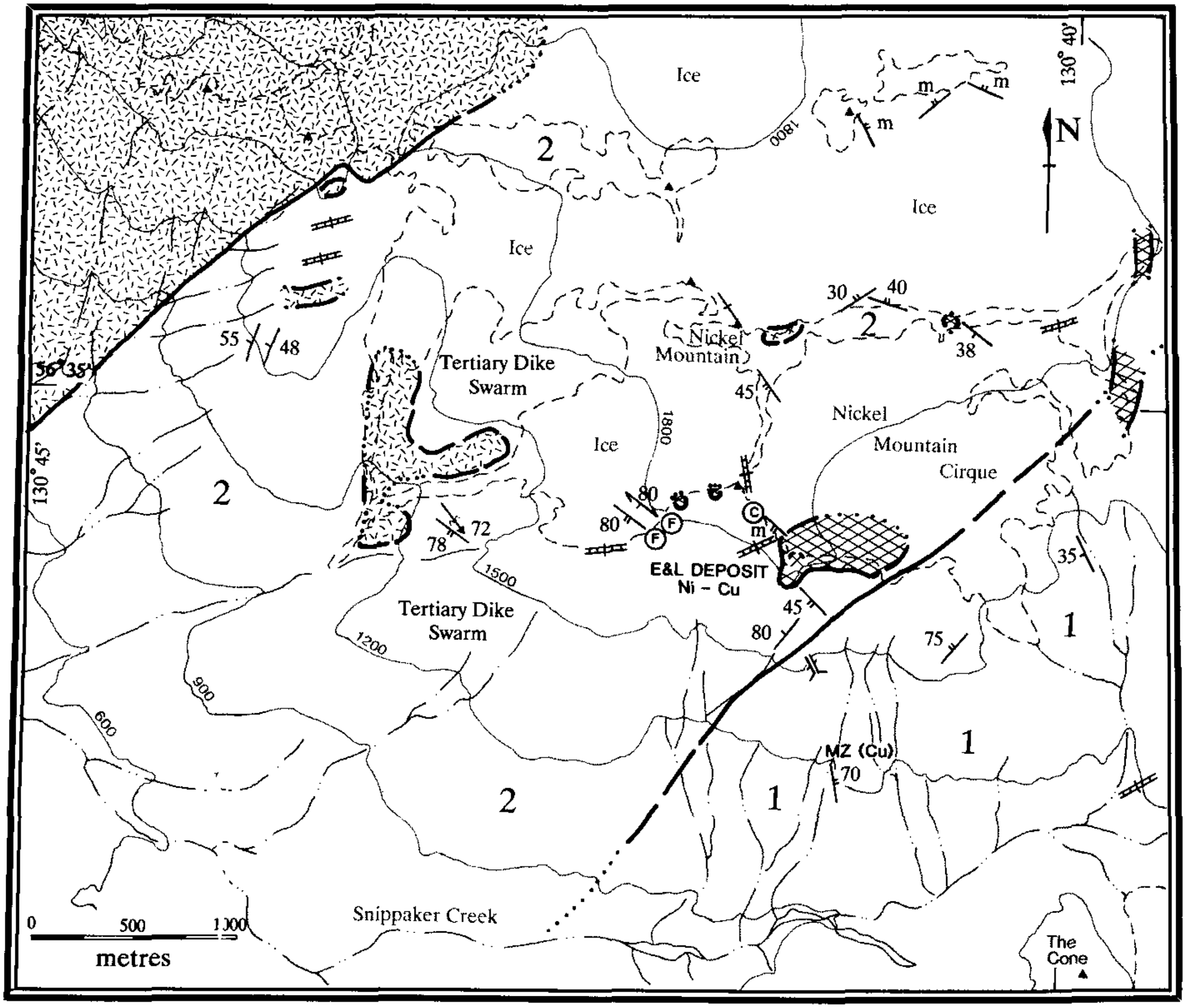

Figure 2-13-2. Interpreted geology of the Nickel Mountain area and the E&L nickel-copper showings.

palladium were obtained from grab samples collected in trenches by Consolidated Silver Standard Mines Limited in 1986 (Quartermain, 1987) and ministry geologists in 1988.

GEOLOGICAL SETTING

Regionally, strata trend northeast with gentle to moderate northwest dips. The Nickel Mountain gabbro intrudes a thick sedimentary and volcanic sequence of the Lower Jurassic Hazelton Group. A large monzodiorite pluton intrudes the volcanosedimentary package 3 kilometres northwest of the deposit. Regional deformation postdates the pluton. Late postdeformation mafic dikes crosscut all rocks in the area.

Sedimentary strata hosting the mineralized gabbro stock are assigned to the Lower to Middle Jurassic Salmon River formation based on lithology, stratigraphic position and fossils. The rocks are black, evenly laminated, rusty weathering, very fine grained argillaceous sandstones, siltstones and mudstones. Small lenses of limestone-chip breccia occur locally and consist of black mudstone matrix with limestone chips up to 4 centimetres across. Lenses are usually less than 1 metre thick over lengths of up to 15 metres. The basal calcareous grit and fossiliferous limestone member of the Salmon River formation type section (Alldrick, 1985; Alldrick *et al.*, 1987) has not been identified in the Nickel Mountain area. However, due to the presence of the limestone-breccia lenses and proximity to the underlying volcanic package, it is inferred that the sediments at Nickel Mountain are lowermost Salmon River formation (Figure 2-13-2).

Ammonoid fossils are preserved in the black argillites. Samples collected in 1965 were identified as *Hildoceratacea*, some similar to *Haugia*, suggesting a Toarcian age (GSC Location 86273; Grove, 1986). The samples were poorly preserved and additional samples were collected in 1989.

LEGEND

TERTIARY

Medium-grained, grey diorite dikes and small plugs (?), 1 to 10 metres across.

MIDDLE JURASSIC TO MIDDLE CRETACEOUS

NICKEL MOUNTAIN GABBRO

Medium to coarse-grained olivine gabbro; composed of plagioclase, pyroxene and olivine. Orbicular textures are present in both pyroxene and plagioclase.

JURASSIC

LEHTO PORPHYRY

Medium to coarse-grained quartz monzodiorite; composed of white plagioclase, pink potassium feldspar, grey quartz, black hornblende and minor biotite. Locally, the potassium feldspar phenocrysts are up to 3 centimetres long. The border phase is commonly a grey/green diorite.

LOWER TO MIDDLE JURASSIC

SALMON RIVER FORMATION

2 — Rusty weathering, black, well-laminated, very fine grained argillaceous sandstones, siltstones and mudstones. Locally contains small lenses of limestone-chip breccia. The basal calcareous grit and limestone are not present. Ammonoid fossils are present but not abundant.

BETTY CREEK FORMATION

1 — Felsic to intermediate volcanics; light to medium green, dacitic ash tuffs and lapilli tuffs, commonly plagioclase porphyritic. Contains interbeds of black siltstone and very fine grained sandstone. Also contains some hematitic clastic layers.

SYMBOLS

Contact (known, approximate, assumed)	
Bedding (tops known, tops unknown, vertical)	
Mineral prospect	
Mineralized showing	MZ (Cu)
Macrofossil sample location	F
Conodont sample location	C
Adit	
Stream	
Contour (in metres)	1500
Peak	▲
Permanent snow/ice boundary	

A thick sequence of felsic to intermediate volcanics and thin interbedded sediments underlies the Salmon River formation. The package consists primarily of dacitic ash tuffs and lapilli tuffs, commonly plagioclase porphyritic. These rocks are light to medium green with some dark green andesitic layers. Tuffs are fine to medium grained and massive to locally well bedded. Interbedded sedimentary members are usually black, thin-bedded fine sandstone and siltstone. These thin sedimentary units are distributed randomly throughout the volcanics. This volcanic sequence can be correlated with the Lower Jurassic Betty Creek formation; however, only minor hematitic clastic sedimentary units characteristic of the Betty Creek type section, are present on Nickel Mountain.

The volcanic strata are dominated by dacitic units in this area and cannot be usefully subdivided. Thus, no distinction has been made between the Betty Creek and Mount Dilworth formations in this study and some of the formational divisions established to the east and south may not be valid in the Nickel Mountain area.

The Nickel Mountain gabbro is a unique lithology in the Stewart-Iskut district. The gabbro intrusions consist of four small plugs less than 100 metres wide at surface, one large stock approximately 800 metres across and a dike swarm approximately 250 metres wide, all occurring along a 3 kilometre northeast trend. The large stock and dike swarm may be connected as they are separated by a large ice-filled cirque.

Petrographic study shows that the dominant mineral phases are plagioclase, pyroxene and olivine. Orbicular textures are common in gabbro adjacent to the mineralization (Plate 2-13-1). The presence of fractures and sheared mineral grains indicates the gabbro has undergone deformation. The stratigraphic and structural evidence suggests the intrusion of the gabbro postdates the Lower to Middle Jurassic sediments and predates the mid-Cretaceous deformation. This brackets the age of intrusion at 185 to 110 Ma.

A large stock of porphyritic quartz monzodiorite, the Lehto porphyry, truncates sedimentary strata of the Salmon River formation north and northwest of Nickel Mountain. Lehto porphyry is interpreted as a Jurassic pluton, based on alteration, deformation and presence of hornblende and potassium feldspar megacrysts; a potassium-argon analysis is in progress. The rock is typically medium to coarse grained with white plagioclase, pink potassium feldspar, grey quartz, black hornblende and lesser biotite. Locally the potassium

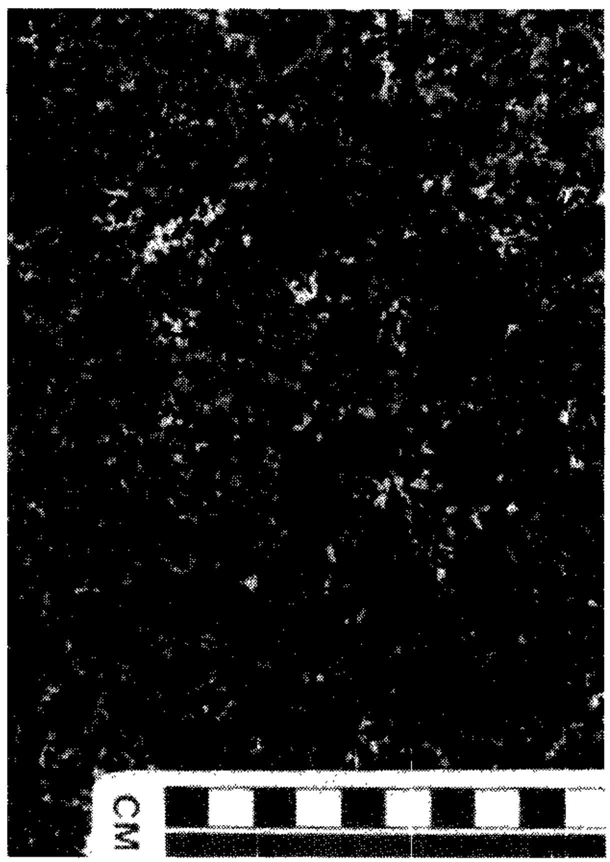

Plate 2-13-1. Orbicular textures in the Nickel Mountain gabbro.

feldspars ccur as phenocrysts up to 3 centimetres long. The margin of the pluton is fine to medium-grained diorite. The contact v ith the surrounding sedimentary rocks varies from sharp, v ith hornfelsed country rocks, to irregular with included stoped sedimentary blocks.

Medium-grained diorite dikes crosscut all other units in the area and are most probably Tertiary in age. They are typically rusty weathering, dark grey diorites, 1 to 10 metres wide with marked variations in strike. They are extensive and continuous but generally trend northeast with subvertical dips. Fresh, light green, fine-grained dikes with needle-like hornblende phenocrysts have also been identified. One crosscuts sedimentary rocks and a gabbro plug west of Nickel Mountain.

Regional deformation has been dated at approximately 110 Ma in the Stewart area (Alldrick *et al.*, 1987). At Nickel Mountain there is a general shortening along a northeast axis. Sediments have taken up most of the stress in open, cylindrical folds. Stereonet plots (Figure 2-13-3) indicate one phase of folding with a fold axis of 15°/305° and an axial plane of 126°/80° southwest. Weak penetrative axial planar cleavage is present in the fine-grained sediments. Volcanic units are block faulted with individual blocks generally undeformed. Interbedded sediments show small-scale folding. Tertiary northwest-southeast extension controlled intrusion of the diorite dikes.

MINERAL DEPOSITS AND ALTERATION

Nickel and copper sulphide mineralization occurs exclusively within the central gabbro body. At surface there are three major mineralized zones. The Northwest and Southeast zones are the most significant; both are roughly triangular with dimensions of 60 by 45 by 45 metres (Sharp, 1965). The East zone is considerably smaller and less continuously mineralized than the other two. Surface and underground drilling indicate an irregular pipelike, possibly interconnected, form to the three zones at depth. Structural data collected by Sumitomo Metal Mining Corporation indicate a 70° southwest plunge to the mineralized pipes (Hirata, 1972) (Figure 2-13-3). Vertical extent of the mineralization has been proved to a depth of 210 metres and the zones remain open laterally and to depth.

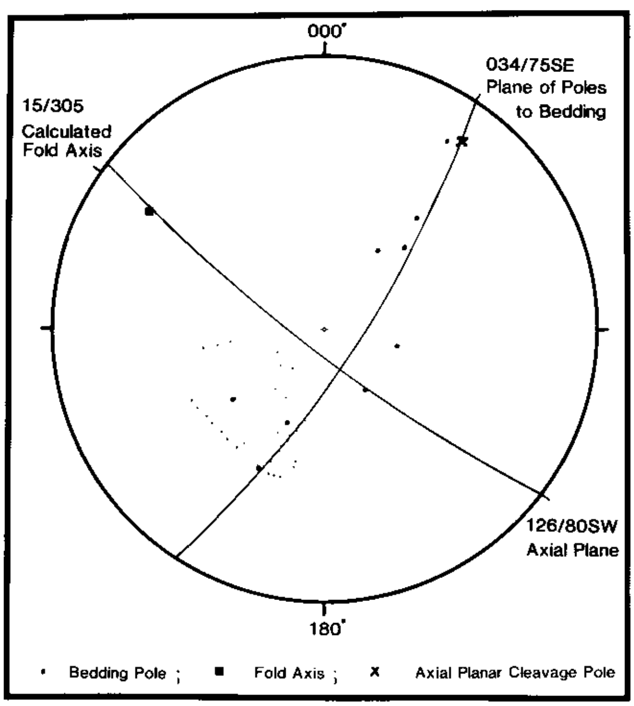

Figure 2-13-3. Stereographic projection of structures in the Salmon River formation, Unit 2. Shaded area is contoured zone of projected plunge of mineralization in the Nickel Mountain gabbro (after Hirata, 1972).

Mineralization is localized along the margins of the intrusion as irregular pipelike zones of veins, disseminations and massive lenses. The mineral textures and spatial relationship of the sulphides to the gabbro indicate that the mineralization is magmatic. Pyrrhotite, pentlandite and chalcopyrite are the dominant sulphides with minor amounts of pyrite, magnetite and "siegenite". Nickel occurs predominantly in pentlandite but it is also present in a secondary nickel sulphide with a composition between siegenite $(Co,Ni)_3S_4$, and violarite $(Ni, Fe)_3S_4$. Chalcopyrite shows minor supergene alteration where covellite locally forms rims around the chalcopyrite and occasionally completely replaces it. Trace amounts of cobalt, noted in assay results, probably occur in both the pentlandite, replacing iron, and the siegenite (Cabri, 1966).

The central gabbro plug is massive with some local shears and faults. The unmineralized part of the intrusion has plagioclase compositions of An_{30-60}, andesine to labradorite; mineralized zones have plagioclase compositions of An_{85-95}, bytownite to anorthite (Hirata, 1972). Hirata concluded that mineralization was restricted to zones where the plagioclase compositions were An_{85-95}. Large lenses of massive, undeformed sparry calcite, 10 to 50 centimetres wide, are present along the margins of the gabbro and tail off into thin stringers.

Gabbro within and around mineralized zones shows extensive alteration; olivine grains are partially or totally altered to serpentine, most plagioclase is altered and abundant chlorite, amphibole, biotite, carbonate, epidote and prehnite occur throughout the matrix (Hirata, 1972).

Alteration of the host sediments is limited to an aureole, less than 20 metres wide, of intense bleaching to a light green colour and partial loss of textures. Previous mapping identified these thermally altered sediments as either chert, siliceous tuffs or metadiorite.

CONCLUSIONS

The Nickel Mountain area is the site of the second largest nickel deposit in British Columbia. The host rock gabbro and its nickel-copper deposit were emplaced during mid-Jurassic to mid-Cretaceous time and are therefore unrelated to the main Lower Jurassic and mid-Tertiary plutonic suites of the region. This suggests that the extensive Jurassic Bowser basin stratigraphy to the east is prospective terrain for similar deposits.

ACKNOWLEDGMENTS

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