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ENDAKO MINES LTD. (N. P. L.)

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GEOLOGY OF THE ENDAKO MOLYBDENUM DEPOSIT

PRESENTED AT CIM, B.C. SECTION MEETING

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By

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INTRODUCTION

Endako Mines is located 100 miles west of Prince George, and is near the geographic center of British Columbia. The property is six miles south-west of the village of Endako which is situated on Highway 16 and on a branch line of the CNR.

HISTORY

The history of the molybdenite deposit dates back to 1927 when two local men staked four mineral claims to cover an area of quartz-molybdenite float. A short shaft was sunk on the so-called two foot wide Stellar vein, and a short adit was driven on another vein by the owners in 1934; some analyses of the vein material were carried out for metallurgical testing. During the period 1934 to 1961, the property was examined by many geologists and several mining companies, but physical work was confined primarily to trenching and some sampling. In 1961, Andrew Robertson optioned the property and in addition to trenching, a diamond drilling program was commenced in May 1962. Canex Aerial Exploration Ltd. entered the exploration of the property in October 1962, and after completion of 190 diamond drill holes for a total of 80,000 feet and 2,700 feet of underground work for bulk sample testing, the decision to develop the property for production was announced in March 1964. Construction of the 10,000 ton per day mine plant and development of the open pit began in June 1964, and the mine was officially opened on 8 June 1965. At present Endako Mines Ltd. (N.P.L.) is operating at 17,000 tons per day at an average grade of 0.24% MoS_2. Two products, molybdenum sulphide and molybdenum oxide are produced.

REGIONAL GEOLOGY

The Endako molybdenite orebody occurs in the Topley Intrusive which is considered to be of late Jurassic age, and is intruded into early Mesozoic sediments and volcanics. Regional distribution of the Topley rocks stretches from Babine Lake to Quesnel, a distance of about 180 miles along a regional northwesterly trend. The Topley is a composite batholith in which granite, quartz monzonite, grandiorite, quartz diorite and diorite have been identified. (See map showing Regional Distribution of Topley Intrusive.)

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LOCAL GEOLOGY

Four distinct rock types of the Topley Intrusive are noted in the mine area and listed below.

a) Endako Quartz Monzonite:

The rock is generally equigranular (3 - 4 mm) with some K-spar crystals occasionally as large as 7 mm. This size difference imparts a suggestion of a porphyritic texture, but is not sufficiently distinctive to warrant the term "porphyritic". The rock type is readily recognized by the characteristic pink K-spar in a greyish rock.

Composition is quartz (30%), pale pink to orange-tinged K-spar (40%), white to greenish-tinged plagioclase (20%), and chloritized black biotite (5 - 10%). The K-spar/total feldspar ratio may vary from 2/3 to 1/2, but is predominantly 1/2 and therefore, the rock type is referred to as quartz monzonite rather than granite.

b) Casey Alaskite:

A fine-to medium-grained (1 - 3 mm) sugary textured leucocratic rock outcrops in the Casey Lake area. Composition is quartz (40%), pale pink K-feldspar (50%), white plagioclase (5%), partially chloritized biotite (2 - 3%), and accessory pyrite and hematite (1%).

c) Glenannan Granite:

A coarse-grained rock of granite to quartz monzonite composition outcrops to the northeast of the mine and north of the Casey alaskite. Composition ranges between quartz (25%), pink K-feldspar (55%), white plagioclase (15%), biotite (5%), and quartz (20%), K-feldspar (40%), plagioclase (30%), biotite (10%). Texturally, the rock changes from essentially equigranular (5 - 6 mm) to porphyritic with K-feldspar and plagioclase crystals up to 2 cm.

Locally, the rock is pegmatitic with very coarse crystals of quartz (25%) (1 cm.), K-feldspar (70%) (2 cm.), plagioclase (5%) (1 cm.), and less than 1% mafic.

d) Francois Granite:

This distinctive red rock lies to the south of the Endako quartz monzonite. Rock is equigranular (3 - 4 mm) and composition is quartz (34%), perthitic K-spar (45%), white plagioclase with greenish cores (14%), biotite (5%), and accessory minerals (2%).

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The distribution of the above and other rock types is shown on the map of the Geology of Endako Mine Area. The oldest rocks in the area are those of the Takla Group of lower Mesozoic age. The Topley has intruded these rocks. Within the Topley, the Endako quartz monzonite is one of the older rocks. The adjacent Francois granite to the south and Casey alaskite to the north are younger as evidenced by dykes which are correlated with these rocks being intruded into the Endako. Two small outliers of Endako quartz monzonite appear to be roof pendents within the Casey alaskite. The Glenannan granite is older than the Casey, as the Casey porphyry intrudes the Glenannan. As yet, no age relation is possible between Endako and Glenannan.

The quartz latite porphyry is restricted to the area of Takla volcanic rocks, but there is not sufficient evidence to suggest that it is pre- or post-Topley. The Tertiary Endako Group volcanic rocks overlie the entire area.

The molybdenum deposit occurs wholly within the Endako quartz monzonite. The orebody is roughly an elongated elliptical-shaped body which strikes S20E, dips 20° to 50° south, and measures 5,500 feet long by 1,200 feet wide.

MINE GEOLOGY

The geology is relatively simple, with host Endako quartz monzonite intruded by pre-mineral aplite, porphyritic granite and quartz feldspar porphyry and post-mineral basalt dykes.

The aplite is a typically pink fine sugary grained rock which shows quartz and K-spar in a graphic intergrowth. The aplite occurs throughout the orebody as 1/4 inch to 4 foot wide unoriented dykes.

The term porphyritic granite is applied to a pink massive, 3% large K-spar phenocrysts in a fine-grained phaneritic granite matrix. These dykes vary from four to fifty feet in width, and generally trend to the northeast.

The most abundant dyke rock is the quartz feldspar porphyry which is a brown to pink rock composed of 10% to 15% phenocrysts of quartz and K-spar in a near aphanitic matrix. The quartz feldspar porphyry dykes range from several inches to 100 feet in width, and typically show very close jointing.

Basalt dykes have been intruded in association with post-mineral fault movements.

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The only observed relationship between the aplite, porphyritic granite and quartz feldspar porphyry is that the quartz feldspar porphyry is the youngest. Cross-cutting relations between aplite and porphyritic granite have not been observed.

Local attitudes of individual dykes may be observed to strike at any angle from the general trend,due to the angular and blocky faulting within the Endako quartz monzonite. The general trend of the dykes is predominantly northeasterly and northwesterly and dip steeply west. These dykes occur as concentrated swarms in two localities within the orebody.

HYDROTHERMAL ALTERATION

Three distinct hydrothermal alteration phases are seen in the Endako ore zone.

a) Introduced K-spar:

The presence of introduced K-spar is noted in two distinct forms: 1. K-spar envelopes developed adjacent to veins and fractures and vary in width from 1/8 to 2 inches; 2. K-spar-biotite zones developed as irregular lenses and bands along fractures in widths up to 8 inches. These zones are less common than envelopes.

b) Quartz-Sericite-Pyrite Envelopes:

A second type of envelope seen adjacent to veins and fractures is a fine-grained grey band composed of quartz sericite and finely disseminated pyrite. The envelopes range in width from 1/8" to 2 inches and are not as common as K-spar envelopes.

c) Kaolinization:

Pervasive kaolinization of the Endako quartz monzonite indicates several degrees of intensity. The degrees of kaolinization are classified on the break down of feldspar as follows:

1. Fresh quartz monzonite

The following minerals are present:

(a) Quartz

(b) K-Feldspar (pink, hard)

(c) Plagioclase (whitish grey, hard)

(d) Biotite (black)

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2. Weak Kaolinization
   (a) Quartz
   (b) K-feldspar (pink, hard)
   (c) Plagioclase (greenish tinged, hard rim with soft greenish and possibly white cores) (Plagioclase is attacked and is breaking down to kaolinite and minor sericite)
   (d) Biotite and/or Chloritized Biotite

3. Moderate Kaolinization
   (a) Quartz
   (b) K-feldspar (pink, hard)
   (c) "Plagioclase" (soft greenish clay with some whitish clay) (Plagioclase has completely broken down)
   (d) Biotite and/or Chloritized Biotite

4. Intense Kaolinization
   (a) Quartz
   (b) "K-feldspar" (whitish pink but may be relatively hard depending on degree of breakdown; important point is that K-feldspar is breaking down to Kaolinite)
   (c) "Plagioclase" (greenish to whitish green soft clays, Plagioclase has completely broken down)
   (d) "Biotite" (generally less mafic present than in less intense alteration types, chloritized and if black, probably secondary)

The extent of significant pervasive alteration approximates the outline of economic mineralization.

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MINERALIZATION

Metallic mineralization in the orebody is simple. Molybdenite and pyrite are the most abundant with minor amounts of hematite and magnetite and trace amounts of chalcopyrite.

Two types of molybdenite mineralization occur within the orebody. The most prominent mineralization is the 6 inch to 4 foot wide continuous quartz veins with characteristic ribbons of molybdenite mineralization; some moly occurs as very finely divided grains within the quartz veins.

The second type of mineralization occurs as fine fractures filled with quartz-moly in the form of a stockwork adjacent to and surrounding the major quartz veins. This zone of stockwork is essentially a halo around the quartz veins which varies in width from 20 to 200 feet.

The distribution of high and low grade molybdenum mineralization is shown on the appended map, Endako Orebody, Plan and Sections. A pyrite halo is noted only on the south side of the orebody where pyrite and quartz without molybdenite occur as fracture fillings.

STRUCTURE

Structural elements of the Endako orebody are illustrated on the attached map Geology of 3399 Bench.

The prevalent attitude of the major quartz-molybdenite veins is roughly easterly to northeasterly and dipping southeasterly as shown on left stereogram.

A plot of 475 major and minor veins is shown on the middle stereogram. Once again the majority of the veins shows up as east-west to N 70 E with southeasterly dip. Some are N 50 W with southwesterly dip which parallels the regional trend; a minor concentration trends N 52 E with a northwesterly dip. Some very prominent flat-lying sets of veins are also encountered.

The concentrations of 163 non-mineralized faults and fractures are seen as northeast and due north attitudes. The EW and NW fault systems generally occur along existing veins and are seen as gouge along contacts and brecciation within the vein.

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In summary, the major veins are striking east-west and south dipping with finer veins to the northwest and northeast; these attitudes are subparallel to the post mineral EW, NW and NE fault movements. This is significant beacuse the vein and fault attitudes within the orebody correspond to the regional NW and EW structural trends.

The area outside of the Endako orebody is virtually devoid of quartz veins and any structural interpretation must explain the restricted extent of the Endako stockwork. It is our opinion that the intersection of the regional EW and NW structures is not sufficient to produce the necessary degree of fracturing which is seen in the Endako stockwork. However, the intersection area of these two zones could be the focal point for intrusion and attendent doming. The doming hypothesis requires that the stockwork be restricted, and it also requires that mineralization and hydrothermal alteration be similarly restricted. The presence of these conditions, plus the intrusions of dykes and the presence of prominent flat-lying vein structures is in agreement with the concept of intrusion and doming.

The Endako orebody is then visualized as hydrothermal alteration and quartz-molybdenite mineralization in a restricted stockwork which was formed along an elongated EW dome by uplift and intrusion at the intersection of regional EW and NW fault systems.

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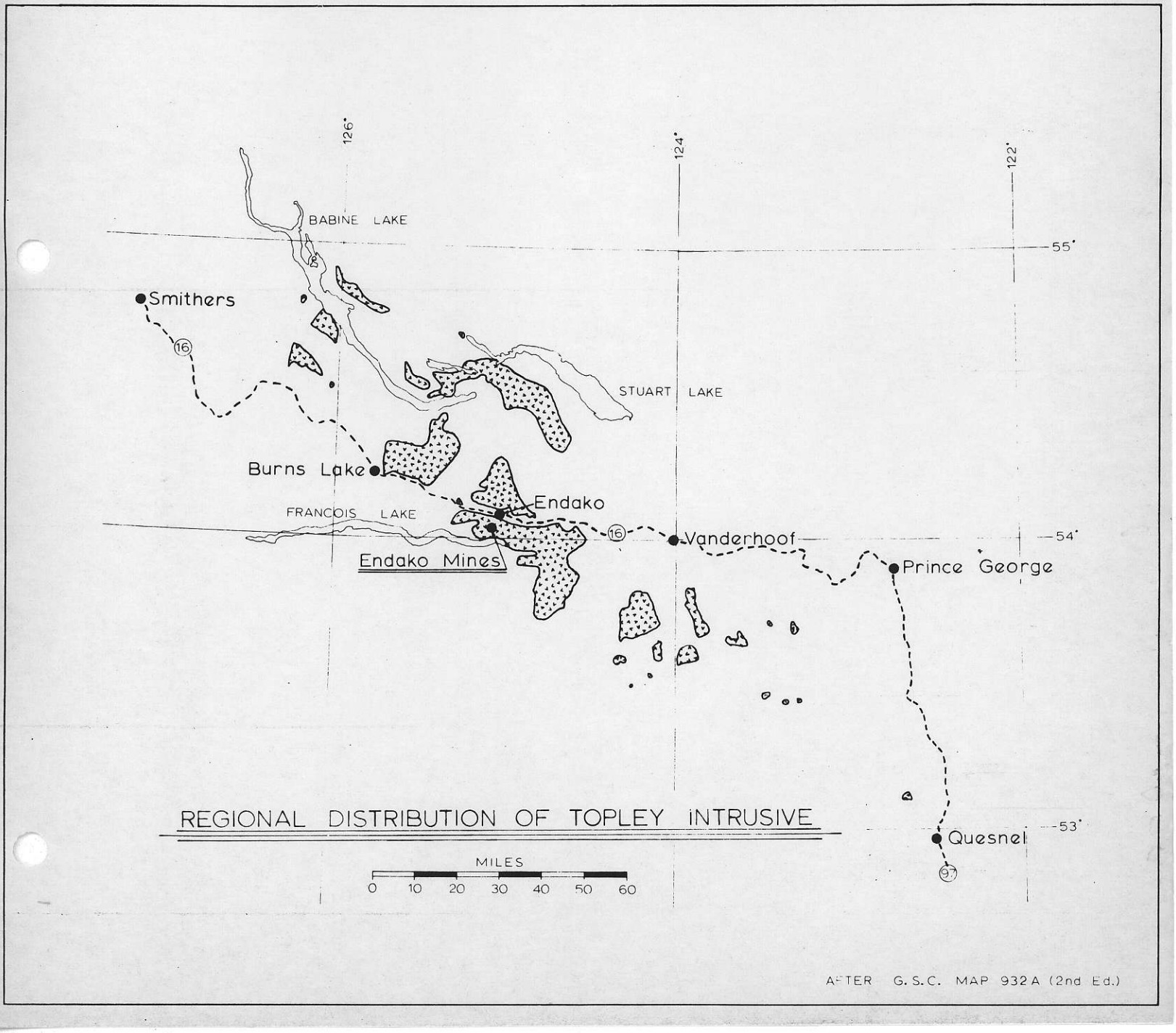
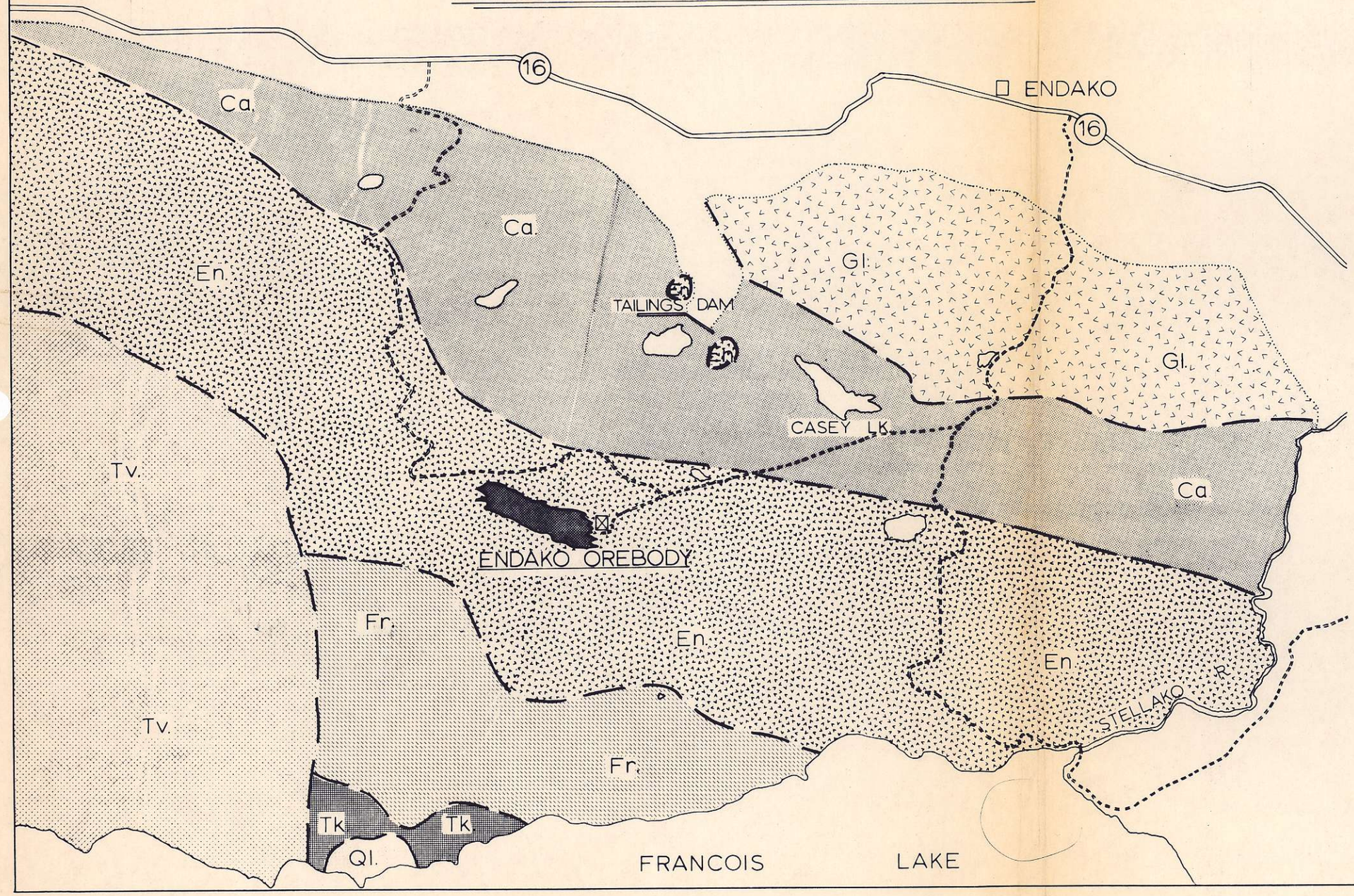


REGIONAL DISTRIBUTION OF TOPLEY INTRUSIVE

AFTER G.S.C. MAP 932A (2nd Ed.)

GEOLOGY — ENDAKO MINE AREA



LEGEND

Tertiary Volcanic Rocks

- Tv — Endako Group

Batholith

- Ca — Casey Alaskite
- Fr — Francois Granite
- Gl — Glenannan Granite
- En — Endako Quartz Monzonite

Menard Stock

- Ql — Quartz Latite Porphyry

Lower Mesozoic Volcanic Rocks

- Tk — Takla Group

- Geological Contact
- Drift Covered
- Road
- Highway 16
- ⊠ Endako Mines Plant Site

SCALE: 1" = $\frac{1}{2}$ mile

0 1 2

N

26000 E

28000 E

30000 E

32000 E

REFERENCE LINE

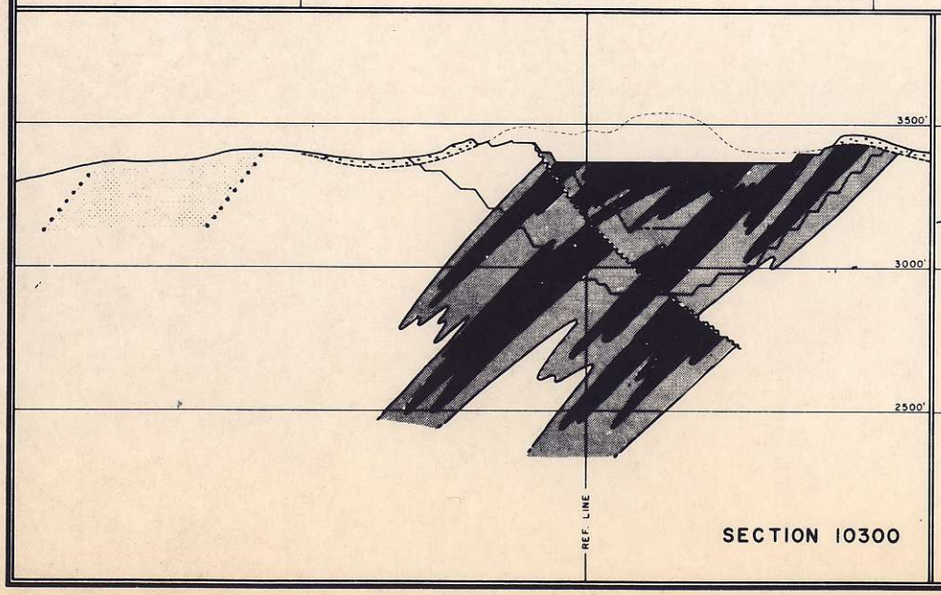
30000 N

28000 N

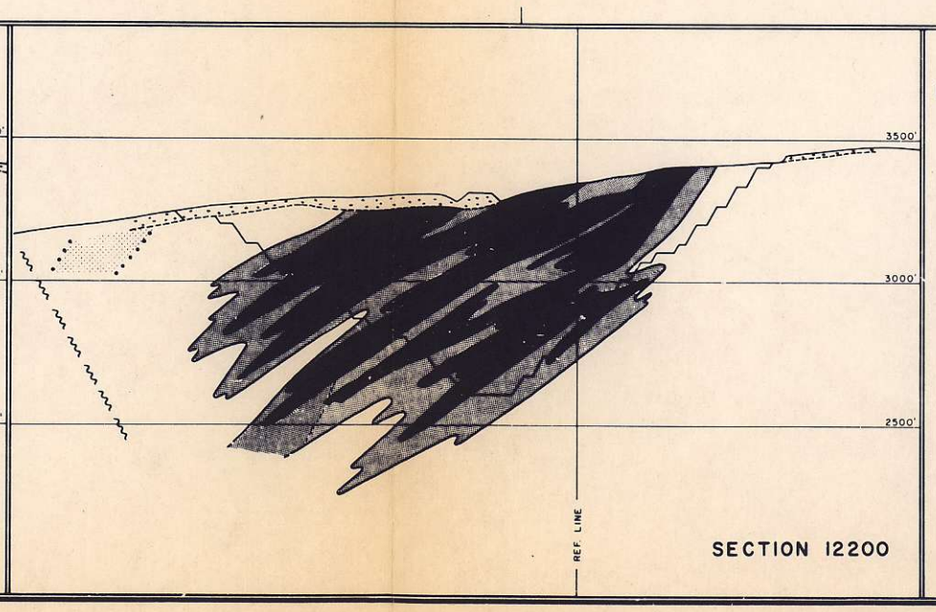
SECTION 10300

SECTION 12200

MINE ROAD



SECTION 10300



SECTION 12200

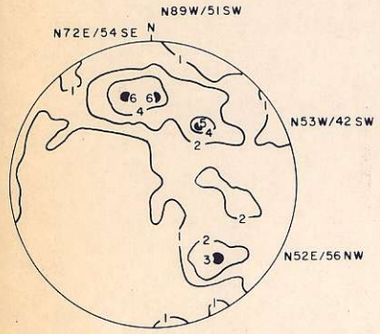
ENDAKO OREBODY PLAN & SECTIONS

LEGEND

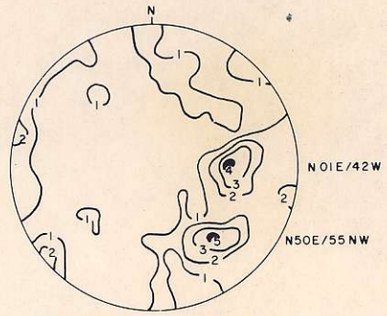
- HIGH GRADE ORE +0.12% MoS_2
- LOW GRADE ORE 0.08-0.12% MoS_2
- PYRITE ZONE
- OVERBURDEN
- FAULT
- INFERRED FAULT
- OPTIMUM PIT CONFIGURATION
- PRELIMINARY ULTIMATE PIT CONFIGURATION

SCALE 0 400 800 FEET

Poles to 95 Quartz-molybdenite veins
(6" width or larger)



Poles to 475 Quartz-molybdenite veins



Poles to 163 Non-mineralized faults

27000 E

31000 N

30000 N

28000 E

29000 E

GEOLOGY OF 3399 BENCH

LEGEND

- Quartz Monzonite
- Quartz Feldspar Porphyry
- Basalt
- High Grade Ore +0.12% MoS_2
- Low Grade Ore 0.08–0.12% MoS_2
- Overburden
- Faults: major, minor
- Quartz Molybdenite Veins

SCALE 0 200 400 FEET