802861

By FRED H. STEPHENS
Associate Editor, Western Miner

ENDAKO MINES

History

THE British Columbia area in which Endako is located was first explored 52 years before the province's historic gold rush—52 years before Queen Victoria proclaimed the Colony of British Columbia.

And, as is the case with most of the Canadian West, the Endako area's early history is told in the journals of early Nineteenth Century fur-traders.

It goes back to 1806—two years before Simon Fraser was to make his memorable voyage to the mouth of the river that bears his name. That year, one of Fraser's aides did a little exploring on his own. His name was John Stuart, one of the traders sent out with Fraser by the North-West Company to blaze an overland route into the rich fur-trapping area of the Pacific Coast.

Setting out from the junction of the Nechako and Fraser Rivers, near the present City of Prince George, Stuart travelled up the Nechako to a scenic lake which he promptly named Fraser Lake, after his rugged chief. The same year, Fraser himself visited the lake and established on its banks a new fur-trading post, Fort Fraser, in the name of the North-West Company.

Thus, not far from Endako, Fort Fraser came into existence 157 years ago—82 years before there was a City of Vancouver.

John Stuart's choice of route to the Pacific Ocean proved, more than a century later, to be a sound one. The Grand Trunk Pacific Railway, now part of the Canadian National system, pushed through the same Fort Fraser en route from Edmonton on the Prairies to Prince Rupert on the Pacific Coast. Later the Provincial highway followed the same general route.

As settlers followed the railroad, a village was founded on the western end of the lake which John Stuart discovered. It was located near where the Endako River enters the lake, and was given the name Fraser Lake. Among the village's early residents were two men, Charles H. Foote and Alf Langley, who were to become the first white men to stumble on the molybdenite ore on which Endako's future is staked.

That was in 1927. Foote and Langley had set out deer-hunting west from the lake. As they hunted the lightly-wooded, rolling hills lying between the Endako River and Francois Lake, six miles to the south, they were attracted by the numerous pieces of richly - mineralized float scattered along the crest of the ridge.

They discovered the ore in place and staked the claims which they called the Stella mine.

During the early years of their tenure, Foote and Langley prospected their claim by making trenches and pits in the vicinity of the molybdenite mineralized float, by sinking a shaft 27 feet on a two-foot quartz molybdenite vein. A short adit was driven in the north bank of a shallow ravine below the shaft. (The showings and workings are described in the B.C. Department of Mines Bulletin No. 9, 1940, by John S. Stevenson. The regional geology is described in Memoir 252, The Geological Survey of Canada, by J. E. Armstrong, 1959).

The information in this and the following articles was compiled from reports and records supplied by the management and engineering staff of Endako Mines Ltd.; Andrew Robertson, the founder and first president of Endako Mines and currently a director of that company; and other reliable sources.

Andrew Robertson is a native son of British Columbia, having been born in Victoria January 12, 1902. After elementary and secondary education in B.C., he proceeded to McGill University from which he later graduated in engineering. In his pre-graduate days he served with the B.C. Lands Department and, in immediately following years engaged in the construction industry in British Columbia and later in Quebec. By 1926 he was drawn to the exploration of mineral properties in Quebec.

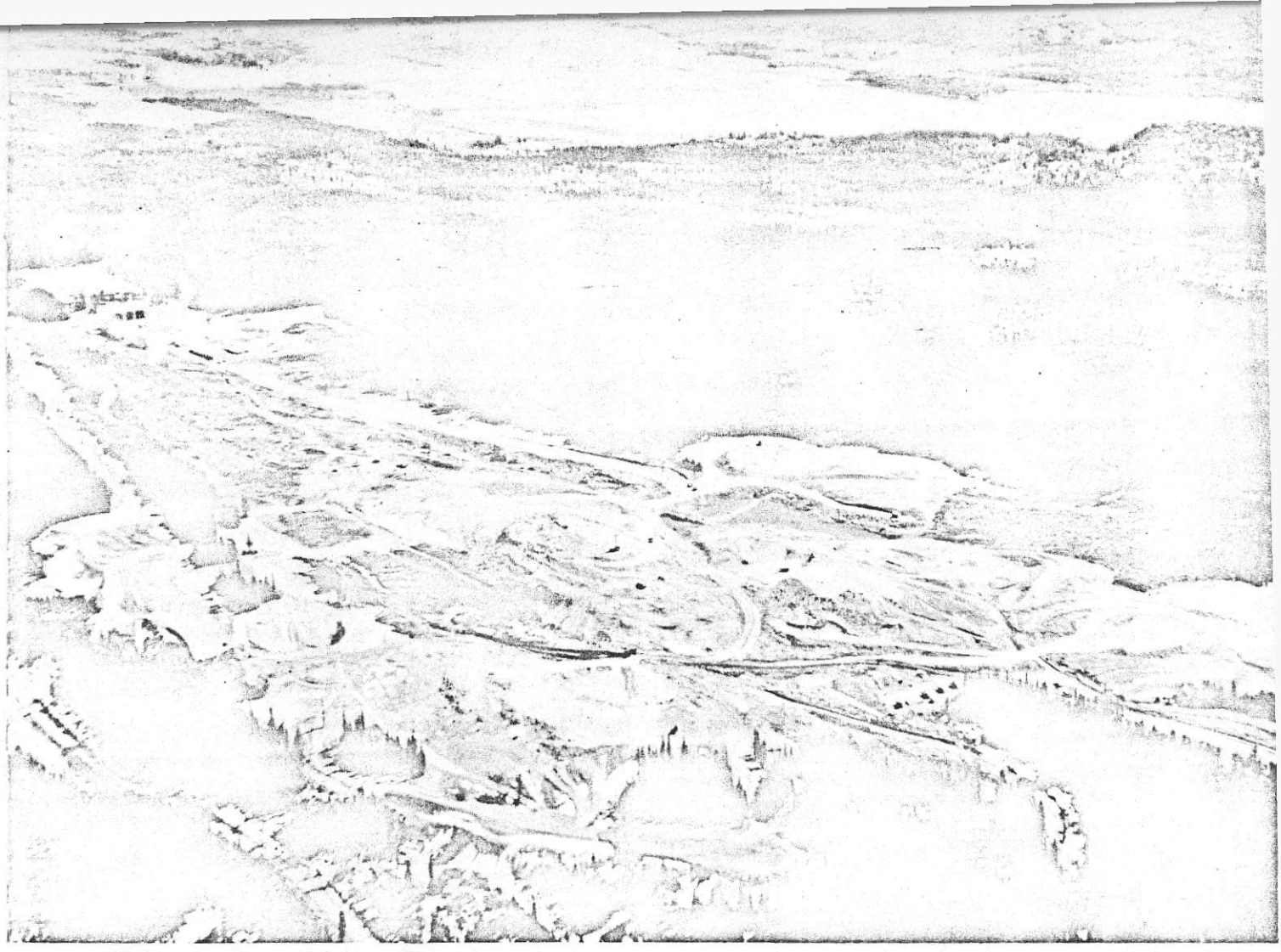
In 1933 Andy worked for Howey Gold Mines at Red Lake. By 1938 he had reached Val d'Or, later to become general manager of Golden Manitou Mines, preparing that company's important property for production; and remaining as vice-president in charge of all operations throughout World War II. He was later president of Yale Lead and Zinc Mines and a director of Mastodon Zinc Mines Ltd. in British Columbia. He returned to Quebec and was responsible for the development of the Barvue Zinc Mine for production at 4500 tons a day.

In 1953, Andy moved to Toronto to head a group of companies including Ascot Metals and Gordon Lake Nickel Mines. He lost control of this project with the advent of the "tight money policy" of 1957 but carried on as president and managing director of Agnico Mines Ltd. in the Cobalt silver camp. On a business trip to his native province on the west coast in 1959 he became interested in the copper prospects of Big Interior Mountain on Vancouver Island and organized a Toronto Syndicate, later to become incorporated as Big 'I' Mines Ltd.

Andrew Robertson

Besides his determined effort with Big 'I', Andy became interested in Utica Mines Ltd. and also extended the activities of Tormont Mines Ltd. into B.C. In 1961 he investigated the Stella molybdenite claims at Endako and, having failed to interest his Toronto associates in the project, he developed them himself and incorporated Endako Mines Ltd for the purpose. The rest is history, to which this volume attests.

Andy commutes between his two homes in Toronto and West Vancouver. He has become a nautical man and maintains a cabin cruiser at Vancouver. He is a member of the Association of Professional Engineers of Quebec, the Canadian Institute of Mining and Metallurgy, the Capilano Power Squadron, The Royal Vancouver Yacht Club, the Engineers Club of Toronto, and the Terminal City Club of Vancouver. He is president and managing director of Big 'I' Mines Ltd. and of Tormont Mines Ltd.; and a director of Endako Mines Ltd., Utica Mines Ltd., and several other British Columbia and Ontario companies.



An aerial view looking over the open-pit workings toward Francois Lake. The concentrator and surface plant are seen at left centre.

All photos unless otherwise specified by George Allen Aerial Photos Ltd.

Over the years, the Stella property was examined for various individuals and companies.

While some engineers recognized the great potential of the property, the unfavourable economic climate of the '30s held it back. In 1952 Kennco did some work and had three large bulldozer cuts made in the overburden but failed to expose the treasure buried beneath.

Charles Foote and his son Whitney maintained their interest in the claims and only lost title through misadventure, but Dr. Riley protected an interest for them. Following lapse of the original claims in 1959, they were restaked by Dr. Chris Riley and associates. In October and November, 1960, Dr. Riley had the claims mapped and the numerous occurrences of float noted. He also had a bulldozer do some stripping in the vicinity of the original trenches.

In July, 1961, Dr. Riley interested mining engineer Andrew Robertson in the Stella molybdenite prospect. Robertson, with extensive production experience in Eastern Canada before returning to his native province of British Columbia, first examined the property in company with Dr. Riley on July 19, 1961.

Encouraged by this first examination, he obtained a three-week examining option to clear the bulldozed area to bedrock. It was found necessary to drill and blast the rock, in order to assess the mineral content. Seven rock trenches were cut in the stripped area and the information so gained, while not conclusive, strongly indicated a major ore structure.

Robertson negotiated a purchase agreement on behalf of an Ontario mining company with Dr. Riley and proceeded to stake open ground to the south and east, adjoining the 26 original Stella claims. His faith was not shared by his eastern associates, however, and the agreement lapsed in November, 1961.

In January, 1962, on behalf of his own company, R. & P. Metals Corporation Ltd., Robertson finalized a new agreement for purchase of the Stella claims. Four months later a diamond drill program was started, as recommended by geologist S. Waisberg and engineer Vic Bjorkman. On May 28, 1962, the first drill hole No. S-1 was at 100 feet depth on the Stella Jay 10 claim. By June 18, the fourth hole was drilling and news of encouraging results spread across Canada.

Endako Mines Ltd. (N.P.L.) was incorporated as a private company on June 21, 1962. On August 10, following acceptance of the prospectus by the Superintendent of Brokers at Victoria, B.C., it became a public company. Trimart Investments Ltd. of Toronto became underwriters, providing the funds for continued development.

By late August, 1962, the ninth hole had been completed and a second diamond drill was on the job. By then, Canadian Exploration Limited (Canex) had expressed interest in the property and Canex personnel visited the Stella project on August 22.

Following this examination, Canadian Exploration Limited entered into a participation arrangement with Endako Mines Ltd. (N.P.L.), which was set forth in a memorandum dated

August 28, 1962. This memorandum defined terms under which the property would be financed through to production, provided that the development program indicated such investment to be justifiable. The actual agreement was signed on September 13, 1962.

Up to this time the development of the Stella claims was financed privately. Due to lack of official knowledge regarding the value of the property, the underwriter was restrained from a public offering of Endako shares. Canex financed development after September 1, and on October 13, 1962, assumed full management control.

Up to that time, 17 holes producing AXT-size core had been drilled to an average depth of 500 feet. Molybdenite mineralization was encountered in every hole, distributed over the total length of the core, so that all core recovered from the top to the bottom of each hole had to be split and assayed.

A third drill was added in October, and by December 2, 1962, when work was suspended for year-end holidays, a total of 52 drill holes were completed.

On January 18, 1963, by an amended agreement, Endako acquired 152 additional mineral claims from Robertson, for the cost of staking. These, principally, adjoined the Stella claims to the north, extending as far as the railway.

Endako at this time also concluded agreements with Tormont Mines Limited and Utica Mines Ltd. (N.P.L.). These agreements provide for the development of their properties adjoining Endako on the east and west respectively in return for a 75% participation in the profits from production after the costs of bringing them into production have been recovered.

Prior to and during the year-end holiday shutdown, methods of improving drilling procedure were sought in order to obtain the highest possible core recovery. It was decided to convert to wireline equipped diamond drills, producing BX size core, and these were introduced when work resumed.

From that time to April 30, excellent core recovery was experienced in 26 holes drilled, and sludge samples recovered with mechanical sample-splitters afforded close assay checks on the core.

Much of the drilling has been exploratory, with holes spaced 800 feet apart. This program has shown mineralization extending over a length of 6,400 feet and across a width of more than 2,000 feet. Lateral and depth limits have not yet been fully defined. Latest drilling has been concentrated on filling in the gaps in the more favourably mineralized part of the zone.

The firm of Chapman, Wood & Griswold Ltd., Consulting Engineers and Geologists, was retained by Endako in November, 1962, to report and advise on the ore development. Their reports have, from time to time, given details of the progress made, together with calculations of the ore position.

At April 30, 1963, using the assay values from 80 diamond-drill holes totalling 40,027 feet, the consultants estimated reserves at 36,000,000 tons of possible and geologically inferred ore grading 0.25% MoS_2. The company's report showed the exploration and development expense to this date at $442,785.

Upon publication of this report, the Vancouver Stock Exchange accepted the Endako filing statement and the shares were called for trading April 25, 1963. Canadian Exploration Limited, having advised Endako the previous January of its intention to proceed with the next stage of development, proceeded with further exploration by diamond drilling with speed and efficiency. On May 3rd, Canex's representatives were appointed to the Endako board of directors.

One of the most comprehensive and extensive sampling procedures was started in August with the incidence of underground development. Raises were driven on a series of the vertical drill holes and a crushing and sampling plant was installed to process the material removed. This procedure supplied an accurate check on the values determined from drill cores and sludges and also provided material for metallurgical testing and pilot-plant runs.

On March 13, 1964, Canex advised Endako of its intention to equip the Stella mine for production with a concentrator of initial capacity to treat 10,000 tons of ore per day. Plans having been prepared in advance, clearing of the plant site and open-pit area started immediately. The construction schedule was set and long-term sales agreements contracted on the bas of production by mid-1965.

As of April 30, 1964, Canex reported an additional 91 diamond-drill holes completed and total expenditures since start of exploration of $1,456,960.

Ore reserves were then estimated by Canadian Exploration Limited engineers on the basis of material available by open-pit mining methods only as follows:

Measured Ore: 48,900,000 tons assaying 0.21% MoS_2
Indicated Ore: 16,500,000 tons assaying 0.20% MoS_2
Inferred Ore: 1,100,000 tons assaying 0.21% MoS_2

Upon declaration by Canex to proceed to production under the terms of the agreement, Canex assumed control of the Board of Directors. Robertson was pleased to hand over control to the able team which had contributed so much in engineering and management skills in bringing the mine to the production stage in record time and at record capacity at a total cost in excess of $22 million.

The company selected the existing village of Fraser Lake as the site for the extensive housing development which provides home for its employees. The village is located on the gently sloping banks of the south shore of the beautiful lake after which it is named.

Here will be a community founded on the development of the Province's natural resources where the residents can look forward to steady lucrative employment and a favourable environment in which to live and bring up their families.

Commencement of construction of the Endako surface plant.
Photo by Andrew Robertson

Geology

Dr. Christopher Riley

Dr. H. T. James

V. B. Bjorkman

ENDAKO MINES LTD., which is scheduled to commence the manufacture of molybdenite concentrate early in June, 1965, is one of the pioneers in the recovery of this new product in British Columbia. The Endako molydenite deposit is situated 115 miles west of Prince George, near the geographic centre of the province. The property lies five miles southwest of the village of Endako, a divisional point on the northern branch line of the Canadian National Railways and on the direct line of Highway 16 between Prince George and Prince Rupert.

A portion of the deposit underlies two small hills in a lightly-wooded area of gently-rolling topography with the surface elevation of the mineralized area ranging from 3200 to 3550 feet above sea level. The mineral claims are recorded in the Omineca Mining Division with the centre of the property at latitude N 54° 02'; longitude W 125° 06'. Francois Lake forms the southern boundary of the claim group.

The principal claims of the Endako deposit were first staked in 1927 by Charles H. Foote and Alf Langdon as the Stella property. Four claims were located to cover an area of mineralized float centred around two small ridges. In 1934, an inclined shaft was sunk on a quartz vein to a depth of 27 feet at which point the quartz pinched out.

From 1934 to 1952, the property was examined by many geologists and engineers, but the only work done was by the owners in order to maintain the claims in good standing. In 1952, a major exploration company carried out a programme of bulldozer trenching, sampling, and geological mapping before relinquishing its option. In 1956, American Standard Mines Ltd. acquired an option to purchase the property but no records have been found of work performed by that company. In 1959, Dr. Christopher Riley and Dr. Howard T. James, well-known Vancouver geological engineers, staked the key claims which the previous owners had permitted to lapse. In July 1961, Andrew Robertson, a British Columbia native son and engineering graduate of McGill University who had distinguished himself in mining operation and exploration principally in eastern Canada, obtained an examining option from the new owners and initiated surface stripping and trenching. His associates, however, failed to share "Andy's" enthusiasm, and as a result the agreement was nullified in November of the same year. Mr. Robertson, undismayed, continued to pursue his original objective and entered into a new agreement in January 1962 on behalf of his own company, R. & P. Metals Corporation. A programme of diamond drilling was commenced in May 1962 under the direction of R. C. Coutts. The initial results of this work were sufficiently encouraging to warrant further drilling. Additional financing to this end was obtained through the formation of Endako Mines Ltd. (N.P.L.) on June 21, 1962.

In late August, 1962, after eight drill holes had been driven, the property was examined by engineers of Canex Aerial Exploration Ltd. On the recommendations in the subsequent report, Canex entered into an option agreement with Endako on October 13, 1962, and immediately a vigorous programme of exploration was undertaken under the joint auspices of both companies. In January 1963, Canadian Exploration Ltd. assumed direct management of the Endako project and pursued its drilling campaign to the end of February 1964, during which time Canex drilled 190 holes for an aggregate of 82,902 feet and drove 2,755 feet of crosscuts, drifts, shafts, and raises.

Confirmation of tonnage and grade through the underground work preceded the decision to carry the project through to production. In May 1964 a start was made on the removal of the forest cover from the mill site and the establishment of haulageways and the open pit. By December 1964, construction of the mill and ancillary buildings had progressed to the stage where the installation of machinery and equipment could be carried on under cover. This work has been completed and preliminary tuneup is in progress. The project is expected to commence production officially on June 8, 1965.

The feat of achieving production on the scale of Endako within slightly more than three years from the time the first diamond-drill hole was driven is certainly deserving of tribute to the technical personnel associated with it.

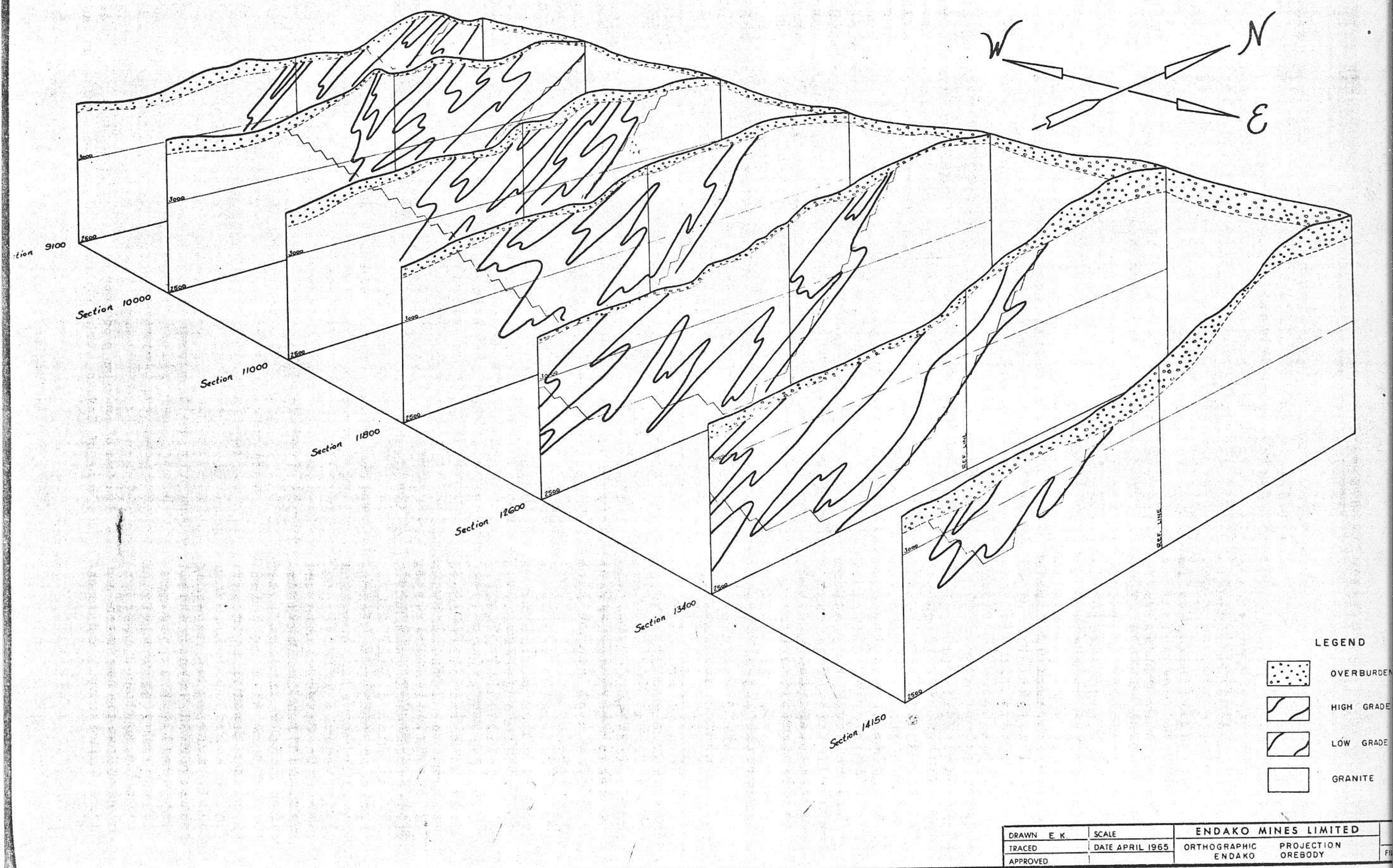
Regional Geology

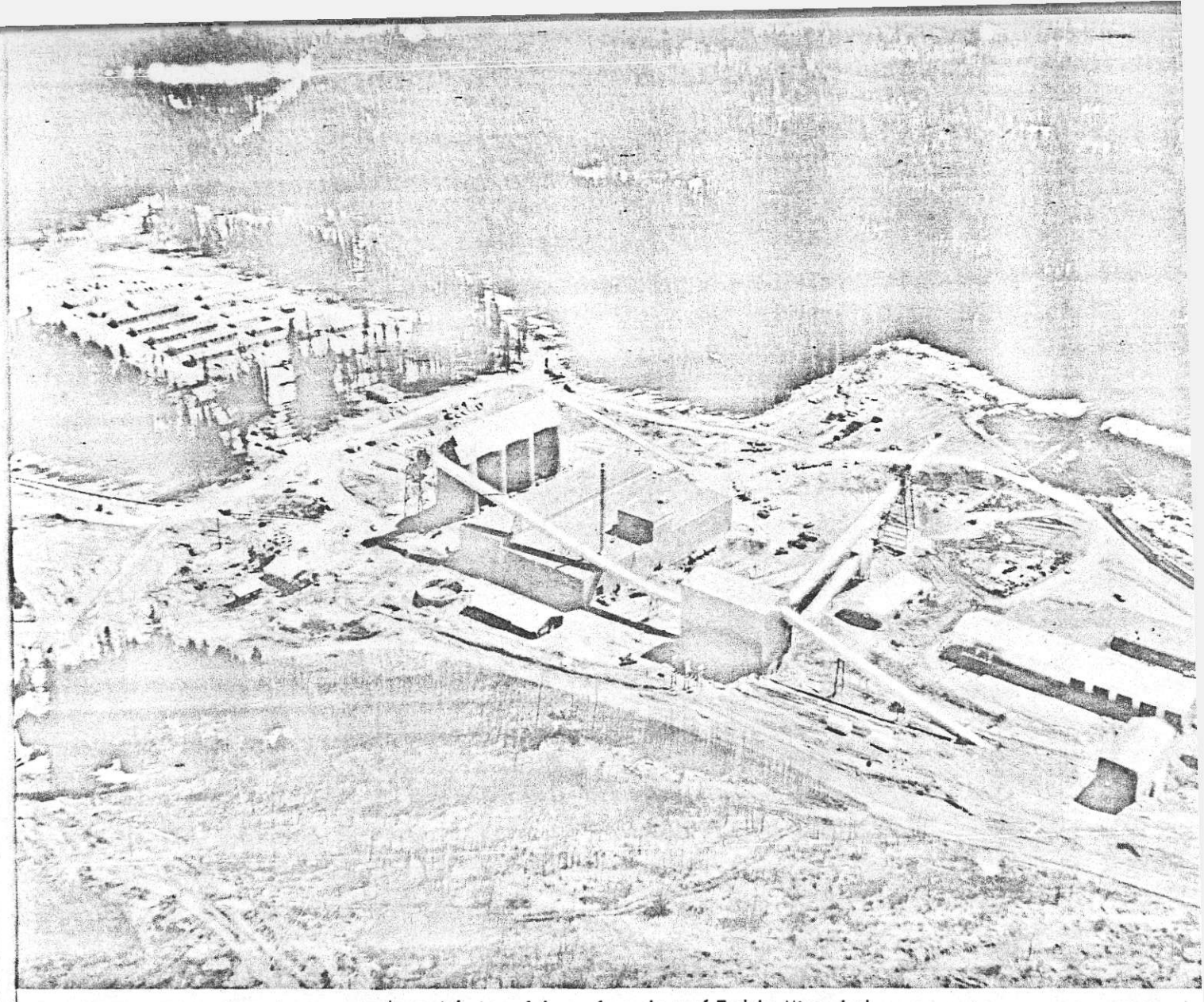
THE Endako molybdenite deposit lies within the Interior physiographic system of the Canadian Cordillera, in the area referred to as the Nechako plateau. In general, the Interior system in Central British Columbia is one of geological complexity, in which sedimentary and volcanic strata range from Late Proterozoic to Oligocene. During this time there were probably four main periods of orogeny with accompanying intrusive activity.

The Endako molybdenite deposit is located within a northwesterly trending batholith of the Topley granite, which is considered to be Jurassic in age. This batholith is 15 miles long by 10 miles wide, and occurs where the general northwest trend of the Cordillera is intersected by a prominent east-west regional lineation. It is predominantly a pink granite, ranging from fine- through coarse-grained, to coarse pegmatite, and is often porphyritic. The Topley granite intrudes Triassic volcanics and is overlain by Eocene volcanics.

The area within a few miles of the Endako deposit was mapped by personnel of Canex Aerial Exploration during the 1963 season. This work has shown that the Endako batholith is not a uniform mass but contains large areas that are predominantly alaskite. Volcanics have been mapped within the granite mass and are of questionable age. The more information obtained the more complex this granite mass becomes.

The Endako area in general has been strongly faulted, with major faults trending east-west, northeast, and northwest. Recognition of the faults is hampered by lack of outcrop and, in many cases, they are inferred only from lineaments discernible on air photos. Drilling on the property


W
N
E
Section 9100
Section 10000
Section 11000
Section 11800
Section 12600
Section 13400
Section 14150
3000
2500
REF. LINE
LEGEND
OVERBURDEN
HIGH GRADE
LOW GRADE
GRANITE
DRAWN E.K.
TRACED
APPROVED
SCALE
DATE APRIL 1965
ENDAKO MINES LIMITED
ORTHOGRAPHIC PROJECTION
ENDAKO OREBODY



An aerial view of the surface plant of Endako Mines Ltd.

and the subsequent removal of overburden from the western pit has provided considerable data as regards structural information on the ore deposit.

Local Geology

Due to an almost total lack of outcrop within the mineralized area, information regarding the local geology was based entirely on diamond drilling, underground workings, and bulldozer cuts that reached bedrock. In the mineralized section the granite shows strong weathering, at times forming a residual soil, as well as an an oxidation of the smaller mineralized fractures from twenty to thirty feet below the bedrock surface.

Rock Types

The Endako deposit occurs in a red porphyritic granite which has undergone different types of alteration. Changes in the type of alteration are usually gradational. Potash metasomatism of varying intensity occurs throughout the orebody with distinctive large pink to red feldspar crystals, that appear much fresher than the surrounding rock. To date only a general relationship between potash metasomatism and molybdenite mineralization has been established. The following is a description of the alteration types plus dike rocks using the terminology, devised during the exploration phase.

Red Porphyritic Granite

This is the normal rock type of the mine area. It is a pink, weathering medium-grained granite with prominent pink, orthoclase phenocrysts that are one-half to one inch in length. Its average mineralogical composition is as follows: quartz 39%, orthoclase 29%, oligoclase 16%, biotite 3%, sericite 2,% calcite 4,% and accessory minerals 5%. Well-rounded, dark-coloured xenoliths, generally rich in biotite and hornblende, are erractically distributed throughout the granite, and average two inches in diameter.

Red Altered Granite

This term has been used to describe a slightly altered red porphyritic granite. Potash metamorphism is more intense, giving the rock a more reddish colour, and slightly hydromica alteration is present, giving the matrix a light greenish tint. Generally this rock type shows a slight reaction to dilute hydrochloric acid.

Kaolinized Granite

Kaolinization of the deposit is not severe; however, it is locally intense in and along fault and slip zones. This type of alteration produces a white soft rock; the kaolin first replacing plagioclase and then, where more intense, forming the major constituent of the rock.

Hydromica Alteration

This alteration is due to the development of a green secondary mica largely at the expense of plagioclase feldspar and, to a lesser extent, orthoclase. The hydromica alteration is also associated with fracturing and faulting, but to a lesser extent than the kaolinization. An exception is the "heavy" hydromica alteration which is found exclusively in, or adjacent to, fault zones. The amount of molybdenite mineralization decreases with an increase in the hydromica content.

Aplite

This term has been used to describe acidic dykes that cut the granite. These dykes are usually porphyritic, and have a fine-grained to micro-crystalline ground mass; they range in texture from a true aplite to a quartz feldspar porphyry. The majority are a few inches in thickness but some are known to exceed fifty feet in width, and have been followed by a drill hole up to 300 feet. The larger dykes tend to be porphyritic. Many of these dykes appear to be following faults and other previous fractures and are extremely irregular in outline where exposed in the underground workings. In general, they are hard brittle rocks that are strongly fractured; molybdenite usually occurs on the fracture surfaces of the aplite within the ore zone.

Lamprophyre

Biotite-lamprophyre dykes occur infrequently in the larger fault zones. None of the lamprophyre seen to date has been mineralized. The lamprophyres observed in the underground workings have been implaced along fault zones and in turn suffered subsequent faulting.

Mineralization

Molybdenite is the only economic mineral noted to date in the Endako deposit. It occurs in quartz veins that are usually less than ¼ inch but range up to four feet in width, and also as films or narrow veinlets of molybdenite, and occasionally in some areas of the orebody as molybdenite disseminations. Characteristically the molybdenite is fine-grained.

Three stages of molybdenite mineralization are recognized. The earliest is represented by molydenite disseminated within the granite, and in a few of the early quartz veins. At several places, crystals of secondary K-feldspar were seen cutting small quartz veins carrying molybdenite. The second stage is represented by the majority of the mineralization, which typically occurs as small quartz veins less than ¼-inch wide, in which the molybdenite is found along the margins and as lenticular ribbons within the quartz. In this case the molybdenite is very fine-grained; one cannot see the individual grains, although their presence is obviously related to fine fractures. Molybdenite in the third and final stages of mineralization is characteristically coarser-grained, with individual flakes clearly visible. A close relationship exists between late stage molybdenite and coarsely crystalline calcite.

The larger quartz veins almost everywhere exhibit a ribboned appearance with thin streaks of molybdenite. Brecciation of the veins is common, with slickensides occurring along the margins and sometimes within the veins. The thinner or hairline veins characteristically have a thin streak of molybdenite either in the centre or along the margins of the veins.

There are essentially two main structural types of mineralization within the Endako deposit. The dominant type of the western portion is that of the "vein zones." By this is meant the zone of mineralization which is parallel to and including one or more of the larger quartz veins. Normally there is an increase in the frequency of the smaller mineralized veins adjacent to the larger veins although their attitude may differ greatly. The majority of the vein zones dips to the south at approximately 45° to 50°.

The second type of mineralization is comprised almost entirely of veinlets that may average ¼ inch or less in width and in some sections are not much over hairline in size. These smaller veins are characteristically "flattish" and have been interpreted to disclose a change in dip from north to south. This type of mineralization is more uniform in grade than the vein-zone type and is characteristic of the eastern part of the Endako deposit.

Pyrite occurs in minor quantities, generally less than one per cent, along the margins of some of the veins and disseminated within the rock. Minor amounts of magnetite and specular hematite occur within the quartz veins. Chalcopyrite has been noted as rare, small, scattered grains along fracture planes in drill core.

Ferrimolybdenite occurs on the surface as an earthy yellow film in close association with molybdenite. Drill-hole intersections show it does not extend to depths greater than 25 feet. Also, there appears to have been a general oxidation and/or leaching of molybdenite, particularly from the small hairline fractures, for the first 20 feet or so below the bedrock surface. It is uncertain whether or not much of the molybdenum has been removed from the rock, or is still present in a form other than ferrimolybdenite.

There does not seem to be any relationship between the type or degree of alteration, and the mineralization, with the exception of a general relationship to secondary K-feldspar. Often, mineralization is better than average in areas where the type of alteration is changing rapidly. The strongly altered zones do not appear very favourable which may be due to their softness, or to removal of mineralization by late solutions.

A very close association exists between molybdenite mineralization and calcite. This is clearly seen when examining the late coarse-grained molybdenite mineralization, and is reported to occur in many of the thin sections examined microscopically. The genetic relationship between molybdenite and calcite suggests that mineralization occurred at relatively low temperatures.

Structure

The relationship between major faulting and mineralization is not too well understood at present. This is in part due to the lack of outcrop, the uniformity of rock type, and the lack of a clear-cut relationship with alteration.

The Endako deposit shows a general trend of N 75° W. The northern edge is sharp and displays a dip of 45° to 65° south. This boundary quickly flattens out to the south and even shows a gentle north dip on the southern limits. A large fault, trending east-west and dipping 45° north, occurs along the creek immediately south of the Endako deposit. Geochemical data suggest this fault marks the regional southern limit of molybdenite mineralization.

Strong pre-mineral faults striking N 75° W and dipping 35° NE occur through much of the east zone and are believed to be one of the controls for ore mineralization. The eastern zone shows a plunge of about 18° to the southwest along the N 75° W axis. The bottom of the zone, as cut off by the plunge, is established by two deep holes in which the grade of mineralization gradually diminishes below 600 feet.

The westernmost portion of the mineralization is mainly of the vein-zone type. On the west zone drill-hole S-103 was extended to a depth of one thousand feet without any noticeable change in the type of grade of mineralization.