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PROPERTY FILE

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CHAPMAN. WOOD & GRISWOLD LTD.
VANCOUVER, BRITISH COLUMBIA

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REPORT OF EXAMINATION

ENDAKO MINES LTD.

STELLA MOLYBDENUM PROSPECT

OMINECA DIVISION, B. C.

November 28, 1962

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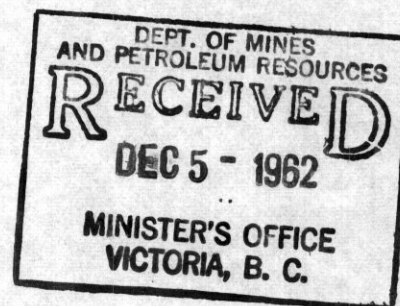
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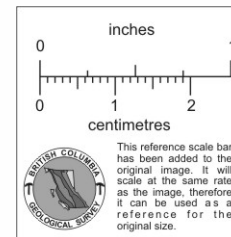
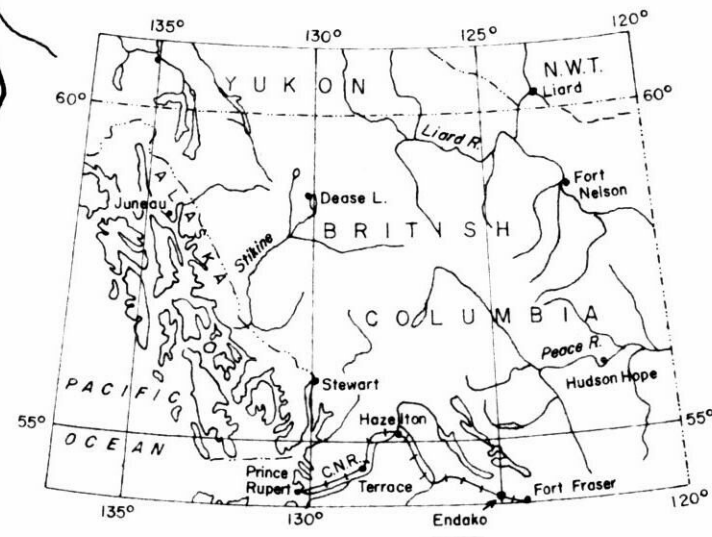
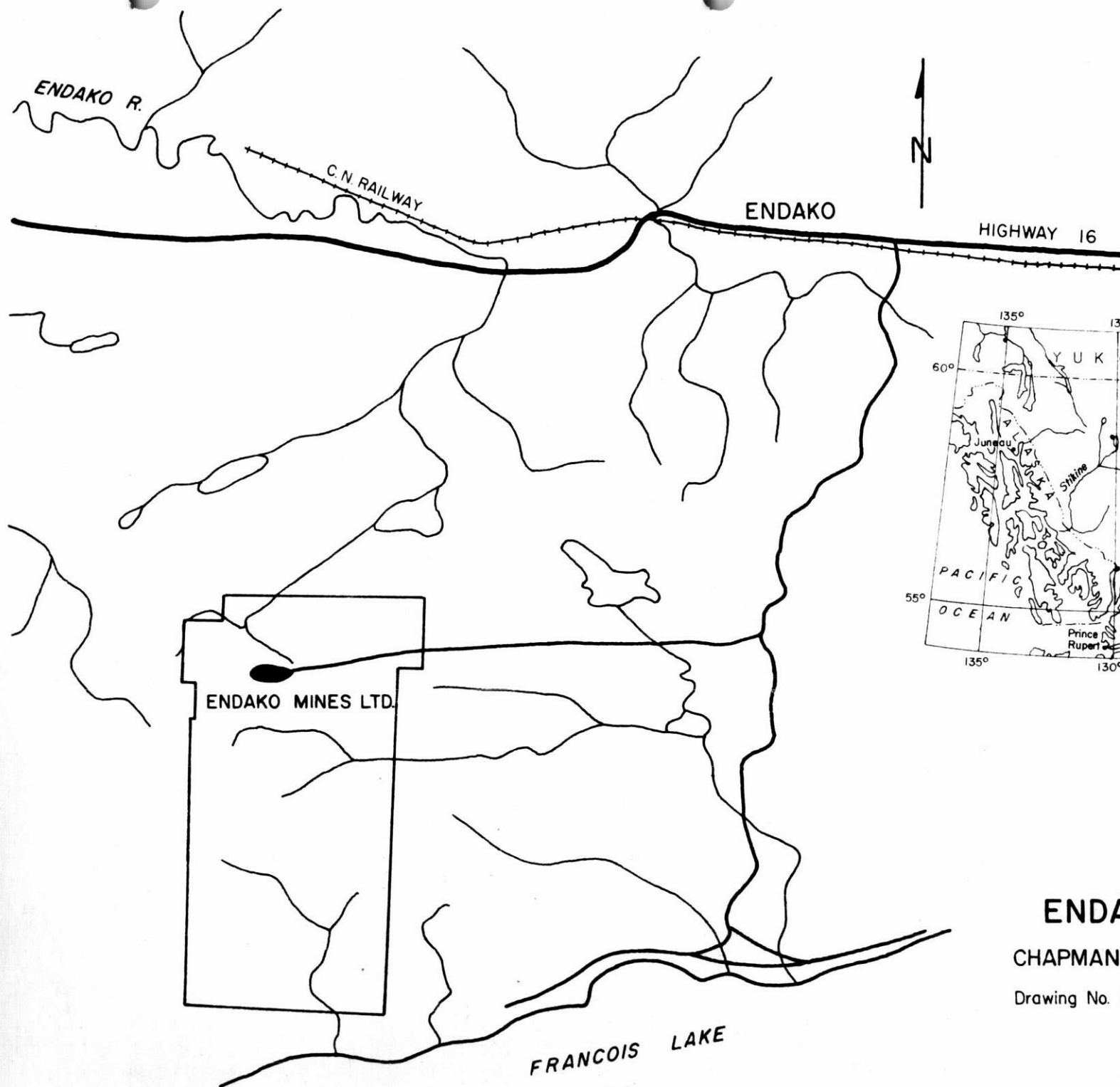
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ENDAKO INDEX MAP

CHAPMAN, WOOD & GRISWOLD LTD.

Drawing No. 232

November, 1962

CONCLUSIONS AND RECOMMENDATIONS

1. Results of diamond drilling 38 holes totalling nearly 21,000 feet on the Stella molybdenite property of Endako Mines Ltd. have indicated the possible existence of a multimillion ton deposit containing significant amounts of molybdenum.
2. An accurate estimate of tonnage and grade which may be anticipated cannot be made at the current stage of exploration.
3. It is believed that core assay values to date are generally lower in molybdenum content than the true values of the deposit. Conversely the sludge assays are thought to be disproportionately high in MoS_2 .
4. It is recommended that certain very exacting procedures be enforced during continuing drilling operations to improve the accuracy of correlating assay values of core and sludge samples. These recommendations, to be applied to a series of six test holes include:
 - a. increasing coring bit size from AXT to BX
 - b. replacing rigid core barrels with double tube swivel type.
 - c. use of face ejection bits.
 - d. consideration of casing at least one test hole in order to increase uniformity of sludge volume.
5. A very extensive program of exploration and development would be warranted if results of 1962 drilling confirm the presently indicated possible grade range of 0.2 to 0.4 percent MoS_2 .
6. Such a program should consist of considerable additional diamond drilling co-ordinated with some underground development of drilled areas and bulk sampling of material therefrom.
7. Expenditure of funds required to complete the 1962 program as planned is thoroughly warranted.

8. Absence of copper minerals in the deposit is an advantage since a copper-free molybdenite concentrate is preferred by many consumers.

9. Although known reserves and productive capacity of established molybdenum producers are adequate to meet current and projected demand, it appears probable that a new producer of high quality molybdenum product could find outlets for substantial quantities for such material.

Respectfully submitted,

CHAPMAN, WOOD & GRISWOLD LTD.

E. P. Chapman Jr.

E. P. Chapman, Jr.

John A. Wood

John A. Wood

November 28, 1962

II

INTRODUCTION

Under authorization of Andrew Robertson, President, Endako Mines Ltd., the firm of Chapman Wood and Griswold Ltd. has examined a molybdenum prospect near Endako, B.C. which is currently being explored in accordance with an operating contract between the company and Canadian Exploration Limited, Vancouver, B.C.

The properties were inspected on November 20 and 21, 1962 by John A. Wood, Vice President, Chapman Wood and Griswold Ltd., following which a series of informative discussions was held between Messrs. Chapman and Wood and key personnel of Endako Mines Ltd. and Canadian Exploration Ltd.

During the inspection procedures in diamond drilling, core and sludge handling, sampling and assaying were subjected to particularly careful analysis. Due to snow conditions it was not possible to examine surface geologic features, but this was not a great handicap since the area is almost entirely covered with glacial till, and very few outcrops exist.

Considerable data on exploration results thru November 15 were made available by both companies and were analyzed prior to visiting the properties. These data were found to be in good order and entirely relevant to the problems at hand, and have provided reasonably adequate background information on the nature of the deposits under investigation.

III

PROPERTIES

The molybdenum deposits of Endako Mines Ltd. are in the Omineca Mining Division, British Columbia, approximately 4 miles south of the village of Endako, a divisional point on the Canadian National Railway. The area, which is in approximately the geographic center of the province can be reached by paved Highway 16 connecting with Prince George, 115 miles to the east; and with Prince Rupert, a coastal port 378 miles to the west. Canadian Pacific Airlines operates daily except Sunday to Prince George and Wednesday only to Prince Rupert.

At present access to the properties from Endako is by 8 miles of graded dirt road. In event the deposits should be put into production, however, a more direct haulage route could be developed, reducing the distance to approximately 4.5 miles.

Nucleus of the properties consists of relocations of lapsed claims formerly known as the STELLA Nos. 1 to 4, and which have been described in G. S. C. Memoir 252 under the heading Stella Molybdenum Property. Although the recent relocations have greatly increased the area of ground held, the aggregate of claims is still generally identified as the Stella property.

Endako Mines Ltd. owns by virtue of outright purchase a total of 57 mineral claims, described as follows:

<u>Claims</u>	<u>Record Numbers</u>
FRAN 1 - 10	14076 - 14085
FRAN 17 - 26	14092 - 14101
FRAN 33, 35, 37	14139, 14141, 14143
FRAN 39, 41	14145, 14147

MO 1 - 9	13175 - 13183
TAN 1 - 4	13426 - 13429
BOOT 1 - 6	13122 - 13127
BOOT 7 - 10	13166 - 13169
BOOT 14, 15	13173 - 13174
JAY 10	12385
BAR 1 Fr. - 6 Fr.	14054 - 14059

Total area covered by the above group of claims is approximately 2470 acres.

We have examined photocopies of records which show that Notice to Group and Affidavit on Application for Certificate of Work have been filed with the office of Sub-Mining Recorder in Vancouver for all 57 claims, dates being August 10, 1962 for the FRAN claims and August 6, 1962 for all others.

It is our understanding that a title investigation has been made by counsel for Endako Mines Ltd., but we have not reviewed the results of this investigation.

A transit survey of claim boundaries was scheduled to commence on November 22, 1962.

IV

TOPOGRAPHY

The area is of moderate relief, elevations ranging from 3000 to 3600 feet above sea level.

There is a distinct east-west orientation of the principle topographic features, not only in the vicinity of ground being explored, but also within a radius of several miles of the property. Stereo-examination of air photos reveals a broad area of glaciated surface generally masking a granitic surface of higher relief.

The zone of mineralization which is being explored occurs within an oval shaped area, probably a drumlin, which is approximately 9000 feet long by 3000 feet maximum width, and which rises 200 to 300 feet above the surrounding terrain.

A reconnaissance topographic map, number 62-199, on a scale of 1000 feet to 1 inch has been prepared from air photos by Hunting Survey Corporation Ltd., but is not included in this report.

V

WATER SUPPLY

There are no constant streams in proximity to the Endako Mines Camp, and hence water for drilling operations has been obtained from small ponds, swamps and run-off.

Little is known of potential groundwater sources.

It appears, however, that adequate water supply for even a large capacity concentrator could be obtained from a series of small lakes lying within a

radius of 4 miles from the properties. Francois Lake, 3 miles to the south, could in itself provide ample water, but the possibility of acquiring rights thereto is doubtful since this lake is a tourist attraction of some renown. Elevation of Francois Lake is 2346 and that of Onion Lake 3100 feet.

VI

POWER AND FUEL

There are at present close to the property no readily available sources of transmitted power of the type and amount which would be required by a large scale mining and milling operation. The proposed future development of Peace River power might affect the situation favorably.

The nearest source of coal would probably be at Telkwa on the C. N. R. near Smithers, the distance being approximately 100 miles.

VII

GEOLOGY AND MINERALOGY

A. Geology

The principal rock formation found on the Stella Molybdenite Property is the Topley granite of late Permian ? age. Bed rock is almost entirely covered by a mantle of glacial till ranging in thickness from several feet to an apparent maximum of about 75 feet.

Recent diamond drilling to depths of approximately 500 feet has made available a large volume of core, the study of which has provided considerable information on the lithology of the igneous rocks. The Topley granite within the broad zone of mineralization appears to have been subjected to an argillic type of hydrothermal alteration of moderate intensity. Within any typical section there are bands or blocks of relatively fresh, unaltered rock

interspersed with segments which have been altered in varying degrees by chloritization and kaolinization.

Numerous thin aplitic dykes ranging in thickness from less than an inch to as much as 2 feet cut the granite sporadically and probably indicate that this is a steep border region of a large intrusive.

In one drill hole a mafic dyke was cut in a section of core approximately 30 feet long.

Irregularly dispersed throughout the host rock is a network of thin quartz veinlets varying in thickness from less than a millimeter up to about 2 inches. In the area of surface trenches several small quartz veins have been exposed which have a maximum width of about 2.5 feet.

The granite is chiefly pink to brick red in color, except where well chloritized or kaolinized, the chloritic types being dark grey-green and the kaolinized types buff to white.

The host rock is predominantly competent except in those sections of fairly intense alteration. In the latter zones it is normally soft, decomposed and frequently rubbly due to presence of more resistant aplite or quartz veinlets.

The rock is well fractured, chiefly by a system of joints which have rather rough surfaces. These fractures have three principal dip ranges: 60 to 80, 40 to 50, and 15 to 30 degrees. It is believed that they are tension fractures developed by shrinkage of the rock mass during alteration. This conclusion is further supported by photo-interpretation of the tectonics of the Endako region.

B. Mineralogy

Gangue minerals are those typical of granitic rocks, namely quartz, feld-

spars, and mafic accessories

Hydrothermal alteration minerals are chlorite, kaolin and hydromicas.

Metallic mineralization of economic importance is found principally as molybdenite (MoS_2) in association with pyrite, hematite, and magnetite. Molybdenite occurs as thin scales or plates along fracture surfaces and in ribbons parallel to walls of the quartz veinlets and veins. There does not appear to be any appreciable dissemination of molybdenum within the rock itself between fractures or veins. Slight oxidation to molybdate has been noted in the uppermost sections of several drill holes.

Preliminary evaluation of the deposits based on analysis of data from 30 diamond drill holes leads to the conclusion that the Stella molybdenite deposit may be marginal in grade, but of considerable extent. A zone in which there is a semblance of continuity of values is illustrated on Drawing 233, appended, and is considered to be a zone of significant molybdenum mineralization. It extends approximately 3600 feet in an east-west direction and averages about 600 feet in width. Based on an area of 2,000,000 square feet and a density factor of 15 cubic feet per ton this zone is estimated to contain 13.3 million tons of rock per 100 feet of depth. Thicknesses of significant mineralization estimated from drill hole core assays range from 100 to 500 feet vertically. The zone is open on both ends and in part at depth.

@ 300 ft = 40 million tons

Ultimate recoverable grade of this deposit cannot be predicted with assurance at the present stage of development; and considerable additional exploration will be required before grade limits can be determined with the optimum degree of accuracy.

It is our opinion that estimated MoS_2 values based on core assays are prob-

ably lower than actual MoS_2 content, and conversely that values based on drill sludge assay are probably higher than actual MoS_2 in the rock. Improved correlation of core and sludge assays, together with bulk sampling from underground development headings is essential to establish valid grade figures for evaluation of the deposit.

There is a possibility that a multimillion ton body of material having molybdenum sulfide content in the range of 0.20 to 0.40 percent may exist in the area now being explored. Since the deposit appears to be amenable to low cost, high tonnage open pit extraction, it would be of economic interest if minimum reserves of 50 million tons grading 0.35 percent MoS_2 or better could be proven. A number of factors including metallurgical recoverability and marketing conditions would strongly influence determination of the optimum rate of extraction, which in turn will relate to the size and grade of deposit required to constitute an orebody.

An apparent advantage which should be noted is the absence of copper in the Stella deposit, which fact should make the concentrate more acceptable to consumers than that marketed as a by-product from the large copper mines of the U.S. and South America.

VIII

EXPLORATION

A. Preliminary

Between 1927 and 1952 locators of the Stella property prospected by means of trenches and pits in an area where molybdenum bearing float was found. They also sank a 27 foot incline shaft on a 2 foot quartz vein carrying values up to 1.6 percent MoS_2 ; and drove a 30 foot adit about 50 feet below the shaft.

In 1952 Kennco Explorations optioned the property and put in 3 long bulldozer

trenches, 2 being on either side of the shaft.

In the fall of 1960 additional bulldozing was done by C. Riley and associates.

In 1961 in order to facilitate an examination by V. B. Bjorkman, Consulting Mining Engineer seven parallel rock trenches were blasted in an area southwest of the incline shaft (see Drwg. No. 233). Assays taken from these trenches showed values in MoS_2 ranging from 0.08 to 2.02 percent over widths from 1 inch to 6.5 feet.

B. Current

Between the period from May 27 to October 13, 1962 Endako Mines Ltd. diamond drilled 17 exploratory holes from surface totalling 9,633.5 feet. AXT core was recovered and principal mineralized sections were split and assayed. Many sludge samples were also collected and assayed, with sample intervals frequently, but not in every instance corresponding to core assay interval. Molybdenum mineralization was encountered in every hole, although distribution of values was highly irregular. Core assays indicated the presence of narrow high grade streaks interspersed with wider sections of low grade material over appreciable vertical distances. Barren rock was encountered very infrequently.

We have examined the logs and assay data from these holes and have found it impossible to obtain a valid correlation between core and sludge values.

Subsequent to October 13, 1962 and up to November 16, 1962 additional AXT drilling of 21 holes totalling 11,576 feet has been completed by Endako Mines Ltd. under terms of the Canex operating contract.

We have also examined the logs and assay data on these holes, with the exception of numbers 31-38 for which assays are not yet available.

Interpretation of results from the second stage of drilling does not differ greatly from that of the first stage. The holes have been more regularly spaced and served to greatly extend the zone of significant mineralization.

C. Future

The problems involved in correlating drill hole assay values for estimation of grade and tonnage are those characteristically found in evaluation of low grade molybdenum deposits. A few will be enumerated:

1. Core recovery, even though it may approach 90% or better for a total drill hole length, is almost always very low in rock sections which are soft and decomposed. Hence this soft material is largely ground and fails to report to the core, but usually reports to the sludge. Since the soft material almost always contains the highest molybdenum concentrations, core samples in these sections, if recovered at all, assay lower in MoS_2 than actual content; while the sludge samples are enriched by disproportionate amounts.
2. If casing is not carried closely behind the drill bit, a series of soft, high value sections may continue to contribute excessive amounts of molybdenite to the sludge samples. If the hole is cased properly and if sludge samples are carefully collected, dried and weighed, there is a better chance for correlation of core and sludge assays.
3. It has been demonstrated at Climax, Colorado that progressing to larger diameter cores from AX through BX to NX gives higher core recovery in the critical sections and greatly improves the accuracy of correlation of drill hole values.

For the above reasons we have concurred in the decision of Canex staff to immediately drill 6 test holes with BX core, giving due consideration to the feasibility of casing at least one of these holes in order to increase the

uniformity of sludge volume. We have recommended use of face rejection bits and double tube swivel type core barrels with provision for trial of both bevel wall and straightwall bits. Following completion of these 6 holes the results should be thoroughly analyzed with a view to applying a correlation formula derived therefrom to the entire 1962 drilling program.

Further extensive exploration consisting of fill-in diamond drilling together with driving some underground headings to intersect drilled areas, and bulk sampling of material removed therefrom will be required in order to thoroughly assess the economics of production from this deposit. As this program progresses, a thorough market survey will also be required. The expenditure required to undertake such a program will be of considerable magnitude. A decision to undertake it should be contingent upon a very thorough evaluation of the 1962 program after it has been completed.

IX

MARKETS

The marketing of molybdenum differs from that of gold, silver and the common base metals to the extent that there are not custom mills and smelters which purchase molybdenum ores and concentrate at quoted prices less treatment charges. Sales are normally made directly to consumers under contract or handled by metal brokers.

The United States of America is both the largest producer of and the largest consumer of molybdenum in the world. In 1960 U.S. is estimated to have produced 76.3% of world output and 90.8% of free world production. In the same year the U.S. consumed 51.3% of the molybdenum used in the free world. American Metals Climax's mine at Climax, Colorado currently furnishes approximately 72% of the U.S. production. Most of the balance is recovered as a by-product from large scale copper operations.

Both world molybdenum price structures and product specification standards are for the most part set by American Metal Climax. For the primary marketable product, molybdenite concentrate, the price currently quoted is \$1.45 per pound of contained molybdenum, an increase of 20¢ per pound since 1958. The price is f.o.b. Climax, Colorado and the cost of containers is extra. The three principal molybdenum products sold by Climax together with typical specification ranges are tabulated below:

	<u>Molybdenite Concentrate</u>	<u>Molybdic Oxide Powder</u>	<u>Molybdic Oxide Briquettes</u>
MoS ₂ %	86-96		
MoS ₃ %		79-96	77.4
Mo %	51-57	53-64	51.6
S % max.	35-38	0.25	0.25
Cu % max.	0.5	0.5	0.5
P % max.		0.25	0.05

Molybdenum products produced as a by-product from copper operations are generally reported to be higher in impurities than similar products from Climax.

Over 50% of the molybdenum consumed goes into alloy steels, including stainless and tool steels. The balance finds a wide variety of uses, including lubricants, chemical catalysts, pigments, coatings and soil conditioners.

A consensus of opinions expressed in metal trade journals and Bulletin 585 U.S. Bureau of Mines, "Mineral Facts and Problems" 1960 is summarized below:

1. The long term outlook for molybdenum is that reserves are ample to meet foreseeable needs that may increase to 80-100 million pounds annually by 1975.

2. The combined reserve in the United States, Chile and Canada is probably over 4 billion pounds of recoverable molybdenum.
3. The commercial reserve of molybdenum in the United States is estimated to be more than 3 billion pounds. About two thirds of this reserve is in the Climax Molybdenum deposit in Lake County, Colorado.
4. Kennecott Copper Corporation's Utah copper mine is the world's second largest source of molybdenite.
5. Estimated Molybdenum Reserves:

<u>COMPANY</u>	<u>LOCATION</u>	<u>TONS</u>	<u>GRADE</u>	<u>SOURCE</u>
A. S. & R.	Silver Bell, Ariz.	No data		
Am. Metals	Climax, Colo.	500 million	0.4% MoS ₂	(1) Estimated
	Urad, Colo.	14 million	0.5% MoS ₂	Telephone
	or	20 million	0.4% "	"
Anaconda	Nye Co., Nev.	No data		
Duval	Esperanza, Ariz.	49 million	0.02% Mo	M. W.
	Ithica Peak, Ariz.	No data		4/62
Kennecott	Bingham, Utah	2d largest world source		M. W.
	Chino, N. M.	No data	0.012% MoS ₂	11/62 M. W. 8/62
Moly. Corp.	Questa, N. M.	(2) 260 million	0.25% MoS ₂	E. M. J. 12/60
Anaconda & Kennecott	Chile, S. A.	750 million	0.2% MoS ₂	(3) Estim-
	Peru	No data		ated

(1) Mineral Facts & Problems, 1960 - U. S. Reserves of more than 3 billion pounds. Estimated Grade at 0.4% MoS₂ = 8# /ton @ 60% Mo = 4.8# Mo per ton @ 85% Recovery = 4# Mo/ton. $\frac{2 \text{ billion lbs. Mo}}{4 \text{ lbs. Mo/Ton}} = 500 \text{ million tons, approx.}$

(2) Reliability of this data is questionable.

(3) Mineral Facts & Problems, 1960 - 1 to 2 billion pounds of Mo. Estimated Grade 0.2% MoS₂ = 4# MoS₂/ton @ 60% Mo = 2.4# Mo/ton @ 85% Recovery = 2# Mo/ton. $\frac{1.5 \text{ billion lbs. Mo}}{2 \text{ lbs. Mo/ton}} = 750 \text{ million tons, approx.}$

6. U. S. production of 49,938,000 lbs. of molybdenum contained in con-

tained in concentrate during the first nine months of 1961 was off 3% compared with the same months of 1960.

Despite the apparent adequacy of reserves and productive capacity to supply projected demands for molybdenum for a number of years, a new producer could probably capture a reasonable share of present and future markets. The large U. S. market is effectively closed to suppliers outside the United States by tariffs. (Current U. S. duty on molybdenite concentrates is 27¢ per pound of contained molybdenum. This is scheduled to drop to 24¢ per pound on June 30, 1963). However, substantial quantities are being used in free Europe, the United Kingdom and Japan. Production from American Metals Climax alone is not sufficient to satisfy free world demand. Molybdenum products equal in quality to those produced by Amax would undoubtedly be preferred by many consumers to the copper by-product material which is higher in impurities.

In our opinion a new producer of molybdenum outside of the United States should be able to meet each of the following tests to insure long term financial success:

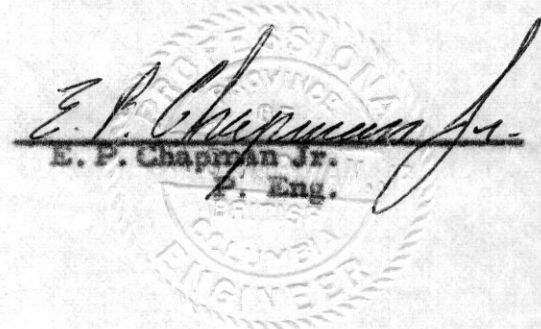
1. Ore should be amenable to concentration into a product equal in quality to that offered by Amax.
2. Costs should permit an adequate profit margin at prices ranging 10 to 20% lower than current market quotations.
3. Geographical location should be such that the cost of transporting products to seaports is reasonable.

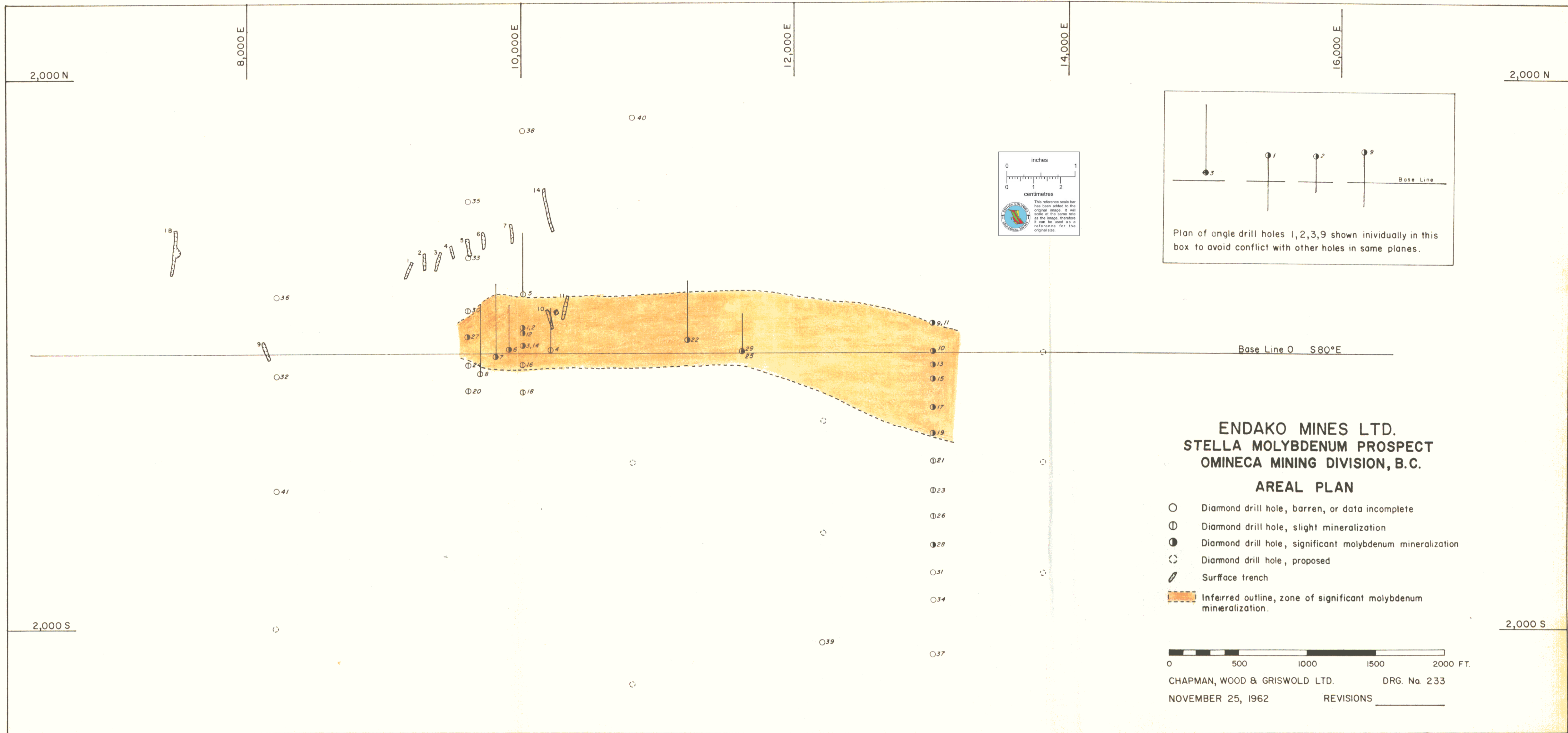
A preliminary assessment of the Endako prospect indicates that if tonnage and grade are sufficient, it can probably qualify with regard to operating cost, product quality and geographical location.

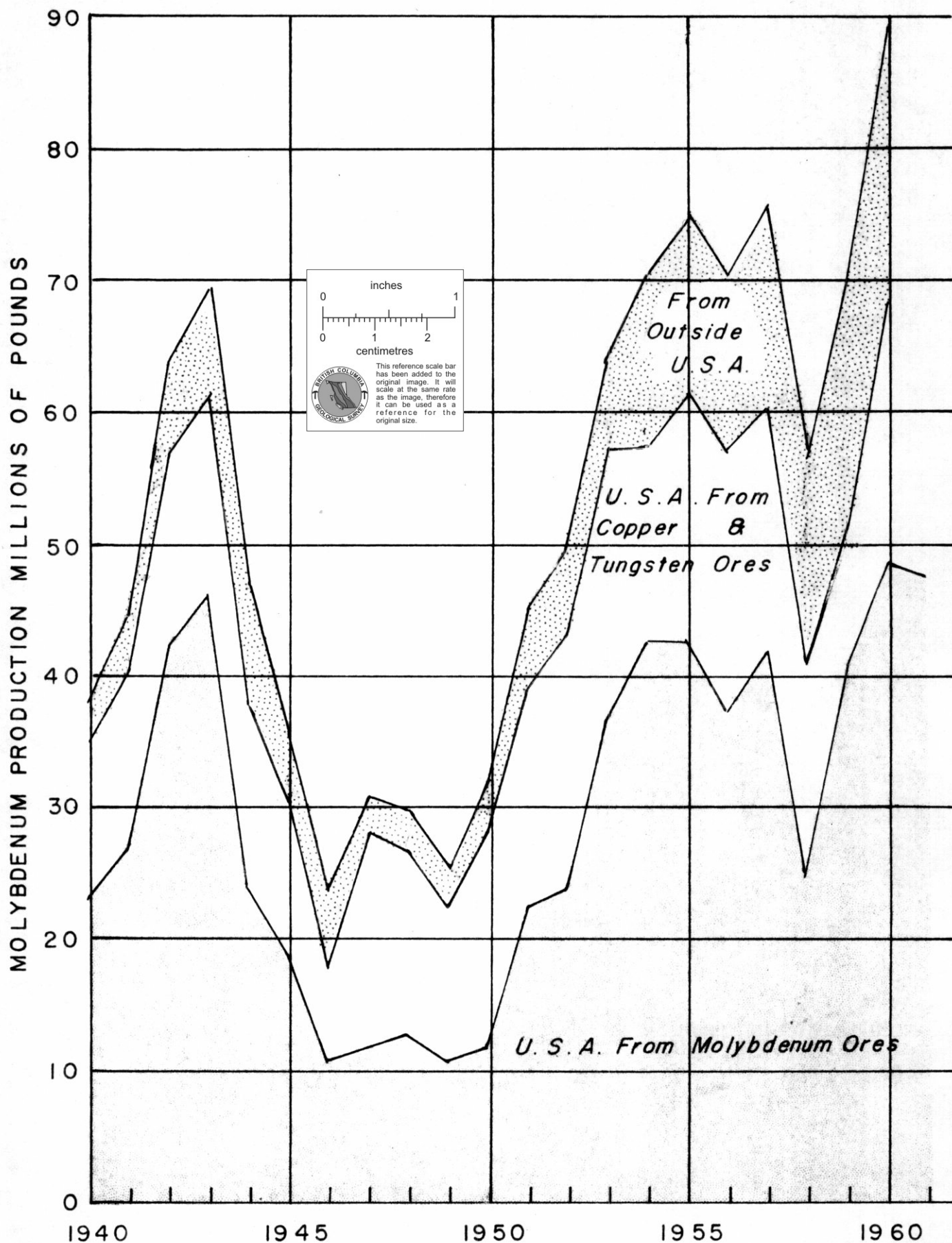
CERTIFICATE

I, E. P. Chapman Jr., of Vancouver, B. C. do hereby certify:

1. That I am a Mining and Geological Engineer, residing at 490 Southborough Drive, West Vancouver, B. C.
2. That I am President of Chapman, Wood & Griswold Ltd., Consulting Mining Engineers and Geologists, with offices at 525 Vernon Drive, Vancouver, B. C.
3. That I am a registered Professional Engineer in the Province of British Columbia and a member of the Consulting Engineers Division of the Association of Professional Engineers of British Columbia.
4. That I have practiced my profession for 27 years.
5. That neither I nor any employee of my company has any direct or indirect financial interest in Endako Mines Ltd. or in any property owned or controlled by it.
6. That the above report is based on an examination of the property during November 1962 by John A. Wood, co-author of the report and review and study by both of us of drill cores, drill logs, assays, maps and other data furnished to us by the companies carrying out an exploration and development program at the Stella property.


E. P. Chapman Jr.
P. Eng.





MOLYBDENUM PRODUCTION 1940-61 BY SOURCES