

POTENTIAL OF THE
MAYO MINERAL DISTRICT, YUKON

CONFIDENTIAL

SUMMARY

The Mayo mineral district has a much larger indicated silver-lead potential than previously thought, indications being that the total potential could exceed a billion dollars in gross value.

The main control for mineralization is the N70°E McQuesten anticline belt which extends for about 70 miles from Clear Creek east to open out against the northwest-trending, southeast-plunging Mayo Lake anticline in the Davidson Mountains. This structure forms an arch of quartzites and phyllites uniquely transverse to the regional trend followed by the Mayo Lake anticline, a marked characteristic shown by several other major Cordilleran mineral districts such as the Coeur D'Alene and Bingham camps. This anticlinal belt is intruded by a row of granitic stocks along its axial region and its north flank while porphyry occurs throughout the belt. Gold, tin, and tungsten mineralization occur near the granitic stocks. Intervening areas are mineralized with silver-lead-zinc and antimony veins occurring largely in a pattern of NE and E-W fault fractures which, along with N-NW cross faults and E-W longitudinal faults form a major tensional fracture pattern that is genetically related to the anticline and is typical of fracture patterns in elongate domes or anticlines in other productive mining camps, oil fields and scale models. A major longitudinal fault or faults extends for about 40 miles along the axis of the anticline, showing down-throw of the north limb.

Within this anticlinal structure silver-lead-zinc and antimony mineralization occurs chiefly in Keno Hill quartzites and greenstones because of their competence, in phyllites under certain structural conditions, and may occur as limited replacements in limestone bands above the Keno Hill quartzites. These favourable Keno Hill quartzites (2500 to 10,000 feet thick) and other rocks are exposed mostly along the axial region of the McQuesten anticline, plunge westward from the flank of the Mayo Lake anticline, are uplifted again by the major Haldane antithetic fault, and are exposed for some distance westward at Seattle Creek along the south flank of the anticlinal structure.

Up to 1964 the main Keno-Galena Hills part of the district has produced a total of about 133 million ounces of silver, 409 million pounds of lead, 233 million pounds of zinc and 3.0 million pounds of cadmium valued at \$275 million, largely in the last 16 years making it Canada's largest silver producer and the world's third largest. This production has come from NE-striking, SE-dipping vein-fault structures which cut the Keno Hill quartzite formation over a distance of 20 miles in the east part of the south limb of the McQuesten anticline. Work in the last couple of seasons, however, has shown that similar northeast vein-faults with high silver values occur in the same favourable host rocks on the north side of the anticline and for 15 miles farther westward, thus doubling or tripling the size and potential of the district. The central silver-rich part of the district

now appears to be about 35 miles long and 15 miles wide, associated with the main anticlinal structure and its major longitudinal fault. Moreover, the overall major structure outlined above, and occurrences of silver-lead mineralization in outlying areas could also add to the potential.

The Haggart Creek area on the north flank of this central district contains considerable silver-lead-antimony mineralization in strong NE- to E-W striking, NW-dipping vein-faults in phyllites. This section may also contain important antimonial silver-lead potential.

The extent and possible potential of outlying parts of the district is entirely unknown though indications generally suggest lower silver content. Larger replacement and vein-type lead prospects with low silver values and some indications of high grade in the Beaver River district and Davidson Mountains north of the producing area may contain important lower grade potential.

Zoning in the district appears to be either a local ore-shoot condition dependent on open space, or a very broad pattern related to the major district structure, therefore similar to the Coeur D'Alene District of Idaho.

The entire framework of major anticlinal doming, with major longitudinal axial faulting, related fracture and fault pattern, closely related mineralization, and its timing and lack of marked zoning, and the large number of indications and widespread type of mineralization strongly suggest that the Mayo silver-lead district is much more extensive than indicated by its present localized production and has much greater overall potential than generally realized before. These characteristics strongly suggest that the district is comparable in potential to the Coeur D'Alene District of Idaho, especially considering expanded possibilities that would enter into the production picture if lower grades could be mined as a result of increased productivity.

Possibilities of economic deposits of gold, tin and tungsten also exist in this district.

The overall potential has not been previously recognized because work has been concentrated almost entirely on Keno and Galena Hills and the other key parts of the district have been neglected in detailed mapping or prospecting, and have not been recognized largely because of residual or glacial overburden and leached outcrops.

Continuing aggressive exploration should lead to further mine development, should give a more accurate indication of the potential in the key central parts of the district, and can be expanded to include acquisition of other outlying prospects and exploration and development of lower grade ores.

* Note:

The term "antiform" can be substituted for "anticline" or "anticlinal" in the case of the McQuesten structure.

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REGIONAL SETTING

Statistical comparison with other parts of the Cordillera on the basis of regional geology and mineral occurrences shows that two or more districts with productive capacity exceeding a billion dollars in gross value may be expected to occur in Yukon, either in districts still to be discovered, or in known districts or prospects whose full potential is yet to be realized.

One of these is the Mayo district which is Canada's foremost silver producer, but whose full possibilities have not yet been explored.

GENERAL

The basic geologic structure of the Mayo district is a $N70^{\circ}E$ arch of quartzite and phyllite 60 miles wide which extends transverse to regional trends for a distance of 100 miles from Clear Creek to beyond Mt. Patterson (see geologic map of Yukon, G.S.C. Map 1048A). The main structure, which dominates the northern half of this arch, is the $N70^{\circ}E$ McQuesten anticline which is intruded by two rows of granitic stocks, one along its axial region and another along its north flank. This anticlinal and intrusive belt, extending some 70 miles from Clear Creek to the Davidson Mountains, has been called the McQuesten mineral belt by the writer (see paper "Silver in Yukon", C.I.M.M. Annual Western Meeting, September, 1962). In the vicinity of the Davidson Mountains this mineral belt merges with a major southeast plunging anticline, the Mayo Lake anticline. The very earliest gold rush to the Yukon in 1885, ten years before the Klondike, was directed at gold on the bars of the Stewart River, derived from this mineral belt. Since that date, prospecting for gold has led to the discovery of the Keno Hill silver-lead-zinc deposits, mineralized localities of gold, tin and tungsten near many of the granitic stocks, and of other silver-lead-zinc and antimony prospects near the stocks and in intervening areas.

Several million dollars' worth of placer gold has been mined from creeks in various parts of the area, but exploration, development, and production of silver-lead-zinc ores have been confined to the high grade area of Keno and Galena hills in the eastern part of the district. More widespread exploration and development have been hindered in the past by remoteness and physical conditions, but production has been increasing with improved conditions so that the total to date, based on present metal prices, would be valued at about \$275 million. However, only a small part of this mineralized district has been explored or even geologically mapped in detail.

With its distinct and regionally unique large-scale structural unity and its widespread genetically related mineral occurrences and intrusives, this mineral belt or district most probably contains a much larger potential than that indicated by its present localized production.

MINERALIZATION IN WESTERN PART OF DISTRICT

The western part of this mineral district consists of unglaciated ridges mantled by generally thin residual overburden and vegetation, with weathered outcrops which have discouraged uninitiated prospectors so that only a little prospecting was done, mainly in the early placer mining days. Very little published information exists on this part of the mineral district, and virtually nothing has been available on mineral prospects within it. Geologic mapping of this western part of the district has been confined to 1 in. = 4 mi. reconnaissance (Geological Survey of Canada Preliminary Map 48---25A, McQuesten, Yukon Territory) with no structural detail or much of interest on mineralization having been published. The writer's information on structure and mineralization is obtained largely from Bostock's original field manuscripts in Ottawa, from familiarity as an assistant in mapping the area in 1948, from a 1949 B.A.Sc. thesis study of the placer concentrates of several creeks, from collection of information over a period of years from various sources, and from several trips into different parts of the area.

Placer gold and accompanying placer tin (cassiterite) and tungsten (scheelite and wolframite) occur in creeks which drain mineralized vicinities in, or between, porphyritic granitic stocks or granodioritic stocks with characteristic accessory allanite, as at Parker, Clear, Josephine, Big Granite, Arizona, Boulder, Sunshine, Rodin, Hight, Haggart, Duncan, Granite, and the Mayo Lake creeks. Through most of this mineral belt small bodies, dikes, and sills of quartz porphyry occur in intervening areas, in which silver-lead-zinc and antimony veins or indications also occur. A number of localities of known or reported mineralization can be detailed for further exploration but are omitted here.

Only the resistant minerals and the lower grade mineralization tend to be preserved from leaching, especially in unglaciated terrain, and even if bedrock is well exposed, there may be little or no sign of important veins because they are weathered down and thinly mantled with overburden. Since most of this mineral belt consists of such terrain with geology, rock types, structure, and mineralization similar to the producing eastern section of the belt, the western section may have similar potential.

Prospecting is slow and discouraging due to permafrost and overburden; however, advantages due to lack of glaciation are:

- (a) Lack of glacial overburden;
- (b) The much better opportunity to trace float, panned concentrates, or geochemical indications upstream or upslope to their sources.

Modern methods of geologic mapping, geochemistry, bulldozer stripping, and systematic panning have proven very effective in mineral discoveries in several such unglaciated areas (Klondike, Mt. Nansen, Peso.)

MINERALIZATION IN EASTERN PART OF DISTRICT

The eastern part of the Mayo mineral district is well known because of the rich silver-lead-zinc-cadmium ore deposits of Keno and Galena Hills and because of numerous other prospects, many of them better exposed or un-

leached because this portion of the district has been glaciated. Prospecting has been difficult and incomplete due to glacial overburden and permafrost, as compared to the advantages of the unglaciated area where little can be seen on surface, however.

Haggart Creek silver-lead-antimony area

Along the north flank of the eastern part of the anticline, granodiorite and diorite bodies intrude a belt of gently north-dipping phyllites overlain and underlain by more quartzitic rocks. This section is cut by steeply north-dipping N70-90°E vein-fault or shear zones, and NW-dipping, N45°E vein-fault zones which carry arsenopyrite, pyrite, jamesonite, galena, sphalerite, chalcopyrite, and substantial silver values or even gold depending on the locality. Bismuth is also an important constituent of some of the zones. Placer concentrates contain gold, abundant scheelite (20%) and ferberite (tungsten), cassiterite (20%) and jamesonite with native bismuth, bismuth tellurides, galena-bismutite, galena, and other minerals. Although found to date largely to the phyllitic section, the veins show sufficient strength and continuity to indicate fair tonnage possibilities especially in lower grades. High silver values due to tetrahedrite have been found on the Peso property (up to 185 oz/ton on No. 1 vein and 1500 oz/ton on the Rex vein) and on the Rio Plata property at Haggart Creek (up to 200 oz/ton). Similar or better veins should occur in the more quartzitic sections on either side of the phyllite, and much closer prospecting is warranted for these.

On the Peso Silver property, Nos. 1, 2 and 6 veins and their vicinity and the Rex vein and its vicinity may contain a few hundred thousand tons averaging 20 to 40 oz/ton silver, 5-10% lead and 2-4% antimony, or a considerable tonnage containing about \$20/ton gross values in silver, lead, antimony, bismuth and zinc. Further exploration must be done to establish true potential, and exploration to the west and east should reveal more of this type of mineralization since a number of such vein zones are indicated in this part of the district. Similar vein zones are reported west of Peso, at least three jamesonite-bearing vein zones several feet wide occur at Haggart Creek, several "antimony" occurrences are reported around the head of Haggart Creek, and silver-lead-antimony showings occur at Lime and Eightmile Creeks.

Several veins carrying interesting gold values either in arsenopyrite or as free gold occur near the quartz diorite body at Haggart Creek, Dublin Gulch, and Potato Hills. Little work has been done on these in recent years.

Scheelite occurs in residual overburden on fractured quartz diorite mineralized by scheelite veinlets at the head of Dublin Gulch, and is reported as float at Ray Gulch. Other tungsten possibilities may occur at limestone-quartz diorite contacts in this belt.

Tin occurs as cassiterite in irregular tourmaline veins in schist on Tin Hill between Dublin Gulch and Upper Haggart Creek, and another "tin" prospect has been reported on the north slopes toward East McQuesten River.

Due to the light cover of overburden, the deeply weathered nature

of the vein zones, and the frequent masking of any float by soil or vegetation cover, initial prospecting of this area was difficult and disheartening. However, bulldozer trenching has demonstrated the ease with which a number of strong mineralized zones could be uncovered and drilling and underground work have indicated what values, mineralogy, widths, continuity, and other conditions may be expected on the basis of surface results. Considering the structure, type, and strength of fracture patterns, the distribution of indicated showings, and the limited exploration to date, a much larger amount of silver-lead-antimony mineralization may be discovered in the Haggart Creek area with probable further values in copper, bismuth, and zinc.

Keno - Galena Hills vicinity

The chief known silver-lead-zinc deposits of the Mayo district are localized in the Keno and Galena Hills vicinity where several northeast-striking, southeast-dipping vein systems cut the competent south-dipping Keno Hill quartzite formation along a length of 20 miles on the south limb of the McQuesten anticline. Work in the last couple of seasons, however, has also shown that similar northeast-striking, northwest-dipping vein-faults carrying high silver values also cut the same Keno Hill quartzites on the complementary north limb of the anticline and for 15 miles farther west, opening up a much larger new field for exploration.

Mineralization of pyrite and arsenopyrite, with or without gold values and silver-lead mineralization, exists in early vein fillings, especially in longitudinal fractures; while later silver-rich mineralization of galena, sphalerite, tetrahedrite, and other silver minerals forms the ore mostly in northeast fractures. The ore is localized in or near competent quartzite or greenstone, particularly in or near vein-fault intersections or branches where vein-faults pass upward into less competent schist or thin bedded quartzite, and often near northwest cross-faults.

The major vein-fault systems on both limbs occur at spacings ranging from a few thousand feet to 4 miles apart.

(a) South Limb

On Keno and Galena Hills at least six vein zones have produced well over 2 million ounces of silver, another half dozen or so have produced lesser amounts, and further exploration may be expected to reveal additional ore.

After the initial discovery of the Silver King vein in the canyon of Galena Creek in 1903, production was first attained from 1913 to about 1917, and veins on Keno Hill were first discovered in 1919. During the 1920's most other veins or indications of them were discovered by individuals using hand methods in areas of fairly extensive but relatively shallow overburden, mostly on north-facing permafrost slopes where the favourable Keno Hill quartzites were exposed. Between 1921 and 1942 nearly all of the mining was done on ore shoots found exposed under the overburden, but due to high costs and apprehensions that the rich ores would not extend to depth, no mining was done below about 400 feet depth, and only a minimum of exploration and development was done.

In 1942 the camp was closed largely because of World War II and depletion of visible ore, but it was reopened again in 1946 and the chief production of the district has been achieved in the last 16 years with mining extending to deeper levels. Economic conditions, chiefly transportation costs and metal prices, have improved in this recent period, enabling mining of lower grades than previously possible. Total production of the district to 1964 is approximately as follows:

	<u>Tons</u>	<u>Silver</u> <u>oz.</u>	<u>Lead</u> <u>lb.</u>	<u>Zinc</u> <u>lb.</u>	<u>Cadmium</u> <u>lb.</u>
Treadwell Yukon Corp. 1922-1942	624,370	44,338,696	96,000,000	---	---
Keno Hill Ltd. Yukon Gold 1921-1924	10,000+	2,000,000	4,000,000	---	---
United Keno Hill Mines 1946-1963	2,254,149	84,241,024	305,304,822	233,076,056	3,060,702
Others (estimated)		2,000,000	4,000,000	---	---
	<u>2,900,000</u>	<u>132,600,000</u>	<u>409,300,000</u>	<u>233,000,000</u>	<u>3,060,702</u>
Value at present prices		\$1.40/oz. \$186 million	13¢/lb. \$53 million	13.5¢/lb. \$31.4 million	\$1.70/lb. \$5.2 million

Total value of production at present prices
\$275 million.

The profitability of the main mining operations in this district are indicated by the following summary:

UNITED KENO HILL MINES LIMITED

Eleven Year Summary Of Operating Data

<u>OPERATING RESULTS:</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>
Sales of concentrates less smelter charges, freight and marketing expenses	\$6,143,115	\$7,001,730	\$7,311,760	\$7,691,701	\$6,659,348	\$6,117,968	\$7,416,590	\$7,280,964	\$7,101,507	\$8,301,313	\$8,805,518
Operating and admin- istrative expenses	<u>4,206,859</u>	<u>4,984,416</u>	<u>4,089,292</u>	<u>4,310,590</u>	<u>4,533,606</u>	<u>4,804,302</u>	<u>4,980,384</u>	<u>5,306,934</u>	<u>5,327,271</u>	<u>5,440,268</u>	<u>6,004,473</u>
Operating profit before undernoted items	<u>\$1,936,256</u>	<u>\$2,017,314</u>	<u>\$3,222,468</u>	<u>\$3,381,111</u>	<u>\$2,125,742</u>	<u>\$1,313,666</u>	<u>\$2,436,206</u>	<u>\$1,974,030</u>	<u>\$1,774,236</u>	<u>\$2,861,045</u>	<u>\$2,801,045</u>
Deduct (add)											
Depreciation and amortization charges	\$1,107,992	\$ 867,349	\$ 743,505	\$ 700,290	\$ 684,150	\$ 470,624	\$ 515,426	\$ 522,131	\$ 522,624	\$ 519,985	\$ 450,629
Expenditures on exploration and development		169,140	255,540	217,434	169,909	278,236	426,258	412,623	441,471	586,616	1,029,639
Other Income	(4,329)	(88,861)	(29,044)	(41,919)	(50,065)	(84,034)	(48,314)	(144,373)	(97,894)	(118,687)	(155,135)
Income Taxes (estimate)	<u>88,000</u>	<u>190,000</u>	<u>650,000</u>	<u>500,000</u>	<u>320,000</u>	<u>62,000</u>	<u>218,000</u>	<u>60,000</u>	<u>70,000</u>	<u>655,000</u>	<u>485,000</u>
Earnings for the year	<u>\$ 744,593</u>	<u>\$ 879,686</u>	<u>\$1,602,467</u>	<u>\$2,005,306</u>	<u>\$1,001,748</u>	<u>\$ 586,840</u>	<u>\$1,324,836</u>	<u>\$1,123,649</u>	<u>\$ 978,035</u>	<u>\$1,218,131</u>	<u>\$ 990,912</u>
 <u>WORKING CAPITAL:</u>											
Current assets	\$1,568,983	\$2,333,786	\$3,598,468	\$4,096,601	\$3,575,016	\$3,196,637	\$4,155,269	\$4,587,299	\$4,804,099	\$5,976,401	\$5,626,616
Current liabilities	<u>715,615</u>	<u>835,684</u>	<u>1,173,343</u>	<u>1,309,471</u>	<u>1,083,638</u>	<u>855,041</u>	<u>932,559</u>	<u>745,540</u>	<u>654,600</u>	<u>1,426,976</u>	<u>1,096,298</u>
	<u>\$ 853,368</u>	<u>\$1,498,102</u>	<u>\$2,425,125</u>	<u>\$2,787,130</u>	<u>\$2,491,378</u>	<u>\$2,341,596</u>	<u>\$3,222,710</u>	<u>\$3,841,759</u>	<u>\$4,149,499</u>	<u>\$4,549,425</u>	<u>\$4,530,318</u>

UNITED KENO HILL MINES LIMITED

Comparative Statement of Production by Years

Fiscal Year	Tons Milled	Production			
		Silver Ozs.	Lead Lbs.	Zinc Lbs.	Cadmium Lbs.
Dec. 31, 1947	20,880	735,195	2,157,090		
Dec. 31, 1948	37,593	1,908,267	5,089,554		
Dec. 31, 1949	29,494	1,403,360	5,330,736	2,272,397	
Dec. 31, 1950	77,465	3,349,848	13,916,231	7,040,569	80,585
Dec. 31, 1951	88,026	3,480,965	13,036,638	7,174,657	94,608
Sept. 30, 1952 (9 mos.)	102,269	3,408,966	14,436,073	10,280,241	139,654
Sept. 30, 1953	156,684	6,252,483	27,313,584	21,245,493	304,722
Sept. 30, 1954	180,249	6,191,599	30,663,549	26,134,700	312,931
Sept. 30, 1955	162,307	5,670,137	26,350,198	24,035,999	302,297
Sept. 30, 1956	155,702	5,582,979	25,083,145	24,107,851	322,379
Sept. 30, 1957	159,885	5,694,850	22,569,908	18,119,454	236,271
Sept. 30, 1958	175,058	5,984,373	22,255,501	18,610,970	229,308
Sept. 30, 1959	173,477	7,307,815	22,865,276	17,717,019	220,281
Sept. 30, 1960	176,745	7,249,101	21,986,887	14,440,774	181,132
Sept. 30, 1961	186,116	7,231,908	17,911,672	15,512,624	202,432
Sept. 30, 1962	184,123	7,000,837	17,587,767	13,885,884	184,364
Sept. 30, 1963	186,721	5,978,075	16,751,012	14,759,821	199,708
Total	2,252,794	84,430,758	305,304,821	235,338,453	3,010,672

NOTE 1 - ADDITIONAL INFORMATION

	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>
Gross Revenue (Sales of Concentrates)	\$8,793,284	\$8,540,143	\$9,635,252	\$10,110,038
Smelter Charges, Freight & Marketing Expenses	1,512,320	1,438,636	1,333,939	1,304,520
Development, Mining, Milling, & General Mine Expenses	5,142,587	5,163,334	5,202,350	5,834,112
Administrative & General Expenses	164,347	163,937	237,918	170,361

NOTE 2

During 1963 the company produced 11,921 tons of silver-lead concentrates, and 12,309 tons of zinc concentrates. After deducting smelting, freight and marketing expenses they received a net value of \$8,805,518 for their metals which resulted in an operating profit of \$2,801,045. The net earnings for the year were \$990,912, compared with \$1,218,131 in 1962. In 1963 all of the company's income was subject to tax as none of its operating mines now qualify for the new mine exemption under the Income Tax Act. Provision for taxes amounted to \$485,000 in 1963.

The ore treatment plant at Elsa operated throughout the year at an average milling rate of 511.5 tons per calendar day. The metal recoveries were silver 88.03%, lead 82.42%, zinc 84.32%.

Ore reserves as of September 30, 1963 totalled 493,955 tons with an average metal content of 34.58 ounces of silver per ton, 6.59% lead and 5.80% zinc. Reserves of the previous year totalled 445,630 tons grading 38.47 ounces of silver per ton, 7.12% lead and 5.08% zinc.

A more aggressive exploration attitude has been adopted within the last year with gratifying results.

During the year 22,441 feet of drifting and crosscutting, 4,723 feet of raising, and 387 feet of shaft sinking were carried out.

Underground diamond drilling totalled 25,762 feet and surface drilling totalled 13,040 feet.

Reference: United Keno Hill Mines Annual Reports 1960-1961-1962-1963.

NOTE 3

During the production years of the earlier Treadwell Yukon operation (1922-1942) all of the present productive veins had been found by individuals using hand methods and ore was mined from the surface to about the 400 foot levels with no extensive exploration or development because of the much higher costs and lower metal prices prevalent at the time. Much of the profit in these earlier years was absorbed by costs of opening up the district, which would not be faced by any new operation being established on comparable near-surface discoveries.

In the United Keno Hill operations the first 5 years, 1946 to 1951, were devoted principally to developing reserves with a consequently higher development to profit ratio but this earlier policy of developing tonnage reserves paid off with high gross returns in 1951, 1952 and 1953. However the earlier years were not as profitable as later years due to exploration and development expenditures, and capital writeoffs and initial reopening of the district under generally adverse conditions of transportation and supply following World War II.

Under present conditions the profitable operation of United Keno Hill Mines would represent what should be expected of a stable mining operation in the district, assuming no improvement in exploration and development or mining practices, or other cost or profit factors. Under present conditions, if near surface orebodies similar to those of the Treadwell Yukon operation are located, the ratio of development costs to profit may reasonably be expected to be even better.

If a stable price for silver is taken as being \$1.25 per oz. U.S. this would give a stable mining operation an additional profit potential on silver of 36% over previous years when the price was 91¢ per oz.

Reserves held by United Keno Hill Mines in 1963 (493,955 tons averaging 34.58 oz/ton silver, 6.59% lead, and 5.50% zinc) total approximately \$39 million in gross value at present metal prices, not including cadmium.

Total past production plus quoted reserves would therefore total about \$314 million at present metal prices. Much more potential still exists on the United Keno Hill Mines properties at depth, along extensions of vein zones, and in "blind" ore zones down dip in the Keno Hill quartzite formation.

While low grade mineralization occurs throughout the producing section and beyond it, high values have been found west to Mt. Haldane and fair values occur at May Creek 20 miles still farther west. Much of the first production came from Keno Hill but the bulk of production has come from two major cross-faulted vein-fault systems on Galena Hill, the Hector-Calumet system, and the Elsa-Silver King system. Two or more similar cross-faulted vein-fault systems have been recently found to the west on the Silver Titan Galena Hill property along this favourable section under a cover of overburden that was previously too extensive for individuals to prospect successfully. Found partly by prospecting and largely by geophysics, the existence of these vein systems has been confirmed by drilling and prospect shafts and since they are similar in pattern, spacing, and strength; cut similar favourable host rocks; and carry indications of high silver values, it is expected that further exploration in the most competent quartzite members, untested to date, should reveal similar deposits. This undeveloped favourable section, about 6½ miles long, is similar in extent and possibilities to the entire main productive section of Galena Hill from which most of the district's wealth has come.

In addition similar veins in the same quartzites on Mt. Haldane contain high values, and the Alice Group in the same quartzites still further west may contain similar values, suggesting a much greater potential.

The future potential of the south limb of the district is thus still very incompletely explored and should yield production well in excess of its past record, especially if costs are reduced or metal prices are improved.

(b) North Limb

On the north limb of the McQuesten anticline, recent geologic, geophysical and bulldozer work has shown the presence of northerly dipping Keno Hill quartzite and greenstone identical to the host rocks of the south limb; the presence of several northeast-striking, northwest-dipping vein-fault zones similar to those of the south limb; and the presence of similar high grade silver mineralization.

On the Shanghai property several vein zones have been found. On No. 2 zone bulldozer trenching in 1962 and 1963 revealed oxidized vein material up to several inches wide from which a grab sample assayed 790.5 oz/ton silver and 1.1 oz/ton gold and a select sample assayed 2292 oz/ton silver, indicating rich mineralization similar to that on the south limb. This mineralization occurs on the hanging wall side of a stronger unexposed vein-fault that has not been dug out due to permafrost, but the walls of

this zone have shown several galena stringers which have given assays of 100 to 135 oz/ton silver. On No. 1 zone, which has an indicated length of over 2000 feet and may be an offset section of No. 2 zone, abundant well mineralized vein float has been found with traces of tetrahedrite assaying up to 148 oz/ton silver and 0.42 oz/ton gold. The float averaged 16 oz/ton silver, 0.08 oz/ton gold and 2.8% lead, and its abundance and variety suggest a strong ore shoot with a good silver-lead ratio.

On the UR property a section of Keno Hill quartzite and greenstone, comparable in thickness and character to that on Galena Hill, is cut by a major vein-fault zone that has been traced for about a mile, and from which traces of galena have been panned which assayed 217 oz/ton silver. A similar vein-fault system occurs in schist about 1700 feet to the west and another occurs within the quartzites some 3500 feet to the east. Another silver prospect has also been reported still farther east.

On the divide from the UR property over to Lynx Creek, an area of Keno Hill quartzite and greenstone contains a locality from which zinc and galena assaying 43 oz/ton silver have been obtained. This locality may also contain higher silver values in strong vein-faults.

About 4 miles west of the Shanghai property two vein-fault zones cut an area of Keno Hill quartzite from which vicinity 250-ounce silver float has been reported. Several distinct air photo lineaments in the vicinity and to the west are strongly suggestive of other northeast vein-fault zones, but these have not even been examined in detail. Part of this area has been staked as the Argent group of claims.

Other than some manual prospecting, very local geologic mapping and geophysics, limited bulldozer trenching, and partial geochemical coverage, no intensive exploration has been done in general on this virgin north limb portion of the district, and the extent of the high grade mineralization is as yet unknown. Underground work is presently being done on the Shanghai No. 1 vein as an immediate target.

Mayo Lake

On Mt. Hinton southeast of Keno Hill, gold- and silver-bearing veins have been found in Keno Hill quartzites, some drifting was done in the 1930's, but no exploration has been directed at this area in recent years. Placer gold occurs in most of the creeks draining the axial region of the southeast-plunging Mayo Lake anticline, and some high grade silver mineralization has been reported but otherwise little is yet known of the possibilities in this section of the district. A tetrahedrite vein low in silver has been reported from Edmonton Creek.

Parts of this area should be very favourable for prospecting.

Davidson Mountains and Beaver River District

North of the producing area, along the northwest projection of the Mayo Lake anticlinal trend, the Davidson Mountains and Beaver River District

form an outlying region of silver-lead deposits of both vein and replacement type, mostly low in silver, but with interesting size and some reported high values.

Davidson Mountains (Refer to G.S.C. Memoir 284)

Several northeast-striking silver-lead vein prospects occur in the Davidson Mountains, on Stand-To Hill, on Mt. Cameron, and on Rambler Hill, with other reportedly mineralized localities, including one on the northwest side of McQuesten Lake. The Stand-To Hill vein is about 2 feet wide and traced for 200 feet, with a silver-lead ratio of 0.9/1; the Mt. Cameron vein is strong and reportedly wide, traced for 2000 feet, with a silver-lead ratio of 1.4/1; and the Rambler Hill vein is 4 feet wide, with a silver-lead ratio of 0.7/1. Not enough has been reported on these prospects to establish grade even across representative widths of the best mineralized sections. The mineralization occurs in and near a section of Keno Hill quartzite. Some higher silver-lead ratios have been reported from this area and from the locality northwest of McQuesten Lake.

Beaver River District (Refer to G.S.C. Memoir 284)

In the Beaver River District, vein and replacement type silver-lead prospects occur on Silver Hill, Grey Copper Hill, McKay Hill, Carpenter Ridge and in other reported outlying localities. Prospects on Silver Hill consist of replacement lenses of massive galena from several feet up to 26 feet in width, traced for distances up to 175 feet, and carrying 6-9 oz/ton silver. On Grey Copper Hill tetrahedrite up to 1100 oz/ton silver has been reported and a vein about 2 to 2½ feet wide with some tetrahedrite and pyrite, carrying about 50 oz/ton silver in one section, is known. On McKay Hill float and vein exposures of galena and tetrahedrite suggest several vein zones, of which the largest exposed prospect showed 12.5 feet assaying 3.25 oz/ton silver and 56.4% lead, with some values up to 62 oz/ton silver being obtained from some of the other galena float, and silver-lead ratios up to 6.5/1. On Carpenter Ridge, considerable float occurs, from which one grab sample gave 8.75 oz/ton silver and 56% lead.

Since the 1920's, little or no exploratory work, even of an examination nature, has been done in the Beaver River District in spite of sizeable galena showings and more local indications of high silver values. These characteristics of the district probably reflect (a) the presence of favourable replaceable limy rocks which produce larger lead deposits with lesser silver where intersected by vein zones and (b) greater irregularity in the silver content of tetrahedrite which may be high or low in silver in this outlying district. With the indicated size of prospects in this district, careful study of its possibilities may be warranted as the Mayo district is developed. If costs can be further reduced for the district as a whole, the Beaver River and Davidson Mountains prospects may contribute some important potential.

At the west end of the Beaver River District, north of Steamboat Lake, minor galena and sphalerite have been found near an area of pronounced limonite seepages from which one piece of gossan yielded 0.5% zinc. Such limonite seepages occur in a number of localities throughout the mineralized portions of the Mayo district and although most cannot be expected to

indicate ore deposits, their occurrence appears to be restricted to mineralized localities, and some may be indicators of hidden deposits. Other silver-lead occurrences are vaguely reported to the west and north of the Beaver River District.

East of the Beaver River District, at Kathleen Lakes, breccia zone replacement of zinc and lead with a few ounces per ton of silver and interesting cadmium content occurs in a section of slates and limestones, with indications of deposition over a strike distance of several thousand feet. This deposit may have size potential but very little work has been done on it or on its general vicinity. The silver and cadmium content of sphalerite in it suggests genetic relationship to the rest of the Mayo district.

Except for scattered reports of silver-lead-zinc, nothing is known yet of the possibilities for these metals to the east of the Beaver River District or of the producing Keno-Galena Hill area. Of particular interest is the reported occurrence of rusty fault zones in the Keno Hill quartzite section of the Patterson Range.

In the Mayo district as a whole the large number, distribution, character, and silver content of silver-lead-zinc and antimony prospects, and of producing deposits alone imply a large metallogenic district. The implications of these deposits in relation to district structure are now outlined.

DISTRICT STRUCTURE

McQuesten Anticline

The McQuesten anticline itself is recognized not only by abundant attitudes (obtained from Geological Survey of Canada manuscripts by H.S. Bostock but not present on published maps) in the schists and quartzites but particularly by the structure of the Keno Hill quartzite formation exposed on both south and north limb on either side of the McQuesten Valley. This quartzite is exposed only near the axial portion of the anticline while several tens of thousands of feet of overlying phyllites and other quartzites form the broader flanks of the anticline which is some 30 miles wide and 70 to 80 miles long.

Stratigraphic Considerations

The stratigraphic sequence, summarized briefly in a paper by the writer on "Silver in Yukon" (1962) and described in more detail by H.S. Bostock, L.H. Green and others of the Geological Survey of Canada, is complicated by very intense overthrusting from north to south, apparently with imbricate thrust sheets and overturned folds. Otherwise the Keno Hill quartzites have been traced for some 130 miles westward, showing remarkable stratigraphic continuity. Because of their competence, these quartzites have been the host rocks for most of the ore produced to date in the district, thus the repetition of these or other competent rocks on the north limb and westward along the McQuesten anticline is a most important factor in exploration for new ore deposits.

The surface trace of this favourable Keno Hill quartzite formation reflects only the present erosion surface - lesser erosion would have exposed Keno Hill quartzites and veins closer to the anticlinal axis, greater erosion would expose them farther back. Since the fracture pattern is known to be more extensive than the limited surface trace of these favourable rocks, blind deposits can also be expected down the dip of the quartzite section.

The presence of limestones in a phyllitic section above this quartzite may also provide favourable loci for limited replacement-type deposits where intersected by vein zones even though no such showings of significance have yet been found aside from the Beaver River District.

The section of Keno Hill quartzites on the north limb is identical to that on the south limb and although the anticlinal structure appears to plunge to the west, these quartzites are brought up and repeated westward on both limbs of the anticline by at least one major antithetic fault. Since the eastern part of the McQuesten anticline is raised or tilted against the Mayo Lake anticline, the westward plunge flattens out to expose these favourable rocks and the overlying limestone-bearing phyllites farther to the west. Other competent quartzite with some limy rocks occurs higher in the structural or stratigraphic section at Boulder Creek, 20 miles west of the section that has been mapped in detail. Favourable host rocks, especially quartzites, may thus recur for some distance westward. Quartzite formations other than Keno Hill quartzites in this overlying sequence form equally competent and favourable host rocks, or if the structural controls

are similar in strength and pattern to those at Peso, the phyllite sections may also prove favourable.

Northeast and southeast of the producing area on Mt. Patterson, and at Mayo Lake, other good possibilities may exist in the Keno Hill quartzites.

Fracture Pattern

The pattern of vein and fault zones in the Mayo district appears to be genetically related to, or affected by, the McQuesten anticline, forming a fracture pattern typical of many other elongate dome or anticline structures mapped in other Cordilleran mining districts and in oil fields, and exhibited by scale model experiments of rising anticlines and domes (see Wisser, E.H., Relation of Ore Deposition to Doming on the North American Cordillera, Geo. Soc. America Memoir 77, 1960). The fracture pattern itself consists of:

- (a) Strong longitudinal faults parallel to strike of formations and of the anticlinal axis (N60°E to E-W), commonly mineralized by early arsenopyrite and pyrite, also by silver-lead and antimony minerals.

Examples: Keno and Galena Hills
North Limb
Haggart Creek

Major longitudinal faults are suggested by geophysical indications in McQuesten Valley; and by physiographic features such as Haggart-Lynx creek valley, and McQuesten Valley with the unique prominence of Mt. Haldane as compared with the corresponding north limb. The physiographic development of McQuesten River valley along the anticlinal axis itself suggests control by some such features, perhaps during Early Tertiary rise of the anticlinal structure.

Cross sections drawn across McQuesten Valley strongly suggest a major longitudinal fault along the anticlinal axis from the vicinity of Keno Hill to Boulder Creek (about 40 miles), with down-throw on the north side, in keeping with tensional faulting considering that the anticline itself lies on the north flank of the broader regional arch. Bostock's original McQuesten manuscript and his G.S.C. map 890A show this fault. This major N70°E fault, reminiscent of the Osburn fault of the Coeur d'Alene district of Idaho, and the related major anticlinal structure are probably the major controls for mineralization in the district.

- (b) Northeast vein-fault zones with normal movement, dipping moderately to steeply southeast on the south flank of the anticline and moderately to steeply northwest or vertical on the north flank.

Mineralization consists largely of silver-lead-zinc with some antimony (jamesonite, tetrahedrite) in the Keno Hill quartzites on both south and north limb, and of silver-lead-antimony with copper and minor zinc on the north flank at Haggart Creek. Tetrahedrite (freibergite) is the chief silver-bearing mineral in both

localities. Ore in the producing part of the district is localized near or at branches or intersections of vein-faults, especially near NW cross-faults, where vein-faults change direction, or where they pass upward from competent quartzite and greenstone into incompetent overlying phyllite.

- (c) NNE to NW cross-faults or a-c faults whose strike, dip and direction of displacement vary considerably in accordance with location and attitude. Some show movement sympathetic to anticlinal doming while others like the Haldane-Haggart fault show major antithetic displacement and eastward dip. On Galena Hill and probably also the north limb, NW cross-faults dip mainly southwest and show right lateral displacement of veins and rock formations.

These cross-fault structures are generally tight, may be locally mineralized, and are apparently pre-mineral to post-mineral in relative age, as are the other fractures of the pattern. In places they appear to exercise important control on localization of ore in their vicinity.

ZONING

Zoning does not appear to result in termination of silver values at any confirmed depth as in more localized districts, but shows the following broad district characteristics instead.

1. No overall zoning has been recognized, except for lower silver values and larger antimony content in outlying parts of the district miles away from the producing area. Without preconceptions as to relationships of ore-bearing fractures to the McQuesten anticline, Dr. J.D. Bateman suggested to the writer in 1961 that if any zoning does exist, it would appear to plunge westward, resulting in greater depth potential westward (in accord with plunge of the anticline).

2. Individual ore shoots may be zoned, bottoming in zinc, but this appears to be a local condition probably related to availability of open space during deposition, since high grade ore occurs beneath some such sections.

3. If any overall zoning exists, individual vein-fault systems may exhibit zoning at different levels according to their individual characteristics.

4. Much of the galena, even in the high grade part of the district, is low in silver the same as in outlying areas with later up-grading having taken place by introduction of silver-rich minerals where open space has been available.

IMPLICATIONS OF MAGNITUDE

The entire framework of anticlinal doming, with a major longitudinal axial faulting, related fracturing and faulting, closely related mineralization and its lack of local zoning, and the type of mineralization indicate that the anticlinal structure is the control underlying a large number of related mineral occurrences. The Mayo silver-lead district thus appears to be much more extensive and to have much greater overall potential than realized previously, for the following reasons:

1. The magnitude of the overall anticlinal structure, over 70 miles long and 30 miles wide.
2. Its transverse trend, similar to the Coeur D'Alene district of Idaho and the Uinta Mountains trend on which Bingham, Utah is localized.
3. The thickness (2500 to 10,000 feet) of favourable quartzite formations, their regional stratigraphic continuity, and their repetition on both limbs and westward along the anticlinal axis.
4. The close genetic relation between anticlinal doming and resultant fracture pattern whose extent is related to magnitude of the anticline but has only been mapped thus far in the eastern part of the district.
5. The close timing of doming, fracturing, and ore deposition and extended period of pre-, intra-, and post-mineral faulting, giving access to favourable structural localities in the numerous fracture systems.
6. The wide distribution of known indications of similar strong mineralization and of related mineralization. For example the Keno Hill type of high grade mineralization is known to occur from Keno Hill on the east to beyond Mt. Haldane 30 miles to the west and from Duncan Creek on the south limb to the Shanghai property 10 miles to the north on the north limb. High grade tetrahedrite is now also known to occur in strong, well mineralized vein-faults of the same general pattern as far as Secret Creek 15 miles farther northwest. Moreover, higher than average silver values reported from Rodin, Boulder, and Arizona creeks suggest that the high grade silver belt may extend 20 miles still farther west along the axis of the anticline, probably related to the axial zone, the main axial longitudinal fault, and other longitudinal faults.
7. The occurrence of high silver values and of occasional gold values in the vein systems in the quartzites on both limbs and along the trend of the anticline vindicates a community of origin postulated previously on the basis of geologic concepts.

- (E) Other outlying areas (eg. Mayo Lake, Mt. Patterson, Beaver District)
- May have considerable lower grade silver-lead potential and perhaps antimonial deposits also.

The magnitude of district possibilities can only be guessed at on the basis of mineral occurrences and similarity of geologic structure; however, the foregoing information strongly suggests that the district should have a potential well over the billion-dollar gross value range, especially considering lower grades and including outlying areas.

Although the most widespread mineral possibilities appear to be in silver-lead-zinc and antimony, the possibilities of economic deposits of gold, tin, tungsten, and other metals like bismuth should not be overlooked in view of geology, similar widely occurring mineralization, and the magnitude of the structure with which mineralization is related.

Gold

Place gold possibilities have been largely explored, several million dollars have been produced, but additional placer production may be anticipated, and some important placer potential may still exist. The potential for lode gold prospects is largely unknown, but appears favourable, and should be considered in any prospecting programme.

An unconfirmed report of sylvanite (gold-silver telluride) having been found in an old cabin down the south fork of the Klondike, along with the confirmed presence of bismuth tellurides in many creeks, of chalcedonic quartz, of fine and wire gold in certain areas, of fine-textured sulfides at Peso, of Tertiary volcanism, and of warm springs near Clear Creek, and of other mineralogic textural evidence also suggest the possibility of "bonanza" type epithermal gold-silver mineralization in this general district.

Tin

No efforts have been made to trace placer tin to its source except at Haggart Creek where a small irregular cassiterite-tourmaline deposit, probably not the main source in the area, was found in schist. Cassiterite was also identified in quartz veins at May Creek in 1963. The following reasoning suggests that economic tin deposits may exist in the area:

1. Most of the creeks have not been tested for tin, yet non-magnetic heavy sand concentrates contain 20% or more cassiterite at Haggart, 10% at Hight, 20% at Boulder, 25% at Clear, and about the same percentage at Arizona Creek. Other untested creeks may contain more.
2. About 85% of the world's tin comes from the circumpacific mountain systems, about 25% of it from South America from similar Precambrian quartzites and schists cut by similar intrusives, with Tertiary volcanism and mineralization, and with associated silver mineralization.

Careful investigation of this tin-bearing mineral belt may thus reveal important tin discoveries by tracing of cassiterite into the vicinity of small or moderate-sized granitic intrusives.

Threatened with increasing shortage, tin prices have climbed from about 90 or 95 cents to about \$1.50 per pound in the last couple of years, and since reserves are dwindling and lie in politically or economically unstable regions, the price future is very attractive, and tin could become a strategic metal. It is suggested that the economics of tin be closely investigated.

Tungsten

The McQuesten mineral belt appears to form the westward projection of a tungsten- and tin-bearing mineral province corresponding with granitic stocks extending in an arc from the vicinity of Coal River in southeastern Yukon through MacMillan Pass, through the Upper Stewart River, and into the McQuesten mineral belt.

Except for scheelite at Dublin Gulch and Hight Creek little is known of lode tungsten deposits in the area, although scheelite occurs in many of the creeks and is particularly abundant at Dublin Gulch and Clear Creek.

Possibilities of replacement-type mineral deposits, whether of tungsten or silver-lead, appear to be limited largely to limy horizons, which occur in the phyllite and quartzite overlying the Keno Hill quartzites. Such localities in proximity to granitic contacts should be tested for tungsten while testing for tin.

REASONS WHY POTENTIAL NOT PREVIOUSLY RECOGNIZED

It is very difficult to comprehend that such a large mineral district with favourable host rocks and vein-fault structures with high silver values has been left only partly explored next to a major producing mine but this has resulted from a combination of the following circumstances:

1. All reconnaissance or semi-reconnaissance mapping of a type that would lead to full recognition of district structure and its extent had been concentrated to the east of the key anticlinal structure. To the west there is very little published information on structure or mineralization and consequently no attention has been directed toward this mineral belt as such, and few concepts of general favourable locations have been set out for guidance.

2. No one with a background or feeling for district structure has conducted a mining exploration programme with an overall objective of defining the extent and total potential of the district. Even with this approach it has taken time and work to build up any picture at all and to recognize the district structure and its relation to mineralization.

3. All operating companies in the district have concentrated their efforts on extraction of available ore and on limited intensified exploration on their properties, being faced in the past by a constant battle with long range transportation and other difficulties leading to high costs.

4. Exploration is slow, difficult, and costly due to remoteness, short season, permafrost, cold winters, and extensive overburden and vegetation which easily masks vein zones to casual exploration, thus preventing easy discovery and discouraging the traditional Canadian prospector who is used to seeing fresh rock.

5. The western part of the area, mapped only on 1 in. = 4 mi. reconnaissance scale, is gentler in topography near the producing section, is partly unglaciated, and therefore has fewer outcrop areas to map or prospect in spite of the thinner residual overburden which is more favourable for gold-pan methods, geochemistry, and bulldozer stripping. Lode prospects in this part of the district are weathered, obscured by mantle and usually leached of surface values, particularly where pyrite has been present.

6. All of the important past discoveries were made by individuals using manual placer mining methods of ground sluicing and prospect-shaft sinking without modern tools like the bulldozer, but their work on Keno and Galena Hills was so thorough in many places that later stripping has exposed only a few new vein zones. However, this type of overburden prospector had virtually vanished by the 1950's when the last exploration boom was sparked by the United Keno Hill Mines development. Little or no such work has been done in recent years and only in the last few seasons has any amount of local bulldozer stripping been done.

7. Due to the richness of discovery after discovery made in the 1920's and 1930's on Keno and Galena Hills, interest remained centered on these hills while the few discoveries made in outlying areas were largely low in grade, thus leading to the concept that other areas were unfavourable.

8. Virtually all of the intensive exploration has been concentrated on Keno and Galena Hills, and the promotional nature of much of the 1950's boom has been detrimental to subsequent interest in the district. Only brief reconnaissance work has been done in outlying areas and this type of work is apt to be discouraging because veins are easily concealed in this district.

The Mayo district requires experience and perseverance in prospecting. Even in the best mineralized zone unaltered quartzite and phyllite wall rocks may be abundantly exposed and a thin cover of overburden may cover a weathered vein, leaving no surface indication of the presence of mineralization. In three seasons of reconnaissance mapping of the McQuesten area only two surface signs of mineralization were encountered. In addition, the necessity of trenching to a satisfactory depth to establish the presence or absence of mineralization must be experienced in order to be realized. These factors have discouraged mapping and prospecting in the district and will continue to discourage prospectors who are not experienced with unglaciated

terrain and this district in particular, and who are not prepared to work thoroughly and do considerable digging.

Even on Keno and Galena Hills there were only two surface indications of mineralization - a 4-inch vein of galena exposed for 18 inches in the canyon of Galena Creek in 1903, and galena-bearing float found at the head of Faro Gulch on the top of Keno Hill in 1919. If it had not been for these two occurrences, found 16 years apart, the district might still lie undiscovered. The only other signs of mineralization are rusty altered greenstone, manganiferous siderite or manganese stain, breccia, limonite, and "live" quartz.

Due to its remoteness and lack of general interest the district was not recognized as having any real potential until the 1920's, when several veins were found by intensive digging by individuals, and the last main productive discovery, the Hector-Calumet, was made in 1934 on Galena Hill.

The recent discovery of high grade mineralization on the north limb and western part of the district in the last two years has opened up a whole new field for exploration similar to that of Keno and Galena Hills in the 1920's, and modern exploration may be expected to produce results much more rapidly.

EXPLORATION

Silver-lead-zinc and antimony ores certainly appear to constitute the main potential of the district, so exploration should be directed primarily at this type of deposit.

For the most effective overall plan and to protect future expansion possibilities, the strongest financial group doing exploration in the district should explore the entire McQuesten mineral belt in conjunction with work in the heart of the high grade silver-lead-zinc district.

The key to success in the district will be to discover enough high grade ore in the central part of the district in order to justify setting up a profitable operation which will justify expansion and continuation of exploration and development to take in outlying prospects. Exploration at present should therefore be concentrated principally on the main Keno Hill quartzite and greenstone sections that are cut by vein-faults carrying high silver values, with additional geologic mapping, prospecting, and prospect examination being done to the west and in outlying areas to define other favourable sections, particularly to determine to what extent Keno Hill type quartzites or similar competent rocks and associated mineralization occur.

Because of the problems peculiar to the district, personnel must be experienced with local conditions to ensure efficiency and results. Some of these conditions are:

1. An understanding of the characteristics and behaviour of permafrost both in exploration, trenching, and construction.
2. Recognition of true bedrock in place under residual overburden or under smeared bedrock ground moraine which underlies some of the till in the glaciated part of the district.
3. Judging depth to bedrock if possible.
4. Recognition of minor vegetation, topographic, and bedrock features indicative of vein zones.
5. Experience in the usefulness of ground sluices, thawed prospect pits and other methods.
6. Recognition of signs of mineralization such as manganese stain, limonite, rusty altered greenstone, "live" quartz, breccia, etc.
7. An appreciation of surface and underground drilling problems and of geologic and ground problems in underground exploration.

Assembling of key properties has been the initial step in an overall plan of exploration for the district. Continued aggressive exploration in various phases on the key new areas should be successful in discovery and development of several new mines.

Respectfully submitted,


Dr. A. E. Aho.

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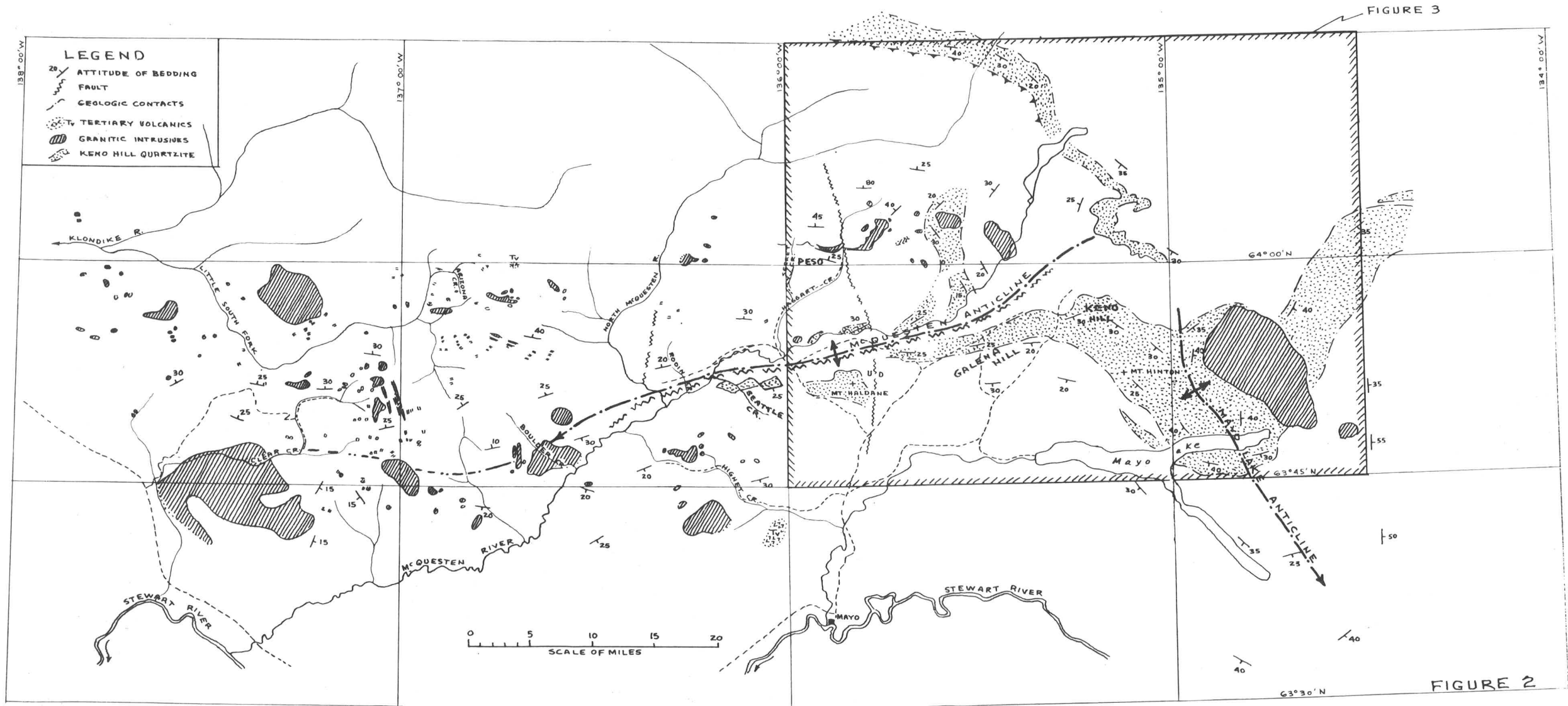
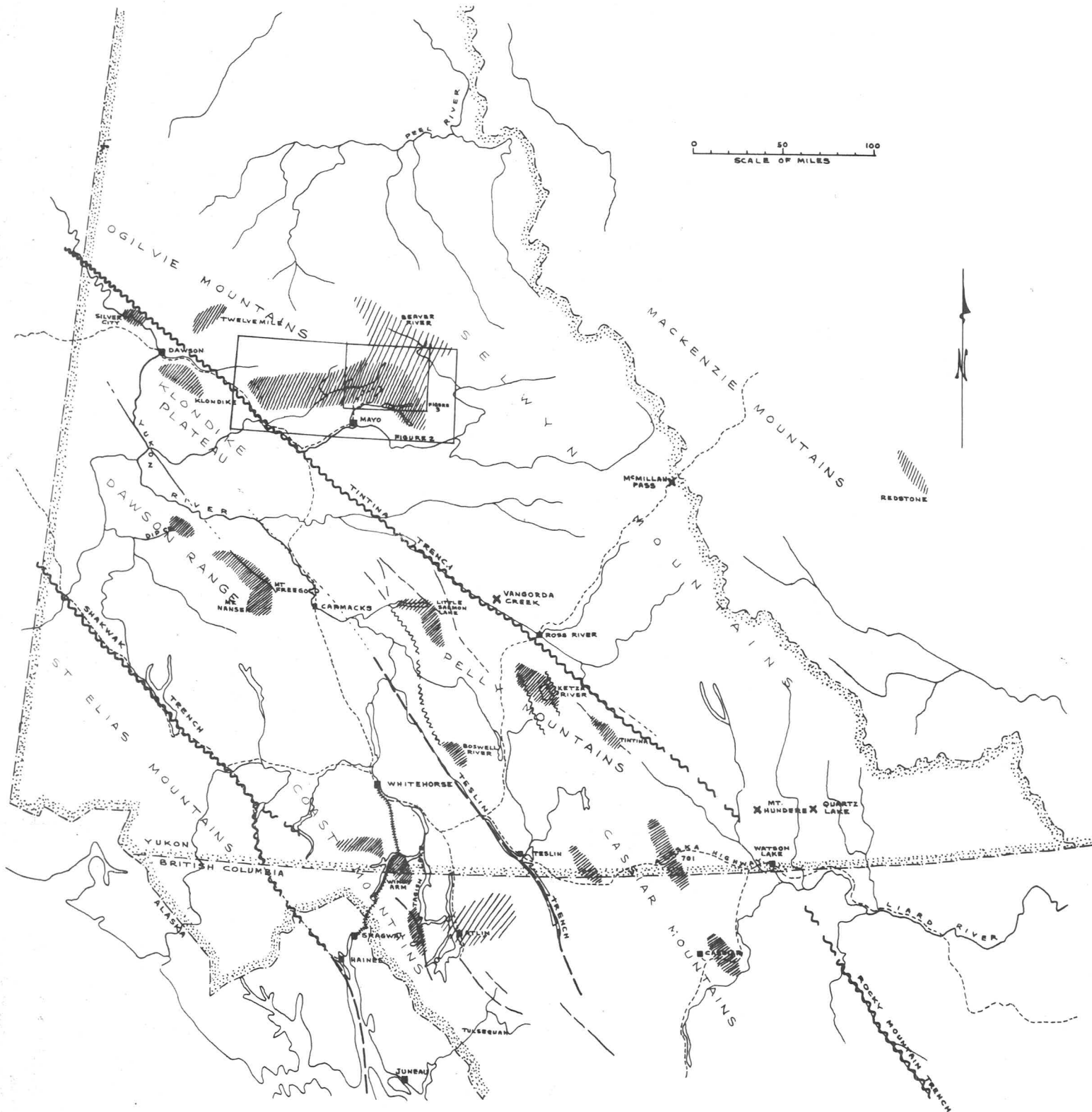


FIGURE 3

McQUESTEN MINERAL BELT
A.E. AHO OCT./63

FIGURE 2



SILVER-BEARING DISTRICTS
IN YUKON

AND ADJACENT NORTHERN BRITISH COLUMBIA

A. E. AHO
OCT. 1903