

MINERAL POSSIBILITIES OF YUKON TERRITORY

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ABSTRACT

Yukon, one of the most potentially accessible, relatively undeveloped regions of Canada, has major mineral possibilities. The Klondike placer gold fields and the Mayo silver-lead district are the sole major producers but large base metal reserves have been discovered in recent years and important asbestos deposits are now being explored. Several major exploration companies are active in this region despite short seasons, permafrost, overburden, remoteness, lack of transportation, and resultant high costs. Proposed new roads can be expected to accelerate development. At present the major future mineral possibilities are considered to be lead-zinc, copper, asbestos, silver-lead, gold, and mineral fuels. These and other mineral possibilities are outlined for various geologic subdivisions of Yukon. Major favourable metallogenic features of Yukon include complexity of rock types and structures, widening of the Cordillera with cross-trends, and variety and quantity of mineralization found even with limited prospecting.

Comparisons with southern British Columbia and the U.S. Cordillera suggest that further exploration will result in discovery and development of more major ore deposits and reserves which will eventually revolutionize economy of mining in Yukon. Such mineral resources, with interior petroleum and natural gas possibilities, and huge coastal hydroelectric power potential, are the foundations of a much larger future mining industry in Yukon.

INTRODUCTION

Yukon Territory lies north of British Columbia and east of Alaska, and comprises the most northerly part of the Canadian Cordilleran region. Most of Yukon is within a 400-mile radius of Skagway, Alaska, or other potential ocean ports in ice-free coastal fjords which offer easy year-around access to cheap water transportation and world commerce. The hydroelectric power potential of the coastal area near Tagish and Atlin Lakes is reported to be 4.9 million horsepower, several times that of Kitimat. Even without considering the separate potential of Stikine River in British Columbia (1.5 million horsepower), this is one of the largest potential sources of cheap hydroelectric power in the world. Behind the mountainous coastal region the interior plateaus and trenches are ideal for development of further major transportation routes, with mountain passes leading to the coastal ports or to the eastern plains and with plateaus and trench valleys providing excellent graded routes to the south.

The chief detriments to more extensive development of Yukon have been remoteness, inaccessibility, lack of population, and therefore resultant high costs. Within the last ten years, however, the Alaska Highway, the Canol road, the Haines road, the Atlin road, the Mayo-Dawson road, and the Cassiar road have helped greatly to open up the region, reduce transportation costs, and stimulate discovery and development. In this period the mines of United Keno Hill Mines Ltd. in Yukon and Cassiar Asbestos Corporation Ltd. in British Columbia have proven very successful. Several large, low grade, base metal deposits and other mineral deposits have also been explored but these remain uneconomic largely because transportation costs to existing smelters are too high. With additional discoveries of large enough tonnages, however, more roads or railways could be built, transportation costs could be decreased, and smelters and other industries might be developed in the region, using the cheap hydroelectric power. It will be shown that such deposits almost certainly exist, so that further development of this region and its resources appears assured as Canadian industry and economy, and world markets expand.

MINING

Discovery of the Klondike gold fields by Robert Henderson and George Carmack in 1896, and numerous lesser discoveries, promoted a great gold mining and prospecting boom around the turn of the century. This resulted in building of the White Pass and Yukon Route railway and establishment of sternwheel steamer traffic down Yukon River. Since then, however, gold production from Yukon has gradually declined. It now totals about \$242 million, largely from the Klondike, with annual production of about \$2.5 million coming mainly from operations of Yukon Consolidated Gold Corporation Ltd.

In the Mayo area rich silver-lead was discovered on Galena Hill in 1906 by H.W. McWhorter, and on Keno Hill in 1919 by Louie Beauvette. A prospecting and mining boom developed in 1920 and over the years several successful mines were brought into production on Keno and Galena Hills and the Treadwell Yukon Company, which operated from 1921 until 1942, produced over 21 million dollars' worth of silver-lead ore and concentrates. Between 1946 and 1957 United Keno Hill Mines Ltd. produced 43,488,900 ounces of silver; 185,946,700 pounds of lead; 138,138,900 pounds of zinc; and 1,843,546 pounds of cadmium. Gross production of Galkeno Mines Ltd., the only other recent producer, totalled about \$4 million between 1954 and 1957. Annual production of the Mayo area has averaged about \$10-12 million gross in the last several years. Total production now exceeds \$110 million.

Elsewhere in the Yukon ore was mined only from the region near the coast and the White Pass and Yukon Railway. Gold-silver-lead ore, reported to have been valued at over \$265,730, was produced from the Big Thing and Venus veins at Windy Arm on Tagish Lake between 1906 and 1920. Copper valued at \$2,711,695 was produced from pyrometamorphic deposits in the Whitehorse copper belt during the same period. Coal for local use has been produced from time to time from seams at Carmacks, and in recent years the main production, about 10,000 tons per year, has been used by United Keno Hill Mines Limited, owner of the mine. Other properties in Yukon have produced minor amounts of silver-lead-zinc, gold, tungsten, and antimony.

The following mining operations were active in the Yukon in 1957:

- (1) United Keno Hill Mines, mining silver-lead ore on Galena Hill and exploring properties on Keno Hill and Galena Hill.
- (2) Yukon Consolidated Gold Corporation, mining placer gold in the Klondike gold fields.
- (3) Galkeno Mines, mining silver-lead ore on Galena Hill and driving lower level adit.
- (4) Yukon Explorations, mining placer gold in Sixtymile River area.
- (5) Waddco Placers, mining placer gold on Haggart Creek.

Other individuals and small syndicates or companies were also active in development and production in 1957.

EXPLORATION

The early years of World War II aggravated a general decline that had been taking place in mineral production, prospecting, population, and interest in the Yukon; then the Japanese threat in the Aleutian Islands spurred construction of the Alaska Highway and other projects in 1942. Building of the Alaska Highway, the Canol road, and the Haines road opened up much new territory and the mineral exploration viewpoint changed from the precious metal outlook to include base metals. Revived mining activity in the Mayo area in 1947 spurred building of the Whitehorse-Mayo road which was completed in 1950; then later a branch road was built to Dawson City and the old Sixtymile road through to Alaska was rebuilt. Since 1945 exploration activity has increased, and recent seasons have seen as many as fifteen to twenty companies in the field. A paper on potential mineral resources of Yukon by Bostock in 1950 did much to arouse exploration activity.

Nearly every season has produced some important or interesting developments. Around 1952 American Smelting and Refining Company explored a major lead-zinc-silver deposit near Hyland River, proving up a reserve reported to be of the order of a million tons of 15% combined lead and zinc with about 6 oz/ton silver. Hudson Bay Exploration and Development Company found and drilled a lead-zinc deposit near Macmillan Pass on the Canol road, proving up over 10 million tons of about 5% zinc with minor lead. The Cassiar Asbestos deposit in British Columbia, staked in 1950, was brought into successful production while the Cassiar road was built. The Hudson Bay Exploration and Development Company's nickel deposit at Quill Creek was discovered in 1952 and explored until 1957, resulting in proven reserves of about 737,000 tons of 2.04% nickel, 1.42% copper, and 0.073% cobalt, with precious metals. The Canalask nickel deposit was discovered at White River soon after, is reported to have an indicated tonnage of about 640,000 tons averaging 1.4% nickel, and is being explored underground. Prospectors Airways' lead-zinc deposit at Vangorda Creek was discovered in 1953 and has been explored until 1957, resulting in a proven tonnage of about 10 million tons of 6% combined lead and zinc with low silver values. In the Ketz River area of Pelly Mountains high grade silver-lead veins were staked in 1954 and have been explored and prospected until 1957. A sizeable low grade zinc-silver-lead deposit at Kathleen Lake, northeast of Mayo, was explored in 1955 by Prospectors Airways. Newmont Mining Corporation staked a copper property at Wasson Lake, near the head of Liard River, in 1955 and explored it until 1957. A short-fibre asbestos property at Cassiar Creek northwest of Dawson, Y.T., was staked in 1955, and explored by Conwest Exploration in 1956, resulting in an indicated potential of several million tons. In 1957 a larger more promising long- and short-fibre asbestos deposit was discovered at Clinton Creek, farther northwest. It was explored by Conwest Exploration early in 1957, then both of these deposits were sold to Cassiar Asbestos Corporation who are now exploring the Clinton Creek deposit underground.

In 1957 the following companies were active in exploration in Yukon:

1. Asbestos Corporation - prospecting serpentinite belts with helicopters.
2. British Yukon Exploration Company - prospecting; and exploring silver-lead deposit at Seagull Lake in Pelly Mountains.
3. Canalask Nickel Mines - exploring underground at nickel property on White River.
4. Canex Aerial Exploration - prospecting near Dawson, Y.T.
5. Cassiar Asbestos Corporation - exploring asbestos deposits bought from Conwest Exploration, northwest of Dawson, Y.T.
6. Continental Mining Exploration - prospecting.
7. Conwest Exploration - prospecting; and exploring asbestos deposits at Clinton Creek, Y.T., and silver-lead veins at Tootsee Lake, B.C.
8. Gaymont Exploration - prospecting in Dawson area.
9. Newmont Mining Corporation of Canada - prospecting; and drilling a copper deposit at Wasson Lake.
10. Northwestern Explorations - prospecting with a helicopter south of Atlin, B.C.
11. Prospectors Airways Company - prospecting; and exploring claims in Macmillan Plateau, and lead-zinc deposit at Vangorda Creek.

A number of individuals also contribute greatly to prospecting and indeed the important discoveries to date have been made by them. In spite of considerable activity, large parts of Yukon remain untouched and few parts have been prospected in any detail.

Costs of exploration in Yukon are higher than in more accessible areas. E.O. Chisholm (1956) summarized costs of exploration and pointed out that the overall cost of a well managed exploration campaign for one season in the Yukon, employing three parties headed by experienced geologists, would be of the order of \$50,000. Exploration of isolated properties would run considerably higher. Some 22 million tons of base metal reserves valued at about \$600 million had been discovered in four years prior to 1956 at a cost of about \$9 million, or about 40¢ per ton of indicated reserves. Further discoveries of reserves have not substantially changed this picture. It can be expected that similar discoveries in the future will provide similar tonnages at similar low net costs.

Prospecting and exploration in Yukon are hindered by:
(a) the short effective prospecting season of three to four months;
(b) the permafrost which hinders trenching in northern and high altitude areas; (c) the weathered mantle which covers nearly all of the unglaciated area; and (d) the lack of lakes, roads, or navigable rivers in large parts of the region, especially in the

unglaciated area. As elsewhere, of course, many ore deposits are associated with zones of weakness and are completely covered with overburden. More detailed prospecting and the use of geochemistry, geophysics, photogeology, airborne equipment, helicopters, and other tools promise to offset some of the difficulties.

A large percentage of prospects in Yukon are near major transportation routes which emphasizes the potential of the more inaccessible areas and the need for more roads. Opening of a road inland through Ross River Trading Post would open up the largest favourable region of Yukon. Proposed roads through Ogilvie or Wernecke Mountains to northern Yukon and from Cassiar, B.C., to the port of Stewart, B.C., would provide better access to much new country.

REGIONAL CONSIDERATIONS

H.S. Bostock (1948, 1950) has outlined the physiographic and geologic subdivisions and potential mineral resources of Yukon Territory. The reader should refer to his publications; to the Geologic Map of Yukon (Geol. Surv. Canada Map 1048A, 1957); to the Geologic Map of Canada (Geol. Surv. Canada Map 1045A, 1955); and to Figure 1.

In summary, the competent framework of Yukon consists of two batholithic-metamorphic belts (Coast and Pelly Mountains) merging in the Klondike region, with major zones of weakness (Shakwak, Teslin, and Tintina trenches) separating or bounding them. Lobes of deeply exposed Precambrian basement rocks project eastward in the Mayo area and in southeast Pelly Mountains. The Anvil and Logan Mountains batholiths also constitute competent eastern massifs. The rest of Yukon Cordillera is composed of deformed rocks of Late Precambrian, Paleozoic, and Mesozoic ages, forming the flanks or cover of the more competent massifs or basement rocks, and cut by local granitic bodies. Patches of Tertiary rocks are common.

In contrast to northern British Columbia, the Cordillera in Yukon bends more westerly to complete the arc into Alaska, is more complex, has a north-eastward bulge, and contains granitic, ultrabasic and metamorphic rocks in this bulge. Nearly all the regional structures noted, and even physiographic subdivisions, change in trend or terminate along a broad "hinge" region extending from near Skagway in Alaska to the mouth of Nahanni River in Northwest Territories. The structural trends bend from N 35°W in northern British Columbia to N 50-55°W in southwest Yukon, and the Cordillera becomes more complex and widens, bulging out 150 miles to the northeast. Within this bulge granitic and metamorphic rocks extend a corresponding 150 miles northeast of Tintina Valley trench (the northern counterpart of the Rocky Mountain Trench) whereas in northern British Columbia they occur almost exclusively southwest

of the Rocky Mountain Trench. The above regional complexity favours the presence of mineral deposits in Yukon. The most northeasterly batholith area, in the Logan Mountains, may significantly correspond to the metal-rich Nelson batholith area of southern British Columbia which occurs at a similar bend of the Cordillera.

Parts of the Cordillera in Yukon also appear to have certain tendencies for cross structure perhaps related to older transverse trends in the Precambrian basement rocks. Although regional folding in Yukon is northwesterly it is locally complicated or even dominated by certain east-west to N 75°E trends particularly between Tintina Valley and Mackenzie Mountains. In Wernecke Mountains a northeasterly to east-west trend of folding in the Precambrian basement under the Paleozoic cover appears to have produced local bulges or uplifts within the regional northwesterly trend. Crossed westerly and northerly trends are also reported in northern Ogilvie Mountains. Perhaps the Cordilleran bulge and its cross-structures reflect Precambrian trends or easterly extensions of Alaskan tectonic trends. In certain areas such transverse structural trends are particularly favourable for mineral deposits.

MINERAL POSSIBILITIES OF INDIVIDUAL AREAS

The following outline of mineral possibilities is based on five seasons' experience in the Yukon in addition to quoted references and other sources.

1. St. Elias Mountains Belt:

This extremely high and rugged southwestern corner of Yukon is composed chiefly of Paleozoic and Mesozoic sedimentary and volcanic rocks, and varied plutonic rocks, with patches and basins of Tertiary sediments and volcanics. The volcanic orogenic facies, structure, and mineral possibilities of this belt are similar to those of its southeast projection into the Alaskan Panhandle and coastal British Columbia. The best economic possibilities of this belt appear to be copper, nickel-copper, gold, and magnetite iron ore.

On the Alaskan side to the west the Kennicott copper deposit testifies to the copper possibilities, and the numerous discoveries of both native copper and sulfides provide further encouragement. Teck Exploration explored an area of copper-zinc float at Jarvis River in 1956, an occurrence suggestive of deposits like Britannia, B.C. Pyrometamorphic copper deposits with or without magnetite iron ore are also a likely possibility. Basic and ultrabasic rocks in a northwest zone along Kluane Range, parallel to Shakwak Valley fault, have yielded numerous nickel-copper-pyrrhotite discoveries of which the most important are the Quill Creek and White River deposits explored by Hudson Bay Exploration

and Development Company and by Canalask Nickel Mines respectively. The presence of several notable placer creeks and vein prospects suggests gold possibilities similar to the Juneau and Chichagof-Sitka gold belts of the Alaskan Panhandle which Twenhofel and Sainsbury (1958) suggest are related to a regional fault pattern which extends into this part of Yukon. An immense, low grade, titaniferous magnetite deposit occurs near Haines, Alaska, and numerous lesser magnetite deposits are scattered along coastal Alaska and British Columbia. These, considered with similar occurrences in the St. Elias Mountains, are indicative of the magnetite iron ore possibilities. Silver-lead, zinc, molybdenite, and other minerals including gypsum and Tertiary and Mesozoic coal have also been discovered in St. Elias Mountains.

Further metalliferous discoveries in this area may be expected to be localized along, or related to, intrusive contacts or longitudinal northwest zones of weakness marked by faulting or plutonic rocks. Most of the St. Elias mountains are little explored except at the fringes because of the high rugged mountains and icefields.

2. Coast Mountains Belt:

The Coast Mountains belt of northern British Columbia, composed of Paleozoic, Mesozoic and metamorphic rocks, and dominated by the Coast batholith, extends northwest into Yukon. It then spreads into partly unglaciated terrain in the Kluane plateau where it is composed of deeply eroded metamorphic and granitic rocks. Here the belt merges with the Dawson Range and Klondike areas to the north and east, to form one of the largest granitic-metamorphic basement complexes exposed in the Cordilleran region.

The northeast contact of the Coast batholith, being in the most accessible part of Yukon, has been well prospected and numerous mineral deposits have been discovered. The deposits appear to be related to the extremely irregular configuration of salients and embayments in the Coast batholith, while in adjacent northern British Columbia they appear to be related to a north-south fault zone or structural discontinuity which defines the east margin of the batholithic-metamorphic belt.

Pyrometamorphic copper deposits with magnetite have been discovered at the south end of Atlin Lake, in the Whitehorse copper belt which has been mined, and in the Aishihik area. Porphyry-type copper occurrences have been noted around the south end of Atlin Lake and in the Tulsequah map-area of British Columbia. The Granduc and Anyox copper deposits occur farther southeast along this northeast contact. Copper, therefore, appears to be the most promising mineral possibility in this belt.

Gold-silver-lead veins at Windy Arm on Tagish Lake have produced some ore and similar veins are known in the Wheaton District. Such deposits may well become economic with further exploration or improved conditions. Numerous lode gold properties are also known but only the Engineer Mine in northern British Columbia has produced significantly. Antimony veins of the Wheaton District constitute an important future potential for antimony. Tungsten, lead-zinc, and nickel prospects also exist.

Bostock (1950, p.8) points out possibilities of gold, copper, tungsten, molybdenum, and other minerals along the southwest contact of the Coast batholith. Although the Coast Mountains belt in the Kluane Plateau region has received some attention in recent years, no significant discoveries have yet been made. The predominance of metamorphic and granitic rocks and of overburden in much of the area has tended to discourage prospecting.

3. Tagish Belt:

The Tagish Belt of south central Yukon consists of a complex basin containing chiefly Mesozoic volcanics and sediments with minor granitic intrusions. It is cut by the Teslin trench which may be a regional fault zone, is partly supplanted on the south by a complexly upfaulted block, and is bounded on the northeast by a possible regional fault at the edge of the Pelly Mountains. This area does not appear to be favourable for metalliferous deposits. Asbestos occurrences in ultrabasic rocks at its southeast end may hold some economic promise. The important resource, however, is Lower Cretaceous and Jurassic coal, of which reserves and quality are largely unknown but are estimated at 231 million tons. The folding, and local disturbance of these coal measures by intrusive rocks, can be expected to produce considerable variations in attitude, thickness, and rank of coal. This resource is well situated for development in the most accessible central part of Yukon.

4. Cassiar Mountains Area:

The Cassiar Mountains batholithic belt of northern British Columbia, flanked by Paleozoic rocks, extends to Wolf Lake in Yukon. Here it locally dies out in an easterly salient. In this area of Yukon silver-lead veins, pyrometasomatic zinc-lead deposits, and asbestos, appear to be the most promising possibilities. Rich silver-lead veins have been found in several localities near the east contact of the batholith in the Yukon and at Tootsee Lake, B.C. Northwest along this belt similar possibilities may exist since rich silver-lead veins have been discovered at Ketza River in Pelly Mountains. Zinc-lead deposits include Hudson Bay's Logjam Creek property, nearby showings around Swift River, Y.T., and others around Haskin Mountain near Cassiar, B.C. Asbestos is a good possibility since southwest of this batholith in Yukon are

several serpentinite bodies which are part of a regional ultrabasic belt. This belt extends sporadically northwest from beyond Cassiar, B.C., through Yukon to Alaska, with asbestos occurrences southeast of Cassiar, B.C., at Cassiar, B.C., and at Quiet Lake, Little Salmon Lake, White Mountains, Dawson, Cassiar Creek, and Clinton Creek. Placer gold at Shootamook and Scurvy Creeks and other localities suggests gold possibilities similar to those of McDame area to the southeast in British Columbia. Tungsten, tin, copper, and other minerals also occur.

5. Pelly Mountains Area:

In general, the Pelly Mountains are an inverted V-shaped, complex part of the main Cordilleran structural backbone which extends southeast through Cassiar and Omineca Mountains into southern British Columbia and Idaho, and northwest into the Klondike area and beyond into Alaska. This backbone is marked by a metamorphic belt, by batholithic masses, by regional faults within it and at its borders, by scattered ultrabasic bodies, and by a distinct regional metallogenic belt. Mining districts along this great belt include the Coeur d'Alene silver-lead deposits of Idaho, the Sullivan Mine, the Cariboo gold fields, the Pinchi Lake mercury belt, Manson Creek placer deposits in B.C., the Cassiar district of B.C., the Klondike gold fields in Yukon, and the Fairbanks gold fields in Alaska. This general belt in Yukon may well turn out to be its major producer of mineral wealth.

The western spur of Pelly Mountains consists of metamorphic rocks cut by the Quiet Lake batholith and lesser granitic masses. It is bounded on the west by a possible regional fault along which the mountains have been raised against the Tagish Belt. Over a million dollars' worth of placer gold was recovered from Livingstone Creek. Silver-lead veins are known at Boswell River, Little Salmon Lake, and several other localities. Copper occurs around Little Salmon Lake and Loon Lakes. The gold, silver-lead, and copper showings in this belt may be related to breaks subsidiary to the margin of the mountain front. Ultrabasic rocks here may contain asbestos.

The central belt of Pelly Mountains is a granitic-metamorphic complex which corresponds to the Cassiar Mountains and extends from Nisutlin Plateau northwest to Glenlyon Range and beyond to join the Klondike area. The ultrabasic belt and metamorphic rocks form the southwest flank while marine Paleozoic sedimentary and volcanic rocks form the northeast flank. These Paleozoics are cut by major faults and are bounded by the Tintina Valley fault trench on the northeast. Continuity of the central belt is locally interrupted by an east-west trend of folding at Little Salmon Lake between St. Cyr and Glenlyon Ranges.

This main belt of Pelly Mountains has been prospected only by reconnaissance parties which have made discoveries of silver-lead, asbestos, copper, molybdenum, nickel, tungsten, gold and other minerals. Further prospecting will almost certainly reveal other deposits of the types already noted in this Cordilleran region, especially in the Cassiar Mountains. Conwest Exploration, British Yukon Exploration and others have recently explored silver-lead veins near the head of Ketzka River. Here numerous silver-lead bodies of breccia filling and replacement origin occur in Lower Cambrian limestone or in dolomite, often where a controlling fissure passes into incompetent overlying slate, but the control of the more important high grade silver-lead veins is not as well understood. Newmont Mining Corporation of Canada have trenched and drilled a sizeable siliceous shear zone with copper at Wasson Lake toward the southeast end of this belt. These deposits appear to be closely related to northerly and northwesterly fault zones, perhaps subsidiary to the regional Tintina Valley fault trench which appears to die out in the southeast spur of Pelly Mountains.

The southeastern spur of Pelly Mountains extends from the Paleozoic flank of the central belt across the southeast end of Tintina Valley fault trench into metamorphic terrane. Fault movement along the Pelly River section of Tintina Valley has resulted in a scarp of Paleozoic rocks on the southwest in Pelly Mountains and subdued metamorphic terrane on the northeast in Pelly Plateau. Up Hoole River, however, this metamorphic terrane rises to the height of the Paleozoics to form part of the southeast spur of Pelly Mountains. The above relations can be explained by pre-Late Tertiary upthrow of the northeast block resulting in its erosion, then Late Tertiary uplift of the Pelly Mountains resulting in reversal of movement in the Pelly River section of the trench. The amount of horizontal displacement is unknown. The continuity of uplift across the trench suggests that the fault zone here is no longer a deep transgressive structure and that it probably does not connect with the Rocky Mountain trench. Remarkably similar relations, even the dying out of the trench, hold for Shakwak Valley, suggesting similar tectonics.

The metamorphic area of the southeastern spur consists of crystalline schists and quartzite with local granitic gneiss and gneissic basic rocks, sizeable serpentinite bodies, and younger intrusives. Patches of volcanics and Paleozoic rocks are common. This area has been prospected only in reconnaissance fashion and small discoveries of copper, asbestos, silver-lead, placer gold, nickel and other minerals have been made. Similarity to the Klondike region suggests that it may be favourable for placer gold if Tertiary gravels protected from glaciation can be found. General similarity with the Mayo area suggests that it may be favourable for both silver-lead and placer gold.

6. Dawson Range Area:

The Dawson Range consists of metamorphic rocks, chiefly schist and quartzite, with some granitic gneiss, invaded by a complex of granitic and syenitic rocks. Patches of Mesozoic and Tertiary volcanics and sediments occur in the area.

Except near previous discoveries, the Dawson Range has received very little prospecting even to date because of difficult access, overburden due to unglaciated terrain, and predominance of crystalline granitic and metamorphic rocks. Yet the geology is very varied, especially in the granitic complex, and as Bostock (1950, pp 11-12) has pointed out, numerous discoveries of placer gold, gold, high grade silver-lead, copper, lead-zinc, antimony, tungsten and other minerals have been made. The most important discoveries to date are the large Brown-McDade gold property which is now inactive, and the Laforma property which has produced several thousand ounces of gold. A copper deposit was explored in 1954 and 1955 at Big Creek by Conwest and Teck Exploration. The complexity of granitic rocks and presence of associated copper mineralization, including porphyry and pyrometasomatic types, suggest that with further exploration the Dawson Range may well develop into a major copper area in the Yukon, similar to the copper belt of the west interior of southern British Columbia. The high silver content of some of the silver-lead discoveries suggests good possibilities for this type of deposit also. Complex structure and presence of placer creeks around Mt. Stewart suggest an area favourable for prospecting.

7. Klondike Area:

The Klondike area is an unglaciated maturely dissected plateau covered with overburden like the Dawson Range, and contains the same general rock types but with more granitic gneiss and schist and less younger granitic rocks. The placer creeks of this area have produced almost \$240 million in gold largely from the Klondike gold fields. Discovery of silver-lead, tungsten, tin, mercury and other minerals in a number of placer creeks in this area suggests the presence of numerous undiscovered lode deposits. Silver-lead, antimony, mercury, copper, and fluorite deposits have been found in several localities, and further discoveries of economic significance can be expected. Not until 1956 and 1957 was general interest in base metal prospecting aroused in this area.

The most important recent discoveries in the Klondike area are the asbestos deposits that occur in serpentinite bodies scattered along the ultrabasic belt which occurs on the northeast side of the Klondike area parallel to Tintina Valley fault trench. Major structural breaks probably parallel this trench. The Cassiar Creek and Clinton Creek deposits on this belt can scarcely be the only major deposits since both were easily visible in outcrops and are reported to have been known since the Klondike gold rush. Fortunately the asbestos fibre tends to concentrate in the residual

mantle of soil which covers the serpentinite host rock in this unglaciated area. Consequently in areas of light overburden in the Klondike area asbestos fluff or "manure" can be discovered and traced by digging shallow test pits, even with a prospector's pick. Light stripping over great distances by bulldozer has been used successfully to trace rock types and fibre in light residual mantle. Further very important discoveries and developments can be expected in this area.

8. Mayo Area:

In the Mayo area a lobe of Precambrian rocks projects east from Tintina Valley along an anticlinal trend punctuated by granitic stocks with closely associated gold, silver-lead, tin, tungsten, antimony, copper, and other mineralization. The eastern end of this east-west trend is intersected by a major southeasterly plunging anticline of the normal northwestern Cordilleran trend and the oldest rocks, with abundant greenstone sills, are exposed in the core of the intersection. The rich silver-lead mines of Keno and Galena Hills lie at the obtuse angle of the intersecting structures. (See Geol. Surv. Canada Map 890A, 1946).

The most obvious mineral possibilities of the Mayo area are in the vicinity of Galena and Keno Hills (a) around known mineralized areas or their fringes in competent quartzite or greenstone where vein faults pass upward into less competent rocks or intersect with one another (Boyle, 1957; and Carmichael, 1957); (b) where the central quartzite member extends from Galena Hill under McQuesten valley to the hillside to the north; and (c) in the Patterson Range and other flanks of the major structure. It can be expected that much more ore may be found around the major structure.

Other good mineral possibilities lie along the Keno Hill-Clear Creek structural trend near and between the granitic stocks especially around Haggart, Hight, Hobo, Boulder, and Clear Creeks. The placer creeks of this area have produced several million dollars in gold and more than \$10,000 in tungsten. Another less well defined east-west belt of structural disturbance and granitic stocks appears to extend along the south margin of the Precambrian lobe. The main east-west structural trend is remarkably similar to the western part of the east-west Uinta Mountains axis of Utah where it is intersected by north-south Cordilleran folds and contains the huge silver-lead and copper deposits of Park City and Bingham, as well as several lesser mining districts. Being partly unglaciated and mantled with overburden, the Mayo area, especially the east-west structural trends, has not been adequately prospected yet and the true potential is unknown.

9. Hyland, Pelly, and Macmillan Plateaus, and Selwyn Mountains:

The limits of the large geologic province northeast of Pelly Mountains are not yet apparent and it is probable that the

area of similar geology extends from Hyland, Pelly and Macmillan Plateaus into Logan and Hess Mountains, thus including most of Selwyn Mountains. The rocks in this region are composed largely of Paleozoic marine sediments and volcanics with some Late Precambrian, patches of Mesozoic sediments and volcanics, and granitic bodies. Granitic batholiths form the Anvil Range of Macmillan Plateau and much of Logan Mountains. An east-west row of stocks with some associated mineralization cuts through Hess Mountains.

The rolling wooded terrain and overburden in much of the Plateau areas, difficulty of access, and remoteness of the mountains, have discouraged prospecting until recently so the possibilities and even the general geology of these areas are largely unknown. However, a number of lead-zinc, copper, and silver-lead discoveries have been made. Numerous copper occurrences hold promise for major copper deposits. The most impressive discoveries are large lead-zinc deposits at the southwest, northeast, and southeast margins of this large region, namely: the Prospectors Airways deposit at Vangorda Creek, the Hudson Bay deposit at Macmillan Pass, and the American Smelting and Refining Company deposit near Hyland River. Little or nothing is known of the main structural controls of these deposits and it is almost certain that further prospecting will reveal other such major discoveries. This is the type of deposit that is most likely to prove large enough to revolutionize mining in the territory. Thus, for the future of the territory, it is imperative that a usable road be established to provide access to this vast favourable region. Either the Canol road should be improved or, better still, a road should be built through Little Salmon Lake vicinity. A ferry should be established across Pelly River at Ross River Trading Post.

10. Ogilvie Mountains and Keel Range Areas:

The southwestern part of Ogilvie Mountains consists of Precambrian and Paleozoic rocks bounded by the Tintina Valley fault trench. Tintina Valley here is chiefly filled with Tertiary sediments containing lignite coal measures estimated at 112 million tons. The highest part of the southwestern section of Ogilvie Mountains is a northwesterly trending core of Precambrian rocks intruded by granitic stocks with closely associated mineralization of silver-lead, copper, and antimony. Silver-lead veins occur at the head of Twelve Mile River, and gold, copper, and other minerals are reported also. A magnetite-hematite deposit was recently discovered at the head of Shell Creek, 45 miles northwest of Dawson. Hematite float and iron formation reported in Ogilvie Mountains may indicate Lake Superior-type iron formation in the Late Precambrian rocks.

Keel Range and the northeastern and northern parts of Ogilvie Mountains are composed chiefly of folded Paleozoic rocks.

11. Wernecke Mountains Area:

Wernecke Mountains, a physiographic subdivision of Selwyn Mountains, appear to form part of a distinct province of folded Paleozoic rocks with dioritic stocks and inliers or uplifts of Precambrian rocks. Silver-lead veins and a sizeable zinc deposit occur around the head of Beaver River and at Kathleen Lakes respectively, perhaps related to a northwesterly belt of folding, dioritic intrusives, and lineaments.

North of this belt a domelike uplift of Precambrian rocks, bounded by marginal folds and cut by dioritic plugs, contains sideritic shear zones with chalcopyrite. This type of copper occurrence is reported at the headwaters of Hart, Little Wind, Wind, Arctic Red and Twitya Rivers, and in the northern Rocky Mountains of British Columbia, apparently constituting a metallogenic province. The known deposits are too small, too erratic, or too low in grade to be economic in their present remote localities.

Hydrothermal veins of massive hematite in the Precambrian rocks give rise to float on Wind and Bear Rivers. Banded sedimentary iron float in the Mayo area may come from the Beaver River district. Any of the late Precambrian areas in Ogilvie, Wernecke, and Selwyn Mountains may contain such iron formation.

At Bond Creek in Wernecke Mountains massive barren pyrite occurs in Precambrian rocks within 20 feet of a continuous exposure of unconformably overlying, unaltered Paleozoic limestone. Such mineral occurrences, confined entirely to the Precambrian rocks, may be Precambrian in age.

12. Old Crow Range and British Mountains Areas:

Only partly mapped and little prospected, these remote ranges of Precambrian, Paleozoic, and granitic rocks contain placer gold on Firth and Blow Rivers, tungsten, and probably other minerals.

13. Mackenzie Mountains, Liard Plateau, and Richardson Mountains Belts:

These Rocky Mountain-type ranges of folded and faulted Paleozoic marine sediments are largely unmapped and almost unprospected. Except for copper reported in association with greenstone sills at Arctic Red River, and fluorite at Liard Hotsprings, B.C., these belts appear to have only remote mineral possibilities.

14. Porcupine Plain, Peel Plateau, and Arctic Plateau:

Rocks in these areas are composed chiefly of undeformed or gently deformed Paleozoic and Mesozoic marine sediments with petroleum possibilities, and continental Cretaceous and Tertiary

sediments with lignite coal measures. The vast hinterland of flat and rolling country extending in a 700- to 800-mile arc within a radius of 400-500 miles of Skagway is potentially oil-bearing. The known occurrence of oil fields in the Plains Region from Texas to Alberta should give some indication of the potential of the vast northern extension of this same geologic province. Moreover, oil and natural gas development experienced in recent years in Alberta and northeastern British Columbia can be expected to spread northward. The occurrence of oil at Norman Wells and Point Barrow, Alaska, and reported seepages and bitumen in the Eagle Plain and Peel Plateau areas are only a beginning. A number of large and small oil companies are studying the region and when exploration results warrant it, the areas will be extensively drilled, discoveries will be made, and pipelines will be built. A short Canadian pipeline route through Yukon to the Pacific Coast and to world markets would be central for most of this region and could help greatly in development of the mineral resources of the territory. An access road should be built through Wernecke Mountains since this would be most central for the largest petroleum potentialities and would serve the largest mineralized area.

CONCLUSIONS

Even with little or no mapping of some of the regional geologic units of Yukon, major structural features generally considered favourable for ore deposits and similar to those in established major mining camps can be noted. With the varying degrees of complexity of rock types and of structure, particularly cross-trends, there is certainly a suitable environment for major deposits provided that mineralization is present. The discovery of considerable variety and quantity of mineralization in numerous parts of these areas, even with limited prospecting to date, shows that the requisite mineralization is indeed present and therefore it is statistically very probable that the conditions necessary for occurrence of a number of major ore deposits are fulfilled.

In a general way the geologic environment of Yukon is similar to that of the southern third of British Columbia, which has produced the largest part of B.C.'s \$3,893,000,000 worth of mineral wealth, with promise of much more, chiefly from base metal deposits developed subsequent to the precious metals. Yukon, a comparable and even more complex region, has by comparison produced chiefly precious metals and only recently has produced large amounts of silver-rich lead-zinc ore. Yukon's past production of over \$350 million plus its known reserves of over \$600 million total about a billion dollars or about a third of the production of southern British Columbia (southern B.C.'s reserves not included). It therefore seems reasonable by comparison to expect that Yukon may someday match or even outstrip southern British Columbia in production, especially since the patterns of geology and sequence of discoveries seem to be developing similarly.

In the U.S. Cordillera (favourable area six times that of Yukon), Billingsley and Locke (1941, p.10) listed five mining districts with production plus reserves (1941) in excess of a billion

dollars, twelve in excess of \$250 million, eleven in excess of \$50 million, and twenty-seven over \$10 million to which more can now be added. Southern British Columbia, comparable in area with Yukon, contains one billion dollar camp, six or more over \$50 million, and a number of smaller ones. If Cordilleran-type deposits of the larger size exist in Yukon, many would be large enough or rich enough to be economic, bringing lowered costs and facilities which would enable production from the smaller ones. The absence of more such major producers and numerous smaller ones in the Yukon is almost certainly a result of (a) insufficient prospecting to locate undiscovered deposits and (b) insufficient exploration or development of known showings, deposits, and favourable areas due to high initial costs. The Yukon probably now has five potential \$250 million camps (Klondike, largely mined; Mayo area, partly mined; and Vangorda Creek, Macmillan Pass, and Dawson asbestos area, all unmined). Further exploration will almost certainly result in discovery or development of more such deposits or perhaps a billion dollar camp or two, which will revolutionize mining in the territory. It cannot be overemphasized, however, that this development can be assured only if new access roads are built and present ones maintained. The most important projects will be (a) an access road to Ross River Trading Post and a ferry across Pelly River to serve the vast interior of the territory, and (b) an access road through the best mineralized area to the potential petroleum areas of northern Yukon.

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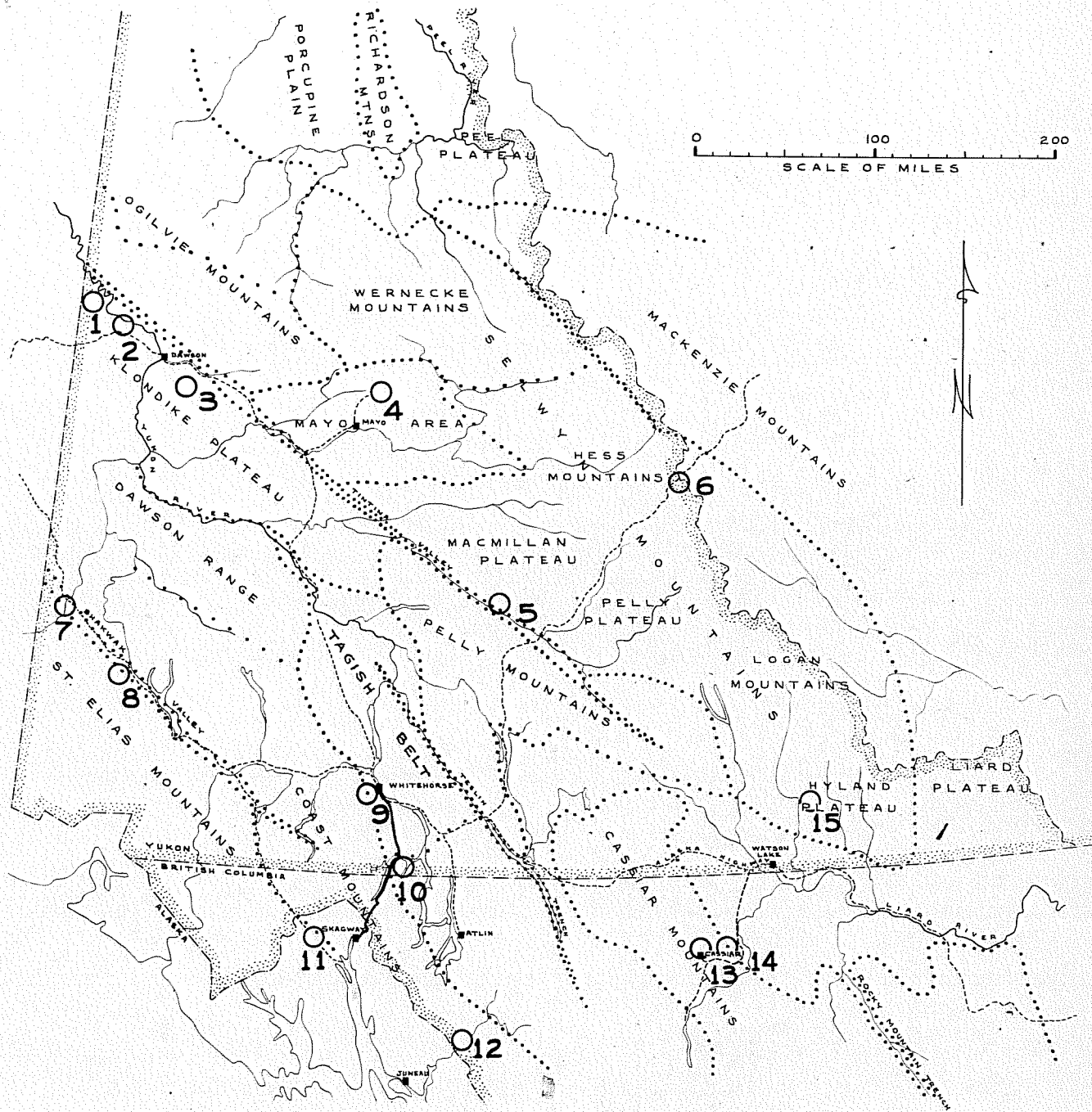


Figure 1
Yukon, Showing Chief Mineral Areas

- | | |
|---|--|
| 1. Clinton Creek asbestos | 9. Whitehorse copper belt |
| 2. Cassiar Creek asbestos | 10. Windy Arm gold-silver-lead |
| 3. Klondike gold fields
(producing) | 11. Klukwan titaniferous
magnetite iron ore |
| 4. Mayo silver-lead-zinc
(producing) | 12. Tulsequah copper-lead-zinc-
gold-silver |
| 5. Vangorda Creek lead-zinc | 13. Cassiar Asbestos (producing) |
| 6. Macmillan Pass lead-zinc | 14. Haskin Mountain zinc |
| 7. White River nickel-copper | 15. Hyland River lead-zinc-
silver |
| 8. Quill Creek nickel-copper | |