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PAPER 67-36

LODE MINING POTENTIAL OF YUKON TERRITORY

(Report and 3 figures)

L. H. Green

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L. H. Green

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

This paper is based on material prepared for the Second Yukon Resources Conference held in Whitehorse in March 1966.

The economy of the Yukon Territory has been based on the mineral industry since the discovery of the Klondike Gold Fields in 1896. The total value of mineral production since that date is about half a billion dollars comprised mainly of placer gold from the Klondike and smaller gold fields and of silver, lead, zinc, and cadmium from the high-grade deposits of the Mayo district. Production of these metals will continue but on a much-reduced scale following the cessation in 1966 of dredging operations in the Klondike and partial curtailment of operations in the Mayo district. Despite reduced production, the annual value of mineral production should rise in the next few years as new asbestos and copper properties are brought into production. In addition, large, recently discovered deposits of base metals may also be brought into production.

Many of the known showings are described briefly and certain conclusions as to the economic importance of various types of deposits suggested. All conclusions are based on information currently available and many will change as new discoveries are made.

LODE MINING POTENTIAL OF YUKON TERRITORY

INTRODUCTION

This paper is based on a paper given by the author at the Yukon Northern Resources Conference held in Whitehorse, Yukon Territory in March 1966. The map of mineral showings and properties (Fig. 1) is a revision of a map compiled for the Conference by a group active in the mineral industry including representatives of the Yukon Chamber of Mines and various government departments.

This paper considers the mineral deposits as they are known at present and suggests rock types or areas in which similar deposits may be expected to occur. Additional exploration is certain to change the picture presented and to suggest possibilities unforeseen at the time of writing. As an example, the base metal deposits of the Vangorda-Ross River area that have sparked much of the recent exploration would probably not be known today except for the fortuitous discovery of a single, inconspicuous outcrop of the Vangorda Creek orebody. Much of the Yukon Territory has a heavy cover of vegetation and unconsolidated deposits and the application of geophysical and geochemical methods combined with careful prospecting seem certain to lead to many new discoveries.

In considering the subject of mineral potential the past production of Yukon Territory must be viewed in perspective with the rest of Canada. Mineral production from 1886 to the end of 1966 is given in Table I. The value of mineral production has been between 11 and 15 million dollars in recent years compared to an estimated 316 million dollars for British Columbia and 4,004 million dollars for all Canada in 1966. While the annual value of production is small compared to the rest of Canada it represents about $1,000 per capita for the limited population and as such supports much of the economy of the territory. With the exception of coal, the mineral products of Yukon Territory are shipped to users elsewhere and with the limited population the demand for construction materials, such as sand and gravel, is negligible.

HISTORY OF PROSPECTING

There had been considerable prospecting for placer deposits prior to the discovery of the Klondike on 17 August 1896 but following this discovery extensive prospecting for placer deposits was done throughout the territory and many of the lode deposits including the copper of the Whitehorse Copper Belt, and Upper White River areas, the gold deposits of the Wheaton,

Manuscript received: April 12, 1967.

TABLE I

Mineral Production of Yukon Territory[1]

Metal or Mineral		1964	1965	1966[2]	Cumulative Total (1886 to 1966 Incl.)
Gold	fine oz.	57,884	45,031	40,035	11,092,739
	$	2,183,611	1,698,975	1,509,320	261,284,240
Silver	fine oz.	5,638,712	4,615,995	4,078,223	146,038,397
	$	7,894,196	6,462,393	5,705,434	121,383,841
Lead	lb.	20,418,415	17,851,309	16,373,000	481,900,893
	$	2,744,235	2,766,953	2,446,126	53,242,828
Zinc	lb.	13,094,653	13,247,653	9,086,000	238,248,489
	$	1,855,512	2,000,396	1,371,986	32,007,226
Cadmium	lb.	132,222	138,918	105,824	2,623,833
		428,399	386,192	253,978	5,078,950
Copper	lb.				14,372,285
	$				3,101,783
Tungsten	lb. (WO_3)				32,169
	$				27,499
Platinum	fine oz.				19
	$				1,553
Antimony					
	$				173
Coal	tons	7,229	8,801	6,000	277,155
	$	98,150	85,626	60,000	2,564,951
Total	$	15,204,103	13,400,535	11,346,844	478,693,044

[1] Figures compiled from Dominion Bureau of Statistics releases (Canadian Mineral Statistics, 1886-1956; Reference Paper No. 68 (1957) and yearly releases).

[2] Preliminary figures.

Carcross, and Dublin Gulch areas and some of the silver-lead deposits of the Mayo area were discovered and staked in the next few years. A second period of intensive prospecting commenced with discovery of high-grade silver-bearing float on Keno Hill in the Mayo area in 1918. In the next few years much detailed prospecting was done there and most of deposits mined subsequently were discovered in this period. Following the increase of price of gold in 1934, placer activity increased and there was considerable exploration for lode gold deposits, particularly in the Carmacks area. With the construction of the Alaska Highway and the Canol Road during the Second World War a period of active exploration began including the introduction of helicopter-supported prospecting by Hudson Bay Mining and Exploration Limited early in the nineteen fifties. Since then the number of individual prospectors had decreased but many company-supported parties have been active, the number varying with metal prices and interest in other areas such as northern British Columbia. Many of the more remote showings were discovered in this recent period. Newer methods introduced include the use of airborne geophysics, particularly near known deposits, and the widespread use of geochemistry. These, combined with improved drilling methods, permit the pinpointing and testing of targets beneath a heavy mantle of vegetation and permafrost. The most exciting discoveries have been the base metal deposits of the Ross River area.

At present, reconnaissance geological mapping of Yukon Territory on the scale of 1 inch to 4 miles is well in hand, and reconnaissance aeromagnetic information is available for much of the territory. Using this information, and using the new techniques, promising ground can be selected for exploration.

GEOLOGIC FRAMEWORK OF YUKON TERRITORY

A simplified geological map (Fig. 2) shows that Yukon Territory consists of a southern portion that has been intruded by granitic rocks and a northern portion of relatively unaltered sedimentary rocks with two small isolated areas of granitic rocks, one near Old Crow, and the other underlying Mount Fitton, near the Arctic coast. In the south two major structural lineaments, Tintina and Shakwak Trenches, slice northwesterly and have been traced far into Alaska. These features are believed to be major faults with suggested displacements of several hundred miles. North of Tintina Trench, Precambrian rocks and a narrow belt of Palaeozoic and younger strata have been intruded by scattered granitic plutons. In addition, two small areas of metamorphic rocks, altered in part to granitic gneiss, occur in southeast Yukon Territory. Much of the block between Tintina and Shakwak Trenches is underlain by metamorphic rocks, commonly referred to as the Yukon Group, which have been intruded by granitic rocks and are probably composed of strata of more than one age. Within this block a small area of mainly Palaeozoic beds cut by granitic plutons lies against Tintina Trench. The Tagish Belt of Mesozoic rocks cut by a few granitic bodies, forms a basin within the metamorphic terrain. Southwest of Shakwak Trench, the geology is less certainly known, particularly in the more mountainous portions, but both Palaeozoic and Mesozoic rocks cut by scattered intrusives are present. More detailed tectono-stratigraphic information is given by Gabrielse and Wheeler (1961).

Nearly all the known showings are in southern Yukon Territory where some granitic rocks are present. Relatively undisturbed sedimentary rocks similar to those underlying much of northern Yukon Territory (Fig. 2) are barren throughout much of North America with the important exceptions of lead-zinc deposits of the Mississippi Valley type, including Pine Point, Northwest Territories and copper deposits similar to that at Ruby Creek, Alaska. To date neither type has been reported from northern Yukon Territory although they may be present (cf. Bern group, 3[1]).

SOURCES OF INFORMATION

Much published information on mineral deposits of Yukon Territory is contained in publications of the Geological Survey of Canada and a lot of the activity in the period 1898 to 1933 is described in the Annual and Summary Reports of the Survey. Many of the original reports are now out of print but they have been reprinted, generally without accompanying maps or photographs, in Memoir 284 compiled by Bostock (1957), a publication readily available and, which for the convenience of the reader, will be referred to in this paper rather than making reference to the original reports. Where appropriate, the date and author of the original publication are also indicated.

Mining developments in the period 1934 to 1940 are described in a series of reports by Bostock (1935, 1936a, 1937, 1938, 1939, 1941); 1960 to 1961 in reports by Skinner (1961, 1962); 1962 to 1963 by Green and Godwin (1963, 1964) and 1964 to 1965 by Green (1965, 1966). Descriptions and bibliographies of the many properties of the Whitehorse area are given by Wheeler (1961) and much information on the Keno and Galena Hills area by Boyle (1965).

MacLean (1914) visited many of the lode properties in 1912 and his report contains many detailed descriptions, including sampling results, particularly for the gold properties of the Klondike and Mayo regions.

Smitheringale (1963) gave a paper similar to the present one at the First Yukon Resources Conference held in Whitehorse in March, 1963.

The map of mineral occurrences (Fig. 1) includes most of the known showings and whenever possible lists a single reference that will lead the reader to available reports. Wherever possible the names given are those in

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[1] Refers to property number on Figure 1.

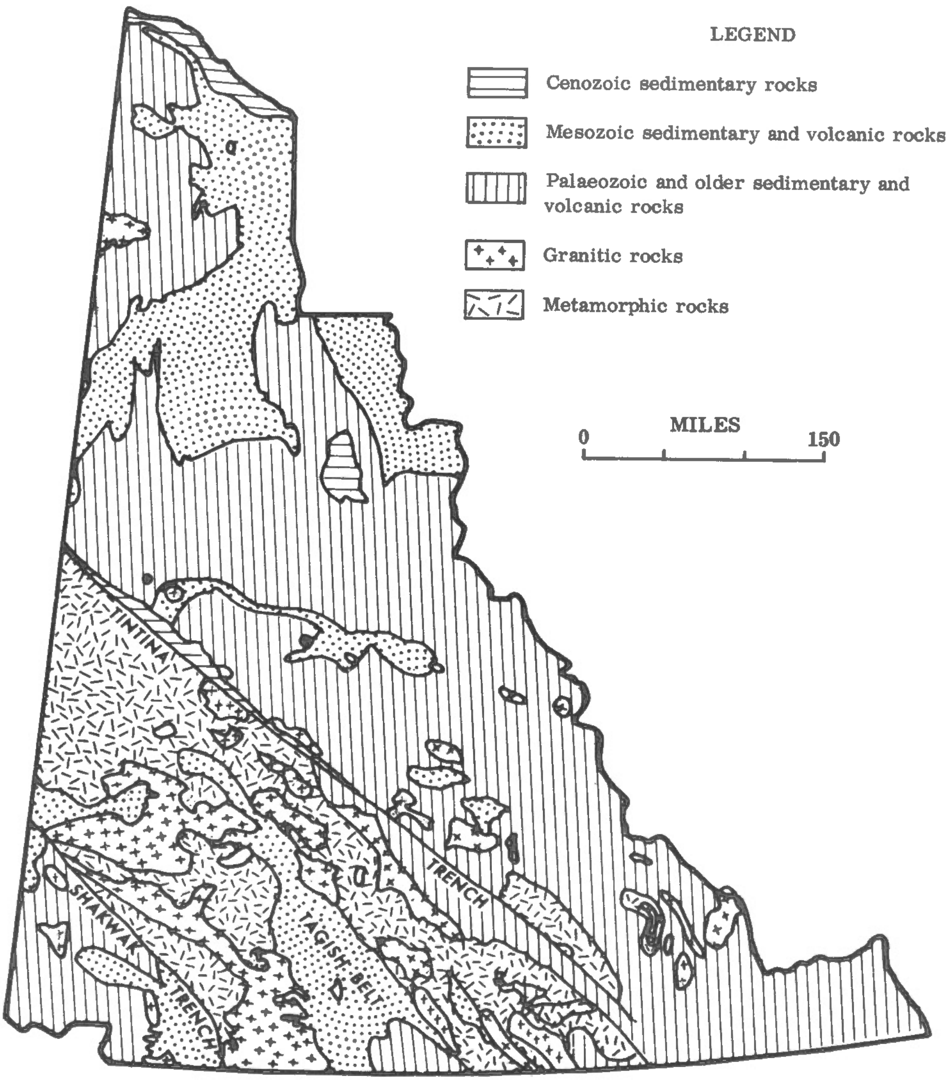

Figure 2. Generalized geology of Yukon Territory.

common use. There is little consistency in the naming of showings and names may refer to the discoverer, to the original claim, to a nearby geographic feature, or to a company that explored the showing. Many showings listed appear to be without economic significance but are included in the two-fold hope that they may be of value as indicators for further work and that the published description will enable the reader to consider them in truer perspective, stripped of legends that have grown about them with the years.

Numerous prospectors and exploration geologists supplied information incorporated in Figure 1 and their assistance is gratefully acknowledged.

The author was Resident Geologist in Whitehorse for the Geological Survey from mid-1962 to mid-1966 and visited many of the mineral properties during this period.

MINERAL DEPOSITS OF YUKON

GOLD

Gold has been the magic word connected with the Yukon since 17 August 1896 and the total production, virtually all won by placer mining, is estimated at over 11 million ounces. From the start of the gold rush, much time and energy has been spent in attempting to find workable lode gold deposits within the placer areas, but to date all efforts have been unsuccessful.

Klondike area

Map: Ogilvie, 115 O[1]

Placer Dredging operations of Yukon Consolidated Gold Corporation (Green, 1966, pp. 86-89) terminated late in 1966 and only independent operators are expected to be active in 1967. Most of the latter operate bulldozer-sluicing plants and new ground suitable for these plants has become increasingly difficult to obtain, particularly in the Klondike area. The operators of these plants are faced with the problem of the fixed price of gold, spiralling costs of mechanical equipment and wages, and insufficient resources to finance the year or more of preparatory work needed to bring new ground into production. Thus although much marginal ground remains, placer production will probably drop during the next few years. Developments that could make additional ground economic for mining include any increase in the price of gold, new methods of materials handling, especially in the removal of frozen muck, and the exploration of remote areas using new techniques of winter road building and rapid drilling.

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[1] Refers to the one inch to four mile geological map of the area described. An index of maps currently available is given in Figure 1.

Descriptions of individual placer operations and of placer areas are given in the series of papers describing the Mineral Industry of Yukon (Green, 1966 and earlier).

Lode In the Klondike region, much of the bedrock consists of the Klondike schist, mainly a soft quartz-mica schist bearing lenses of quartz parallel to the foliation and up to a few inches in width. The schist and quartz lenses are cut here and there by rusty fault zones containing some quartz. Specimens of quartz carrying free gold occur in placer concentrates and have also been found in place although never in sufficient amounts to form a workable deposit. The best known attempt at lode mining is the Lone Star (36[1]: Bostock, 1936a, p. 7) which has been explored intermittently since the turn of the century.

Other descriptions of lode properties and exploration are given in MacLean (1914, pp. 17-126) for 1912, and in a number of the Summary and Annual Reports compiled by Bostock (1957) including Cairnes (op. cit. pp. 343-350) for 1911, Cockfield (op. cit. pp. 597-598 and 617-618) for 1929 and 1930, respectively. Klondike Lode Gold Mines Limited (35) were active in the Eldorado-Upper Bonanza Creek areas between 1960 and 1962 (Green and Godwin, 1963, p. 19).

Workable deposits may well be present in the Klondike but the showings explored to date hold little promise. As suggested by McConnell in his 1907 report on the Klondike Gold Fields (in Bostock, 1957, pp. 105-109) the placer gold could have originated through the weathering of a vast amount of rock containing quartz veins with gold values of a few cents per ton. Thus a mineable deposit might occur where the small gold-bearing veins were closely spaced so that the ground could be worked as a unit.

Mayo area

Maps: Nash Creek, 106 D; Mayo, 105 M

In Mayo area, most of the larger valleys have been scoured by glaciation, in marked contrast to the Klondike region, and the placer deposits probably lie much closer to their bedrock source. There, many placer deposits occur near mineralized contact aureoles of granitic rocks where concentrations of the gold in gravels have escaped glacial scouring. Dublin Gulch may be considered a "vest pocket" example of this relationship and its basin contains a number of gold-bearing quartz veins that were explored unsuccessfully early in the century (16: McLean, 1914, pp. 127-158, Boyle, 1965, pp. 82-86).

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[1] See Figure 1a, index of properties.

Dawson Range area

Map: Carmacks, 115 I

In the Dawson Range area, a number of narrow veins carrying high values in gold or gold and silver occur in granitic and metamorphic rocks that have been cut by numerous dykes and small intrusions of acidic rocks, ranging from rhyolite through quartz porphyry to granite porphyry. Properties of this group include the Laforma (73: Green, 1966, pp. 29-31), the Webber, Huestis, and Brown McDade (77: Green, 1966, pp. 34-38) all of which have been explored underground, and a number of smaller ones described by Johnston (1937, pp. 10-20). In most, the veins contain discontinuous lenses of quartz that are up to a few feet in width, appear to follow faults, and are frequently surrounded by an extensive clay alteration extending 10 feet or more from the vein. The gold-bearing veins commonly contain minor pyrite and arsenopyrite whereas the gold- and silver-bearing veins of the Webber and Huestis showings contain pyrite, arsenopyrite, galena, sphalerite, stibnite and some of the less common silver-bearing minerals. Most of the veins that have been explored underground cut minor amounts of acidic intrusive rock, chiefly quartz porphyry. There appears to be an association between the distribution of these rocks and the known showings in a northwest-trending belt about 30 miles in length and up to 12 miles in width. A few marginal placer deposits have been explored in this area and most lie close to known lode showings. The area appears to offer considerable potential for small, high-grade, lode operations.

Carcross-Wheaton area

Map: Whitehorse, 105 D

In this area of southern Yukon Territory gold- and silver-bearing quartz veins cutting metamorphic, granitic, and volcanic rocks, all of probable Mesozoic age, have been explored intermittently since the turn of the century (Wheeler, 1961, pp. 119-131). In general, the veins are narrow with erratic variations in precious metal content and in type and amount of metallic minerals present. Gold- and silver-bearing tellurides are known from those occurring in metamorphic rock. Many of these showings are held as Crown-granted mineral claims and most of the remainder have recently been restaked, some for the first time in many years. During 1966, two properties, the Arctic Caribou (159: Big Thing, Green, 1966, pp. 55-60) and the Venus (158) were explored underground. The area appears to offer some promise for the development of small tonnage operations treating high-grade ore. In most presently known showings, the quartz veins appear too widely spaced and values too erratic to consider mining of a larger block of ground as a large tonnage, low grade operation.

Ketza area

Map: Quiet Lake, 105 F

A unique gold deposit (112: Skinner, 1961, p. 39) explored by Conwest Exploration Company between 1954 and 1960 contains gold values in lenses of pyrrhotite, arsenopyrite, and pyrite deposited parallel to the bedding of Early Cambrian limestone adjacent to a fault.

SILVER

Most of the silver produced in the territory comes from deposits in which silver, associated with lead and zinc, is the main metal of value. In general, deposits of this type consist of narrow veins containing galena and sphalerite in a gangue of siderite and quartz. In the primary ore, much silver is in the form of fine grains of argentiferous tetrahedrite within galena but discrete grains of silver-bearing minerals also occur. Oxidized ores contain many secondary silver minerals, including native silver. Mining costs are high in narrow vein deposits of this type and there can be little profit unless the product shipped, either hand-sorted ore or silver-bearing lead concentrate, has a high silver content. The so-called silver to lead ratio is a useful figure in dealing with assays from this type of deposit. For example, a sample that assayed 40 ounces per ton of silver and 10 per cent lead would be referred to as having a 4 to 1 silver to lead ratio.

Keno and Galena Hills area

Map: Mayo, 105 M

This area has produced virtually all of the silver, lead, and zinc mined in Yukon Territory. A recent description of the camp is given by Boyle (1965). Most of the ore mined has a 4 to 1 or better silver to lead ratio and comes from veins in massive quartzite presently considered to be of Mesozoic age. The area is heavily covered by vegetation and slide rock and this combined with deep permafrost has made surface exploration extremely difficult. In the past, prospectors found most showings by hand shafting on single claims but in recent years the present operating company, United Keno Hill Mines Limited (45: Green, 1966, pp. 10-17) has undertaken a major exploration program involving overburden drilling and geochemical sampling, which together yielded much the same type of information obtained from shafting. The deposits have been mined almost continuously since 1920 and the camp still appears to have a good potential despite the partial curtailment of operations by United Keno Hill Mines Limited late in 1966.

Other than the main deposits on Keno and Galena Hills numerous others (9, 10, 11, 12, 17, 43, 44, 46 etc.) nearby have been explored and some small shipments made. In general, silver to lead ratios for these peripheral deposits are 1.5 to 1 or less, a ratio too low to excite great interest under present conditions. Recent geochemical work (Gleeson, 1966a-d) indicates that the most favourable areas for prospecting lie close to the known showings.

From the Keno and Galena Hills area the late Mesozoic massive quartzite that is host rock to the ore has been traced westward in a sweeping arc to the Dawson area (ref. maps 106 D, 116 A, 116 B, C). One showing (22) is known in the latter area but the silver to lead ratio is low.

Area southwest of Tintina Trench

Recently, silver-bearing galena veins have been explored in the Sixtymile area (33, 34: Green, 1966, pp. 26-28) and in the Dawson Range area, the latter by Casino Silver Mines Limited (79: Green, 1966, pp. 39-42). The veins cut a variety of rock types and all have silver to lead ratios of 2 1/2 to 1 or less. However, several showings are known in both areas and each would appear worthy of additional careful prospecting.

Boswell River area

Map: Quiet Lake, 105 F

In this area, about 50 miles east-northeast of Whitehorse, quartz veins with silver-bearing galena (99: Green, 1966, pp. 60-62) occur in metamorphic rocks. The known veins are narrow and have only minor amounts of silver and lead, however, they are spread over a distance of 5 miles and other more favourable deposits may be found.

Logjam Creek area

Map: Wolf Lake, 105 B

At the Logjam property (151: Green, 1966, pp. 75-76) narrow quartz veins bearing silver minerals cut a sill-like body of Mesozoic diorite. No other similar showings have been discovered in the immediate area.

Ketza River area

Map: Quiet Lake, 105 F

Silver-lead showings were discovered in the area in 1947 and prospecting has continued intermittently since. Many of the showings are now held by Silver Key Mines Limited (111: Green, 1966, pp. 64-68). The known showings lack a consistent pattern; they occur in a number of rock-units and include vein, lens-shaped deposits parallel to contacts, and replacement deposits. Silver to lead ratios are variable but some very high silver assays have been obtained, mainly from float.

Ketza River to Rancheria areas

Maps: Quiet Lake, 105 F; Finlayson Lake, 105 G; Wolf Lake, 105 B

A distinctive type of deposit associated with limestone of Early Cambrian age extends from the Ketza area, near Ross River southeasterly into northern British Columbia. Generally, deposits of this type are in the form of galena- and sphalerite-bearing lenses that lie beneath thin layers of schist within the limestone. Some cross-cutting veins are also present. Examples include the Oxso (113: Green, 1965, pp. 42-43), Tintina Silver (117: Green and Godwin, 1963, pp. 26-29), Luck (146: Green and Godwin, 1963, pp. 31-32) and Frances River Syndicate (142: Green and Godwin, 1964, pp. 44-45) properties. Both silver assays and silver to lead ratios vary widely and this, combined with apparently limited size and high transportation costs, has precluded mining these deposits in the past, even as high-grading operations. However, if smelter facilities were available in the general area it might be possible to mine some as relatively small tonnage, high-grade operations.

LEAD-ZINC

Lead-zinc deposits, lacking appreciable precious metal values, must be potentially large tonnage operations to be of economic interest. A number of such deposits occur in varied geologic settings in southeastern Yukon Territory and the area holds promise of becoming a major lead-zinc province.

Vangorda area

Maps: Tay River, 105 K; Glenlyon, 105 L

The original Vangorda deposit (61: Green and Godwin, 1964, pp. 31-32) was first staked in 1953 and the discovery of the Faro (62: Green, 1966, pp. 47-50) and Swim (59: Aho, 1966a, b; Green, 1966, p. 50) deposits in 1965 sparked an exploration boom in this area. The deposits consist of large pyrrhotite and pyrite masses, in part containing potentially economic amounts of lead and zinc, that replace contorted schist, phyllite and volcanic rocks of presumed Mississippian age. Published tonnages and grades for the Vangorda deposit are 9,400,000 tons averaging 4.96 per cent zinc, 3.16 per cent lead, 0.27 per cent copper and 1.06 ounces of silver per ton, and for the Faro deposit 40 million tons averaging about 10 per cent combined lead and zinc and one ounce of silver per ton. The geological controls of the deposits are not known with certainty although a relationship to northeast-trending faults and the effect of the proximity of the Anvil batholith have been suggested. The belt of potentially favourable rock lies on the northeast side of Tintina Trench and appears to extend from southeast of Ross River into the Glenlyon area, a distance of about 60 miles in the Tay River map-area alone. Considerable exploration work was done in the area in 1966 but no new discoveries were announced. Much of the favourable area is deeply covered by glacial debris and geophysical and geochemical methods would appear to offer the most promising means of locating drill targets.

MacMillan Pass area

The Tom property (52: Green, 1965, pp. 47-48) is reported to contain over 10 million tons averaging about 5 per cent zinc. Barite and sphalerite partially replace a limestone band in a sequence of black, cherty slate, and chert-grain grit of Ordovician to Silurian age. Similar deposits may be expected in the same general area but the remoteness and relatively low grade of the deposit make it of limited economic interest unless smelter facilities become available in the general area.

Hyland and Coal Rivers area

Map: Frances Lake, 105 H

The Norquest group of showings (133: Green, 1966, pp. 68-71), located just west of the Canada Tungsten road occur in bands of altered marble within schist and gneiss formed by the metamorphism of Proterozoic sedimentary rocks. Where mineralized, the marble has been almost totally replaced by secondary silicate minerals and variable amounts of pyrrhotite with some pyrite, sphalerite, and lesser amounts of galena and chalcopyrite. The better showings contain about 10 per cent zinc and smaller quantities of lead, copper, and cadmium. The metasedimentary rocks of the area have been cut by numerous granitic intrusions and the marble bands range from those that are only partially altered and contain minor amounts of zinc, through highly altered bands with good values and considerable continuity, to mere remnants almost engulfed by the intrusions. Zinc showings are widespread and the area would appear to merit much additional prospecting.

About 30 miles to the east-northeast, lead-zinc showings (138: Skinner, 1961, p. 46) in skarn developed from Early Cambrian limestone have been traced over a wide area.

Cassiar Mountains area

Map: Wolf Lake, 105 B

A group of showings (150: Green, 1966, pp. 76-79) were explored early in the fifties and have been staked intermittently since. The showings are somewhat similar to those of the Norquest group in that they occur in carbonate bands, in part replaced by secondary silicate minerals, iron sulphides and sphalerite, that form in metamorphosed sedimentary rocks of probable Late Devonian and Early Mississippian age. The area was one of intrusive activity.

Coal River area

The MacMillan showing (141: Green, 1966, pp. 72-74) is reported to contain about 1 million tons containing 10 per cent zinc, 5 per cent lead, and 1.8 ounces of silver per ton. The deposit occurs as a replacement in a limestone conglomerate within a sequence of maroon and green shale and pebbly quartzite of probable Proterozoic age. Rocks of this unit (Douglas and MacLean, 1963) underlie much of the area northeast of Tintina Trench and extend in a sweeping arc from this area to the Alaska boundary, a distance of about 600 miles. However, deposits similar to the MacMillan showing are unknown and, with the exception of the Norquest showings (133) and showings in the Mayo area (12, 16, 17) rocks of the unit are singularly barren.

COPPER

The limited copper production from Yukon Territory in the past has been mainly in the form of hand-sorted ores from properties in the Whitehorse Copper Belt and Johobo Mines in the Haines Junction area. Chalcopyrite is the main copper mineral in many of the known showings and because of its relatively low copper content, about 34.5 per cent, it is impossible to produce a high grade concentrate from this mineral. Thus in the more remote areas, deposits containing chalcopyrite are of limited economic interest unless they appear large enough to bear the cost of setting up large-scale, low cost per ton, mining, milling, and transportation operations.

Whitehorse Copper Belt

Map: Whitehorse, 105 D

The deposits of the Whitehorse Copper Belt contact metamorphic deposits, with copper and iron minerals, developed near the contact of Triassic limestone with granitic rocks. Past production is about 13 million pounds of copper and the deposits are currently being prepared for mining by New Imperial Mines Limited (172: Green, 1966, pp. 50-51). Open-pit reserves are estimated at about 5 million tons containing 1.10 per cent copper mainly in three open-pits spaced over about 15 miles. A mill is currently being built adjacent to the Little Chief orebody near the centre of the belt. Recently, additional drilling near this deposit has indicated that deep ore that can be recovered by underground mining may be present. The geological setting of the deposits can be duplicated in a number of places in the Whitehorse area and these appear worthy of additional prospecting.

Haines Junction area

Map: Dezadeash, 115 A

At the Johobo mine (176: Green and Godwin, 1963, pp. 24, 25) over 1 million pounds of copper have been produced from massive lenses of copper-bearing minerals in Mesozoic volcanic rocks. Copper minerals include chalcopyrite and bornite. The massive nature of the copper minerals and the presence of much bornite enabled operators to hand-sort material containing over 20 per cent copper. Known lenses on the property have been mined out.

White River area

Map: Kluane, 115 F, G

Native copper and other copper minerals, including chalcocite, occurring in volcanic rocks, have been known since the turn of the century (83: Muller, 1967, pp. 108-110) and a slab of native copper, weighing about 2,590 pounds, at the McBride Museum in Whitehorse, was brought from this area in recent years. Native copper in association with volcanic rocks is known in many places throughout the world but the only important camp of this type is in the Lake Superior district.

The Kennecott copper deposit, now worked out, was in Alaska about 75 miles southwest of the White River area. The deposit contained copper-rich minerals, mainly chalcocite, deposited near the contact between limestone and underlying volcanic rocks, both of Triassic age. Total production is estimated to have been 1.2 billion pounds of copper, all from mines on a single mountain. Projected regional trends indicate that similar geological relationships may occur in the mountainous, partially glacier-covered area of southwestern Yukon Territory. Considerable exploration has been carried out both in Alaska and Yukon Territory but to date the Kennecott deposit remains unique.

Area between Shakwak and Tintina Trenches

Maps: Aishihik Lake, 115 H; Carmacks, 115 I

Scattered copper deposits have been explored in the metamorphic rocks between these two trenches. These include contact metamorphic deposits (95: Cockfield in Bostock, 1957, p. 568) near Giltana Lake in the Aishihik area and the Revenue showing (76: Green, 1966, pp. 31-33) associated with a small quartz porphyry intrusion in the Dawson Range and other deposits in this general region (71, 68, 96). To date, the entire area appears to lack the disseminated copper of 'porphyry' deposits within intrusive rocks that have created so much mining and exploration in British Columbia (Ney, 1966, pp. 295-303). Throughout much of Yukon Territory Triassic volcanic rocks similar to those associated with many of the deposits in British Columbia, are lacking.

Pelly River area

Maps: Finlayson Lake, 105 G; Sheldon Lake, 105 J

Two copper properties, North Lakes (120: Skinner, 1962, pp. 40-41) and Fire Lake (121: Skinner, 1962, pp. 39-40) were explored between 1960 and 1961 and restaked early in 1966. Both are within an area underlain by schist and gneiss intruded by granitic rocks, and consist of replacement of bands of schist by pyrrhotite, pyrite, chalcopyrite, and some sphalerite. When first explored, prior to the completion of the Watson Lake-Ross River road, the deposits were in a remote area and initial exploration suggested that relatively small tonnages of low-grade material were present. However, with improved transportation and should a source of cheap sulphuric acid become available, it might be possible to treat even relatively small tonnages of ore to recover a high-grade product.

Late in 1966, Atlas Explorations Limited announced (Western Miner, November 1966, pp. 24-25) the discovery of the Pike showing (54) containing values in copper, lead, zinc, and silver within an altered porphyry intrusion.

Numerous other minor copper showings are known in the general area and some exploration work has been done in the past.

Wernecke Mountains area

Maps: Nash Creek, 106 D; Larsen Creek, 116 A

Scattered copper showings (7, 18, 19) in a host rock of Precambrian carbonate rocks occur in the Wernecke and Ogilvie Mountains area (Green and Roddick, 1962). Most form narrow veins that commonly contain lenses of massive chalcopyrite up to a few feet in width. However, the known deposits appear too small and too remote to be of economic interest.

MOLYBDENUM

Only a few molybdenum showings have been reported and none are known to be of the disseminated type associated with intrusive rocks, that supply the bulk of world production.

In the extreme southwest corner of Yukon Territory, molybdenite float has been reported from Steele Glacier (87: Skinner, 1962, p. 36) and to the northeast across Shakwak Trench a number of small showings have been explored.

In the Pelly Mountains area, exploration work has been done on two molybdenite deposits, Canol Metal Mines (106: Skinner, 1961, pp. 41-42) and the Molly group (108: Green and Godwin, 1964, pp. 45-46) both of the contact metamorphic type. Both proved to be of limited size although of reasonably good grade.

NICKEL

Kluane area

Map: Kluane, 115 F, G

Two nickel deposits, Wellgreen (88: Muller, 1967, pp. 110-111) and Canalask (84: Muller, 1967, p. 111) occur in Kluane area, a few miles southwest of Shakwak Trench. Both are associated with ultrabasic sills, now altered to serpentine that occur in sedimentary and volcanic rocks of the Cache Creek Group of Permian age. At the Wellgreen deposit lenses of nickeliferous pyrrhotite occur at the contact of basic rocks associated with the sill and adjacent siliceous tuffs and at the Canalask deposit, lenses of nickeliferous pyrrhotite occur in volcanic rocks about 200 feet from the sill. Both deposits have been explored underground and the Wellgreen is reported to contain 728,000 tons containing 2.05 per cent nickel, 1.42 per cent copper plus gold, cobalt, and platinum; the Canalask contains 550,000 tons containing 1.68 per cent nickel.

The showings were discovered in 1952 and 1954, respectively, and resulted in considerable activity in this area for the next few years but little has been done since. Other ultrabasic bodies have been mapped from near the Canalask property southeastward to near Haines Junction, and the entire belt would appear worthy of careful prospecting.

Ross River area

Float of nickel-bearing ultrabasic rocks was found in Bruce Lake area (115: Green and Godwin, 1964, pp. 42-43) but in subsequent exploration little was found in place and the nickel content was very low.

TUNGSTEN

Flat River area, N. W. T.

Maps: Frances Lake, 105 H; Nahanni, 105 I.

To date, there are no commercial tungsten deposits in Yukon Territory but the Canada Tungsten property (136: Green and Godwin, 1963, pp. 34-37) is located a few miles east of the Yukon-Northwest Territories boundary and makes a substantial contribution to the economy of the territory. The deposit occurs in skarn developed near the contact of a distinctive Early

Cambrian 'ore limestone' with granitic rocks. In the immediate area, much of the 'ore limestone' was removed by erosion prior to deposition of the overlying later Cambrian rocks, and the scattered areas (in 105 H, I) where remnants are in contact with granitic rocks, are the most promising for exploration. Some showings are also known near the contact of younger limestones with granitic rocks but those discovered to date are small and appear unlikely to be of commercial value.

MacMillan Pass area

The MacMillan Pass showing (51: Green, 1965, pp. 48-50), about 110 miles northwest of the Canada Tungsten property, occurs near the contact of limestone of Late Cambrian or Ordovician age with granitic rocks. No estimates of tonnage are possible without drilling.

Mayo area

Small tungsten showings (16, 42, 48) are known in the area and small shipments of placer scheelite have been made from Dublin Gulch (Bostock *in* Little, 1959, pp. 19-37). The showings include scheelite-bearing quartz veins in granitic rocks and scheelite-bearing skarns but known showings are small and of limited interest.

Dawson Range area

The placer deposits of Canadian Creek contain considerable amounts of the tungsten mineral, ferberite (80: Bostock, op. cit. pp. 16-19 and 30) and one small shipment is reported. Country rock at the head of the creek consists of pegmatitic and porphyritic rocks cut by numerous quartz veins and three samples taken at 300-foot intervals across 900 feet contained a trace of WO_3 in one and 0.10 per cent in the remaining two.

Cassiar Mountains area, southeastern Yukon Territory

Limited exploration work has been done at the Yukon Tungsten property (145: Green, 1966, pp. 80-82) on a narrow quartz vein carrying wolframite and minor cassiterite.

ANTIMONY

Antimony deposits are known from the Wheaton area, near Whitehorse, the Mayo area, and the Dawson area. Many of the deposits are described by Bostock (1941, pp. 33-38). Recently, exploration work has been done on the Becker Cochran property (Yukon Antimony Corporation, 167: Green, 1966, pp. 52-55), the Hawthorne property (41: Green, 1966, pp. 20-21) and the Antimony Mountain property (20). Most of the showings consist of narrow quartz veins carrying stibnite and, in some cases, values in precious metals. Elsewhere, antimony-lead minerals, mainly jamesonite, occur in some of the silver-lead deposits, especially the Rex (17) in the Mayo area.

IRON

Float of dense, specular hematite, commonly with some jasper, has been known in the Yukon Territory since early in the present century but the large Snake River deposit (Crest Exploration, 5: Green and Godwin, 1963, pp. 15-18 and Green, 1965, pp. 23-23) was not discovered until late in the 1961 field season and was staked early in 1962. The iron formation occurs within the Rapitan Formation, a thick sequence of Proterozoic conglomeratic mudstone deposited in an arc along what is now the Mackenzie mountains and extending westward to Yukon River north of Dawson. However, the Rapitan Formation was folded and eroded prior to the deposition of carbonate rocks of Ordovician age and only isolated pockets remain. Some iron formation has been found at several outcrops of the Rapitan Formation but the best of the known deposits are those of the Snake River area where one proposed open pit alone contains over one billion tons of material containing between 40 and 50 per cent iron. Some form of concentration would be required to produce a commercial product.

Southwest of the Crest deposit, showings of micaceous specular hematite, with some chalcopyrite, sparked a minor staking rush in 1958. These deposits generally occur at the contact between two Proterozoic rock units and have a markedly different setting from those of the Crest deposit. One showing (Pacific Giant Steel Ores, 6: Green, 1966, pp. 21-23) is currently held and some work has been done on it. In the Dawson area, another deposit (28) containing hematite and magnetite in Proterozoic rocks was explored in 1958. The material at both properties could be upgraded to a high iron content with relatively simple treatment, but tonnages are as yet unknown, and the problem of developing a low cost transportation system to tidewater remains.

ASBESTOS

Ultrabasic rocks, the host for asbestos deposits, are known (Fig. 3) from a wide zone southwest of Tintina Trench, in a narrow band northeast of Tintina Trench in the Pelly area, and in a narrow band southwest of Shakwak Trench. Only one property, Clinton Creek (32: Christian, 1966 and Green, 1966, pp. 25-26) is currently being brought into production but drilling has been done at a number of other properties (Foxy, 30; Caley, 26; Hoole River, 116; Tower Peak, 101; and Rex, 175). Minor amounts of asbestos fibre have been reported from many of the remaining ultrabasics. Aeromagnetic maps covering much of central Yukon Territory have recently been published by the Geological Survey of Canada and these, combined with the available geological coverage, should suggest many areas favourable for additional prospecting.

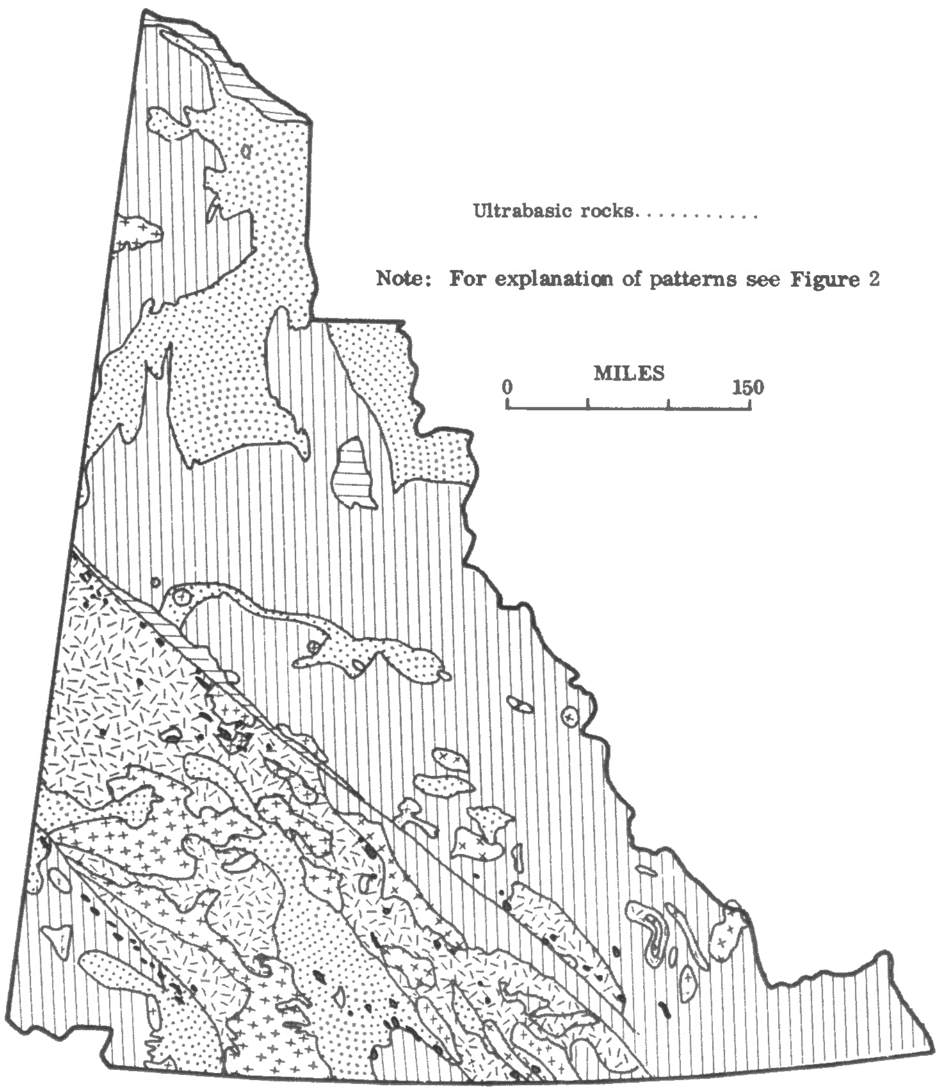

Figure 3. Known occurrences of ultrabasic rock in Yukon Territory.

OTHER INDUSTRIAL MINERALS

With the exception of asbestos, most industrial minerals, including both non-metallic minerals and construction materials, have a low cost per ton. Thus with a small local population and high transportation costs to markets elsewhere, there is little prospect of more than minor production.

Although there are numerous gypsum and anhydrite deposits (93: Muller, 1967, p. 115) in the Kluane area that are relatively close to tidewater via the Haines road, there is little prospect of the deposits becoming economic at present prices. Scattered barite deposits occur in the Pelly area, and, if needed, might be utilized locally in drilling muds.

COAL

Coal deposits were explored in a number of locations early in the present century and some mining was attempted but was successful only in the Carmacks area. Much of the work was done in conjunction with the development of the Klondike Gold Fields and the deposits worked were either close by the placer region or near Yukon River, the main transportation route of the period. The deposits will be considered in two groups, bituminous coals of Jura-Cretaceous age of the Tagish Belt and Tertiary coals, principally along Tintina Trench and Duke Depression. Potentially coal-bearing Mesozoic and Tertiary rocks underlying large areas of northern Yukon will not be considered in this paper.

Bituminous Coals of the Tagish Belt

Maps: Carmacks, 115 I; Laberge, 105 E; Whitehorse, 105 D

Carmacks area

Coal measures of Jura-Cretaceous age are known in a number of places in the Tagish Belt but have been worked extensively only in the vicinity of Carmacks. The bulk of the coal is in the Tantalus Formation of Jura-Cretaceous age, but some occurs in the underlying Laberge Group of Jurassic age. Except at the Tantalus Butte Mine (66: Green, 1966, pp. 121-124), currently being worked, and the former Tantalus Mine across the river, little is known of the thickness or quality of the coal seams. At the former, the seam being mined in mid-1965 was about 13.5 feet thick and was classified as high volatile B bituminous, and non-coking coal.

Whitehorse area

Some exploration work was done on the Whitehorse and Mount Bush showings (170, 164: Wheeler, 1961, pp. 143-144) early in the century. The coal is semi-anthracite to anthracite with a high ash content and the deposits are of little economic interest.

Other areas

Coal float is known in the Big Salmon area, about 50 miles southeast of Carmacks (97: Bostock and Lees, 1938, p. 16) and in the Nordenskiold River area south of Carmacks. The basin in which the Tantalus Formation (and the less-important Laberge Group) was deposited must have covered a large area within the Tagish Belt of which only isolated pockets remain. Additional exploration could conceivably locate new coal showings both in known areas of the Tantalus Formation and in areas where the formation has not been previously recognized. Considerable reserves of good-quality coal, possibly including coking coal, may be present in the Tagish Belt.

Tertiary Coals

Tintina Trench area

Map: Dawson, 116 B, C

Tertiary coals occur along Tintina Trench and attempts were made to mine several of the deposits early in the century and, in one case, again in 1937. The main deposits are at Coal Creek, a tributary of Rock Creek (23: Bostock, 1957, pp. 30-33; 1938, pp. 13-16), Coal Creek, east of Fortymile (27: Bostock, 1957, pp. 30-33) and Cliff Creek, downstream from Fortymile (29: Bostock, 1957, pp. 32-33). There is little prospect of these deposits becoming economic, the coal is lignitic, seams are seldom more than 5 feet thick and are much thinned and faulted. To the southeast, similar float has been observed in some of the streams crossing Tintina Trench but these deposits can be expected to have the same limitations as those in the Dawson area.

Kluane area

Sub-bituminous coal of Tertiary age occurs in Duke Depression southwest of Shakwak Trench (91: Muller, 1967, pp. 113-115). Seams are thin and the deposits appear to have little or no economic significance.

Liard Plain area

Tertiary coals are reported (143: Bostock, 1950, p. 28) to occur in places along the Alaska Highway and in river valleys in this area. Much of the area is drift covered and Bostock (op. cit.) suggests that 100 square miles or more may be underlain by lignite-bearing measures. In the present author's opinion, it is doubtful if much information either on the thickness or structure of the lignite seams can be obtained from poor surface exposures in this area.

CONCLUSIONS

PROBABLE POTENTIAL OF KNOWN DEPOSITS

The following conclusions are based on the deposits known at present and are likely to change as additional discoveries are made:

Gold

Small scale placer operations will continue and could expand appreciably with the introduction of new mining methods or an increase in the price of gold. Most of the known lode gold deposits are narrow, gold-bearing quartz veins and there is considerable potential for small tonnage mining operations, particularly in the Dawson Range and Carcross areas. In the Klondike area, presently known lode showings hold little promise for mining.

Silver

Production from the Keno and Galena Hills area will probably continue despite the present partial curtailment of mining. Elsewhere, silver-lead deposits with less favourable silver to lead ratios may come into production particularly if there is an increase in the price of silver.

Lead-Zinc

Southeastern Yukon is a major lead-zinc province with the best deposits in Ross River area. When transportation and possibly smelting facilities are established for the main deposits others in the general area may also become economic.

Copper

The deposits of the Whitehorse Copper Belt are currently being brought into production. Elsewhere, most of the deposits presently known are probably too small to bear the cost of establishing mining plants and transportation facilities. Until recently the principal interest was in high-grade deposits and relatively little has been done in the search for larger, lower grade deposits, similar to those currently being developed to the south in British Columbia.

Molybdenum

The showings investigated to date hold little promise for large tonnage operations.

Nickel

A nickel belt worthy of much additional exploration appears to be present on the southwest side of Shakwak Trench.

Tungsten

There is a good possibility that additional tungsten deposits are present along the Northwest Territories-Yukon boundary, especially in the vicinity of the Canada Tungsten deposit.

Antimony

Most of the known showings occur in narrow quartz veins containing stibnite. Deposits of this type are of limited interest at present prices and mining costs.

Iron

Immense tonnages of low grade material are present. Their development will depend on the availability of markets, the development of methods to produce a suitable concentrate, and a transportation system capable of handling the tonnages involved. The discovery of large amounts of petroleum or natural gas close to the Snake River deposits could speed the development of this major resource.

Asbestos

Ultrabasic rocks, the host for asbestos deposits, are widespread and many contain traces of asbestos fibre. Many remain to be explored and the chances of finding additional economic deposits are excellent.

Coal

Considerable reserves of good quality coal, possibly including coking coal, may be present in the Tagish Belt. The demand has been limited in the past and little exploration has been done.

POSSIBLE FUTURE DEVELOPMENTS

Many mineral showings are known in the Yukon Territory but their distribution is uneven, possibly in part due to remoteness or lack of outcrop in some areas. Recent advances, including the use of geochemistry, geophysics, the publication of geological and aeromagnetic maps for much of Yukon Territory, and the use of helicopter transportation, afford the means to select favourable areas for detailed exploration. Many new discoveries will undoubtedly result from the careful application of these techniques followed by detailed prospecting, geochemical and geophysical work, and improved methods of exploration drilling. In addition, constant reappraisal of the known showings and their use as indicators for additional detailed exploration should lead to other discoveries. In particular, the use of these approaches may aid in the search for large deposits of lead-zinc, copper, molybdenum and asbestos. The brightest future appears to lie with the highly mechanized, large tonnage operations that can operate at low unit cost. Small tonnage operations, mining narrow veins, may be faced by ever increasing costs per ton.

The type of products shipped may change dependent on metal prices and discoveries but the mineral industry is certain to continue to play a major role in the economy of Yukon Territory.

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