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WHITEHORSE DISTRICT, YUKON

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Preface

This report is a somewhat condensed edition of Geological Survey Memoir 150, which is now out of print. The information presented is essentially that contained in the original report and is neither revised as to geological information nor brought up to date in the matter of mineral developments. It will, however, continue to provide useful information on one of the most accessible, best known, and more interesting parts of Yukon until such time as a more adequate study can be made, and is accompanied by a patterned copy of the same map as that used to illustrate the original memoir.

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Illustration

WHITEHORSE DISTRICT, YUKON

TOPOGRAPHY

Whitehorse district lies between latitudes 60 and 61 degrees north and longitudes 134 and 136 degrees west. It occupies parts of the Coast Range and Yukon Plateau physiographic provinces, the line of demarcation between the two being nowhere very definite, but following, in general, a course north-northwest from Windy Arm through the western part of Wheaton district and down the valley of Ibex River. West of this boundary granitic intrusions predominate; east of it they are subordinate to sedimentary and volcanic formations.

COAST RANGE

The Coast Range consists of a complex of mountains that have little symmetry of arrangement other than a rough alinement along the northwesterly trending axis of the range. The common forms are jagged, needle-like, or saw-toothed peaks with knife-edged ridges and sharply incised valleys.

YUKON PLATEAU

Throughout Whitehorse district to the east of the Coast Range are extensive remnants of what appears to have been an old erosion surface that has been uplifted and dissected. This is the Yukon Plateau, an undulating upland exhibiting a nearly level profile sweeping away in all directions to the horizon and broken only here and there by isolated residual mountains rising above the general level. This upland surface truncates alike most of the rock formations of the district and these vary widely in degrees of resistance. The upland stands at an average elevation of 5,000 feet. To the westward it gradually increases and finally fingers out among the mountains of the Coast Range.

Streams have cut valleys from 1,500 to 4,000 feet deep in the upland surface. In the eastern half of the district the valleys divide the upland into several distinct units. One of these lies east of Lake Bennett and south of Tagish Lake; another is enclosed by Watson River Valley, Tagish Lake, Marsh Lake, and Lewes River; a third extends eastward from Marsh Lake and Lewes River. Though these areas include peaks as high as many of those in the Coast Range, there is a greater proportion of lowland area in this region than in the Coast Range province, and, therefore, the average elevation is considerably less.

GLACIATION

U-shaped valleys, truncated spurs, and hanging valleys are conspicuous features of glacial action in this district. Morainal and glaciofluvial deposits are abundant, particularly on the valley floors. Roches moutonées are apparent in the lower areas of bedrock and exhibit polished and striated surfaces. The general direction of the latest ice movement was northward, but in detail was controlled by the local topography. Well preserved striae were found close to 5,900 feet[1] 4 miles

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[1] All elevations are referred to sea-level.

north of the head of Cap Creek, indicating that Pleistocene ice stood at least at this elevation, and that little of the district, even on the higher mountains, projected above it. Some parts, however, as in the Wheaton area, show little evidence of upland glacial modification though standing at considerably lower elevations. Ice movements there were concentrated in the valleys and their chief effects were those of valley glaciers rather than continental ice-sheets.

GENERAL GEOLOGY

A great variety of rocks, both sedimentary and igneous and ranging in age from Precambrian (?) to Recent, outcrop in Whitehorse district. The oldest comprise a group of metamorphic rocks supposed to be of Precambrian age. The Palaeozoic is represented chiefly by a thick series of slates, cherty quartzites, and limestone. Great amounts of bedded tuff and conglomerate with interbedded marine shale were laid down in Mesozoic time. All these rocks were intruded in later Mesozoic time by rocks of the Coast Range batholith, to which is ascribed the origin of all the ore deposits of the district. Post-batholithic rocks are represented by volcanic formations and dykes and are assigned to the Tertiary and Quaternary periods.

Table of Formations

Age	Formation	Lithological character
Quaternary	Superficial deposits	Gravel, sand, boulder clay, silt, muck, morainal materials, volcanic ash, soil
Tertiary	Acid volcanics	Rhyolite, granite porphyry, and related volcanics, with associated tuffs and breccias
	Newer volcanics	Andesite, basalt, and related dyke rocks, with associated tuffs and breccias
Upper Jurassic or later	Coast Range intrusives	Granitic rocks ranging in composition from granite to diorite, with associated porphyritic phases
	Older Volcanics	Andesite, diabase, basalt, and related volcanics with associated tuffs and breccias
	Tantalus conglomerate	Conglomerate, with sandstone, shale, and seams of coal
Lower and Middle Jurassic	Laberge series	Argillite, shale, sandstone, arkose, greywacke, tuff, conglomerate

Triassic (or, and) Carboniferous (?)	Limestone	Limestone, more or less dolomitic
Devonian (?)	Taku group	Slates, cherty quartzite, etc.
	Gold series (?)	Pyroxenite, peridotite
Precambrian (?)	Mount Stevens group	Sericite and chlorite schist, mashed basic to semi-basic volcanics, gneissoid quartzite, hornblende gneiss, and limestone

MOUNT STEVENS GROUP

The metamorphic rocks (10)[1] referred to in reports on the district as the Mount Stevens group include a number of members that differ widely in appearance, composition, and, possibly, age. They are, however, all so extremely altered that their mode of origin and succession are in many places uncertain. They consist of sericite and chlorite schists, greenstone schists, sericitic quartzites, gneissoid quartzites, hornblende gneisses, and crystalline limestone. The sericite schists are light grey, soft, fissile rocks consisting of quartz and sericite with a little orthoclase, plagioclase, and calcite. They appear to have been rhyolite breccias originally. The chlorite schists are pale to dark green or occasionally reddish, soft, friable rocks. Calcite and chlorite are their chief constituents. The greenstone schists appear to have formed from diabases, andesites, and related rocks. They are fine- to medium-grained, greenish rocks with a laminated structure, and are commonly porphyritic. Some are composed chiefly of plagioclase and chlorite, with some calcite and quartz. Others consist of plagioclase and augite with zoisite and chlorite. The sericitic quartzites are dark greenish, fine-grained rocks with close foliation, and are of sedimentary origin. The gneissoid quartzites are prevailingly light grey to white, commonly with colour banding. The rocks have a fine, gneissoid structure and to the eye appear to consist entirely of quartz but actually consist of grains of quartz intergrown with feldspar, which is much altered to sericite and calcite. A little biotite is also present. The hornblende gneisses are fine- to coarse-textured rocks with gneissoid structure and have the appearance of crushed intrusive rocks. They contain variable quantities of plagioclase, quartz, and hornblende, and some augite. The limestones are white to slate grey, somewhat argillaceous or siliceous, and generally form massive beds.

[1] Numbers in brackets refer to units in the map legend.

No fossils and no evidence of the age of the Mount Stevens group has been found in this district, other than that it antedates the Coast Range intrusions and Gold series. Similar metamorphic rocks in other parts of Yukon are placed in the Yukon group, some members of which are believed to be of Precambrian age whereas others are known to be Palaeozoic. In this district they include rocks of both igneous and sedimentary origin and may also vary widely in age.

GOLD SERIES (?)

Pyroxenite and peridotite (9) are present at a number of localities in the district, but only two occurrences are large enough to map. One of these, in the bend of Wheaton River, is a pyroxenite body and intrudes metamorphic rocks (10). The other, on Michie Creek, is mainly peridotite carrying 80 per cent or more olivine. It is dark grey or black with locally a greenish tinge, and as a whole is quite massive. Weathered surfaces are coarsely pitted and are bright reddish brown. Chromite constitutes about 2 per cent of the rock and serpentine is an important alteration product. The serpentine is dark olive-green with a waxy lustre and a pale brown coating of weathered products. Some veins of it have central veins of chrysotile asbestos in which the longest fibres seen were three-sixteenths of an inch. No evidence of the precise age of these rocks was obtained, but they are similar lithologically to the "Gold series" of northern British Columbia, which is thought to be Devonian.

TAKU GROUP

Cherty quartzite, slate, and limestone (8) are the principal constituents of a sedimentary assemblage referred to as the Taku group. The cherty quartzite varies from a thinly bedded to massive, grey or light-coloured, in places iron-stained, rock. The slate is locally closely folded and broken by faults. It is thinly bedded and grades into the cherty quartzites. Some grey to black, hard, brittle chert beds are included with the other sedimentary strata. Along Windy Arm all these beds underlie limestone (7) of probable Carboniferous age and have been mapped as Devonian (?).

LIMESTONE

The bodies of limestone (7) are fine to coarse textured and range from greyish blue to almost white. Around Tagish Lake they are prevailingly marble and in many places are handsomely and curiously marked with grey and black lines and spots. In this area, too, some beds contain considerable silica that stands in relief on weathered surfaces, and occasional layers, particularly near the bottom of the series, are composed largely of cherty material. Some sections of the limestone here are at least 3,000 feet thick. In the northern areas the limestone is generally coarsely crystalline, but in places where it contains argillaceous matter the rock is fine-grained.

A few poorly preserved fossils have been collected in this district. One of these suggests a Devonian age, another Carboniferous, and others Triassic. The fossil evidence in every case is meagre and does not permit the conclusion that Devonian and Triassic are represented. Consequently, all limestones except those included in the Mount Stevens group have been placed in the Carboniferous[1].

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[1] More recent study of the Laberge district (Cockfield, W.E., and Lees, E.J.: "The Occurrence of Marine Triassic in Southern Yukon"; Trans. Roy. Soc., Canada, 1931, Vol.XXV, Sec.IV, pp. 101-104; Bostock, H.S., and Lees, E.J.: Laberge Map-area, Yukon; Geol. Surv., Canada, Mem. 217, pp. 11 and 12, 1938), which lies adjacent to the north, has shown that the limestone bodies there, those similar to and in prolongation of the same belt as those on the east of Lewes River, are of Upper Triassic age. Near Big Salmon River in Laberge district another limestone was found to contain fossils assigned to the Mississippian, though it is possible they may be of Pennsylvanian or even Permian age.

LABERGE SERIES AND TANTALUS FORMATION

The Laberge series and Tantalus conglomerate are mapped together (6) in this district because they are of about the same age and the Tantalus occupies areas too small to be shown separately.

The Laberge series contains many thousand feet of strata. A section 4 miles east of Mount Lorne has an apparent thickness of over 10,000 feet, but may possibly include some duplication by faulting or close folding. In Wheaton River area a section of over 5,000 feet is exposed. Here it is composed of slate, shale, sandstone, arkose, greywacke, conglomerate, tuff, and breccia. The arkose is light to dark grey or pale greenish, and includes occasional reddish grey beds. It forms fine- to medium-grained, massive rocks with vague stratification apparent only at a distance. Associated with the arkoses are tuffs so similar in appearance that it is generally difficult to distinguish the two rock types. The conglomerate forms thick beds in which the constituent fragments vary in size from sand grains to boulders more than a foot in diameter and represent detritus from either andesitic volcanic rocks or granodiorite intrusions. The shales are interbedded with arkose and sandstone layers $\frac{1}{4}$ to 1 inch thick. In places they are light grey to black and form zones 20 to 30 feet thick of uniform colour. In other places they may be iron stained, but where freshly broken are grey or black. The sandstones are friable, prevailingly greyish, yellowish, or light brown rocks and form massive beds.

Beds similar to those of the Wheaton River section follow a belt along the margin of the Coast Range. On either side of Coal Lake they contain several coal seams about midway of the section. Northward, toward Lake Laberge, tuffaceous beds become prominent and volcanic material increases in importance to the east. There two main types of tuffs may be recognized, one fine-grained and well-bedded, the other medium-grained and massive. These are interbedded, but in places may comprise thicknesses of several hundred feet of one type without any of the other. On the whole, too, the bedded tuffs are somewhat more abundant than the others.

The typical bedded tuff is a grey, dense rock with conchoidal fracture. Distinct bedding planes are spaced from 1 to 2 inches apart. Parallel to, and between them are indistinct, narrow layers slightly darker than the rest of the rock. Two sets of joint fractures intersect the rock normal to the bedding, and together with the bedding planes are coated with reddish brown iron oxide. The rock is formed mainly of angular fragments, not more than 0.1 millimetre long, of feldspar and quartz. Some biotite and magnetite are generally present and, less commonly, pyrrhotite and titanite.

The massive tuff is not easily distinguished from diabase or basalt, but reveals its clastic nature on weathered surfaces. Where interbedded with fine tuff and shale it may be mistaken for arkose or greywacke. The rock is composed of crystal and minor rock fragments. Crystals of plagioclase in general make up 60 to 70 per cent of the rock and quartz about 15 per cent. Hornblende may constitute up to 10 per cent of the tuff, and titanite, apatite, biotite, augite, pyrite, and pyrrhotite are accessory minerals. The contact with the bedded tuff is sharp in places.

Apparently all gradations are to be found between the fine- and coarse-grained tuffs and between the massive and finely laminated varieties. They grade on the one hand into shales and on the other into breccias and conglomerates. In some localities the fine tuff contains a few widely scattered, large rock fragments.

Conglomerates, although subordinate in amount to the finer grained clastics, form a conspicuous and important part of the Laberge series. They are widely distributed and more abundant near the Coast Range than farther east. They are associated with bedded tuffs at several places in the northeastern part of the district. In some beds pebbles range up to 3 inches in length, in other beds there are boulders up to 2 feet in diameter. Sorting is notably poor or lacking, as in till. Cobbles or boulders more than 2 or 3 inches in diameter are commonly rounded, but with few exceptions smaller cobbles or pebbles are subangular to angular. In some beds much of the interstitial material is tuffaceous.

The conglomerate as exposed in different places holds a varied assortment of detritus. Six miles east of Mount Lorne it contains rounded pebbles of fine-grained igneous rocks and a few angular fragments of thin-bedded black shale. Southeast of Mount Lansdowne a bed, at least 25 feet thick, contains fragments of tuff, quartzite, granite, and various porphyritic rocks in a fine- to medium-grained, tuffaceous matrix. Five miles south and 2 miles west of Mount Lansdowne a coarse conglomerate contains abundant limestone detritus as well as pebbles, cobbles, and boulders of banded tuffs, fine-grained volcanic rocks, and some of probable quartz porphyrites and rhyolites. Conglomerates in the vicinity of Mount Michie are not as coarse as those to the west. The pebbles, too, are notably more angular, are composed of igneous rocks and quartzites, and exhibit no evidence of bedding. Northwest of Mount Michie a large area is underlain by two varieties of conglomerate, one fine and the other coarse and of greater areal extent. The finer type contains angular pebbles up to $\frac{1}{2}$ inch long, with the majority much smaller, embedded in a dark, fine-grained matrix. The coarser type contains rounded to subangular, oval and flat fragments of porphyritic rocks, andesite, limestone, and sandstone from 3 inches to 1 foot long.

The contacts of the Laberge series with underlying formations and Coast Range intrusions are usually not well exposed. In the northeastern part of the map-area a contact between Laberge bedded tuff and limestone was seen. There the tuff appears to overlie the limestone with angular discordance, but the bedding of the limestone is indistinct and the attitude uncertain. Near Mount Lorne the contact of the Laberge and Coast Range granodiorite is definitely intrusive, with large apophyses from the main granodiorite body extending into the adjacent tuff. Granitic dykes, probably related to the larger intrusive bodies, cut the bedded tuffs and the greenstones associated with them.

Fossils found in shale beds of the Laberge series in the Whitehorse district indicate a middle Lower Jurassic to lower Middle Jurassic age[1].

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[1] In the Laberge district (Geol. Surv., Canada, Mem. 217, 1938, pp. 13 to 15) many fossil collections were obtained from the lower member of the Laberge series and show it to be of early Lower Jurassic age. In that district, however, the lower members of the series seems to vary much in thickness and in places the middle member appears to rest directly on the Lewes River series of Triassic limestones, sandstones, shales, and greywacke. No fossils were obtained in the Laberge district from the middle and upper members of the series, which make up many thousand feet. In the Carmacks district, Yukon (Memoir 189, 1936, p. 27) a collection of fossils taken from the lower part of the series is dated as either late Lower, or early Middle, Jurassic.

Small areas of Tantalus formation have been found on the west side of the district close to the Coast Range. This formation consists mainly of massive conglomerate beds, but also includes sandstone, shales, and coal seams. A section west of Annie Lake is 1,700 to 1,800 feet thick. The conglomerate is distinctive in that it is composed almost entirely of pebbles

of quartz, chert, and slate. The pebbles are generally held in a siliceous cement. They are remarkably uniform in size, rarely exceeding 3 inches and most of them between 1 and 2 inches in diameter. The sandstone consists of the same materials.

The Tantalus formation appears to overlie the Laberge series conformably. Fossil plants collected from the coal and shale beds both in this district and neighbouring areas have been determined as uppermost Jurassic or lowermost Cretaceous, probably the latter[2].

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[2] In 1942, W.A. Bell of the Geological Survey, in a memorandum states that collections from the Tantalus formation at Tantalus mine near Carmacks can now be referred definitely to the Lower Cretaceous.

OLDER VOLCANICS

The Older Volcanic rocks (5) comprise andesites, diabases, and basalts, and, as mapped, include minor related intrusive bodies of diorite, gabbro, and hornblendite. Though widely scattered over the district these rocks are most concentrated in a belt that extends northwestward along the eastern edge of the Coast Range batholith and in another belt, less well defined, that lies east of Lewes River.

These rocks carry abundant feldspar phenocrysts, 1/8 inch or more long, in a fine-grained groundmass. In some instances phenocrysts of hornblende and biotite are also present. Magnetite and pyrite are common and their oxidation products stain the rocks brown. Fresh surfaces are typically green, but red, brown, and bluish varieties were also observed. Tuffs and breccias occur in many places.

Plagioclase is always present, and generally in two generations. It ranges from oligoclase to bytownite in composition, but is more commonly andesine or labradorite. The acid plagioclase is present chiefly in the groundmass. Orthoclase forms phenocrysts in a few cases and is also a constituent of the groundmass. The ferromagnesian minerals include hornblende, biotite, pyroxene, and olivine. Both the common green hornblende and brown basaltic hornblende were found, but the former is by far the more plentiful. Biotite is common and is in some cases the only ferromagnesian mineral present. Pyroxene, usually diopside, is present, but seldom in phenocrysts of sufficient size to be detected by the unaided eye. Olivine has been noted in some augite andesites. Pyrite and magnetite are abundant, and often occur in grains large enough to be detected with the naked eye.

The alteration of these rocks in some cases is well advanced, and in many instances masks their original character. Calcite, chlorite, epidote, and zoisite are abundant as secondary constituents.

The abundant volcanic members of the group range from andesites to basalts. The former class includes hornblende andesites, mica andesites, and augite andesites, and the associated tuffs and breccias are mainly andesitic in composition.

Near Crag Lake the rock is greenstone and is locally schistose. It is probably an altered diabase or basalt. Somewhat similar greenstones make up most of the area of these "Older Volcanics" northeast of Tagish Lake.

An important area of greenstones lies northwest of Marsh Lake. Similar greenstones occur on the east side of McClintock Valley near Marsh Lake, but are not shown on the map because of their intimate association with bedded tuffs of the Laberge series.

The rock exposed for nearly 3,000 feet up the slope of the mountains northwest of Marsh Lake is everywhere massive. Small dykes of porphyritic greenstones and small veins of epidote traverse it at various points. In places the rock is greenish grey, medium-grained, and granular; in other places the texture is porphyritic and is visible on weathered surfaces. Fine-grained phases commonly hold small phenocrysts of dark mineral and, occasionally, feldspar. Hand specimens give little indication of a clastic texture, but under the microscope the rock is seen to be fragmental and to carry a large proportion of angular fragments of augite andesite and basalt.

Among other variations of the greenstones in this area one contains altered phenocrysts of a mineral believed to have been olivine; another, large crystals of hornblende; and a third is dark purple with greenish mottling and contains 60 per cent labradorite.

The area between McClintock River and Byng Creek is underlain by massive greenstones that may be mainly intrusive. The rocks are fine-grained, dark green, and weather dark reddish brown. A thin section from one specimen proved to be of peridotite, and from another specimen, actinolite schist.

The greenstones composing Mount Byng include, in addition to the more usual fine-grained varieties, some fairly coarse, granular rocks rich in hornblende. Conglomerates and bedded tuffs occur on the south flank of the mountain. The rocks on the upper parts of the mountain are hornblende gabbro and diabase.

The large belt of these rocks northeast of Cap Creek is composed of greenstones. Specimens from this area included representatives of diorite porphyry, diabase, and andesite.

In the Whitehorse district considerable difficulty was experienced in distinguishing the tuffs interbedded in the Laberge series and those of the Older Volcanics. The rule followed was to represent as Laberge all rock dominantly clastic, even though there was little or no bedding, and to show as Older Volcanics those areas where flows predominated.

The Older Volcanics probably all pre-date the granitic intrusive rocks. Some of the flows are more recent than the beds of the Laberge series with which they come in contact. The writers are of the opinion that the Older Volcanics are to a large extent contemporaneous with the Laberge beds; and that the tuffs, which are so plentiful in the Laberge series, are to be attributed to the same period of volcanism[1].

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[1] Subsequent work in the adjacent Teslin-Quiet Lake area and Laberge district (Geol. Surv., Canada, Mem. 203, 1936, and Mem. 217, 1938) reveal that in the latter most of the volcanic rocks overlie the sedimentary rocks of both the Laberge series and the Tantalus formation unconformably and are, therefore, Cretaceous. In the Teslin-Quiet Lake area, large quantities of volcanic materials were found interbedded with the Laberge series and closely associated with it in distribution. These are placed in the Jurassic, but it is thought that they are not all of the same age and that they may be in part post-Jurassic.

COAST RANGE INTRUSIVES

All the granitic intrusive rocks (4) are included under this heading and comprise many different types. At most places they are fresh, grey rocks, at others, pink. They are medium- to coarse-grained and in places porphyritic, with feldspar phenocrysts 1 inch to 2 inches long.

The essential minerals are quartz, orthoclase or microcline, plagioclase, and, nearly everywhere, hornblende and biotite. Augite is less common under the microscope. Quartz commonly constitutes between 10 and 25 per cent of the rock, and feldspars 60 to 70 per cent. Orthoclase and microcline are, as a rule, nearly equal in amount to plagioclase, which is most commonly oligoclase or andesine. Hornblende and augite are intergrown in many instances.

Examinations of the rocks from detached bodies in the eastern parts of the district show that they vary little from those of the main areas to the west and south.

The rock mass north of Mount Lorne has a granular texture and biotite is almost the only dark mineral. The intrusive body west of Mount Lansdowne is composed of pink granite porphyry except at the lower elevations where the texture is more typically granitic. Phenocrysts of light-coloured plagioclase and a few of quartz make up about 50 per cent of the rock. The groundmass is granular and contains more orthoclase than plagioclase. Magnetite, apatite, and titanite are accessory minerals.

Bodies of these rocks near Mount Caribou are partly porphyritic and partly granular. The porphyritic variety is grey and contains phenocrysts of plagioclase and hornblende in a fine-grained groundmass. Andesine is the most abundant mineral constituent; orthoclase is plentiful; and quartz is subordinate. The granular variety is coarse-grained. Labradorite feldspar constitutes about 66 per cent of the rock; orthoclase, 15 per cent; quartz, 6 per cent; and ferromagnesian minerals 12 per cent.

Intrusive rocks in other parts of the map-area east of Lewes River include variations of the porphyritic and granular types and, in places, more nearly true granites. Some contain more soda feldspar than those described above.

In the eastern half of the district large dykes, varying in composition from granite to diorite and in texture from porphyritic and holocrystalline to granular, intrude greenstones (5) and tuffs (6) and are believed to be offshoots from the larger intrusive bodies. There is a notable absence of pegmatite and other differentiated dyke rocks in the area as a whole, although small aplitic dykes have been observed.

Where contacts are exposed, the Coast Range intrusive rocks (4) have been found cutting the Laberge series and Tantalus formation (6) and the Older Volcanics (5) in this district, and the same holds true in neighbouring areas to the north. This would seem to date the Coast Range batholith as post-Jurassic, but certain factors, namely, the presence of boulders of similar rocks in the Laberge series, and the fact that certain bodies of volcanic rocks in the Laberge district, close to the northwest corner of the Whitehorse map-area and very similar to those of the Older Volcanics (5), are believed to overlie the intrusive rocks, suggest that the batholith may be a complex of intrusions and that some are of pre-Cretaceous age.

NEWER VOLCANICS

A group of volcanic rocks (3) consisting mainly of andesites and basalts forms a number of small, isolated bodies in the central and western parts of the district. The principal areas of these rocks are between the upper parts of Watson and Wheaton Rivers. There they are deeply weathered and fresh specimens are difficult to obtain. Black, and various shades of green and grey, predominate, but shades of red, ranging from dull brick-red or purple to bright vermilion and lavender, are by no means rare. Black scoria is abundant and tuffs, which seen from a distance are white to light pink, are abundantly developed north of Wheaton River.

The andesites and basalts are porphyritic, with phenocrysts of plagioclase and augite. The plagioclases range from oligoclase to bytownite, and the rocks include both green and brown basaltic hornblende. The pyroxene is commonly diopside or hypersthene and some olivine is present. Near Ibex Mountain and Whitehorse the rocks are scoria and basalt.

These rocks cut the Older Volcanics (5) and the Coast Range intrusives (4), and in areas north of Wheaton River are cut by the acid volcanics (2). The large valley between Wheaton and Watson Rivers appears to have been cut into them and on either side the upland surface of the Yukon Plateau continues across their contacts without interruption. On the other hand, in areas near Whitehorse the flows poured into the valley of Lewes River after it had been excavated in the plateau to its present depth. From these factors it is apparent that the newer volcanics (3) include two groups of volcanic rocks, somewhat similar in lithology but different in age, as has been found in the Carmacks and Ogilvie districts. Those in the areas between Wheaton and Watson Rivers can be correlated with the Carmacks group of earlier Tertiary age and those of the areas near Whitehorse with the Selkirk series of late Tertiary or Pleistocene age.

ACID VOLCANICS

A number of small areas of fine-grained acid intrusive and volcanic rocks in the Wheaton River part of the district, west of Fish Lake and south of Mount Byng, have been grouped together under the name acid volcanics (2). In the southern part of the areas of these rocks, south of Mount Byng, the main types are rhyolite, granite porphyry, and related types with granitic habit, some of which would pass for porphyritic granite or granite. The volcanic members are flows and tuffs and cover only small areas; the greater part of the group is represented by dykes or other small intrusive bodies. In some places the dykes are so numerous that they make up the greater part of the areas of older rocks they have invaded. They are massive and the only structural feature noted was widely spaced jointing. Some of the rhyolites are intruded by small, porphyritic dykes. Variations of the rhyolites resemble quartzite; others have a flinty appearance and conchoidal fracture. Under the microscope the rock is seen to be porphyritic, with phenocrysts forming from 5 to 8 per cent of the whole. The phenocrysts are 60 to 80 per cent feldspar, chiefly plagioclase, the remainder being quartz. The groundmass is a holocrystalline, medium- to fine-grained aggregate of quartz and feldspar.

In the more northern areas of these rocks tuffs are more prominent, but flows are still important. No bedding is apparent. The rocks are light greenish grey to purplish grey. Small, white fragments or phenocrysts are scattered through a cryptocrystalline darker groundmass. In places fragments of older rocks, including granodiorite, lie in them.

The small area in the fork of Byng Creek consists of light pink granophyre.

In Wheaton district these rocks form volcanic necks, surface flows, and tuffs, and are considered to be of late Tertiary age.

QUATERNARY DEPOSITS

Extensive and, in places, thick deposits of unconsolidated materials (1) lie in the valleys and lowlands. The higher and more rugged parts of the map-area are, to a great extent, thinly covered and commonly contain large areas of broken rock of local origin, and some outcrops. In places where extensive areas of the old upland surface remain, at an elevation of about 5,000 feet, considerable stretches of soil, up to tens of feet in depth and derived mainly from local bedrock, cover the surface.

The valley accumulations, with the exception of alluvial cones and present stream wash, are of glacial origin, being moraines and deposits of glacial streams and lakes. These glacial deposits consist of sand, gravel, silt, clay, and till. A great terrace fill of these materials near Whitehorse diverted Lewes River from a previous more easterly course into its present one cut in the lava flows at Miles Canyon and Whitehorse rapids. The terrace deposits are at least 300 feet thick. Exposures indicate that the terrace is made up mainly of white, bedded, glacial lake silts, with sands and some gravels above and in channels in them. The terrace surface is pitted in places by kettle holes, and cut banks along Lewes River below Whitehorse expose sections through some kettle holes showing the down warping of the silt beds as well as the depressions in the surface above them. Glacial till or boulder clay, though probably underlying many of the valley areas under the stream and lake deposits, is rarely exposed.

Deposits of peat have formed in some favourable valley areas. A layer of white volcanic ash, about 1 inch thick, is present in the top soil on flats and gentler slopes where it has not been washed away.

STRUCTURAL GEOLOGY

The lack of distinctive members in the Laberge series and Older Volcanics, together with the separation of the areas of these formations into numerous, small, isolated blocks by drift-covered valleys and by bodies of intrusive rocks have prevented structures being followed from one block to another. In these blocks, as a rule, the strike shows a prevailing northwest trend and dips are steep. Intense close folding is apparent, and incompetent beds are highly contorted. Where evidence is available these structures appear to have been formed before invasion by the Coast Range batholith. From the adjacent, more recently studied Laberge district, to the north, a broad syncline upwarped along its centre extends southward into the Whitehorse district where its continuity is represented on the west by the belt of Older Volcanics along the edge of the Coast Range, and on the east by areas of these rocks and of the Laberge series east of Lewes River. The upwarped, central part of the syncline, between Tagish Lake and Lake Laberge, is occupied in part by older masses of limestone, mainly of Palaeozoic age. Farther north the limestones in the upwarp are Triassic.

ECONOMIC GEOLOGY

Whitehorse district contains numerous mineral deposits, and coal is also known to occur at several points. Almost all the known mineral deposits have been described from time to time in reports of the Geological Survey, but as these accounts are scattered through many reports, some of which are out of print, the salient features of the deposits are repeated below.

ORE DEPOSITS

The ore deposits of Whitehorse district, for convenience of description, may be divided into four main groups:

(a) Gold-silver quartz veins
(b) Antimony-silver veins
(c) Silver-lead veins
(d) Contact metamorphic deposits

Gold-Silver Veins

These veins are widely distributed in southern Yukon, and occur in Windy Arm and Wheaton areas, Whitehorse district. They occur in a general way in a belt paralleling the trend of the Coast Range. They are also present in the Coast Range intrusives, in the Older Volcanics, and in the schists of the Mount Stevens group. The vein fillings consist chiefly of quartz with subordinate amounts of calcite and barite. Galena is the most characteristic metalliferous mineral. Arsenopyrite, chalcopyrite, stibnite, pyrite, and tetrahedrite are common; rarer minerals include argentite, pyrargyrite, jamesonite, chalcocite, yukonite, native gold, native silver, and tellurides, with the usual oxidation products.

Windy Arm District

Many claims have been located in Windy Arm district, as that part of Whitehorse district lying between Bennett Lake and Windy Arm of Tagish Lake is commonly called. Much work was done on them prior to 1912; since that time some of the properties have been worked intermittently. The various properties are readily accessible from Carcross on the White Pass and Yukon Route, which serves as the centre for the district.

Big Thing. The Big Thing is located 5½ miles south of Carcross and is connected with that point by wagon road. The property was worked for a number of years by J.H. Conrad and subsequently taken over, for money advanced, by representatives of Mackenzie and Mann.

The development work includes an inclined shaft of 450 feet, with four levels that total over 700 feet of drifting. An adit 2,320 feet long intended to crosscut the vein at depth was also run, and from this several crosscuts and raises were driven.

The ore deposit is a fissure vein that cuts granitic rocks. It strikes north 55 degrees east and dips northwest from 25 to 35 degrees. It is mostly from 2 to 8 feet thick, although in places it attains a thickness of 12 feet. The mineralization is of quartz with pyrite and arsenopyrite, and subordinate galena, chalcopyrite, and stibnite.

To the east of the shaft the vein is repeatedly faulted; to the west of the shaft where exposed in the various levels it is relatively regular. Cairnes estimated, in 1916, an average value of $15 a ton in gold and silver for the ore. It is known that the shipments made since that time have been relatively small, as the mine has been closed down for most of this period.

Montana. The Montana is another of the original Conrad properties and is located high on the mountain side 3 miles south of the Big Thing.

The development work includes a drift along the vein for a distance of about 700 feet. An incline shaft was sunk, which for part of its depth follows the vein, but departs from it where the vein changes its dip. A short crosscut has been run from the bottom of the shaft to intersect the vein at that depth.

The vein is a fissure, in volcanic rocks, striking about north 10°30' east, astronomic, and dipping southwest at 10 to 30 degrees. It has a thickness of 2 to 5 feet and is composed mainly of quartz, with which is associated galena, pyrite, arsenopyrite, pyrargyrite, argentite,

native silver, and lead carbonate. The principal values are in silver, but the pyritic parts also contain gold. In places the vein matter, especially adjoining the walls for thicknesses of 8 to 18 inches, is very highly impregnated with silver minerals and assays $80 to $90 a ton. The rest of the vein is of much lower grade.

M and M. The M and M is also one of the original Conrad claims. The vein outcrops on the left bank of Pooly canyon near the top of the hill and has been traced about 400 feet on the surface. It is a fissure in andesite, striking almost due north and dipping west at an angle of 15 degrees. It has a thickness of 6 to 12 inches, and is composed mainly of quartz with which occur pyrargyrite, stephanite, freibergite, tetrahedrite, and carbonates. A small shipment is reported to have yielded $165 a ton in gold and silver, mostly the latter.

Venus. The Venus is one of the most extensively developed of the original Conrad properties, and like the others came under the control of Mackenzie and Mann. Two claims are included, Venus No. 1 and Venus No. 2; the bulk of the work has been on No. 2. On No. 1 a shaft 52 feet deep has been sunk on the vein and from the bottom of the shaft drifts have been run about 50 feet in opposite directions.

On the Venus No. 2 two adits have been driven, which cut the vein at different depths. The upper adit is 80 feet long and encounters the vein at 75 feet below the surface. The lower adit is 600 feet long and cuts the vein at 263 feet below the level of the upper adit. From the upper adit drifts have been run 108 and 88 feet to the south and north, respectively. From the lower adit drifts have been run 583 and 622 feet to the south and north, respectively. Several raises and stopes have been driven from this lower level, and two winzes, 235 and 400 feet deep, have been sunk from the north and south drifts.

The vein is a fissure cutting andesites and has a strike of north 10 degrees east and a dip to the west ranging from nearly flat to 60 degrees. The fissure is in most places of a compound nature, and the vein as a whole is confined between two main fault-planes from a few inches to 8 or 9 feet apart. The ore material averages from 2½ to 3 feet thick, and consists of quartz, galena, pyrite, and arsenopyrite, with jamesonite, yukonite, chalcopyrite, and chalcocite, as well as oxidation products. The gold value rarely exceeds $50 a ton and is generally under $25; the silver values vary from less than an ounce to 100 ounces to the ton. The ore in the higher grade shoots averages from $30 to $50 a ton in all values, but much of the vein is low grade, running from almost nothing to about $20 a ton.

Dail and Fleming Group. A number of claims, generally known as the Dail and Fleming group, are situated immediately south of the Venus. These include the Venus Extension, Red Deer, Humper No. 1 and No. 2, Nipper No. 2, and Beach.

The development work includes an incline shaft 120 feet deep on the Venus Extension, a crosscut and drift of 205 feet on the same claim; a crosscut and winze on the Nipper No. 2; a winze and drift on the Humper No. 2; and a number of open-cuts and pits.

Three principal veins have been found. These are known as the Venus, Humper, and Red Deer. The Venus vein is the same as the one developed on the Venus property, and has been traced entirely across the Venus Extension. Its characteristics are somewhat similar to those given for the Venus property, except that the attitude of the vein is nearly flat, and the vein is intensely leached and oxidized.

The Humper vein also occurs in a fissure traversing andesitic rocks. The strike varies from east and west to north 60 degrees east and the dip from 35 degrees to 65 degrees to the north and northeast. The thickness of the vein is from 10 to 24 inches. The vein is composed of quartz with which are associated argentite, pyrargyrite, stephanite, galena, pyrite, and some native silver.

The Red Deer vein, also a fissure in andesite, strikes north 30 degrees east and dips northwest at an angle of 50 degrees. It is, where exposed, from a few inches up to 3 feet in thickness, and is composed of quartz that carries pyrite, galena, and various high-grade silver minerals.

Wheaton District

Most of the properties of Wheaton district are readily reached from Robinson station on the White Pass and Yukon Route, from which point a wagon road leads to Carbon Hill, passing within short distances of most of the properties described. The bridge across Wheaton River on this road has been washed away in recent years so that the river must be forded. This can only be done in the later part of the season.

The Wheaton deposits occur in a belt 16 miles long and 9 miles wide, and most of them lie in the central strip of this belt, 2 miles wide and extending from Mount Stevens across Gold Hill and Hodnett Mountain. Other veins have been found on Mount Anderson and Red Ridge, to the west and east, respectively, of this 2-mile belt. Most of the veins strike, in a general way, parallel to the belt in which they occur; this belt parallels the trend of the Coast Range Mountains to the west. The veins are as a rule steeply inclined, with a prevailing easterly dip.

The deposits occur chiefly in the Coast Range intrusive rocks, but also exist in the schistose members of the Mount Stevens group. The veins in the intrusionsare regular in strike, thickness, and mineral composition for considerable distances. One has been traced 3,000 feet and has 4 or 5 feet of vein material over this distance. How far the other veins extend is not known, but some have been traced for 1,500 feet. They vary in thickness from a few inches to 7 or 8 feet, but the average vein in the granite is 3 or 4 feet thick. In the schist the materials have been deposited in lens-shaped masses, or in irregular fissures that may connect these lenses or be independent of them. The lenses are mostly 6 or 8 feet thick and 20 to 40 feet long. One lens on the Acme claim is 30 feet wide and 100 feet long.

The vein fillings consist of quartz with subordinate amounts of calcite. Galena is the characteristic metalliferous mineral. Pyrite, chalcopyrite, native gold, sylvanite, hessite, petzite, and telluric ochre also occur.

Mount Stevens. The Acme claim is situated on top of Mount Stevens. The vein consists of a lenticular mass of quartz, which occurs in chloritic or sericitic schists, is 30 feet wide at one place, and appears to be about 100 feet long. In some places galena and pyrite occur, but the bulk of the quartz contains no metalliferous minerals.

Buffalo Hump Group consists of three claims, the Sunrise, Golden Slipper, and Wheaton. On the Golden Slipper claim a certain amount of quartz float carries disseminated galena with free gold and sylvanite. The vein from which this material came has not yet been discovered.

On the Sunrise claim, a quartz vein, in a fissure in granite, carries some galena and native gold. The vein is 7 feet thick in one

place, but does not average more than 2 or 3 feet for the 50 feet that the ore has been traced. The values are very erratically distributed.

Midnight Group. The Midnight group is situated on the southeastern face of Stevens Mountain, and consists of eight claims.

The veins are in reality dykes of granite porphyry that have been altered and silicified. The infiltration of secondary silica was accompanied by the deposition of native gold, galena, and pyrite. Two main dykes have been recognized, one 50 feet wide and the other 25 feet wide. A rough sampling of the property indicated that the values are spotty and not maintained over the width of the dyke, but are confined to the places where gold or sulphides are visible. A considerable amount of surface work has been done on the deposits.

Wheaton Mountain. The McDonald Fraction, situated near the western edge of Wheaton Mountain, has a vein cutting granite and striking north 47 degrees west. Its dip is nearly vertical. The vein is well mineralized, chiefly with argentiferous galena, which in places constitutes the greater part of the vein filling. A 20-foot shaft has been sunk on the vein. A number of samples taken from the vein and from the dump at the shaft all assayed less than $1 a ton in gold and silver.

The Silver Queen and Gopher claims are situated on the western part of Wheaton Mountain and are the principal claims in a group of seven. On the Silver Queen is a quartz vein in granite, about 3 feet thick, which contains galena and pyrite. On the Gopher is an irregular, lenticular mass of quartz in greenstone schist, which at its widest point is 7 feet from wall to wall. The quartz carries scattered particles of galena.

Tally-Ho Gulch. The Tally-Ho group is situated on the west side of Tally-Ho Gulch.

The ore occurs in a brecciated fault zone 4 to 12 feet thick cutting a granitic formation. The zone strikes northwest and dips to the northeast at 60 to 70 degrees; a drift has been run along it 290 feet, leading from which are a 40-foot raise and a 15-foot crosscut.

The granitic fragments of the fault breccia have been cemented by quartz, and a vein of quartz of varying thickness has been deposited along the foot-wall. The quartz carries considerable galena and from $9 to $80 a ton in gold and silver. It is thought that a considerable percentage of the quartz will average $20 to the ton in gold and silver.

Whirlwind and Sheep Mountain Groups. These groups consist of six and five claims, respectively. Two main veins have been discovered on the property and extend along the face of Mount Anderson for a distance of 2,000 feet or more. The greater part of the development work has been done on the lower vein. A drift 350 feet long has been run on this vein, which over this distance has an average thickness of 18 inches and a maximum thickness of 6 feet. About 150 feet below this drift, a crosscut 172 feet long has been driven to the vein and a drift from the end of the crosscut follows the vein for 150 feet. Over this distance the vein has a thickness of 18 to 20 inches.

Continuing to the southeast along the face of Mount Anderson vein outcrops have been exposed by surface workings for a distance of 2,000 feet. These may be parts of two or possibly three additional veins, but are more likely the continuation of the lower vein repeatedly faulted. On the Sheep Mountain group, the most southerly exposure is termed by the owners the "big showing". The quartz here has an aggregate thickness of $3\frac{1}{2}$ to $4\frac{1}{2}$ feet and is well mineralized.

The lower vein is claimed to average $10.60 a ton in gold, silver, and lead; the lead running 8 per cent and valued at the rate of 4 cents a pound. The gold is mostly low, but occasional samples have carried 3 ounces to the ton.

Approximately 200 feet in elevation above the outcrop of the lower vein, an upper vein outcrops. This strikes about due east and is nearly vertical. The vein consists of quartz with disseminated galena and pyrite. An adit 35 feet long has been run to crosscut the vein, and a drift 75 feet long has been run in a southerly direction from the end of the adit. The vein as exposed has a thickness of 4 to 20 inches, and samples taken from it at close intervals contained $5 to $18 a ton in gold, silver, and lead.

Gold Hill and Vicinity. The Gold Reef claim is situated on Gold Hill. The vein strikes north 55 degrees west and dips southwest at 50 to 60 degrees. It occurs in greenstone schist and is one of the most regular of the veins so far found in the schistose formation. It has been traced for 1,000 feet and has an average width of 4 to 5 feet. The quartz, with the exception of occasional particles of pyrite, contains practically no metalliferous minerals. A few pockets of ore have been found, however, containing native gold, sylvanite, hessite, petzite, and telluric ochre. Although considerable development work was done less than a ton of this rich ore has been discovered.

The Legal Tender is the only other claim in this locality on which development work has been done since 1906. This claim lies on Mineral Hill overlooking Watson Valley. The vein is a fissure in granite, and strikes in a northwesterly direction and its attitude approaches the vertical. The fissure is filled with quartz and argentiferous galena, with occasional masses of chalcopyrite. A drift 100 feet long has been run on the vein, which for this distance remains fairly persistent in strike, dip, thickness, and degree of mineralization.

Mount Reid Property. Two claims have been staked on the eastern slope of Mount Reid.

The vein is only partly exposed in a small gulch, tributary to Skukum Gulch, and has been traced on the surface for a distance of 1,000 feet by means of pits, most of which had caved at the time of examination. The gangue of the vein is quartz, mineralized with galena, pyrite, stibnite, and arsenopyrite. At the only point where exposed the vein had a thickness of 3 feet.

Mascot Group. This property is situated on a small gulch near the head of Watson River.

The development work consists of an adit 200 feet long, which, however, could not be examined in 1922 as it was filled with water and ice. The outcrop of the vein is visible along a cliff face for nearly 2,000 feet. Assays from the outcrop show values of $15 to $30 in gold, silver, and lead. Below the adit the vein is 6 feet wide, but inside the portal it narrows to 2 feet, and, according to information supplied, to 6 inches at the face.

Antimony-Silver Deposits

The area containing these deposits is limited, so far as is known, to the eastern face of Caribou Hill and part of Chieftain Hill, Wheaton district. The deposits are of the fissure-vein type, the fissures occurring in Coast Range intrusive rocks and the andesites and volcanic breccias of the Older Volcanics.

Two of the veins have been traced for distances of 2,000 feet; but other outcrops are rather commonly covered with superficial materials, and none of them has been followed for more than 200 feet. The veins vary in thickness from 2 or 3 inches to 6 feet, but 1 to 3 feet is about the average of the more valuable. Stibnite constitutes the greater part of the vein fillings in some parts of the veins, and in such cases is associated with minor amounts of sphalerite and jamesonite. Where any gangue is present it is as a rule quartz; barite and calcite occur only in subordinate amounts. The veins that are richest in silver consist of a quartz gangue, impregnated with galena and tetrahedrite, and a small amount of antimony minerals. In fact, ores that are high in silver are mostly low in antimony and vice versa, but there are places where silver and antimony occur together in considerable amounts. Assays running over 500 ounces of silver to the ton have been obtained, but they are exceptional, and most of the ores of the better grade, carrying galena and tetrahedrite, run from 100 to 200 ounces of silver a ton. The higher grade stibnite ores carry from 50 to 65 per cent antimony.

Chieftain Hill and Vicinity

The only vein of any importance known on Chieftain Hill is exposed in a prominent draw, about halfway to the summit. Two claims, known as the Morning and Evening claims, were formerly located on this deposit, but these have since lapsed and been relocated. The cuts, trenches, and pits made on these claims have all filled in, but the vein is visible where it crosses the gulch and there has a thickness of 5 feet. The vein consists chiefly of quartz and stibnite, with subordinate amounts of zinc blende; 2 feet of this thickness is composed almost entirely of stibnite. The vein narrows rapidly in each direction from this point, being not more than 6 inches to a foot in thickness 50 feet away.

Carbon Hill

Fleming Property. A group of six claims on the western face of Carbon Hill includes the claims formerly known as the Porter group.

A number of veins have been discovered on this property, the exact number being uncertain due to the fact that in some cases not enough work has been done to permit of correlating parts of veins. The veins occur cutting Coast Range granitic rocks and andesites of the Older Volcanic group. The development includes 1,100 feet of underground workings. The veins range from a few inches to 3 feet in thickness, but are generally under 2 feet thick. Average samples of the vein material rarely carry more than 20 to 25 per cent antimony, and in most cases less than 20 per cent. The gold content is mostly less than $1 a ton. The silver and lead values are, however, important. The better veins contain from 15 to 30 ounces of silver to the ton, with occasional assays of 50 ounces. The average silver content for all the veins is somewhat less than 5 ounces. Lead in average samples is in most cases under 5 per cent.

Goddell's Claims. These claims occur on the Wheaton River slope of Carbon Hill, about a mile north of the Fleming group.

Two parallel veins, 20 to 30 feet apart, outcrop in a gulch on these claims, and are distinctly exposed, extending up the mountain side for 2,000 feet. They cut Coast Range granites, and strike north 83 degrees west and are almost perpendicular. The veins consist of quartz impregnated with jamesonite and arsenopyrite, and are from 2 to 6 feet thick.

Becker-Cochran Property. This claim is situated on the eastern side of Carbon Hill. The vein has a thickness of possibly 3 feet, but as it had not been stripped when visited very little definite information was available. Samples taken from the vein float indicated 21 to 40 per cent of antimony and no silver.

Silver-Lead Veins

Although silver-lead veins are treated as a separate group, it will be seen that they possess many points in common with the gold-silver-quartz type, and that the division between the two classes is not very sharp. Parts of some of the deposits considered under the head of gold-silver quartz veins are valuable chiefly for their silver and lead content. The deposits considered below, however, have certain characteristics that have caused them to be considered as a separate group.

Veins of this class occur on Idaho Hill and Mount Follé in the arkoses of the Laberge series. The deposits are tabular in form, but there is a lack of definition between the walls and the ore. The veins are exceedingly irregular in thickness, ranging from a few inches up to 4 to 6 feet.

The vein materials consist mainly of quartz, calcite, galena, arsenopyrite, zinc blende, pyrite, and chalcopyrite. Quartz is the chief gangue mineral, and arsenopyrite and galena are the principal sulphides. The ores generally contain only a few cents to the ton in gold, and rarely have more than $2. Assays of better grade ores yielded approximately 50 ounces of silver and 40 per cent lead.

Union Mines. The property known as Union Mines consists of two claims. It is many years since any work has been done on these claims.

Twelve veins have been found. One of these is, where exposed, 2½ feet thick. The others, throughout the greater part of their lengths, vary in thickness from 4 to 12 inches, but in a few places masses of ore ranging, with included rock, from 2 to 4 feet thick and from 5 to 20 feet long were found. One irregular area, possibly 12 feet wide and 20 feet long, appeared to be half ore. Most of the veins strike about north 12 degrees west and dip 60 to 70 degrees to the southwest.

Nevada Mines. This group of eight claims was located as an extension to the Union Mines group. Only two veins are exposed on the Nevada group; these are similar to those at Union mines except that they contain much less galena, and so consist mostly of quartz, calcite, arsenopyrite, zinc blende, pyrite, and chalcopyrite.

Contact Metamorphic Deposits

Almost all the deposits belonging to this type occur within the Whitehorse copper belt, which extends 12 miles along the valley of Lewes River from a point east of Dugdale northwestward to the base of Mount Hackel. One deposit in Wheaton River district also falls within this class.

Whitehorse Copper Belt

The ore deposits occur chiefly at or near the contacts between limestone and granitic intrusions, deposits being found both in the limestone and in the granite.

The principal economic minerals of the district are the two copper sulphides, bornite and chalcopyrite. Tetrahedrite occurs at the Arctic Chief and small bunches of chalcocite at the Best Chance and other places. Oxidation products are abundant and except at the Pueblo are seldom important as ores. They include the carbonates malachite and azurite, the oxides cuprite and malaconite, and the silicate chrysocolla.

Native copper is in some places associated with the cuprite.

Iron sulphides are not abundant and nowhere form large masses. Scattered grains of pyrite occur in the granites and altered limestones, and pyrrhotite occurs at the Arctic Chief.

The iron oxides, magnetite and hematite, are widely distributed. Magnetite is especially abundant and lenses of this material from a few inches to 360 feet in length are found all along the belt, mostly in the altered limestones, but also in the altered granites. Hematite is less common, but is the principal mineral in the Pueblo deposit.

Other metallic minerals of less frequent occurrence are arsenopyrite, stibnite, galena, sphalerite, and molybdenite. Gold and silver occur in all the ores. Both are occasionally found as native minerals.

The principal non-metallic minerals accompanying the ores are garnet (andradite), augite, wollastonite, actinolite, epidote, calcite, clinochlore, serpentine, and quartz.

The ore-bodies fall into two classes; those in which the copper minerals are associated with magnetite and hematite and those in which silicates are the chief gangue minerals. The magnetite orebodies are numerous and occur enclosed completely in altered limestone, or along the lime-granite contact, or in the altered granite. The largest bodies discovered are the Best Chance, 360 feet in length, Arctic Chief 230 feet, and Little Chief 100 feet. The magnetite masses are always sprinkled with grains and masses of bornite and chalcopyrite. Hematite masses are much less common than magnetite, only one large body being known. This is the Pueblo lode. It differs from the magnetite ore mainly in the greater oxidation of the copper minerals.

Showings characterized by silicate gangue are numerous wherever the lime-granite contact is exposed. These vary from a sprinkling of copper minerals to lenses of considerable size, such as are developed on the Grafter, Copper King, War Eagle, and Valerie. All the important bodies of this class occur in the limestone, close to the granite, and are in many cases separated from the granite by a zone of more or less completely replaced limestone.

As practically no geological work has been done on these deposits since the report by McConnell, descriptions of the individual deposits need not be given here. At some of the properties considerable mining has been done since the date of McConnell's report, and as in many cases the workings are inaccessible, due to the fact that the properties have been shut down for a number of years, it is felt that any description based on McConnell's report would be considerably out of date. Since 1915 comparatively little mining has been done in the Whitehorse belt. It is to be expected that a considerable tonnage still remains to be extracted, if the occasion should arise when economic conditions would render the mining of the Whitehorse ores profitable.

Fleming Claim

The Fleming claim is situated on a small ridge facing Wheaton River about a mile west of Becker Creek.

The ore materials occur in a hornblende gneiss of the Mount Stevens group, close to the contact between the gneiss and the Coast Range granodiorite. The deposits follow the strikes and dips of the gneisses, trending north 42 degrees west and inclined at 60 to 90 degrees in either direction.

The largest deposit is 30 feet wide with length unknown; near this are two smaller bands 4 to 6 feet wide. The mineral deposits consist of magnetite, specular hematite, chalcopyrite, pyrite, quartz, calcite, epidote, actinolite, and garnet, apparently grossularite. The central part of the large deposit consists chiefly of iron and copper and contains about 1 per cent copper. Gold does not exceed $2 a ton.

COAL

Coal has been found at two localities in Whitehorse district. Only a very little mining has been done, chiefly on account of lack of market.

Whitehorse Coal

A number of claims known as the Whitehorse coal claims have been located at the head of Coal Creek, near Granger Mountain. A tunnel about 60 feet long has been run on one of the seams and a few open-cuts have been made; otherwise the coal is practically undeveloped. The strike of the seam at the tunnel is north 63 degrees west with a dip of 42 degrees to the northeast. The seams measured were 9 feet 8 inches, 10 feet 4 inches, and 2 feet 6 inches. It is probable that a number of other seams, as yet undiscovered, exist. The coal is anthracitic in character—no seams of coking coal were found. Four samples were taken: A, B, C, of the seams in the order mentioned, and D, a sample of a seam found in the creek below the workings, which may be the same as one of the others. The proximate analyses follow:

Sample	A	B	C	D
Water	2.15	3.78	3.76	2.35
Volatile combustible matter	6.10	10.06	8.34	6.65
Fixed carbon	69.86	38.38	62.50	42.27
Ash	21.98	47.48	25.40	48.73
	100.09	99.70	100.00	100.00

Mount Bush

Three seams of coal were partly stripped at the outcrop on Mount Bush, Wheaton district, and the outcrops of what appeared to be several other seams were noted. The seams stripped occur in the Tantalus conglomerates, and were 18 inches, 6 feet, and 5 feet thick. At this place the coal measures are intersected by a fault with a displacement of at least 5,000 feet, which will cut off the seams at a depth of 2,000 feet from the discovery, measured along the seams. The coal is a semi-anthracite. The high ash content in the following analysis is probably due to the fact that the sample was taken from the frozen outcrop and contained a high percentage of sand and other materials. The following sample was taken from the 6-foot seam.

	Per cent
Moisture	4.78
Volatile combustible matter	8.62
Fixed carbon	56.50
Ash	30.10
	100.00

BIBLIOGRAPHY

Bostock, H.S.: Geol. Surv., Canada, Mem. 234, pp. 34 to 38 (1941).

Cairnes, D.D.: "Portions of Conrad and Whitehorse Mining Districts"; Geol. Surv., Canada, 1908.

_____ Geol. Surv., Canada, Mem. 31, 1912.

_____ Geol. Surv., Canada, Sum. Rept. 1915, pp. 36 to 49.

_____ Geol. Surv., Canada, Sum. Rept. 1916, pp. 34 to 44.

Cockfield, W.E.: Geol. Surv., Canada, Sum. Rept. 1922, pt. A, pp. 1 to 8.

_____ Geol. Surv., Canada, Sum. Rept. 1927, pt. A, pp. 14 to 18.

_____ Geol. Surv., Canada, Sum. Rept. 1929, pt. A, pp. 13 to 15.

_____ Geol. Surv., Canada, Sum. Rept. 1930, pt. A, pp. 10 and 11.

Cockfield, W.E., and Bell, A.H.: Geol. Surv., Canada, Mem. 150, 1926.

Dawson, G.M.: "Report on an Exploration of Yukon District, N.W.T."; Geol. Surv., Canada, Ann.Rept.,1887-88, vol. III,pt. 1, rept. B.

Gwillim, J.C.: "Report on Atlin Mining District"; Geol. Surv., Canada, Ann. Rept. 1899, vol. XII, pt. B.