CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

Paper 52-30

GEOLOGY AND MINERAL DEPOSITS OF WHITEHORSE MAP-AREA, YUKON TERRITORY (Preliminary Account)

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OTTAWA
1952

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Illustration

GEOLOGY AND MINERAL DEPOSITS OF WHITEHORSE MAP-AREA, YUKON TERRITORY

GENERAL STATEMENT

Whitehorse map-area contains an important airport at Whitehorse, and is accessible by motor vehicle via the Alaska Highway, and by the White Pass and Yukon Railway from Skagway, Alaska.

Field work for the present report was begun in 1946 by J. G. Fyles, continued during June 1947 by J. R. Johnston, and completed by the writer during the field seasons of 1948 to 1951. These field seasons extended from the beginning of June to the end of September, during which the weather was generally fair and pleasantly warm, only 28 days of field work being lost as a result of bad weather in these 4 years.

ACKNOWLEDGMENTS

The author wishes to acknowledge the courtesies extended by many of the residents of the Whitehorse area, as these facilitated the work in many ways.

Able and satisfactory assistance was given: in 1946, by J. W. Lee and J. C. Amy; in 1947, by M. C. Robinson and A. Hall; in 1948, by L. L. Price, J. D. Aitken, and W. Mundie; in 1949, by L. T. Jory, W. S. Pentland, and L. C. Kilburn; in 1950, by C. E. C. Daw, J. C. Riddle, and G. Skoreyko; and in 1951, by W. R. A. Baragar and Z. Nikiforuk.

PHYSIOGRAPHY AND GLACIATION

The western part of the map-area, south of Takhini River, lies within the northern limit of the Coast Mountains. The main valleys in this sector are narrow and steep-walled, and have hanging tributaries. The upland surface is represented by broad ridges and small tablelands between 5,000 and 6,000 feet high surmounted by groups of mountains up to an elevation of 8,000 feet. Cirques are abundant, and many small glaciers occur in the south, where the mountains are higher and more rugged.

The remainder of the map-area lies within the Yukon Plateau. There it is dissected into smoothly rounded upland areas up to an altitude of about 6,000 feet, with locally more rugged peaks rising above them, and separated by broad valleys, the floors of which are 2,000 to 2,500 feet above sea-level.

During Pleistocene time the area was overridden, to an altitude of 6,000 to 6,500 feet, by an ice-sheet that, on the evidence of boulder trains and glacial grooves, moved northwesterly.

Most of the valleys are timbered to an elevation of 4,500 feet and, except for some of the narrower, high valleys in the southwestern part of the district, offer good routes of travel for horses. Tarpauline-covered canoes or boats may be used on Marsh, Tagish, and Bennett Lakes, and aircraft with floats can land on these or any of the other larger lakes.

Table of Formations

Era	Period or epoch	Formation and thickness (feet)	Lithology
Cenozoic	Pleistocene and Recent		Glacial drift, alluvium, loess, volcanic ash
	Tertiary	Miles Canyon basalts, 150 ±	Basalt; minor pyroclastic rocks
		Unconformity	
			Granite porphyry
		Intrusive contact	
		Skukum volcanic rocks, 4,000 +	Andesite, porphyritic andesite, basalt, trachyte, and rhyolite lavas; agglomerate and tuff
		Unconformity	
Mesozoic	Post-Upper Jurassic or Lower Cretaceous		Pink granite
		Intrusive contact	
		Coast intrusions	Granodiorite, granite, quartz monzonite, quartz diorite, and allied rocks
		Intrusive contact	
			Pyroxenite, peridotite, and serpentine
		Intrusive contact	
		Hutshi group 2,000 +	Andesite, porphyritic andesite, basalt; agglomerate and tuff; minor conglomerate at base

Table of Formations (continued)

Era	Period or epoch	Formation and thickness (feet)	Lithology
		Unconformity	
Mesozoic	Upper Jurassic or Lower Cretaceous	Tantalus formation, 2,500 +	Conglomerate, sandstone, siltstone, argillite, and coal
	Lower Jurassic and (?) later	Laberge group 6,500 ±	Conglomerate, arkose, greywacke, quartzite, siltstone, and argillite
		Unconformity	
	Upper Triassic ~~and~~ ~~[illegible]~~	Lewes River group, 10,000 ±	Greywacke, arkose, siltstone, argillite, limestone, and tuffaceous equivalents; conglomerate; agglomerate and tuff; andesite, porphyrytic andesite, and basalt lavas
		Relations not known	
Palaeozoic	Carboniferous and/or Permian (?)	Taku group	Limestone, limestone-breccia, chert; basic lavas and pyroclastic rocks
		Relations not known	
Precambrian and later		Yukon group	Quartz-mica schist, mica schist; quartz-chlorite schist; quartzite; feldspathic gneiss; injection gneiss; gneissic porphyritic granite

DESCRIPTION OF FORMATIONS

Yukon Group

The Yukon group of closely folded metamorphic rocks lies within the area of granitic intrusions. It is composed chiefly of brown and grey, silvery quartz-mica schist and mica schist; greenish grey, quartz-chlorite schists, locally garnetiferous; grey and white, banded quartzite; and some light brown feldspathic gneiss. Discontinuous lenticular beds of white crystalline limestone, which in many places are highly contorted, are associated with the schists and quartzites.

Southwest of Alligator Lake is an area of light brown, feldspathic gneiss, injection gneiss, and highly sheared and gneissic porphyritic granite.

The age of these rocks in this map-area is not known.

Taku Group

The Taku group is exposed in the southeast corner of the area, where it consists mostly of white and grey limestones, partly fossiliferous, and minor limestone-breccia. Two or more bands of, in part, grey and banded; in part, black and massive; in part, rusty, black, and highly contorted ribbon chert are interbedded with the limestone. Near some lavas on the island at the mouth of Windy Arm the limestone contains abundant chert nodules and silicified fossils. Intercalated with the limestones is a volcanic assemblage of dark green and purple, altered, amygdaloidal and vesicular basic lavas, tuffs, and breccia, with minor clastic sedimentary rocks. No estimate of the total thickness of the Taku rocks could be made because of the close folding and lack of marker beds.

Fusilinids obtained from the fossiliferous limestones suggest a probable Permian or Carboniferous age.

Lewes River Group

The Lewes River group of mainly Upper Triassic age underlies much of the map-area, and may be broadly divided into two facies -- one chiefly sedimentary, the other containing much volcanic material.

Volcanic rocks are scarce east of Lewes River, where the group is composed of at least 10,000 feet of clastic sedimentary rocks, characterized by graded bedding, and two bands of limestone. The clastic rocks are mainly grey and greenish grey greywacke; in addition, they include some arkose, grey and greenish buff siltstone, grey and rusty black argillite, and interbedded conglomerate composed mostly of green volcanic fragments. Much of the finer clastic rock may be of pyroclastic origin. The limestone occurs at, or very near, the top of the section, and attains a maximum thickness of 1,800 feet along Lewes River Valley near Whitehorse. It is light and dark grey, and in places is almost black. At the head of Cap Creek, rounded black chert nodules ½ inch across are abundant in the limestone. In some areas the rocks may be of Jurassic age, as they occur stratigraphically and structurally above a conglomerate that contains many limestone pebbles and that overlies the Upper Triassic limestone.

West of Lewes River, volcanic rocks are common. They comprise light and dark green, purple, and maroon andesite, porphyritic andesite, and dark grey basaltic lavas; agglomerate; and as much as 2,000 feet of tuff. This igneous assemblage is intercalated with dark green greywacke, minor arkose, siltstones, black argillite, limestone lenses, and minor conglomerate, the last composed dominantly of volcanic fragments, though including some of greywacke, chert, limestone, and granite.

The total observed thickness of volcanic and sedimentary rocks west of Lewes River is about 4,500 feet, but the base of the section is not exposed.

Limestones and associated fine-grained clastic rocks in the western or volcanic facies of the Lewes River group have yielded fossils of definite Upper Triassic age, whereas fossils found in similar rocks east of Lewes River are only dated tentatively as Triassic.

Laberge Group

The Laberge group of clastic sedimentary rocks overlies the Lewes River group disconformably. Its lithology varies considerably both along and across the strike of the rocks.

In the vicinity of Fish Lake, the group is dominantly conglomeratic, particularly in the lower part of the section, with lesser interbedded, brown, grey, and greyish green arkose; grey quartzite; grey and greyish green siltstone; and grey and black argillite. A quartz-pebble conglomerate occurs near the top of the exposed section. The total observed thickness in this region is about 6,500 feet. The fragments of the conglomerate have an average diameter of 2 to 3 inches and a maximum of 10 inches, and are composed of granitic rocks, green volcanic rocks, greywacke, tuff, and limestone. About half the fragments are granitic.

The conglomerate thins from about 5,000 feet at Fish Lake to about 1,500 feet southwest of Lake Laberge and to 1,500 feet at the mouth of Two Horse Creek. It is missing at the exposed base of the group south of McCrae.

South of Carcross, at the top of the exposed Jurassic section, is 1,500 feet of conglomerate, containing many granitic pebbles and cobbles, separated from the base of the section by 3,000 feet of interbedded greywacke, arkose, siltstone, and argillite. The sedimentary rocks below the conglomerate show graded bedding.

The large area west of Marsh Lake underlain by the Laberge group is composed of closely folded, interbedded greywacke, arkose, siltstone, argillite, and minor conglomerate. The base of the section was not recognized, and no estimate of the thickness could be made.

All fossil collections indicate a Lower Jurassic age for this group.

Tantalus Formation

The Tantalus formation is found in fault contact with both the Lewes River group and the Laberge group on the southwest limb of the syncline passing through Fish Lake. The same rocks occur west of Annie Lake in fault contact with volcanic rocks of uncertain age; but their contact relations with the Laberge group at this point could not be determined. Two small patches of Tantalus formation are found in the granite on Carbon Hill.

The Tantalus consists of at least 2,500 feet, and perhaps as much as 4,000 feet, of mainly conglomerate, with some sandstone, siltstone, argillite, and coal. Most of the beds are speckled black and grey, and in many places are also rusty brown. The conglomerate is distinctively composed of well-sorted, well-rounded, black and grey chert and some white quartz pebbles, which average about $\frac{1}{2}$ inch in diameter.

Near Carmacks, similar rocks have been found to overlie the Laberge group with apparent conformity, and contain plant fossils suggesting an Upper Jurassic or Lower Cretaceous age.

Hutshi Group

The Hutshi group occurs at various localities in the map-area. It is composed of at least 2,000 feet of light and dark green andesite and porphyritic andesite, purple and black basalt, much agglomerate, and tuff. At the base of the group, some coarse, poorly sorted conglomerate, containing many granitic boulders, is mixed with much angular fragmental material that may be of pyroclastic origin.

In the western and southern parts of the map-area, these rocks have gentle dips and overlie the Laberge group with angular unconformity. In the east, however, much of the exposed group shows no structure, and the rocks have been included with the Hutshi group because of their lithological similarity to the Hutshi of the west and because the surrounding sedimentary rocks appear to dip under the volcanic rocks, except east of Cap Creek where the contact is along a fault.

Most of the Hutshi rocks exposed in the map-area are intruded by granitic rocks.

Ultramafic Rocks

Ultramafic rocks are found in five widely scattered localities as distinct, mappable bodies. In each case the surrounding rocks have been intensely deformed and altered.

Most of the rock appears to be pyroxenite, more or less altered to serpentine, but there is probably some associated peridotite.

Each body shows evidence of much deformation in the form of numerous intersecting fractures and shear zones. Virtually all joints have a coating of serpentine and show slickensides.

Irregular dykes of pyroxenite traverse the main mass of serpentinized pyroxenite north of Mount Michie. Veins and veinlets of serpentine are very numerous, but only a very few veinlets of asbestos were seen, and these are less than $\frac{1}{4}$ inch wide.

The serpentinized pyroxenite body west of Lake Laberge is contained in deformed Laberge group rocks and is believed to intrude them. Southwest of Little Atlin Lake, a porphyritic granite body is adjacent to the pyroxenite. The contact between the two bodies is not exposed, but the pyroxenite is profoundly altered, with the development of rosettes of amphibole, at points nearest the granite, whereas the granite is unaltered. Consequently, the pyroxenite is believed to have been intruded after the deposition of the Laberge group and before the emplacement of the granite.

The altered volcanic rocks east of Marsh Lake and northwest of Little Atlin Lake contain many irregular bodies of serpentine.

Coast Intrusions

Granitic rocks underlie a considerable part of the map-area, and in most places it has been impossible to separate those of similar composition and character into distinct bodies. Where, however, some sort of separation has been possible, a medium- to coarse-grained, grey and grey and brown, non-foliated biotite-oligoclase granodiorite is the most common type. In most places it maintains a fairly uniform texture and composition to its borders, and in only a few places displays any foliation. It intrudes rocks as young as the Hutshi group, and crosscuts sharply the foliation of the metamorphic rocks.

The next most abundant type is a coarse-grained, pale brown, biotite granite characterized by smoky quartz. Here and there, where its contact with the granodiorite is exposed, the granite appears to intrude the granodiorite and exhibits a distinct border phase, 2 to 50 feet wide, that is finer grained and contains no biotite. Miarolitic cavities containing smoky quartz crystals are common in this contact zone, whereas the quartz elsewhere in the groundmass occurs in large, rounded grains. Fluorite was noted in some of the cavities.

Hornblende-biotite quartz diorite forms small masses; its relations to other plutonic rocks are not known.

Hornblende diorite occurs as small bodies, usually marginal to, and older than, the large bodies of granodiorite.

Gneissic porphyritic granodiorite, with pink or flesh-coloured microperthite phenocrysts, outcrops in a belt from Lake Bennett to the head of Becker Creek. A similar granodiorite, with grey orthoclase phenocrysts, is found associated with the metamorphic rocks southwest of Alligator Lake.

An 'intrusive breccia' is exposed at the head of West Arm, at the head of the south fork of Wheaton River, and in the northwestern part of the area near the head of Byng Creek. It consists of fragments of grey granodiorite and brownish syenite, ranging from angular blocks more than a foot across to rounded ones a few inches in diameter, and individual crystals of feldspar in a green, fine-grained, chloritic groundmass. On a mountain south of the west end of West Arm the breccia shows intrusive relations with the granodiorite, and is itself cut by aplite dykes.

All the plutonic bodies contain small, pegmatitic clots and are intersected by aplite dykes, most commonly near their borders. They intrude post-Lower Jurassic volcanic rocks, and are correlated with the Coast intrusions of British Columbia and southeastern Alaska.

Pink Granite

Three distinctive bodies of pinkish granite are exposed in the eastern part of the map-area. The rock is a medium- to fine-grained, non-foliated granite containing about 15 per cent quartz and about equal amounts of pink orthoclase and white albite. West of Cap Creek, good exposures indicate that it intrudes the somewhat foliated granodiorite. At the head of Byng Creek, the pink granite cuts the 'intrusive breccia'.

No mineralization is known to be associated with this granite.

Skukum Volcanic Rocks

The Skukum volcanic rocks occur mainly in the Wheaton River area, and include all volcanic rocks, except the younger Miles Canyon basalts, that have not been intruded by the previously described granitic rocks.

These volcanic rocks comprise light green andesite, porphyritic andesite, purple and dark grey basalts, pale purple and pink trachyte, and pale brown rhyolite flows, as well as much pyroclastic material.

On Chieftain Hill, the Skukum volcanic rocks are seen to rest unconformably on the granodiorite, and in upper Watson River Valley they lie unconformably on both granitic and metamorphic rocks of the Yukon group. West of West Arm at least 4,000 feet of these volcanic rocks apparently overlie flat-lying volcanic rocks of the Hutshi group, which are cut by diorite dykes.

In most places the Skukum rocks have gentle or flat dips. Part of the group has been cut by granite porphyry.

No mineral deposits have been found in these rocks.

Granite Porphyry

Small stocks and related dykes of rusty brown granite porphyry are widely scattered throughout the map-area. The rock is composed of phenocrysts of orthoclase and a few rounded quartz grains in a matrix of granophyre. Some bodies contain much pyrite, particularly those between Berney Creek and Wheaton River.

The granite porphyry intrudes all previously described granitic rocks and some of the Skukum volcanic rocks, and is probably related in origin to the acidic members of that group.

Miles Canyon Basalts

The Miles Canyon basalts appear in scattered exposures south and southwest of Whitehorse. They are composed mostly of flows up to about 40 feet thick, with minor pyroclastic material, and conform in a general way with the present topography. The flows are scoriaceous, and their lower parts contain pebbles and boulders from the underlying surface.

Dykes related to these flows are seen to intrude the Skukum volcanic rocks and dykes related to the granite porphyry.

Superficial Deposits

Superficial deposits of mainly Pleistocene age occupy virtually all the valleys, and form thick accumulations in the larger ones, such as Lewes River and Takhini River Valleys. None was seen below glacial till except on Joe Creek, where sands are exposed below about 30 feet of till.

Above the till lie glacio-fluvial gravels, sands, and silts and Recent alluvium, loess, and volcanic ash.

Metamorphic Rocks

Metamorphic equivalents of, mainly, the Lewes River group but also, possibly, of the Taku, Laberge, and Hutshi groups are chiefly meta-sedimentary rocks, such as schistose greywacke, chloritic slates, and crystalline limestone, and meta-volcanic rocks such as greenstone, schistose greenstone, and amphibolite. Gradations to biotite and chlorite schists and gneiss occur between Ibex and Takhini Rivers toward the granite contacts, and similar gradations were noted south of Friday Creek, between Watson and Wheaton Rivers near Hodnett Lakes, and south of Mount Stevens.

Large areas of volcanic rocks have been altered to greenstone and, locally, west of M'Clintock River and north of Michie Creek, to amphibolite. Many isolated patches of greenstone and amphibolite are also found within the areas of granite.

In a few places, such as on Windy Arm and north of Joe Mountain, irregularly textured dioritic rocks grade into amphibolites and greenstones and in part into 'mixed rocks' or migmatites, and may represent partly granitized material.

Areas of altered volcanic rocks east of Marsh Lake and northwest of Little Atlin Lake contain numerous veinlets and pods of serpentine, and numerous, contorted and fragmentary stringers of very fine-grained to dense quartz or recrystallized chert.

Volcanic Rocks of Uncertain Age

Volcanic rocks of undertain age have been mapped separately from those of the Lewes River and Hutshi groups, which they resemble lithologically. Their relations to these and other rocks are such that their correlation is uncertain; some exposures are completely surrounded and intruded by granitic rocks; others are in fault contact with rocks of known age; and the contact relations of still others are uncertain.

STRUCTURAL GEOLOGY

Folding

With few exceptions, all rocks older than the Hutshi group have been deformed into northwest trending folds.

Folding in the Yukon group is very irregular and too complex to be depicted in detail on the map; consequently, only major folds are represented. Drag-folds indicate that the folds are overturned both to the northeast and to the southwest. Where bedding and schistosity were observed together they were seen to be nearly always parallel.

The Taku group has also been intensely and irregularly deformed. Most of the limestone is poorly beeded, and its structure can best be observed from a distance, where thick, massive beds can be seen folded together with volcanic rocks and chert. The volcanic rocks rarely show any structure, but the ribbon chert exhibits a high degree of irregular folding and crumpling. East of Taku Arm, the Taku group displays a radiating or fan-shaped pattern of fold axes in contrast with the northwest trend west of Taku Arm.

Except for an area north of Crag Lake and one near Mount M'Clintock, the rocks of the Lewes River and Laberge groups and the Tantalus formation have been folded along northwesterly trending axes. Near Fish Lake, the folds in the Laberge group are broad and open, and it is here that the conglomerate is thickest. Folding in both the Lewes River and Laberge groups becomes most intense along a zone more or less defined by the broad valley of Lewes River and Marsh Lake. The zone is characterized by steeply dipping, almost isoclinally folded beds, and the argillaceous strata have developed a slaty cleavage. In addition, the rocks are considerably sheared. A similar zone of close folding occurs in the northeastern corner of the map-area within, and near, Teslin River Valley. Serpentinized pyroxenite bodies were observed within both zones. Between Lewes and Teslin Rivers, however, the structure appears to be chiefly a west-dipping homocline interrupted by faults and plutonic intrusions.

In the area north of Crag Lake the Laberge group rocks are deformed into folds overturned to the southeast, plunging northeast, and broken by small thrusts near the crests of anticlines. Near Mount M'Clintock the axes of the folds apparently bend around a granodiorite body that intrudes the sedimentary rocks. East of Tagish the structure in the Laberge group has not yet been resolved.

The Hutshi group rocks are mostly gently dipping; they rest unconformably on folded Lewes River and Laberge group rocks and yet are themselves cut by granitic intrusions.

The Skukum volcanic rocks and Miles Canyon basalts are mostly flat-lying. Variations are apparently due to initial dips and modifications by faulting.

Faulting

No thrust faults on a large scale have been recognized within the map-area. North of Crag Lake, however, folds overturned to the southeast have been broken by small thrusts near the crests of the anticlines. Also, on the southwest limb of the Fish Lake syncline, a steep reverse fault has thrust the Lewes River group onto the younger Tantalus formation.

Several north-trending faults have been mapped, but the nature of movements along them is not clear. Many of them are believed to be normal faults in which younger rocks have been dropped into contact with older formations, but it is not known how much horizontal movement was involved.

A few faults trend at right angles to the strike of the rocks. Some of these, such as one at the north end of Gray Ridge, are normal faults, but others, particularly some of those west of Marsh Lake, are believed to be small tear faults.

A fault extending from Watson River Valley to Primrose River was noted in the air photographs. Where the fault was observed on the ground, west of the sharp bend near the head of Watson River, the rocks were much sheared and brecciated. The displacement and direction of movement, however, are unknown.

The faults are not all of the same age. Reverse faults involving the Tantalus formation, small thrusts in the Laberge group, and, perhaps, what may be tear faults, were probably involved in the deformation of Tantalus and older rocks before the deposition of the Hutshi group. Faulting in the Hutshi group may have occurred shortly after its consolidation, or may be of the same age as the faults that affected the Coast intrusions and Skukum volcanic rocks.

ECONOMIC GEOLOGY

General Statement

There has been little mining activity in the Whitehorse area since the publication of the earlier reports on the district.

In 1936, some development work was done on a gold property on the ridge between Skukum and Berney Creeks.

In 1948, several pits and trenches were excavated on the ridge east of the lower bend in Becker Creek in order to determine the extent of the gold-silver veins exposed on the west face of the ridge top.

Currently, the old Becker-Cochran property on the southeastern slope of Carbon Hill, where silver-antimony veins outcrop, is being explored by Messrs. J. Cox and W. McAllister.

In most of the properties, exposures of mineralized rock are poor: trenches and pits have slumped; shafts are filled with water; many of the portals of the adits have caved; and others, particularly those at high elevations, are sealed by ice. The only indication of the nature of the mineralization in many of the workings was to be found in the dumps.

The writer's knowledge of the mineral deposits in the area has been gained from observations of what can be seen in the old workings and from earlier published descriptions.

Metalliferous Deposits

Placer Deposits

Near the forks on Sheldon Creek, in the extreme north-eastern part of the map-area, are remains of placer workings reported to have been worked in the thirties. The stream has cut down through glacial till to form a stream bed composed of coarse gravel with numerous large boulders. Nothing is known of the production of this creek.

Lode Deposits

Gold-Silver. All gold showings indicated on the map by the symbol Au carry some silver in addition to gold; but where silver occurs in appreciable amounts, the occurrence is indicated by the combined symbol for gold and silver, Au Ag.

Gold-silver, quartz-vein deposits occur in three types of rocks: (a) metamorphic rocks; (b) granitic rocks of the Coast intrusions; and (c) rocks believed to represent the Hutshi group.

(a) Several quartz veins occur in a narrow band of metamorphic rocks, consisting of chlorite and quartz-chlorite schist, greenstone, and minor crystalline limestone, that outcrops from Mount Stevens northwest to Watson River. The veins strike north 30 degrees west, about parallel with the schistosity, and dip steeply northeast, except on Gold Hill where they dip steeply southwest. They appear as discontinuous lenses up to, but generally much less than, 200 feet long and 3 feet wide. In places the lenses are alined with each other; in others they are arranged *en échelon*, separated by thin strips of schist.

The veins consist chiefly of vuggy, crystalline quartz, some calcite, and metallic minerals. The metallic constituents are mainly pyrite -- found as scattered grains and crystals, thin stringers, and, rarely, as massive pods; some finely disseminated galena; minor native gold; and the tellurides sylvanite, hessite, and petzite.

The sulphides, tellurides, and gold form only a small part of the vein, and their distribution is very irregular. Consequently, it is difficult to obtain representative samples, and only the richest ore pockets have been extracted.

(b) Quartz veins carrying gold and silver are found in granitic rocks of the Coast intrusions, particularly near their contacts with older formations. These veins have various attitudes: those on the ridge between Skukum and Berney Creeks and on the ridge east of the lower bend in Becker Creek strike about east and are vertical; those near the gulch northeast of Tally-Ho Mountain are nearly parallel in strike and dip with the quartz veins in the metamorphic belt; and the veins at the head of Watson River and north of Montana Mountain have gentle dips.

The walls of the veins are generally smooth and commonly carry some gouge, and at the gulch northeast of Tally-ho Mountain, the wall-rocks are brecciated. The veins are interpreted as fault fissures, but as good markers are lacking the amount and direction of movement are unknown. The quartz veins vary in width from a few inches to as much as 4 feet, and are remarkably persistent in that several of them have been traced for as much as 1,000 to 2,000 feet horizontally and 500 feet vertically.

The vein quartz is vuggy and crystalline, and in several places shows coarse comb structure. The sulphides are mainly galena, with lesser amounts of pyrite. Native gold is rare. The galena is coarse grained where it forms massive lenses in the quartz, but is finely divided or appears as thin veinlets in other places. The pyrite occurs either disseminated or as veinlets, and is associated with the galena.

The sulphides form irregular bodies in the quartz that pinch and swell, split into thin veinlets, or occur in sparsely scattered grains. Their appearance is that of discontinuous lenses in the persistent quartz veins.

(c) West of Windy Arm, several gold-silver deposits occur along two sets of veins in rocks that may belong wholly or partly to the Hutshi group or partly to older, meta-volcanic rocks. One set strikes northerly, and dips about 50 degrees west; the other set strikes east, and dips about 45 degrees north.

The veins show many of the same characteristics as those found in the Coast intrusions. They may extend for as much as 3,000 feet along strike; the walls are smooth, gently sinuous, and have gouge along them; and the sulphide bodies within the vuggy, coarsely crystalline quartz pinch and swell irregularly from a few inches to 6 or 7 feet. In the Venus mine, however, old stopes indicate that lenses that pinched out along strike were mined down the dip for more than 100 feet to give the appearance of vertically pitching ore shoots.

The sulphides are mainly massive galena, with lesser amounts of pyrite, arsenopyrite, ruby silver, grey copper, jamesonite, and sphalerite.

Antimony-Silver. Antimony deposits carrying some silver are found on Carbon Hill and to the northwest, across Wheaton River, on Chieftain Hill. The veins are in granitic rocks of the Coast intrusions and in volcanic rocks of uncertain age cut by these intrusions.

The veins on Chieftain Hill strike east and are vertical, whereas those on Carbon Hill strike east and southeast and dip steeply south or southwest. They vary from a few inches up to 4 feet in width, and on the southeastern slope of Carbon Hill split into two or three veins to form a mineralized zone about 12 feet wide. The extent of the veins is not known for they are cut by granite porphyry and rhyolite porphyry dykes and are intersected by numerous small slips. In addition, vegetation and talus cover the exposures.

The sulphide bodies exhibit the characteristics of the gold-silver veins in that they form irregular, discontinuous bodies within a gangue chiefly of quartz, with calcite and barite. The sulphides are mainly stibnite, which forms either dense, fine-grained masses or partly radiating groups of prismatic crystals; galena, which occurs intimately with the stibnite; grey copper; and silver-lead-antimony sulphides.

Because of the badly weathered nature of the exposure on the old Becker-Cochran property on Carbon Hill, no reliable channel sample representative of the unweathered mineralized zone could be taken. A grab sample from a dump yielded 32.0 per cent antimony.

Silver-Lead. At least three silver-lead veins outcrop west of Annie Lake in rocks of the Laberge group. The veins strike about north and dip steeply east or west. They are from 3 or 4 inches to $1\frac{1}{2}$ feet wide, and can be traced intermittently across the mountainside for several hundred feet. Massive, irregular sulphide bodies up to 7 inches across are found in a gangue of quartz and calcite. The sulphides are mainly dense galena and arsenopyrite, with minor pyrite and sphalerite. An apple-green mineral is found in the weathered parts of the veins.

Additional veins, or extensions of those referred to above, are reported on the lower slopes of the hill south of the creek tributary to Annie Lake about midway of its west shore.

Copper. Three types of copper deposits are known in the Whitehorse area: (a) deposits at or near the contact of granite and limestone or other lime-rich rocks; (b) deposits at the contact of pyroxenite with limestone; and (c) quartz-vein deposits in pre-Tertiary volcanic rocks.

(a) The most important copper deposits in the map-area are those found west of Whitehorse at or near the contact of the granitic rocks of the Coast intrusions with the limestones of the Lewes River group.

The chief ore minerals are bornite and chalcopyrite, which occur most commonly in a skarn composed of brown garnet, diopside, some epidote, and tremolite. They are also found in a magnetite-rich skarn, best exposed in the Arctic Chief mine in the south-central part of the 'Copper belt'. Specular hematite is very common at the Pueblo mine, immediately north of the road leading to Fish Lake.

In most places the contact between the limestone and the granitic rocks is masked by the skarn that occurs partly in the altered granite and partly in the limestone. In the granitic areas, the skarn is massive, and grades gradually into dark dioritic-looking rocks, whereas, in many places in the limestone areas, the skarn shows a distinct banding, probably caused by preferential replacement by certain minerals along planes parallel with the bedding in the limestone. The contact between the skarn and the recrystallized limestone is commonly sharp. Bodies of copper sulphides, either as massive pockets or disseminated masses, are nearly always found in the skarn along the limestone-skarn contact.

Exposures are not plentiful along the copper belt, and it is possible that much of the drift-covered area may hold more deposits. The magnetite-rich skarns of the central part of the belt may lend themselves to magnetic methods of exploration.

A small copper prospect lies on the northeast spur of Carbon Hill at the contact of Yukon group rocks with granodiorite of the Coast intrusions. The Yukon group gneisses and schists strike at an angle to the granite contact, and trenches have exposed two bands of skarn that have replaced lime-rich layers. The skarn bands contain discontinuous lenses 3 to 10 inches wide of massive chalcopyrite, bornite, and specular hematite.

(b) North of Jubilee Mountain, in the southeast corner of the map-area, a lens of limestone in meta-volcanic rocks lies adjacent to a body of pyroxenite. The contact is concealed by talus, but for about 30 feet between the limestone and the talus there is exposed a dark green rock composed mostly of actinolite, epidote, and some garnet. Along its contact with limestone this rock carries disseminated bornite, chalcopyrite, specular hematite, and magnetite.

(c) The remaining copper deposits are quartz veins containing a little disseminated chalcopyrite, bornite, and pyrite, and occurring in pre-Tertiary volcanic and sedimentary rocks.

Conclusions

None of the metalliferous deposits of the area, whether within granitic rocks of the Coast intrusions or in rocks that they invade, is far from a granitic contact, and none has been recognized to be associated with rocks younger than the Coast intrusions.

Copper mineralization appears to have favoured contact zones of Coast intrusions with limestones or lime-rich rocks of any age.

In the gold-silver and antimony-silver deposits, the fault fractures or fracture systems that permitted the formation of quartz veins are extensive, but the sulphide content of the veins is irregular in occurrence and the showings difficult to evaluate.

Non-metallic Deposits

Fluorite. Small showings of this mineral were found at the head of the south fork of Wheaton River. Cubes and octahedra of fluorite about 1 inch to 1½ inches across occur with pyramidal crystals of quartz in several cavities 2 or 3 feet across in the granite that is characterized by smoky quartz. Most of the showings are within a few hundred feet of the border of the granite body.

Coal. Coal occurs in the Tantalus formation on the south side of Mount Granger and on the ridge northeast of Pugh Peak, west of Annie Lake. At the time the workings were visited, all the excavations on Mount Granger had slumped, and no coal in place was observed.

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