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GEOLOGICAL RECONNAISSANCE ALONG THE
ALASKA HIGHWAY BETWEEN WATSON LAKE AND
TESLIN RIVER, YUKON AND BRITISH COLUMBIA

(REPORT AND MAP)

By
C. S. Lord



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CONTENTS

	Page
Introduction.....	1
General statement.....	1
Access.....	1
Settlements, supplies, and communications.	2
Military restrictions and regulations.....	2
Physical features.....	2
Climate.....	3
Vegetation.....	4
Wild life.....	4
References.....	4
General geology.....	5
Summary statement.....	5
Table of formations.....	5
Group A.....	6
Group B.....	8
Group C.....	9
Group D.....	10
Peridotite and dunite.....	11
Granite, granodiorite, and allied rocks...	12
Basalt.....	14
Structural geology.....	15
Economic geology.....	16
Metallic mineral deposits.....	16
Coal.....	19
Suggestions to prospectors.....	19

Illustration

Preliminary map - Watson Lake to Teslin River, Yukon
and British Columbia.

GEOLOGICAL RECONNAISSANCE ALONG THE
ALASKA HIGHWAY BETWEEN WATSON LAKE AND
TESLIN RIVER, YUKON AND BRITISH COLUMBIA

INTRODUCTION

General Statement

This report briefly describes the geology along the Alaska Highway between the west bank of Liard River near Watson Lake and the east bank of Teslin River near the outlet of Teslin Lake. For this distance the highway is close to the Yukon-British Columbia boundary and mainly within Yukon. The area examined comprises a strip about 195 miles long and from 2 to 30 miles wide. The Alaska Highway was opened late in 1942 and the field work for this report was done in the summer of 1943. Very little was known of the geology of the region prior to 1943, except that granitic rocks were present and hence might be the source of metalliferous mineral deposits.

A minimum of lode prospecting had been done in the map-area before the completion of the highway. About thirty-five men prospected from bases on this part of the highway during 1943, but because geological maps were not available had to devote considerable time to reconnaissance and were unable to accomplish more than preliminary investigations.

The writer is indebted to many persons for assistance throughout the season. Local residents, Dominion Government officials in Whitehorse, and prospectors and geologists working in the area were particularly helpful. Special recognition should be given for the co-operation of employees of the Consolidated Mining and Smelting Company of Canada. Suggestions offered by Mr. J.L. Rumble were of great help in planning the season's work. Personnel of the United States Army, the United States Public Roads Administration, and of various contracting companies engaged on highway and related work supplied many services and much helpful information. Efficient assistance in the field was rendered by Messrs. W.B. Blair, D. Carlisle, A. Checko, and J.H. Parliament.

Access

Access to the area is provided by the Alaska Highway, which connects Dawson Creek, British Columbia, with Whitehorse, Yukon. Dawson Creek is connected with Edmonton, Alberta, by the Northern Alberta Railway and is about 655 miles by highway from Watson Lake. Whitehorse, in turn, is accessible from tidewater at Skagway, Alaska, by the railway of the White Pass and Yukon Route and is about 75 miles by highway from Teslin River. Airplanes operated by Canadian Pacific Airlines call at Watson Lake airport on scheduled flights between Edmonton and Whitehorse. Docks at Watson Lake and Teslin are commonly used by seaplanes.

Settlements, Supplies, and Communications

Permanent settlements within and near the map-area comprise the small trading post of Teslin, on Nisutlin Bay of Teslin Lake, and Lower Post, on Liard River about 15 miles southeast of Watson Lake. Both places are on the highway and limited quantities of essential provisions may be obtained there, but parties operating on this section of the highway should plan to purchase most of their supplies from Edmonton, Dawson Creek, Vancouver, or Whitehorse. Post offices are located at Teslin and Watson Lake, both in Yukon. Commercial telegrams are accepted at Department of Transport radio stations at Teslin and Watson Lake. The United States Army has established control stations on the highway at intervals of about 100 miles. Those within the map-area are at Brooks Brook, 26 miles northwest of Teslin, on Swift River, 71 miles east of Teslin, and east of Liard River near Watson Lake. Duties of the troops stationed at these points include continuous patrol of the highway, the servicing of United States Army vehicles, and the control of all traffic on the highway.

Military Restrictions and Regulations¹

Those planning to use the highway for prospecting should obtain the mimeographed memorandum "Use of the Canadian-Alaskan Military Highway for Prospecting" from the Director, Lands, Parks, and Forests Branch, Department of Mines and Resources, Ottawa.

The Alaska Highway is operated by the Northwest Service Command of the United States Army as a military project, and civilian travel not connected with defence projects is kept at a minimum. However, suitably equipped and financed prospecting parties, on complying with certain formalities at Edmonton or Whitehorse, are issued by the United States Army with permits to travel on the road. Civilians will not be able to obtain supplies, transportation, or other services from the Army, and must plan their operations accordingly.

Physical Features

Most of the area is mountainous and elevations range from about 2,000 feet to over 7,000 feet above sea-level. The highway² follows a good grade through a con-

Parts of the highway were relocated from time to time during 1943, so that the final location will differ slightly from that shown on the accompanying map.

tinuous valley, various parts of which are occupied by Morley, Swift, and Rancheria Rivers. This valley cuts

across Cassiar Mountains, which trend about north-northwest. Morley and Swift Rivers flow westerly into Teslin Lake and Rancheria River flows easterly into the Liard. Elevations on the road range from about 2,000 feet at Liard River and about 2,250 feet at Watson and Teslin Lakes to about 3,200 feet at the divide between the headwaters of Swift and Rancheria Rivers. Along the east side of Teslin Lake, and east from Teslin to Porcupine Creek, many of the hill tops are rounded and the highest rise to an elevation of about 5,000 feet. Groups of jagged granitic peaks, some of them about 7,000 feet high, lie about 10 miles south of Swan Lake and a few miles north of the Swift River control station. Between Porcupine Creek and mile 105E the road follows

One hundred and five miles east of Teslin. Mileage figures throughout this report refer to mileage as shown by mile posts in use during the summer of 1943. They are numbered east and west from Teslin. Some are shown on the accompanying map.

the narrow steep-walled valley of Rancheria River and passes through the rugged granitic core of Cassiar Mountains. Throughout this section the hills characteristically rise steeply from Rancheria River to gently sloping shoulders at about 4,500 feet. These extend a mile or so back from the river before rising abruptly to jagged peaks, many of which exceed a height of 6,000 feet. Easterly from mile 105E the hills become progressively lower and more rounded, and at mile 119E the highway crosses the lower Rancheria River and enters a nearly flat, drift- and gravel-covered area that extends easterly to Liard River and Watson Lake.

The area has been strongly glaciated and the effects of ice action are particularly evident between Swan Lake and mile 105E. Many of the streams occupy broad U-shaped valleys, and tributaries in the higher mountains commonly head in glacial cirques. Cirques are most numerous on the north and east slopes of the higher mountains, and a few contain small patches of ice on their head-walls. Most of the valley bottoms are filled with drift and a few are characterized by gravel ridges, called eskers, and by shallow depressions called kettleholes. Some of the main tributaries of Swift and Rancheria Rivers occupy broad graded valleys for the greater part of their length, but enter the main rivers through precipitous gorges cut in gravels or bedrock. The valleys of Morley, Swift, and Rancheria Rivers are deeply filled with sand and gravel, and in places the streams have cut through several hundred feet of this material and left long terraces on either side. Bedrock is rarely exposed in the stream channels. Ice-damming, torrential deposition of gravels, and other effects of glaciation have caused many changes in drainage, particularly near the divide between Swift and Rancheria Rivers. Glacial erratics are common to heights of over 5,200 feet.

Climate

The region is one of moderate precipitation. Cloudy skies were common during the summer of 1943 and some rain, mainly as showers, fell on about half the days of the field

season. During the winter, snow probably rarely exceeds a depth of 4 feet. Small areas of ground may remain frozen throughout the year. In normal years the efficient prospecting season would probably extend from early in June to late in September.

Vegetation

The main valley and the lower slopes of the mountains are well wooded and timber line is at an elevation of about 4,500 feet. The most common trees are white spruce, lodgepole pine, balsam fir, and aspen poplar. Other varieties noted include black spruce, white birch, balsam poplar, and tamarack. Trees commonly range up to a foot in diameter. Exceptional stands of white spruce, as near the highway near Hazel Creek and on the east bank of Liard River, contain trees ranging up to $1\frac{1}{2}$ feet at the butt. Much of the country has been burnt over during the past 40 years and underbrush is not excessive. No trouble was experienced in finding sufficient natural feed for a pack-train of fourteen horses during the season of 1943, and horses are reported to have been wintered successfully near the head of Morley Bay.

Wild Life

The most common large animals are black bear, Osborn caribou, moose, and wolves. During the summer caribou were plentiful enough above timber line in granite areas to serve as a substantial source of food for prospecting parties. Other game noted includes grizzly bear, sheep, goat, geese, ducks, dusky and spruce grouse, and ptarmigan. Fish include grayling, lake trout, pike, Dolly Varden, and whitefish.

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GENERAL GEOLOGY

Summary Statement

The oldest recognized rocks, those of Group A, comprise a metamorphic assemblage of gneisses, schists, limestone, dolomite, and other rock types. These are overlain by interbedded, argillaceous, siliceous, and calcareous strata of Group B, probably of Palaeozoic age. Group C consists mainly of limestone, dolomite, and schist; it is separated from Group B by the Cassiar granitic batholith and is of probable Carboniferous age. The volcanic rocks comprising Group D, of probable Jurassic age, are mostly tuff, andesite, and agglomerate. They are separated from all older formations by granitic intrusions. A body of ultrabasic rocks occurs within the group of Jurassic volcanic rocks and probably intrudes it. The granitic rocks of the Cassiar batholith and related intrusions are, with the exception of Tertiary (?) basalt, the youngest consolidated rocks noted. Overlying all consolidated formations are Pleistocene and Recent superficial deposits.

Table of Formations

Era	Period	Lithology
	Tertiary (?)	Basalt
Mesozoic	Jurassic or later	Granite, granodiorite, and allied rocks; undifferentiated schist and gneiss
		Peridotite and dunite; serpentine
	Jurassic (?)	Group D: tuff, andesite, agglomerate, argillite, and schist
Palaeozoic	Carboniferous (?)	Group C: limestone, dolomite, argillite, slate, phyllite, quartzite, and schist
Palaeozoic (?)		Group B: argillite, slate, phyllite, chert, quartzite, arkose, conglomerate, and limestone
Palaeozoic and, or, Pre-cambrian		Group A: gneiss, schist, limestone, dolomite, quartzite, and greenstone

The age of Group B relative to Group C is not known

Group A

Rocks of Group A comprise mainly gneisses and schists and are the most highly altered of the map-area. The original character of many of them was not determinable, but others are altered equivalents of sedimentary and volcanic formations. They outcrop along the highway between miles 20E and 54E, on the east shore of Teslin Lake near the Yukon-British Columbia boundary, as a northwesterly trending belt that crosses the road between miles 84E and 87E, and as another belt lying about 8 miles northwest of Pine Lake.

The most extensive exposures of these rocks are along the highway between 20 and 54 miles east of Teslin. They have been subdivided tentatively into three divisions, lying stratigraphically one above the other. The lowest is mainly albite gneiss; the intermediate division consists of greenstone and green and grey schists; and the upper division comprises schistose, calcareous, and siliceous rocks.

The rocks of the lowest division outcrop along and north of the highway between mile 20E and Smart River. They include the most highly altered rocks of Group A, and, although predominately albite gneiss, include bands of quartzite, limestone, and dolomite. The albite gneiss is a thoroughly recrystallized, medium-grained, light grey to dark green rock composed of albite, quartz, biotite, chlorite, epidote, white mica, and magnetite in widely varying proportions. In places, as northwest of the mouth of Smart River, the constituent minerals are segregated in grey, green, and speckled bands an inch or so wide. Elsewhere it is a dark green foliated rock containing numerous grains of white albite, or resembles a light grey, slightly schistose, granitic rock or a white, schistose quartzite. All these types appear to be interlayered in bands that range in width from a few inches to many feet. Associated with the gneiss are bands, up to 100 feet wide, of pink quartzite. The limestone is white to buff and crystalline. The dolomite is a finely crystalline, thinly banded, grey and white rock.

The rocks of the intermediate division outcrop a few miles northeast of the junction of Smart and Swift Rivers and about 5 miles south of the outlet of Lower Morley Lake. They include greenstone and various green and grey schists of uncertain origin. The greenstone, in part banded, is a dark green rock with numerous visible flakes of black mica. It is composed of a fine-grained aggregate of quartz, plagioclase feldspar, biotite, chlorite, epidote, specularite, and magnetite. The schists are fine- to medium-grained and contain various proportions of chlorite, quartz, mica, graphite, and talc.

The rocks of the upper division extend south and southwest from the mouth of Logjam Creek. They include grey and buff crystalline limestone, calcareous mica schist, well-bedded, grey, platy, quartz-mica schist, and white quartzite.

Along the east shore of Teslin Lake, near the Yukon-British Columbia boundary, light green and grey, quartz-chlorite-mica schists are overlain by grey and buff, crystalline limestone, some of which contains numerous parallel flakes of white mica. These rocks are classed tentatively with Group A because of the lithological resemblance of some of the schists to those observed a few miles east of the mouth of Smart River.

The other two areas underlain by rocks of Group A lie along the western edge of the Cassiar granitic batholith; one forms a belt more than 20 miles long and crosses the highway between 84 and 87 miles east of Teslin; the other occupies a wedge-shaped band that extends northwesterly more than 13 miles from a point about 8 miles northwest of Pine Lake. The rocks in these two areas are lithologically similar and are mainly sedimentary gneisses, but include minor bands of flaky grey to green schists and a little limestone or dolomite. The gneisses are medium-grained, grey, banded rocks made up of various proportions of quartz, feldspar, biotite, and white mica. The thickness of the bands ranges from a small fraction of an inch to many feet, so that some outcrops appear massive whereas others are finely banded. The massive rock contains rounded grains of feldspar, commonly between 1/16 and 1/8 inch in diameter, set in a fine-grained, dark grey groundmass of quartz and mica. The finely layered gneiss may be crumpled, and is made up of light grey layers containing abundant quartz alternating with fine-grained, dark grey partings of biotite. The texture and composition of all the gneisses suggest that they have been derived from impure siliceous sediments and that the banding probably represents original bedding. The associated schists range from light grey and green to dark greenish grey, and contain quartz, chlorite, sericite, and a little feldspar. Many of them probably represent altered sedimentary layers, but some, with abundant chlorite, may have been derived from minor bands of volcanic rocks.

Although more detailed work on the rocks of these two areas may indicate that they are altered phases of Group B, they are provisionally placed in Group A because they are about equally altered and, also, because they appear to lie stratigraphically below typical, less altered rocks of Group B. Most of them are, however, lithologically distinct from the Group A rocks found along the highway between miles 20E and 54E.

The age of the strata of Group A is not known, as no fossils were seen in them. Fossils, possibly crinoid stems, are reported to occur in limestone on Porcupine

Fahrni, K.C.: Consolidated Mining and Smelting Company of Canada, Limited; personal communication.

Creek, and, if so, at least some of the rocks assigned to Group A are of Cambrian or later age, probably Palaeozoic. More highly altered rocks found elsewhere in Group A may be of Precambrian age.

Group B

Rocks of Group B include a wide variety of sedimentary types and are much less altered than the underlying rocks of Group A. The main body crosses the highway between miles 54E and 84E and a smaller belt has been traced, with one gap, for about 21 miles northwest from the south end of Summit Lake. The main criterion used in separating Groups A and B was degree of metamorphism, and the boundary as mapped is intended to separate schists and gneisses from sedimentary rocks whose argillaceous strata have been rarely altered beyond a phyllite.

Probably the most abundant rocks of Group B are interbedded argillite, slate, phyllite, and chert, but quartzite, arkose, conglomerate, limestone, and other rocks occur here and there. The stratigraphic sequence is not known, as the rocks are folded and recognizable horizon markers were not found. The argillaceous strata are commonly black, but some are light greenish grey or purple. They are commonly well bedded and range from compact argillite through flaky, well-cleaved slate to lustrous, thinly laminated rocks or phyllites. The cherts are widely distributed as bands ranging from a fraction of an inch to several hundred feet in thickness. They are dense, white, grey, or black rocks with a conchoidal fracture and waxy lustre. Some are distinctly bedded, whereas others are massive and mottled in shades of grey. Much chert has been fractured and recemented by veinlets of white quartz, and some of it breaks into thin slabs the sides of which are coated with a little white mica. The quartzites are fine-grained, grey, greenish grey, and brown rocks in beds commonly between 1 and 5 feet thick. The beds contain 75 to 90 per cent quartz as grains, commonly rounded and clear, set in a fine-grained groundmass made up of various proportions of biotite, sericite, chlorite, and feldspar. A few beds, of feldspathic quartzite or arkose, contain considerable twinned and untwinned feldspar, and in some of these grains of quartz and pink and white feldspar are as much as $\frac{1}{4}$ inch in diameter. Rocks near the base of Group B, on a peak about 5 miles northwest of the mouth of Logjam Creek, include fine-grained arkose of angular to rounded quartz and feldspar grains, and sheared pebbly quartzite. Conglomerate beds were observed a mile north of mile 65E and at several places from 1 to 4 miles north of mile 78E. So far as known they do not mark important stratigraphic intervals. North of mile 65E the conglomerate probably overlies limestone and underlies mottled grey chert. It may be several hundred feet thick and is an unsorted aggregate of pebbles and cobbles. The pebbles are subangular, average about 1 inch in diameter, and are mainly of grey, green, and black chert, but a few are of dark grey quartzite. The cobbles are rounded, range up to about 10 inches in diameter, and are mainly of dark grey quartzite. The pebbles and cobbles are in contact and make up most of the rock. The matrix is grey and siliceous except near the limestone where it is buff coloured and limy. North of mile 78E chert conglomerate was noted at several horizons within chert or interlayered with slate and phyllite. Much of it was distinguished from the adjacent mottled cherts only after careful examination on suitably weathered surfaces.

It was sheared and contained elongated, grey and pale green, chert pebbles and cobbles set in a cherty or fine-grained schistose matrix. Many pebbles were 2 or 3 inches long, and the largest cobbles measured about 12 inches by 3 inches. The limestones are mainly well bedded; dense, white, grey, and pale greenish grey rocks and none is known to be dolomitic. Some bands are a few tens of feet thick, whereas the thickness of others may be several hundred feet. Individual beds range from less than an inch to more than 3 feet in thickness. White limestone forms a prominent hill about 2 miles north of mile 63E. It contains fossils¹ suggestive of crinoid stems. No

¹ Wilson, A.E.: Palaeontological Section, Geol. Surv., Canada.

recognizable volcanic rocks were found in Group B, although pale green, massive to schistose rocks near the highway, 74 miles east of Teslin, may be altered dacite.

Group C

Rocks of Group C are mostly limestone and dolomite, but include some argillite, slate, phyllite, quartzite, and schist. They lie along the eastern edge of the Cassiar batholith, cross the highway between miles 103E and 119E, and were traced 12 miles north and 16 miles south of the road. Limestone and dolomite comprise about 75 per cent of the group. Most of the beds are between 1 inch and 3 feet thick. The limestone is dense to crystalline and mainly white to light grey; a little of it is dark grey or black. The dolomite is noticeably heavier and much of it is fine-grained and grey and weathers buff. North of the highway, within a belt 5 miles wide lying along the western edge of Group C sedimentary rocks, the limestone and dolomite are commonly schistose as a result of thin, crinkled micaceous partings, some of which cross the bedding at acute angles. The schistose limestone and dolomite grades into soft, grey, flaky phyllite and schist, some of which is calcareous. In parts of this belt limestone and dolomite, schistose limestone and dolomite, and phyllite and schist are present in about equal proportions. Well-bedded, greenish grey argillite and slate were found south of the highway near mile 121E. The quartzites are mainly white blocky rocks wherein the individual, rounded, clear quartz grains are barely visible in the coarsest beds. They outcrop in a few places near the granite 8 to 15 miles south of the road and, together with greenish argillite and slate, comprise nearly all the rock mapped from 1 to 4 miles south of the road about 121 miles east of Teslin.

Some of the rocks of this group have been conspicuously altered near their contact with the granitic rocks. Probably in most places the width of the notably altered zone is less than 200 feet, but about 7½ miles south of the highway at mile 103E altered dolomitic beds were noted as much as ½ mile from the nearest exposed granitic rocks. The altered, impure limestones and dolomitic rocks are now

white to greenish, granular or fibrous rocks made up of various proportions of quartz, calcite, dolomite, garnet, diopside, tremolite, plagioclase, and metallic iron minerals. Another common altered rock is banded in shades of green and brown and contains quartz, biotite, pyroxene, amphibole, plagioclase, sphene, and iron minerals. Some grey mica schists contain knots of biotite and brown laths, up to $1\frac{1}{2}$ inches long, of, probably, andalusite. A tough, dense, black, siliceous rock was found at several places near the granite 5 miles or more south of the highway.

The rocks of Groups C and B are separated by the Cassiar batholith, so that their relative age is unknown. However, the two groups differ lithologically and perhaps also in age. Palaeontological evidence¹ suggests that

¹A.E. Wilson: Palaeontological Section, Geol. Surv., Canada.

Group C includes rocks of Carboniferous age. A specimen collected 1 mile north of mile 112E was identified as Lophophyllum ? cascades Warren?. Another specimen, collected 12 miles south of mile 103E, was identified as Hapsiphyllum calcareforme (Hall)?. The age of these forms is probably late Mississippian or early Pennsylvanian. A cup coral, too poorly preserved for identification, was found 5 miles south of mile 106E.

Group D

Group D is an assemblage of interlayered tuff, andesite, agglomerate, argillite, and their schistose equivalents. These rocks occupy a belt that extends northwesterly from Morley Bay, along the east shore of Teslin Lake to its outlet. The volcanic rocks and their altered equivalents make up 90 per cent or more of the group.

Tuffs are by far the most common rocks. In many places they are medium-grained, dark greenish grey, massive or indistinctly bedded rocks with a few scattered fragments of dense black cherty material up to $\frac{1}{4}$ inch in length. Less commonly they are well bedded, dark grey, and weather white or ashy grey. Many of such beds are less than $\frac{1}{2}$ inch thick and some show a gradation in grain size from coarse at the bottom to fine at the top. Most of the tuffs contain fragments of very fine-grained porphyritic volcanic rock, grains of augite, and altered plagioclase.

The andesites are dark green porphyritic rocks. The groundmass is dense and dark green and contains phenocrysts of glistening black blocky amphibole and pyroxene, up to $\frac{1}{4}$ inch long and, commonly, smaller, indistinct, dull greenish white laths of altered plagioclase. Most of these rocks are massive, but some contain amygdules and others are probably flow breccias. The feldspars are commonly highly altered and were not identified. Some of the dark green porphyritic rocks contain abundant phenocrysts of pyroxene, but none of feldspar, and may be basalts.

The agglomerates are not readily distinguished from the massive porphyritic andesite except on the weathered surface. They contain rounded fragments of porphyritic andesite, commonly between $\frac{1}{2}$ inch and 6 inches in diameter, in a matrix of similar material. In places the fragments make up one-third to one-half of the rock.

Bands of soft argillite, hard cherty argillite, and calcareous argillite occur here and there throughout the volcanic rocks. They are black or dark grey and probably tuffaceous.

Between Morley and Nisutlin Bays and between 6 and 12 miles north-northwest of Teslin the rocks of Group B have been intruded and altered by granitic rocks and are now fine- to medium-grained green schists made up of various proportions of quartz, feldspar, amphibole, biotite, chlorite, sericite, epidote, and other minerals.

Lees¹ examined rocks of Group D near the outlet of

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Lees, E.J.: Geology of Teslin-Quiet Lake Area, Yukon; Geol. Surv., Canada, Mem. 203. (1936).

Teslin Lake and considered them to be of Jurassic age. The outcrops examined by him were designated as "Laberge series? volcanics". Group D rocks are older than the adjacent granitic rocks, but no direct evidence of their age relative to Groups A, B, and C, was found by the writer.

Peridotite and Dunite

A body of massive peridotite and dunite outcrops near Geddes Creek, about 13-miles northwest of Teslin and $1\frac{1}{2}$ miles northeast of the highway. It measures about 5 miles by 1 mile and trends northwesterly parallel to the surrounding volcanic rocks of Group D. The core of the body is mainly peridotite and the edges dunite, but the two types were not seen in contact. Peridotite is probably the most common rock. It is heavy, dark green, and crystalline with a rusty brown surface. Fresh surfaces show dark green cleaved crystals of pyroxene, up to $\frac{1}{2}$ inch long, set in a groundmass of greenish glassy olivine or its alteration product, dense black serpentine. The pyroxene commonly comprises about half the rock. No chromite was recognized. Some fracture surfaces in peridotite are lined with fine-grained magnetite. In a few places the rock is cut by hair-like seams of a fibrous, asbestos-like mineral. The dunite is a smooth-surfaced, fine-grained, dark green, equigranular rock with a greenish brown weathered surface $\frac{1}{2}$ inch or more thick. The fresh rock is composed mainly of olivine, but contains a little pyroxene, magnetite, and serpentine derived from olivine.

The peridotite and dunite mass was not seen in contact with other rocks, but its composition and form suggest that it intruded the adjacent Group D volcanic rocks. Lees¹ mapped similar ultrabasic rocks near the

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Lees, E.J.: Op. cit., pp. 14, 15, and 19.

outlet of Teslin Lake and considered them to be Jurassic or younger, and inferred that they were older than adjacent granites.

Granite, Granodiorite, and Allied Rocks

Four bodies of granite, granodiorite, and allied rocks were mapped. One crosses the highway between miles 6E and 20E, another lies a few miles south of the outlet of Swan Lake, and still another outcrops on Seagull-Creek, a few miles north of the Swift River control station. An extensive granitic body, perhaps the northerly extension of the Cassiar batholith, crosses the upper Rancheria River. All these masses, with the possible exception of that north of the Swift River control station, are of very similar appearance and composition and are probably genetically related to each other.

The granitic rocks that cross the highway between 6 and 20 miles east of Teslin have been traced northwesterly from the Yukon-British Columbia boundary across Morley River and Nisutlin Bay and beyond, for a total distance of about 30 miles. Topography suggests that these rocks may extend another 17 miles northwesterly, through unmapped territory, to connect with granitic rocks mapped by Lees² a few miles

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Lees, E.J.: Op. cit.

northeast of the outlet of Teslin Lake. In the vicinity of Nisutlin Bay the granitic rocks grade into and include an unknown amount of quartz-mica schist and gneiss that probably occur as numerous irregular bodies. These rocks could not be mapped separately, as wide areas in the vicinity of the bay are covered with overburden. The granitic rocks vary widely in colour, texture, and composition, due, in part at least, to varying degrees of contamination with the associated schists and gneisses, which probably represent altered sedimentary or volcanic rocks or both. The normal intrusive rock is a medium- to coarse-grained, light grey, massive rock ranging in composition from granite to quartz monzonite or granodiorite. It contains about 30 per cent smoky brown quartz, 30 to 55 per cent microcline and orthoclase, 35 to 15 per cent sodic plagioclase, and up to 5 per cent biotite. Other types include medium-grained, dark grey, massive quartz diorite and diorite containing about 35 per cent hornblende and biotite.

Granodiorite outcrops about 3 miles south of the outlet of Swan Lake and extends more than 13 miles south of the lake. This intrusion is for the most part a remarkably uniform, massive, medium- to coarse-grained, well-jointed rock. Much of it is equigranular, with mineral grains ranging up to about 3/8 inch, but occasional phenocrysts of pink feldspar up to 1 inch long were seen. One thin section contained about 35 per cent quartz, 60 per cent oligoclase-andesine, and 5 per cent biotite and hornblende, but some of the pink phenocrysts, not seen in thin section, may be potash feldspar. A few pink aplite dykes, commonly less than 6 inches thick, were noted. Near its northern edge, a few miles south of Swan Lake, some of the granodiorite is finer grained and gneissic and contains more dark minerals.

Granite is exposed on Seagull Creek about 1 1/2 miles from its mouth and probably extends more than 8 miles to the north-northwest. It is uniformly massive, coarse-grained, light grey rock with no noticeable alteration except in places where the surface is deeply weathered to a crumbly brown rock. The granite contains about 40 per cent smoky grey quartz, 50 per cent creamy to buff orthoclase with a little intergrown albite, and 10 per cent biotite. Mineral grains average about 3/8 inch, but a few 1-inch feldspar phenocrysts were seen. The rock commonly contains veins, up to 1 inch wide, of quartz and black tourmaline, or pockets, up to 3 inches in diameter, of the same minerals. A few exposures of a porphyritic phase composed of 1/4 inch dark quartz grains and 3/8 inch creamy feldspar crystals, in a fine-grained, speckled brown groundmass, were observed and may represent dykes that cut the granite.

The Cassiar granitic batholith trends north-northwest and crosses the highway between miles 87E and 103E. Its western edge was traced about 40 miles and its eastern edge about 30 miles. The batholith is about 14 miles wide, except near the south edge of the map-area where it narrows to about 5 miles. Its western edge probably swings sharply towards the west a few miles south of the map-area. Most of the rock is light grey, massive,

Campbell, N.: Consolidated Mining and Smelting Company of Canada, Limited; personal communication.

and medium- to coarse-grained. Some of it contains phenocrysts of pink feldspar up to 1 inch long, and locally these comprise about a third of the rock. It ranges from granite to granodiorite, but the common variety is probably biotite-quartz monzonite. Six thin sections averaged: quartz, 30 per cent; potash feldspar, including microcline, 32 per cent; plagioclase feldspar, commonly oligoclase, 28 per cent; and biotite, hornblende, and muscovite, 10 per cent. The intrusion is cut by many pink aplite dykes, and by a few pegmatite and lamprophyre dykes. The aplite and pegmatite dykes ordinarily do not exceed a foot in width, whereas the lamprophyre dykes are commonly several feet wide. Some pegmatite contains black tourmaline and red-brown garnet. No inclusions of sedimentary or volcanic rocks were recognized within the massive phases of the intrusion.

A wide variety of gneissic phases was observed south of the road within a belt a mile or so wide along the western edge of the intrusion. The gneissic structure is probably best developed within $\frac{1}{2}$ mile of the edge of the batholith and seems to grade easterly into that of the normal massive rocks of the batholith. The gneiss is a fine-grained, light grey, foliated rock made up of various proportions of quartz, microcline, plagioclase, biotite, and white mica. Much of it is layered with light and dark grey bands, the layering being due to variations in grain size and mineral content. Foliation and banding commonly strike parallel to the border of the intrusion. The bands range from less than 1 inch to many feet in thickness. Crushed feldspar phenocrysts, up to $1\frac{1}{2}$ inches long, occur locally. In thin section many of the mineral grains are seen to be crushed and some of the rock is traversed by thin parallel partings of very fine-grained quartz, feldspar, and white mica.

The eastern contact of the batholith was seen in several places. In one place pegmatitic and aplitic rocks comprise nearly half the granitic material within 1,500 feet of the contact. At another place coarse-grained, massive, granitic rock extends to within 10 feet of the contact with no noticeable change other than a slight rustiness. Elsewhere the rock within several feet of the contact is fine-grained and contains very little dark minerals, or is a mixture of fine-grained aplitic material and coarse-grained pegmatite.

So far as known all the granitic rocks are of about the same age. Granitic rocks cut Groups A, B, C, and D and are thus post-Carboniferous (?), and younger than the Jurassic (?) volcanic rocks of Group D. The intrusions are, therefore, tentatively dated as late Jurassic or younger.

Basalt

Black olivine basalt was found on Swift River at the mouth of Smart River, at the inlet of Swan Lake, on Rancheria River at miles 95E and 110E, and on Big Creek. No basalt was found in place above an elevation of about 3,250 feet, and at the first four localities named above it outcrops at or within 400 feet of the bottom of the Swift-Rancheria Valley. The basalt mapped at 110 miles east of Teslin was not examined, but was identified through binoculars by its colour and columnar jointing; it may extend a few miles south of the map-area and underlie a flat, drift- and lake-covered area that extends southeast from Rancheria River in that vicinity. Flat-topped drift-covered hills near Big Creek suggest that the area underlain there by basalt may be much greater than shown. Wherever seen the basalts are flat or very gently tilted lava flows, several of which are between 5 and 20 feet thick. Good columnar jointing is common. The greatest thickness of lava seen was about 150 feet. Near mile 94E basalt was reported by an assistant to rest on drift. On Big Creek an outcrop near the base of a flow about 20 feet thick contained well-rounded boulders of basalt about 1 foot in diameter. Open cavities or vesicles are especially numerous near the tops of the flows, where in places they occupy about half the rock; many are between $\frac{1}{8}$ inch and 2 inches long. Ordinarily they are roughly spherical, but some are pipe-like, or irregular in shape, or are parts of chains of

interconnected cavities. Pale green glassy olivine is visible in most hand specimens and makes up 5 to 25 per cent of the rock; other constituents are in microscopic grains and include labradorite, brown pyroxene, magnetite, and volcanic glass. No alteration is apparent.

The basalt was not found in contact with other rocks, but because of its remarkably fresh appearance and its content of glass it is considered to be the youngest consolidated rock in the area. Glacial erratics of similar basalt are common up to elevations of about 5,200 feet and the rock must, therefore, be older than at least part of the Pleistocene. Near the junction of Rancheria and Liard Rivers, Dawson¹ found basalt overlying clay, soft shale,

¹ Dawson, G.M.: Report on an Exploration in the Yukon District, N.W.T., and adjacent Northern Portion of British Columbia, 1887; Geol. Surv., Canada, Pub. No. 629, p. 99 (1892).

and lignite that he thought resembled Miocene lignites of British Columbia. The basalt within the present map-area is, consequently, believed to be, in part at least, of late Tertiary age.

STRUCTURAL GEOLOGY

The formations of Group A have an average dip of about 50 degrees. Between mile 20E and Hazel Creek they trend southeast or east and dip southwest or south. Between Smart River and Swan Lake, and south of Swift River, they strike northeast and dip southeast; they bend sharply towards the north where they cross Swift River, and north of the river strike between north and northwest and dip northeasterly beneath the rocks of Group B. Between miles 84E and 87E they trend about north-northwest parallel to the border of the Cassiar batholith and dip about 55 degrees west-southwest away from the intrusion and beneath the formations of Group B.

The main body of Group B formations probably occupies a major syncline that trends northwesterly. Dips average about 38 degrees. On both flanks of this structure Group B rocks strike northwest and rest on, and dip away from, Group A rocks. The strata within the central part of the major syncline trend in many directions and probably form several smaller folds, the axes of which possibly trend about north-northwest and lie several miles apart. Group B formations along their eastern border overlie those of Group A without observed unconformity. Along their western border, near the outlet of Swan Lake, the recorded attitudes of Group B strata vary widely from the nearest recorded attitudes of Group A strata: observations are, however, too widely spaced to indicate a major structural discordance.

Most of the beds within Group C strike between northeast and northwest and the dips average about 45 degrees.

Observed attitudes within 5 miles of the Cassiar batholith suggest that most formations within this belt, excepting those near the highway, strike nearly parallel to the edge of the batholith and dip away from it. Within that part of this belt that extends about 4 miles north and 2 miles south of the highway the beds strike in many directions and in part are nearly flat-lying.

At most places rocks of Group D strike about northwest, nearly parallel to Teslin Lake, and dip northeast. Dips average about 58 degrees.

The foliation of schists and gneisses within the granitic rocks near Nisutlin Bay ordinarily trends between north and northwest and dips more than 70 degrees.

The foliation and banding of the gneissic phases of the Cassiar batholith trend about north-northwest and dip more than 65 degrees.

The basalt lavas are generally nearly horizontal.

ECONOMIC GEOLOGY

Metallic Mineral Deposits.

Tungsten has been found on the Fiddler Group of claims (1)¹, owned by Consolidated Mining and Smelting

¹ This number appears on the accompanying map and shows the approximate location of the deposit.

Company of Canada. A trail leads to the claims from the highway near mile 105E. The group was staked early in July 1943 by Messrs. D.M. Baird, H.B. Denis, K.C. Fahrni, J.W. Forrest, and D.R.E. Whitmore, and includes Back, Greig, Elgar, Handel, and Frank claims. The country rock is mostly grey, crystalline, micaceous limestone and soft grey sericite schist or phyllite. The attitude of the beds probably varies from place to place, but the dip is generally less than 15 degrees. These rocks are cut by many barren stringers or groups of stringers of glassy to white, rhythmically banded, crystalline quartz with numerous open crystal-lined spaces. Elsewhere brecciated rock is cemented by similar quartz. Mineralized vein quartz outcrops at an elevation of about 5,100 feet on a rounded peak and on an adjacent cirque wall. The vein or veins trend northeasterly, dip gently southeasterly, range in width from a fraction of an inch to about 3½ feet, and in part lie at an angle to the bedding. The quartz is glassy to white, banded, and in crystals up to about 1½ inches by 3 inches. These project into long open spaces that parallel the banding and the vein walls. On the top of the peak the quartz probably ranges up to about 1 foot in width and has been traced for some 200 feet by several shallow pits. On the cirque wall, which forms one side of the peak, a quartz vein up to 3½ feet wide is reported to have been traced for

about 400 feet. Some of the quartz on the peak contains abundant, glistening, dark brown wolframite in blades an inch or more long. Associated, less abundant minerals include galena, sphalerite, malachite, azurite, chalcopryrite, grey copper (?), fluorite, scheelite (?), white carbonate, a soft, greenish, micaceous mineral, powdery, greenish yellow material, and iron oxide. A specimen of the wolframite contained¹ 12.6 per cent MnO. A picked

1

Fabry, R.J.C.: Mineralogical Section, Geological Survey.

sample of quartz and wolframite assayed² 0.59 per cent tin

2

Bureau of Mines, Department of Mines and Resources, Ottawa.

and 15.00 per cent WO_3 . The form in which the tin occurs is not known. In a saddle about 1,000 feet northwest of the occurrence of mineralized quartz, rusty, fine-grained, dark green, bedded rock contains a little pyrite, pyrrhotite, sphalerite, galena, and fluorite as disseminated grains and in thin seams. About 3,000 feet northwest of the mineralized quartz, several linear features trend northwesterly across the southerly face of a 5,200-foot peak. One of these has been explored for about 200 feet by several shallow trenches. These expose gossan for widths up to about 6 feet. This material is mostly porous, dark brown, hard limonite and yellowish, powdery iron oxide, but includes a little crustified and drusy quartz and a few pockets of galena.

Botryoidal limonite float is abundant about 2 miles south of the highway at mile 104E (2). It occurs in drift overlying dense, white, buff-weathering dolomite or limestone, or both, within a few hundred feet of the edge of the granitic batholith and has probably not been transported more than a few feet. The area of limonite float parallels the granite contact for more than 1,000 feet. One specimen of nearly solid dark brown limonite assayed³:

3

Bureau of Mines, Department of Mines and Resources, Ottawa.

gold, 0.005 ounce a ton; silver, 0.79 ounce a ton; tungsten, nil.

Galena and sphalerite were found at an elevation of about 5,100 feet on top of a ridge about 7 miles south of the highway at mile 104E (3). Claims were staked in this vicinity by Mr. Gunnar Berg late in the summer. The occurrence lies within altered sedimentary rocks close to the east border of the Cassiar granitic batholith. Fine-grained galena, light brown sphalerite, pyrite, and a greenish yellow stain occur in a knob of rusty rock about 100 feet in diameter. The knob is surrounded by drift but probably

lies within 50 feet of the granite. The rock is a mixture of black siliceous rock cut by fine-grained, sugary, white, drusy quartz and a breccia of white quartz in a black siliceous matrix. It contains many open cavities, as though minerals had been leached from it, and breaks into small fragments with many polished surfaces that suggest considerable shearing. The metallic minerals probably comprise less than 5 per cent of the surface rock. A picked specimen with abundant yellow stain assayed¹: gold,

¹ Bureau of Mines, Department of Mines and Resources, Ottawa.

trace; silver, 9.83 ounces a ton; lead, 7.23 per cent; zinc, 3.86 ounces a ton; molybdenum, none; tungsten, none. Another sample is reported² to have contained considerable gold.

² Gunnar Berg: Personal communication.

Another occurrence of galena and sphalerite lies about $1\frac{1}{2}$ miles southwest of the above deposit, in a deep notch that crosses a ridge at an elevation of about 5,200 feet (4). It is separated from the above occurrence by a drift-filled valley that trends about east. So far as known this occurrence was not staked during the summer of 1943. The notch trends about southwest and approximately marks the contact between sedimentary rocks to the southeast and granitic rocks to the northwest. Sedimentary rocks immediately southeast of the notch include fine-grained, white, black, and mottled quartzite, grey crystalline limestone, and white dolomite with diopside and fibrous tremolite. Altered sedimentary types within the notch include a variety of grey, green, and black, fine-grained, rusty, siliceous rocks, layered light greenish rock with bands and knots of brown garnet, fine-grained quartz-mica schist, rusty black graphitic slate, and fine-grained, black, graphitic limestone. At one place on the northwest side of the notch grey mica schist was seen in contact with fine-grained pink and coarse-grained pegmatitic granite. The contact strikes north 50 degrees east and dips 55 degrees southeast. Rusty vuggy vein quartz is abundant in the talus in the notch, and some contains pockets of pyrite 2 inches across or a little soft chalky white material. Some white quartz and associated grey siliceous rock in the talus has a greenish yellow stain and contains a little fine-grained galena and brown sphalerite. A specimen of quartz-garnet rock contained a few grains of a grey mineral thought to be scheelite: it displayed blue-white fluorescence when tested with an ultra-violet lamp. However, no tungsten was detected when similar material was assayed by the Bureau of Mines at Ottawa.

Coal

Dawson¹ reported lignite (low-grade coal) on the

1 Dawson, G.M.: Report on an Exploration in the Yukon District, N.W.T.; and Adjacent Northern Portion of British Columbia, 1887; Geol. Surv., Canada, Pub. No. 629, pp. 93 and 98-100. (1898).

lower Dease River, on Liard River at two points (5,6) near where the highway now crosses it, and at other places on the Liard as far upstream as the mouth of Frances River. These occurrences were not examined by the writer and the following remarks are from Dawson's report. The lignite is commonly impure and laminated. It occurs as seams up to about 3 feet thick associated with soft white to grey clays, shales, and coarse sandstones. These rocks, possibly of Miocene age, dip at angles up to about 15 degrees and in places contain fossil leaves. On Liard River, near the mouth of Rancheria River, they are overlain by basalt. Similar basalt was found by the writer on the highway at Big Creek, about 21 miles west-southwest of the mouth of Rancheria River, but the underlying rocks were not exposed. It is, however, possible that Tertiary rocks with lignite underlie parts of the drift-covered country traversed by the highway between mile 119E and Liard River.

Suggestions to Prospectors

All of the map-area west of the lower Rancheria bridge, at mile 119E, is metalliferous country, and none of it should be completely disregarded by the lode prospector except, perhaps, the central parts of the granitic bodies. Lignite (low-grade coal) possibly occurs in places between the lower Rancheria bridge and Liard River, but metalliferous deposits are not likely to be found there because of the mantle of drift and Tertiary rocks. All areas adjacent to granitic rocks should be examined, especially those underlain by (1) limestone and dolomite, (2) interbedded rocks of widely varying competency (strength), especially where these have been strongly folded or faulted, (3) rocks cut by numerous quartz veins, (4) rusty rocks, and (5) faults and shear zones. Metallic mineral deposits commonly occur near stocks or small bodies of granitic rock, or where sedimentary or volcanic rocks have been invaded by tongues from larger granitic masses. Most known mineral deposits in the map-area lie within the limestones, dolomites, and associated rocks of Group C close to the eastern edge of the Cassiar batholith, that is, north and south of the highway at about mile 105E. This section contains gold, silver, copper, lead, zinc, tungsten, and tin, and clearly warrants further prospecting. The work should be continued to the north and south beyond the limits of the map-area. Rocks of Group B vary widely in competency, with the result that in places, such as north of the highway between Seagull Creek and Pine Lake, they have

been invaded by numerous quartz veins, some of which contain a little pyrite. This, and other areas of quartz veins, some of which are shown on the accompanying map, should be examined. Many rusty areas were seen beyond the limits of the map-area between the headwaters of Smart River and Logjam Creek; these were not studied, but they undoubtedly warrant prospecting.

Prospectors should not neglect to search for tin minerals. Tin was detected in one sample from the Fiddler group where it is associated with wolframite, a mineral characteristic of some tin deposits. Tourmaline, another common associate of tin, occurs in pegmatites in granitic rocks 6 miles northwest of these claims and is common in seams and pockets, accompanied by quartz, in granite near Seagull Creek. Cassiterite is the tin mineral to be sought for, but is easily overlooked in outcrops. Recent experience by the Geological Survey elsewhere in Yukon suggests that tin-bearing localities are best found through the liberal use of the gold pan.