CANADA

DEPARTMENT OF MINES AND RESOURCES

HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES AND GEOLOGY BRANCH

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GEOLOGICAL SURVEY

MEMOIR 217

LABERGE MAP-AREA, YUKON

BY

H. S. Bostock and E. J. Lees

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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Looking north across Lewes River from hills west of Big Salmon.

CONTENTS

Illustrations

Laberge Map-area, Yukon

CHAPTER I

INTRODUCTION

Laberge map-area, bounded by latitudes 61 and 62 degrees and longitudes 134 and 136 degrees, comprises 4,500 square miles in the southern part of Yukon Territory. It is traversed by Lewes River and by the Whitehorse-Dawson road, and as these are the main routes of transportation in Yukon, most of the prospectors going into the territory have passed through the district. The first discoveries of gold in Yukon were probably made on Lewes, Teslin, and Big Salmon Rivers in this area, yet with the exception of Livingstone placer camp, which has produced somewhat over $1,000,000 in gold, no important mineral discovery has been made in the district. The area, however, should not be regarded as probably lacking in mineral deposits. Except perhaps for placer ground, it has hardly been prospected at all and may be regarded as being virgin ground.

Whitehorse, the terminal of the White Pass and Yukon Route railway and the head of navigation on Lewes River, is 19 miles south of Laberge map-area. Lake Laberge and Lewes River form a waterway extending north and south through the middle of the district and in summer a regular steamship service is maintained on this route. Teslin River is also navigable. Big Salmon River is a fast, rocky stream and is only used by small, shallow-draft boats. Both main branches of this stream have been ascended by poling boats. All three rivers are swift, but have no rapids that cannot be ascended or descended by relatively high-powered boats. High water on Teslin River occurs about the end of June. Thereafter the water-level usually drops steadily, and relatively early in summer the river becomes low and difficult for large boats to navigate. Lewes River, with large lakes and glaciers at its heads, rises more slowly, reaches high water stage late in summer, and remains moderately high in September. Big Salmon River rises abruptly, reaches high water stage early, and drops very low towards the end of summer.

The Whitehorse-Dawson road traverses the west border of the map-area. Tractors are employed and of late trucks and automobiles have been run on the road, particularly in the latter part of summer when the road is dry and in the autumn when it is frozen. A road connects Livingstone with Mason Landing on Teslin River and has been in regular use in summer. A road connecting Lower Laberge and Braeburn, and another road following Mandanna Creek Valley have fallen into disuse.

Other than these roads no regular trails for use by horses have been established, though in many places stretches of trail have been worn. Though trails are lacking, pack-horses can be taken through any part of the district. A winter trail for dog teams has been established from Lake Laberge to Teslin Crossing and on to Livingstone.

Aeroplanes can be hired at Whitehorse or Carcross, 55 miles south of the district, and can land at various points along Lewes and Teslin Rivers or on lakes west of these rivers. East of the rivers, lakes large enough for planes to land on are few.

A telegraph line from Whitehorse to Dawson follows the west shore of Lake Laberge and Lewes River. Telegraph operators are stationed at Lower Laberge and at Carmacks, a few miles north of the map-area. Hootalinqua and Big Salmon are connected by telephone with Lower Laberge and Carmacks.

The white population consists of the telegraph operators and their families, a few woodcutters on Lewes River, and a few prospectors and trappers at Livingstone and on Boswell River, perhaps in all as many as twenty-five. Several families of Indians have their headquarters at Big Salmon or along Teslin River. Trapping, woodcutting for the steamers on Lewes River, and placer gold mining are the occupations of the inhabitants.

The map-area has a semi-arid climate, but the light precipitation does not make itself felt as it does in more southern latitudes where evaporation is intense. The summers, though subject to brief cold spells, are warm; the days are sunny, but thunder showers are common in the mountainous sections. June and July are almost continuous daylight. Splendid vegetables and hardy grains can be grown. In winter the snowfall is light, so that in many parts of the district horses can find sustenance on open grassy slopes and frozen meadows. Periods of very low temperature occur during the winter season, but normally are brief. Flocks of ducks are able to spend the winter at Lower Laberge where the current keeps an area of shallow water clear of ice except during the very coldest weather.

The country for the most part is timbered except on the south slopes of hills and above timber-line, which is at elevations of 4,000 to 4,500 feet. Above timber-line large areas are covered by dwarf birch, willows, and grass. The dry, sunny, south faces of the hills are occupied in many places by bunch-grass and sage, whereas northward facing slopes are characterized by alpine plants, spruce, moss, etc. The trees are white spruce, black spruce, balsam fir, black pine, white birch, balsam poplar, and aspen poplar. Of these the white spruce is the most valuable for timber and firewood.

Moose inhabit all parts of the district, but they are not plentiful except in the northeast part. The large Osborn caribou range in Big Salmon Mountains, and the small migratory caribou are found in north and west parts of the district in some seasons. A few grizzly bears inhabit the mountainous country, and black and brown bears are to be found anywhere. Other game and fur animals are wolf, coyote, fox, lynx, marten, mink, weasel, beaver, muskrat, marmot, ground squirrel, tree squirrel, jack rabbit, etc. Three kinds of grouse and two of ptarmigan were observed in the map-area.

The earliest notice of the geology of the district is by Dawson,[1] who in 1887 travelled up Lewes River. McConnell[2] in 1898 made a reconnaissance survey of Big Salmon River, and in 1900 he examined Livingstone Creek gold placer camp.[3] Cairnes[4] in 1907 carried out geological work along Lewes River and Lake Laberge, and commenced the study of an area west of the north end of the lake and of a second area about Nordenskiöld River Valley. He continued this work during 1908 and the results obtained were published in the form of a short memoir.[5]

In 1929 and 1930 the junior author (E. J. Lees), under the supervision of W. E. Cockfield, geologically explored the western half of the district. In 1931 he explored the part of the eastern half lying south and west of Big Salmon River, except a limited area in the southeast corner that he studied in 1935. The area north of Big Salmon River was geologically studied in 1934 by the senior author (H. S. Bostock). Geological field assistants in 1929 were J. Stevenson, E. Raynor, and A. Cole; in 1930, A. Cole, N. O. Solly, and C. Hillary; in 1931, N. O. Solly, J. R. Johnston, and J. Y. Smith; and in 1934, J. E. Armstrong.

[1] Dawson, G. M.: Geol. Surv., Canada, Ann. Rept. 1887-1888, pt. B, pp. 151-159.
[2] McConnell, R. G.: Geol. Surv., Canada, Sum. Rept. 1898, pp. 46-55.
[3] Geol. Surv., Canada, Sum. Rept. 1900, pp. 25-30.
[4] Cairnes, D. D.: Geol. Surv., Canada, Sum. Rept. 1907, pp. 10-15.
[5] Geol. Surv., Canada, Mem. 5.

CHAPTER II

PHYSICAL FEATURES AND GLACIATION

Laberge map-area is a part of the Yukon Plateau and lies close to the southwest edge of this region. The plateau surface varies in elevation above sea-level from 3,600 to 3,800 feet, as in the part of the district northwest of Lake Laberge, to 4,500 to 5,000 feet where it borders mountain ranges such as Big Salmon Mountains in the east or the Miners Range in the west. Other mountain masses and ranges of hills also rise from the plateau surface and it is deeply dissected by many broad valleys.

The map-area was almost completely, perhaps completely, covered by the last continental ice-sheet of the Glacial period, although the edge of this sheet lay only some 20 miles northwest of the border. The only areas that may not have been covered by the ice-sheet are the highest parts of the Miners Range and of Big Salmon Mountains. In the Miners Range glacial erratics were found as high as 6,200 feet above sea-level, and as the highest point of the range rises only to 6,700 feet it is evident that only a very small part may have remained uncovered. In Big Salmon Mountains numerous erratics were noted as high as 6,500 feet on the west side of Mount Black. This mountain rises to 7,044 feet and is the highest point in the district. A piece of quartzite found on top of this granite peak was supposed to be an erratic, indicating that the ice-sheet overrode the mountain,[1] but it is possible that the fragment of quartzite was derived from an inclusion in the granite and was not glacially transported. North of Big Salmon River no evidence of glaciation was noted above heights of 6,000 feet. It may be, therefore, that small areas of the Big Salmon Mountains were not covered by the ice-sheet. Striæ and boulder trains show that the general direction of movement of the ice-sheet was to the northwest.

The bottoms of broad valleys that cross the hills lie at elevations of between 2,700 and 3,000 feet above sea-level, and in places broad terraces cut in rock lie at the same elevations along the sides of the deeper valleys. A second erosion level is indicated by other valleys whose bottoms lie at elevations of 2,000 to 2,500 feet above sea-level. These two erosion levels are more marked in the western part of the map-area than elsewhere. The valleys of the higher level have a general northwest trend. One of these valleys extends from Lake Laberge across the low hills between Coghlan Lake and Lewes Mountain and thence northwest to Mandanna Creek Valley and down it to Lewes River. This valley appears to have been the original course followed by Lewes River between Lake Laberge and the mouth of Mandanna Creek, but now Lewes River below Lake Laberge runs northeasterly and easterly to join Teslin River, entering Teslin River Valley through a relatively narrow gap in the valley side. This gap is not of post-Glacial origin as it is cut down to grade in very hard rocks and the amount of erosion involved is much greater than the

[1] Bostock, H. S.: Geol. Surv., Canada, Sum. Rept. 1931, pt. A, p. 2.

post-Glacial erosion exhibited by the river at Five Finger Rapid.[1] It is improbable that the diversion of the Lewes River drainage was due to excavation of a new channel by action of the last ice-sheet, as considerable sections of the present valley are transverse to the direction of ice movement. The diversion of Lewes River may have taken place during an interglacial period.

All the lower parts of the map-area are underlain by extensive deposits of drift. They occupy the floors of the main valleys, where they are of considerable depth, and into them the main streams have cut trench-like courses commonly 200 feet deep.

A large body of gravel sand and boulder clay piled up on the east, south, and west of Lewes Mountain is believed to be a terminal moraine. It impedes the erosion of the course of Lewes River and holds up the level of Lake Laberge.

Eskers are common forms in the large valleys in the central and northwest parts of the map-area. In some places they extend across the valleys and are higher at the ends on the valley sides than in the middle.

A great part of the drift deposits forms terraces. Most of these are within a few hundred feet of the valley floors, but they stand at all levels on the valley sides. The higher terraces are small as a rule. Most of them occur in the mouths of tributary valleys and embayments in the sides of the main valleys. Such terraces in Miners Range were seen up to elevations of 5,500 feet. Lower terraces are more extensive, covering large areas of the valley floors. The larger of these terraces are 100 to 250 feet above the main streams, and they contain numerous and large kettle-holes in some areas. The rivers have developed narrow trench-like valleys bounded by great cut banks. Lower again, in the trench-like valleys, at levels up to about 50 feet above the present rivers, other small terraces have developed. These, unlike the higher terraces, are not marked by kettle-holes.

The higher terraces on the valley sides are probably formed of sand and gravel. The great cut banks in the lower terraces show them to be made up of bedded silt, sand and gravel, and glacial till. Where the glacial till is visible it lies at the base of the exposures. A bank at the mouth of North Big Salmon River shows 100 feet or more of glacial till overlain by nearly an equal thickness of gravel and sand. On Lewes River below Big Salmon, and on Teslin River below the crossing, more than 100 feet of silt beds are exposed in the banks. These silts are composed of beds, a few inches to 3 or 4 feet thick, of alternately white silt and fine sand with, in places, small amounts of coarser sand and gravel with a few boulders. The lowest terraces, which have no kettle-holes, are entirely of river gravel, sand, and silt.

It is thought that most of the terraces formed in bodies of water that developed along the sides of the bodies of ice that filled the valleys during the waning stages of the ice-sheet. The thick drift deposits that form extensive terraces on the bottoms of the larger valleys are thought to have been formed at later stages in lakes of considerable size, resulting from the existence of temporary dams of drift and ice. The lowest terraces, of river gravel, etc., were formed during the incising of the river courses in these extensive drift deposits after the disappearance of the glacial ice.

[1] Bostock, H. S.: Geol. Surv., Canada, Mem. 189, pp. 10-11.

CHAPTER III

GENERAL GEOLOGY

Geologically Laberge map-area is characterized by the northerly to northwesterly strike of the strata and major structural features. Big Salmon Mountains, forming the east edge of the district, are underlain by a thick group of altered sediments, of Precambrian or early Palæozoic age, invaded by large bodies of Mesozoic or Tertiary granitic rocks. In the southwest corner lies the eastern edge of an extensive batholithic area of Mesozoic or Tertiary granitic intrusives. Between the batholithic area on the west and the area of Precambrian or early Palæozoic strata on the east is a 50-mile wide belt of Triassic, Jurassic, and perhaps Cretaceous sediments overlain by extensively developed volcanic rocks of, presumably, Cretaceous age. The sedimentary and volcanic rocks are cut by numerous bodies of granitic rocks. At one place, amongst the Mesozoic strata, fossiliferous limestone of late Palæozoic age has been found, and possibly other developments of limestone in the eastern part of the district may be of Palæozoic age.

Table of Formations

Late Tertiary to Recent		Alluvium, glacial drift, volcanic ash
Miocene or older	Little Ridge volcanics, etc.	Basalt, andesite, dacite, rhyolite, etc.
Upper Jurassic or later		Granite porphyry, monzonite porphyry, etc. Granite, granodiorite, monzonite, etc.
		Peridotite, hornblendite, serpentine
Upper Jurassic or Cretaceous	Hutshi group	Andesite, basalt, tuff, agglomerate, breccia
Upper Jurassic or Lower Cretaceous	Tantalus formation	Conglomerate, sandstone, shale, coal
Jurassic	Nordenskiöld formation	Dacite, tuff, breccia
	Laberge series	Conglomerate, greywacke, arkose, sandstone, argillite
Triassic	Lewes River series	Limestone, argillite, greywacke, sandstone
Carboniferous or Permian		Limestone
Precambrian and, or, Palæozoic		Sheared granodiorite
	Yukon group	Quartzite, phyllite, argillite, limestone, schist, gneiss, greenstone

YUKON GROUP

The altered sedimentary and igneous rocks assigned to the Yukon group occur only in the eastern part of the map-area, where they underlie the greater part of Big Salmon Mountains. They extend for miles east of the district, and according to McConnell[1] form a great anticline whose axis strikes northerly and crosses Big Salmon River about 5 miles east of Laberge map-area. Thus the Yukon group rocks in Laberge district lie in the upper part of the west limb of the anticline.

McConnell divides the rocks into three great divisions: a basal series of quartzitic and micaceous schist and crystalline limestone; an intermediate series of granular limestone; and an upper series of dark slates, green schists, tuffs, limestones, and serpentine. No persistent, thick, limestone division has been recognized in Laberge district, though there are belts of limestone lenses. It may be that the limestone lenses represent McConnell's intermediate division, but it seems probable that they do not and that the Yukon group rocks in Laberge district belong only to the upper division. Over the greater part of the area occupied by them, nearly as far north as North Big Salmon River, they strike northwest to north. Approaching North Big Salmon River their strike changes to north to northeast, but farther north returns to northwest to north. The strata for the most part dip to the west but not everywhere, as the rocks are affected by a number of minor folds and a few major folds. The axial planes of such secondary folds as were observed dip to the west. The areas of Yukon group rocks south of Big Salmon River were mapped first and no attempt was made there to subdivide the rocks that form the group.

In the area between North Big Salmon River and Big Salmon River above the mouth of South Big Salmon River, the Yukon group strata are divisible into five members. The same divisions extend to the north and to the south across Big Salmon River, but there the lowest division lies east of the border of the map and strata belonging to higher divisions of the group than those that are found north of Big Salmon River are developed along the southwestern border of the area occupied by the Yukon group rocks. The estimated thickness of the five members in the area north of Big Salmon River are given below:

	Feet
(5) Highest member: schists, greenstone, quartzite, amphibolite, gneiss	4,000
(4) Quartzite, commonly in thick beds	3,000
(3) Green and light-coloured schist, quartzite, large lenses of limestone	2,500
(2) Dark, commonly black, schist, slate, quartzite, and limestone	2,000
(1) Micaceous quartzite, mica schist, limestone	3,500

Member No. 1. The lowest member as developed at the head of D'Abbadie Creek is constituted as indicated in the following tabular statement, in which the strata are listed in descending order:

	Feet
Light grey, quartz-mica schist and micaceous quartzite	200 to 300
Thin-bedded, white to grey limestone	150
Interbedded crystalline limestone and coarse mica schist	150

[1] McConnell, R. G.: Geol. Surv., Canada, Sum. Rept. 1898, pp. 48-49.

	Feet
Interbedded quartzite and mica schist, mainly coarsely crystalline; at the top equal amounts of quartzite and schist in thin beds with thin beds of limestone; the beds of schist decrease in thickness and those of quartzite increase downwards and towards bottom are 4 inches to 3 feet thick separated by beds of schist 2 to 4 inches thick	2,500
Limestone	50 to 100
Quartzite	300
Base beyond the eastern boundary of the map-area.	

Strata believed to belong to this member occur farther north on the northwestern slopes of Rangifer Mountain, but it is doubtful if they extend north of North Big Salmon River where they seem to have been cut out by bodies of intrusive granitic rocks of later age. Southward from D'Abbadie Creek the strata of Member No. 1 strike east of south and cross the eastern boundary of the district before reaching Big Salmon River.

Member No. 2. This member on the ridge between D'Abbadie and Teraktu Creeks is composed of the following strata, listed in descending order.

	Feet
Blue-black quartzite and schist	400
Blue-black schist holding quartzose lumps and lenses	500
Blue-black schist	200
Interbedded, black schist, black calcareous argillite, and blue-black quartzite	100
Lenses of white limestone	50
Dark grey, chlorite-mica-quartz schist	100
Limestone beds ½ to 2 inches thick, alternating with beds of grey schist ¼ to 1 inch thick	200
Blue-black or dark blue-grey schist with some beds of greenish chlorite-mica schist and a few thin beds of limestone underlain by blue-black or dark blue-grey, slaty quartzite, argillite, and schist	500

On the south side of Teraktu Creek the upper parts of this member contain beds of quartzite and limestone followed by 800 to 1,000 feet of black, argillaceous rocks. They all lie relatively flat, exhibit little metamorphism, and break into thin slabs along their bedding planes. These rocks are probably represented by the dark and blue-black schists in other localities. To the north of D'Abbadie Creek the rocks of this member are more metamorphosed and commonly contain graphite.

This member is characterized by the dark colour of the greater part, and was readily traced from the west side of Solitary Creek south across the lower part of Carlson Creek, the upper part of Teraktu Creek, and on south of Big Salmon River. The member continues south of this river, but its distribution in this part of the map-area was not determined.

Member No. 3. This member occupies a broad area south and southeast of Solitary Mountain, extends southwesterly under North Big Salmon Valley to D'Abbadie Creek and on to Teraktu Creek, forming a band 1 to 2 miles broad where it crosses the two creeks. It continues south across Big Salmon River, but its course in the south was not determined. This member, as displayed on a ridge bordering the north side of D'Abbadie Creek, is mainly composed of light green, schistose rocks varying from a quartzite to a chlorite-epidote-white-mica-quartz schist. The schists are laminated with straight, parallel layers of white quartz $\frac{1}{50}$ to $\frac{1}{20}$ inch thick and $\frac{1}{10}$ to $\frac{1}{2}$ inch apart. In places gneiss occurs with these rocks, and about 200 feet of limestone is present in about the middle of the member. The limestone is crystalline and holds thin beds of cherty quartzite. Limestone that forms bluffs along the southeast side of North Big Salmon River Valley near Carlson Creek, and limestone occurring farther north to the south of the head of Illusion Creek, is thought to be a continuation of the limestone in the D'Abbadie Creek section. Immediately south of this creek the limestone ceases, but is believed to be that which forms a synclinal cap on the ridge northwest of the peridotite area on the south side of Teraktu Creek and to reappear southeasterly across Big Salmon River. Gneisses exhibiting augen and mylonite were noted in some places in this member.

Member No. 4. This member is chiefly composed of white to light grey quartzite, in beds 1 to 4 feet thick, interbedded with brown mica schist, in beds up to 2 inches thick, and some beds of dark grey and green schist. Much of the quartzite carries scattered flakes of biotite and of white mica. At the base the quartzites are green and interbedded with green schists similar to those of the member below, making the boundary between them difficult to determine. Some small lenses of limestone occur with the quartzites of the lower part of the member. In places the rocks have been altered to quartzose gneisses. On the west side of the valley of North Big Salmon River, in the ridge opposite the mouth of Carlson Creek, a few outcrops of conglomerate were seen in horizons belonging to this member. The conglomerate occurs in beds 3 to 10 feet thick. The whole conglomerate is now sheared and recrystallized to a quartzose schist, but the outlines of elongated pebbles are clearly visible in it. The more distinct pebbles are of quartzite. The member forms a belt of prominent points extending from Lokken Mountain southward to Last peak, and continues on south of Big Salmon River.

Member No. 5. In the low mountain spurs south and north of the lower part of Teraktu Creek the following section, here recorded in descending order, is present:

Altered, basic, igneous rocks (greenstone) composed of hornblende, chlorite, epidote, and a little white material, probably altered feldspar, cut by numerous epidote veins; most of the greenstone is massive, but a few schistose zones are present.
Soft, greenish chlorite-mica schists with some thin beds of grey limestone. The limestone contains much mica, giving it a schistose structure.
Grey, siliceous schists.

Northward along the strike of the rocks, in the ridge southwest of the mouth of D'Abbadie Creek, dark green, foliated amphibolite, hornblendite, and hornblende-rich diorite are present. These rocks are all foliated parallel to the schists. West of and overlying them are green chlorite schists with smaller amounts of quartzite, quartz-mica schist, and limestone, all in beds $\frac{1}{2}$ to 2 feet thick. With these rocks, hornblende gneiss occurs in places. The greenstones, amphibolites, etc., may be intrusives and younger than the Yukon group.

This member forms the lower slopes of the mountains fronting on Big Salmon River between the mouths of North Big Salmon and South Big Salmon Rivers. In the mountains to the south, a belt of sheared, basic, igneous rocks and chlorite schists extends southeastward along the east side of Mendocina Creek and across to the head of South Big Salmon River. These may correspond to the basic igneous rocks associated with Member No. 5 north of Big Salmon River. West of this belt and west of the body of peridotite, etc., crossing the head of Livingstone Creek are rocks that presumably overlie Member No. 5. They strike southeasterly and dip westerly at high angles. As displayed in the vicinity of Livingstone Creek, they afford the following section, in descending order:

Interbedded, cherty quartzites, black argillites, and limestones, with some sericitic, chloritic, talcose, and graphitic schists.
Green, schistose rocks; mostly tuffs.
Grey, quartz-biotite schist, white and light grey sericite schist, and grey argillite.
Green, sheared rocks, mainly igneous, foliated diabase, and green, chloritic schists.
Grey, quartz-mica schist, white and grey schist, and micaceous quartzites; lenses of limestone are present in the lower horizons.

The upper part of this section was seen in Livingstone Creek Valley, where the rocks are considerably less metamorphosed than most of the members of the group that lie below them. Particularly noteworthy is the unaltered state of some of the chert beds with the limestone, and also the grey limestone itself.

The strata of Big Salmon Mountains that are assigned to the Yukon group appear to form a continuous sequence, and are mainly of sedimentary origin. All are altered, but the degree of alteration varies greatly. Some exhibit very little recrystallization, whereas others have been converted into gneisses. In the immediate vicinity of the bodies of Mesozoic granitic rocks, the Yukon group strata in places exhibit alterations due to the intrusions, but in the main the alteration is not so related and is the feature that distinguishes the group as a whole from all others occurring in the district. The Yukon group beds are unconformably overlain by Tertiary volcanic rocks, they are invaded by granitic masses of, presumably, Mesozoic age, but their relations with the fossiliferous Palæozoic and Mesozoic of the district are unknown. In the Boswell Mountain area, where Triassic and Jurassic strata adjoin Yukon group beds, the general structure indicates that the Mesozoic strata unconformably overlie the Yukon group rocks. Presumably the Yukon group strata are of Palæozoic or Precambrian age, or may be in part Palæozoic, in part Precambrian.

PRECAMBRIAN OR LATER GRANODIORITE

A belt of sheared granodiorite surrounded by Yukon group beds stretches northwards from the north slope of Livingstone Creek Valley to the south side of Mendocina Creek Valley. The granodiorite varies in composition and degree of metamorphism. Presumably it intrudes the Yukon group beds. It is unlike the Mesozoic granitic rocks, and because it exhibits the same schistose structure as is displayed by the Yukon beds, it is tentatively considered to be of Precambrian or early Palæozoic age. On the accompanying geological map of Laberge district, the granodiorite has been erroneously indicated as being a member of the Yukon group.

CARBONIFEROUS OR PERMIAN LIMESTONE

On the west side of Lewes River Valley, 4 miles south of Big Salmon, grey, massive limestone was found in one outcrop to hold fossils identified as follows: *Productella?*, *Productus?*, and *Clisiophyllum* (?). The fragmentary condition of the fossils makes their identification doubtful, and though a Mississippian age is indicated it is possible the beds are Pennsylvanian or even Permian. They are surrounded by, and probably are unconformably overlain by, Hutshi volcanic rocks of Mesozoic age. Bodies of grey limestone like that holding the Palæozoic fossils form prominent ridges in many localities. These bodies west of the Teslin-Lewes Valley carry Triassic fossils and belong to the Lewes River series, but east of this valley no fossils were found in them and though they have been assigned to the Lewes River series, some or all of them may be of Palæozoic age.

LEWES RIVER SERIES

The Lewes River sedimentary series is exposed in many areas west of the Teslin-Lewes Valley. The individual areas vary much in size, but all are elongated along northerly to northwesterly directions and display anticlinal structures modified in varying degrees by faults and minor folds. The structures are not well exposed as a rule, but some closed and overturned folding is apparent in places, as in Maunoir Butte where the series appears to be overturned to the west. East of the Teslin-Lewes Valley, bodies of limestone like the limestone of the Lewes River series are grouped in this series, but as fossils have not been found in these eastern limestones their age is uncertain and some or all may be of Palæozoic age like the limestone southwest of Big Salmon. One of these eastern bodies of limestone, namely that one lying east of Big Salmon River between Illusion and Walsh Creeks, appears to overlie Tantalus beds, but it is thought this appearance is due to thrusting of the limestone westward over the younger, Tantalus formation. The limestone of this area is more than 1,000 feet thick. At the base it is blue-grey and much of it consists of breccia containing chert fragments.

The base of the Lewes River series was not observed in the map-area. The series as developed in Laberge map-area consists of three members: a lower, limestone member; a middle, clastic member; and an upper, limestone member. The limestone of both the lower and upper members is mainly massive, light grey or bluish grey, crystalline, and traversed by calcite veinlets. The massive limestone constituting the lower member has an estimated thickness of 2,000 feet where it outcrops on Lewes Mountain. The same limestone is repeated a few miles east on the east side of Lewes River, and there is followed on the east by a belt of the middle, clastic member and this in turn by a belt of the upper, limestone member. One cross-section of the belt of the middle, clastic member indicates a total thickness of about 1,700 feet of greywacke accompanied by some argillite, an occasional thin limestone bed, and at the base a considerable thickness of greywacke holding sparsely distributed pebbles. A second section across the belt, 2 miles south of the first, indicates a thickness of about 2,000 feet of greywacke with some argillite, etc.

The middle, clastic member, as it occurs farther west on a ridge a few miles northeast of Braeburn, is at least 2,450 feet thick; the section is as follows:

	Feet
Sandstone, argillite, and a few beds of limestone; not well exposed..	1,000
Sandy argillite, sandy limestone, and concealed intervals..	159
Massive limestone (coral reef)..	65
Green sandstone, massive limestone (20 feet), partly concealed..	100 to 280
Argillite and thin beds of limestone..	119
Red sandstone, largely concealed..	700

In some sections of the clastic member an horizon of volcanic materials is present. The massive limestone in the middle of this section is mainly made up of poorly preserved corals with echinoids and pectens, and in places is believed to represent coral reefs.

The upper, limestone member where it occurs east of Chain Lakes, about 6 miles north of Frank Lake, is 400 feet thick. Elsewhere, so far as known, the thickness is less and varies considerably, perhaps indicating that some erosion took place prior to the deposition of the overlying Laberge series, which, however, appears to be conformable upon the Lewes River series.

Fossils were obtained from strata of various horizons in the Lewes River series and from a considerable number of localities. They were examined by the junior author (Lees) and found to indicate an Upper Triassic age.

Fossils from the Limestone Members

cf. *Thecosmilia delicatula* (Frech)
Crinoid column
Crinoid anchor
Cidaris
Cyrtina lewesensis Lees
cf. *Dielasma julicum* (Bittner)
D. suttonense (Clapp and Shimer)
Terebratula (?) piriformis Suess
Pecten (Chlamys)
Pecten (Variamussium) Klushaensis Lees
Plicatula
Gervillia
Dicerocardium n. sp.
Loxonema? sp.
cf. *Naticopsis ilita* Quenstedt

Fossils from the Middle, Clastic Member

cf. *Steinmannia utriculus* Regny
cf. *S. lydia* Regny
Isastrea cf. *vancouverensis* (Clapp and Shimer)
Thecosmilia fenestrata Reuss
Cyrtina lewesensis Lees
Spiriferina (?)
Koninckina (?)
Pecten (Variamussium) yukonensis Lees
P. (Variamussium) Klushaensis Lees
P. (Chlamys) (?)
Lima (Plagiostoma) n. sp.
Halobia ornatissima Smith
Pseudomonotis subcircularis (Gabb)
Trigonia textilis Lees
Cardium cf. *curtum* M. and H.
Cassianella
Juvavites subinterruptus Mojs

LABERGE SERIES

The Laberge series largely occupies the 30-mile wide belt of country lying between the Miners Range on the southwest and the Semenof Hills on the northeast. It also occurs in small areas in or bordering the Miners Range and Semenof Hills. The strata in a general way lie in a series of synclines striking northwesterly and separated by anticlinal areas occupied by the Lewes River series.

No single complete section of the Laberge series has been found in Laberge map-area. It appears to consist of three members: a lower member of sandstone and argillite; a middle member of conglomerate; and an upper member of sandstone and argillite. The upper member has been recognized only in the west and northwest parts of the district.

In the hills east of the upper part of Mandanna Creek, the lower member is present resting on Lewes River limestone and overlain by the middle, conglomerate member. In one cross-section the lower member appears to be about 1,800 feet thick, but possibly faulting has caused duplication of the strata. In another cross-section, 3 miles to the north, the apparent thickness is 900 to 1,200 feet. The member is largely concealed in this area, but so far as it is exposed it consists largely of red grit, argillaceous sandstone, shale, and conglomerate, with some greywacke, and, near the top, one thin bed of limestone. Fossils from a bed just below the middle conglomerate member indicate the age to be early Lower Jurassic.

Southeast of the Mandanna Creek area, at a point about 3 miles southeast of Coghlan Lake, the lower member appears to be somewhat less than 400 feet thick. Farther southeast, at a point 4 miles south of Miller Lake, the lower member appears to be about 800 feet thick. A cross-section of the member as developed south of Miller Lake is as follows:

Conglomerate of the middle member	Feet
Concealed	300
Limestone conglomerate	10
Concealed	50
Argillite and sandstone	100
Concealed	450
Lewes River strata	

There are no indications of the presence of the red sandstones that characterize the northern sections, seen on the eastern side of the main belt of sedimentary rocks. Fragmentary plant remains are present in some of the sandstones in this southeastern part.

West of the narrowest part of Lake Laberge steeply dipping black argillites, at least 1,000 feet thick and perhaps more than 4,000 feet thick, form many outcrops. These rocks belong to the Laberge series and they appear to dip beneath the middle, conglomerate member, but possibly they belong to the upper member. The argillites are banded dark brown and black, and in what appears to be the upper third there are beds, about 4 inches thick, of fine-grained, grey sandstone. East of the south end of Richthofen Lake, the following section was measured:

	Feet
Black argillite	(?)
Concealed	50
Conglomerate	10
Yellow grit	100
Concealed	340
Banded, black argillite; base not exposed	400

The yellow grit is like the rock of a bed that occurs elsewhere above the middle member, but the conglomerate of the 10-foot bed is in every way like the conglomerate of the middle member and may represent it.

The conglomerate of the middle member consists of closely packed, rounded boulders, varying from 2 inches to 2 feet in diameter, lying in a matrix that is commonly greywacke. The boulders are mainly porphyritic volcanic rocks, but in the lower part of the member boulders of granodiorite are numerous and a few of limestone and other rocks are also present. In one locality, in the hills east of the upper part of Mandanna Creek, the conglomerate is at least 250 feet thick. West of Coghlan Creek the thickness of the conglomerate is estimated to be 700 feet, with the base not exposed and the upper surface an erosion surface. Near the west shore of the head of Laberge Lake the thickness is estimated to be 400 feet. In the vicinity of Richthofen Lake, the thickness, as already stated, may be only 10 feet.

The beds of the upper member of the Laberge series have been removed by erosion from most places in the district. In the Mandanna Creek area, in one locality a thickness of 50 feet of coarse, white to light cream-coloured sandstone overlies the middle, conglomerate member. In the northern part of the hills between Mandanna Creek and Chain Lakes, a considerable thickness of massive greywacke is exposed. These rocks presumably belong to the upper member. Farther south, in the area west of Lake Laberge, some part or all of the widely displayed, thick argillite series may belong to the upper member.

The area west of the road between Braeburn and Kynocks was mapped by Cairnes.[1] This is the only area in the district where the upper part of the Laberge series is in contact with the overlying Tantalus formation, and forms a continuous section with it. At the base, according to Cairnes, there are at least 200 feet of reddish sandstone and conglomerate. "The reddish colour is due to iron oxide in the calcareous cementing material; the boulders and pebbles consist chiefly of granite and fine-grained greenish rock. Over these red beds are 800 to 900 feet chiefly of coarse, soft, generally dark green, loosely cemented sandstones, interbedded with which are some dark yellow sandstones—the colour of the green strata being due chiefly to the chloritic cementing material. Above these are 1,000 feet of almost white, coarse sandstone composed almost entirely of clear, quartz pebbles and a white cement. Occasionally the binding material contains some iron oxide, causing the sandstones to have a reddish, mottled appearance. Toward the top of this white sandstone are occasional intercalated dark shale beds, in which are the coal seams of the lower coal horizon. Overlying the white sandstone is the Tantalus conglomerate." This section, according to Cairnes, represents approximately 2,000 feet

[1] Cairnes, D. D.: Lewes and Nordenskiöld Rivers Coal District; Geol. Surv., Canada, Mem. 5, p. 32 (1910).

of strata, but he does not say how close the base of the section is to the massive conglomerate of the middle member. The "lower coal horizon" referred to was not found elsewhere in the district.

These sections of the different members indicate that the Laberge series has a thickness of about 4,500 feet, but adding the argillites west of Lake Laberge the thickness would be 5,500 or possibly 8,800 feet. In the adjacent Whitehorse[1] and Carmacks[2] districts the maximum thickness is 10,000 and 9,000 feet, respectively.

Fossils were collected from the Laberge series at eight localities. Most or all of the collections are from the lower member. They indicate an early Lower Jurassic age. The forms contained in the various collections as identified by the junior author (Lees) are as follows:

Mytilus (Pharomytilus?) n. sp.
Modiola n. sp.
M. aff. *scalpra* (Goldfuss)
Gervillia cf. *inflata* Schaff
Pinna
Pleuromya cf. *summissiornata* McLearn
Pholadomya donacina voltz var.
Nucula (?) cf. *strigillata* Goldfuss
Pecten (Chlamys) large sp.
Lima (Ctenostreon)
Trigonia aff. *costatula* Lyc.
cf. *Psiloceras erugatus* Bean
Arnioceras n. sp.
Belemnites

The Laberge series appears to overlie conformably the Lewes River series, but the relations of the two series were not established and the wide variation in thickness of the upper member of the Lewes River series may indicate that the two periods of deposition were separated by an interval of erosion. The lower member of the Laberge series seems to vary much in thickness and in places the middle, conglomerate member appears to rest directly on Lewes River strata. These conditions suggest that an interval of erosion and, perhaps, of folding preceded the deposition of the conglomerate member.

NORDENSKIÖLD FORMATION

The rocks of this formation occur in a number of detached areas in the northwest quarter of the map-area, and to the west of the border in Klusha Creek Valley. They were first described by Cairnes[3] from the areas on both sides of Klusha Creek. The main rock of all the areas is a dark grey, massive dacite, with phenocrysts of quartz and feldspar and some of biotite and hornblende in a cryptocrystalline groundmass making up 50 per cent and more of the rock. The feldspar phenocrysts are mainly andesine, but some are more basic. A little sanidine is also present. The feldspar phenocrysts are considerably fractured, and fine veinlets of groundmass penetrate them. The quartz phenocrysts show resorption.

[1] Cockfield, W. E., and Bell, A. H.: Whitehorse District; Geol. Surv., Canada, Mem. 150, p. 15 (1936).
[2] Bostock, H. S.: Carmacks District; Geol. Surv., Canada, Mem. 189, pp. 25-26 (1936).
[3] Cairnes, D. D.: Lewes and Nordenskiöld Rivers Coal District, Yukon Territory; Geol. Surv., Canada, Mem. 5, p. 29 (1910).

The rock has a conspicuously granular appearance and small fragments of a fine-grained, green, volcanic rock occur in it. It weathers reddish brown.

The dacites of the areas between Frank Lake and Mandanna Creek appear to lie above the conglomerate member of the Laberge series and below arkoses presumably belonging to the upper member of the same series. Near the north end of Frank Lake are exposures of the Laberge conglomerate holding rounded boulders of a rock closely resembling the dacite, but of slightly different texture. Boulders of other rocks are also present. The boulders vary in size up to 2 feet in diameter and are closely packed. The matrix of some beds is sandstone, but in other, immediately overlying beds, the matrix in composition and texture closely resembles the Nordenskiöld dacite. At another locality conglomerate with greywacke matrix is overlain by conglomerate with porphyritic dacite matrix, the greywacke grading into dacite within a thickness of 1 foot. These relations apparently indicate that the Nordenskiöld dacite and the Laberge conglomerate are of the same or nearly the same age.

TANTALUS FORMATION

The Tantalus formation outcrops in a number of detached areas in the southwest and northeast borders of the broad belt of Mesozoic rocks that form the greater part of Laberge map-area. Beds of conglomerate 3 to 5 feet thick interstratified with sandstone beds 4 inches to 1 foot thick, occasional zones of sandstone, lesser quantities of shale, and, in some places, coal seams make up the formation. The conglomerate and sandstone are light coloured when fresh or weathered. Compared with the other clastic formations of the district they are remarkably uniform in size of pebble and in the materials of which the pebbles are composed. A great part of these are of white quartz, the remainder is of quartzite, chert, and cherty argillite of black or pale green colours. The pebbles are usually well rounded, ½ to 2 inches in average diameter, rarely as large as 3 inches. In any one bed the maximum size is strikingly uniform. The matrix is sand of the same materials and the cement is usually calcareous. There is little sign of stratification within the beds. The shale, which is coarse, light grey, and thin bedded, rarely outcrops, but apparently makes up only a small part of the formation. Outcrops of coal seams were not seen in this district. Sandstone and conglomerate are well exposed along a part of the second tributary up Walsh Creek. At one place fragments of shale and coal were noted in the bank between sandstone outcrops, and coal float is abundant in the creek gravels below this point and also in the gravels along Big Salmon River for a few miles above its mouth. This coal is believed to come from the areas of Tantalus formation in the vicinity. Coal is reported to have been found in the area of this formation on Claire Creek. In the adjacent Carmacks and Whitehorse districts several seams, some over 7 feet thick, have been found in this formation, and it is probable that coal seams are a normal part of the formation.

The Tantalus strata of the area on Claire Creek are estimated to be 650 to 750 feet thick, and the strata of the area east of Big Salmon are estimated to be somewhat more than 1,000 feet thick.

The relations of the Tantalus formation with the Lewes River and Laberge series were not observed in the Laberge map-area. In other districts the Tantalus beds are reported to overlie the Laberge series conformably.[1] The Hutshi volcanic rocks are undoubtedly younger than the Tantalus beds, but the relations of the two rock groups were not directly determined.

No fossils were found in the Tantalus formation during the course of the present work, but collections made in adjacent areas by Cairnes were determined as indicating at first Cretaceous age and later Jurassic age.[2] In 1936 a collection of fossil plants was made at the Tantalus Butte mine by J. R. Johnston. These were examined by W. A. Bell, who reports on them as follows: "The plants comprise abundant sterile and a few fertile pinnæ of *Coniopteris* sp. In addition there are several fragments of *Cladophlebis* similar to *C. fisheri* Knowlton and a poor fragment of an *Acrostichopteris* recalling *A. longipennis* Fontaine.

"The age is certainly either Upper Jurassic or Lower Cretaceous, although the florule is too small to state unequivocally which. The species of *Coniopteris* present is abundant in floras homotaxial with that of the lower part of the Blairmore formation and is present also in the Kootenay flora. It has, however, close affinities with the Jurassic species, *Coniopteris hymenophylloides* Brongniart. *Cladophlebis fisheri* first recorded from the Montana Kootenay is apparently very close to *Cladophlebis vaccensis* Ward recorded from the Jurassic of Oregon."

On the basis of this statement the age of the Tantalus formation is considered to lie between the limits of the Upper Jurassic and Lower Cretaceous.

HUTSHI GROUP

The name Hutshi group is used here to include the rocks mapped by Cairnes[3] in the western part of the district under the names Hutshi group and Schwatka andesites.

The Hutshi rocks are mainly lava flows, but breccias, agglomerates, and tuffs are also present and predominant in some areas. Various developments of small intrusions such as dykes are presumably of the same age as the effusives and related to them. The volcanic rocks form large areas in the Miners Range and the Semenof Hills and smaller areas in the territory between these two ranges. The structure of each area is synclinal, modified by faulting and minor folds. The tops and bottoms of lava flows are rarely discernible, but where they are they commonly show steep dips.

The lavas are predominantly light to dark green, or less often purple, brown, and black, medium to fine grained, and porphyritic, the phenocrysts being of hornblende, pyroxene, and feldspar. In the Miners Range the Hutshi rocks appear to be mainly andesites with some basalts. In the area east of the north end of Lake Laberge agglomerates predominate.

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[1] Cockfield, W. E., and Bell, A. H.: Geol. Surv., Canada, Mem. 150, p. 22.
Bostock, H. S.: Geol. Surv., Canada, Mem. 189, pp. 27-38.

[2] Cairnes, D. D.: Lewes and Nordenskiöld Rivers Coal District, Yukon Territory; Geol. Surv., Canada, Mem. 5, p. 38 (1910); and Geol. Surv., Canada, Sum. Rept. 1915, p. 41.

[3] Cairnes, D. D.: Geol. Surv., Canada, Mem. 5, pp. 36-43.

The Hutshi volcanic rocks correspond to the Mount Nansen group of Carmacks district[1] and the older volcanics in Whitehorse[2] district. They are believed to be younger than the Tantalus formation. In places they rest on the Laberge series and in other places on the Lewes River series. Presumably an interval of folding and erosion intervened between the time of deposition of the Tantalus beds and the extrusion of the Hutshi lavas. As the Tantalus formation is of Upper Jurassic or Lower Cretaceous age, the Hutshi rocks can scarcely be older than Lower Cretaceous. They are cut by granitic bodies believed to be of Mesozoic or early Tertiary age and, therefore, are presumably of Cretaceous age.

BASIC INTRUSIVES

The rocks here grouped as basic intrusives form a few bodies invading the Yukon group in Big Salmon Mountains. One area of these rocks, band-like in outline, crosses the head of Livingstone Creek with a northwesterly strike. The northwestern part of this band is composed of black, coarse, unaltered hornblendite. The central and southeastern parts are formed of serpentine. Though the relations of this body of basic rocks to the surrounding Yukon group strata were not observed, there seems little doubt that the basic rocks intrude the Yukon group beds.

A second area of serpentine occurs at the east border of the district, north of Big Salmon River. The serpentine is sheared. Tongues of it project from the main body into the bordering Yukon group. This serpentine mass is a western projection of a large stock of peridotite forming a high mountain immediately east of Laberge map-area. A small body of serpentine, apparently intrusive, occurs to the northwest on the ridge north of D'Abbadie Creek.

West of North Big Salmon River the Yukon group strata are invaded by a small body of a coarse-grained rock largely composed of hornblende, but in composition verging on hornblende-rich diorite.

These bodies of basic rocks are thought to be related in origin and are assumed to be the earliest phases of the granitic intrusives.

GRANITE, GRANODIORITE, MONZONITE, ETC.

Little Ridge, in the southwest corner of Laberge map-area, is formed of pink, medium-grained granodiorite overlain by bodies of the Little Ridge volcanic rocks. The granodiorite is the edge of a very large body of granitic rocks extending west and south, which has been assigned to the Coast Range intrusives and stated to be younger than the Hutshi volcanic rocks.[3] The relations between the granodiorite and the Hutshi volcanic rocks were not determined in Laberge district. Pink granodiorite resembling the Little Ridge rock forms a large stock south of Teslin Mountain. This body intrudes the Hutshi rocks and the Laberge series.

A stock-like body, 5 or 6 miles in diameter, situated west of Teslin River a few miles above Miller Creek, is largely formed of pink, medium-grained monzonite. A grey, porphyritic phase occurs along part of the

[1] Bostock, H. S.: Carmacks District; Geol. Surv., Canada, Mem. 189, p. 29.
[2] Cockfield, W. E., and Bell, A. H.: Whitehorse District; Geol. Surv., Canada, Mem. 150, pp. 23-29 (1926).
[3] Cockfield, W. E., and Bell, A. H.: Geol. Surv., Canada, Mem. 150, p. 29.

southeast border of this stock. Similar monzonite, both granitic and porphyritic, forms a smaller stock situated a few miles northwest beyond Miller Creek.

Pink, medium-grained, biotite granite occurs east of Mount Black, along the east border of Laberge map-area, and continues for many miles to the east and southeast. The granite in places is porphyritic and in many places is cut by tourmaline-bearing aplite and pegmatite dykes. It sends numerous, sheet-like masses into the bordering Yukon group rocks.

Granitic rocks outcrop along the eastern border of the district from Mount D'Abbadie northward. They are part of a body extending at least 5 miles east of the district. The usual rock is a grey, medium-grained, biotite granite, much of it holding only a very small amount of biotite. In various places the rock is richer in plagioclase feldspar and coarser grained than elsewhere. South of North Big Salmon River the granite holds innumerable inclusions of the Yukon group rocks which in places underlie 40 per cent of the area of the intrusive mass. Along its south border the granite cuts sharply across the strata of the Yukon group, sending into them only a few dykes and sills. Along the west border, sills and dykes are numerous and the Yukon group sediments have been extensively recrystallized to banded gneisses, etc. Pegmatite and aplite dykes are numerous within the granite area, as are also fine-grained quartz porphyry and andesite porphyry dykes.

The large area of granitic rocks lying farther west along the edge of the mountains, north of North Big Salmon River, contains a variety of types. In the northern part the rock is a grey, coarse-grained granite or granodiorite resembling the coarser granites of the area to the east. Large pink feldspars and large grains of quartz are conspicuous. It is cut by aplite and seams of hematite follow the joint planes. In the south part of the area the rocks are more basic. Phases intermediate between them and the granites of the north part are also present. The most common of the more basic types is composed of, in order of abundance, plagioclase feldspar, orthoclase, hornblende, quartz, and biotite. The most basic type is a dark, hornblende-rich diorite, which forms only a small part of the whole body. It holds inclusions of hornblendite and is cut by small pegmatite dykes. Inclusions of the Yukon group in the granite along the contact and dykes extending into these rocks near the contacts show the granite to be younger than the Yukon group. The inclusions of hornblendite seem to indicate that it is younger than the rocks grouped as basic intrusives.

The bodies of granite, granodiorite, etc., intrude the volcanics of the Hutshi group wherever the nature of the relationship was determined. No reason exists for supposing that the granitic rocks are not all of one general age and, therefore, all are regarded as being younger than the Hutshi rocks, which for reasons already given are considered to be probably of Cretaceous age. The granitic rocks in Big Salmon Mountains are overlain by volcanic rocks believed to be equivalents of the Carmacks volcanics of probably Miocene age. Presumably the granites, etc., are of late Cretaceous or early Tertiary age.

PORPHYRIES

Fine-grained porphyries such as usually occur as dykes are present in the Laberge map-area forming part or all of a large number of intrusive bodies, some of which are very large. The largest of these bodies is at least 20 miles long and in places 4 miles wide. It lies east of Chain Lakes. Within it are two small areas of light grey, medium-grained granodiorite. Much of the area is covered, but the rest of the mass appears to consist of fine-grained rock, mostly granodiorite porphyry. The porphyry varies from pink to grey and consists of phenocrysts of andesine and a few of orthoclase and hornblende in a micrograniticbase. The phenocrysts commonly parallel one another and in places are thickly packed. Some parts of the intrusive mass are mainly of white aplite, composed chiefly of orthoclase and albite. The southwest edge of the intrusive, as displayed at one place in a small canyon, shows large blocks of Lewes River and Laberge sediments surrounded by sheets and irregular bodies of porphyry. Small bodies believed to be satellites of the main body occur along the east side of it, cutting Hutshi volcanics. The rocks composing them vary from cream-coloured aplite and quartz porphyry to medium-grained granitic varieties.

Most of the bodies of porphyry are of the composition of granodiorite, but in some types such as dacite porphyry or quartz monzonite porphyry prevail. The relations of the fine-grained porphyries to the coarse-grained granitic types with which they are associated in places was not determined, but it seems probable that one type grades into the other as they are closely related in composition and in several places intermediate varieties were observed. This being so, the porphyries are presumably of the same age as the coarse-grained granitic types. It is possible, however, that some at least of the porphyries are much younger, for they resemble intrusives found in adjoining districts and which have been considered to be of Tertiary age and considerably younger than the granites, granodiorites, etc.

LITTLE RIDGE VOLCANIC ROCKS

In the southwest corner of Laberge map-area a few areas of volcanic rocks occur on Little Ridge, where they rest on granodiorite that is part of a large body extending to the west and south. These volcanic rocks are lithologically similar to those composing the Hutshi group as developed nearby in the Miners Range, but the Hutshi rocks are cut by bodies of granitic rocks and presumably are older than the granodiorite of Little Ridge. It may be, however, that the Little Ridge granodiorite is older than the other granitic bodies of the district and that the Little Ridge volcanics belong to the Hutshi group which they so much resemble.

The Little Ridge volcanic rocks are mainly andesitic lavas, but coarse-grained, bedded tuff is present in considerable amounts. Both the lavas and the tuffs contain rounded and irregular boulders of rock like the granodiorite of the area. The boulders are up to 18 inches long and in places are so numerous as to give the rocks the general appearance of conglomerates. The volcanic rocks lie in nearly horizontal positions, and apparently are much younger than the granodiorite. They may be correlatives of the Carmacks volcanics found in neighbouring districts and believed to be of Miocene age.

TERTIARY VOLCANIC ROCKS

In addition to the Little Ridge volcanic rocks that may be of Tertiary age, several considerable areas in the northeast and southeast corners of Laberge district are underlain by volcanic rocks believed to be of Tertiary age. One area in the northeast is on a ridge extending southeasterly from Mount Lokken and is occupied by andesite, dacite, rhyolite, and porphyritic lavas and dykes. The rocks are pale green and brown to nearly white. They are surrounded and underlain by Yukon group rocks which as seen in a creek valley are cut by dykes composed of representatives of most if not all of the flow rocks. Two other Tertiary areas occur a few miles to the east and are formed of lava flows. One of these areas is Solitary Mountain, which viewed from the east is seen to be made up of lava flows dipping gently northeast and in thickness amounting to 1,500 feet or more. They are dark brown and blue-black andesites and basalts with red, vesicular upper parts. In places they exhibit columnar jointing. They rest on a moderately even surface of Yukon group rocks. The third area of volcanic rocks is on the south side of Solitary Mountain, where a thin sheet of lava forms a cap on a broad hill top.

A large number of dykes of white to grey rhyolite, quartz porphyry, dacite porphyry, and andesite, as well as green, glassy lava, cut the granite of Rangifer Mountain. Though these dyke rocks are on the whole rather more acid than the lavas of the several areas to the north, they presumably are closely related to them. The lavas are lithologically identical with the Carmacks volcanics,[1] and like them are considered to be of Miocene age or older.

Two areas of Tertiary volcanic rocks occur in the southeast corner of the district. One area, lying between Boswell and Indian Rivers, is occupied by dense, dark brown, amygdaloidal basalt. In the second area, lying east of Baker Lake, are outcrops of black, dense basalt and porphyritic dacite with a dense groundmass. The lowest dacite flows hold a few pebbles of granite. The lavas of both these southern areas are also correlated with the Carmacks volcanics.

UNCONSOLIDATED SUPERFICIAL DEPOSITS

In a number of creeks on the west flank of Big Salmon Mountains rusty gravels have been found resting on bedrock decomposed to a depth of several inches, and overlain by boulder clay, glacial gravels, or recent stream gravels. The pebbles in the pre-Glacial gravels are entirely of local bedrock. They are angular or slightly rounded, are rarely over 12 inches long, and most of them are partly decomposed. The old gravels were seen in the upper part of D'Abbadie Creek and in a number of creeks near Livingstone, as on Lake Creek where in the base of a placer working they are 6 to 8 feet thick.

The widespread glacial deposits have been referred to in an earlier chapter. Of the post-Glacial deposits, the most noticeable is a deposit of white, fine, volcanic ash. On comparatively level stretches of ground it forms a persistent layer 3 to 6 inches thick lying at or close to the surface. Capps[2] has shown that a layer of volcanic ash on White River, Alaska, may be about 1,400 years old. The ash in Laberge district is presumably of the same age.

[1] Bostock, H. S.: Geol. Surv., Canada, Mem. 189, pp. 40 and 43.
[2] Capps, S. R.: U.S. Geol. Surv., Prof. Paper 170-A.

CHAPTER IV

ECONOMIC GEOLOGY

INTRODUCTION

The only mineral production of Laberge map-area has been from the gold placers, of which those of Livingstone camp were the most important. Very little effort has been spent searching for lode deposits although general geological conditions, especially in the area occupied by Yukon group rocks, do not seem unfavourable to their presence. As already stated, coal is reported to occur in the Tantalus formation on Claire Creek, and in all probability is present in areas of these rocks northeast and east of Big Salmon. It is not unlikely that coal also occurs in some areas of the Laberge series, which is coal-bearing in adjoining districts. A good grade of bituminous coal is mined from the Tantalus formation at Carmacks and it is to be expected that this formation in the Laberge map-area will yield similar grades.[1]

GOLD PLACERS

The first discovery in Yukon of paying gold placers was made in 1881 in Laberge map-area when a party of four miners having descended Lewes River as far as the mouth of Big Salmon River, ascended the latter river and found gold in paying quantities in some of the river bars.[2] In the spring of 1886 Cassiar bar on Lewes River, a few miles above the mouth of Big Salmon River, was discovered. It was reported to have yielded, in some cases, at the rate of $30 a day a man, and gold valued at many thousands of dollars was obtained from it, chiefly in 1886. In 1887 Dawson pointed out[3] that on Lewes River, bars holding gold in paying quantities had been found only below Hootalinqua, that the best bars were within a distance of 70 miles, and that Cassiar bar was the richest. According to reports by prospectors, many bars along Lewes River below Hootalinqua yielded as much as $10 a day a man. Prior to 1887, gold had also been found on bars on Teslin River. After the discovery of gold on Fortymile River, most of the miners left Laberge map-area.

In 1898 when McConnell ascended Big Salmon River he found a few unexperienced miners on that river[4] and was informed that coarse gold occurred on lower reaches of the river, but was unable to verify this report. He stated that a number of bars on Lewes River below Big Salmon were worked successfully during the period of low water in years preceding 1898, and that in 1898 some work was done on a few bars on Teslin River but that the results were not very satisfactory.

In 1900 an attempt was made to dredge Cassiar bar. About 50,000 cubic yards of gravel was washed and the yield was reported to average

[1] Bostock, H. S.: Carmacks District; Geol. Surv., Canada, Mem. 189, pp. 58-62.
[2] Dawson, G. M.: Geol. Surv., Canada, Ann. Rept. 1887-88, pt. B, pp. 180-181.
[3] Op. cit.
[4] McConnell, R. G.: Geol. Surv., Canada, Sum. Rept. 1898, pp. 49, 51.

5 cents a cubic yard. The dredge was then taken to the Klondike, and since that time the river bars have not received much attention. The richest bars appear to have been on Lewes River between a point 6 or 7 miles above Cassiar bar and a point about the same distance below Big Salmon. In recent years, after the river begins to drop in August, two or three placer miners have usually worked on the bars in this stretch. A bar, sometimes termed Lower Cassiar bar, 4 or 5 miles above Big Salmon, and another, 3 to 4 miles below the same place, have received the most attention. The gold occurs as fine dust. It is notable that the best paying river bars on Lewes and Big Salmon Rivers are located in the path of the glacial ice that moved northwesterly across Livingstone placer gold camp.

In 1898 Livingstone placer camp on South Big Salmon River was discovered, and in the first decade of the century became a booming camp. No official record of the gold production is available, but the camp is believed to have produced more than $1,000,000 in gold. Placer mining has been carried on in this camp every year since its discovery, but in the "twenties" production fell very low. In 1930 there was a revival of interest in the camp that has led to an increase in output during the last few years.

Livingstone camp has been described by McConnell, Cairnes, Cockfield, and Bostock.[1] The following account is based on these reports and information obtained in 1935 by the junior author (E. J. Lees).

The camp consists of ten creeks tributary to South Big Salmon River along a stretch of about 18 miles. Nine of these creeks flow from the east across Yukon group rocks; one only comes from the west, from an area of Mesozoic strata.

Livingstone Creek has been by far the most important creek in the camp. Within Big Salmon Mountains it flows westerly, but where it enters the valley of South Big Salmon River it turns north and follows a narrow valley, continuing northward along the edge of the main valley for 2 miles before it bends westward again to the river. Where the creek enters this northward trending valley it is about 15 feet wide, and its length above this point is about 6 miles. From its head it flows for about 3 miles in a shallow, U-shaped valley with a gradient of about 100 feet a mile. Below this stretch the valley assumes a V-shape and narrows to a canyon for the last three-quarters of a mile before the creek turns north. The gradient of the creek increases, reaching a maximum of about 500 feet a mile in the canyon. The floor in the canyon and in the narrower part of the valley above is 50 to 100 feet wide.

The canyon walls are of rock except close to the head of the canyon where the south wall is of sand, gravel, and boulder clay, with large boulders filling an old channel. The floor of the old channel is a few feet higher than the floor of the present channel, but the gradient of the old channel is lower than that of the present stream, and half a mile or so up stream the old channel is 40 feet below and more than 1,000 feet south of the present channel, a ridge of bedrock rising between them.

Gold was first discovered in the canyon, Discovery claim being close to its head. Very little gold was found in the creek above the canyon.

[1] McConnell, R. G.: Geol. Surv., Canada, Sum. Rept. 1900.
Cairnes, D. D.: Geol. Surv., Canada, Sum. Rept. 1907.
Cockfield, W. E.: Geol. Surv., Canada, Sum. Rept. 1930, pt. A.
Bostock, H. S.: Geol. Surv., Canada, Sum. Repts. 1931, 1932, 1933, and 1934, pt. A.

The gold lay on bedrock and in crevices in it. The gravel in the canyon rarely exceeded 3 feet in depth and in places bedrock was bare. The steep grade of the creek and the shallowness of the gravels made the ground easily workable and the canyon claims were soon worked out.

In 1905 or 1906 the old channel was discovered and activities renewed. A layer of rusty gravel of local rocks formed the base of the unconsolidated materials filling the old channel, and in this layer was a paystreak averaging about 30 feet in width and 2 feet in depth. The first claims along the old channel were worked separately by driving adits from the present channel. This method in the case of the claims higher up the valley necessitated long adits through the ridge of bedrock bounding the old channel and inclined shafts at their inner ends where they reached the old channel. This method of operating the claims led to difficulties in draining the workings (they lay below the level of the present channel), and work on the upper claims stopped until finally the workings were connected and the water allowed to drain through them. There then followed a second revival of activity. As the old channel was followed upwards, the gold is said to have become finer and scarcer, rich patches such as were present in the lower part did not occur, and the gravels could no longer be worked at a profit. Finally, an attempt was made to work these claims by hydraulicking the whole of the materials filling the old channel, but the great depth of frozen materials, the presence of many boulders, and doubts as to the returns to be won, led to the abandonment of the attempt soon after it had begun.

Some distance up the present creek channel, at a point abreast of the higher workings in the old, buried channel, a second buried channel is reported to have been discovered on the north side of the creek. An adit was run along it, with what results are not known, but as there was little gold in the creek below it, it probably did not contain a rich paystreak.

According to McConnell, the gold found on Livingstone Creek was coarse, and he states that a third of that obtained from Discovery claim consisted of nuggets over an ounce in weight. The largest nugget was valued at $304 and the second largest at $295, the gold being valued at $16 to the ounce, the ordinary price of placer gold at that time although the assay value was stated to average $18.20. A few nuggets had rough surfaces and included fragments of quartz, but as a rule they were smooth. Discovery claim is stated to have yielded $11,000 in 1900. Cairnes, writing in 1907, says that the claims on the old channel had produced, on the average, about $25,000 each. He stated that in 1906 the total production was about $90,000, and he estimated it would be more than $100,000 in 1907. Much magnetite in grains and coarse lumps, native copper, garnet, and cinnabar accompanied the gold.

The gravels that lay at the base of the materials filling the buried channel and that carried the paystreak were probably of pre-Glacial origin. The overlying materials were of Glacial origin. After the ice disappeared, Livingstone Creek in re-excavating its bed followed a new course for some distance above the canyon, and the pre-Glacial stream gravels with their gold content were, along this stretch, preserved. Downwards from about the head of the canyon, the present stream followed the course of the pre-Glacial stream; the glacial filling and gravels were largely removed, but the gold, or most of it, remained.

It has been supposed that rich gravels exist at the mouth of the canyon where the creek turns northward to follow the narrow valley along the east edge of the main river valley. At this point a shaft was put down 70 feet with great difficulty, but without reaching bedrock. The northward trending valley now followed by the creek is believed to have been produced during the Glacial period, and if it was would not hold pre-Glacial gold-bearing gravels. If the valley existed before the Glacial period it probably was scoured by the ice-sheet, whose movement was parallel to its course. It, therefore, seems unlikely that any gravels in the north-trending valley hold good paystreaks. If this valley is of Glacial age, it is probable that the pre-Glacial course of Livingstone Creek continued westward from the lower end of the canyon, and any remnant of the continuation of the paystreak will lie in that direction.

Summit Creek, the next creek north of Livingstone Creek, is small. It heads in a broad valley with a moderate gradient. Two or three miles from its head the valley narrows, the gradient steepens, and as the side of South Big Salmon Valley is approached the creek cascades through a narrow canyon. Discovery claim on Summit Creek is at the lower end of the canyon. McConnell states that in 1900 gold valued at more than $1,200 was taken from this claim. The creek is reported to have yielded more than $30,000 in gold. The gravels on it were thin and otherwise resembled those on Livingstone Creek. In later years the claims above Discovery have been worked from time to time, and in 1931 and 1935 two miners were working them.

Lake Creek, the next creek north of Summit Creek, is also a small stream heading in a valley with a low gradient. Two or three miles down stream the creek enters a narrow canyon that continues to the edge of the main valley. On Lake Creek, Discovery claim is a short distance above the canyon and the other claims extend from it up the valley, where the gradient is comparatively gentle. The gravels holding the paystreak lie at depths of 4 to 8 feet on Discovery claim, but upstream the depth to them increases to 30 feet. They are not frozen and they contain few large boulders.

The following section was exposed in 1931 by a fresh working on the north side of the creek:

	Feet
At top: boulder clay	16
Poorly sorted gravel with rounded pebbles	6
Rusty gravel and sand	6 to 8
Bedrock	

The rusty gravel and sand are composed solely of fragments of rocks such as are exposed in the valley. The fragments are angular and few are more than 12 inches long. These gravels are thought to be pre-Glacial. The underlying bedrock is decomposed and soft for a depth of a few inches. The gold occurs mainly in the base of the rusty gravels, but also to some extent all through them. The overlying gravels and till carry very little gold.

Lake Creek is said to have yielded more than $40,000 in gold, obtained from the rusty gravels that lay in an old channel north of but close to the present creek. Except on Discovery claim and near it, where the gravels lie close to the surface, the old workings consist of a network of adits burrowed irregularly into and along the old, buried channel, leaving intervening patches of gravel untouched.

From about 1915 to 1930 the creek was abandoned. In 1930 M. T. Kerruish commenced work on the creek and up to 1935 he had washed some 30,000 cubic yards with a small hydraulic plant. The work has been done some distance above Discovery claim where he has hydraulicked the old channel, washing out some of the old workings and following the old channel upstream with a broad cut. The gold in the pre-Glacial gravels is fairly coarse and smooth, but that in the overlying glacial deposits is finer and yellow and some of it occurs with white quartz in irregular grains.

Cottoneva Creek, the next creek north of Lake Creek, is considerably larger than either Lake or Summit Creeks. A mile above where it enters the main valley, it flows through a canyon half a mile long. Above the canyon, the valley is wide with gently sloping sides. The gold-bearing gravels as compared with those of the southern creeks lie deeper and include a larger quantity of coarse materials, and these conditions combined with those resulting from the comparatively gentle gradient of the valley make it difficult to work the gravels. Though the first discovery of gold was made on Cottoneva Creek, the creek received little attention during the earlier days of the camp. Later, considerable work was done on it. Much hydraulic and other equipment was installed though little was accomplished. In the last few years two or three miners have worked on the creek with considerable success.

Little Violet Creek, the next creek north of Cottoneva Creek, has not, so far as known, attracted much attention, but one or two miners have worked on it from time to time. The creek valley is narrow and steep and where it joins the main river valley the gradient increases. Work done has been mainly above the steepest stretch. Rusty gravels like those on Lake Creek are present. The flow of water is small and many boulders are present.

Mendocina Creek, the northernmost and largest in the camp, and its tributary, Dycer Creek, have been prospected from time to time and gold has been found. It is reported that the gravels are deeply buried, unfrozen, and hold many boulders.

St. Germain Creek flows from the west and joins South Big Salmon River between Cottoneva and Little Violet Creeks. It was staked in the early days of the camp, but with what results is unknown.

Martin, Sylvia, and May Creeks join South Big Salmon River above Livingstone Creek. Work has been done on all, but with what results is unknown. Old sluice-boxes seen on May Creek indicate that a serious attempt was made to work this creek. In 1934 and 1935 two miners were working on Martin Creek.

A number of other creeks, in addition to those of Livingstone camp, are known to carry gold. All lie in the eastern part of the map-area, in the part underlain by Yukon group rocks. Some years ago a little coarse gold was found on a northern creek, probably Illusion Creek. A little gold was also found on Walsh Creek. At about the same time placer gold was discovered on D'Abbadie Creek and this creek was prospected in many places, some small exposures of rusty gravels were seen and are believed to be pre-Glacial. In recent years some gold has been recovered from D'Abbadie Creek. In the southeast corner of Laberge map-area, gold has been found on Little Bear Creek. This creek was prospected in 1932 and 1935.

All the streams on which placer gold has been found, with the exception of St. Germain Creek, flow across Yukon group rocks. The gold on St. Germain Creek was found near its mouth, very close to the area of Yukon group rocks, and may have come from the area of these rocks. Thus the known distribution of the placer gold supports the belief that the source of the gold lies in the area of the Yukon group rocks. On some of the gold-bearing creeks quartz veins are conspicuous, but it is not known if the quartz veins contributed the gold or any part of it. The gold-bearing gravels on several of the creeks appear to be of pre-Glacial age and it seems reasonable to assume that practically all the placer gold was produced during a long period of pre-Glacial (or inter-Glacial) weathering and accumulation. The original, pre-Glacial gold-bearing stream gravels were liable to destruction by the ice-sheets and glaciers of the Glacial period. Such of the pre-Glacial gravels as had accumulated in deep, narrow valleys running across (approximately northeast-southwest) the direction of movement (approximately northwest) of the ice-sheet had a chance of not being destroyed by the moving ice. Pre-Glacial gravels remaining in the higher valleys would in all probability be destroyed by the valley glaciers that developed at the close of the Glacial period. Pre-Glacial gravels remaining in the lower valleys might remain because the lower valleys were not invaded by valley glaciers. The remnants of the pre-Glacial gold-bearing gravels were deeply buried beneath glacial materials that doubtless largely filled the valleys at the close of the Glacial period. Since then the streams, in the process of re-excavating their courses, have in places uncovered or partly uncovered the old gravels, and have in places largely destroyed them and produced new placers. The conclusion is that gold-bearing gravels may be expected in parts of creeks in the area of Yukon group rocks, the parts being such as are relatively low-lying, narrow, deep, and running along a northeast-southwest direction.

LODE DEPOSITS

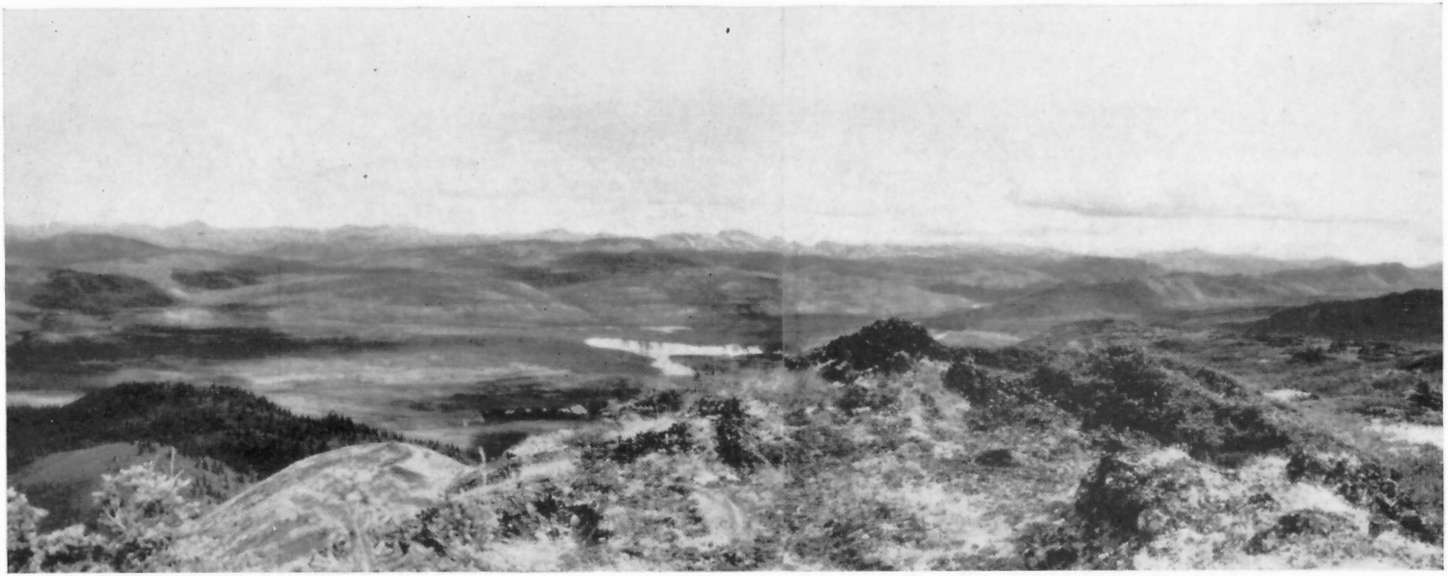
Very little effort has been devoted to the search for lode deposits in Laberge map-area. It is believed that the fewness of the discoveries so far made is not necessarily an indication that lode deposits are lacking. Many large and small bodies of intrusive rocks of acid and intermediate composition are exposed in different parts of the map-area, and many of them are of types with which mineral deposits are associated in other regions.

Quartz veins occur in several of the valleys near Livingstone and north of Big Salmon River. From time to time it has been reported that a quartz vein in the Livingstone area has been found to carry important amounts of gold, but in most, if not all, cases later sampling has failed to confirm the earlier reports.

In 1933 a trapper reported finding a vein of considerable size northwest of Hootalinqua. A sample of the vein material consisted of approximately equal amounts of quartz and pyrite.

Prior to 1900 a group of claims was staked in the southeast corner of the map-area. The ground has since been restaked and exploratory work has been done from time to time. The claims lie on the west side of the valley joining the valley in which Loon Lakes lie with the valley of Fish Creek. The country rocks are grey schists, quartzite, and limestone of the Yukon group. The workings, consisting of two adits, are on a hillside facing east and rising steeply from the valley floor. When visited, in 1931, the adits had collapsed. The entrance to the lower is 250 feet above the valley floor, that of the higher is 50 feet northwest and 50 feet higher. According to notes taken by D. D. Cairnes in 1907, on the occasion of a visit to the property, the lower adit was 180 feet or more, perhaps 270 feet, long and the upper 50 feet long. They are driven in a 35-foot zone that is much iron stained and, in places, copper stained. A short distance south large quartz bodies strike parallel to the schistosity of the enclosing rocks and pinch and swell in short distances. One body is 75 feet wide where widest. Most of the quartz is white. The large bodies are traversed by numerous quartz veins 2 to 4 inches wide, and some of which are 20 feet or more long. Much of the quartz appears to be barren, but in areas of various sizes up to 20 feet by 20 feet, the quartz holds much finely granular pyrite, a little chalcopyrite, and patches of malachite and azurite.

PLATE II



75040 75041

Looking east across Teslin River from hills west of Teslin Crossing.

75666

A. The head of South Big Salmon River and Mount Black.

75654

B. Looking north down Lewes River near Hootalinqua.

INDEX