



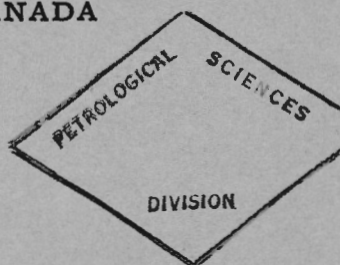
CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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GEOLOGICAL SURVEY OF CANADA

PAPER 53-7



A GEOLOGICAL RECONNAISSANCE OF THE  
NORTHERN SELWYN MOUNTAINS REGION,  
YUKON AND NORTHWEST TERRITORIES

By

J. O. Wheeler

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OTTAWA

1954

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# CONTENTS

	Page
Introduction .....	1
Historical notes .....	2
Accessibility and transportation .....	3
Natural resources .....	3
Physiography .....	4
Drainage .....	5
Selwyn Valley .....	5
Valleys .....	6
Upland areas .....	6
Influence of structure and lithology .....	6
Cirques .....	7
Nivation features .....	7
Landslides and rock glaciers .....	7
Height of drift .....	8
Thickness of drift .....	9
Constructional features .....	9
Glaciation .....	10
Maximum elevation and thickness of valley glaciers .....	10
Direction of ice movement .....	10
General geology .....	11
Introduction .....	11
North Rackla River and Bonnet Plume River areas .....	11
Table of formations .....	11
Description of formations .....	12
Sedimentary rocks' .....	12
Cambrian and earlier(?) .....	12
Silurian or Devonian and earlier .....	14
Devonian(?) or later .....	18
Formations whose age, relations to rocks of known age, and distribution are uncertain ...	20
Intrusive rocks .....	22
Diorite .....	22
Area east of Snake River and Selwyn Valley .....	23
Table of formations .....	23
Description of formations .....	24
Sedimentary rocks .....	24
Cambrian and earlier(?) .....	24
Cambrian(?) .....	25
Post-Cambrian(?) .....	25
Rocks east of Selwyn Valley .....	25
Rogue River area and west of Selwyn Valley .....	26
Table of formations .....	26
Description of formations .....	27
Sedimentary and volcanic rocks .....	27
Ordovician(?) or Silurian .....	27
Post-Silurian .....	28
Volcanic rocks .....	29
Sedimentary rocks of probable early Palaeozoic age .....	30

	Page
Intrusive rocks .....	31
The Rogue River and Keele Lake stocks .....	31
Arrowhead Lake stock and those south of Rogue River .....	32
Quartz diorite .....	32
Trachytoid syenite .....	33
Contact metamorphism .....	33
Character and age of the intrusions .....	34
Structural geology .....	34
Unconformities .....	34
Folds .....	35
Faults .....	36
Thrust faults .....	36
Normal faults .....	37
Faults whose direction of movement is unknown .....	37
Summary .....	38
Economic geology .....	38
Introduction .....	38
Metalliferous deposits .....	39
Quartz veins associated with diorite in the northern area .....	39
Iron formation .....	39
Mineral occurrences associated with granitic stocks ..	40
References .....	41

### Illustration

Preliminary map — Geological sketch map of the Northern Selwyn Mountains Region, Yukon and Northwest Territories .....	In pocket
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A GEOLOGICAL RECONNAISSANCE OF THE  
NORTHERN SELWYN MOUNTAINS REGION,  
YUKON AND NORTHWEST TERRITORIES

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INTRODUCTION

During the field season of 1952 a geological reconnaissance was made of an area in the northern Selwyn Mountains embracing the headwaters of Rackla, Bonnet Plume, Snake, Stewart, and Hess Rivers lying between north latitudes 63 and 65 degrees.

The writer was accompanied by Z. Nikiforuk, assistant, and by E. and F. Kohse, packers, without whose ability and energy the journey could not have been made with such success and comfort. He also wishes to acknowledge the assistance given him by H. S. Bostock, Geological Survey of Canada, while preparing for the field season; and by A. C. Tuttle, Topographical Survey, and W. S. Kennedy while at field headquarters in Mayo, Yukon Territory.

Eight horses were used for transport, and the party was supplied at intervals by aircraft from Mayo.

The area was reached from Wernecke in 6 days by travelling a distance of 45 miles along Keno Ladue and Beaver Rivers to Kathleen Lake, where field work was begun. Along this route much soft, mossy, and swampy ground was encountered, passable for horses only when the ground remains frozen to within a foot of the surface. Horse feed is scarce, and is found only in relatively recently burnt-over areas.

The return journey of 175 miles, from just east of longitude 132 degrees on Hess River, where field work ceased, to Pelly Crossing via Fairweather Lake, North Russell Creek, Macmillan River, Kalzas Lake, and Crooked Creek, was made in 3 weeks. The route, particularly along Macmillan Valley, is not recommended for horse travel because of much burnt timber, deadfall, beaver sloughs, and muskeg.

Traverses were run near the line of travel and, where exposures permitted, the geology was sketched in. The geology was plotted directly onto mosaics of air photographs and then transferred to a drainage map traced from the mosaics. All elevations quoted in the report were recorded by aneroid barometer, which could be checked with only two known elevations during the season. As it was not possible to ford Bonnet Plume River near Corn Creek, the country around Pinquicula Lake was reached by aircraft.

Bad weather and poor visibility hampered work along North Rackla River in early July, and from Arrowhead Lake to Hess River in the latter part of August. Average temperatures during June and July were about 60° F. and in August about 50° F.

## HISTORICAL NOTES

Previous knowledge of the geology of the northern Selwyn Mountains has been gained from reports on their marginal areas by early investigators<sup>1</sup>, and, orally, from prospectors who penetrated

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<sup>1</sup>See References at the end of this report.

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the region.

J. Keele (1910, p. 10)<sup>2</sup> reports that in 1897-8 some miners

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<sup>2</sup>Dates, etc., in parentheses are those of References at the end of this report.

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en route to the Klondike came by way of Keele (Gravel) and Twitya Rivers to the divide and descended Hess and Stewart Rivers to the Yukon. In 1902, R. G. McConnell and Keele explored by canoe the upper part of Macmillan River and some of its main branches to within 80 miles of its source. In 1905, Keele explored Stewart River by canoe as far as the Tasin Mountains, and in the same year Charles Camsell crossed Braine Pass and descended Wind and Peel Rivers. Then, in 1907-08, Keele crossed the Selwyn and Mackenzie Mountains from Ross River, across Christie Pass, and down Keele River to the Mackenzie.

The upper Beaver River area was visited by W. E. Cockfield in 1923 and 1924, at which time he examined silver-lead showings on Mackay and Silver Hills. Later in the twenties, L. Wernecke, of Treadwell Yukon Mining Corporation, prospected part of the northern Selwyn Mountains by means of aircraft.

In 1944 and 1945, E. D. Kindle made a geological reconnaissance along the Canol Road, and since 1946 several prospecting parties have been active in the Selwyn Mountains.

From 1949 to 1951, Topographical Survey parties mapped part of the area. In this work, helicopters were used to advantage in the Bonnet Plume-Wind River area by A. C. Tuttle.

Louis Brown, of Mayo, has taken out hunting parties in the Bonnet Plume-Wind River area for several years and has himself spent some time exploring Stewart River drainage.

## ACCESSIBILITY AND TRANSPORTATION

Several routes for pack-horses have been used to enter the region, but there are no trails. The northern and central parts of the area can be reached from Keno Hill, north of Mayo, via McQuesten Lakes, Beaver River, Braine Pass, and Wind River; or by Keno Ladue and Beaver Rivers to Kathleen Lake; and from Mayo by Stewart River, or by Hess and Rogue Rivers. Much trail-cutting is required on routes along Stewart, Hess, and Rogue Rivers. The central and southern parts may be reached from the Canol Road, constructed in 1942. From Macmillan Pass northwest to Keele Peak and to the head of Hess River the country is open and travel is easy.

Good travelling and good feed for horses are common everywhere as far north as Goz Creek. North of this area feed is scarce, and the valleys become more difficult for travel as many canyons have been formed where tributaries enter Bonnet Plume River Valley. North of Goz Creek, the Bonnet Plume becomes large and swift, and cannot be forded by horses with safety when the water is even moderately high. Such conditions extended into July in 1952.

Canoes have been used on Wind, Beaver, Stewart, and Macmillan Rivers, and on parts of Hess River.

Prevailing rates in 1952 for chartered aircraft were as follows: Callison's Flying Service, at \$85 an hour, out of Dawson; and Whitehorse Flying Service, at \$80 an hour, out of Whitehorse. Lakes known to be suitable for aircraft are marked on the accompanying map. In a de Havilland "Beaver", the flight from Dawson to Mayo requires 1 hour; the trip from Mayo to Pinquicula Lake, Misty Lake, or Arrowhead Lake requires 1 1/2 hours; and a flight from Whitehorse to Arrowhead Lake may be made in about 2 1/2 hours.

Supplies may be obtained from stores either in Mayo or Whitehorse.

## NATURAL RESOURCES

Timber occupies most of the valleys up to elevations of 4,000 to 4,500 feet. It is, however, sparse and small in the valleys of Wind River, Snake River, and Reptile Creek, and is lacking in Bear River Valley. No timber is found for 20 miles along Selwyn Valley south of the bend in Cloudy Creek.

Spruce is the most common tree. Most commonly it is stunted; but, in some places, trees 50 to 60 feet high and 12 to 18 inches thick are found almost to timber-line.

Some balsam appears at timber-line. It is scarce in the northern part of the region, but is plentiful at or near timber-line along Rogue River, Marmot Creek, and Hess and Macmillan Rivers.

Very little balsam poplar was seen in the northern areas, but some was noted near the forks of Snake River. It is common, together with cottonwood, along Hess and Macmillan Rivers. Willow and dwarf birch (buck-brush) are found almost everywhere. In sparsely timbered areas, such as around Goz Lakes, on Snake River, and in Selwyn Valley, these bushes are the only source of firewood. Along Rogue, Hess, and Macmillan Rivers, willow, dwarf birch, and alder are so plentiful as to be a considerable hindrance to travel in those valleys. Jack pine and lodgepole pine grow in Macmillan River Valley.

Among the small, wild fruits, blueberries are abundant, but raspberries, cranberries, and red and black currants are only locally plentiful.

The following game was seen in the region: abundant caribou and moose, sheep, grey wolf, grizzly bear, black bear, wolverine, beaver, weasel, red fox, rabbit, pika, ground squirrel, red squirrel, and various mice. The hoary marmot was seen only south of Stewart River and west of Selwyn Valley. The following birds were observed: Canada goose, duck, grouse, ptarmigan, swan, raven, eagle, hawk, owl, Canada jay, and many smaller birds.

Grayling, pike, trout, and salmon abound in many of the streams and lakes.

### PHYSIOGRAPHY

The area mapped lies almost wholly within the northern Selwyn Mountains, which have an average altitude of about 6,500 feet, with a few peaks or groups of peaks rising to, or above, 8,500 feet. At the head of Corn Creek, a group of limestone peaks approach 10,000 feet, and Keele Peak, in the south, is 9,700 feet above sea-level.

The relief varies from one part of the region to another. Along Bonnet Plume River, from Kohse Creek northward, where the elevation of the valley floor is about 2,500 feet, the relief is as much as 5,000 feet, but near the headwaters of Bonnet Plume River and along Selwyn Valley, where valley bottoms range in elevation from 3,500 to 4,000 feet, it is only 3,000 feet.

## DRAINAGE

The drainage shows some distinctive patterns, which appear to be controlled by structure. The major valleys north of Keele Lake to near Bonnet Plume Lake, such as Selwyn Valley, and the valleys of Snake River and Bonnet Plume River north of Kohse Creek, bear north 55 degrees west. The structural trends east of Bonnet Plume River and along Selwyn Valley are roughly parallel with the main valleys. The mountains are further dissected by tributaries, which hang as much as 1,000 feet above the major valleys.

### Selwyn Valley

Selwyn Valley extends as a conspicuous feature for nearly 60 miles northwest from east of Keele Lake to near Bonnet Plume Lake. It is a remarkably straight, flat-floored trench, varying in width from 2 miles near Misty Lake to 3 miles where Hess River leaves it. The cross-profile of the valley between the two branches of Stewart River suggests a trough-in-trough form. The slopes of the valley walls become more gentle at the bottom of faceted spurs at elevations of about 5,300 feet, but at about 4,800 to 5,000 feet the slope becomes steeper again to where, at an elevation of about 4,000 feet, it flattens and merges with the valley floor. Terraces are perched at the top of the lower trough. The southern part of the trench is a single trough in which the slope of the valley walls below the truncated spurs begins to flatten at about 4,600 feet, finally merging with the valley floor at about 4,100 feet above sea-level. Along much of this southern part, Selwyn Valley is occupied by braided channels of Hess River, by many small lakes in kettles, and by muskeg. The northern part contains, at intervals, tributaries of Stewart and Bonnet Plume Rivers. It may be significant that Snake River has the same trend and may represent a prolongation of the structure controlling the position of Selwyn Valley. Snake River and Selwyn Valley are flanked to the east by closely folded and faulted rocks and to the west by rocks of a different structural or lithological character.

The shorter tributary valleys flowing into Selwyn Valley from the west head in cirques, and in most cases their floors hang above the trench by as much as 1,000 feet. These shorter valleys have tributaries of their own that enter mainly from the south from small north-facing cirques.

Southwest and west of Bonnet Plume Lake, the major valleys show a more westerly trend, represented by Stewart, Nadaleen, East Rackla, and Bonnet Plume Rivers, recording thereby the swing of the structural trends from northwest to west. Most of the north-flowing tributaries head in cirques.

Radial drainage patterns are illustrated around some of the granitic stocks in the southern part of the region mapped.

## VALLEYS

All the major valleys, particularly the valleys of Bonnet Plume and Snake Rivers, are U-shaped trenches with flat floors varying in width from 3/4 mile to 1 1/2 miles. For most of their courses the streams are braided on gravel flats, with only short stretches of canyon. Tributaries entering these major valleys debouch from canyons onto wide alluvial fans.

Many of the gravel flats especially were covered with as much as 7 feet of ice until late July or August, and ice was found even in a few of the gravel-floored canyons. Similar conditions are described by Camsell (1906, p. 12) on Braine Creek 35 miles northwest of Rackla River, and by Cockfield (1925, p. 3) in the Upper Beaver River area. They attribute the formation of the sheets of ice to constant overflowing of water during the winter. Camsell believes much of the water is supplied from tributaries fed by springs in limestone. These ice-sheets may, on occasions during break-up, offer dangerous travelling over the wide gravel flats because of undermining by water and convergent caving and slumping of the ice.

The walls of the valleys up to an average elevation of 5,700 feet show smoothed and rounded ridges, truncated spurs, and glacial grooves and striae.

## UPLAND AREAS

Above an elevation of 5,700 feet, the upland areas are composed of rugged mountains characterized by sharp peaks, narrow ridges, and steep cliffs. Only the lower peaks, those below 5,700 feet, exhibit rounded summits and smoothed ridges. Such low hills are the ridges just north of Rackla Lake, those east of Selwyn Valley near the bend in Cloudy Creek, and the low hills south of Rogue River at the extreme western edge of the area mapped.

## INFLUENCE OF STRUCTURE AND LITHOLOGY

In addition to its influence on the drainage pattern, the structure controls, to some extent, the form of some mountain masses. East of Bonnet Plume River, north of Kohse Creek, and southwest of the same river, south of Kohse Creek, are several parallel ridges with asymmetrical cross-sections. The less steep eastern slopes are dip-slopes that reflect the prevailing east and northeast dips in these areas.

Lithological control is illustrated by the more subdued topography of areas underlain predominantly by slate, such as the one between the head of Kohse Creek and Rusty Mountain. They are in marked contrast with the higher and more rugged surrounding dolomite and limestone terrain.

An illustration of the kind of topography produced by resistant rocks is afforded by the rugged mountains formed of granitic stocks and of baked and hardened cherts and slates within the rusty contact-metamorphic zone surrounding them. The cherts and slates beyond this zone show a more subdued topography, characterized by fewer sharp peaks and smoother ridges covered with felsenmeer.

### CIRQUES

Cirques are abundant. They are most common on the north, northeast, and east sides of mountain masses, and on the western and southern slopes are confined chiefly to areas in which glaciers now exist.

Cirques are found at various elevations. Near Rackla Pass the floors of west-facing cirques lie at elevations of 4,400 and 4,850 feet, and near Algae Mountain those of similarly oriented cirques are at 5,800 feet. West of Misty Lake, the floors of east-facing cirques are at elevations of 5,000 and 5,500 feet, and south of Rogue River those of north-facing cirques are 4,100 to 4,200 feet above sea-level. In general, however, cirque floors are lower on north- and east-facing cirques than those facing south and west.

Existing glaciers and small ice-fields are found on the highest mountains in the region and, with few exceptions, are on the north and east sides of these groups of mountains.

### NIVATION FEATURES

Nivation hollows and benches 75 feet wide composed of broken, lichen-free rock and scree, and apparently formed by nivation processes, are found on north and northeast slopes up to the highest elevations. The benches are most common a few feet below the crest of ridges on the slopes least exposed to the sun, where snow banks remain for long periods.

### LANDSLIDES AND ROCK GLACIERS

Several landslides and a few mudflows were noted in the region. Three large slides were seen in the area between Snake and Bonnet Plume Rivers, near Duo Lakes. One of these, across Bonnet Plume River, is about 2 miles long by 1 1/2 miles wide.

It consists of a jumble of huge limestone blocks, some the size of a small house, that are found several hundred feet up on the south, or far side of the valley from the source of the slide. It appears to have been caused by slippage along a steeply dipping bedding plane on the steeper limb of an asymmetrical anticline. The slide has some timber growing on it near its borders, and Bonnet Plume River has cut a trench through it; consequently, the slide is not very recent, but is certainly post-glacial.

Two other slides of a different character were seen near the headwaters of Rogue River. The one across Slide Creek shows the special features particularly well. It is about 1 1/2 miles long by 1/3 mile wide, and has partly dammed Slide Creek to form a small turquoise-blue lake. The creek has now cut a channel, 15 to 20 feet deep, through the slide. The lower third of the slide consists of many mounds of unsorted rock material, chiefly slates. The central part of the slide contains no mounds but is characterized by two marked levees, one on each side of the trough of the slide. These levees are similar to those found with mudslides on Rubble Creek. The uppermost part of the slide is composed of several parallel slumps oriented at right angles to the direction of the slide. Only some fireweed, blueberry bushes, and willow have yet taken root on the slide, which appears to have come down in the winter or early spring mixed with considerable snow or ice. In fact, it must have been sufficiently lubricated with snow or melting ice to produce the levees on either side as it flowed downward. The included snow or ice thus wasted away in situ and left the present jumble of depressions and mounds.

Several small rock glaciers were observed in the region, most of them around the headwaters of Rogue River. They display concentric ridges covered with considerable moss and lichen.

#### HEIGHT OF DRIFT

Glacial drift was seen to reach elevations of about 4,700 feet along upper North Rackla River and Bonnet Plume River, near Pinquicula Lake. Erratics were noted up to an altitude of 5,400 feet 6 miles north 30 degrees east of Nadaleen Mountain. At the head of Goz Creek, drift is virtually lacking at elevations above 4,200 feet, but near the mouth of Reptile Creek an erratic of hematite-bearing quartzite was found at 4,500 feet. Limestone erratics were seen at 5,300 feet on the low ridges east of the bend of Cloudy Creek. North of Old Cabin Creek drift reaches an elevation of 5,100 feet, though quartz diorite boulders derived from a nearby stock were found up to 5,600 feet. South of Rogue River, west of Emerald Lake, quartz diorite boulders, derived from stocks to the east, were seen up to an altitude of 5,250 feet.

## THICKNESS OF DRIFT

The larger valleys, such as North Rackla River below Rusty Mountain, Bonnet Plume River north of Kohse Creek, Snake River near Reptile Creek, and Rogue River contain drift 100 to 150 feet or more in thickness. The headwaters of their tributaries, however, at elevations of 4,000 feet, contain much less drift. Overburden is 50 to 70 feet thick on upper North Rackla River, 50 to 75 feet thick on Hematite Creek, 30 to 50 feet thick in pockets near Goz Lakes, and 75 feet thick on upper Marmot Creek. Much of the area underlain by grey limestone northwest of Goz Lakes is free of drift.

## CONSTRUCTIONAL FEATURES

The drift covered areas reveal Kame terraces at several places in most of the major valleys. Prominent terraces line the walls of Rogue River Valley near Arrowhead Lake along Old Cabin Creek, and stream terraces 100 feet or more above the present stream levels occur on North Rackla, upper Bonnet Plume, and Snake Rivers. The cutbanks display till overlain by glacio-fluvial clayey gravels and sands.

At the mouth of some of the tributaries entering Selwyn Valley from the west are flat-topped terraces, at an elevation of 4,600 feet, composed of sands. These appear to represent deltas formed by tributary streams entering a standing body of water from the west. No terraces were seen on the east side of Selwyn Valley.

Lateral moraines and eskers were seen 2 miles east of Kathleen Lake; in North Rackla River Valley, at the mouth of Salutation Creek; in Corn Creek Valley, 2 miles upstream from the mouth of Black Canyon Creek; in Goz Creek, 2 miles above its mouth; and on Snake River, north of Duo Lakes.

Terminal moraines were noted on Beaver River, 3 miles above the mouth of Rackla River, and at the southeast end of Misty Lake.

Kettles are displayed in the valley of Kathleen Lake; on Corn Creek, at the mouth of Black Canyon Creek; in Bonnet Plume Valley, for 2 miles below the mouth of Goz Creek; in Selwyn Valley, on Old Cabin Creek; on the divide 4 miles northwest of Arrowhead Pass; and abundantly in the depression formed by the confluence of Marmot Creek over Rogue River and its tributaries.

## GLACIATION

### MAXIMUM ELEVATION AND THICKNESS OF VALLEY GLACIERS

A number of features indicate that ice once occupied a considerable part of most of the valleys. At a maximum elevation of about 5,700 feet there is a marked change in topography, above which spurs, ridges, and summits are rugged and sharp, and below which spurs are faceted, ridges are rounded and smoothed, and rock exposures show striae and chattermarks in some places. Erratics have been found up to an elevation of 5,400 feet. Those found at 5,600 feet between Old Cabin Creek and Rogue River have their source so close at hand, and from a higher altitude, that they may have been transported by a cirque glacier belonging to an alpine stage of glaciation rather than to the main stage of valley glaciation. Overburden or drift, consisting of a till and overlying glacio-fluvial material, has been found at varying elevations recorded above. The upper limit of ice was probably slightly above 5,200 feet in the Rogue River area, between 5,400 and 5,700 feet in the Rackla Lake district, and at least 4,500 feet along Snake River. The average thickness of the ice that once occupied the valleys must then have been between 1,500 and 2,000 feet.

### DIRECTION OF ICE MOVEMENT

It appears that, in general, ice movement was in directions coinciding with the present gradients of the valleys. Evidence for the direction of movement was gained mainly from the direction of slope of kame terraces and lateral moraines, distribution of erratics, and, in one instance, striae and chattermarks. No conclusive evidence could be found as to direction of ice movement on the divides between Bonnet Plume and Snake Rivers, and Wind and Rackla Rivers, or in the valley containing Rackla Lake and in Selwyn Valley. In general, ice moved northward down Corn Creek and Snake and Bonnet Plume River Valleys, southward along North Rackla River, eastward along the valley of Kathleen Lake, and, according to Keele (1906, p. 20), west along Stewart River Valley. In the Rogue River area, ice moved down valleys to the depression north of Arrowhead Lake and out to the west by Rogue River Valley and over the tops of the low, intervening ridges.

The great abundance of kettle holes in the depression at the confluence of the many tributaries of Rogue River suggests that, during the waning stages of Glacial time much stagnant ice was left behind to waste away in situ, leaving angular granitic boulders scattered over the surface of the central and southern parts of the hollow.

GENERAL GEOLOGY

INTRODUCTION

In view of the large area traversed in the one field season, and the fact that little time could be spent at any particular locality, however complex the geology there, correlations across the area were difficult to make, particularly as fossil evidence was extremely scarce. For purposes of description, it has been found convenient, therefore, to divide the map-area into three separate parts, between which it has not been possible to establish definite correlations, but within each of which the succession of formations and their structural relations are better known. These three parts comprise: (1) the North Rackla River and Bonnet Plume River areas; (2) the area east of Snake River, and Selwyn Valley; and (3) the Rogue River area and the area west of Selwyn Valley. The geology of each of these three parts will, consequently, be taken up in order, before continuing with more general features of the map-area as a whole.

NORTH RACKLA RIVER AND BONNET PLUME RIVER AREAS

Table of Formations

Era	Period or Epoch	Map-unit and thickness (Feet)	Lithology
Cenozoic	Quaternary		Glacial drift, alluvium
	<u>Unconformity</u>		
		24	Diorite
	<u>Intrusive contact</u>		
Palaeozoic	Devonian(?) or later	22-23: 2,500+	Grey and cream-coloured limestone
		21 : 1,000±	Grey slates, conglomerate
		18-20: 1,500 to 2,300±	Grey limestone containing algae
		15-17: 3,000±	Quartzite, slate, iron formation
		14 : ?	Chert-bearing grey limestone
		13 :	Interbedded carbonaceous slates and limestone

<u>Disconformity</u>			
Proterozoic(?)	Silurian or Devonian	10-12: 800+	Grey limestone
		7-9 : 2,600 <sup>±</sup>	Yellow and brown weathering, grey limestone
		4-6 : 2,400 <sup>±</sup>	Grey, maroon, and green slates, sand- stone, and conglomerate
	<u>Unconformity</u>		
	Cambrian and earlier (?)	3 :	Dark slates, quartzite
		2 :	Grey limestone
		1 :	Reddish brown weathering dolomite and sandy dolomite contain- ing algae; some grey limestone

Relations to above rocks uncertain

Palaeozoic(?)		DL :	Grey and brown weathering cream-coloured dolomite and limestone
		SQ :	Interbedded brown slates and quartzites

Description of Formations

Sedimentary Rocks

Cambrian and Earlier (?)

(Map-units 1-3)

The area bounded roughly by Bonnet Plume River, Kohse Creek, and the large valley leading west to Wind River is underlain, almost wholly, by closely folded rocks of probable Cambrian and earlier (?) age.

The most widespread, and what is believed to be the oldest, formation (map-unit 1) is composed of reddish brown weathering dolomite and sandy dolomite, with minor amounts of grey limestone, dark grey slate, and quartzite. The reddish brown weathering has an almost constant depth of about 1/16 inch. Where sandy, cherty, or argillaceous facies are represented, the more resistant quartzose parts stand out in relief over the dolomite to produce an extremely rough surface. Freshly broken surfaces have a dense, bluish grey colour, and give no reaction with dilute hydrochloric acid. The rock is composed mostly of fine-grained dolomite, but is associated with some carbonate that maintains a high relief under the microscope, and is a ferruginous carbonate, probably siderite; this could account for the rusty weathered surface. In addition, minute quartz grains, 0.04 mm. in diameter, and some pyrite are scattered through the rock. Some bands contain a considerable proportion of dark clay minerals, and at some localities chert nodules, 1/4 to 1/2 inch in size, and irregular, cherty patches 2 inches across, are prominent, together with numerous quartz veinlets up to 2 to 3 mm. wide.

Much of the rock shows an irregular banding, which in places is interrupted by minute ruptures transverse to the banding. These features resemble those due to flowage and compaction in hydroplastic muds, and are here interpreted as evidence of deformation prior to consolidation and lithification of the dolomitic muds. Much of the rock has a rough sandy texture, and on Salutation Peak it is oolitic. Beds showing grain gradation from sands, through silts, to muds were seen in many places.

Concretions are common. In part they are composed of argillaceous material, are about an inch across, and probably represent mud balls; and in part they consist of dark brown, mammillary, limonitic material and are 6 to 8 inches in diameter.

A distinctive feature of these rocks is the presence of concentrically banded circular forms, mostly 4 to 6 inches across, though some attain a diameter of 12 to 14 inches. Some are columnar in habit, and taper at one end. They are believed to be algal structures similar to cryptozoon or to Collenia (Fenton and Fenton, 1937). They appear in great numbers or clusters suggestive of 'colonies' that form bioherms. In many instances much cherty material occurs between the individual algal structures.

Within the dolomitic formation are a few beds of grey, granular, stylolitic limestone and bluish grey, platy, pyritic slates and quartzites, which, in some localities where their stratigraphic position is uncertain, may belong in part to map-units 2 and 3.

A banded, pale green, chloritic limestone that contains inset, sinuous bands, and discontinuous lenses of sandy, less

resistant material, overlies the algal-bearing dolomite near the summit of Algae Mountain and the slates and quartzite near the top of Pass Mountain. Elsewhere, a grey weathering, pale grey limestone (map-unit 2) that outcrops near the heads of each of the uppermost forks of North Rackla River apparently overlies the dolomite conformably.

Dark grey and black slates associated with varying amounts of grey and white quartzite (map-unit 3) overlie the dolomites with apparent conformity at many localities. Near the mouth of Salutation Creek the slates contain limy concretions aligned parallel with the bedding. The upper part of the slates in the area between the creek and the valley leading to Wind River are particularly limy. They show graded bedding and, in the southernmost part, a red coloration. At the head of the west branch of the headwaters of North Rackla River the grey limestone of map-unit 2 flattens toward the east and appears to be overlain by the slates and quartzites of map-unit 3.

As much of the geology was viewed from a distance it is possible that disconformities, if present, were not recognized. Either much of the grey limestone was removed prior to deposition of the slates and quartzites, or, as seems more probable, as no disconformities were seen, the grey limestone was deposited in a few, small, isolated basins.

This sequence of dolomites, grey limestone, and slates and quartzites, the thickness of which is not known, is overlain with angular discordance on the east wall of Bonnet Plume River Valley, north of Pinquicula Creek, by an assemblage of slates and yellow and brown weathering limestone, which are, in turn, overlain by grey limestone of Silurian or Devonian age. The beds beneath the grey limestone, above the unconformity, may be of Silurian(?) or earlier age. In the upper Beaver River area, 45 miles to the west, Cockfield (1925, p. 5) describes closely folded, pre-Ordovician, calcareous or dolomitic sandstones and limestones interbedded with minor slates and argillites. The assemblage weathers dull red to brown, and is overlain with angular unconformity by a sequence of Ordovician, Silurian, and Devonian sedimentary rocks. The dolomites, limestones, slates, and quartzites of the North Rackla River area probably correspond with the similar pre-Ordovician strata north of Beaver River. The unconformity beneath the Ordovician beds in the latter area appears to be represented north of Pinquicula Creek and, consequently, the age of the rocks beneath it is probably Cambrian or earlier(?).

Silurian or Devonian and Earlier  
(Map-units 4-12)

A Silurian or Devonian formation and older rocks that underlie it, bound, on the east, the area underlain by Cambrian and earlier(?) rocks.

The unconformity is well exposed on the east wall of Bonnet Plume River Valley, north of the mouth of Pinquicula Creek, at an elevation of about 3,500 feet. The reddish weathering dolomites and grey slates strike north 30 degrees east and dip 80 degrees southeast; whereas the slates overlying the basal conglomerate strike north 5 degrees east and dip 35 degrees west. Higher on the mountain the slates swing to north 50 degrees west and dip northeast at 40 degrees. The basal conglomerate cuts across both the dolomite and the slates.

The conglomerate has an average thickness of about 35 feet, locally increasing to 50 feet, and may be divided into two parts according to the size of its boulders. In the lower third of the conglomerate these average about 6 inches across but reach a maximum of 14 inches, whereas in the upper two-thirds they average 2 to 3 inches in diameter. The boulders are moderately well rounded, but have a low sphericity, owing to their tabular character. They consist mainly of grey quartzite, some of which is limy and some is banded but not limy; brown weathering, dark grey dolomite; dark grey limestone; and dark greenish rocks. A gritty matrix occupies about 20 per cent of the rock volume, and the conglomerate, as a whole, is well cemented, with quartz veins and veinlets cutting indiscriminately through matrix and pebbles. A few measurements were taken at two localities, within 500 feet of one another, about a mile north of the mouth of Pinquicula Creek, on the orientations of tabular boulders that form a well-developed imbricate structure. The attitudes of the imbrication were plotted on a stereonet, and the points rotated to bring the slates, which conformably overlie the conglomerate, into the horizontal. This brings the attitude of the imbricate structure into about its original position. The average of fourteen measurements at one locality indicated that the direction of stream flow was north 37 degrees east, and the average of seven measurements at the other locality indicated the direction to have been north 12 degrees west. It is inferred, therefore, that a possible source-area for the conglomerate lay slightly west of south of the mouth of Pinquicula Creek, or that area now underlain by Cambrian and earlier(?) dolomites, limestones, quartzites, and slates beneath the unconformity.

The crossbedded grits and sandstones are overlain conformably by as much as 2,400 feet of slates, which are chiefly grey and black, but include conspicuous green and maroon strata.

North of Pinquicula Creek, the conglomerate and slates (map-unit 4) are conformably succeeded by about 1,000 feet of yellow and brown weathering, banded, dark grey limestone (map-unit 7). The bands vary in thickness from a small fraction of an inch to 6 inches, and are interbedded with some grey weathering limestone, which in places is slaty. This formation appears to thicken to as much as 2,600 feet south of Corn Creek.

Conformably above the yellow and brown weathering limestone is at least 800 feet of pale grey weathering, dark grey, dense limestone (map-unit 10). In some localities it is considerably fractured and recemented by white calcite, and in others it shows an alternating light and dark banding.

Two collections of fossils or possible organic structures were taken from this limestone south of Corn Creek. One collection was reported by P. Harker, Geological Survey of Canada, to comprise Stromatopora-like chert concretions, but without any definite organic structures. The other collection, from float in Fossil Creek, was examined by D. J. McLaren, Geological Survey of Canada, who states that: "The coral . . . . may belong to the genus Disphyllum, but it might be a columnariid such as Fasciphyllum or Spongophyllum. In either case a Silurian or Devonian age is probable, and a closer determination cannot be attempted". The float is from the grey limestone formation that forms the west wall of Fossil Creek Valley and is different from the limestone on the east side, which may not be of the same age.

The area between Kohse Creek, Bonnet Plume River, and Bonnet Plume Pass, underlain by a sequence of rocks of similar lithology, has been correlated with map-units 4, 7, and 10, described above. The slates of map-unit 5 are chiefly grey and dark grey to black, but lack green or maroon shades. In some localities, particularly east of Kohse Creek, these slates are finely laminated and platy. They become increasingly limy toward the top of the section, and contain several beds 10 to 20 feet thick of dark bluish grey limestone. About a mile east of Kohse Creek, just east of a patch of Cambrian and earlier(?) rocks, a small diorite body intrudes limy slates and interbedded limestone. Within 150 feet of the diorite contact the limestone has been silicified and reveals circular forms about 1/4 inch across containing radial structures. A fossil collection taken from this locality may contain corals, but the specimens are so poorly preserved that no positive identification could be made.

A conglomerate composed of subrounded, black limestone and cherty quartzite pebbles, 1/4 to 1/2 inch in size, outcrops between Kohse and Rubble Creeks, and also near the head of the south branch of Kohse Creek. It is only a few feet thick and contains lenses of grey sandstone.

The relations to the underlying Cambrian and earlier(?) dolomitic rocks west of the Bonnet Plume are not completely understood. From a distance, the slates appear to be structurally conformable with the dolomites, for, along Kohse Creek, they have a constant dip to the east where they appear to overlie the east-dipping dolomites on the east limb of an anticline that is well exposed near the head of Kohse Creek. The contact between the slates and the dolomites, however, was not visited. The small patch of dolomite east of Kohse Creek appears in the core of an asymmetrical anticline.

On a mountain at the head of the south fork of Kohse Creek, relations between the slates (map-unit 5) and the overlying beds are well exhibited. The rocks grade from slates, with interbeds of grey-brown limestone, into yellow and brown weathering, dark bluish grey, finely laminated limestone (map-unit 8) exactly similar to that east of Bonnet Plume River.

On the east side of the same mountain, pale grey weathering, dark grey limestone (map-unit 11) overlies the yellow and brown weathering limestone with apparent conformity. The actual contact is obscured by talus, but the ever increasing number of grey limestone bands toward the top of the yellow and brown weathering limestone suggests a gradation from the latter into grey limestone.

Several factors affect the correlation of the rocks in the Kohse Creek area with those east of Bonnet Plume River. In both areas a similar sequence of slates, yellow and brown weathering limestone, and grey limestone overlies the Cambrian and earlier(?) dolomitic rocks; also, the yellow and brown limestone is identical in each area. These facts suggest that the two areas are underlain by correlative rocks.

The relations of these early Palaeozoic formations to the underlying dolomitic rocks, however, are apparently different on each side of Bonnet Plume River: east of the river the contact is marked by an angular unconformity, whereas west of the river the slates appear from a distance to be structurally conformable with the dolomites. The apparent conformity may be accounted for by a coincidence of structure. The trend of the slates and limestones swings from northwest, near Pinquicula Lake, to slightly east of north west of Bonnet Plume Pass in such a way that an unconformity may be masked, except to direct and detailed observation. If the slates are conformable with the dolomites (map-unit 1), then the rocks of the Kohse Creek area must belong with those below the unconformity east of Bonnet Plume River, and would, therefore, be older than map-units 4, 7, and 10. For reasons given above, however, it is believed that the formations in the two areas are correlative, and that an unconformity probably does exist east of Kohse Creek.

East of Bonnet Plume Pass, a sequence of slates, yellow and brown weathering limestone, and grey limestone (map-units 6, 9, and 12) was observed from a distance. These rocks are correlated with the beds of Kohse Creek and Pinquicula Lake areas on the basis of apparently similar sequence and lithology.

The dark grey, finely banded limestone (map-unit 12) outcropping between Bonnet Plume Pass and Rackla Lake, which is overlain by quartzite, is correlated on lithology. In some places the limestone is brecciated, with fragments about an inch across

cemented by white calcite; in others, it is characterized by flattened oolites up to 1/8 inch in size. Part of the oolitic rock may be dolomitic. Some of the limestone encountered between Kathleen Lake and Rusty Mountain shows beds of similar flattened oolites.

#### Devonian(?) or Later

The group of Devonian(?) or younger formations (map-units 13 to 23) embraces a sequence of sedimentary rocks believed to overlie Silurian and Devonian formations.

The basal formation of this sequence (map-unit 13), consisting of crumpled, dark grey to black, carbonaceous slates, green, chloritic slates, and grey-brown limestone, is exposed on a mountain at the head of Fossil Creek and in canyons within the drift-filled valley leading from Pinguicula Lake southeast across the lower parts of Hematite and Black Canyon Creeks and into Corn Creek. The formation lies structurally above the Silurian or Devonian grey limestone and is overlain disconformably by 150 feet of red beds and a thick succession of chert-bearing limestone.

The contact is exposed at the head of Fossil Creek. The base of the red beds is a reddish conglomerate that varies from 0 to 20 feet in thickness and lies on an irregular surface. The conglomerate is missing in some places along this contact. The fragments, chiefly limestone, are tabular, and are so oriented that they lie with their greatest dimensions, which range from 2 to 12 inches, parallel with the bedding. The conglomerate grades upward into dark purple, gritty beds and quartzites, with some shaly members. At the top a pale pink cherty quartzite passes gradually into the succeeding cream-coloured, vuggy limestone, which contains grey chert beds up to 4 inches thick.

On Hematite Creek, the chert-bearing limestone (map-unit 14) is grey and brownish, as well as cream coloured. In part, it is muddy, and is characterized by alternating light and dark bands 1/32 to 1/8 inch wide. The chert appears as nodules or elongated, discontinuous lenses alined parallel with the bedding, or as beds up to 12 inches thick. It includes some grey chert, but is commonly black, particularly near the top of the formation.

The chert-bearing limestone on Hematite Creek is overlain, probably conformably - the actual contact was not seen - by about 3,000 feet of white, pale greyish green, and purple quartzite, minor maroon and green slates, and iron formation (map-unit 15). The quartzite is composed mainly of subrounded grains of quartz about 0.1 mm. in size. A few bands of hematite-bearing quartzite, from 1 inch to 2 or 3 inches thick and totalling about 12 to 14 inches, occur in a section about 700 feet thick. Associated

with them are purple and greenish, mud-cracked and oscillation ripple-marked slates, and at the top of that part of the section in which hematite is found is a 1-foot bed of brown weathering siderite and, a few feet above it, another bed, also a foot thick, of grey-brown, very dense limestone showing incipient replacement by siderite.

North of Rackla Lake is a white-banded quartzite, with minor grey slates (map-unit 16), which overlies a limestone correlated with the Silurian or Devonian formations. The quartzite is probably the equivalent of the quartzite and iron formation on Hematite Creek, as in both localities the quartzitic formation is overlain directly by limestone containing algal structures (map-unit 19).

Some brown weathering, grey and pale brown quartzite (map-unit 17) that outcrops around Goz Lakes is lithologically similar to the quartzites near Rackla Lake, and is correlated with them on this basis.

The limestone (map-unit 18) containing algal structures, which succeeds the quartzitic formation, is roughly 1,500 feet thick. It is cream weathering, grey and grey-brown rock interbedded with a few 5- to 6-foot bands of dark grey to black, shaly limestone and some quartzite. The algal structures are similar to those exposed in rocks around upper North Rackla River. Some of the limestone at the head of Hematite Creek, however, weathers brown, and is not unlike some of the Cambrian and earlier(?) dolomites. The actual contact between the algae-bearing limestone and the underlying quartzites was nowhere visible, and it seems possible either that these algal forms have a long time range, at least until the Devonian Period or later, or that there were two distinct intervals of algal building, and that this limestone is correlative with, or related to, the Cambrian and earlier(?) dolomitic rocks, and may have been brought up by thrust faults from the east to its present position.

West of Snake River, around Goz Lakes, the quartzite is overlain by 2,300 feet of relatively flat-lying limestone (map-unit 20), which is capped by a prominent bed of red shaly limestone as much as 100 feet thick. The limestone is mostly grey to dark grey, partly grey-brown, on the fresh surface, but weathers to a pale grey or grey-brown colour. The lower half of the section contains much detrital and muddy looking limestone, whereas the upper part is mostly a grey, dense, cleaner looking rock. The uppermost beds beneath the red limestone, however, contain much detrital matter. A few nodules collected from the central part of the section were examined by P. Harker, Geological Survey of Canada, who comments as follows: "... Nodular limestone - possibly phosphatic, with Girvanella-like structure . . . . . contains few structures of definite organic origin. 'Girvanella' is a form

genus, and includes various types of encrusting organisms, usually arranged concentrically around a nucleus. Girvanella-like structures occur at many horizons in the Palaeozoic, perhaps especially in the Devonian and Carboniferous". Correlation of this limestone formation (map-unit 20) with those to the west (map-unit 19) and northwest (map-unit 18) is difficult. It occupies a position above a quartzite, as do the algae-bearing limestones, but is overlain by red beds at the base of the succeeding limestone section, whereas northeast of Rackla Lake as much as 1,000 feet of slates and thin conglomerate (map-unit 21) are inserted between the algae-bearing limestone and the red beds at the base of the uppermost limestone formation.

Thin conglomerate beds are found at the base of the grey slates (map-unit 21) and also near their top, and a little dark grey limestone is interbedded with the slates. The basal conglomerate is composed of angular fragments, up to 2 inches in size, of chert and dark grey, banded limestone in a pale grey limestone matrix. The upper, rusty coloured conglomerate is about 30 feet thick, and is composed mainly of moderately well-rounded limestone pebbles averaging 1 inch to 2 inches in diameter; some boulders attain 8 inches in size. These flat-lying slates and conglomerates were traced for 2 or 3 miles to the east.

At least 1,500 feet of flat-lying, grey and cream-coloured, banded limestone, with pale green and maroon, shaly members at its base, lie above the slates and conglomerates northeast of Rackla Lake (map-unit 23). The limestone is characteristically smooth weathering and very dense.

West of Snake River, 2,500 feet or more of flat-lying and locally folded, pale grey and dark grey limestone (map-unit 22) is exposed above the prominent bed of orange or maroon, argillaceous limestone.

The flat-lying limestones in these two areas are believed to be correlative on the basis of their positions above red beds and their general lithological similarity. It is possible that the 1,000 feet of slates and conglomerates northeast of Rackla Lake may be represented by a disconformity around Goz Lakes, but as the actual contact between the red beds and the underlying limestone was obscured, the relations there are uncertain.

Formations Whose Age, Relations to Rocks of  
Known Age, and Distribution Are Uncertain  
(Map-units SQ and DL)

Much of the area from Duo Creek to north of lower Goz Creek is underlain by two formations the inter-relations of which are known, but whose relations to the formations previously described could not be determined.

A formation of irregularly folded, interbedded, dark grey slates, slaty siltstones, and quartzites (map-unit SQ) is overlain by a group of flat-lying, pale grey and brown weathering, dense, grey dolomites and limestones, and minor, bluish grey weathering, grey limestone (map-unit DL). The quartzites are crossbedded in part, and contain concretions, and the dolomites and limestones are veined by many rusty carbonate and pyritic zones. Specimens of light grey limestone from Goz Creek were reported by P. Harker to contain hollow spherules of uncertain origin, with definite organic structures.

A group of dark-coloured rocks (map-unit SQ?) of unknown lithology, northwest of the mouth of Duo Creek, appears to overlie the dolomites and limestones described above. These may be part of the series of interbedded slates and quartzites (map-unit SQ) and have been thrust over the carbonate rocks by a fault or overturned fold, or they may represent a slate formation still younger than the carbonate rocks.

Grey and brownish grey weathering limestones, which seem from a distance to be similar to the limestones of map-units 20 and 22, appear to underlie much of the area north of Bonnet Plume River southeast of Duo Creek. A pale grey quartzite, appearing black when covered with lichen (map-unit 17?), forms a rugged mountain north of Bonnet Plume Lake. This quartzite is not unlike that exposed near Goz Lakes, and lends support to the idea that the same sequence of rocks that outcrop around Goz Lakes is found farther southeast between Bonnet Plume and Snake Rivers.

Although no part of the area between Snake River and the right-angle bend in Corn Creek was visited, it appears from a distance to be underlain mostly by slightly folded, grey limestone whose age is uncertain. West of the northernmost part of Snake River are some bright yellow and brownish rocks of unknown lithology. Their relations are not known, but their distribution is outlined approximately on the accompanying map.

South of Corn Creek, east of the right-angle bend, a sequence of beds seen from a distance appears to represent the formations around Pinquicula Lake. It was possible to trace and map the contacts of the individual formations and, thereby, to indicate, in a general way, the trend of the formations in this region.

Because of the complex structure on the east side of Bonnet Plume River, near the mouths of Pinquicula and Corn Creeks, it was not possible to map the geology satisfactorily.

A large part of the area between the large valley leading from Rackla Lake to the head of Wind River and East Rackla River

is underlain mainly by grey limestone, with some brown weathering limestone and dark grey and red slates. Northeast of Kathleen Lake, the grey limestone is lithologically similar to the limestone north of Rackla Lake (map-unit 12), which has been correlated with Silurian or Devonian formations around Pinquicula Lake. The limestone in the western part of the Nadaleen Range also appears from a distance to be similar to that north of Rackla Lake (map-unit 12). South of Rackla Lake, the grey limestone contains bands of pale greenish and reddish limestone not unlike that at the base of the uppermost limestone formation exposed northeast of Rackla Lake (map-unit 23). It is possible, therefore, that some of the grey limestone south and southwest of Rackla Lake may be correlative with the youngest limestone northeast of Rackla Lake (map-unit 23).

### Intrusive Rocks

#### Diorite

Several bodies of diorite outcrop in the North Rackla River and Pinquicula Lake area. Small irregular bodies or stocks are exposed on North Rackla River, north and northwest of Rusty Mountain and at several points along Kohse Creek. In addition, several steeply dipping to vertical, west trending dykes, 10 to 80 feet wide, have intruded the sedimentary rocks in many places from Kathleen Lake to Pinquicula Lake. The larger dykes are shown on the map, not to scale but to emphasize their pattern and distribution.

The stocks are composed of coarsely jointed, medium-grained, mottled green diorite, which locally contains clots of plagioclase grains 1/2 inch in size. Some bodies, particularly one east of Kohse Creek and another west of North Rackla River 6 miles south of Salutation Peak, are considerably sheared, altered, and veined by calcite.

Many of the dykes are porphyritic and contain some amygdules near their borders. Phenocrysts of plagioclase and pyroxene up to 5 mm. long are set in a dense, bluish green matrix. The amygdules are 3 to 4 mm. across, and are composed of calcite. A thin section of a dyke north of Kathleen Lake showed the rock to be composed essentially of 15 per cent andesine phenocrysts in a matrix composed of 70 per cent andesine and 30 per cent mafic minerals, the latter completely altered to chlorite and carbonate. Apatite, magnetite, and ilmenite constitute minor accessory minerals.

Dykes that cut the reddish brown dolomitic rocks show pronounced bleached border zones as much as 50 feet wide. Limestones cut by diorite dykes are veined by calcite at the dyke contacts,

but elsewhere show little alteration or recrystallization, whereas impure limestone east of Kohse Creek has been silicified to within 150 feet of the diorite contacts.

Some of the diorite bodies, particularly on Pinguicula and Black Canyon Creeks, carry a little chalcopyrite and pyrite, either sparsely disseminated through the rock or occurring in small quartz veins in the diorite.

Two west trending dykes on Hematite Creek above the mouth of Black Canyon Creek have been faulted into a series of en échelon blocks as a result of minor movements upwards and to the southwest.

The diorite has intruded rocks as young as the crumpled carbonaceous slates and limestones in lower Hematite Creek, but was not seen to have cut rocks believed to overlie this formation. On the other hand, all the contacts between the sedimentary rocks and the diorite were seen to be intrusive, and no fragments of diorite were observed in the rocks younger than the crumpled slates and limestone. The dykes transect the folds of the Cambrian and earlier(?) rocks, but east of Bonnet Plume River are themselves involved in small thrusts. The age of intrusion cannot be definitely placed. The diorites cut rocks slightly younger than Silurian or Devonian (map-unit 13) and antedate the deformation of the Palaeozoic rocks. In the upper Beaver River area, Cockfield (1925, p. 8) places the age of the augite andesites and augite diorites as not older than Silurian or perhaps Devonian.

#### AREA EAST OF SNAKE RIVER AND SELWYN VALLEY

Table of Formations

Era	Epoch or Period	Map-unit and thickness (Feet)	Lithology
Cenozoic	Quaternary		Glacial drift, alluvium

Unconformity

Palaeozoic	Post-Cambrian(?)	VI: 2,000+	Dark grey and light grey limestone
		V: 500-1,000	Quartzite, conglomerate
		IV: 800-2,000	Light brown weathering, cream-coloured limestone

	Cambrian(?)	III	Brown-banded slates and sandstones
Proterozoic(?)	Cambrian and earlier(?)	II	Brown weathering limestone
		I	Brown weathering quartzites

Relations to above formations unknown

(East of Selwyn Valley)

Palaeozoic(?)		P3: 600	Dark grey limestone
		P2: 1,400	Light brown weathering, grey and brown, slaty limestone and slate
		P1: 1,500+	Brown and white quartzite

Description of Formations

Sedimentary Rocks

The following descriptions deal with the folded rocks examined along Reptile Creek.

Cambrian and Earlier(?)  
(Map-units I, II)

The oldest rocks appear to be those that form the core of an anticline southeast of Reptile Creek below the mouth of Storm Creek. From float, and their appearance from a distance, these rocks are probably mainly brown weathering quartzites. Above these brown rocks, in the same anticline, is a pale brown weathering, pale grey limestone. The thickness of these two formations could not be determined.

Cambrian(?)  
(Map-unit III)

A formation composed of brown and grey-brown, interbedded slates and sandstones (map-unit III) seems to overlie the beds in the anticline referred to above. The succession and structure, however, are not clear, and there is some doubt as to the stratigraphic position of map-units I and II. The slates and sandstones outcrop, also, on the northwest side of Reptile Creek, beneath a light brown weathering, cream-coloured limestone. A fossil collection obtained from a dark grey sandstone near the base of this formation south of the east fork contained a brachiopod of Lower Palaeozoic, possibly Cambrian, age.

Post-Cambrian(?)  
(Map-units IV-VI)

The basal formation of the group succeeding the Cambrian(?) strata comprises 800 to 2,000 feet of light brown to orange weathering, cream-coloured, locally grey, limestone. In several places the upper part includes a red facies composed of maroon, slightly argillaceous limestone. The bright brown weathering stands out in contrast with the dull, dark brown weathering of the overlying quartzite formation, thus facilitating the interpretation of the structure in the region.

The overlying quartzite, which appears to thicken from 500 feet near the mouth of Reptile Creek to about 1,000 feet by the lake at its head, weathers dull, rusty brown, though locally it has a maroon facies. It is chiefly a grey and light grey, dense quartzite, but in part has gritty layers and some thin beds of pea-size quartz-pebble conglomerate.

The highest beds exposed are light and dark grey weathering, grey limestone, interbedded with minor, pale green and maroon, slaty beds. The lower members comprise banded, knobby, detrital limestone, whereas the upper strata consist of well-bedded, alternating light and dark grey limestone. The thickness is difficult to estimate because of the irregular folding, but appears to be at least 2,000 feet.

Rocks East of Selwyn Valley

The territory east of Selwyn Valley from Bonnet Plume River nearly to Keele Lake is composed mainly of a group of rocks whose relations to other rocks of known age could not be determined. The drift-filled Selwyn Valley marks the western boundary of this group. No time was available to visit the area at the headwaters of

Snake, Bonnet Plume, and Stewart Rivers in order to establish relations between this group and the rocks on Reptile Creek.

The structure reveals that east of Selwyn Valley this group is composed essentially of the following succession of formations: a basal formation (map-unit P1) comprising at least 1,500 feet of brown weathering, brown and white, or grey, speckled quartzite and slaty quartzite, which contains minor, interbedded, grey limestone; an intermediate formation (map-unit P2) conformably overlying the quartzite and about 1,400 feet thick, composed of light brown weathering, grey and brown, slaty limestone and limy slates, and locally containing nodules, concretions, and veins or clots of quartz and calcite; and an upper formation (map-unit P3) composed of as much as 600 feet of dark grey limestone.

The age of this group is not known, but the appearance of the rocks and their slight degree of metamorphism suggest a likeness to those exposed along Reptile Creek. It is probable, therefore, that this group is of Palaeozoic age.

#### ROGUE RIVER AREA AND WEST OF SELWYN VALLEY

Table of Formations

Era	Period or Epoch	Map-unit and thickness (Feet)	Lithology
Cenozoic	Quaternary		Glacial drift, alluvium
	<u>Unconformity</u>		
	Tertiary(?)	D, DA, DB	Granitic rocks, quartz diorite Syenite
<u>Intrusive contact</u>			
Palaeozoic	Post-Silurian	C	Basalt; pyroclastic rocks
		<u>Unconformity</u>	
		B	Grey and green slates, greywacke, conglomerate, and chert

Ordovician(?) or Silurian	A	Interbedded chert and slate; includes some greywacke and conglomerate, probably of map-unit B
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Rocks west of Selwyn Valley whose relations  
to formations above are not known

Palaeozoic(?)	Early Palaeozoic(?)		Grey and green slates, quartzite, and grey limestone
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Description of Formations

Sedimentary and Volcanic Rocks

Ordovician(?) or Silurian  
(Map-unit A)

The greater part of the area bounded on the east by a possible fault stretching from the head of Slide Creek to Hess River, on the south by Hess River, and on the northwest by Rogue River is underlain by closely folded rocks of Ordovician(?) or Silurian age.

The rocks are composed chiefly of chert, with minor, interbedded, dark slates. Most of the chert is rusty weathering, and dark grey or black, but, particularly west of Arrowhead Lake and in the extreme southwest corner of the area mapped, it exhibits brilliant shades of red and green. The chert occurs mostly in beds 1 inch to 3 inches thick, and where it is interbedded with slates the chert beds are as much as 6 inches thick. The chert is locally nodular, and in several places shows a fine banding. The slates are mainly black or bluish grey and break into thin plates. Near the granitic stocks, however, they are baked and hardened into what appears to be a hard, blocky fracturing hornfels, and the cherts are recrystallized into fine, sugary, quartzitic rocks.

In addition, this formation contains, at various localities, thin beds of dark grey, speckled greywacke, grit, and conglomerate. The dense, well-compacted conglomerates are composed of pea-size

pebbles, including some cobbles up to 3 inches in diameter; these are nearly all of black and grey chert, and are generally moderately well rounded. Some red and some green slates and breccias composed of angular fragments of chert in a limy, green, gritty matrix were observed 2 1/2 miles northeast of the mouth of Marmot Creek. Because the folding is very close and the structure complicated, it was not possible to determine conclusively whether the red and green slates, greywackes, and conglomerates are conformable members of the chert and slate formation, or whether they belong to the overlying formation (map-unit B) composed mainly of clastic rocks. If the latter is the case it seems probable that the clastic rocks are represented as infolds within the slates and cherts.

Close folding and lack of horizon markers have made it impossible to estimate the thickness of this formation.

A fossil collection obtained at an elevation of 6,900 feet, 2 1/2 miles southeast of Arrowhead Lake, was examined by L. M. Cumming, Geological Survey of Canada, who reports: "Graptolite forms, probably a straight thecaed Monograptus sp., and a species of Certatiocaris McCoy (telson fragment). As no sicula could be observed on any of the graptolite specimens, the possibility of their being distal fragments of Ordovician Didymograptus types cannot be eliminated. With the above proviso in mind, these black shales may be regarded as of Silurian age". This information places the age of this formation as Silurian or possibly Ordovician. The formation may be correlated with Upper Ordovician graptolite-bearing, interbedded slates, cherty argillites, and cherts on Ross River near John Lake (Keele, 1910, p. 38), and with the chert division of early Palaeozoic rocks, described by Kindle (1946, p. 14), outcropping between miles 226 and 252 on the Canol Road.

#### Post-Silurian (Map-units B and C)

The formation chiefly of clastic rocks (map-unit B) believed to be younger than the Ordovician(?) or Silurian cherts and slates consists mainly of dark green, maroon, and grey slates; some impure sandstones, chert, and minor limestone; and conglomerate. It was recognized in three localities: on both sides of Slide Creek, north of Old Cabin Creek, and near the southwest limit of the area mapped. In addition, as previously mentioned, parts of this formation are thought to have been mapped with Ordovician(?) or Silurian rocks.

The actual contact between the rocks of map-unit B and the cherts and slates of map-unit A was not seen. West of Emerald Lake, however, the attitudes on either side of the southern contact between the two formations are parallel, or nearly so, suggesting

at least structural conformity in this locality. No basal conglomerate or other evidence of a marked break was seen and, hence, it is believed that the formations are probably conformable. West of Slide Creek, however, the relationships are not so clear. Lack of time prevented a solution of the difference in structure between the two formations. East of Slide Creek the Ordovician(?) or Silurian rocks of map-unit A are folded almost isoclinally into numerous close folds, which show persistent trends for more than 15 miles. The formation of clastic sedimentary rocks (map-unit B), on the other hand, appears to have been deformed into extremely irregular folds, the trends of which could not be determined.

The rocks of map-unit B west of Slide Creek are composed of highly deformed and shattered, green and grey slates; green, finely banded cherts; greywackes; conglomerate containing chert pebbles; and breccias composed of subangular fragments of green, aphanitic rocks, but chert beds similar to those in the Ordovician(?) or Silurian formation were found both above and below the conglomerate. Several outcrops of an unusual nature were seen on the ridges west of the mouth of Slide Creek. A dark green, shattered and crumbly, slaty rock contains rounded fragments up to 6 inches across scattered over its surface and partly embedded in it. The fragments are of dark green, dense, hard material suggestive of altered andesite or basalt. The appearance is that of a conglomerate that has been badly shattered, and from which the finer particles of the matrix have been removed by mass-wasting, to leave behind scattered boulders and pebbles on the surface.

On the mountains north of Old Cabin Creek, beds of grit, quartz-pebble conglomerate, red and brown slate, and minor limestone appear to be in fault contact with volcanic rocks. A collection of what were thought to be plant fossils was obtained from the known slates at an elevation of 5,150 feet. These were examined by P. Harker of the Geological Survey, who reported that they appeared to have definite organic arrangement but do not resemble any known land flora. They may be seaweed impressions, and if so would indicate that these rocks are of marine origin.

The age and thickness of this formation of clastic rocks (map-unit B) is not definitely known, but, as it appears to be conformable with the Ordovician(?) or Silurian rocks, it is probably of mid- or late Palaeozoic age. Kindle (1946, p. 15) describes similar rocks outcropping between miles 260 and 290 on the Canol Road, but could not determine their age.

#### Volcanic Rocks

The only locality in which volcanic rocks were encountered lies between Old Cabin Creek and Rogue River. Possibly as much as 2,000 feet of relatively flat-lying volcanic rocks composed

of rusty weathering, pink and cream-coloured breccia containing angular fragments about 1/2 inch in size are succeeded by dark grey basalt flows. The tops of some of the flows are extremely scoriaceous and in places amygdaloidal, the amygdules being composed chiefly of white calcite.

The age of these volcanic rocks is uncertain. They are relatively flat-lying and do not seem to have been involved in the deformation that folded the sedimentary rocks (map-units A, B) in the Selwyn Mountains region. To the east, in the Mackenzie River area (Hume and Link, 1944), Cretaceous formations lie disconformably or with slight angular discordance on Devonian and older rocks. These Cretaceous rocks comprise crossbedded sandstones and quartz-pebble conglomerate at the base, overlain by sandstones, siltstones, and shales that have been folded, eroded, and overlain by flat-lying, Tertiary, clastic, sedimentary rocks. It is probable that a major deformation took place in the Mackenzie River area at the close of Cretaceous time. The clastic rocks of the Cretaceous formations, however, represent detritus derived from uplifts that probably occurred farther west during Cretaceous time. It is possible, therefore, that the rocks of the Mackenzie Mountains and, perhaps, those of the Selwyn Mountains also began to be deformed in early Cretaceous time. This deformation may then have gradually progressed eastward until, at the end of the Cretaceous, it terminated with the folding and faulting of the Cretaceous and older rocks in the Mackenzie River area. Based on such assumptions, it is believed that the volcanic rocks in the Selwyn Mountains region may have been laid down on an eroded surface in late Cretaceous or early Tertiary time.

Some flat-topped hills between Old Cabin Creek and the most westerly quartz diorite stock may be capped by volcanic rocks.

#### Sedimentary Rocks of Probable Early Palaeozoic Age

A considerable area west of Selwyn Valley in the eastern part of the Nadaleen Range is underlain by folded slates, quartzites, and limestone that are probably of early Palaeozoic age.

North-northeast of Nadaleen Mountain, dark grey, banded, hackly limestone appears to be overlain by an assemblage of rusty weathering, grey-green slates, with sandy interbeds 6 to 8 inches thick; brownish grey, banded, argillaceous siltstone; limy quartzite; and some limestone conglomerate.

Between Goz Creek and Bonnet Plume River, grey and brownish weathering, cherty and fragmental, grey limestone is overlain by brown weathering, greyish brown slates and quartzite.

From the region around Bonnet Plume Lake the rocks west of Selwyn Valley have more of a greyish or greenish hue than

the greyish brown of the two areas described above. Red slates are prominent near Bonnet Plume Lake where they serve to reveal the nature of the folds in that area. Also in this region is a conglomerate containing blocks up to 1 1/2 feet across in an argillaceous matrix overlying a brownish grey and red weathering, grey, muddy limestone. But the rocks are mainly greyish green slates and quartzites. Grey limestone, which seems to be near the base of the section, is exposed chiefly in anticlines and, either because of structural conditions or non-deposition, is not found southeast of the bend in Cloudy Creek. A fossil collection from this grey limestone, west of Misty Lake, was examined by D. J. McLaren of the Geological Survey, who reports that it contains algal structures that resemble 'Girvanella', and that, although this form has a long time range, he would suggest an early rather than a late Palaeozoic age.

Where viewed from a distance, the rocks forming the mountains west of the south end of Bonnet Plume Lake near Nadaleen Mountain appear to be composed of slates, quartzites, and limestone similar to those described above.

The relations of map-units PA and PB to the Ordovician(?) or Silurian cherts and slates are uncertain. The two formations were not seen in contact, but mosaics from air photographs show a marked lineament that separates them and that stretches from the head of Slide Creek almost to Hess River. It is interpreted as a fault.

### Intrusive Rocks

Several granitic stocks are exposed in the rugged, glacier-hung mountains in the vicinity of Rogue and Hess Rivers.

#### The Rogue River and Keele Lake Stocks

The two large stocks, one at the head of Rogue River and the other near Keele Lake and culminating in Keele Peak at an elevation of 9,700 feet, were not visited, but were viewed from a distance, and their contacts sketched in from information gained elsewhere in the field and from an interpretation of mosaics of air photographs. Glacier-borne float in the depression north of Arrowhead Lake gave an indication of the sort of rocks of which the Rogue River stock is composed. Most boulders were of a pale grey, medium-grained biotite granite or granodiorite, some showing coarse porphyritic textures with feldspar phenocrysts 3/4 inch long; others exhibited trachytoid texture; still others contained many rounded, dark grey, speckled, biotite-rich inclusions up to 3 inches across. Many boulders revealed the presence of white to pale pink aplite dykes, which cut grey granodiorite.

## Arrowhead Lake Stock and Those South of Rogue River

The remaining stocks, which were visited, are of two types. All of them, where sampled, are composed of quartz diorite except the one northwest of Emerald Lake, which is a trachytoid syenite. Another granitic stock was seen south of the westernmost quartz diorite stock between the limit of the area mapped and Hess River.

**Quartz Diorite.** The quartz diorite stocks, on the basis of rather inadequate sampling, generally confined to within less than 1/2 mile of the border of the bodies, have the following approximate composition: quartz, 5 to 15 per cent; plagioclase ( $An_{32-36}$ ), which is commonly zoned, 70 to 80 per cent; orthoclase, 0 to 5 per cent; green hornblende, 0 to 5 per cent; and brown biotite, 5 to 15 per cent. Accessory minerals are apatite, zircon, magnetite, and pyrite. They are fine- to medium-grained, equigranular, hypidomorphic rocks in which the plagioclase is slightly speckled with shreds of white mica and the orthoclase, if present, clouded with clay minerals.

The small body southeast of Arrowhead Lake has many subrounded inclusions of varying composition, orientation, and dimensions within 50 to 100 feet of the contact. Some are as much as 20 to 30 feet across. Near the Arrowhead Lake stock are three nearly vertical, porphyritic quartz monzonite dykes about 100 feet wide, which strike parallel with the bedding of the sedimentary rocks but cut across their dips at a very small angle. The composition of the dykes is essentially as follows: feldspar phenocrysts, in a matrix composed of 30 per cent quartz, 40 per cent; oligoclase, 30 per cent; orthoclase, 30 per cent; and mafic minerals, 10 per cent.

The contacts of all the stocks are steep, sharp, and relatively smooth, and no foliation or preferred orientation of mineral grains was recognized in any of these intrusions.

The northern contact of the westernmost stock in the area mapped exhibits some features peculiar to the contacts of these stocks. Within 500 feet of its contact with the adjacent sedimentary rocks, the quartz diorite becomes finer grained; mafic grains decrease from 2 to 3 mm. in size to about 0.5 mm. and increase in quantity from 20 per cent to 30 to 35 per cent. In addition, the quartz diorite contains numerous ovoid inclusions of mafic-rich hornblende-biotite quartz diorite. The intrusive contact is steep, and cuts sharply across the sedimentary beds, which are locally much contorted within a few hundred feet of the quartz diorite. Locally, quartz diorite dykes, up to 50 feet long and 5 to 10 feet wide, intrude the sedimentary rocks, both parallel with the bedding and across it.

The quartz diorite is cut by many pale grey aplite dykes, most of them 1 inch to 6 inches wide, but some as much as 12 inches, on an average strike of north 80 degrees west and a dip of 20 degrees northeast. Some dykes are steeper and merge with, or intersect, the flatter ones. Pegmatitic clots, but no dykes, were seen in many places; they are composed chiefly of smoky quartz, white feldspar, and some black hornblende and pyrite.

Trachytoid Syenite. Northeast of Emerald Lake, a stock, rectangular in plan, is composed of medium- to coarse-grained trachytoid syenite. Its composition at a point 1/2 mile south of the tungsten showing at its northern contact is as follows: orthoclase, 80 per cent; plagioclase (albite-oligoclase), 5 per cent; augite, 10 per cent; hornblende, 5 per cent; and accessory sphene, apatite, pyrrhotite, chalcopyrite, and pyrite. The orthoclase is clouded with clay minerals and some sericite, and the augite is altered partly to uraltite and partly to biotite and chlorite.

Near the margin of the body, close to the tungsten showing, the syenite is porphyritic. Rectangular, grey and white feldspar phenocrysts up to 3/4 inch long are embedded in a grey, fine-grained matrix. Some of these phenocrysts are zoned, and in one place a phenocryst was seen to straddle the boundary between a dark inclusion and the fine-grained trachytoid groundmass. Ovoid and angular inclusions, some of which are banded, occur near the borders of the syenite, and in many instances feldspar laths sweep around them parallel with their borders.

The syenite contains many dykes, up to a foot wide, and irregular bodies of pale brown, fine-grained leucogranite composed almost wholly of quartz and orthoclase. In addition, there are small pegmatite dykes, coarse grained in the centre and bordered by narrow, fine-grained, biotite-rich zones. The central part is composed of pale grey feldspar grains up to 1 inch long, smoky quartz, and minor muscovite. Some pegmatites contain coarse calcite and lenses of brown scheelite. The pegmatites and aplites form vertical and flat-lying dykes transverse to the direction of preferred orientation of the feldspar laths in the syenite.

### Contact Metamorphism

Each stock in the area is surrounded by a rusty halo, 1/2 mile to a mile wide, within which the sedimentary rocks have been metamorphosed into hornfels and recrystallized chert, which stand out in rugged relief over the adjacent unmetamorphosed strata. The chert and baked slates have been thoroughly impregnated with pyrite, which, upon weathering, produces the rusty colour that makes the halo such a conspicuous feature.

## Character and Age of the Intrusions

No time was available to collect conclusive evidence on the nature and mechanics of intrusion. Some inferences may, however, be made. The lack of secondary foliation and cataclasis in the granitic bodies suggest that they have undergone little or no deformation since their intrusion. The preferred orientation of the feldspar laths in the trachytoid syenite probably represents primary flow structure, and the roughly circular or rectangular plans of the intrusive bodies does not evidence any control by the structure of the folded rocks. On the other hand, in most case, the stocks abruptly interrupt and transect the structural trends of the sedimentary rocks. Only near the west border of the westernmost stock and on the southeast side of the Rogue River stock do the structural trends conform roughly with the outline of the borders of the stocks. It is possible that these two instances reflect the influence of the intrusion upon the pre-existing structure. In detail, the borders of the intrusions in some places abruptly transect the bedding without visible distortion of the strata or even of the flat-lying volcanic rocks, but in other places some crumpling has occurred.

An idea of the age of the intrusions can be gained only by indirect evidence. They were intruded after volcanic rocks were laid down on an eroded surface of sedimentary rocks. As previously outlined, these volcanic rocks are believed to be possibly late Cretaceous or early Tertiary in age. Consequently, the granitic rocks may then have been intruded in Tertiary time.

## STRUCTURAL GEOLOGY

### UNCONFORMITIES

The major unconformity in the region is that exposed east of Bonnet Plume River north of the mouth of Pinquicula Creek. The unconformity, its possible extension along Kohse Creek, and its correlation with that found in the upper Beaver River area have already been discussed in describing the adjacent formations. The structural significance of this unconformity is that the Cambrian and earlier(?) rocks that underlie the upper North Rackla River area were deformed prior to the deposition of the early Palaeozoic and succeeding formations. Therefore, it is believed that in earliest Palaeozoic time, probably in the Cambrian, a disturbance took place that affected both the upper Beaver River and North Rackla River areas. The disturbance in the North Rackla River area produced structures that now trend north 25 degrees east in contrast with the northwest trend of the younger rocks. As a result of this disturbance and corresponding uplift, a small land mass probably existed during part of Cambrian time in what is now the upper North Rackla River area, and supplied clastic sediments to the base of the overlying early Palaeozoic formations.

The conglomerate at the base of the red beds below the chert-bearing limestone east of Fossil Creek locally overlies crumpled slates and limestone. Many of the fragments in this conglomerate are rounded, and this and the varying thickness of the conglomerate seem to imply erosional conditions more severe than those of an interformational character. Hence, it is believed that the 'break' below this conglomerate represents a disconformity because, as a whole, formations above and below it are structurally conformable.

## FOLDS

Several distinct trends of fold axes are apparent within this part of Selwyn Mountains.

The Cambrian and earlier(?) formations (1-3) have been deformed into moderately close folds whose axes trend about north 25 degrees east, and in one instance can be seen to plunge northeast. In general, the axial planes of the folds between North Rackla River and Kohse Creek are more or less vertical, but west of North Rackla River, north of Salutation Creek, the only information gained was from distant views, and the interpretation of the structure there is uncertain.

The folds on each side of the Selwyn Valley maintain a trend of north 55 degrees west as far north as Bonnet Plume River. The formations of probable early Palaeozoic age west of Selwyn Valley are irregularly folded; the folds are mainly overturned to the west and have small drag-folds and small thrust faults on their upper limbs, as illustrated in structure-section GH. On the other hand, the folds south of Bonnet Plume Lake are strongly overturned to the northeast. At the head of Marmot Creek, the folds appear to be open for some distance across the range, and these abruptly pass into an irregular, closely folded, crumpled zone.

East of Selwyn Valley, the formations are overturned to the southwest and are broken by thrust faults, as shown in structure-section GH near Misty Lake. Some of the thrusts seem to have broken through just below the crests on the under limbs of the folds. Near the head of Hess River the rocks have been deformed into vertical open folds.

West of Bonnet Plume Lake, the more or less vertical folds in rocks of probable early Palaeozoic age swing due west, and continue in this direction south of Rackla Lake to Kathleen Lake. Although the fold structures along lower North Rackla River could not be satisfactorily determined, the low dips and evidence of beds completely overturned, as indicated by inverted oscillation ripple-marks, suggest that the formations have been strongly overturned toward the south. Small, north-dipping thrusts and shears accompany these features.

Structure-section EF illustrates the character of the northwest trending folds east of Snake River. Flat-lying, apparently little deformed beds become crumpled into large, vertical, chevron folds. Between Snake River and a normal fault to the east, the formations are strongly overturned to the southwest, a feature also illustrated by a recumbent anticline south of Reptile Creek, but abruptly terminated at the valley of Snake River.

Between Snake and Bonnet Plume Rivers, east of Duo Creek, the folds in the limestone in the northern part are open, but towards the south they become more closed, and farther south, above the big landslide, they appear strongly asymmetrical. Though broken by several faults, the folds have a general westerly trend.

The formations east of the area of Cambrian and earlier(?) rocks show remarkably little folding, as illustrated in structure-sections AB and CD. Dips are mainly to the east, and the axial planes of most of the minor folds that have been recognized dip to the east. Such features are, for example, exhibited by the crumpled, carbonaceous slates and limestones in Black Canyon Creek, which have been deformed into disharmonious folds distinctly overturned to the west. On Hematite Creek, however, the chert-bearing limestone has been pushed into open folds that rapidly change eastward into tight, vertical, chevron folds broken by steeply dipping faults.

The interbedded chert and slate formation underlying much of the Rogue River area has been folded into tight, isoclinal folds whose axes, in the eastern part, trend north 55 degrees west, and in the vicinity of Arrowhead Lake swing to the southwest. Other changes in trend have been described in connection with the structural relations of the granitic stocks. The constant, almost vertical dips around Arrowhead Lake and Old Cabin Creek suggest isoclinal folding, which is borne out, in detail, by small isoclinal drag-folds. The structure of the clastic sedimentary rocks overlying the cherts and slates is very irregular and could not be properly determined.

## FAULTS

### Thrust Faults

Several thrust faults occur in the northern Selwyn Mountains region, and appear to be most pronounced in the early Palaeozoic rocks east of the area underlain by formations of Cambrian and earlier(?) age around upper North Rackla River. The following features suggest their occurrence: (1) the constant easterly dip of the formations; (2) repetition of strata; for example, south of Corn Creek the sequence of slate, yellow and brown weathering limestone, and grey limestone is repeated without a change in dip, and similar repetitions of a succession of strata correlated with

those above are indicated south of Bonnet Plume River east of Kohse Creek. North of Pinquicula Creek, yellow and brown weathering limestone is overlain by grey limestone and overlies a succession of slates, yellow and brown weathering limestone, and grey limestone; (3) associated with the two features described above are small thrust faults, such as those that have displaced the diorite dykes on Iron Creek, where slickensides indicate a movement upwards and toward the southwest; for example, small thrusts occur in the carbonaceous slates and limestones that have been overturned to bring rocks on the east up and toward the west; and (4) the folded rocks are overturned mainly to the west and southwest.

As previously described in the section dealing with folds, small thrusts are associated with the overturned folds on each side of Selwyn Valley. East of the trench, some of the thrusts break through near the crests of the folds, whereas to the west they occur on the under limbs of the folds.

Keele (1906, p. 17) states that, above the forks of Rackla River the limestone and associated rocks are overthrust onto argillites believed to be of Triassic age. Such overthrusting is to be expected in association with the evidence for strongly overturned folds on lower North Rackla River.

### Normal Faults

Several normal faults have been recognized in the area mapped. Some of small displacement occur west of North Rackla River. Between Bonnet Plume and Snake Rivers, around Goz Lakes and Duo Creek, normal faults striking northwest are recorded by the relative displacement of a prominent red bed. Another, northwest trending normal fault occurs east of Snake River. Structure-section ED indicates the relative movement in which the quartzite beds east of the fault have been dropped from a higher position west of the fault.

A topographic depression that follows the southern contact between the flat-lying volcanic and folded sedimentary rocks outcropping between Rogue River and Old Cabin Creek is believed to mark the position of a fault contact. The volcanic rocks, which comprise the highest elevations of the mountains in this locality, appear to have been down-faulted on the south, so that the folded sedimentary strata stand topographically higher along a ridge leading south to Old Cabin Creek.

### Faults Whose Direction of Movement is Unknown

A prominent lineament appears on the mosaics of air photographs which is inferred to represent a fault separating the rocks of probable early Palaeozoic age from Ordovician(?) or Silurian cherts and slates.

Snake River Valley and Selwyn Valley mark the north-west trending linear boundary that abruptly separates folded rocks on the east from folded or flat-lying rocks of a different structural or lithological character to the west. It is possible that these valleys may be controlled by large faults of unknown displacement.

A small fault north of Rackla Lake brings grey limestone on one side against the overlying quartzite on the other, but the nature of the movement is not known.

### Summary

In summary, the structural pattern in the southern part of the area mapped, south of Bonnet Plume Lake, consists, in the east, of northwest trending folds overturned to the southwest and broken by small thrusts and, possibly, by large, persistent, north-west trending faults of unknown displacement. In the west, on the other hand, the pattern in its southern part is that of northeast trending, isoclinally folded rocks intruded and complicated by post-tectonic granitic stocks, and in its northern part by folds that swing to the northwest parallel with the structures along Selwyn Valley.

In the northern part of the area mapped, three distinct trends are revealed. West of Bonnet Plume Lake, west trending folds pass into gently dipping rocks that are, apparently, strongly overturned and possibly overthrust to the south. An area of relatively flat-lying beds separates the northwest trending, folded rocks east of Snake River from the northwest trending, apparently predominantly thrust-faulted rocks east of the area underlain by northeast trending strata of Cambrian and earlier(?) age. It is significant that the area in which thrust faulting is most common in the Palaeozoic rocks lies east and northeast of the area in which the rocks were deformed in pre-Ordovician, probably Cambrian time. The older mass may have exerted some effect upon the way in which the Palaeozoic rocks were deformed, as a result of which they failed more by thrust faulting than by folding.

## ECONOMIC GEOLOGY

### INTRODUCTION

Although, from time to time, prospectors have entered the Selwyn Mountains region, no mineral prospects have been explored nor mines developed within the area mapped.

Silver lead showings were described by Cockfield (1924, 1925) in the upper Beaver River area 40 miles west of North Rackla River, and the Hudson Bay Mining and Smelting Company have recently been exploring a base metal property in the vicinity of Fuller Lake south of the Canol Road near Macmillan Pass.

Camsell (1906, p. 23) described quantities of hematite float, found mainly with jasper or ferruginous chert, along Wind River and, most particularly, at the mouth of Bear River, and recorded a considerable deflexion of the compass in this area.

Keele (1906, p. 22) described float hematite in jasper observed near the forks of Rackla River, and also described (1910, p. 50) hematite on Keele (Gravel) River about 10 miles below the mouth of Natla River. The hematite is coarsely laminated with red siliceous slate, and occurs in a formation 50 to 100 feet thick interbedded between Cambrian(?) conglomerate and dolomite. The iron formation contained 25 per cent iron.

In general, the northern and central parts of the area mapped in 1952 seemed to indicate very little in the way of mineral deposits. The southern part, however, which contains granitic stocks, was regarded as more encouraging.

## METALLIFEROUS DEPOSITS

### Quartz Veins Associated with Diorite in the Northern Area

Many quartz veins, 4 inches to a foot wide and generally striking west and dipping steeply or vertically, contain specks of chalcopyrite and pyrite. The quartz, much of which is rusty, is vuggy and exhibits comb structure. A 3/4 pound grab sample taken from a quartz vein east of Kohse Creek assayed: gold, nil; silver, 0.03 ounce a ton. A 3/4 pound grab sample from a rusty and brecciated shear zone nearby assayed: gold, nil; silver, 0.04 ounce a ton.

Chalcopyrite and pyrite were seen to be sparsely disseminated through a small diorite body on Pinquicula Creek and in float from Black Canyon Creek.

No colours of gold were obtained from panning of the creeks in the northern part of the area.

### Iron Formation

As noted in describing the quartzite formation (map-unit 15), hematitic quartzite was found on Hematite Creek, 3 miles east of Pinquicula Lake, where a total of 12 to 14 inches of hematitic quartzite is distributed through a 700-foot section in bands 1 inch to 2 or 3 inches thick. These bands are in sharp, sinuous contact both parallel with and angling across the bedding of the quartzite. Under the microscope, a thin section from one of the bands shows subrounded to angular quartz grains of about 0.01 mm. that have apparently been partly replaced by hematite.

One hematitic band is regarded as having formed by the replacement of a permeable bed of breccia about 2 inches thick.

A 1 1/2-pound sample across 2 inches of hematitic quartzite contained 28.79 per cent iron, and a 1-pound sample from a block of float contained 33.85 per cent iron.

The hematitic quartzite bands were not located along their strikes above the drift and talus in the valley, and no hematitic float was seen in the nearest two eastern tributaries downstream on Hematite Creek.

At the top of the hematite-bearing section of quartzite and slate on Hematite Creek is a 1-foot bed of red-brown weathering, grey-brown siderite. A few feet higher in the section is a 1-foot bed of dense, grey limestone that contains rounded and irregular shaped patches of coarse-grained siderite. A thin section across the contact of a lens of siderite with the limestone reveals a fine-grained limestone containing a few rounded grains of quartz invaded by siderite grains, 3 mm. across, which replace the limestone but not the quartz grains. A 1/2-pound grab sample from the siderite-bearing bed contained 22.20 per cent siderite.

In contrast with the hematitic quartzite bands, however, the siderite bed swings northward and is exposed about 1,800 feet upstream, below the next forks. It was also traced southeastward over the intervening spur into the next creek to the east, a distance of about 4,000 feet and vertical range of 400 feet.

Judging by Camsell's description (1906, p. 23), the most favourable area in which to prospect for iron is up Bear River. The writer has found from experience, however, that float must be sought along the likely creeks and, once discovered, must be followed, if possible, to its source rather than pursue the practice of viewing mountains from a distance or from aircraft in the hopes of recognizing bands of iron formation. Red beds containing no hematite are too common in the area. The observed association of hematite with quartzite, may, however, be important. Quartzites comprising the higher peaks near the head of Bear River, as described by Camsell (1906, p. 22), were seen by the writer from the air on a flight up Bear River, past Gillespie Lake, to Bonnet Plume River.

#### Mineral Occurrences Associated with Granitic Stocks

Northwest of Emerald Lake, a carbonate vein containing lenses of the tungsten mineral, scheelite, outcrop within the trachytoid syenite near its northern contact. Parts of the vein are exposed in a jumble of talus at the east margin of the glacier beneath a 200-foot cliff, but the vein was not seen on the cliff above, owing probably to poor visibility at the time. In the talus, lenses 2 inches

wide and 6 inches long of pale brown scheelite were embedded in a coarsely crystalline carbonate vein about 6 inches wide. The wall-rock also contains disseminated scheelite, as revealed under fluorescent light.

In addition, quartz veins up to 4 inches wide containing lenses and veinlets 1/2 inch to an inch wide of pyrrhotite, some chalcopyrite, and pyrite cut the syenite. The wall-rock also contains scattered grains of these metallic minerals and a little molybdenite and arsenopyrite.

A 3-pound grab sample from one of the quartz veins assayed: gold, trace; silver, 0.18 ounce a ton; copper, 0.31 per cent; and nickel, 0.06 per cent.

In the short time available, no mineral occurrences were observed in or around the quartz diorite stocks, except the abundant pyrite within the rusty weathering metamorphic halo surrounding each stock. Nevertheless, only a small part of these bodies and their borders was visited, and it is felt that the areas within these metamorphic haloes should be favourable ground for prospecting.

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EDMOND CLOUTIER, C.M.G., O.A., D.S.P.  
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY  
OTTAWA, 1954.