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GEOLOGICAL SURVEY

PRELIMINARY REPORT

NORTHWEST QUARTER OF THE
FORT FRASER MAP-AREA, B. C.

BY
J. E. Armstrong

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NORTHWEST QUARTER OF THE FORT FRASER MAP-AREA, B.C.

By J.E. Armstrong

INTRODUCTION

Fort Fraser map-area (west half) lies in central British Columbia between latitudes 54 and 55 degrees north, and longitudes 125 and 126 degrees west. The area was geologically mapped during the summers of 1936 and 1937. A preliminary report on the area south of Babine Lake was issued in 1937¹.

¹ Preliminary Report on the West Half of the Fort Fraser Map-Area, B.C., Paper 37-13, 1937; Geol. Surv., Dept. of Mines and Resources.

This report is concerned primarily with that part of the area north of Babine Lake.

Babine Lake may be reached by wagon road, either from Burns Lake or Topley, on the Canadian National railway, 151 and 185 miles, respectively, west of Prince George. The road from Burns Lake branches 11 miles north, at Pinkut Lake, one branch leading north 10 miles to Donald Landing, and the other northeast 16 miles to Silver Island Landing. This road is suitable for automobile travel as far as Pinkut Lake. The road from Topley to Babine Lake is 24 miles long.

The north arm of Stuart Lake, Trembleur Lake, and Middle River are accessible by water routes from Fort St. James at the foot of Stuart Lake. Fort St. James is reached by a good motor road 41 miles long, from Vanderhoof, on the Canadian National railway 69 miles west of Prince George. Motor launches from Fort St. James take 20-ton scows to Trembleur Lake and Middle River via Stuart Lake and Tache River. Babine Lake may be reached by an 8-mile portage from the Indian village of Nacoochie (Stuart Portage) on the north arm of Stuart Lake. A 4-mile portage connects Cunningham Lake with the north arm of Stuart Lake. To facilitate the transport of supplies over these portages wagons and teams may be hired at the Indian villages of Nacoochie and Babine Portage. The country is well provided with trails over which pack horses could be taken, but horses are not available within the area and it would be difficult to take them in because of the large lakes

to be crossed.

The area is heavily forested below 5,000 feet in elevation with spruce, balsam, jack pine, and poplar.

Trout and whitefish occur abundantly in all the lakes, and salmon are found in Babine Lake. Moose, deer, and black bear are plentiful. Game birds to be found are grouse and ptarmigan.

The only settlements within the area are the Indian villages of Donald Landing, Babine Portage, Nacoochie (Stuart Portage), and Middle River, and except for a few white settlers on Babine Lake there are no other inhabitants.

Normally, prospecting could be carried on from the middle of April to the middle of October, but during the rest of the year the snowfall is too heavy and the temperature too low.

The first geological mapping of any part of the area was done in 1879 by G.M. Dawson, who made an exploration survey along Babine and Stuart Lakes¹. In 1915 a reconnaissance survey was made

¹ Report on an Exploration from Port Simpson on the Pacific Coast to Edmonton on the Saskatchewan Embracing a Portion of the Northern Part of British Columbia and Peace River Country; Geol. Surv., Canada, Rept. of Prog., 1879-80, pt. B, pp. 106-107.

by C. Camsell along part of Trembleur Lake and Middle River².

² Exploration in the Northern Interior of British Columbia, Geol. Surv., Canada, Sum. Rept. 1915, pp. 70-75.

PHYSICAL FEATURES

The map-area lies mainly in the northwest corner of the Northern Interior Plateau, but it also embraces a small part of the mountain region that borders the plateau to the north. Although spoken of as a plateau much of the area is not a true plateau, but a transition zone between mountain country and plateau, the average relief being from 1,500 to 2,500 feet, with peaks rising 4,000 feet

above the valley bottoms in the Middle River Range. The valleys are wide with fairly flat bottoms, with an average elevation above sea-level of 2,200 to 2,700 feet. This region contains innumerable lakes ranging in size from mere ponds to Babine Lake, the largest in the province.

In the areas underlain by Carboniferous sedimentary and volcanic rocks the hills have gradual, unbroken slopes and rounded summits. Outcrops are usually small and do not project above the surface. The ridges underlain by Carboniferous rocks strike approximately northwest-southeast in conformity with the axis of deformation of these rocks. In the areas underlain by intrusives the hills have broken slopes, in many places taking the form of a series of ridges, each 100 to 200 feet high, and rising higher and higher until the summit is reached. The summits have a castellated appearance, due to numerous large outcrops having cliff-like slopes, and projecting 50 to 100 feet above the general elevation. The high peaks of the Middle River Range are underlain by batholithic rocks.

The hills made up of Tertiary lavas commonly have long, gradual, gently sloping tops and steep sides.

GENERAL GEOLOGY

The oldest rocks in the area are presumably of Carboniferous age, and consist of sedimentary, extrusive, and metamorphic types. They are divided into three divisions: a lower group of chert, argillite, slate, and minor amounts of greenstone and limestone; a middle group of greenstone, and minor amounts of chert, argillite, slate, and limestone, which conformably overlies the preceding group; and an upper group of massive limestone, and minor amounts of chert, argillite, and greenstone. The bedded members of the Carboniferous strike northwest and have been tightly folded, the dips normally being steep. The Carboniferous rocks have been intruded by Mesozoic (?) batholithic masses, stocks, sills, and dykes, ranging in composition from ultrabasic to acidic. These various intrusives may represent different phases of a continuous period of igneous activity. Near the borders of the acid batholiths and stocks the Carboniferous rocks have been metamorphosed to gneisses, schists, and banded, foliated, and recrystallized types. The ultrabasic rocks, now in all stages of serpentinization, were originally peridotites, dunites, and pyroxenites. The serpentine rocks in places have been altered to carbonate-quartz-mariposite and carbonate-talc rocks. Associated with the ultrabasics are less basic gabbroic and diabasic intrusives. The bodies of granite, granodiorite, syenite, and diorite are the more acidic and later representatives of this period of continuous igneous activity.

Unconformably overlying the Mesozoic (?) acid intrusives is a group of Mesozoic (?) andesitic flows and fragmental rocks. Rhyolitic dykes and stocks were injected at a late stage in this period of vulcanism. The Tertiary rocks in the area are nearly horizontal, amygdaloidal, and vesicular lava flows. Related to these lava flows are andesitic and basaltic dykes. Several isolated patches of conglomerate unconformably overlie the Tertiary lavas. Much of the area has been glaciated, resulting in a mantle of glacial material in the lower parts, and a rearrangement of the drainage.

Table of Formations

Pleistocene and Recent		Recent alluvium and glacial drift Calcareous tufa	
(?)		Conglomerate	
Tertiary		Andesitic and basaltic dykes	
		Vesicular and amygdaloidal, andesitic, basaltic, and dacitic lava flows; flow breccia, and feldspar porphyry	
Mesozoic (?)	Volcanics	Rhyolitic dykes, stocks, and flows	
		Andesite breccia, andesite, basalt, and related porphyry	
	Acid Intrusives	Microcline granite, albite granite, muscovite granite, granodiorite, syenite, hornblende diorite, augite, diorite; and related dykes	
	Basic Intrusives	Peridotite, pyroxenite, dunite, gabbro, diabase, serpentine, carbonate-quartz-mariposite rock, carbonate-talc rock, serpentine schist, and amphibolite	
	Group 3	Massive limestone, and minor amounts of chert, argillite, and greenstone	
	Group 2	Andesite greenstone, and minor amounts of chert, argillite, and limestone	Metamorphosed equivalents of groups 1 and 2; gneiss, schist, banded foliated sediments, amphibolite, foliated greenstones, and recrystallized limestone
Carboniferous		Group 1 Chert, argillite, slate, and minor amounts of greenstone and limestone	

Carboniferous

At least one-quarter of the map-area is underlain by rocks mapped as Carboniferous. Sedimentary, extrusive, and metamorphic types are all well represented. The close folding and extensive faulting of these rocks makes it impossible to determine their exact stratigraphic sequence, and, therefore, the summarized section below is merely an attempt to indicate the general order of succession. It is also impossible to make more than a rough approximation of their total thickness or of that of the various groups, but the estimates given below indicate the relative amount of each group. The order is descending, group 1 being the oldest.

	Maximum Thickness	Areal Extent
Group 3 Massive limestone, and some intercalations of argillite, chert, and andesite greenstone	Feet 4,000 +	50 square miles (90 per cent limestone)
Group 2 Andesite greenstone with minor amounts of argillite, chert, and limestone	10,000 +	150 square miles (90 per cent greenstone)
Group 1 Chert, argillite, and slate with some andesite greenstone, and minor amounts of limestone	10,000 +	150 square miles 40 per cent chert 40 " " argillite and slate 15 per cent greenstone 5 " " limestone
Total thickness	24,000 +	

J.G. Gray has traced the Carboniferous rocks along their strike from the west half of the Fort Fraser map-area into rocks along the shores of Stuart Lake assigned by G.M. Dawson^{1,2} to the

¹ Report on Exploration in British Columbia, Geol. Surv., Canada, Rept. of Prog. 1876-77, pt. B, pp. 55-57 (1878)

² Report on an Exploration from Port Simpson on the Pacific Coast to Edmonton on the Saskatchewan; Geol. Surv., Canada, Rept. of Prog. 1879-80, pt. B, p. 106 (1881).

Lower Cache Creek series of Carboniferous age. Dawson bases his conclusions as to their age upon the occurrence of Fusilinæ and crinoid stems in the limestones of Pope Mountain. The writer collected fossils from the limestones outcropping along the south shore of Kazchek Lake, and this collection was reported on by F.H. McLearn of the Geological Survey as follows: "This lot contains a variety of crinoid stems. They may be of Palæozoic age, but I do not feel I can make a dating on the basis of these fossils".

Group 1. The most extensive occurrences of this group are found along the shores of Stuart, Trembleur, and Cunningham Lakes, and in the Middle River Range, and in areal extent they occupy 150 square miles.

The cherts, which are the most characteristic rocks of the group, are generally blue-grey, but range in shade from cream-grey to black, and in places are pale green. They are fine-grained, and are thinly bedded, the beds being only $\frac{1}{2}$ to 2 inches thick with thin partings of argillaceous material between them. Only very rarely do the argillaceous partings equal the chert beds in thickness. In many localities the partings have been metamorphosed to mica schist. The cherts are greatly crumpled.

Besides the argillaceous partings separating the thin beds of chert, argillite and slate, in thicknesses ranging from 100 to 3,000 feet or more, are interstratified with the cherts. These argillites and slates are grey to black, but where iron minerals are present they weather to shades of brown and red. They commonly contain much carbonaceous material, which gives them a lustrous appearance. These argillaceous sediments in many places have a blocky appearance, due to jointing in three directions, two nearly vertical, and one nearly horizontal.

On the southeast slope of Tsitsutl Mountain, bands of limestone up to 150 feet wide occur interbedded with the argillites, slates, and cherts.

Along the shores of Trembleur Lake, interstratified with the cherts, argillites, and slates, are andesite greenstones up to 500 feet thick.

Group 2. This group, which is composed of andesite greenstone with interstratified beds of argillite, chert, and limestone up to 200 feet thick, overlies conformably and grades by interbedding into group 1. The rocks of this group occupy about 150 square miles, the larger areas occurring near the east end of Babine Lake, west of Cunningham Lake, and at the west end of Trembleur Lake. This group attains a maximum thickness of 10,000 feet near Babine Lake.

The andesite greenstones are fine-grained, grey-green to dark green rocks. They normally show a rough foliation of the mineral constituents, and where the deformation has been intense they have been changed to hornblende and to chlorite schists.

Intrusive bodies of serpentine and pyroxenite up to 500 feet wide and of unknown length occur in the greenstones, and the writer believes they are related to the younger basic rocks described elsewhere in this report.

Group 3. This group is composed of massive limestone with some intercalations of argillite, chert, and andesite greenstone. East of Middle River it reaches a maximum thickness of 4,000 feet or more. West of Trembleur Lake these limestones conformably overlie the greenstones of group 2.

Mount Copley is composed entirely of massive, grey limestone forming part of a great limestone band, 5 or more miles wide, that extends southeast to Pope Mountain, Stuart Lake, and northwest to Takla Lake. This limestone band was noted by A.C. Selwyn in 1875¹ who described it as follows: "From the summit,

¹ Report on Exploration in British Columbia in 1875, Geol. Surv., Canada, Rept. of Prog. 1875-76, p. 78 (1877)

known as "Pope's Cradle",, this great limestone band can be traced by the eye, forming a broad belt of white rocky ridges, or isolated hills, for a distance of not less than thirty-five or forty miles on a bearing E.S.E., and W.N.W. Looking down upon it from Pope's Cradle, it has the appearance of a hogged-back rugged and broken ridge, winding through the country". This grey limestone generally weathers to a paler grey or white, and in many places has a very irregular surface due to the presence of silicified portions that stand out on the weathered surface. The limestone, which occupies an area of 15 square miles at the west end of Stuart and Trembleur Lakes, is usually crystalline and dark in colour, some being black due to the presence of a large amount of argillaceous material.

Metamorphism. The Carboniferous rocks are metamorphosed at and near their contacts with the larger bodies of Mesozoic (?) acid intrusives. These contact zones of metamorphic rocks vary in width from 500 yards to 2 miles, the widest being found around the acid intrusives outcropping near Babine Lake. In these zones the thinly bedded cherts are bleached and recrystallized, and their argillaceous partings are changed to biotite. The argillites are metamorphosed to slate, graphite schist, biotite schist, and quartz-biotite schist, and the limestones are recrystallized. The andesite greenstones have been changed to chlorite and hornblende schists.

The zone of metamorphism around the granodiorite body north of Stuart Lake is representative of the above. The order of occurrence there is as follows:

Approaching the granodiorite ↓	Argillite)	Zone one mile wide
	Slate)	
	Graphite schist)	
	Biotite schist)	
	Quartz biotite schist)	
	Augen gneiss)	
	Granodiorite		

Intricately folded hornblende-feldspar gneisses and banded sediments are exceptionally well developed near the Radio Gold Mine property. The Carboniferous rock types from which these were formed is uncertain.

Mesozoic (?) Basic Intrusives

Peridotites, dunites, and pyroxenites in all stages of serpentization are found in the map-area. Associated with them are less basic gabbroic, diabasic, and dioritic differentiates. These basic intrusives normally have gradational contacts with one another. Areas of greenstone and amphibolite, up to 5 square miles in extent, thought to be of Carboniferous age, are so intimately intruded by basic rocks that they could not be mapped separately.

Two large areas of these basic intrusives are present in the map-area. One, covering an area of 65 square miles, extends northward from Cunningham Lake to near Trembleur Lake, and the other with an areal extent of 160 square miles includes the greater part of the Middle River Range, and extends northwest from Trembleur Lake to the northern extremity of the map-area. A body of peridotite 80 square miles in area underlies the Mount Williams group of mountains and extends southward to Trembleur Lake. Another large body of peridotite, 40 square miles in extent, lies between Stuart and Cunningham Lakes. Bordering this peridotite mass are three areas of pyroxenite and gabbro, ranging in size from 5 to 10 square miles each. The largest body of gabbro and diabase is 35 square miles in extent and underlies Deescius and Tsitsutl mountains. Several bodies of peridotite up to 2 square miles in area occur in this gabbro, diabase body.

The peridotites are dark green, medium-grained rocks, that weather to bright orange and reddish brown. They are composed of olivine, with a minor amount of pyroxene, the pyroxene crystals standing out on the weathered surface. The dunites form irregular masses, $\frac{1}{2}$ to 2 square miles in size, in the peridotites. They are dark green to black, medium-grained rocks composed of olivine.

The pyroxenites are coarse-grained rocks and are composed essentially of pyroxene, although they contain some basic feldspar and grade into gabbro. They are dark green and weather to brownish and reddish tints.

The peridotites, dunites, and pyroxenites have all undergone partial or complete alteration to serpentine, and it is in many cases impossible to ascertain the original composition of the rock. The serpentine is olive or emerald green and is normally of the variety antigorite, although veins of the columnar variety picroilite are found in some localities.

These serpentized rocks are commonly traversed by numerous shearing planes along which light green serpentine has been developed. Between the shearing planes the rock is broken and rounded into ellipsoidal fragments, $\frac{1}{8}$ inch to 3 feet in diameter, each ellipsoid consisting of dark green serpentine free from shearing. This feature is best seen on the weathered surfaces.

In the area lying between Trombleur Lake and Mount Williams about 10 per cent of the serpentized peridotites have been altered to carbonate-quartz-mariposite, and carbonate-talc rocks. These altered rocks occur in fractured zones ranging in width from 10 to 500 feet, separated by zones of unaltered serpentized peridotites of approximately the same width. The largest quantity of such rocks was observed along Mount Williams ridge where they were traced for more than 2 miles.

The carbonate-quartz-mariposite rocks are buff to yellow-brown, and medium to coarsely crystalline. They are composed of buff-coloured ankeritic carbonate, quartz, and the bright green chrome-bearing mica mariposite, erroneously thought by many of the prospectors in the region to be a copper mineral. These rocks are intersected by a network of quartz stringers.

The carbonate-talc rocks are less abundant than the carbonate-quartz-mariposite rocks. They have a greasy feeling, are greenish buff in colour, and are composed of 40 per cent ankerite carbonate, and the remaining 60 per cent of talc. The high per cent of talc imparts to them a dense appearance. Both types of altered rocks contain specks of pyrite and chalcopyrite.

The gabbros and diabase are medium-to coarse-grained, dark green rocks consisting essentially of pyroxene (diplago) and a basic plagioclase feldspar. The pyroxene is usually partly altered to hornblende, and the feldspar to zoisite and saussurite.

The amphibolites are dense to fine-grained, pistachio to dark green rocks composed of hornblende, epidote, and saussurite. They normally have a crude foliation.

The Mesozoic (?) basic intrusives intrude the Carboniferous rocks. In the Middle River Range the basic intrusives are cut by a body of granite, and south of Stuart Lake they are cut by stocks of augite diorite, and syenite. In no place were the basic intrusives seen to cut the Mesozoic (?) acid intrusives or younger rocks.

Mesozoic (?) Acid Intrusives

The rocks grouped here are of many different types, and occur as batholithic masses and stocks.

The largest body of these rocks extends northeasterly from Babine Lake to Stuart Lake and is 80 square miles in area. Diorite is the normal type, but with the addition of quartz and biotite it grades into quartz diorite. The rocks are medium- to coarse-grained, green rocks characterized by abundant hornblende. Stringers of epidote cut them everywhere. The rocks in many places show well-developed foliation, which strikes northwest conforming with the strike of the Carboniferous rocks they intrude. Jointing in three directions, two nearly vertical and one nearly horizontal, is prevalent. Similar rocks occur near the Taltapin and Radio mines.

A body of muscovite granite occupies 27 square miles north of Sixteenmile Creek. It is a coarse-grained, white rock composed of quartz, feldspar, and white mica. As it grades into diorite, and as no sharp contact with the diorite has been observed, both it and the diorite may represent different phases of the same body.

An irregular area of intrusive rocks, 20 square miles in size, lies northeast of Wright Bay, Babine Lake. It is occupied by granite in its western half, and by albite syenite in the eastern half. Normally the granite is a grey, medium-grained, non-porphyrific rock containing considerable grey-green feldspar. But all gradations between grey, pink, and white varieties are found. The pink variety is coarse-grained, porphyritic, and composed of pink and white feldspar, quartz, biotite, and hornblende. The pink feldspar usually forms large crystals up to 2 inches in size; whereas the white feldspar along with the quartz forms the base of the rock. Locally this pink granite is foliated, the strike of the foliation being north 50 degrees east. The white granitic rocks are non-porphyrific, medium- to fine-grained, and contain very little pink feldspar. Stringers and spots of epidote are present in all the varieties.

The syenite is a medium-grained, grey-brown rock, that weathers to a reddish brown due to the presence of considerable pyrite. It is composed predominantly of albite and a minor amount of hornblende.

A body of granodiorite occupies 16 square miles north of Stuart Lake. It is a medium-grained white rock composed of white feldspar, quartz, and biotite. Jointing in three directions, two vertical and one horizontal, is well developed. This granodiorite body has not been completely unroofed, so that roof pendants and inclusions of metamorphosed Carboniferous rocks are common in the area.

A body of granite, 25 square miles in area, cuts the Carboniferous rocks in the Middle River Range. It is a medium-grained grey to white rock composed of albite, quartz, and a little biotite. Contact phases of syenite are found. As in many of the other granitic rocks in the area jointing is well developed in three directions, two being vertical as elsewhere, but the third direction instead of being horizontal is at an angle of 45 degrees to the horizontal.

Stocks of albite syenite and augite diorite outcrop south of Redrock Lake, and west of Stuart Lake, respectively.

The acid intrusives intrude the Carboniferous rocks and Mesozoic (?) basic intrusives, and are overlain by volcanics believed to be pre-Upper Eocene.

Dyke Rocks

Dyke rocks believed to be related to the Mesozoic (?) acid intrusives cut the Carboniferous strata, and in places cut the acid intrusives. Along the shores of Trembleur Lake numerous grey to buff, fine- to medium-grained, porphyritic and non-porphyritic, granitic dykes, varying in width from 6 inches to 100 feet, can be seen cutting the Carboniferous strata. They are composed of quartz, feldspar, and minor accessory minerals, pyrite in many cases being conspicuous.

Grey-green to dark green, aphanitic to fine-grained, porphyritic and non-porphyritic lamprophyre dykes, up to 10 feet wide, cut the diorite body north of Babine Lake, and the granite body in the Middle River Range. Associated with these lamprophyres are aplite dykes, varying in width from an inch or two to one foot.

Near Babine Lake, and especially in the vicinity of the Radio Gold Mine property, the Carboniferous greenstones are cut by fine-grained, dark greyish green diorite dykes 10 or more feet in width. In places these dykes are so numerous they make up about 25 per cent of the outcrops.

Mesozoic (?) Volcanics

These volcanic rocks may be divided into two divisions: (1) andesitic flow and fragmental rocks; and (2) rhyolitic rocks cutting the andesitic rocks.

Andesitic Rocks The best exposures of the andesitic rocks are found along the ridge lying between Wright Bay, Babine Lake, and Tochcha lake. The most characteristic member of this division is a green or purple eruptive andesite breccia that weathers to a much lighter shade. Most of the fragments are andesite, but fragments of rhyolite, chert, granite, and feldspar also occur. The fragments vary in size from 1/16 inch to 6 inches in diameter and are embedded in a green or purple glassy matrix. On the north side of Tochcha Lake a purple andesite flow breccia composed of fragments of andesite in a hematitic matrix is found. Near it a dark green, epidotized, augite andesite flow breccia outcrops. These breccias on the north side of Tochcha Lake have been correlated with those south of the lake on the basis of lithological similarity only and they may be of different ages.

The eruptive andesite breccia lying between Wright Bay and Tochcha Lake is interbedded with flows of dark green to black, porphyritic augite andesites. These **andesite** flows weather reddish brown and contain phenocrysts of augite up to 1/8 inch in length. Of a lesser areal extent are interbedded flows of red, purple, and lavender, porphyritic trachytes and andesites. They contain phenocrysts of white feldspar up to one-quarter inch in length set in a hematitic groundmass.

These andesitic flow and fragmental rocks exceed 1,000 feet in thickness.

Rhyolitic Rocks The only locality in which flows of rhyolite were observed was along the shore of Wright Bay (Babine Lake) where they overlies conformably flow rocks of the andesite division. These rhyolite flows are dense, non-porphyritic, banded, pinkish brown rocks.

Intrusive bodies of rhyolite varying in size from dykes 3 to 10 feet wide to stocks $\frac{1}{4}$ mile in diameter are found throughout the map-area cutting the older rocks and members of the andesite division, but in no place cutting the Tertiary lavas. The two largest stocks are exposed on Silver Island and Tsitsutl Mountain and dykes are especially abundant near Taltapin Mountain. These rhyolite intrusives are dense, porphyritic, white and buff rocks. They contain phenocrysts of colourless quartz and white feldspar from one-eighth to one-quarter inch in diameter, in a dense feldspathic base.

Both the andesite and rhyolite divisions are younger than the granitic rocks found outcropping in the same localities. They directly overlie the granitic rocks, contain fragments of them, and the intrusive members of the rhyolite division cut the granitic rocks.

Tertiary Lavas

Tertiary lavas occur as large areas south of Babine Lake, and to a lesser extent north of the lake. These rocks are chiefly green, red, brown, and black, dacitic, andesitic, and basaltic, amygdaloidal, and vesicular lava flows, which are in places as much as 2,000 feet thick. Chalcedonic quartz, cream-coloured calcite, pectolite, prehnite, and zeolites fill the amygdules.

Interbedded with these vesicular flow rocks are breccias, and columnar basalts. The breccias are of two distinct types: (1) an andesitic flow breccia in which angular fragments of a brown vesicular andesite are embedded in a glassy matrix; and (2) an acid flow breccia composed of small, angular fragments of andesite, chert, quartz, jasper, feldspar, and granite in a glassy green matrix. Along the north shore of Babine Lake, west of Sixteenmile Creek, several outcrops of columnar basalt occur in which six-sided columns are well developed. The mountain at the east end of Babine Lake is composed of pitch black, compact, olivine basalt in which there are a few scattered vugs containing prehnite and zeolites.

These rocks are placed in the Tertiary because in the southern part of the Fort Fraser map-area they unconformably overlie Upper Eocene sediments,¹ and are overlain in places by glacial drift.

¹ Preliminary Report on the West Half of the Fort Fraser Map-Area, B.C., Paper 37-13, 1937, Geol. Surv., Dept. of Mines and Resources, pp. 14 and 16.

Tertiary Dyke Rocks

On the north and west slopes of Taltapin Mountain, and close to the areas of Tertiary lavas near the east end of Babine Lake, andesitic and basaltic dykes related to the Tertiary lavas are abundant. They are dark green, fine-grained, hard rocks commonly impregnated with pyrite.

Conglomerate

A poorly consolidated conglomerate has been found in two localities. Five miles west of Mount Williams it is exposed over an area $\frac{1}{4}$ square mile in extent, and 2 miles south of the west end of Trembleur lake an exposure 100 yards square is found. In both cases the exposures unconformably overlies Tertiary lavas.

The conglomerate is made up of pebbles and boulders ranging in size from $\frac{1}{4}$ inch to 2 feet in diameter. The pebbles and boulders are fairly well rounded and consist mainly of amygdaloidal and vesicular andesite, granite, greenstone, serpentine, and chert. The matrix, which is very crumbly, is siliceous. The thickness of this conglomerate is unknown, but it does not exceed 200 feet.

Calcareous Tufa

Along the north shore of Trembleur Lake calcareous tufa has been deposited by springs along fissures in the argillites. Individual deposits are from 3 to 6 inches thick, and 10 to 25 square feet in area. The tufa is a white to buff, porous rock composed of calcite and fragments of argillite around which the calcite has been deposited.

ECONOMIC GEOLOGY

Only a limited amount of prospecting has been done in the map-area north of Babine Lake, and until recently mineral claims had been developed only south of this lake. The properties near Babine Lake are: the Taltapin group, the Radio Gold Mine, Limited, and the Silver Island Mining Company. As these properties were described in detail in the report¹ on the area south of Babine Lake,

¹ Preliminary Report on the West Half of the Fort Fraser Map-Area, B.C., Paper 37-13, 1937; Geol. Surv. Dept. of Mines and Resources, pp. 17 and 19 to 23.

and as little further information regarding them has been obtained only a brief synopsis of them will be given here.

Taltapin Group

This group consists of the Silver Fox and six adjoining claims. The mineral deposits are narrow (2 inches to $3\frac{1}{2}$ foot wide) irregular veins, and consist of galena, chalcopyrite, sphalerite, pyrite, tetrahedrite, and a little white mica in a quartz gangue. The mineral deposits occur in andesite greenstones of Carboniferous age. The greenstones are intruded by a medium-grained, grey granodiorite. The most favourable showings are on the Silver Fox claim where veins occur close to (150 feet), and on both sides of, a tongue of granodiorite 200+feet wide. East and south of the Silver Fox claim less favourable showings occur in roof pendants of greenstone, 200+feet in diameter, in the granodiorite. The chief values are in silver, lead, and zinc.

Radio Gold Mines Limited

The showings occur at the contact of metamorphosed Carboniferous rocks and a body of granodiorite and diorite. Several, large, irregular lenses of glassy quartz carrying very minor amounts of pyrite, chalcopyrite, and molybdenite are exposed in the metamorphosed Carboniferous rocks (gneisses, schists, and banded foliated sediments). These quartz lenses attain a maximum size of 20 to 30 feet thick and 100 to 200 feet long. Elsewhere on the property there is much epidote, magnetite, and bronze-coloured pyrite scattered throughout the country rock. Assays indicate only small amounts of gold and silver.

Silver Island Mining Company

The veins occur near the contact of a rhyolite stock with a body of diorite. The mineral deposits, which are narrow fissure veins (1 to 6 inches wide) in the diorite, consist of tetrahedrite (grey copper), argentite, native silver, and small amounts of galena, sphalerite, chalcopyrite, pyrite, malachite, and azurite in a gangue of calcite, barite, and quartz. Assays of samples from these narrow veins show a silver content of 9 to 693 ounces a ton.

Boling Property

This property is situated at Boling Point, on the north side of Babine Lake. At the time the writer visited the property the prospecting adits that had been driven were caved in, and as there were no showings at the surface an examination was not possible. The property is located in an area of foliated Carboniferous greenstones approximately one-quarter mile from a diorite body.

Asbestos Showings

At the head of Peters Creek on the north slope of Mount Williams a deposit of chrysotile asbestos occurs in a body of serpentized peridotite. Outcropping at the surface is a zone of asbestos approximately 25 feet wide, which is traceable for 100 feet before it disappears under the talus. In this zone are stringers of asbestos from $1/8$ inch to $1\frac{1}{2}$ inches wide and from $1/8$ inch to 1 foot apart. Stringers $\frac{3}{4}$ inch or more wide may commonly be traced for 25 feet. The asbestos consists of minute fibres arranged parallel to one another, and at an angle of 60 to 90 degrees to the walls. The asbestos stringers have clearly defined walls. In a few cases the asbestos fibres run from wall to wall of the stringers without a break, but normally the stringers have a parting within them. In some cases the parting is parallel to the walls of the stringers, but commonly it takes an irregular position. The whole zone contains about 5 per cent asbestos.

The fibre is brittle and of poor commercial quality. As the rocks are deeply weathered, there is no doubt that the fibre has sustained some injury during surface alterations. The fact that the fibre is brittle here does not necessarily mean that fibre that may occur elsewhere in the vicinity would also be brittle, as in the Eastern Townships of Quebec both types (brittle and flexible) are found in close proximity to one another.

Two miles northwest of the showing described above a deposit of tremolite asbestos is found. Three veins, each 4 to 10 inches wide, and 200 feet apart, occur in a body of serpentized peridotite. The veins could only be traced about 20 feet to where they disappeared under the talus. The fibres extend from wall to wall of the veins, and are very brittle. Associated with this tremolite asbestos are veins of picrolite serpentine. This deposit has no commercial value as it is too small and the asbestos is of a very inferior grade.

Altered Serpentine Rocks

In view of the fact that prospectors had reported values in gold from the carbonate-quartz-mariposite and carbonate-talc rocks, samples were submitted to the Bureau of Mines to be assayed, and the following results were returned:

- Sample No. 1. Carbonate-quartz-mariposite rock from the north slope of Mount Williams: gold, trace; silver, 0.12 ounce a ton.
- Sample No. 2. Carbonate-quartz-mariposite rock from about one mile east of Mount Williams: gold, trace; silver, 0.01 ounce a ton; copper, trace; nickel, 0.07 per cent.
- Sample No. 3. Carbonate-talc rock from the north shore of Trembleur Lake 6 miles west of Middle River Village: gold, trace; silver, 0.01 ounce a ton.
- Sample No. 4. Carbonate-quartz-mariposite rock, high in quartz (75 per cent), from an outcrop 3 miles up Baptiste Creek: gold, 0.035 ounce a ton; silver, 0.07 ounce a ton; chromium, none.

Other Mineral Showings

Throughout the map-area numerous veins of white quartz, up to 10 feet wide, cut the Carboniferous rocks, and the Mesozoic (?) acid and basic intrusives. The veins are barren though exhibiting a little copper and iron stain.

On the south slope of Tsitsutl Mountain pyrite and chalcopyrite in very small amounts have been formed in a band of limestone near its contact with a granite body.

Placer Deposits

A little placer gold has been found in Peters Creek and claims have been staked there, but as the values seldom ran more than four to five colours a pan little work was done. A few nuggets valued from 50 cents to \$2 have been found in Peters Creek.

Gold colours have been obtained on panning several other creeks flowing out of the Middle River Range, but as yet sufficient values have not been obtained to encourage further work.

Prospecting Possibilities

As some of the veins exposed in the Topley map-area lie close to rhyolite intrusives, and as the silver-lead mineralization at Silver Island occurs at the contact of a rhyolite body with an older body of diorite, it is possible that other mineral deposits may occur near the contact of some of these bodies of rhyolite intrusives with older rocks elsewhere in the map-area.

The Taltapin silver-lead property occurs in Carboniferous greenstones near the contact of a granodiorite body. The Radio Gold mine is located at the contact of metamorphosed Carboniferous rocks and a body of granodiorite and diorite. The Boling property is underlain by Carboniferous greenstones near a diorite body. On the south slope of Tsitsutl Mountain pyrite and chalcopyrite have been formed in a band of Carboniferous limestone near its contact with a granite body. In view of the above facts the Carboniferous rocks near the borders of the Mesozoic (?) acid intrusives would appear to be favourable to future prospecting.

The showings of asbestos observed in the peridotite body on the north slope of Mount Williams indicate that asbestos of good quality and perhaps in quantity may be present in the serpentized peridotites outcropping between Cunningham and Stuart Lakes and in the Middle River Range. Chromite is another mineral to be looked for when prospecting the peridotites as it is associated with these rocks. The platinum group of minerals are associated with basic igneous rocks, so when panning the streams flowing through areas of these rocks a careful watch should be kept for indications of this group of minerals.