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WHITESAIL LAKE MAP-AREA, BRITISH COLUMBIA

(REPORT AND MAP)

By

S. Duffell

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INTRODUCTION

Whitesail Lake map-area lies between latitudes 53° and 54° and longitudes 126° and 128° in the Coast district of British Columbia. It occupies about 6,000 square miles, and forms a large part of the storage basin being utilized in the power developments of the Aluminum Company of Canada for its aluminium production plant at Kitimat on the west coast. Included within the area is the greater part of Tweedsmuir Provincial Park, and the general region is well known to tourists who have come to visit this natural playground.

Access to the area is normally by road from Burns Lake, on the Prince Rupert line of the Canadian National Railways, to Ootsa Lake. A good gravel road follows the north shore of the lake from Ootsa Landing to Wistaria, thence northward to the head of François Lake, where it connects with the road along the north shore of that lake. During the summer of 1951, the Aluminum Company of Canada constructed an all-weather gravel road from the head of François Lake to Tahtsa Lake, and built roads a short distance up Kemano Valley and the valley of Horetsky Creek. Numerous farm and logging roads traverse the northeastern corner of the area, but elsewhere roads are non-existent. Trails are few except in that part of the area between Ootsa and Eutsuk Lakes, where there are several. On Chikamin Range a good trail extends from a deep bay on Whitesail Lake, just west of Zinc Bay, to a cabin at timber-line about 1,750 feet above the level of the lake. From the head of Whitesail Lake a good trail leads to the Harrison gold property on Lindquist Lake, and there is a trail up Swing Peak from a point on Tahtsa River called Copps Cabin. Transport within the area is mainly by boat along the rivers and lakes, and by pack-train. In the Coast Mountains proper, resort must be made chiefly to back-packing. Aircraft may be used to advantage in most parts of the area because of the many lakes available for landing. Central B.C. Airways maintains a base at Burns Lake for service in this part of the country.

Physiographically the area includes parts of both the Nechako Plateau and the Pacific Ranges of the Coast Mountains. The long, narrow lakes, such as Tahtsa, Whitesail, Morice, and Eutsuk, all head within the eastern border of the Coast Mountains but have their outlets within the plateau region. Near the heads of these lakes both shores are flanked by northeast trending ranges, which appear to represent a transition between the main Coast Mountains and the plateau region. They are each characterized by a main peak, with an elevation of about 7,000 feet, toward their southwestern end and a plateau-like summit about 4,000 to 5,000 feet high toward their northeastern end, which gradually merges with the plateau.

Rock exposures are plentiful throughout the area, especially above timber-line, which is at an elevation of about 4,000 feet near the head of Tahtsa Lake and 5,000 feet in the Quanchus Range. Many of the flat-topped ridges and spurs above timber-line are covered with a thick layer of rock talus or felsenmeer that masks the bedrock. All of the valleys and much of the area along the eastern border of the map-area is occupied by a drumlinized till plain. The entire area appears to have been glaciated, and glacial striae have been found on most of the higher peaks. Even today these peaks are pocked with active alpine glaciers. The direction of movement of the ice in Pleistocene time, as indicated by striae and drift ridges in the

drumlinized till plain, is north 55 to 80 degrees east. The ice was at least 4,000 feet thick, and rode completely over Wells Gray Peak, at an elevation of 7,211 feet, without change in direction.

GEOLOGY

GENERAL STATEMENT

The geological history of the map-area, as expressed by its bedrock formations, began in Mesozoic time. A small area of Upper Triassic volcanic and sedimentary strata form an upfaulted block in the northeast corner of the area. Volcanic and sedimentary rocks of mainly Middle Jurassic age underlie the greater part of the area, but Lower Jurassic and possibly early Upper Jurassic rocks may also occur. These rocks are correlated with the Hazelton group of Jurassic and, probably, Lower Cretaceous age. Intrusive into the Hazelton group are the plutonic rocks of the Coast intrusions, which underlie a large part of the area, particularly in the southwest. Late Lower Cretaceous rocks on Swing Peak and Laventie Mountain are cut by two small stocks of the Coast intrusions, and are not included with the Hazelton group. Along Whitesail River and Ootsa Lake a series of mainly acidic flows, but including some andesite and basalt, rests unconformably on the Hazelton group. These rocks are believed to be of Upper Cretaceous or later age, and though they have been subjected to considerable deformation, they were not found to be invaded by the Coast intrusions. Lying unconformably above these acidic flows are Tertiary basaltic lavas, which are most widespread in the eastern part of the map-area. Thick accumulations of till, fluvioglacial material, and alluvium occur along the main valleys and in the plateau region of the eastern part of the area.

Mineral deposits occur mainly along the eastern border of the main mass of the Coast intrusions. Lead-zinc deposits, carrying some gold and silver, are most common, but gold, copper, and scheelite deposits are known.

TABLE OF FORMATIONS

Era	Period or epoch	Group or formation	Lithology
Cenozoic	Pleistocene and Recent		Till, gravel, sand, clay, alluvium
	Unconformable contact		
	Miocene or earlier		Basalt, tuff; gabbro dyke
Unconformable contact			
Mesozoic or Cenozoic	Upper Cretaceous or later		Rhyolite, dacite, andesite, basalt; breccia, tuff; minor conglomerate

Not in contact

Mesozoic	Jurassic and later	Coast intrusions	Granodiorite, diorite, granite, quartz diorite, syenite, quartz monzonite, monzonite, gabbro
	Intrusive contact with Hazelton group; in part at least intrusive into Lower Cretaceous beds		
	Lower Cretaceous		Argillite, arkose, breccia, tuff, andesite, basalt
	Probable unconformity		
	Jurassic	Hazelton group	Breccia, tuff, andesite, dacite, rhyolite, basalt; argillite, greywacke, chert, conglomerate; minor limestone
	In part correlative with Hazelton group; cut by Coast intrusions		
	Triassic (?) and Jurassic	Metamorphosed Hazelton group (in part)	Greenstone, amphibolite, phyllite, schist, gneiss, recrystallized limestone; undifferentiated minor intrusions of diorite and granite
	Fault contact with Hazelton group		
	Upper Triassic		Breccia, tuff, andesite, argillite

TRIASSIC ROCKS

The oldest exposed rocks in the map-area occur on Verdun Hill north of the settlement at Ootsa Landing. Fossils found in these rocks indicate a definite Upper Triassic age, and are the only Triassic fossils found in the area. These rocks are in fault contact with those of the adjacent Hazelton group, and represent an upfaulted block with an area of about 6 square miles. They consist of green andesite flows, greenish grey andesitic breccias, with red and green fragments, tuff, and dark argillite, and are very similar lithologically to parts of the Hazelton group, from which they are separated on the basis of their contained fossils.

JURASSIC ROCKS

Hazelton Group

The Hazelton group in Smithers map-area to the north of and adjoining Whitesail Lake map-area consists of an apparently conformable succession of interbedded sedimentary and volcanic rocks ranging in age from pre-Middle Jurassic to Lower Cretaceous. They include marine strata of Upper Jurassic or lowest Lower Cretaceous age as well as some continental strata that are correlative with the Kootenay and Blairmore formations of Alberta[1].

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[1] Geol. Surv., Canada, Preliminary map, Paper 44-23, 1944.

In the Whitesail Lake area, Middle Jurassic and most probably pre-Middle Jurassic strata are represented, but no Upper Jurassic or lowest Lower Cretaceous beds were identified. The Cretaceous continental beds referred to in the Smithers area do not extend into the Whitesail Lake area but end just north of its northern boundary. The Lower Cretaceous beds occurring on Swing Peak and Laventie Mountain in Whitesail Lake map-area are younger than those beds included with the Hazelton group in the Smithers area, and are possibly correlative with the Haida formation of Queen Charlotte Islands. They are, therefore, not included with the Hazelton group in this report, but are described separately.

Volcanic and sedimentary rocks of mainly Middle Jurassic age representing the Hazelton group underlie the greater part of Whitesail Lake map-area. The principal belt of these rocks is adjacent to the eastern contact of the main body of the Coast intrusions, and traverses the area in a northwesterly direction. These rocks constitute the strata on Patullo, Chikamin, Whitesail, Sibola, and Tahtsa Ranges, parts of Kasalka Range, and on those unnamed ranges along Nanika and Morice Lakes. Most of these rocks are of Middle Jurassic age, as indicated by fossil evidence. No strata of definite Lower Jurassic age were identified, but their presence is inferred. On the western slope of Troitsa Peak, fossils of lowest Middle Jurassic age were collected from sedimentary strata interbedded with rhyolite flows. As this horizon is not at the base of the Troitsa Peak section, it seems probable that some of the strata included with the Hazelton group is of Lower Jurassic age.

On Chikamin Mountain and along Tahtsa River, a succession of sedimentary and volcanic rocks yielded fossils from a higher horizon than that at Troitsa Peak. The sedimentary section on Chikamin Mountain exposes about 2,500 feet of tuffaceous greywacke, black argillite, grey-green tuffs, impure limestone, and thin-banded chert. A sedimentary section at least 2,500 feet thick near the mouth of Nadina Lake yielded similar fossil collections. Fossils of the same age were found along Tahtsa River, on Tweedsmuir Peak, Michel Peak, and on Nadedikus Mountain.

Overlying these sedimentary beds on Chikamin Mountain and along Eutsuk Lake is a thick series of volcanic tuffs, flows, and breccias. These are well exposed on the west end of Chikamin Range, on Key Mountain, and on Mount Preston. On Mount Preston they are folded into a syncline representing about 6,000 feet of bedded volcanic rocks.

The overall thickness of the Hazelton group in Whitesail Lake area is at least 10,000 feet.

The most common and characteristic rock types of the group are volcanic tuffs and breccias. Fragments consist largely of volcanic rocks, but include minor amounts of sedimentary and plutonic materials. The fragments range from fine ash to blocks a foot or more in length, but are most commonly $\frac{1}{4}$ to $\frac{1}{2}$ inch long. The matrix of these pyroclastic rocks is similar to that of the fragments, only more finely comminuted. Most of the tuffs may be termed lithic, but lapilli, crystal, and cindery varieties also occur.

Lava flows of andesitic and basaltic composition form a large part of the Hazelton group. They are porphyritic rocks, commonly exhibiting phenocrysts of feldspar 1/8 to 1/4 inch in length. These phenocrysts are characteristic of the lavas of the group, and were largely responsible for Dawson[1] applying the name 'Porphyrite' to the

[1]Dawson, G. M.: Geol. Surv., Canada, Reports of Progress: 1875-76, p. 250; 1876, p. 83.

group. The flows are commonly 20 to 50 feet thick and exhibit a variety of colours, including green, brown, red, purple, grey, orange, and black. Amygdaloidal and vesicular types are not common. Flows of rhyolitic and dacitic composition are less common than the more basic lavas.

The sedimentary rocks of the Hazelton group include fine-grained black argillite, minor impure limestone, thin-bedded, grey-green chert, and others best described as tuffaceous greywackes. The argillites, though generally dark, may be limonite brown and, rarely, green. No pure limestones were seen, but some of the beds contain a high percentage of carbonate. The uppermost 500 feet of the peak of Chikamin Mountain consists mainly of grey-green chert in bands that are commonly less than 1 foot, and many less than 1 inch, in thickness. Similar chert was seen along the north shore of Eutsuk Lake and on Tableland Mountain.

In the northeast corner of the map-area is exposed a series of interbedded green andesite flows, tuffs, argillites, and chert-pebble conglomerates. The argillites have yielded some poorly preserved fossils of Jurassic age, and on the basis of this evidence these rocks have been included with the Hazelton group. East of Eutsuk Peak, near the eastern border of the area, massive greenstones of uncertain age predominate. In 1951, H. W. Tipper[2], working in Nechako map-area to

[2]Tipper, H. W.: Geol. Surv., Canada; personal communication.

the east, found these greenstones interbedded with sedimentary strata that yielded fossils of Jurassic age; accordingly, they have been mapped with the Hazelton group.

The structure of the Hazelton group is mainly one of moderate folds, with occasional sharp crenulations. Hedley[3] gives an apt

[3]Hedley, M. S.: Tahtsa-Morice Area; Geol. Surv., Canada, Map 367A, 1936.

description of the structure as that of a comparatively flat-lying blanket warped into open flexures and caught locally into sharp folds. Angles of dip are commonly less than 50 degrees and rarely more than 60 degrees. The general trend of the rocks is northwest, with local variations. East of the main mass of the Coast intrusions, the Hazelton strata are cut by numerous masses of plutonic rocks some of them of batholithic proportions. Each of these masses has disturbed the Hazelton group strata locally, so that structures are not continuous for any great distance. Each range of mountains in the district has a core of plutonic rock, and thus the structures of one range are rarely continuous with those of another.

Due to widespread intrusion by plutonic rocks, the Hazelton group has been regionally metamorphosed, and effects of contact metamorphism may be commonly observed. On the mountain east of Sandifer Lake, well-developed crystals of epidote, specular hematite, garnet, and a little chalcopyrite occur in a zone 400 feet long and about 60 feet wide adjacent to a small stock of granite. Similar evidence of mineralization was seen in a metamorphosed impure limestone bed near the granitic core of Chikamin Mountain. On Lindquist Mountain, dark shales near a diorite mass have been altered to andalusite schist. Epidote and chlorite occur almost everywhere. At the head of Tahtsa Lake and extending south is a large area of volcanic and sedimentary rocks, which may be in part pre-Hazelton, that include tuff, breccias, lavas, argillites, and limestone. The volcanic members are now largely greenstones, chlorite schists, and amphibolites; the limestones have all been recrystallized; and the argillites are no more than dark schists. The whole metamorphic zone is cut by granitic dykes and cupolas of diorite.

Because of the lack of distinctive marker beds and the general similarity of the various rock types, faults are difficult to recognize and only relatively few have been mapped. There is known to be complex faulting at the head of Whitesail Lake and on Core Mountain; the large quartz veins on the Harrison gold property at Lindquist Lake have been offset by faults; and strata on Mount Sweeney have been faulted along bedding planes, which are commonly marked by seams of gouge. Other faults on Mount Sweeney run transverse to the strike of the beds and definitely offset them. The sedimentary beds at the west end of Whitesail Range were probably brought to the surface along faults, and crushed zones near the granite contacts on this range suggest further faulting. Still other faults have been observed striking both parallel with the batholithic contact and transverse to it. Although no major structural faults have been identified, the long narrow lakes characteristic of the area are probably due to fracturing in the main body of the Coast intrusions. These lakes accord with the transverse fracture system of the batholith, and are probably due to the same structural conditions responsible for the fiords of the British Columbia coast.

LOWER CRETACEOUS ROCKS

On Swing Peak and Laventie Mountain is exposed a series of interbedded black argillites, fawn to grey arkoses, and minor volcanic rocks, with an aggregate thickness of about 5,000 feet. Argillites predominate near the base of the section, and the arkoses are thin bedded near the base but become thicker higher in the series. The argillites have yielded marine fossils of late Lower Cretaceous age, and unidentified carbonaceous fragments were found in the arkoses. These sedimentary rocks are succeeded by a volcanic series of tuffs, breccias, and flows very similar to those of Jurassic age.

The relationship of the Cretaceous rocks to adjacent Jurassic strata is uncertain, but is probably represented by an unconformity. No actual contacts between them were observed, but the Cretaceous rocks strike nearly west and dip southerly whereas the Jurassic rocks strike a little east of north, with dips both east and west.

COAST INTRUSIONS

Subsequent to the deposition of the Hazelton group, plutonic intrusion was widespread throughout the area and persisted for a long time. Although it is difficult to date the separate intrusions closely, all of those observed cut Middle Jurassic strata and two of the intrusive bodies are known to cut the Lower Cretaceous rocks.

The eastern boundary of the main mass of the Coast intrusions extends from the head of Tesla Lake, in the southern part of the area, northwestward in a sinuous line across the heads of Eutsuk, Whitesail, Tahtsa, and Morice Lakes. South and west of this line the greater part of the map-area is underlain by Coast intrusions consisting mainly of granodiorite, diorite, granite, and quartz diorite. Southwest of Surel Lake and between there and Seel Lake the intrusive rock is a coarse-grained, fresh, hornblende granite, exhibiting large, well-developed phenocrysts of pink orthoclase, greyish white oligoclase, and colourless quartz, which is interstitial to the plagioclase. Hornblende is the principal ferromagnesian mineral, but a little biotite can generally be seen, and magnetite, sphene, and apatite occur as accessory minerals. South of Musclow Lake, the intrusive rock is a dark grey granodiorite, and around the head of Nanika Lake are exposures of quartz diorite, granite, and granodiorite. Elsewhere in the area are separate exposures of Coast intrusions, some of which are of batholithic proportions. Several of these are sufficiently distinctive to be described separately.

Quanchus Batholith

The Quanchus batholith, named by Marshall[1] after the Quanchus Range, occupies a large part of the high plateau between Ootsa and Eutsuk Lakes. It forms the core of Quanchus Range, Michel Peak, Chef Ridge, and the southern slope of Eutsuk Peak, and outcrops along the south shore of Eutsuk Lake and near Detna Lake. A small quartz diorite mass of Watut Mountain is of similar mineral composition to the mass near Detna Lake, and as both appear to be differentiates of the Quanchus batholith they are included with it. Except for these two small bodies of quartz diorite the batholith consists mainly of granite and quartz monzonite.

[1] Marshall, J. R.: Eutsuk Lake Area, Coast District, B.C.; Geol. Surv., Canada, Sum. Rept. 1925, pt. A, pp. 144-154 (1926).

The main rock type is a granite composed largely of orthoclase and quartz, with minor oligoclase, a little hornblende and biotite, and accessory magnetite, apatite, sphene, and zircon. The orthoclase is flesh coloured, imparting a general pinkish colour to the rock, and is commonly kaolinized. Locally the percentage of oligoclase to orthoclase increases to the point where the rock may

be called a quartz monzonite. Micrographic intergrowths of quartz and orthoclase are characteristic of the rocks of the batholith. The quartz is commonly clear, but along Eutsuk Lake and on Chef Ridge is quite smoky. In the Quanchus Range proper, the rock is largely fine to medium grained, even textured, rarely coarse grained, and pink to grey in colour. On Chef Ridge and south of Eutsuk Lake it is coarse and porphyritic, consisting almost entirely of orthoclase and quartz with rare ferromagnesian minerals. The orthoclase is pink on fresh surface, but weathers white, and the bare hills and ridges composed of this granite are very conspicuous. Similar rock outcrops on both shores of Eutsuk Lake near its eastern end.

The Quanchus batholith intrudes Jurassic rocks of the Hazelton group, but is unconformably overlain by Miocene basalt and does not intrude certain acidic lavas outcropping along its eastern borders and on Ootsa Lake, which are believed to be of Upper Cretaceous or later age. Therefore, the Quanchus batholith was emplaced between Middle Jurassic and Upper Cretaceous time, probably at the close of the Jurassic Period.

Diorite

Several promontories on Eutsuk Lake are composed of a diorite intrusion, which also outcrops on the southeast side of Chikamin Range, on Lady Susan Island, and south of Redfish Lake. The diorite outcropping on Eutsuk Peak is probably also a correlative intrusion. It is a dark grey plutonic rock composed essentially of andesine (An_{44}), hornblende, minor augite, and accessory magnetite.

Gabbro

Three small bodies of gabbro were noted at widely separate localities within the map-area. One of these forms a distinct hill, just north of the settlement at Ootsa Landing, that was formerly used by the Provincial Forestry Department as a lookout post. This body is composed of a medium-grained rock containing feldspar laths, which locally may be up to $\frac{1}{4}$ inch long. In thin section it is seen to consist of well-developed phenocrysts of labradorite (An_{62}), augite largely altered to fibrous amphibole, chlorite, and minor magnetite.

In Tahtsa Range, a small stock of gabbro outcrops west of the granitic intrusion in Sibola Range. It is a fine- to medium-grained, dark grey rock, which in hand specimens much resembles many of the diorites associated with the Coast intrusions. In thin section, however, it was found to consist mainly of labradorite (An_{53}) and hornblende, with minor magnetite.

On Core Mountain, gabbro forms a small stock about 1,000 feet in diameter, of similar character and feldspar composition to that on Tahtsa Range.

Red Granite

On Whitesail Range, along Bone Creek and the east shore of Whitesail Lake, there outcrops a fairly coarse-grained red granite. Its largest exposure is on the southeast slope of the range, and a few small cupolas outcrop along Tahtsa River near the Mosquito Hills. This is a medium- to coarse-grained red granite, containing about 50 per cent orthoclase, 25 per cent oligoclase, 15 to 20 per cent clear quartz, and 5 to 10 per cent magnetite, brown biotite, and accessory apatite. On Bone Creek, some of the orthoclase phenocrysts are as

much as $\frac{3}{4}$ inch long. This intrusive rock differs in appearance from that of the larger intrusions, and some of its contacts were observed to be along faults. In part, the ratio of plagioclase to orthoclase increases sufficiently for the rock to be classed as a monzonite.

Red Syenite

Between Wahla Lake and Eutsuk Lake, on Nadedikus Mountain, Oppy Lake, and Two Bear Hill, there are stocks and bosses of a red intrusive rock that is mainly syenitic in character, but locally contains sufficient quartz to be termed a granite or quartz monzonite. It is essentially a red, fine- to medium-grained, plutonic rock, which in the hand specimen shows phenocrysts of pink orthoclase, minor oligoclase, rare quartz, and fine needles of hornblende. Under the microscope, the rock is seen to consist of about 65 per cent cloudy orthoclase, 25 per cent oligoclase, 5 per cent quartz, and 5 per cent hornblende and magnetite. It commonly shows graphic intergrowths of quartz and feldspar, and is very similar in general character to the red granite on Whitesail Range, but contains less quartz.

Mount Bolom Stock

A large part of Mount Bolom is composed of a light-coloured porphyritic granite that cuts the late Lower Cretaceous rocks on Laventie Mountain and Swing Peak. The granite is a medium- to fine-grained, light-coloured rock containing phenocrysts of cloudy orthoclase in a finer grained groundmass of plagioclase and quartz, with a little biotite and hornblende. Under the microscope the quartz, which comprises about 15 per cent of the rock, is clear; the orthoclase is cloudy, and commonly shows slight graphic intergrowths with quartz.

Swing Peak Stock

A light-coloured, porphyritic, intrusive rock that outcrops on Swing Peak may be associated with the mass on Mount Bolom. It is light brown to rusty weathering, and is composed of phenocrysts of feldspar, biotite, and hornblende in a light grey groundmass. This rock intruded the late Lower Cretaceous rocks on Swing Peak, and was probably emplaced at the close of Cretaceous time.

UPPER CRETACEOUS OR LATER VOLCANIC ROCKS

Outcropping near the east end of Whitesail Lake, along Whitesail River, on both shores of Ootsa Lake, and generally east of the Quanchus Range, is a series of mainly rhyolites and dacites, with minor andesites and basalts, tuffs and breccias, and rare, thin beds of conglomerate. The basalts are commonly characterized by large, well-developed phenocrysts of labradorite, giving the rock a porphyritic texture. The rhyolites exhibit flow lines, spherulitic structures, and a creamy white weathered surface; they form the distinctive white ridges and bluffs along Ootsa Lake. The aggregate thickness of the group is uncertain but is probably at least 3,500 feet.

The basal member of this group outcrops on the east side of Whitesail Lake about 1 mile from the mouth, and is a very coarse conglomerate composed of roundstones of Hazelton group rocks in a sandy matrix. The roundstones range from cobble size to well-rounded boulders 8 to 12 inches in diameter. Above the conglomerate is a black,

amygdaloidal basalt succeeded by interbedded, relatively thin, basalt and rhyolite flows.

Dips, where observed, varied between 30 and 55 degrees, and the group appeared to be gently folded. Near the head of Ootsa Lake these rocks are cut by narrow basalt dykes.

No fossils were found in these rocks within the boundaries of the map-area, but near Marilla post office on Ootsa Lake, about 20 miles east of the area, fossil leaves and freshwater shells were obtained by Tipper[1] in 1949 and 1950 at a sedimentary horizon within

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[1]Tipper, H. W.: Geol. Surv., Canada; personal communication.

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the group. The leaves indicate a probable Upper Cretaceous or later age. These rocks overlie the Hazelton group unconformably and are in turn unconformably overlain by younger basalts.

MIOCENE OR EARLIER BASALT

The youngest consolidated rocks in the map-area are relatively flat-lying basaltic flows and related tuffs and breccias that overlie the rhyolitic rocks described above. No fossils were found in these rocks, but they are similar to other basalts that are widespread in the interior of the province and are known to be of Oligocene or Miocene age. The largest exposures are on the southwest shoulder of Chef Ridge and around the head of Fenton Lake. Near the headwaters of St. Thomas Creek they form a distinct escarpment about 800 feet high. They are widespread in the northeast corner of the map-area, and occur on Mosquito Hills, the eastern tip of Whitesail Range, and as numerous small outliers east of Quanchus Range. Four small conical-shaped hills on the north shore of Eutsuk Lake east of Sand Cabin Bay are composed entirely of this basalt and appear to have been sources for it.

Some of the flows contain large, well-developed crystals of labradorite; and a few contain small amounts of olivine. Vesicular and amygdaloidal varieties occur, in which the amygdules consist of calcite, stilbite, and quartz.

A fresh-looking gabbro dyke exposed in the northeast corner of the map-area, near Tatalrose, closely resembles certain phases of the Miocene basalts prevalent in that part of the area, and is probably an intrusive phase of these basic rocks. It is a light grey rock with phenocrysts of labradorite (An_{56}) in a fine-grained groundmass of plagioclase, biotite, and subordinate augite.

PLEISTOCENE AND RECENT OVERBURDEN

Pleistocene and Recent unconsolidated materials of glacial and fluvioglacial origin are widespread in the map-area, particularly within its eastern half. The entire area was covered by ice during Pleistocene time, and glacial erratics may be seen even on mountain tops. The main valleys in the eastern part of the area are filled with till and reworked glacial debris. Locally there are deposits of varved clay. The plateau areas east of the mountains are covered with a thick mantle of glacial drift characterized by parallel ridges

(drumlins) and grooves similar to those described by Armstrong and Tipper[1]. The direction of these ridges and grooves is commonly north

[1]Armstrong, J. E., and Tipper, H. W.: Glaciation in North-Central British Columbia; Am. Jour. Sci., vol. 246, May 1948, pp. 283-310.

50 to 70 degrees east, but topographic features cause local variations. These directions coincide with those of the glacial striae observed in the rocks. The conditions described in the paper by Armstrong and Tipper, as noted particularly in Carp Lake map-area, extend westward into Whitesail Lake map-area. The drumlin-type ridge is commonly about 50 feet high, and varies in length from ¼ mile to 2 miles. On air photographs, these ridges and parallel grooves show up very plainly in wooded sections and are best observed where the ice flowed uphill. Commonly the ridges are marked by a growth of jack pine, and the adjacent grooves by a slough or swamp, or by long, narrow lakes.

The ice collected on the highlands of the Coast Mountains and flowed from there northeasterly, so that all east-trending valleys were natural outlets for the ice stream. Striae indicate that the topography had some local effect, but striae at the higher elevations indicate a direction of movement of north 60 to 70 degrees east, which is similar to that indicated by the ridges and grooves.

The western part of the map-area even today is characterized by alpine glaciation, and nearly every peak has its ice-cap or cirque glacier. Commonly a peak may have two or three small cirque glaciers, and some ice-caps are 8 to 10 miles long. Streams from these glaciers carry a tremendous load of rock flour and coarser debris during the warmer months of the year, and this material is carried down the steep mountain slopes to be deposited in mountain-lake basins or carried into the main valleys by the larger streams. Alluvial fans occur commonly where streams from alpine glaciers enter lakes at the foot of steep-sided mountains. In several instances, such fans were observed to have completely, or almost completely, dammed the lake except for a very narrow channel. Much of this material is ultimately carried downstream by rivers such as the Tahtsa and Whitesail, and accumulates in the deltaic deposits forming at the head of Ootsa Lake and other large lakes in the area.

The mountain glaciers are retreating, and the lower parts of some of the ranges include many ice-free cirques.

ECONOMIC GEOLOGY

Whitesail Lake map-area includes about 85 miles of the mineralized eastern contact zone of the main body of the Coast intrusions. Prospecting along or tributary to this zone has been carried out by individual prospectors and mining companies during the past 40 years, and has resulted in the discovery of numerous lead-zinc vein deposits, some gold-bearing veins, several copper-bearing veins and shear zones, and some scheelite. However, until 1951 none of these proved to be of sufficient size or grade to warrant more than preliminary development. Furthermore, transportation problems and lack of power installations have handicapped any mining venture in the past. In 1951, the Aluminum Company of Canada began active development of the tremendous power resources of this

region. To do so they built a good road to Tahtsa Lake for transportation of machinery and supplies, and this, together with the expected power supply, should greatly facilitate future prospecting and mining operations.

Interest in the mineral possibilities of the area has been centred mainly around Mount Sweeney, Sibola Peak, Chikamin Mountain, Lindquist Mountain, and Surel and Tesla Lakes; minor interest has been shown in Huckleberry Mountain, Sandifer Lake, Core Mountain, and Red Bird Mountain.

Lead-zinc deposits, containing some silver and gold, occur on Mount Sweeney, Swing Peak, and Chikamin Mountain. Copper occurrences have been reported from the mountain east of Sandifer Lake and from Red Bird and Tesla Mountains and Chezko River. From 1944 to 1946 much interest was shown in the gold-bearing veins on the Harrison group of claims on Lindquist Mountain, where scheelite also occurs.

LEAD-ZINC DEPOSITS

Mount Sweeney

Emerald Glacier Group(1)[1]

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[1]Numbers in parentheses are those used on the accompanying map for the same property.

References: B.C. Minister of Mines, Ann. Repts.: 1916, pp. 164-165; 1919, pp. 104, 105; 1929, pp. 183, 184. Geol. Surv., Canada, Sum. Rept. 1924, pt. A, pp. 56, 57 (1925).

This property, situated on the south side of Sweeney Mountain about 6 miles from Tahtsa River, was first staked in 1915 by W. J. Sweeney and associates. It has received perhaps more active exploration than any other showing in the area. In 1917 and again in 1919 it was optioned by J. Cronin of Prince Rupert, who drove a drift adit 125 feet along the vein zone at an elevation of 6,385 feet. Work was later done by the Consolidated Mining and Smelting Company of Canada Limited between 1928 and early 1931, during which period the original adit was extended, and two more adits were driven, one at an elevation of 5,989 feet and the other at 5,418 feet. Results from this work were disappointing, and no further interest was shown in the property until 1949 when Emerald Glacier Mines Limited was formed to take over the property. Late in 1950 and early in 1951, this company completed a rough winter road from the head of François Lake to the property; brought in machinery and supplies; and made ready for mining operations during the summer of 1951. This work coincided with the decision by the Aluminum Company of Canada to proceed with their power development of the area, and in May 1951 they assumed responsibility for the completion and maintainance of the road, which would also serve their operations on Tahtsa Lake.

The ore on the Emerald Glacier property is vein material in a shear zone 10 to 20 feet wide in which occur lenses of solid sulphides up to 10 feet wide. The zone has been traced on the surface for at least 1,000 feet. It strikes north 5 degrees west

and dips easterly at 50 to 70 degrees. The host rocks are volcanic and sedimentary members of the Hazelton group, which have been disturbed by the intrusion of the granitic stock on Sibola Peak. The sheared zone containing the ore occurs along a monoclinal crumple in the Hazelton group rocks. The vein matter is concentrated along the foot-wall of the shear, which is marked by much gouge. Heavy sphalerite and galena mineralization, with minor chalcopyrite, occurs in a gangue of quartz, minor calcite, and wall-rock.

Early work in the upper adit had disclosed a zone 250 feet in length strongly mineralized with sphalerite and galena. When the property was visited in the early summer of 1951 the present operators had extended this drift about 100 feet, with some ore still showing in the face. Diamond drilling was in progress to test the downward extension of the orebody, but no results had been obtained at that time. Latest reports[1] indicate that ore is being shipped

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[1]The Precambrian, vol. 25, No. 2, p. 50, Feb. 1952.

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from the upper tunnel, which has an orebody with a developed length of 320 feet. Sampling of this orebody gave an average of 11 ounces silver a ton, 10 per cent lead, and 20 per cent zinc across an average width of 3 to 4 feet.

Swing Peak

Captain Group(3)

References: B.C. Minister of Mines, Ann. Repts.: 1927, pp. 154-155; 1929, p. 184; 1945, pp. 67, 68.

This group of six claims, situated on the northeast slope of Swing Peak, was previously known as the Swannell group. It is owned by C. McNeill of Ootsa Landing and G. A. Young of Vancouver.

The main showing is a shear zone that strikes nearly north and dips steeply to the east. This zone crosses both the lavas and the fine-grained porphyritic intrusive rock that comprise this part of Swing Peak. In 1929 and 1930, Tahtsa Mining Company drove an adit 383 feet long at an elevation of 4,985 feet. This adit intersected and explored the shear zone 100 feet below its most prominent surface exposure. Little work other than surface prospecting has been done since.

The rocks of Swing Peak have been intruded by a fine-grained porphyritic diorite, which has been fractured and faulted in a north-south direction. Most of the fractures are narrow, but some reach a width of 3 feet or more. They dip steeply to the east, and are commonly marked by much gouge. Some of these fractures are mineralized with galena, sphalerite, pyrite, arsenopyrite, and tetrahedrite in a gangue of quartz, minor calcite, and wall-rock.

The main mineral showing is on a persistent shear zone that strikes north and dips 85 degrees to the east. A drift from the crosscut adit was driven on this zone and all mining was entirely within the porphyritic diorite. Several minor fractures were intersected in the crosscut, but no evidence of mineralization was encountered up to 110 feet from the face of the drift. At this

point the adit intersected a fracture containing 6 to 18 inches of gouge and a mineralized seam 1 inch to 4 inches wide on the hanging-wall that continued for 65 feet.

A picked sample of ore from this seam yielded, on assay, 12.40 per cent lead, 5.42 per cent zinc, 63.07 ounces silver a ton, and a trace of gold.

About 150 feet below the adit and on the northerly extension of the shear zone, C. McNeill has recently uncovered a mineralized lens 20 feet long and 1 foot to 2 feet wide where the zone is 3 feet wide. No work has been done on this showing, but an assay of a sample of the ore gave 22.40 per cent lead, 9.50 per cent zinc, and 25.00 ounces of silver and 0.005 ounce gold a ton.

About 750 feet southwest of the adit are two narrow mineralized stringers about 4 feet apart striking north 25 degrees west, dipping 75 degrees to the northeast, and mineralized like the seam in the adit. About 500 feet to the southeast on the strike of these stringers, an open-cut exposes a similarly mineralized vein 6 to 7 inches wide.

Chikamin Mountain

The Harrison brothers of Wistaria have prospected Chikamin Mountain for many years, and have uncovered several narrow veins mineralized with galena, sphalerite, and chalcopyrite and carrying gold and silver. In 1945, Privateer Mines Limited drilled several holes on the Roosevelt claim and staked some additional claims, but nothing has been done since.

The showings occur on the western flank of Chikamin Mountain, and are narrow quartz veins that strike north 15 to 45 degrees west and dip vertically to 70 degrees southwest. The sedimentary and volcanic rocks of the Hazelton group composing this part of the mountain strike north 15 to 30 degrees west and dip 20 to 30 degrees to the southwest. They form the southwestern limb of an anticline that is intruded by a small stock of granite. Though narrow, the quartz veins are persistent, one of them having been traced for nearly 2,000 feet. The vein on the Garner claim, on which an adit has been driven, shows banded and comb structures suggestive of fissure filling. The ore minerals in the veins are mainly galena and sphalerite, with minor amounts of chalcopyrite, arsenopyrite, pyrite, ruby silver, and in one showing, lollingite. The gangue is quartz, with minor calcite and sheared wall-rock.

Mentor Group(7)

References: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, pp. 52, 53 (1925). B.C. Minister of Mines, Ann. Repts.: 1926, p. 146; 1927, p. 155; 1945, pp. 68, 69.

This group of two claims along the south shore of Whitesail Lake in Zinc Bay at the foot of Chikamin Mountain was formerly known as the Cariboo group. In 1916, it was being explored by a Prince Rupert syndicate, who drove an adit along a shear zone striking north 25 degrees west and dipping 75 degrees northeast. The zone, consisting of sheared rock, with a few irregular stringers of quartz and calcite, is mineralized with sphalerite, galena, pyrite, and chalcopyrite. An assay of the best ore encountered at that time

gave: gold, trace; silver 0.8 ounce a ton; copper, 0.5 per cent; and zinc, 32 per cent.

The adit followed the foot-wall of the shear zone for 50 feet, and then turned at right angles to cut across the formation. These workings were caved when the showing was visited in 1949, but an assay of a sample of ore taken from the vein near the portal of the adit gave: lead, 10.2 per cent; zinc, 13.74 per cent; gold 0.02 ounce a ton; and silver, 3.26 ounces a ton.

About 800 feet west of the adit is an open-cut on two parallel veins about 3 feet apart and 10 to 12 inches wide. They strike north 15 degrees west and dip vertically. The wall-rock is silicified and heavily pyritized for several feet on either side of the veins. A sample of ore from these veins assayed: lead, nil; zinc, 28.51 per cent; gold, 0.01 ounce a ton; and silver, 0.82 ounce a ton.

Roosevelt Group(8)

References: Geol. Surv., Canada, Sum. Rept. 1924, pt. A, pp. 53, 54 (1925). B.C. Minister of Mines, Ann. Repts.: 1926, pp. 146, 147; 1945, p. 69.

This group of eight claims is reached by 2 miles of well-graded trail that leads from the deep bay just west of Zinc Bay on the south shore of Whitesail Lake. On the claims, an adit was driven southeasterly for 37 feet to where it is reported to have intersected a shear zone containing a quartz stringer up to 8 or 9 inches wide. When visited in 1949, the adit portal was caved and the adit inaccessible. A pile of about 5 tons of sorted ore lay on the dump, and a sample of this material assayed: lead, 14.0 per cent; zinc, 31.6 per cent; gold, 0.04 ounce a ton; and silver, 14.38 ounces a ton. In 1945, Privateer Mines Limited did about 500 feet of drilling in three holes south of the showing; the results are not known. No further work has been done on the property.

Garner No. 1 and Marie(9)

References: Geol. Surv., Canada, Sum. Rept. 1924 pt. A, pp. 54, 55 (1925). B.C. Minister of Mines, Ann. Rept. 1935, p. A24.

The well-graded trail up Chikamin Mountain from the deep bay in Whitesail Lake leads to a cabin just at timber-line, 1,750 feet above the lake. From there a trail leads to the old Nickel Plate or Ruby adit on the Garner claim, 900 feet above the cabin. The adit, 118 feet long, was driven on a narrow quartz vein that strikes north 45 degrees west, dips vertically, and carries galena, sphalerite, pyrite, chalcopyrite, and tetrahedrite. The quartz shows both banded and comb structures, evidence of fissure filling. In 1939, B. T. O'Grady of the British Columbia Department of Mines sampled the vein in the adit. The results gave an average assay of 0.036 ounce gold and 14.4 ounces silver a ton, across a vein width of 12.86 inches. A sample taken at the face by S. S. Holland of the same department in 1945 assayed: 0.08 ounce gold and 14.5 ounces silver a ton, 0.9 per cent copper, 7.4 per cent lead, and 8.7 per cent zinc. A sample of the ore taken by the writer in 1949 gave 0.04 ounce gold and 14.38 ounces silver a ton, 18.40 per cent lead, and 6.61 per cent zinc.

About 700 feet higher on the mountain and on the strike of the vein, an open-cut exposes four stringers, each 1 inch to 3 inches wide within a total width of 30 inches. A picked sample from this showing assayed: 0.06 ounce gold and 71.06 ounces silver a ton, 16.4 per cent lead, and 7.54 per cent zinc. Some ruby silver noted in this showing probably accounts for the high silver assay.

Rainy and Gold Coin(10)

These claims are on the south side of Chikamin Mountain just below the summit. An adit about 25 feet long, known as the California, and some open-cuts expose vein matter for a length of about 50 feet. The adit is driven on a shear zone containing two narrow quartz stringers 1 inch and 6 inches wide, respectively, and about 6 feet apart. They strike north 20 degrees west and dip 70 degrees southwest. The portal of the adit was caved at the time of the visit, but the dump revealed 4 or 5 tons of sorted vein material. A selected sample of this assayed: gold, 0.01 ounce a ton; silver, 119.06 ounces a ton; lead, 12.0 per cent; zinc, 3.0 per cent; and copper, 0.50 per cent.

Surel Lake(12)

A traverse up the stream that enters Surel Lake on the south side about 1½ miles from the outlet encountered some narrow quartz veins mineralized with pyrite, sphalerite, molybdenite, and chalcopyrite. The veins are about 3 inches wide. An assay of a selected sample yielded: lead, trace; zinc, 9.92 per cent; copper, 0.08 per cent; and gold 0.02 ounce and silver 0.64 ounce a ton.

GOLD DEPOSITS

Lindquist Lake

Harrison Group(5)

References: B.C. Minister of Mines, Ann. Repts.: 1944, pp. 175-177; 1945, pp. 71-72.

The main gold showings in the map-area are those of the Harrison group of twenty-eight claims and one fraction, staked by the Harrison brothers of Wistaria. The group is situated on the south slope of Lindquist Mountain and along Lindquist Lake. There, large surface exposures of a flat-dipping quartz vein were found to carry gold and silver. The contact between a dioritic phase of the main Coast intrusions and Hazelton group rocks extends westerly along the south slope of Lindquist Mountain. The quartz vein outcrops in the diorite near the contact, and dips about 45 degrees northward toward the Hazelton group rocks. North trending faults offset the vein by as much as 900 feet. These faults are marked by silicified wall-rocks, and are expressed topographically by small depressions. The vein matter consists of sphalerite, arsenopyrite, galena, pyrite, tetrahedrite, chalcopyrite, and tellurides (hessite and altaite), in a quartz gangue.

Pioneer Gold Mines Limited developed these claims from 1944 to 1946. A good pack-trail was built from the head of Whitesail Lake to the property, and camps established both at Whitesail

Lake and at timber-line below the showings. Some surface work and 3,728 feet of diamond drilling were done in 1945, and 8,812 feet of diamond drilling in 1946. The drilling indicates that the vein dips gently to the north toward the diorite-Hazelton group contact and that the contact itself dips south at about 55 degrees. The vein has a dip distance of about 150 feet to where it reaches the contact and breaks into stringers. Drilling was done to explore the contact zone, and numerous intersections were encountered that indicated mineralization across vein widths of 2 to 4 feet.

Assay returns on samples taken along the vein have varied considerably and some have run high in gold and silver, probably due to the telluride content. The following table, listing information taken from a company report, is indicative of the average gold and silver content of the vein as drilled:

Section	Length	Width	Gold	Silver
No.	Feet	Feet	Ounces	Ounces
1A	50	3.0	0.16	1.6
1B	25	4.3	0.217	1.6
2	One hole	2.2	0.02	0.4
3	150	7.5	0.228	3.62
4	270	7.8	0.295	5.6
5A	80	19.0	0.18	4.3
5B	270	10.7	0.294	8.2
6	128	6.0	0.19	7.27
7	90	17.3	0.06	1.8
8	90	10.0	0.21	9.15

No work was done on the claims between 1946 and 1950, but in 1951 the group was taken over by Deerhorn Gold Mines Limited, and during the summer of that year the claims were surveyed. It is expected this company will undertake active development in 1952.

In addition to gold, scheelite has been discovered on these claims in quantities sufficient to warrant active prospecting. It occurs in the metamorphosed Hazelton group rocks close to their contact with the diorite, but only in minor amounts in the gold-bearing quartz vein.

Lam and Old Timer Groups

Reference: B.C. Minister of Mines, Ann. Rept., 1945, p. 72.

The Lam group of four mineral claims to the southwest, and the Old Timer group of six claims to the northwest of the Harrison group are also on Lindquist Mountain. The showings on these groups were not seen, but little work has been done on them. The Lam group is underlain by a dioritic phase of the Coast intrusions, and its contact with the Hazelton group cuts across the Old Timer group.

Surel Lake

Surel Lake Group(13)

Reference: B.C. Minister of Mines, Ann. Rept., 1945, pp. 72, 73.

The Surel Lake group of claims was staked by J. J. Hepson in 1945 near the falls on Surel Creek. It is also near the contact of the Coast intrusions with Hazelton group rocks. The showings were not seen, but it is reported that the vein is 1 foot to 2 feet wide, that it is exposed for 50 feet, and that it carries some gold.

Core Mountain

Core(6) and Shirley Groups

Reference: B.C. Minister of Mines, Ann. Rept., 1945, p. 70.

The Core group of twelve claims, staked in 1944 by Fred Pauling and Orald Harrison of Wistaria, covers a gabbro outcrop on the south slope of Core Mountain, and the Shirley group of eight claims lies between the Core group and the entrance to Little Whitesail Lake. The Consolidated Mining and Smelting Company of Canada Limited had a base camp in a protected bay on the Core group, and did a little trenching. No veins were uncovered, but it is reported that some heavily pyritized material carried a little gold.

The south slope of Core Mountain is marked by a distinct fault that strikes northeast and dips vertically to steeply southeast. The fault is marked topographically by a narrow gorge occupied by a creek. A small mass of gabbro lies to the northwest of the fault, with broken and altered Hazelton group rocks to the southeast. Locally, the course of the fault is marked by much silicification and carbonatization of the wall-rocks and by the occurrence of much pyrite. Some pyrrhotite and chalcopyrite were also observed. Between the fault and the lake shore the Hazelton group rocks contain a little disseminated pyrite, pyrrhotite, and chalcopyrite.

Tahtsa River

Riverside Group(2)

Reference: B.C. Minister of Mines, Ann. Rept., 1945, pp. 65-67.

This group of four claims, staked by J. W. McNeill, J. Knox, and the late G. Seel, all of Ootsa Lake, lies on the north side of Tahtsa River about 1½ miles below the junction with Kasalks Creek and close to Huckleberry Mountain. Dark green tuffs, breccias, and flows of the Hazelton group, which constitute the strata on Huckleberry Mountain, also underlie the claims of this group. On Huckleberry Mountain and adjacent hills pyrite and arsenopyrite occur in narrow quartz veins and small patches of disseminated sulphides in the bedrock. The veins are commonly 1 inch to 6 inches and rarely up to a foot or more in width, and have an irregular strike. On the Riverside claims a quartz vein 2 to 5 inches wide, striking north 75 degrees east and dipping vertically to 85 degrees southeast, is exposed for 100 feet. The vein is mineralized with arsenopyrite, pyrite, chalcopyrite, and sphalerite, and it is reported that the highest assay gave 0.36 ounce gold a ton.

COPPER DEPOSITS

Chalcopyrite is a common constituent of many of the mineral occurrences in the area, but no deposit has been found of sufficient size or grade to warrant development for its copper content alone.

Sandifer Lake(4)

On the mountain east of Sandifer Lake, near the headwaters of the west fork of Laventie Creek, chalcopyrite is sparsely distributed in a contact metamorphic zone about 400 feet long and 40 to 60 feet wide. This showing was staked during the summer of 1950 by C. McNeill of Ootsa Landing and G. A. Young of Vancouver. It occurs along the north contact of a small stock of granite, and consists of a mass of well-developed crystals of epidote and garnet, with chlorite and minor amounts of specular hematite, chalcopyrite, pyrite, and bismuthinite.

Chezko River(15, 16)

Reference: B.C. Minister of Mines, Ann. Rept., 1926, pp. 150-151.

In the canyon of Chezko River about 2 miles below the outlet of Tesla Lake, chalcopyrite occurs (16) in a rusty weathering shear zone of green andesite. The zone is 15 feet wide, strikes north 45 degrees west, and dips vertically. Midway of it is a 6-inch quartz vein containing chalcopyrite, hematite, pyrite, and galena. The zone is exposed for about 300 feet and about 60 feet down the wall of the canyon. A sample of the mineralized material assayed: 0.02 ounce gold and 1.6 ounces silver a ton, and 3.59 per cent copper.

On the southeast slope of Two Bear Hill the writer's party discovered a mineralized zone (15) 3 to 4 feet wide that strikes north 50 degrees west. The zone is exposed for 200 feet and contains quartz stringers mineralized with chalcopyrite, pyrite, and hematite. An assay of a grab sample of the mineralized material yielded a trace of gold and 7.9 per cent copper.

Tesla Mountain

Reference: B.C. Minister of Mines, Ann. Rept., 1926, pp. 149-150.

Mr. G. A. Young of Vancouver, who has prospected the map-area for many years, reports the occurrence of copper-bearing minerals in a persistent quartz vein on Tesla Mountain. This vein was not seen by the writer.

Red Bird Mountain(14)

References: B.C. Minister of Mines, Ann. Repts.: 1929, p. 185; 1945, p. 73.

Red Bird Mountain is on the south side of Eutsuk Lake between Mount Haven and Key Mountain. An occurrence of copper on this mountain was reported by B. R. Harrison and J. Worth in 1929, but no work of consequence has been done on the showings, which were not seen by the writer.

Surel Lake(11)

On the west side of the creek flowing into the head of Surel Lake from Surel Pass, a quartz vein 1 foot to 2 feet wide

has been exposed for 25 feet in diorite near its contact with the Hazelton group. The vein strikes north 80 degrees west and dips 42 degrees southwest. It is mineralized mainly by chalcopyrite and pyrite.