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SALMON ARM MAP-AREA BRITISH COLUMBIA

(REPORT AND MAP)

By

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OTTAWA

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SALMON ARM MAP-AREA,

BRITISH COLUMBIA

(Preliminary Account)

By

A.G. Jones

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Illustration

Preliminary map - Salmon Arm, B.C. (Second edition)	In envelope

SALMON ARM MAP-AREA, B.C.

INTRODUCTION

The Salmon Arm map-area lies in south-central British Columbia between latitudes 50 and 51 degrees, and longitudes 119 and 120 degrees. Included in the area are the important community centres of Vernon, Salmon Arm, Armstrong, Enderby, and Chase. Kamloops lies 16 miles to the west of the area, Kelowna 10 miles to the south, and Revelstoke 48 miles to the east.

Canadian Pacific and Canadian National railways, highways, second class roads, and logging roads give ready access to much of the area. Boats can be used on Shuswap and Okanagan Lakes and on South Thompson River. Several parts of the area, however, lack roads and good trails.

The map-area is in a deeply dissected southeastern part of the Interior Plateau of British Columbia, with an average relief of about 4,000 feet, the lowest elevation being 1,100 feet, on Shuswap Lake, and the highest 6,990 feet, on Mount Tod. The higher parts of the area are mostly heavily wooded, and vegetation is thick except in the arid region around Okanagan Lake. Overburden is moderate to deep throughout the map-area and, consequently, outcrops are sparse or lacking in many sectors.

The first geological map of the area was made by G.M. Dawson[1] and published in 1897. Daly[2], in 1911 and 1912, mapped the territory adjacent to

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[1]Dawson, G.M.: Shuswap Sheet, B.C., Geol. Surv., Canada, Pub. No. 604, 1898.
[2]Daly, R.A.: A Geological Reconnaissance between Golden and Kamloops, B.C., along the Canadian Pacific Railway; Geol. Surv., Canada, Mem. 68, 1915

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the Canadian Pacific Railway transcontinental line and along the shores of Shuswap and Adams Lakes. Cairnes[1] in 1930 and 1931, and Holland[2] in

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[1]Cairnes, C.E.: Mineral Resources of Northern Okanagan Valley, B.C.; Geol. Surv., Canada, Sum. Rept. 1931, pt. A, pp. 66-109 (1932).

Unpublished map manuscript.

[2]Holland, S.S.: Unpublished report and map manuscript.

1932 conducted more detailed investigations of the general geology and mineral deposits of the southern half of the map-area. During the past 3 years the work has been advanced by Rice[3] (1945-46) and the writer (1947) to the

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[3]Rice, H.M.A.: Salmon Arm map-area, B.C.; Geol. Surv., Canada, Prelim. Map 46-7, 1946.

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extent that the mapping is nearly completed. The accompanying geological map incorporates the results of all previous work, but the conclusions and interpretations presented in it and in this report are as yet necessarily tentative.

GENERAL GEOLOGY

SEDIMENTARY AND VOLCANIC ROCKS

Mount Ida Group

The Mount Ida group, the oldest known in the area, includes a thick series of sedimentary, volcanic, and metamorphic formations, probably conformable throughout, and of Precambrian or Palaeozoic age. The group is overlain unconformably by late Palaeozoic rocks. It occupies about half of the map-area, or that part lying, in general, northeast of a line joining the northwest and southeast corners. The group has been subdivided into eight formations of known stratigraphic positions, and includes some isolated, undifferentiated strata in the southwest corner whose position in the group has not been established.

King Edward Formation

The King Edward formation, named from its typical occurrence in the vicinity of King Edward Lake, southeast of Vernon, outcrops in that part of the area only. The most typical and abundant rocks are hornblende gneiss and schist, but biotitic phases are also common and locally dominant. Mica schist, micaceous quartzite, and marble occur, particularly in the upper strata of the formation. Amphibolitic gneisses and amphibolites are prominent in the Beaver Lake region, and may be in part intrusive. This formation is more severely metamorphosed, thermally and dynamically, than any other of the group. The base of the formation is not exposed.

Larkin Formation

The Larkin formation occurs along the railway north and south of Larkin station, after which it was named, and conformably overlies the King Edward strata. The contact is placed arbitrarily above the bulk of the hornblende gneisses, and for that reason is somewhat indefinite. Included in the Larkin formation are micaceous quartzites, mica schist and gneiss, small amounts of chloritic lava, and rare limestone. These rocks appear along the Armstrong-Vernon highway and in the hills east and south of Vernon. The thickness of the formation has been estimated as more than 13,000 feet.

Chase Formation

The Chase formation is characterized by quartzitic limestone, quartzite, and limy quartzite, but also includes argillite or its metamorphic equivalent mica schist. These rocks are generally white to blue-grey weathering, and exhibit well-defined, widely spaced bedding by colour banding and textural differences. Weathering usually produces thick tablets or slabs parallel with the bedding. The base of the Chase is placed below the lowermost quartzitic limestone, and the top above the uppermost member of the same rock. The thickness is estimated at about 5,500 to 7,000 feet.

Salmon Arm Formation

The Salmon Arm formation lies immediately above the Chase, and is composed of a thick series of argillaceous beds that have been largely metamorphosed to mica schist and gneiss. The least metamorphosed phase of the formation is a phyllite exposed just east of Armstrong. Much of the mica schist and gneiss carries numerous aplite and pegmatite sills that range from an inch to several feet in thickness. Estimates of the total thickness of the formation vary between 7,000 and 28,000 feet, the larger figures applying to regions where much magmatic material has been added.

Adams Lake Formation

The first prolonged volcanic interval is marked by the andesitic lavas and minor tuffs of the Adams Lake formation. The volcanic rocks in their

least altered state are highly chloritized and, therefore, are aptly termed "greenstones", and are in places sheared into chlorite schists. The greenstones merge into hornblende schist and gneiss in local regions of higher grade metamorphism. Flow banding in the lavas is extremely common and provides a fairly reliable guide for mapping attitudes. In places, too, the rock is so finely layered as to be almost indistinguishable from bedded tuff. A few thin argillite members are contained among the volcanic strata. The thickness of the formation is estimated at 9,000 to 14,000 feet.

Mara Formation

The Mara formation, named after Mara Lake where it is well exposed, is a mixed succession of argillite or, more commonly, mica schist, andesitic lava, and limestone members. The schist greatly predominates over the other types, but is commonly limy and grades into argillaceous limestone. The lava resembles that of the Adams Lake formation. The Mara is 5,000 to 10,000 feet thick.

Sicamous Formation

The Sicamous formation can be divided on a lithological basis into three members of approximately equal thickness. The upper and lower members are mostly limestone, with a distinctive platy bedding. The limestone is commonly argillaceous and graphitic, and is generally cut by numerous small, irregular veins of white calcite. The middle Sicamous member is predominantly argillite and limy argillite, with minor amounts of thin-bedded limestone. The best estimates of the formation's thickness range from 6,000 to 10,000 feet, the smaller figure probably being more nearly correct.

Eagle Bay Formation

The Eagle Bay formation is well exposed along the south shore of Shuswap Lake in the vicinity of Eagle Bay, after which it is named, and is the thickest member of the Mount Ida group. It appears only in the north and northeast parts of the area. Most of the formation is greenstone, almost identical with that of the Adams Lake formation. The rock is derived from andesitic lava and tuff in about equal proportions, all of which has been chloritized except where more extreme metamorphism has produced hornblende schist and gneiss. Several limestone members are included in the Eagle Bay formation, two of which are mapped. One of these is Daly's Tshinakin limestone, which is estimated to be 4,000 feet thick. Argillite occurs throughout the formation, and constitutes some thick members. Conglomerate and quartzite are minor constituents, but are locally prominent. The top of the Eagle Bay formation is not exposed within the map-area, so the estimated thickness of 25,000 feet may be considered a minimum.

Undifferentiated Mount Ida Group

In the southwest part of the map-area is a broad, northwest-trending belt of volcanic and argillaceous rocks that have been mapped separately. The volcanic rocks are identical with those of the Adams Lake and Eagle Bay formations, in so far as their megascopic appearance and altered condition are concerned. The widespread alteration is due mainly to chloritization of the volcanic rocks, but within some small areas higher grade metamorphic processes have produced hornblende and biotite schists and gneisses. Small amounts of limestone and quartzite are also present. These rocks are tentatively included in the Mount Ida group on the basis of their lithology, degree and type of alteration, and stratigraphic position with respect to the Cache Creek (?) group. They may be the equivalent of the Eagle Bay formation.

Cache Creek Group (?)

The Mount Ida group is overlain unconformably by formations of Upper Palaeozoic age, lithologically similar, and probably correlative with, the Cache Creek group. The best exposures of the unconformity are at Glenemma (west of Armstrong); on Salmon River, 11 miles south of Westwold; and on the west slopes of Whiterocks Mountain. The conglomerate that marks the unconformity contains pebbles of quartzite, chloritic lava, limestone, vein quartz, granite, diorite, hornblendite, hornblende gneiss, and mica schist, although pebbles of all these types do not occur in every locality.

Two divisions of the Cache Creek group are shown on the map as consisting mainly of argillite or mainly of volcanic rocks, but each of these contains important amounts of the rocks of the other division as well as some limestone, quartzite, chert, and conglomerate. The interstratification of the various rock types is complex and not well known. Included in the group are rocks classed by Dawson as Nisconlith and Cache Creek. Abundant marine fossils of Permian age and some fragmentary fossils of possible Carboniferous age have been found in the argillite or other beds of the volcanic division. The volcanic rocks comprise both tuffs and lavas, generally of andesitic composition. Many of the lavas have abundant augite or hornblende phenocrysts, and many consist of typical flow breccia. The degree of alteration is slight except in local zones of mineralization. Chlorite and hornblende schists are rare, and micaceous schist and gneiss are found only very close to Mesozoic intrusive bodies. Estimates of the thickness of the Cache Creek (?) group are highly speculative, due to the intense faulting, but are probably in excess of 25,000 feet.

Nicola Group

Rocks of the Nicola group appear within the map-area only at the west border, on South Thompson River. They consist mainly of green and purple augite porphyry lavas and flow breccia. Slate, tuff, and limestone conglomerate are minor constituents. Except for slight epidotization the Nicola volcanic rocks are little altered. Recognition of the Nicola group as such rests primarily on projection from the adjoining Nicola map-area to the west, where it is determined to be of Upper Triassic age.

Kamloops Group

Rocks of the Kamloops group comprise volcanic and minor sedimentary types. Lavas of basaltic composition are the characteristic and by far the most abundant of the volcanic rocks, but lavas and pyroclastic rocks of rhyolitic composition are locally dominant. The sedimentary strata are ill-sorted, fluviatile and lacustrine conglomerate, shale, and sandstone, generally loosely cemented, and containing coaly or carbonized organic material such as logs, sticks, and leaves. Talus materials or accumulations of coarse conglomerate commonly mark the base of the group. The sedimentary rocks are more common at the base than elsewhere in the group, but may also occur as layers a few hundred feet thick sandwiched between flows. The Kamloops rocks occur characteristically as flat-lying cappings on many present-day hills and as extensive mesa-like highlands, but are also found in present valleys and at other low elevations. The group overlies the pre-Tertiary formations with marked angular discordance. Beyond the map-area sedimentary rocks of the Kamloops group have yielded a Lower Miocene or Oligocene flora. The observed thickness of the Kamloops group varies from a minimum of about 100 to 2,000 feet.

INTRUSIVE ROCKS

Pre-Permian (?) Intrusions

The existence of pre-Permian intrusive rocks has been almost certainly established. Four miles northeast of Vernon, rocks identical with

those of the Permian Cache Creek group unconformably overlie granite and pegmatite dykes that intrude the Larkin formation of the Mount Ida group. Large bodies of similar types of granite, together with pegmatitic and aplitic intrusions, are seen in the northern half of the map-area, and are associated with extreme metamorphism and granitization of the formations of the surrounding Mount Ida group. It is possible that some of these are also of pre-Permian age although they are all correlated provisionally and mapped with the Mesozoic, Coast intrusions for want of contrary evidence. A small granite body near Vernon is the only one whose age seems definitely to be established as pre-Permian.

The Cache Creek group (?) of sedimentary and volcanic rocks on the west slopes of Whiterocks Mountain, at the southern border of the map-area, unconformably overlies the undifferentiated Mount Ida group and contains pebbles of hornblendite and diorite in its basal conglomerate. Some hornblendite, similar to that of the pebbles has been found cutting the Mount Ida group nearby, although no diorite has as yet been found in place.

On Salmon River southwest of Westwold, the erosional unconformity between the Cache Creek (?) and Mount Ida groups truncates large, serpentinized peridotite dykes that cut the older formations. Similar peridotite dykes, some of which are very large, are abundant throughout the Mount Ida rocks on the west side of the area, but have not been found within the Cache Creek group anywhere in the map-area.

Coast Intrusions

Intrusive rocks correlated with the abundant Jurassic and Cretaceous batholithic intrusions of western British Columbia, occupy extensive areas in the southern half of the map-area. They intrude the Cache Creek (?) group and older rocks as small batholiths, stocks, sills, and dykes. They consist mainly of granodiorite and quartz diorite, and some phases are porphyritic. The only ultramafic rock known to intrude the Permian formations is a body of amphibolite on the south side of Coldstream Valley east of Vernon.

Mesozoic intrusive rocks undoubtedly also occur in northern parts of the map-area, but most of the granitic rocks there are quite different from those in the south. They are in general gneissic, fine-grained, leucocratic granodiorites and commonly contain muscovite. The contacts of these granitic bodies with the Mount Ida group rocks are usually indefinite, and the gneissic banding within the granite is commonly parallel with the foliation or bedding of the surrounding sedimentary and volcanic rocks. The tremendous quantity of pegmatite and aplite associated with these granites is not duplicated by any of the Mesozoic granites around Okanagan Lake. The implication is that much of the granite in the northern half of the area may be of pre-Permian rather than Mesozoic age, but in view of the uncertainty that still exists in distinguishing the older rocks they are included with the Coast intrusions for the purposes of this preliminary report.

Upper Cretaceous or Later Intrusions

Light-coloured, pinkish, granitic intrusions occur at several localities in the vicinity of Okanagan Lake. These have a syenitic appearance and generally contain less quartz than the Coast intrusions. The common rock types are granite, syenite, and quartz syenite. They cut the Coast intrusions, but afford no other evidence of their age in Salmon Arm map-area. In lithology, general character, and mode of occurrence they are similar to the Otter intrusions of Princeton map-area, and may be correlated with them with some certainty. In the Princeton area the Otter intrusions have been determined to be post-Lower Cretaceous and pre-Miocene in age.

STRUCTURE

Most of the faulting and much of the folding of the Mount Ida group in the north and northeast parts of the map-area are probably genetically related to the late Mesozoic orogenic period. Some of the deformation is, however, pre-Permian. On Salmon River southwest of Westwold Cache Creek sedimentary rocks striking north 10 degrees east and dipping 20 degrees west lie unconformably on the greenstone, argillite, and limestone of the Mount Ida group, which strike north 70 degrees east. Possibly the folding along east-west axes and the northward tilt of formations in the northern part of the area are further reflections of the same pre-Cache Creek orogeny.

FAULTS

The pre-Tertiary formations of the map-area are broken into long strips by a system of linked faults. Most of the faults strike northwesterly, but some trend north, and a few, east of north. The dips of most faults are unknown, but probably nearly vertical. Similarly, the nature and amount of movement are not known. Considering the irregularity of most fault traces and the haphazard patchwork effect of the formations between the faults, it might be assumed that the movement was essentially vertical and involved more or less independent blocks.

Small zones of shattering are numerous, and many of the large 'faults' shown on the map actually represent fault zones containing a few to several smaller, parallel faults. The Cache Creek group, especially, is so broken by faults that its constituent formations could not be recognized. Formations of the Mount Ida group, on the other hand, are less intricately fractured, and dips are generally moderate or shallow except near faults. Tertiary formations are, in general, undisturbed or only moderately tilted.

Fault movements, therefore, seem to have taken place before and immediately after the Mesozoic intrusions.

FOLDS

The overall pattern produced by folding is mostly masked by faults. The Sicamous limestone is gently folded along northwest-trending axes in the region southeast of the Salmon Arm, and in the same place is cross-folded along east-trending axes. Folding in the latter direction is also apparent in the Chase formation south of Niskonlith Lake. Several gentle folds, with plunges to the northwest, occur in the Eagle Bay formation.

In the north and northeast parts of the map-area the formations of the Mount Ida group have a general tilt to the north, and thus have strikes normal to those of the faults. The Cache Creek group (?) strata, however, mostly strike parallel with the faults.

The strata of the King Edward formation are everywhere so intensely and minutely folded that attitudes are meaningless on the scale of the accompanying map.

MINERAL DEPOSITS

A list of prospects and mines of the map-area is given on the margin of the accompanying map. None of the metalliferous mines of the area has shipped much ore or concentrate, and no mines except the Falkland gypsum quarries are working at present.

The close relation of mineral deposits to major faults of the map-area was first pointed out by Rice[1].

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[1]Rice, H.M.A.: Salmon Arm Map-area, B.C.; Geol. Surv., Canada, Prelim. Map 46-7, 1946.

Subsequent field work has supported the idea and extended its application to include the gypsum at Falkland. Most of the known deposits occur in presumably Cache Creek rocks.

Prospects of the precious metals, gold and silver, are more numerous than those of base metals. Within a radius of 8 miles of Vernon are many prospects in which the main metal is gold. Beyond that distance, and up to 15 miles from Vernon, a larger proportion of prospects contain silver as the most important metal, accompanied by some lead, zinc, and gold. The most important copper prospects are found in the vicinity of Shuswap Lake.

The gypsum deposits of Falkland appear to be hydrothermal replacements of tuff and argillaceous sedimentary rocks along a major fault zone. The replacement bodies themselves are faulted in directions parallel with the main fault, and for that reason are somewhat discontinuous. Many of the gold and silver-bearing quartz veins in the vicinity of Vernon are, unfortunately, also crushed and faulted. All of these deposits were formed in fault zones and probably later movement along the same faults accounts for the crushing.

The peridotite dykes that cut the Mount Ida rocks on the west side of the area carry asbestos and chromite, but as yet no body of commercial size has been developed.

The coal prospect on Shorts Creek has been examined and described by Cairnes, and similar small Tertiary coal deposits resulting from accumulations of detrital organic material have been noted elsewhere in the area. The areas of Tertiary sedimentary rocks, however, are small, and it is unlikely that coal deposits of commercial size occur in them.