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ROSSLAND MAP-AREA BRITISH COLUMBIA

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H. W. Little

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INTRODUCTION

The stratigraphic and structural study of the Jurassic sedimentary and volcanic rocks, begun in Salmo map-area in 1959 (Frebold and Little, 1962; Little, in press)[1] and continued in 1961 (Little, 1962), was extended westward into Rossland map-area in 1962. As most of the region known to be underlain by these rocks has now been mapped for publication on a scale of 1 inch to 1 mile, the project is regarded as completed. All other rocks within the map-area have also been mapped but have received less attention.

Acknowledgments

The writer was ably assisted in the field by R.I. Thorpe and G.O. Raham. Thorpe also mapped in greater detail that part of the area extending from the eastern slopes of Granite Mountain, Mount Roberts, and O.K. Mountain to the eastern edge of the area, and examined several mineral properties. This work, it is expected, will furnish the data for a Ph.D. thesis. The writer is grateful for the courtesies of many residents of the area, particularly the geological staff of the Consolidated Mining and Smelting Company of Canada Limited, who made available all their pertinent geological maps and reports, both surface and underground.

DESCRIPTION OF FORMATIONS

Map-unit A comprises high-grade metamorphic rocks of uncertain age. Previously (Little, 1962) they were believed to be largely metamorphosed equivalents of the Archibald Formation, but they appear to grade laterally southwestward into the Mount Roberts Formation. Furthermore, relict pebbles of recrystallized chert (?) were seen at various places in the gneiss between Neptune Creek and Columbia River. Marble occurs on the Sullivan Creek logging road, and both limestone and chert-pebble conglomerate are common constituents of the Mount Roberts Formation but have not been seen in the Archibald Formation. Relict pebbles are present also in the gneiss east of Castlegar airport, northeast of the map-area.

The rocks of map-unit 1 resemble parts of the thick and probably complex assemblage of poorly exposed sediments along the lower valley of Pend-d'Oreille River in Trail map-area. In 1962, additional fossils were collected along the road cut 800 to 850 feet easterly from the culvert over Sevenmile Creek. Brachiopods were identified by E.W. Bamber of the Geological Survey as <u>Leiorhynchus</u> sp. (?), which ranges in age from Devonian to Permian. Ammonites, collected from a point about 20 or 25 feet across the strike from the brachiopods, were identified by H. Frebold of the Geological Survey who states that there is little doubt that they are Jurassic, possibly

[1]Names and/or dates in parentheses refer to publications listed in the References.

early Upper Jurassic. The rocks are well exposed at the locality and, in the writer's opinion, no fault of the magnitude necessary to eliminate the entire Rossland Group could exist there. Further work in the field will be necessary to resolve this anomaly. In the meantime, the rocks of map-unit 1 will have to be regarded as of unknown age, but probably no older than Devonian and no younger than Jurassic.

If the rocks of map-unit 1 on Grouse Ridge are older than the Rossland Group it is possible that the contact, which is not exposed there, is an unconformity, in which case map-unit 1 must form the core of an anticline plunging northeasterly. It seems more likely that the contact is the westward continuation of the Waneta fault, for R.G. Yates of the United States Geological Survey (personal communication, December 20, 1962) has found no evidence of the Waneta fault south of the International Boundary for more than a few hundred feet west of Columbia River. The contact, therefore, is shown as an assumed fault and map-unit 1 on Grouse Ridge is regarded as possibly an overthrust plate.

Although argillite and limestone are common in the Mount Roberts Formation (2) the assemblage differs from that of map-unit 1, and greywacke, chert, and argillaceous quartzite are locally abundant. A little agglomerate and some volcanic flows may be present northeast of Paterson. Volcanic rocks occur sparingly in the formation on the south slope of Red Mountain and are more abundant on the north slope.

Fossils collected in 1949 were identified as of Permo-Carboniferous age, a Pennsylvanian age being favoured (Little, 1960, pp. 48-51). From collections made in 1962, only two have been diagnostic. From the most westerly of the localities about 3/4 mile northwest of Paterson, two genera of corals were identified by Bamber. One of these resembles *Dibunophyllum oregonensis* which has been described from the Coffee Creek Formation in Oregon and is considered to be of Mississippian age. The other locality, about 900 feet east of the first, yielded poorly preserved foramanifera identified by T.P. Chamney of the Geological Survey as being of Carboniferous, possibly Pennsylvanian age.

The age of the Mount Roberts Formation is therefore Carboniferous, but it is possible that much of the unfossiliferous sediments in the northern part of the area is Permian, for rocks of this age are widespread to the south and west of the map-area.

The Mount Roberts Formation is overlain unconformably by the Rossland Group (3). The unconformity is exposed on a small hill, 2,200 feet northwest of International Boundary monument No. 175. There basal agglomerate and flow breccia of the Rossland Group contains numerous fragments of rocks of the Mount Roberts Formation, of which limestone that is commonly fossiliferous is most conspicuous. Limestone-bearing agglomerate is widespread in the area and is almost invariably near the base of the Rossland Group.

On the east slope of Mount Roberts and on the north slope of the hill 3 miles north of Rossland, no evidence of structural unconformity between the Mount Roberts Formation and the Rossland Group was seen other than an unusual abundance of fragments of Mount Roberts sediments in Rossland agglomerate. Indeed, the transition from greywacke to volcanic rocks appears to be gradational, with gradual increase upward in the abundance of volcanic rocks, mainly agglomerate or flow breccia.

Throughout the map-area the Rossland Group (3) consists of volcanic rocks with minor intercalations of sediments. Where the latter exceed 100 feet or so in thickness they have been indicated (3a) on the map, but rarely are they more than about 200 feet thick. These sediments are hard, black to grey siltstones that resemble those of the Archibald Formation which underlies the volcanic rocks of the Rossland Group to the east in Trail and Salmo map-areas. Similar sediments, but with much interbedded volcanic material (3b), occur near Rossland. Bodies of augite porphyry (3c), believed to be mainly intrusive, are prominently developed near Rossland and are probably sills and laccoliths related to Rossland volcanism.

Fossils collected from unit 3a at three localities were identified by Frebold. Arnioceras sp. of Sinemurian (early Lower Jurassic) age occurs at an elevation of 3,750 feet on the nose between Grouse Ridge and Malde Creek, 1.15 miles due north of the International Boundary. A poorly preserved pelecypod from a point 0.6 mile due west of that locality, and small ammonites from Ivanhoe Ridge 1 mile southeast of the highway were regarded as probably of Sinemurian age.

An apparent thickness of at least 2,000 feet of lava lies stratigraphically below the sediments of the first of these three localities, and, if a thrust plate of map-unit 1 is assumed, an additional thickness would be concealed under it, but not if the contact is an unconformity. Sediments at the second locality are about 1,100 feet stratigraphically above the first. Sediments at the last locality appear to be about 6,800 feet above the unconformity at the base of the Rossland Group. However, as volcanic rocks only are exposed in this interval, and no attitudes could be obtained, the structure is not known and the true thickness may be less.

To the east, in Salmo map-area, the basal Rossland volcanic rocks are underlain with apparent conformity by a great thickness of fossiliferous sediments of Sinemurian age—the Archibald Formation (Frebold and Little, 1962). In Rossland map-area, however, this is not the case, except perhaps on the hill about 1 1/2 miles south of Blueberry Creek in the northwest part of the area where sediments resembling the Archibald beds rest upon rocks correlated lithologically with the Mount Roberts Formation. The contact, if exposed, was not seen, but the dips of the capping rocks are very steep so that the beds appear to be truncated below. This contact is therefore probably a fault, though as its nature is not known it is not so shown on the map.

Sediments resembling the Hall Formation of Toarcian and later age (Frebold and Little, 1962) were encountered only on a ridge about 2 miles northwest of Old Glory Mountain (3d). Ammonites collected from them were identified by Frebold as "Harpoceratids, poorly preserved. Gen. et sp. indet. Age: Toarcian". Because these sediments are very little metamorphosed they may be in fault contact with the adjacent Coryell batholith. Their extent is very limited.

In summary the Rossland Group within Rossland map-area consists almost entirely of volcanic rocks. The lower part is equivalent in age to the Archibald Formation of Salmo map-area. Toarcian sediments are very limited in extent, and none of the post-Toarcian succession exposed in the Salmo map-area appears to be present in Rossland map-area.

Bodies comprising mainly serpentinite (4) form a belt extending from the west slope of Deer Park Hill southwestward to Big Sheep Creek, and another small body occupies the southwest corner of the map-area. The serpentinite is cut by Coryell syenite, by quartz-feldspar porphyry (7) and by dykes believed to be Nelson (5).

The largest body of Nelson plutonic rocks (5) is the Trail batholith, the western part of which lies between Murphy and Milkranch Creeks, and is largely quartz diorite. The southern end of the Nelson batholith, extending perhaps 3 miles into the map-area, appears to be largely diorite. East of Mount Mackie, however, there is a body of biotite granite or quartz monzonite (5a) containing numerous moderate-sized phenocrysts of flesh-coloured feldspar that resembles certain phases of the Valhalla plutonic rocks (Little, 1960). Elsewhere in the area, smaller bodies of Nelson rocks occur.

Map-unit 6, comprising the so-called 'Rossland monzonite', consists of mainly medium-grained monzonite. It was previously regarded by the writer (Little, 1960, pp. 77, 80) as probably of metamorphic origin and therefore earlier than the Nelson rocks. In many places it does indeed appear to grade into Rossland lavas of similar composition. The relationship between the type body at Rossland and the Nelson has not been established. Southeast of Trail and on Mount Neptune, rocks that are megascopically similar to the monzonite cut Nelson rocks. In the new highway cut just northwest of Rossland the monzonite grades into a porphyritic facies, but this differs in appearance from the porphyritic monzonite that occurs in discrete bodies (10a), believed to be related to the Coryell.

An irregular body of quartz-feldspar porphyry (7) occurs on the east side of Big Sheep Creek in the vicinity of the Velvet mine, and it differs in appearance from all other acidic and intermediate rock types. Its relationship to the Nelson is unknown, but it is older than the Coryell.

The Sophie Mountain Formation (8) outcrops on Grouse Ridge, Mount Sophia, and in a hill in the southwest corner of the map-area. On Grouse Ridge, roundstones in the conglomerate are as large as 2 or 3 feet in diameter on the east side and generally less than 9 inches on the west. They are commonly subangular to subrounded. On Mount Sophia the largest roundstones are rarely more than 6 inches in diameter. Nearly all roundstones at both localities consist of hard, brownish purple quartzite, some of which is feldspathic.

The roundstones in the conglomerate in the southwest corner of the map-area are up to a foot in diameter and consist predominantly of brownish purple quartzite but, unlike the conglomerate farther east, other rock types are abundant. Dyke and granitic rocks, one or two of which megascopically resemble phases of the Nelson rocks, are common, and some vein quartz and greywacke form pebbles and a few boulders. This conglomerate, because of the presence of the brownish purple quartzite, is tentatively correlated with the Sophie Mountain Formation.

This distinctive quartzite has not been encountered in place, but because of the size and subangular shape of the largest roundstones the source must have been not very distant. The source rock must therefore have since been removed by erosion or by faulting.

The lavas capping Old Glory Mountain and extending northward into the valley of upper Lamb Creek (map-unit 9) are more alkaline in character than the Rossland Group and closely resemble Daly's Midway Group (Daly, 1912) of early Tertiary age. Furthermore, the more northerly exposures are apparently underlain locally by a thin bed of creamy to white arkose that resembles some of the Kettle River

Formation, which underlies the Midway lavas to the west. The most abundant rock is agglomerate, but dark greenish grey porphyritic flows, probably basalt, are interbedded and are best exposed on the ridge extending southward from the summit of Old Glory Mountain, where they dip gently southwestward. There the volcanic rocks are traversed by large dykes of syenite from the underlying Coryell batholith.

The Coryell batholith is the largest body of Coryell rocks (10) in the map-area and underlies much of the western part. It comprises a complex of rocks that vary in composition from syenite to granite and quartz monzonite, quartz-bearing syenite being the dominant rock type. They vary in grain size from coarse to fine. The dominant colour is pink or reddish, but some phases are almost white. In some places, particularly east of Old Glory Mountain, the rock is porphyritic, and there biotite is the common visible accessory. Elsewhere hornblende also is relatively abundant, and a little augite and sphene may be seen. Fine-grained porphyritic green dykes are numerous both within and adjacent to the batholith, particularly the southern part. These are believed to be late phases of the Coryell. In the northwestern part of the area pink syenite dykes are unusually numerous.

Several smaller bodies of Coryell rocks, mainly syenite, occur in the area. There are also a number of small bodies of porphyritic augite-biotite monzonite (10a) that are believed to be an early facies of Coryell intrusion. On the ridge north of Hanna Creek, one such body, containing large facetted plates of biotite, appears to grade into normal syenite and seems to be a contact phase of the Coryell batholith.

Sheppard aplitic granite (11) forms several small bodies in the southeast part of the area, where it cuts the Sophie Mountain Formation. Aplite dykes are numerous there and are present in some other parts of the area. A large dyke of granite porphyry near Rossland is believed to be Sheppard.

Near Paterson two small plugs of diorite (?) porphyry (12) are shown. One of these cuts Sheppard aplite. Other smaller bodies of megascopically similar rock occur elsewhere, especially near Rossland. Drysdale (1915, p. 27, 28, 215-218) stated that there, however, it is a border and dyke facies of the Nelson granodiorite, with which it is said to be gradational, and that it is cut by monzonite. In the central Rossland mines, dykes of diorite porphyry cut the monzonite.

Structural interpretations are uncertain and tentative due to paucity of outcrops, horizon markers, top determinations, and fossils, and limitations imposed by the scale of mapping, size of party, and time. Most data have been obtained in the vicinity of Rossland. There Thorpe suggests that the Mount Roberts Formation during Rossland time consisted of an open anticline, the axis of which is near the valley west of Red Mountain. This anticline was bevelled by erosion, and on the unconformable surface volcanic and sedimentary rocks of the Rossland Group were laid down. Subsequently, possible thrust faulting from the west caused repetition of the succession west of the present position of the large northerly trending dyke of syenite (pulaskite ?). Imbricate structure related to this fault would account for the intimate mixture of lavas and sediments that resemble the Mount Roberts in the wedge of rocks mapped as Rossland just north of the serpentinite body in Little Sheep Creek. Subsequently the rocks were tilted to the west and block faulting may have occurred. Three such north-trending faults, on which the east side moved down, are postulated. One is now occupied by the syenite dyke; the second lies in the valley west of Red Mountain; and the third is just east of the summit of Red Mountain. No evidence of this fault is visible and perhaps the body of augite porphyry was intruded along it, though this is regarded as unlikely because the augite porphyry is believed to be genetically related to the Rossland lavas. Along the new highway for some distance north of Topping Creek the rocks are highly sheared where a lineament is evident on the aerial photographs.

Near Paterson the Mount Roberts Formation trends northeast with steep to vertical dips. Several top determinations from crossbeds were made, but very few with confidence. The top determinations indicated tight isoclinal folds but drag-folds and fracture cleavage that would be expected, are singularly uncommon. The overlying Rossland Group has in general a similar trend but appears to form more open folds with local flexures in which the strike is northwest and the dip northeast, indicating a northeast plunge at least as far as Baldy Mountain.

North of Hanna Creek little is known of the structure, but it is probable that the Mount Roberts Formation is tightly folded. To the northeast these rocks appear to grade into paragneiss which can be traced several miles northeastward. In upper Murphy Creek, however, the Mount Roberts Formation trends westward and can be traced some miles west of the map-area.

Few major faults have been found in Rossland map-area. No evidence of the continuation of the major fault along Beaver Creek in the adjoining Trail area (Little, 1962, p. 5) was found. The fault that passes through Warfield could be traced only as far as Hanna Creek but may extend much farther. Rocks older than Coryell are intensely sheared in the uppermost part of Lamb Creek.

No ore was produced from any mines in the area in 1962, but exploration was carried out by a few companies. One object of this project was to determine if possible the time of emplacement of the gold-copper ore of the central mines of Rossland Camp. Brock (1906, pp. 15-18) thought the ore was earlier than the lamprophyre and basic and acidic dykes, though in the Giant and Jumbo mines he saw ore in and around alkali syenite (Coryell) dykes. Drysdale (1915, pp. 85-93, 140, 148) contended that successive intrusions of lamprophyre occur, variously related to the Nelson (Trail), Coryell, and Sheppard intrusions. The first were cut by sulphides, with little or no gold; the second by gold-bearing veinlets; and the third were unmineralized. Drysdale considered that sulphide mineralization with minor gold was related to the Nelson and gold mineralization to the much later Coryell. He admitted the Coryell "pulaskite" adjacent to the Spitzee and Giant orebodies is slightly impregnated by sulphides but presumably related this to his later period of mineralization. However, it is apparent that the positions of these orebodies are controlled by the "pulaskite" contact, and the ore, therefore, in the present writer's opinion, is later than Coryell.

Bruce (1917, p. 235) favoured two periods of mineralization, but contended that abundant sulphides accompanied the gold of the later period.

Gilbert (1948, p. 193) could see no good evidence for two periods of mineralization, and concluded that all the dykes in the mines are older than the ore.

In 1962, only the upper workings of the central mines were accessible, though parts even of these were inaccessible or dangerous. The accessible workings were examined carefully by the writer and his assistants who were greatly aided by plans supplied by the geological staff of the Consolidated Mining and Smelting Company of Canada. The veins traverse the monzonite (which is younger than Nelson) and diorite porphyry which cuts the monzonite. Pyrite stringers from the veins cut lamprophyre dykes that intrude the diorite porphyry, and long stringers of chalcopyrite from the vein cut a mica lamprophyre that intrudes monzonite and may be younger than the diorite porphyry. Assays to determine whether this chalcopyrite carries gold have not yet been made. In most places the veins terminate against the lamprophyre dykes and continue beyond them. In some places, however, the vein swells against the dykes, indicating the dykes acted as a barrier; in others the vein pinches out as the dyke is approached from either side, likewise suggesting that the dykes influenced ore deposition. In no place were xenoliths of ore found in the lamprophyres, nor were dykelets from the main dykes seen to enter the ore.

The writer therefore agrees with Gilbert that there is no good evidence for more than one period of mineralization or that this is related to Nelson intrusions. Indeed, all the evidence seen by the writer suggests that the ore in the central mines was probably related to Coryell intrusions and is therefore believed to be Tertiary.

An examination of the lower workings of the Velvet mine was made. The ore there is younger than the Coryell and therefore Tertiary.

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