CANADA
DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 44-20

NICOLA
BRITISH COLUMBIA

(MAP AND DESCRIPTIVE NOTES)

By

W. E. Cockfield

OTTAWA
1944

CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

Paper 44-20

NICOLA MAP-AREA, BRITISH COLUMBIA

(Descriptive Notes)

By

W.E. Cockfield

OTTAWA, 1944

CONTENTS

Illustration

NICOLA MAP-AREA, B.C.

INTRODUCTION

The map-area lies east of Cascade Mountains within the belt of Interior Plateaux. Topographic features comprise rolling summits, broad upland areas, and deeply cut valleys. Thompson River and its main tributaries, the North and South Thompson, and Nicola River occupy the master valleys. A considerable part of the area consists of the open sage-brush covered country that is characteristic of the "dry belt" of British Columbia. Forest growth on the lower slopes of the hills, particularly on southern and western exposures, consists of widely spaced trees forming open, park-like areas. On the upper and northern slopes the forest growth is dense, and in places large amounts of windfall render travel difficult.

The entire area has been glaciated, and glacial striae were observed on the highest summits. The general direction of movement of the ice-sheet was southeasterly and locally southerly. Many raised beaches, terraces, and abandoned deltas point to extensive changes of drainage during the retreat of the ice.

GEOLOGY

The oldest formations recognized occur mainly in the eastern part of the map-area and consist of a group of altered sedimentary and volcanic rocks (1)[1]. They represent, in the main, formations

[1] Numbers in brackets refer to map-unit numbers on the accompanying map and map legend

in the main, formations formerly included in the widespread Cache Creek series, and are so greatly altered and deformed that their succession could not be determined. Many of the more prominent bands of limestone (1a) were mapped separately in the hope that they would serve as horizon markers, but they were found useless for that purpose. In places, however, they contain fairly abundant, poorly preserved fossils. Collections made by the writer suggest a Pennsylvanian age; others, possibly more diagnostic, made elsewhere indicate that the rocks may be Permian. At a few localities these rocks show decided foliation.

In the northeastern part of the area greenstone is relatively abundant and has been mapped separately (2). These greenstones are generally fine-to medium-grained, badly altered, and generally slightly schistose rocks, and are believed to be continuous with similar rocks to the north of the map-area that have been mapped by Uglow[2] as the Fennell formation and by Walker[3] as the Fennell batholith. They were

[2] Uglow, W.L.: Geol. Surv., Canada, Sum. Rept. 1921, pt A, pp. 77-78.

[3] Walker, J.F.: Geol. Surv., Canada, Sum. Rept. 1930, pt.A, pp. 132-133.

considered by Uglow to consist of sills and lavas and by Walker to be entirely intrusive. At a few points evidences of flow structures were obtained by the writer and the rocks are, consequently, believed to be interbedded with the Palaeozoic sedimentary rocks and are grouped with them. The possibility that some of them represent sills is not precluded.

A group of foliated rocks (A) is shown separately on the map. Their age is composite for although they are believed to be mainly late Palaeozoic, Triassic members may be present. They also include much granitic material.

The Triassic period (3) is represented largely by volcanic rocks that are mainly greenstones. These volcanic rocks include green, red, or grey lavas with breccias, agglomerates, and tuffs. In places thin bands of argillite, lenses of limestone, and, more rarely, thin beds of conglomerate are present. The lavas are mostly andesites and basalts and are in large part fine-grained, but include hornblende and augite porphyries and feldspar porphyries. Much of the rock is altered and chloritized. The rocks are generally massive and boundaries between individual flows are difficult to distinguish. Fossils were found at points widely scattered over the map-area, chiefly in the limestones, but some were obtained from the argillite and, at one locality, from conglomerate. Most of the fossils are poorly preserved and not diagnostic, but determinations made indicate an Upper Triassic age. The name Nicola group was given to this assemblage of rocks by Dawson[1], and this district constitutes

---

1 Dawson, G.M.: Geol. Surv., Canada, Rept. of Prog. 1877-8, pp. 74-76B; Ann. Rept., vol. VII, pt. B, pp. 54-56, (1894).

---

the type area for the group.

Owing to the difficulty of determining the attitude of these volcanic rocks, their structure is only imperfectly known. Locally, however, attitudes were obtained on tuff or other sedimentary beds. Synclinal folds are indicated in places near the eastern margin of these rocks in the Meander Hills south of Nicola Lake and in the valley of Stump Lake. The Iron Mask batholith near Kamloops is also intruded into one limb of a syncline. On Swakum Mountain there is evidence of an anticline with a northerly trending axis. The folds in the southern part of the area appear to trend north; near Kamloops Lake, however, the trend is to the northwest.

A small body of volcanic rocks (4) of Jurassic or possibly Cretaceous age occurs near the southwestern corner of the map-area. It is composed of lavas that were not recognized elsewhere in the map-area, but are more extensive to the south in the Princeton map-area[2] where they are described

---

2 Rice, H.M.A.: "Preliminary Map, Princeton, British Columbia, and Descriptive Notes"; Geol. Surv., Canada, Paper 42-6

---

as hard, dense, red and purple lavas with the composition of andesite. There they were found to occupy a stratigraphic position between the Upper Triassic and Lower Cretaceous groups.

Intrusive rocks (5) range in composition from granite to gabbro and represent possibly several periods of igneous activity. All are younger than the Triassic rocks (3) and pebbles and fragments of some of them are found in the Lower Cretaceous agglomerates (6). The main bodies are composed principally of granodiorite and quartz diorite and many of the mineral deposits of the area are presumed to be related to them. One body deserving special mention is the Iron Mask batholith (5b). It ranges in composition from syenite to gabbro, but is mainly diorite and gabbro. Quartz is largely absent from these rocks and is also sparse in the mineral deposits that occur within the area of the batholithic rocks. Small bodies of pyroxenite occur within the outcrop area of the batholith, but are believed to represent an earlier intrusion.

Rocks of Lower Cretaceous age (6) occur in the southwestern part of the area adjoining a belt of similar rocks in the Princeton map-area, and are believed to extend down the valley of Nicola River to join with an area of rocks of similar age near Spences Bridge[1]. An agglomerate at the base

---

1 Drysdale, C.W.: Geol. Surv., Canada, Sum. Rept. 1912, pp. 136-138

---

contains boulders and blocks of granitic rocks and of hard, reddish lava (4). It is overlain by breccia, basalt, and feldspar porphyry. Many of the exposures are not readily distinguishable from Triassic volcanic rocks (3), and in the area between Coldwater River and Howarth Creek outcrops of fossiliferous limestone indicate that some at least of the associated volcanic rocks are Triassic. Arkose and conglomerate appear at one locality on the southern slope of McInnes Mountain, but their relations to the volcanic rocks are not known. Outcrops of rhyolite were observed at a few places on the slopes overlooking lower Nicola River. Similar rocks are reported by Drysdale from the Spences Bridge formation. No identifiable fossils were obtained from the group within the map-area, but at Kingsvale, a short distance to the south, Rice[2] obtained plant remains of Lower Cretaceous

---

2 Rice, H.M.A.: Op. cit., p. 3

---

age. Included with the rocks of this group are a number of smaller bodies of breccia and agglomerate that carry boulders and fragments of the granitic rocks of the region or of the Triassic limestones, and which in part would not otherwise be distinguishable from the Triassic volcanic rocks. It is probable that the separation of these members from the Triassic volcanic rocks is by no means complete. The Lower Cretaceous rocks in the southwest part of the area strike in general northwest and dip at low angles to the southwest. Locally, however, they are steeply inclined.

Two groups of rocks (7 and 8) are mapped as Lower Cretaceous or later. One group (7) occurs only in the northwest part of the area. It was mapped by Dawson and Drysdale as Tertiary. No positive evidence of its age was obtained, as no identifiable fossils were found. The relations of these

rocks to those of proved Cretaceous age are unknown, but they are intruded and mineralized by granitic rocks that have been found invading rocks of known Tertiary age. The presence of fossil twigs, fragments of wood, and plant stems indicates that the rocks are probably of continental origin. They dip to the east and southeast, and in the vicinity of Carabine and Criss Creeks are cut by small granitic stocks.

Overlying these strata is a group of volcanic and sedimentary rocks (8). These appear only in the northwestern part of the area, east of Durand Creek, on Carabine Creek and near Pass Lake. At the latter two localities small bodies of picrite occur. This is a porphyritic rock either mottled dark and light green, or dark red and light green owing to the development of hematite as an alteration product within large crystals. It consists essentially of large rhombs or rounded rhombs of olivine, now largely altered to serpentine, with hematite and magnetite, and smaller crystals of pyroxene, in a fine-grained groundmass of pyroxene, serpentine, and other minerals. In places the picrite is partly altered to magnesite. The rock is believed to be extrusive. A thin band of clastic rock composed essentially of the same minerals occurs east of Carabine Creek, and is thought to be related to the picrite at that locality. It consists of grains of a mineral probably formerly olivine but now nearly completely altered to serpentine, grains of pyroxene and clay, and magnetite, hematite, and other minerals. The rock is well bedded and is a tuff similar in composition to the picrite extrusives. The rocks of this group are also intruded by the granitic stocks referred to above.

Certain small stocks of granite and granodiorite (9) cut Cretaceous (?) sedimentary and volcanic rocks (7 and 8), and are probably of Upper Cretaceous or Tertiary age.

Tertiary sedimentary rocks (10) occur at a number of localities. In the mapping they have been subdivided into two main groups wherever possible. The beds of the Coldwater group (10a) occur in the southern part of the area and consists of sandstone, shale, and conglomerate with coal seams, but contain, so far as is known, no intercalated lava flows or tuffaceous material. Fossils collected from them indicate an Upper Eocene age, and at Merritt, along Nicola River east of Merritt, and at Quilchena Creek, the strata are apparently overlain unconformably by lava flows. At the latter two localities the lava flows may be much younger than the Oligocene lavas (11) whereas those at Merritt may be Oligocene. No rocks that could with certainty be referred to the Coldwater group were found in the northern part of the map-area. Many of the other occurrences of Tertiary sedimentary rocks are mapped as the Tranquille group (10b). These also consist of shale, sandstone, and conglomerate with thin beds of coal, but tuff makes up a very considerable part of the group. Fossils collected from these rocks indicate an Oligocene age, but this evidence is not in itself sufficiently conclusive to affirm that they differ in age from the Coldwater group. In places, however, they are underlain and overlain apparently conformably by Tertiary lavas (11) and it is, consequently, felt that the subdivision into the two groups is justified.

Much of the map-area is underlain by Tertiary volcanic rocks (11). These are mainly green or purple andesites and brown, black, or grey basalts, with minor amounts of trachyte, and white to pale grey rhyolite. In places they rest with

apparent unconformity on Tertiary sedimentary beds, but in other places seem to be conformable with them. The uppermost flows are commonly nearly horizontal, and these and certain flows developed as escarpments along some of the valleys are probably relatively young. Those nearly horizontal flows occurring in the valleys have been mapped separately (11a). They consist of vesicular basalt and, on Quilchena Creek, a flow of this rock rests upon unconsolidated material consisting of greenstone detritus, whereas nearby Tertiary sedimentary beds (10a) dip nearly vertically. It seems probable that most of the Tertiary volcanic rocks are of Oligocene age, but that Miocene or possibly more recent members are present. Except as mentioned above, however, no separation could be made.

MINERAL DEPOSITS

Lode Deposits

The mineral deposits of the map-area represent a number of diverse types and have provided several productive properties. The total production has not been large, however, in comparison with some nearby districts. In the period from 1900 to 1939 the production of the principal metals, such as gold, silver, copper, lead, and zinc, from Kamloops and Nicola mining divisions was slightly over $3,000,000. This would comprise the production of nearly all the principal properties of the map-area, but also includes the production of some properties that lie outside the area.

Vein deposits of gold and silver, with lead, zinc, and copper, occur in the Triassic greenstones at Stump Lake, and similar veins and replacements occur in the greenstones and limestones on Swakum Mountain. Much work has been done on the Stump Lake deposits, which were among the early lode discoveries of the province, and shipments of ore and concentrates have been made from time to time. The veins are commonly less than 2 feet wide, but have been followed for considerable lengths, in one case up to 1,800 feet, and have been proved by workings and drilling to a maximum depth of over 1,000 feet. The ore occurs in shoots within the veins, with intervening narrow or low-grade sections. On Swakum Mountain, much less work has been done on deposits of a similar type.

Copper-bearing deposits occur in the granitic rocks along Guichon Creek and form an easterly extension of the Highland Valley camp. They contain copper minerals associated in many places with molybdenite and tourmaline, and occur as veins and in shattered zones in the granitic rocks. In some instances, as at the Snowstorm, low-grade mineralization is found over considerable widths. Some bodies of high-grade ore have been mined from properties within the map-area, notably at the Snowstorm and Aberdeen mines.

Many copper deposits are situated in and around the Iron Mask batholith. Those within the batholith are marked by a scarcity of quartz and an abundance of magnetite and apatite. Scarcity of quartz and fairly abundant magnetite and apatite are also features of the diorite and gabbro. The deposits occur as veins, impregnations in the country rock, and as stock-works. Only a few show good gold values. In many places there is a pronounced development of pink

albite and epidote in the country rock adjacent to the deposits, and this alteration may be of significance in the search for other ore-bodies. Many of the deposits are impregnations in the country rock and have poorly defined walls. The principal producers have been the Iron Mask and Copper King mines. Some deposits situated in the Triassic rocks surrounding the batholith contain more quartz and may have an origin unrelated to the batholith. Veins of magnetite and apatite also occur in the rocks of the Iron Mask batholith. Shipments of about 15,000 tons were made from the Glen Iron mine prior to 1902 to be used as a flux for smelting copper ores.

Many scattered veins and disseminations of copper minerals have been found in the Triassic volcanic rocks; bands of specular hematite carrying copper minerals also occur in them; and a lead-zinc deposit with barite gangue appears in these rocks on Iron Mountain.

Quartz veins are numerous in Palaeozoic sedimentary rocks in the northeastern part of the map-area and in small granitic stocks that cut these rocks. They have been explored chiefly for their gold and silver content, but to date production has been very small. Locally good gold values have been obtained. In some instances the veins within the sedimentary beds have been greatly disturbed by faulting. Veins within granitic rocks near Jamieson Creek and near Ramage range up to about 20 feet in width, but none has yet proved to be economic. Quartz veins also appear in Palaeozoic sedimentary strata west of Criss Creek, but gold assays obtained from these are low. High-grade gold ore was obtained in veins in porphyry dykes cutting serpentine on Cannel Creek, but development work proved the material to lie in huge blocks of drift partly buried in glacial materials. Although similar porphyry dykes have been found in place, exploration work to date has disclosed only low-grade ore in them.

Gold-silver deposits occur in Cretaceous (?) sedimentary rocks close to a granitic stock on the upper part of Criss Creek. These contain abundant sulphide minerals, such as pyrite, galena, sphalerite, and chalcopyrite, but as a rule are low grade although promising assays have been obtained at some places. Quartz veins with molybdenite appear on the same properties.

Two deposits of contact-metamorphic origin are known. One is on Swakum Mountain and consists of a band of limestone altered to garnet and epidote and carrying copper minerals and scheelite. The deposit is at least 350 feet long and has an average width of 40 feet. It has been proved by drilling to extend to a depth of at least 200 feet at several points. The tungsten content is low. A second deposit consisting of skarn rock with magnetite is situated north of Heffley Lake. In neither case is intrusive rock known in the immediate vicinity of the deposits.

Mercury showings are widely scattered in the northwest corner of the map-area from near Tunkwa Lake to Criss Creek. They occur in the Triassic volcanic rocks and in Cretaceous (?) sandstones, conglomerates, and volcanic rocks. The deposits in greenstone commonly show the enclosing rock altered to ankeritic carbonate. The cinnabar is associated mainly with veins and stringers of dolomite, and to a lesser

extent with rock that has been replaced by chalcedony. The cinnabar occurs as small grains and short, narrow seams. Mercury production from these deposits has been less than 150 flasks, largely produced prior to 1900 and mostly from the one property at Copper Creek. Nearly all the mercury prospects were prospected or developed to some extent in 1940 and 1941, and on two of them small quantities of ore were retorted on an experimental scale. The resulting production was less than 2 flasks of mercury. Deposits disclosed during this period of prospecting were nearly all low grade. The formation of rusty weathering carbonate zones is noticeable on both sides of Thompson Valley in the western part of the area, but relatively few mercury deposits are known on the south side. Several similar carbonate zones occur in the valley of the upper part of Nicola River. No cinnabar was found with them.

Placer Deposits

Placer mining has been carried on in the map-area since the early sixties, generally on a small scale and with low returns. The production of placer gold in Kamloops and Nicola mining divisions between the years 1900 and 1939 was 2,981 ounces valued at $69,723. Most of this came from Kamloops mining division. This figure includes the total production of the map-area except for a small part that lies within Ashcroft mining division, but also includes some placer gold produced from creeks lying outside the map-area. Parts of the lower reaches of Tranquille River, Jamieson Creek, Criss Creek, and the part of Thompson River immediately below the mouth of Deadman Creek have been worked. Several attempts were made to dredge North Thompson River near the mouth of Jamieson Creek and the lower part of Tranquille River, but these were not successful. A small amount of work was being done on the lower parts of Criss Creek and Tranquille River during the period 1939 to 1941.

Industrial Minerals

Industrial minerals within the map-area include gypsum, hydromagnesite, sodium sulphate, sodium carbonate, magnesium sulphate, and diatomite. Gypsum occurs at a number of localities, as, for example, on the benches north of Merritt, on the benches west of Knutsford, and east of Carabine Creek. Small shipments made from time to time have been used chiefly for fertilizer. Deposits of hydromagnesite occur near Buce Lake, Barnhart Vale, and Campbell Range, but have not been utilized. Sodium sulphate, sodium carbonate, and magnesium sulphate occur in and around some of the small ponds scattered over parts of the area. A limited production of sodium sulphate and sodium carbonate has been made. Diatomite occurs with Oligocene sedimentary rocks near Red Lake post office in the northwestern part of the area.

Coal

Coal has been mined for many years from the basin of Coldwater rocks (8a) near Merritt. The mines of Middlesboro Collieries, Limited, have operated for a period of 37 years, and for much of that time have been the only

mines producing coal in the map-area. In 1943, however, some of the workings of the Diamond Vale colliery were being opened up after having been idle since 1917. Owing to the lack of a complete section, it is impossible to relate the different exposures to one another. However, it appears probable that as many as ten coal seams are represented. At the western margin of the basin, where mining is now being carried on by Middlesboro Collieries, the rocks lie in tight folds with axes striking northwest and plunging southeast. The dip of the measures is in many places 70 degrees. In the central part of the basin the dips are more moderate, the strata striking generally northwest and dipping southwest at around 30 degrees. The actual extent of the coal measures beneath the drift in Nicola Valley is a matter of conjecture. In places this drift attains a thickness of from 40 to 175 feet, and one drill hole is reported to have penetrated 600 feet of glacial and alluvial material. Although drilling has been done, the records of some of the holes are not available. One hole near the junction of Nicola and Coldwater Rivers is reported to have penetrated into the underlying volcanic rocks without encountering the coal measures. It is probable that near the northern edge of the basin these measures have been completely removed by erosion in places. One point of importance is that a nearly horizontal flow of basalt on the south side of Nicola River is deemed to be of Oligocene or Miocene age and, consequently, younger than the coal measures. This was shown in an earlier report[1] as a tongue of Triassic

---

[1] Ells, R. W.: Map-Coal Basins of Quilchena Creek, Coldwater River, Coal Gully, and Guichon Creek; Geol. Surv., Canada, Ann. Rept. Vol. XVI, 1904.

---

volcanic rocks with the coal measures lying on either side of it. The writer's interpretation is that these basalts are younger than the coal measures and that the latter would pass beneath the basalt unless, of course, they were removed by erosion prior to the extrusion of the lava flows.

On Quilchena Creek very little mining has been done, but drilling a number of years ago encountered several seams of workable coal. A little coal has been mined for local use.

Similar rocks occur in the valley of Guichon Creek where, however, only isolated outcrops could be found. This basin is probably separate from the Merritt basin but its extent is not known. Some drilling was done, but the results are not known to the writer.

Thin seams of coal were discovered, in 1888, in Tertiary rocks on Guerin Creek southwest of Kamloops. Although some development was done and a small amount of coal was mined for local consumption, the occurrence was not found to be economic. Boring undertaken in these beds farther to the northwest, near Tranquille, failed to disclose coal.