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PRELIMINARY MAP

VANCOUVER NORTH

BRITISH COLUMBIA

By

J. E. Armstrong

OTTAWA
1954

Price, 25 cents

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(Descriptive Notes)

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DESCRIPTIVE NOTES FOR VANCOUVER NORTH MAP, B. C.

Introduction

The map-area occupies part of the Coast Mountains, north of Burrard Inlet, and part of the Georgia Depression, which includes the Fraser River Lowlands and the Gulf of Georgia. Much of the mountainous part is difficult to explore, as the slopes are either covered with dense forest growth or their continuity is interrupted by precipitous rock faces.

Sedimentary and Volcanic Rocks

The Bowen Island group(1) was named from its widespread occurrence on Bowen Island where the rocks comprising the group have been least affected by metamorphism. In mapping these rocks on Bowen Island and other nearby islands, it was found that they fell naturally into two main divisions, one consisting largely of basaltic and andesitic lavas and the other of interbedded tuffs and sedimentary rocks. However, no definite stratigraphic sequence could be worked out, as similar lithological types occur throughout the section. All the rocks are recrystallized to some extent, but primary structures are generally preserved, and in most places the Bowen Island strata appear to occupy compressed folds striking about north 70 degrees west.

The most abundant rock types are the lavas, which are generally massive, medium- to fine-grained, dark green rocks consisting primarily of hornblende and plagioclase feldspar. Interbedded with the flows are sheared agglomerates and breccias of similar composition. The tuffs are mainly fine-grained, thinly banded rocks, which grade into cherty looking rocks showing only faint traces of bedding. Interbedded with and grading into the tuffs, but not so thick, are quartzites, argillites, and slates. In places the tuffs and interbedded sedimentary rocks have been metamorphosed to chloritic and biotitic schists.

The pre-granitic rocks outcropping in the Lynn Creek, Hollyburn, Caulfeild, and Horseshoe Bay areas have been correlated with the Bowen Island group mainly on lithological evidence, although, owing to extensive metamorphism and metasomatism, the correlation is at best only the most reasonable assumption, and possibly some of these rocks should be correlated with the Gambier group. Changes in the rocks exposed in the Lynn Creek area and in the area including the summits of Mounts Strachan and Hollyburn(2A) have resulted in the abundant development of fine-grained chlorite, epidote, and albite. In many places the original textures have been obliterated, although major structures are preserved. On the other hand, the rocks exposed on the lower slopes of Mount Hollyburn and in Caulfeild and

Horseshoe Bay areas(2B) have undergone further changes, resulting in somewhat coarser grained rocks, which in many places have a marked banded appearance, alternating layers consisting of feldspar-rich and hornblende-rich material. In places these latter rocks have been extensively replaced (granitized), producing granitic and dioritic gneisses.

The only fossil yet found in the Bowen Island group is a deformed Spirifer ? obtained from a recrystallized limestone in the Lynn Creek area. The rocks are similar to those mapped as Anderson Bay and Texada formations on Texada Island, the former believed to be of late Palaeozoic age and the latter Triassic, probably Upper Triassic. These two formations are separated by a slight angular unconformity, but no such discordance has been recognized between different parts of the Bowen Island group, and the evidence to date is insufficient to state whether the Anderson Bay or Texada formation is the nearest correlative or whether both are represented in the group.

The rocks of the Bowen Island group are separated from those of the overlying Gambier group(3) by an angular unconformity. During the interval represented by this unconformity the Bowen Island group rocks were folded, metamorphosed, and partly granitized; some of the plutonic rocks were formed; and the land was uplifted and eroded. At the base of the overlying Gambier group rocks is a basal conglomerate consisting of angular to rounded boulders and fragments up to 25 feet in diameter, but generally less than 2 feet, embedded in a matrix of rock detritus. The rounded and subrounded boulders are represented largely by rock types lithologically similar to those of the older Bowen Island group and older plutonic rocks and probably representing beach material accumulated along a steep shoreline, whereas the angular and subangular fragments may be in part volcanic ejectamenta and in part talus that fell on the beach. The matrix consists mainly of angular and subangular small fragments of the underlying rock, which, in most of the areas where the conglomerate is well exposed, is predominantly granitic. The conglomerate grades upward into a normal volcanic breccia.

In all except the Mount Brunswick area the Gambier group consists mainly of pyroclastic rocks and lavas, with minor interbedded sedimentary material. The section exposed on Mount Brunswick, however, includes 2,000 feet of slate, argillite, quartzite, and arkose, and is at least 6,000 feet thick. In general, the Gambier rocks are much less altered than those of the Bowen Island group, but in places they contain chlorite and epidote, and in other places some of the volcanic rocks have been changed to resemble diorite.

Although reliable attitudes were observed only locally in the Gambier group, in most places these rocks appear to occupy northwesterly trending folds. Dips of Gambier group strata are

in general less steep than those of the older, Bowen Island rocks, the former averaging about 45 degrees, although locally much steeper, and the latter about 75 degrees. Of special note is the near-vertical, average dip of the plane of the unconformity separating the Gambier group from the older rocks, indicating that the latter, including the older plutonic rocks, were all severely deformed.

No fossils have been found in the rocks of the Gambier group, and no evidence as to their age has been obtained except that they are younger than the Bowen Island group and some of the plutonic rocks, and older than the Burrard formation and some of the plutonic rocks. This evidence suggests a Mesozoic age, and the possibility that they may be correlative with Upper Cretaceous rocks of the Squamish-Garibaldi Park area.

Along Burrard Inlet the gently dipping Burrard formation(4) rests on the eroded surface of the plutonic rocks. The beds have an aggregate thickness of at least 2,000 feet, and are predominantly, if not wholly, of continental origin. Fossil plants indicate that the formation is probably of mid-Eocene age.

The Kitsilano formation(5) rests on the eroded surface of the Burrard, but like the latter has a gentle dip to the south. It is probably 2,000 feet thick in the vicinity of Vancouver, and is also largely of continental origin. On the basis of fossil plants the beds are believed to be of late Oligocene or early Miocene age.

South of the map-area, both the Burrard and Kitsilano formations are probably much thicker, and may have a combined thickness of at least 10,000 feet. Around Burrard Inlet, they form a gentle monocline dipping about 15 degrees to the south. Due to the scarcity of outcrops, it is not known if the southerly dip continues south of the map-area.

Basaltic dykes(6) cut the Kitsilano and Burrard formations and the plutonic rocks; the largest exposure is at Prospect Point. Laccolith-like bodies of basalt outcrop at Ambleside (Sentinel) Hill and Little Mountain. A very unusual tuff, containing rounded pebbles up to several inches in diameter, outcrops on the south side of False Creek, and fine-grained, reddish and orange-banded tuffs have been exposed in several excavations in downtown Vancouver.

Plutonic Rocks

The plutonic rock classification used in these descriptive notes and on the accompanying map is based on the relative proportion of quartz, orthoclase and microcline, plagioclase feldspar, and mafic minerals (mainly hornblende, biotite, and augite). The plutonic rock names, as used on this map, may be

defined as follows: Granite is a plutonic rock with more than 10 per cent quartz; orthoclase and microcline feldspar comprise more than 50 per cent and plagioclase feldspar less than 50 per cent of the feldspar content; and one or more mafic minerals form less than 50 per cent of the rock. Granodiorite is a plutonic rock with more than 10 per cent quartz; orthoclase and microcline feldspar comprise 10 to 50 per cent and plagioclase feldspar 50 to 90 per cent of the feldspar content; and one or more mafic minerals constitute less than 50 per cent of the rock. Quartz diorite is a plutonic rock with more than 10 per cent quartz; orthoclase and microcline feldspar comprise 0 to 10 per cent and plagioclase feldspar 90 per cent or more of the feldspar content; and one or more mafic minerals constitute less than 50 per cent of the rock. Diorite is a plutonic rock with less than 10 per cent quartz; orthoclase and microcline feldspar comprise less than 10 per cent and plagioclase feldspar more than 90 per cent of the feldspar content; and one or more mafic minerals constitute less than 50 per cent of the rock. Gabbro is a plutonic rock with less than 10 per cent quartz; orthoclase feldspar forms less than 10 per cent and plagioclase feldspar more than 90 per cent of the feldspar content; and one or more mafic minerals constitute more than 50 per cent of the rock.

In the more widely used classifications, the separation into various rock types has depended on the kind or chemical composition of the contained plagioclase feldspar in addition to the relative proportions of the essential minerals. However, such a classification was not found practicable in this area in that much of the plagioclase exhibits oscillatory zoning, in consequence of which its average composition could be determined only by chemical analyses or detailed microscopic examination. Further, wherever detailed studies were made, and the average composition of the plagioclase feldspar determined, it was found that specimens from the same outcrop and obviously from parts of one homogeneous mass contained zoned plagioclase feldspar with varying average compositions, thus necessitating several rock names for this mass. Also, a field classification of the plutonic rocks seemed preferable to one requiring the use of the microscope, and in this connection it was noted that in most of the plutonic rocks exposed in the map-area the potash feldspars (orthoclase and microcline) were pink and the plagioclase feldspars white, and their relative proportions fairly readily determinable.

In mapping, it was found that, although the separation of the plutonic rocks into the five rock types as defined could be easily made, a division on the basis of mineral facies, particularly the relative proportions of the various mafic minerals, would convey a much more understandable picture of the relation of the plutonic rock types to one another, and to the older sedimentary and volcanic formations. In this map-area, hornblende and biotite are the only important mafic minerals in the plutonic rocks, and all the rocks fall naturally into the fourfold facies division(Bh, BH,

Hb, and H) outlined in the legend. For example, hornblende granite(H_I), granodiorite(H_{II}), etc., are more closely associated than the different varieties of granite, such as hornblende granite(H_I), biotite-hornblende granite(Bh_I), etc. Normally, the ratio of hornblende to biotite in the plutonic rocks increases near the exposed areas of older volcanic and sedimentary strata, indicating the profound influence of these older formations on the composition of the plutonic rocks, and in a few places, particularly as Bowen Island, some augite occurs in the hornblende zone. Also, the general trend of the various facies divisions is roughly parallel with that of the pre-plutonic rocks, and except for a few bodies of pegmatitic granite, which have intrusive contacts, all facies are gradational into adjoining masses; they do not appear to represent separate intrusions and, indeed, may not be of igneous or magmatic origin. Most of the diorites and gabbros and many of the quartz diorites vary greatly in composition and texture, and as a result have a hybrid appearance.

Included rock, derived from pre-plutonic formations and pre-granitic dykes, may form as much as 50 per cent of the plutonic masses, but generally does not exceed 2 to 3 per cent, and in places, particularly in the more acidic bodies, may be lacking. These inclusions are commonly rounded or ovoid, but may be elongate. They vary in length from a fraction of an inch to 25 feet or more, with an average range of from 3 inches to 3 feet. Although they exhibit all stages of conversion from schist, gneiss, meta-andesite, and pre-granitic dyke to plutonic rock, inclusions are dominantly dark grey-green, fine-grained rocks of dioritic appearance, containing large porphyroblasts of plagioclase feldspar. These feldspars are similar in all respects to those found in the enveloping plutonic rock.

The plutonic rocks were apparently formed at more than one period in the geological history of the map-area. Granitic pebbles in volcanic rocks of the Bowen Island group indicate that some plutonic rocks had formed prior to the deposition of this group, and although no bodies of this relative age were recognized in the course of field mapping, the plutonic rocks in many parts of the area cannot, owing to lack of evidence, be assigned to any definite period in its geological history. Wherever plutonic rocks are in contact with Bowen Island group strata they are younger; similarly, wherever they were observed in contact with Tertiary strata they are older. The contacts of the plutonic rocks with the Gambier group strata indicate that some were formed prior to the deposition of the Gambier and some afterwards. For example, the hornblende-biotite granodiorite(Hb_{II}) mass exposed on the southern part of Gambier Island is unconformably overlain by Gambier group strata, whereas the hornblende diorite(H_{IV}) outcropping in Alberta Bay on the mainland coast is younger than the Gambier group strata. Similarly, the hornblende diorite(H_{IV}) and quartz diorite(H_{III}) underlying Mount Hanover and Mount Harvey, northeast and east of Alberta Bay, also appear to be younger. However, in most of the

map-area the Gambier group and plutonic rocks are not in contact and relative age relationships could not be established.

Dyke Rocks

The Bowen Island group is cut by pre-granitic, andesitic looking dykes, which in most places have been altered to rocks with a granulitic texture. These dykes, most of which strike either about 10 degrees west of north or 20 degrees east of north, occur in many places as relict bodies in the plutonic rocks, partly or wholly preserved and maintaining their original trends. There is little doubt that they are older than the plutonic rocks, as many were seen to be cut by them.

The plutonic rocks and the Bowen Island and Gambier group rocks are cut by pre-Tertiary andesitic and trachytic dykes.

Surface Geology

Most of the area south of the Coast Mountains is covered with a mantle of surface deposits as much as 500 feet or more thick. These consist largely of river deposits, glacial drift, interglacial sediments, and a little peat.

Mineral Deposits

A shaft sunk on a small copper prospect in Gardner Bay on the east side of Bowen Island is reported to have encountered a thin seam of bornite along a shear zone in the volcanic rocks of the Bowen Island group. At the time of examination it was impossible to verify this discovery, as the shaft, said to be about 75 feet deep, was flooded and the surface overgrown.

On the east side of Bowen Island, an adit on the Bowena property has been driven about 40 feet along a mineralized shear zone in interbedded dark green lavas and cherty tuffs of the Bowen Island group. The shear zone strikes about north 15 degrees east and dips steeply to the southeast. The deposit contains disseminated pyrite, chalcopyrite, malachite, and azurite across widths ranging up to 20 feet.

North of Newman Creek, along the east side of Howe Sound, a prospect adit has been driven on a sparsely mineralized, easterly striking shear zone in greenish, porphyritic andesite and breccia of the Gambier group. The shear zone is mineralized with specks of chalcopyrite, partly altered to malachite.

Mineral showings occur at two places, about 1,500 feet apart horizontally and 1,200 feet vertically, on the claims of Lynn Creek Zinc Mines Limited. In both places the deposits, consisting largely of sphalerite, with smaller amounts of pyrrhotite, galena, chalcopyrite, pyrite, cubanite, marcasite, and hematite, occur as replacements in fractured and metamorphosed, thin limestone beds interbedded with meta-andesite, argillaceous quartzite, and skarn of the Bowen Island group, near their contact with quartz diorite. Mineralization appears to have been most effective where the limestone beds are intersected by shear zones. The lower workings expose two northerly trending mineral zones, 80 feet apart; the western zone is 1 foot to 5 feet wide and has been uncovered for 400 feet, and the eastern zone is 12 to 15 feet wide and is exposed for 90 feet. These mineral zones contain ore shoots up to 100 feet long and 4 feet wide assaying as much as 30 per cent zinc. Two or more northeasterly trending mineral zones, 5 to 20 feet wide, have been exposed at intervals at the upper workings by a series of trenches. Reported assays indicate from 10 to 35 per cent zinc across widths of 4 to 14 feet.

Several small copper deposits were observed on the ridge east of Lynn Creek and south of the Needles, and probably include those of the Swayne Copper and Mountain Lion groups. They consist of chalcopyrite and pyrite disseminated along northeasterly trending shear zones in narrow bands of silicified limestone of the Bowen Island group. These zones have been exposed for only a few feet, and none is more than 8 feet wide.