GEOLOGY OF THE BRITANNIA DISTRICT
BRITISH COLUMBIA

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Condensed Version - B. G. Stone

The Britannia district is 25 miles north of Vancouver in a "roof pendant" of andesitic to dacitic volcanic and sedimentary rocks enclosed by several plutons of the Jurassic-Cretaceous Coast Range batholith. The pendant is one of many similar generally northwest trending pendants in the batholith. The pendant rocks, herein assigned to the Britannia group, have been correlated on lithologic and structural similarities with the Jurassic (?) Gambier group which outcrops a few miles to the south. The Britannia ore bodies are in a complexly deformed belt, called the Britannia shear belt, which trends west-northwest across the pendant. The shear belt may be a remnant of a major structural zone, now exposed in scattered pendants along the northwest-trending axis of the Coast Range batholith.

STRATIGRAPHY

The volcanic rocks are typical of the calc-alkaline suite of intermediate to acidic pyroclastic volcanism. Andesite flows, flow breccia, pyroclastic rocks and related clastic sedimentary rocks and argillite are widespread in the Britannia and Gambier groups. Centres of pyroclastic dacitic volcanism occur in both groups and host all ore bodies and major sulphide occurrences. A general stratigraphic section through a dacitic centre is in the Jane Basin area:

top		thickness
Andesite	flow breccia, flows, coarse pyroclastic rocks	200+ft(70+m)
Argillite	black, locally with coarse volcanic fragments, siltstone interbeds common	900 ft(300m)
Dacite	coarse lithic tuff, plagioclase phenocrysts common, regions of very abundant large dacite fragments common; in part capped by crystal tuff and fragmental argillite	500 ft(160m)
Andesite	complex sequence of fine to medium tuffs, finely bedded pyritic sediments; sericite schist variously derived from these rocks, fine dacitic tuffs and sediments, and argillite	450 ft(140m)
Dacite	coarse lithic tuff, non-porphyritic, coarse dacitic fragments uncommon; more uniform than younger dacitic unit, but they are difficult to distinguish in moderately to strongly deformed areas.	400 ft(120m)

In contrast the section on Goat Ridge about a mile north of the Jane Basin and away from the dacitic centre is as follows:

top		thickness
Argillite, Siltstone	well bedded, locally cherty	60+ft(20+m)
Andesite, Basalt	flows, in part pillowed, local hyaloclastic sedimentary rocks, local to widespread argillite interbeds	400 ft(120m)

STRATIGRAPHY (continued)

top		thickness
Argillite	well bedded, black, locally with dacitic fragments, probably stratigraphic equivalent to argillite near top of Jane Basin section	600 ft(190m)
Andesite	massive flows and/or intrusions to the north, coarse pyroclastic rocks to the south with local units with very abundant coarse dacitic fragments, local sedimentary interbeds.	1000 ft(330m)

As is to be expected in this type of environment, local and regional stratgraphic variations are large, and the absence of continuous reliable marker units has hampered stratigraphic and structural interpretation.

EARLY DEFORMATION (D_o, D_1, D_2)

The earliest deformation (D_o) produced open, concentric, flexural-slip folds with gently plunging west-northwest axes. This style is evidenced at Britannia by the Britannia anticline and syncline, both of which have been strongly modified to obliterated by later deformation.

The next deformation produced the Britannia and other smaller shear belts. Several episodes of inhomogeneous strain resulted in rock assemblages equivalent to those of the lower greenschist facies of regionally metamorphosed rocks.

The first episode of shearing deformation (D_1) was the most intense, causing orientation of sericite and chlorite plates and flattening of lithic fragments to produce a foliation, S_1. Numerous folds, F_1, were formed with S_1 as axial plane cleavage. The axial plane of the shear zone roughly corresponds to the axial plane of the Britannia anticline.

The second episode of shearing deformation (D_2) produced a foliation, S_2, which cuts and folds S_1 into steeply west plunging folds. S_2 is best developed in rocks in which S_1 is also well developed.

All three deformations were produced by a northwest trending compressional stress couple oriented perpendicular to the axis of the shear belt. A compressional stress couple of this magnitude could have been caused by the collision of two crustal plates.

DEFORMATION OF ORE BODIES

Recent work indicates that ore bodies were deformed during D_1. Evidence proving such deformation is difficult to document because of the ease of recrystallization of quartz and sulphides under stress even at low temperatures but such features as tightly folded veins, strained quartz in ore veins, fractured pyrite grain, boudinaging of sulphide veins and rotation of rock fragments within massive sulphides indicate deformation of the ore bodies.

DESCRIPTION OF ORE BODIES

Based on the evidence of deformation of sulphides, a hypothesis was developed that the ore bodies are late-stage products of the dacitic volcanism; the model is similar to that for the Kuroko deposits in Japan.

Major sulphide concentrations occur in pyroclastic dacite units and in

DESCRIPTION OF ORE BODIES (continued)

immediately overlying andesitic tuffs and sediments. Most ore bodies are near the upper contact of the lower dacitic tuff unit (see Jane Basin stratigraphic section), but the No. 10 body is near the upper contact of the upper dacitic tuff unit.

The ore bodies aan be classified according to the Kuroko model:

TYPE	EXAMPLES
1. Sphalerite-barite-(chalcopyrite-galena) (black ore)	Jane, Fairview Zinc
2. Pyrite-chalcopyrite-(quartz-chlorite) (yellow ore)	No. 10, Victoria, Empress
2(a). Sphalerite-pyrite-chalcopyrite-(quartz-chlorite) (mixed black and yellow ore ?)	No. 8
3. Quartz-pyrite-chalcopyrite (siliceous ore)	Bluff, No. 5, No. 10, Fairview veins
4. Anhydrite (gypsum); barite (sulphate "ore")	Widespread zones near sulphide ore bodies

Deformation has strongly disturbed the original ore bodies so that their present disposition may not give an accurate picture of their original distribution. Each type of ore appears to have a particular mode of occurrence in the dacitic centre. Black ore occurs in fine andesitic sediments, tuffs and sericite schists above the contact with the coarse dacitic tuff, and generally spatially removed from the other types of sulphide ore. Yellow and mixed black and yellow ore occur along and near the contact of the coarse dacitic tuff and overlying andesitic sediments, fine tuffs, and cherty sediments. The highest grade ore is generally just above the contact. Cherty sediments are particularly abundant in the No. 8 ore bodies. Siliceous ore occurs mainly in coarse dacitic tuff as a series of quartz-sulphide veins and vein stockworks in a strongly silicified rock. Most occurrences are near the stratigraphic top of the coarse dacitic tuff and commonly the grade of ore increases towards the top. However, the Fairview veins are spread through the entire unit. Sulphates, especially anhydrite, are widespread in the shear belt, especially in andesitic sediments and sericite schists near the ore bodies. Fine andesitic sediments above the coarse dacitic tuffs locally contain up to 50% very fine grained pyrite in tiny lenses elongated parallel to bedding. They may be a poorly developed equivalent to the pyritic cap of some Kuroko deposits. Some coarse tuffs contain local zones with abundant fragments rich in very fine grained pyrite. These may represent an original massive sulphide body near the volcanic vent which was fragmented and carried off during formation of the coarse tuff.

DACITE INTRUSIONS

During a period of dilatency following the major compressional deformation, abundant dacite magma was intruded. In the foliated rocks dikes were formed subparallel to S_1, while in rocks with little or no foliation sills and irregular bodies were formed.

Most of the dikes are cut and bleached by northeast trending vuggy quartz-carbonate-chlorite gash veins which locally contain scattered sulphides - sphalerite, galena, chalcopyrite, pyrite, pyrrhotite and very rarely realgar. Where dacite dikes cut ore bodies chalcopyrite has migrated from the ore bodies to form massive brassy blobs in the late veins.

DACITE INTRUSIONS (continued)

The source of the dacitic magma might be similar to that of the earlier pyroclastic dacites; this would suggest a short interval between original volcanism, ore formation, deformation and later dacite intrusion.

LATE DEFORMATION

A third metamorphic foliation, S_3, is formed locally and is parallel to the northeast trending gash fractures in dacites and to a series of late northeast trending faults.

A fourth metamorphic foliation, S_4, is a widespread strain-slip cleavage which cuts all other foliations and dacite dikes. It is prominent locally and is best developed in rocks with relatively strong S_1.

A major series of late faults cut the rocks in the shear belt sub-parallel to its margins. The faults are braided and larger ones contain up to a few feet of gouge. Most faults contain very little gouge and movements of several feet have been observed on faults with practically no gouge.

All the ore bodies are cut by many small faults, and most ore bodies are bounded by major faults on at least one side. The smaller faults have broken up continuous sulphide bodies into a large number of irregularly shaped blocks causing severe problems in ore control.

COAST PLUTONIC ROCKS

Several major plutons and numerous minor bodies intrude the Britannia pendant.

On the northeast are several bodies of massive acidic plutonic rocks which may be connected at depth (Squamish, Mountain Lake and Seymour River plutons). The main rock type is a coarse grained quartz-rich granodiorite. The rocks intrude massive andesite and argillite of the Goat Ridge section. The coarse grained granodiorite of the Squamish pluton has been dated at 94 m.y. (K/A method).

On the southwest is the Furry pluton, composed mainly of foliated quartz diorite. Foliation is most intense along the border of the pendant. The rock along part of the contact is similar to fine grained leucogranodiorite of the Squamish pluton.

Several other intrusions occur within the pendant but age relations among them are unclear because of lack of contact relations.

LATE DIKES

Unaltered andesite and lamprophyre dikes cut all rocks and form very continuous thin sheets sub-parallel to S_1 and less commonly cutting S_1. The age of the andesite dikes is uncertain. Some cut dacite dikes; some are boudinaged; some are in the gouge of late faults but are not deformed; some are slightly foliated.

The lamprophyre dikes probably are related to the Pleistocene Garibaldi group of volcanic and hypabyssal rocks which outcrop extensively a few miles to the north.

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