METALLOGENY OF THE TALLY POND VOLCANICS, VICTORIA LAKE GROUP, CENTRAL NEWFOUNDLAND

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ABSTRACT

The Victoria Lake Group in central Newfoundland is a thick sequence of volcanic, volcaniclastic and sedimentary rocks deposited during the development of an Early-Middle Ordovician island arc. Volcanic rocks occur within two principal volcanic units, informally termed the Tulks Hill and Tally Pond volcanics. The volcanic rocks consist of intercalated mafic and felsic rocks that are predominantly pyroclastic; mafic pillow lava is more common in the Tally Pond volcanics than in the Tulks Hill volcanics. The felsic volcanics occur as laterally extensive sheets of crystal and crystal-lithic tuff, breccia and minor flows. Sedimentary rocks consist of sandstone, siltstone, shale, argillite, chert and minor interbedded conglomerate. The clastic sedimentary rocks appear to be derived from the adjacent and underlying volcanic rocks of the Victoria Lake Group to the southwest.

Six volcanogenic sulfide occurrences are known in the Victoria Lake Group. Four occur in the Tulks Hill volcanics and two in the Tally Pond volcanics. The Tally Pond (Boundary) deposit and Burnt Pond project both occur in the felsic pyroclastics of the Tally Pond volcanics. The Tally Pond deposit comprises two zones of massive sulfides underlain by a zone of pervasive chlorite-pyrite (-chalcopyrite) alteration.

INTRODUCTION

Metallogenic studies, as part of a new five-year (1984-89) project designed to investigate the pre-Caradocian volcanogenic mineral deposits of central Newfoundland, were started in July, 1984. The 1984 studies concentrated on the Tally Pond Volcanics, and involved regional rock geochemistry and detailed stratigraphic, structural and geochemical studies in the area of the Tally Pond deposit.

Access to the area is provided by woods roads from Millertown and Grand Falls. The area is characterized by a heavily forested (fir, spruce), gently undulating landscape with extensive glacial till cover. Consequently, bedrock exposure is poor.

PREVIOUS WORK

Parts of the area have been mapped in detail by mineral exploration companies, including ASARCO, Abitibi-Price and Noranda. The first systematic geological mapping was done at 1:250,000 scale by the Geological Survey of Canada (Riley, 1957; Williams, 1970). The Newfoundland Department of Mines and Energy has done 1:50,000 scale regional mapping of the King George IV Lake (12A/4), Victoria Lake (12A/6), Star Lake (12A/11E), Lake Ambrose (12A/16), Noel Paul's Brook (12A/9), Buchans (12A/15), Badger (12A/16) and Grand Falls (2D/13) map areas (Kean, 1977, 1979a,b, 1983; Kean and Jayasinghe, 1980, 1982; Kean and Mercer, 1981).

Brown (1952) proposed the name 'Victoria River Series' for the volcanic and sedimentary rocks in the Lake Ambrose - Victoria River area. Riley (1957) proposed the name 'Strides Group' for similar rocks in the western half of the Red Indian Lake map area. Kean (1977) abandoned these names and proposed and defined the 'Victoria Lake Group' to include all the pre-Caradocian volcanic and sedimentary rocks in this area (Figure 1).

Volcanogenic sulfide mineralization in the rocks presently assigned to the Victoria Lake Group was first discovered in the early 1900's near the mouth of Victoria River. Subsequently, five other volcanogenic base metal deposits have been discovered, the Jacks Pond, Tulks East, Tulks Hill and Tally Pond (Boundary) deposits and the Burnt Pond prospect.

REGIONAL GEOLOGY

The Victoria Lake Group underlies that part of the Dunnage Zone of central Newfoundland which extends from Grand Falls in the northeast to King George IV Lake in the southwest; and from Red Indian Lake in the north to Noel Paul's Brook in the south.

The Ordovician geological development of the Dunnage Zone is recorded in three very broad geologic settings: (1) ophiolitic sequences which are interpreted to have formed as oceanic crust; where contacts are preserved, these are always the stratigraphically lowest units and they are believed to represent basement to most of

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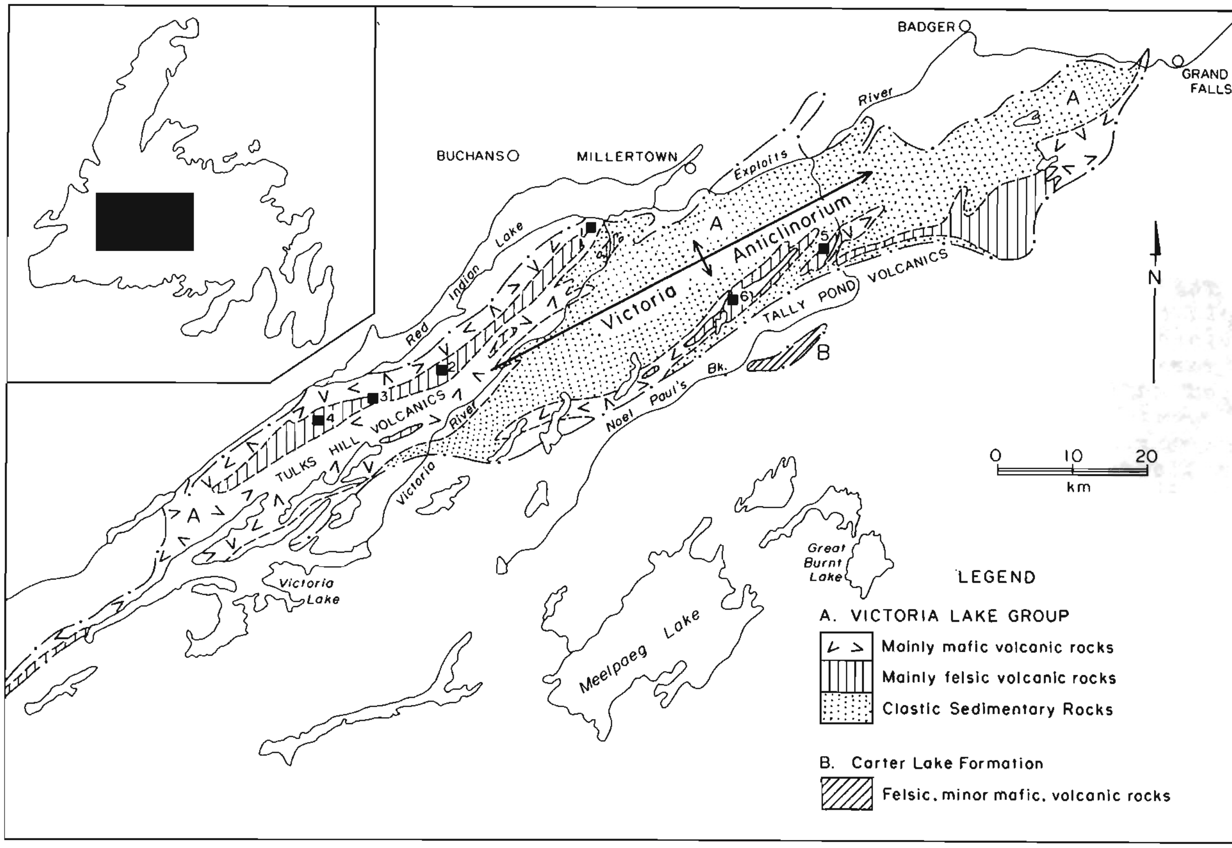

Figure 1: *Early to Middle Ordovician volcanic-dominated island arc sequences and massive sulfide deposits (solid squares) in central Newfoundland. A - Victoria Lake Group; B - Carter Lake Formation. Lines - felsic volcanic rocks; Vees - mafic and intermediate volcanic rocks; stippled - sedimentary rocks. Massive sulfide deposits: 1. Victoria Mine; 2. Jacks Pond; 3. Tulks East; 4. Tulks Hill; 5. Burnt Pond; 6. Tally Pond (after Swinden and Thorpe, in press).*

the younger rocks in the Dunnage Zone; (2) tholeiitic and calc-alkaline volcanic and subvolcanic rocks and related volcaniclastic rocks which stratigraphically overlie the ophiolites and range up to 8 km in total thickness. These units consist of mafic and felsic, dominantly submarine volcanic and volcaniclastic rocks, and are generally interpreted to represent the remains of one or more Early-Middle Ordovician island arcs; and (3) post-island arc flysch, argillite and conglomerate which stratigraphically overlie many of the island arc sequences and are mainly derived from them. These sedimentary rocks range in age from Middle Ordovician to Early Silurian and are succeeded by younger Silurian rocks consisting of subaerial, mainly felsic, volcanic rocks and terrestrial sediments.

In the south-central part of the Dunnage Zone, the ophiolite sequences are represented by the King George IV Lake, Annieopsquotch, Star Lake and Shanadithit Brook Complexes. The King George IV Lake and Annieopsquotch Complexes are faulted against the Early-Middle Ordovician island arc sequences of the Victoria Lake Group to the southwest of Red Indian Lake, but are interpreted to have been in original stratigraphic continuity (Herd and Dunning, 1979).

The Victoria Lake Group is conformably overlain by Caradocian age black shales and cherts in the northeast which in turn are conformably overlain by Middle Ordovician to Early Silurian flysch, argillite and conglomerate. Siltstone and tuffaceous sandstone of the Harbour Round Formation overlie the Victoria Lake Group in the Red Indian Lake area. This assemblage of rocks is in fault contact with the Buchans Group and the Southwest Brook Complex along the Lloyds River - Red Indian Lake fault system to the northwest.

The southern and southeastern limits of the Victoria Lake Group are marked by the unconformably overlying, locally fault-modified, Rogerson Lake Conglomerate, which in turn is faulted against the mafic volcanics of the Pine Falls Formation and unnamed volcanic, sedimentary and metamorphic rocks south of Noel Paul's Brook.

Rocks of the study area occupy a regional northeast-trending anticlinorium (Victoria Anticlinorium). Regionally, the sequence youngs northwesterly on the north limb and southeasterly on the south limb of this structure; however, there are many smaller scale, first order and second order folds resulting in variable facing directions. Poor exposure, however, generally precludes deciphering the detailed structure.

GEOLOGY OF THE VICTORIA LAKE GROUP

The Victoria Lake Group is a sequence of volcanic, epiclastic and sedimentary rocks that has been dated by conodonts collected from limestone lenses near the stratigraphic top of the Group as Late Llanvirnian (Kean and Jayasinghe, 1982). It is also conformably overlain by Carodocian shale and chert (Kean and Jayasinghe, 1982). The thickness of the Group cannot be estimated with any degree of certainty because of folding and poor exposure.

The Victoria Lake Group can be divided into two major regional facies: (1) volcanic rocks in the southwest and along its southeastern margin, comprising approximately 60% of the group, and (2) a predominantly sedimentary facies to the northeast which is laterally equivalent and derived from the volcanic rocks.

Volcanic Rocks

Volcanic rocks predominate in the southwestern part of the Victoria Lake Group and along its southeastern margin. The two principal volcanic units are informally termed the Tulks Hill volcanics in the southwest and the Tally Pond volcanics in the southeast. Due to poor exposure and complicated structural relations, it is not known whether the Tally Pond volcanics are stratigraphically equivalent to the Tulks Hill volcanics. However, the types of felsic volcanic rocks and the relative proportions of felsic and mafic lithologies in the two units are similar. Small intercalations of volcanic rocks also occur within the clastic sedimentary rock facies of the Victoria Lake Group to the northeast. Similar rock units are sporadically present farther east and are assigned to the Carter Lake Formation (Kean and Jayasinghe, 1980).

Tulks Hill volcanics: The Tulks Hill volcanics, host to the Victoria mine and the Jacks Pond, Tulks East and Tulks Hill deposits, consist of mafic to felsic volcanic rocks. The mafic volcanic rocks are mainly pyroclastic, comprising mafic to intermediate aquagene tuff, reworked tuff, lapilli tuff, agglomerate and breccia. Mafic epiclastic volcanic rocks are also common. Mafic lavas are not common in this unit, but where present they exhibit small, commonly flattened, pillows with thin selvages and little interpillow material. Pillow breccias are present locally.

The felsic volcanic rocks occur as laterally extensive sheets of crystal and crystal-lithic tuff, breccias and minor porphyritic flows and shallow intrusions. The major significant mineralization occurs in the felsic volcanics.

Tally Pond volcanics: The Tally Pond volcanics consist of intercalated mafic and felsic volcanic rocks. The mafic volcanic rocks comprise vesicular and amygdaloidal, generally pillowed, flows and mafic to andesitic tuff, agglomerate and breccia. Mafic pillow lava is more common in the Tally Pond volcanics than in the Tulks Hill volcanics. The pillows are generally small and have little interpillow material; where present, the latter consists of mafic tuff (probably hyaloclastic) and minor green chert. The breccias contain mafic volcanic rock fragments that range up to 20 cm across. Some of the breccias contain pillow fragments and are interpreted to be pillow breccias.

The felsic volcanic rocks, which are host to the Tally Pond deposit and Burnt Pond prospect, consist of tuff, lapilli tuff and breccia. Flow-banded rhyolite and rhyolitic breccia are locally present and quartz-feldspar, generally black, subvolcanic porphyries are common. The lapilli tuff consists of subangular to rounded clasts of white, gray and green dacite and rhyolite, in places flow banded, in a fine grained to locally vitric, tuffaceous matrix. The breccias contain angular felsic volcanic fragments ranging from 3 to 45 cm in length in a tuffaceous matrix. Locally, gas breccias are developed and consists of flow-aligned, *in situ* brecciated clasts in an aphanitic to vitric, siliceous matrix.

Carter Lake Formation: The Carter Lake Formation consists of predominantly felsic volcanic rocks with fewer mafic volcanic rocks. It occurs intercalated with unnamed sedimentary and metasedimentary and metavolcanic rocks south of Noel Paul's Brook, and is not part of the Victoria Lake Group, but is interpreted to be age equivalent.

Mafic volcanic rocks consisting of pillow lava and pillow breccia are minor. The pillows range from 16 to 60 cm in size and contain calcite amygdules near their margins.

Quartz and quartz-feldspar porphyries and crystal tuffs, minor crystal-lithic, fine-grained silicic tuff and faintly flow-banded rhyolite comprise the felsic volcanic rocks.

Sedimentary Rocks

Clastic sedimentary rocks constitute most of the northeastern facies of the Victoria Lake Group (Kean and Jayasinghe, 1982). This facies consists of sandstone (graywacke) with interbedded siltstone, shale, argillite, conglomerate and rare limestone. Siliceous siltstone and chert are more common near the top of the sequence. Locally, there are thin inter calations of volcanic rocks.

The sequence generally displays cyclic bedding. A typical cycle consists of a lower unit of conglomerate and pebbly sandstone constituting almost 40% of the cycle. It generally has erosional bases with scour and fill structures, load casts and flame structures. It grades upwards into sandstone, which forms about 50% of the cycle. The sandstone grades from coarse at the bottom to fine towards the top, where faint laminations, crosslaminations or convolute laminations may be developed. The sandstone layer is overlain by thinly laminated siltstone, argillite or shale. The contact between the siltstone and underlying sandstone is sharp and free of erosional features. The cycles mainly include ABCE and ABE Bouma divisions (Bouma, 1962) and, locally, CE divisions.

These clastic sedimentary rocks contain a predominance of volcanic detritus and both the amount of pyroclastic material and the coarseness of pyroclastic and epiclastic material increase towards the volcanic rocks of the Victoria Lake Group to the southwest. This suggests that the clastic sedimentary rocks were derived from the adjacent and underlying volcanic rocks of the Victoria Lake Group.

Intrusive Rocks

The Victoria Lake Group is intruded by linear bodies of medium grained quartz monzonite, minor granite and granodiorite which appear to be related to volcanism. Fine to medium grained diorite and gabbro with rare coarse grained phases occur as small plugs to large bodies throughout the Victoria Lake Group.

VOLCANOGENIC SULFIDES

Six principal volcanogenic base metal sulfide occurrences are known in the Victoria Lake Group. They are the Victoria mine and the Jacks Pond, Tulks East and Tulks Hill deposits in the Tulks Hill volcanics and the Tally Pond (Boundary) deposit and Burnt Pond prospect in the Tally Pond volcanics. The locations of these deposits and prospects are shown on Figure 1. Of these, only the Tally Pond deposit will be discussed here.

Tally Pond (Boundary) deposit: The Tally Pond (Boundary) deposit, a significant Cu-Zn-Ag massive sulfide deposit, was discovered by Noranda Exploration Limited in 1982. Grades and tonnage figures are confidential at present.

The rocks near the deposit are poorly exposed and the massive sulfide body is exposed by trenching. Diamond drill core offers the best opportunity to study the mineralization.

The deposit occurs within a gently dipping sequence of felsic lapilli tuff on the south limb of a northeast-trending anticline developed on the south limb of the Victoria Anticlinorium. However, parasitic folds, probably on the scale of tens of metres, and possible minor cross-folds complicate the local structure. The deposit occurs in an inlier of the felsic volcanics which is overlain to the north and south by fine siliceous siltstone and interbedded sandstone.

The deposit actually consists of two zones, referred to as the North and South Zones. The North Zone dips gently northwards for the most part and the South Zone dips gently southeastward; however, dips in the eastern part of the South Zone appear to be to the north. There is no conclusive evidence that the North and South Zones are structural repeats of the same strati graphic horizon. Both zones have areas of alteration developed beneath them. Both the alteration areas extend or dip to the north. A rhyolite dome or plug with associated breccia is present in the South Zone.

The deposit mineralogy consists of fine grained pyrite and variable amounts of chalcopyrite, covellite and sphalerite; galena is present locally as a minor constituent. The contacts of the massive sulfides with the hanging wall and the footwall are sharp, although the footwall displays a zone of pervasive alteration that is generally present below the massive sulfides, in particular in the proximal facies. Also in the proximal facies, breccia textures are locally well developed. Distal parts of the massive sulfides generally display well developed bedding and laminations and, locally, graded bedding is apparent; there is generally very little alteration in the footwall in these areas.

The alteration consists mainly of variably intense chloritization accompanied by veinlets, blebs and disseminations of pyrite and lesser chalcopyrite. The chloritization is characterized by black chlorite which occurs in and replaces the matrix of the tuffs and locally completely replaces the rock. It also occurs as veins and blebs. *In situ* gas(?) brecciation and veining by chlorite and minor graphite are locally developed. Sporadically and randomly developed in the alteration zones are white, bleached areas caused by sericitization and silicification; this type of alteration is well developed in parts of the South Zone. The alteration zones are interpreted to represent volcanogenic hydrothermal activity related to massive sulfide deposition.

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