TOWARD A VICTORIA LAKE SUPERGROUP: A PROVISIONAL STRATI-GRAPHIC REVISION OF THE RED INDIAN TO VICTORIA LAKES AREA, CENTRAL NEWFOUNDLAND

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ABSTRACT

The Victoria Lake supergroup is a structurally complex, composite collection of Ordovician and older arc-related magmatic and sedimentary rocks. The volcanic-dominated portion of this supergroup has been divided into the predominantly Early Cambrian and/or older Tally Pond assemblage, and the Late Cambrian and possibly younger Tulks Hill assemblage. Clastic sedimentary rocks that occur between (and possibly also as distinct packages within) these two assemblages are Late Ordovician and older.

Adjacent to the Victoria Lake supergroup are the Middle Ordovician (Llanvirn) Sutherlands Pond and Harbour Round assemblages. These units are all in thrust contact with each other, the thrust faults being generally marked by zones of black shale mélange. The Sutherlands Pond assemblage consists predominantly of rhyolite breccia, calc-alkaline mafic volcanic rocks (in part pillow lavas), crystal tuff and black shale, and small limestone reefs. The structurally overlying Harbour Round assemblage consists of distal and proximal bimodal volcanic sequences including tholeiitic pillow basalt, and associated volcanogenic wacke and siltstone, as well as jasperite beds.

Volcanogenic massive sulphides are common throughout the felsic volcanic parts of the Victoria Lake supergroup and indicate at least two distinct periods of mineralization. Some of the more significant deposits include Duck Pond and Boundary in the Tally Pond assemblage, and the Bobbys Pond, Daniels Pond, Jacks Pond, Long Lake, Tulks East, Tulks Hill and Victoria Mine in the Tulks Hill assemblage. In contrast, the younger calc-alkaline rocks of the Sutherlands Pond assemblage do not host any significant sulphide showings, although disseminated pyrite mineralization is common. The tholeiitic Harbour Round assemblage appears to be largely barren of any sulphide mineralization.

INTRODUCTION

The Victoria Lake Group was originally proposed by Kean (1977) to describe the pre-Caradocian, volcanic and sedimentary, greenschist-facies rocks that can be traced north of Victoria Lake to the southeastern shore of Red Indian Lake. Subsequent work (e.g., Kean, 1985; Dunning *et al.*, 1987) indicated that this group consisted of two chronologically and palaeogeographically distinct units. Consequently, as part of the Red Indian Line – Targeted Geoscience Initiative Project, the Victoria Lake Group is being re-examined to determine its tectonic and structural history, and thus help expand the geological framework on which future volcanic massive sulphide exploration can be based.

This paper presents the initial field results from this study that suggest that the Victoria Lake Group actually consists of at least three distinct Ordovician and older units, each with their own internal stratigraphy. The stratigraphic relationships between the three units are poorly known and hence these supracrustal rocks should probably be classified as the Victoria Lake supergroup (*see* Evans and Kean, 2002). As an interim measure pending further mapping, geochemistry and geochronology, the internal subdivisions within the proposed Victoria Lake supergroup are given the informal classification of assemblages. It is expected that future work will enable us to formalize them into groups.

The study area encompasses parts of the Victoria Lake, Lake Ambrose, Noel Paul's Brook, Snowshoe Pond, Star Lake, Buchans and Badger 1:50 000-scale map sheets (NTS map areas 12A/6, 12A/7, 12A/9, 12A/10, 12A/11, 12A/15 and 12A/16, respectively). The bedrock geology of this area was mapped previously by Kean (1979a, b, 1982), Kean and Jayasinghe (1980), Colman-Sadd (1987) and Evans *et al.* (1994a, b, c). Fieldwork during the 2001 season was primarily focused on Red Indian Lake and its southern hinterland to Long Lake, west of the Victoria River, and consisted of lithological and structural mapping in combination with revised aeromagnetic data and sampling for whole-rock geochemical analysis and U–Pb zircon geochronology.

PREVIOUS WORK AND REGIONAL GEOLOGY

The Victoria Lake Group as originally defined by Kean (1977), constitutes part of the Exploits Subzone of the Dunnage Zone (Williams *et al.*, 1988; Figure 1); it could be subdivided into a southwestern dominantly volcanic terrane and a northeastern dominantly volcanic-derived sedimentary terrane. Kean and Jayasinghe (1982) informally divided the volcanic rocks of the Victoria Lake Group into two major regional units; the Tulks Hill and Tally Pond volcanics.

Kean and Evans (1988a) considered the Tulks Hill volcanics as consisting of numerous bands and lenses of volcanic and volcaniclastic rocks that formed a belt along the southwestern side of the Victoria Lake Group (Figure 2). The Tulks Hill volcanics were interpreted as predominantly crystal and crystal-lithic pyroclastic deposits, along with associated effusive, porphyritic flows and shallow-level intrusives, as well as minor flowbanded rhyolite sequences. These felsic volcanic rocks are locally intercalated with minor mafic tuff, tuff breccia and flows (locally pillowed). Subsequent U-Pb zircon dating has shown that this is a composite unit containing at least two

Figure 1. Area of study in relation to the lithotectonic zones of the Newfoundland Appalachians (modified after Williams et al., 1988).





Figure 2. The geology of the Victoria Lake Group prior to the instigation of the Red Indian Line Targeted Geoscience Initiative Project (modified after Kean and Evans, 1988a, b; Evans et al., 1990; Dunning et al., 1991).

geochronologically distinct components; a ca. 498 Ma age for the sequence at the Tulks Hill deposit (Evans *et al.*, 1990) and a ca. 462 Ma age for the Victoria Bridge sequence (Dunning *et al.*, 1987). The dated portion of the Victoria Bridge sequence is now considered not to be related to the Tulks Hill volcanics (*see below*).

Kean and Jayasinghe (1982) defined the Tally Pond volcanics as a belt of intercalated mafic and felsic volcanic rocks that form the southeast margin of the Victoria Lake Group (Figure 2). These rocks have been informally split into three parts (Dunning et al., 1991): Diversion Lake group, Sandy Lake sequence and Lake Ambrose volcanic belt (Figure 2). The Diversion Lake group is a chemically distinct series of pillow basalts (Kean and Evans, 1988a) that were believed to be conformably overlain by Caradocian black shale and were therefore interpreted as Middle Ordovician. The Sandy Lake sequence and Lake Ambrose volcanic belt have lithologically similar mafic and felsic volcanic rocks, but are separated by faults, and hence have not been correlated (Dunning et al., 1991). Whereas the age of the Sandy Lake sequence remains essentially unconstrained, the Lake Ambrose volcanic belt has two identical U–Pb zircon ages of 513 ± 2 Ma (Dunning *et al.*, 1991); the first sample obtained from north of Tally Pond and the second sample from between Rogerson Lake and Lake Ambrose.

The Harbour Round Formation (Figure 2) was originally interpreted as a marker horizon of siltstone that conformably overlies the Victoria Lake Group south of Red Indian Lake (Kean, 1978; Kean and Jayasinghe, 1980). These rocks in turn were believed to be conformably overlain by the Harbour Round basalts, which were correlated to the post-Caradocian island-arc rocks of the Buchans Group (Kean, 1979b; Kean and Jayasinghe, 1980). To the south and east, the Rogerson Lake Conglomerate unconformably overlies the Victoria Lake Group, although the contact is generally sheared and faulted (Kean and Evans, 1988a). As the Rogerson Lake Conglomerate occurs as a narrow band of polymict conglomerate and sandstone with locally derived clasts, it represents a molasse-type deposit (Kean and Evans, 1988a), and has generally been considered equivalent to the Silurian Botswood Group (e.g., Kean, 1983; Williams, 1995). The Victoria Lake Group is separated to the west from the Buchans Group and the Annieopsquotch ophiolite complex of the Notre Dame Subzone by the Red Indian Line (Figure 3).

VICTORIA LAKE SUPERGROUP

The proposed Victoria Lake supergroup (Evans and Kean, 2002) constitutes the volcanically dominated Tulks Hill and Tally Pond assemblages and one or more sequences of clastic sedimentary rocks (Figure 3). In addition to these



Figure 3. Generalized geology of the Red Indian Lake area. In part incorporates information from Kean and Evans (1988a, b), Evans et al. (1990), Dunning et al. (1991), Hogan and Evans (1991), Thurlow et al. (1992), Whalen (1993), Evans et al. (1994a, b, c), Whalen and Currie (1988), Oneschuk et al. (2001) and Pollock and Wilton (2001). Selected mineral deposits: B - Boundary (Zn, Cu, Pb, Ag, Au); Bo - Bobbys Pond (Zn, Cu, Pb); BP - Burnt Pond (Zn, Cu, Pb); Da - Daniels Pond (Zn, Pb, Cu, Ag, Au); DP - Duck Pond (Zn, Cu, Pb, Ag, Au); JP - Jacks Pond (Cu, Pb, Zn); LL - Long Lake (Cu); TE - Tulks East (Zn, Cu, Pb, Ag, Au); TH - Tulks Hill (Zn, Pb, Cu, Ag, S); VM - Victoria Mine (Cu, Zn, Pb, Au, Ag).

units it may, subsequent to additional study, also be shown to include the Sutherlands Pond assemblage (*see later*). Further investigations will also be undertaken to determine whether the Harbour Round assemblage (*see later*) and the unclassified pillow basalt sequence that occurs at the southern end of Red Indian Lake (Figure 3) should be included in the Victoria Lake supergroup.

Evans and Kean (2002) have suggested that the Victoria Lake supergroup also occurs to the south of the Rogerson Lake Conglomerate as the Point of Woods belt. This belt consists of the mafic volcanic dominated Pine Falls Formation (Mullins, 1961; Kean and Jayasinghe, 1980), the bimodal volcanic sequence of the Carter Lake Formation (Mullins, 1961; Kean and Jayasinghe, 1980), the Lake Douglas basalts (Colmann-Sadd, 1987) and a belt of unclassified sedimentary and volcanic rocks of assumed Ordovician age that outcrop west of Noel Paul's Line (Figure 1).

TALLY POND ASSEMBLAGE

The Tally Pond assemblage refers to a composite set of volcanic and sedimentary rocks that form the eastern edge of the Victoria Lake supergroup. The eastern margin of the Tally Pond assemblage is marked by the Rogerson Lake Conglomerate (Figure 3), whereas its western limit is defined by a zone of black shale mélange that can be traced intermittently from Victoria Lake to northeast of Noel Paul's Brook (Evans and Kean, 2002). The sense of motion along this break is currently unknown.

The main sequence of volcanic rocks within the Tally Pond assemblage belongs to the Lake Ambrose volcanic belt of Dunning *et al.* (1991), herein referred to as the Lake Ambrose sequence. This sequence consists of the arc-like Lake Ambrose basalts (Evans *et al.*, 1990) intercalated with felsic pyroclastic rocks, including volcanic breccia, tuff and crystal tuff, and flow-banded rhyolite. The Lake Ambrose basalts consist of dark green to grey, pillowed to massive, amygdaloidal, tholeiitic flows, along with minor mafic tuffs and tuff breccias. Chemically, the Lake Ambrose basalts are island-arc tholeiites showing generally prominent Nb troughs, with rare-earth-element (REE) normalized to primitive mantle profiles that are flat to slightly light-rare-earthelement (LREE) enriched (Swinden *et al.*, 1989; Pollock and Wilton, 2001).

U–Pb zircon ages of 513 ± 2 Ma (Dunning *et al.*, 1991) were obtained from potentially intrusive quartz-feldspar porphyry bodies within the Lake Ambrose sequence. Several attempts to date definitively erupted units have failed due to an absence of zircon (G.R. Dunning, personal communication, 2001). Although this age can only be regarded as a minimum, it nevertheless makes the Lake Ambrose sequence the oldest dated island-arc sequence within the Dunnage Zone of the Appalachian Orogen (Dunning *et al.*, 1991).

The Sandy Lake basalts are a chemically distinct package of basalts that occur northeast of the Lake Ambrose sequence (Figure 3). Formerly, these basalts were referred to as the Sandy Lake sequence (Evans et al., 1990). However, herein the Sandy Lake sequence is expanded to not only include the distinctive Sandy Lake basalts but also the bimodal volcanic rocks that occur in fault contact with them. No direct dating exists for the Sandy Lake sequence, although the bimodal volcanic rocks have been tentatively correlated with the Lake Ambrose sequence on the basis of chemical and petrographic similarities (e.g., Evans et al., 1990; Dunning et al., 1991). However, the Crippleback Lake Quartz Monzonite, which was dated at ca. 565 Ma (Evans et al., 1990), seems to intrude the Sandy Lake sequence on basis of outcrop pattern and related crosscutting minor intrusions and offshoots (Evans et al., 1994c). Furthermore, the Lake Ambrose and Sandy Lake sequences are separated by a sedimentary rock package that includes black shale mélange (J.C. Pollock, personal communication, 2001). Thus, despite the lithological and chemical similarities between the two sequences, the Sandy Lake sequence could be substantially older than 513 Ma.

The distinctive Sandy Lake basalts of the Sandy Lake sequence have chemical affinities to boninites (Swinden *et al.*, 1989; Evans *et al.*, 1990), however, the dataset is small and the primitive mantle-normalized spidergram profiles exhibit a fair degree of scatter (*see* Figures 18a and 19 of Swinden *et al.*, 1989). All of the samples are highly depleted and have a prominent Nb trough, but it is unclear whether they show the concave REE profile associated with typical boninitic magmatism or have flat to slightly heavy-rare-earth-element (HREE) enriched profiles (Figure 18a of Swinden *et al.*, 1989).

The volcanic rocks of the Lake Ambrose and Sandy Lake sequences are bounded by, and locally intercalated with, one or more packages of sedimentary and epiclastic rocks. These rocks include thinly bedded, grey to green and black siltstone, greywacke, pebble conglomerate and black shale, and minor tuff. limestone and red siltstone. Some of the black shale is locally transformed into mélange. These sedimentary rocks probably cover a wide age range. Some units are potentially Neoproterozoic, as they are intruded by offshoots from the ca. 565 Ma Crippleback Lake Quartz Monzonite (J.C. Pollock, personal communication, 2001). Potentially equivalent rocks in the southern part of the Tally Pond assemblage are possibly intruded by the Valentine Lake Intrusive Complex (P. Valverde-Vaquero, personal communication, 2001), which is dated at ca. 563 Ma (Evans et al., 1990).

The Diversion Lake group (Kean and Evans, 1988a) that occurs northeast of the Sandy Lake sequence (Figure 2) should probably also be included within the Tally Pond assemblage. The Diversion Lake group consists of green mafic to intermediate pillowed flows, pillow breccia, lapilli tuff and massive tuff, which are distinguished from all the other basalts in the Tally Pond assemblage, as they do not have arc-like chemical characteristics (Swinden *et al.,* 1989). On a depleted mantle-normalized spidergram the Diversion Lake basalts exhibit LREE enrichment and have a small positive Nb anomaly (Figure 18c of Swinden *et al.,* 1989). The age of the Diversion Lake group is unknown.

TULKS HILL ASSEMBLAGE

The Tulks Hill assemblage extends from Victoria Lake to just southeast of the Victoria River delta, and represents two packages of bimodal volcanic and minor clastic sedimentary rocks, referred to as the Long Lake and Tulks sequences (Figure 3). The northwestern margin of the assemblage is marked by a generally narrow band of black shale mélange that separates it from the Harbour Round and Sutherlands Pond assemblages, and represents the northwestern limit of the Victoria Lake supergroup as currently defined.

The age of the Tulks Hill assemblage is constrained by an Late Cambrian U–Pb zircon date of 498 +6/-4 Ma from near the Tulks Hill massive sulphide deposit (Evans *et al.*, 1990); no date has yet been obtained for the Long Lake sequence. The age of the Tulks sequence is further constrained by a concordant 495 \pm 2 Ma zircon date (Evans *et al.*, 1990) for the subvolcanic Roebucks Quartz Monzonite intrusion. The portion of the Victoria Bridge sequence of Kean and Jayasinghe (1982) that was identified as Llanvirn (Dunning *et al.*, 1987; Evans *et al.*, 1990) is now considered to form part of the Sutherlands Pond assemblage (*see later*).

The Tulks sequence forms a 10- to 15-km-wide belt of felsic-dominated bimodal volcanic rocks with minor interbedded sedimentary rocks that extends southwestward for over 65 km from the Victoria River at least to Victoria Lake. Common rock types in the Tulks sequence are light grey-green to white, dacitic to rhyolitic quartz and feldsparporphyritic pyroclastic flow deposits having crystals typically between 1 and 6 mm in diameter, crystal-tuff breccias, ash tuffs, rhyolite flows that locally preserve flow banding and small subvolcanic quartz-feldspar porphyry intrusions. Mafic volcanic rocks form a relatively minor component of the Tulks sequence, probably less than 20 percent of the unit, and consist mostly of tuff, lapilli tuff and volcanic breccia. Pillow lava and pillow breccia also occur, however their distribution is very limited. The pillows are typically small, amygdaloidal, locally variolitic and flattened. Kean and Evans (1986) have suggested that some of the units that were mapped as massive basalt flows may in fact be mafic sills. The distribution of sedimentary rocks within the Tulks assemblage is very restricted, being largely limited to a few beds of massive volcanogenic wacke and siltstone, and very rare limestone. Jasperite seams (generally less than 5 mm thick) are present within some of the pyroclastic flow deposits. These are interpreted to represent regional exhalative deposition that occurred during the small periods of quiescence between pulses of volcanic activity.

Geochemically, the mafic volcanic rocks have been subdivided into two populations: the arc tholeiite-like Baxters Pond – Beatons Pond basalts and the transitional upper basalts (Swinden *et al.*, 1989; Evans and Kean, 2002). On depleted-mantle normalized multi-element spidergrams, the Baxters Pond – Beatons Pond basalts exhibit mildly to highly depleted, relatively flat to slightly concave profiles (Swinden *et al.*, 1989). In contrast, the upper basalts have a non-arc-like, LREE enriched depleted mantle normalized multi-element spidergrams profile with no Nb trough (Figure 16d of Swinden *et al.*, 1989). These rocks have been interpreted as transitional between island-arc and rifted-arc (Evans and Kean, 2002).

The Long Lake sequence appears to stratigraphically overlie the Tulks sequence on the basis of sparse younging indicators. The Long Lake sequence is lithologically similar to the Tulks sequence except for the higher proportion of mafic volcanic rocks and typically larger phenocrysts in the felsic porphyries. The mafic volcanic rocks are generally highly magnetic and are therefore readily outlined by the airborne magnetic data (Oneschuk *et al.*, 2001). The magnetic anomalies associated with these mafic rocks can be traced beneath the clastic sedimentary package that bounds the Long Lake sequence to the east, suggesting a discordant relationship between these two units.

Exploration companies originally subdivided the Long Lake sequence (or belt as it was referred to) from the Tulks sequence to describe the volcanic and volcaniclastic rocks that outcrop on Long Lake (Graves and Squires, 1992; McKenzie et al., 1993). This unit has been extended to include the rocks that outcrop northeastward from Costigan Lake to Number 5 Steady on the Victoria River on the basis of lithological similarities and the continuity of geophysical signatures. The main rock types within the Long Lake sequence are dark green, mafic pyroclastic rocks including tuff, crystal tuff, lapilli tuff, volcanic breccia and reworked deposits, and white to grey-green, dacitic to rhyolitic, quartz-feldspar crystal tuff, crystal tuff breccias and pyroclastic flow deposits. Pillow basalts, massive mafic flows and aphyric felsic tuff and ash are also present, along with relatively rare sedimentary (in part epiclastic) rocks. The most distinctive rock in this assemblage is a crystal tuff with prominent, large (up to 15 mm in diameter), equant, blue to milky quartz xenocrysts that typically account for approximately 20 percent of the rocks volume.

Geochemically, the basaltic rocks of the Long Lake sequence are arc-like ranging between island-arc tholeiites and calc-alkaline basalts (Swinden *et al.*, 1989). On depleted mantle-normalized spidergrams, the mafic volcanic rocks all exhibit large Nb-troughs, with slight LREE-enrichment for the arc tholeiites to large LREE-enrichment for the calcalkaline basalts. Such chemical signatures would suggest a mature arc setting.

CLASTIC SEDIMENTARY ROCK SEQUENCE(S)

Currently, it is unclear whether the package of predominantly clastic sedimentary rocks that separates the Tally Pond and Tulks Hill assemblages (Figure 3) represents one or more sedimentary sequences. This sedimentary package consists predominantly of pre-Caradocian turbidites composed of greywacke having interbedded siltstone, shale, conglomerate and rare limestone (Kean and Evans, 1988a, b). These rocks are overlain by Caradocian black shale, which in turn is conformably overlain by marine greywacke and conglomerate (Kean and Mercer, 1981) of the Badger group (Williams, 1995).

SUTHERLANDS POND ASSEMBLAGE

The Sutherlands Pond assemblage (Figure 3) is a newly identified grouping of rocks that were previously included within the Tulks Hill and Harbour Round assemblages. The Sutherlands Pond assemblage consists of a relatively narrow (typically less than 5 km wide) band of dominantly felsic volcanic rocks, which extend for approximately 35 km southwestward from the Victoria River delta. It is bounded to the east and west by thrust faults that are marked by highly deformed black shale mélange units, typically ranging between 10 and 100 m thick.

The main lithological component of the Sutherland Pond assemblage is moderately to highly deformed, massive, thickly bedded, grey to white, aphyric to sparsely quartz and feldspar phyric, rhyolite breccia. Aphyric rhyolite, felsic tuff, ash tuff, quartz and feldspar crystal tuff, mafic tuff and pillow basalt are also present. Interbedded with these volcanic rocks are volcaniclastic sandstone, siltstone, black shale and limestone; the limestone frequently occurring as small reefs within sheared black shale horizons.

The Sutherlands Pond assemblage has been dated by U-Pb zircon at 462 +4/-2 Ma (Dunning et al., 1987) on a green, quartz and feldspar-porphyritic rhyolite samples at the head of the Victoria River delta. This is in agreement with the presence of Llanvirn conodonts (Stouge, 1980; Kean and Jayasinghe, 1980) from a limestone pod 20 m north of the dated sample. Previously these rocks had variously been interpreted as part of both the Tulks Hill and Harbour Round assemblages (the so-called Victoria Mine sequence of Kean and Jayasinghe (1982) and Harbour Round belt of McKenzie et al. (1993), respectively). There is only very limited geochemical data currently available for the Sutherlands Pond assemblage (Kean and Evans, 1988a; data listed in Saunders, 1995). However, this data does suggest that the mafic volcanic rocks are calc-alkaline in composition (Kean and Evans, 1988a), and hence that the Sutherlands Pond assemblage formed in a mature or continental-arc setting.

HARBOUR ROUND ASSEMBLAGE

The Harbour Round assemblage is a bimodal volcanic and sedimentary package of rocks exposed along the southcentral shore of Red Indian Lake (Figure 3), and possibly extend southwestward toward Wood Lake. This assemblage incorporates most of the sedimentary Harbour Round Formation and Harbour Round basalts of Kean (1979a) and Kean and Jayasinghe (1980), but has a more restricted distribution than the Harbour Round belt of McKenzie et al. (1993). The northwestern contact of this assemblage is hidden beneath Red Indian Lake in this region but is interpreted as a southeast-directed thrust based on correlation with units to the north and south, and from reflection seismic survey data (Thurlow *et al.*, 1992). Previous studies (e.g., Kean, 1979a; Kean and Jayasinghe, 1980; Evans *et al.*, 1990) interpreted the Harbour Round assemblage to lie conformably, although locally fault modified, above the Victoria Lake Group. This interpretation is rejected in favour of a thrust contact that is marked by very highly strained phyllonite and black shale mélange.

The rocks within the Harbour Round assemblage are green to buff quartz-wacke and siltstone, jasperite, heterolithic to felsic volcanic and/or epiclastic, bedded conglomerate, lapilli-tuff, tuff and ash tuff, mafic tuff and pillow basalt (locally hematitic). The assemblage is provisionally separated into upper and lower parts by an erosional unconformity, which is marked by a series of heterolithic conglomerates. These conglomerates range from massive to decimetre thick beds that exhibit load-casts and reverse grading. Clasts are typically sub-angular to well-rounded, range up to 60 cm in diameter and consist of massive and pillowed basalt, aphyric felsic ash/rhyolite and jasperite. The unconformity is interpreted as a change in volcanic centre, with the lower sequence representing more a distal style of volcanism than the upper sequence.

The presence of abundant interpillow and fragments of jasper within the mafic volcanic rocks has been suggested to be a distinguishing feature of the Harbour Round basalts and led Kean and Jayasinghe (1980) to include them with the Skidder basalts, which were then considered part of the Buchans Group. It is worth noting that jasper clasts also occur within the mafic volcanic rocks of the Sutherlands Pond assemblage, and to a lesser extent those of the Tulks Hill assemblage, and so the mere presence of jasper is not a discriminant. Geochemically, the mafic volcanic rocks of the Harbour Round assemblage are tholeiitic (Kean and Evans, 1988a,b; data listed in Saunders, 1995). From the limited data available, it appears that these basaltic rocks are either mid-ocean ridge- or back-arc-like in composition, however, the dataset is at present insufficient to overrule the possibility that they have affinities to island-arc tholeiites. Hence, a relationship to the tholeiites of the Skidder basalts (Pickett, 1987) cannot be excluded at this stage. The dataset is sufficient to distinguish them from the adjacent calc-alkaline basalts of the Sutherlands Pond assemblage, with which they have been linked previously (e.g., McKenzie et al., 1993).

A ca. 464 Ma U–Pb zircon date (V.J. McNicoll, personal communication, 2001) has been obtained for a felsic tuff horizon from the lower sequence of the Harbour Round assemblage. An indistinguishable Llanvirn age has been obtained from a lithologically similar package of rocks, approximately 80 km to the southwest in the Wood Lake area (P. Valverde-Vaquero, personal communication, 2001), suggesting a possible continuity of the Harbour Round assemblage. A narrow fault-bounded band of pillow basalt, exposed at the southern end of Red Indian Lake and in the Lloyds River valley, may also be part of the Harbour Round assemblage.

ECONOMIC GEOLOGY

Approximately 130 mineral occurrences and prospects are documented within the Victoria Lake supergroup (Evans and Kean, 1987) consisting of volcanogenic massive sulphides (VMS) and epigenetic gold. Generallly, the gold occurrences are associated with quartz veins in high alumina and potassium alteration systems with only trace amounts of base metals (Evans and Kean, 1987; Evans, 1996). Examples of such systems include the Midas Pond, Road (Camp), Valentine Lake and West Tulks occurrences. The VMS mineralization is mainly restricted to the felsic volcanic dominated sequences and consists of disseminated, stockwork, brecciated and massive sulphides. Most of the mineralized showings are dominated by disseminated to stringer pyrite and minor chalcopyrite, whereas the more significant deposits have extensive amounts of sphalerite, chalcopyrite and galena (Evans and Kean, 1987). Major Victoria Lake supergroup VMS deposits include the Duck Pond and Boundary deposits within the Tally Pond assemblage, and the Bobbys Pond, Daniels Pond, Jacks Pond, Long Lake, Tulks East, Tulks Hill and Victoria Mine deposits within the Tulks Hill assemblage.

At least two phases of VMS mineralization are recorded within the Victoria Lake supergroup, although metallogenic differences between the Daniels Pond, Tulks East and Victoria Mine deposits (McKenzie *et al.*, 1993) suggest that mineralization, in at least the Tulks Hill assemblage, occurred as several distinct events over an extended time period. This assertion is supported by the apparently younger stratigraphic position of the Long Lake mineralization.

Although disseminated pyritic mineralization is fairly common throughout the Sutherlands Pond assemblage, no significant showings or occurrences are reported in this assemblage. Consequently, the Sutherlands Pond assemblage is considered to have a low potential for containing any viable VMS deposits. The Harbour Round assemblage, on the other hand, has virtually no sulphide mineralization at all, and thus has a very low economic potential. An area that may warrant further investigation for VMS mineralization is the belt of clastic sedimentary rocks that occurs between the Tulks Hill and Tally Pond assemblages, as it is apparent from airborne geophysics (Oneschuk *et al.*, 2001) that the VMS-hosting Long Lake sequence of the Tulks Hill assemblage continues beneath this sedimentary package.

SUMMARY AND CONCLUSIONS

A supergroup is defined in the North American Stratigraphic Code as a "formal assemblage of related or superposed groups, or groups and formations", whereas groups are intended to "express the natural relationships of associated formations" (North American Commission on Stratigraphic Nomenclature, 1983). It is evident from both preexisting and current studies that the Victoria Lake Group as originally defined by Kean (1977) needs to be changed to the rank of supergroup (see Evans and Kean, 2002), as the different ages and tectonic juxtaposition of the various volcanic and sedimentary sequences that make up the Tally Pond and Tulks Hill assemblages preclude them from being considered as a series of associated formations. The informal term assemblage has been used as the next lower stratigraphic rank as it is currently unclear whether the Tally Pond and Tulks Hill assemblages each represent distinct groups or are a combination of several groups and/or formations. In particular, the latter situation may well apply to the Tally Pond assemblage where Lower Cambrian or older rocks are tectonically juxtaposed with Middle Ordovician sedimentary rocks.

FUTURE RESEARCH

The full extent of the Victoria Lake supergroup has yet to be firmly established. Evans and Kean (2002) have proposed that the Carter Lake and Pine Falls formations, along with other unnamed volcanic and sedimentary rocks that outcrop to the south and west of the Rogerson Lake Conglomerate should be considered a southern terrane within the Victoria Lake supergroup. Furthermore, it remains to be resolved whether the Sutherlands Pond and/or Harbour Round assemblages should be considered part of this supergroup.

Another major issue that needs to be resolved is determining the exact age and duration of volcanism within each of the assemblages. The apparently intrusive nature of the Neoproterozoic Crippleback Lake Quartz Monzonite suggests that the Early Cambrian age obtained from the Tally Pond assemblage is not representative of at least some of the assemblage's volcanic rocks. Similarly, the Long Lake sequence in the Tulks Hill assemblage is chronologically unconstrained beyond appearing to be stratigraphically above the Tulks sequence. Geochronological investigations are currently in progress to help constrain the age ranges of the Tally Pond and Tulks Hill assemblages. Also further dating, by both U–Pb zircon and conodonts, is being attempted on the Sutherlands Pond and Harbour Round assemblages to confirm that they are wholly Llanvirn in age.

Geochemical investigations (both whole-rock and Ndisotopic) are underway to help constrain the tectonic setting of the various assemblages. This should be useful in determining whether the Sutherlands Pond and Harbour Round assemblages belong in the Victoria Lake supergroup, as well as how the pillow basalt sequence that outcrops at the southern end of Red Indian Lake should be classified. It is also hoped that chemically distinct marker horizons will be apparent to assist in defining the structural development of the region.

Subsequent field studies will focus on: i) extending this stratigraphy to the southeast; ii) identifying the nature of the contacts between the constituent parts of the Victoria Lake supergroup; iii) further defining the volcanic and sedimentary units within the Tally Pond assemblage; and iv) categorizing and potentially subdividing the clastic sedimentary rock package that occurs between the Tally Pond and Tulks Hill assemblages.

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