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TECTONOSTRATIGRAPHIC RELATIONSHIPS IN THE LLOYDS RIVER AND TULKS BROOK REGION OF CENTRAL NEWFOUNDLAND: A GEOLOGICAL LINK BETWEEN RED INDIAN AND KING GEORGE IV LAKES

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ABSTRACT

Several fault-bound, generally west-facing belts of characteristic lithology underlie the Lloyds River–West Tulks Brook area of central Newfoundland. From west to east, these are the Lloyds Gorge, Lloyds River, Star Brook, Halfway Pond, West Tulks Pond and Pats Pond belts.

The Lloyds Gorge belt is composed predominantly of felsic rocks of unknown affinity, whereas the Lloyds River belt is represented by gabbro–leucogabbro and/or trondjhemite along with sheeted dykes and pillow lavas that occur near Red Indian Lake. The Star Brook and Halfway Pond belts consist of predominantly felsic and mafic supracrustal rock types, respectively, and appear to be present from Red Indian Lake to King George IV Lake. The Pats Pond belt includes abundant quartz–feldspar porphyry as well as associated tuff and tuff breccia. Locally, it appears to be disconformably overlain by sedimentary rocks of the West Tulks Pond belt.

Preliminary geochemical and geochronological data indicate that the Lloyds River belt may be a correlative of the Buchans Group/Skidder basalt; it may also be present in the King George IV lakes area. The Harbour Round assemblage appears to be continuous from Red Indian to King George IV Lake as the Halfway Pond and Star Brook belts. The Sutherlands Pond assemblage probably occurs near the southern end of Red Indian Lake as volcaniclastic rocks that locally contain limestone pods. The Harbour Round and Sutherlands Pond assemblages are interpreted to be part of the Notre Dame Subzone and are potentially genetically linked, such that the Sutherlands Pond assemblage represents the rifting of the Harbour Round arc. The Pats Pond belt and the immediately overlying sedimentary rocks of the West Tulks Pond belt belong to the Exploits Subzone. Furthermore, they are correlated with Tremadocian rocks southwest of Victoria Lake, which are petrographically very similar, and are considered to represent the youngest phase of the Victoria Lake supergroup. Together, these rocks are designated as the Pats Pond assemblage.

The position of the Red Indian Line is tentatively interpreted to lie between the Harbour Round or Sutherlands Pond assemblage, and the Victoria Lake supergroup and is typically marked by black shale mélange or phyllonite zones. Hence, the redefined Red Indian Line extends from the Victoria Mine site, through Sutherlands Pond and along the southeastern hinterland of Red Indian Lake before disappearing underneath the Carboniferous cover sequence. The Red Indian Line is next exposed on a small island at the southern end of Red Indian Lake, after which it heads south along the Tulks Valley and through West Tulks and Pats ponds. Southwest of Victoria Lake, the Rogerson Lake Conglomerate and Victoria Lake supergroup are truncated by the Victoria Lake Shear Zone and the Red Indian Line becomes masked by the Dunnage–Gander boundary.

INTRODUCTION

The Red Indian Line Targeted Geoscience Initiative, in part, studies the boundary relationships between the Exploits and Notre Dame subzones within the Dunnage Zone of central Newfoundland (Figure 1). This paper presents the initial results following the 2002 field season and attempts to bridge the gap between the areas covered during

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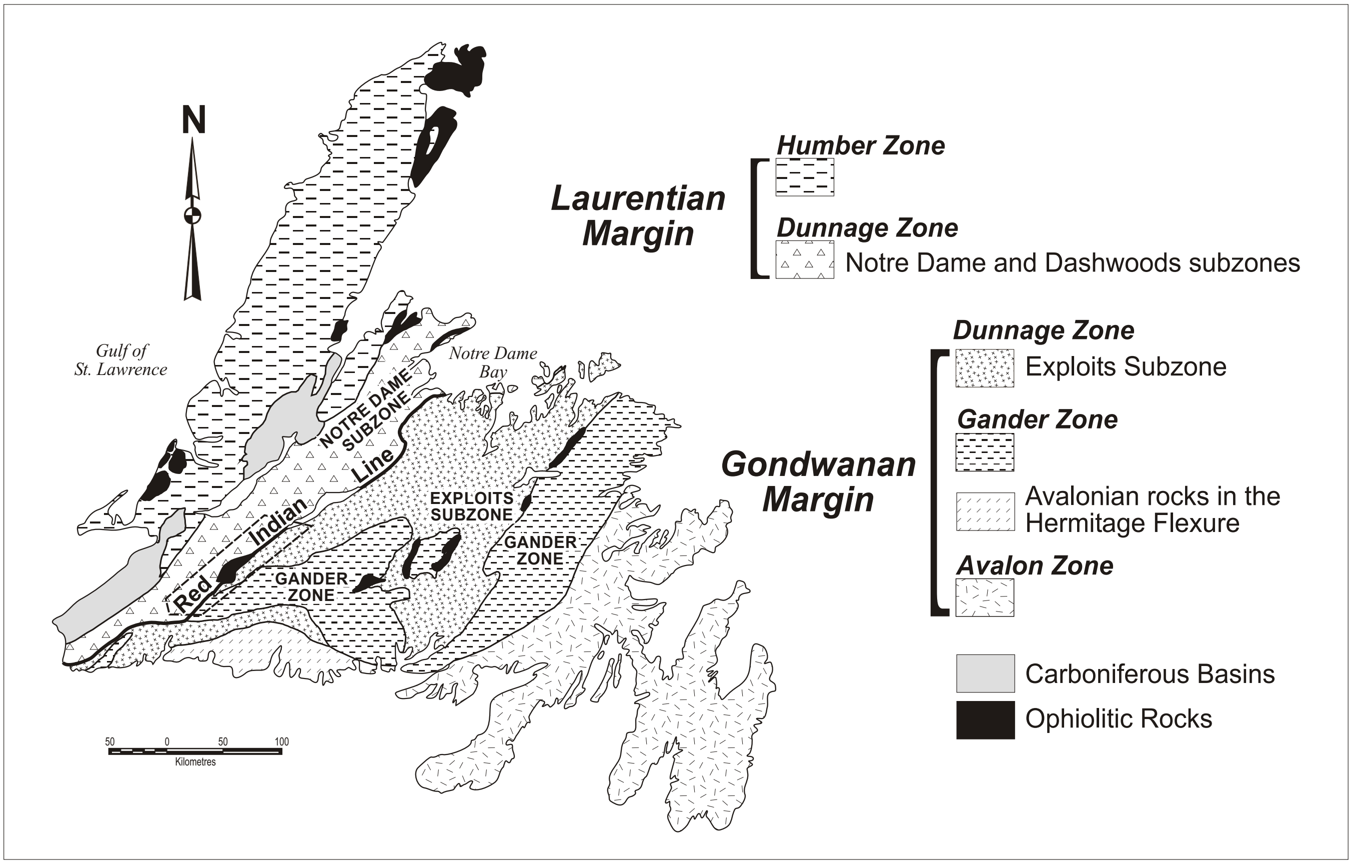

Figure 1. *Area of study in relation to the lithotectonic zones of the Newfoundland Appalachians highlighting the traditional position of the Red Indian Line (modified after Williams* et al.*, 1988).*

the previous years' work as described in Rogers and van Staal (2002), and Zagorevski and van Staal (2002). The study area comprises parts of the King George IV, Puddle Pond, Victoria Lake, Lake Ambrose and Star Lake map sheets (NTS map areas 12A/04, 12A/05, 12A/06, 12A/10 and 12A/11, respectively). In particular, this study focuses on the region between the Lloyds River Valley and West Tulks Brook (Figure 1). It describes the various belts of similar volcanic and/or sedimentary rocks that are present within the study area and fits them into an overall regional geological context. To this end, this research will follow, and add to, the stratigraphic framework developed by Rogers and van Staal (2002), where geological units are given the informal classification of assemblage (*see below*). It is intended that future work will enable the assemblages described to be formalized into groups and/or formations. The development of this regional stratigraphy provides the basis from which tectono-structural relationships, such as the position of the Red Indian Line, are determined and should help focus future mineral exploration.

PREVIOUS WORK AND REGIONAL GEOLOGY

The first major regional-scale geological mapping of the Red Indian Lake (NTS 12A) map area was conducted by Riley (1957) and Williams (1970), with subsequent, more detailed mapping conducted by Kean (1977, 1979a, b, 1982, 1983), Kean and Jayasinghe (1980, 1982), Herd and Dunning (1979), Dunning (1984), and Evans *et al.* (1994a, b, c). In addition, there have been numerous industry-led investigations throughout the region (e.g., Grimes-Graeme (1934), MacKenzie (1988), MacKenzie *et al.* (1988, 1990, 1993), Desnoyers (1990a, b) and Squires *et al.* (1990)) that have added to the database.

The Dunnage Zone of central Newfoundland (Williams, 1979) preserves Cambro-Ordovician volcano-sedimentary and associated intrusive rocks of ophiolitic, island-arc and back-arc tectonic affinities (Dean, 1978; Kean, 1977; Kean *et al.*, 1981; Dunning *et al.*, 1987, 1991; Swinden, 1990).

Williams *et al*. (1988) subdivided the Dunnage Zone into the Notre Dame (west) and Exploits (east) subzones (Figure 1) on the basis of structural, stratigraphic, faunal and Pb-isotopic contrasts. These two subzones are separated by the Red Indian Line, which has traditionally been interpreted to occur along the trace of the Lloyds River Valley and Red Indian Lake (*see* Williams *et al.*, 1988; Evans and Kean, 2002, also see Thurlow *et al*., 1992). The Notre Dame Subzone, as originally defined included the Buchans Group, Harbour Round basalt (Kean and Jayasinghe, 1980) and Annieopsquotch ophiolite belt, whereas the Exploits Subzone contained the pre-Caradocian volcanic and sedimentary rocks of the Victoria Lake supergroup (Kean, 1977; Evans and Kean, 2002). The two subzones formed on opposite sides of the Iapetus Ocean (Neuman, 1984; Colman-Sadd *et al*., 1992) and as such, the Red Indian Line represents the fundamental Iapetus suture zone in central Newfoundland.

Evans and Kean (2002) included all of the Cambro-Ordovician rocks that occur east of Lloyds River and west of the Silurian(?) Rogerson Lake Conglomerate in their definition of the Victoria Lake supergroup. They further subdivided the stratigraphy to the southeast of the Lloyds River Valley into the Harbour Round belt and the Tulks Hill volcanic sequence. A unit of tuffaceous carbonaceous shale (West Tulks Pond sedimentary rocks – Evans and Kean, 2002), exposed in the Tulks Valley, separates these two sequences.

Rogers and van Staal (2002) presented a framework for the various rock units that occur on the southern hinterland of Red Indian Lake. They indicated that the Victoria Lake supergroup consists of several petrographically and chronologically distinct, dominantly volcanic assemblages that are separated from each other by thrust faults. These assemblages are, from southeast to northwest, the Tally Pond (ca. 511 Ma – Dunning *et al.*, 1991; V. McNicoll and J. Pollock, unpublished data, 2002), Long Lake (ca. 505 Ma – V. McNicoll and N. Rogers, unpublished data, 2002) and Tulks Hill (ca. 498 Ma – Evans *et al*., 1990) assemblages. Furthermore, Rogers and van Staal (*op. cit.*) suggested that the Harbour Round (ca. 462 Ma – V. McNicoll and N. Rogers, unpublished data, 2001, 2002) and Sutherlands Pond (ca. 460 Ma – Dunning *et al.*, 1987; V. McNicoll and N. Rogers, unpublished data, 2002) assemblages are potentially unrelated to the Victoria Lake supergroup and may, in fact, be part of the Notre Dame Subzone, which would therefore require the position of the Red Indian Line to be revised.

GEOLOGICAL RELATIONSHIPS IN THE LLOYDS RIVER–WEST TULKS BROOK AREA

Field based studies in the Lloyds River–West Tulks Brook area (Figure 2) have delineated several northeast-striking belts of characteristic rock types. Generally, the belts are bound on either side by reoriented D_1 thrusts or high-angle reverse faults that are interpreted as having a west side up motion with a generally sinistral component. The belts are herein informally referred to using local geographical names in order to facilitate discussion.

LLOYDS GORGE BELT

The Lloyds Gorge belt (Figure 2) consists of a narrow zone of sheared felsic and mafic volcanic and/or intrusive rocks that outcrop discontinuously along Lloyds River (Unit 2e of Kean, 1982). Several graphite and sulphide-rich horizons are exposed; this indicates the local deposition of sulphidic carbonaceous black shale. In the Lloyds River area, the rocks locally contain biotite and garnet and are intruded by garnet-bearing granite that is petrographically similar to plutons of the Notre Dame Subzone (Whalen, 1993). At least two phases of deformation are discernable in outcrop, with a moderate to strong S_1 foliation that is folded by tight to isoclinal F_2 folds.

The Lloyds Gorge belt is truncated to the northeast prior to reaching Red Indian Lake (Figure 2). The belt is structurally truncated to the west of Pats Pond by the overlying thrust sheet that contains the Annieopsquotch ophiolite (Lissenberg and van Staal, 2002).

LLOYDS RIVER BELT

The Lloyds River belt occurs to the southeast side of Lloyds River (Figure 2) as a fault-bounded belt of coarse- to fine-grained gabbro, leucogabbro, trondhjemite and fine grained, potentially volcanic, mafic rocks (Kean, 1982). Near the southern end of Red Indian Lake, the gabbro passes into sheeted dykes and pillow lavas. Geochemically, the basalts have supra-subduction zone-like characteristics (Rogers *et al.*, 2002) and are very poorly exposed to the north-northeast, before disappearing beneath the Carboniferous cover sequence (Shanadithit formation, Kean, 1978).

The Lloyds River gabbro is heterogeneously deformed, such that mylonite zones characterized by extreme grain-

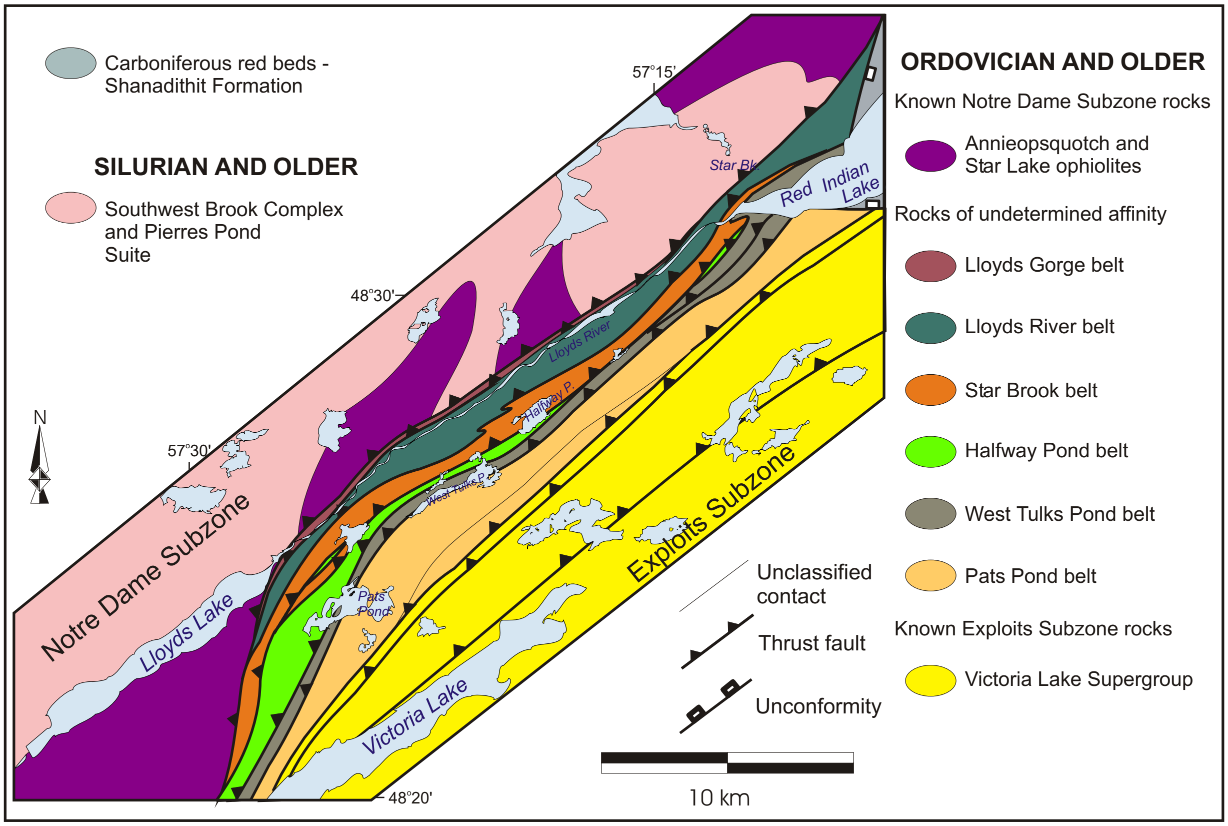

Figure 2. *Lithotectonic belts identified within the Pats Pond and West Tulks Pond area.*

size reduction commonly surround pods of weakly deformed material. Two phases of deformation are generally visible: a strong S_1 foliation folded by open to tight, shallow to moderately west-plunging folds. The intensity of internal deformation decreases to the northeast, which has resulted in the sheeted dykes and pillow lavas that occur there commonly appearing macroscopically undeformed. The northwest margin of the Lloyds River belt is metamorphosed at amphibolite-grade, as indicated by an amphibole–plagioclase–titanite-oxide mineral assemblage. The rest of the belt has been affected by pervasive greenschist-facies metamorphism.

The northwestern contact with the Lloyds Gorge belt consists of moderate to high-strain, fine-grained mafic rocks exposed on the north shore of Lloyds River (Plate 1a), and locally amphibole–porphyroclastic mylonite. These rocks are in contact with the Lloyds Gorge belt along most of the length of Lloyds River. Near Star Brook, the Lloyds River belt basalts are in fault contact with plutonic rocks of the Notre Dame Subzone. The southern contact with the structurally underlying felsic volcanic rocks is very poorly exposed but is marked by a zone of higher strain and is interpreted as a thrust fault.

STAR BROOK BELT

Structurally underlying the Lloyds River belt are the predominantly felsic tuffs and mafic dykes of the Star Brook belt (Figure 2). The tuffs are fine grained, typically beige- to grey-weathering and are locally quartz and feldspar xenocrystic. Trace amounts of jasper are locally present, and near Pats Pond interbedded felsic tuffs and jasper occur (*see* Zagorevski and van Staal, 2002, Figure 2b). Where preserved, bedding is generally poorly developed, but where present, grading indicates a dominantly westward-younging direction. Bedded tuffs commonly contain a bedding-parallel S_1 foliation, which is subsequently folded by asymmetric s-shaped F_2 folds. At least locally, a garnet–biotite–muscovite–plagioclase–quartz–oxide mineral assemblage is present in the altered rocks.

HALFWAY POND BELT

The Halfway Pond belt occurs to the south of the Star Brook belt (Figure 2) as a band of basalt containing minor diabase and gabbro that extends from near the southern end of Red Indian Lake to the Wood Lake area. The mafic volcanic rocks consist of pillowed flows, pillow breccias and

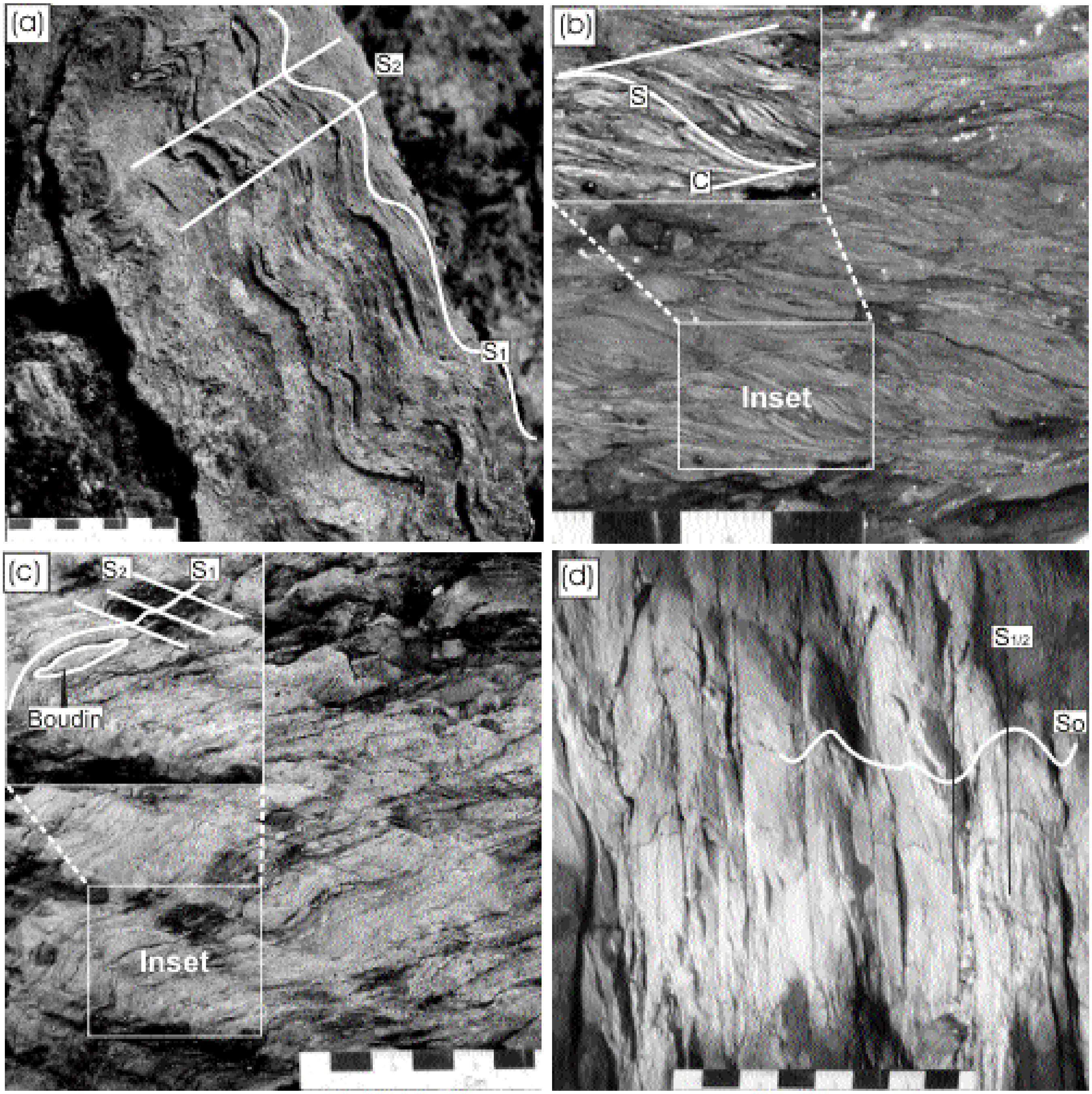

Plate 1. *(a) Fine-grained mafic rocks on the northwest margin of Lloyds River Belt illustrating relationship between strong S_1 foliation defined in part by quartz veins, and transecting S_2 cleavage with associated shallowly plunging F_2 folds. Sample taken from the Lloyds River gorge. Vertical face; facing southwest, 1-cm-scale card divisions. (b) Sinistral slip component in the shear zone separating Star Brook belt and Halfway Pond belt in the Pats Pond area. Independent evidence suggests that this is an S–C fabric. Horizontal outcrop; top to the west. (c) Highly strained, interbedded tuff and siltstone south of Pats Pond with a layering-parallel S_1 foliation overprinted by the transecting S_2 fabric. S_1 is defined by boudinaged tuffaceous beds that behaved more competently during deformation than the surrounding siltstone and shale. Moderately inclined outcrop; top to the southwest. (d) Typical Tulks Hill fine-grained sulphidic tuff east of Pats Pond. Note the high-angle relationship between bedding and cleavage, indicating that this is a fold hinge. Horizontal surface; top to the southwest.*

massive flows, commonly with minor sulphide mineralization. Where well-formed pillows are present, they typically indicate younging to the northwest. The belt attains a maximum thickness of several kilometres near Pats Pond and to the south of the Annieopsquotch ophiolite slice. The northwest contact is interpreted as an easterly directed thrust fault having a sinistral shear component, marked by a well-exposed phyllonite zone in the Pats Pond area (Plate 1b). The belt is truncated prior to reaching Red Indian Lake.

WEST TULKS POND BELT

The West Tulks Pond belt (Figure 2) consists of interbedded fine-grained felsic tuffs and volcaniclastic turbidites that are well exposed in the Pats Pond and West Tulks Pond areas and less obvious continuations to the northeast and southwest. The main portion of this belt has a well-defined, generally northwest-younging stratigraphy that consists of lower fine-grained tuffaceous turbidites that grade into coarse-grained heterolithic volcanic breccias, which are in turn overlain by black shale. The contact with the structurally overlying Halfway Pond belt is defined by highly strained, interbedded tuff and siltstone (Plate 1c) and by sheared black shale.

Volcanogenic breccias, which are locally interbedded with tuffaceous turbidites, are a characteristic unit within the West Tulks Pond belt. The volcanogenic breccia comprises abundant felsic volcanic fragments (50 percent), having accessory fragments of fine-grained tuff (30 percent) and black shale (5 percent) set in a finer grained quartz and feldspar-rich groundmass (15 percent). Quartz phenocrysts in the volcanic fragments and the matrix are commonly smoky in appearance. This unit is continuous from southwest of Pats Pond to the northeast portion of West Tulks Pond, where it is exposed on an island.

On Red Indian Lake, the West Tulks Pond belt exhibits a fining-upward (westward) sequence that is capped by a black shale mélange that locally includes limestone pods. These rocks are overlain by volcanic breccias that are dominated by aphyric rhyolite clasts. This sequence suggests that the dominantly metasedimentary rocks of the West Tulks Pond belt may represent a collage of several lithologically similar sequences.

PATS POND BELT

The Pats Pond belt (Figure 2) consists of coarse-grained quartz–feldspar porphyry as well as associated tuff and tuff breccia. This unit is continuous from Pats Pond to Red Indian Lake, and is correlated with rocks exposed along the northwestern shore of Victoria Lake. The internal stratigraphy of this belt is poorly constrained due to the massive nature of the rocks. The tuffs contain up to 20 percent by volume of quartz crystals up to 2 cm in diameter, although the modal diameter is approximately 4 mm.

The upper contact of this unit is interpreted to be disconformable with the southern margin of the West Tulks Pond metasedimentary rocks, as was observed on Pats Pond, although it is frequently marked by a chloritic phyllonite zone that has west side up motion.

Grey feldspar-phyric rhyolite tuff and massive rhyolite, as well as lithologically similar quartz-phyric breccia that are exposed along several ridges to the east of the West Tulks Brook have provisionally been included within the Pats Pond belt. Consequently, a high-strain zone that is exposed along the southeastern side of the West Tulks Brook valley is interpreted as marking the lower contact of this unit.

TULKS HILL ASSEMBLAGE

Volcanic rocks previously classified as belong to the Tulks Hill assemblage of the Victoria Lake supergroup (Rogers and van Staal, 2002; Rogers *et al.*, 2002) are exposed east of the West Tulks Brook Valley. This sequence is comprised predominantly locally of quartz porphyritic rhyolitic tuff, lapilli tuff and tuff breccia and minor flow-banded rhyolitic, sedimentary (including siltstone and shale), mafic volcanic and intrusive rocks. The fine-grained tuffaceous rocks are commonly thinly bedded, locally graded, and are generally mineralized (Plate 1d). Reverse grading indicated by scoured bases of beds is common. Generally, the bedding is transposed into the dominant foliation. Locally, steeply plunging fold hinges are preserved within the transposition foliation. Structural facing reversals within hinge zones indicate at least two phases of folding. Combined with the generally poor exposure, this impedes detailed structural analysis and resolution of the internal stratigraphy of the assemblage in this area.

A zone of mafic, felsic, and minor sedimentary rocks separates the Pats Pond belt from the main part of the Tulks Hill assemblage (Figure 3). The intensity of deformation is generally moderate to high, with less deformed material in the central portion of this zone. Evans and Kean (2002) assigned this unit, which includes their Baxters Pond basalt, to the Tulks Hill assemblage. Some of the units, such as the andesitic dykes, are similar to Evans and Kean's (2002) description of the area around the Tulks deposit. However, the Baxters Pond basalts and some volcaniclastic rocks are separated from the dyke-bearing sequence by a high-strain zone, which also manifests itself as a weak aeromagnetic

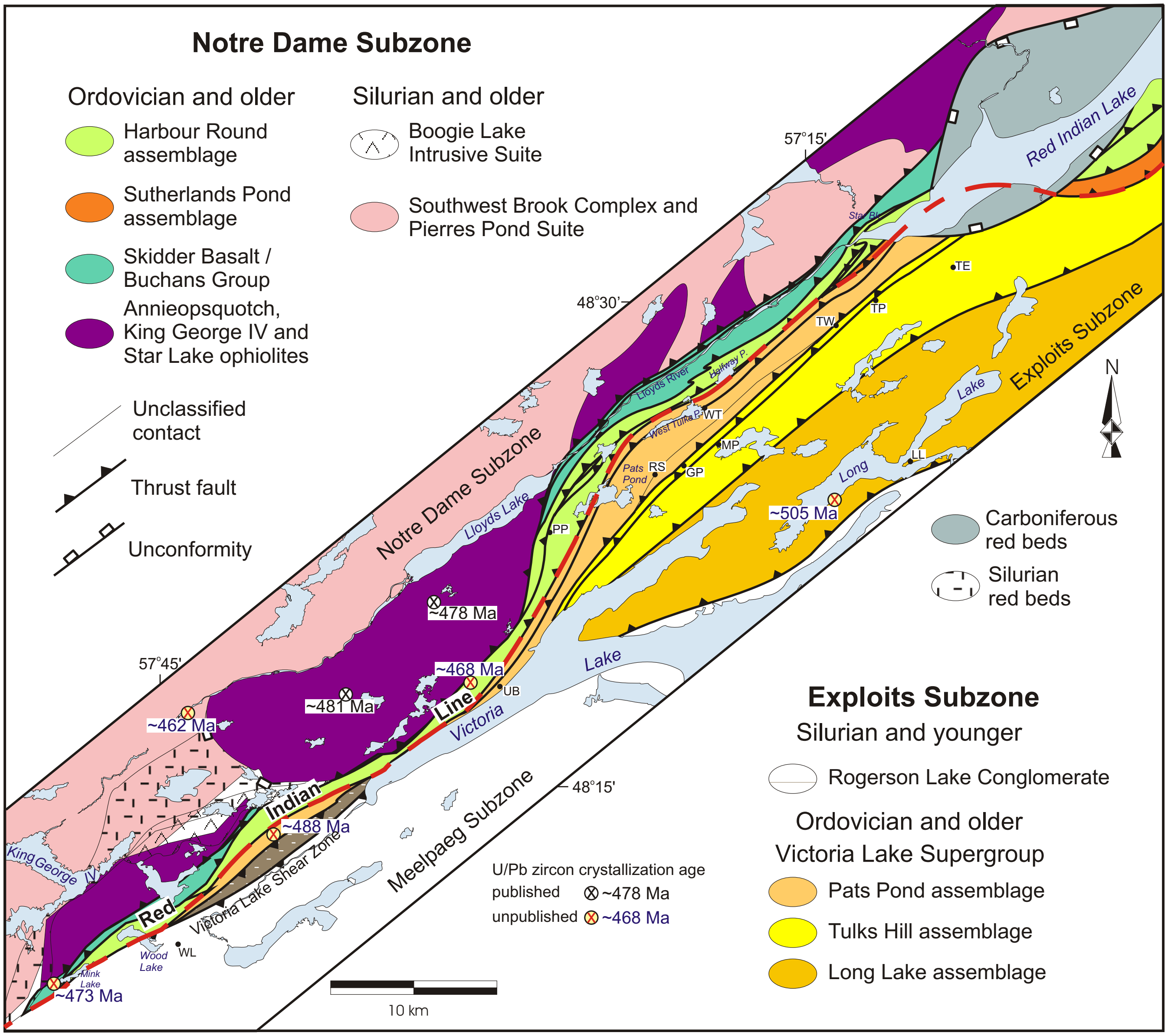

Figure 3. *Geological map of the Red Indian Lake – Wood Lake area. In part compiled and modified from Kean and Evans (1988a, b), Whalen and Currie (1988), Evans* et al. *(1990), Hogan and Evans (1991), Thurlow* et al. *(1992), Whalen (1993), Evans* et al. *(1994a, b, c), Oneschuk* et al. *(2001, 2002), Evans and Kean (2002), Lissenberg and van Staal (2002), Rogers and van Staal (2002), Rogers* et al. *(2002) and Zagorevski and van Staal (2002). U–Pb zircon ages from Dunning and Krogh (1985), P. Valverde-Vaquero (unpublished data, 2001), V. McNicoll and N. Rogers (unpublished data, 2002) and V. McNicoll and A. Zagorevski (unpublished data, 2002). Selected mineral occurrences: GL – Glitter Pond (Ba); LL – Long Lake (Cu, Zn); MP – Midas Pond (Au); PP – Pats Pond (Ag); RS – Road (Camp) Showing (Au); TE – Tulks East (Zn, Cu); TP – Tulks Prospect (Zn, Cu); TW – Tulks West (Cu, Zn); UB – Unnamed Brook (Zn); WL – Wood Lake (Zn, Au); WT – West Tulks Pond (Au).*

lineament (*see* Oneschuk *et al*., 2001, 2002). At present it cannot be conclusively demonstrated whether these rocks constitute a sheared slice within the Tulks Hill assemblage, or if this sequence represents a separate volcano-sedimentary unit.

STRATIGRAPHIC CORRELATIONS AND THE POSITION OF THE RED INDIAN LINE

One of the major problems encountered in correlating the stratigraphic sequences from the West Tulks area to the northeast and southwest is the general lack of exposure in key areas, particularly near the southern end of Red Indian Lake. This problem is further compounded by an absence of distinctive geophysical markers and the lithological similarities between several of the recognized belts described above.

BUCHANS GROUP AND SKIDDER BASALT

Mapping in the Mink Lake area south of King George IV Lake (Figure 3) has revealed the presence of jasperoidal, locally hematite-stained, pillow basalts, and associated jasper-bearing felsic tuffs that previously were tentatively interpreted to represent a continuation of the Llanvirn Harbour Round assemblage, based on their lithological similarity and proximity to Harbour Round-like rocks (*see below*). However, a preliminary age of ca. 473 Ma (V. McNicoll and A. Zagorevski, unpublished data, 2002) suggests that these rocks are middle Arenig and are more likely related to the 473 +3/-2 Ma (Dunning *et al*., 1987) Buchans Group (Figure 3). Geochemical analyses are in progress in order to test this correlation. Furthermore, it is possible that the felsic volcanic rocks of the Lloyds Gorge belt represent a connecting slice between the Buchans Group type locality and similarly aged rocks near Mink Lake. The possible extension of the Buchans Group to the south of King George IV Lake could have a significant impact on base-metal mineral exploration, which until now has been very limited in that area.

On the basis of their relative stratigraphic positions, the basaltic pillow lavas of the Lloyds River belt may be correlative to the Skidder basalt that outcrops northeast of the Carboniferous cover. The supra-subduction zone-like whole-rock geochemical signatures (Rogers *et al*., 2002) and the presence of sheeted dykes suggest a possible ophiolitic origin for this belt, a tectonic interpretation that has previously also been proposed for the Skidder basalt (Pickett, 1987).

HARBOUR ROUND ASSEMBLAGE

In the Wood Lake area (Figure 3) a sequence of Llanvirn (ca. 464 Ma - P. Valverde-Vaquero, unpublished data, 2001), fine-grained silicic tuffs that are locally interbedded with jasper, red shale, and jasper-bearing, hematitic basalts, are correlated with the Harbour Round assemblage of Rogers and van Staal (2002). The correlation is based on the petrographic similarities, indistinguishable U–Pb zircon ages and chemical characteristics (P. Valverde-Vaquero, unpublished data, 2002) of the rocks in the Wood Lake area from those of the Harbour Round assemblage type locality on the southeastern shore of Red Indian Lake. This sequence of interpreted Harbour Round assemblage rocks is extended northeastward to include the felsic tuffs of the Star Brook belt as described above, and may also include part of the mafic volcanic dominated Halfway Pond belt (Figures 2 and 3). However, as these rocks are separated from the type locality of the Harbour Round assemblage by the unconformably overlying Carboniferous redbeds it is not possible, at this stage, to confirm the correlation.

SUTHERLANDS POND ASSEMBLAGE

Rogers and van Staal (2002) defined the Sutherlands Pond assemblage as a Llanvirn belt of massive aphyric rhyolite, rhyolitic tuff and basalt that are interbedded with abundant volcaniclastic and sedimentary rocks, locally including small, but relatively widespread limestone pods, bound on either side by faults, which in part are marked by narrow zones (generally less than 50 m thick) of black shale mélange. Initial whole-rock geochemical investigations have revealed that the mafic volcanic rocks of the Sutherlands Pond assemblage generally exhibit a distinctive E-MORB-like signature (Rogers *et al*., 2002).

The most likely correlative of the Sutherlands Pond assemblage to the south of the unconformably overlying Carboniferous Shanadithit formation is the volcaniclastic portion of the West Tulks Pond belt that lies structurally above the mélange observed on a small island at the southern end of Red Indian Lake. In addition, it is possible that at least a portion of the Halfway Pond belt in the West Tulks Brook area correlates with the Sutherlands Pond assemblage as opposed to the Harbour Round assemblage. This possibility cannot be assessed until further geochemical investigations are complete.

PATS POND ASSEMBLAGE

The Pats Pond assemblage is proposed herein to represent the rocks of the volcanic-dominated Pats Pond belt, as described above, and the petrographically very similar bimodal tuff breccia (Zagorevski and van Staal, 2002) that occurs immediately north of the Rogerson Lake Conglomerate southwest of Victoria Lake (Figure 3). This breccia has been provisionally dated at ca. 488 Ma (V. McNicoll and A. Zagorevski, unpublished data, 2002). This early Tremadocian age and the presence of ca. 560 Ma inherited zircons (V. McNicoll, personal communication, 2002) suggest that the Pats Pond assemblage should be included as a distinct unit within the Victoria Lake supergroup, as opposed to an upper section of the Tulks Hill assemblage. Additional dating and geochemistry is required to confirm this assessment.

POSITION OF THE RED INDIAN LINE

The Red Indian Line, which is, by definition, the fundamental suture between the Peri-Gondwanan Exploits Subzone and the Peri-Laurentian Notre Dame Subzone (Williams *et al*., 1988), has traditionally been drawn through Red Indian Lake and the Lloyds River Valley (Figure 1). However, work presented here and elsewhere (e.g., Rogers and van Staal, 2002, Rogers *et al*., 2002) suggests that the Harbour Round assemblage (the type locality of which is on the southeastern shore of Red Indian Lake) is part of the Notre Dame Subzone. This is in part based on the petrographic and geochemical similarities between the mafic volcanic rocks of the Harbour Round assemblage and those of the Buchans Group and Skidder basalts. Furthermore, a combined reflection seismic survey and geological study (Thurlow *et al.*, 1992) indicates that the Harbour Round assemblage lies structurally below the Skidder basalts and forms part of the Notre Dame Subzone. Due to the similarity in age and their apparently identical inherited zircon populations (V. McNicoll, personal communication, 2002) it seems probable that the Harbour Round and Sutherlands Pond assemblages are related, with the slightly younger Sutherlands Pond representing a rifted arc sequence within the Harbour Round arc (Rogers and van Staal, 2002; Rogers *et al*., 2002). Consequently, the position of the Red Indian Line needs to be redrawn such that it traces the contact between the Harbour Round–Sutherlands Pond assemblage (Peri-Laurentian) and the Victoria Lake supergroup (Peri-Gondwanan). In the Victoria Mine area (approximately 35 km northeast of Figure 4) this tectonic boundary would correlate with the Jig Zone fault (McKenzie *et al*., 1993). Along most of the southern boundary of the Sutherlands Pond assemblage, the Red Indian Line is marked by a relatively narrow (typically less than 50 m) zone of black shale mélange, as is seen within the West Tulks Pond belt at the southern end of Red Indian Lake. Farther to the southwest, the Red Indian Line would lie between the Tremadocian Pats Pond assemblage and the Llanvirn Harbour Round assemblage (Halfway Pond belt) (Figures 2 and 3). This contact is poorly preserved in the southwestern part of the area due to late northwest-directed thrusting that is evident in the probably Silurian Rogerson Lake Conglomerate (Valverde-Vaquero and van Staal, 2001), which likely overprints early Silurian (Zagorevski and van Staal, 2002) southeast-directed thrusting (Figure 3).

Consequently, the Red Indian Line likely continues from the Victoria Mine site, through Sutherlands Pond and along the southern hinterland of Red Indian Lake before disappearing underneath the Carboniferous cover of the Shanadithit formation. To the south of the Carboniferous cover sequence, the Red Indian Line extends from southern Red Indian Lake along the Tulks Valley and through West Tulks and Pats ponds (Figure 3). Southwest of Victoria Lake, the Rogerson Lake Conglomerate and Victoria Lake supergroup are truncated by the Victoria Lake shear zone (Valverde-Vaquero and van Staal, 2001, 2002) where the Red Indian Line is largely masked by the Dunnage–Gander boundary.

CONCLUSIONS

Lithological mapping and preliminary U–Pb zircon dating and geochemical analyses have delineated lithotectonic belts that are tentatively correlated to assemblages identified by Rogers and van Staal (2002) and Valverde-Vaquero and van Staal (2001, 2002). The Sutherlands Pond and Harbour Round assemblages appear to continue from Red Indian Lake to the Wood Lake area, and may be genetically related to each other. According to our current interpretation that these units belong to the Notre Dame Subzone, it follows that the southeastern margin of these assemblages would define the trace of the Red Indian Line.

FUTURE RESEARCH

The preliminary interpretations of the field data presented above are being tested using geochemistry, geochronology and micro-structural analysis. Geochemistry (whole-rock, trace-element and Nd-isotopic analysis) from all assemblages will be used as a regional correlation tool and to constrain tectonic setting and possibly relationships among assemblages. This work should also enable the stratigraphic units described above to be formalized into groups and/or formations.

Studies are in progress to determine the age of the Lloyds River belt, Skidder basalt, and the provenance of units within the West Tulks Pond belt using U–Pb zircon geochronology and to determine the age of the southeast-directed thrusting using Ar–Ar techniques.

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