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STRATIGRAPHY AND STRUCTURAL GEOLOGY OF THE ORDOVICIAN VOLCANO-SEDIMENTARY ROCKS IN THE MARY MARCH BROOK AREA

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ABSTRACT

The Mary March Brook area was previously considered to be underlain by rocks of the Lundberg Hill and Sandy Lake formations of the Buchans–Roberts Arm belt. Detailed outcrop investigations and analyses of the geomagnetic anomalies suggest that this interpretation needs to be revised and the area is here subdivided into the Harry's River ophiolite complex, Mary March Brook and Seal Pond formations (Buchans–Roberts Arm belt), and the Red Indian Lake group. The boundaries between some of these tectonostratigraphic units are interpreted to be thrusts that were subsequently folded by F_2 folds. The revised stratigraphy and the recognition of regional thrusts and folds have important implications for mineral exploration in the study area.

INTRODUCTION

The Mary March Brook area lies within the belt of Ordovician volcanic rocks generally termed the Buchans–Roberts Arm belt, and it forms a geological link between the economically important Buchans mining district (*e.g.*, Thurlow and Swanson, 1987) and the area around the Gullbridge mine (*e.g.*, Pope *et al.*, 1991; Figure 1); previous detailed mapping of the Mary March Brook area was conducted by Kean (1979). Subsequently, Thurlow and Swanson (1981) applied the stratigraphy developed for the Buchans Mine, and assigned the volcanic rocks to either the Lundberg Hill or Sandy Lake formations (Figure 2; *see* compilation of Davenport *et al.*, 1996). As both the Lundberg Hill and Sandy Lake formations are considered unproductive in the Buchans Mine area (Thurlow and Swanson, 1987), the Mary March Brook area was not always viewed as highly prospective for VMS exploration. Nevertheless, the area has been the subject of several industry investigations. It includes many sulphide showings including ore-grade sulphide intersection near the shore of the Red Indian Lake (Figure 2). The existing stratigraphic information does not provide an adequate regional framework to constrain the tectonostratigraphic position of mineralization (Figure 2). The recent establishment of logging roads and related clear-cutting has greatly improved the access and exposure in this area, allowing detailed investigation and sampling.

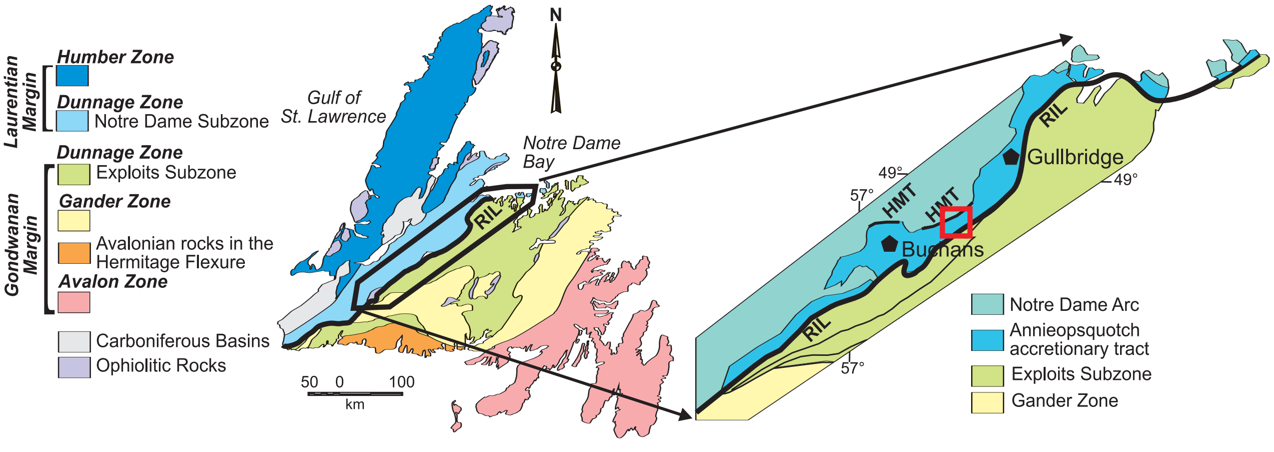

Figure 1. *Tectonostratigraphic zones of the Newfoundland Appalachians (modified after Williams* et al.*, 1988) and subdivision of the Notre Dame subzone into the Notre Dame Arc and Annieopsquotch accretionary tract. HMT - Hungry Mountain thrust, RIL - Red Indian Line (modified from van Staal* et al.*, 1998). Location of the study area indicated by the red polygon.*

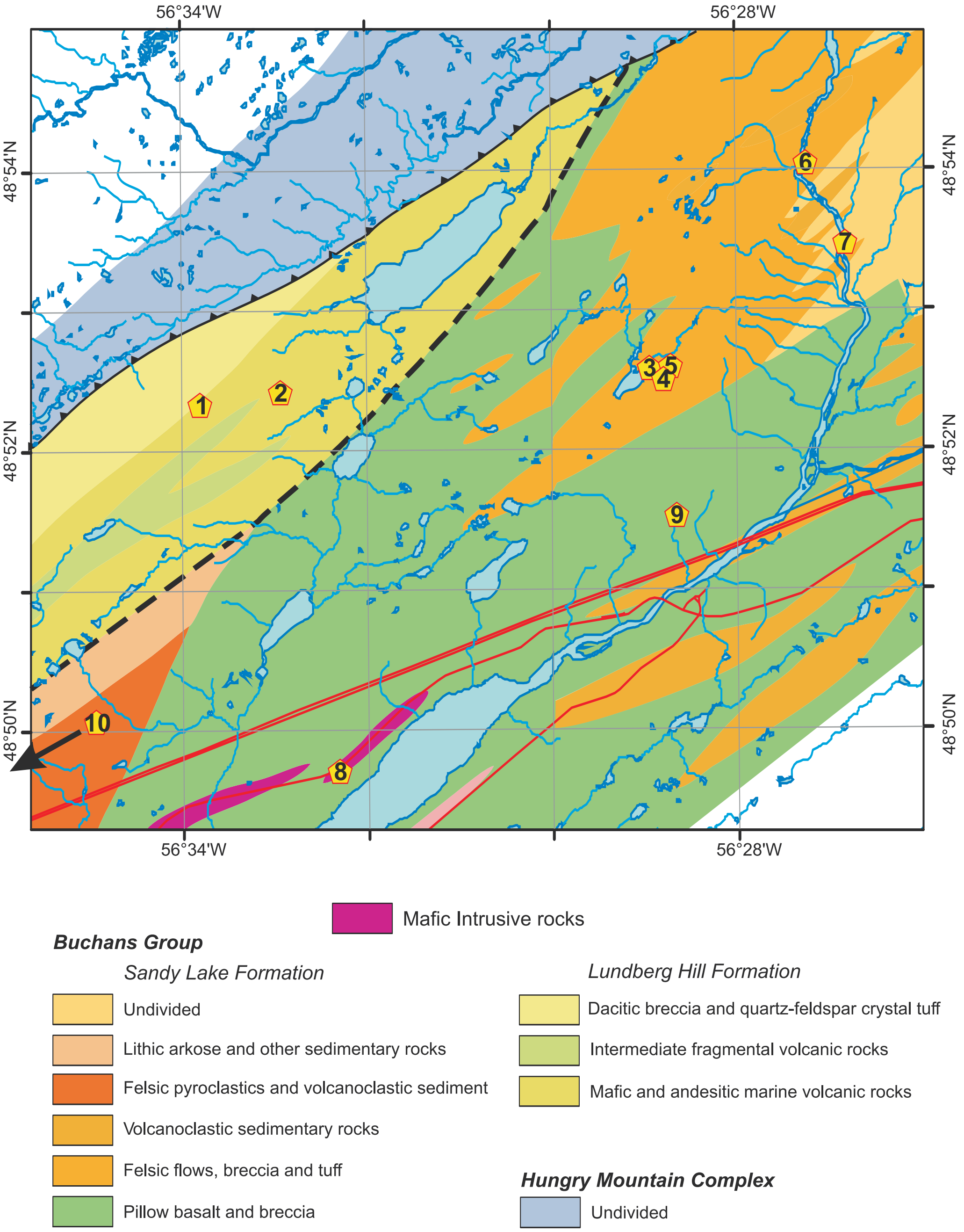

Figure 2 *Previous geology of the Mary March Brook area (modified from Davenport* et al., *1996). Mineral occurrences: 1. Seal Pond (012A/15/Zn014), 2. sulphidized rhyolite breccia (this study), 3-5. Beaver Pond and Buchans Junction North #2 (012A/16/Zn001, 012A/16/Ag001, 012A/16/Pyr005), 6. Transported sulphides (Squires* et al., *1992), 7. sulphidized rhyolite breccia (this study), 8. Mary March zone (012A/15/Pyr001), 9. Buchans Junction North (012A/16/Cu003), 10. Connel Option.*

The purpose of this contribution is threefold: 1) to describe the tectonostratigraphic relationships between the various volcano-sedimentary packages in the Mary March Brook area; 2) to integrate the Gullbridge South geophysical survey (Dumount and Potvin, 2007a and b) with bedrock mapping and discuss the structural history of the area using a combination of mapping and interpretations of geomagnetic anomalies; and 3) to compare the stratigraphy and preliminary geochemical data from the Buchans and Red Indian Lake areas.

STRATIGRAPHY

Zagorevski *et al.* (2007b) proposed several new units in the areas covered by the Buchans (12A/15) and Badger (12A/16) NTS map areas. These are informally referred to, herein, as the Harry's River ophiolite complex, Mary March Brook formation and Seal Pond formation. The nomenclature utilized in this contribution is provisional, and differs from Kean (1979) and Thurlow and Swanson (1981). The use of provisional nomenclature by Zagorevski *et al.* (2007b) is required because the use of stratigraphic terms from the Buchans Mine area carries genetic and mineral-potential implications that may cause some confusion in the literature (Thurlow and Swanson, 1987). The introduction of provisional units is also warranted because the rock types in the area significantly differ from the reported lithological and geochemical characteristics of the Lundberg Hill and Sandy Lake formations from the Oriental Mine sequence of the Buchans Group (*cf.,* Jenner, 2002).

HARRY'S RIVER OPHIOLITE COMPLEX

The Harry's River ophiolite complex (Figure 3; Harry's River metabasite of Thurlow *et al.*, 1992) underlies the northern portion of the study area and comprises highly deformed and metamorphosed mafic rocks in the footwall of the Hungry Mountain thrust (Thurlow, 1981). The strain decreases to the south, where a sequence of pillow lavas (Plate 1a) intruded by metagabbro can be easily discerned. Unlike any of the rocks in the Buchans Group in the immediate vicinity of the town of Buchans, the Harry's River ophiolite complex is metamorphosed up to amphibolite facies and is dominated by mafic rock types. Also, these are geochemically distinct from the mafic rocks of the Buchans Group. The basalts of the Harry's River ophiolite complex have predominantly non-arc transitional to enriched mid-oceanic ridge compositions, in contrast to the calc-alkaline basalt of the Buchans Group (Figure 4).

MARY MARCH BROOK FORMATION

The Mary March Brook formation (Figure 3) is characterized by a bimodal volcanic assemblage that is pervasively altered on a regional scale. Felsic volcanic rocks of the formation can display a wide range of volcanic textures and colours. The rhyolitic/dacitic rocks are characteristically poor in either quartz or feldspar phenocrysts, which, when present, are typically <1 mm in diameter. Feldspar is generally either lath-shaped single crystals or glomeroporphyritic. The proportions and textures of these phenocryst phases vary within a single flow, and appear to be related to the location with respect to the flow boundaries. The flows have a dome-like geometry and probably represent texturally zoned domes and cryptodomes that are surrounded by pyroclastic aprons. The inner portions of the domes are characteristically massive, finely quartz and feldspar porphyritic. The massive quartz-feldspar porphyry grades into autobrecciated aphyric to finely porphyritic flows that locally contain grey, flow-banded tongues of rhyolite and pumiceous matrix. The outer portions of the domes contain strongly amygdaloidal flows and pumiceous pyroclastic rocks that enclose grey, flow-banded rhyolite, chloritic rhyolite, and aphyric rhyolite blocks (Plate 1b). The distal portions include lithic lapilli tuff, ash tuff, and rare crystal tuff.

Mafic volcanic rocks are medium- to light-green amygdaloidal plagioclase-porphyritic pillow lavas and breccias (Plate 1c). Pyroxene locally forms important macroscopic phenocrysts, but is generally rare. The pillow lavas commonly contain interpillow white to hematitic chert, and, locally, the related pillow breccias are strongly hematitic. The pillows are commonly strongly altered, chloritized and/or converted to epidosite. Minor mafic-derived sandstones are exposed, notably on Mary March Brook.

The mafic and felsic rocks of the Mary March Brook formation are interfingered on a regional scale. Rhyolitic and basaltic breccias laterally grade into each other. The zones of transition are commonly strongly altered making identification of the primary rock type difficult; however, mafic fragments are typically amygdaloidal whereas felsic fragments are finely quartz porphyritic. Additional evidence for bimodal magmatism is provided by mafic and felsic dykes that cut the respective extrusive rocks. The geochemical characteristics of the lower Mary March Brook formation (Figure 4) are distinctly different from that of the Buchans Group.

SEAL POND FORMATION

Zagorevski *et al.* (2007a) proposed the Seal Pond formation (Figure 3), which also comprises bimodal volcanic rocks. The structural/stratigraphic base of the formation is marked by the appearance of a quartz glomeroporphyritic to megacrystic rhyolite. The remainder of the Seal Pond formation generally comprises quartz±feldspar-porphyritic felsic volcanic rocks including grey to reddish brown flow-banded rhyolite (Plate 1d) and orange tuff to tuff breccia. These have similar geochemical characteristics to the underlying Mary March Brook formation (Figure 4). In the Buchans area, significant amounts of magnetite-bearing mafic volcanic and intrusive rocks are locally present. Detailed mapping along Mary March Brook suggests that the contact between the Seal Pond and Mary March Brook formations is stratigraphic. In this area, the Seal Pond formation comprises better defined lenticles of mafic volcanic rocks than that seen in the Mary March Brook formation. However, these pillow basalts are still strongly altered and interlayered with pink to maroon quartz-phyric rhyolite (Plate 1d), quartz porphyritic pyroclastic rocks and fine-grained volcaniclastic sedimentary rocks (Plate 1e). The rhyolite and shallow intrusive rocks in this section petrographically resemble the Sandy Lake and "feeder" granodi-

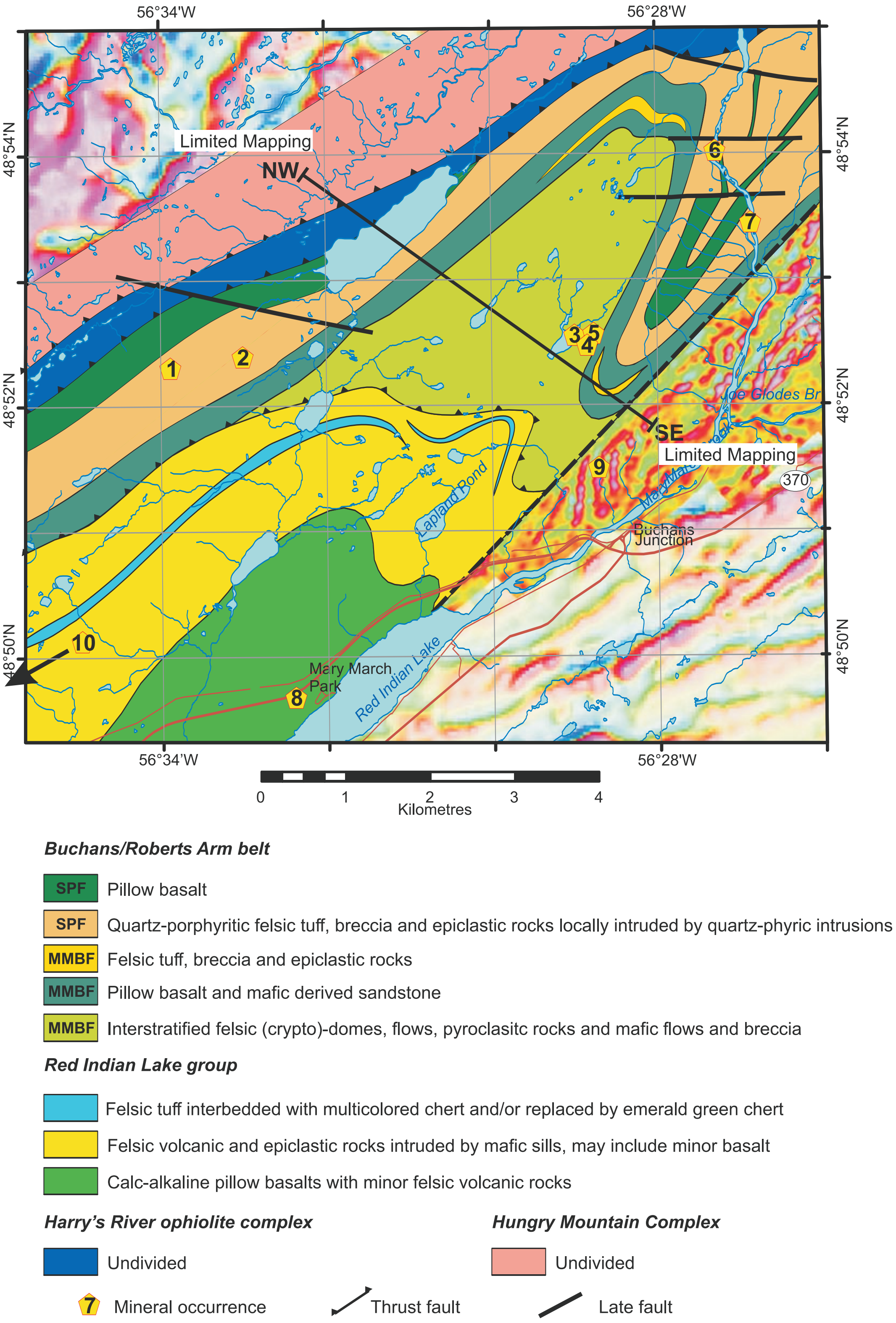

Figure 3 *Revised geology of the Mary March Brook area. Location of crossection in Figure 7 is indicated. MMBF – Mary March Brook formation, SPF – Seal Pond formation. See Figure 2 for identification of mineral occurrences.*

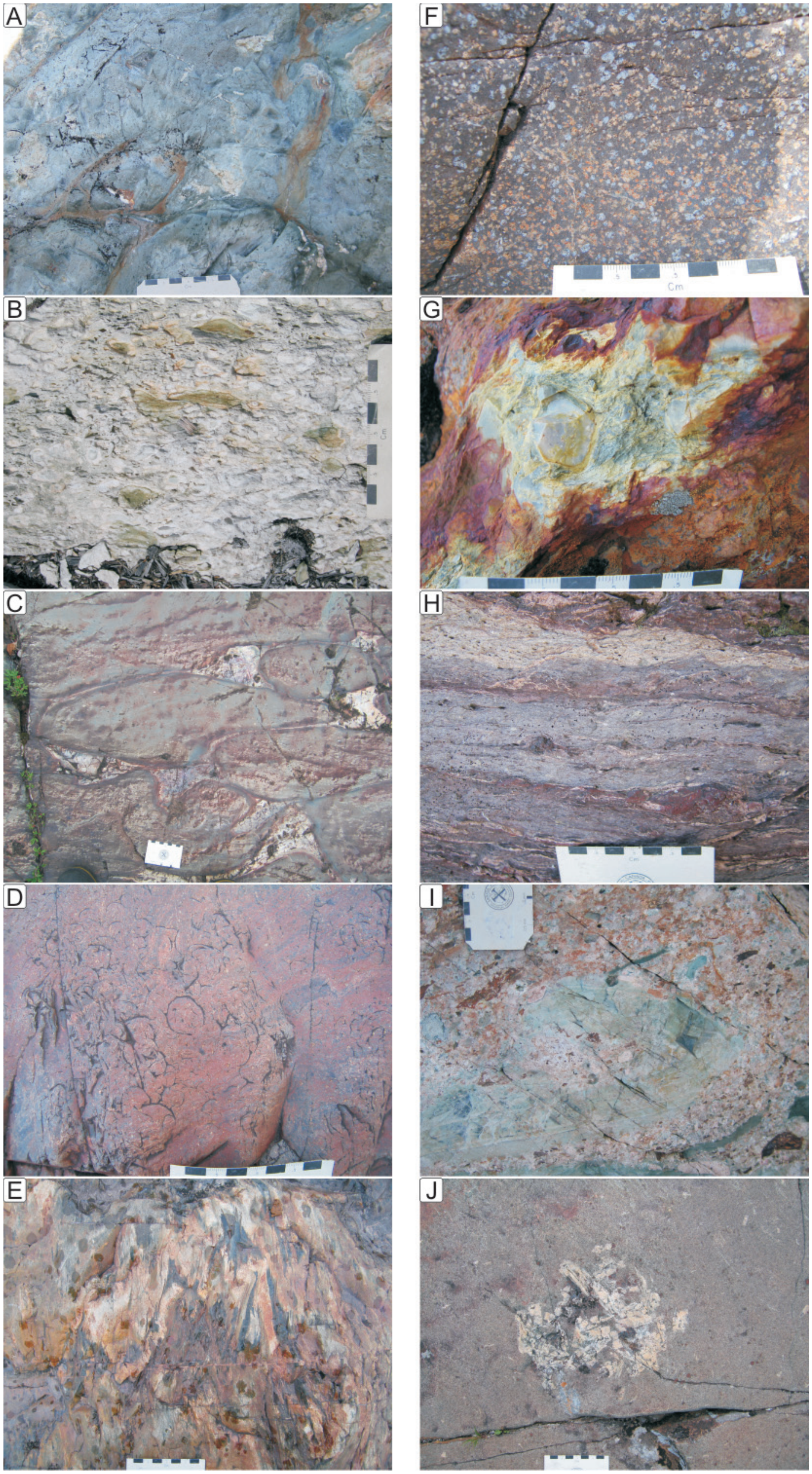

Plate 1. *Photographs of the volcano-sedimentary units in the Mary March Brook area (scale card divisions 1 cm). A) Harry's River ophiolite complex amphibolite-facies pillow basalt. B) Mary March Brook formation rhyolite. C) Mary March Brook formation pillow basalt. D) Seal Pond formation perlitic flow-banded rhyolite. E) Seal Pond formation epiclastic tuff and dark shale folded by upright infolds in the hinge of a regional syncline. F) Seal Pond formation quartz-feldspar porphyry. G) Seal Pond formation epiclastic tuff and dark shale folded by upright m-folds in the hinge of a regional syncline. H) Highly strained hematitic basalt at the base of Mary March Brook formation. I) Volcanoclastic breccia with abundant chert fragments. J) Typical texture of the post-Silurian mafic dyke.*

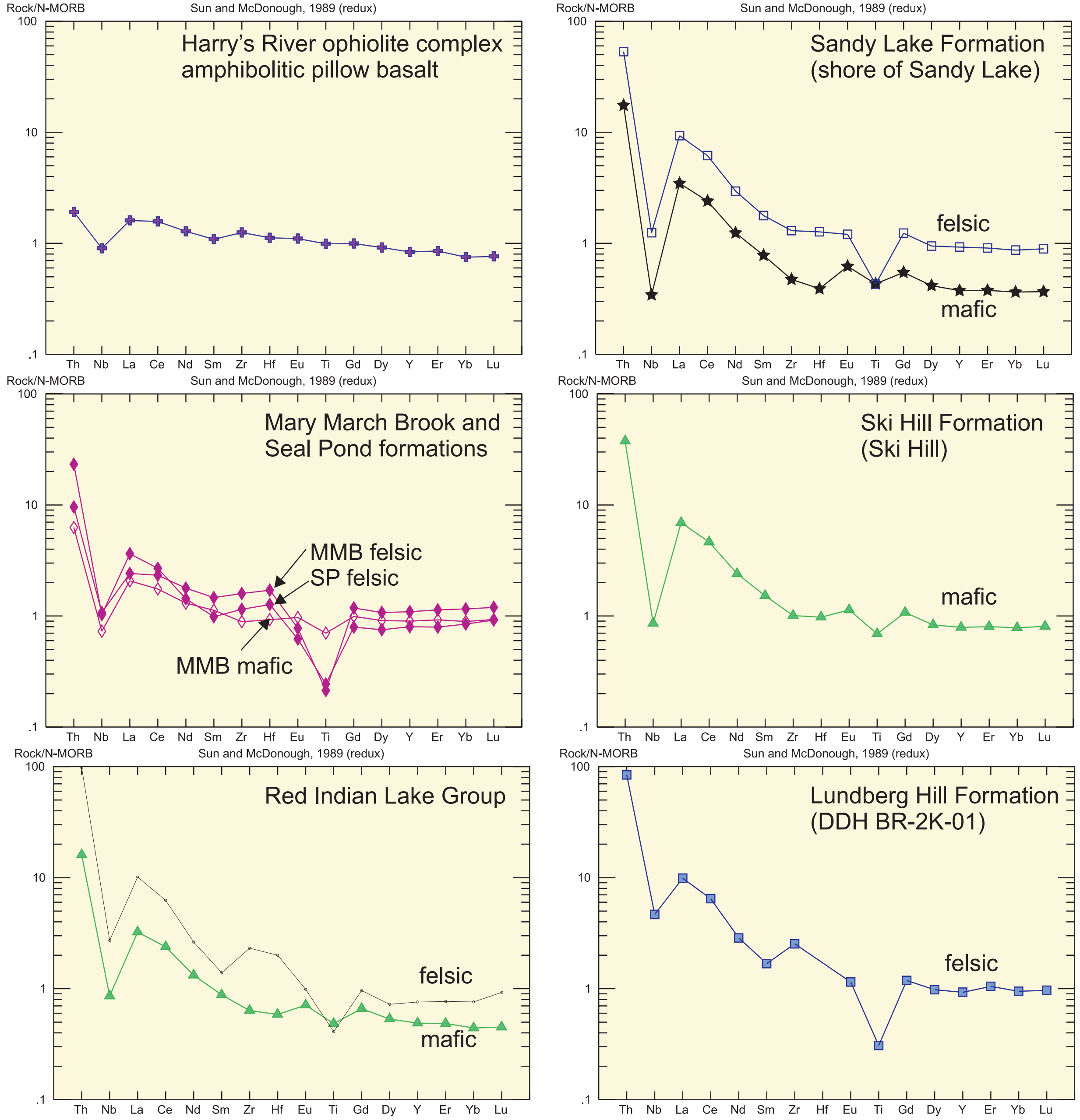

Figure 4. *Geochemical characteristics of the tectonostratigraphic units in the Mary March Brook and Buchans areas (normalization factors from Sun and McDonough, 1989; DDH BR-2K-01: Jenner, 2002).*

orite intrusions (Plate 1f). The Seal Pond formation hosts several localities of strongly altered volcanic rocks, including two strongly pyritized rhyolite breccia outcrops containing trace base-metal sulphides; these were observed during this study (Plate 1g; Figure 3).

RED INDIAN LAKE GROUP

The ca. 464 Ma Red Indian Lake group (Zagorevski *et al.*, 2006) comprises rocks that were previously allocated to several informal units, such as the Healy Bay siltstone, Harbour Round basalt (Thurlow *et al.*, 1992), Harbour Round formation (Kean and Jayasinghe, 1980) and Skidder basalt (Pickett, 1987). Three revised units were proposed for the Red Indian Lake group, *i.e.*, the Harbour Round, Healy Bay and Skidder formations (Rogers *et al.*, 2005; Zagorevski *et al.*, 2007a).

The rocks situated in the southern study area (Figure 3) were previously assigned to the Sandy Lake formation (Thurlow and Swanson, 1981), Footwall arkose and Footwall basalt (Kean, 1979). Rogers *et al.* (2005) assigned them to the Red Indian Lake group and interpreted the contact with the overlying Mary March Brook formation to be a folded thrust; however, the contact was not observed directly. Detailed mapping of the boundary revealed a narrow, high-strain zone (Plate 1h; Figure 3), supporting the interpretation of Rogers *et al.* (2005).

Following the nomenclature of Rogers *et al.* (2005), rocks in the study area are assigned to the upper calc-alkaline basalt member of the Harbour Round formation and to the felsic tuff-dominated Healy Bay formation. The tholeiitic to transitional calc-alkaline lower tholeiitic basalt member of the Harbour Round formation (Skidder formation) are exposed to the southwest of the study area. The whole-rock chemical characteristics of the calc-alkaline sequence are similar to those of the Buchans Group; however, subtle geochemical differences are apparent (Figure 4). In addition, preliminary Sm/Nd isotopic data for the study area suggest a lower degree of interaction with old crust in the Buchans Group than in the Red Indian Lake group (Zagorevski *et al.*, 2006).

The Healy Bay formation in the study area is dominated by felsic pyroclastic rocks and comprises laminated, bedded to massive ash to lapilli tuff and epiclastic rocks, locally interbedded with multicoloured chert. The common presence of emerald to light-green chert fragments (Plate 1i) and replacement horizons distinguishes this unit from the tuffaceous felsic rocks in the Buchans Group.

POST-ORDOVICIAN DYKES

A mafic dyke swarm has been documented throughout the area on the basis of outcrop observations and interpretation of geophysical data. The dykes generally trend east and cut across a weak foliation in the host rocks. These dykes are compositionally and texturally distinct from the probable feeder dykes of the host sequences in that they are unaltered and undeformed. The dykes commonly display subophitic to ophitic texture. Another noticeable characteristic of this dyke swam is the common presence of megacrystic plagioclase and gabbroic patches that are either pegmatite pockets or xenoliths (Plate 1j). At present, the age of these dykes is unknown, although a petrographically identical swarm having a similar orientation in the Gullbridge area cuts across the Dawes Pond pluton, the Twin Lakes complex, and the Skull Hill quartz syenite (415 ± 2 Ma: Kean and Jayasinghe, 1982) implying post-Late Silurian emplacement if the correlation is valid.

INTERPRETATION OF GEOMAGNETIC ANOMALIES

In the following discussion of the geomagnetic anomalies in the Mary March Brook area, both the residual total field and first vertical derivative data are utilized (Figures 5 and 6; Dumount and Potvin, 2007a and b). The geophysical data allows us to better elucidate structural and stratigraphic features, and integrate them with outcrop observations. The discussion proceeds broadly from the north-northwest, where the bedrock exposure allows direct correlation of anomalies with rock types, to the east, where bedrock exposure is extremely poor.

HARRY'S RIVER OPHIOLITE COMPLEX

In the northwest study area, a prominent high magnetic anomaly (Feature 1 in Figures 5 and 6) closely coincides with the limited exposures of the predominantly amphibolite-facies magnetite-bearing mafic rocks that constitute the Harry's River ophiolite complex. The western boundary of the anomaly corresponds to a high-strain zone and marks the contact with the felsic plutonic rocks of the Hungry Mountain Complex, and as such forms the extension of the Hungry Mountain thrust (Thurlow, 1981) in this area. The eastern boundary of this magnetic anomaly corresponds to a high strain zone that is observed on the southwestern shore of Seal Pond. This high-strain zone comprises mylonite, hornblende and epidote porphyroclastic metabasite tectonites, which could belong either to the Harry's River ophiolite complex or to the Mary March Brook formation.

MARY MARCH BROOK FORMATION

The surface extent of the Mary March Brook formation is marked by distinctly different magnetic susceptibility at different stratigraphic levels. The stratigraphically lowest bimodal rocks have low magnetic susceptibility. The susceptibility contrast between felsic and mafic rocks is also low, resulting in the lack of prominent geophysical anomalies that can be linked to stratigraphic horizons.

Stratigraphically higher volcanic rocks have a higher susceptibility contrast between the felsic and mafic rocks, and consequently a series of linear magnetic anomalies follow the stratigraphic contacts in this area. Specifically, a series of anomalies (Feature 2 in Figures 5 and 6) display a consistent convergence toward the southwest and are truncated along east–west trends (Feature 3 in Figures 5 and 6). The magnetic anomalies (Feature 2) closely coincide with a pillow basalt unit that has moderate magnetic susceptibilities. The convergence of the trends suggests the presence of a fold hinge, which is offset by late faults (Feature 3). The presence of such regional folds is also supported by limited structural data on the shore of Mary March Brook, where sedimentary rocks in the interpreted core of the regional fold are folded by outcrop-scale, shallowly northeast-plunging m-folds (Plate 1e), indicating that the regional fold is a northeast-plunging syncline.

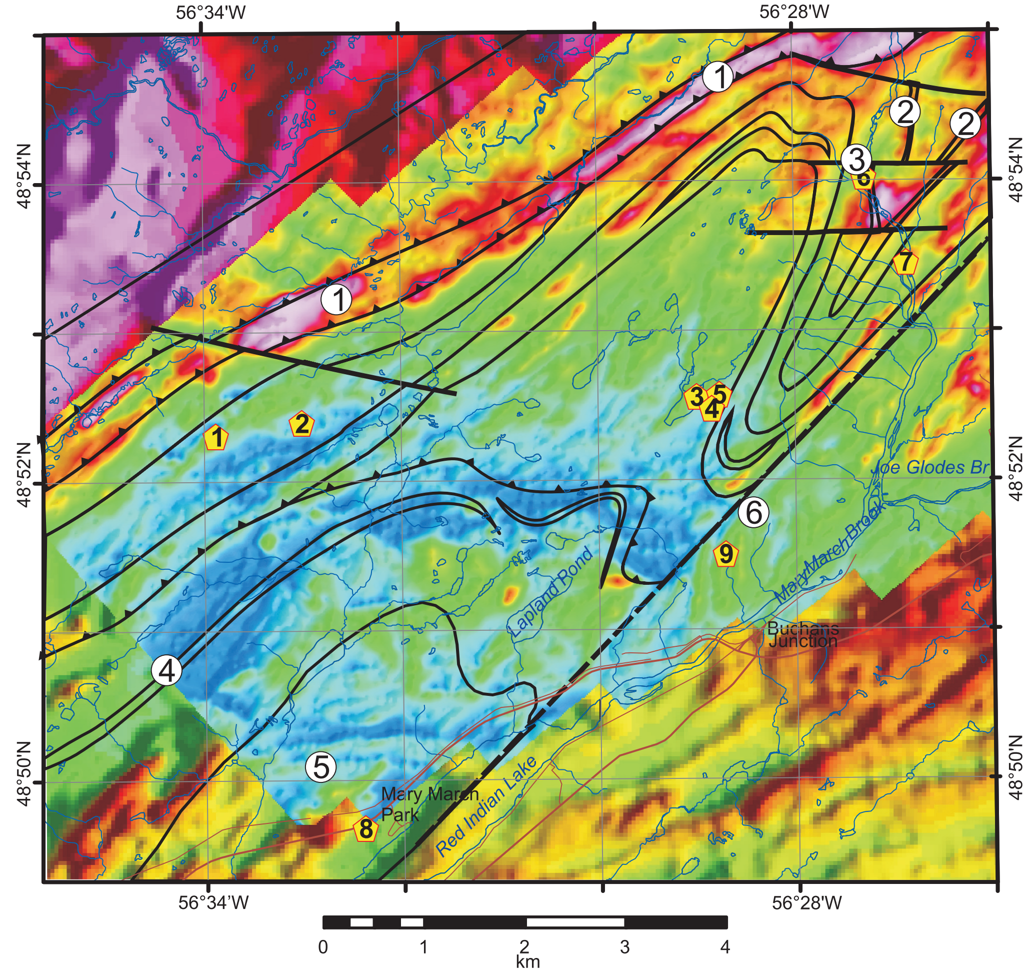

Figure 5. *Residual-total-magnetic field of the Mary March Brook area (Dumount and Potvin, 2007b). Numbers with white background refer to geomagnetic features discussed in text.*

RED INDIAN LAKE GROUP

A very non-magnetic unit appears in the southwest study area and corresponds to fine-grained tuff, epiclastic tuff, wacke, and multi-coloured chert, herein assigned to the Healy Bay formation of the Red Indian Lake group. All of the components of this unit have extremely low magnetic susceptibilities. A thin linear positive magnetic anomaly (Feature 4 in Figures 5 and 6) in the centre of this unit appears to correspond to a chert-rich portion of this package that forms a good marker horizon to the southwest. The continuation of this unit to the east-northeast on the first vertical derivative map is obscured by magnetic anomalies related to east-trending dykes occasionally seen in outcrop. The residual total-field data suggests the continuation of the low susceptibility unit to the east, however the predominance of magnetic and non-magnetic mafic volcanic rocks of both Red Indian Lake group and Mary March Brook formation in this area requires the Healy Bay formation to thin significantly, probably as a result of tectonic excision, as suggested by outcrops of a high-strain zone. The moderately magnetic unit with complex, mottled anomalies in the southern part of the study area broadly corresponds to the pillow basalts and felsic rocks of the Red Indian Lake group.

POST-ORDOVICIAN DYKES

The late dykes, despite being, typically, only 1 to 2 m wide, are coincident with weak to prominent positive magnetic anomalies on both the residual total field and first vertical derivative maps (Feature 5 in Figures 5 and 6). The magnetic anomalies are consistently linear to slightly curvilinear and have the same east–west trends as measured in outcrops. A very interesting feature of the dykes is that they appear to cut across folds (Feature 2) and are locally coincident with inferred faults (Feature 3). In the southern part of the survey area, the east–west-trending, closely spaced magnetic anomalies dominate the magnetic signatures in the low magnetic susceptibility units. The abundance of these dykes suggests that they represent a dyke swarm formed in response to a north–south extensional event.

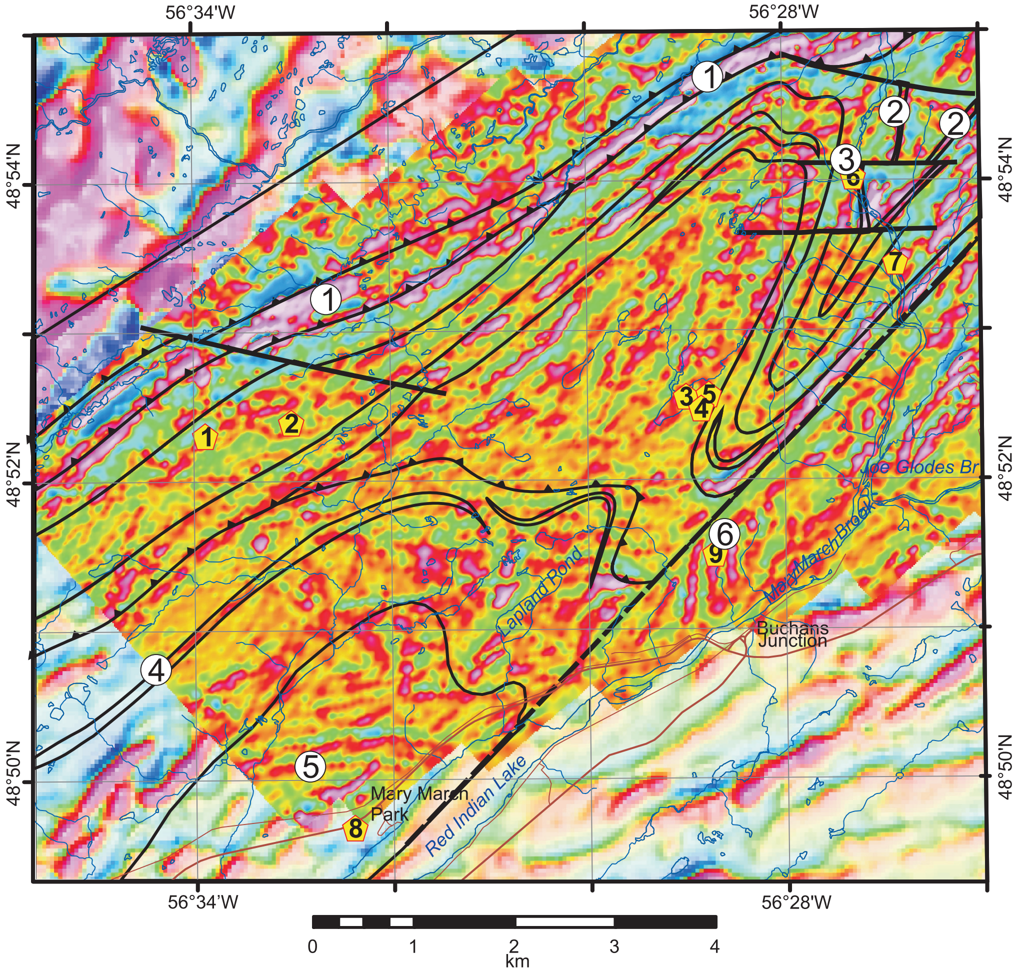

Figure 6. *First vertical derivative of the magnetic field of the Mary March Brook area (Dumount and Potvin, 2007a). Numbers with white backgrounds refer to geomagnetic features discussed in text.*

LATE FAULTS

In the southern part of the study area a set of north-trending, subparallel magnetic anomalies are truncated to the north. The truncation occurs along a low linear magnetic anomaly that strikes to the northeast (Feature 6 in Figures 5 and 6), subparallel to the north-northeast-trending limb of a regional syncline. It displays remarkable continuity across the study area and appears to truncate the northeastern extension of the Harry's River ophiolite complex. This feature is thus interpreted to represent an important fault zone.

STRUCTURAL GEOLOGY

The rocks in the study area are heterogeneously deformed and generally preserve an incomplete deformation history. However, several key outcrops provide information on the timing of folding with respect to the formation of shear zones and faults. In addition, the geophysical data have proven to be very useful for reconstructing the structural history.

EARLY SHEAR ZONES

The study area comprises a southeast-directed thrust stack of several unrelated structural panels. The structurally highest panel is marked by the plutonic rocks of the Hungry Mountain Complex (Whalen *et al.*, 1987) intruding into presumably ophiolitic amphibolites equivalent to the Annieopsquotch ophiolite complex to the west and southwest (Whalen *et al.*, 1997). The base of the Hungry Mountain Complex is marked by the extensive, but poorly exposed, Hungry Mountain thrust. The Hungry Mountain Complex in the study area is marked by C–S granodiorite tectonites in the hanging wall and mafic mylonites of the Harry's River ophiolite complex in the footwall. The fabrics associated with the Hungry Mountain Complex vary in attitude along strike, and are northwest dipping to the west, but vertical to southeast dipping in the northeast. The northwest-dipping fabrics preserve an excellent C–S fabric indicative of south-southeast-directed thrusting (*cf.*, Calon and Green, 1987; Thurlow, 1981). In contrast to the structurally lower thrusts, the zone of shearing is relatively wide.

The basal thrust of the Harry's River ophiolite complex has not been identified directly in the study area as the deformation in the Harry's River ophiolite complex is pervasive and affects of the Hungry Mountain Complex cannot be ruled out. However, changes in the metamorphic grade, lithological, and chemical characteristics across the basal contact suggest that the boundary with the underlying Mary March Brook and Seal Pond formations is an important out-of-sequence thrust.

The contact of the Mary March Brook formation and structurally underlying Red Indian Lake group is marked by tectonites in several places, suggesting that it is a fault. This interpretation is supported by the apparent thinning of the Healy Bay formation, which is probably excised along an originally shallow-angle thrust fault.

F$_2$ FOLDS

As described previously, a regional anticline–syncline pair folds the Mary March Brook and Seal Pond formations. The axial-planar cleavage to these folds is an S$_2$ crenulation cleavage. The crenulation cleavage deforms a pre-existing discrete S$_1$ foliation that appears to be related to D$_1$ thrusting. The map pattern of the interpreted thrust contact between the Mary March Brook formation and Red Indian Lake group suggests that the thrust is folded by the F$_2$ folds.

LATE FAULTING

The interpretation of late faults is predominantly based on the interpretation of geophysical anomalies. The first generation of late faults trends east and probably dips steeply. The displacement suggested by the pattern of magnetic anomalies is predominantly down-dip. The second generation of late faults trends northeast. An interesting feature of these faults is that the post-Ordovician dykes described in the previous sections do not appear to cut across them, and at least locally they clearly seem to be truncated. A similar relationship between the dyke swarm and similarly oriented late faults is suggested by the magnetic anomalies in the Gullbridge North aeromagnetic survey (Dumount *et al.*, 2007). In that area, the displacement may be reconstructed if the dyke swarm is utilized as a piercing point across the fault. This gives a dextral displacement, with up to 12 km of motion. The orientation of these faults is kinematically consistent with the north–south extension (or east–west compression) suggested by the post-Silurian dyke swarm.

IMPLICATIONS FOR EXPLORATION

The study area is host to several sulphide prospects including the Connel Option (Figures 2 and 3) and the Mary March zone (Mary March Wilderness Park area), as well as Seal Pond, Buchans Junction North and Beaver Pond showings. As such, unravelling the tectonostratigraphy and structural history will have significant implications for mineral exploration. The possible tectonostratigraphic setting of the deposits is discussed in the context of their host sequences.

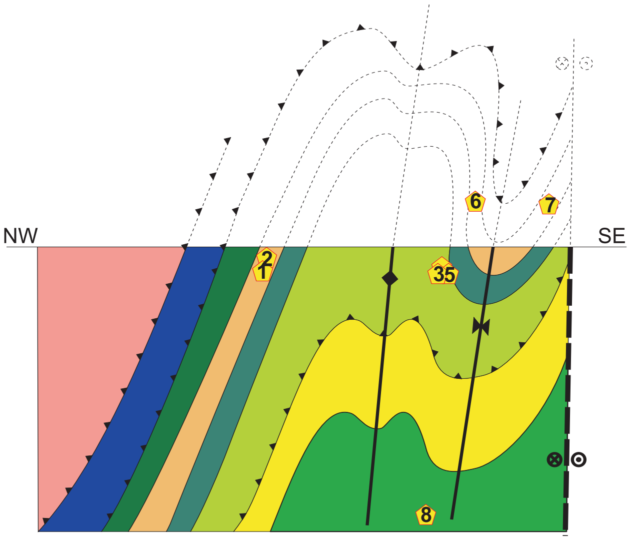

Figure 7. *Geological cross-section of the Mary March Brook area. The sulphide occurrences (*see *Figure 2) are projected for reference.*

MARY MARCH BROOK AND SEAL POND FORMATIONS

The Seal Pond, Buchans Junction North and Beaver Pond prospects are hosted by the Mary March Brook and Seal Pond formations, which are believed to be in stratigraphic contact. In addition to these prospects, these formations host several unnamed sulphide occurrences including a Zn–Pb-bearing breccia, thought to represent transported ores (Squires *et al.*, 1992) and two localities of strongly sulphidized rhyolite breccia (this study; Figure 3). Together these occurrences help define the regional folding structure (Figure 7). In addition, these appear to be linked with chlorite and epidosite alteration zones (*e.g.*, Zagorevski *et al.*, 2007b; Zagorevski and van Staal, 2007).

Mineralization

Along Mary March Brook, Zn–Pb-bearing breccia (Squires *et al.*, 1992) and sulphidized rhyolite breccia (Plate 1f) occur on opposite limbs of an interpreted syncline (Figure 7), with an intervening late fault. The stratigraphic relationships are consistent with the two occurrences having formed a single stratigraphic horizon prior to faulting. The only drilling to test mineralization in proximity to these localities was DDH MM-92-1 (oriented-60º toward 131), but this failed to produce any significant sulphide intersections (Squires *et al.*, 1992). At the time of exploration work, the stratigraphy was thought to dip moderately to the northwest (*e.g.*, Squires, 1996). However, as the Zn–Pb-bearing breccia occurs on an east-southeast-facing limb of a northeast-trending syncline, the drilling probably intersected the footwall of the Zn–Pb-bearing breccia, approximately parallel to the stratigraphy.

The Beaver Pond and Buchans Junction North occurrences (in proximity to Beaver Pond; mineral occurrences 3 to 5 in Figure 3) are located on an east-southeast-facing limb of a northeast-trending syncline. They appear to occupy a similar stratigraphic position as the mineralization on Mary March Brook (Figure 3, mineral occurrences 6 and 7). Hence, this folded and faulted stratigraphic horizon may form an important target for mineral exploration. The same stratigraphic horizon should continue to the northwest, across the hinge of a northeast-plunging anticline. Following this horizon accurately across the hinge is difficult due to lack of distinctive stratigraphic horizons or magnetic anomalies. However, the sulphidized felsic breccias having polymetallic veins and the Seal Pond prospect (Figure 3, mineral occurrences 1 and 3; Squires *et al.*, 1992) appear to form part of the same general stratigraphic horizon on the northwest-facing limb of the anticline.

Alteration

A systematic examination of the alteration characteristics was not undertaken as part of this study. However, pervasive alteration on the regional scale (both chloritic and epidosite) is a distinctive feature of the Mary March Brook formation (Zagorevski *et al.*, 2007b; Zagorevski and van Staal, 2007). Most of this alteration appears to be largely restricted to the footwall of the above-mentioned mineralized horizon. As such, the style of alteration may be a useful vector toward mineralization.

RED INDIAN LAKE GROUP

The Mary March zone (Mary March Wilderness Park area: Figures 2 and 3) and Connel option are hosted by the Red Indian Lake group volcanic and epiclastic rocks. Although little information is available on either of these, available Pb-isotopic data clearly indicated these to be isotopically distinctly different from the deposits in Buchans and from each other (Pb/Pb isotopes: Cumming and Krstic, 1987). The Mary March zone occupies a lower stratigraphic position than the Connel option, and is located near the projection of a regional hinge zone. Hence, continued delineation of the mineralized horizon should take into account the potential of folding and tectonic thickening of mineralization in the fold hinge. The continuation of the Mary March zone to the southeast may be limited by the apparent brittle fault identified on the basis of geomagnetic anomalies (see previous).

The Connel option is hosted by the Healy Bay formation of the Red Indian Lake group. The Healy Bay formation forms a continuous northwest-dipping stratigraphic package to the southwest of the study area. The exact stratigraphic position of the prospect in not obvious from industry data, however it appears to lie close to the multicoloured chert horizon. In the study area, this stratigraphic horizon hosting the Connel option appears to be cut out by a thrust and/or late strike-slip fault (Figure 3).

CONCLUSIONS

The Mary March Brook area forms an important and (reasonably) well-exposed link between the Buchans and Roberts Arm groups. Stratigraphic, geochemical, isotopic and geochronological investigations of the rocks in the Mary March Brook area are ongoing. Preliminary data suggests that the volcanic rocks can be divided into two distinct sequences, *i.e.*, the Mary March Brook and Seal Pond formations and Red Indian Lake group. The Mary March Brook and Seal Pond formations are considered to form part of the Buchans–Roberts Arm belt. The rocks of the Red Indian Lake group are separated from the Buchans Group by a folded thrust fault (Figure 7) and display distinctly different chemical characteristics in the study area (Figure 4). Since both the Harbour Round and Healy Bay formations are host to VMS mineralization northwest of Red Indian Lake, the Red Indian Lake group southeast of Red Indian Lake (Rogers *et al.*, 2005) also represents an interesting target for VMS exploration.

Assessment reports on central Newfoundland commonly refer to any VMS-style mineralization as "Buchans-style", "Buchans-type" or "in proximity to Buchans Mining Camp". Although this is probably very important in terms of investment perspective, such statements are commonly geologically simplistic. Central Newfoundland is host to many VMS occurrences of distinctly different ages, from ca. 511 Ma to ca. 465 Ma, which are hosted by volcanic sequences of distinctly different stratigraphic, geochemical and isotopic characteristics. Additionally, volcanic sequences of similar ages that formed at vastly different locations (*e.g.*, peri-Laurentian Red Indian Lake group (Rogers *et al.*, 2005; Zagorevski *et al.*, 2006) *vs* peri-Gondwanan Sutherlands Pond Group (Rogers *et al.*, 2005; Zagorevski *et al.*, 2007c) in the extreme example) are commonly juxtaposed. Hence, the identification of differences between the VMS occurrences and their host sequences is paramount to assessing the mineral potential of specific volcano-sedimentary packages.

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