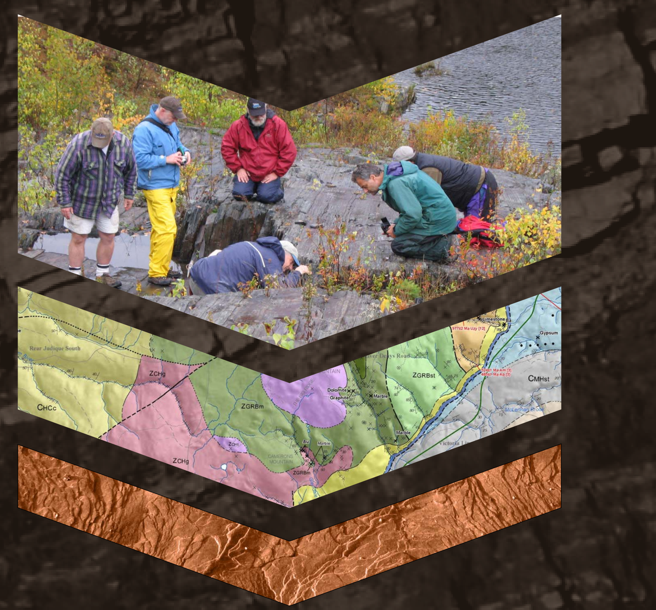
Natural Resources

Geology Matters 2014



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Geological Mapping and Resource Assessment

Preliminary Geology And Related Mineral Potential Of The Cheticamp Area, Cape Breton Island, Nova Scotia

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INTRODUCTION

The Cheticamp Pluton and the Faribault Brook area are located in Cape Breton Island, Nova Scotia, in the western part of the Aspy terrane, an area considered to be part of the microcontinent of Ganderia (Fig. 1). The Late Neoproterozoic age of the Cheticamp Pluton (Barr *et al*., 1986; Jamieson *et al*., 1986), however, is not typical of the rest of the Aspy terrane, which is made up mainly of Ordovician-Devonian metavolcanic, metasedimentary and plutonic rocks. The contacts of the pluton are mainly faults, and hence its relationship with the adjacent Jumping Brook Metamorphic Suite is uncertain (e.g., Barr *et al*., 1986, 1992; Jamieson *et al*., 1989; Tucker, 2011).

Interpretations of the petrology and tectonic setting of the Cheticamp Pluton have been difficult to make due to a lack of mapping and sampling in the northern and southernmost parts of the pluton, and the absence of a modern chemical database. This investigation aims to fill in these knowledge gaps and increase understanding of the origin of the Cheticamp Pluton and its relationship to other parts of Ganderia.

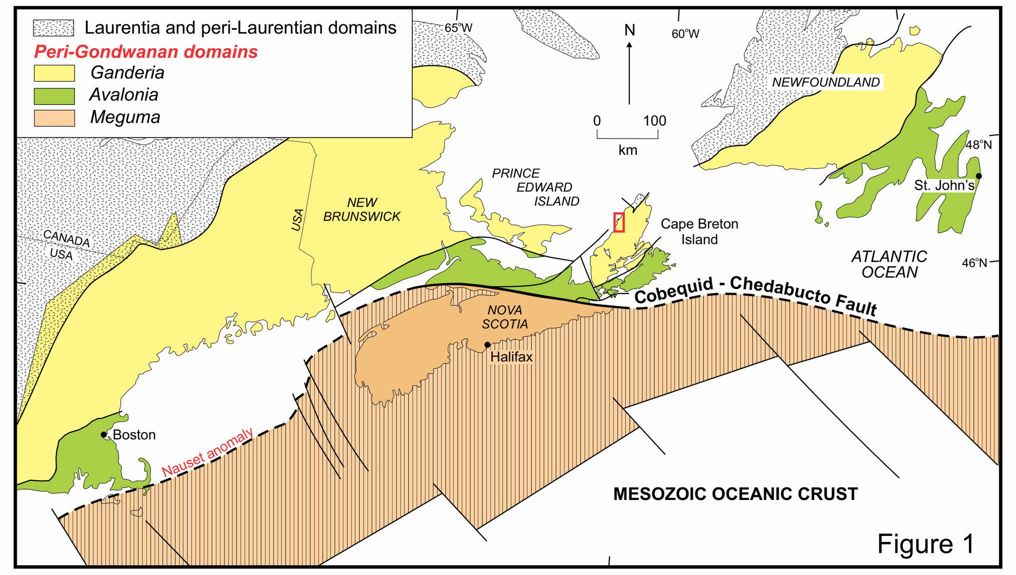


Figure 1

This area has been an economic mineral exploration target since the 1890s, with the discovery of Zn, Cu, Pb, Fe, As, and Au in the Jumping Brook Metamorphic Suite (e.g., Sangster *et al*., 1990 and references therein). Recent work has shown significant Cu and Ba mineralization in the Cheticamp Pluton and Fisset Brook Formation.

Current understanding is that rock types in the Faribault Brook area include metasedimentary rocks, mafic and felsic metavolcanic rocks, amphibolite and varied gneissic and plutonic rocks, with ages ranging from Late Neoproterozoic to Devonian (e.g., Lin *et al*., 2007). It has been suggested that these rocks and others in western Cape Breton Island may correlate with those in parts of Ganderia in central Newfoundland and New Brunswick (Fig. 1), which host important economic mineral deposits (e.g., Barr *et al*., 1998; van Staal, 2007; van Staal *et al*., 2009). In order to further investigate these possible correlations, more detailed studies of field relations, rock types, geochemistry and tectonic setting are needed in western Cape Breton Island.

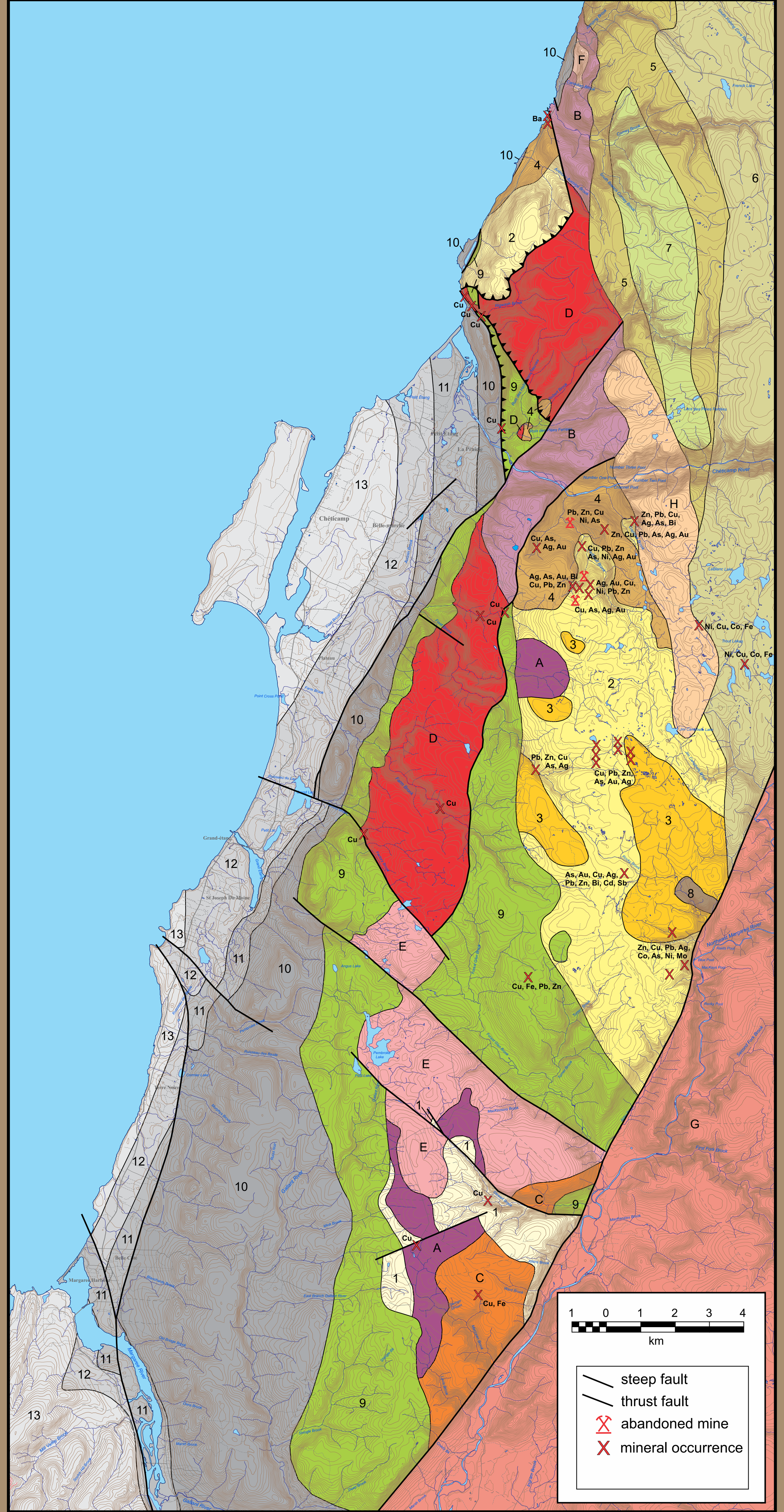
PURPOSE

One of the key strategies to successful mineral exploration is a better understanding of the host rocks, which can indicate whether viable ore deposits are a possibility, or whether the occurrences are more likely localized enrichments that are not economic. Furthermore, if the rocks of the Jumping Brook Metamorphic Suite can be correlated with known ore-rich units in Newfoundland or New Brunswick, it could indicate that more exploration should be focused in the area. A detailed geochemical, geochronological and structural study is underway to address these issues.

ACKNOWLEDGMENTS

The work on the Cheticamp Pluton is part of an M.Sc. thesis project supervised by Drs. Sandra M. Barr (Acadia University) and Chris E. White (Nova Scotia Department of Natural Resources-NSDNR). Funding is provided from an NSERC Discovery Grant to SMB and operating funds provided to CEW from NSDNR. Special thanks is directed to Taylor Chew (Acadia University) for his exceptional help in the field, especially on those steep Cheticamp hills. Travis McCarron (University of New Brunswick) is also thanked for sharing some of his current geological data collected from his Ph.D. on the metamorphism of the Jumping Brook Metamorphic Suite. Additional insights into the economic geology of the Cheticamp area was provided by Garth DeMont (NSDNR). James Bridgland (Cape Breton Highlands National Park) is greatly thanked for his help in securing a collection permit in the park.

Finally, a special thanks to the kitchen staff at Laurie's Motel for providing a more than hearty breakfast with endless coffee to fuel our exploits up those never-ending hills, while the coyotes and bears watch and wait patiently for us to weaken and falter.



LEGEND

PLUTONIC UNITS

DEVONIAN

- H — **SALMON POOL GRANITE:** red to pink, medium- to coarse-grained, equigranular granite
- G — **MARGAREE PLUTON:** red to pink, coarse-grained to megacrystic alkali-feldspar granite

NEOPROTEROZOIC(?)

CHETICAMP PLUTON

- F — red, fine- to medium-grained equigranular syenogranite
- E — medium- to coarse-grained, equigranular to locally megacrystic, muscovite- biotite-bearing monzogranite; U-Pb zircon age of 550 ± 8 Ma (Jamieson *et al*., 1986)
- D — pink to red, medium- to coarse-grained, inequigranular to locally megacrystic, granodiorite to monzogranite
- C — red, medium- to coarse-grained, subporphyritic granodiorite
- B — grey to red-grey, fine- to medium-grained, equigranular tonalite to granodiorite
- A — grey to red-grey, medium- to coarse-grained, equigranular to porphyritic diorite to quartz diorite

"STRATIFIED" UNITS

CARBONIFEROUS

- 13 — **CUMBERLAND and PICTOU GROUPS**: undivided clastic rocks
- 12 — **MABOU GROUP**: undivided clastic and carbonate rocks
- 11 — **WINDSOR GROUP** undivided carbonate and clastic rocks

DEVONIAN to CARBONIFEROUS

- 10 — **HORTON GROUP**: undivided clastic rocks

DEVONIAN

- 9 — **FISSET BROOK FORMATION:** basalt, rhyolite, and clastic rocks

SILURIAN TO DEVONIAN (and/or older)

- 8 — Rocky Brook conglomerate
- 7 — **GEORGE BROOK FORMATION:** dark green, coarse-grained amphibolite with relict dioritic and gabbroic textures

NEOPROTEROZOIC(?)

JUMPING BROOK METAMORPHIC SUITE (JBMS)

- 6 — **FISHING COVE RIVER FORMATION**: silver to light grey garnet- kyanite-bearing schist and gneiss. Gradational into Corney Brook Formation
- 5 — **CORNEY BROOK FORMATION**: silver to light grey phyllite and schist containing coarse staurolite, garnet and kyanite at higher metamorphic grades. Maybe in part gradational or equivalent to Dauphine Brook Formation
- 4 — **DAUPHINE BROOK FORMATION**: dark grey slate and thinly to thickly bedded phyllitic arkosic sandstone, conglomerate (with pale blue quartz clasts) and thinly bedded white quartzite; minor phyllitic felsic crystal to crystal lithic tuff; rare, pale yellow, garnet-muscovite-bearing schist. Minor sheets of pale grey, fine- to medium-grained subporphyritic granite
- 3 — **BARREN BROOK FORMATION (maybe in part equivalent to Dauphine Brook Formation):** pale grey schistose arkosic sandstone and conglomerate (with pale blue quartz clasts); minor felsic crystal tuff. Lacks slate noted in Dauphine Brook Formation and is typically more metamorphosed and hence schistose in character
- 2 — **FARIBAULT BROOK FORMATION:** dark green, fine-grained amphibole and chlorite-rich phyllitic mafic tuff and basalt flows and synchronous mafic sills/dykes; local pillow structures preserved; minor quartz-muscovite schist interbeds
- 1 — **STEWART BROOK FORMATION:** pale grey to grey to pale green, metasiltstone, phyllitic quartzo-feldspathic sandstone, and muscovite-rich schist and gneiss. Locally hornfelsic and spotted with biotite and cordierite close to contacts with Cheticamp Pluton

ECONOMIC GEOLOGY

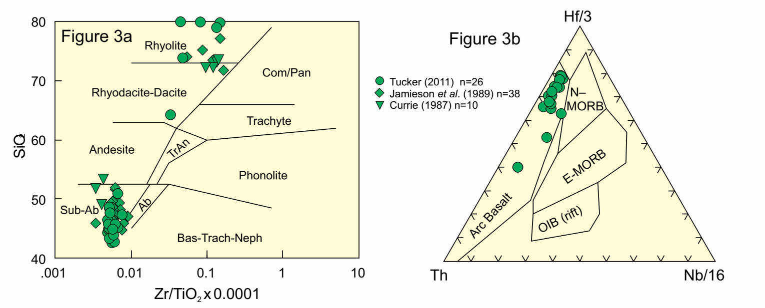
An occurrence of galena was found in schist in the lower part of Faribault Brook in 1897 (Alcock, 1930) and since then the region has been explored for its numerous base metal occurrences (Fig. 2) and locally mined (Fig. 4a). Mapping confirmed that most of the mineralization occurs near the contact between the Faribault Brook and overlying Dauphinee Brook formations. The most abundant type of mineralization consists of pyrite, pyrrhotite, chalcopyrite and arsenopyrite, with some deposits containing galena and sphalerite (Fig. 4b) and gold.

The mineralized layers and pods are 3-5 cm thick, 5-30 cm long, and are concordant with the main schistosity. They are often folded and strongly boudinaged, confirming a pre-metamorphic/deformational origin (e.g., Lynch and Mengel, 1995). A younger set of sulphide-bearing, deformed quartz veins were recognized this summer at many of the showings, suggesting a later remobilization of quartz and sulphide minerals.

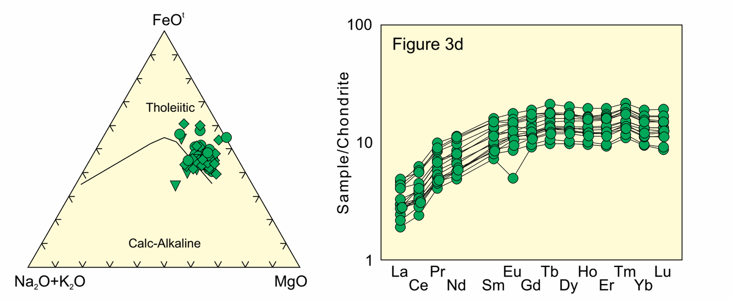
In addition, mapping has also delineated several Cu-bearing shear zones, fractures and carbonate veins in the Cheticamp Pluton and Fisset Brook Formation. Numerous barite veins are associated with faults along the western margin of the Cheticamp Pluton.

GEOCHEMISTRY

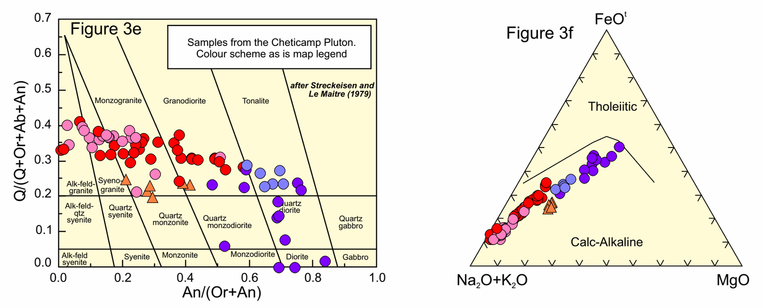
Mostly mafic samples from the Faribault Brook area, with inferred igneous protoliths, were selected for whole-rock chemical analysis (Tucker, 2011) with additional data from (Jamieson *et al*., 1989; Currie, 1987; Barr *et al*., 1986). Whole-rock data from this study were obtained from all units in the Cheticamp Pluton, supplemented with additional samples from Barr *et al*. (1986).

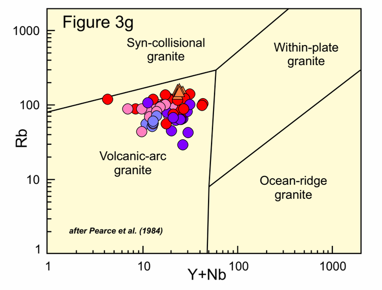


Using Zr and Ti plotted against SiO_2, the mafic samples plot in the subalkalic basalt field (Fig. 3a). The subalkalic character is also shown in the felsic samples that plot mostly in the rhyodacite-dacite and rhyolite fields (Fig. 3a). On the Th-Hf-Nb discrimination diagram, the mafic samples plot in the island arc tholeiite field because of their low Nb relative to Th and Hf (Fig. 3b). On the AFM plot the samples appear tholeiitic (Fig. 3c).



On a chondrite-normalized REE diagram, the metabasalt sample patterns are mostly parallel to one another and show strong light REE depletion (Fig. 3d). Only one sample shows a significant negative Eu anomaly, indicative of plagioclase fractionation. The light-REE depleted pattern displayed by these samples is typical of mid-ocean ridge basalt and generally attributed to derivation of the parent magmas from a depleted mantle source (e.g., Winter, 2010).





Geochemical classification based on a normative Q'-ANOR diagram (Fig. 3e) shows the Cheticamp Pluton ranging from diorite to granodiorite to alkali-feldspar granite. Combined with the AFM diagram (Fig. 3f) this indicates a calc-alkalic trend. On the tectonic setting discrimination diagram (Fig. 3g) all samples plot in the volcanic-arc granite field.

SUMMARY

Mafic samples from the Faribault Brook Formation have chemical characteristics indicative of island-arc tholeiite to N-MORB affinity. The chemical characteristics, combined with the locally observed pillows and association with turbiditic sediments, are most likely indicative of a back-arc basin setting. The Cheticamp pluton has arc-like characteristics and may represent the adjacent Late Neoproterozoic continental margin magmatic arc. Overall the chemical data are consistent with a co-magmatic relationship among all of the igneous units in the study area, but they do not necessitate such a relationship.

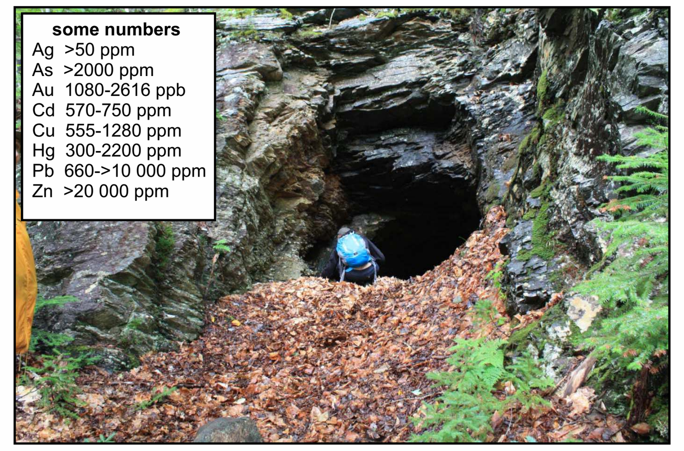


Figure 4a. 1 of 4 audits at the Galena Mine in the lower part of Faribault Brook. Note the pale brown schist at the opening that hosts the Pb, Zn, Cu mineralization (see below).

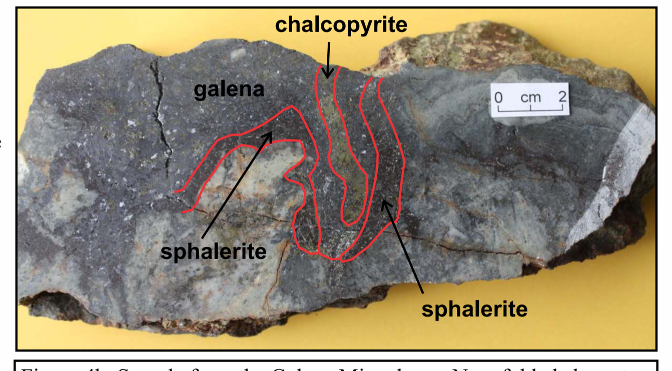
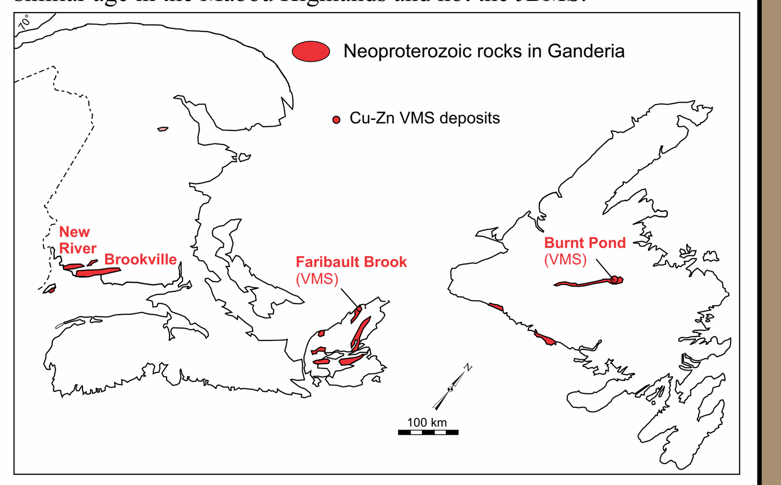


Figure 4b. Sample from the Galena Mine dump. Note folded character of ore. (Sample from the infamous G. DeMont collection).

REGIONAL CORRELATIONS

Late Neoproterozoic rocks with similarities to the Jumping Brook Metamorphic Suite occur in both Newfoundland and New Brunswick (Fig. 5). In central Newfoundland, the Crippleback Lake intrusive suite is dated at 563 ± 2 Ma (Evans *et al*., 1990) and consists of three plutons: Crippleback Lake, Valentine Lake and Lemottes Lake (Rogers *et al*., 2006). These plutons intruded the Sandy Brook Group but have been suggested to be co-magmatic with that group (Rogers *et al*., 2006). The Crippleback Lake intrusive suite is interpreted to have formed in a continental arc like the Cheticamp Pluton. The Sandy Brook Group consists of pillowed and massive basalts, mafic tuffs, cryptocrystalline andesite flows and cherty, quartz-phyric, high-silica rhyolite (Rogers *et al*., 2006). Units that have similarities to the Faribault Brook Formation and the basaltic units in the Sandy Brook Group have arc characteristics and are considered to be island arc tholeiites (Rogers *et al*., 2006). This possible correlation is important because these rocks in Newfoundland host the Burnt Pond volcanic massive sulpide (VMS) deposit (Squires and Moore 2004).

In New Brunswick the New River terrane (Fig. 5) occupies a similar position as the western part of the Aspy terrane. Although similar in age, these rocks differ from the JBMS in that they have not been regionally metamorphosed and have a much higher proportion of volcanic components. The New River terrane also includes ca. 620 Ma rocks (Johnston *et al*., 2009) that may correlate with rocks of similar age in the Mabou Highlands and not the JBMS.



AGE

The age of the Jumping Brook Metamorphic Suite (JBMS) and its contact relations with the Cheticamp Pluton have been long-standing problems ever since the Cheticamp Pluton was dated at 550 ± 8 Ma (Jamieson *et al*., 1986). The contact between the JBMS and Cheticamp Pluton is mainly faulted and evidence for contact metamorphism in the JBMS is ambiguous. Most workers have considered the pluton to be older than the JBMS (e.g., Currie, 1987; Jamieson *et al*., 1989, 1990), based in part on Silurian ages obtained from volcanic units elsewhere in the Aspy terrane (e.g., Barr and Jamieson 1991), but others (e.g., Woods 1986) interpreted that the pluton intruded the JBMS.

The age of 551 ± 0.9 Ma reported by Lin *et al*. (2007) for a "tuffaceous" sample from the lower part of the Barrens Brook Formation suggests that the units are of similar age. If the tuffaceous sediment has been reworked, this date would represent the maximum depositional age and the unit might be considerably younger. A metapsammite sample from the Dauphinee Brook Formation contained detrital zircon with a minimum age of 546 ± 2 Ma, which overlaps with the age of the Cheticamp Pluton. This evidence suggests a Late Neoproterozoic age for the JBMS and Cheticamp Pluton.

The evidence against this interpretation comes mainly from the age of 420 ± 7 Ma obtained for the quartz porphyry at Galena Mine (Lin *et al*. 2007). Contact relations are not clear in these highly altered and deformed rocks and hence it is not known with certainty if the quartz porphyry intruded the Dauphinee Brook Formation or is it part of the stratigraphy.

FUTURE WORK

More detailed geological mapping and geochronology are needed in order to resolve with certainty the relationships among the rock units in the Faribault Brook area. In particular felsic metavolcanic units in the Jumping Brook Metamorphic Suite should be targets for additional U-Pb geochronology to confirm the Neoproterozoic age suggested by this study. In addition, more U-Pb geochronology on the Cheticamp Pluton is required to properly define its age(s).

Additional geochemical and isotopic analyses are required to better understand the tectonic setting of the volcanic and sedimentary units and to aid in regional correlations to formations elsewhere in Atlantic Canada.

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