Progress Report on the Meguma Terrane Bedrock Mapping Project, Eastern Shore of Nova Scotia

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Introduction

Geological investigations related to the Meguma terrane bedrock mapping project continued through the summer of 2019 on parts of the Liscomb (NTS 11E/01), Upper Musquodoboit (NTS 11E/02), Tangier (NTS 11D/15), and Ecum Secum (NTS 11D/16) map areas in the Eastern Shore of Nova Scotia (Fig. 1). The main objectives of project are to improve the current knowledge of the geological history and mineral potential of the Goldenville and Halifax groups by (1) systematically collecting field data to produce 1:50 000-scale geological maps of the area, (2) building a chemostratigraphy using both portable XRF (pXRF) and certified lithogeochemical analyses, (3) obtaining better controls on depositional age and source areas of the units using detailed U-Pb detrital zircon and isotopic studies, and (4) producing a metamorphic map to document variations in regional metamorphic grade and establish the possible presence of buried plutonic units. Details of the mapping program, methodology, and previous geological investigations in the Eastern Shore were described in White and Vaccaro (2019).

During the 2019 field season, some areas included in the 2018 field season were remapped due to new road construction and upgrades of older trails into drivable roads as a result of extensive gold exploration. In addition, the dry summer during 2019 resulted in low water conditions in all the lakes, rivers, and streams. These factors provided a rare opportunity to observe outcrops that were previously inaccessible.

Preliminary Results

During August and September of 2019, mapping at a scale of 1:10 000 was continued within a region extending from the Governor Lake map area (White and Scallion, 2011) southward to the Sheet Harbour area (Fig. 1). As previously described by White and Vaccaro (2019), this swath provides a nearly complete cross-section perpendicular to the northeasterly strike of the Goldenville and Halifax groups, and includes the River Lake and Mulgrave Lake plutons. Large areas of glacial till obscure the outcrop, however, and hence prevent the construction of a reliable geological cross-section. Mapping along strike out of these till-covered areas is required to enable mapping of formations and construction of a detailed cross-section .

Structural data were collected from all outcrops visited during this study and multiple magnetic susceptibility measures were acquired from each lithology at each outcrop and compiled with the 2018 data into an ARC GIS database. Over 100 rock samples were collected in 2019, in addition to the 150 samples collected during the 2018 field season, and were slabbed, thin sectioned, and analyzed with the pXRF.

Stratigraphy

Based on field relations, petrography, and geochemistry (pXRF), the geology (lithologies and stratigraphy) in the mapped area is similar to geology in the Trafalgar area to the north (White and Scallion, 2011) and Moose River area to the west (Horne and Pelley, 2007). The oldest mappable unit recognized in the Goldenville Group is the Taylors Head Formation of Horne and Pelley (2007). The underlying Moose River and Tangier formations, recognized farther to the west by Horne and Pelley (2007), have not yet been observed. The Taylors Head Formation consists mainly of grey, thickly bedded (1 m to several metres) metasandstone interlayered with thin green metasiltstone beds generally less than 0.5 m thick. Calc-silicate lenses 1 to 20 cm thick are abundant. This unit also contains abundant, well preserved sedimentary structures, as documented by Waldron and Jensen (1985).

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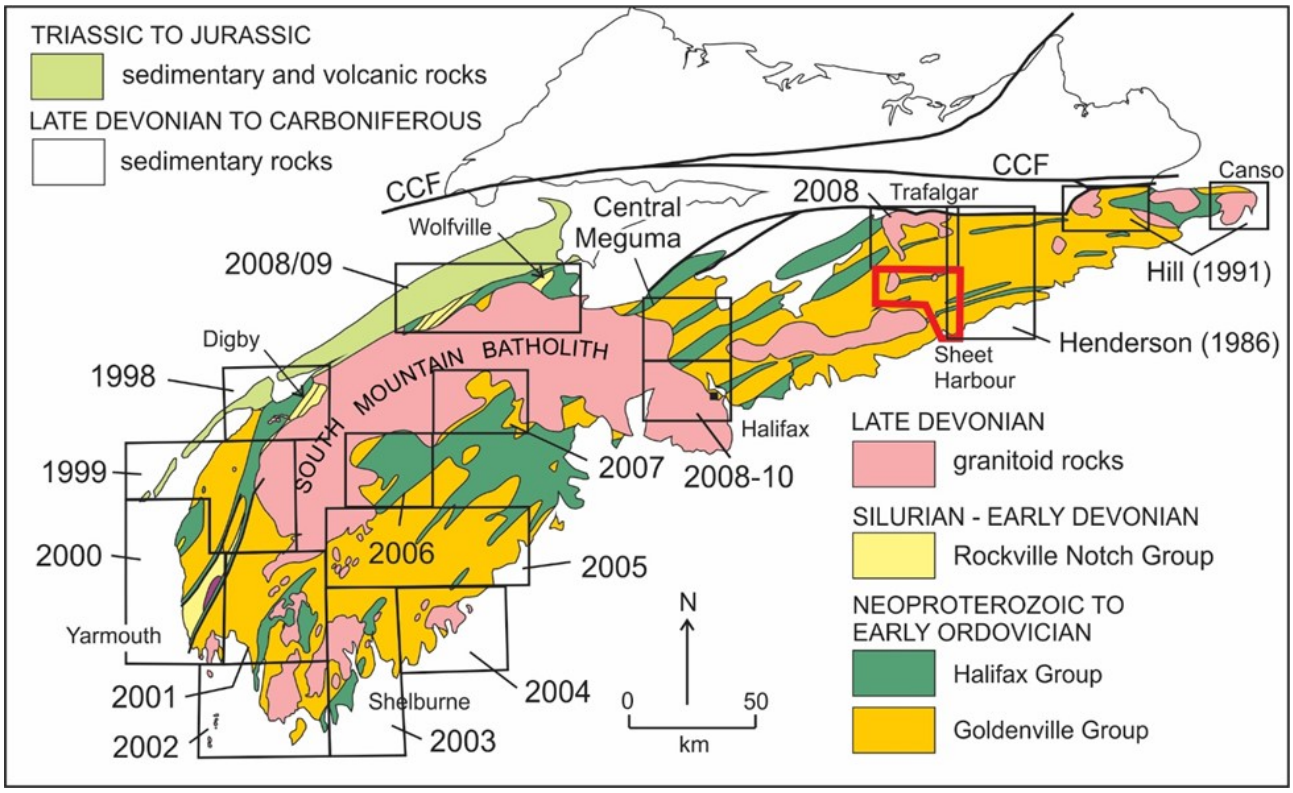

Figure 1. Simplified geological map of the Meguma terrane, southern Nova Scotia, showing the location of the area mapped in 2018 and 2019 (red outline) in relation to other mapped areas (year of mapping indicated). CCF = Cobequid-Chedabucto Fault

The thin (~300 m) Beaverbank Formation, the Mn-bearing uppermost unit of the Goldenville Group (White, 2010; White and Barr, 2012), overlies the Taylors Head Formation in the map area. The contact is gradational over 50 m, with a relatively abrupt disappearance of thick metasandstone and an increase in Mn-bearing metasiltstone. The formation consists mainly of thinly bedded to finely laminated, grey metasiltstone and slate. Metasandstone is rare, but where present it forms thin (10-20 cm) beds. A characteristic feature of this formation is the common presence of thin (<1 cm to 10 cm), brown to purple to dark grey, Mn-rich beds and laminations. Where the metamorphic grade is higher they form coticule-rich, pytigmatically folded bands. In places Mn-rich dark grey nodules/coticules are abundant. This unit locally contains abundant pyrite and pyrrhotite. Based on pXRF analyses the MnO and total S contents range from 1.5 to 22 wt% and 500 to 8000 ppm, respectively. A new feature, not documented elsewhere in the Meguma terrane (c.f. White, 2010; White and Barr, 2012) is the presence of thin lenses, up to 10 cm thick, of dark grey to black, Mn-rich marble that typically displays cone-in-cone structures.

The overlying Cunard Formation, the lowest unit in the Halifax Group, is characterized by black to rust-brown slate with variable amounts of interbedded (<1 m) cross-laminated metasiltstone and metasandstone. Like the Beaverbank Formation, this unit contains abundant pyrite and pyrrhotite with total S contents up to 50 000 ppm. In contrast to the Beaverbank Formation, MnO contents are consistently below 0.20 wt%. As yet, units equivalent to the overlying Glen Brook or Lumsden Dam formations documented in the central and southwestern parts of the Meguma terrane (White, 2010; Horne et al., 2009; White and Barr, 2012) were not observed.

Based on the last two summers of field mapping it appears that only a relatively thin part of the overall Meguma terrane stratigraphy is represented in the area between Trafalgar and Sheet Harbour, consisting of only the upper part of the Goldenville Group (Taylors Head and Beaverbank formations) and the lower part of the Halifax Group (Cunard Formation).

Intrusive Units

Two plutons, River Lake and Mulgrave Lake, intrude the Goldenville and Halifax groups in the study area. The River Lake pluton was mapped by Thomas (1982), who described it as muscovite-biotite-bearing, medium- to coarse-grained porphyritic granodiorite around the margins, gradational to monzogranite in the core. Abundant pegmatite and aplite dykes occur throughout the pluton and country rocks. A northwest-trending fault cuts and offsets the pluton (Thomas, 1982), which Horne and Pelley (2007) termed the Sheet Harbour Fault and using the aeromagnetic data of King (2000) interpreted a sinistral strike-slip sense of movement. Due to low water conditions outcrops that display structures related the Sheet Harbour fault were well exposed farther to the southeast in West River, which confirmed the style and sense of movement.

The Mulgrave Lake pluton was mapped and described by Dwyer (1975) as adamellite, a term no longer used in the plutonic rock classification (Streckeisen, 1976). Its texture and mineralogy are similar to those of the monzogranite to granodiorite of the River Lake pluton. In addition to muscovite and biotite, however, the Mulgrave Lake pluton also contains niobium-rich rutile, as noted by Dwyer (1975), and the presence of cordierite was noted in this study. Compared to the River Lake pluton the Mulgrave Lake pluton has few pegmatite and aplite dykes. It also displays a weak foliation defined by planes of randomly oriented K-feldspar phenocrysts. Given the lack of foliation in the hornfelsic country rocks it is assumed that this fabric is related to magma flow.

Both plutons display narrow but well developed contact metamorphic aureoles that are superimposed on regional greenschist-facies mineral assemblages and textures. The aureoles are best developed in pelitic rocks of the Goldenville and Halifax groups. Peak metamorphic conditions are evident adjacent to the contact where the mineral assemblage andalusite (typically idioblastic chiastolite) + sillimanite (fibrolite) + cordierite + garnet is developed. Based on pelitic metamorphic petrogenetic grids, this assemblage corresponds to a temperature of 675° at pressures of 2 GPa (7 km). The narrow contact aureoles suggest that these plutons cooled quickly and the pegmatite/aplite dykes that cut the aureole are late-stage features.

Future Work

Initially, bedrock mapping was to focus on the Goldenville and Halifax groups and data from the plutonic units compiled from previous work. Based on the past summer's work it became clear that many of the plutonic units have not been previously mapped at an appropriate scale, if at all, and lack modern petrological work (c.f. Dwyer, 1975). Several of these plutons host rare-element occurrences (e.g., Be, Li, Mo, W, Sn, Ta) and the region has the potential for exploitable rare-element mineralization (Archibald et al., 2020). Hence, plutonic rocks will be included in the mapping program in collaboration with students and faculty from Acadia and St. Francis Xavier universities. The new information acquired in this mapping program will result in a better understanding of the distribution of economic mineralization and help to establish a predictive model to increase mineral exploration successes in the area.

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References

Archibald, D.B., Barr, S.M., and Nickerson, S.J. 2020. Mineralization associated with granitoid rocks in the eastern Meguma terrane, Nova Scotia; in Geoscience and Mines Branch, Report of Activities 2019-2020, eds. D.R. MacDonald and E.W. MacDonald; Nova Scotia Department of Energy and Mines, Report ME 2020-002, p. 1-8.

Dwyer, G.J. 1975. Petrology of the Mulgrave Lake adamellite pluton; unpublished B.Sc. thesis, Dalhousie University, Halifax, Nova Scotia, 28 p.

Henderson, J.R. 1986. Geology, Ecum Secum area, Nova Scotia; Geological Survey of Canada, "A" Series Map 1648A, scale 1:50 000.

Hill, J.D. 1991. Geology of the Forest Hill area; in Petrology, Tectonic Setting, and Economic Potential of Peraluminous Granitoid Plutons in the Canso and Forest Hill Areas, Eastern Meguma Terrane, Nova Scotia; Geological Survey of Canada, Bulletin 383, 96 p (includes two 1:50 000 scale maps).

Horne, R.J. and Pelley, D. 2007. Geological transect of the Meguma terrane from Centre Musquodoboit to Tangier; in Mineral Resources Branch, Report of Activities 2006; Nova Scotia Department of Natural Resources, Report ME 2007-1, p. 71-89.

Horne, R.J., Ryan, R.J., Corey, M.C., and Fox, D.L. 2009. Bedrock geology map of the Waverley area, part of NTS Sheet 11D/13 (Sheet 1 of 4), Halifax County, Nova Scotia; Nova Scotia Department of Natural Resources, Open File Map ME 2009-002, scale: 1:25 000.

King, M. S. 2000: Enhanced aeromagnetic and digital elevation map of eastern Nova Scotia (11C/13, 11D/10, 11D/11, 11D/12, 11D/13, 11D/14, 11D/15, 11D/16, 11E/01, 11E/02, 11E/03, 11D/04, 11F/04, 11F/05, 11F/06); Nova Scotia Department of Natural Resources, Mineral Resources Branch, Map 2000-2, scale 1:250 000.

Streckeisen, A. 1976. To each plutonic rock its proper name; Earth-Science Reviews, v. 12, p. 1-33.

Thomas, W. 1982. Petrology and geochemistry of the River Lake pluton; unpublished M.Sc. thesis, Acadia University, Wolfville, Nova Scotia, 130 p.

Waldron, J.W.F. and Jensen, L.R. 1985. Sedimentology of the Goldenville Formation, Eastern Shore, Nova Scotia; Geological Survey of Canada, Paper 85-15.

White, C.E. 2010. Stratigraphy of the Lower Paleozoic Goldenville and Halifax groups in the western part of southern Nova Scotia; Atlantic Geology, v. 46, p. 136-154.

White, C.E. and Barr, S.M. 2012. The new Meguma: stratigraphy, metamorphism, paleontology, and provenance; GAC-MAC Joint Annual Meeting, St. John's, Newfoundland, post-meeting field trip; Field Trip Guidebook B5, 68 p.

White, C.E. and Scallion, K.-L. 2011. Bedrock geology map of the Governor Lake area, part of NTS sheets 21E/01, 02, 07, and 08, Colchester, Guysborough, Halifax, and Pictou counties, Nova Scotia; Nova Scotia Department of Natural Resources, Mineral Resources Branch, Open File Map ME 2011-013; scale 1:50 000.

White, C.E. and Vaccaro, M. 2019. Bedrock mapping in the Meguma terrane: a long awaited return to the Eastern Shore of Nova Scotia; in Geoscience and Mines Branch, Report of Activities 2018-2019, eds. E.W. MacDonald and D.R. MacDonald; Nova Scotia Department of Energy and Mines, Report ME 2019-002, p. 77–79.