Geology of the Cape George Point Area, Northern Antigonish Highlands

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Introduction

During the early summer of 2013, detailed mapping and sampling was conducted near Cape George Point (NTS 11F/13) at the northernmost part of Cape George in the Antigonish Highlands (Fig. 1). This mapping completed the regional Antigonish Highlands Bedrock Mapping Project (White and Archibald, 2011; White *et al*., 2011, 2012; White and Drummond, 2014). Details of the mapping program, methodology and previous geological investigations are summarized in the publications cited above. The purpose of this report is to describe the geology of the Cape George Point area and report a new fossil occurrence.

Historical Perspective

The northern tip of Cape George between Livingstone and Ballantynes coves consists entirely of rocks of the Carboniferous Horton Group, except for two narrow east-west-trending belts along the coast just east of Cape George Point at School Brook and Cormorant Cliff coves (Fig. 2; Benson, 1974; Boucot *et al*., 1974). On present-day maps these geographic terms are not in use, and this area is collectively called Bans Cove; however, the older geographic terms are retained here. These two areas were previously mapped by Fletcher (1887) as fault-bounded packages of rocks of presumed Silurian age. He collected a suite of fossils that were subsequently confirmed to be Silurian by Ami (1895).

During the summer of 1958 (Boucot *et al*., 1959), R. Fletcher spent three weeks mapping these two areas at a scale of 1 inch to 50 feet. In 1959, J. Griffin rechecked Fletcher's maps, and based on additional fossil evidence, both Griffin and Fletcher considered the two sequences of interbedded grey and red sandstone (red beds), shale, limestone and quartzite to range from Middle Ordovician to Devonian with only the Ordovician units intruded by hornblende diorite (Boucot *et al*., 1959). The resulting maps along with rock and fossil descriptions, stratigraphy and structural analysis were included in Boucot *et al*. (1974).

Keppie (1980) resampled limestone interbedded with quartzite and shale from the School Brook Cove section and recovered Early Silurian conodonts, thelodonts and ostracods. Based on this age, he correlated this unit with the Beechill Cove Formation and the lower part of the Ross Brook Formation of the Arisaig Group exposed at Arisaig. Boucot *et al*. (1974) considered the Silurian fauna they discovered to be unlike the fauna of the Arisaig Group or the Silurian fauna of any other locality in Nova Scotia. This distinction was verified by the only known discovery of the ichnogenus *Bergaueria perata* from eastern Canada by Pickerill (1989) in the same Silurian-bearing fossil rocks of Boucot *et al*. (1974). However, based on similar fossils and lithologies, Boucot *et al*. (1974) included the faulted Upper Silurian to Devonian red beds in the Moydart, Stonehouse and Knoydart formations of the Arisaig Group.

School Brook Cove Section

Because of coastal erosion, much of the coastline has changed since the work documented by Boucot *et al*. (1974), and hence the detailed outcrop maps (plate 13 in Boucot *et al*., 1974) have changed considerably but are still of limited use. The oldest rocks exposed along the eastern side of School Brook Cove consist of dark grey to grey to white, thinly to thickly bedded quartz arenite interlayered with pale brown limy siltstone and fossiliferous limestone (Fig. 3a). Fossils recovered by Boucot *et al*. (1974) from the quartz arenite and limestone

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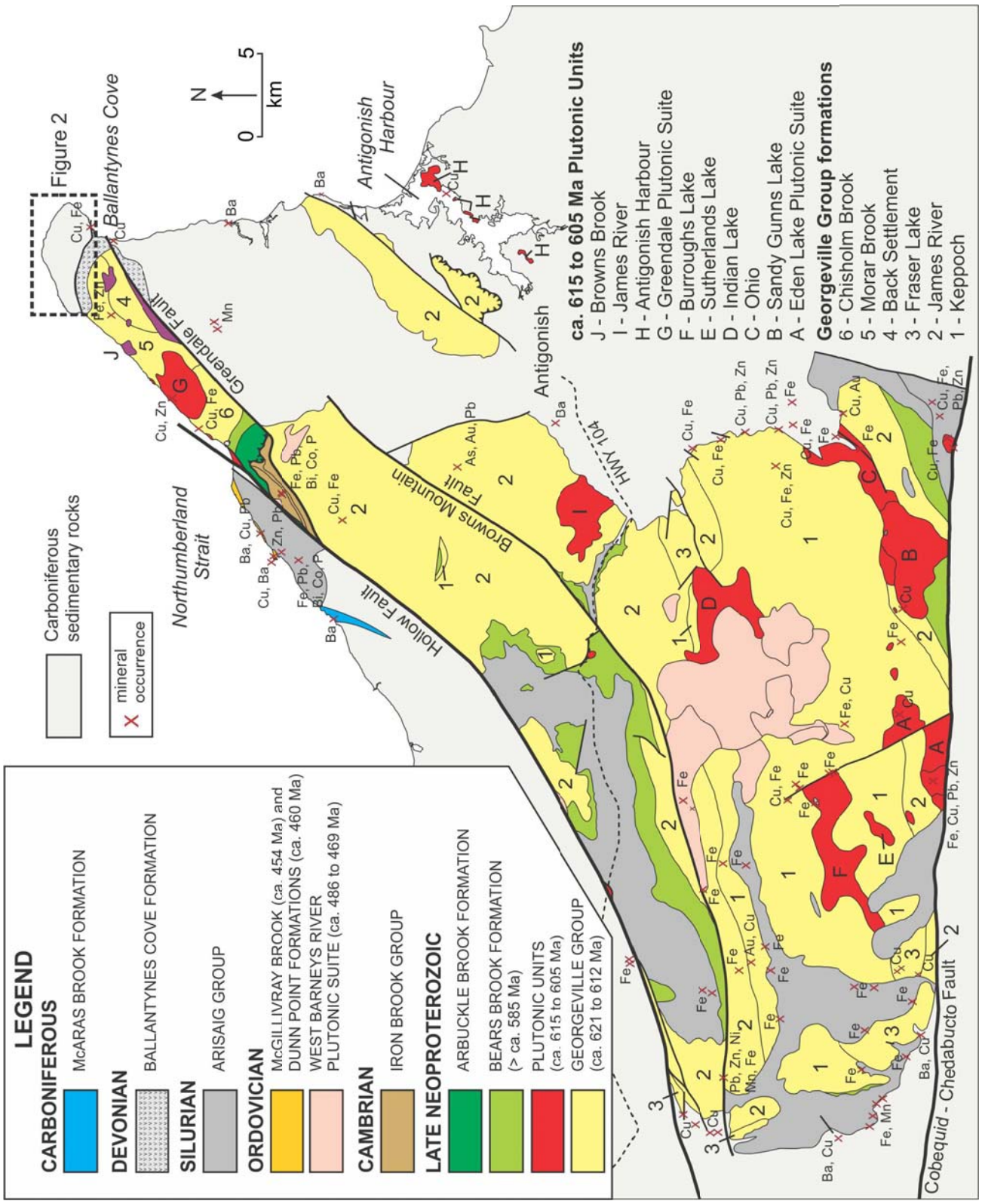

Figure 1. Simplified geological map of the geology in the Antigonish Highlands after White *et al*. (2012). Location of the 2013 map area described here is indicated by the dashed box.

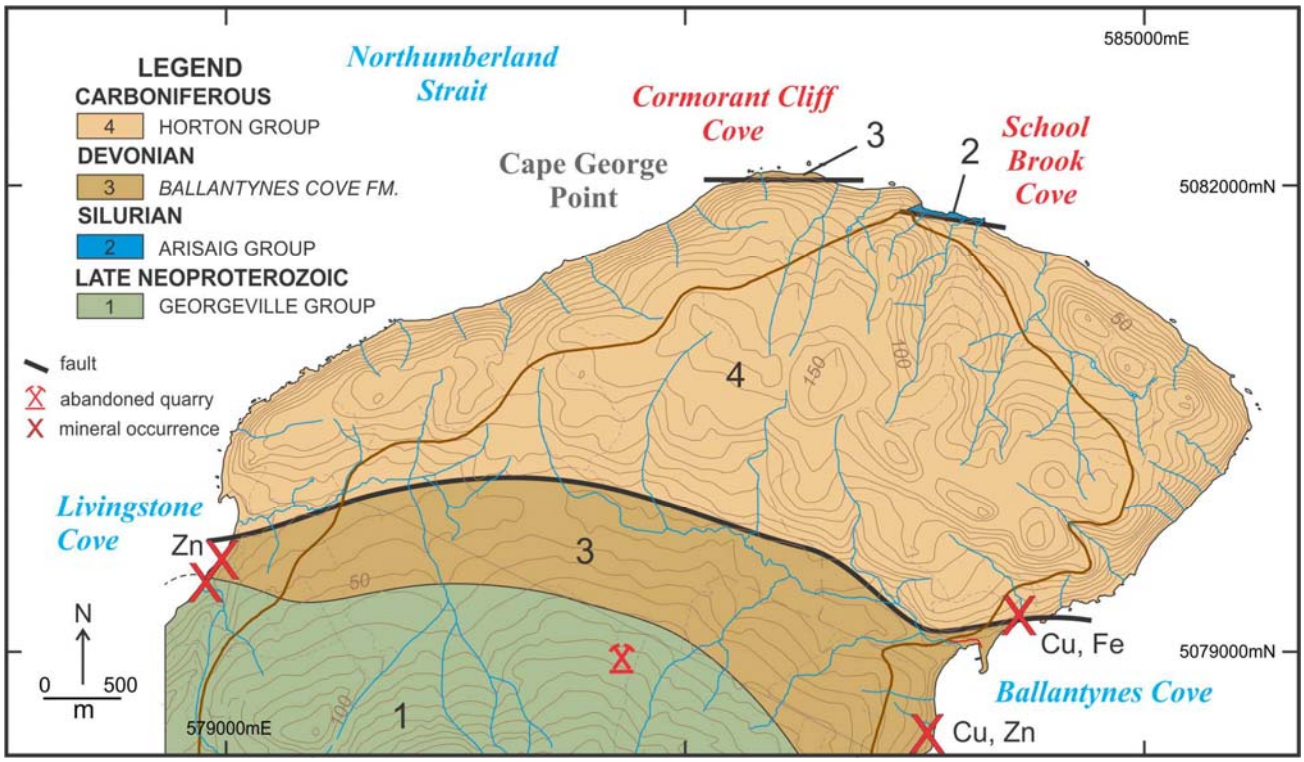

Figure 2. Simplified geological map of the northernmost Antigonish Highlands after White *et al*. (2012) and this study.

include brachiopods, tentaculitids and a trilobite fragment; Boucot *et al*. (1974) considered these fossils to be Middle or Upper Ordovician. However, conodonts, thelodonts and a few ostracodes recovered from same limestone outcrop (locality F7 of Boucot *et al*., 1974) in School Brook yielded Early Silurian (Llandoverian) ages (Keppie, 1980), indicating these rocks are the same age as the lower parts of the Arisaig Group and not Ordovician.

The section at the mouth of School Brook consists of white to pale grey, massive to thickly bedded quartz arenite, which locally contains abundant vertical *Scolithus* worm tubes (Fig. 3b). Where carbonate cement is present, the quartz arenite weathers pale brown. Silurian brachiopods and a few fish fragments were recovered from these quartz arenite units by Boucot *et al*. (1974).

The sedimentary rocks are intruded by a suite of dark grey-green, very fine grained to locally plagioclase-porphyritic, magnetic (susceptibility up to 50×10^{-3} SI units) monzodiorite sills and dykes. These units are in turn intruded by red, aplitic to coarse-grained to pegmatitic bodies of monzodiorite to monzonite (Fig. 3c). The finer grained monzodiorite is locally amygdaloidal and displays ‘flow’ fabrics and magma mingling textures with the coarse-grained monzodiorite/monzonite. In addition, the intrusion contains numerous country rock xenoliths. Although termed hornfels by Boucot *et al*. (1974), many of the xenoliths are ‘baked’ and well indurated but show no new metamorphic mineral growth. All these textural features suggest emplacement at a relatively shallow depth. Based on chemical characteristics, Sommers (1980) considered this ‘sill’ to have A-type affinity, which suggested an Ordovician rifting event.

West of School Brook, the quartz arenite and associated intrusive rocks are in faulted contact with a sequence of poorly indurated, thinly bedded, grey to maroon and red slate, siltstone, sandstone and minor limestone. The red beds commonly contain caliche nodules and abundant detrital muscovite, which were not observed in units to the east. Trace fossils and root casts are present at the base of several sandstone beds (Fig. 3d). This

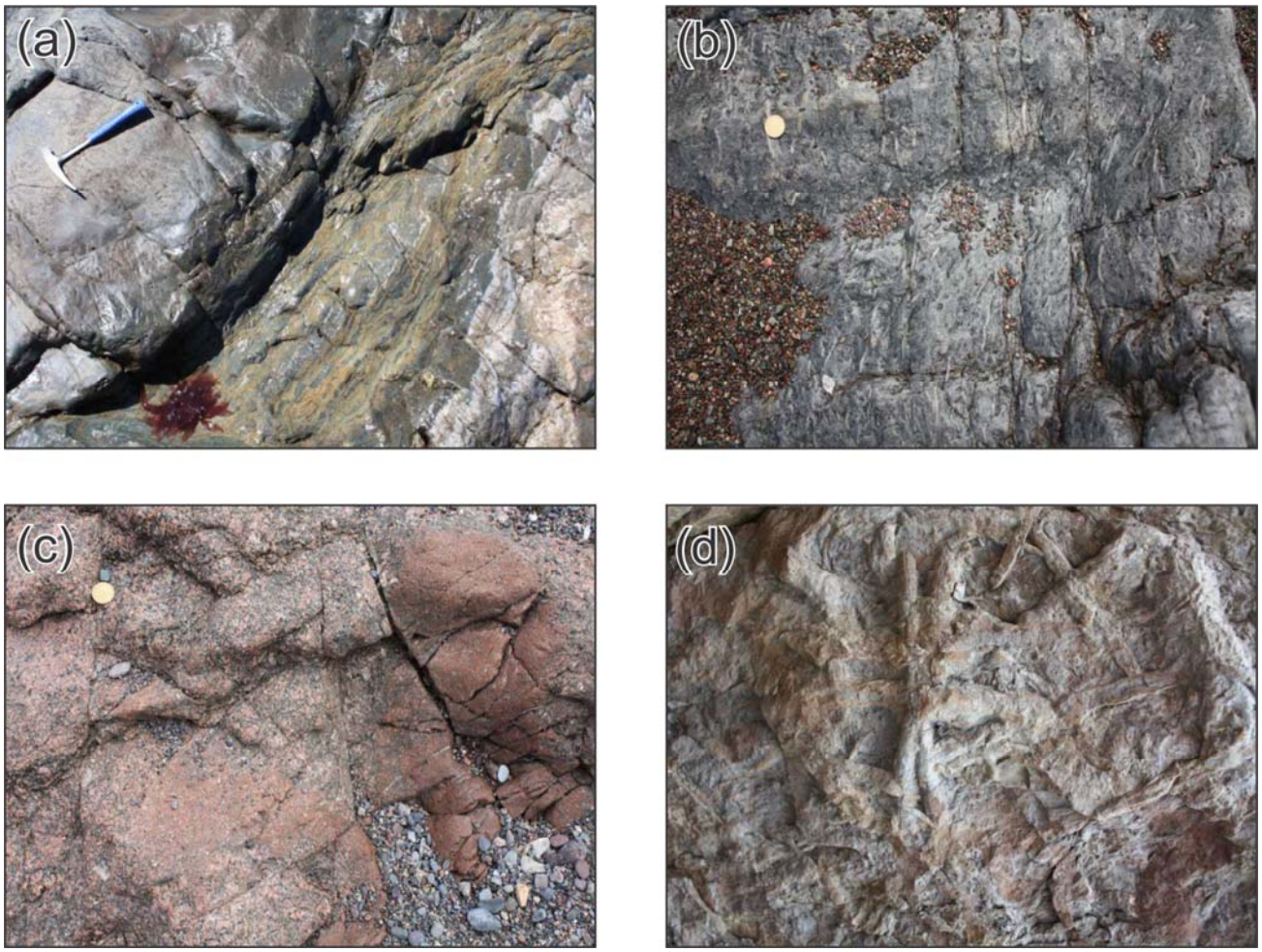

Figure 3. (a) Laminated to thinly bedded, dark grey quartz arenite interlayered with brown limestone (centre) with white quartz arenite (right) of the Arisaig Group. Both units are cut by a dark grey, fine-grained monzodiorite (left). Hammer is about 30 cm long. (b) Thickly bedded quartz arenite with abundant vertical worm tubes (*Scolithus*). One-dollar coin shown for scale. (c) Red, coarse-grained monzonite with aplitic patches. One-dollar coin shown for scale. (d) Base of fine-grained sandstone bed displaying abundant trace fossil casts. Field of view is about 40 cm.

sequence of rocks lacks the abundant intrusive rocks observed to the east and shows no signs of being baked by an intrusion. Based on fossils and the presence of red beds, Boucot *et al*. (1974) and later workers (e.g. McNamara, 1984; Reilly, 1984) considered this sequence to represent the Moydart, Stonehouse and Knoydart formations of the upper parts of the Arisaig Group.

At the western end of School Brook Cove, a red-brown basal conglomerate-breccia of the Horton Group rests with an angular unconformity on the above units, consistent with the interpretation that the units below the unconformity represent the upper part of the Arisaig Group.

Cormorant Cliff Cove Section

Access to the Cormorant Cliff Cove section is not easy as all routes are overgrown with trees and alders. The entire section exposed along the shore consists of thinly bedded, grey sandstone and siltstone with maroon siltstone and pale blue mudstone and siltstone. Fossils recovered from this section are similar to those extracted from the Stonehouse and Knoydart formations in the Arisaig area (Boucot *et al*., 1974) and hence are correlated with those units; however, the Cormorant Cliff Cove section does not lithologically resemble the Moydart, Stonehouse and Knoydart formations exposed in the Arisaig area or the western part of

the School Brook Cove section where the Horton Group unconformably overlies those units.

Although not mentioned in previous descriptions, red conglomeratic beds up to 3 m thick occur throughout the Cormorant Cliff Cove sequence. Not previously reported from the grey siltstone beds are localized occurrences of dendritic trace fossils (Fig. 4a) and fish with associated scales and spines (Fig. 4b, c), which may be late Devonian in age (R. Miller, written comm., 2013). In the locations shown as hornblende diorite (e.g. Boucot *et al*., 1974, plate 14) we observed well layered mafic crystal-tuff beds (Fig. 4d) and basalt flows that are conformable with the grey siltstone. This section appears to grade into the overlying conglomerate of the Horton Group. We interpret this section as equivalent to the Ballantynes Cove Formation (Fig. 1), which consists of conglomerate, sandstone, basalt flows and rare rhyolite flows dated at ca. 373 Ma (Dunning *et al*., 2002).

If these observations are correct, then the A-type intrusive rocks exposed in School Brook Cove are likely Early Silurian in age and hence may be related to the A-type West Barneys River Plutonic Suite (e.g. Archibald *et al*., 2013) exposed farther to the southeast in the Antigonish Highlands.

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Figure 4. (a) Dendritic trace fossils on bedding plane. One-dollar coin is for scale. (b) Ribs and spinal column of an unidentified fish. One-dollar coin is for scale. (c) Spine from fish. One-dollar coin is for scale. (d) Thinly bedded mafic crystal tuff. One-dollar coin is for scale.

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References

Ami, H. M. 1895: Notes on a collection of Silurian fossils from Cape George, Antigonish County, Nova Scotia, with descriptions of four new species; Nova Scotia Institute of Natural Science, Proceedings and Transactions, v. VIII, p. 411–415.

Archibald, D. B., Barr, S. M., Murphy, J. B., White, C. E., MacHattie, T. G., Escarraga, E. A., Hamilton, M. A. and MacFarlane, C. R. M. 2013: Field relations, petrology, and tectonic setting of the Ordovician West Barneys River plutonic suite, southern Antigonish Highlands, Nova Scotia, Canada; Canadian Journal of Earth Sciences, v. 50, p. 727–745.

Benson, D. G. 1974: Geology of the Antigonish Highlands, Nova Scotia; Geological Survey of Canada, Memoir 376, 92 p.

Boucot, A. J., Dewey, J. F., Dineley, D. L., Fletcher, R., Fyson, W. K., Griffin, J. G., Hickox, C. F., McKerrow, W. S. and Ziegler, A. M. 1974: Geology of the Arisaig area, Antigonish County, Nova Scotia; Geological Society of America, Special Paper 139, 191 p.

Boucot, A. J., Fletcher, R. and Griffin, J. G. 1959: Middle or Upper Ordovician in Nova Scotia; Geological Society of America Bulletin, v. 70, p. 1572.

Dunning, G. R., Barr, S. M., Giles, P. S., McGregor, D. C., Pe-Piper, G. and Piper, D. J. W. 2002: Chronology of Devonian to early Carboniferous rifting and igneous activity in southern Magdalen Basin based on U–Pb (zircon) dating; Canadian Journal of Earth Sciences, v. 39, p. 1219–1239.

Fletcher, H. 1887: Report on geological surveys and explorations in the counties of Guysborough, Antigonish, and Pictou, Nova Scotia; Canadian Geological Survey Annual Report for 1886, pt. P, v. II, p. 5–128.

Keppie, J. D. 1980: Fossils from School Brook Cove, Cape George, Nova Scotia; *in* Mineral Resources Division Report of Activities 1979, ed. K. A. McMillan; Nova Scotia Department of Mines and Energy, Report 80-1, p. 123–126.

McNamara, L. B. 1984: The geologic interpretation of eastern Cape George; B.Sc. thesis, Saint Francis Xavier University, Antigonish, Nova Scotia, 38 p.

Pickerill, R.K. 1989: *Bergaueria petata* Prantl, 1945 from the Silurian of Cape George, Nova Scotia; Atlantic Geology, v. 25, p. 191–197.

Reilly, B. A. 1984: Geology of the western portion of Cape George; B.Sc. thesis, Saint Francis Xavier University, Antigonish, Nova Scotia, 29 p.

Somers, G. 1980: Petrogenesis of a differentiated intrusive, School Brook Cove, Cape George, Nova Scotia; B.Sc. honours thesis, Saint Mary's University, Halifax, Nova Scotia, 65 p.

White, C. E. and Archibald, D. B. 2011: Preliminary geology of the southern Antigonish Highlands, northern mainland Nova Scotia; Nova Scotia Department of Natural Resources, Open File Illustration ME 2011-001.

White, C. E., Archibald, D. B., MacHattie, T. G. and Escarraga, E. A. 2011: Preliminary geology of the southern Antigonish Highlands, northern mainland Nova Scotia; *in* Mineral Resources Branch, Report of Activities 2010, ed. D. R. MacDonald and K. A. Mills; Nova Scotia Department of Natural Resources, Report ME 2011-001, p. 145–164.

White, C. E., Barr, S. M., Archibald, D. B., Drummond, J., Voy, K., Escarraga, E. A. and MacFarlane, C. R. M. 2012: A new geological interpretation of the Antigonish Highlands, northern Nova Scotia; Nova Scotia Department of Natural Resources, Open File Illustration ME 2012-002.

White, C. E. and Drummond, J. 2014: Preliminary geology of the northernmost Antigonish Highlands, northern mainland Nova Scotia; *in* Mineral Resources Branch Report of Activities 2012, ed. D. R. MacDonald and E. W. MacDonald; Nova Scotia Department of Natural Resources, Report ME 2013-001, p. 103–115.