

Bedrock Geology of the Southwestern Meguma Terrane, Nova Scotia¹

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Department of Geology, Introduction

Detailed bedrock mapping in the southwestern Meguma terrane of Nova Scotia, from Digby to Shelburne (Fig. 1), is part of a five year program initiated in 1998 by the Nova Scotia Department of Natural Resources. The principal goals of the project are to produce a series of 1:50,000 scale geological maps of the area, to describe and interpret the sedimentary, igneous, metamorphic, and deformational history, and evaluate the economic potential. We report here preliminary results from the first two years of the project.

Map Units

The *Goldenville Formation* consists mainly of grey, massive to locally laminated or cross-laminated metasandstone and interbedded metasiltstone and slate, with minor coarse-grained metasandstone and conglomerate. Carbonate and manganese concretions are common in metasandstone beds. Rare trace fossils have been observed, but not assigned an age. ⁴⁰Ar/³⁹Ar ages from detrital single and multigrain muscovite samples from the Digby area yield an average age of ca 550 Ma, in agreement with previously obtained U-Pb dates from detrital zircon and titanite (Krogh and Keppie, 1990) and ⁴⁰Ar/³⁹Ar muscovite ages (e.g. Hicks *et al.*, 1999) obtained elsewhere in the Goldenville Formation.

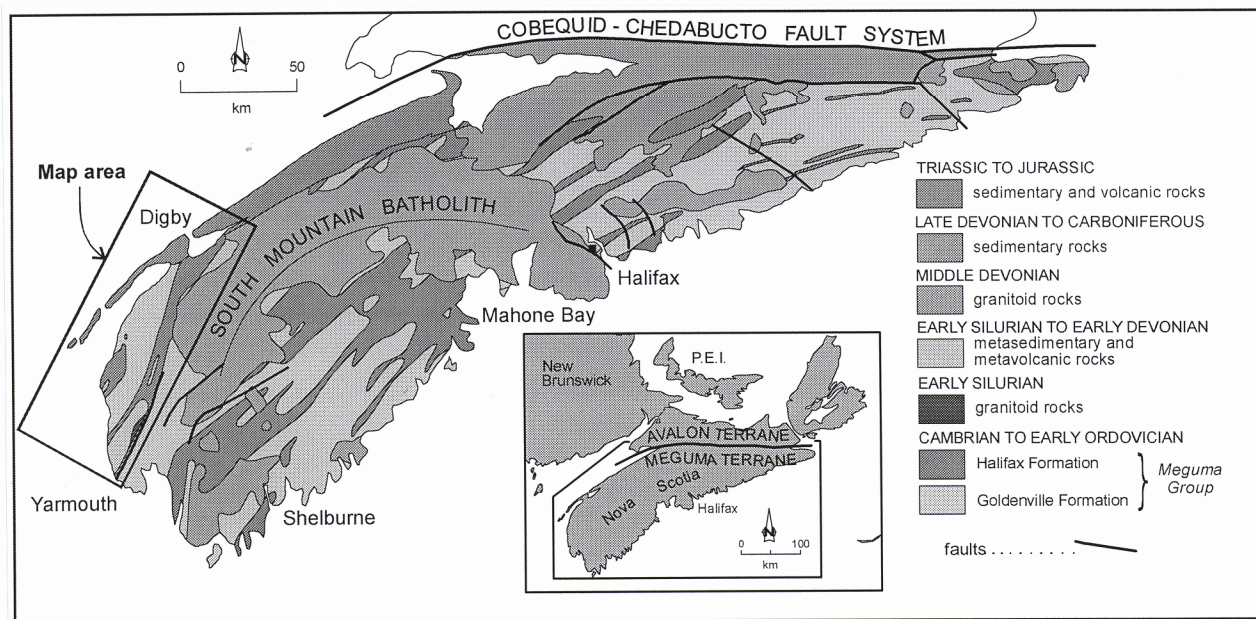


Fig. 1. Geological map of the Meguma terrane, Nova Scotia, showing the location of the map area.

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The overlying *Halifax Formation* has been divided into several informally defined members. The basal Bloomfield member consists of distinctly banded maroon and green, locally mottled metasilstone to slate with minor calc-silicate nodules. This unit is stratigraphically and structurally conformable with the underlying Goldenville Formation and in places appears gradational. The strata overlying the Bloomfield member are divided into the (i) Acacia Brook member in the northeastern part of the mapped area, characterized by light-to dark grey, planar laminated slate with minor metasilstone and metasandstone, and (ii) Cunard member to the southwest, consisting of dark grey to black, sulphide-rich slate and metasilstone. The Acacia Brook and Cunard members may be facies equivalent on the basis of their stratigraphic position immediately above the Bloomfield member. However, The Acacia Brook member contains characteristics that are more similar to the Bloomfield member and the Acacia Brook formation may “pinch-out” to the southwest. The Bear River member is the uppermost unit of the Halifax Formation in the northeastern part of the mapped area and consists of light- to dark colored, silty slate with minor metasilstone, slate, and metasandstone. Along strike to the southwest this member is interpreted to interdigitate with the Sissaboo River member which contains thinly laminated green-grey metasilstone and slate. Thin crossbedded metasandstone lenses are characteristic of both members. Fossil occurrences are generally sparse, although trace fossils are abundant. Early Tremadoc acritarch microfossils were reported by Doyle (1979) and Early Tremadoc specimens of the graptolite *Rhapdinopora flabelliforme* have been recovered near the top of the Bear River member (White *et al.*, 1999). A $^{40}\text{Ar}/^{39}\text{Ar}$ age obtained from detrital muscovite sample yielded an apparent age of ca. 596 Ma.

The *White Rock Formation* is well exposed in the Digby and Yarmouth areas. The contact with the underlying Halifax Formation in the Yarmouth area is faulted; however, in the Digby area the contact is a disconformity or angular unconformity. In the Digby area the White Rock formation consists of grey to dark grey slate and metasilstone with minor light grey metasandstone. Calc-silicate lenses are common. A characteristic feature of this formation is a thick (up to 30 m), laminated and cross-stratified metasandstone layer. Primary sedimentary structures are common and upper Silurian vertebrate and crinoid remains have been collected near the top of the formation (Bouyx *et al.*, 1997). Single and multigrain detrital $^{40}\text{Ar}/^{39}\text{Ar}$ muscovite ages range from ca. 550 to 440 Ma. In the Yarmouth area, the White Rock Formation has been divided into 7 stratigraphic units composed of predominantly metavolcanic rocks with mafic to felsic lithic and crystal tuff interlayered with mafic flows, metasilstone and metasandstone. Associated with the metavolcanic rocks is the fault-bounded granitic Brenton Pluton. Mafic volcanic rocks of the White Rock Formation have chemical features indicating alkalic affinity and within-plate tectonic setting. The felsic volcanic rocks are chemically similar to the Brenton Pluton and both have some characteristics of within-plate A-type granites. U-Pb dating (zircon) from a felsic unit yields a preliminary age of 438 \pm 31/-35 Ma, supporting the Silurian age of the White Rock Formation based on fossil evidence from elsewhere in the formation and similar to the detrital muscovite age.

The *Torbrook Formation* conformably overlies the White Rock Formation in the Digby area and consists of poorly cleaved, grey metasilstone and calcareous metasilstone with minor slate, metasandstone, marble, and rare ironstone. Primary sedimentary structures and Early Devonian (Lochkovian to Lower Emsian) shelly fossils are common (e.g. Bouyx *et al.*, 1997).

Numerous mafic sills intrude all above units and have been divided into two suites based on field relations. The older suite is restricted to the Halifax Formation and appears to have been emplaced during deposition of the formation. A younger suite occurs in the Halifax, White Rock and Torbrook formations. Both types of sills were previously interpreted to be tholeiitic transitional to alkalic and were emplaced in a continental, within-plate tectonic setting (Barr *et al.*, 1983). However, additional geochemical studies are in progress to confirm the older data.

Devonian granitoid units in the mapped area consist of the ca 370 Ma South Mountain Batholith and Ellison Lake and Clayton Hill plutons. They consist of medium- to coarse-grained monzogranite and granodiorite with megacrysts of K-feldspar. These intrusions produced well developed contact metamorphic aureoles with abundant andalusite and cordierite that are superimposed on regional fabrics.

The *Wolfville Formation* unconformably overlies the Meguma Group and South Mountain Batholith. It consists of Middle to Late Triassic red, coarse-grained sandstone and conglomerate with minor red-brown siltstone and shale. The *Blomidon Formation* conformably overlies the Wolfville Formation and consists of red-brown to grey-green siltstone and minor sandstone and shale. Palynomorph assemblages indicate a mainly Late Triassic age, with the very top of the formation extending into the Jurassic (Wade *et al.*, 1996). The *North Mountain Formation* conformably overlies the Blomidon Formation and consists of a succession of basaltic flows dated at ca 202 Ma (U-Pb zircon; Hodych and Dunning, 1992).

Deformation and Metamorphism

The lower to middle Paleozoic rocks and mafic sills were deformed into regional northeast- to north-northeast-trending, moderately plunging folds with axial planar cleavage during the Devonian Acadian Orogeny. However, the White Rock and Torbrook formations are exposed in a regionally continuous syncline that extends throughout the mapped area and in the northeast these rocks are typically poorly cleaved or lack cleavage. Regional metamorphism associated with the Acadian Orogeny was at greenschist facies conditions for the majority of the mapped area with a peak metamorphic mineral assemblage of muscovite + chlorite + albite in the pelitic rocks. In the southwest, metamorphic grade locally reached amphibolite facies with a peak metamorphic mineral assemblage of biotite + garnet + staurolite + cordierite + andalusite in the pelitic rocks. $^{40}\text{Ar}/^{39}\text{Ar}$ muscovite and whole rock data indicate that deformation and metamorphism associated with the Acadian Orogeny was at ca 400 Ma (e.g. Hicks *et al.*, 1999; this study).

The intrusion of the ca 370 Ma South Mountain Batholith and Ellison Lake and Clayton Hill plutons produced well-developed contact metamorphic aureoles that are superimposed on regional fabrics. Close to the plutons cordierite and andalusite are abundant. A $^{40}\text{Ar}/^{39}\text{Ar}$ whole-rock age of ca 370 Ma from the Torbrook Formation likely reflects thermal overprint by the adjacent South Mountain Batholith.

Major Middle Carboniferous (ca. 320 Ma) deformation, characterized by southeast-dipping shear zones and northwest verging folds, overprint the Acadian folds in the southwestern part of the mapped area (Culshaw and Liesa, 1997). One shear zone has been extended northeast to the Digby area where it is defined by a wide zone (locally > 1 km) of shear-related crenulation and minor folds and overlaps the boundary of the Goldenville and Halifax formations. Displacement is mainly northwest-directed dip-slip in the southwest; however, displacement in the northeast is strike-slip.

Discussion and Summary

In this study, the traditional unit names in the Meguma terrane have been used. However, recently it has been suggested that the Meguma Group be elevated to the rank of supergroup, the Goldenville and Halifax formations to group status, and the White Rock and Torbrook formations combined into the Annapolis Supergroup (e.g. Schenk, 1997).

The Halifax Formation in the Digby - Yarmouth area has been subdivided into several discrete members in which the overall stratigraphy is broadly comparable to that documented elsewhere in the Meguma Group (e.g. Schenk, 1997). Subdivisions in the Goldenville Formation were not recognized largely due to the monotonous character of the formation. The Bloomfield member represents the lowermost stratigraphic unit in the Halifax Formation and is overlain by the Acacia Brook and Cunard members. The Bear River member and facies equivalent Sissaboo River member represent the uppermost unit and the presence of early Tremadoc fossils suggests that the Cunard, Acacia Brook and Bloomfield members, together with the Goldenville Formation, are Cambrian in age.

The U-Pb age combined with fossil control indicate that the White Rock Formation is entirely Silurian in age. This suggests a time gap of approximately 60 Ma between the top of the Halifax Formation and the deposition of the White Rock Formation, and supports the presence of an unconformity between the two formations. The Torbrook Formation contains Early Devonian fossils and is in gradational contact with the underlying White Rock Formation.

The $^{40}\text{Ar}/^{39}\text{Ar}$ data suggest that the ca. 400 Ma Acadian Orogeny occurred immediately after deposition of the Torbrook Formation and was near completion prior to the intrusion of the South Mountain Batholith. The intense crenulation fabrics in the Bloomfield, Acacia Brook and Cunard members clearly define deformation that was after the Acadian Orogeny and can be traced along strike to shear zones defined in the Yarmouth area. This deformation is Middle Carboniferous in age and postulated to be related to strike-slip movement along the terrane-bounding Cobequid-Chedabucto fault system. It may record final docking of the Meguma terrane against North America.

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Biographical Note:

Chris White graduated from Acadia University in 1984 with a B.Sc. Honours degree in Geology and graduated from Dalhousie University with a Ph.D. in Earth Sciences in 1996. He worked as a Postdoctoral Fellow and laboratory instructor at Acadia University. He is presently employed as a Project Geologist with the Nova Scotia Department of Natural Resources.

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