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Avalonia Versus Ganderia in Southern New Brunswick

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GAC-MAC 2014: FIELD GUIDE SUMMARY

The On-going Saint John Geology Enigma: Avalonia Versus Ganderia in Southern New Brunswick

GAC–MAC Fredericton 2014, post-meeting field trip

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FIELD TRIP OBJECTIVES

The geology of the Saint John area in southern New Brunswick has long been recognized for its complexity. In 1938, after more than one hundred years of geological investigation, F.J. Alcock began his Geological Survey of Canada Memoir on the geology of Saint John by writing *"Perhaps no other area of similar size in Canada has presented so many geological problems as has that which includes and immediately surrounds the city of St. John, New Brunswick."*

The Saint John area lies within the northern Appalachians, a long-lived accretionary orogen that records the opening and closing of the Iapetus and Rheic oceans. The Canadian Appalachians were first defined and subdivided by Hank Williams in the 1970's, who placed all of the rocks in southern New Brunswick within his 'Avalon Zone', correlative with the rocks in the type area on the Avalon Peninsula in Newfoundland. The Avalon Zone was characterized by a variety of Neoproterozoic volcanic, plutonic, and sedimentary rocks, but the main basis for assignment to the Avalon Zone was the presence of an overlying Cambrian-Ordovician sedimentary cover sequence with Atlantic-realm trilobite fauna, interpreted to have formed on the eastern side of the Iapetus Ocean.

Over the decades, this fundamental interpretation has changed dramatically as a result of geological work spanning several disciplines, but likely the most important have been mapping and geochronology. As a result, a revised lithotectonic map of the Appalachian Orogen was produced by Jim Hibbard and colleagues in 2006. Contrasts in age, isotopic characteristics, provenance, structural features, and tectonothermal evolution, as documented in numerous publications, have led to the recognition of three fault-bounded, Neoproterozoic belts or terranes in southern New Brunswick. From east to west these include the Caledonia, Brookville and New River terranes (Fig. 1). In addition, mostly Early Silurian volcanic and sedimentary rocks and related plutons occur in fault-bounded belts separating the Brookville and New River terranes (Kingston Group) and within the New River terrane (Mascarene Group). To the west of the New River terrane and Mascarene cover sequence are Ordovician rocks of the Annidale and St.

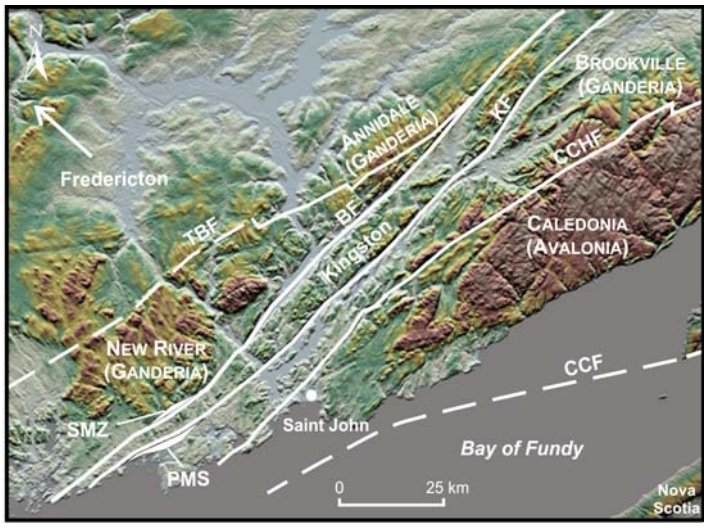

Figure 1. Map of southern New Brunswick showing terranes and terrane-bounding faults (white lines). Abbreviations: BF, Belleisle Fault; CCF, Cobequid-Chedabucto Fault; CCHF, Caledonia-Clover Hill Fault; KF, Kennebecasis Fault; PMS, Pocologan Metamorphic Suite; SMZ, Seven Mile Lake Mylonite; TBF, Taylor Brook Fault. Digital elevation map derived from NASA Shuttle Radar Topographic Mission (SRTM).

Figure 2. Cape Spencer Granite (ca. 625 Ma) of the Avalonian Caledonia terrane at Cape Spencer on the shore of the Bay of Fundy looking east along the inferred trend of the Cobequid-Chedabucto Fault.

Figure 3. Outcrop of the stromatolite *Archaeozoon acadiense* in the Green Head Group on Green Head Island. Photograph by D. Nance.

Croix terranes.

The revised northern Appalachian map places the northern edge of the Avalon Zone, now known as Avalonia, at the Caledonia-Clover Hill Fault (CCHF) that passes through the Saint John area, leaving only the relatively narrow Caledonia terrane in Avalonia. The Brookville, New River, Annidale and St. Croix terranes situated north of this fault are included in the 'Gander Zone', now known as Ganderia. Hence in this latest interpretation, most of New Brunswick (and adjacent Maine) is included in Ganderia. Avalonia is mostly located offshore, underlying the Gulf of Maine, and re-emerging in the Boston area of southern New England.

Although some aspects of this new scenario are compelling, a number of questions remain. For example, Neoproterozoic magmatism in both the New River and Caledonia terranes occurred in two distinct pulses, one at ca. 625 Ma and one at ca. 555 Ma. Is this magmatism related? What is the significance of fossiliferous Cambrian rocks with Atlantic-type fauna in the New River and Brookville terranes? Are they part of the Saint John Group, representing the Avalonian cover sequence in the Caledonia terrane? If so, what are the implications for Ganderia versus Avalonia? Why are the Silurian arc-related volcanic rocks of the Kingston Group and adjacent high-pressure mylonite of the Pocologan Metamorphic Suite (PMS) on the inboard side of the Brookville terrane (within Ganderia) if they represent the arc/accretionary wedge associated with the juxtaposition of Avalonia and Ganderia as current models suggest? Can we reconcile Late Neoproterozoic and Early Cambrian plutonism and uplift in the Brookville terrane with events in adjacent terranes in the same time interval? The two-day field trip will focus on these and other unresolved issues by visiting outcrops, which provide supporting and/or contrary evidence for current models.

Over both days, participants will see ca. 625 Ma and ca. 555 Ma granitoid rocks and fossiliferous Cambrian rocks in the New River and Caledonia terranes (Fig. 2), ca. 555–540 Ma volcanic and plutonic rocks in the Brookville and New River terranes, and Silurian arc rocks of the Kingston belt that separate 'Ganderian' rocks of the Brookville and New River terranes. Highlights of Day 1 include carbonate 'olistostrome' and low-pressure gneiss in the Brookville terrane and mylonitic Carboniferous rocks of the allochthonous Partridge Island block in the Caledonia terrane. Highlights of Day 2 include a visit to the first scientifically described Precambrian fossil, the stromatolite *Archaeozoon acadiense* (Fig. 3). We will also see a variety of mylonitic rocks in the high-pressure Pocologan Metamorphic Suite and Seven Mile Lake mylonite zone.

The fundamental questions explored on this field trip are critical to understanding the Appalachian Orogen and the nature of 'Avalonia' and 'Ganderia' before, during, and after their journeys across Iapetus to the Laurentian margin. This field trip provides the opportunity to discuss these issues on the outcrop, and complements the 2014 GAC–MAC Symposium entitled: *Evolution of the Appalachian-Caledonide-Variscan and correlative orogens: Recent developments.*

ADDITIONAL INFORMATION

This two-day excursion begins on Saturday morning May 24th in Fredericton; participants will travel by van to the Saint John area (approximately 120 km), making field stops along the way. The trip includes one overnight stay in Saint John, and returns to Fredericton at the end of day 2 (Sunday, May 25th). Most field stops are easily accessible roadside exposures and coastal outcrops; however, in some cases walking is on slippery, uneven surfaces. One stop includes a 1.5 km hike on a grassy-rocky trail in hilly terrain and a 100 m walk through woods to the coast.