Insights into tectonic assembly and crustal substrate of the NE Trans-Hudson Orogen from the Cumberland Batholith

Joseph B. Whalen*
Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8
jwhalen@NRCan.gc.ca

Natasha Wodicka
Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8

Bruce E. Taylor
Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8

Summary

The voluminous (~221,000 km^2), ca. 1.865-1.845 Ga Cumberland batholith (CB) is a major component of the northeast Trans-Hudson orogen (THO) on Baffin Island. Its petrogenesis and tectonic context has been interpreted based on a 900 km granitoid rock geochemical-isotopic (Nd-O) transect. The mainly granulite grade, high-K to shoshonitic CB consists of infracrustal (I-type) granites which display a spectrum of tectonic affinities. ε_{Nd} 1.85 Ga signatures (-12 to -2) of both mafic and felsic CB units suggest a dominance of evolved sources. The CB, interpreted as a post-accretion batholith resulting from large-scale lithospheric mantle delamination, stitches and obscures tectonic boundaries between the southern Rae craton and various microcontinental blocks within the internal THO. Isotopic signatures in the interior of the CB (-2 to -7) are more radiogenic than those within Archean domains in central (-8 to -15) and southern (-5 to -19) Baffin Island. The isotopic transect is interpreted as 'imaging' an accreted microcontinental block (Meta Incognita) and the bounding Archean cratons in south (Sugluk block) and central (Rae) Baffin Island.

Introduction

The petrogenesis and tectonic setting of the Cumberland batholith was examined based on a 900 km geochemical and isotopic transect through it and into bounding Archean crustal domains in central and southern Baffin Island (Fig. 1). Nd and O isotopes , and U-Pb geochronology are used to supplement major and trace element geochemical data. In the light of these data, we examine what the CB reveals about the crustal substrate beneath the Baffin Island segment of the THO and its bounding Archean cratons, and discuss the tectonic evolution of this region.

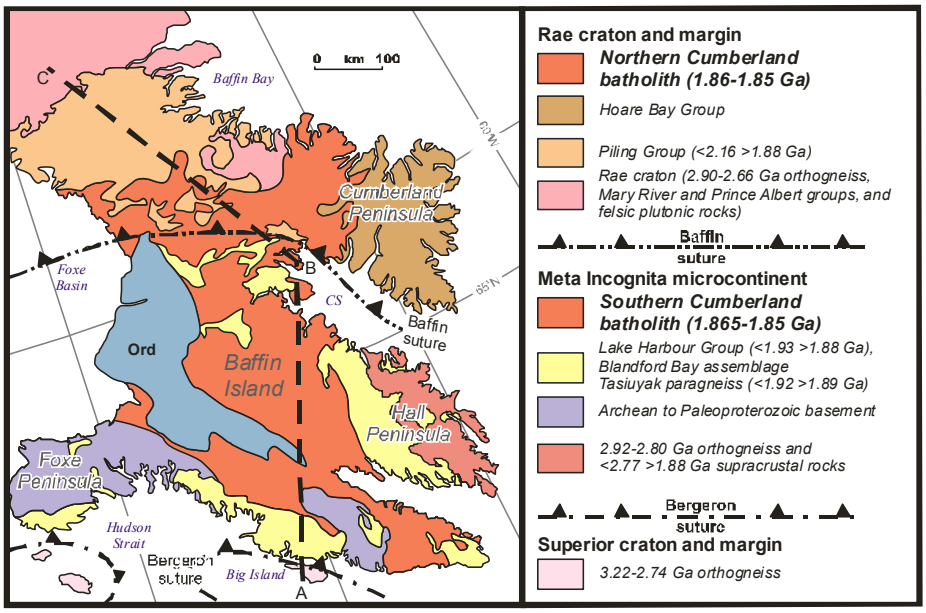

Figure 1: Simplified geological summary map of southern Baffin Island showing major tectonostratigraphic assemblages and bounding crustal sutures as defined by St-Onge et al. (2006a; slightly modified from their Figure 2).

Geochemical and isotopic results

The mainly granulite grade CB, emplaced over an age span of between 14 to 24 Ma, consists mainly of high-K to shoshonitic monzogranite and granodiorite. The CB includes granites of arc, within-plate (A-type) and post-collisional affinity. It also includes adakitic granites, characterized by high $(La/Yb)_{CN}$ and Sr/Y, and interpreted as partial melts of greatly thickened eclogitic crust within post-collisional settings, such as Tibet. Volumetrically minor CB mafic rocks exhibit both arc and non-arc features. Metaluminous to slightly peraluminous compositions and $\delta^{18}O$ (VSMOW) values (+6 to +10‰) indicate derivation from infracrustal (I-type) sources. ε_{Nd} 1.85 Ga signatures (-12 to -2) of both mafic and felsic CB units suggest a dominance of evolved sources. Our transect documents south to north Nd isotopic variations (Fig. 2), including southern and northern domains, each about 200 km wide, that are characterized by strongly negative ε_{Nd} (1.85 Ga) values (-5 to -19 and -8 to -15, respectively). The southern domain includes Archean basement of the Sugluk block exposed on Big Island (Corrigan et al., 2009) and CB and post-CB plutonic samples that intrude the Meta Incognita microcontinent, whereas the northern domain is restricted to the exposed Rae craton and includes Archean basement and post-CB plutonic samples. The ~600 km wide central domain, underlain mainly by CB plutonic rocks (Fig. 1), is characterized by uniform and more radiogenic ε_{Nd} (1.85 Ga) values. Within this central domain, there is a northward trend in CB samples to more negative ε_{Nd} (T) values (-2.5 to -5.5) and thus slightly older T_{DM} ages (2.3 to 2.7 Ga) (Fig. 2). In general, these features are interpreted as imaging or mapping the continental lithosphere beneath south to central Baffin Island, such that spatial variation in T_{DM} values (Fig. 2b) likely maps changes in the age of underlying crustal substrate.

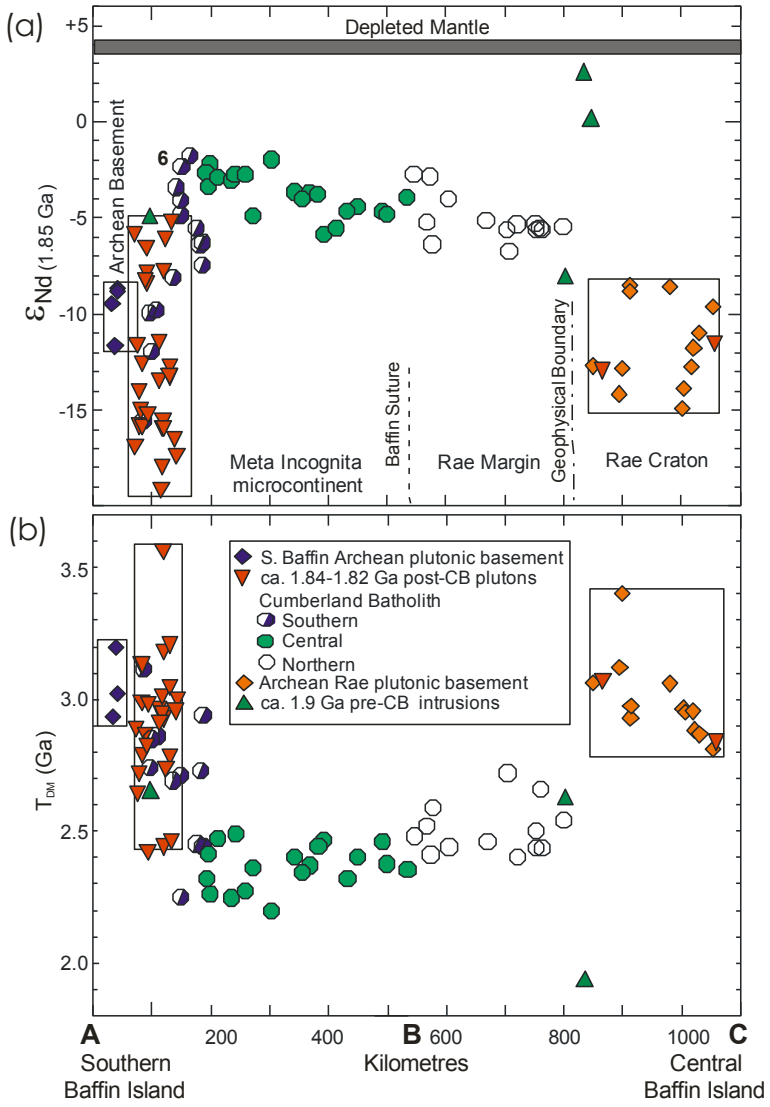

Figure 2: (a) ε_{Nd}(1.85 Ga) values, and (b) Nd T_{DM} ages (in Ga) vs. distance (in km) for granitoid samples projected on a south to central Baffin transect (see line A-B-C in Fig. 1). Both bounding Archean basement terranes and South Baffin post-CB magmatism sample ranges are outlined by boxes.

Tectonic Implications

In southern Baffin Island, we interpret the isotopically more evolved domain defined by CB and post-CB samples as imaging the Archean Sugluk block at depth beneath the southern Meta Incognita microcontinent. Combined isotopic and geochronological data suggest these southern plutons were derived from a deep Sugluk crustal melt source and that at least some assimilation of upper Meta Incognita crustal material took place during iascent and emplacement. These results further imply that Sugluk block and Meta Incognita microcontinent collision occurred prior to CB magmatism. The ~600 km wide central domain, with an average T_{DM} age of ca. 2.4 Ga (Fig. 2b), encompasses both the southern Rae margin and a large part of Meta Incognita microcontinent. In general, the transect shows no clear indication of the Baffin suture as delineated in Fig. 1. There are two possibilities: (1) Prior to CB magmatism the Rae craton was composite, including 3.0 Ga and 2.4 Ga domains. During Paleoproterozoic rifting, a major

portion of the ca. 2.4 Ga crustal block rifted from the Rae craton, isolating the Meta Incognita microcontinent. Prior to CB emplacement, this composite microcontinent collided with composite Rae, during which remnant Rae 2.4 Ga crust was reunited with rifted 2.4 Ga Meta Incognita crust along the Baffin suture; (2) A regional-scale magmatic event is required to explain the extent and overall uniformity of the ca. 2.4 Ga isotopic domain straddling the Baffin suture. Current data do not allow us to distinguish between these tectonic scenarios and they are not mutually exclusive. Increasing Nd isotopic and U-Pb zircon evidence for the presence of a dominant Paleoproterozoic basement component within the Meta Incognita microcontinent suggests that basement to this terrane likely represented the main source of the CB magmas within the ca. 2.4 Ga isotopic domain south of the Baffin suture. In contrast, the nature of CB magma sources within the Rae margin north of the Baffin suture remains unclear.

References

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