Early crustal history of the Slave craton, northwestern Canada

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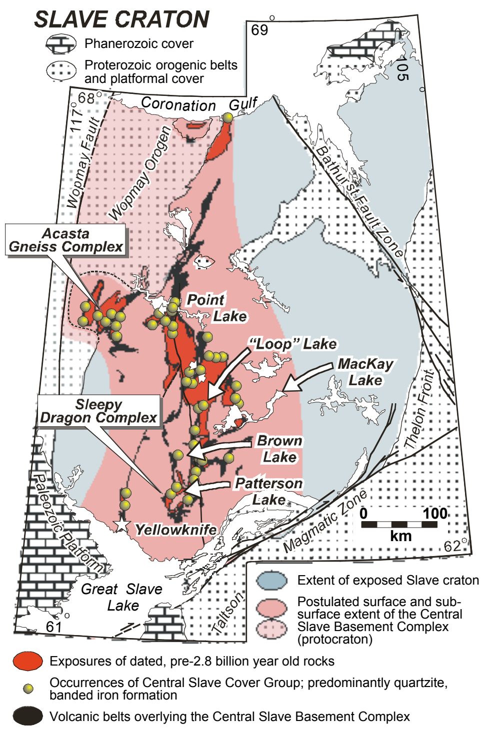
Introduction

The nucleus of the Archean Slave Province (containing Earth's oldest rocks, the Acasta gneisses) is a 4.03-2.85 Ga composite crustal block underlying the western half of the province. Recent work suggests that this protocraton (the Central Slave Basement Complex (CSBC); Bleeker et al. 1999a, b) forms the stratigraphic and structural basement to 2.85-2.60 Ga volcanic and sedimentary assemblages, thus uniting elements of earlier tectonic models (e.g. Henderson 1985, Kusky 1989). A distinctive basal supracrustal unit is the 2.85-2.80 Ga Central Slave Cover Group which marks the regional extent of the CSBC. In contrast, the eastern Slave Province preserves only a Neoarchean crustal history (Davis & Hegner 1992). A collisional suture remains a viable option for the mutual boundary, but this boundary is largely obscured by younger cover.

This talk examines the early history of the CSBC as revealed mainly by U-Pb dating (both TIMS and SHRIMP). The distribution of age-defined basement domains suggest that mobile belt-like processes may have played a role in early crustal genesis.

Chronology of protocraton development

The oldest rocks of the CSBC are 4.03-3.95 Ga granitoid gneisses and gabbros of the Acasta gneiss complex. Pb and Nd isotopic data hint at an eastward extension of this crust; however, oldest-known protolith and zircon inheritance ages 80 km to the east at Point Lake are <3.4 Ga. The Acasta gneisses were intruded at 3.7-3.6 Ga by gabbro, tonalite, and granite sheets marking one or more crustal growth events.



Possibly 30% of the present-day protocraton existed by 3.51 Ga as indicated by inherited zircon in 2.94 Ga tonalite at "Loop" Lake. Metamorphism in the Acasta area at this time indicates that both areas may have belonged to a single block. Granitoid plutonism across much of the protocraton between 3.41-3.30 Ga is either directly dated or inferred from zircon inheritance ages, suggesting that much of the present-day CSBC existed by 3.3 Ga. Between 3.4-3.0 Ga, granitoid plutonism involved reworking of older crust as well as juvenile additions. High-grade metamorphism and gneissic fabric development likely occurred during this interval.

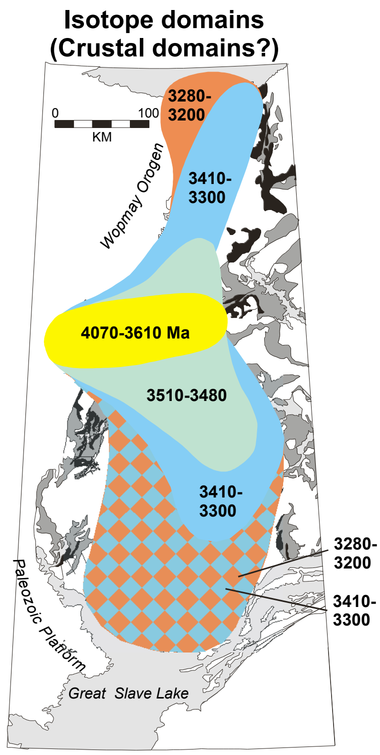
The oldest known supracrustal rocks, consisting of volumetrically minor 3.14 Ga rhyolite and a 3.31 Ga(?) felsic volcaniclastic unit were also deposited.

A major crustal growth/recycling event at 2.99-2.90 Ga was marked by voluminous TTG magmatism across the southern half of the CSBC. This resulted in widespread occlusion of older rocks; however, inherited zircons and crustally contaminated isotopic signatures reveal their presence. Field and U-Pb data suggest that tectonic activity also occurred at this time. The northern region lacks the 2.99-2.90 Ga TTG suite but was widely modified by granitic plutonism at 2.90-2.86 Ga.

Temporary cratonic stability occurred at 2.85 Ga when a clastic-chemical sedimentary package containing ultramafic flows and/or sills (the Central Slave Cover Group) was deposited regionally. Precise ages of 2853 Ma and 2826 Ma are obtained from rare felsic volcanic units within the succession (Ketchum & Bleeker 2000). This distinctive cover sequence outlines the folded structural geometry of the protocraton (Bleeker et al. 1999a, b). Field and U-Pb data also indicate regionally significant plutonism and high-grade metamorphism between 2.85-2.82 Ga, contemporaneous with cover group deposition.

Discussion

An expanding geochronological database along with existing Nd and Pb isotope data suggest that maximum crustal ages within the CSBC young outward from a central core containing the Acasta gneisses. The exact significance of this age pattern is currently unclear, but a key observation is that Acasta crust was influenced by younger thermal-plutonic events that generated oldest crust in other parts of the protocraton. One possible interpretation is that continental margin accretionary processes account for the age pattern. Another is tectonic amalgamation of discrete crustal fragments (e.g. Davis et al. 1994), although no features consistent with this observation have been identified in either the crust or subcontinental lithospheric mantle. Early generations of gneissic fabric could be due to one, both, or neither of these crustal growth scenarios.



Inherited zircon ages and Nd-Pb isotopic data indicate that recyling of older crust during regional magmatic activity was an important theme after 3.3 Ga (see also Yamashita et al. 2000). This will be tested by GEMOC's TerraneChron™ method (e.g., Griffin et al. 2004) which combines U-Pb (laser ablation ICP-MS), Hf isotope (laser ablation MC-ICP-MS), and electron microprobe data from individual zircon populations to reveal modes of crustal evolution. An overview of this approach will be provided.

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