Subduction-driven growth and modification of cratons: examples from Canada and Greenland

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Cratonic crust and underlying mantle roots are thought to have a shared history of growth and modification since the Archean. However, debate continues on whether their coupled growth was due to mantle plumes or early forms of subduction. Cratonic mantle eclogites are central to this debate and here we present evidence from two such xenolith suites from Canada and Greenland for subduction-driven growth and modification of cratonic lithosphere.

We have determined the Pb isotope compositions of clinopyroxenes from eclogite xenoliths from the northern Slave and the West Greenland North Atlantic craton (NAC). Clinopyroxenes from NAC eclogites define a secondary isochron with an age of 2.7±0.3 Ga, which intersects a terrestrial Pb isotope evolution curve at ca. 2.62 Ga. This suggests Late Archean eclogite formation via melt extraction during subduction of oceanic crust [1]. Pb isotope compositions of the Slave clinopyroxenes do not define a statistically meaningful isochron. Instead, they appear to form a mixing array extending from clinopyroxene with unradiogenic Pb ($^{206}Pb/^{204}Pb \sim 14.3$) to the host Jurassic kimberlite ($^{206}Pb/^{204}Pb \sim 19.2$). We believe this array was produced by mixing between kimberlitic- and eclogitic derived Pb. Hence, the least radiogenic Pb isotope composition that intersects the Stacey-Kramers evolution curve at ca. 2.2 Ga has age significance. Importantly, this model age falls within the age range of 2.3-1.8 Ga shown by other eclogites from the Slave craton [2].

Both the Slave and NAC eclogite xenoliths have geochemical signatures that indicate oceanic crust protoliths, including $\delta^{18}O$ values that range above the mantle average (5.2-6.4‰). Moreover, the eclogite ages coincide with putative subduction events in each craton. NAC eclogite formation coincides with 2.9-2.7 Ga crustal growth marked by the intrusion of TTG granitoids in West Greenland. These TTGs are interpreted as melts of subducted oceanic basalts from their complementary relationship with the refractory NAC eclogites. The Slave eclogites coincide in age with the ca. 1.9 Ga subduction event that affected the western craton margin. Unlike Greenland, this subduction event did not add significantly to the Slave cratonic crust, and instead introduced eclogitic material to the craton root [2]. Furthermore, ca. 1.9 Ga eclogitic diamonds from the Slave craton [3] suggest that this subduction event introduced appreciable amounts of carbon into the mantle lithosphere. Thus, while both eclogite suites record craton evolution events, major crustal growth was only associated with the Archean Greenland eclogites, whereas late-stage cratonic root modifcation including metasomatism and diamond growth are marked by the Paleoproterozoic Slave eclogites.

[1] Tappe *et al.* (2011) *Geology* **39** 1103-1106. [2] Schmidberger *et al.* (2005) *EPSL* **240**, 621-633.

Formation of eclogites and pyroxenites below Attawapiskat, Superior Craton (Canada)

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Seventeen eclogite and 16 pyroxenite xenoliths from the Victor kimberlite at Attawapiskat will be used to assess whether they show evidence for a shallow origin as oceanic crust, emplaced into the Superior SCLM by tectonic stacking. Eclogites contain omphacite + garnet, whereas the pyroxenites contain diopside + garnet ± enstatite; three broad groups (Ca, Fe or Mg-rich) are recognised through their reconstructed whole rock major and rare earth element chemistry.

The sole high-Ca kyanite-bearing eclogite is the only sample with a positive Eu anomaly and has a subchondritic REE_N pattern consistent with an oceanic crust precursor undergoing dehydration/low degree partial melting during subduction. Fe-rich eclogites have flat $MREE_N$ to $HREE_N$ –indicative of a low-pressure origin – and depleted $LREE_N$. The high Mg eclogites and pyroxenites have similar flat $MREE_N$ to $HREE_N$, but enriched $LREE_N$ indicating a shallow origin and a subsequent stage of fluid metasomatic enrichment. Reconstructed whole rock compositions for these high Mg eclogites and pyroxenites rocks overlap with orogenic pyroxenites [1], suggesting a possible primary origin as basaltic intrusives in the shallow lithosphere.

Cpx from all the compositional groups have depleted Sr isotopic compositions (0.7019-0.7039) relative to present day bulk earth (0.7045). The majority of the samples have $\delta^{18}O$ overlapping, within uncertainty, to the mantle value. Mantle-like $\delta^{18}O$ values do not rule out oceanic crust as protoliths [2,3], and therefore these data cannot be used to distinguish between a low versus a high pressure origin. Evidence for involvement of crustal components in the genesis of the Superior's lithospheric mantle are flat $MREE_N$ to $HREE_N$ patterns and a positive Eu anomaly in the kyanite-bearing eclogite. Re-Os analyses and in-situ cpx Pb-Pb dating of these eclogites and pyroxenites are currently underway.

[1] Pearson et al. (1993) *Journal of Petrology* **34,**1,125-172 [2] Hart et al. (1999) *Geochimica et Cosmochimica Acta* **63**,4059-4080 [3] Schmickler et al. (2004) *Lithos* **75**,173-207