Metasomatism and oxidation state of the mantle root beneath the Rae craton, Canada

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The Rae craton is an important part of the Canadian Shield and was amalgamated to the Slave craton at ~ 1.9 Ga [1]. Recent geophysical and geochemical data indicate a protracted geodynamic history [1, 2]. Even though the oxidation state of the Earth's mantle has an important influence of fluid compositions and melting behavior, no data on the oxidation state of the Rae's mantle are available.

The aims of this study were to 1) determine the oxidation state (fO_2) of the lithosphere beneath the Rae craton, 2) link these results to potential metasomatic overprints and 3) compare the geochemical evolution with the Slave craton. We studied 5 peridotite xenoliths from Pelly Bay (central craton) and 22 peridotites from Somerset Island (craton margin).

Pelly Bay peridotites give T < 905°C and depths of ~80–130 km. Garnets have depleted or "normal" REE patterns, the latter samples recording fO_2 values ~0.5 log units higher. The deeper samples are more enriched and oxidised. Peridotites from Somerset Island record T ~825-1190°C, a $\Delta \log fO_2$ ranging from ~ FMQ – FMQ-3.6 from a depth interval of ~100-150 km. Garnets exhibit two REE signatures – sinusoidal and "normal" - indicating an evolutionary sequence of increasing metasomatic re-enrichment and a shift from fluid to melt dominated metasomatism.

Compared to the Slave craton, the Rae mantle is more reduced at ~80km but becomes up to 2 log units more oxidised (up to ~FMQ-1) at ~100-130 km. Similar oxidising conditions can be found >140 km in the Slave mantle [3]. Especially under Somerset Island, the lithospheric mantle has contrasting fO2 and metasomatic overprints in the same depth range, which may represent juxtaposed old and rejuvenated domains [2].

[1] Liu et al. (2016) Precamb Res, 272; [2] Snyder et al. (2015) Geochem Geophys Geosyt, 16, 3555 – 3574; [3] Yaxley et al. (2017) Sci Rep 7.1, 30.