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The Hadean origin of the Archean Napier Complex (East Antarctica)

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Details regarding the early evolution of the mantle-crust system are still poorly constrained due to the great scarcity of >3.7 Ga rocks in the geological record. The Napier complex (East Antarctica) is an Eoarchean craton that contains some of Earth's oldest rocks. This complex recorded Meso- and Neoarchean metamorphism that reached extreme conditions corresponding to granulite facies at 2.5 Ga (1050-1120°C and 7-11 kbar). As a consequence, most samples exhibit disturbed radiogenic isotope systematics (e.g., Rb-Sr, Sm-Nd) and zircon crystals found in such samples are very complex rendering isotopic systematics interpretations challenging. The analytical methods employed in previous studies do not allow these complexities to be understood, which motivated the present contribution.

Here we studied two granulitic orthogneisses labelled 78285007 (Mount Sones) and 78285013 (Gage Ridge) that correspond to the oldest available rocks from the Napier Complex. Mount Sones displays typical characteristics of Archean tonalite-trondhjemite-granodiorite (TTG) suites (e.g., high Na_2O/K_2O, high Sr/Y, fractionated REE patterns with low heavy REE concentrations) with a normative composition intermediate between tonalite and trondhjemite whereas Gage Ridge has a composition closer to that of granite despite a strongly fractionated REE pattern and a pronounced positive Eu anomaly. We have conducted zircon texture assessment using cathodoluminescence and back-scattered electron images in annealed and not annealed crystals. We have subsequently combined U-Pb age profiling by laser-ablation inductively-coupled-plasma mass spectrometry (LA-ICP-MS) and Lu-Hf isotope systematics measurement by LA-MC-ICP-MS in these zircon crystals. Finally, we analysed ^{146,147}Sm-^{143,142}Nd isotopesystematics in corresponding whole-rock samples to better constrain the early history of their source.

Our results reveal that Mount Sones and Gage Ridgeorthogneisses formed at 3794 ± 40 and 3857 ± 39 Ma, respectively, with initial ε_{Hf} of -2.6 ± 1.5 and -3.6 ± 2.5, respectively. Sm-Nd isotope measurements indicate a μ^{142}Nd of -8.7 ± 3.9 and a ε_{Nd} of -2.0 ± 0.3 at 3794 Ma for Mount Sones, whereas Gage Ridge exhibits a μ^{142}Nd of -12.1 ± 6.2 and a disturbed ^{147}Sm-^{143}Nd systematics. Taken altogether our results indicate that the oldest granitoids of the Napier Complex formed by reworking of 4456-4356 Ma mafic protocrust(s). Our inferred petrogenesis is similar to what has been proposed for other Eoarchean terranes worldwide (e.g., Itsaq Gneiss Complex, the Acasta Gneiss Complex, the Nuvvuagittuq Supracrustal Belt, and the North China craton). We propose that Hadean protocrusts were massively reworked in the Eoarchean to form cratons which, in

turn, would account for both the absence of Hadean crust in the geological record and its little influence throughout the Archean despite crustal growth models proposing that ≤ 25% of present-day volume of continental crust was formed by the end of the Hadean.