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Large Oxygen and hafnium isotopic variations in zircon from the Saglek Block (North Atlantic Craton) document reworking of mature supracrustal rocks as early as 3.5 Ga

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The most ancient rocks in the geological record provide insights into the processes that shaped the evolution and composition of the first continental masses. Due to both the scarcity and the polymetamorphic history of exposed Eoarchean (>3.5 Ga) crust, the study of early geodynamic processes is very challenging and most of our knowledge has been learned from only a few localities on Earth.

The present study focuses on felsic meta-igneous rock from the Saglek Block (North Atlantic Craton), a locality where recent zircon U-Pb dating studies indicate earliest crust formation in the Eoarchean (Komiya et al., 2017; Sałacińska et al., 2018; Vezinet et al., 2018). We performed in situ oxygen isotopes measurement (SIMS analyses) in zircon grains that have been carefully selected from CL-imaging for the good preservation of their internal structure and for their pristine composition in rare Earth element. We then performed U-Pb/Hf isotopes by laser ablation split stream (LASS)-ICP-MS. The results indicate 3 distinct crystallization events: (1) an Eoarchean event at ca 3.86 Ga; (2) an early Paleoarchean metamorphic event at ca. 3.5 Ga, and (3) a Neoarchean event (ca. 2.7-2.8 Ga) with zircon domains showing complex zoned overgrowths. While the 3.86 Ga magmatic domains display mantle-like δ18O(+4.9±0.2‰ to +6.8.0±0.2‰, n=30), large O-isotope fractionation (δ18Ovalues up to +9‰) characterise the Paleoarchean metamorphic event. Such elevated δ18O signatures provide unequivocal evidence for hydrosphere–crust interactions and reworking processes resulting in metamorphic zircon growth at ca. 3.5 Ga, namely 1 Ga before the Archean-Proterozoic transition (Vezinet et al., 2019).

Interestingly, the two oldest age groups have chondritic to sub-chondritic εHfi values: +1.0 ± 2.2 to –5.5 ± 1.8 whereas large variations in Hf isotope composition (εHfi value from –11.2 ± 2.5 to –20.3 ± 1.5) are found in the 2.8–2.7 Ga zircon domains. Such intra-sample heterogeneities implies a significant perturbation of Hf-isotope composition during metamorphic events related to mixing of fluid with inherited (older) Hf isotope source. In the light of these results, we will discuss the potential consequences of isotope perturbation on whole-rock isochrones interpretation.

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