Triple oxygen isotope compositions of >3.81 Ga ultramafic rocks

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The highly siderophile element contents of the silicate Earth are best explained by <2% of Earth's mass accreting after equilibration with the core was possible [1]. Potentially, this late accretion process delivered materials with a different oxygen isotope composition than that of the terrestrial mantle at the time (e.g., [2]). Tungsten isotope systematics suggest that parts of the early Archean crust formed from mantle domains that were deprived of late accreted materials (e.g., [3]). Here, we present triple oxygen isotope data of mineral separates of dunite samples from the >3.81 Ga Ujaragssuit Nunât layered intrusion (SW Greenland) [4] in order to investigate whether an isotopically distinct signature of the pre-late veneer mantle is also present for oxygen. Oxygen was extracted from mineral grains by means of laser-induced fluorination using BrF_5 as the reagent, and was purified and analysed following the protocols in [5]. Olivine from the San Carlos peridotite was measured for reference and yielded stable results of $\delta^{18}O$ = 5.16 ±0.19 relative to VSMOW and $\Delta'^{17}O$ = -104 ±3 ppm. $\Delta'^{17}O$ represents the deviation from a given reference line (RL) in $\delta'^{17}O$ vs. $\delta'^{18}O$ space, and is reported here relative to a RL with slope λ = 0.5305 with zero intercept [5]. Oxygen isotope thermometry indicates equilibration temperatures of ~800°C for olivine and orthopyroxene mineral pairs. Olivine fractions yield $\Delta'^{17}O_{Ol}$ = -92 ±6, i.e. higher than $\Delta'^{17}O_{Ol}$ in the Phanerozoic mantle (-101 ±3 ppm [5]). The $\delta^{18}O_{ol}$ values of the layered intrusion vary between 4.69‰ and 5.14‰ and are on average slightly lower than $\delta^{18}O_{ol}$ in the Phanerozoic mantle (5.2 ±2‰), in agreement with [6]. We show that the combination of $\delta^{18}O_{ol}$ and $\Delta'^{17}O_{ol}$ variations cannot be explained by the absence of a late veneer component in the Ujaragssuit Nunât mantle source, but are well explained by a petrogenetic scenario in which a mantle source with oxygen isotope compositions similar to the Phanerozoic mantle incorporated hydrothermally altered lithosphere. This tentatively suggests that the primordial mantle source of the Ujaragssuit Nunât intrusion had indistinguishable $\Delta'^{17}O$ from the Phanerozoic mantle at the level of <5 ppm.

[1] Chou et al. *LPSC* 1978 **9** 219-230 [2] Herwartz et al. 2014 *Science* **344** 1146-1150 [3] Willbold et al. 2015 *EPSL* in press [4] Rollinson et al. 2002 *JPET* **43** 2143-2170 [5] Pack and Herwartz, *EPSL* 2014 **390** 138-145 [6] Lowry et al. 2003 *Prec R* **126** 273-288