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Oxygen Isotope ($\delta^{18}O$, $\Delta'^{17}O$) insights into subcontinental mantle evolution since the Archean

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Major changes in crustal evolution occur in the late Archean and around 2.5-2.0 Ga, reflected in $\delta^{18}O$ and $\Delta'^{17}O$ of shales and granites [1] and a multitude of other geochemical proxies, many of which are linked to initiation of plate tectonics. We here present high-precision laser fluorination analysis of oxygen isotopic composition ($\delta^{18}O$, $\Delta'^{17}O$) of olivine and other minerals in 71 peridotite mantle xenoliths from cratonic to off-cratonic settings on four continents and in modern oceanic subduction zones. Ages were constrained by modeling of melt extraction in Re-Os and Sm-Nd systems and formation ages of the host continental lithosphere. We observe a subtle but systematic trend in $\delta^{18}O$ olivine values from 5.351±0.097‰ (>2.5Ga, 2s, n=9), 5.220±0.111‰ (2.1-2.0 Ga, n=40), 5.213±0.109‰ (1.8Ga, n=15), 5.168±0.088‰ (0-0.8Ga, n=7). Estimated bulk-rock compositions define a similar trend. Archean olivines have $\Delta'^{17}O_{0.5305}$ of -0.047±0.011‰ (n=9), post Archean $\Delta'^{17}O_{0.5305}$ are -0.051±0.010‰ (n=12) overlapping within error of the San Carlos olivine standard. When plotted vs age, a similar $\delta^{18}O$ trend is recognized in a previously published dataset of Mattey et al. (1994). Changes in age designation of some xenoliths from model melt extraction age to the age of the lithosphere do not change the trend. This subtle 0.10-0.15‰ temporal decrease in $\delta^{18}O$ from the oldest to the youngest groups is explained by initiation and subsequent intensification of the modern-style plate tectonics, whereby continental mantle is made, at least partly, of accreted melting residues generated or transformed in mantle wedges above subduction zones, fluxed by low-$\delta^{18}O$ fluids from subducting slabs. We present the estimate for the pre-subduction Bulk Silicate Earth as $\delta^{18}O$ of 5.38‰ for olivine and 5.58‰ for bulk peridotite.

[1] Bindeman IN (2021) RiMG 86, 241-290.