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A model of unidirectional and accumulative fluxes from mantle to the lithosphere explaining crustal growth via triple oxygen isotope mass balance throughout Earth's history

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We here propose a model of a global mass balance of crustal recycling and growth based on the temporal variations of D'^{17}O and d^{18}O in an attempt to explain temporal d^{18}O increase of the hydrosphere recorded by multiple sedimentary proxies (shales, cherts, and carbonates) with decreasing age. We have recently reported on a coeval 0.2‰ d^{18}O decrease of continental mantle peridotite from the primary Earth-Moon value of 5.57‰ [1] from mid-Archean to Phanerozoic attributed to the initiation of surface recycling sometime in the Archean linked to plate tectonics initiation or its style. This is balanced by a trend in shales and granites that show d^{18}O increase through time, and a stepwise decrease in D'^{17}O, at around 2.4 Ga. We present new analyses of shales and granites that further support and resolve these observations. The trend is explained by emergence of land and initiation of subaerial oxidative weathering (generating high-d^{18}O, low-D'^{17}O products) in the mid-Archean [2-3]. In our model, high-d^{18}O sediments are progressively accreted into the growing continental crust, while low-d^{18}O peridotitic interiors of imbricating and subducting slabs are accreted under continental lithosphere on Ga-timescales [1], creating a positive d^{18}O flux to the surface measuring 4‰ over 2 Ga. Flux can be made larger if low-d^{18}O slabs are additionally lost into convecting mantle, after delivering their high-d^{18}O tops (sediments, basaltic pillows) to the growing crust. We construct a series of mass balance simulations and demonstrate that a 0.5-3‰ increase in ocean d^{18}O values is possible due to these processes. Including the change in the processes observed in continental granites around 1 Ga may then account for even as much as 10‰ increase in seawater d^{18}O from the pre-1Ga Earth. Furthermore, using triple oxygen isotope systematics, we suggest that isotopically negative ocean (-5‰ or lower, [3]) does not conflict with previously held global mass-balance of high-temperature hydrothermal vs weathering fluxes, due in part to a planet with plate tectonics and decoupling of water-rock interaction at mid-ocean ridges.

[1]Bindeman et al. (2022) *Nat Comm* 13, 3779; [2]Bayon et al. 2022. *EPSL*, 584, 117490; [3]Kanzaki and Bindeman (2022) *Chem Geol* 604, 120944