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Geodynamic investigation of the processes that control Lu-Hf isotopic differences between different mantle domains and the crust

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The chemical and isotopic composition of both the Earth's mantle and the continental crust are greatly influenced by subduction zone processes, such as the formation of continental crust through arc volcanism and the recycling of surface material into the deep mantle. Here we use a combined geodynamical-geochemical approach to investigate the long term role of subduction on the Lu-Hf isotopic evolution of the mantle and the continental crust.

We apply the geodynamic model developed by Brandenburg et al., 2008. This model satisfies the geophysical constraints of oceanic heat flow and average plate velocities, as well as geochemical observations such as ^{40}Ar in the atmosphere, and reproduces the geochemical distributions observed in multiple isotope systems which define the HIMU, MORB and EM1 mantle endmembers. We extend this application to investigate the detail of terrestrial Lu-Hf isotope distribution and evolution, and specifically to investigate the role of sediment recycling in the generation of EM2 mantle compositions. The model has been updated to produce higher resolution results and to include a self-consistent reorganisation of the plates with regions of up-/down-wellings. The model assumes that subduction is initiated at 4.5 Ga and that a transition from 'dry' to 'wet' subduction occurred at 2.5 Ga. The modelling suggests that the epsilon Hf evolution of the upper mantle can be generated through the extraction and recycling of the oceanic crust, and that the formation of continental crust plays a lesser role. Our future intention is to utilise the model presented here to investigate the differences observed in the noble gas compositions (e.g., ^{40}Ar/^{36}Ar, ^{3}He/^{4}He) of MORB and OIB.

Brandenburg, J.P., Hauri, E.H., van Keken, P.E., Ballentine, C.J., 2008. Earth and Planetary Science Letters 276, 1-13.