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IMPLICATIONS OF SUBDUCTION REHYDRATION FOR EARTH'S DEEP WATER CYCLE

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The Earth's global geochemical water cycle is controlled by two major competing processes: water outgassing at mid-ocean ridges and hotspots and the potential re-injection of surface water into the mantle at subduction zones. The substantial uncertainty in this water cycle is the amount of water that is recycled at subduction zones. It is now generally accepted that some of the more enriched mantle components (HIMU&EM) have formed by the recycling of sediments and crustal material. One way to determine the amount of water that is recycled back into the mantle is, therefore, to measure the volatile contents of these recycling associated mantle components as sampled in OIB and MORB. Dixon et al. (2002) has recently taken this approach and finds that slabs most likely efficiently dehydrate during subduction and that the most primitive (FOZO) mantle components are significantly wetter than the recycling associated EM or HIMU mantle components and the even drier depleted mantle source that melts to form MORB. Dixon et al.'s conclusions on slab-dehydration are in striking agreement with our recent conclusions from numerical modelling of slab dehydration beneath modern and paleo-subduction zones when coupled to a parameterised whole mantle convection model. Based on these numerical experiments we present here a mantle evolution scenario in which the oceans have formed by water outgassing from the mantle but in which the Earth's surface and deep water cycle are still in close contact through mantle rehydration by plate subduction. In this scenario, the present day Earth is characterized by a mantle that has been largely, but not completely outgassed (∼93%). Due to slab recycling, it contains about ∼25% of the exosphere's water content and ∼20% of its initial water content, of which ∼2/3 has been recycled back from the exosphere. These numbers are in close agreement with

the results of Dixon et al. in that we find similar water concentrations for wet primitive mantle and much drier recycled slabs. It seems, therefore, completely consistent that hotspots with a FOZO-component in their source will make wetter basalts than hotspots whose mantle sources contain a larger fraction of EM and HIMU components, and also consistent that progressive melting beneath a mid-ocean ridge should eventually be able to ’dehydrate’ the mantle, so that the MORB source is even drier. Thus these results are consistent with a plum-pudding whole mantle convection evolution scenario in which plate subduction plays an important role in partially filtering the water content of the recycled sediments and crust that form the sources of the more enriched mantle plums.