H isotopes of Manus Basin glasses: a unique perspective on mantle plumes and recycling processes

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The Manus back-arc basin is a complex region where erupted lavas show superimposed plume, MORB and subduction-related components. He isotope studies of submarine glasses [1] show high $^3He/^4He$ ratios (up to $15R_A$) consistent with derivation from a lower mantle plume, thought to originate at the core-mantle boundary. Subsequent work [2] found anomalously low $\delta^{18}O$ values in the high $^3He/^4He$ samples, reflecting either a unique deep mantle component or the involvement of an ancient recycled slab component with the Manus plume. Here we report new hydrogen isotope, volatile and trace element data obtained using SIMS techniques on the same suite of glasses.

δD values of Manus glasses span a wide range – from high arc-like values (-33‰) to values as low as -126‰, significantly lower than typical MORB values (-70 ± 10‰) [3]. δD values show a striking correlation with water contents, whereby the highest water content samples (up to 1.6 wt%) have high δD values, consistent with prior studies investigating subduction-related waters preserved in melt inclusions and glasses [4-5]. The low water content samples (down to 0.09 wt%) have exceptionally low δD values. One explanation for this observation is magmatic degassing [6]; however, the lowest δD samples also have the highest CO_2 contents and CO_2/Nb ratios. We argue that the low δD values reflect a unique source component, rather than degassing processes. Intriguingly, the low δD samples have the highest $^3He/^4He$ values, and thus a dry, low δD source would characterize the source region of the Manus plume. Alternatively, if the low δD values are the result of an ancient recycled slab component entrained by the Manus plume, as suggested by the corresponding low $\delta^{18}O$ values, then this would imply that fractionations associated with the subduction process have the potential to modify the H isotope ratio of the Earth's mantle.

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[2] Macpherson et al. (2000) *EPSL* **176** 171-183
[3] Craig and Lupton (1976) *EPSL* **31** 369-385
[4] Shaw et al., (2005) Goldschmidt abstract
[5] Poreda (1985) *EPSL* **73** 244-254
[6] Kyser and O'Neil, *GCA* (1984) **48** 2123-2133