Recycling volatiles into the mantle

C.J. BALLENTINE

Deptarment of Earth Sciences, University of Oxford, UK
(chris.ballentine@earth.ox.ac.uk)

That volatiles are recycling into the mantle via subduction is not news, but estimates of their flux remain unresolved. One reason is because the uncertainties in both the volatile flux into subduction zone systems and a surface return flux of similar magnitude result in an uncertainty in the residual that is too large for a useful flux into the deep mantle to be unambiguously derived.

A promising approach to resolve this issue is through the use of noble gases [1]. It is becoming clear that the mantle originated with both light and heavy noble gas isotopic composition similar to that found trapped within carbonaceous chondrites [2,3]. The isotopic composition of the atmosphere is quite different and we can identify the impact of subducting surface volatiles into the mantle by determination of the mantle light, shielded, isotopes of xenon ($^{124,126,128}Xe/^{130}Xe$).

Results from well gases and MORB show an 80-90% contribution of recycled xenon to the mantle source [3,4], and the impact of a recycled volatile component is now being resolved in MORB using other noble gas isotopic systems such as $^{40}Ar/^{36}Ar$ [5]. With mantle noble gas concentration estimates the total recycled Ar and Xe amount can be determined to and compared with the recent re-determination of noble gas (and halogen) flux into subduction zones [6] to estimate subduction efficiency. Linking the noble gas subduction residue to other volatiles remains a challenge but the halogens provide many similar characteristics and may yet provide that link [7,8,9,10].

[1] Holland *et al.*, *Nature* 2005; [2] Ballentine *et al.*, *Nature*, 2005; [3] Holland *et al.*, *Science* 2009; [4] Parai and Mukhopadhyay , *G^3* 2015; [5] Parai *et al.*, *EPSL* 2012; [6] Chavrit *et al.*, *GCA* submitted [7] Ruzie-Hamilton *et al.*, *Goldschmidt* 2016; [8] Sumino *et al.*, *Goldschmidt* 2016; [9] Kobayashi *et al.*, *Goldschmidt* 2016; [10] Broadley *et al.*, *Goldschmidt* 2016