Halogens and water in MORB and OIB and the origin of HIMU

MARK A. KENDRICK[1]*, HÉMOND C.[2], KAMENETSKY V.S.[3], DANYUSHEVSKY L.[3], DEVEY C.W.[4], RODEMANN T.[3], JACKSON M.G.[5], PERFIT M.R.[6]

1 – RSES, Australian National University, Australia.
*correspondence: mark.kendrick@anu.edu.au
2 – Laboratoire Géosciences Océan, IUEM-UBO, France.
3 – University of Tasmania, Australia.
4 – GEOMAR, 24148 Kiel, Germany.
5 – University of California Santa Barbara, USA.
6 – University of Florida, USA.

The heavy halogens (Cl, Br, I) are strongly incompatible volatile elements that are concentrated in Earth's surface reservoir. They are strongly fractionated from each other in the surface reservoirs and in subduction zones by the affinity of Br + I for organic matter and the preferential incorporation of Cl^- into some hydrous minerals. However, Cl, Br and I have indistinguishable incompatibilities in the Earth's mantle, meaning they serve as sensitive geochemical tracers that are not fractionated by magmatic processes [1].

We investigated the F, Cl, Br, I and H_2O content of OIB and MORB glasses sampling all the mantles major end-member reservoirs including EM1, EM2, HIMU, DMM and FOZO. Samples affected by local contamination with seawater-derived halogens are excluded based on correlations between Cl, Br, H_2O and K and those that have elevated Br/Cl and low K/Cl ratios characteristic of hydrothermal brines. Samples that pass this filter have narrow ranges of Br/Cl (0.0028 ± 0.0008) and I/Cl (0.00006 ± 0.00003), that are considered representative of the mantle and indicate that halogens have a similar origin in all the major mantle reservoirs investigated. The median I/Cl of the mantle ~0.00006 is significantly lower than the calculated primitive mantle value of 0.00027 ± 0.00012. The data also show that HIMU influenced glasses have some of the highest Cl/K, F/Pr and H_2O/Ce ratios of any mantle reservoir investigated.

These findings can be explained if surface-derived halogens and water introduced by subduction have completely overwhelmed primordial components in Earth's mantle. The apparent water and halogen enrichment of some HIMU reservoirs, which are depleted in other fluid mobile elements and have high Nb/U and Ce/Pb, can be explained if halogens and water are introduced into the mantle in serpentinised lithospheric mantle associated with dehydrated oceanic crust [1].

[1] Kendrick et al. 2017. Nature Geoscence 10, 222-228.