Lithospheric serpentinites dominate the global halogen cycle

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In order to better understand the global halogen cycle between Earth's surface reservoirs and mantle we investigated the relative abundances of F, Cl, Br and I in arc and backarc lavas and compared them with other mantle outputs and subduction zone inputs including sedimentary pore waters, sediments, altered ocean crust and serpentinites.

Arc and backarc lavas in the SW Pacific (Manus, Woodlark, Lau, Tonga, Hunter Ridge, N Fiji Basin) have been derived from sources enriched by similar slab-fluids with F/Cl of ~0.1, Br/Cl of ~0.0028 and I/Cl of 0.0001-0.001. The F/Cl ratio is much higher than seawater reflecting enhanced mobility of F in aqueous fluids at sub-arc depths. The Br/Cl ratios are uniformly lower than than sedimentary pore waters, sediments and forearc serpentinites and encompass a range identical to altered ocean crust, lithospheric serpentinites and MORB/OIB. The I/Cl ratios encompass a narrower range than altered ocean crust and lithospheric serpentinites and a wider range than MORB/OIB, but the median values are all similar.

Halogen fluxes between the Earth's surface reservoirs and mantle are estimated to explain the observed halogen relative abundance ratios and comply with existing flux constraints. The model developed suggests forearc fluxes of halogens are larger than previously estimated (with an upper limit for Cl equivalent to the arc flux) and halogens are significantly subducted into the deep mantle in oceanic crust and lithospheric serpentinites. Preferential subduction of Cl relative to I over Earth's history has reduced the I/Cl ratio of the mantle from a Primitive ratio of ~0.00027 to the modern value of ~0.00006. Our data repudiate previous suggestions that halogens and noble gases might be deeply subducted in sedimentary pore waters and do not favour forearc serpentinites as significant reservoirs for subduction of volatiles to arc depths or beyond. Instead, the subducted volatile budget to arcs and the deeper mantle is dominated by incompletely dehydrated altered ocean crust and lithospheric serpentinites, with lithosperic serpentinites likely dominant[1].

1 - Kendrick et al (2020). EPSL 530: 115921