Process of volatile addition to Earth revealed by halogens in chondrites

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Understanding the mechanisms by which volatiles were delivered to the terrestrial planets can provide fundamental constraints on accretionary processes important to early Earth evolution. Chlorine, Br and I, the heavy halogens, act as tracers of these processes due to their high incompatibility and fluid mobility. Here, we redefine the relative and absolute abundances of halogens in primitive chondritic meteorites using the high-sensitivity noble gas proxy isotopes of $^{38}Ar_{Cl}$, $^{80,82}Kr_{Br}$ and $^{128}Xe_{I}$[1]. We find that Br/Cl and I/Cl in all chondrites (carbonaceous, enstatite, Rumuruti and primitive ordinary) are characterised by a very limited range and are indistinguishable from current bulk silicate earth (BSE) halogen estimates. These meteorites also show similar halogen abundances that are ~6, ~9 and between 15-37 times lower than previously reported estimates[2] for Cl, Br and I, respectively. This new dataset now negates the need for Earth to have preferentially lost its halogens compared with elements of similar volatility. The lower abundances of Cl, Br and I also now suggest that late accretion of carbonaceous chondrite material alone cannot account for present-day terrestrial volatile inventories[3,4]. Futhermore, an estimated ~90% of BSE halogens reside in Earth's exosphere[5]. This requires early and efficient extraction of halogens to terrestrial surface reservoirs. We suggest that one means to accomplish this is the high solubility of halogens in aqueous fluids[6], a solution that is fully consistent with recent observations of a more volatile rich late-stage terrestrial accretion[3].

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