A cosmochemical perspective on Earth's volatile element budget

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All known inner solar system bodies are depleted in volatile elements relative to CI chondrites, which provide a reference composition for the solar system. The chemical composition of the bulk silicate Earth (BSE) suggests that Earth exhibits a similar volatile element depletion pattern as carbonaceous chondrites (CC) [1]. However, Earth's volatile element depletion pattern is obscured by core formation and there are several problems with a CC-like depletion pattern, as the overabundance of In in the BSE [2,3,4].

We have recently shown that CC display a hockey stick volatile element depletion pattern [5], where volatile elements with 50% T_C between 800 and 500 K (the "plateau volatile elements") are unfractionated from each other. Chondritic ratios of Zn, In and the halogens (Cl, I and Br) in the BSE [4,6] now indicate that Earth also exhibits a hockey stick volatile element depletion pattern [7], in contrast to the long-standing paradigm of ever increasing depletion with elemental volatility. This revised volatile element pattern explains the apparent overabundance of In in the BSE without the need of exotic building materials [2] or vaporization from precursors or during the Moon-forming giant impact [3]. Assuming overall lithophile behavior for Zn and In, we can provide better estimates on plateau volatile element abundances in Earth's core and bulk Earth.

The relative abundances of Zn and In in the BSE suggest the accretion of 10-15 wt.% CI-like material before core formation ceased. However, accretion of a substantial CC component is in contrast to Earth's mass-independent isotope composition which is most similar to enstatite chondrites (EC) [8]. Suitable terrestrial building materials are therefore possibly characterized by EC-like mass-independent isotope composition but a more primitive CC-like hockey stick volatile element depletion pattern.

[1] Allègre et al. (2001) *EPSL* **185**, 49-69. [2] Wang et al. (2016) *EPSL* **435**, 136-146. [3] Norris and Wood (2017) *Nature* **549**, 507-510. [4] Witt-Eickschen et al. (2009) *GCA* **73,** 1755-1778. [5] Braukmüller et al. (2018) *GCA* **239**, 17-48. [6] Clay et al. (2017) *Nature* **551**, 614-61. [7] Braukmüller et al. (in review) *Nature Geosc.* [8] Dauphas (2017) *Nature* **541**, 521-524.