Halogens as key tracers of volatile evolution in the terrestrial planets

P.L.CLAY[1*], R. BURGESS[1], H. BUSEMANN[2], L. RUZIÈ-HAMILTON[1], B. JOACHIM[3], J.M.D. DAY[4], I.C. LYON[1], A. J. KING[5], S.S. RUSSELL[5], P. F. SCHOFIELD[5], C. J. BALLENTINE[6]

[1]School of Earth & Environ. Science, Univ. of Manchester, UK (correspondence: patricia.clay@manchester.ac.uk)
[2]Inst. Geochemistry & Petrology, ETH, Zürich, Switzerland
[3] Faculty of Geo- and Atmos. Sci., Univ. of Innsbruck, Innsbruck, Austria
[4] Scripps Institution of Oceanography, Univ. of Californa, San Diego, California, USA
[5] Dept. of Earth Sciences, Natural History Museum, UK
[6] Dept. of Earth Sciences, Univ. of Oxford, Oxford, UK

The mechanism(s) and timing of volatile (e.g., H, C, N, noble gases, and halogens) delivery to the terrestrial planets are key to understanding Earth's early evolution, yet are difficult to precisely determine. The heavy halogens, Cl, Br and I, are both moderately-to-highly volatile and incompatible, so their distribution is influenced by the physical and chemical processes that drive planetary evolution. These factors make the heavy halogens valuable tracers of volatile-addition, -loss and -transport processes.

The fate of halogens during accretion has traditionally been difficult to account for because of their extreme depletion in bulk silicate earth (BSE) relative to CI chondrite, requiring a mechanism to preferentially extract halogens from Earth without affecting other lithophile elements of similar volatility. However, recent work [1] redefined halogen abundances in chondrite meteorites, demonstrating that Br/Cl and I/Cl are characterised by a limited range that is also indistinguishable from current BSE estimates. Lower absolute abundances of Cl, Br and I also negates the need for halogen-specific loss and sheds light on mechanisms of volatile delivery. Specifically, that late accretion of carbonaceous chondrite material alone cannot account for estimates of present day terrestrial volatile inventories [2, 3]. The implications of these results will be discussed along with new measurements from two CI chondrites, Orgueil and Ivuna and two metamorphosed 'CI-like' chondrites (Y-82162 and Y-980115) [4], within the context of halogen delivery and distribution during accretionary processes and subsequent sequestration in terrestrial surface reservoirs.

References: [1] Clay et al., *Nature,* 551, 614-618, (2017) [2] Marty, B., *EPSL*, 313–314, 56–66 (2012). [3] Wang, Z. & Becker. *Nature* 499, 328–331 (2013). [4] King et al., *Geochim. Cosmochim. Acta*, 165, 148-160, (2015).