The University of Oxford Department of Earth Sciences

EARTHSCIENCES

UNIVERSITY OF OXFORD

Volatile loss and gain from planetesimals during early solar system melting events

Supervisory Team	• **Prof B. Wood** www.earth.ox.ac.uk/people/bernie-wood • **Prof T. Mather** www.earth.ox.ac.uk/people/mather

Overview

The terrestrial planets and the moon are all depleted in moderately volatile elements relative to the sun and the volatile rich primitive CI chondrite meteorites from the asteroid belt. These depletions are conventionally explained by assuming that all inner solar system bodies are mixtures of varying proportions of volatile-rich (CI-chondrite-like) and volatile-poor materials. The result is a general depletion trend reflecting the volatility of the element. Note that volatility in this context is correlated with the temperature at which the element would condense from a solar gas with elements condensing at low temperatures being most volatile.

Depletions below the rough trend are generally assumed to be due to partitioning of "siderophile" elements into the core (Fig 1).

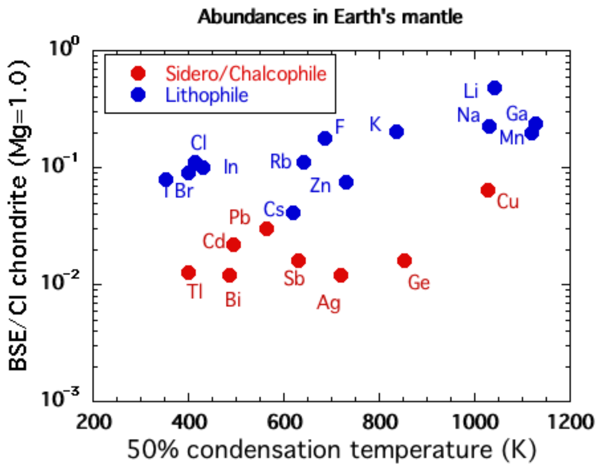

Figure 1

A recent D.Phil student in Oxford (Ashley Norris) has questioned the conventional interpretation by showing that abundances in the Earth correlate extremely well with measured volatilities from molten silicate liquid. This has led to the idea that Earth and other planets lost their volatile elements by vaporisation either on precursor bodies or during the Moon-forming giant impact (Norris and Wood 2017) (see Fig. 2) and that these elements were not accreted in the "conventional" way.

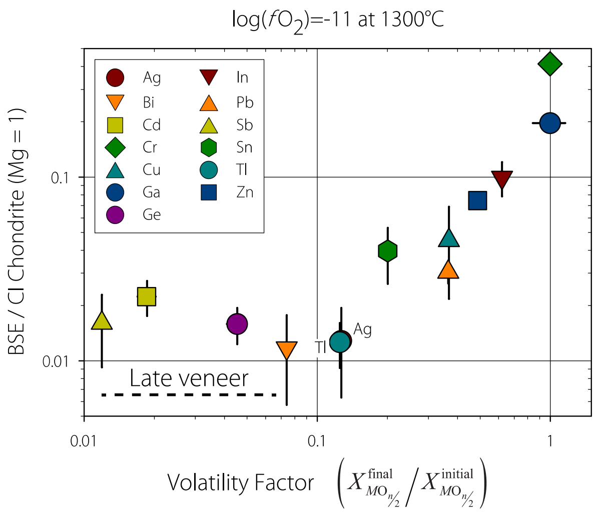

Figure 2

The principal question surrounding the experiments completed by Ashley Norris is that, although they employed known low oxygen pressures, the gases in the experiments did not contain hydrogen. In the early solar nebula hydrogen was by far the dominant gas and volatilities of many elements, e.g., Cl and S should be very sensitive to the presence of hydrogen. This project will therefore use our newly-established hydrogen source to investigate element volatilities under more realistic early solar system conditions. The project will involve performing experiments at controlled conditions at high temperatures for relatively short times (typically 60-180 mins) then performing in-situ analyses (by electron microprobe and Laser-Ablation ICP-MS) of the product melts/glasses. By varying the hydrogen partial pressure we will be able to simulate the highly reducing conditions in the solar nebula and test the hypothesis of volatile loss from precursor bodies under reducing conditions. An interesting “add-on” is that many of the data will also find more general applicability in studies of volcanic degassing on Earth, especially on the early planet before the oxygenation of the atmosphere – a critical period in Earth’s evolution (Martin et al., 2007).

References & Further Reading

Norris, C. A. and B. J. Wood (2017). "Earth's volatile contents established by melting and vaporization". Nature 549(7673): 507-+.

R.S. Martin, T.A. Mather and D.M. Pyle, Volcanic Emissions and the Early Earth Atmosphere, Geochimica et Cosmochimica Acta, 71, 3673-3685, 2007. (doi:10.1016/j.gca.2007.04.035)

Further Information

Contact: Bernie Wood (bernie.wood@earth.ox.ac.uk).