The Origin of Earth's Volatiles – New Constraints from Isotopic Analyses of Meteorites

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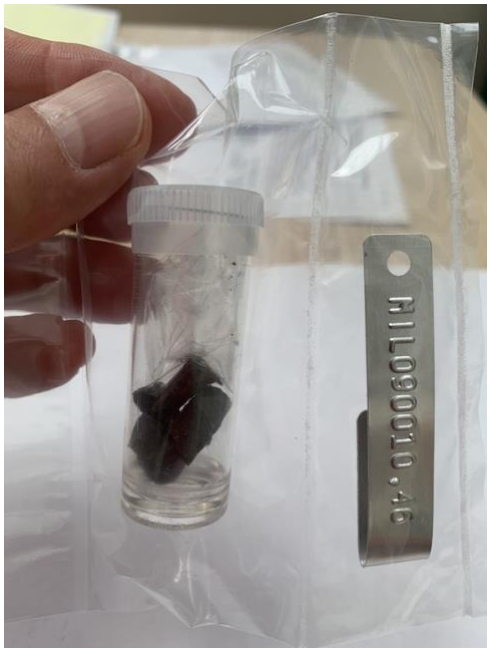
When the initially hot protoplanetary disk cooled, refractory metals and metal oxides condensed first, followed by Fe metal and Mg silicates, whereby the latter are the main building blocks of Earth and the other terrestrial planets. For these elements, all solar system bodies have *relative* abundances that are similar to the bulk Solar System, as represented by the Sun and CI carbonaceous chondrites, a group of primitive meteorites. A different picture emerges for the volatile constituents, some of which (like water) are essential for planetary habitability. Volatile elements and compounds condensed late and, relative to CIs, all other meteorites are variably depleted in these constituents. This depletion was subsequently inherited by the terrestrial planets, where it is best characterized for Earth but has also been confirmed for the Moon, Mars and Mercury. A key question concerns the origin of the building blocks which contributed to Earth's volatile budget, as this guides our basic understanding of how habitable planets are formed. In particular, were Earth's volatiles sourced from inner Solar System materials or were they provided by asteroids with 'stray' orbits that originated from the more volatile-rich outer Solar System?

To obtain new constraints on the origin of Earth's volatile inventory, the project involves analyses of meteorites to determine variations in both mass-dependent and mass-independent isotope compositions of volatile elements, including zinc, cadmium, tellurium, and thallium, for various meteorite types and meteorite constituents (such as CAI's and chondrules), as well as terrestrial rocks. Samples from the Moon and Mars are also slated for analysis, to investigate the volatile sources for these bodies.

To address this goal, the project involves significant hands-on analytical research in the MAGIC Laboratories at the Department of Earth Science & Engineering of Imperial College London (see http://www.imperial.ac.uk/earth-science/research/research-groups/magic/). This includes sample preparation in the clean room facilities and high-precision isotope analyses with one of our three isotope ratio mass spectrometers.



The project is suitable for a student with a background in geology, chemistry and planetary science, or equivalent experience. Further information about the project can be obtained directly from Mark Rehkamper at markrehk@imperial.ac.uk.

The picture shows a meteorite sample from Antarctica (the CO3 chondrite MIL 090010) that is curated by NASA at the Johnson Space Center in Houston. This and other meteorite samples from NASA, various museums (e.g., the NHM) and private collectors will be analysed in the current project.