Tracing the Origin of Volatiles for the Earth, Moon and Mars – New Constraints from Isotopic Analyses of Meteorites

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Volatiles are elements or compounds that are gaseous at relatively low temperatures. They include the six most common elements found in living organisms, as well as water. As such, volatiles are a key ingredient for the emergence of life.

A research topic of high current interest in planetary sciences is the origin of the building blocks that provided volatile constituents to the terrestrial planets, including the Earth. Such information is important as it guides our understanding of how habitable planets are formed. Important specific questions are:

– Were Earth's and Mars' volatiles sourced from inner Solar System materials or were asteroids with 'stray' orbits that originated from the more volatile-rich outer Solar System a necessary source?
– Do the Earth and Moon have the same source(s) of volatiles?
– To what extent did the terrestrial planets obtain their volatiles from evolved and differentiated asteroids rather than primitive undifferentiated chondritic matter?

To address these questions, the project involves analyses of meteorites, and samples from Moon and Mars, to determine variations in both mass-dependent and mass-independent isotope compositions of volatile trace elements, including zinc, cadmium, tellurium, and thallium.

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, museums (e.g., the NHM) and private collectors will be analysed in the current project.

An additional question of interest is the distribution of volatiles in the primitive chondritic meteorites that may be the key source of volatiles for the terrestrial plants. This issue can be addressed by additional analyses of chondrite constituents, in particular the fine-grained matrix and chondrules.

Given its goals, 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 our three isotope ratio mass spectrometers.

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