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Evidence for recent water on Mars from the shergottite meteorites: Geological, palaoclimatological and astrobiological implications

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Introduction & context: The shergottite meteorites are igneous rocks that sample the relatively young (150–475 Ma) crust of Mars, and so provide unique and very valuable insights into the planet's geological evolution. One of the most important questions in Martian geology and astrobiology is how recently liquid water was present at or near to the planet's surface, and the shergottites may help answer this question. To date, mineralogical studies on these meteorites have been inconclusive – traces of phyllosilicates and carbonates have been found, but unambiguously attributing them to pre-terrestrial aqueous activity has proven difficult. By contrast, analysis of the ratio of deuterium to hydrogen (D/H) in apatite and glass reveal the presence of water with very high D/H values. This water could be derived from the Martian atmosphere, which is currently highly enriched in deuterium owing to loss of hydrogen to space, or could have been present within the shergottite parent melt. In the latter case the water could have been sourced by the assimilation of crustal materials, which had themselves interacted with the Martian atmosphere. Therefore, the extent to which shergottites record the presence of groundwater within the shallow crust of Mars currently remains unknown.

Aims: This project aims to definitively answer the question of whether the shergottites provide evidence for liquid water in the Martian crust by combining petrological, mineralogical and isotopic tools. Initial work will focus on those meteorites that are known to contain secondary minerals. These phases will be located by electron microscopy, then characterised further by a suite of techniques including electron backscatter diffraction, laser Raman spectroscopy and transmission electron microscopy. Such observations may provide clear evidence for the provenance of these minerals (i.e., Martian or terrestrial), but it is likely the conclusive answers will come only from D/H analysis by NanoSIMS. The outcomes of this project will be a new understanding of the history of water late in the geological evolution of the Martian crust that will feed directly into current and future efforts to produce an integrated understanding of the evolution of the atmosphere, lithosphere, and potentially also the biosphere of Mars.

Application procedure: There are two routes to apply for this PhD project.

Applicants for a College of Science and Engineering Scholarship (available to UK, EU and International students) should submit the following five items to Leenah Khan (leenah.khan@glasgow.ac.uk) by 5pm (Glasgow time), Thursday 31st January, 2019:

(1) a Research Proposal of maximum 750 words (in Word, not PDF) comprising title, proposed supervisor(s), aims and objectives, research context, research methodology, and bibliography;
(2) a two-page CV;
(3) a specimen of academic writing (such as a coursework essay) of no more than 3000 words;
(4) academic transcripts (only using the pages with course marks noted).
(5) Applicants should also ask two referees to send a reference letter to Leenah Khan (leenah.khan@glasgow.ac.uk).

If you have your own funding, please apply via the website of the College of Science and Engineering*. The application deadline is 31 January 2019. Please contact the principal supervisor with any questions (Martin.Lee@Glasgow.ac.uk).

*https://www.gla.ac.uk/schools/ges/researchandimpact/postgraduate/#/applyingtoundertakeaphdingeographicalandearthsciences