Delivery of water to early Earth by the carbonaceous chondrite meteorites

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**Aim:** This project asks whether the Earth’s hydrosphere could have come from outer space via the impacts of water-rich meteorites. The focus of this work will be on analysing the abundance and hydrogen isotopic composition of water in Mighei-like carbonaceous chondrite meteorites. These rocks contain ~9% water, and come to Earth from outer parts of the asteroid belt. CM carbonaceous chondrites are the focus of much current attention given that both NASA and the Japanese space agency have missions to collect and return samples of carbonaceous chondrite asteroids.

**Rationale:** The Mighei-like (CM) carbonaceous chondrite meteorites contain water that is hosted mainly within phyllosilicate minerals, principally serpentine. These rocks could therefore be the mechanism by which extraterrestrial water was delivered to the surface of the early Earth (i.e., after it had cooled following its initial formation). However, not all CM carbonaceous chondrites contain the same amount of water, and this project focuses on those that have been heated prior to falling to Earth. This heating is believed to have taken place within their parent asteroid, and was responsible for driving off much of their original water. The nature and timing of this heating are both unknown, but are critical to understand in order to evaluate the potential flux of extraterrestrial water to Earth.

**Methods:** The petrography, mineralogy and chemical composition of meteorite samples will be characterised by scanning electron microscopy, and their water content and hydrogen isotopic compositions will be measured by stepped pyrolysis at the Scottish Universities Environmental Research Centre. Results will then be used to inform models of the early evolution of the Solar System.

**Knowledge background of the student:** The project is suitable for a graduate with a good honours degree in geology or Earth science.

**Career prospects:** This project will equip the student with skills in planetary science, mineralogy and geochemistry, which could lead to employment in areas such as resource exploration, environmental management and space science. There are also many opportunities for PhD research in planetary science in the UK and internationally.

**Application procedure:** This project is available as a one/two year MSc, but can be extended to a PhD. For entry in 2019 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/#/applyingtoundertakephdingeographicalandearths sciences