Space weathering of carbonaceous asteroids and its astrobiological implications

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Introduction: Two missions are currently en route to collect and return samples from carbonaceous asteroids and return them to Earth. The OSIRIS-Rex mission (NASA) will sample Bennu, whereas Hayabusa2 (Japan Aerospace Exploration Agency, JAXA) will visit the asteroid Ryugu. Both asteroids have affinities to the carbonaceous chondrite meteorites. As they are composed of anhydrous and hydrous silicate minerals together with water and organic molecules, these meteorites are of particular interest with regards to the delivery of biologically important molecules to early Earth and Mars. The missions will collect samples of fine-grained regolith that have been to ‘space weathered’; this term describes a group of processes that physically and chemically alter the surfaces of airless bodies. The effects of space weathering on carbonaceous asteroids are very poorly understood [1]. Therefore in preparation for the sample return missions, considerable efforts are being made to understand space weathering, for example by using spectroscopic measurements of asteroids [2] and laboratory laser/ion irradiation experiments [3]. This project seeks to test and ground-truth results from these studies by studying samples of carbonaceous asteroid regoliths that are available as the CM carbonaceous chondrite meteorites.

Project description: This project will focus on carbonaceous chondrite meteorites that have been exposed to the space environment over long timespans. Space weathered meteorites will be identified by the presence of olivine grains that contain abundant damage tracks, and so must have been irradiated by charged particles during an extended period in the regolith exposure. The effects of space weathering on hydrous silicate minerals and organic compounds will be described, and will probably include heating, dehydration, and amorphisation. Also of interest is determining the thickness, chemical composition and mineralogy of space weathered rims on olivine grains. This part of the project will use the revolutionary technique of atom probe tomography at one of our partner institutions (University of Sydney or Curtin University). Our previous atom probe results have shown that the space weathering of olivine grains collected from the regolith of the asteroid Itokawa by the first JAXA Hayabusa mission has formed water, and so we are keen to understand whether the same process occurred on carbonaceous asteroids – if so, meteorites containing space weathered mineral grains could have been a significant source of water for Earth.

Training: The student will work with a dynamic team of planetary scientists at the University of Glasgow where they will gain a suite of skills in mineralogy, petrology, planetary science and astrobiology in addition to science communication. The student will work within a vibrant planetary science research community in the UK and internationally, and will have the opportunity to travel widely in order to undertake research and present results at conferences.

Application procedure: 3.5 years of funding for this project is available through an award from the Science and Technology Facilities Council to the University of Glasgow. Please apply via the website of the College of Science and Engineering*. The application deadline is 31 May 2019, and the project will start in October 2019. Contact Martin.Lee@Glasgow.ac.uk with any questions.

*https://www.gla.ac.uk/postgraduate/research/earthsciences/#/applyonline