Probing the origin(s) of volatiles in the Moon and their resource potential

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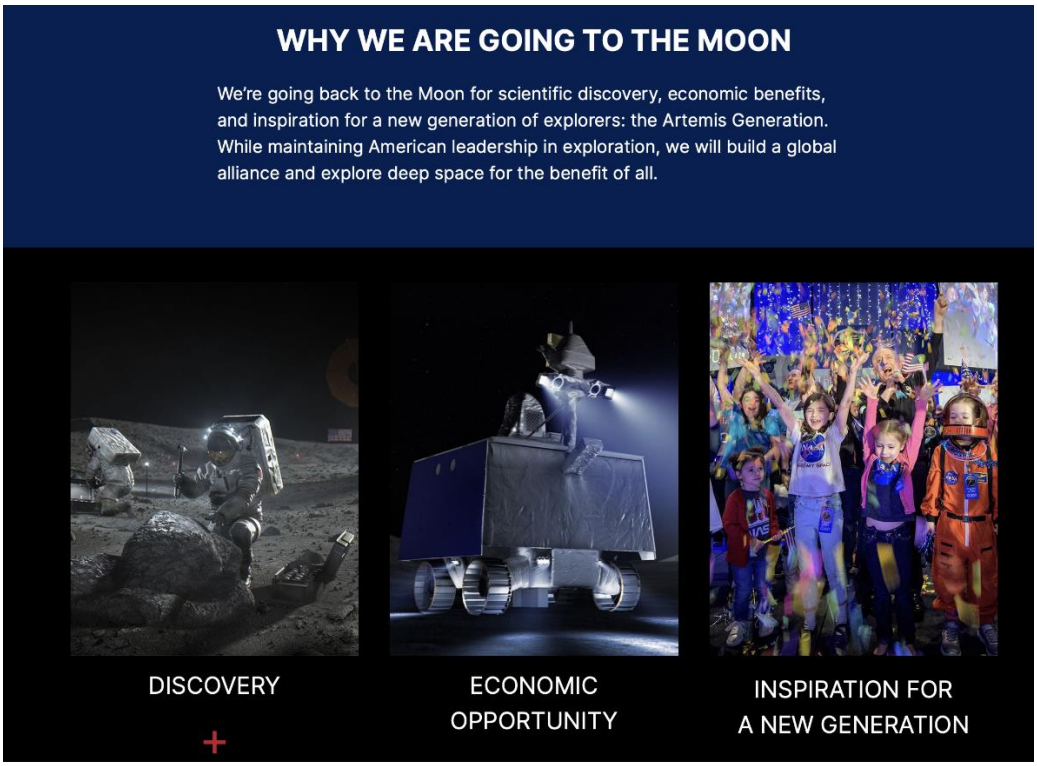

Project highlights:

1. The project goals will be accomplished through (a) the determination of volatile element distribution and their isotopic compositions in new lunar samples, including those from the recently opened Apollo 17 core, using microbeam analytical techniques; (b) placing these data within the context of lunar geological processes to evaluate the origin and inventory of volatiles on the Moon and its potential usefulness as a resource. Results from this project would be of direct relevance for developing sampling strategies on future lunar missions.

2. We seek a highly motivated candidate with an interest in cosmochemistry and a willingness to participate in developing and applying new analytical protocols for the analysis of planetary materials. They will receive training in the analysis of extra-terrestrial samples in modern, state-of-the-art, laboratories, gaining valuable transferrable skills. Techniques to be used will include electron microscopy (SEM, EBSD, EPMA) and ion probe (for age dating and volatiles). The successful applicant will be part of a dynamic research team consisting of several PhD students, post-doctoral researchers and international collaborators.

Project description:
When first returned, the lunar samples appeared to be from a barren, dry, environment, but recent advances in analytical capability and understanding of the lunar surface have forced us to revise this assessment, and we now realise that the lunar surface contains a wealth of useful volatiles that have the potential to be a critical resource for future exploration [1]. This is a key driver of the upcoming Artemis programme, catalysing a global interest in the exploration of the Moon.
A major challenge with the study of lunar samples is that they were returned to Earth 50 years ago and exposed to various environments in the curation facility since. However, new pristine samples have recently become available through a meticulously planned opening of two new cores from the Apollo 17 mission that have been stored unopened since their return in 1972. The Open University staff are members of a NASA-funded consortium for systematically examining the Apollo 17 Core Sample Vacuum Container (CSVC) sample 73001 and its double drive tube companion 73002.

Consequently, the availability of pristine lunar samples provides an ideal opportunity to:

- Measure the abundance and isotopic composition of indigenous volatiles in pristine lunar samples.
- Constrain the effects of processes (such as cosmic-ray spallation) that could have modified the original isotopic signature of volatiles in lunar samples.
- Define volatile reservoirs and volatile cycles on the Moon.

The proposed studentship will focus on measurements of volatiles (e.g., H, Cl) in lunar samples, building upon recent work carried out at the Open University [2-3]. In addition, the student would have an opportunity to contribute towards developing a new analytical protocol for measuring Li isotopes in lunar minerals to derive CRE ages, which can be used to correct the measured H isotope ratios to ascertain their original H isotopic composition.

References:

1. Anand et al. (2012) A brief review of chemical and mineralogical resources on the Moon and likely initial in situ resource utilization (ISRU) applications. Planet Space Sci 74 (1), 42-48.
2. Barnes et al. (2019) Multiple volatile reservoirs in the lunar interior revealed by the isotopic composition of chlorine in lunar basalts. Geochim Cosmochim Ac
3. Tartese et al. (2013) The abundance, distribution, and isotopic composition of Hydrogen in the Moon as revealed by basaltic lunar samples: implications for the volatile inventory of the Moon. Geochim Cosmochim Ac 122, 58-74.