

A CubeSat for Lunar Prospecting

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Summary:

This project will focus on modelling and development of a self-contained miniature analytical instrument for volatile extraction and characterisation on airless bodies. The instrument will be part of a system which will be compatible with standard CubeSat form factors (10x10x10 cm) and form part of deployed instruments on small landers to the moon or to other Solar system small bodies.

Project Highlights:

- Developing simulation model for a novel miniature mass spectrometer devices
- Designing low-power ion-source technology based on Carbon Nano Tube structures
- Developing protocols and techniques for volatile extraction from lunar material
- Establishing utility of instrumentation for future exploration missions

Recent years have seen a growing interest in lunar exploration, with most international space agencies planning to return humans to the surface of the Moon, and to establish a long-term presence. In Situ Resource Utilisation (ISRU) offers the opportunity to make use of locally available resources and to potentially reduce the costs associated with transporting materials such as water, hydrogen and oxygen to the lunar surface.

Water is considered the most useful resource as it can be used for a number of purposes including; life-support and following electrolysis the Hydrogen and Oxygen can be used as propellant (the most massive component of a rocket propulsion system). The polar regions of the Moon have long been known to be possible traps for solar system volatiles due to the low temperature of permanently shadowed areas [1,2]. Recent remote sensing missions have established the presence of volatiles (including water) at the surface and shallow sub-surface at these Polar Regions making them targets for in-situ missions to determine their ground-truth volatile inventory.

In addition to these polar volatiles, oxygen can be extracted from lunar minerals distributed over wider Lunar latitudes by reduction with hydrogen at high temperature. Research at The Open University [3,4] has demonstrated oxygen extraction from Lunar minerals. A miniature, CubeSat form factor prospecting and oxygen extraction system that can be deployed to many geological diverse areas of the moon such as Mare, highlands, and pyroclastic flows that is compatible with near term lunar landers may pave the way future human presence on the Moon.

The successful candidate will build on existing sample processing and extraction techniques and use mass spectrometer technologies developed by The Open University. The student will work with the instrument development team to design, construct and evaluate technologies

that are compatible with the industry standard CubeSat form factor to demonstrate end-to-end processes. The instrument will be based on those developed for the Ptolemy and [LUVMI](#) (Lunar Volatiles Mobile Instrumentation) projects but will require modifications and sample handling and processing system additions.

References:

[1] Paige et al. (2010) Science, 330, 6003, 479-482.

[2] Vasavada et al., (1999) Icarus 141: 179-193.

[3] Sargeant et al., (2019a) Planetary and Space Science: DOI:
<https://doi.org/10.1016/j.pss.2019.104759>

[4] Sargeant et al., (2019b) Planetary and Space Science. DOI:
<http://dx.doi.org/doi:10.1016/j.pss.2019.104751>

Qualifications required:

BSc Physics / Engineering (programming / CAD experience is an advantage).