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Lunar Science, Volatiles Prospecting and In-Situ Resource Utilisation: Synergistic Science and Exploration

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Abstract

A host of new missions to the surface of the Moon are in preparation internationally. A key objective is to perform in-situ investigations of putative water ice and other volatiles, and determine their abundance and extractability for future In-Situ Resource Utilisation (ISRU). This paper describes how a range of existing and developing technologies and techniques may be applied for the benefit of lunar science and exploration.

1. Introduction

The Open University (OU) has been a key player in lunar science since the Apollo era, with activities spanning from analysis of returned samples to in-situ instrumentation, and from scientific- to exploration-motivated research in volatiles and other potential resources in and on the Moon [Anand, 2010; Anand et al., 2012; 2014].

Initial interests were in the development and application of specialised mass spectrometers for stable isotopic studies of Apollo, Luna and meteorite samples. As a natural progression, OU since started a programme of miniaturising these instruments for flight on major space missions including the Rosetta comet investigation [Wright et al., 2015; Morse et al. 2015] and the ExoMars 2020 Surface Platform.

Investigations of lunar volatiles, whether motivated by scientific or exploration objectives, can be addressed through a combination of the above experience and capabilities. The miniature science laboratory ProSPA [Barber et al., 2018a] is being developed for the prospecting and analysis of lunar ices and chemically/physically-sorbed volatiles within the PROSPECT package for the Luna-27 lander (Roscosmos/ESA). It combines elements of earlier space instruments to replicate laboratory-based analytical protocols that have previously been applied to returned lunar samples and meteorites. These experiments can therefore be performed in-situ on the Moon on freshly drilled samples in new locations, with the results being valuable both in themselves and as context for the wealth of existing sample analysis data in the literature.

Further instrument and mission concepts are in development for science and resource prospecting from rovers [Biswas et al., 2018] and penetrators [Barber et al., 2018b].

OU is also preparing for the transition from prospecting for lunar resources, to developing a new sustainable mode of space exploration based on the utilisation of local resources (ISRU). Activities in this area range from chemical processes for the extraction of oxygen from lunar regolith [Sargeant et al., 2018] to microwave processing for additive manufacturing (3D-printing) of lunar materials [Lim et al., 2017; Srivastava et al., 2016].

This presentation will describe current and developing capabilities, interests and aspirations and how these are being applied in the context of European and international plans for lunar science and exploration. The potential synergies between in situ science and laboratory analysis of new returned samples will be explored, with a view to science and exploration advancing together for mutual benefit.

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