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Volatile Analyzer for Lunar Polar Missions. Everett.K. Gibson[1], Colin T. Pillinger[2], David S. McKay[1], and Lester J. Waugh[3]. [1]KR, NASA-JSC, Houston, TX 77058, [2]PSSRI, The Open University, Milton Keynes, MK7 6AA, UK, [3]EADS Astrium, Stevenage, UK. everett.k.gibson@nasa.gov

One of the major questions remaining for the future exploration of the Moon by humans concerns the presence of volatiles on our nearest neighbor in space. Observational studies, and investigations involving returned lunar samples and using robotic spacecraft infer the existence of volatile compounds particularly water [1]. It seems very likely that a volatile component will be concentrated at the poles in circumstances where low-temperatures exist to provide cryogenic traps. However, the full inventory of species, their concentration and their origin and sources are unknown. Of particular importance is whether abundances are sufficient to act as a resource of consumables for future lunar expeditions especially if a long-term base involving humans is to be established.

To address some of these issues requires a lander designed specifically for operation at a high-lunar latitude. A vital part of the payload needs to be a volatile analyzer such as the Gas Analysis Package specifically designed for identification quantification of volatile substances and collecting information which will allow the origin of these volatiles to be identified [1]. The equipment included, particularly the gas analyzer, must be capable of operation in the extreme environmental conditions to be encountered. No accurate information yet exists regarding volatile concentration even for sites closer to the lunar equator (because of contamination). In this respect it will be important to understand (and thus limit) contamination of the lunar surface by extraneous material contributed from a variety of sources. The only data for the concentrations of volatiles at the poles comes from orbiting spacecraft and whilst the levels at high latitudes may be greater than at the equator, the volatile analyzer package under consideration will be designed to operate at the highest specifications possible and in a way that does not compromise the data.

Various space agencies are considering a lunar landing mission near the end of this decade. Hopefully, those missions will include a lunar water and volatile resource analyzer. A team from NASA-JSC, The Open University, EADs Astrium and other industrial, educational and international scientific colleagues have been studying the design for a water and volatile analyzer using the heritage from the Gas Analysis Package of Beagle 2 and the Lunar Beagle concept instrument [2]. The purpose of the study was to produce a preliminary design for a package to characterize water and volatiles during the lunar landing mission provisionally scheduled for launch by the end of the decade. The design took into consideration the problems created by contamination and was compatible with all mission and environmental constraints.

The analysis instrument under study would provide information on the measurement of the number density and composition of both neutrals and ions in the lunar exosphere. Whilst the measurement of neutrals are doubtless important and insightful (e.g. answering questions such as the efficiency of cryogenic trapping of individual species, efficiency during the fourteen day lunar night (and their release during the temperature rise associated with the dawning of the lunar day). The long term monitoring of the lunar exophere is important to understand because of increased human presence on this delicate environment.

The instrument package under consideration would also include the capability to collect samples in the vicinity of the lander. Surface and sub-surface samples would be collected utilizing a device such as a lunar mole [2]. The samples would be characterized via XRF, Mossbauer and optical spectroscopy prior to water and volatile analysis. Techniques developed for the Beagle 2's Gas Analysis Package [2] will be used for "processing" the sample prior to releasing the water and volatiles by heating. Identification of the released volatiles will be made via mass spectrometry along with measurements of the volatiles abundances and isotopic compositions.

Hopefully, the volatile analyzer package can be selected for a future lunar lander and additional vital information can be provided to the scientific and engineering community on the state and role of water and volatiles on the Moon.

References: [1] Gibson E.K., Pillinger C.T. and Waugh L.J. (2010) Lunar Beagle and Lunar Astrobiology, *Earth, Moon and Planets*, 107, 25-42. [2] Gibson, E.K., Pillinger C.T. and Waugh L.J. (2009) *Beagle 2 The Moon Concept Study*, NASA-JSC, 125 pgs.