ESA LUNAR LANDER'S SEARCH FOR VOLATILES.

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Introduction: Following the Apollo era the moon was considered a volatile poor body. Samples collected from the Apollo missions contained only ppm levels of water formed by the interaction of the solar wind with the lunar regolith [1]. However more recent orbiter observations have indicated that water may exist as water ice in cold polar regions buried within craters at concentrations of a few wt. % [2]. Infrared images from M3 on Chandrayaan-1 have been interpreted as showing the presence of hydrated surface minerals with the ongoing hydroxyl/water process feeding cold polar traps. This has been supported by observation of ephemeral features termed "space dew" [3]. Meanwhile laboratory studies indicate that water could be present in appreciable quantities in lunar rocks [4] and could also have a cometary source [5].

Lunar Lander: The European Space Agency (ESA's Directorate of Human Spaceflight and Operations) have provisionally scheduled a robotic mission to demonstrate key technologies to enable later human exploration. Planned for launch in 2018, the primary aim is for precise automated landing, with hazard avoidance, in zones which are almost constantly illuminated (e.g. at the edge of the Shackleton crater at the lunar south pole). The Lander design requirement for constant solar illumination restricts the landing location, however these sunlit areas are close to permanently shadowed volatile rich regions and the analysis of volatiles is a major science objective of the mission.

Lunar Volatile and Resources Analysis Package: The authors have been commissioned by ESA to conduct an evaluation of possible technologies to be included in L-VRAP which aims to demonstrate volatile extraction and determine the volatile inventory of the moon with a view for future In-Situ Resource Utilization (ISRU). Surface samples will be collected by a robotic arm with the possibility of a rover to collect more distant samples. The concentration, chemical and accurate isotopic ratios (D/H, $^{12}C/^{13}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$ and noble gases) of liberated volatiles will be determined, possibly using similar technology to the Philae comet lander of the Rosetta mission [6]. In addition the chemical and isotopic composition of the transient lunar atmosphere will be monitored [7]. Modeling the effects of contamination from the Lander is an essential part of this study so that these can be recognized and minimized.

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