# Lunar Mission One: Paving the Way for Human Habitability on the Moon

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**Summary**
A human base on the Lunar South Pole would offer unique opportunities for scientific research that are not available on the Earth or in Low-Earth orbit. Difficulties faced by potential human inhabitants include the loss of $H_2O$ (water ice) as $H_2$ is created due to the regoliths exposure to cosmic rays. Lunar Mission One proposes to send a robotic lunar lander to obtain essential knowledge required for the preparation of human habitation on the Moon.

## 1. Introduction

Lunar Mission One (LM1) is a proposed robotic lander mission to the Moon, funded by public subscriptions to a buried archive of Life on Earth with an anticipated launch date within the next ten years. Stage 1 was successfully funded by international public backers through a capital funding campaign using the crowdfunding platform 'Kickstarter'.

LM1's proposed mission objectives are aligned to the Global Exploration Roadmap [1] and can provide scientific data essential for implementation of a 'Moon Village', as envisioned by the European Space Agency (ESA) [2].

The ESA Director General has stated that 'The Moon Village is open to any and all interested parties and nations' [3] and LM1 reflects this open inclusivity as a truly international project, welcoming contributions from scientific engineers, scientists of different fields and volunteers of all backgrounds.

## 2. Mission objectives to provide essential knowledge for human habitability

The Lunar South Pole is a primary candidate as the site for a human lunar base [4, 5] due to the power harnessing advantage of virtually constant exposure to solar radiation. This would also power the LM1 lander throughout its surface mission timeline and would provide useful data on the reliability of using solar power as a focal energy source.

The lander will carry equipment to enable analysis of the geochemistry of the lunar crust. This will include a wire-line drilling system (Figure 1), which will be accompanied by a jointed robotic arm for handling core samples, as well as a number of instruments to analyse the samples and determine the volatile content of the lunar regolith.

The lander will retrieve lunar samples from a borehole of >20m deep at the landing site. This is to be accomplished by lowering the complete drill assembly into the borehole by an attached cable. The drill assembly will repeat a drilling cycle of increasing depths of around 15cm. At each 15cm interval, the attached cable will retrieve the regolith core sample to the surface for analysis by the on-board instruments in situ.

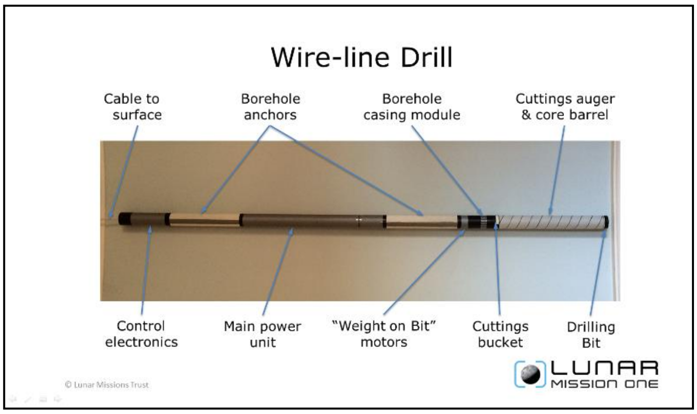


Figure 1: Example of a Wire-line Drill. (*Lunar Mission One: A new way to explore outer space* [2016])

An area of research that would be further enhanced by the prospect of a lunar base would be the study of the flux and composition of cosmic rays. One important difficulty faced by potential human inhabitants is the erosion of lunar regolith and chemical alterations, including the loss of $H_2O$ (water ice) as molecular hydrogen is created due to the regoliths exposure to cosmic rays [6]. Levels of $H_2$ per original $H_2O$ (%) against cosmic ray penetration depth of lunar regolith is shown in Figure 2.

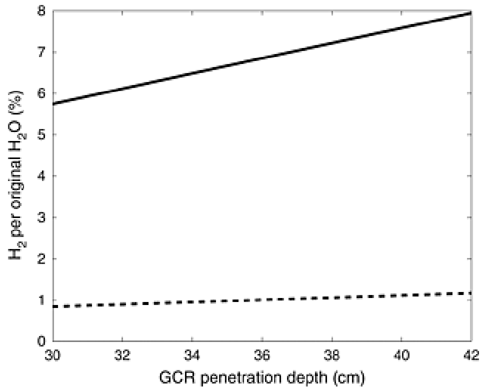


Figure 2: Levels of $H_2$ per original $H_2O$ (%) against cosmic ray penetration depth of lunar regolith. (*The formation of molecular hydrogen from water ice in the lunar regolith by energetic charged particles, J. Geophys. Res. Planets, 118, 1257–126, 2013*)

LM1 could provide essential data using an on-board Neutron spectrometer to determine hydrogen concentrations in the local geology to be compared with orbital measurements, such as those observed by the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) on the Lunar Reconnaissance Orbiter (LRO).

LM1 also proposes to analyse materials using a Raman-LIBS (Laser Induced Breakdown Spectrometer) to determine elemental composition, local mineralogy and volatiles as well as measuring the surface environment for the suitability of the South Pole as a location for a lunar base.

The lander will have the potential to conduct proof-of-concept studies for experiments that would bring long term benefits to various scientific fields that would be enriched by a lunar base [7]. These include low-frequency radio astronomy from the Moon, terrestrial emission, the lunar exosphere, and the effects of the lunar surface on radio propagation and communication. Proposed on-board instruments are shown in Table 1.

| Instruments / Science Goals | Goal 1: Geochemistry & Mineralogy | Goal 2: Impact chronology (including SPA Basin Age)* | Goal 3: Volatiles | Goal 4: Internal Thermal | Goal 5: Environment (Dust, radiation, seismic surface conditions) | Goal 6: Resources | Goal 7: Radio-Astronomy/ Magnetosphere Studies | Goal 8: Science Education |
|---|---|---|---|---|---|---|---|---|
| Landing Site Imager | | | | | X | X | | X |
| IR Spectrometer | X | | | | X | X | | |
| X-ray/Gamma-ray Spectrometer | X | X (v. approx age only*) | X (if low energy response) | | | X | | |
| Raman-LIBS | X | | X | | | X | | |
| Mass Spectrometer | X | X (v. approx age only*) | X | | X | X | | |
| Neutron spectrometer | X | | X | | | | | |
| Seismometer | | | | X | X | X | | |
| Heat Flow | | | | X | | | | |
| Dust, Radiation Charging Package | | | | | X | X | | |
| Sample Imager | X | | X | | | X | | X |
| Radio-astronomy demo package | | | | | | | X | X |
| Magnetospheric Imager | | | | | | | X | X |

Table 1: Example Instruments and Science Goals (*Preliminary Lunar Science Drivers for Lunar Mission One [2014]*)

## 3. Conclusion

A human base on the Lunar South Pole would provide a valuable resource for carrying out scientific research that cannot be conducted on Earth, as well as to pave the way for future possible human habitation of the Solar System. However, data will be required on the local suitability of every aspect of a lunar base (materials, sustainability, location, etc.) from the surface before any planning and construction can begin. A robotic lander, with the mission objectives and payload that Lunar Mission One provides [7], can obtain the essential knowledge required for a lunar base in a cost-effective way and gather significant scientific data *in situ*.


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2) Lunar Mission One


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### Short Summary


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