

SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

Author: Dr. Graham Dorrington
RMIT University, Australia, Australia

MICRO-PROBE FOR MARIUS HILLS PIT RECONNAISSANCE

Abstract

The discovery of the Marius Hills Pit by the SELENE (Kaguya) spacecraft in 2009 [1] may represent a significant game changer for future lunar exploitation since this feature could represent an access point to a major lava tube, or some similarly large subsurface void. To date, an overhang region is known to exist, but the full extent of the void is still unknown. Although future remote sensing techniques may help to constrain the void dimensions, what will be needed at some stage is a reconnaissance mission that focuses on obtaining images from near the base of the pit. There are several ways such a preliminary reconnaissance could be performed, but one of the most promising and lowest risk would be to deploy a micro-spacecraft, or probe, that could perform a propulsive hop from a landing site about 1-10 km distant. A ballistic hop requires a lower delta-V requirement than hover-type translations and would permit the near-circular entrance of the pit to be identified from high altitude such that corrective flight path changes could then be actioned en-route. On approach to the pit entrance, the probe would use retro thrust to slow its velocity and then slowly descent into the pit along a vertical path near its centreline. Images could be acquired while the probe remains thrusting in hover mode near the base of the pit, or after soft landing on the pit floor, although both these options have problems: the latter option constitutes high risk since the pit floor is known to be rubble strewn, whereas hovering with vertical thrust could result in regolith ejection and view obscuration. Another option, that avoids both these problems, is to deploy an imaging unit on a short tether below the main propulsive unit. Indeed this third option is recommended in this paper as one of the most promising operational concepts. Some details of this selected probe system are described. A key issue is the size and mass estimate of the probe. It is concluded that a preliminary Marius Hill Pit reconnaissance mission could be achieved with a micro-probe with a mass of order 10 kg using well proven technologies.

[1] Haruyama, J. et al. (2009) "Possible lunar lava tube skylight observed by SELENE cameras", GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L21206, doi:10.1029/2009GL040635.