

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 1 (2A)

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LUNAR GEOLOGY ORBITER: UPDATE ON MISSION DEFINITION AND STUDY PROGRESS

Abstract

The Lunar Geology Orbiter (LUGO) is a small satellite exploration mission to the Moon lead by an international team consisting of 30 institutions from ten different countries that has been ongoing a feasibility study since 2022 and an ESA-funded Phase 0 study since 2023. This paper summarizes the outcomes of the study up to the Mission Definition Review (MDR). The objectives of the mission are to a) understand the thermal evolution of the Moon by studying irregular mare patches (IMPs) and b) support future human exploration by detecting lava tubes.

The primary goal of LUGO is to determine whether IMPs are young (<100 Myrs) or old (2.5 Gyrs). If confirmed that they are young, this would challenge the current understanding of the thermal evolution of the Moon and lead to a shift in the current paradigm about rocky planetary bodies' evolutions. The secondary goal is to understand the physical properties of subsurface intact lava tubes by their detection and characterization, to enable their future in-situ exploration and use for habitation. The spacecraft will be a 150 kg smallsat on an eccentric lunar orbit with a very low perilune (< 20 km) over the selected areas of interest, to enable sufficient surface and subsurface mapping resolution. To answer whether IMPs are formed by a young solid basaltic material or old porous lava foams, the mission will use Ground Penetrating Radar (GPR), LiDAR, Hyperspectral Camera and Narrow Angle Camera to measure a) porosity/density of the IMPs, as an indicator of their inner structure, b) the thickness of the regolith, as an indicator of the IMP's formation age, c) mineral composition of regolith to study the effect of space weathering over time, d) topographic features associated with the IMP (size and distribution of boulders, surface roughness, crater morphologies). Further, the GPR will identify and characterize intact lava tubes. Lastly, the scientific value of an impact by the spacecraft into the lunar surface will be evaluated.

The paper will present the final results of Phase 0, namely the mission objectives and concept, mission analysis, preliminary design and parameters of each instrument to satisfy scientific objectives requirements, overall mission requirements and the mission definition. Furthermore, we will describe the main risks and challenges from programmatic and technical aspects of carrying such a mission as well as the lessons learned throughout the process.