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ASSESSMENT OF OPERATIONAL SCENARIOS FOR MINING ICY REGOLITH IN THE INTERIOR OF THE LUNAR SOUTH POLE CRATERS AND PRELIMINARY ANALYSIS FOR TRANSFER SOLUTIONS IN FUTURE MISSIONS TO THE MARS HIGH-LATITUDE POLAR CRATERS

Abstract

In crewed missions water access and utilization will be pivotal in order to establish long-term surface presence on Moon and Mars and similar operative capabilities and technologies will be exploited. Lunar south pole crater rims are the major target for the next Artemis exploration missions in order to establish the first human outpost on the Lunar surface. Permanently shadowed areas in the interiors of the craters are considered as one of the most viable locations to extract water from the frozen Lunar regolith layer, both in terms of abundance and availability. The main issues in performing extraction of water from icy regolith are the depth of possible water deposits in the crater interior, estimated to be in the order of 1 or 2 km, and the difficulty to provide a continuous power supply to payloads and equipment in the crater interior.

In this study, different tele-robotic mining architectures are proposed and a trade-off analysis of operational scenarios is explored in order to enable mining and roving capabilities in the crater interiors. The crater rims of the Lunar South Pole, which have the highest capacity of continuous sunlight available on the Moon, will be targeted for a dedicated infrastructure both to power the surface movable element able to perform multiple descents/ascents in the crater interior and as depot for the extracted water to supply a close-by human settlement. An analysis of the feasibility and transferability of the proposed Lunar operational solutions is finally carried out in order to be used for future human-rated missions targeted to Mars craters. The high-latitude Mars craters will be a possible location for future robotic and human missions as a target for water extraction. Permanent frozen water is present in the interior of the northern craters: the ice in the bottom is permanently stable because the crater acts as a natural cold trap avoiding the sublimation of ice during the summer seasons (Mars Express revealed that the interior of the Korolev crater could host about 2200 km3 of water ice).

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