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# REGOLITH MINING IN SHACKLETON CRATER: PROPELLANT, BUILDING MATERIALS AND VITAL RESOURCES PRODUCTION FOR A LONG DURATION MANNED MISSION


## Abstract

The return of humans on the Moon is strongly endorsed by the International Space Exploration Coordination Group (ISECG) as a fundamental step in the journey to Mars. Lunar and Cislunar exploration has the potential to unlock a whole new domain of advancements and opportunities that would benefit life on Earth and on other worlds. In this framework, In Situ Resource Utilisation (ISRU) is among the most important objectives to be addressed in order to enable permanent presence on other celestial bodies.

The baseline for this paper is LUnar Propellant Outpost (LUPO) mission, which aim was producing liquid oxygen from Lunar South Pole regolith water hydrolysis to refuel spacecrafts. The first objective of the present work is the resizing of the extraction and production systems to match the establishment of a permanent crew of 20 people. New data about water availability in the extraction site can further increase liquid oxygen yield. The design of the plants is then analysed to satisfy the water and oxygen demands of crew habitats and manned elements operating on Lunar surface. Layouts and technologies are revised in view of the latest advancements.

On top of this, new ways of utilizing resources are analysed. Propellant production from regolith has as waste product a huge amount of dehydrated regolith (DR), given that almost nine thousands tons of regolith are needed to extract 240 tons of water. An evaluation of a DR processing and storage strategy in preparation to tests and applications as building material is performed. Furthermore, molecular hydrogen from water hydrolysis can, when not used for propulsion purposes, considered as a valuable reducing agent in more advanced processes that can be established in the next future, such as regenerative air revitalization units and methane synthesis from CO2.

Results show how the overall resizing and improvements implemented increase both production volumes and system efficiency, while simultaneously increasing the autonomy of lunar elements. This, along with the opportunities related to DR exploitation, consistently optimizes a basic architecture of lunar ISRU activities and benefits the related economical aspects.