Evaluation of Lunar Regolith Potential as Construction Materials Source for Future Artemis Base Camp

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Abstract

For the development of long-duration crewed space missions, it is necessary to build the infrastructure to give human life support to astronauts (Levrino et al., 2014). Due to the high costs of space travel, it is necessary to make use of materials and resources *in situ* for the construction of lunar bases such as Artemis Base Camp (NASA, 2020). The identification of mineral and rock resources that can be used for this purpose will be carried out.

Introduction

Artemis Base Camp lies ahead in the goals of the Lunar Exploration Analysis Group (ISECG, 2020), this long duration habitation project will require a good understanding of lunar regolith geomechanics and the study of its possible use at buildings and other infrastructure construction.

Lunar regolith is an unconsolidated mix that is present in almost all the lunar surface and it is the result of continuous meteorite impacts (Mckay et al., 1992).The regoliths bedrocks range between basalts and anorthosites, these mafic rocks are enriched in minerals like olivine, pyroxene, ilmenite and calcic plagioclase (Brunflet et al, 1971). Glass is also common as an impact product, by this process some Al is accumulated, and a particular texture called aggregates can form (Mckay 1992), these structures are agglomerates of glass and rocks debris within a glass matrix and represent a big part of lunar regolith composition. Another important point is the presence of native Fe as a result of space weathering (Wiesli et al., 2013).

Prior compositions can be useful for infrastructure in a number of ways. Different methodologies are being tested to recover oxygen and metal from lunar regolith (Schwandt et al., 2012); aluminium, titanium, magnesium and iron are common in those minerals and could be retrievable for industrial and infrastructural purposes (Happel, 1992). The other high necessity will be construction materials, basic habitats designs require some kind of concrete for its construction (Reuss et al, 2006). This have been addressed before, lunar concrete would be very different from the ones used on earth, calcite is not available to create cement, so sulfur have been postulated as an alternative, which would be extracted from troilite, a sulphide present in lunar regolith (Toutanji et al, 2012). The other main components of concrete are the aggregates, those are the solid fragments of the mix and provide support to the structures. Lunar minerals seem suitable as aggregates, even the high glas percentage may not be a problem due to the lack of atmospheric humidity. Mixes with 65% to 35% aggregates/cement ratios have been proposed (Toutanji et al, 2012). Various authors have tested these mixes in lunar environmental conditions and seem suitable for construction purposes with certain precautions (Grugel, 2012)(Toutanji et al, 2012)(Markandeya Raju et al, 2014).

Methodology

We propose a three objective exploration of the lunar south pole surface and regolith to address their suitability as location and source of future base camps on the Moon. All the activities would be realized with help of the unpressurised rover (ISECG, 2020).

1. The first step would be to identify a suitable zone for a base camp construction, in this early stage the evaluation may be done with a few variables: slope, terrain roughness, suitable changes in illumination and closeness to interest zones such as Permanently Shadowed Regions (PSR´S).
2. Recollection of regolith and rock samples from the place previously selected. These samples should vary in lithology and in composition. It would be ideal to recover both rock and regolith, of different grain sizes. These samples would be returned to Earth, where better simulants could be prepared to evaluate the geomechanical and compositional capabilities of these materials.
3. Astronauts would map the potential outcrops of materials in the surrounding areas, this would allow the detection of possible deposits and to make rough calculations of their reserves.

Projected results

1. Identify, classify, and characterize mineral and rock resources on the Lunar surface.
2. Identify the most suitable construction area for the construction of the Lunar base.
3. Determine the capabilities of alternative construction technologies (Such as sulfur concrete) in a real Lunar environment, as well as its integrity against micrometeoroids and spatial debris.

Challenges

1. Find a real alternative to common construction technologies in order to take advantage of resources *in situ* for future constructions on the Lunar surface.
2. Solve the problem of transport of heavy material from Earth to the Moon by using material from lunar regolith in a place of an important research target.
3. Solve the micrometeoroids and spatial debris problem over possible future structures finding new construction technologies that withstand the impacts without losing structural characteristics.
4. Find new construction technologies with possibilities of providing shelter against ionizing radiation (Solar wind, solar flares, cosmic rays) on the Lunar surface for future Lunar colonies.

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