Application of Biosolids and Wastewater to Lunar Regolith to Jump Start Soil Generation

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In situ resource utilization (ISRU) will be required for any long-term missions to planetary bodies outside of Earth. The Artemis missions present a golden opportunity to answer some basic science objectives on this front and give us a head start in developing sustainable long-term solutions to the problems presented by long term habitation in the space environment. In particular, there are two issues which may have synergistic solutions, and which would be easily investigated on the early Artemis missions. Those issues are what to do with wastewater and biosolids that cannot be or are not fully reused and how to generate usable soil for long-term and sustainable food production.

Land application of biosolids/wastewater has been shown to be both beneficial and sustainable (including little to no negative impacts) over long time spans (Zerghzi, et al 2010). Such application has been shown to significantly increase microbial activity and to enhance soil macro nutrients such as carbon nitrogen and phosphorus (Pepper, et al 2008). Lunar regolith, to our knowledge has no existing microbial community so for soil to be generated from it, it will need to be seeded with some pre-existing culture. Wastewater and biosolids could possibly jump start this process if applied to lunar regolith by inoculating it with a microbial community and by adding necessary elements such as carbon and other organic elements. Additionally, it should be investigated if the addition of wastewater/biosolids to lunar regolith will have a positive change on some of the more challenging aspects of its physical structure as biological weathering is one of the key components of soil generation on Earth (Zaharescu, et al. 2019). Does the presence of microbes and additional elements weather the sharp edges of lunar regolith particles which have previously existed in an abiotic environment? Does the inoculated microbial community thrive or even survive in this new mixed environment? These questions can be answered with relatively simple experiments during the first Artemis missions. In addition, answering these questions will address parts of both the feed forward and sustainability themes of the Lunar Exploration Analysis Group's Lunar Exploration Road Map.

Science Objectives:

1. **Determine viability of inoculated microbial communities in wastewater/biosolid and lunar regolith mixtures.** Can microbial communities survive and thrive in this mixture or would some intermediate pre-processing step be necessary to enable soil generation? What do these communities look like over the course of the experiment?
2. **Investigate the physical properties of the wastewater/biosolid and lunar regolith mixtures.** What ratio of regolith to wastewater/biosolids results in the most soil like and usable/workable mixture? Does addition of wastewater/biosolids result in weathering of lunar regolith particles? What is the distribution of particle sizes in the resultant mixture? What is the macronutrient makeup of the final mixture? Is it amenable to plant growth? Are there any other chemical contaminants or by-products which can pose a risk to microbial communities or the crew?

References

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