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Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

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MAKING IN SITU RESOURCE UTILIZATION (ISRU) A REALITY ON THE MOON: THE INTERNATIONAL LUNAR RESOURCE PROSPECTING CAMPAIGN (ILRPC)

Abstract

Being able to live off the land through in situ resource utilization (ISRU) is enabling for sustained human Solar System exploration. To hone the skills and technologies needed to do this, Earth has been blessed with its nearby Moon that contains important enabling resources. Estimating and understanding the reserve potential of lunar resources requires extensive exploration work, which begins with a prospecting campaign. This process demands significant coordination, resources, and financial and technical capabilities. Fortunately, the Moon is very popular as there are ongoing active missions from 4 countries and 30 missions planned between now and the end of the decade. The ILRPC has started to coordinate active and proposed lunar missions to obtain much needed datasets that increase the probability of finding elevated concentrations of a resource at multiple locations. This requires integration of orbital datasets that provide locations for surface ground-truth missions. Initial ideas are described in Neal et al. (2024) Acta Astronautica 214, 737-747. Since then, specific locations at the lunar south pole have been identified for detailed investigation of polar water ice. These are not the large permanently shadowed regions (PSRs) because these are often deep and difficult to access, requiring 10+km round-trip traverses in 20-60K temperatures to access the water ice. Smaller PSRs are targeted that show potential for buried and surface water based on obtained data, as these should be accessible. It is important to understand the nature of these deposits beyond accessibility, such as form, extractability (geotechnical properties), distribution, composition, to assess reserve potential. For polar water ice there is only one point of ground truth from the LCROSS mission to Cabeus crater. What LCROSS demonstrated was that the ice deposit is impure and refining capabilities would be needed. But is the Cabeus data representative of ice from other PSRs? The ILRPC intends to initially integrate orbital datasets to highlight optimal locations for surface assets to be deployed, and to initiate preliminary reserve potential estimations. Data from the surface assets will be used to refine the integrated orbital data so it can be a more predictive model as exploration proceeds. This approach can be used for other lunar resources and can enable new space-faring nations to contribute to this prospecting campaign in addition to demonstrating new national

capabilities. The international nature of the ILRPC is critical for compliance to international law, which will be discussed in a companion presentation.