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SUSTAINABLE LUNAR MINING: EXPLORATION, EXTRACTION, AND FEASIBILITY ANALYSES

Abstract

The depletion of mineral resources on Earth has generated an interest in mining activities beyond the planet with the Moon emerging as the most promising near-Earth space object. The Moon has important mineral riches such as helium-3, the rare earth elements, and water ice, for their roles in space exploration, in-situ resource utilization (ISRU), and long-term human presence beyond Earth.

This study looks into lunar mining in a multidisciplinary perspective that employs remote sensing techniques, such as hyperspectral imaging for mineral prospecting, by satellites located in lunar orbit. The data from these satellites will also be crucial in defining areas of high potential for mining. The study is also investigating extraction processes which have been developed specifically for the Moon's low-gravity and vacuum environment and enrichment system designs for refining lunar materials. This study also comprises one of the most critical components-the design of an orbital refueling station in lunar orbit to store and supply extracted fuel resources to spacecraft for deep-space missions.

One of the sustainability benefits that the project will provide would be the resultant savings in fuel needed to launch huge volumes of fuels from Earth. Rockets launched from Earth would require only enough fuel to reach the Moon because the rest of the fuel for transiting to deep space missions would be available from the lunar orbital station. This would result in very low-cost missions and make more feasible long-term exploration of space. The sustainability and feasibility analyses will look at issues of economic feasibility and the long-term environmental impacts on the utilization of lunar resources as well.

This research shall aim to advance efficient and sustainable lunar mining through addressing key technical and logistical challenges. The study outcomes are expected to be instrumental in supporting future developments in lunar colonization and commercial space ventures.