

HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM (A5)  
Long Term Scenarios for Human Lunar Presence (2)

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MINING THE MOON: A FIRST STEP IN HARNESSING EXTRATERRESTRIAL RESOURCES

**Abstract**

Much like Earth, the Moon is host to a variety of minerals from which can be extracted valuable materials. As humanity is becoming increasingly aware of the finite nature of its home planet's resources, multiple space agencies have set the goal of establishing a permanent lunar outpost. Such a colony could host small-scale mining operations aiming to study and develop this form of space resource utilization.

The first application of mining technology on the Moon could very well be the construction of the outpost, as buildings on the lunar surface would be exposed to micrometeorites, radiation and significant temperature variations. Despite the high cost related to developing and sending a likely unmanned excavator to Earth's natural satellite, an underground base could be safer, more durable and easier to maintain.

Once such a safe haven established, experimental resource utilization could begin. The four basic steps in the mining process are fragmentation, excavation, material handling and mineral processing. Even on Earth, there exists a range of environmental and operational constraints that have caused an array of technologies to develop for each step. Applying them on another celestial body will require considerable rethinking.

While there exists significant challenges in transporting to the Moon the material required to undertake a mining operation, several operational aspects are more favorable than on Earth. The Moon's top surface, called regolith, consists of material finely comminuted from impacts due to the lack of any significant atmosphere, reducing the need for comminution. Also, the excavation and material handling processes will be done under a gravitational pull one sixth of that on Earth's surface, reducing needs in energy. Moreover, the materials likely to be first considered for extraction, oxygen and hydrogen, are partly found as entrapped gases, which would reduce the complexity of initial mineral processing. Further mining could include the extraction of helium-3, a gas owing its relatively high occurrence on the moon to solar wind. If this promising fuel for nuclear fusion sees its speculated potential confirmed, the already valuable helium-3 could push most other energy sources into obsolescence and be financially worthwhile. Many challenges lie ahead in this field, such as the cost of transporting material to the Moon which could offset any effort to have a mining operation piggyback lunar colonization, but research on Earth concerning mining machinery automation and micro-mining techniques provide a solid basis from which lunar mining could be developed and subsequently expanded.