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PLANETARY PROTECTION ISSUES FOR IN SITU RESOURCE UTILIZATION ON THE MOON AND MARS

Abstract

As recommended in numerous human space exploration reports, and as reflected in the long, recorded history of human exploration on Earth, future human space missions attempting to provide even a limited presence on the Moon or Mars (or elsewhere) should plan on the use of in situ resources to support human life in space. Whether or not there are mission systems capable of reclaiming breathing gases or using human waste to close the loop on food and air production, there is a clear need to make up for the anticipated imperfection of loop closure by such systems, and the recycling of propulsion gases is never going to be practical. As such, in situ resource utilization remains a priority development for future human missions beyond Earth orbit. Ongoing technology efforts have identified lunar and martian materials that might contribute to resource production on those bodies. Lunar ilmenite, for example, has been cited as a source of oxygen for propulsion systems (and possibly for breathing purposes) while polar deposits of (mostly) water ice on both the Moon and Mars seem like attractive targets for both breathing and propulsion purposes. Nonetheless, the use of these materials, even if the technology to convert them is perfected, is not "free." In particular, the ices to be found at the lunar poles may preserve a record of cometary impacts on the Moon (and thus be a proxy for the deposition of water and other volatiles on the Earth) and the martian ices may both be of interest in and of themselves and may cap potential huge (and possibly inhabited) subsurface aquifers that hold the secrets to life on Mars—and possibly the origin of life in the solar system as a whole. This paper will discuss various forms of resource utilization for human missions and point out the potential and pitfalls relative to preserving the science value of the exploration missions themselves, and their safety.