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IN SITU RESOURCE DEVELOPMENT ON THE MOON, MARS AND BEYOND: CONSIDERATIONS  
FOR THEIR APPROPRIATION AND USE

**Abstract**

It has been suggested that the use of in situ resources on the Moon or Mars and from destinations beyond will be critical to the transformation of humans from a one-planet species into a spacefaring one. Numerous human space exploration reports and the history of human exploration and discovery bear out the concept. Space resources can be used to support human life in space by being incorporated into mission systems, and supplementing systems capable of reclaiming breathing gases or re-using human waste. They can also provide fuel for travel by rocketry. Increasingly (taking a theme from science fiction) the idea of first capturing, then trading or selling in situ resources is also growing in prominence, and attracting some limited investment funding as well. While ongoing efforts have identified lunar and martian materials that might contribute to resource production, it is clear that even with reliable technology to convert them into usable supplies, they will not be “free.” For example, ices at the lunar poles may preserve a record of lunar impacts that could be destroyed by wholesale removal, and martian ices may preserve a record (perhaps the only record) of organics from an earlier era. Accordingly, different approaches to the use of some in situ resources will need to be balanced against the scientific value that they represent. Also, there is the potential for inadvertent exposure to materials that aren’t known to be safe (e.g., possible cyanide in the lunar ices and potential life forms buried in martian ice). Hence a balance between use and protection must be established, and that balance is represented within the COSPAR planetary protection policy [1] and the Outer Space Treaty (OST) [2]. Various forms of in situ resource utilization, their potential benefits and the pitfalls of their use, including the challenges posed by the OST, as well as the practical consequences of resource appropriation and use by humans in space will be covered in this paper.

Refs. [1] COSPAR: Planetary Protection Policy (revised 24 March 2011). COSPAR, Paris, France, 2011. [2] United Nations, Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, U.N. Doc. A/RES/2222/(XXI); TIAS No. 6347, 25Jan1967.