SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and Development (1)

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ASTEROID REDIRECT MISSION CONCEPT: A BOLD APPROACH FOR UTILIZING SPACE RESOURCES

Abstract

The utilization of natural resources from asteroids is an idea that is older than the space program. Konstantin Tsiolkovskii included in *The Exploration of Cosmic Space by Means of Reaction Motors*, published in 1903, the "exploitation of asteroids" as one of his fourteen points for the conquest of space. The technologies are now available to transform this endeavor from an idea into reality.

A critical resource for human space exploration is water, which can used for propellants, radiation shielding, thermal control, human consumption, non-potable applications (plant growth, cleaning, etc.), and other uses. Carbonaceous asteroids may consist of up to 40% extractable volatiles by mass (approximately 20% water), along with other valuable materials (metals, minerals, carbon compounds, etc.). C-type asteroids also possess low compressive strength that simplifies cutting, crushing, and processing, which could be a key target characteristic for practical resource extraction and recovery.

The Asteroid Redirect Mission (ARM) is a mission concept with the goal of robotically returning a small (approximately 7 m diameter) near-Earth asteroid (NEA), or part of a large NEA, to cislunar space using a 50 kW-class solar electric propulsion (SEP) vehicle and currently available technologies. The mass of the asteroidal material returned from this mission can be up to approximately 1,000 metric tons, depending on the orbit of the target NEA and the thrust-to-weight and control authority of the SEP vehicle. Even larger masses could be returned in the future as technological capability and operational experience improve. The use of high-power solar electric propulsion is the key enabling technology for this mission concept.

The paradigm shift enabled by the ARM concept would be to allow in-situ resource utilization (ISRU) to be used at the human mission departure location (i.e., cislunar space) versus at the deep-space mission destination. This approach eliminates, or drastically reduces, the barriers associated with utilizing ISRU for human deep-space missions. Also, the testing and validation of extraction and processing equipment and methods would enable large-scale commercial ISRU operations to become a reality, and enable a future space-based economy utilizing processed asteroidal materials, along with many other important benefits that would result from the successful completion of this mission.

This paper will provide a brief overview of the ARM concept, discuss the key technologies and capabilities that would be developed in support of the mission, and focus on how the mission would benefit humanity's quest to expand its presence into the solar system.