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HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
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THE ASTEROID-ENHANCED CASE FOR MARS

Abstract

While recent government initiatives have focused on near Earth asteroids (NEAs) as exploration destinations, their primary long-term value is as low-cost resources to enable other space priorities, such as Moon and Mars expeditions. Asteroid resources available in "free space" regions such as geosynchronous orbit, high lunar orbit, and Lagrange points substitute for propellant, structures and other elements that otherwise would be launched at high cost from Earth. As one example, moving asteroid resources to geosynchronous orbit can cost as little as 100 to 500 m/s (net of maneuvers such as lunar swing-bys), while lifting material from the Earth's surface to GEO requires a delta-V in excess of 12,000 m/s.

In addition to reducing the Earth-launch mass required for Mars expeditions, abundant asteroid resources also enhance the viability of architectures based on reusable rather than expendable elements. Designing for reusability carries with it the burden of extra mass; for example, reusability requires higher margins on structural strength and carrying fuel reserves to establish stable parking orbits rather than accepting disposal orbits. For Mars campaigns, this boosts the price of an already-costly undertaking. Asteroid resources allow some of this extra mass to be added at lower cost than launching it from the ground. Propellant, heat shields for Mars entry, radiation shielding and structures all can be "locally sourced" once an expedition has arrived in cis-lunar space – keeping the cost of the initial Mars campaign lower than otherwise possible and *making subsequent voyages far less expensive.*

Even before the first Mars expedition, asteroid-sourced components will greatly reduce the cost of preliminary activities such as creating and operating rotating fractional to full-gravity habitats, where inner levels provide lunar and Martian gravity and outer levels offer normal Earth gravity simultaneously for controlled studies of reduced-gravity impacts on human, animal and plant health. It would be unconscionable to commit to long-term habitation of Mars without prior research on how 38 percent normal gravity impacts the viability of crops and livestock, let alone people.

A roadmap for creating an asteroid industry supportive of deep space human exploration is presented, with mass budgets and examples of deltaV requirements to specific asteroids.