Finding Near-Earth Asteroid (NEA) Destinations for Human Exploration: Implications for Astrobiology

Rob Landis, NASA Wallops Flight Facility, Wallops Island, VA
Paul Abell, NASA Johnson Space Center, Houston, TX
Brent Barbee, NASA Goddard Space Flight Center, Greenbelt, MD
Lindley Johnson, NASA Headquarters, Washington, DC

The space between the Sun, Earth, and Mars swarms with near-Earth asteroids and comets. These objects represent the leftover building blocks of early Solar System formation and contain information crucial to understand the processes that influenced planetary accretion and the origins of life. These primitive objects are also some of the most easily accessible bodies in interplanetary space for robotic and human exploration. However, the current number of catalogued near-Earth objects represents just a small percentage of the estimated population that is projected to exist within near-Earth space. In order to plan for affordable future human space flight (HSF) opportunities, a more complete set of human-accessible near-Earth asteroids (NEAs) with well-known orbits must be obtained. The critical first step towards the goal of mounting piloted missions to NEAs is to complete a near-Earth object (NEO) survey using a space-based asset (or assets) that is more effective in discovering additional NEAs than existing ground-based systems.

The current number of known potential NEA targets for HSF is limited to those objects whose orbital characteristics are similar to that of the Earth. This is due to the projected capabilities of the exploration systems currently under consideration and development at NASA. However, NEAs with such orbital characteristics often have viewing geometries that place them at low solar elongations and thus are difficult to detect from the vicinity of Earth. While ongoing ground-based surveys and data archives maintained by the NEO Program Observation Program Office and the Minor Planet Center (MPC) have provided a solid basis upon which to build, a more complete catalog of the NEO population is required to inform a robust and sustainable HSF exploration program. Since all the present NEO observing assets are currently confined to the vicinity of the Earth, additional effort must be made to provide capabilities for detection of additional HSF targets via assets beyond Earth orbit.

A space-based NEO survey telescope located beyond the vicinity of the Earth, has considerable implications for planetary science and astrobiology. Such a telescope will provide foundational knowledge of our Solar System small body population and detect targets of interest for both the HSF and scientific communities. Data from this asset will yield basic characterization data on the NEOs observed (i.e., albedo, size determination, potential for volatiles and organics, etc.) and help down select targets for future HSF missions. Ideally, the most attractive targets from both HSF and astrobiology perspectives are those NEAs that may contain organic and volatile materials, and which could be effectively sampled at a variety of locations and depths.

Presented here is an overview of four space-based survey concepts; any one of which after just a few years of operation will discover many highly accessible NEO targets suitable for robotic and human exploration. Such a space-based survey mission will reveal incredible returns for several disciplines including: exploration, *in situ* resource utilization, planetary defense, and science. Of particular, interest to the scientific

community is the potential for obtaining new insights into Solar System formation and evolution as well as furthering the field of astrobiology through analysis of samples returned from organic- and volatile-rich NEAs.

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