NASA's Asteroid Redirect Mission: The Boulder Capture Option

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NASA is examining two options for the Asteroid Redirect Mission (ARM), which will return asteroid material to a Lunar Distant Retrograde Orbit (LDRO) using a robotic solar-electric-propulsion spacecraft, called the Asteroid Redirect Vehicle (ARV). Once the ARV places the asteroid material into the LDRO, a piloted mission will rendezvous and dock with the ARV. After docking, astronauts will conduct two extravehicular activities (EVAs) to inspect and sample the asteroid material before returning to Earth. One option involves capturing an entire small (~4–10 m diameter) near-Earth asteroid (NEA) inside a large inflatable bag. However, NASA is examining another option that entails retrieving a boulder (~1–5 m) via robotic manipulators from the surface of a larger (~100+ m) pre-characterized NEA. This option can leverage robotic mission data to help ensure success by targeting previously (or soon to be) well-characterized NEAs. For example, the data from the Hayabusa mission has been utilized to develop detailed mission designs that assess options and risks associated with proximity and surface operations. Hayabusa's target NEA, Itokawa, has been identified as a valid target and is known to possess hundreds of appropriately sized boulders on its surface. Further robotic characterization of additional NEAs (e.g., Bennu and 1999 JU3) by NASA's OSIRIS REx and JAXA's Hayabusa 2 missions is planned to begin in 2018.

The boulder option is an extremely large sample-return mission with the prospect of bringing back many tons of well-characterized asteroid material to the Earth-Moon system. The candidate boulder from the target NEA can be selected based on inputs from the world-wide science community, ensuring that the most scientifically interesting boulder be returned for subsequent sampling. This boulder option for NASA's ARM can leverage knowledge of previously characterized NEAs from prior robotic missions, which provides more certainty of the target NEA's physical characteristics and reduces mission risk. This increases the return on investment for NASA's future activities with respect to science, human exploration, resource utilization, and planetary defense.