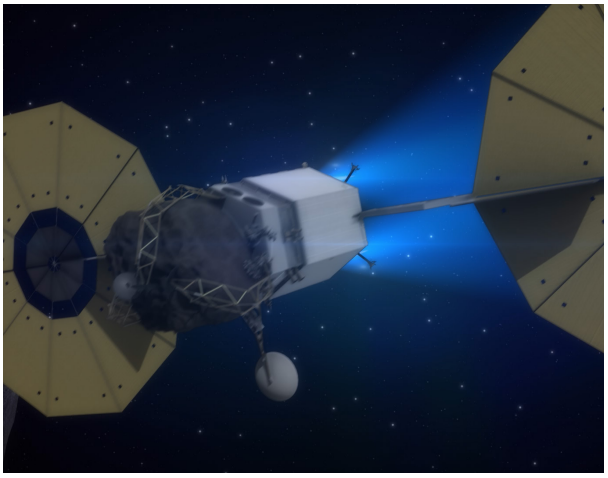
National Aeronautics and Space Administration

NASAfacts

Asteroid Redirect Mission

NASA is developing a first-ever robotic mission to visit a large near-Earth asteroid, collect a multi-ton boulder from its surface, and redirect it into a stable orbit around the moon. Once it's there, astronauts will explore it and return with samples in the 2020s. This Asteroid Redirect Mission (ARM) is part of NASA's plan to advance the new technologies and spaceflight experience needed for a human mission to the Martian system in the 2030s.



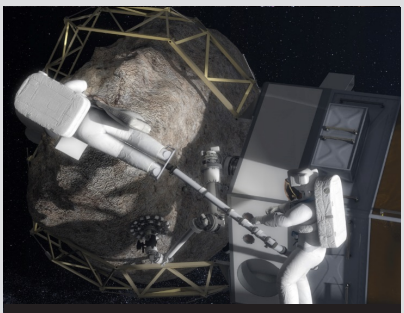
The spacecraft will rendezvous with the large asteroid and use robotic arms with anchoring grippers to retrieve a boulder from the asteroid. While there, the spacecraft will characterize the asteroid and demonstrate at least one planetary defense technique before transporting the boulder to a stable lunar orbit.

IDENTIFY, REDIRECT, EXPLORE

A combined robotic and human mission spurring the development and demonstration of advanced deep space exploration capabilities

NASA's Infrared Telescope Facility, Mauna Kea, Hawaii

Concept image of robotic retrieval of a boulder from the asteroid's surface.



Concept image of two crew members exploring the boulder in lunar orbit.

Identify. In 2013 NASA's Near Earth Object Observation (NEOO) Program began to amplify its coordinated efforts across the agency and global asteroid-observation community to detect, track and characterize potentially hazardous asteroids. It increased the discovery rate by 45 percent in 2014. This enhanced effort has also increased the count of asteroids that are known to come very close to the Earth-moon system and that might be suitable candidates for the ARM. Using telescopes on Earth and in space, NASA has already identified four candidate asteroids that have the right physical characteristics suitable for the mission.

Redirect. Once a target asteroid has been identified, NASA will launch a robotic vehicle to rendezvous with the boulder-rich target. The spacecraft will further characterize the asteroid before selecting a boulder; it will then descend to the asteroid's surface, collect the mass, and ascend and resume its journey. The spacecraft will be powered by the most advanced Solar Electric Propulsion (SEP) system ever, with 30 times more capability than the current state-of-the-art. SEP uses power converted from sunlight to produce a continuous low thrust at very high efficiency levels, which substantially reduces the amount of propellant needed to travel to the asteroid and to transport the multi-ton boulder to an orbit around the moon.

Explore. The first humans to visit the captured boulder will travel aboard NASA's Orion spacecraft, launched from the new and powerful Space Launch System (SLS) rocket. This next class of astronauts will leverage knowledge from decades of operations in space, including the construction and use of the International Space Station in low-Earth orbit. Investigating an asteroid in deep space presents new levels of challenge and opportunity for human space exploration. At distances of up to 300,000 miles from Earth, the crew will be farther from our home planet than ever before, operating at the frontier of human exploration.

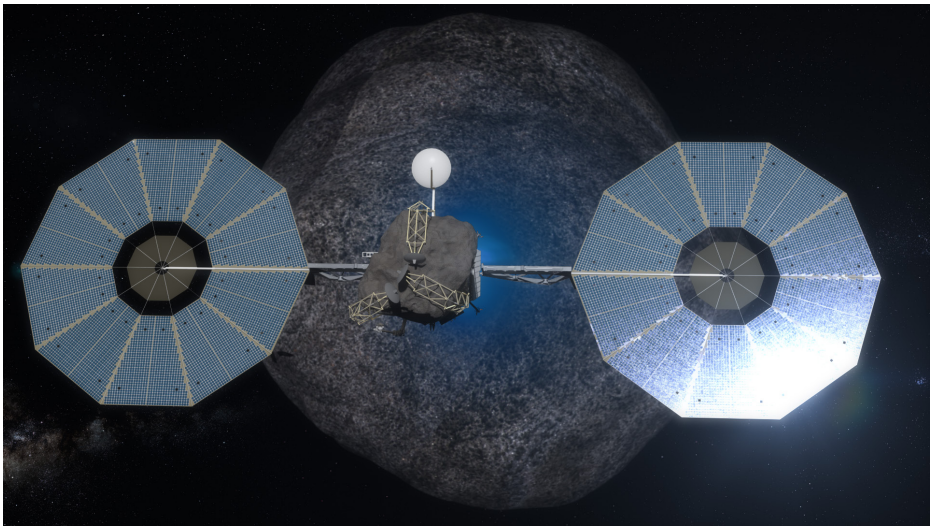
Asteroid Redirect Mission

Why Should Humans Explore Asteroids?

Robotic asteroid missions, such as NASA's Near Earth Asteroid Rendezvous (NEAR) and Dawn have revealed important findings about asteroids. These missions provide important clues to our solar system's early formation, increasing our knowledge about the population of small bodies in Earth's neighborhood, and better preparing us for human journeys to Mars and other deep space destinations. The upcoming OSIRIS-REx mission – which will orbit asteroid Bennu for almost 26 months and return a surface sample to Earth – will provide valuable proximity operations and asteroid characterization experience in preparation for the ARM.

These robotic mission achievements have increased our understanding of how to operate around asteroids, but direct human investigation will amplify our knowledge about these ancient remnants of the beginning of our solar system. Astronaut exploration techniques allow for rapid responses to unforeseen challenges and opportunities, maximizing scientific and exploration returns. Mission planners will still define mission and science objectives, but astronaut intuition, situational adaptation, and decision-making skills provide an effective and unique way to achieve them. Autonomous crew decision-making is an essential capability for success in exploring deep space, and will become increasingly important as future missions take astronauts to Mars and destinations even farther into the solar system.

Depending on the composition of the asteroid's boulder, the mission may establish that asteroids can be mined for water, metals, and other compounds and volatiles that could aid human exploration by providing consumables, radiation shielding, and propellants. The ability to harvest resources from asteroids – rather than relying on resupply missions from Earth – is a key capability for long-term, deep space exploration missions and pioneering of space.



Concept image of the ARM robotic spacecraft leaving a large asteroid, heading to a lunar orbit with a boulder captured from the asteroid's surface. Image Credit: NASA.

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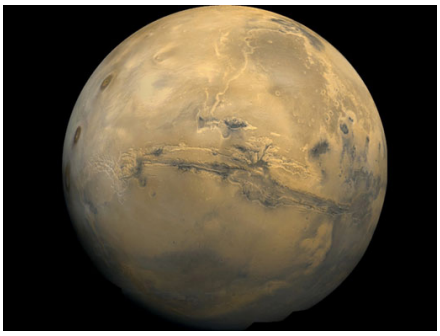
NP-2015-01-1302-HQ

Asteroid Redirect Mission: Into the Proving Ground



The Proving Ground is the next phase of missions that will prove our ability to safely live and work far away from Earth for extended periods of time. Centralized in cis-lunar space, the Proving Ground is a deep space environment farther than humans have ever traveled—yet still in a safe return distance to Earth.

The ARM is an early mission in the Proving Ground, marking a significant advancement in human exploration. It will build on the capabilities developed in low-Earth orbit and tested on space station, while pushing the envelope on state-of-the-art capabilities needed for the next human destination: Mars.

The mission will leverage new space suits and systems while evaluating sample-handling techniques and investigating opportunities to harvest resources from planetary surfaces. Just as advanced SEP will do for cargo, SLS and Orion will revolutionize deep space travel for humans traveling to destinations deep into the solar system.

The ARM represents a challenging and inspiring next step for humans in space on the journey to Mars, spurring the development and demonstration of advanced planetary defense and deep space exploration capabilities, and fostering innovative partnerships here on Earth.