SCIENTIFIC EXPLORATION OF NEAR-EARTH OBJECTS VIA THE ORION CREW EXPLORATION VEHICLE.

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Introduction: The concept of a crewed mission to a Near-Earth Object (NEO) has been considered since the early stages of the Apollo program [1] and has been analyzed in depth as part of the Space Exploration Initiative [2]. Several other studies have also investigated the possibility of sending similar missions to NEOs [3-6]. A recent study has been sponsored by the Advanced Projects Office within NASA's Constellation Program to examine the feasibility of sending a Crew Exploration Vehicle (CEV) to a NEO. The ideal mission profile would involve 2 or 3 astronauts on a 90 to 180 day flight, which would include a 7 to 14 day stay for proximity operations at the target NEO. This mission would be the first human expedition to an interplanetary body outside of the cislunar system and prove useful for testing technologies required for human missions to Mars.

Scientific and Practical Rationale: Piloted missions using the CEV to NEOs will not only provide a great deal of technical and engineering data on spacecraft operations for future human space exploration, but have the capability to conduct an in-depth scientific investigation of these objects. From a scientific perspective missions to NEOs are vital to understanding the evolution and thermal histories of these bodies during the formation of the early solar system, and to identifying potential source regions from which these NEOs originated.

NEO exploration missions will also have practical applications to resource utilization and planetary defense; two issues that will be relevant in the not-too-distant future as humanity begins to explore, understand, and utilize the solar system. A significant portion of the NEO population may contain water, an attractive source of life support and fuel for future deep space missions. The subject of planetary defense from impacting asteroids has garnered much public and Congressional interest recently because of the increasing discovery rate of asteroids with a small, but non-zero probability of striking Earth. Many proposed deflection schemes depend critically on asteroid characteristics such as density, internal structure, and material properties – precisely the parameters a crewed mission to a NEO could measure.

CEV Science Capabilities: A CEV-type mission will have a much greater capability for NEO science and exploration than would robotic spacecraft. The main advantage of having piloted missions to a NEO is the flexibility of the crew to perform tasks and to adapt to situations in real time. A human crew is able to perform tasks and react quickly in a micro-gravity environment, faster than any robotic spacecraft could (rapid yet delicate maneuvering has been a hallmark of Gemini, Apollo, Skylab, and Shuttle operations). In addition, a crewed vehicle is able to test several different sample collection techniques, and to target specific areas of interest via extra-vehicular activities (EVAs) much more capably than a robotic spacecraft. Such capabilities greatly enhance any scientific return from these types of missions to NEOs.

Conclusions: Much of the interpretation about the formation of asteroids and comets (i.e., parent bodies of the NEO population) is based on data from meteorite and inter-planetary dust particles recovered on Earth. However, with pristine samples from known locations within the solar system, scientists can start to "map outcrops" and glean new insights into the compositions and formation history of NEOs. While such knowledge will aid in a better understanding of our solar system, it also has the potential for more practical applications such as resource utilization and NEO hazard mitigation. These scientific, commercial, and hazard mitigation benefits, along with the programmatic and operational benefits of a human venture into deep space, make a mission to a NEO using Constellation systems a compelling prospect.

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