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HUMAN EXPLORATION OF THE MOON, MARS, AND NEOS USING PRESSURIZED VEHICLES: CHALLENGES, COMMONALITIES, AND THE ROLE OF HUMAN ROBOTIC PARTNERSHIPS

Abstract

The availability of nimble pressurized mobility systems or pressurized vehicles will be key to the human exploration of the surfaces of the Moon, Mars, and NEOs. Compared to unpressurized approaches for mobility systems, pressurized vehicles greatly extend the possible duration, range, and scope of surface exploration activities, in particular for science operations. Beyond the common challenges presented by space exploration in general, the greatest specific challenge facing the use of pressurized vehicles on Moon, Mars, or NEOs, is to be able to cope with the changing and often incompletely known physical conditions presented by the terrain being explored. We apply recent lessons learned through field science and exploration operations investigations at the Haughton-Mars Project (HMP) on Devon Island in the High Arctic, and in the Mojave Desert of California, to identify and analyze key challenges and commonalities for humans exploration using pressurized vehicles on the Moon, Mars, and NEOs. From our analysis, we identify potentially critical areas for human robotic partnerships and examine their implications in the context of the Global Exploration Roadmap. The HMP's Northwest Passage Drive Expedition, a simulated pressurized rover traverse across the Arctic carried out with three distinct crews over the course of 3 years (2009-2011) will be used to illustrate what some the key challenges for pressurized vehicle exploration may be. The Expedition has in particular yielded important insights for: a) the requirements of planning and re-planning of traverses, both in advance and in real-time; b) the critical advantages offered by dual and multiple pressurized vehicle traverse strategies vs single pressurized vehicle operations; c) the use of piloted and robotic ATVs for both scouting, fetching, and rescue functions; d) timelines for science operations and EVAs based on field and traverse realities; e) the critical advantages of incorporating IVA science operations systems such as vehicle external robotic arms; f) crew performance, real-time decision-making, and crew resource management (CRM); g) minimum crew sizes for pressurized vehicle traverses.