MOON DIVER: A MISSION CONCEPT FOR EXPLORING THE HISTORY OF LUNAR MARE DEPOSITS WITH THE AXEL EXTREME TERRAIN ROVER

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Introduction: The lunar mare basalt deposits serve as natural probes into the lunar interior. Studies of the morphologies and spectral properties of exposed surface basalts have yielded major insights into the thermal history and chemical composition of the Moon [e.g., 1-3]. Still unknown are the compositional, petrologic, and thermal changes in each mare basin through time; information which can only be accessed through examination of their cross-sectional exposure. Recent images returned by the Kaguya and Lunar Reconnaissance Orbiter missions have revealed the presence of deep mare pits containing meter-scale layer stratigraphy exposed in their walls ([4-6], **Fig. 1**). A mission to a mare pit would address numerous top priority lunar science goals laid out in community reviews [7], the Decadal Survey [8], and the Lunar Exploration Roadmap [9].

Before now, the desire to send a mission to these targets was tempered by the difficulty of reaching them given the mobility of traditional rovers. The Axel Extreme Terrain Rover [13], developed by the Jet Propulsion Laboratory in collaboration with Caltech, has the mobility necessary to approach, anchor, and rappel into this type of pit, revolutionizing our capability to access and explore in-place stratigraphy on the Moon.

The Axel Rover: The Axel rover consists of two wheels connected by a thick axle containing a winch and a tether [13]. Scientific instruments are housed inside the wheel well (**Fig 1**). Over flat terrains (for example, from the landing site to the investigation area), the Axel rover can traverse like an ordinary rover. Once it approaches a steep section, the Axel rover can set an anchor and rappel down the steep slope by letting out the tether stored inside the axle [10; **Fig. 1**]. Two Axels can be combined to form a "DuAxel" (**Fig. 1**), or one Axel can replace an axle on a more traditional rover body [10].

This functionality allows the rover to descend steep to vertical slopes (and ascend them again). The rover can even dangle in free space and continue to let out its tether.

The rover can communicate through its cable, alleviating common communication problems facing other cave-exploring robots. The rover can also receive power through its tether, meaning that it could leave a solar panel on the surface and still receive power to explore a dark cave below [10]. The functionality of this rover would allow a mission to examine and characterize lava layers exposed in the wall of a mare pit crater during abseil descent. Mineralogy (provided by the miniature spectrometer), texture (provided by the microimager), and measurements by additional instruments (housed by Axel's 6-8 instrument bays), or on the larger body of the DuAxel, would reveal changes in composition and morphology throughout the section. Axel's onboard cameras could record layer thicknesses and document the presence and characteristics of intervening soil layers.

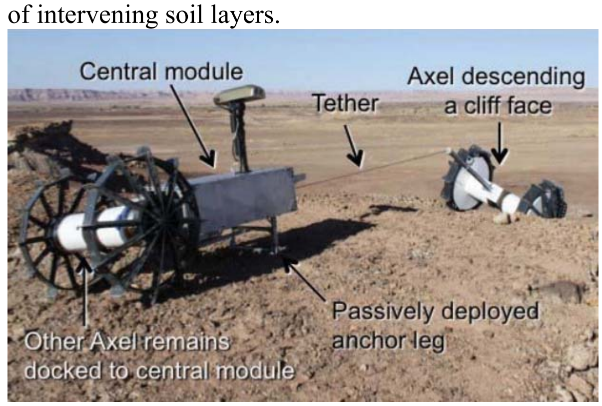

Figure 3. The DuAxel rover configuration at work in the field (figure from [10])

Once on the floor of the pit, or in a subsurface lava tube, Axel could explore potentially up to 1 km underground; [10]). After exploring the pit, the rover could reel itself back up the wall and either continue roving across the surface or rappel down a different side of the pit.

References:

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Acknowledgments: This work was carried out at the Jet Propulsion Laboratory California Institute of Technology under a contract with NASA.