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Moon Exploration – Part 2 (2B)

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MOON DIVER: DESCENDING INTO THE GEOLOGICAL HISTORY OF LUNAR VOLCANISM

Abstract

In 2009, the Japanese spacecraft Kaguya discovered several holes in the surface of the Moon, which may provide beneficial locations for future habitation, providing protection from radiation and micrometeorites and a refuge from the extreme temperature swings of the lunar surface. Scientifically, the treasure could be found within the walls of the pits: the exposure of near-vertical cross-sections through the Moon's uppermost crust, extending from the top of the regolith, through the regolith/bedrock transition, and through up to 70 m of intact lunar mare bedrock layers. The Moon Diver mission concept would employ the extreme-terrain Axel rover to descend into a pit in Mare Tranquillitatis, using it as a natural drill hole to access an unprecedented exposure through the regolith and bedrock of the Moon's secondary crust. The science goals are to understand the formation and evolution of the Moon's secondary crust, to achieve three objectives: (1) Determine the extent to which the regolith is representative of the underlying bedrock; (2) Determine whether the mare basalts were emplaced massively in turbulent flows, or if they were emplaced incrementally in smaller, but more numerous complex or inflated flows; and (3) Determine the composition(s) of the parental magmas of the exposed basalts and what they tell us about the magma source regions in the lunar interior. These objectives would be achieved by scaling the cross-section exposed in the wall of a mare pit, where both the process of regolith formation and the sequence of mare lava formation can be understood in their full contexts. The rover would carry a suite of three simple instruments: (a) a set of high-resolution cameras to capture the macroscale morphology of the regolith and near and far pit walls with color stereo images, (b) an Alpha-particle X-ray Spectrometer (APXS) to measure the elemental composition of both regolith and lavas, and (c) a Multispectral Microscopic Imager (MMI) that uses controlled LED lighting to characterize grain, vesicle, and crystal size as well as capturing spatially-resolved minerology. The rover would also carry a Surface Preparation Tool (SPT), which creates a fresh, flat surface for the instruments to examine when needed.