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THE NEXT STEP FOR PERMANENT HUMAN PRESENCE ON THE MOON, THE DEVELOPMENT OF THE LUNAR ECONOMY, AND THE FIRST STEP TO A SUSTAINABLE HUMAN MARS EXPLORATION PROGRAM

Abstract

Lunar exploration since Apollo shows the presence of volatile deposits in a variety of locations. Understanding the composition, abundance, variability, and form of the volatile deposits are exceedingly important for science (age and composition will yield important information about ultimate origin) and exploration (abundance, variability, and form of the volatile deposits for life support and rocket fuel).

Polar Ice Deposits: Clementine and Lunar Prospector missions showed significant H deposits in permanently shadowed regions (PSRs) at the lunar poles. These initial data were verified by the LCROSS mission that showed up to 5 wt

Surface OH Deposits: The M3 instrument on the Chandrayaan-1 mission showed the presence of surface OH extending from the polar regions. Its very presence was a huge surprise to the lunar science community. While probably not relevant for exploration, this discovery demonstrates how little we actually know about the interaction of the solar wind with airless bodies. Is this surface OH the feedstock for the PSR H deposits? If it is, what is the timescale for transport? (i.e., how renewable are these deposits?) This has important implications for exploration.

Volcanic Glass Deposits: Apollo 15 low-Ti green glasses contain significant volatile contents. The widespread presence of volatiles in the lunar mantle was confirmed by the analysis of the Apollo 17 high-Ti glasses. The M3 data have been used to show a significant OH/ H2O signature in many (but not all) volcanic glass deposits.

Capable landed missions that can survive the low temperatures in PSRs and multiple lunar day-night cycles are required to understand the composition, nature, heterogeneity, and how extensive these deposits are. The data returned will help science and exploration objectives. Most importantly, it will define whether these lunar resources are actually reserves. Such data are critical for the growth of the burgeoning commercial lunar sector as business cases can be robustly developed. If there are extensive volatile reserves present on the Moon, these would facilitate a cislunar refueling infrastructure for deep space missions that would not only facilitate a sustainable human Solar System program, it would develop a new sector of the global economy.