LUNAR SURFACE VOLATILES.

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Introduction: Since the publication of New Views of the Moon, understanding of surface volatiles on the Moon has increased significantly. In 2000, the existence of water on the Moon was a hypothesized, but not definitively demonstrated. Some tantalizing support for the presence of water existed in neutron observations consistent with the presence of H [1] and radar backscatter consistent with ice [2]; however neither of these observations provided conclusive evidence.

Since that time, an armada of spacecraft including Chandrayaan-1, Deep Impact, Cassini, LRO, LCROSS, and LADEE provided compelling evidence that water is not only present on the Moon, but it also is more prevalent than previously expected [3]. Additional information from Kaguya, ARTEMIS, Chang'e-3, ground-based telescopic observations, lab work, Apollo sample analysis, and modeling have expanded the understanding of the processes involved in the source, distribution, and retention of volatiles on the Moon.

Quantities of Interest: For both scientific understanding and for utilization of lunar volatiles as a resource to enable exploration, there are four main quantities of interest: abundance, distribution, composition, and physical form. These quantities have some relevant observations in recent years. Often it is the integration of these data sets that must be used to determine the answers. Scientifically, we would also like to understand the age and origin of these volatiles as they may provide further understanding of the volatiles distribution of the inner solar system. We present the state of knowledge on each of these quantities [4].

Physical Processes: Understanding of lunar volatiles is important for the understanding of the physical processes acting on the Moon and on other airless bodies in the solar system. In order to examine, constrain, and compare the physical processes that control the amount and distribution of volatiles on the surface of the Moon, it is important to study it as a system. The system begins with the sources of volatiles. Present day sources, and constraints on past sources, are being quantified by recent and ongoing missions [e.g. 5,6].

Next, the redistribution of the volatiles from the point of delivery is studied. Recent evidence points to a diurnal cycle of OH/H2O adsorbed to the surface [e.g. 7,8]. Volatiles migrating throught the aexosphere interact with the surface [9]. The LADEE observations of the Chang'e 3 exhaust plume was a controlled experiment of a real vapor release on the Moon that constrained these surface interactions [10]. Migration into te shallow subsurface may also serve as a reservoir for surface derived volatiles [e.g.11]. The migration influences the eventual delivery of volatiles to cold traps.

The stability of volatiles in permanently shadowed regions is the next piece of the system. New data regarding the thermal, illumination, radiation, and regolith properties in the PSRs have increased understanding of the retention and migration of volatiles in PSRs [e.g. 12]. In addition, the processes that remove volatiles from PSRs may not remove them from the system, but instead redistribute the volatiles laterally or with depth. This produces a heterogeneity in the distribution that provides insight into which processes have dominating effects. Understanding the volatiles in the PSRs, especially in comparision to similar regions on the planet Mercury, may provide insights to the age and origin of inner solar system volatiles.

Conclusion: Volatiles on the surface of the Moon are a potential resource, and hold a lot of information about important planetary processes.

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