CHARACTERISTICS AND EVOLUTION OF THE LUNAR REGOLITH. J. B. Plescia[1], [1]The Johns Hopkins University, Applied Physics Laboratory, Laurel MD 20723 USA (jeffrey.plescia@jhuapl.edu).

Introduction: The lunar regolith is the fragmental layer that covers the surface of the Moon (Figure 1). This is the surface that is observed by remote sensing instruments (with penetration depths ranging from microns to meters) and from which lunar samples were collected and returned to Earth. It is also the surface on which surface instrumentation was placed. Understanding the characteristics, formation and evolution of the lunar regolith is thus critical to understanding the data and samples.

Data from recent lunar missions and research have provided a more precise picture of the nature of the lunar regolith and how it varies laterally and vertically. Those data have also begun to show how the regolith evolves over time. Of particular interest is the properties of regolith in areas of permanent shadow where the surface temperature can reach 40K [1].

Formation Mechanisms: The lunar regolith is composed of rock and mineral fragments as well as agglutinitic glass, with particle sizes ranging from microns to tens or hundreds of meters. Projectiles ranging in size from micro-meteorites to asteroids have impacted the surface over billions of years continuously reducing the size of the particles and vertically mixing the materials [2-7]. In addition to physical destruction, thermal fatigue [8-9] can induce mechanical failure reducing the grain size over time. The result is a layer that is meters thick overlying more intact basalt in the mare and a basin-ejecta megaregolith in the highlands [10-11].

Figure 1. Lunar regolith at the Apollo 16 site.

Each new impact excavates material from depth that is typically less mature than the surrounding regolith and it forms a deposit of material ranging from boulders to dust surrounding the crater. As that new material is exposed, it is subjected to mechanical and thermal stress and the effects of space weathering.

Physical Properties: The Apollo core samples demonstrate that while the regolith is layered, the layers are not laterally continuous. Layers represent individual impact ejecta deposits and those deposits extend only about 1 crater diameter from the source crater. The result is an overlapping of approximately circular deposits of varying thickness and diameter.

The density of the regolith increases rapidly with depth over the upper 1 m and then appears to be more or less constant (although there is no direct data). UV and visible photometry shows that the uppermost few microns to millimeters is composed of a fine-grained, very porous structure having low density.

Volatile Storage: The regolith has an abundance of H in the polar areas, particularly in areas of permanent shadow. The H-bearing species is assumed to be H_2O although the material has not been directly sampled. Thermal modeling, ultraviolet and radar data suggest it is H_2O [12-15]. OH and H_2O occur across the surface as an ephemeral adsorbed layer that migrates on a diurnal time scale. It has also been suggested that there is significant transport of H (or H-bearing species) into and out of the regolith on diurnal time scales [18]. Understanding the processes of volatile migration requires an understanding the physical structure of the regolith (e.g., porosity, permeability).

Summary: Our understanding of the properties of the lunar regolith, its formation, and the role it plays in the production, transport and storage of volatiles has changed dramatically over the last decade. We now have sufficient information to quantitatively understand the active processes.

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