LUNAR REGOLITH - NEW VIEWS. J. B. Plescia[1], M.S. Robinson[2] and G. Kramer[3] [1]The Johns Hopkins University, Applied Physics Laboratory, Laurel, MD USA 20723, [2]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287, [3]Lunar and Planetary Institute, Houston, TX 77058.

Introduction: The lunar regolith, that grainy, texturally complex, deposit that covers the Moon's surface has been revealed to be a more complicated system than previously recognized. Pre-Apollo, the regolith was viewed as a static layer that kept the Moon warm in the coldness of space. More recently, data from many robotic missions indicate that the regolith hosts and possibly drives a complex volatile cycle. We now have a better view of how density and thermal properties of the regolith vary with depth and across the surface, the current cratering rate and the timescale of overturn and gardening, latitudinal variations in regolith properties and temporal variability of volatiles (H, OH, H_2O) on and within the surface. An intriguing aspect is that many fresh craters have ejecta blankets that are thermally anomalous (unusually cold at night).

Density: The regolith density profile, based on Apollo and Luna cores, is not a simple function of depth, but varies among layers and between cores [1]. Individual core layers can not be traced laterally and so at any given point, details vary. However, the sum of these individual layers results in a density stratigraphy that smoothly increase with depth and can be modeled using the Diviner thermal data [2, 3, 4].

Regolith Gardening: The process of crater formation causes overturn of the regolith; the depth of turnover and amount of material displaced correlate with the energy of the event. The rate of overturn is an important control on the maturity of the regolith, and the rate at which rocks and boulders are excavated from depth. Originally, a gardening rate (99% of the material would be overturned) for 20 cm was estimated at >5 x 10^9 yr. [4, 5]. Using the number of contemporary impact events, revealed through LROC temporal imaging, the overturn rate for the top 20 cm was estimated to be 10^7 yr. [6].

Siegler et al. [7] observed a mirror image offset from the north and south poles of large-scale H deposits and proposed that the offset was due to true polar wander. If H enriched regions indeed indicate polar wander, the retention of anomalously high H over billions of years demands that the gardening rate is significantly lower than current estimates or gardening does not effect adsorbed H.

Rock Survival: Rocks on the lunar surface have been assumed to be obliterated by catastrophic rupture (largest fragment <50% of the original). Such models [8] predict the median lifetime for a population of 10 cm rocks of the order 10^7 years. Catastrophic breakup dominates over micro-meteorite abrasion. More recently, thermal fatigue has been suggested to contribute to rock breakdown. Interior temperature gradients cause stresses that propagate fractures and break apart the rock [9-11]. This process is estimated to considerably reduce surface rock lifetime.

Latitude Variability: The H parameter [3], an estimate of the density profile (and thus thermal inertia) of the top 10s cm of the regolith, may vary with latitude suggesting a change in the regolith properties with latitude. Polarimetry [12] indicates the grain size of the uppermost surface increases from ~ 60 µm at the equator to 115 µm at high latitude. Radar CPR decreases with latitude [13] suggesting that the polar regolith (top 10s cm) is less dense than equatorial regolith. Far-UV and thermal data also suggest a decrease in regolith density profile [3, 14].

Volatile Variability: Absorptions near 3 µm in reflectance spectra indicate that the amount of OH and/or H_2O on the surface (to mm depth) varies as a function of latitude and time of day [15-16]. Neutron absorption [LRO LEND; 17] and proton reflectivity [CRaTER; 18] also both suggest that the amount of H in the shallow subsurface (10s cm) varies diurnally. The implication is that significant quantities of H must be moved into and out of the regolith (10s of cm) over diurnal timescales.

Conclusions: New measurements are providing insight into processes occurring on and in the regolith, answering some questions and raising many new questions about regolith formation and evolution and how the regolith forms, stores and transports volatiles.

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