NEW INFRARED VIEWS OF THE MOON FROM DIVINER. D. A. Paige[1] and The Diviner Team, [1]Dept. of Earth, Planetary and Space Sciences, UCLA (dap@moon.ucla.edu)

Introduction: During the past decade, remote sensing datasets have filled many gaps in lunar knowledge. The Diviner Lunar Radiometer Experiment on the Lunar Reconnaissance Orbiter has mapped the lunar surface for almost seven years, acquiring a dataset of unprecedented quality, detail, and coverage. The analysis of these data has provided several new views of the moon that can be summarized as follows.

Lunar Thermal Environment: Surface and near-surface temperatures of the moon represent a key boundary condition on the thermal state of the lunar interior, lunar surface processes, the behavior of volatiles, and the interaction between the lunar surface and the lunar exosphere. LRO's polar orbit has enabled Diviner to acquire multi-spectral infrared observations over the entire lunar surface at all local times at a spatial resolution of <500 meters. These measurements enable detailed characterization of diurnal and seasonal surface temperature variations, which provide valuable information regarding regolith structure and evolution, as well as the behavior of volatiles. They also reveal the moon to have one of the most extreme thermal environments in the solar system, although some highly rocky areas may have more hospitable thermal environments for long-term human habitation.

Lunar Regolith Properties: Diviner's time-varying multispectral measurements provide information on the bulk thermal properties of the regolith from cm to meter scales. More than 98% of the moon's surface is covered with fine-grained dust that increases in density with depth. Young impact craters have excavated large (>1m) blocks that are readily detectable as warm anisothermal anomalies in nighttime infrared maps. The youngest impacts on the moon are surrounded by extensive regions containing low-density soil and are detectable as cold anomalies in nighttime infrared maps. The creation of these "Diviner cold spots" appears to be a ubiquitous lunar process.

Lunar Regolith Evolution: By correlating crater age measurements from lunar samples and crater counts with Diviner rock abundance data, it has been possible to obtain a much clearer picture of the rate at which the lunar surface evolves over time. The typical time-scale for the degradation and burial of ejecta blocks on the lunar surface by micrometeorite bombardment is on timescales ~500 million years. By cataloguing the density of rocky craters in various states of degradation, it has been possible to infer that the impact flux as recorded by the moon has increased by a factor of two during the past 300 million years. Superposed on this process is the creation and degradation of lunar cold spots, which appears to occur on timescales of ~200,000 years.

Lunar Composition: Diviner uses three narrow channels near 8 microns wavelength to map the location of the Christiansen Feature, a thermal emission feature which is related to bulk silicate polymerization, occurring at shorter wavelengths for feldspathic minerals and longer wavelengths for mafic minerals. Diviner's compositional maps show that Most lunar terrains have spectral signatures that are consistent with known lunar anorthosite and basalt compositions. However, the data have also reveal the presence of highly evolved, silica-rich lunar soils in kilometer-scale and larger exposures, expanding the compositional range of the anorthosites that dominate the lunar crust, and shown that pristine lunar mantle is not exposed at the lunar surface at the kilometer scale. Together, these observations provide compelling evidence that the Moon is a complex body that has experienced a diverse set of igneous processes.

Polar Volatiles and Heat Flow: Diviner has made extensive thermal emission measurements in the lunar polar regions. The results show that the moon's permanently shadowed regions are considerably colder than had been pre-LRO models had predicted. The moon's polar regions contain extensive surface and subsurface regions that are cold enough to permit the thermal stability of water ice and other volatile and organic species. LCROSS detected the presence of a number of volatile species at its impact site in Cabeus Crater. Diviner measured temperatures of lower than 37K in this area, which allows for the thermal stability of the diverse range of volatiles that LCROSS detected. Other data sources suggest that the moon's polar cold traps are depleted in water ice and other volatiles, at least near the surface. This is in sharp contrast to the results of Earth-based radar and MESSENGER observations at Mercury, which show the presence of abundance near-surface water ice. Diviner has measured annual minimum brightness temperatures of less than 20K in localized areas in the lunar south polar region. These measurements can be used to infer upper limits for the heat flow rate from the lunar interior. The results suggest that average global heat flow on the moon is considerably lower than that measured at the Apllo 15 and 17 sites, which is consistent with measurements of the concentration of radiagenics in the lunar crusts and models for the composition of the lunar mantle