Geophysical Research Abstracts
Vol. 16, EGU2014-4619, 2014
EGU General Assembly 2014


# Revealing lunar crustal density stratification with GRAIL data

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The bulk density of the porous lunar crust has recently been mapped using high-resolution gravity provided by the Gravity Recovery and Interior Laboratory (GRAIL) mission. However, the vertical structure of the crust, which is key to understanding its thermal and seismic characteristics, and its origin and subsequent modification, is currently poorly known.

Here, we analyze GRAIL data using a localized, multitaper admittance approach to determine the vertical density structure of the lunar crust. We used spherical harmonic coefficients of the Moon's gravity, topography, and topography-induced gravity fields up to spherical harmonic degree $\ell = 550$. The gravity data were derived from the GRAIL nominal and extended missions' tracking data; the topography data were derived from the principal axis referenced Lunar Orbiter Laser Altimeter (LOLA) data.

We find that mare regions are characterized by a distinct decrease in density with depth, while the farside is characterized by an increase in density with depth at an average rate of $\sim 30$ kg m$^{-3}$ km$^{-1}$ and typical surface porosities of 20 %. Such high inferred surface porosity values are compatible with Apollo samples and lunar meteorites. The Apollo 12 & 14 landing site region has a similar density structure to the farside, permitting a comparison with seismic velocity profiles. The South Pole-Aitken (SP-A) impact basin region appears distinct with a near-surface low-density (porous) layer 2-3 times shallower than the rest of the farside. This result suggests that redistribution of material during the large SP-A impact likely played a major role in sculpting the lunar crust. Mapping the spatial distribution of shallow porosity, as we have attempted here, will allow comparison with other data sets.