THE LUNAR SOUTH POLAR CRUST. David E. Smith[1], Maria T. Zuber[1], Gregory A. Neumann[2], Sander J. Goossens[3], Erwan Mazarico[2], and James W. Head[4], [1]Dept. of Earth, Atmospheric and Planetary Sciences, MIT, 77 Massachusetts Ave., Cambridge, MA 02139 (smithde@mit.edu); [2]Solar System Exploration Division, NASA Goddard Space Flight Center, 8800 Greenbelt Rd. Greenbelt, MD 20771; [3]Center for Research and Exploration in Space Science and Technology, University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore MD 21250, [4]Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI 02912.

Introduction: Global high-resolution gravity [1] and topography [2] of the Moon provide a unique opportunity to study the shallow structure of the lunar crust. Together, these datasets provide information on the thickness, density and porosity of the crust, and their variation with both location and depth.

Here, recognizing the non-uniqueness of gravity observations, we explore the relationship of these crustal properties in the region of the lunar south pole for both the largest structures, such as the South Pole-Aitken basin as well as some smaller impact features.

Bouguer Gravity: Correcting the free-air gravity for the potential due to the topography produces Bouguer gravity, which reveals the anomalous gravity due to density contrasts within the Moon. In this process the density of the material that comprises the topography is adjusted so as to minimize the undulations of the Bouguer gravity on the reference surface, usually defined as the mean radius of the region.

The spherical harmonic representation of gravity has an implied scale that relates the harmonic degree to physical distance with the lowest degrees corresponding to larger dimensions and the higher degrees to smaller dimensions.

In Figures 1 and 2 we show the Bouguer gravity of the lunar south pole region below latitude 80S for the degrees 2-10 (Fig 1), and 120-540 (Fig 2).

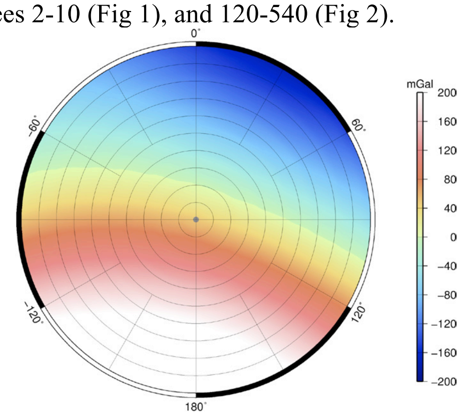

Figure 1. Bouguer gravity field of the lunar south pole poleward of latitude 80S for degree 2-10 representing scales of 500-2500 km. The field at these scales is dominated by South Pole-Aitken basin.

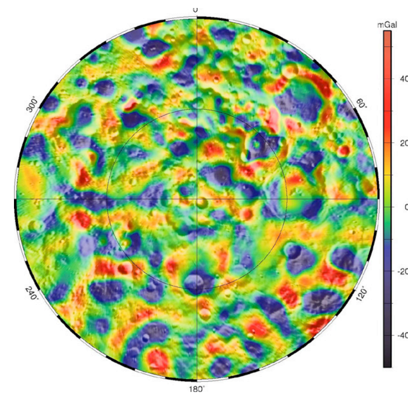

Figure 2. Bouguer gravity field of the lunar south pole below Lat 80S for degree 120-540 represnting scales of 10-45 km. Craters and smaller impact basins dominate the Bouguer gravity at these scales with much of the signal arising from within the crust.

These two figures show that SP-A, which dominates at the long wavelengths, shows no evidence of SP-A at short wavelengths, such as more, fewer, or different style craters and hence supporting the argument that SP-A is much older than the present surface.

Crustal Thickness: Fig. 3 shows the crustal thickness in the south polar region for degrees 2-420, so it includes the longer wavelengths as well as most of the shorter wavelengths in Fig 2.

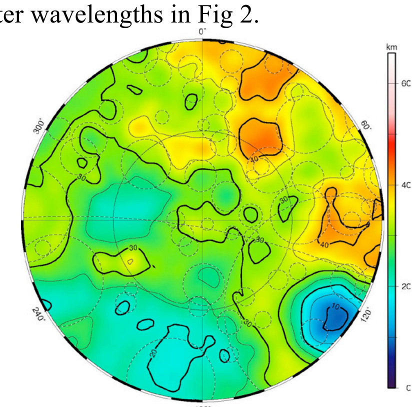

Figure 3. Crustal thickness of the lunar south pole below latitude 80S of model 1 by Wieczorek et al. [3].

Within SP-A Fig. 3 indicates the crustal thickness is generally about 15 km, less than half the average thickness of the lunar crust, with the exception of the southern most part of the Schrodinger crater where the crust is probably less than 10 km thick. There is a very high liklihood that a melt sheet comprises much of the crustal column in this region, and [4,5] have explored the implications for the gravity data.

We have previously investigated the environment of lunar south pole volatile emplacement and age [6,7]. Here we ask, could volatiles slowly released from the upper crust, be the source of the H_2O ice detected on the lunar surface? If this process were to exist then the Bouguer gravity field might show negative anomalies in region of the more prominent locations where hydrgogen has been identified by LEND data, i.e. the Cabeus and Shoemaker craters. However, investigating the Bouguer field by degree-range, implying depth, shows no obvious connection between ice and gravity except at the surface where the anomalies could just as easily be variations in local porosity resulting from the impact process.

References: [1] Zuber, M. T. et al. (2013) *Science 339,* 668-671, doi:10.1126/science.1231507. [2] Smith D. E. et al. (2010) *Geophys. Res. Lett. 37,* doi:10.1029/2010GL043751, [3] Wieczorek M. A. et al. (2013) *Science 339,* 671-675, doi:10.1126/science.1231530. [4] Vaughan, W. M., and J. W. Head, Planet. Space Sci., 91, 101-106, doi: 10.1016/j.pss.2013.11.010. [5] Vaughan,W. M., et al. Icarus, 223, 749-765, doi: 10.1016/j.icarus.2013.01.017. [6] Zuber, M. T. et al., *Nature, 486,*378–381, doi: 10.1038/nature11216. [7] Tye, A. R., et al., Icarus, 255, 70-77, doi: 10.1016/j.icarus.2015.03.016