RE-EVALUATING THE GEOPHYSICAL EVIDENCE FOR A PROCELLARUM IMPACT BASIN ON THE LUNAR NEARSIDE.

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Introduction: The lunar Procellarum region has been proposed to be a mega-basin on the basis of its composition, low topography, thin crust, and possible basin rings [1,2]. However, the evidence for and against the Procellarum basin is equivocal [3]. Here the geophysical evidence for the Procellarum basin is re-evaluated using gravity [4] and topography [5] data.

Gravity and crustal thickness: GRAIL gravity data revealed a quasi-rectangular pattern of magmatic-tectonic structures surrounding Procellarum [6]. These structures are incompatible with an interpretation as the rim of an ancient basin, but do not rule out the possibility of such a basin. The thin crust in Procellarum appears consistent with a basin [7]. However, the long-wavelength variations in crustal thickness are dominated by the nearside-farside asymmetry (degree 1), with superposed bulges on the nearside and farside (degree 2). The symmetry of these low degree patterns favor simple models that make *a priori* predictions of degree 1 and 2 variations [8–12]. Although a giant impact might be invoked to explain the asymmetry, the degree 1 pattern is centered on a point that is far from the center of Procellarum. After removal of degrees 1 and 2, the crust in Procellarum is no thinner than that in the surroundings. The remaining crustal thickness signature of Procellarum is noteworthy only for the buried rift valleys previously identified in GRAIL data [6].

Topography and slopes: Although the preservation of a rim scarp is unlikely for a structure of such great antiquity, the long-wavelength signature of the topographic transition at the edge of the basin may still be expected to be preserved. To test for the signature of the basin rim, slopes were calculated from spherical harmonic topography with a low-pass cosine taper between degrees 20 and 30 (corresponding to a spatial wavelength of 440 km). This filter highlights the rim of the ancient SPA basin. In contrast, the proposed Procellarum basin is noteworthy only for the very low slopes over the maria contained within the region, with slopes along the proposed basin rim rarely rising above the mean farside slope.

Summary: The observed crustal thinning in Procellarum is entirely explained degree 1 and 2 variations in crustal thickness that are likely a result of early asymmetries in crustal formation. The proposed basin is not surrounded by a topographic transition that can be interpreted as a basin rim. Structures observed in gravity data trace out a polygonal pattern and are a result of early magmatic and tectonic processes. Geophysical evidence does not support the existence of the Procellarum basin.

References: [1] Cadogan P. H., (1974), *Nature*, *250*, 315–316. [2] Whitaker E. A., (1981), in *Multi-ring Basins*, P. H. Schultz and R. B. Merrill, Eds. pp. 105–111. [3] Spudis P. D. and Schultz P. H., (1985), *LPS XVI*, 809-810. [4] Zuber M. T. et al., (2013), *Science*, *668*, 1–5. [5] Smith D. E. et al., (2010), *GRL, 37*, 1–6. [6] Andrews-Hanna J. C. et al., (2014), *Nature*. *514*, 68–71. [7] Wieczorek M. A. et al., (2013), *Science, 339*, 671–675. [8] Roy A. et al., (2014), *Astrophys. J., 788*, L42. [9] Byrne C. J., (2007), *Earth, Moon Planets*. *101*, 153–188. [10] Loper D. E., (2002), *JGR 107*, doi:10.1029/2000JE001441. [11] Jutzi M. and Asphaug E., (2011), *Nature*, *476*, 69–72. [12] Garrick-Bethell I. et al., (2014), *Nature*, *512*, 181–184.

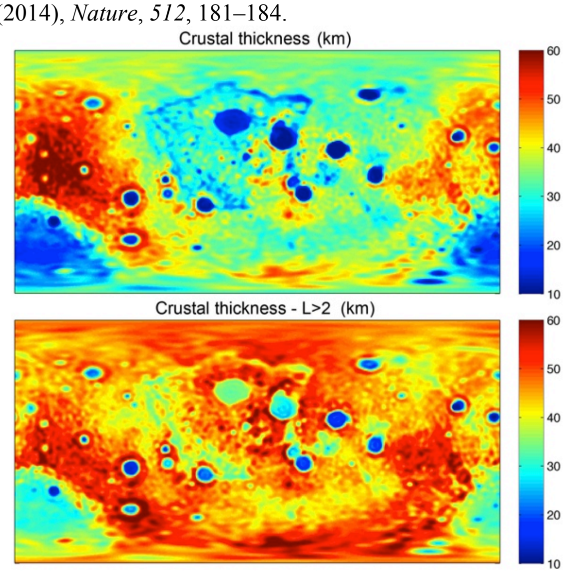

Figure 1. Crustal thickness [7] for all degrees (top; centered on nearside) and after removing degrees 1 and 2 (bottom).

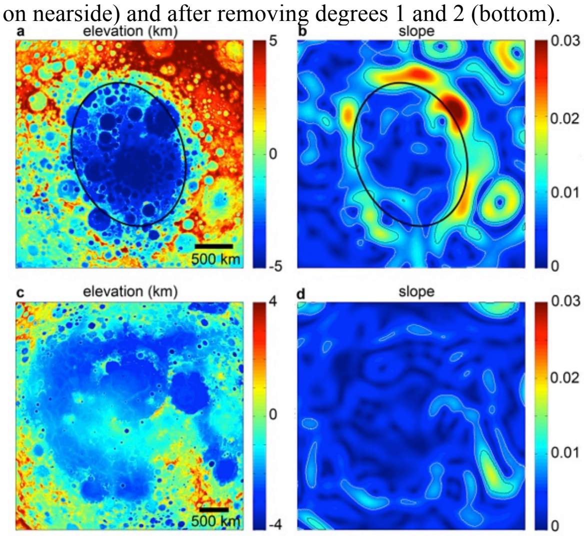

Figure 2. Topography (left) and slope (right) for the SPA basin (**a,b**) and Procellarum region (**c,d**). Black and white contour lines indicate the +1σ and +2σ slopes of the farside.