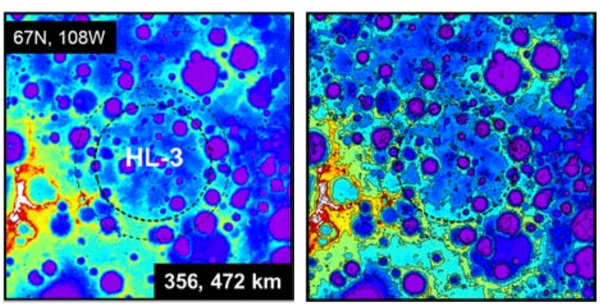
NEW CANDIDATE LARGE LUNAR BASINS FROM LOLA DATA H. V. Frey, Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, Herbert.V.Frey@nasa.gov, and G.C. Romine, San Francisco State University

Summary: LOLA data provide evidence for a significant number of new candidate large basins not previously recognized in earlier, lower resolution topographic data. Combined with a LOLA-based test of large candidate basins derived from ULCN2005 and model crustal thickness data (see companion abstract), we suggest the number of basins > 300 km diameter on the Moon likely exceeds 100, more than twice the number suggested from photogeologic studies.

Introduction: In a companion abstract [1] we use recent Lunar Orbiter Laser Altimeter (LOLA) data to test the validity of candidate lunar basins suggested by Unified Lunar Control Net 2005 data [2] and by model crustal thickness data [3]. We determined a "Topographic Expression" score using LOLA data and compared that with a similar score derived for each candidate basins using the ULCN2005 data. Of 98 basins originally suggested from these older data [4] we would delete < 15 based on the new LOLA data; most of the candidate unnamed Quasi-Circular Depressions (QCDs) found in the ULCN2005 data, and the Circular Thin Areas (CTAs) found in the model crustal thickness data, area likely previously unknown large impact basins.

LOLA data was also used to search for more subtle new candidate basins that the older, lower resolution data would not have been able to reveal. This was done independently be each of us in the same way earlier candidates were determined from ULCN2005 and later evaluated using an interactive graphics program called GRIDVIEW to stretch, contour and profile LOLA data at both 16 and 32 pixel/degree resolution. We found a large number of candidate QCDs, many of which also had CTA signatures in model crustal thickness data. Several examples are shown below.



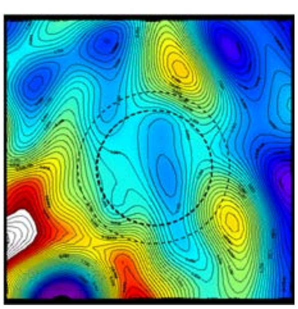
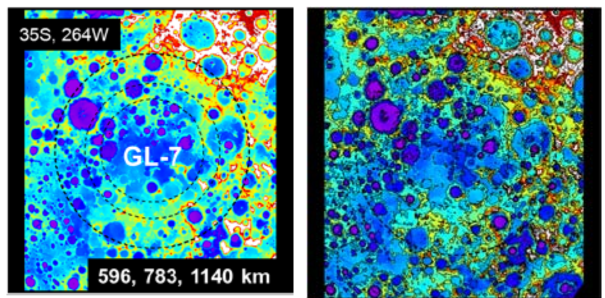


Figure 1. Candidate basin HL-3 is a Quasi-Circular Depression in stretched LOLA topography (above), shown with 500 m contours (upper right). The candidate basin also has a weak signature in model crustal thickness data (left) contoured at 1 km.

Results. Figure 1 shows a candidate basin perhaps > 450 km in diameter revealed in LOLA data, which also has a somewhat elongated CTA signature. This is a rare high northern latitude candidate. Our earlier inventory [4] derived from older data had very few high northern latitude QCDs or CTAs, and even this new feature is fairly subtle. It remains a puzzle why there are so few obvious large impact basins at high northern latitudes.

Figure 2 shows a second example of a candidate large basin first found in LOLA data. If real, this feature is of Imbrium size with an outer ring 1140 km in diameter. The topography provides suggestions for inner rings as well. This area was the site of several somewhat smaller candidate basins earlier suggested based on ULCN2005 topography [4]. As a result of the testing describe in the companion abstract [1], tight clustering of smaller impact craters, and the evidence for this larger candidate basin, several of those smaller features have been deleted from the current inventory.

Model crustal thickness data in this area are also consistent with a larger basin, as shown in the Figure.



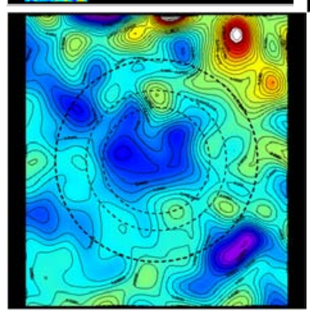


Figure 2. New candidate basin GL-7 is an Imbrium-size candidate basin found in LOLA data (above). Topographic contours are 500 m; crustal thickness signature (left) has 2.5 km contours and has a structure supporting the existence of this candidate basin.

One additional example is shown in Figure 3. This includes the area where Wilhelms [5] lists a large (580 km diameter) "possible" basin called Marginis. Neither the LOLA topography (top left) nor the model crustal thickness data (top right) provide any compelling evidence for this basin, which is located east of Crisium and north of Smythii. Marginis was one of ten Wilhelms basins that were excluded from our earlier inventory [4] for lack of basin-like topographic structure, and the higher resolution LOLA data is certainly consistent with this. Much more compelling is the QCD signature of what appear to be two overlapping basins, HL-1 and GL-6, though HL-1 is very much overprinted by the Crisium ring structure. It is in fact departures from the circularity of that ring structure in the topography that suggest the presence of an underlying structure.GL-6 is likewise overprinted by Smythii, so these two LOLA-found candidate basins are clearly older than the large named basins whose formation has no doubt obscured the original structure and made them far less obvious to photogeologic observation.

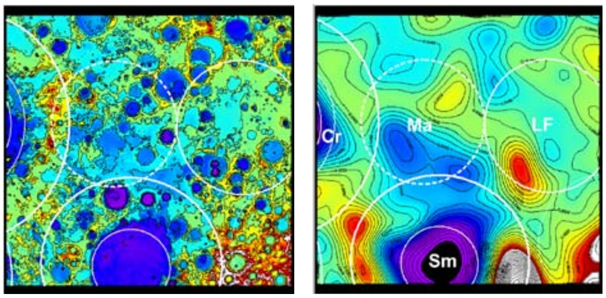


Figure 3a. LOLA topography (left) and model crustal thickness data (right) for the area east of Crisium (Cr) and north of Smythii (Sm). MA is the “possible” Marginis Basin from Wilhelms [5] list, which is not well supported by either the topography or crustal thickness data. LF = Lomonosov-Fleming.

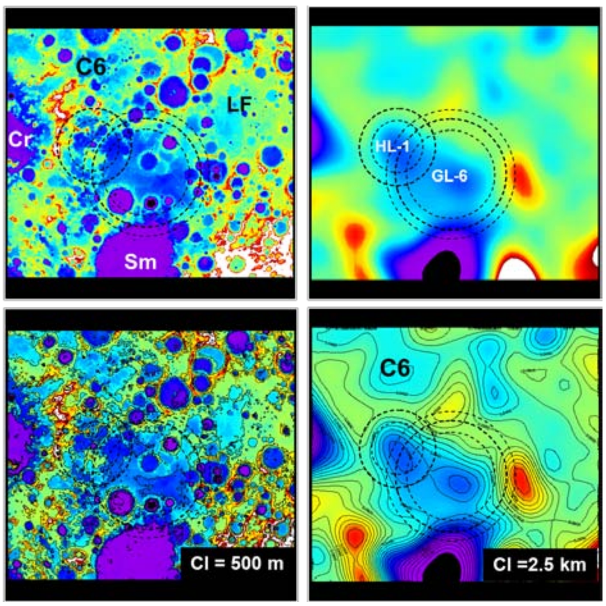


Figure 3b. Two overlapping candidate basins, HL-1 and GL-6, are suggested by the LOLA topography (left) and may explain the elongate, double lobe character of the model crustal thickness data (right) shown above. Bottom panel shows contours (500 m, 2.5 km for topography crustal thickness, respectively).

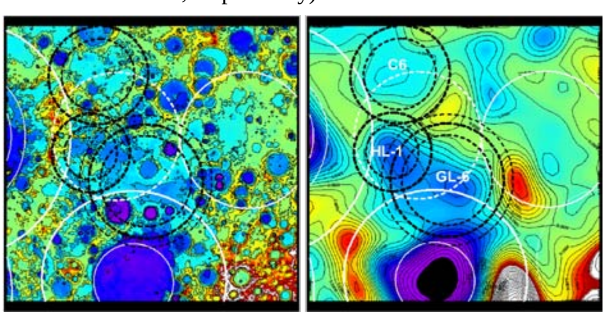


Figure 3c. New candidate basins HL-1 and GL-6, together with the CTA C6, better described both the topography (left) and the crustal thickness (right) character of this area than does the possible Marginis Basin.

Current inventory of candidate large basins. The LOLA test described in the companion abstract [1] suggested removing perhaps 12 and certainly no more than 15 entries from the earlier inventory of 98 [4]. The initial search conducted here by each of us independently suggested those losses are more than made up by possible new candidates found in the LOLA data, most of which also have good crustal thickness signatures. GL found evidence for 18 new QCDs, of which 12 appear to be good candidates. HF found another 9 candidates; 6 of these are strong possibilities. The current inventory is 104. The population of large impact basins on the Moon is likely at least a factor 2 greater than that suggested by photogeologic studies alone [4].

Figure 4 shows the cumulative frequency curve for this inventory, compared with that from the full list of 45 named basins from Wilhelms [5] and the smaller number (33) that actually have basin-like topography. The new curve is essentially identical to that found earlier using ULCN2005 topography [4], also shown, and follows a -2 powerlaw trend down to the 300 km diameter cutoff. By contrast, the basins derived from photogeologic studies alone show a sharp departure from this -2 powerlaw trend for D<500 km, most likely some observational falloff perhaps related to lighting conditions for the best available imagery used [4].

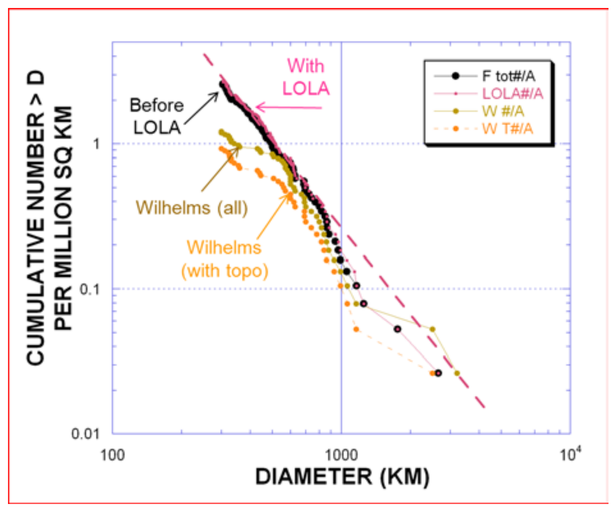


Figure 4. Cumulative frequency curves for the current inventory on candidate large lunar basins compared with that from the earlier inventory of 98 basins, the full list of 45 Wilhelms basins, and for the 33 named basins having basin-like topography.

References. [1] Romine, G. and H. Frey. (2011) LPSC XVII (this volume). [2] Archinal, B.A. et al. (2006) USGS Open File Report 2006-1367. [3] Wieczorek, M.A. et al. (2006) New views of the Moon: Reviews in Mineralogy and Geochemistry, vol. 60, 221-364, 2006. Downloaded from http://www.ipgp.fr/~wiecz0r/CrustalThicknessArchive/CrustalThickness.html [4] Frey, H.V. (2010) Chapter 2, GSA Special Publication *Recent Advances and Current Research Issues in Lunar Stratigraphy* (in press). [5] Wilhelms, D.E, (1987) The Geologic History of the Moon, USGS Professional Paper 1348.