IMPROVING THE INVENTORY OF LARGE LUNAR BASINS: USING LOLA DATA TO TEST PREVIOUS CANDIDATES AND SEARCH FOR NEW ONES H.V. Frey, Planetary Geodynamics Lab, Goddard Space Flight Center, Greenbelt, MD 20771, Herbert.V.Frey@nasa.gov, H.M. Meyer, Geology & Environmental Geosciences, College of Charleston, Charleston, SC, and G.C. Romine, Physics & Astronomy, San Francisco State University, San Francisco, CA.

Summary: Topography and crustal thickness data from LOLA altimetry were used to test the validity of 98 candidate large lunar basins derived from photogeologic and earlier topographic and crustal thickness data, and to search for possible new candidates. We eliminate 23 previous candidates but find good evidence for 20 new candidates. The number of basins > 300 km diameter on the Moon is almost certainly a factor 2 (maybe 3?) larger than the number of named features having basin-like topography.

Introduction: Unified Lunar Control Net 2005 data [1] and model crustal thickness data [2] were previously used to search for possible previously unrecognized large lunar impact basins [3,4]. An inventory of 98 candidate topographic basins > 300 km in diameter was found [5]. This includes 33 named features (only those having basin-like topography) out of the 45 listed by Wilhelms [6], 38 additional Quasi-Circular Depressions (QCDs) found in the ULCN2005 topography, and 27 Circular Thin Areas (CTAs) found in model crustal thickness data [2]. Most named features and adddi-tional QCDs have strong CTA signatures, but there may be a class of CTAs that are not easily recognized in the old and low resolution ULCN2005 topography.

Lunar Orbiter Laser Altimeter (LOLA) data have recently become publically available. We used these data to (a) refine the center and ring diameters of known basins, (b) test the viability of the candidate basins previously found (as described above), and (c) search for additional candidate basins not revealed by the earlier lower resolution data. We used the LOLA topography directly but also a recent new model crustal thickness data that includes Kaguya gravity data [7]. We repeated a "Topographic Expression" (TE) and a "Crustal Thickness Expression" (CTE) scoring exercise originally done with the basins found in ULCN and earlier model crustal thickness data [5]. Each candidate was scored on a scale from 0 (no topographic basin or circular thin area signature) to 5 (strong circular low or strong circular thin area signature). These were combined into a total score used to rank the probability for each candidate basin. We used the same GRIDVIEW software to stretch, contour and profile the LOLA and new crustal thickness data as was done with the ULCN2005 and older model crustal thickness data.

Figure 1 compares ULCN2005 and LOLA topography for three named basins. LOLA data clearly shows better the circular basin and raised rim structure of obvious features like Orientale or Poincare. Orientale rates a 5 Topographic Expression (TE) score in both data sets. Poincare QCD structure, evident in the older data, is even more obvious in the higher resolution LOLA data. The TE scores for this basin are 3 and 4 for ULCN and LOLA topography, respectively. Australe was previously noted as not having basin-like structure in ULCN2005 topography [5]; the same is true in LOLA data. Australe could have had a TE score of -1 or -2 in ULCN data; from the LOLA data we give it a 0.

Figure 2 shows a similar comparison between older [2] and more recent [7] crustal thickness data for the Lorenz Basin. The CTE score goes up considerably in the new data.

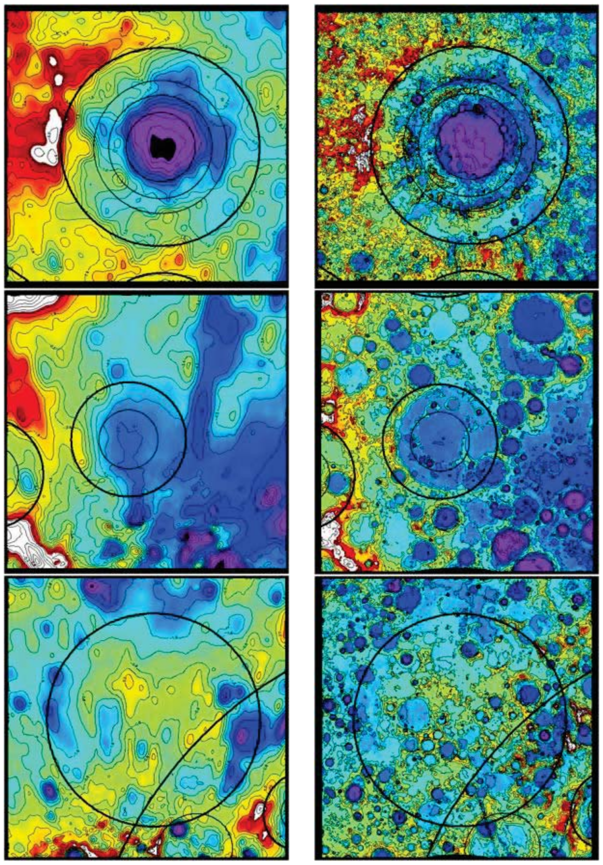


Figure 1a. ULCN2005 (left) and LOLA (right) topography for the area around the (top to bottom) Orientale (D=930 km), Poincare (D=331 km) and Australe (D=880 km) Basins, all named in Wilhlems' [6] list. Contour interval is 400 m for both. The much improved resolution of the LOLA data is obvious. Orientale and Poincare are obvious basins; Australe lacks basin-like structure.

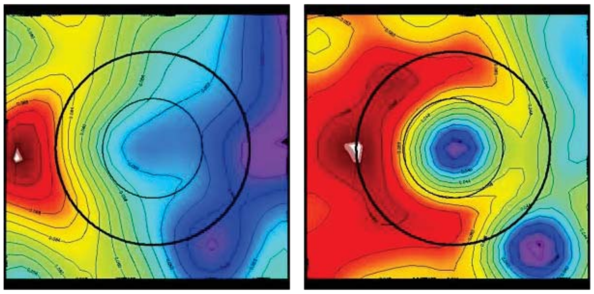


Figure 2. Older [2] (left) and more recent [7] (right) model crustal thickness data for the area around the Lorenz Basin. A weak Circular Thin Area (CTA) structure was suggested by the older data (CTE score = 1) but is very obvious in the newer model (CTE score $\geq$ 4).

Testing the previous candidates: For all previous candidates two or more of us re-evaluated the TE score (HF, GR, HM) and the CTE score (HF, HM). We are in good agreement for nearly all candidates, and especially on which candidates should be eliminated from the earlier inventory. **Named Basins:** The earlier study [5] found no topographic basin structure for 10 named basins [6]. The same 10 are again eliminated because LOLA data also shows no basin-like structure. In addition, Sikorsky-Rittenhouse is now dropped because LOLA data show that the diameter is actually < 300 km [8], the cutoff for our inventory. **Additional QCDs:** We eliminate 11 additional QCD candidates from the earlier study [5] mostly because the improved resolution of LOLA data show that both the apparent large circular structure and the depth of the proposed candidate basin can be explained by clusters of deep smaller craters [8] (see Figure 3). **Other CTAs:** We also removed 11 CTA candidates from the earlier inventory. In some cases the new model crustal thickness data [7] fails to show the CTA signature found in the earlier model data; sometimes that area actually has positive topographic relief [8]. In other cases clusters of small and deep craters likely explain the apparent CTA structure previously observed [9]. **Overall:** We deleted a total of 23 candidates from the earlier inventory [5] including all features with summary scores (TE + CTE) < 3. Thus 75 of the original 98 candidates survive. To this we add a number of new candidate large basins as described below.

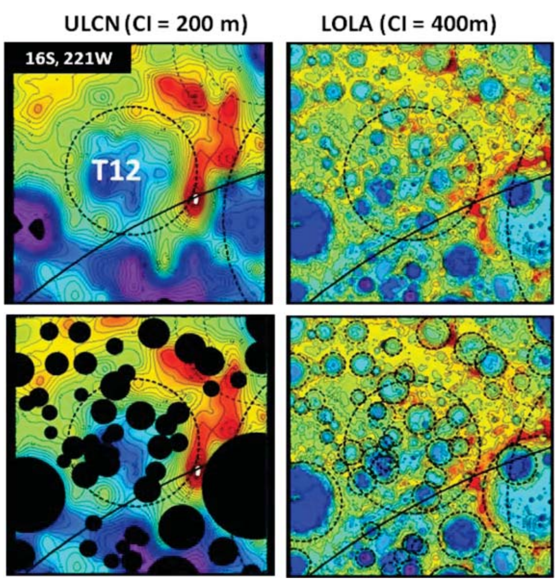
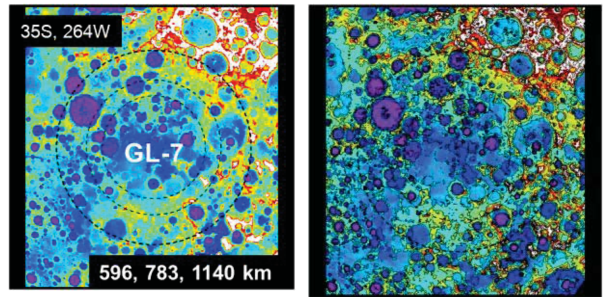


Figure 3. ULCN (left) and LOLA (right) topographic data for the area near QCD T12 [5]. The apparent large roughly circular low can be explained by the cluster of small and deep craters revealed in the LOLA data, as indicated in the bottom panels.

New Candidate Basins: A number of new candidate basins were revealed by LOLA data [9, 10]. Though generally subtle, often overprinted by other more prominent basins, and small, at least one is of Imbrium size (Figure 4) and has both QCD and CTA structure. The newer crustal thickness data also suggests several new candidate basins [9], some of which do not have obvious QCD structure (Figure 5).



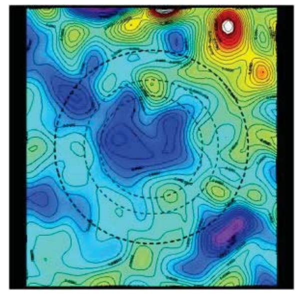
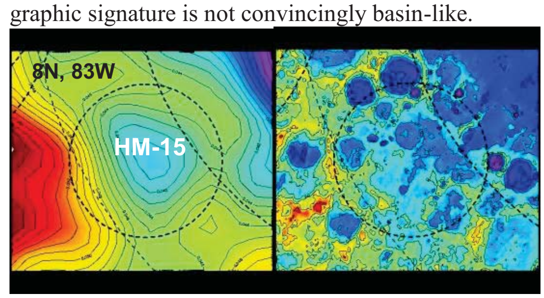


Figure 4. Candidate GL-7 is an possible Imbrium-size basin found in LOLA data (above). Topographic contours are 500 m; crustal thickness data (left) has 2.5 km contours and shows a structure supporting the existence of this basin.

Figure 5 (below). Candidate CTA basin HM-15 [9] is ~ 304 km in diameter. The CTA signature in the new model crustal thickness data [7] is obvious, but the topographic signature is not convincingly basin-like.



Summary: LOLA based topographic and crustal thickness data suggest 23/98 candidate basins found using older data should be dropped. But these same data suggest there could be 20 new candidates that should be added to the inventory: these include 12 new QCDs and 8 new CTAs, all with summary scores > 3. There are 83 candidates with summary scores > 4 and 63 with summary scores > 5. The likely inventory is at least a factor 2 (maybe a factor 3) greater than the number of named basins having basin-like structure.

References. [1] Archinal, B.A. et al. (2006) USGS Open File Report 2006-1367. [2] Wieczorek, M.A. et al. (2006) New views of the Moon: Reviews in Mineralogy and Geochemistry, vol. 60, 221-364, 2006. [3] Frey, H.V. (2008) LPSC 39, abstract #1344. Frey, H.V. (2008) Workshop on Early Solar System Impact Bombardment, Houston, TX. [4] Frey, H.V. (2009) LPSC 40, abstract #1687. [5] Frey, H.V. (2010) Chapter 2, GSA Special Publication *Recent Advances and Current Research Issues in Lunar Stratigraphy*. [6] Wilhelms, D.E, (1987) The Geologic History of the Moon, USGS Professional Paper 1348. [7] Wieczorek, M.A., private communication. [8] Romine, G. and H. Frey (2011) LPSC 42, abstract #1188. [9] Meyer, H. and H. Frey (unpublished data). [10] Frey, H. and G. Romine (2011) LPSC 42 abstract #1190.