USING LOLA DATA TO TEST THE REALITY OF CANDIDATE LUNAR BASINS DERIVED FROM OLDER DATA

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Summary: LOLA data were used to assess the reality of 92 candidate large basins on the Moon derived from photo-geologic and earlier topographic and crustal thickness data. Ten named basins lack basin-like topographic structure. Of 65 possible previously unknown basins identified, 13 are eliminated as viable candidates, but this is offset by new candidates found in LOLA data (see companion paper).

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 basins > 300 km in diameter was found [5]. This includes 33 named features (those having basin-like topography) out of the 45 in the list 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. Most named features and other QCDs have strong CTA signatures, but there appears to 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 test the viability of the candidate basins previously found. To do this we repeated a “Topographic Expression” scoring exercise originally done with the ULCN candidate basins [5]. Each candidate was scored on a scale from 0 (no topographic basin signature) to 5 (strong circular low signature). This became part of a total score which also included an expression score for the crustal thickness signature of the same 98 basins. We used the same GRIDVIEW software to stretch, contour and profile the LOLA data as was done with the ULCN2005 and model crustal thickness data.

Figure 1 shows a comparison of ULCN2005 (left) and LOLA (right) topography for three named basins in Wilhelms [6] list: Orientale, Poincare and Australe (top to bottom). LOLA data clearly has far superior resolution at 32 pixels/degree and generally 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 was obvious in the older data and is even more pronounced 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] and the same is true in the LOLA data. In principle Australe could have had a -1 or -2 in ULCN data; from the LOLA data we give it a 0.

Figure 2 shows TE scores for the 98 candidate basins previously identified [5]. Both GR and HF independently determined the LOLA TE scores using 16 pixel/degree and 32 pixel per degree data, respectively. The ULCN2005 TE scores are by HF only and are given in [5] along with a Crustal Thickness Expression (CTE) score and a total score which is the sum of the TE and CTE scores. ULCN2005 TE scores are shown by the large open squares. LOLA TE scores from GR are indicated by the large blue circle; HF LOLA TE scores are shown by the small red circles.

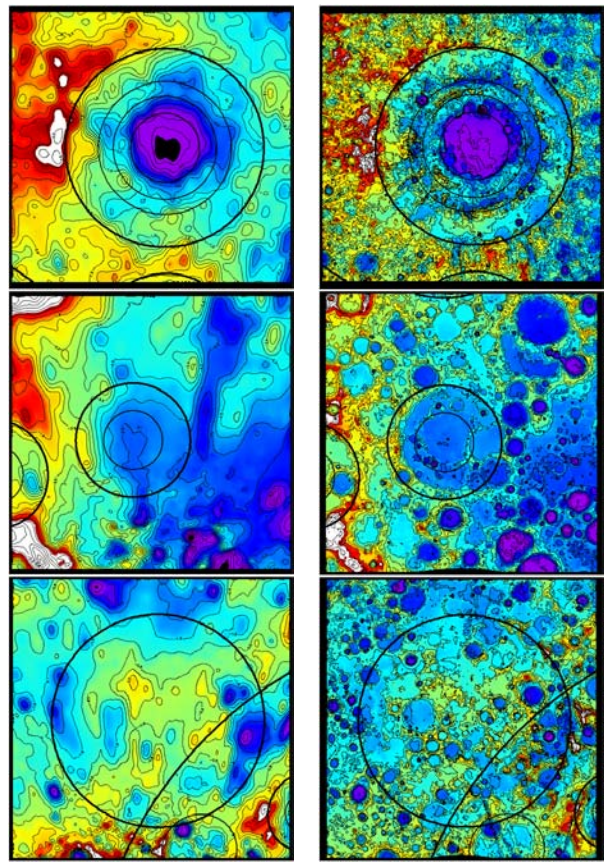

Figure 1a. ULCN2005 (left) and LOLA (right) topography for the area around the (top) Orientale (D=s930 km). (middle) Poincare (D=331 km) and (bottom) Australe (D=880 km)Basins, all named in Wilhlems' [6] list. Contour interval is 400 m for both. The much improved resolution of the LOLA data is obvious. Orientale and Poincare are obvious basins; Australe lacks basin-like structure. Topographic expression score from ULCN/LOLA are 5/5 for Orientale, 3/4 for Poincare (indicating a better QCD structure in LOLA data) and 0/0 for Australe. Australe could even rate a -1 in ULCN data, indicating positive relief where a basin should exist.

Results. Figure 2a shows the results for the 45 named basins from Wilhelms [6] list. Many of these had original TE scores of 4 or 5 in the original study; most remain the same or have slightly higher scores in the LOLA study. Frey [5] reported that 10 of the Wilhelms basins had no basin-like topography in ULCN2005 data. The same remains true with the LOLA topography. In addition, Sikorsky-Rittenhouse drops off the revised inventory because its diameter as determined from LOLA data is 275 km, not the 310 km listed by Wilhelms or the 319 km suggested earlier by Frey from ULCN2005 data [5].

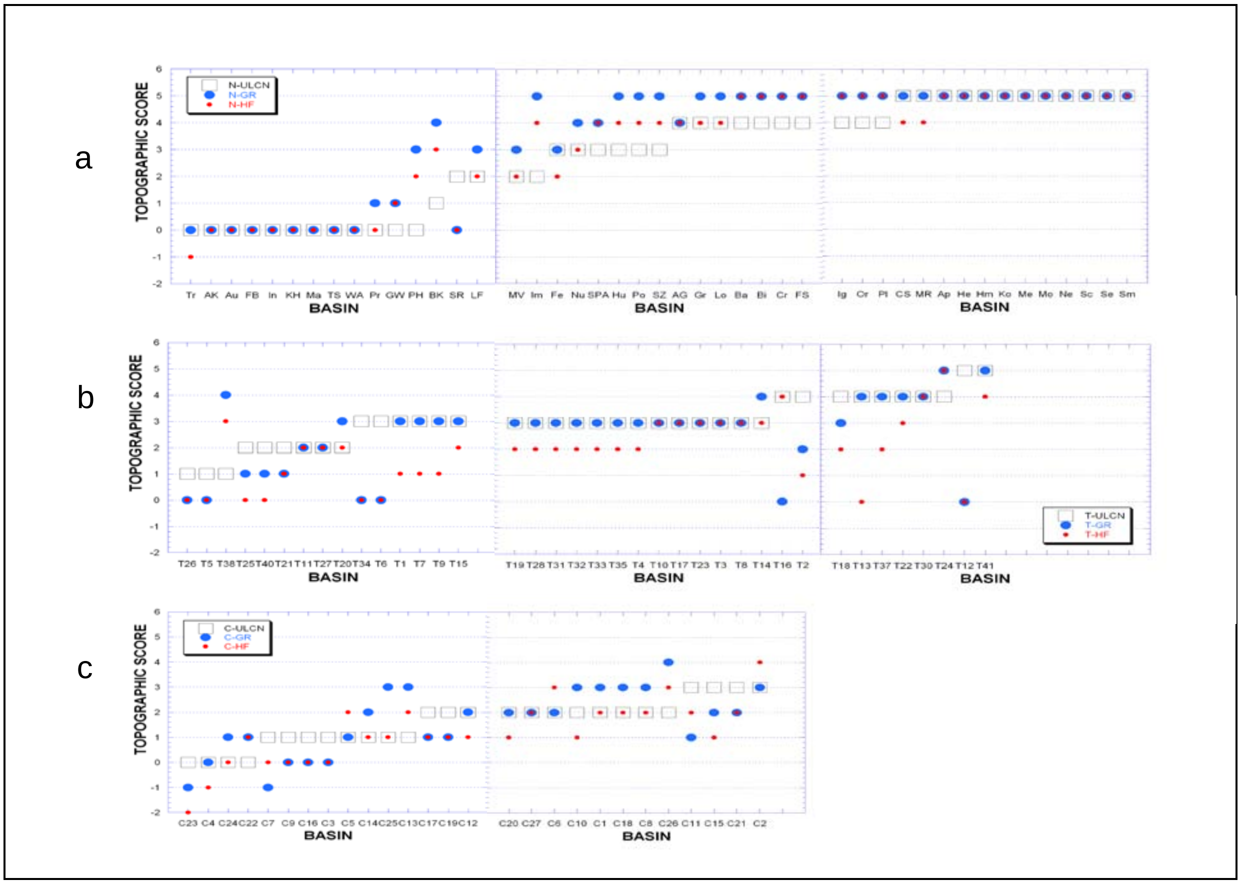

Figure 2b shows TE scores for QCDs other than named basins. HF tends to score somewhat lower than GR, but most of the 38 QCDs previously suggested as candidate large basins have LOLA TE scores close to those derived from ULCN2005 data. There are notable exceptions, and both HF and GR identify the same 5 QCDs that now get a 0 TE score. In most of these cases, the higher resolution LOLA data reveal what appeared to be a single large QCD as being due to a cluster of smaller impact features so grouped as to appear like a single circular low in the lower resolution ULCN2005 data. In one case (T16) HF and GR have very different scores because of a difference in interpretation: GR views the QCD as being part of a named feature (Moscoviense) and infers a low angle impact producing a single elongate structure, whereas HF views the QCD as an older basin underlying the Moscoviense basin.

Figure 2c shows TE scores for 27 CTAs from [5]. These generally had lower TE scores from the ULCN2005 data than did the QCDs; had they had a stronger topographic signature they would likely have been identified as QCDs. Again HF tends to score lower than GR, but several of the CTAs have improved topographic support in LOLA data and in only a few cases does the LOLA topography suggest that the CTA is spurious (e.g., due to a cluster of smaller impacts as discussed above, or having a positive topographic signature associated with the CTA).

Summary: LOLA data suggests that less than 15 of the 98 candidate basins found using ULCN2005 and model crustal thickness data should probably be dropped. This includes one more named feature (Sikorsky-Rittenhouse), at least 7 other QCDs and maybe 2-3 others with low TE scores, and 2 or maybe 3 additional CTAs. As described in a companion abstract [7] these "losses" are more than offset by new candidate basins found in the LOLA data: GR finds evidence for 18 possible new basins > 300 km diameter, of which at least 12 are very good candidates. HF finds evidence for an additional 9 features, at least 6 of which appear to be strong candidates. The current inventory of likely large impact basins on the Moon based on LOLA data and model crustal thickness data is likely at least 104, more than twice the number of previously known named basins.

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. Downloaded from http://www.ipgp.fr/~wiecz0r/CrustalThicknessArchive/CrustalThickness.html [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. (2009b) Crustal thickness evidence for more previously unrecognized large lunar basins, LPSC 40, abstract #1687. [5] Frey, H.V. (2010) Chapter 2, GSA Special Publication *Recent Advances and Current Research Issues in Lunar Stratigraphy* (in press). [6] Wilhelms, D.E, (1987) The Geologic History of the Moon, USGS Professional Paper 1348. [7] Frey, H. and G. Romine, LPSC (this volume).