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An Inventory of Degraded Lunar Basins using LROC Stereo Terrain Models

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Abstract

We search for degraded Lunar Basins using terrain models derived from LROC-WAC stereo images.

1. Introduction

Large impact structures represent important time markers and provide clues to the early history of the Moon. Basins are the most prominent Lunar topographic features, however, older basins may be highly degraded and difficult to identify. Hence, Digital Terrain Models with higher spatial resolutions allow us to make more confident identifications of Lunar basins and a better reconstruction of their morphologies.

Previous lunar topographic data sets used for studies of basins include the stereo model obtained by the Clementine cameras (grid size: 5 km) [1]. The LIDAR instrument onboard Clementine provided coverage for latitudes up to 60-70° [2]. The Laser altimeter LALT onboard the Japanese Kaguya polar orbiting spacecraft [3] provided a near-global lunar topography model, however, the orbit tracks suffered from longitude gaps of up to 10 km near the equator. The LRO onboard Laser altimeter LOLA is currently assembling a global topographic data set that is based on similar polar orbit tracks, but which is significantly higher in spatial resolution.

1.1 DTM

As is described previously in [4], a Digital Terrain Model was derived from stereo images of the Wide Angle Camera of the Lunar Reconnaissance Orbiter Camera. The LROC WAC consists of a 1k x 1k CCD frame which is split into sub-frames for 7 different spectral bands. For the stereo processing, the visible band data are used. The camera is operated in the "push-frame mode". WAC's IFOV is 5.1 arcmin, its ground scale from 65 km orbit altitude 100 m/pxl.

Within the overlap of WAC images from adjacent orbits, area-based image matching was carried out. Using forward ray intersections, ground points were derived and interpolated to form the DTM. From nominal 65 km orbit altitude we obtain approx. 50% overlap and 30° stereo angle at the equator. The mean 3D forward ray intersection error is about 50 m.

We selected the entire WAC stereo data acquired during commissioning and nominal mission phase until March 31, 2010 to derive a DTM working model with a grid spacing of 500 m (Fig. 1). This globally uniform spatial resolution greatly exceeds the spatial resolution of the LOLA data in the equatorial areas. Comparisons were made to Kaguya LALT data, to verify that the model does not suffer from systematic bias. Latitudes > 80° have currently been excluded from processing because of low solar incidence and prevalence of shadows in the area.

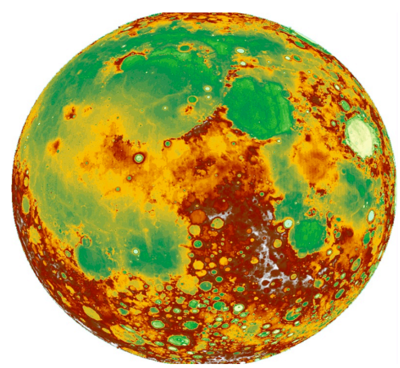

Figure 1: Color coded lunar DTM derived from Stereo-WAC-Images in orthographic map projection.

1.2 Basin List

The basis of our inventory is the well-known list by C. Wood, including 58 basins, classified in 4 categories, 1) definitely confirmed basins, (17 basins), 2) confirmed (13 basins) 3) very tentatively confirmed (17 basins), 4) unconfirmed (11 basins). In our study, we focused on the 28 tentatively and unconfirmed basins. In addition, 6 more basin candidates, proposed by Cook [1] on the basis of the Clementine stereo DTM, were included in our survey. Other 4 basins of [1] were already mentioned in [2]. Coordinates of the basins and ring diameter(s), for some basins also rim heights [3] are given in these lists.

2. Procedure

Each of the basins was studied separately. Relevant portions from the global DTM centered about candidate basins were extracted and reprojected for investigations. Hill shade models with four complementary azimuths of illumination were used to accentuate the surface and his characteristics. In addition, the DTM was color coded with different stretches to emphasize small height differences. Perspective views as well as slope maps were used to support the analysis.

If positively identified, the location of the basin, number of rings, the circular (or ellipsoidal) shape of rims, the height of the rims and the depth of basins were measured from the DTM.

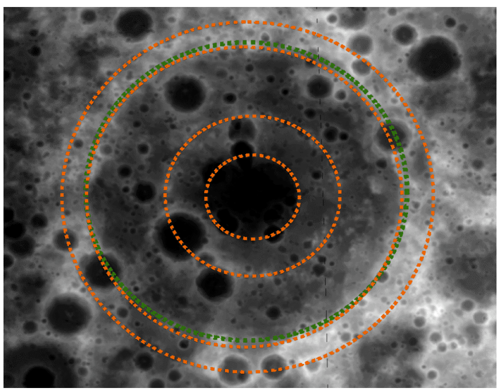

Figure 2: This figure shows the uncertain basin Freundlich-Sharonov in stereographic projection with it's known rim in green. The orange rims were discovered during this analysis.

Name	Location		Dia a km	Dia b km
Bailly-Newton	S73	W057		
Dirichlet-Jackson	N13	W158	470	490
Fitzgerald-Jackson	N25	W169	400	390
Kohlschutter-Leonov	N13	E156	420	450
Lomonosov-Fleming	N17	E104	770	770
Riemann-Fabry	N41	E099		
Wegner-Winlock	N41	E108	260	260
Sylvester-Nansen	N83	E045		
Wegner-Winlock	N41	E108		
Unnamed 1	N50	E165		
Unnamed 2	S20	W070		
Unnamed 3	N30	E165		
Unnamed 4	N45	E055		
Unnamed 5	N60	E139		
Unnamed 6	N55	W030		

Table 1: Previously proposed lunar basins (selection) with locations and diameters measured in this study. Underlined basin were confirmed within this analysis.

6. Results and Conclusions

While our survey is not yet complete, and results are still preliminary, we have positive identifications for 5 of the 15 proposed basins (such as Dirichlet-Jackson, Fitzgerald-Jackson), whereas other basin candidates (e.g. Riemann-Fabry, Bailly-Newton) could not be confirmed (Table 1). We derive height of rims and depths for some of the identified basins. Our analysis will help in investigations of morphologies and the statistics of old impact basins.

References

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