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Kilometer scale roughness analysis of Lunar Digital Terrain Model

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Introduction:

The lunar terrain reflects its impact and volcanic histories. Since meteoroid impact has been a ma-jor process in forming the topography of the lunar highlands, quantifying surface roughness might be useful in distinguishing the ejector unit of the highland and may contribute significantly to the strati-graphic study of the Moon.

The lunar explorer, SELENE, will be launched in FY 2007. SELENE has three cameras for scien-tific observation, and they compose one system, called the Lunar Imager and SpectroMeter (LISM) (Haruyama et al., 2000). The Terrain Camera (TC), one of the LISM instruments, will capture stereo-scopic images of the lunar surface with a spatial resolution of 10m (Haruyama et al., 2006a). Recently, the Digital Terrain Model (DTM) system for LISM TC data has developed (Haruyama et al., 2006b). This system will provide a relative DTM for the entire lunar surface. Accordingly, it is important to prepare automatic processing methods, which suit for such a large DTM dataset. Thus, in our previ-ous report (Yokota et al., 2007), we have prepared DTM of three regions from stereoscopic images of the Apollo Mapping Camera, and we demonstrated an indicator of topographic roughness on a kilome-ter scale. But the upper limit of the horizontal scale is limited to 3 km in the previous study. In this paper, we expand the scale of analysis to ~10 km. Additionally, we compare the kilometer scale roughness with millimeter scale roughness, which was reported by Helfenstein and Shepard (1999), to examine the interpretation method of the kilometer scale roughness.

Data set:

To produce the DTM, we used multipurpose Digital Elevation Model software, produced by CCS (Central Computer Service Co., Japan). This is a prototype of the DTM producing system for the LISM TC data. We have prepared DTMs of three regions in the Apollo observation area (Figure 1). The map resolution was adjusted to 0.001 degree/pixel depending on the resolution of the input image, corresponding to 30.3m in the latitudinal direction. For each region, two DTM are made from the dif-ferent pairs of images. Detail of the applying procedure for the Apollo images has been reported by Yokota et al. (2007).

Method:

We adopted the RMS deviation (Allan deviation) method (Shepard et al., 2001) to quantify the roughness of lunar surface. We use 1 km as the unit scale.To simplify computation, we sampled the DTM data only in the north-south direction because this direction has a fixed scale in the simple cy-lindrical projection map. The RMS deviation was computed for each cell, after sub-tracting the average slope of the cell in the latitudinal direction. The minimum step size dx of this analysis is 1 km. Ac-cording to the recommendation of Shepard et al. (2001), the maximum step size dx is limited by 0.1 of the cell size.

Results and Discussion:

Differences between target cells have been found in the deviograms (RMS deviation versus step size). Deviogram of Apollo 17 landing site shows break point at step size ~6 km. A break point is also seen at ~2km of Apollo 16 Descartes mountain region, probably due to the crater wall. In our previous study at step size 0.3-3 km, any break point is not seen in deviograms. One expectation from that study is that all steep trend data might have break points at larger step size. The plot of far side highland, has not show break point until step size 14 km. Much larger DTM or another approach is required to check the break point scale of lunar far side. Our future works are (1) development of classification method of roughness parameters, (2) development of a visualization method of roughness on the global lunar map, and (3) investigation of deviogram break point at far side highland.