Geophysical Research Abstracts
Vol. 12, EGU2010-7842, 2010
EGU General Assembly 2010

Topography and Crustal Thickness of the Moon by KAGUYA (SELENE) Selenodesy Observation

Sho Sasaki (1), Yoshiaki Ishihara (1), Hiroshi Araki (1), Hirotomo Noda (1), Sander Goossens (1), Noriyuki Namiki (2), Takahiro Iwata (3), Hideo Hanada (1), and Koji Matsumoto (1)

(1) National Astronomical Observatory of Japan, RISE Project, Oshu, Japan (sho@miz.nao.ac.jp, 0081 197 227120), (2) Chiba Institute of Technology, Narashino, Japan, (3) ISAS/JAXA, Sagamihara, Japan

The Japanese lunar mission KAGUYA (SELENE) was launched on September 14th, 2007 and continued its operation by June 11th, 2009. Laser altimeter (LALT) on board KAGUYA obtained the first precise global topography of the Moon with range accuracy of 5m [1]. Range data exceeded 20 million by the end of the mission. In the polar regions where laser altimeter on board CLEMENTINE did not observe, LALT clarified topographic features including permanently shadowed areas. Distribution of solar illumination rates was also estimated at elevated areas [2]. The amplitude of the power spectrum of topography spherical harmonics is larger than that of the previous model at L>30 [1].

Using 4-way Doppler tracking with relay satellite OKINA, KAGUYA obtained the first precise gravity field of the lunar far-side [3]. Multi-frequency VLBI observation using subsatellites OKINA and OUNA improved the accuracy of gravity. Combined with topography data, we estimate Bouguer anomaly and the crustal thickness variation of the Moon [4]. The region with the thinnest crust is Mare Moscoviense in the far side.

We have better correlation of spherical harmonics coefficients between gravity and topography than the previous model [3]. Gravity signatures of far-side impact basins are mostly explained by topography except for the central high. Then, Bouguer anomaly distribution is relatively smooth both within South Pole-Aitken basin (SPA) and within far-side highland terrain (FHT). This would imply relatively smooth crust-mantle boundary there. SPA is also characterized by the admittance spectra. Although the crustal thickness of SPA is much thinner than that FHT, the elastic thicknesses of both zones are not so different on the basis of the admittance. SPA area would be elastically supported by a part of upper mantle.

Based on CLEMENTINE data , Garrick-Bethell and Zuber (2009) stated that the SPA basin is characterized by an ellipse with axes 2400 by 2050 km and the center at 53S - 191E [5]. They advocated that the basin was formed by an oblique impact. However, the lack of accurate far-side gravity data and topography data around the south pole region prevented quantitative discussion on the morphology and the interior structure of the South Pole Aitken basin. Our KAGUYA data confirmed that direction of an ellipse denoting the depression is similar to their result although the aspect ratio is slightly smaller. The region with the thinnest crust is probably offset southward from the center of the SPA. This may be explained by the oblique impact hypothesis.

References:
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