PPS23-P07 Room:Convention Hall Time:May 25 18:15-19:30

Gravity anomaly uncorrelated with topography in the Moon and its origin

UCHIDA, Mako[1*] ; ISHIHARA, Yoshiaki[2] ; HIRAMATSU, Yoshihiro[1]

[1]Kanazawa Univ., [2]JAXA

Based on the gravity field model with the spherical harmonics up to degree and order 420 estimated from the observation data of the initial mission phase of GRAIL, Zuber et al. (2013) reported that, from order and degree of 80 to 300, 98% of the gravity disturbance potential of the Moon is caused by the topography and the remaining 2% of it is uncorrelated with the topography but is caused by subsurface high-density materials. Recent analysis of GRAIL data of the all mission phases provides the gravity field model with the spherical harmonics up to degree and order 900 (Lemoine et al. 2014; Konopliv et al., 2014). We can, therefore, expect to obtain detailed information of the interior of the Moon from this model. In this study, from the latest selenodetic data, we detect areas where gravity anomaly is uncorrelated with lunar topography, estimate the density structure of the crust beneath the areas, and infer its origin.

We use the topographic model of LRO_LTM01_PA_1080 with the spherical harmonics of degree and order 1080 (Neumann, 2013). Bouguer anomaly is calculated from the topographic data and the gravity potential data of GRGM900C (Lemoine et al., 2014) with the Bouguer correction density of 2560 kg/m3 and is expanded by the spherical harmonics of degree and order 600 based on the accuracy of the gravity data (Lemoine et al., 2014). We estimate the depth of the lunar Moho using a gravity inversion of Wieczorek and Phillips (1998) and subtract the Bouguer anomaly caused by the relief of the Moho from the original one. This Bouguer anomaly, hereafter referred to as the residual Bouguer anomaly, represents gravity anomaly caused by density anomalies in the crust. In the estimation of the Moho depth, we set the crustal density of 2750 kg/m3 and the mantle density of 3360 kg/m3 so that our estimation coincides with seismological estimations of the crustal thickness at Apollo 12/14 sites and the average crustal thickness reported by previous works. We detect 23 areas where the residual Bouguer anomaly is uncorrelated with the topography. For 14 areas where distinct positive anomaly is recognized, we estimate the shape and the position of a high-density body (a density contrast of 610 kg/m3) in the crust using the prism approximation of Banerjee and Gupta (1977). The other 9 areas are characterized by nearly zero residual Bouguer anomaly, suggesting that the relief of the Moho causes the gravity anomaly uncorrelated with the topography.

The estimations for all 14 areas show that the shape of the high-density body is sill-like and the body is located at the base of the crust, in other words adjacent to the Moho. Comparing the reflectivity map of the wavelength of 750 nm produced by the multi-band imager of the SELENE (Ohtake et al., 2008) to the location of the 14 areas, we reveal that the 14 areas are distributed in the lunar mare with low reflectivity. The 14 areas are distributed along ridges and/or rings of impact basins. These facts suggest that the high-density bodies are related to past igneous activity and the formation process of the ridges and impact basins.

From the above, we propose a following scenario. The formation of cracks in the crust accompanied with the formation of the ridges and impact basins promotes the magma intrusion into the crust. Insufficient pressure and buoyancy due to poor volatiles makes the magma intrude laterally like sill at the base of the crust near the Moho. We suggest that high-density bodies with long wavelength are modeled as the relief of the lunar Moho because the density of the bodies is considered to be comparable to the mantle density.

Acknowledgements: We use the topographic data released by the LOLA Data Archive (http://imbrium.mit.edu/LOLA.html) and the gravity data released by the NASA PDS Geoscience Node (http://pds-geosciences.wustl.edu/missions/grail/default.htm). We also use the SHTOOLS (http://shtools.ipgp.fr) for the calculations in this study.

Keywords: ridge, impact basin, gravity inversion, intrusion, magmatism