A spatio-temporal change of the density structure beneath impact basins of the Moon

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Impact basin, a large-scale structure on the surface of the Moon, is formed by a giant impact in the past and is considered to affect the evolution of not only the surface but also the internal structure of the Moon. Recent analyses of GRAIL data of the all mission phases provide the gravity field model with the spherical harmonics up to degree and order of 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 gravity model. In this study, from the latest selenodetic data, we estimate the density structure (i.e., Moho) beneath the impact basins and discuss differences of the density structure.We use the topographic model of LRO_LTM01_PA_1080 with the spherical harmonics of degree and order of 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 of 600 (wavelength ~9km). We estimate the depth of the lunar Moho using the gravity inversion method of Wieczorek and Phillips (1998). In the estimation of the Moho depth, considering the values of crustal density reported by Han et al. (2014), we set the crustal density of 2750 kg/m3 and the mantle density of 3360 kg/m3 [Ishihara et al., 2009], respectively, 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 apply a downward continuation filter with the half-power degree of 100. The crustal structure is expanded by the spherical harmonics of degree and order of 600. We call the density structure calculated by this method as global model.We estimate the local Moho relief using the gravity inversion method of Rama Rao et al. (1999) for each impact basin. The crustal density and mantle density are the same as the case of the global model and we set a spatial resolution to 10 km. We set the initial boundary depth to the deepest point of the global model and the shallowest point of the density structure to the deepest point of the topography for each impact basin. We call the density structure obtained by this method prism model.To evaluate the prism model structures quantitatively, we take following four steps.(1) We make the azimuthally averaged cross section of the prism model within 1.5 times of the positive Bouguer anomaly area [Neumann et al., 2015] for each impact basin.(2) We define the area within the radius of the positive Bouguer anomaly as the inner region and the outside area as the outer region.(3) We define the distance from the center to the farthest point within top 15% of the depth width as D_upper and that from the center to the intersection between the linear fitting line of the outer region data points and the cross section profile as D_lower.(4) We calculate D_upper/D_lower.We found that the distribution of the value of D_upper/D_lower showed positive correlation with the size of the impact basins and have regional characteristic. We suggest that the latter is controlled by the difference of the internal temperature structure, because it is consistent with the distribution of radioactive elements [Jolliff et al., 2000] and the thermal state at the time of basin formation estimated based on viscoelastic deformation calculation [Kamata et al., 2013]. In the presentation, we discuss the major control on subsurface structure, together with calculation results of viscoelastic deformation.

Keywords: impact basin, inversion, viscoelastic deformation

