

Lunar magnetic field observations by MAP-LMAG onboard SELENE (Kaguya): global mapping of the lunar magnetic anomaly

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Lunar MAGnetometer (LMAG) of the magnetic field and plasma experiment (MAP) onboard the SELENE (Kaguya) spacecraft was designed for precise observation of the vector magnetic field around the Moon. The LMAG mission has three main objectives: (1) mapping the magnetic anomaly of the Moon, (2) measuring electromagnetic and plasma environment around the Moon and (3) estimating electrical conductivity structure of the Moon. The magnetic field around the Moon has been successfully observed and calibrated at a nominal altitude of ~100 km by LMAG on Kaguya in a polar orbit during November, 2007 to December 2008 [1, 2, 3]. After this period, the altitude of Kaguya was lowered to be 10-50 km on the farside and 30-70 km on the nearside in order to provide detailed maps around the South-Pole Aitken region. Here we report the global mapping results of the lunar magnetic anomaly mainly from the high altitude observations [3], which have been open at the SELENE archives.

The new method of mapping magnetic anomalies was applied to time series of one-second average data which were observed at the high altitude in a polar orbit during November, 2007 to December, 2008. About 20 % of 14 month data passed the selection criteria. Since the solar activity has been very low during this period, an effect of the external field fluctuation is small enough to detect a weak signal of the lunar magnetic anomalies even at ~100 km altitude. As a result, initial global maps of the lunar magnetic anomaly in one-degree bins were obtained with 95 % coverage of the lunar surface. Applying the equivalent pole reduction (EPR) method [4] to the LMAG bin data at ~100 km altitude, full-coverage magnetic anomaly maps were obtained at a constant altitude of 100 km with an error level of +/- 0.2 nT.

Accuracy of the obtained maps should be checked, since signatures of lunar magnetic anomalies are sometimes comparable to the external field fluctuation at the high altitude. More than ten isolated and clustered magnetic anomalies of relatively strong intensities have been reported by previous studies using the Lunar Prospector observation. All of the reported anomalies are identified at the same localities on the Kaguya-LMAG maps. Therefore the LMAG maps at 100 km altitude have a good accuracy with respect to strong anomalies. It is also seen on the LMAG maps that weaker anomaly patterns are distributed almost over the Moon. We made maps at 30 km altitude from the LP dataset provided by Richmond and Hood (2008), since they have not shown and discussed weaker anomalies than 3 nT at 30 km altitude. Radial component distribution on the surface estimated by the EPR method is compared with that of the LP 30 km maps. As a result, widely distributed anomaly patterns well agree between the two maps. Besides, initial global maps from the low altitude observation show similar distributions of weak and strong anomalies. These suggest that most parts of lunar crust might be magnetized in a global magnetic field of the early Moon like a dynamo field.

References: [1] Shimizu, H. et al. (2008) *Earth Planets Space*, 60, 365. [2] Takahashi, F. et al. (2009) *Earth Planets Space*, 61, 1269. [3] Tsunakawa, H. et al. submitted to *Space Sci. Rev.* [4] Toyoshima, M. et al. (2008) *Earth Planets Space*, 60, 365. [5] Richmond, N. C. and Hood, L. L. (2008), *J. Geophys. Res.*, 113, E02010.

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