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Spherical harmonic analysis of the lunar magnetic anomalies

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We have analyzed the magnetic field due to the lunar magnetic anomalies applying the spherical harmonic expansion by n = 370 in order to investigate a global feature of the magnetic anomaly distribution. Purucker and Nicholas (2010) reported the spherical harmonic model of the lunar magnetic anomalies (n = 170) using the anomaly field at 30 km altitude from the Lunar Prospector observation. They reported that low degree terms of the spatial power spectra (n < 15) are remarkably smaller than higher order components. According to their interpretation, the absence of the magnetic anomaly is caused by the cratering history of the lunar surface such as demagnetization of the lunar crust. However, if a crater of several hundreds in diameter induces demagnetization or remagnetization of the lunar crust, its sparse distribution may possibly enhance similar wavelength components of the spectra. Thus we have checked the power spectra applying the recently developed method, the surfce vector mapping method.

We first carried out a global mapping of the radial component Br on the surface through the inversion of the magnetic field observation by a satellite (Tsunakawa et al., 2010). The Lunar Prospector dataset was used in the present study, since the LP spacecraft orbited around the moon at about 20-40 km altitudes during the low altitude phase. We calculated Br values at generalized spiral points of 0.2 degree distance on the surface to retain the uniform spatial resolution. A plausible trade-off parameter in the inversion was estimated for each of 15 x 15 degree regions assuming a constant value. Since the trade-off parameter is equivalent to a ratio of the data fitness to the amplitude of anomalies, it varies from place to place. We applied the spherical harmonic expansion (n = 12) to the trade-off parameter distribution on the surface. Then we again solved the inverse problem using fixed trade-off parameters, and connected regional maps of the anomalies to provide a global one. Using the Br distribution at the generalized points, which is not suited to the spherical harmonic analysis, we calculated Br values at 10 km altitude at equal intervals (0.2 degree) in latitude and longitude. Based on the orthogonality, we obtained the spherical harmonic coefficients by n = 370.

Our results show that low degree components are significantly larger than the results by Purucker and Nicholas (2010). This seems to be consistent with the dichotomy in the magnetic anomaly distribution of the moon. The difference between two results may be caused by filtering procedures in the analysis.