Global mapping of the lunar crustal magnetic field by equivalent source method using magnetic monopoles

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In the 2007 JGU meeting, we reported an objective scheme for estimating the spatial distribution of lunar crustal magnetic field from the satellite magnetometer data, and applied it to the Reiner Gamma magnetic anomaly on the nearside of the moon. Here, we provide the global vector map of the lunar crustal magnetic field using this scheme.

The scheme is a variant of the equivalent source method for estimating the 3-d magnetic field. This entails solving a linear inverse-problem to determine the magnetic sources distributed on the surface of the Moon that satisfy the observational data. Our scheme improves the equivalent source method in three respects. The first improvement is that the source calculation is performed simultaneously with detrending. The second is that a great number of magnetic charges (magnetic monopoles) are used as the equivalent sources. The third is that the distribution of the magnetic charges is determined by the damped least squares method, and the optimum smoothness is determined objectively by minimizing Akaike's Bayesian Information Criterion (ABIC). Thus, there is no adjustable parameter in the calculation. It guarantees the objectivity of the whole scheme and the independence of the results from the calculation process.

In this study, we select LP magnetometer data of quiet times in all area of the Moon, and produce the global lunar crustal field map at altitudes of 40 km. Utilizing the data obtained at different altitudes, we were able to find more than two sets of reasonably stable data in all regions of the Moon, except for a few parts of polar region and the western mid-latitude region on the lunar farside. Following the visual inspection of the magnetic field distribution, the Moon is divided into 96 fan-shaped areas, where the scheme is individually applied. As a result of calculation, the magnetic filed is stably estimated. Comparing to the observational data not used in calculation, our global map accurately reproduces the spatial distribution of lunar crustal field.