True polar wander of the early Moon estimated from small isolated magnetic anomalies on the SVM map

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Recent studies on the lunar magnetism indicate that the global magnetic field was generated by a core dynamo of the early Moon, although the present Moon has no global magnetic field. Since the crustal magnetic anomaly could record the early Moon's magnetic field as remanent magnetization, probably TRM, the magnetization directions of the lunar magnetic anomalies (LMAs) may yield information on the core dynamo of the early Moon.

Runcorn (1982, 1983) argued clusters of magnetic pole positions from the magnetization directions estimated by Hood et al. (1980), which were determined by fitting magnetized disks to the LMA observations of Apollo 15 and 16 subsatellites. Takahashi et al. (2014) applied dipole approximation to 24 isolated LMAs observed by Kaguya and Lunar Prospector at 20-40 km altitudes. These studies suggest the true polar wander by several tens of degrees in the early Moon. However, the observation data used in the previous studies could generally be affected by the crustal fields within relatively wide area. Thus it is not evident whether the individual LMAs consist of a single magnetic source or not.

We use the global maps of the LMAs on the spherical lunar surface with the Surface Vector Mapping (SVM) method [Tsunakawa et al., 2015]. The SVM data with high spatial resolution (0.2 degrees on the map) are useful for finding small isolated anomalies to be approximated with a single dipole or a small magnetic source body. We have studied single isolated LMAs [Ikeuchi et al., 2016 in SGEPSS Fall Meeting]. We found 82 LMAs of diameter ˜2 degrees, suggesting the true polar wander of the early Moon at 3-4 times through the cluster analysis.

In the present study, we have selected 154 small isolated LMAs and approximated them with a single dipole source or a small magnetic source body (magnetized disk or vertical prism). These LMAs include a new dataset of 72 smaller LMAs (diameter ˜1 degree). We estimated the magnetic poles from the magnetization directions of LMAs and applied a cluster analysis based on the Ward's method.The result shows four clusters of magnetic poles associated with the polarity reversal: the one is located near the selenographic north pole (P1; Takahashi et al., 2014), the one is at low-to-mid latitude on the far side (P2; Takahashi et al., 2014), the one is at low latitude on the eastern hemisphere (P3; Tsunakawa et al., 2015), the one is at low latitude area on the near side (P4; present study). These magnetic pole clusters imply that the dipolar field would be generated by a core dynamo, while the true polar wander like switching a pole position might occur more than once in the early Moon and its angle might be 40˜90 degrees.