SMALL-SCALE MAGNEITC ANOMALIES: NORTHEAST REGION OF LUNAR NEAR SIDE. S.-M. Baek[1], K.-H. Kim[1], and H. Jin[1], [1]School of Space Research, Kyung Hee University (**1732, Deogyeong-daero, Yongin-si, Korea)** *(baek_seulmin@khu.ac.kr)*

Introduction: Using the Lunar Prospector Magnetometer (LP-MAG) data, we investigate small-scale magnetic anomalies in the vicinity of Crisium and Marginis basins. The Crisium magnetic anomalies are representative magnetic features in Nectarian times [*Hood*, 2011]. The magnetic anomalies over the Mare Marginis are located to the antipode of Orientale which was formed in Imbrian times.

It has been suggested that Marginis anomalies were formed by amplified magnetic field generated by Orientale impact plasma cloud. We examine whether there are characteristics of magnetic parameters (e.g., depth and direction) for Marginis and Crisium anomalies.

Data set: In this study, the data obtained at low altitudes (~15-45 km) were selected from the passes occurring in 29-31 January, 1-2 February, 11-15 March, and 5-9 May 1999. We have to selecte certain regions to minimzed effect of external fields. The LP-MAG data were converted to local coordinates with radial, east, and north component along each orbit track. In our study 10-min running averages was adopted as detrending method.

Crisium anomalies: Figure 1a shows magnetic field filtered over Mare Crisium using data obtained on 1 Febuary 1999. The two main Crisium anomalies are clearly identified with large filed perturbations. The Crisium anomalies have polarized perturbation showing a bipolar (north-then-south) in δB_N and a negative monopolar (inward) in δB_R. These field perturbations can be expected from a single dipole source. From inspection of the data in the range -25°~45°N latitude, many magnetic anomalies showing bipolar and monopolar could be found, marked by dashed vertical lines. Although most of them have amplitude smaller than the Crisium anomalies, their magnetic fields are polarized such as Crisium anomalies.

In order to distinguish spatial and temporal magnetic field variations observed by the LP spacecraft, we used the LP-MAG data obtained from different altitudes. In Figure 1b and 1c we plot the deterended magnetic field obtained at altitudes of ~20 km on 14 March 1999 and ~36 km on 8 May 1999, respectively. Each of the field components at different altitudes shows a nearly identical variation. The high degree of similarity between the LP-MAG data at different altitudes assures us that the field variations are not associated with temporal field variation but with the spatial variation related to the lunar anomalies.

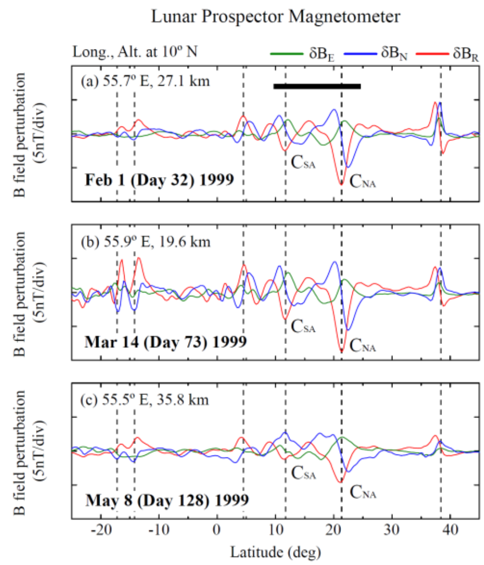

Figure 1 The magnetic field data filtered by removing 10-min running averages. Magnetic fields were measured over the Crisium magnetic anomalies.

Marginis anomalies: The largest concentration of magnetic anomalies appear antipodal to the young large impact basins (i.g. Crisium, Serenitatis, Imbrium, and Orientale). The high-albedo swirls with magnetic anomalies have been mapped antipodal to the young large impact basins, most notably at Mare Ingenii and Mare Marginis, corresponding antipodal to the Imbrium and Orientale, respectively. Magnetic field magnitude over the Marginis have been mapped by {\it Richmond et al.} [2005]. Unlike the Crisium anomalies, the Marginis anomalies are overlapped each other (see the Figure 3 in {\it Richmond et al.} [2005]), and their structures are complex. However, we can find isolated small-scale polarized magnetic perturbation in vicinity of Marginis.

Description of Results: We used the data over Crisium and Marginis obtained at different altitudes. Many magnetic anomalies were distributed in a wide range of distances from two basins shown in Figure 2. We selecte magnetic anomalies which only appear more than two times on three different months. In Figure 3, there are two groups. One is Crisium group and the other is Marginis group. Circle size is relative source's depth. Size of circle in Marginis group are smaller than those of Crisium group.

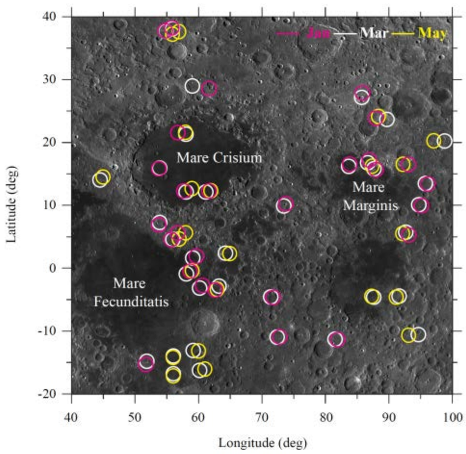

Figure 2 Distribution of small-scale anomalies. The background image is the Clementine albedo map. A total of 28, 36, and 23 individual source regions were identified using January data (Magenta), March (White), and May (Yellow) data, respectively.

These tendency is shown at different altitudes (not shown here). As mentioned above, the Crisium magnetic anomalies are representative magnetic feature in Nectarian times [*Hood*, 2011]. The magnetic anomalies over the Mare Marginis could be generated in Imbrian times because Orientale basin was formed in Imbrian times. From a magnetic perspective, we suggest that Marginis anomalies are younger than Crisium anomalies in time. If there are correlation between depth and formation times, we suggest that the deeper source is, the older anomaly is.

Adjacent sources are generally magnetized in very different direction when we consider directions of magnetization in local coordinates. There are no obvious tendency for the directions of magnetization whether it is perpendicular to or parallel to the lunar surface.

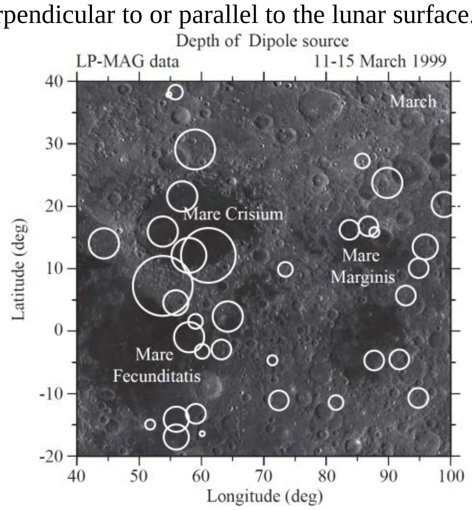

Figure 3 Distribution of magnetic anomalies using data obstained 11-15 March 1999. Circle size is relative source's depth.

However, a quantitative analysis of the inferred orientations reveals that the directions are not random in SEL coordinates. Figure 4 shows the number of I_{SEL}, which is the angles between the lunar spin axis and the moment vector. Most inferred directions are parallel to the lunar equatorial plane. This tendency is also confirmed at different altitudes.

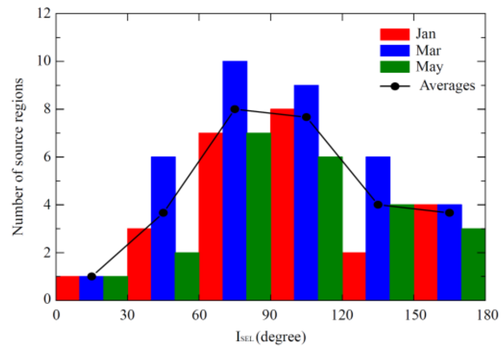

Figure 4 Histogram showing the numver of source whose inferred directions of magnetization in SEL coordinates.

Summary: We found that the small-scale magnetic anomalies are widely distributed with a polarized perturbations showing bipolar and monopolar. We investigated dipole moment directions for all anomalies and compared to their directions. It is clear that the inferred directions of magnetization are not the same. But a more detailed examination reveals that the distribution of magnetic anomalies is not entirely random. First, results of source's depth are divided into two groups depending on the source location. Depth of one group is relatively deeper than those of other group. Assuming that the depth of the source of the magnetic anomaly corresponds to the age of the magnetization, we suggest that Crisium group (40~70°E) may have been created earlier than Marginis group (70~100°E). Second, most inferred directions of magnetization are parallel to the lunar equatorial plane, implying ambient magnetic field was oriented mainly perpendicular to the Lunar spin axis.

Reference: [1] Hood, L. L. (2011), Central magnetic anomalies of Nectarian-aged lunar impact basins: Probable evidence for an early core dynamo, *Icarus, 211*, 1109-1128. [2] Richmond et al. (2005), Correlations between magnetic anomalies and surface geology antipodal to lunar impact basins, *J. Geophys. Res., 110*, E05011, doi:10.1029/2005JE002405.