MODELING FOR THE COMPLICATED MAGNETIC ANOMALIES IN THE SOUTHERN PART OF MARE CRISIUM. S.-M. Baek[1], K.-H. Kim[1], I. Garrick-Bethell[1,2], and Ho Jin[1], [1]School of Space Research, Kyung Hee University (1732, Deogyeong-daero, Yongin-si, Korea), [2]Earth and Planetary Science, University of California, Santa Cruz (1156 High Street Santa Cruz, CA, USA)

Introduction: It has been known that the Moon has dispersed crustal magnetic anomalies instead of a global field like the Earth. The several anomalies within the basin are associated with the basin-forming impact. They are believed to be formed by thermoremanent magnetization (TRM) of melt rocks generated by impact in steady magnetic field (e.g., lunar dynamo). Therefore, the source property of the anomaly can provides information on the lunar dynamo field. It has been reported that Crisium has two strong anomalies, which are distributed near its inner northern and southern edges. Unlike previous studies, we identified two isolated anomalies showing different magnetic field structures in the southern part over the Crisium. Their sources are located at different depths with different magnetization directions. We suggest that the different magnetization directions and anomaly depths are due to the orientation of the dynamo dipole axis over the timescale during which the Crisium anomalies coolded.

Data set: In the present study, we use Lunar Prospector magnetometer (LP-MAG) data obtained at low altitude (< ~40 km) on 13-14 March 1999 and 7-8 May 1999. Only nightside LP-MAG data were collected to avoid distortion by the solar wind. To isolate the crustal magnetic field from the interplanetary magnetic field (IMF), we remove the background field via a 10-min running average (e.g., *Baek et al., 2017*).

Observation: Figure 1 shows the filtered magnetic fields observed over the Crisium basin. Crisium northern anomaly (C_{NA}) shows a negative single perturbation in δB_R and a positive-then-negative in δB_N from 56°E to 60°E. Polarity of C_{NA} is consistent regardless of orbit tracks. These perturbation can be expected from dipole oriented vertically downward (*Baek et al., 2017*) . δB_R and δB_N of C_{SA} have the same polarity as those of C_{NA} from 56°E to 58°E in longitude, indicating that the magnetization direction of C_{SA} is similar to that of C_{NA}. However, the δB_N polarity changes to a positive single perturbation, and the δB_R polarity changes to a positive-then-negative structure at 59°E. These field configurations of C_{SA} extend to 64°E. Present study is motivated by changing perturbations over the C_{SA} unlike the C_{NA}. We therefore focus on C_{SA}. These perturbations observed over the Crisium can be expected from a dipole source. These field configurations of C_{NA} and western part in C_{SA} (56°E-58°E) are expected from a single dipole source with a magnetization direction oriented radially downward. The magnetization direction of eastern part in C_{SA} (59°E-64°E) is parallel to the lunar surface and oriented southward. Thus, we suggest that C_{SA} is made up of two dipole sources; one is that the dipole moment is oriented vertically downward to the lunar surface, called "C_{SA1}", and the other is that the dipole moment is oriented horizontally southward, called "C_{SA2}".

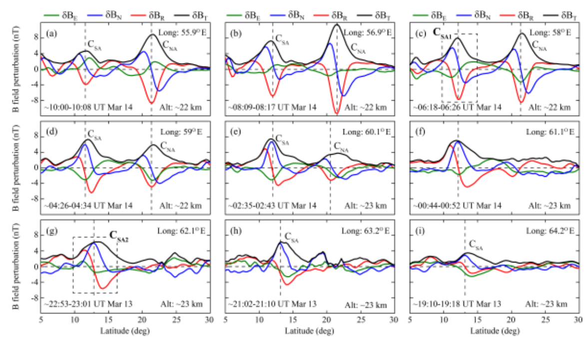

Figure 1 Magnetic field data measured on LP during the intervals crossing over the Crisium anomalies on 13-14 March 1999. Components are plotted in LOC coordinates. C_{SA} and C_{NA} indicate the south and north magnetic anomalies, respectively, in the Crisium.

Dipole Model for Isolated Magnetic Anomaly: Using a dipole model for Crisium magnetic anomalies, we examine the dipole moment vector (**M**) and depth (*d*) of the dipole source from the lunar surface for each anomaly. Figures 2 and 3 shows the root-mean-square (RMS) deviations of the observed data from the dipole model field for C_{SA1} and C_{SA2}, respectively, with different depths from the lunar surface. The optimized dipole moment is determined by finding the smallest RMS. The latitudinal RMS deviations for C_{SA1} are relatively constant in the region of 11.6°N -12.6°N and the smallest mean of the averaged RMS value in that region was 1 nT at d = 25-35 km. The inferred direction of the dipole moment for C_{SA1} is oriented radially downward and south-eastward (I = 74° and D = 137°). For C_{SA2}, the dipole directions are I = 13° and D = 169° obtained in the region of 12.3°N ~14.4°N and the minimum RMS value is 0.6 nT at d = 55-65 km. The direction of the moment vector for C_{SA2} is very close to the horizontally and inclined southward.

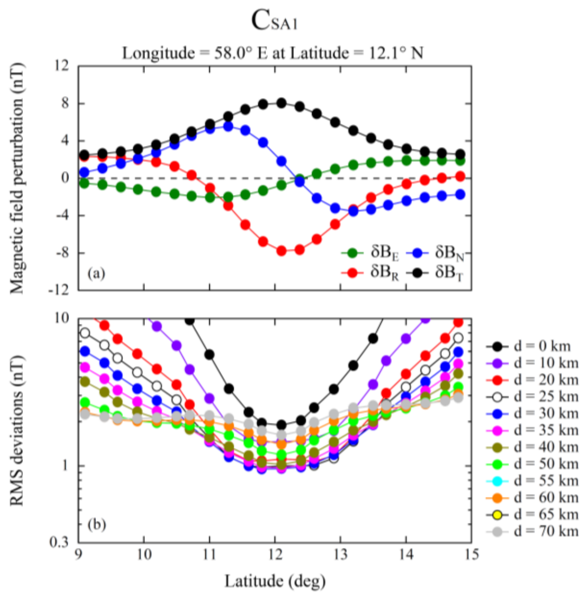

Figure 2 (a) The magnetic field data of C_{SA1} (b) The RMS deviations of the observed data from the dipole model field for C_{SA1} with different depths from the lunar surface.

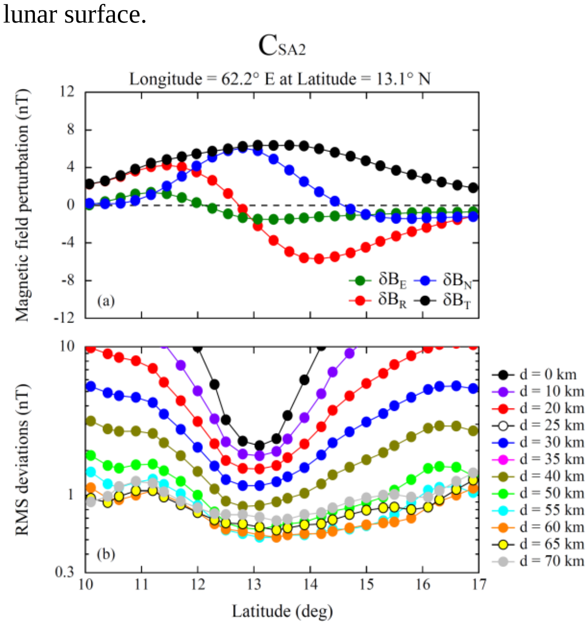

Figure 3 The format is the same as that in Figure 2 except for C_{SA2}.

Conclusion: We confirm that Crisium has two magnetic anomalies inner northern and southern edges using low altitude Lunar Prospector magnetometer (LP-MAG) data. We suggest that C_{SA} consist of two sources with different magnetization directions. We have the paleomagnetic pole position estimated for each Crisium anomaly as C_{SA1} = (10°S, 78°E) and C_{SA2} = (68°S, 92°E). The pole positions for the Crisium anomalies are considerably scattered. If our estimates using low altitude data are correct and the Crisium anomalies are magnetized by a core dynamo of the Moon, their variable directions imply that the core field was rotated between formation times of C_{SA1} and C_{SA2}, implying the motion of the paleomagnetic pole. This motion may have arisen either from true polar wander, or through changes in the orientation of the core field. We therefore expect that Crisium anomalies will be important key to solve the lunar dynamo field using their source properties inferred by our source model.

Reference: [1] Baek et al. (2017), Detailed study of the Mare Crisium northern magnetic anomaly, *Journal of Geophysical Research: Planets*, 122.2, 411-430.