CHARACTERISTICS OF SMALL-SCALE MAGNETIC ANOMALIES OUTSIDE OF MARE CRISIUM.

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Introduction: Small structures of magnetic anomalies near Crisium are examined by using data acquired with the magnetometer (MAG) on Lunar Prospector (LP). Near the inner northern and southern edges in the Crisium basin, there are magnetic anomalies showing a bipolar perturbation in north-south magnetic field component (B_z) and monopolar perturbation in the radial component (B_x). From inspection of the data in the range of 40° ~ 100° E in longitude and –20° ~ 40° N in latitude covering Crisium, many small-scale magnetic anomalies were also found. They are distributed in a wide range of distances from Crisium. Although most of them have amplitudes smaller than the two main Crisium anomalies, their magnetic polarities (in B_x and B_z) are similar to those at Crisium. This suggests that the origin of the small structures of magnetic anomalies near Crisium is not different from that of the Crisium anomalies. In this study, we are discussing what causes these small anomalies.

Data Set: The MAG data were used when LP was located less than 45 km in altitude for the period between 11 March 1999 and 15 March 1999 to examine lunar magnetic anomalies. During this interval, the Moon was in the solar wind. In this study, only night side MAG data were selected to minimize the effect of the interplanetary magnetic field.

Examples of Magnetic Anomalies near Crisium: Figure 1 shows magnetic field variations in the Selenocentric Solar Ecliptic (SSE) coordinate system measured at ~45 km by LP orbiting over the Crisium magnetic anomalies. Each field component is plotted as a function of universal time. The two main Crisium anomalies are clearly identified with large field perturbations in all field components. The main characteristics of the anomaly are a bipolar (north-then-south) perturbation in B_z, a monopolar (inward) perturbation in B_x, and a monopolar perturbation in B_y. The peak in B_x, marked by vertical dashed line, is located near a mid-point of B_z showing a bipolar (north-then-south) perturbation. The north and south anomalies in the Crisium basin are indicated by "C_{NA}" and "C_{SA}", respectively, in Figure 1. Interesting features include magnetic field perturbations outside Crisium even though their amplitude is smaller than those in Crisium and that their polarities in B_x and B_z are similar to those of the two main Crisium anomalies. That is, each B_x peak appears near a mid-point of a positive-then-negative B_z perturbation. We confirmed that these small perturbations are not temporal but spatial, by comparing MAG data obtained from different LP orbits. This suggests that their origin may not be different from that of the two main Crisium anomalies. In this study, we also examined a spatial distribution of such small structures of magnetic anomalies in the vicinity of the Crisium. We found that the small scale magnetic anomalies are widely distributed with a pattern similar to the magnetic polarity in B_x and B_z of Crisium anomaly. Figure 2 shows a distribution of the events with a monopolar perturbation in B_x in the region of 40° ~ 100° E in longitude and 20° S ~ 40° N in latitude. They were distributed in a wide range of distances from Crisium.

Conclusion: We have presented a map of small-scale magnetic anomalies in the vicinity of Crisium obtained by MAG on the Lunar Prospector. We found many small-scale anomalies of the Moon. These anomalies vary considerably in size. In this paper, we take no account of B_y because we could not define clearly magnetic polarities of B_y and B_y was not necessarily fully correlated with other components in many LP data during other intervals. Why magnetic fields show unusual magnetic polarities? Besides, what are small-scale magnetic anomaly sources? In future work, we are going to separate internal field from external field (e.g., solar wind) and the LP magnetic field data will be rotated into local coordinates in order to define clearly the small structures of magnetic anomalies. We are going to investigate magnetic anomalies in entire region of the Moon and will look for various patterns of magnetic anomalies.

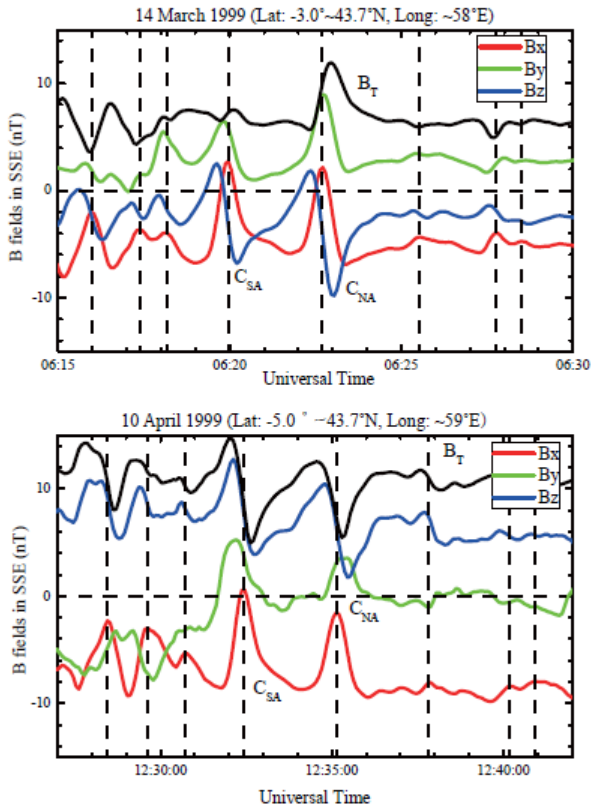

Figure 1 – *Top* Magnetic field data measured on LP during the interval 06:15-06:30 UT on 14 March 1999. Components are plotted in SSE coordinates. During the interval, LP was orbiting at an altitude of ~29 km above the Crisium basin. C_{SA} and C_{NA} indicate the south and north magnetic anomalies, respectively, in the Crisium. The vertical dashed lines indicate a peak point in the component of B_x for each small magnetic anomaly near Crisium and for Crisium anomalies.
Bottom Magnetic field data measured on LP during the interval 12:27-12:42 UT on 11 April 1999. This graph is similar to the data on 14 March 1999 (*Top*).

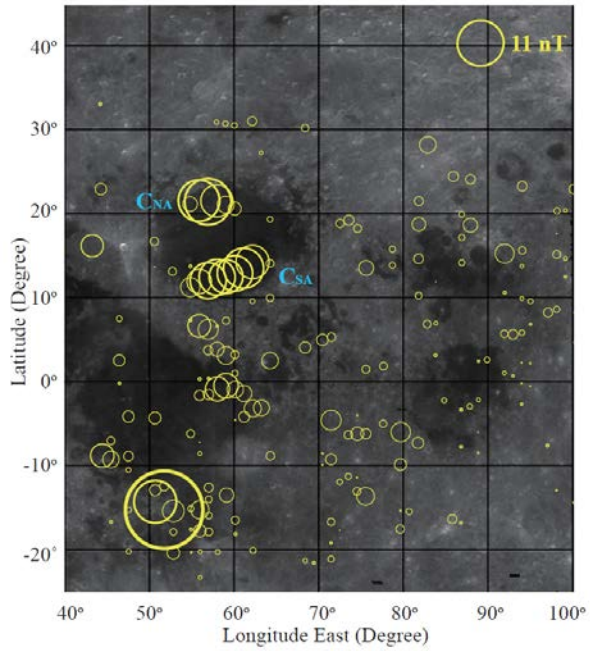

Figure 2 - A distribution of monopolar perturbations in B_x shown in Figure 1. The amplitude of all events is smaller than those of the two main Crisium anomalies, except for the magnetic anomaly observed near 15° S in latitude and 52° E in longitude. This anomaly is antipode of Hertzsprung.