TESTING THE ANTIPODAL EJECTA MAGNETIZATION HYPOTHESIS: A CLOSER LOOK AT THE GEOLOGIC SETTING OF THE LUNAR GERASIMOVICH MAGNETIC ANOMALIES.

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Introduction: The Moon no longer possesses a global magnetic field [1], but areas of its surface were permanently magnetized during the global field era. Unfortunately, the exact geologic origin and age of any of the Moon's crustal magnetic anomalies is unknown, complicating efforts to make inferences about the history of the Moon's dynamo. Proposals for crustal magnetic sources include dikes and ejecta [2,3]. Linking any crustal magnetic anomaly to a basin with known age would provide the age of the magnetic anomaly. Inversions for the source properties at such an anomaly could then constrain the strength and direction of the dynamo field at the time of basin formation. However, even anomalies that are found within basins, such as Crisium [4], have uncertain origins and ages, since they may have formed from the basin's melt sheet [5], or been intruded as dikes or sills long after the basin formed. Here we focus on basin ejecta deposits; any such magnetized material would have cooled quickly and recorded a field that corresponds to the basin's age.

Impacts cause ejecta to preferentially accumulate at the impact's antipode. This antipodal ejecta may become magnetized through compression of either the interplanetary magnetic field, or the global magnetic field of the Moon [6-8]. To determine whether or not this process occurred at the location of a specific magnetic anomaly, we look at the correlations between magnetic field and geology at a candidate antipodal location. Here we study the Gerasimovich magnetic anomaly, which is roughly antipodal to Mare Crisium. This work expands on previous work that looked only at the Mare Imbrium and Mare Serenitatis antipodes [9], as well as an initial geologic mapping of the Gerasimovich anomaly region by Hood et al. [8]. We also refer the reader to recent work on the magnetization directions at Gerasimovich at this meeting [10].

Methods & Observations: In creating maps of the Gerasimovich area, we used topography, reflectance, and magnetic field data. The topographic maps were created with LRO LOLA data and the magnetic field data is a spherical harmonic model that combines Kaguya and Lunar Prospector magnetometer data [11], evaluated at 30 km. Figure 1 shows magnetic field contours overlaid on topography. The maximum Gerasimovich magnetic anomaly, indicated by the purple arrow, is located approximately 110 km away from the antipode, indicated by the black cross. Reflectance maps

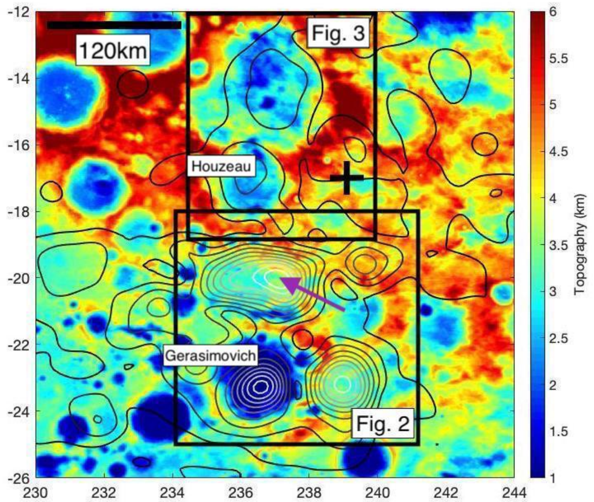

Fig. 1 – LRO LOLA topographic map of the Gerasimovich anomaly area overlain with total magnetic field contours from 30 km altitude. The maximum/minimum contour line corresponds to 43.5/4.9 nT, respectively. The black cross indicates the antipode of the center of Mare Crisium, the purple arrow indicates the area of highest magnetic field, and the black boxes indicates the areas shown in Figs. 2 and 3.

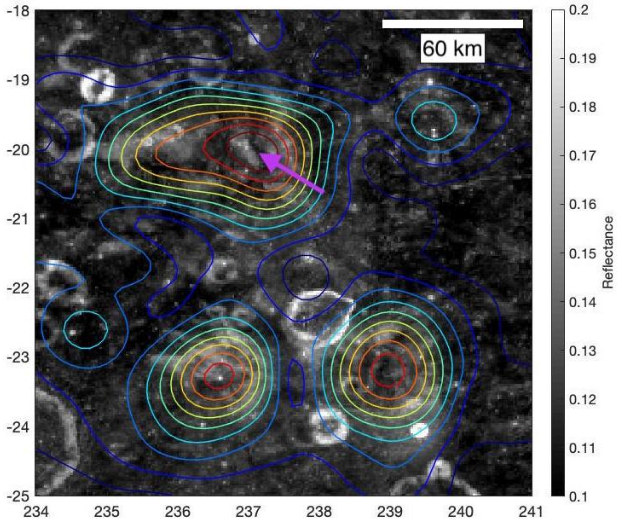

Fig. 2 – Kaguya 750nm reflectance map of the highest-field areas of the Gerasimovich anomaly. The maximum/minimum contour line corresponds to 43.5/4.9 nT, respectively. As in Fig. 1, the purple arrow indicates the region of highest field. The Mare Crisium antipode is not within these lat./lon. limits.

were created with 750 nm Kaguya reflectance data. Figures 2 and 3 show the areas indicated by the bottom and top black subset boxes in Figure 1. Figure 2 shows the magnetic field contours overlaid on top of the 750 nm reflectance data in the region of highest field, and Figure 3 shows the contours over the reflectance data in the area north of the highest field that includes the Mare Crisium antipode.

Interpretation and discussion:

Magnetic field morphology – Broadly, the Gerasimovich anomaly is not one singular anomaly: it consists of a trio of anomalies in the south, one of which is contained within the Gerasimovich crater (Fig. 1). To the north, a pair of moderate strength anomalies are found (Figs. 1 & 3).

Westward offset from the Crisium antipode – Although the Gerasimovich anomalies are located close to the Mare Crisium antipode, it has yet to be determined whether or not they are actually related to the impact that created Mare Crisium. To address this, we consider how the Moon's rotation rate at the time of impact affects the placement of ejecta at the impact's antipode. The Gerasimovich anomalies display a roughly north-south linear arrangement, as well as a westward displacement from the geometric antipode of Crisium (Fig. 1). Both of these features are to be expected for antipodal ejecta traveling around a rotating Moon [9]. For example, if the impact occurred when the Moon's rotation period was 12 days (a semimajor axis of ~34 Earth radii), then the displacement of the ejecta, after a flight time of 4-8 hours, should be approximately 5-10° west of the antipode [7]. Thus, the placement of the Gerasimovich anomalies have passed the first major test as to whether or not they are actually related to the Crisium impact.

Correlations with topography – Interestingly, the pair of moderate strength anomalies north of Gerasimovich are very well correlated with the topography of two craters (Fig. 3). Similarly, there is a strong magnetization arising from inside the Gerasimovich crater, although it is less clear if the magnetization there arises from the lunar swirls [12] (Fig. 2), or is more diffusely distributed throughout the crater, as it appears to be in the pair of northern craters in Figure 3 (the northern pair of anomalies exhibit no swirls). We presently do not have a good explanation for the correlation of topography and field for the northern pair for craters. We speculate that concentrated seismic shaking within the craters could have randomized and thereby weakened any preexisting anomaly's bulk magnetization. Interestingly, Maxwell & Garrick-Bethell [10] found that the directions of magnetization in these craters differ from the magnetization of the trio in the south.

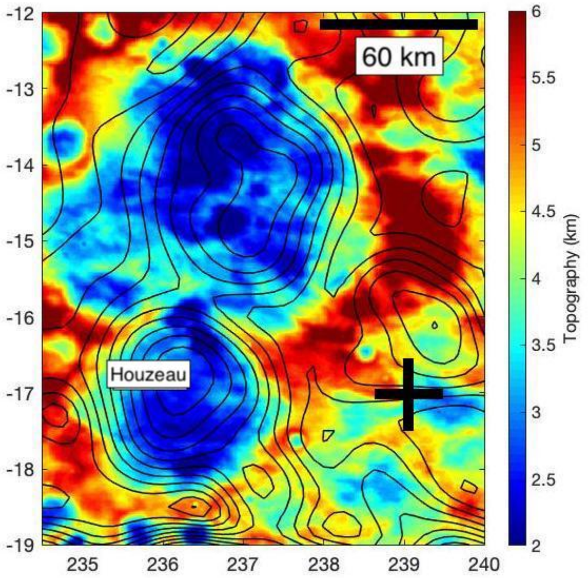

Fig. 3 – LRO LOLA topographic map of the northern region of the Gerasimovich anomaly. These two maxima in magnetic field correspond to lows in topography. The maximum/minimum contour line corresponds to 15.4/1.7 nT, respectively. The black cross at 239.1°E, 17°S indicates the location of the antipode of the center of Mare Crisium.

Conclusions: The westward displacements of the five magnetic anomalies near Gerasimovich crater, compared to the Crisium antipode, are consistent with them arising from ejecta from the Crisium impact. There are strong correlations between topography and field structure for two of the anomalies, but we have no good explanation for them at this time.

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