ISOLATED LUNAR MAGNETIC ANOMALIES: INTERACTION WITH THE SOLAR WIND. N. C. Richmond[1,2], L. L. Hood[1] and E. M. Harnett[3]. [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, Az, 85721, USA (nic@lpl.arizona.edu, lon@lpl.arizona.edu), [2]Planetary Science Institute, 1700 E. Ft Lowell Suite 106, Tucson, Az, 85719, USA, [3] Earth and Space Sciences, Box 351310, University of Washington, Seattle, WA 98195-1310, USA (eharnett@ess.washington.edu)

Introduction: It has been proposed that the apparent association between lunar crustal magnetization and albedo [e.g. 1, 2, 3] is due to either: (a) cometary impact [4, 5]; (b) meteoroid impacts [6, 7]; (c) deflection of the solar wind by crustal anomalies, preventing optical maturation of the regolith [8, 9]. In this paper, we investigate more quantitatively the possibility that lunar crustal anomalies are capable of deflecting the solar wind, producing swirl-like high-albedo markings on the lunar surface. For this purpose, we make use of a recently produced global map of the vector lunar magnetic field [10]. The global map was produced using LP-MAG data from quiet external conditions (when the Moon was in the solar wind and the spacecraft was in the lunar wake, and data from the geomagnetic tail). However, passes were also identified under dayside solar wind conditions that could potentially be useful for studying the crustal fields. These data measure the internal fields due to the crustal source, the external fields due to the incident solar wind and any fields resulting from the interaction between the crustal anomalies and solar wind. In combination with measurements from quiet external conditions, these data can be used to investigate the way in which the crustal anomalies interact with the solar wind and identify possible lunar mini-magnetospheres.

Method: In order to investigate the interaction between the solar wind and crustal anomalies, we use two methods. First, we compare coverage over isolated crustal sources obtained under magnetically sheltered external conditions and when the crustal sources were exposed to the solar wind. Second, we use forward modeling methods to investigate the distribution of magnetization. Forward modeling is a nonunique approach for studying source properties. However, for isolated sources that have a simple dipolar structure, forward modeling can be used to investigate source properties. Extending previous studies [11] we estimate the direction and strength of magnetization, but use an iterative approach to determine the best-fit distribution of magnetization. This is done by dividing the area of interest into elements that can be magnetized in different combinations, with the direction of magnetization the same for all magnetized elements. Note: We make no starting assumptions regarding the spatial distribution of the source.

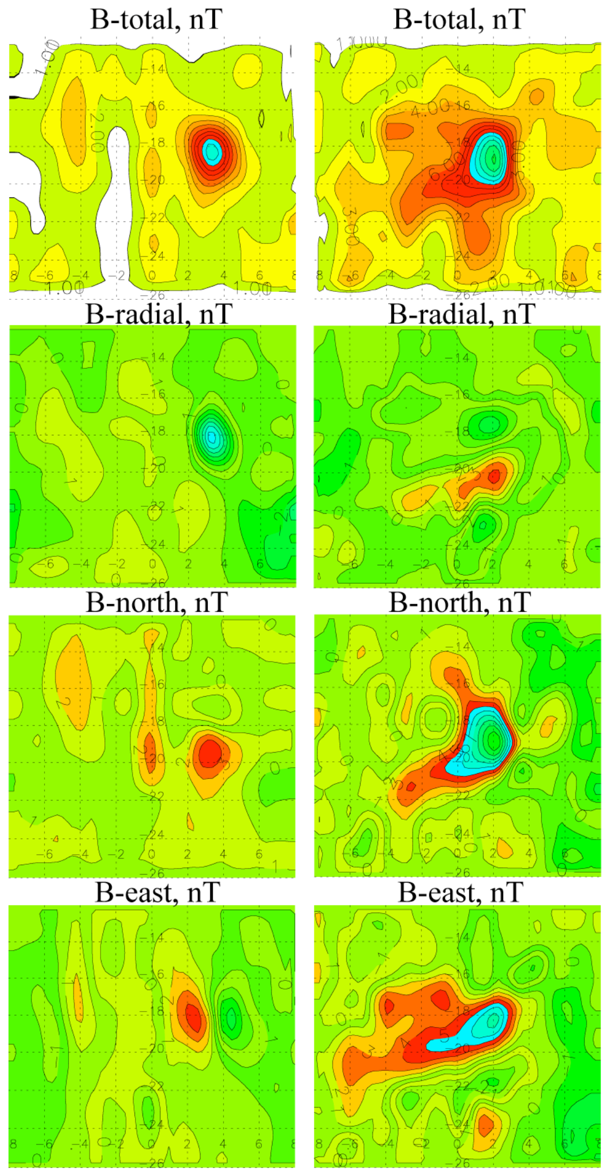

Figure 1. Low altitude LP-MAG coverage of the region near the crater Airy obtained under magnetically sheltered geomagnetic tail conditions (left, altitude ~28 km) and dayside solar wind (right, altitude ~37 km) coverage.

Isolated Anomaly Near the Crater Airy: An isolated anomaly has been mapped near the crater Airy, which shows an apparent correlation with a high albedo region [12]. The mapping of [10] has shown that this anomaly has a simple source structure and can been mapped under multiple sets of external conditions (see Figure 1).

Coverage Under Different Plasma Conditions: Figure 1 presents a comparison of two sets of LP-MAG measurements over this location, one from magnetically quiet external conditions and the other from times when the crustal source was exposed to the solar wind. It is clear from the data measured under magnetically quiet external conditions that the anomaly at Airy is predominantly dipolar, with a radial field direction. However, when exposed to the solar wind, the anomaly is noticeably amplified and distorted.

Key differences between the dayside solar wind passes and those from the geomagnetic tail region include: a) Increase in the total field strength; b) Broadening of the area of magnetization; c) Different apparent direction of magnetization. These are all observations consistent with numerical modeling results on the likely characteristics of lunar mini-magnetospheres [13].

Modeling the Spatial Distribution of Magnetization: To further understand the interaction between the solar wind and crustal magnetization at this location, we have carried out forward modeling, using the method described previously, to estimate anomaly source properties. The best-fit direction of magnetization was found to be nearly radial, with the corresponding spatial distribution of magnetization presented in Figure 2. The result in Figure 2 presents the best-fit distribution for 7 magnetized elements. The background image in Figure 2 is the Clementine albedo map. It is clear that the best-fit source distribution closely matches an unusual albedo region in the area.

Discussion and Conclusions: The results in this study provide observational evidence of a mini-magnetosphere at the anomaly near Airy and indicate that the source of the anomaly is approximately collocated with a region of unusual albedo. The correlation between albedo and magnetization has been reported previously for other anomalies [e.g. 1, 2, 3, 11]. However, the model result here is the first effort to provide a best-fit solution that makes no prior assumptions about the source distribution. The results indicate that Airy is sufficiently strong that it can interact with the solar wind under the measurement conditions. In combination with the association between the source and a region of high albedo, this provides further evidence in support of the theory that some lunar anomalies are able to deflect the solar wind and preserve high albedo regions of the lunar regolith. The next step in this research is to use the forward modeling result as an input into models that study the interaction between crustal anomalies and the incident solar wind [13, 14] to investigate the nature of the interaction in more detail.

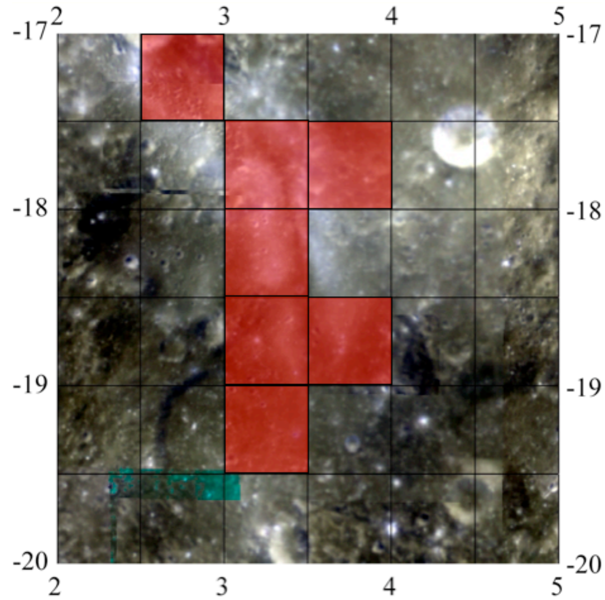

Figure 2. Overlay plot of the best-fit spatial distribution of magnetization at Airy and the Clementine albedo map. The grid shows the distribution of elements in the area. The elements shaded red correspond to the best-fit distribution of magnetization.

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