A Comparison of Lunar Prospector Thorium and Magnetic Field Data within South Pole Aitken Basin.

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Introduction: The South Pole Aitken (SPA) basin is a unique place since it is the largest impact basin on the Moon with a vertical relief of 12 km and a diameter of 2500 km [1]. Because of its great size, the impact which created this basin excavated material deep from the lunar crust and maybe even the mantle [2, 3]. In addition to the possible lower crustal/mantle material, there have also been suggestions that SPA basin contains material from the Imbrium impact due to impact ejecta focusing at the antipode of Imbrium basin [4]. The likelihood of Imbrium ejecta being present within SPA, however, has been disputed [5]. As part of the effort to understand the nature of the material within SPA, we present an analysis of Lunar Prospector thorium and magnetic field data where we directly address the possibility that Imbrium impact ejecta is located within SPA basin.

Magnetic Field Data: Magnetic field data has been taken with the Lunar Prospector Magnetometer/Electron Reflectometer (MAG/ER) [6, 7]. According to recent interpretations, these data are consistent with the hypothesis that crustal de-magnetization occurs at the location of large impact basins and crustal magnetization occurs antipodal to large impact basins [7]. A possible explanation for the antipodal magnetization is that the large basin impacts will produce a plasma cloud that compresses and amplifies any existing ambient magnetic field at the antipode. The basin ejecta which arrives at the antipode can then produce anomalous magnetic fields through the process of shock remnant magnetization [7, 8]. As seen in Figure 1, there are indeed large magnetic fields in the northwestern portion of SPA basin which are near the antipodes of the Imbrium (33°S, 162°E) and Serenitatis (27°S, 161°W) basins.

Thorium Abundances within SPA: Within SPA basin, it has been observed that the thorium distribution is segregated into two components: a spatially broad, moderate level thorium component that covers the entire basin and a localized, higher thorium component in the northwestern portion of the basin [9, 10]. The moderate-thorium component has the signature that for lower elevations the thorium abundances are larger and for higher elevations, the thorium abundances are smaller. This elevation/thorium relation is observed over the whole Moon (Figure 2) and is consistent with the idea that lower crustal and/or mantle material (as may be exposed in SPA) contains greater thorium abundances than upper crustal material [e.g. 2, 3]. In contrast, the localized, high-thorium component does not follow the elevation/thorium relation [9, 10]. We therefore suggest that this high-thorium component was emplaced by a process that is fundamentally different than the process which emplaced the moderate level thorium. Since this high-thorium component is located very close to the Imbrium basin antipode, it is possible that this thorium was emplaced as ejecta from the Imbrium impact [4, 10].

Analysis: We calculated an empirical relation between topography and thorium using the whole Moon thorium and topography data [11] to enhance the signature of the high-thorium component and reduce the effect of the moderate-thorium component within SPA. This relation is shown as the blue solid line in Figure 2. The assumed crustal component was then subtracted from the thorium data within SPA (solid red points in Figure 2) to get a topography corrected thorium map (Figure 3) that should be dominated by the high-thorium component. A comparison of the topography corrected thorium and magnetic field maps shows a very good association. If the antipodal magnetization hypothesis is correct, then these data appear to show that the high-thorium component may indeed be the result of Imbrium impact ejecta.

A different way to look at the data is shown in Figure 4 where both uncorrected (open circles) and corrected (solid, red circles) thorium abundances within all of SPA are plotted versus magnetic field measurements (the thorium data has been rebinned to 5°x5° to match the LP-ER data). While both the uncorrected and corrected thorium data is correlated with the magnetic field data, the topography correction clearly improves the correlation by increasing the correlation coefficient (R_{corr}=0.69 vs. R_{uncorr}=0.39) and reducing the scatter.

Conclusions: We conclude there is a correlation between regions of high magnetic field and high thorium abundances within SPA basin. If the hypothesis of [7] is correct that the magnetic anomaly is due to magnetized material from the Imbrium impact, then these data are evidence that the localized thorium component within SPA is also associated with the Imbrium impact.

References: [1] Spudis, et al., *Science*, 266, 1848, (1994); [2] Lucey et al., *JGR*, 103, 3701 (1998); [3] Pieters et al., *GRL*, 24, 1903 (1997); [4] Haskin, L. A., *JGR*, 103, 1679 (1998); [5] Hawke and Spudis, *Proc. Lunar High. Crust*, 467 (1980); [6] Lin et al., *Science*, 281, 1480 (1998); [7] Halekas et al., *LPSC XXXI*, this vol.; [8] Hood and Huang, *JGR*, 96, 9837 (1991); [9] Lawrence et al., *GRL*, 26(17) 2681 (1999); [10] Lawrence et al., *JGR*, in press (2000); [11] Smith et al., *JGR*, 102, 1591 (1997).

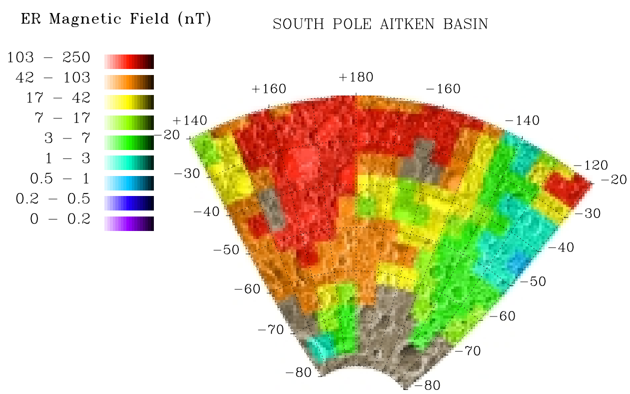

Figure 1

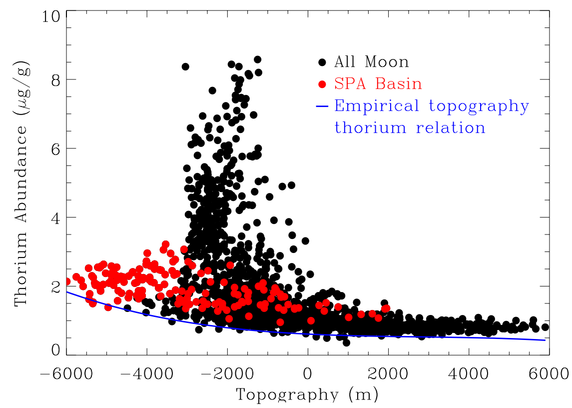

Figure 2

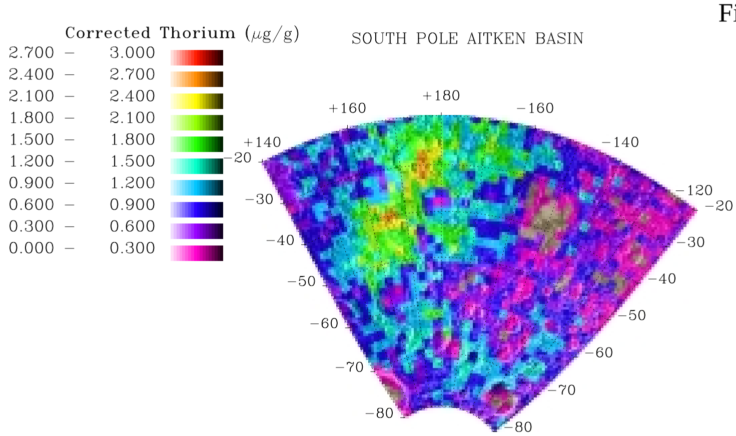

Figure 3

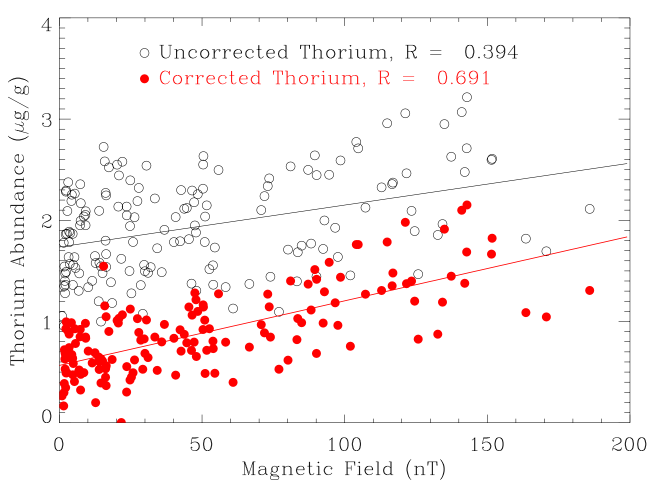

Figure 4