Preliminary Findings of a Study of the Lunar Global Megaregolith.

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Hartmann [1] first coined the word "mega-regolith" to describe that part of the lunar crust that has a variable thickness of up to several kilometres, sandwiched between the surface thin regolith layer of a few metres in thickness and the bedrock below. Hartmann [2], described megaregolith as a "product of cataclysm… at least a few kilometres deep".

This study presents new information on the lunar megaregolith, using iron and titanium concentrations in crater ejecta derived from Clementine mission data and the Lucey et al [3] iron and titanium mapping methods with the US Geological Survey ISIS software. Croft [4], Grieve [5], and later workers showed that craters excavate about 10% of their diameters for craters between 5 - 50 km across. These craters thus sample the upper few kilometres of the Moon and allowing probing of the megaregolith on a global scale. Worn/degraded craters or craters where basalts flows had covered the ejecta were excluded. The ejecta from 2059 craters of diameters between 5 and 50 km were analysed. Twelve points were collected from each crater ejecta field. No point exceeded a distance of one crater radius from the crater rim. These data were collected from the 12.00 o'clock position just outside the crater rim in a counter-clockwise direction and equally spaced. The average concentration (by weight percent) for Fe and Ti values for each point were entered into a spreadsheet and averaged with the calculated standard deviation. The derived data of this study were used to produce maps of iron and titanium concentrations spanning a global region of 60 N to 60 S (see Figures 1and 2). The bedrock map of Tompkins and Pieters [5] is used to compare the relationship, if any, between the megaregolith with the bedrock and the Lucey et al surface Fe and Ti maps.

The highlands megaregolith appears to consist of two distinct units, one of higher iron concentration (up to 6.4 % surrounding the larger basins), and the other a low iron unit (0-3.7%). When compared other mapping products [6-8], the new maps allow access information to the extent to which surface composition correlates with the composition of materials at greater depths. The average composition of the highland megaregolith varies around the Moon, being more iron-rich on the western near side (Procellarum province) and very iron-poor (felspathic) in the central far side highlands.

The distribution of iron concentrations in general mirrors the trends seen in the iron global maps [8], suggesting that to a first order, the surface composition is representative of the average composition of the upper few kilometres of the Moon. The preservation of distinct provinces mitigates against the widespread distribution of a homogenous blanket of material from some single source (e.g. the Imbrium basin [9]).

As expected, the iron values for the mare megaregolith are high (up to 18.3 %) reflecting the thick basaltic fill of the large maria and possibly for more mafic highland crust that underlies the near side maria.

South Pole-Aitken Basin shows concentrations similar to near side to the maria and may be an expression of lower crustal material possibly mixed with upper mantle material [10], in addition to localised titanium-rich basalt flows [11]. The very low iron region north of SPA basin on the far side may represent both highly feldspathic SPA basin ejecta [12] and remnants of the original primordial anorthositic crust, created during the lunar magma ocean [13].

This study provides a new approach to understanding lunar geological development. The intention is to use these new maps to understand the nature of the lunar upper crust, to derive the geological evolution of specific regions and to study the large impact processes and the evolution of megaregolith growth. The new data can shed light on both process and history in the formation of the early lunar crust.

References:

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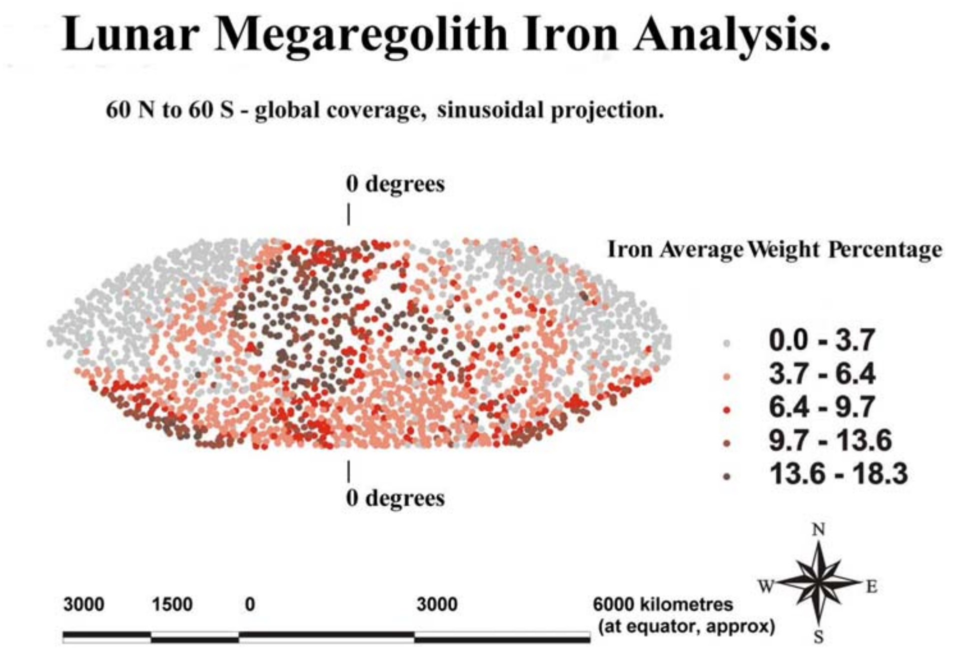

Figure 1. Preliminary average iron weight percentage analysis of crater ejecta to indicate iron concentration in the megaregolith.

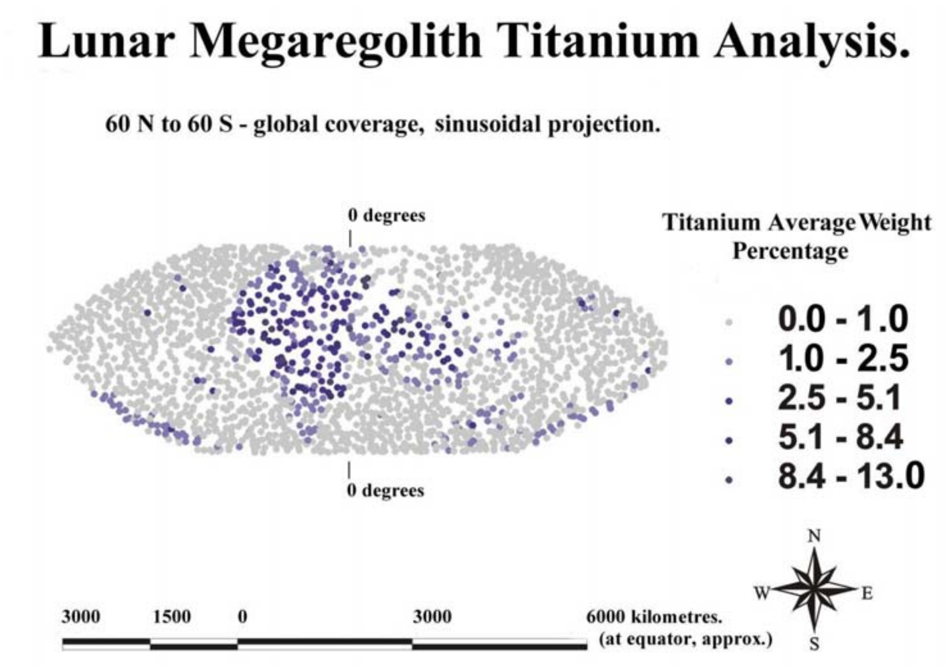

Figure 2. Preliminary average titanium weight percentage analysis of crater ejecta to indicate titanium concentrations in the megaregolith.