IMPACT MELT DIFFERENTIATION IN SOUTH POLE-AITKEN BASIN.

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Introduction: Impact melt sheets associated with the terrestrial Sudbury and Manicouagan impact structures have evidently undergone igneous differentiation [1-2]. Since basin-forming impacts on the Moon are thought to have generated voluminous impact melt sheets [3], a natural question (posed also by [1]) is: Did impact melt sheets on the Moon also differentiate, and, if so, how did the process of impact melt differentiation control lunar crustal evolution?

The process of impact melt differentiation is probably less efficient on the Moon than on Earth (see [4]), as: (1) impact melt sheets on the Moon are generally thinner than on Earth, since a given impactor excavates a larger crater in lunar gravity than in terrestrial gravity; (2) impact melt sheets on the Moon cool more quickly than equally thick impact melt sheets on Earth, mainly because anorthosite clasts predominant in lunar impact melt are less readily fusible than basaltic or granitic clasts in terrestrial impact melt; and (3) if crystal settling is the mechanism by which impact melt sheets differentiate (see [5] for a contrary perspective), crystals settle more slowly through impact melt sheets in lunar gravity than in terrestrial gravity. Considering the magnitude of these effects, we conclude that only the largest lunar basins (Orientale-size and larger) host impact melt sheets that have undergone igneous differentiation. We consider in this abstract the implications of impact melt differentiation in the largest and oldest lunar basin (excepting the dubious Procellarum basin), the South Pole-Aitken basin (SPA).

We ground our discussion of the implications of impact melt differentiation in SPA by modeling the igneous stratigraphy of SPA impact melt differentiates. We will demonstrate that this stratigraphy is consistent with the likely stratigraphy of the SPA interior (Figure 1).

Implications of impact melt differentiation in SPA: (1) The noritic floor of SPA [11-13], though more mafic than typical lunar highlands crust, is anomalously feldspathic for the floor of a basin formed by an impact which is modeled to have excavated nearly 100 km into the Moon [14], completely through the lunar crust. Moreover, geophysical measurements [9] suggest that the noritic floor of SPA is >10 km thick. We suggest that the thick noritic floor of SPA is better understood as an impact melt differentiate than as lunar primary crust. (2) Since the SPA floor is not necessarily primary crust, the noritic composition of the SPA floor need not represent the composition of the lunar primary lower crust. (3) If the noritic SPA floor is an impact melt differentiate, then samples from nearly any nonmare location in the SPA interior can be used to date the SPA-forming impact. (4) An SPA-forming impact that melts pre-cumulate overturn mantle gives rise to a different set of impact melt differentiates than a similar impact that melts post-cumulate overturn mantle [15]. The composition of SPA impact melt differentiates constrains the date of the SPA-forming impact. For additional information about the implications of impact melt differentiation on the Moon, consult [16].

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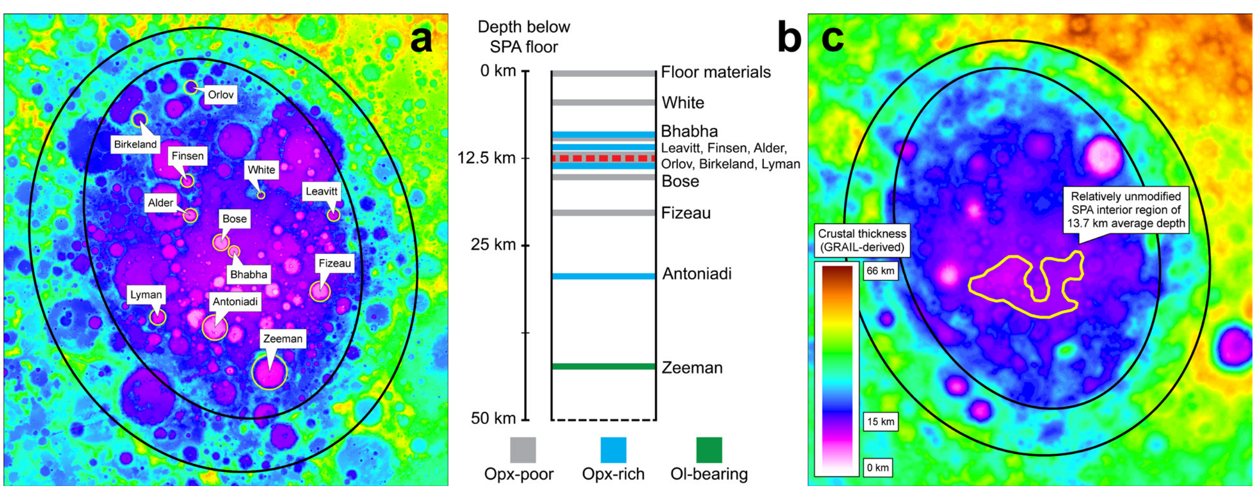

Figure 1. Spectroscopic and geophysical constraints on SPA subsurface stratigraphy: (a) twelve complex craters with previously characterized central peaks [6-8]; (b) constraints on subsurface stratigraphy from central peak mineralogy; the dashed red line at 12.5 km depth corresponds to (c) the average (GRAIL-derived) crustal thickness [9]. Rim outlines from [10].