MOON MINERALOGY MAPPER OBSERVATIONS OF SOUTH POLE – AITKEN: CONSTRAINTS ON BASIN FORMATION. D. P. Moriarty[1] and C. M. Pieters[1], [1]Dept. of Geol. Sci., Brown Univ., Providence, RI, Daniel_Moriarty@Brown.edu

Introduction: With a diameter of ~2500 km and a maximum depth of ~12-14 km, The South Pole – Aitken basin (SPA) on the lunar farside is one of the largest (and oldest) impact basins in the solar system [1-6]. As such, SPA is key to understanding large impact processes as well as the structure of the lunar interior. Here, we compare impact basin formation models to Moon Mineralogy Mapper (M^3) observations.

Vertical Impact Model: The simplest basin formation models invoke vertical impacts. For a SPA-scale vertical impact, scaling relationships predict total excavation of crustal materials from the transient cavity [e.g. 7]. Large quantities of melt are formed, primarily from mantle materials [7-9]. Uplift and collapse of melted mantle materials at the center of the forming basin result in sloshing of these materials over the rim of the transient cavity and emplacement overlying exterior crustal materials [7,10]. Extensive collapse of the transient cavity deforms and translates materials inward and results in a final topographic depression larger than the transient cavity by a factor of ~2 [7]. This results in a two-zone basin structure: an inner zone comprised of mostly mantle melt and an outer zone comprised of mantle melt overlying crustal materials [7].

Model Variations: *Melt sheet differentiation*. Melt bodies can differentiate under certain conditions (low viscosity, slow cooling, and convection) [11]. If a melt sheet fully differentiates, individual exposures of the melt sheet would not represent the bulk composition [9,12]. However, the stratigraphy formed via differentiation is sensitive to the bulk composition [9]. *Oblique impact*. Vertical impacts are statistically unlikely, the most likely impact angle on any planetary body being 45^o [13]. For a given transient crater volume, highly oblique impacts reduce the total volume of impact melt produced and shift the melt region shallower and downrange [14]. Oblique impacts also result in a muted central uplift as well as less melt retention in the basin interior [7,10]. *Low-speed / large projectile*. For a given transient crater volume, low-speed / large projectile impacts produce less melt [8,15]. Additionally, excavation and melting occur in shallower zones. A larger impactor cross section could trap more crustal materials in the melt region, effecting the bulk melt composition [16]. An oblique impact by a very large impactor would cause impactor decapitation and energy decoupling, preserving a large transient cavity with pre-impact stratigraphy [15]. *Clast-rich melt*. Many models treat melted materials as a strengthless fluid. This in unrealistic, as crater modification and partial melting would result in clast-rich melts [16]. The inclusion of clasts results in two-phase flow and limits the overshoot of melt beyond the transient cavity rim during mantle uplift and collapse [16].

M^3 Observations: For this study, a survey of compositional units was performed for NW SPA using M^3 data. Although the lunar mantle is expected to contain significant olivine, observations of SPA have revealed a paucity of the mineral [17-21]. This is consistent with three SPA impact scenarios: (1) shallow excavation and melting resulting from a highly oblique and/or low-velocity impact (sampling mostly lower crustal materials), (2) an upper mantle lacking significant olivine (implying mantle overturn did not occur [17]), or (3) sequestration of olivine at unsampled depths via melt sheet differentiation [9]. (3) would also require a mechanism to constrain mantle melt to central SPA (such as clast-rich melt flow), since thinner melt deposits in outer SPA are less likely to differentiate and sequester olivine at unsampled depths.

Central SPA is dominated by low-Ca pyroxene (LCP), which is exposed in craters of various sizes (suggesting that it is pervasive over a range of depths) [18-20]. Outer SPA exhibits juxtapositions of LCP- and plagioclase-rich materials, also at a wide range of depths. The scale of heterogeneity in this region ranges from 100s of meters to ~100 km. If SPA impact ejecta (mafic melt and breccia) was emplaced over the crust surrounding the transient cavity, large-scale mixing and deformation of these layers may occur during the modification stage, producing the observed heterogeneity [7]. The inward motion of external materials during collapse may also explain the occurrence of plagioclase-rich crustal materials near the basin center (such as in the central peaks and ejecta of Alder). Characterizing the petrogenesis of individual LCP-rich exposures through quantitative spectral analysis will further constrain the basin formation process.

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