ASYMMETRIC EJECTA EMPLACEMENT FROM SOUTH POLE-AITKEN BASIN: 3D HYDROCODE MODELING RESULTS. J. D. Kendall[1], [1]Purdue University, Department of Physics and Astronomy, 525 Northwestern Ave, West Lafayette, IN 47907 (email: jordan.d.kendall@gmail.com).

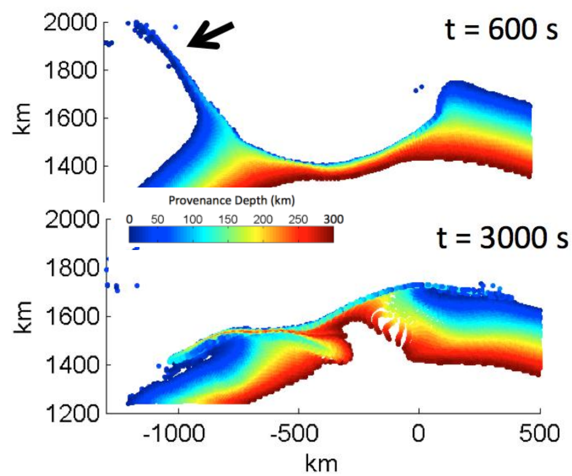
Introduction: The largest known impact on the Moon formed the South Pole-Aitken (SP-A) basin and excavated material as deep as the mantle. From crater scaling laws [1], the impact that formed the SP-A basin likely excavated material onto the surface that likely originated from the crust and upper mantle. Thus, SP-A is of great interest for future space missions and possible sample return missions [2,3]. Using the latest hydrocode modeling techniques and the highest resolutions yet achieved for SP-A, we find the SP-A impact ejected enough material to deeply cover the lunar farside. The SP-A basin, a ~2500 km diameter farside basin, is the largest and oldest observable lunar impact structure. The basin's elliptical shape is indicative of an oblique impact (around 30° to 45° to the horizontal) by an asteroid greater than 200 km in diameter traveling from South to North [4,5,6]. During the impact process, ejecta leave the crater and travel well beyond the transient crater rim (Figure 1) before emplacement upon the surface.

Numerical Model: We use iSALE-3D, an impact shock physics hydrocode capable of three-dimensional (3D) simulations [7,8], to determine the ejecta distribution, volume, and thickness for an obliquely-approaching impactor. We calculate the trajectory of ejecta that leave the crater and return to the lunar surface. Our work also incorporates the curvature of the lunar surface in 3D (entirety of Moon is modeled) for both the impact and ejecta models.

Results: In these simulations, an ejecta blanket forms (Figure 1), with a thickness of kilometers, over the entire lunar farside. The ejecta deposit primarily in a distorted annulus along the northern region of the SP-A basin and the nearby lunar farside highlands. Although the nearside-farside dichotomy is too large to be attributed entirely to SP-A ejecta deposition, the basin ejecta have nevertheless made a substantial contribution to the farside mass anomaly. In addition to ejection of crustal material, we predict that an impact of this scale also excavates and ejects upper mantle material beyond the transient crater rim and final basin rim.

We determined the thickness and original depth (or provenance depth) of the debris deposited for each point on the Moon's farside. The ejecta extends mainly downrange from the basin rim: very little is deposited uprange due to the obliquity of the impact (Figure 1). The range of the ejecta is inversely related to its initial depth. Crustal material (<50 km depth) travels farthest and blankets the largest area of the farside. Upper mantle material (>50 km depth) occupies a distorted annulus downrange of the transient crater rim. The ejecta volume and area decrease with increasing excavation depth.

Figure 1: We illustrate the evolution of mantle material as the crater opens and collapses. A 200 km diameter impactor strikes at 15 km/s and a 45° angle from the horizon (down and to the left). We plot only the tracers along the plane of impact with the center of the Moon at the origin. The tracer colors represent initial depth from the surface (dark blue) to an initial 300 km depth (red).



Conclusion: We find that the debris underlying the lunar farside highlands mainly consists of material excavated by the SP-A basin-forming impact. The Moon's upper mantle material is most likely to be exposed in close proximity to the SP-A basin's north rim. Our model and results will be useful for any future misisons to the South Pole-Aitken basin or large scale impact structures on the Moon.

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