**THE CASE FOR A LUNAR SAMPLE RETURN MISSION NEAR THE SOUTH POLE-AITKEN BASIN: PERSPECTIVES FROM IMPACT MODELING.** Jordan D. Kendall[1,2] and Noah E. Petro[1], [1] NASA Goddard Space Flight Center, [2] University of Maryland, Baltimore County (jordan.d.kendall@nasa.gov).

**Introduction:** The largest known impact on the Moon formed the South Pole-Aitken (SPA) basin and excavated material possibly as deep as the mantle. However, this implies a curious conundrum: olivine's scarce appearance in reflection spectra on the lunar surface, particularly in the center of SPA. From modeling studies and scaling laws, we know the largest basins on the Moon excavated and ejected large portions of the lunar upper mantle and lower crust onto the lunar surface. The rarity of olivine on the current lunar surface suggests the lunar upper mantle and lower crust is not olivine rich, contrary to previous views of the composition of the lunar mantle. Rather than olivine, a recent study suggests low calcium pyroxene dominates the Moon's upper mantle, which correlates well with other studies that find similar results in the reflectance spectra of small craters and larger basins, petrologic modeling, gravity studies, and seismic data (Melosh et al., 2017).

*Mantle Ejecta:* Using the latest hydrocode modeling techniques (iSALE-3D), we find the SPA impact ejected enough material to deeply cover the lunar farside. In our conservative case **(Fig. 1)**, 2.21 x $10^6$ $km^3$ of mantle material ejects beyond the final crater rim from initial depths up to 75 km. Our model also allows us to map the ejecta distribution, thickness, and layering, thus providing a useful tool for determining scientifically rich regions to land with future sample return missions. The Moon's upper mantle material is more likely exposed near the SPA basin's north rim. This suggests a sample return mission near the northern ridge of SPA basin provides the most likely location to encounter material originally from the upper mantle. At the South Pole, we also expect ejecta emplacement but we require future model improvements to state with certainty. Therefore, we argue that SPA provides multiple regions of interest for future space missions and sample return missions and would deliver insightful scientific discoveries about the formation of the Moon, in turn telling us more about the Earth and other planetary bodies in our solar system.

**Figure 1:** Color contours illustrating SPA ejecta thickness of a 200 km diameter impactor striking at an angle 45° and 15 km/sec, traveling 18° NW along the major axis of the best-fit ellipse (from Garrick-Bethell and Zuber 2009). We center the lunar farside at 0° longitude.