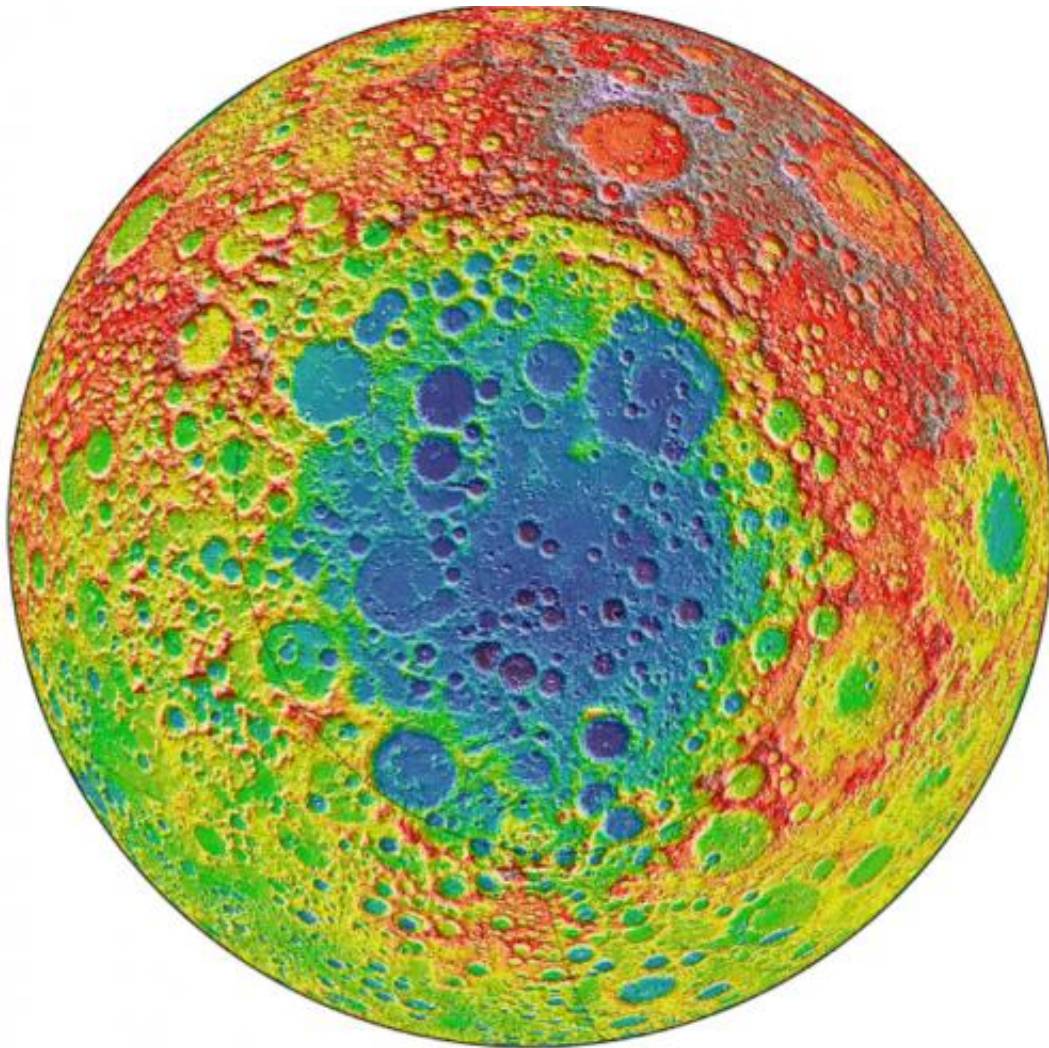


# Ancient crater could hold clues about moon's mantle

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Red areas on the topographic image indicate high elevations, and blue or purple areas indicate low elevation. The South Pole Aitken basin could hold clues about the composition of the Moon's mantle. Credit: NASA/GSFC

Researchers from Brown University and the University of Hawaii have found some mineralogical surprises in the Moon's largest impact crater.

Data from the Moon Mineralogy Mapper that flew aboard India's Chandrayaan-1 lunar orbiter shows a diverse mineralogy in the subsurface of the giant South Pole Aitken basin. The differing mineral signatures could be reflective of the minerals dredged up at the time of the giant impact 4 billion years ago, the researchers say. If that's true, then the South Pole Aitken (SPA) basin could hold important information about the Moon's interior and the evolution of its crust and mantle.

The study, led by Brown graduate student Dan Moriarty, is published in online early view in the *Journal of Geophysical Research: Planets*.

At 2,500 kilometers across, the SPA is the largest impact basin on the Moon and perhaps the largest in the solar system. Impacts of this size turn tons of solid rock into molten slush. It has been assumed generally that the melting process would obliterate any distinct signatures of pre-existing mineralogical diversity through extensive mixing, but this latest research suggests that might not be the case.

The study looked at smaller craters within the larger SPA basin made by impacts that happened millions of years after the giant impact that formed the basin. Those impacts uncovered material from deep within the basin, offering important clues about what lies beneath the surface. Specifically, the researchers looked at the central peaks of four craters within the basin. Central peaks form when material under the impact zone rebounds, forming an upraised rock formation in the middle of the crater. The tops of those peaks represent pristine material from below the impact zone.

Using Moon Mineralogy Mapper data, the researchers looked at the light

reflected from each of the four central peaks. The spectra of reflected light give scientists clues about the makeup of the rocks. The spectra showed substantial differences in composition from peak to peak. Some crater peaks were richer in magnesium than others. One of the four craters, located toward the outer edge of the basin, contained several distinct mineral deposits within its own peak, possibly due to sampling a mixture of both upper and lower crust or mantle materials.

The varying mineralogy in these central peaks suggests that the SPA subsurface is much more diverse than previously thought.

"Previous studies have suggested that all the central peaks look very similar, and that was taken as evidence that everything's the same across the basin," Moriarty said. "We looked in a little more detail and found significant compositional differences between these central peaks. The Moon Mineralogy Mapper has very high spatial and spectral resolution. We haven't really been able to look at the Moon in this kind of detail before."

The next step is figuring out where that diversity comes from.

It's possible that the distinct minerals formed as the molten rock from the SPA impact cooled. Recent research from Brown and elsewhere suggests that such mineral formation in impact melt is possible. However, it's also possible that the mineral differences reflect differences in rock types that were there before the giant SPA impact. Moriarty is currently undertaking a much larger survey of SPA craters in the hope of identifying the source of the diversity. If indeed the diversity reflects pre-existing material, the SPA could hold important clues about the composition of the Moon's lower crust and mantle.

"If you do the impact scaling from models, [the SPA impact] should have excavated into the mantle," Moriarty said. "We think the upper

mantle is rich in a mineral called olivine, but we don't see much olivine in the basin. That's one of the big mysteries about the South Pole Aitken basin. So one of the things we're trying to figure out is how deep did the impact really excavate. If it melted and excavated any material from the mantle, why aren't we seeing it?"

If the impact did excavate mantle material, and it doesn't contain olivine, that would have substantial implications for models of how the Moon was formed, Moriarty said.

Much more research is needed to begin to answer those larger questions. But this initial study helps raise the possibility that some of the original mantle mineralogy, if excavated, may be preserved in the Moon's largest impact [basin](#).

Carle Pieters, professor of geological sciences at Brown, and Peter Isaacson from the University of Hawaii were also authors on the paper. The work was supported by NASA's Lunar Advanced Science and Exploration Research (LASER) program and the NASA Lunar Science Institute (NLSI).

Provided by Brown University

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