Lunar swirl patterns and topography are related, study finds

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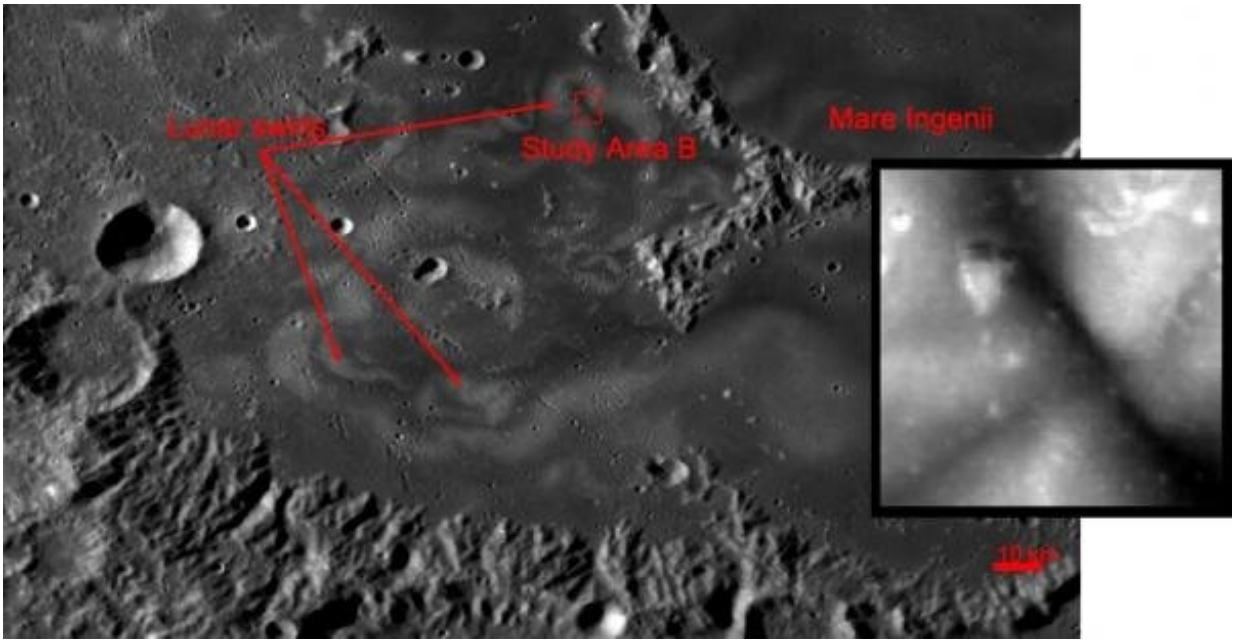

This image shows the swirl region within Mare Ingenii, highlighting one of the study areas (inset). The bright and dark swirl pattern is stark against the lunar mare terrain. Credit: The images are from the Lunar Reconnaissance Orbiter Camera (LROC) extracted from the LROC quickmap (https://quickmap.lroc.asu.edu/).

Bright and dark swirling patterns on the Moon's surface have been linked to the topography of the swirls, says a new paper by a team of scientists from the Planetary Science Institute.

"This is the first time there has been a demonstrated correlation between the swirl albedo patterns and topography," said PSI Senior Scientist Deborah Domingue, lead author of "Topographic Correlations within Lunar Swirls in Mare Ingenii" that appears in *Geophysical Research Letters*. Albedo is the measure of brightness or the proportion of light reflected from a surface, with a dark object having a low albedo. PSI scientists John Weirich, Frank Chuang, Amanda Sickafoose and Eric Palmer are co-authors.

"Until now the swirls were thought to overlay the topography, which has been cited as part of the evidence that they are created through shielding of the surface from the solar wind by the magnetic fields present at swirls. This correlation argues that there is more than just shielding from space weathering that goes into their creation," Domingue said.

Two swirl regions in Mare Ingenii—a large, dark basaltic plain formed by ancient volcanic eruptions on the Moon's far side—display a correlation between albedo and topography, where the bulk elevation in the bright regions is lower than the bulk elevation in the dark regions. These differences are apparent in the meter-scale-resolution topographical data.

"For swirls, dust transport is the process most affected by elevation changes and we now re-examine the role of dust mobility across the lunar surface in the context of this new discovery," Domingue said.

The light and dark albedo patterns that define swirls appear intertwined. The light or bright albedo regions represent areas that are shielded by the associated magnetic anomalies, show spectral properties that are less mature, and display a decreased abundance of implanted solar wind hydrogen (which forms OH). The dark albedo regions show spectral properties that are more mature than the bright areas. All of this is in comparison to the background surface. This is strong evidence that solar

wind shielding plays a role in their formation. However, some of these properties can also be explained by the differences in the fine-grained versus the courser-grained components of the lunar soils, not just by weathering differences.

"The question becomes how much do we understand the processing of the lunar surface and the migration of fine-grained materials. Swirls are not only a place to test our ideas on space weathering of the surface, but of the efficiency of dust migration across the surface," Domingue said. "If we are going to have long-term installations on the surface of the Moon, how do we protect against issues that fine-grained dust present to robots, habitats, space suits and other machinery, let alone on the health and safety of humans present on the surface for long durations?"

More information: Deborah Domingue et al, Topographic Correlations Within Lunar Swirls in Mare Ingenii, *Geophysical Research Letters* (2022). DOI: 10.1029/2021GL095285

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