



## UNIVERSITIES SPACE RESEARCH ASSOCIATION

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### **SOFIA Reveals Map of Moon's Water Near its South Pole Artemis Landing Sites**

**Washington DC – March 15, 2023.** A new study using NASA's and DLR's now-retired [Stratospheric Observatory for Infrared Astronomy \(SOFIA\)](#) has pieced together the first detailed, wide-area map of water distribution on the Moon. With clear, identifiable lunar features marked out by the water data, the study provides hints about how water may be moving across the Moon's surface, particularly near its South Pole — an important area for space exploration. The results were presented at a press conference at the 2023 Lunar and Planetary Society Conference in Houston, TX today.

The new map covers about one-quarter of the Earth-facing side of the lunar surface, below 60 degrees latitude and extends to the Moon's South Pole. Given the large region covered, the researchers could easily identify how water relates to surface features on the Moon, staying away from sunlight and favoring cold areas.

"When looking at the water data, we can actually see crater rims, we see the individual mountains, and we can even see differences between the day and night sides of the mountains, thanks to the higher concentration of water in these places," said Bill Reach, lead author of the paper and director at Universities Space Research Association and director of the SOFIA Science Center at NASA's Ames Research Center in California's Silicon Valley.

This finding, along with two previous SOFIA results about the [amount](#) and [distribution](#) of water on the Moon's sunlit surface, tracks a unique light signature of water. Other missions observing wide areas of the lunar surface have studied different wavelengths of light, which can't distinguish water from similar molecules, such as hydroxyl. The Moon's water is present in the soil and might be found as ice crystals, or as water molecules chemically bound to other materials.

Instead of determining the absolute quantity of water in the region, the researchers compared the data obtained around the Moon's South Pole to a relatively dry reference region near the Moon's equator to see how its abundance changes. The water was found in greater concentrations on the shadowed sides of craters and mountains, similar to the way skiers on Earth know the slopes receiving less direct sun retain snow longer. This suggests the Moon's local geography plays an important role in the amount of water present.

In late 2024, NASA's Volatiles Investigating Polar Exploration Rover (VIPER) will land in the region studied by SOFIA, atop [Mons Mouton](#), to conduct the first resource mapping mission beyond Earth. The flat-topped lunar mountain will be a region of emphasis in the next paper from the team that led the current study of SOFIA data.

And, as NASA prepares to send astronauts back to the Moon under [Artemis](#), the agency has identified 13 candidate landing regions near the lunar South Pole. Through Artemis, NASA will land the first woman and the first person of color on the Moon, and lunar water will be a critical resource for establishing a long-term human presence.

“With this map of SOFIA data, and others to come, we are looking at how water is concentrated under different lunar environmental conditions,” said Casey Honniball, a visiting assistant research scientist and VIPER science team member at NASA's Goddard Space Flight Center, in Greenbelt, Maryland, who was involved in the work. “This map will provide valuable information for the Artemis program on potential prospecting areas but also provides regional context for future missions, like VIPER.”

In addition to the southern region for which the new map results were created, SOFIA observations of sites relevant to other missions are in the archive and now being analyzed. NASA Artemis-related missions will target both polar and non-polar regions, including [Lunar Trailblazer, which will orbit the Moon to map its hydroxyl and water](#).

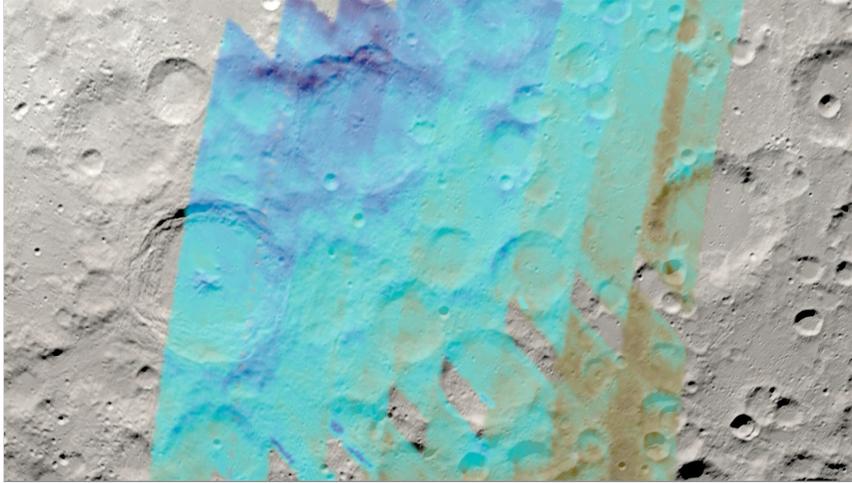
Where the Moon's water may be coming from — whether it exists inherently in the Moon's minerals or is exclusively delivered by comets and solar wind, and whether it is migrating along the Moon's surface — is another important question left open by the SOFIA observations. VIPER will aim to better understand this distinction, which is important in determining if the water is widespread and deep within the surface, or only scattered at or near the surface.

It's clear, however, that even at its lowest limit, the Moon contains much more water than we once believed.

“Our common knowledge from the Apollo era that the Moon is bone dry was wrong,” said Paul Lucey, a professor at the University of Hawaii at Mānoa and co-author on the paper. “We already know it's wrong, but the question is by how much.”

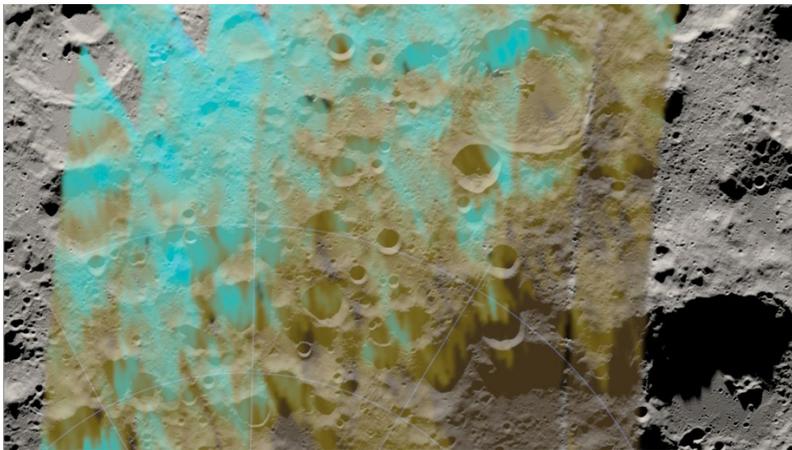
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SOFIA was a joint project of NASA and the German Space Agency at DLR. DLR provided the telescope, scheduled aircraft maintenance, and other support for the mission. NASA's Ames Research Center in California's Silicon Valley managed the SOFIA program, science, and mission operations in cooperation with the Universities Space Research Association, headquartered in Columbia, Maryland, and the German SOFIA Institute at the University of Stuttgart. The aircraft was maintained and operated by NASA's Armstrong Flight Research Center Building 703, in Palmdale, California. SOFIA achieved full operational capability in 2014 and concluded its final science flight on Sept. 29, 2022.



**Caption:** A visualization of SOFIA data of a “light signature” of water overlaid on a visualization of the Moon as it appeared at the time of the observations in Feb. 2022. Darker blue indicates a higher concentration of water. Near the top left of the studied region, a “wet ridge” is visible in dark blue, where the water is particularly concentrated on the shady side of a steep lunar feature. Halfway down the left side of the region is Moretus Crater. The inner wall on the crater’s upper half is clearly delineated in dark blue, indicating a greater presence of water on this shady surface. Although the right side of the region is drier overall, water can still be seen tracing the insides of craters in light blue.

**Credits:** NASA's Goddard Space Flight Center Scientific Visualization Studio/Ernie Wright



**Caption:** This visualization shows the data from SOFIA’s observations of a “light signature” of water overlaid on a visualization of the Moon as it appeared at the time of the observations in Feb. 2022, with blue indicating a higher concentration of water. A large crater at the top right of the study region, Schomberger Crater, shows bold streaks of blue where more water is present on its shaded inner wall.

**Credits:** NASA's Goddard Space Flight Center Scientific Visualization Studio/Ernie Wright



**Caption:** A visualization of the Moon with the region of SOFIA's lunar water observations indicated in blue. SOFIA has pieced together the first detailed, wide-area map of water distribution on the Moon. The new map covers about one-quarter of the Earth-facing side of the lunar surface below 60 degrees latitude and extends to the Moon's South Pole.

**Credits:** NASA's Goddard Space Flight Center Scientific Visualization Studio/Ernie Wright

## About SOFIA

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### About USRA

Founded in 1969, under the auspices of the National Academy of Sciences at the request of the U.S. Government, the Universities Space Research Association (USRA) is a nonprofit corporation chartered to advance space-related science, technology and engineering. USRA operates scientific institutes and facilities, and conducts other major research and educational programs. USRA engages the university community and employs in-house scientific leadership, innovative research and development, and project management expertise. More information about USRA is available at [www.usra.edu](http://www.usra.edu).

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