Stores of ice confirmed on Sun-scorched Mercury

MESSENGER finds evidence of pure water ice near planet's north pole.

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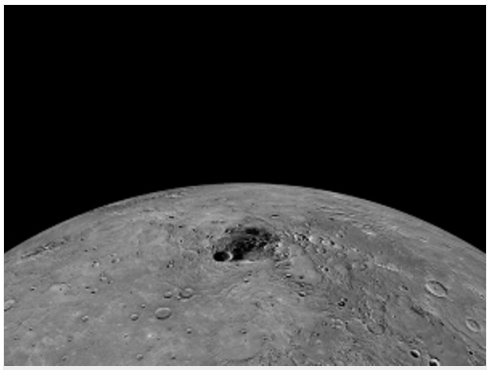
Talk about a land of fire and ice. The surface of Mercury is hot enough in some places to melt lead, but it is a winter wonderland at its poles — with perhaps a trillion tonnes of water ice trapped inside craters — enough to fill 20 billion Olympic skating rinks.



NASA/Johns Hopkins Uni Applied Phys Lab/Carnegie Inst of Washington

Water ice is abundant in Mercury's dark polar craters.

The ice — whose long-suspected presence[1] has now been confirmed by NASA's orbiting MESSENGER probe — seems to be much purer than ice inside similar craters on Earth's Moon, suggesting that the closest planet to the Sun could be a better trap for icy materials delivered by comets and asteroids. Three papers detailing the findings are published today in *Science*[2, 3, 4].

Despite Mercury's blistering 400 °C temperatures, the floors of many of its polar craters are in permanent shadow, because the planet's rotational axis is perpendicular to its orbital plane, so its poles never tip towards the star. Indeed, radar pinged to the planet from Earth in the past 20 years has revealed bright regions[1] near the poles consistent with metres-thick slabs of pure water ice.

But "radar does not uniquely identify water ice," says David Lawrence, a planetary scientist at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. Sulphur, for example, could have produced a similar radar signature.

Now, three different lines of evidence back the water-ice interpretation. Infrared laser pulses fired at the planet by MESSENGER's Mercury Laser Altimeter have revealed bright regions inside nine darkened craters near the planet's north pole[2]. These bright regions, thought to be water ice, line up perfectly with ultra-cold spots that, according to a thermal model of the planet that takes into account Mercury's topography, should never be warmer than –170 °C[3].

A third team, using MESSENGER's Neutron Spectrometer, has spotted the telltale signature of hydrogen — which they think is locked up in water ice — in those same regions[4]. "Not only is water the best explanation, we do not see any other explanation that can tie all the data together," says Lawrence, lead author of the spectrometer study.

So where did the water come from? The bright icy spots identified by MESSENGER's laser are surrounded by darker terrain which receives a bit more sunlight and heat. The neutron measurements suggest that this darker area is a layer of material about 10 centimetres thick that lies on top of more ice, insulating it.

Dark materials

This darker material around the bright spots may be made up of complex hydrocarbons expelled from comet or asteroid impacts, says David Paige, a planetary scientist at the University of California, Los Angeles, and first author of the thermal-model paper[3].

Paige and his colleagues suggest that when these icy bodies slam into Mercury, their components migrate over time — by repeatedly vaporizing and precipitating — to the cooler poles, where they get stuck in the frigid polar craters.

But even there, sunlight will sometimes hit parts of the craters' interiors, vaporizing the water ice and leaving behind 'lag deposits' of hydrocarbons that gradually become thicker and darker as they are chemically altered by sunlight.

Small impacts should have buried the surface if the ice were a billion years old, and the MESSENGER researchers believe it might be much younger than that, perhaps 50 million years old.

"The ice deposits we are looking at are not ancient," says Paige.

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References

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