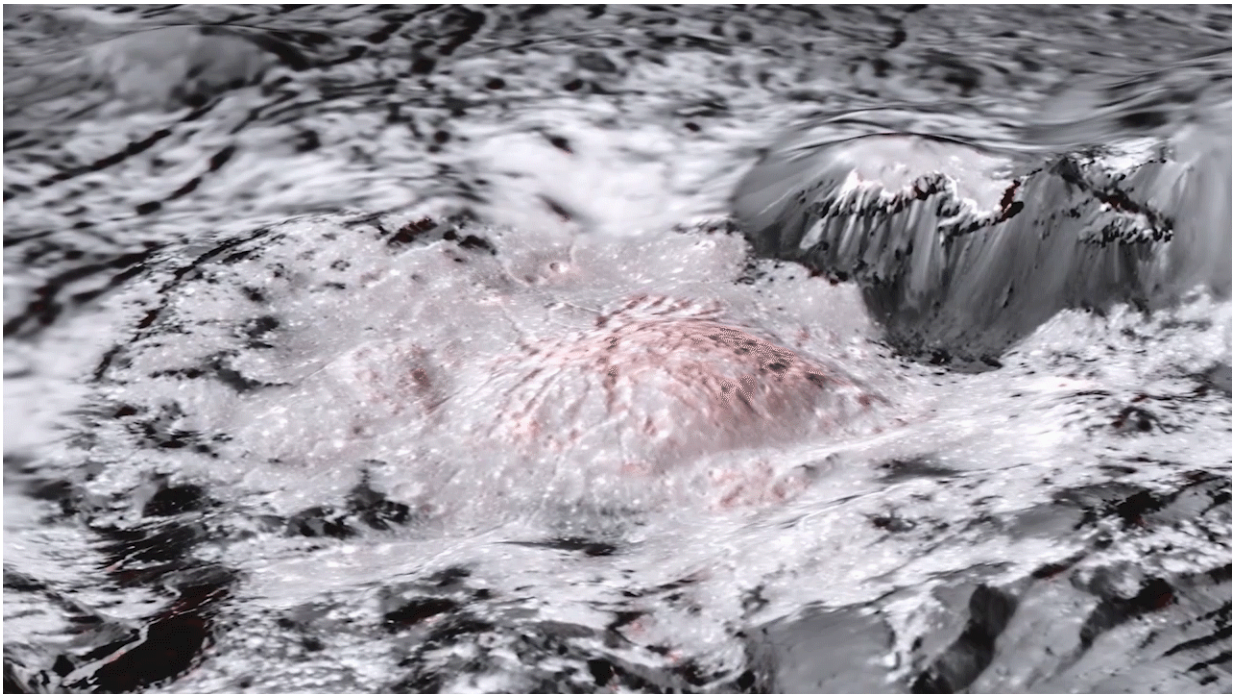


Mystery solved: Bright areas on Ceres come from salty water below

August 11 2020, by Gretchen McCartney



Images of Occator Crater, seen in false-color, were pieced together to create this animated view. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

NASA's Dawn spacecraft gave scientists extraordinary close-up views of the dwarf planet Ceres, which lies in the main asteroid belt between Mars and Jupiter. By the time the mission ended in October 2018, the orbiter had dipped to less than 22 miles (35 kilometers) above the surface, revealing crisp details of the mysterious bright regions Ceres

had become known for.

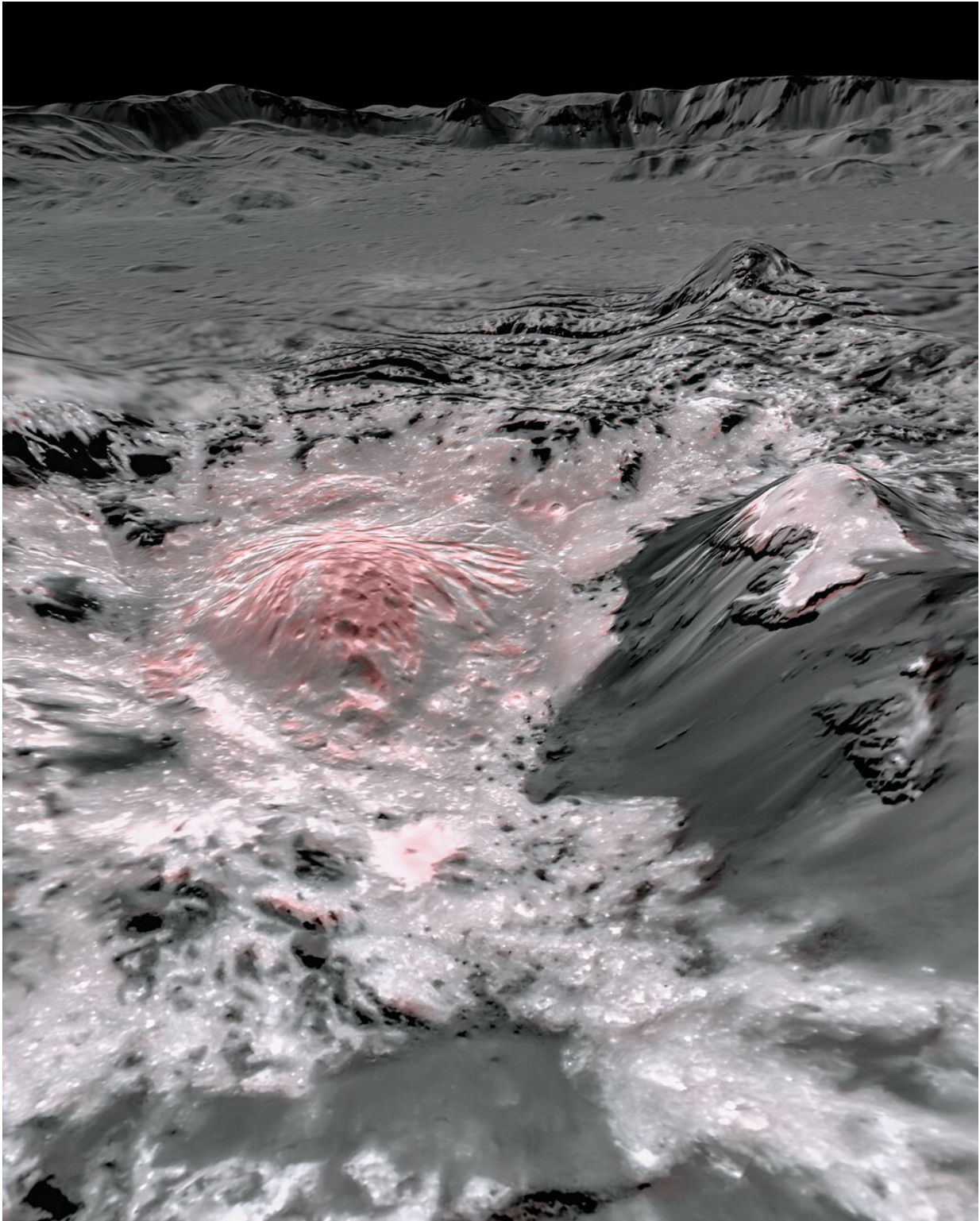
Scientists had figured out that the bright areas were deposits made mostly of sodium carbonate—a compound of sodium, carbon, and oxygen. They likely came from liquid that percolated up to the surface and evaporated, leaving behind a highly reflective salt crust. But what they hadn't yet determined was where that liquid came from.

By analyzing data collected near the end of the mission, Dawn scientists have concluded that the liquid came from a deep reservoir of brine, or salt-enriched water. By studying Ceres' gravity, scientists learned more about the dwarf planet's internal structure and were able to determine that the brine reservoir is about 25 miles (40 kilometers) deep and hundreds of miles wide.

Ceres doesn't benefit from internal heating generated by gravitational interactions with a large planet, as is the case for some of the icy moons of the outer solar system. But the new research, which focuses on Ceres' 57-mile-wide (92-kilometer-wide) Occator Crater—home to the most extensive bright areas—confirms that Ceres is a water-rich world like these other icy bodies.

The findings, which also reveal the extent of geologic activity in Occator Crater, appear in a special collection of papers published by *Nature Astronomy*, *Nature Geoscience*, and *Nature Communications* on Aug. 10.

"Dawn accomplished far more than we hoped when it embarked on its extraordinary extraterrestrial expedition," said Mission Director Marc Rayman of NASA's Jet Propulsion Laboratory in Southern California. "These exciting new discoveries from the end of its long and productive mission are a wonderful tribute to this remarkable interplanetary explorer."



This mosaic image uses false color to highlight the recently exposed brine, or

salty liquids, that were pushed up from a deep reservoir under Ceres' crust. In this view of a region of Occator Crater, they appear reddish. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

Solving the Bright Mystery

Long before Dawn arrived at Ceres in 2015, scientists had noticed diffuse bright regions with telescopes, but their nature was unknown. From its close orbit, Dawn captured images of two distinct, highly reflective areas within Occator Crater, which were subsequently named Cerealia Facula and Vinalia Faculae. ("Faculae" means bright areas.)

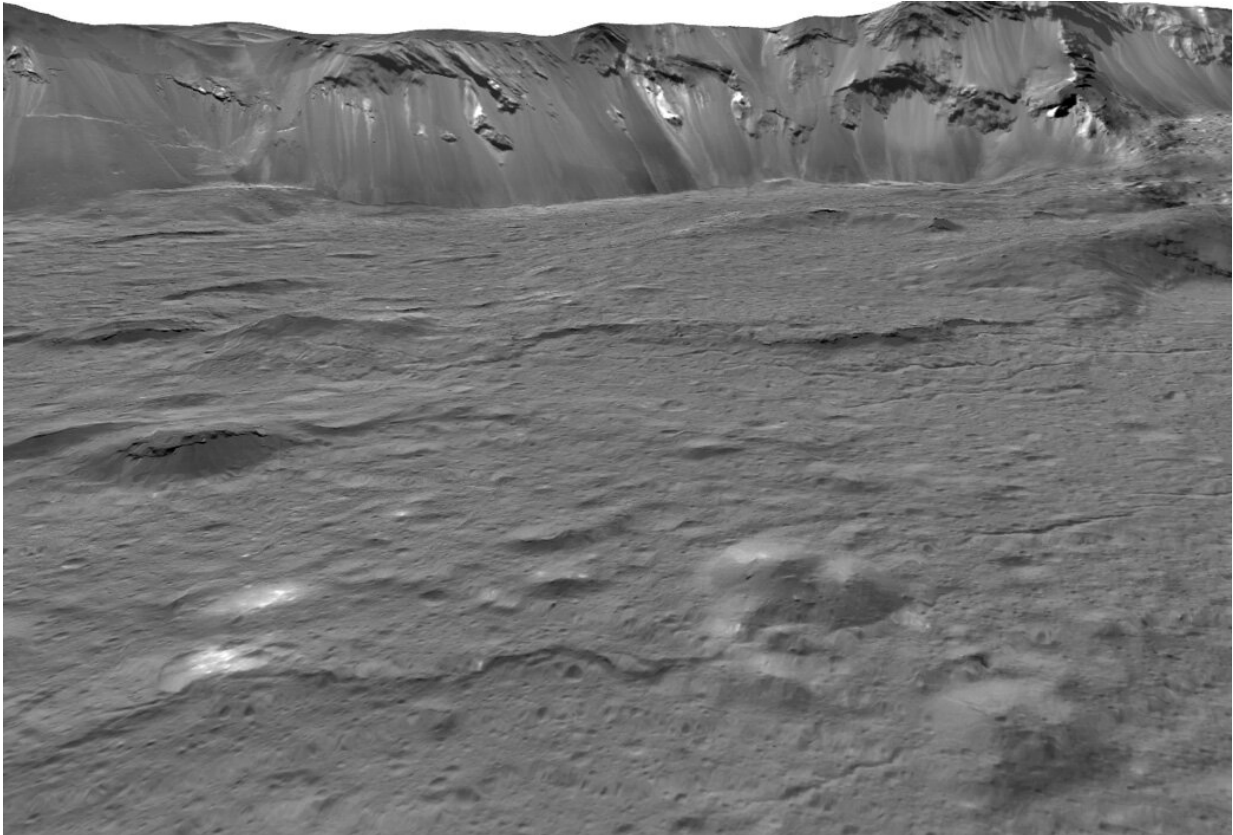
Scientists knew that micrometeorites frequently pelt the surface of Ceres, roughing it up and leaving debris. Over time, that sort of action should darken these bright areas. So their brightness indicates that they likely are young. Trying to understand the source of the areas, and how the material could be so new, was a main focus of Dawn's final extended mission, from 2017 to 2018.

The research not only confirmed that the bright regions are young—some less than 2 million years old; it also found that the geologic activity driving these deposits could be ongoing. This conclusion depended on scientists making a key discovery: salt compounds (sodium chloride chemically bound with water and ammonium chloride) concentrated in Cerealia Facula.

On Ceres' surface, salts bearing water quickly dehydrate, within hundreds of years. But Dawn's measurements show they still have water, so the fluids must have reached the surface very recently. This is evidence both for the presence of liquid below the region of Occator Crater and ongoing transfer of material from the deep interior to the

surface.

The scientists found two main pathways that allow liquids to reach the surface. "For the large deposit at Cerealia Facula, the bulk of the salts were supplied from a slushy area just beneath the surface that was melted by the heat of the impact that formed the crater about 20 million years ago," said Dawn Principal Investigator Carol Raymond. "The impact heat subsided after a few million years; however, the impact also created large fractures that could reach the deep, long-lived reservoir, allowing brine to continue percolating to the surface."



This mosaic of Ceres' Occator Crater is composed of images NASA's Dawn mission captured on its second extended mission, in 2018. Bright pits and mounds (foreground) were formed by salty liquid released as Occator's water-

rich floor froze after the crater-forming impact about 20 million years ago.
Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA/USRA/LPI

Active Geology: Recent and Unusual

In our solar system, icy geologic activity happens mainly on icy moons, where it is driven by their gravitational interactions with their planets. But that's not the case with the movement of brines to the surface of Ceres, suggesting that other large ice-rich bodies that are not moons could also be active.

Some evidence of recent liquids in Occator Crater comes from the bright deposits, but other clues come from an assortment of interesting conical hills reminiscent of Earth's pingos—small ice mountains in polar regions formed by frozen pressurized groundwater. Such features have been spotted on Mars, but the discovery of them on Ceres marks the first time they've been observed on a dwarf planet.

On a larger scale, scientists were able to map the density of Ceres' crust structure as a function of depth—a first for an ice-rich planetary body. Using gravity measurements, they found Ceres' crustal density increases significantly with depth, way beyond the simple effect of pressure. Researchers inferred that at the same time Ceres' reservoir is freezing, salt and mud are incorporating into the lower part of the crust.

Dawn is the only spacecraft ever to orbit two extraterrestrial destinations—Ceres and the giant asteroid Vesta—thanks to its efficient ion propulsion system. When Dawn used the last of a key fuel, hydrazine, for a system that controls its orientation, it was neither able to point to Earth for communications nor to point its solar arrays at the Sun to produce electrical power. Because Ceres was found to have organic

materials on its surface and liquid below the [surface](#), planetary protection rules required Dawn to be placed in a long-duration orbit that will prevent it from impacting the dwarf planet for decades.

More information: "Recent Cryovolcanic Activity at Occator Crater on Ceres," A. Nathues et al. 2020 August 10, *Nature Astronomy* www.nature.com/articles/s41550-020-1146-8

"Impact-driven Mobilization of Deep Crustal Brines on Dwarf Planet Ceres," C. A. Raymond et al. 2020 August 10, *Nature Astronomy* www.nature.com/articles/s41550-020-1168-2

"Evidence of Non-uniform Crust of Ceres from Dawn's High-resolution Gravity Data," R. S. Park et al., 2020 August 10, *Nature Astronomy* www.nature.com/articles/s41550-020-1019-1

"Fresh Emplacement of Hydrated Sodium Chloride on Ceres from Ascending Salty Fluids," M. C. De Sanctis et al., 2020 August 10, *Nature Astronomy* www.nature.com/articles/s41550-020-1138-8

"Impact Heat Driven Volatile Redistribution at Occator Crater on Ceres as a Comparative Planetary Process," P. Schenk et al., 2020 August 10, *Nature Communications* www.nature.com/articles/s41467-020-17184-7

"The Varied Sources of Faculae-forming Brines in Ceres' Occator crater Emplaced via Hydrothermal Brine Effusion," J. E. C. Scully et al., 2020 August 10, *Nature Communications* www.nature.com/articles/s41467-020-15973-8

"Post-impact Cryo-hydrologic Formation of Small Mounds and Hills in Ceres's Occator Crater," B. E. Schmidt et al., 2020 August 10, *Nature Geoscience* www.nature.com/articles/s41561-020-0581-6

Provided by Jet Propulsion Laboratory

Citation: Mystery solved: Bright areas on Ceres come from salty water below (2020, August 11)
retrieved 13 March 2024 from <https://phys.org/news/2020-08-mystery-bright-areas-ceres-salty.html>

<p>This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.</p>
--