NASA's Juno provides high-definition views of Europa's icy shell

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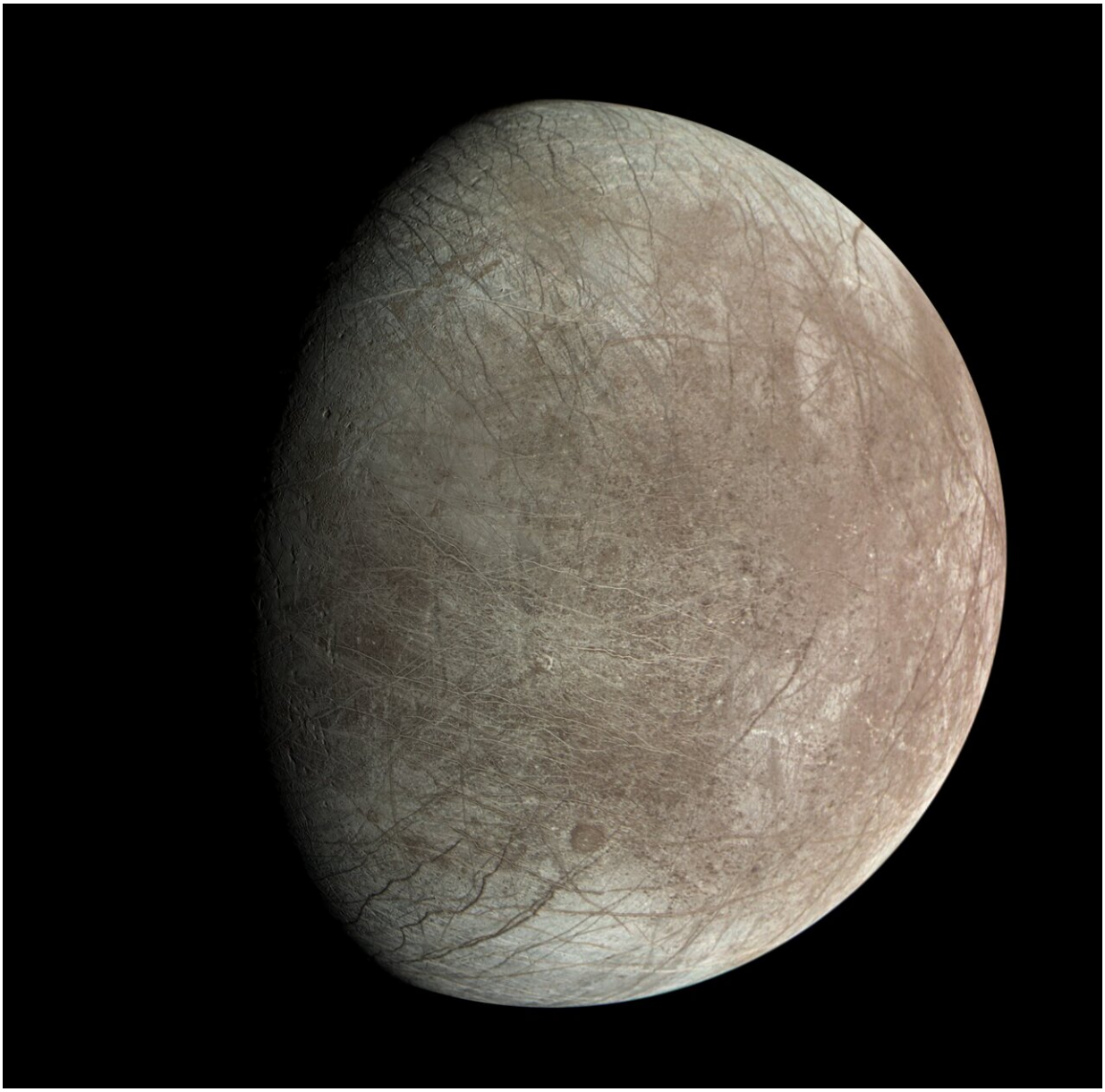


Jupiter’s moon Europa was captured by the JunoCam instrument aboard NASA’s Juno spacecraft during the mission’s close flyby on Sept. 29, 2022. The images show the fractures, ridges, and bands that crisscross the moon’s surface. Credit: NASA/JPL-Caltech/SwRI/MSSS; Image processing: Björn Jónsson (CC BY 3.0)

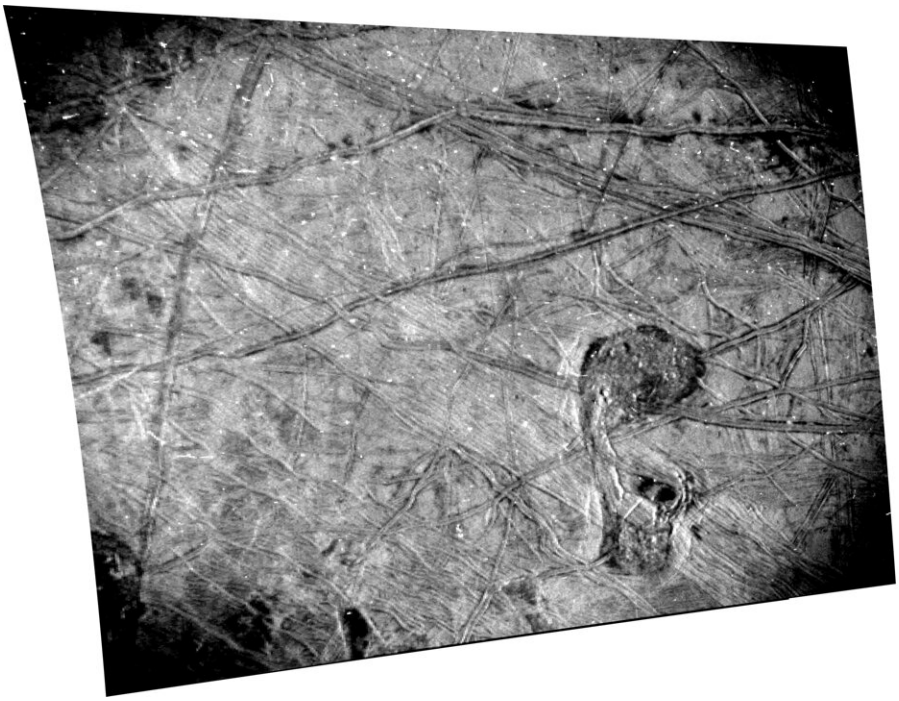
Images from the JunoCam visible-light camera aboard NASA's Juno spacecraft supports the theory that the icy crust at the north and south poles of Jupiter's moon Europa is not where it used to be. Another high-resolution picture of the icy moon, by the spacecraft's Stellar Reference Unit (SRU), reveals signs of possible plume activity and an area of ice shell disruption where brine may have recently bubbled to the surface.

The JunoCam results recently appeared in the *Planetary Science Journal* and the SRU results in the journal *JGR Planets*.

On Sept. 29, 2022, Juno made its closest flyby of Europa, coming within 220 miles (355 kilometers) of the moon's frozen surface. The four pictures taken by JunoCam and one by the SRU are the first high-resolution images of Europa since Galileo's last flyby in 2000.

True polar wander

Juno's ground track over Europa allowed imaging near the moon's equator. When analyzing the data, the JunoCam team found that along with the expected ice blocks, walls, scarps, ridges, and troughs, the camera also captured irregularly distributed steep-walled depressions 12 to 31 miles (20 to 50 kilometers) wide. They resemble large ovoid pits previously found in imagery from other locations of Europa.



This black and white image of Europa's surface was taken by the Stellar Reference Unit aboard NASA's Juno spacecraft durring the Sept. 29, 2022 flyby. The chaos feature names "The Platypus" is seen in the lower right corner. Credit: NASA/JPL-Caltech/SwRI

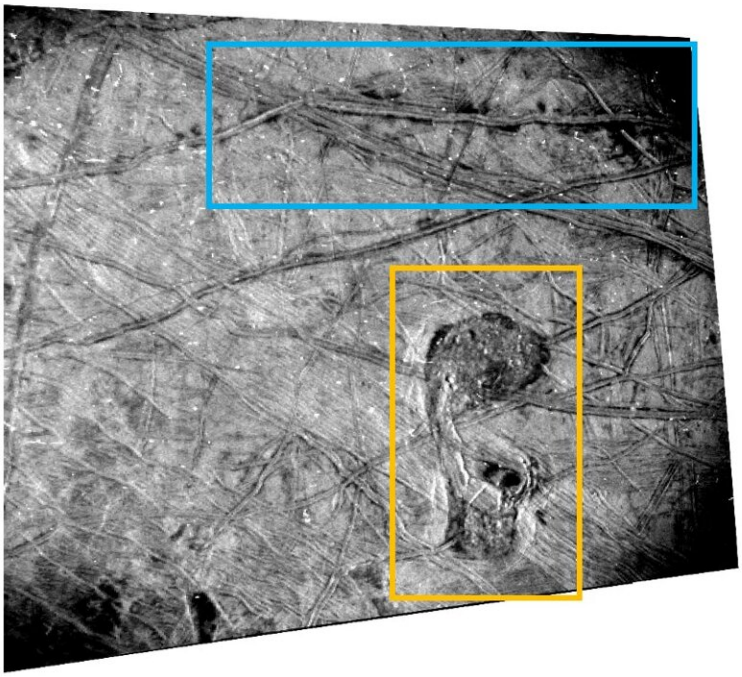
A giant ocean is thought to reside below Europa's icy exterior, and these surface features have been associated with "true polar wander," a theory that Europa's outer ice shell is essentially free-floating and moves.

"True polar wander occurs if Europa's icy shell is decoupled from its rocky interior, resulting in high stress levels on the shell, which lead to predictable fracture patterns," said Candy Hansen, a Juno co-investigator who leads planning for JunoCam at the Planetary Science Institute in Tucson, Arizona. "This is the first time that these fracture patterns have been mapped in the southern hemisphere, suggesting that true polar wander's effect on Europa's surface geology is more extensive than

previously identified."

The high-resolution JunoCam imagery has also been used to reclassify a formerly prominent surface feature from the Europa map.

"Crater Gwern is no more," said Hansen. "What was once thought to be a 13-mile-wide impact crater—one of Europa's few documented impact craters—Gwern was revealed in JunoCam data to be a set of intersecting ridges that created an oval shadow."



This annotated image of Europa's surface from Juno's SRU shows the location of a double ridge running east-west (blue box) with possible plume stains and the chaos feature the team calls "the Platypus" (orange box). These features hint at current surface activity and the presence of subsurface liquid water on the icy Jovian moon. Credit: NASA/JPL-Caltech/SwRI

The Platypus

Although all five Europa images from Juno are high-resolution, the image from the spacecraft's black-and-white SRU offers the most detail. Designed to detect dim stars for navigation purposes, the SRU is sensitive to low light. To avoid over-illumination in the image, the team used the camera to snap the nightside of Europa while it was lit only by sunlight scattered off Jupiter (a phenomenon called "Jupiter-shine").

This innovative approach to imaging allowed complex surface features to stand out, revealing intricate networks of cross-cutting ridges and dark stains from potential plumes of water vapor. One intriguing feature, which covers an area 23 miles by 42 miles (37 kilometers by 67 kilometers), was nicknamed by the team "the Platypus" because of its shape.

Characterized by chaotic terrain with hummocks, prominent ridges, and dark reddish-brown material, the Platypus is the youngest feature in its neighborhood. Its northern "torso" and southern "bill"—connected by a fractured "neck" formation—interrupt the surrounding terrain with a lumpy matrix material containing numerous ice blocks that are 0.6 to 4.3 miles (1 to 7 kilometers) wide. Ridge formations collapse into the feature at the edges of the Platypus.

For the Juno team, these formations support the idea that Europa's ice shell may give way in locations where pockets of briny water from the subsurface ocean are present beneath the surface.

About 31 miles (50 kilometers) north of the Platypus is a set of double ridges flanked by dark stains similar to features found elsewhere on Europa that scientists have hypothesized to be cryovolcanic plume deposits.

"These features hint at present-day surface activity and the presence of subsurface liquid water on Europa," said Heidi Becker, lead co-investigator for the SRU at NASA's Jet Propulsion Laboratory in Southern California, which also manages the mission. "The SRU's image is a high-quality baseline for specific places NASA's Europa Clipper mission and ESA's (European Space Agency's) Juice missions can target to search for signs of change and brine."

Europa Clipper's focus is on Europa—including investigating whether the icy moon could have conditions suitable for life. It is scheduled to launch on the fall of 2024 and arrive at Jupiter in 2030. Juice (Jupiter Icy Moons Explorer) launched on April 14, 2023. The ESA mission will reach Jupiter in July 2031 to study many targets (Jupiter's three large icy moons, as well as fiery Io and smaller moons, along with the planet's atmosphere, magnetosphere, and rings) with a special focus on Ganymede.

Juno executed its 61st close flyby of Jupiter on May 12. Its 62nd flyby of the gas giant, scheduled for June 13, includes an Io flyby at an altitude of about 18,200 miles (29,300 kilometers).

More information: C. J. Hansen et al, Juno's JunoCam Images of Europa, *The Planetary Science Journal* (2024). DOI: 10.3847/PSJ/ad24f4

Heidi N. Becker et al, A Complex Region of Europa's Surface With Hints of Recent Activity Revealed by Juno's Stellar Reference Unit, *Journal of Geophysical Research: Planets* (2023). DOI: 10.1029/2023JE008105

Provided by NASA