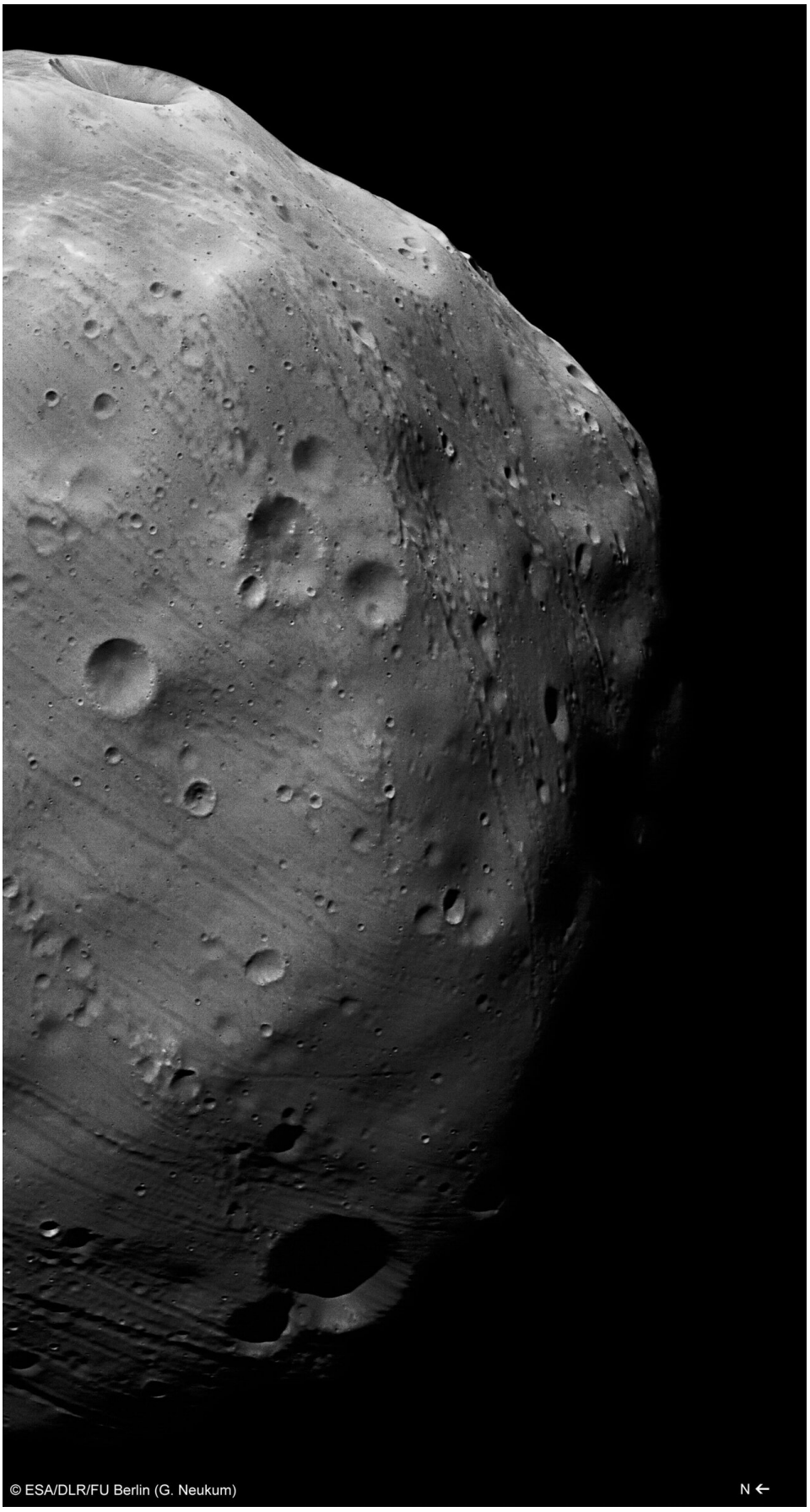
A close encounter with a mysterious moon

October 31 2022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The High Resolution Stereo Camera (HRSC) onboard the ESA spacecraft Mars Express took this image of Phobos using the HRSC nadir channel on 7 March 2010, HRSC Orbit 7915. This image has additionally been enhanced photometrically for better bringing features in the less illuminated part. Resolution: about 4.4 meters per pixel. Credit: ESA/DLR/FU Berlin (G. Neukum),

In 1877, American astronomer Asaph Hall discovered two small moons circling the planet Mars, later named Phobos and Deimos after the Greek for "fear" and "panic."

But it was excitement, rather than fear and panic, that characterized the close encounter with Phobos made by ESA's Mars Express spacecraft in the run up to Halloween this year. The recent flyby of the larger Martian moon offered the perfect opportunity to test one of the 19-year-old spacecraft's latest upgrades.

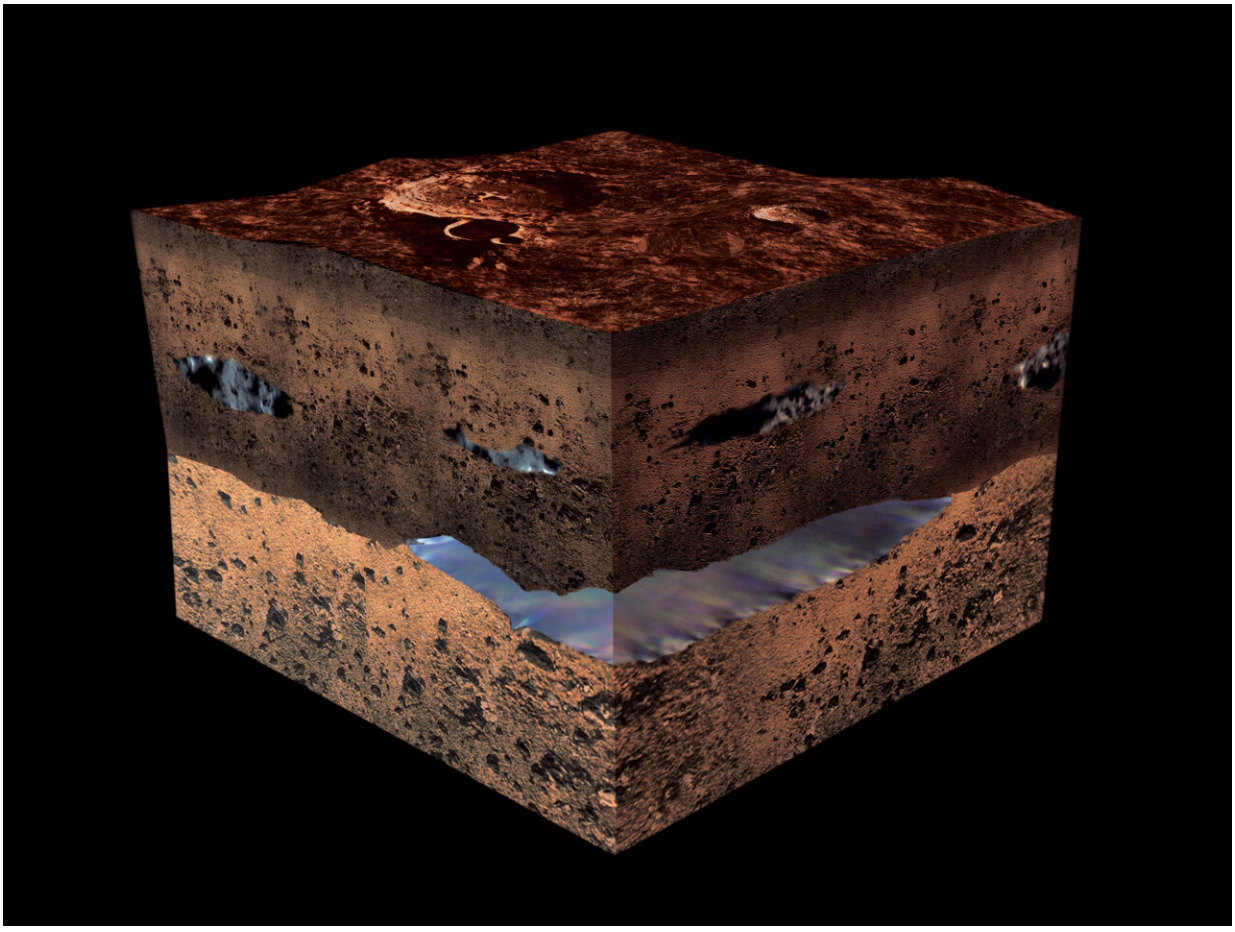
The MARSIS instrument on Mars Express was originally designed to study the internal structure of Mars. As a result, it was designed for use at the typical distance between the spacecraft and the planet's surface —more than 250 km.

But it recently received a major software upgrade that allows it to be used at much closer distances and which could help to shed light on the mysterious origin of the moon Phobos.

"During this flyby, we used MARSIS to study Phobos from as close as 83 km," says Andrea Cicchetti from the MARSIS team at INAF. "Getting closer allows us to study its structure in more detail and identify

important features we would never have been able to see from further away. In future, we are confident we could use MARSIS from closer than 40 km. The orbit of Mars Express has been fine-tuned to get us as close to Phobos as possible during a handful of flybys between 2023 and 2025, which will give us great opportunities to try."

"We didn't know if this was possible," says Simon Wood, Mars Express flight controller at ESA's ESOC operations center, who oversaw the upload of the new software to the ESA spacecraft. "The team tested a few different variations of the software, with the final, successful tweaks uploaded to the spacecraft just hours before the flyby."



Artist's impression of water under the martian surface. If underground aquifers like that really do exist, Mars Express has a good chance of finding them. The implications for human exploration and eventual colonisation of the red planet would be far-reaching. Credit: Medialab, ESA 2001

Mysterious origins

MARSIS, famous for its role in the discovery of signs of liquid water on the Red Planet, sends low-frequency radio waves towards Mars or Phobos, using its 40-meter long antenna.

Most of these waves are reflected from the body's surface, but some travel through and are reflected at boundaries between layers of different materials below the surface.

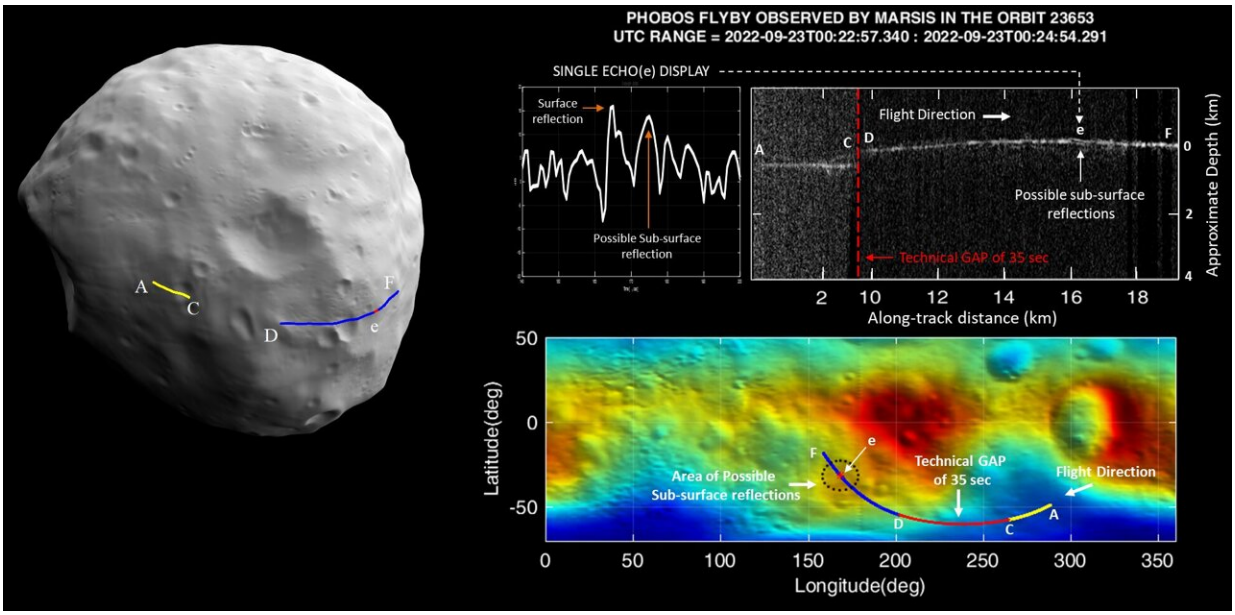
By examining the reflected signals, scientists can map the structure below the surface and study properties such as the thickness and composition of the material.

For Mars, this could reveal different layers of ice, soil, rock or water. But the internal structure of Phobos is more of a mystery, and the upgrade to MARSIS could offer important insight.

"Whether Mars' two small moons are captured asteroids or made of material ripped from Mars during a collision is an open question," says ESA Mars Express scientist Colin Wilson. "Their appearance suggests they were asteroids, but the way they orbit Mars arguably suggests otherwise."

"We are still at an early stage in our analysis," says Andrea. "But we have already seen possible signs of previously unknown features below the

moon's surface. We are excited to see the role that MARSIS might play in finally solving the mystery surrounding Phobos' origin."



The MARSIS instrument on ESA's Mars Express spacecraft uses its recently upgraded software to peer beneath the surface of the martian moon Phobos. Credit: INAF - Istituto Nazionale di Astrofisica

What does this image show?

The top-right image shows the "radargram" acquired by MARSIS during the flyby of Phobos on 23 September 2022. A radargram reveals the "echoes" created when the radio signal emitted by MARSIS bounces off something and returns to the instrument. The brighter the signal, the more powerful the echo.

The continuous bright line shows the echo from the moon's surface. The lower reflections are either "clutter" caused by features on the moon's

surface, or, more interestingly, signs of possible structural features below the surface (e).

"Section A–C was recorded using an older configuration of the MARSIS software," says Carlo Nenna, MARSIS on-board software engineer at Enginium, who is implementing the upgrade. "The new configuration was prepared during the 'technical gap' and successfully used for the very first time from D–F."

The left and bottom-right images show the path of the observation across the surface of Phobos.

Provided by European Space Agency