

The southern hemisphere of Phobos, up close

21 January 2011

During the last of a series of eight encounters with the martian moon Phobos, the High-Resolution Stereo Camera (HRSC) on ESA's Mars Express spacecraft acquired a detailed view of the martian satellite. The orbiter flew past Phobos at a distance of only 100 kilometres on 9 January 2011 and imaged the southern hemisphere of the irregularly-shaped moon. Researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) planned the image acquisitions, during which the orbiter was moving past Phobos at 2.3 kilometres per second, and processed the resulting data.

Since Mars express flies in an elliptical orbit around the Red Planet, it regularly moves away from Mars and approaches Phobos, which orbits the planet at an altitude of roughly 6000 kilometres, about every five months. With data obtained during this flyby, the researchers were able to image large parts of the southern hemisphere of the moon for the first time at a resolution of 3.8 metres per pixel. HRSC scanned the martian moon, which is just over 20 kilometres across, with five of its nine sensors that are located sequentially in the camera. The sensors were active for a total of about a minute per sensor; Phobos was in the field of view for only nine seconds.

Craters, grooves and a boulder as big as a house

Klaus Dieter Matz, a researcher at the DLR Institute of Planetary Research (Institut für Planetenforschung), planned the image acquisition. To obtain the sharpest possible images given the high speed of the spacecraft during the flyby, Mars Express had to slew during the rendezvous. For the computation of this complicated manoeuvre, the researchers considered the orbit of the moon and the exact path of the Mars Express orbiter, which ESA determines from a variety of parameters. Corrections during image acquisition were not possible as control signals transmitted from ground stations on Earth would have taken 19 minutes and 47.4 seconds to reach the spacecraft, but the manoeuvre was accomplished without any problems. However, "The maximum speed at which ESA could turn Mars Express during the flyby was 0.15 degrees per second. For ideal images, the spacecraft must be rotated at 0.26 degrees per second during the high-speed flyby," explained Matz. The effects caused by the limited slew rate were corrected later during processing.

In the images, it is easy to see numerous craters and 'grooves' – markings whose origin is still undetermined. A boulder as big as a house discovered on the surface of Phobos casts a distinctive shadow. "With every Phobos image from the stereo camera, we can improve the three-dimensional model of the martian moon," says Prof. Jürgen Oberst of the DLR Institute of Planetary Research. "Most importantly, the new image data helps us to continuously improve the global image mosaic of the martian moon so that an atlas of Phobos can eventually be produced." Among other applications, the evaluation of the photographs is important for the Russian mission 'Phobos Grunt', which begins in November this year ('Grunt' is the transliteration of the Russian word for 'ground'). The mission includes plans for a lander to touch down on the martian moon, collect rock and dust samples with a robotic arm, and return them in a capsule to Earth. The lander will then spend a year on the surface of Phobos, performing scientific measurements in the martian environment.

About HRSC

The High Resolution Stereo Camera (HRSC) experiment on the European Space Agency's Mars Express mission is led by the Principal Investigator (PI) Prof. Dr Gerhard Neukum, who was also responsible for the technical design of the camera. The science team of the experiment consists of 45 Co-Investigators from 32 institutions and 10 nations. The camera was

developed at the German Aerospace Center (DLR) under the leadership of the PI, G. Neukum, and built in cooperation with industrial partners (EADS Astrium, Lewicki Microelectronic GmbH and Jena-Optronik GmbH). The experiment on Mars Express is operated by the DLR Institute of Planetary Research, through ESA/ESOC. The systematic processing of the HRSC image data is carried out at DLR. The scenes shown here were processed by the PI-group at the Institute for Geosciences of the Freie Universität Berlin in cooperation with the DLR Institute of Planetary Research, Berlin.

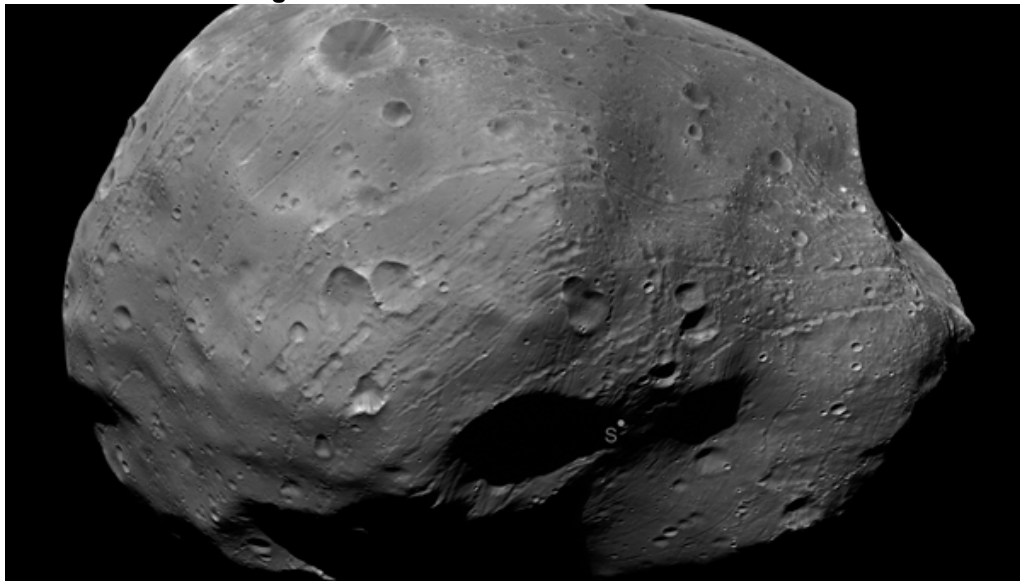
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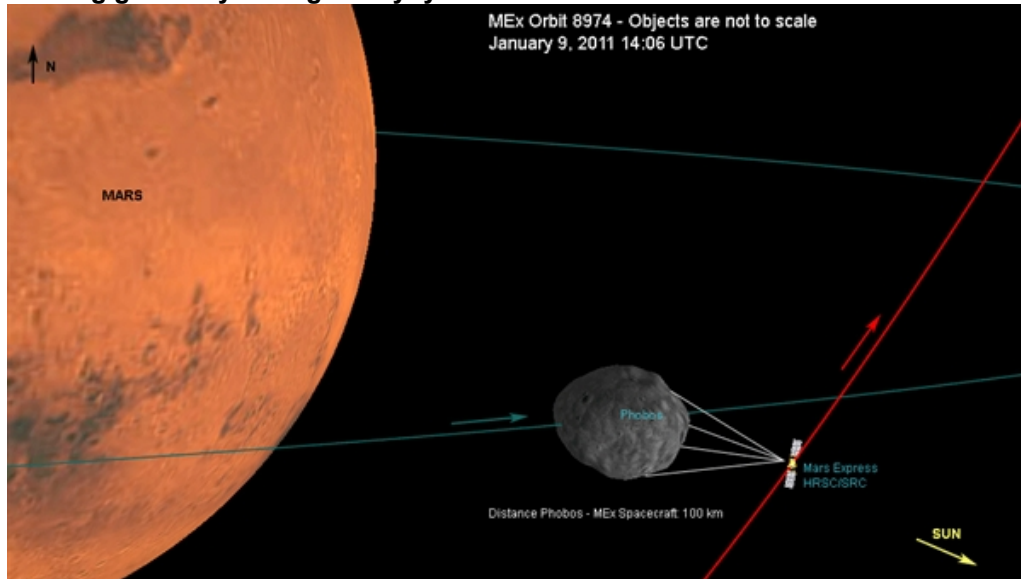
Stereo-1 channel image of Phobos



The DLR-operated High Resolution Stereo Camera on board ESA's Mars Express spacecraft acquired images of Phobos on 9 January 2011. The south pole is visible at the bottom right, just next to the dark crater. This image of Phobos has been photometrically enhanced to make details in the poorly-illuminated areas appear more clearly. The resolution is 3.9 meters per pixel. Copyright note: As a joint undertaking by DLR, ESA and FU Berlin, the Mars Express HRSC images are published under a Creative Commons licence since December 2014: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO. This licence will also apply to all HRSC images released to date.

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Viewing geometry during the flyby



The DLR-operated High Resolution Stereo Camera on board ESA's Mars Express spacecraft acquired images of Phobos on 9 January 2011. This graphic shows the positions of Mars, Phobos and Mars Express at the time the image data was acquired. Since Mars express flies in an elliptical orbit around the Red Planet, it regularly moves away from Mars and approaches Phobos, which orbits the planet at an altitude of roughly 6000 kilometres, about every five months. Copyright note: As a joint undertaking by DLR, ESA and FU Berlin, the Mars Express HRSC images are published under a Creative Commons licence since December 2014: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO. This licence will also apply to all HRSC images released to date.

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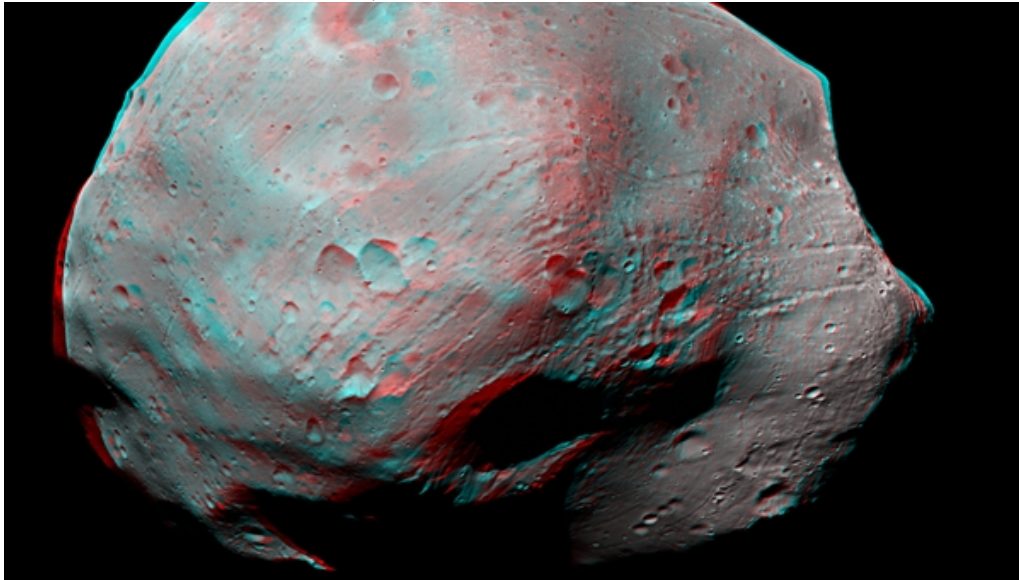
HRSC image of Phobos



The DLR-operated High Resolution Stereo Camera (HRSC) on board ESA's Mars Express spacecraft acquired images of Phobos on 9 January 2011. Seven images acquired by the Super Resolution Channel (SRC), with a resolution of about three metres per pixel, are superimposed on the HRSC nadir channel image. The SRC images show greater detail of the surface of Phobos. Copyright note: As a joint undertaking by DLR, ESA and FU Berlin, the Mars Express HRSC images are published under a Creative Commons licence since December 2014: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO. This licence will also apply to all HRSC images released to date.

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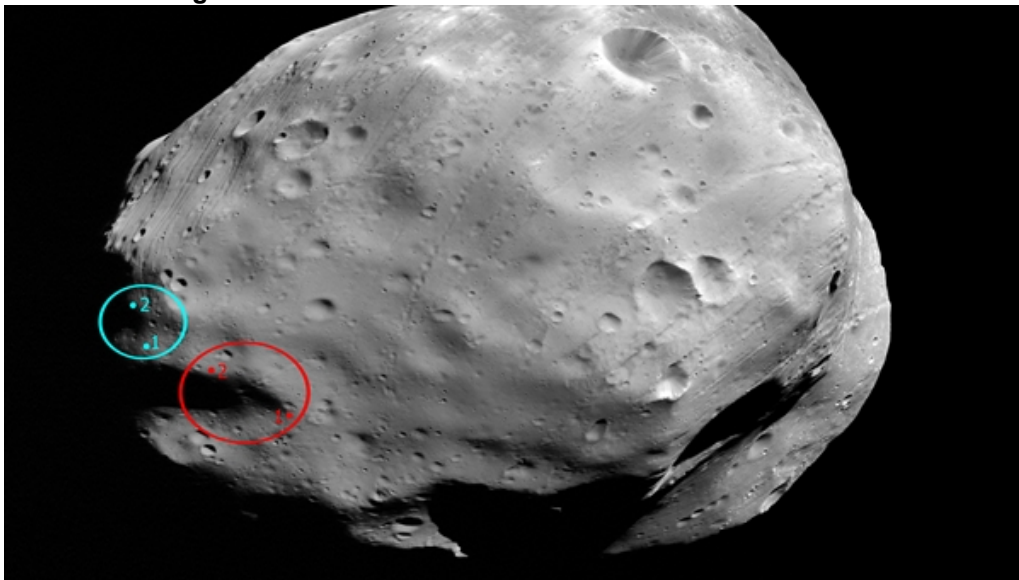
3-D view of the Martian moon, Phobos



This 3D anaglyph image was generated from a combination of the nadir (vertical view) and one of the four stereo channels of the HRSC. Use red-blue or red-green glasses to obtain a 3-D impression of the landscape. This image was acquired on 9 January 2011 at a distance of 100 kilometres from Phobos with a resolution of 8.1 metres per pixel during orbit 8974. Due to the stereo viewing geometry during the flyby a small part of the moon's edge is only visible to the right eye, resulting in odd 3D-perception in this area. This part has been slightly adjusted for better viewing. Also, for the left eye at the left edge of the image four small data gaps have been interpolated. Copyright note: As a joint undertaking by DLR, ESA and FU Berlin, the Mars Express HRSC images are published under a Creative Commons licence since December 2014: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO. This licence will also apply to all HRSC images released to date.

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Planned landing site of the Russian Phobos-Grunt mission



The DLR-operated High Resolution Stereo Camera (HRSC) on board ESA's Mars Express spacecraft acquired images of the martian moon Phobos on 9 January 2011. This image has a resolution of 8.2 metres per pixel, acquired during orbit 8974. The ellipses mark the previously planned (red) and currently planned (blue) landing sites for the Russian Phobos-Grunt (Phobos-Soil) mission. Copyright note: As a joint undertaking by DLR, ESA and FU Berlin, the Mars Express HRSC images are published under a Creative Commons licence since December 2014: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO. This licence will also apply to all HRSC images released to date.

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