Mars Express - The 8000-metre scarp of Ius Chasma

01 March 2012

Ius Chasma is one of the main graben in Valles Marineris, one of the largest known canyon systems in the Solar System. Over a length of 940 kilometres, Ius Chasma forms the northern boundary between the western half of this enormous valley system and the Martian highlands. These images, acquired with the High Resolution Stereo Camera (HRSC) operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) on board ESA's Mars Express spacecraft, show a section of the northern scarp of Ius Chasma, along which landslides have occurred.

As with the East African Rift on Earth, the Martian crust split and formed this gigantic canyon system, 3500 kilometres long and up to 11 kilometres deep. The trigger for this crustal tectonic activity was the formation of the Tharsis Bulge, the largest volcanic region on Mars, consisting of multiple lava flow deposits with a total thickness of several kilometres. The load that this imposed gave rise to immense stresses in the planet's crust, leading to the formation of faults. The Tharsis Bulge started forming over three and a half billion years ago during the Noachian Era, the earliest period in Mars' history, and continued until late in the Hesperian Era, which ended around three billion years ago. Both of these geological periods saw a significant increase in volcanism on Mars. The images show part of the graben that is bordered to the north by one of the Martian highland plateaus.

System of tectonic faults

The scarp drops 8.2 kilometres to the floor of the chasma. The immense stresses in the rock created multiple parallel faults, leading to the formation of the grabens; traces of these faults can also be seen on the plateau, where the stresses have created smaller, parallel grabens in some places. Additional faults have occurred at right angles to the main system (image detail 1).

Multiple large, overlapping landslides have collapsed into the chasma (image detail 2). A light, streaked zone can be seen along the uppermost, and hence most recent, landslide. This could indicate a change in the material making up the highlands in this region. Remnants of an older landslide can be seen in image detail 3. Large, dark structures catch the eye in the centre of the area shown. These dunes accumulated here as a result of the Martian winds. Their dark colour is probably due to their being composed of dust and sand from weathered basalt, which is one of the most common iron- and magnesium-rich volcanic rocks on Earth as well.

Several light-coloured deposits nearby may be landslide material that has been exposed to weathering for a shorter time; this is bedrock from the nearby Martian highlands that has been exposed along the scarp and underneath, in the open. The landslide deposits also exhibit flow structures that can be seen as elongated meandering rilles, fanning out with increasing distance. It is possible that ice or water stored in the highlands played a part in causing the landslides.

The term 'chasma' (Greek for crevice, abyss or fissure, plural 'chasmata') is used by the International Astronomical Union to refer to a steep-sided, elongated depression or valley. 'Ius' refers to Io, one of Zeus' favourites in Greek mythology, after whom Jupiter's moon Io – also volcanically active – and the Ionian Sea are named.

The HRSC images were acquired on 16 September 2005 during orbit 2149 from an altitude of a little over 250 kilometres. The best image resolution is about 13 metres per pixel. The images show an area at 7 degrees south and 282 degrees east.

Image processing and the HRSC instrument on Mars Express

The colour images were created from the nadir channel, the field of view of which is aligned perpendicular to the surface of Mars, and the colour channels; the oblique perspective views were generated from HRSC stereo channel data. The anaglyph, which creates a three-dimensional impression of the landscape when viewed with red/blue or red/green glasses, was derived from the nadir channel and one stereo channel. The black-and-white image is based on data acquired by the nadir channel, which has the highest resolution of all the channels. The colour-coded plan view is based on a digital terrain model of the region, from which the topography of the landscape can be derived.

The HRSC camera experiment on the European Space Agency's Mars Express mission is headed by Principal Investigator (PI) Professor Gerhard Neukum (Freie Universität Berlin), who was also responsible for the technical design of the camera. The science team consists of 40 co-investigators from 33 institutions in ten nations. The camera was developed at DLR under the leadership of the PI and it was built in cooperation with industrial partners EADS Astrium, Lewicki Microelectronic GmbH and Jena-Optronik GmbH. The instrument is operated by the DLR Institute of Planetary Research in Berlin-Adlershof, through ESA/ESOC. The systematic processing of the HRSC image data is carried out at DLR. The images shown here were created by PI-group at the Institute of Geological Sciences of the Freie Universität Berlin.

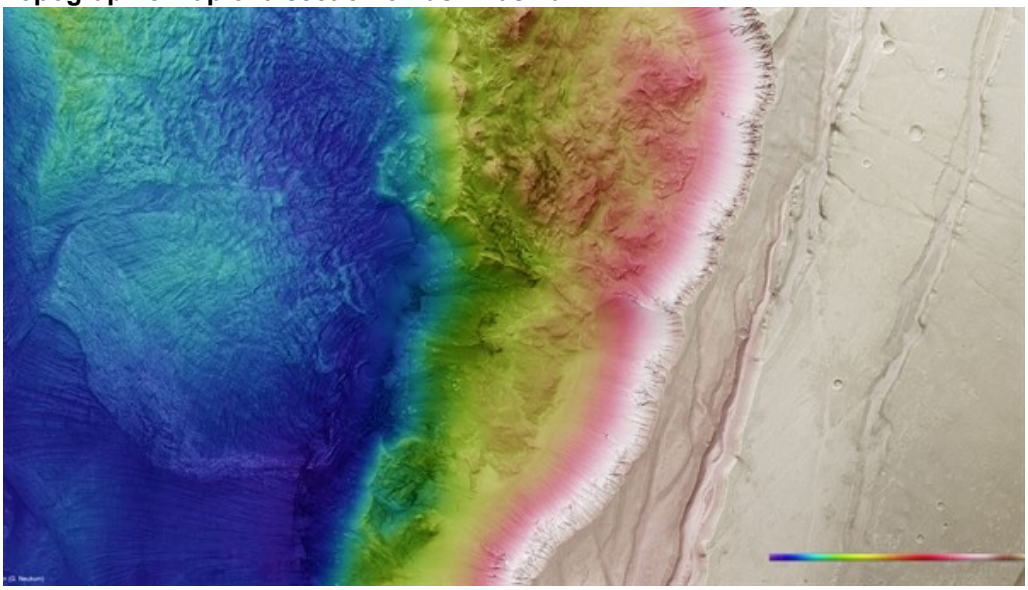
Contacts

Elke Heinemann
German Aerospace Center (DLR)
Corporate Communications
Tel.: +49 2203 601-2867
Fax: +49 2203 601-3249
elke.heinemann@dlr.de

Prof.Dr. Ralf Jaumann
German Aerospace Center (DLR)
Institute of Planetary Research, Planetary Geology
Tel.: +49 30 67055-400
Fax: +49 30 67055-402
Ralf.Jaumann@dlr.de

Ulrich Köhler
Deutsches Zentrum für Luft- und Raumfahrt (DLR) - German Aerospace Center
Tel.: +49 30 67055-215
Fax: +49 30 67055-402
ulrich.koehler@dlr.de

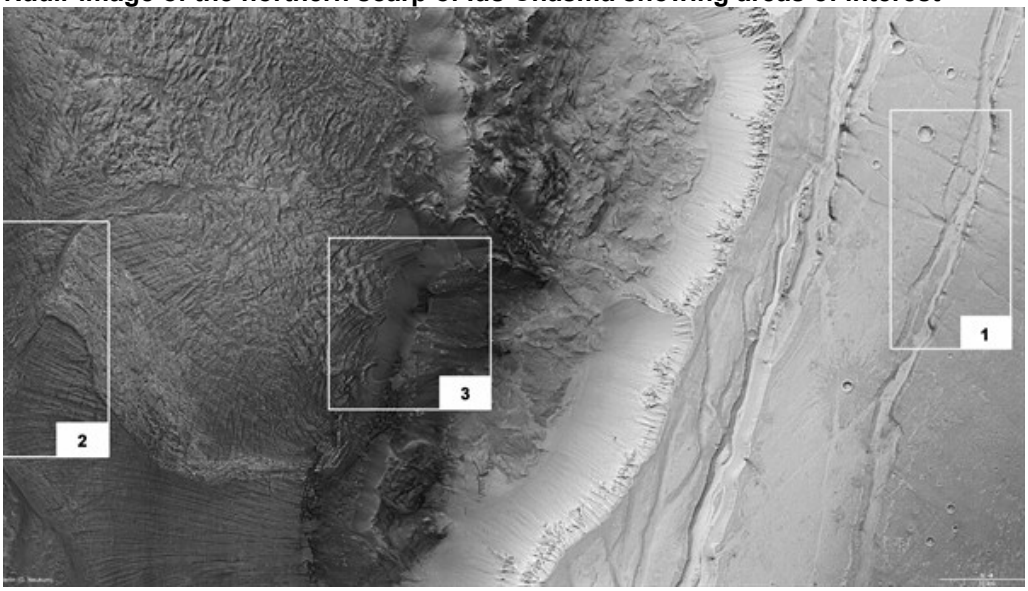
Topographic map of a section of Ius Chasma



Digital terrain models that illustrate the topography of the region using false colours can be derived using the HRSC stereo camera. The altitude can be read from the colour scale at the bottom right; north is to the right. In the absence of 'sea level', the elevation data is referenced to an areoid - a modelled equipotential surface on which everything experiences the same gravitational attraction towards the centre of the planet. While the valley floor of Ius Chasma is 4000 metres below the areoid, the level of the surrounding Martian highlands is more than 4000 metres above the reference surface – over a horizontal distance of less than 20 kilometres, there is a drop of more than eight kilometres. 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.

Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

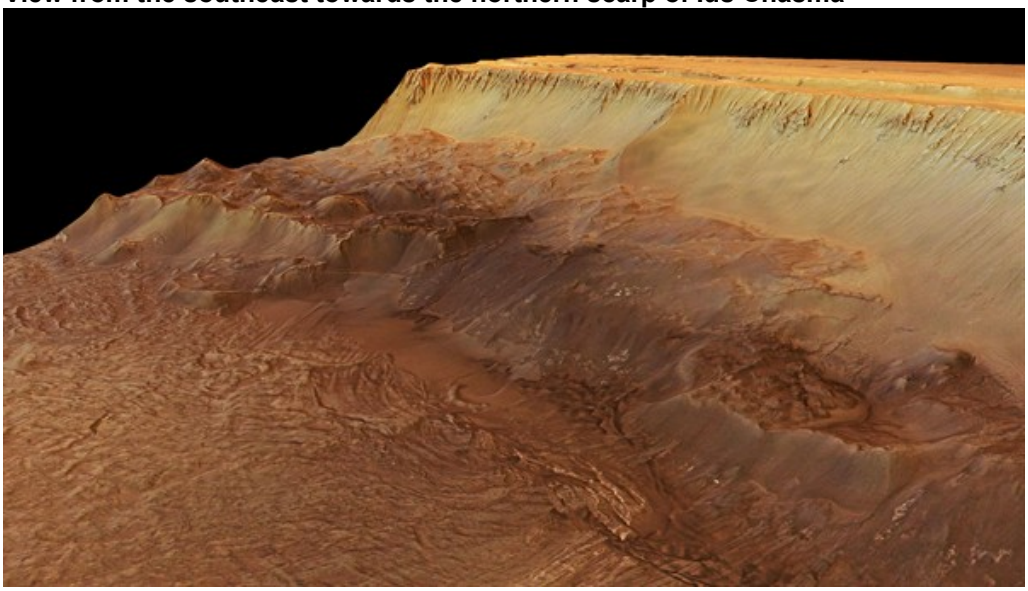
Nadir image of the northern scarp of Ius Chasma showing areas of interest



The nadir channel of the High Resolution Stereo Camera (HRSC) system, which has its field of view oriented vertically onto the planet’s surface, delivers the highest image resolution of all the camera channels. During orbit 2149, ESA’s Mars Express spacecraft was about 250 kilometres above Ius Chasma, resulting in an image resolution of 13 metres per pixel. The imaged area measures about 120 kilometres by 60 kilometres. Parallel to the direction of the main fault of Ius Chasma, other extension faults can be seen in the adjacent Martian highlands; these faults are intersected at right angles by side faults (detail 1). Several overlapping, large-scale landslides are visible below the escarpment of Ius Chasma (detail 2). The remains of an ancient landslide have been overlaid by younger rock masses (detail 3). 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.

Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

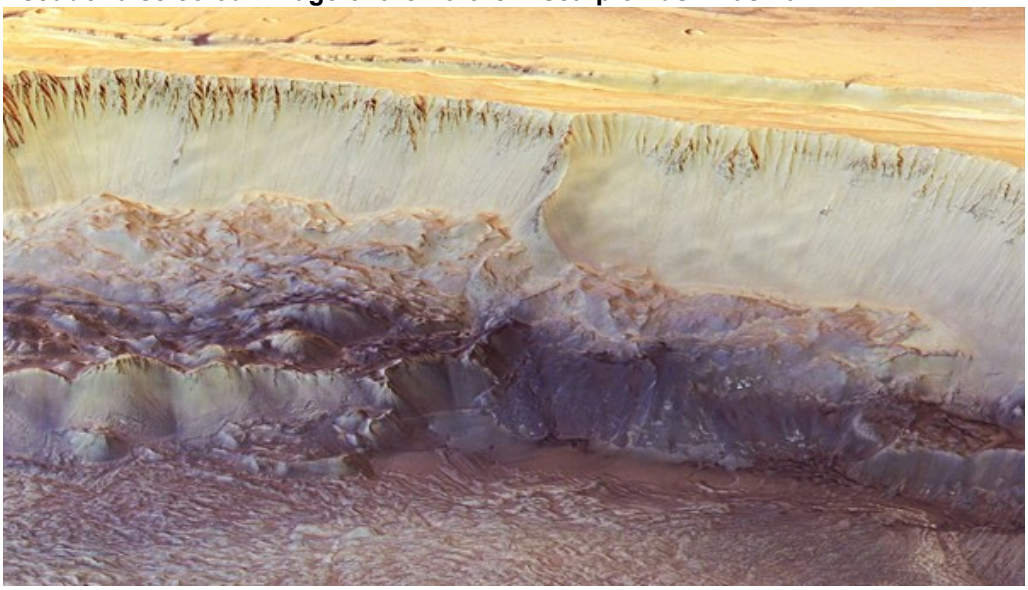
View from the southeast towards the northern scarp of Ius Chasma



Realistic perspective views of the Martian surface can be generated from data acquired by the stereo and colour channels of the High Resolution Stereo Camera (HRSC) on ESA's Mars Express spacecraft, which are oriented at an angle with respect to the planet's surface. This image shows the 8200-metre-high scarp that drops from the Martian highlands into Ius Chasma, one of the main graben in the Valles Marineris, the largest canyon system on Mars. A number of large landslides have occurred along the scarp, depositing large amounts of rock in the valley. The landslide deposits also exhibit flow structures that can be seen as elongated meandering rilles, fanning out with increasing distance. This suggests that ice or water stored in the highlands played a role in causing the landslides. 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.

Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

Pseudo-false colour image of the northern scarp of Ius Chasma

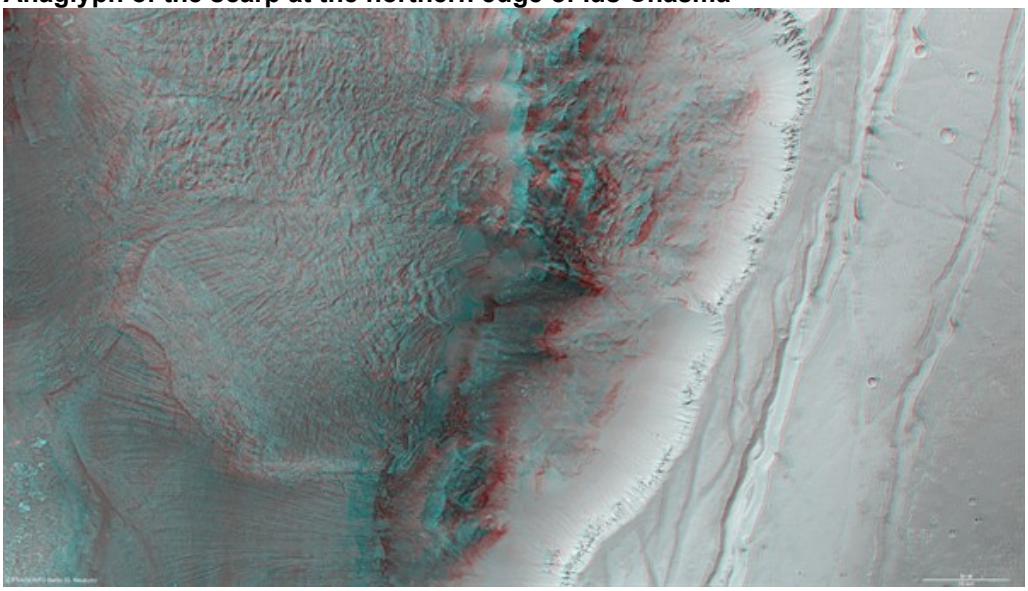


Realistic perspective views of the Martian surface can be generated from data acquired by the stereo and colour channels of the High Resolution Stereo Camera (HRSC) on ESA's Mars Express spacecraft, which are oriented at an angle with respect to the planet's surface. By increasing the image contrast in the individual colour channels (red, green, blue), subtle differences in the material visible on the Martian surface are revealed in pseudo-false colours. Multiple large, overlapping landslides have collapsed into the Chasma. A light, streaked zone can be seen along the uppermost, and hence most recent, landslide. This could be indication of a change in the material making up the highlands in this region. Remnants of older landslides

can be seen in the foreground. 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.

Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

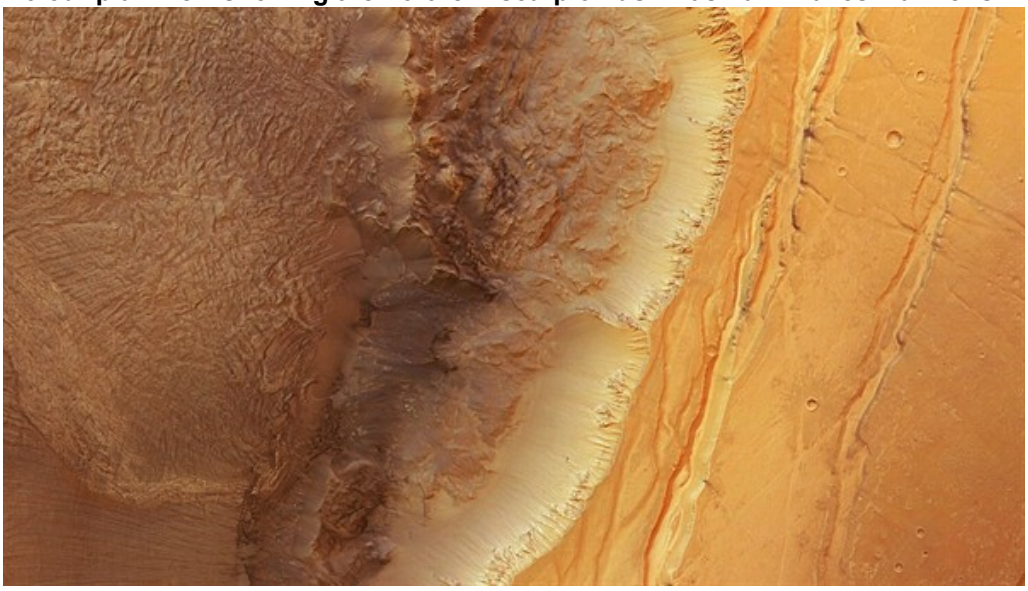
Anaglyph of the scarp at the northern edge of Ius Chasma



Anaglyph images can be created using data from the nadir channel of the High Resolution Stereo Camera (HRSC) system, the field of view of that is directed vertically down onto the Martian surface, and one of the four stereo channels, which are directed obliquely towards the surface. By using red/blue (cyan) or red/green glasses, a three-dimensional impression of the landscape is obtained; north is to the right in the image. The giant scarp that descends from the Martian highlands into the valley of Ius Chasma looks particularly impressive when viewed in 3D – over a horizontal distance of less than 20 kilometres, the altitude changes by about 8200 metres. The very irregularly shaped mounds of landslide debris reach heights of up to 2000 metres. 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.

Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

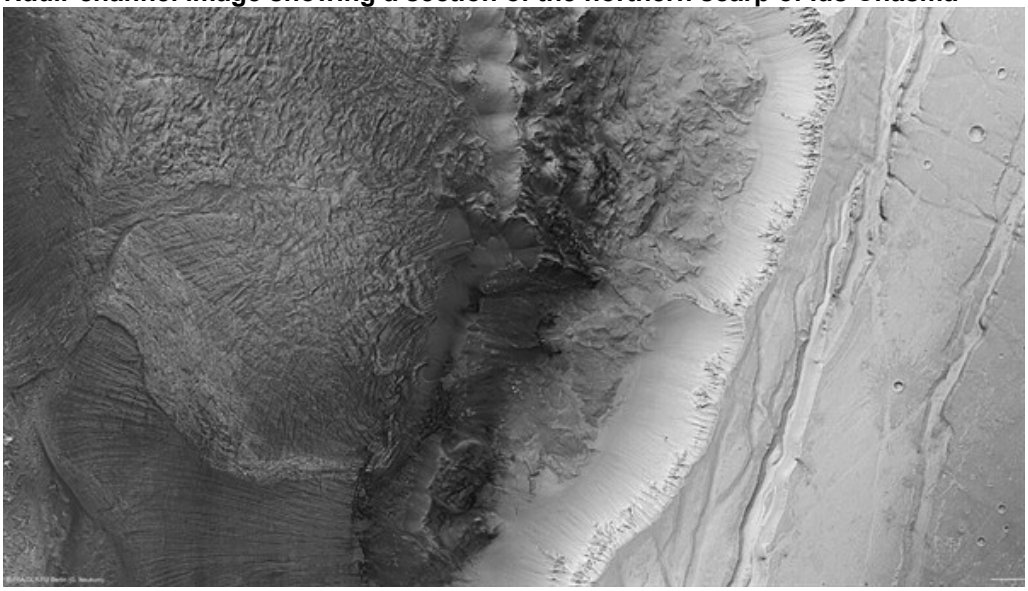
Colour plan view showing the northern scarp of Ius Chasma in Valles Marineris



This colour plan view was created using the nadir channel, which is directed vertically down onto the Martian surface, and the colour channels of the High Resolution Stereo Camera (HRSC) camera system on board ESA's Mars Express spacecraft; north is to the right in the image. The image covers an area of 7200 square kilometres, which is about the size of the island of Corsica. The different colour shades where movements of rock have occurred along the northern scarp of Ius Chasma, which runs vertically through the centre of the image, suggest that the mineralogical composition differs across the various regions of the Martian highlands. 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.

Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

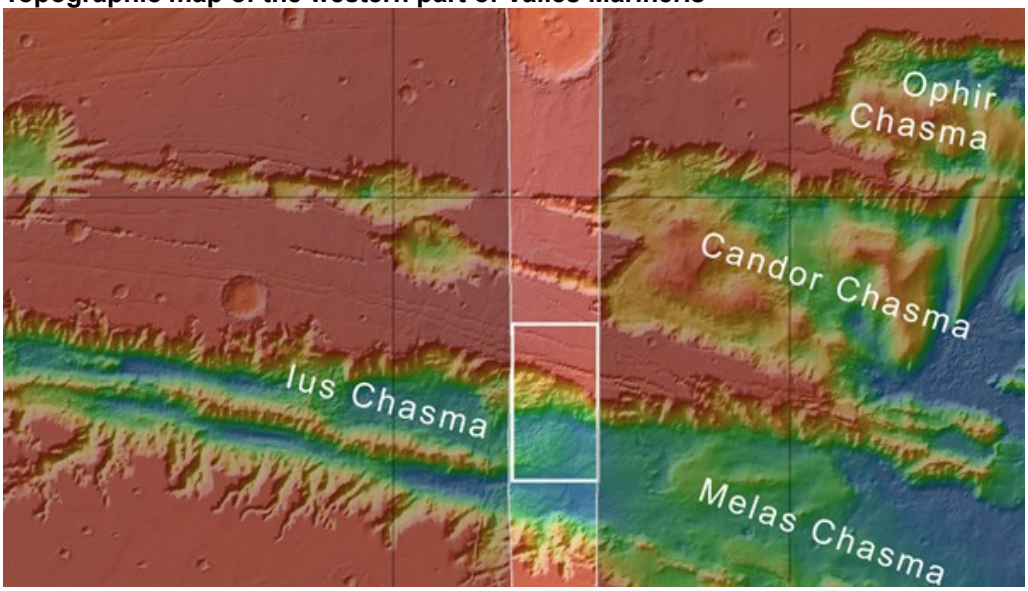
Nadir channel image showing a section of the northern scarp of Ius Chasma



The nadir channel, which points vertically down towards the planet’s surface, enabled High Resolution Stereo Camera (HRSC) image data to be captured with a resolution of 13 metres per pixel as Mars Express flew over the northeast of Ius Chasma during orbit 2149. These enable small-scale geological structures to be identified; north is to the right in the image. The image covers an area of approximately 120 kilometres by 60 kilometres. The right half is occupied by the Martian highlands, which have numerous extension faults across them. Running vertically through the centre of the image is the scarp at the northern edge of Valles Marineris, which is more than eight kilometres high. The valley floor of Ius Chasma is visible in the left half of the image. A number of landslides have occurred and their debris fields overlap. The pattern of the landslides suggests that water played a role in their formation. 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.

Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

Topographic map of the western part of Valles Marineris



Ius Chasma forms the northern boundary of the western half of the Valles Marineris canyon system; it is almost 1000 kilometres long. The Martian highlands descend about eight kilometres to the floor of Ius Chasma over a steep scarp. ESA's Mars Express spacecraft has flown over Ius Chasma many times; the images shown here are of the area in the small, inner rectangle. They were acquired during orbit 2149, which took place on 16 September 2005.

Credit: NASA/JPL (MOLA); FU Berlin.
