Rolling hills and broad valleys in Ismeniae Fossae

14 November 2013

Gentle, rounded landscapes make up the Ismeniae Fossae, and can be seen in these newly released images created using data acquired by 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. Most craters and slopes are completely covered by a layer of fine-grained material that was probably transported there by the wind.

Ismeniae Fossae is located on the border of the southern highlands, stretching out to the adjacent plains of the northern lowlands. The landscape in this region is characterised by rather angular, rugged mountains and deep valleys. The transition from highlands to lowlands occurs along a narrow zone in which erosion has created a striking landscape through the action of rivers, wind, ice and groundwater. This topographic dichotomy between the northern lowlands and the older, heavily cratered southern highlands is one of the most striking features of our neighbouring planet.

The surface of Mars in the southern area of images 1, 4 and 5 exhibits remarkably little in the way of topographical profile. The edges of the terrain are smoothed and rounded as a result of erosion and the deposition of a layer of sand and dust. An old, approximately 20-kilometre-wide impact crater, which is cut in two by a valley-shaped depression, is barely visible as an outline.

Outlier in former crater

Most of the Ismeniae Fossae region can be seen in the topographic overview map (image 2). A trench-like valley stands out in the south, which ends in several branches, or fossae to the northeast at the 130-kilometre-wide Moreux Crater. The name Ismeniae is derived from the Ismenus River in ancient Boeotia, an area of land northwest of Athens. The western edge of Moreux Crater (named after the French astronomer Louis-Théophile Moreux, 1867-1954) can be seen in the lower right of images 1, 4 and 5. The landscape image in the overview map reveals that Ismeniae Fossae could consist entirely of the eroded remnants of a filled impact basin up to 470 kilometres in diameter.

The shape and texture of the exposed residue within this basin, and also the wide valley cutting through the area, resembles a geological landscape type on Mars referred to as 'chaotic terrain'. Such areas (including, for example, Iani Chaos, Aureum Chaos or Aram Chaos) are extremely rugged; across their erosion-marked surfaces, individual boulders and hills form a jumbled structure of outliers (Engilsh for Zeugenberge) in a chaotic arrangement. This geological feature was probably formed when subterranean ice melted and the resulting caverns collapsed.

Rock glaciers left their mark

Starting from this chaotic area, a long, narrow depression follows a crescent shape into the region, which can be seen in the upper part of image 1. This depression can reach up to two kilometres in depth in some places. Its flanks are soft and its boundaries undulating. Its surface is engraved with a pattern of grooves, and streaked structures running parallel to the slopes that surround the valley can be seen.

Such a pattern can be found in many similar valleys with a rectangular profile. Geologists refer to them as 'lineated valley fills'. The surface texture suggests that ice was once present, possibly in the form of a rock glacier: These are streams of ice, covered by broken ice and rubble, which have slowly flowed down a valley. Numerous narrow, branched valleys west of Moreux Crater suggest that water once flowed on the Martian surface.

Other unusual features of this landscape area are the groups of round or elliptical, sometimes interconnected depressions on the plateau, which can be seen on the left of images 1, 4 and 5. These are either an aggregation of secondary craters – the result of strikes by ejecta from a large impact in the vicinity – or sinks and pits that arose after ice sublimated at or just below the surface.

Image processing and the HRSC experiment on Mars Express

The images were created using data acquired by HRSC on 16 June 2013 during Mars Express orbit 11,709. The image resolution is about 20 metres per pixel. The images show a section at about 40 degrees north and 42 degrees east.

The colour plan view (image 1) was created using data from the nadir channel, the field of view of which is aligned perpendicular to the surface of Mars, and the colour channels of the HRSC. The oblique perspective view (image 3) was generated using data from the HRSC stereo channels. The anaglyph (image 4), which provides a three-dimensional view of the landscape when viewed using red-green or red-blue glasses, was derived from data acquired by the nadir channel and one stereo channel. The colour-coded topographic view (image 5) is based on a digital terrain model of the region, from which the topography of the landscape can be derived.

The High Resolution Stereo Camera was developed at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and built in collaboration with partners in industry (EADS Astrium, Lewicki Microelectronic GmbH and Jena-Optronik GmbH). The science team, which is headed by principal investigator (PI) Ralf Jaumann, consists of over 40 co-investigators from 33 institutions and ten countries. The camera is operated by the DLR Institute of Planetary Research in Berlin-Adlershof. The images shown here were generated by the Institute of Geological Sciences at FU Berlin in conjunction with the DLR Institute of Planetary Research in Berlin.

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View of the northeastern part of the Ismeniae Fossae region

The landscape forms in the left (southern) half of the image show remarkably little in the way of a topographical profile. The streaked structures in the foothills of the rectangular profiled valleys probably resulted from flowing ice, which was covered with debris and rubble (rock glaciers). The western edge of Moreux Crater can be seen at the lower right. 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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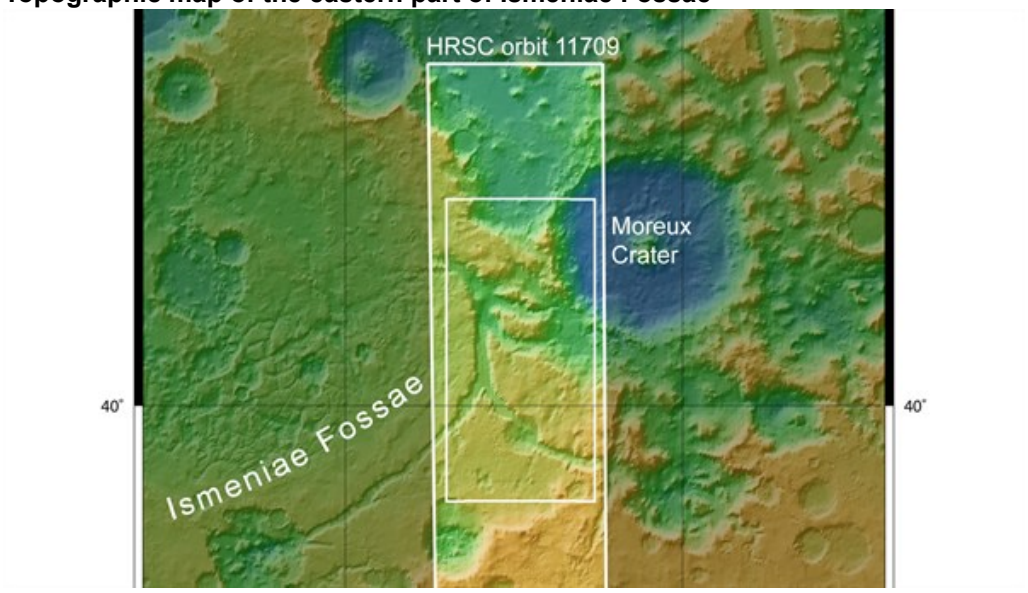
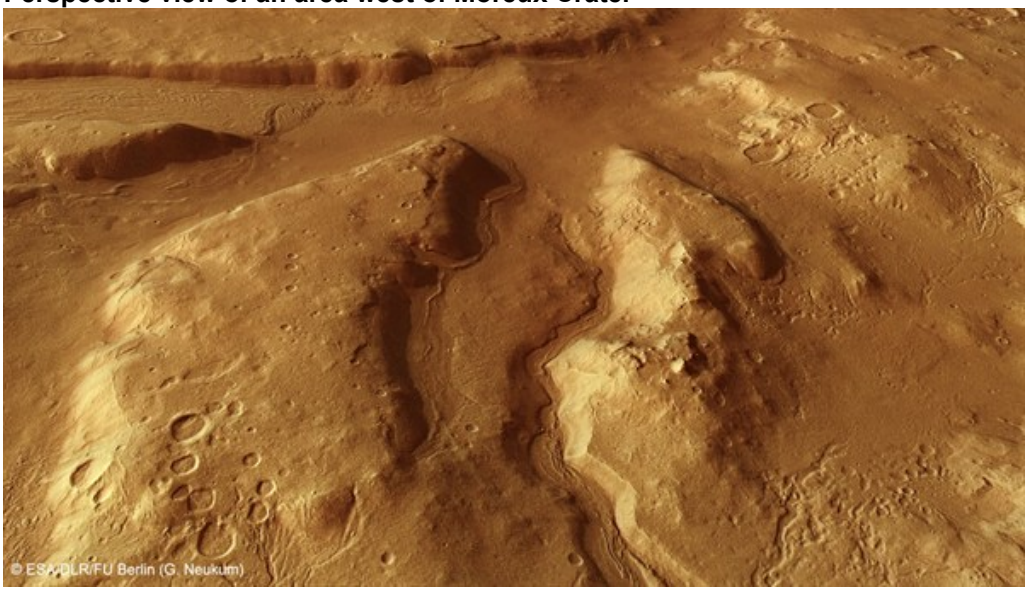
Topographic map of the eastern part of Ismeniae Fossae



Topographic map of the eastern part of Ismeniae Fossae, in the transition zone from the southern highlands to the northern lowlands of Mars. The main valley of Ismeniae Fossa forms the southeastern boundary of an impact basin more than 400 kilometres in diameter that has been almost completely levelled by erosion.

Credit: Credit: NASA/JPL/MOLA/FU Berlin.

Perspective view of an area west of Moreux Crater



Perspective view of an area west of the Moreux Crater, where the main branch of Ismeniae Fossae (top left) meets several lateral valleys from the east. Linear structures running parallel to the valley slopes and referred to as ‘lineated valley fills', indicate that glacial ice covered by rubble and debris pushed through the valley, leaving a distinctive pattern on the surface. An aggregation of small, round, sometimes elliptical depressions in the left foreground could be sinkholes, created by sublimating ice, or secondary craters that resulted from strikes by the ejecta from a large impact crater. 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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Anaglyph image of Ismeniae Fossae

When viewed with red-cyan or red-green glasses, this image reveals a three-dimensional view of the landscape of Ismeniae Fossae. This is particularly good for viewing the rectangular profile of the up to 2000-metre-deep, trench-like valleys. Also shown is the structure of 20-kilometre impact crater that has been almost completely levelled by erosion. 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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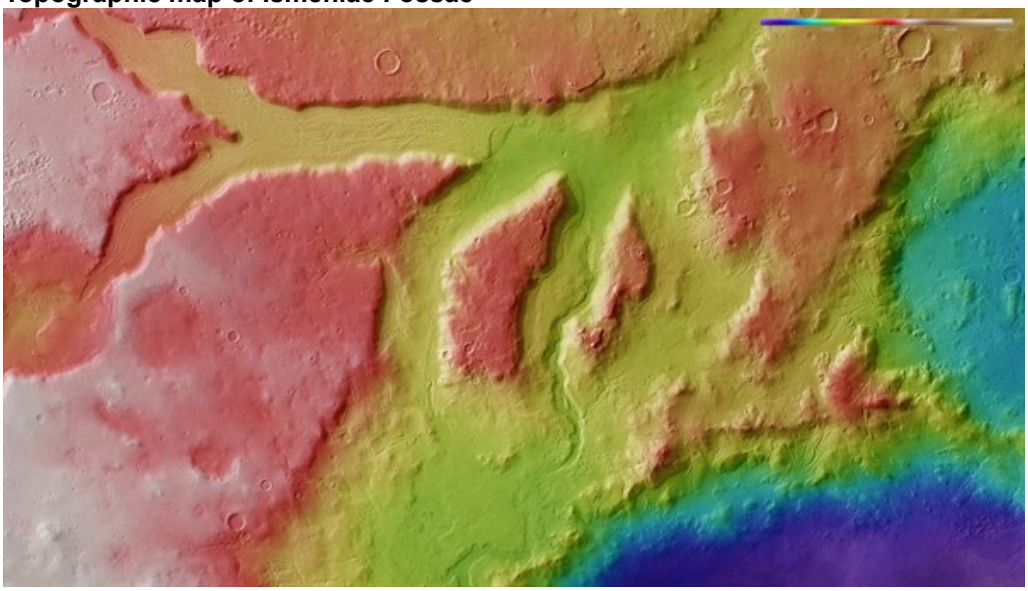
Topographic map of Ismeniae Fossae



Topographic terrain models with an accuracy of 10 to 20 metres can be derived using stereo image data acquired by HRSC, from which the height above or below a reference surface can be determined. 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. The slight differences in the plateau's height can be seen in the left half of this image of the Ismeniae Fossae region. The distinctive rectangular cross section of the approximately 2000-metre-deep valley is clearly visible. 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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