Mars Express – Former lakes and rivers in Acidalia Planitia

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Former crater lakes and dendritic river valleys in Acidalia Planitia – a place for microorganisms?

The images from the High Resolution Stereo Camera (HRSC), carried on board ESA's Mars Express spacecraft and operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), were acquired on 21 June 2011 and show the transition zone between the western edge of Acidalia Planitia and the Martian highlands. Acidalia Planitia is a plain in the northern lowlands, lying between the Tharsis volcanic province and Arabia Terra, to the north of the Valles Marineris. The famous Cydonia region (the 'face on Mars') is also located in the Acidalia plain. The imaged region covers an area roughly 150 by 70 kilometres, making it a little larger than the island of Crete. Acidalia is the name of a spring in Boeotia (modern Attica) in central Greece where, according to legend, Venus, the goddess of love, frequently bathed with the Graces. For this reason she is sometimes referred to as 'Acidalia' (Venus Acidalia).

Once there was water activity on the surface of Mars

There are numerous river valleys in this section of the transition zone from the Martian highlands to the northern lowlands of Acidalia Planitia. Some of these valleys show what is referred to as a dendritic pattern, imitating the shape of the uniform branching of a tree. Such flow patterns occur as a result of precipitation, in the form of rain or snow, for example. The existence of dendritic outflow systems on Mars indicates that the planet once had a different, presumably warmer and more humid, climate – at least at some point in time.

Isolated fractures in the Martian crust are visible in the upper section of the images – on the right hand side. They continue into the neighbouring Idaeus Fossae region (outside of this image). Water stored in subterranean cavities may have escaped from these fractures. To the west, in the upper section of the image, several craters 10 to 20 kilometres wide and filled with sediment can be seen; this is the origin of some of the river valleys. It can be assumed that the craters were once filled with water, forming lakes. In the central section of the images there are several smaller, very well preserved craters. These were presumably formed after the water activity ceased and thus were not filled with water and eroded, nor were sediments deposited there.

Regions like the one shown here are of great significance for the search for life on Mars. The clear markers of crater lakes are evidence of the presence of surface water in the past history of Mars. Sediments from such lakes are of particular interest to astrobiological research, as the existence of water over extended periods of time is a prerequisite for the development of microorganisms.

Image processing and the HRSC experiment on Mars Express

These HRSC images were acquired during Mars Express' orbit 9534. The image resolution is about 15 metres per pixel. The images show a section at 37 degrees north and 306 degrees east.

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.

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Colour overhead view of the western edge of Acidalia Planitia

This colour view was created using the nadir channel, which is directed vertically down onto the Martian surface, and the HRSC camera system colour channels on ESA's Mars Express spacecraft; north is to the right in the image. The image section shown here covers an area of around 11,000 square kilometres. Numerous river valleys can be made out in this section of the transition zone between the Tempe Terra region in the Martian highlands and the northern lowlands of Acidalia Planitia. The dendritic pattern of these river valleys suggests that these structures formed a long time ago by surface water, which presumably precipitated onto Mars in

the form of rain or snow. Many of the large craters are filled with sediment that the water transported into these impact structures, which were once much deeper. 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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Perspective view from the southeast to the northwest over Acidalia Planitia

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 board ESA's Mars Express spacecraft, which are oriented at an angle with respect to the planet's surface. The image shows a view from the southeast over the plain of Acidalia Planitia to the northwest towards the Martian highland of Tempe Terra. In the foreground and in the centre at the upper edge of the image, four craters with obvious, sharp rims can be seen; they were presumably formed when water activity in this region had ceased, as no sediment has been deposited in their interiors. A larger, older crater to the upper left of the centre of the image is different; its interior has been almost completely filled with sediment, transported there by rivers during the early period of Mars' history. 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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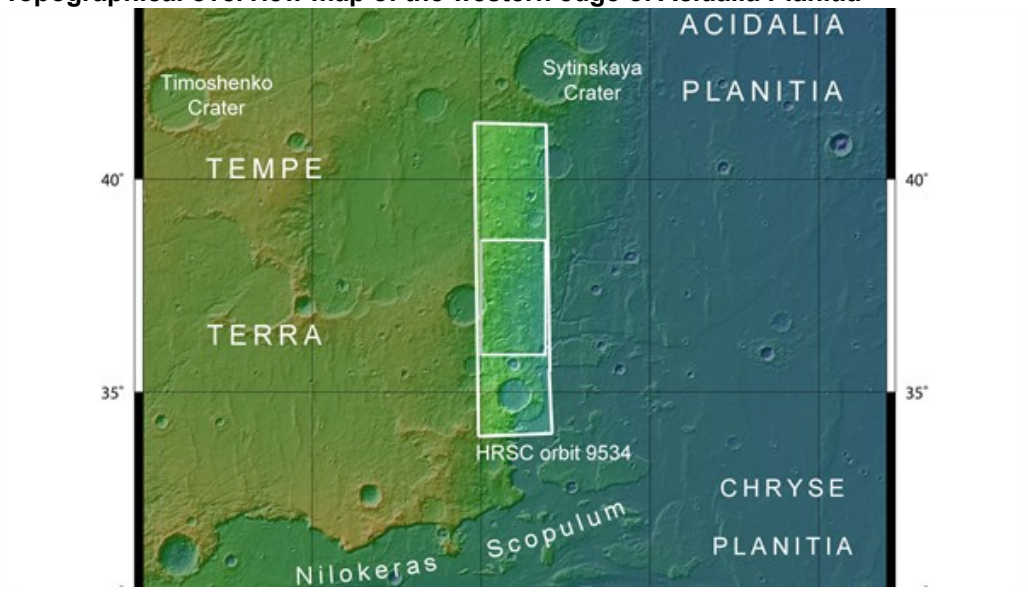
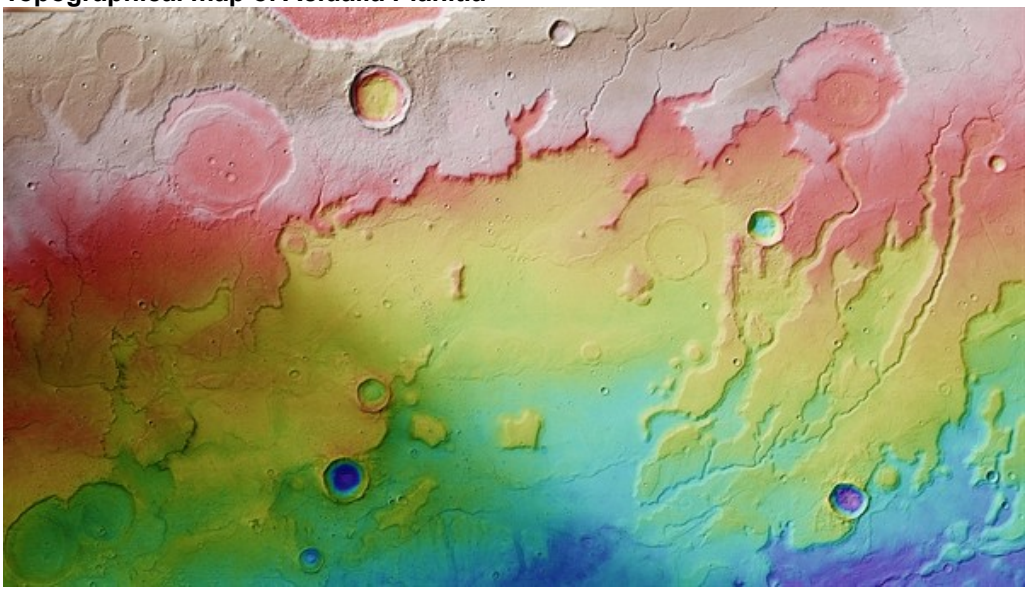
Topographical overview map of the western edge of Acidalia Planitia



The Acidalia Planitia region is part of the northern lowlands of Mars, and is located to the northeast of the Tharsis volcanic province. To the west, it is bordered by the Tempe Terra highland region. The HRSC stereo camera on board ESA's Mars Express spacecraft acquired images of the transition zone between Tempe Terra and Acidalia Planitia on 21 June 2011 during orbit 9534, from an altitude of around 260 kilometres (larger framed rectangle). The images reproduced here are located in the smaller, inner rectangle. Numerous structures in this region indicate the activity of water in the early history of Mars.

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

Topographical map of Acidalia Planitia



Using the HRSC stereo camera, digital terrain models can be derived that illustrate the topography of the region using false colours. The altitude allocation can be read from a colour scale at the upper left; north is to the right in the image. 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 transition from the Martian highlands in the west – at the top in the image – to the lowlands of Acidalia Planitia is clear. The terrain falls by more than two kilometres over a distance of less than 100 kilometres. It is also easy to see that some of the large craters in the highlands are filled almost to the rim with material deposited there by flowing rivers a long time ago, whereas several younger, deep craters in Acidalia Planitia still retain their original bowl-shaped form and contain no sediment. 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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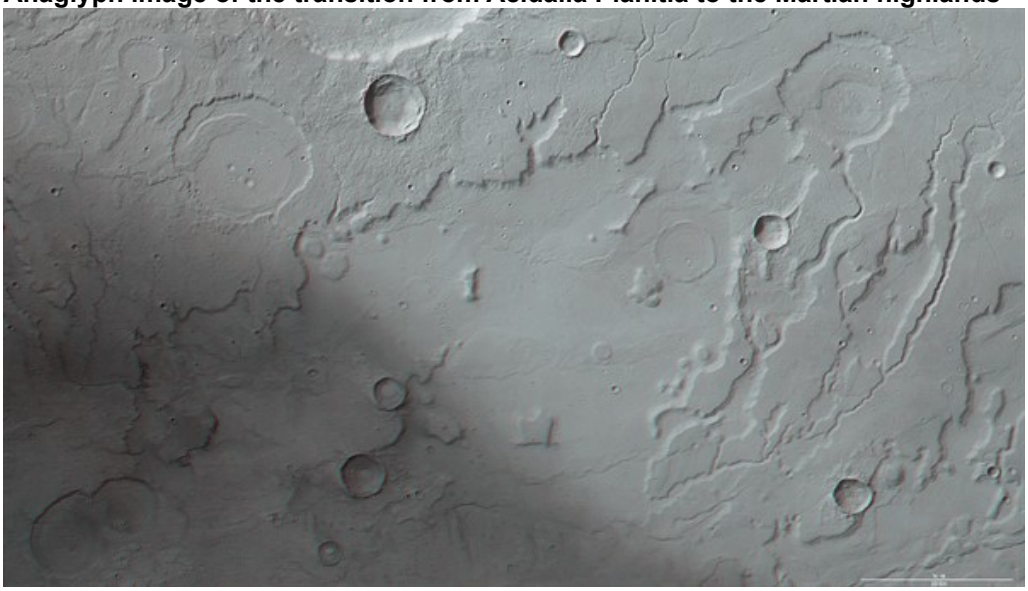
Anaglyph image of the transition from Acidalia Planitia to the Martian highlands



Anaglyph images can be created from the nadir channel in the HRSC camera system, which looks vertically at Mars, and one of the four stereo channels, which are directed obliquely at the surface. Using red/blue (cyan) or red/green glasses gives a three-dimensional impression of the landscape. North is to the right in the image. The 3D effect clearly shows the marked transition from the Tempe Terra region on the upper edge of the image to the lowlands of Acidalia Planitia. Over a horizontal distance of about 70 kilometres, the terrain displays a difference in altitude of over two kilometres. Also easy to see are the valleys that were carved out by flowing rivers in the early history of Mars. Several large impact craters have been filled almost to their rims with sediments transported here by these rivers, whereas a number of smaller craters still retain their deep, bowl-shaped form and contain no sediment.
