



## Winter atmosphere on Mars

*06 December 2012*

Observing a seasonal phenomenon has its own special appeal on Mars. As the planet's rotational axis has a slightly greater inclination to that of Earth, our planetary neighbour experiences distinct seasons too – except these last around twice as long since it takes nearly two Earth years for Mars to orbit the Sun. Frost deposits are not uncommon in winter, even at mid-latitudes – as these images of Charitum Montes show. The High Resolution Stereo Camera (HRSC) on board ESA's Mars Express spacecraft, which is operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), acquired these images on 18 June 2012.

On looking at the colour images it is immediately apparent that parts of the usually orange- to ochre-coloured surface of Mars are covered with a white substance. This is a very thin layer of solid carbon dioxide (dry ice), deposited across the surface like a hoar frost during winter. The carbon dioxide ice crystals have precipitated onto the ground from the Martian atmosphere. The warmer temperatures of spring will soon ensure that the ice sublimates – that is, transitions directly from a solid to back to a gas.

### **Numerous craters – evidence of a very ancient region of Mars**

In the HRSC images, the numerous different-sized craters are immediately apparent. This is an unmistakable sign that the major structures of the landscape are very old, probably more than three billion years. The highest points in this region, which can be made out particularly well in the colour-coded topographic map (image 6/6), are the mountains of Charitum Montes.

In the centre of image 1/5 is a crater almost 50 kilometres in diameter – approximately the size of the metropolitan area of Berlin – which has a bowl-shaped depression filled to a substantial degree by thick layers of sedimentary deposits, forming a level floor. The sediments were transported and deposited by rivers entering through breaches in the north and west of the crater walls. The uppermost – youngest – layer of these deposits shows a streaked pattern, attesting to its transportation and deposition by flowing water.

Various unusual, triangular black areas are visible under the northeastern rim of the crater. These are a field of dunes that the wind has deposited and heaped up in front of the 'obstacle' formed by the crater wall by carrying dark material – presumably ash or dust of volcanic origin.

Also interesting are craters that seem to be sitting on a kind of plinth that surrounds the impact structures. In many cases, such as the small crater on the plain to the northeast of the region (lower right in full-size image 1/6), they are reminiscent of an egg in a frying pan. Another good example of a structure of this type, known by Mars geologists as 'rampart craters', is in the large crater to the southeast (lower left in the image).

More unusual structures are evident in the interiors of two craters to the south of the region (on the left edge of images 1/6 and 5/6). Various layers are clearly distinguishable by their texture and colour. The topmost layer of sediment appears significantly brighter and has a very smooth surface; also, it does not seem to be particularly thick. It has not quite covered some small impact craters, and their outlines can still be clearly traced through the covering of sediment. The outlines in this layer are conspicuously sharp, which is perhaps the result of a more recent erosion process. The layer underneath this covering of sediment is somewhat darker and displays a rough, textured surface. Furthermore one layer of sediment is clearly raised up from the other deposits, forming mesa-like structures as a result of erosion.

As with other regions in the vicinity of Argyre, Charitum Montes was first described by Eugène Michel Antoniadi (1870-1944) in his work 'La Planète Mars'. They were apparent to the astronomer in his telescopic observations due to their contrasting brightness in comparison to the surroundings.

Charitum Montes runs through the Martian highlands, parallel to the southern edge of the Argyre impact basin; HRSC images of the region have been presented in recent months, for example of Nereidum Montes to the northwest (1 November 2012), Hooke Crater (4 October 2012) and, just 150 kilometres further northwest, the Galle Crater with mountains in its interior forming the shape of a smiley face (10 April 2006).

### **Image processing and the HRSC experiment on Mars Express**

The images were acquired by HRSC during Mars Express orbit 10,778 from an altitude of around 400 kilometres, giving an image resolution of about 20 metres per pixel. The images show an area at 53 degrees south and 334 degrees east.

The colour plan view (1/6) was acquired using the nadir channel, which is directed vertically down onto the surface of Mars, and the colour channels of the HRSC; the perspective oblique views (2/6, 3/6) were computed from data acquired by the HRSC stereo channels. The anaglyph image (5/6), 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 colour-coded view (6/6) 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 board 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 45 co-investigators from 32 institutions in 10 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. The systematic processing of the HRSC image data is carried out at DLR. The images shown here were created by the Institute of Geological Sciences at Freie Universität Berlin in cooperation with the DLR Institute of Planetary Research, Berlin.

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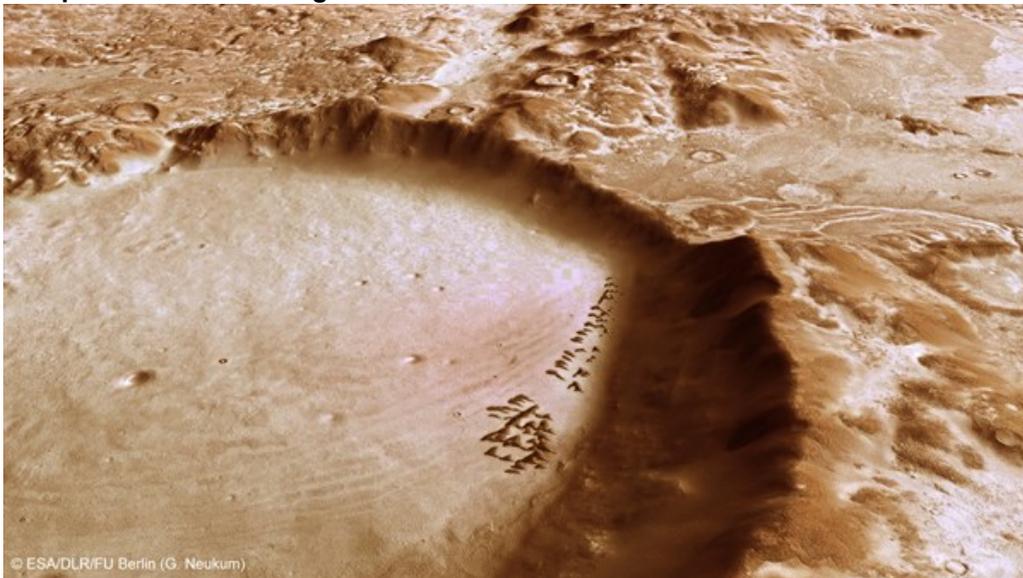
### Colour plan view of the southeastern Charitum Montes



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) on board ESA's Mars Express spacecraft; the resolution is 20 metres per pixel. Charitum Montes runs through the Martian highlands, parallel to the southern edge of the Argyre impact basin. Numerous craters of different sizes are immediately apparent. This is an unmistakable sign that the major structures of the landscape are very old, probably more than three billion years. 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.

### Perspective view of a large crater and dune field in Charitum Montes

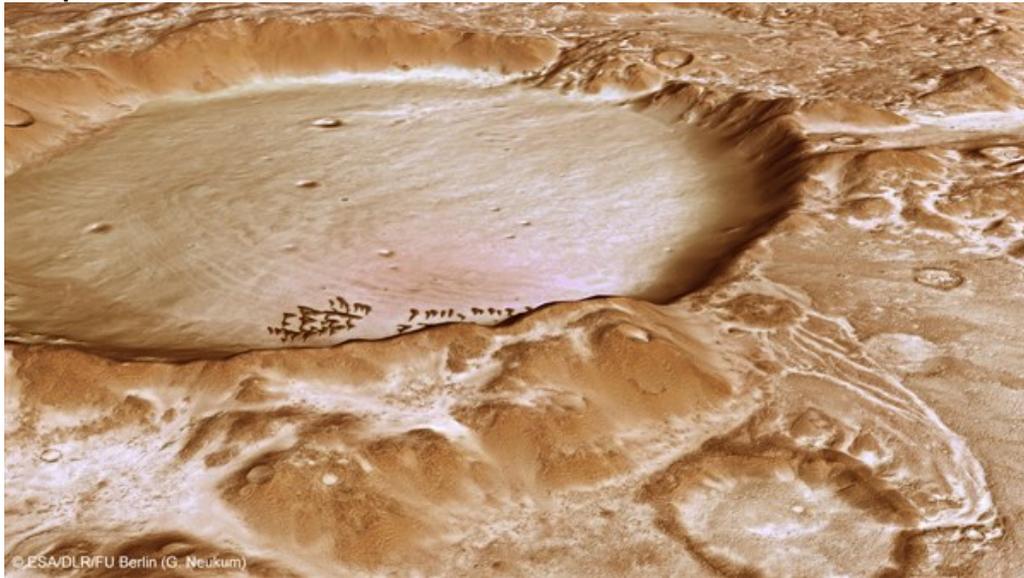


Realistic perspective views of the surface of Mars can be generated from data acquired by the stereo and colour channels of the High Resolution Stereo Camera (HRSC) on board ESA's Mars Express spacecraft, which are oriented at an oblique angle with respect to the planet's surface. This image shows a crater almost 50 kilometres in diameter – approximately the size of the metropolitan area of Berlin. Under the northeastern rim of the crater a number of unusual, triangular black areas are visible. These are a field of dunes that the wind has deposited and heaped up in front of the 'obstacle' formed by the crater wall by carrying dark material – presumably ash or dust of volcanic origin. Copyright note: As a joint undertaking by DLR, ESA and FU Berlin, the Mars Express HRSC images are published under a Creative Commons

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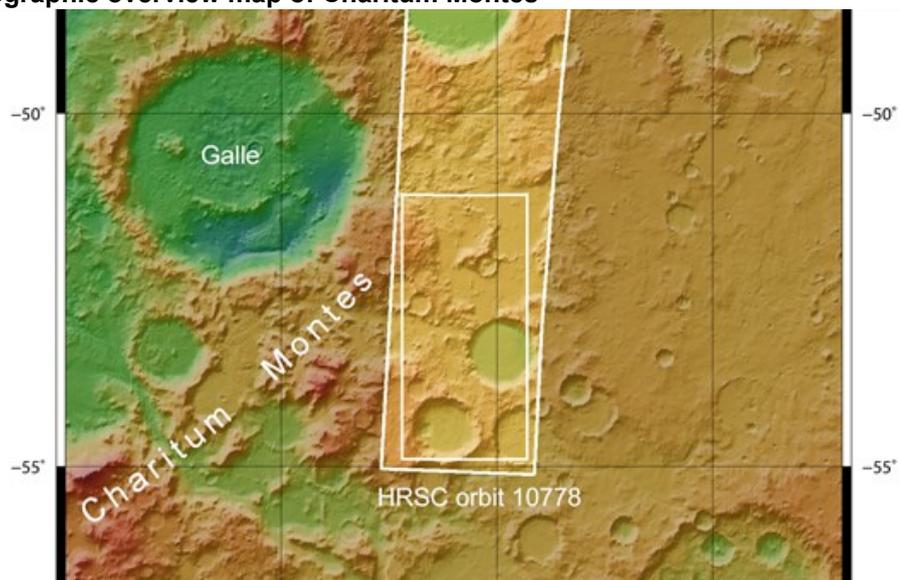
### Perspective view of craters in Charitum Montes



Realistic perspective views of the surface of Mars 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 oblique angle with respect to the planet's surface. This image shows a crater almost 50 kilometres in diameter – approximately the size of the metropolitan area of Berlin. Its bowl-shaped depression has been filled to a substantial degree by thick layers of sedimentary deposits, forming a level floor. The sediments were transported and deposited by rivers entering through breaches in the north and west of the crater walls. Evidence of such a flow is visible in the right foreground. The uppermost – youngest – layer of these deposits shows a streaked pattern, attesting to its transportation and deposition by flowing water. 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 overview map of Charitum Montes



Charitum Montes runs through the Martian highlands, parallel to the southern edge of the Argyre impact basin. On 18 June 2012, the High Resolution Stereo Camera (HRSC) on board ESA's

Mars Express spacecraft, which is operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), acquired images of a portion of this mountain range during orbit 10,776. The images presented here are from the small inner rectangle within the HRSC imaging strip.

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

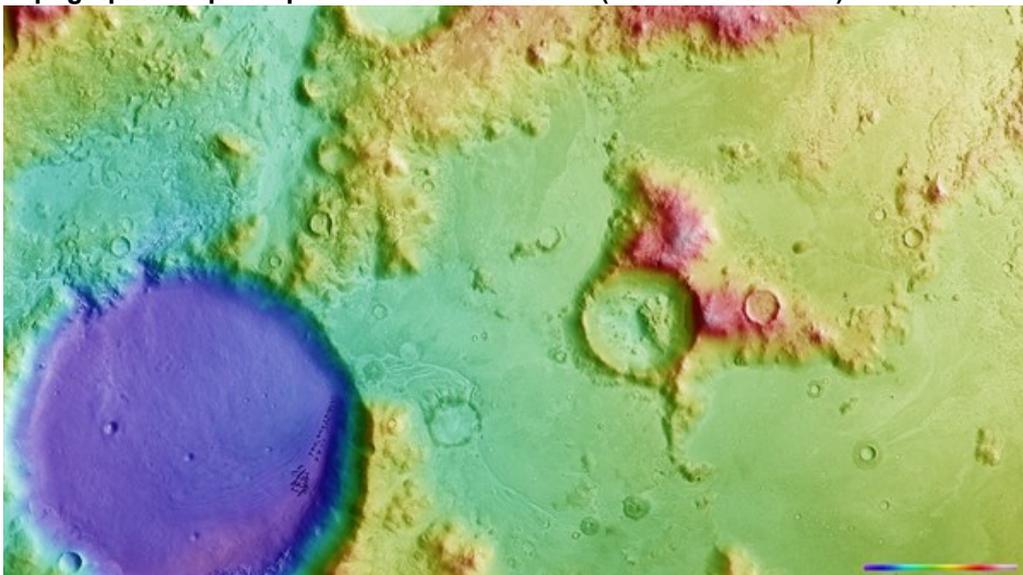
### **Anaglyph image of part of Charitum Montes**



Anaglyph images can be created from the nadir channel of the High Resolution Stereo Camera (HRSC), which looks vertically down at Mars, and one of the four stereo channels, which are directed obliquely towards the surface. Using red/blue (cyan) or red/green glasses gives a three-dimensional impression of the landscape. This image was acquired on Mars Express orbit 10,778 and shows an area at 53 degrees south and 334 degrees east, in which a part of the Charitum Montes mountain system can be seen. 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 a part of Charitum Montes (HRSC terrain data)**



Using the High Resolution Stereo Camera (HRSC), digital terrain models can be derived that illustrate the topography of the region using false colours. The altitudes can be read from the coloured scale at the bottom right of the image (blue: low-lying regions; red: regions at higher altitude). 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. Charitum Montes runs through the Martian highlands, parallel to the southern edge of the Argyre impact basin. 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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