

Deep winter in Argyre Planitia

18 September 2014

On 20 April 2014, the High Resolution Stereo Camera (HRSC) on the ESA Mars Express spacecraft, which is operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), imaged the northern part of the enormous Argyre Planitia impact basin in the southern hemisphere of Mars. At that time, it was deep winter in the area, as can easily be seen from the ground frost covering the interior of Hooke Crater and large sections of the landscape in the image.

The longest nights are two months past, and the start of spring is still far off here at 45 degrees south. Large sections of the lower-lying regions are covered with a thin layer of carbon dioxide ice (dry ice). This sort of ground frost occurs when carbon dioxide ice crystals have precipitated onto the ground from the Martian atmosphere. In higher altitude regions, this no longer occurs, except in a few places lying in shadow, such as on the slopes of the smaller craters. In places that are more exposed to the – albeit still weak – winter sun, the carbon dioxide ice has evaporated again. A hill inside Hooke Crater is also covered in the thin ice deposits.

Crater formed by two impacts

Hooke Crater appears to have been formed by two impacts. The larger crater is almost 140 kilometres in diameter, whereas the smaller one is just 50 kilometres across. Inside the smaller crater is a large hill with a prominent plateau, the western part of which is covered by a dark dune field. Unlike the majority of those on Earth, the dunes on Mars are dark, as they consist of volcanic ash. Rare examples of this on Earth occur on Hawaii, or in New Zealand – places where volcanism is predominant.

On the other side, to the south-east, the ends of several layers on the slope of the hill indicate that the structure appears to be made of different layers of sediment that have been covered with a thick layer of sand and dust or frost. It is possible that the entire hill was formed by the deposition of material transported into the interior of the crater by the wind.

Marked by the wind

Numerous ranges of hills running in parallel can be seen in the left half of the image (images 1, 3 and 5), especially to the southwest of the larger crater. These formations are known as yardangs, and they are caused by wind erosion. When the wind blows grains of sand in the same direction over an extended period of time, the formations are scoured out of the stone as if by a sandblaster. Their orientation also indicates the direction from which the wind has been constantly blowing – here, they run towards Hooke Crater, so from south to north. Clearly, the sand accumulates in this wind trap.

Chaotic terrain in Argyre Planitia – a process that may still be ongoing

Another interesting detail visible in these HRSC images is the occurrence of several small chaotic areas. One is located in the upper half of the centre of the image, and another in the lower part. There are a few mesas and hills in smaller depressions here. Chaotic regions (including the much more striking examples of Iani Chaos, Aureum Chaos or Aram Chaos near the equator of Mars) are extremely fissured surface areas marked by erosion, where individual boulders and hills form a confused structure of chaotically arranged 'witness mountains'. These probably formed when underground ice melted and the cavities that were formed collapsed in on themselves. The surfaces of the two chaotic regions in this image appear to not have completely collapsed yet, so there may still be considerable quantities of water ice under the surface and there could be further collapses later in the course of the geological development.

Location of Hooke Crater

Argyre Planitia is the second largest impact basin on the Red Planet, after Hellas Planitia. It is around 1800 kilometres in diameter, five kilometres deep and was formed by a giant meteorite impact during the early history of the planet. Hooke Crater, which can be seen in the centre of the image, is 138 kilometres in diameter and around two and a half kilometres deep. It lies to the north of the Argyre impact basin. The name of the crater comes from English physicist and astronomer Robert Hooke, who lived from 1635 to 1703.

Image processing

The (HRSC) High Resolution Stereo Camera images were acquired on 20 April 2014 during orbit 13,082 of Mars Express, at 46 degrees south and 316 degrees east. The image resolution is about 63 metres per pixel. The colour image (image 1) was captured using the nadir channel of the HRSC, which is directed vertically down onto the surface of Mars; the perspective oblique view (image 2) was computed from the HRSC stereo channels. The anaglyph image (Image 3), 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 plan view (image 5) is based on a digital terrain model of the region, from which the topography of the landscape can be derived.

The HRSC experiment

The High Resolution Stereo Camera was developed at 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 52 co-investigators from 34 institutions and eleven countries. The camera is operated by the DLR Institute of Planetary Research in Berlin-Adlershof.

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View of Argyre Planitia and Hooke crater



This image shows that the interior of the Argyre basin is covered largely by frost. It is carbon dioxide 'snow' that trickles down from the clouds of the Martian atmosphere in winter. Large sections of the lower-lying regions are covered with a thin layer of carbon dioxide ice (dry ice). In higher altitude regions, this no longer occurs, except in a few places lying in shadow, such as on the slopes of the smaller craters. The carbon dioxide-ice snow then lies down for a few months as a thin veil over the landscape. Fields of dark, crescent dunes are visible in Hooke crater; these are ice-free, because the dark material absorbs the sparse atmospheric heat better and vaporises the carbon dioxide snow quickly. The higher areas in the north (right) are already free of ice. 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 Hooke crater in the north of Argyre Planitia

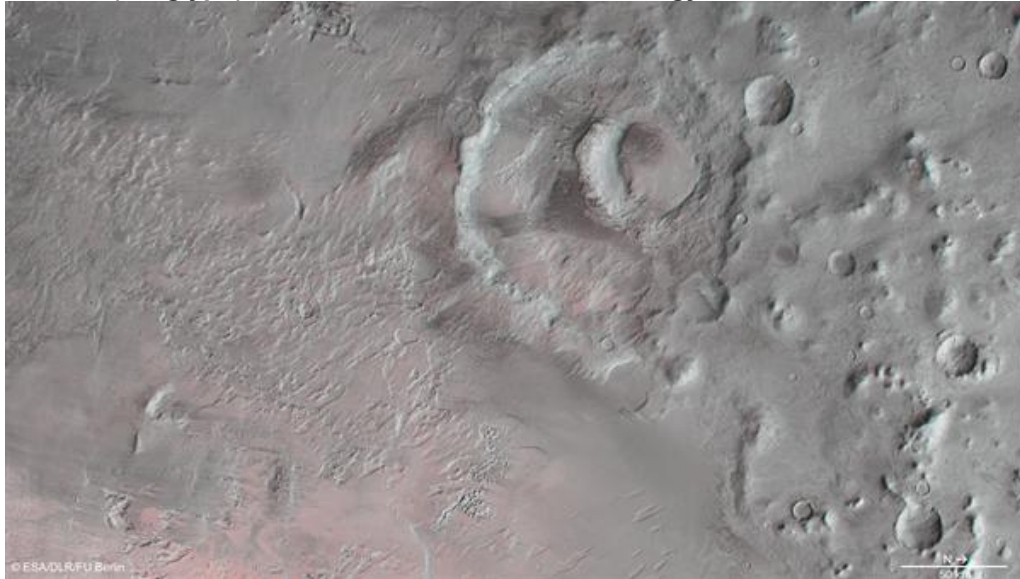


Digital terrain models have been generated using image data from the HRSC camera system's nadir and stereo channels, from which the topography of the Martian surface can be derived. The image shows the 150-kilometre-wide Hooke crater. It was named after the English polymath Robert Hooke (1635-1703) named, who worked as an astronomer at the Royal Society. A second smaller crater stands out; inside it is a large hill with a prominent plateau, the western part of which is covered by a dark dune field. Some of the layers at the right edge of the plateau are disrupted, suggesting that the structure was formed as a result of the transport of material

by the wind to the crater interior. The wind played a significant role in shaping the landscape, at least in recent times, as is also visible in the yardangs. 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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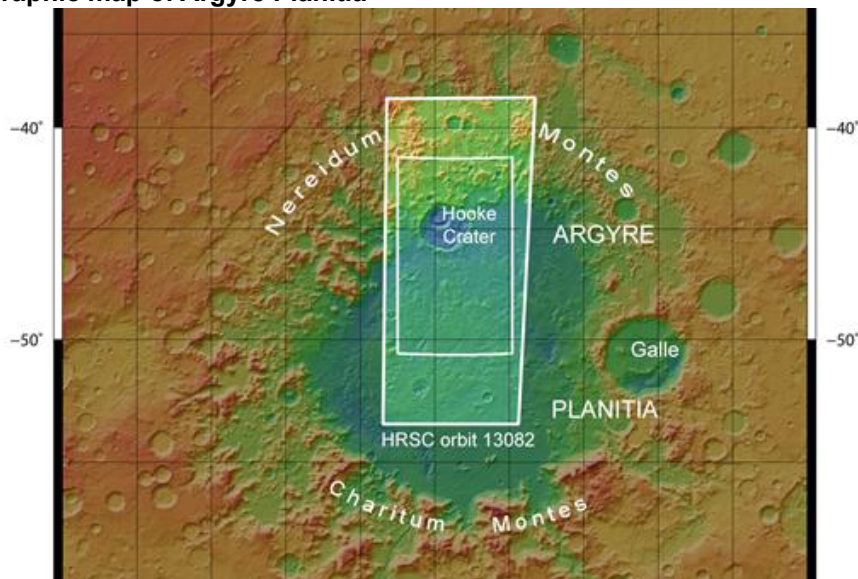
3D view (anaglyph) of Hooke Crater in the north of Argyre Planitia



The nadir channel, which is directed vertically down onto the surface of Mars, and one of the four stereo channels in the DLR-operated HRSC camera system, can be used to create anaglyph images, which produce a realistic, three-dimensional view of the landscape when viewed with red/blue or red/green glasses. Thus, the structure of the crater Hooke is visible in more detail here than in the colour plan view. Weathering processes have greatly eroded the rim of both Hooke Crater and the smaller crater that lies to the northwest. Clearly visible is the unusual plateau in the smaller crater with a remarkably smooth surface. It is possible that the wind created this structure. 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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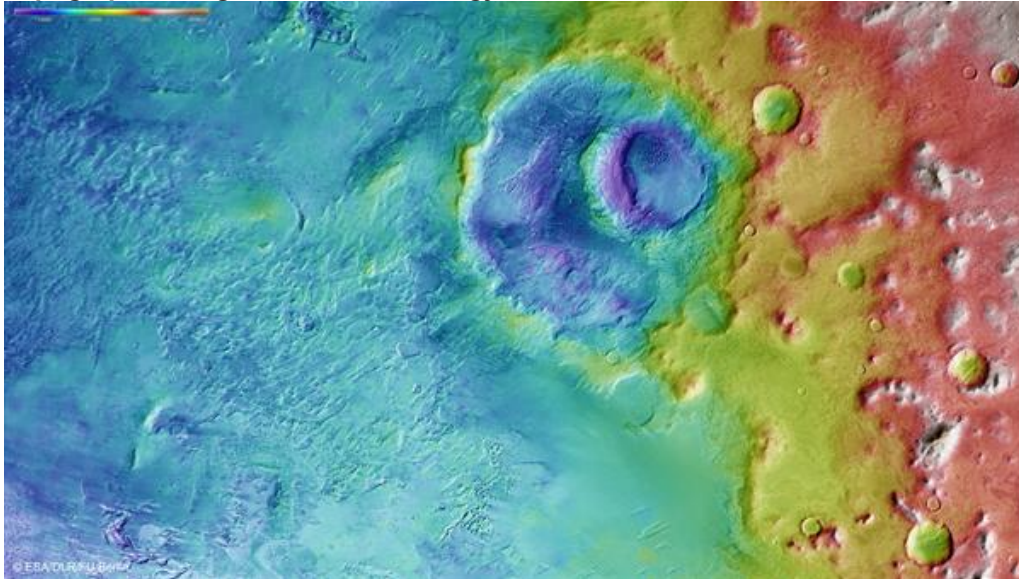
Topographic map of Argyre Planitia



After Hellas basin, Argyre Planitia is the second largest impact structure on Mars. It is one of the most striking features in the southern Martian highlands, and has a diameter of about 1800 kilometres and is five kilometres deep. During winter in Argyre Planitia and the surrounding highlands, temperatures can drop to minus 100 degrees Celsius, and carbon dioxide frost falls from the atmosphere and covers the landscape.

Credit: NASA/JPL/MOLA; FU Berlin.

Topographic image of the north of Argyre Planitia



Topographic terrain models are derived from the stereo image data of the HRSC camera system operated by DLR. The altitude differences in the depicted landscape can be represented. North is to the right. In the left half, the plains of Argyre Planitia are visible. In the transition to the edge of the impact basin, the outline of the 150-kilometre Hooke crater is visible along with a second, younger smaller crater in its northern part. The hilly landscape in the north (right) rises more than 4000 metres above the base of Argyre 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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