



3D flight over Hydraotes Chaos on Mars

16 October 2014

Among the most interesting landforms on Mars are features referred to as 'chaotic terrain'. Dozens or even hundreds of isolated mountains up to 2000 metres high are scattered in these extensive regions. Seen from orbit, they form a bizarre, chaotic pattern. Such terrains are found over a large area to both the west and east of Valles Marineris, the largest canyon in the Solar System. Hydraotes Chaos is a typical example of this type of landscape. This large basin, approximately the size of the German state of Baden-Württemberg, lies in the Martian highlands, near the equator.

Headwaters of large rivers that flowed from the highlands

No comparable landforms are found on Earth. Scientists believe that water in the form of ice was stored in cavities beneath the surface of the highlands early in the history of Mars; this was then heated and thawed out. It was then placed under so much pressure that it escaped to the surface with great force through fissures and fault zones. As it flowed out, the water eroded the terrain and gradually left behind the striking landscape visible today. Another factor supporting this theory is that many of the chaotic terrains on Mars are located at the head of large outflow channels, through which enormous quantities of water flowed out of the highlands towards the northern lowlands.

The quantities of water that were first stored in Hydraotes Chaos and then flowed northward through Simud Valles must have been enormous. They flowed away from a drainage area about 1500 kilometres in diameter, an area approximately the size of central Europe. The Hydraotes basin is 420 kilometres in diameter. It is thought to have formed a very long time ago – over three and a half billion years – during the Noachian Period on Mars.

Generation of the images and animations

The data used to generate these images and the simulated overflight were 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. Once again, image strips from orbit 18 – symbolically significant for the HRSC scientists – were edited and used for the animations and images shown here. Over 10 years ago, in January 2004, Mars Express flew over Hydraotes Chaos during orbit 18. This was the third time that the HRSC camera had been switched on, and the images in the image strips, which were over 1000 kilometres long, were so spectacular that they were drawn on for publication of the first images from the successful ESA mission. To be able to show the western half of the Hydraotes Chaos basin in a larger regional context, additional HRSC images from subsequent orbits were used for the large image mosaic. The region shown is around 400 by 200 kilometres.

The images and animations were generated by the Planetary Sciences and Remote Sensing Group at Freie Universität Berlin, which was headed by Gerhard Neukum (1944 – 2014) from the beginning of the Mars Express mission.

In memoriam – Gerhard Neukum

Professor Neukum is considered the 'father' of the HRSC camera system. In the late 1980s, at the former Institute of Optoelectronics at the DLR site in Oberpfaffenhofen, he developed the idea for a High Resolution Stereo Camera for systematic, high-precision mapping of the Martian topography. An HRSC was originally flown on the Russian Mars 96 mission, which failed shortly after launch. Together with other colleagues, Professor Neukum, who was by then Director of the DLR Institute of Planetary Research in Berlin-Adlershof, energetically lobbied for a Mars

mission under the aegis of the European Space Agency (ESA). This was the birth of ESA's Mars Express mission, which has been orbiting Mars since 25 December 2003 and transmitting high-resolution 3D data from the HRSC experiment of the surface of Mars back to Earth. Gerhard Neukum passed away on 21 September 2014. He was one of the most prominent planetary researchers in Germany and one of the world's recognised experts in the field. He made a name for himself in his chosen field with the work he conducted on the chronology of Solar System bodies.

Image processing

The centre of the images is located at 323 degrees east and 2 degrees north. HRSC images from orbits 0018, 2035, 2057 and 3180 were used for the image mosaic. The colour image (image 3) was acquired using the nadir channel of the HRSC, which is directed vertically down onto the surface of Mars, and the colour channels; the oblique perspective view (image 4) was computed from data acquired by the HRSC stereo channels. The colour-coded plan view (image 5) is based on a digital terrain model, 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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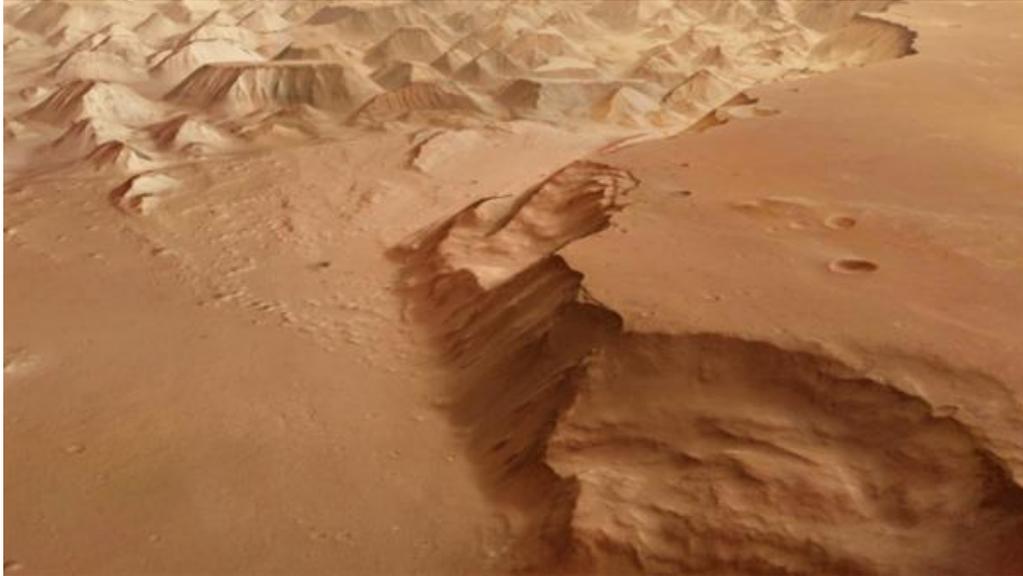
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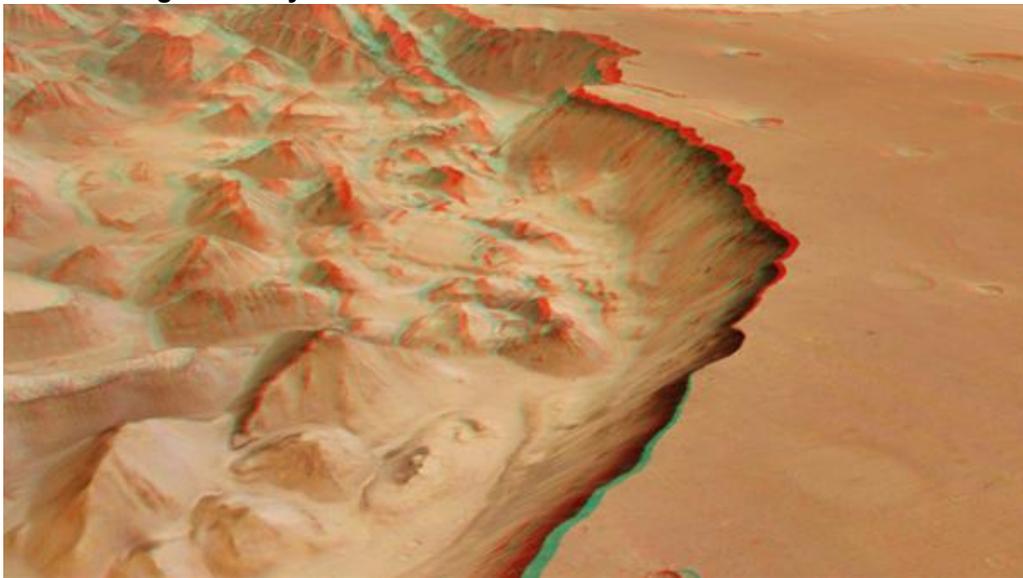
Video: Flight over Hydrates Chaos on Mars



The data used to generate the simulated overflight were 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. Once again, image strips from orbit 18 - symbolically significant for the HRSC scientists - were edited and used for the animations and images shown here. Over 10 years ago, in January 2004, Mars Express flew over Hydrates Chaos during orbit 18. This was the third time that the HRSC camera had been switched on, and the images in the image strips, which were over 1000 kilometres long, were so spectacular that they were drawn on for publication of the first images from the successful ESA mission.

Credit: ESA/DLR/FU Berlin.

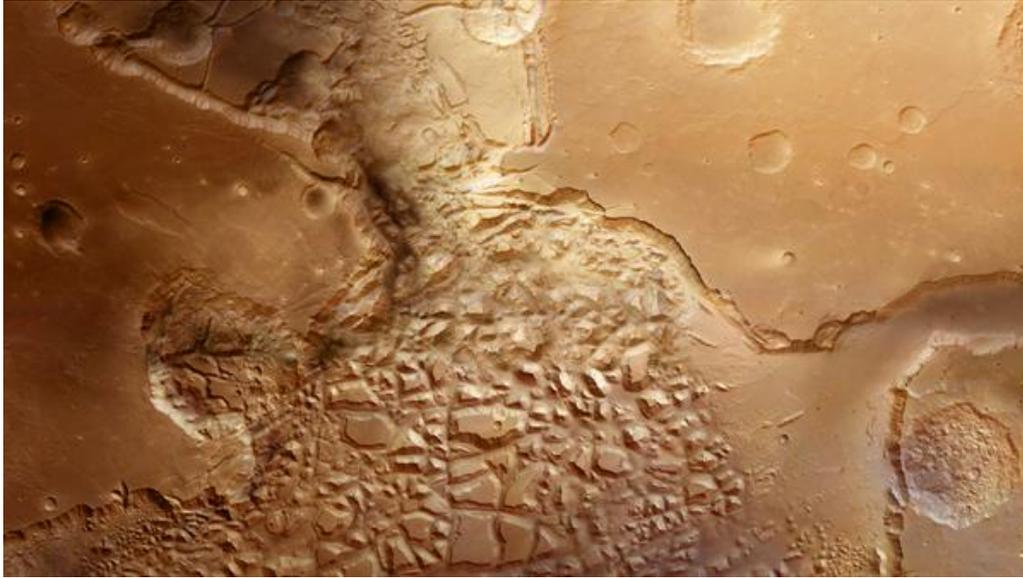
Video: 3D flight over Hydrates Chaos on Mars



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Credit: ESA/DLR/FU Berlin.

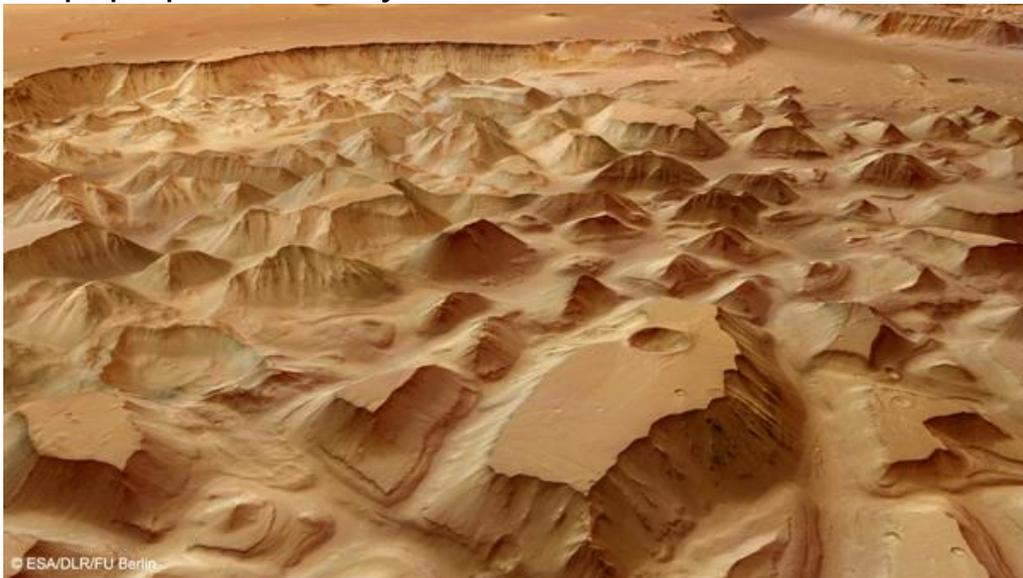
Colour plan view of Hydraotes Chaos



This colour plan view of Hydraotes Chaos clearly shows the slightly more than 2000-metre-deep valley where many mesas, buttes and hills are arranged in a seemingly chaotic way; these are the result of an intense erosion process. No comparable landforms are found on Earth. It is believed that water in the form of ice was stored in cavities beneath the surface of the highlands early in the history of Mars; this was then heated and thawed out. It was then placed under so much pressure that it escaped to the surface with great force through fissures and fault zones and the overburden collapsed in large slabs. As it flowed out, the water eroded the terrain and left behind the striking landscape visible today. North is to the right in the image. In the hi-res downloadable image, north is up. 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.

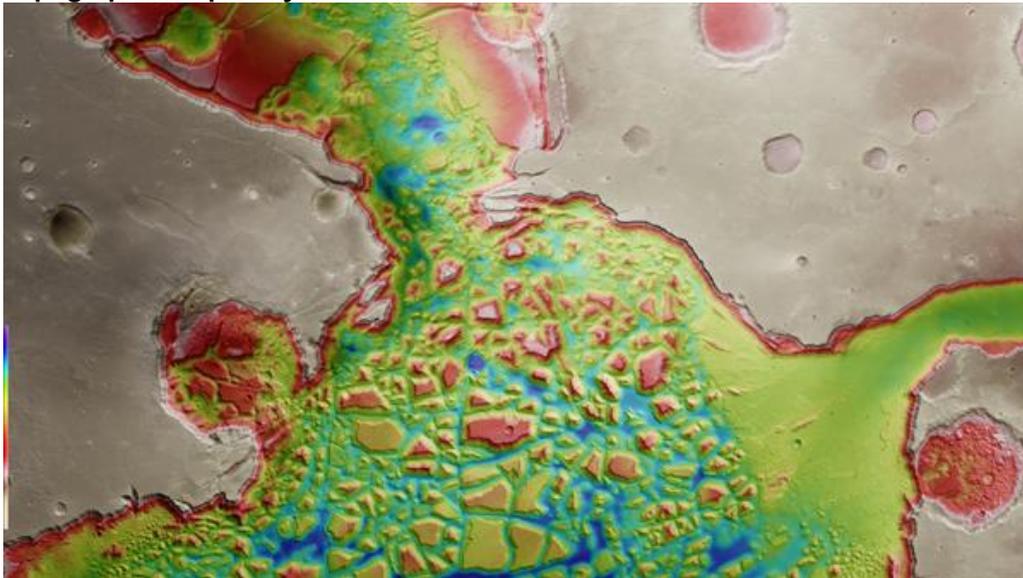
Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

Oblique perspective view of Hydraotes Chaos



The Hydraotes basin has a diameter of 420 kilometres. This oblique view, which was derived from image data acquired by the HRSC stereo channels, shows the structure of the numerous mesas, buttes and hills that resisted the erosive power of flowing water and today tower above the base of the valley. At the foot of some mesas, terraces and the remains of landslides are visible. In the background, the beginning of the Simud Valles outflow channel is 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.

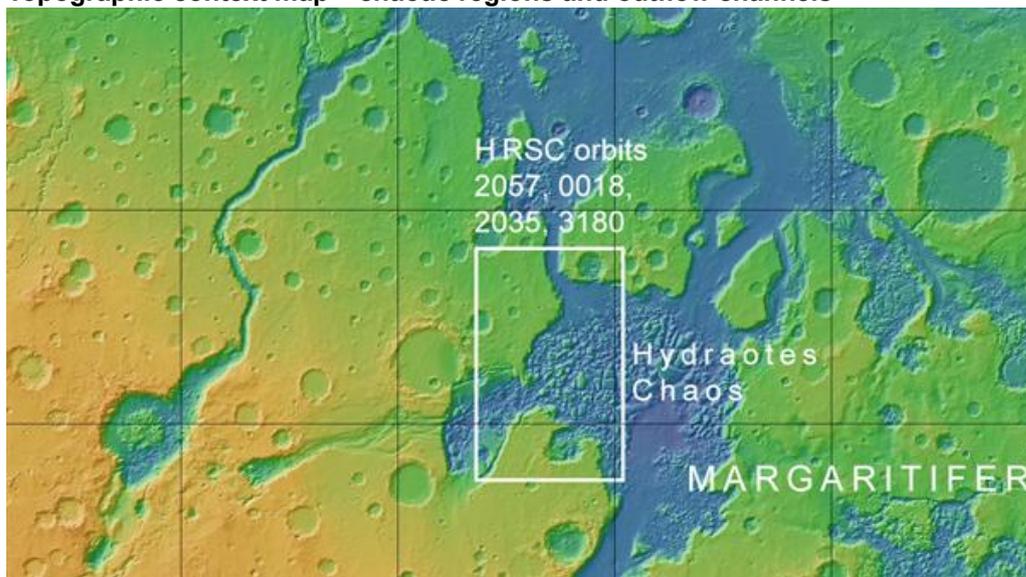
Topographic map of Hydrates Chaos



Terrain models can be derived from the stereo image data acquired by the HRSC camera system operated by DLR. 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. It is clear that the plateaus of the many mesas are remnants of the once continuous level of the surrounding Martian highlands in Hydrates Chaos. The mesas almost all have heights of between 1000 and 2000 metres. Also visible is the beginning of Simud Valles, a large outflow channel through which Hydrates drained to the north. The false colours indicate different heights; the scale is shown at the left of the image. North is to the right in the image. In the hi-res downloadable image, north is up. 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 context map – chaotic regions and outflow channels



At the eastern end of the Valles Marineris canyon system, there are numerous chaotic regions and some of the largest outflow channels on Mars. These were formed billions of years ago by huge masses of water flowing in the direction of the northern lowlands. The valley in which Hydrates Chaos is situated is approximately the size of southern Germany.

Credit: NASA/MOLA; FU Berlin.

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