Vast volumes of water once flowed in Ladon Valles

02 August 2012

On 27 April 2012, 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 acquired images of part of Ladon Valles. These images show an area north of the Holden and Eberswalde craters in Mars' southern highlands.

The overview map clearly shows that, at one time, substantial quantities of water flowed in a southerly direction, both along Ladon Valles and directly from the southern highlands, into an immense and ancient impact basin. A double crater lies on the northwestern edge of this old basin, a feature also easily identifiable in these images.

Sedimentary deposits provide evidence of water activity

Small watercourses that lead into the large impact crater can be seen to the west and above these two partially overlapping craters. To the east and below the Sigli and Shambe craters lies the mouth of Ladon Valles. Light-coloured sediments can be observed here and at isolated points further north. On closer scrutiny, light-coloured and striated sedimentary layers become visible. Studies indicate that these sediments are partly made up of clay minerals, formed through the influence of water. The presence of these minerals make it possible to conclude that liquid water was present in this area of the Martian surface for a relatively long period of time, most likely in the form of rather large enclosed bodies of water, such as a lake or a small landlocked sea. Extensive arc-shaped fracture structures along with smaller impact craters can be identified in the middle and right-hand area of this image. This most probably arose due to additional weight and the associated ‘compaction’ (compressive action) of large masses of sediment that built up in the impact basin, causing stresses in the crust.

The interconnected craters of Sigli (to the south) and Shambe (to the north) were probably formed almost simultaneously by a double impact. This double crater is also partially filled with sediments. In contrast to the larger impact crater, this feature has many fracture areas that were probably not caused by tectonic stresses in the Martian crust. Instead, this pattern is more reminiscent of desiccation cracking, albeit on a large scale, and may therefore be the outcome of what were once wet sediment layers drying out over an extended period of time. This caused their volume to decrease and, in turn, gave rise to expansion cracks.

Image processing and the HRSC experiment on Mars Express

These images were acquired with the HRSC system during Mars Express orbit 10,602. The image resolution is approximately 20 metres per pixel. These images show a section at 18 degrees south and 329 degrees east.

The plan-view colour image 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; 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 was 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

40 co-investigators from 33 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.

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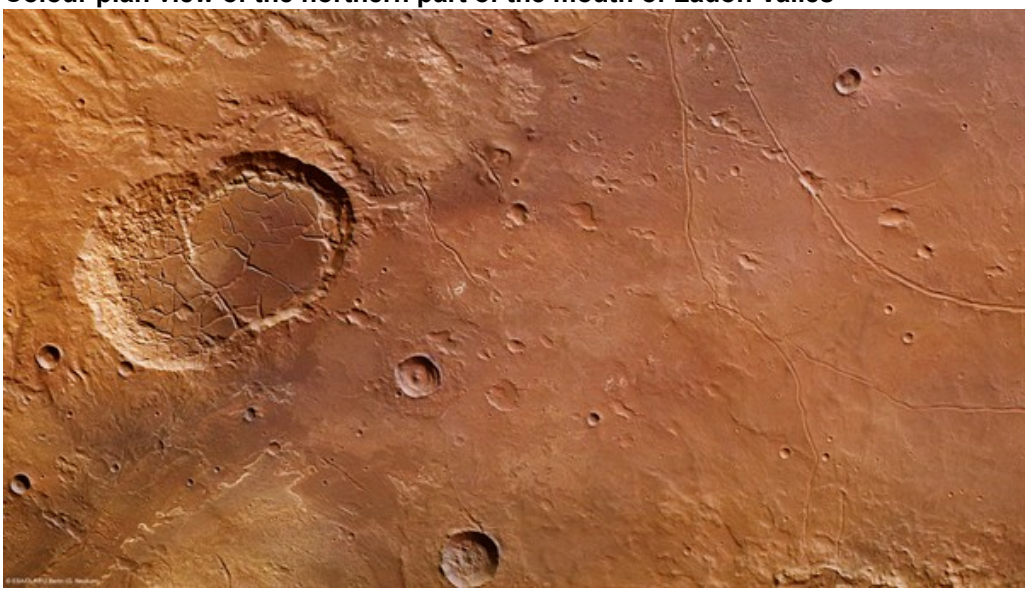
Colour plan view of the northern part of the mouth of Ladon Valles



This colour plan view was created by combining data from the nadir channel of the High Resolution Stereo Camera (HRSC) on board ESA's Mars Express spacecraft, which is directed vertically down onto the planet's surface, with data from the colour channels; north is to the right. The image covers an area of 22,500 square kilometers, roughly the size of New Hampshire. In this area, water has left many signs of its presence on the landscape, such as layers of sediment (lower left) and, on the lowland areas, sporadic light, almost white, deposits of minerals that formed in 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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Anaglyph image of the north of Ladon Valles with the craters Shambe and Sigli

Anaglyph images can be created using data acquired the nadir channel of the High Resolution Stereo Camera (HRSC) system, 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. Particularly striking are the two deep, overlapping craters in the Martian highlands, named Shambe (left, diameter 25 kilometres) and Sigli (diameter 30 kilometres). On the crater floors, deposits can be seen, which probably originated in standing water and are now covered with a pattern of cracks. In the right half of the image, in addition to scattered, smaller impact craters, extended arc-shaped fault structures are 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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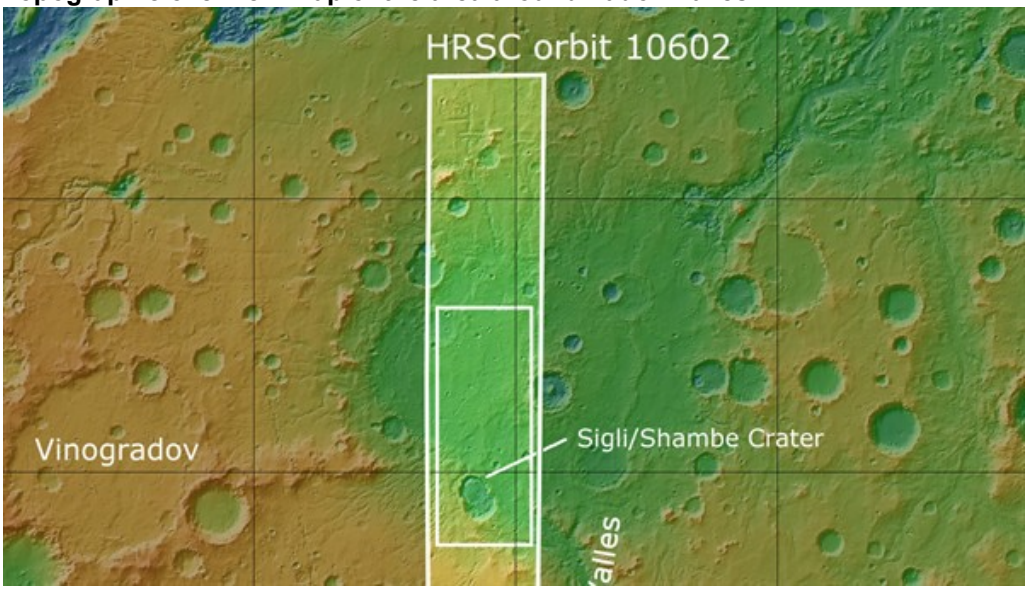
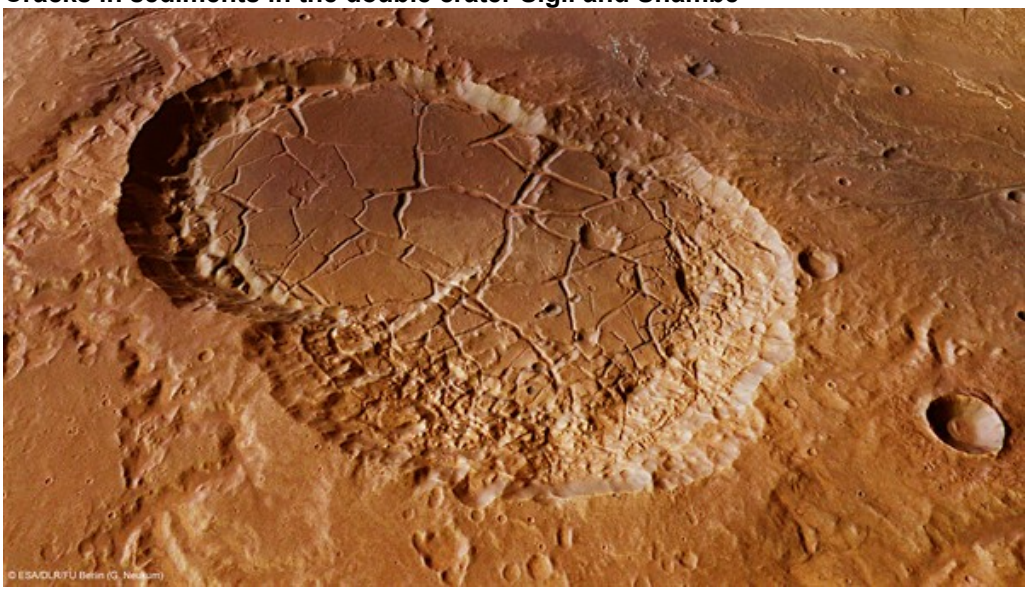
Topographic overview map of the area around Ladon Valles



Starting south of Holden Crater, a system of valleys and depressions extends over several hundred kilometres from the southern Martian highlands towards the north. Already, in this overview map, it can be seen that water flowed through valleys such as Ladon Valles into a large, ancient and already heavily eroded impact basin. On 27 April 2012, the High Resolution Stereo Camera (HRSC) operated by DLR on board ESA's Mars Express spacecraft acquired images of the northern part of the mouth of Ladon Valles and the double crater Sigli / Shambe during orbit 10,602 from an altitude of about 480 kilometres. The features depicted in the other images presented here are located in the small, inner rectangle.

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

Cracks in sediments in the double crater Sigli and Shambe



At the edge of Ladon Valles, close to the transition between the Martian highlands and the northern plains, large amounts of water flooded through a narrow valley and into a vast and ancient impact basin during an early period of Mars' history. Sediments were deposited by this water In Sigli and Shambe, two smaller, overlapping impact craters in the west of Ladon Valles. A pattern of cracks can be observed in the surface of the sediment. These could have been formed by a process similar to desiccation cracking on Earth, and ice may have played a role in their creation. Shambe, the crater in the foreground has a diameter of 35 kilometres and is named after a historic city in Sudan. Sigli is named after a town in Indonesia and has a diameter of 30 kilometres. 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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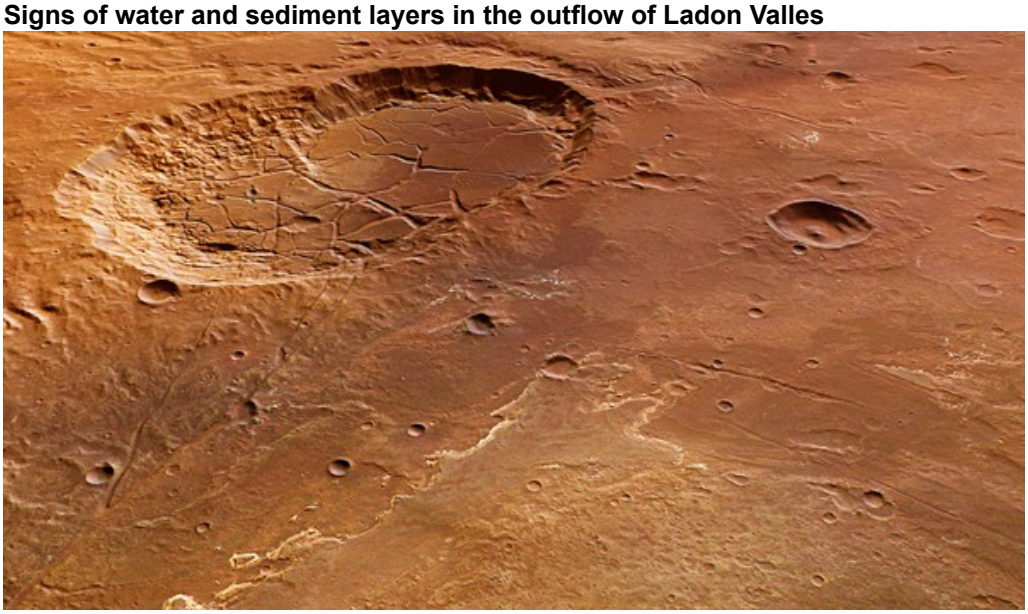
Signs of water and sediment layers in the outflow of Ladon Valles



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 view from the southwest shows the mouth of Ladon Valles (foreground), from which large quantities of water flowed onto a low-lying plain, depositing layers of sediment. Near the boundary of the outflow, bright material can be seen that is thought to consist of minerals that formed in either standing or flowing water. In the background, the two overlapping craters Shambe (left, diameter 35 kilometres) and Sigli (30 kilometres) also have sediments deposited

on their floors. 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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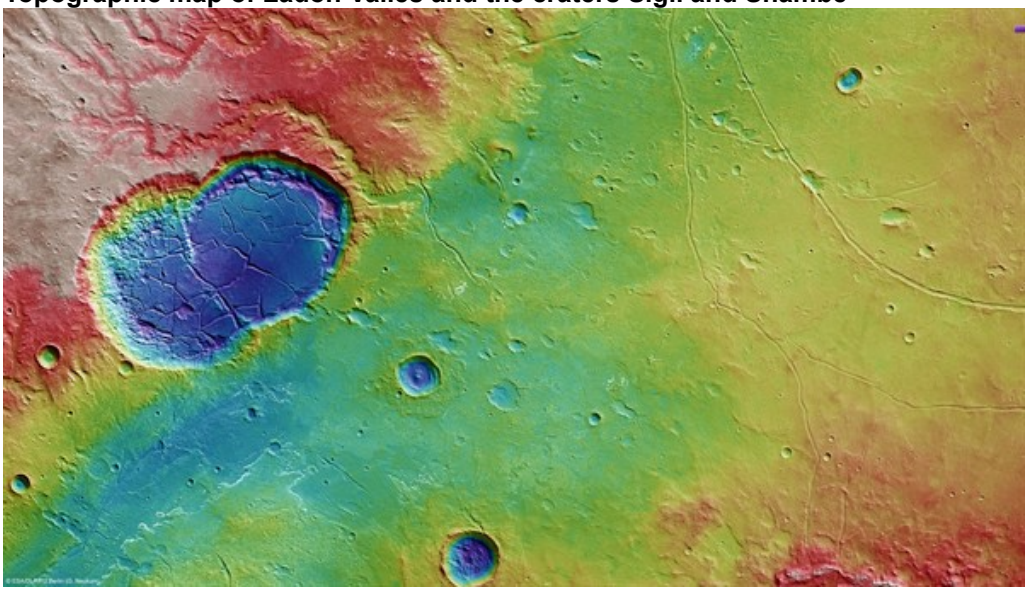
Topographic map of Ladon Valles and the craters Sigli and Shambe



In this image we can see numerous signs that, during an early period of Mars' history, water flowed both in the lowlands of an ancient, already heavily eroded impact basin that Ladon Valles opens out to (lower left), and in the adjacent uplands. In the elevated areas in the southeast (top left), meandering river beds have been carved. The two deep, overlapping craters Sigli and Shambe (left) were filled with standing water. 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 top right of the full 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 area shown is about 225 by 100 kilometres. 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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