Seeing Hellas Planitia

14 August 2014

When looking at Mars through a telescope, once does not usually recognise many landscape features – especially since observations are often affected by dust storms that rage in the Martian atmosphere. The Hellas Planitia impact basin is, however, visible as a large, light, almost circular area in the southern hemisphere. Images of the deepest parts of this impact basin – with unusually great visibility – have now been 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.

The Hellas basin was formed when a huge asteroid, probably well over 100 kilometres across, impacted the young Martian crust. That happened about 4.1 billion years ago, towards the end of the Noachian period, which lasted until about 3.7 or 3.8 billion years before our time. During this period, the greatest number of asteroid impacts occurred on the Solar System's inner planets. This is clear from the numerous circular, dark volcanic rock-filled craters on the near side of the Moon. Even Earth was not spared from these heavy cosmic collisions during the 'Late Heavy Bombardment'. The dynamic nature of Earth's crust has long erased all traces of these impacts. With a diameter of roughly 2200 kilometres, together with the South Pole-Aitken basin on the far side of the Moon and the Valhalla basin on Jupiter's moon Callisto, Hellas is one of the largest impact scars in the Solar System.

Water could be stable at the bottom of Hellas

Today, Hellas Planitia is the deepest preserved impact basin on Mars. An altitude of more than 4000 metres separates the floor of the basin from the edge of the innermost of several concentric crater-ring mountains. Moreover, the altitude difference reaches an overwhelming 9000 metres to the peaks of the outermost mountain ranges of the crater rings formed by the impact. Over time, the interior of Hellas Planitia has been greatly altered by geological processes. The wind has blown dust into the basin, glaciers and streams have transported and deposited sediment, and volcanoes have built up layers of low-viscosity lava on the floor of Hellas. Despite its exposure to erosion and coverage by deposits for a long period of time, it is the best-preserved large impact basin on Mars.

The deepest points of Hellas are located in the western part, shown here in the HRSC images acquired on 17 December 2013 during Mars Express orbit 12,690 at 57 degrees east and 33 degrees south. The good visibility conditions from orbit on this day are uncommon because, usually, fierce dust storms that blow from the highlands and the arc of mountains over the plain of Hellas produce a haze of dust and aerosols that partially obscures the surface. At the deepest points of Hellas, the atmospheric pressure is almost twice that at ground level in the adjacent Mars highlands. At times, the pressure and temperature conditions are sometimes above what is known as the 'triple point' of water, so that in some places, water on the surface could be stable. At higher elevations on Mars, water rapidly 'evaporates' due to the low atmospheric pressure.

The HRSC image data was first processed at the DLR Institute of Planetary Research and the images were prepared by scientists from the Planetary Science and Remote Sensing Department of the Free University of Berlin to produce the results shown here.

Glaciers with thicknesses of up to 450 meters suspected

The form and shape of many landscape features in Hellas Planitia suggest that ice and glaciers have had an effect on the interior of the basin – and perhaps still exist under the thick dust cover. Radar measurements with the SHARAD instrument on board the NASA Mars

Reconnaissance Orbiter (MRO) suggest that under the elongated, sinuous debris and rubble structures, glaciers with a thickness of up to 450 metres are still hidden from the gaze of the camera in several smaller craters in Hellas. Large-scale analysis of the images suggests that a thick layer of dust could be covering the entire area. An old crater, 40 kilometres across, in the southern (left) half of the images can only be recognised from its outlines; it has probably been filled by lava flows, whose flow fronts extend from east to west through the centre of the image.

In the images, two other, clearly better preserved, craters are visible; the larger of the two has a diameter of about 25 kilometres. What is striking is the unusual morphology of the craters and their surrounding areas. From the north (top right in images 1, 3 and 4, and top left in image 2) a thick band that looks like a dust covered fire hose extends up to the crater rim. There is a similarly patterned, oval-shaped structure inside the larger crater. At the southern edge of the crater, there is material whose surface shows flow structures. On closer inspection, it indicates the flow direction that ran parallel to the edges of these structures. It is very likely that debris and rubble-covered glacial ice has produced these phenomena. Looking at image 3 with 3D glasses, you can also recognise layers in the crater edges.

Image processing

The image data were acquired with the High Resolution Stereo Camera (HRSC) during Mars Express Orbit 12,690 on 17 December 2013. The image resolution is approximately 15 metres per pixel. The colour plan view (image 1) was created using the nadir channel, which is directed vertically down onto the surface of Mars and the colour channels; the oblique perspective view (image 2) was calculated from data acquired by the HRSC stereo channels. The anaglyph (image 3), which gives a three-dimensional impression of the landscape when viewed with red-blue or red-green glasses, was derived from data acquired by the nadir channel and one stereo channel. The colour-coded plan view (image 4) 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 the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; 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 11 countries. The camera is operated by the DLR Institute of Planetary Research in Berlin-Adlershof. The images presented here were created by the Planetary Sciences Group at the Freie Universität Berlin.

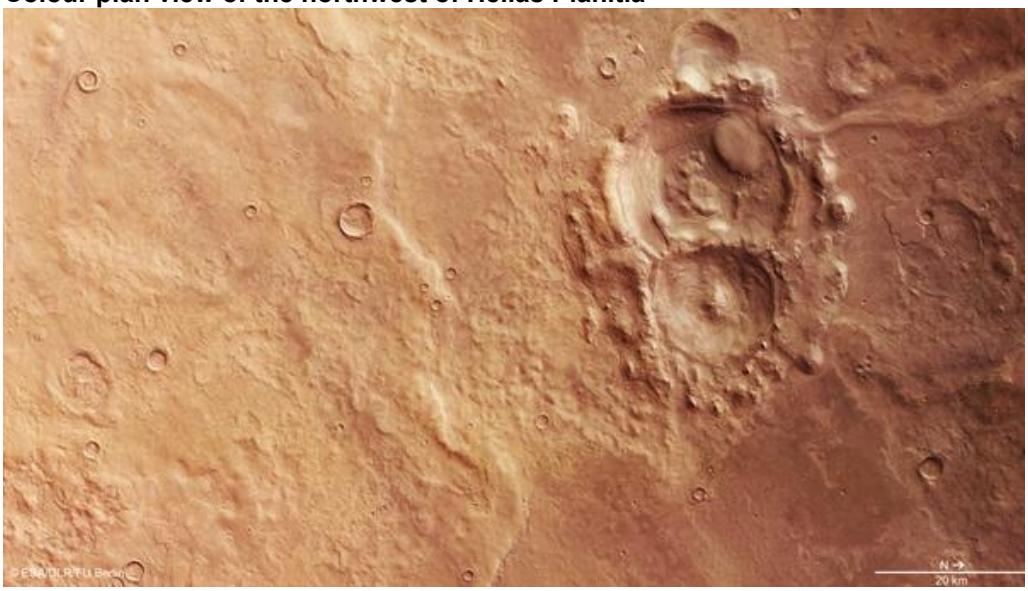
Contacts

Elke Heinemann
German Aerospace Center (DLR)
Corporate Communications
Tel.: +49 2203 601-2867
Fax: +49 2203 601-3249
elke.heinemann@dlr.de

Prof.Dr. Ralf Jaumann
German Aerospace Center (DLR)
Institute of Planetary Research, Planetary Geology
Tel.: +49 30 67055-400
Fax: +49 30 67055-402
Ralf.Jaumann@dlr.de

Ulrich Köhler
Deutsches Zentrum für Luft- und Raumfahrt (DLR) - German Aerospace Center
Tel.: +49 30 67055-215
Fax: +49 30 67055-402
ulrich.koehler@dlr.de

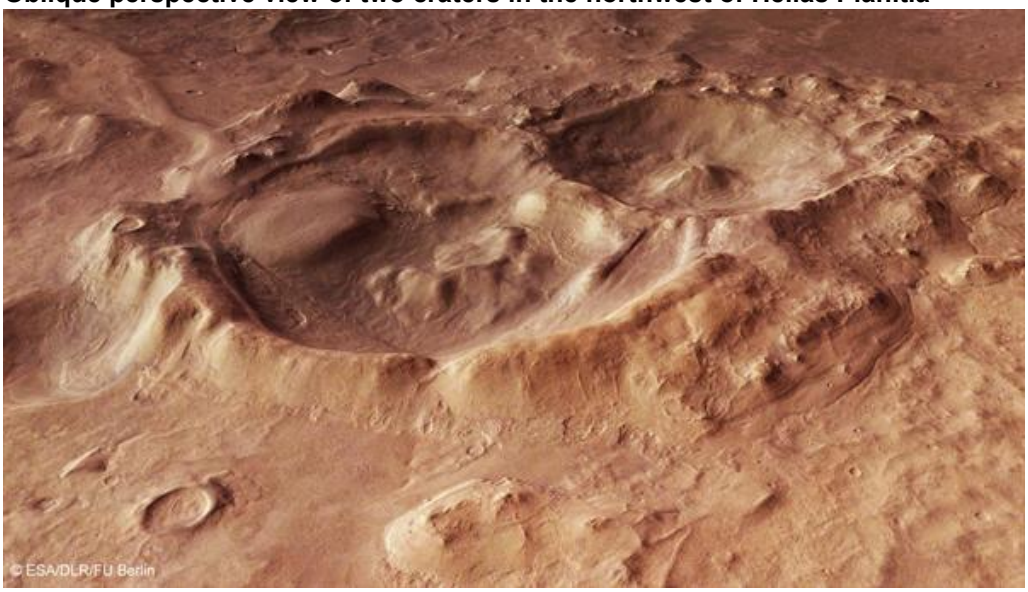
Colour plan view of the northwest of Hellas Planitia



Through a telescope, Hellas Planitia is one of the few structures that can be identified relatively easily. The more than 2000-kilometre-wide and up to eight-kilometre-deep basin stands out because of its strikingly light colour, which can be seen on the left side of the image. Over time, winds have brought large amounts of dust into the basin from the Martian Highlands, deposited it there and covered the plain with a light coat of dust. 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 two craters in the northwest of Hellas Planitia



The influence of ice and glaciers on the shape of the landscape can be seen in two unnamed craters in Hellas Planitia. In the background, an elongated ‘hose’ covered by rubble and dust stretches from the higher-lying areas in the 4000-metre-high edge of Hellas in the northwest in the direction of the larger crater. In the interior of this crater, an unusually shaped deposit area can also be seen – both these features probably date back to the flow of glacial ice. Glacial flow

structures are also visible at the crater edges in the foreground. 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.

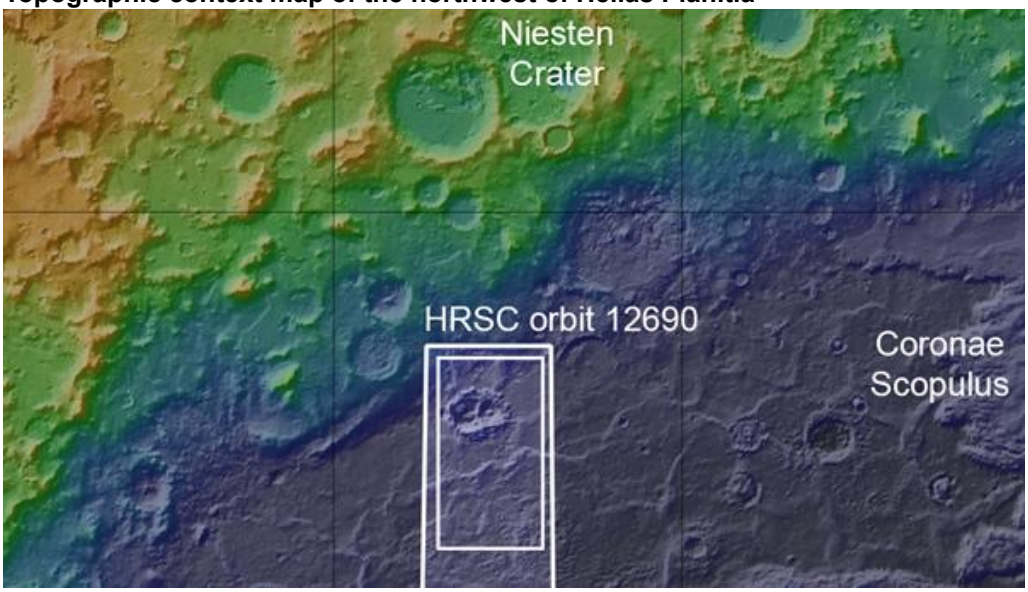
Credit: ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO.

3D view (anaglyph image) of the northwest of Hellas Planitia

Anaglyph images can be created using data from the nadir channel of the HRSC camera system operated by DLR, which is oriented perpendicular to the surface of Mars, and one of the four stereo channels, providing realistic, three-dimensional views of the landscape using red-blue or red-green glasses. Upon closer inspection of the double crater, the morphology of various unusual glacial structures can be seen in the right half of the image. 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.

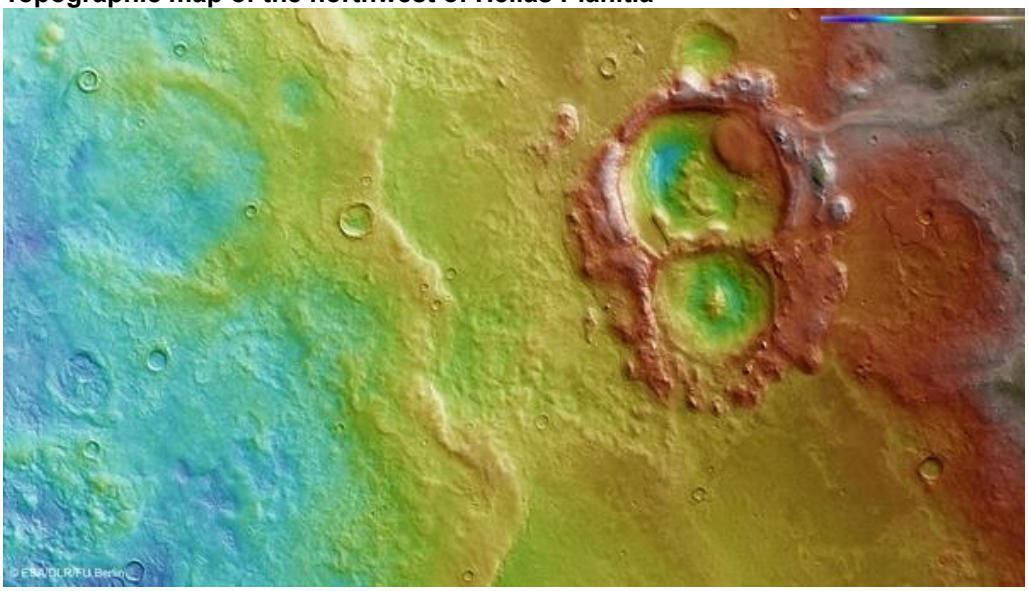
Topographic context map of the northwest of Hellas Planitia



Hellas Planitia is the best preserved and largest known impact basin on Mars. It has a diameter of roughly 2200 kilometres. At its deepest points, the bottom of Hellas is 8000 metres below the level of the Martian southern highlands. The HRSC stereo camera, operated by the DLR on board ESA's Mars Express spacecraft, imaged the northwest of Hellas in exceptionally good atmospheric conditions on 23 December 2013.

Credit: NASA/JPL/MOLA; FU Berlin.

Topographic map of the northwest of Hellas Planitia



Topographic terrain models are 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. In these, even small differences in height can be shown and subtle terrain levels detected such as, for example, a striking flow front of a large solidified lava flow which, coming from the South (left) has come to a standstill roughly in the centre. Unusual structures extend in the direction of two craters from the more than 1000-metre-higher regions in the North, which are probably of glacial origin. 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.

Contact details for image and video enquiries as well as information regarding DLR's terms of use can be found on the DLR portal imprint.