Mars Express mission extended until the end of 2018

18 December 2014

It follows an elliptical orbit around Mars, undisturbed, almost lonely – the orbiter Mars Express. For 11 years now – to be precise since Christmas Eve 2003 – the first and, for some time now, European Space Agency longest-serving interplanetary mission has been travelling around our planetary neighbour. ESA recently extended the mission by two years, until 2018. This will give the High Resolution Stereo Camera (HRSC)), operated on board Mars Express by the German Aerospace Center (Deutsches Zentrums für Luft- und Raumfahrt; DLR), numerous additional opportunities to record the entire surface of Mars in high resolution, colour and, above all, in 3D.

HRSC is the longest-serving German experiment in the Solar System

Mars Express carries seven scientific experiments on board. One of them is the HRSC, developed by DLR and built in collaboration with German industry partners. It reliably delivers three-dimensional data to help provide answers to scientific questions. Additionally, the experiment seeks to produce the first global, topographical image map of Mars. The nine HRSC channels (one nadir channel pointing straight down on the surface of Mars, also four colour and four stereo channels) produce image resolutions of up to 10 metres per pixel, depending on the distance to the planet's surface.

Over 90 percent of the Martian surface has been recorded since 2004 – roughly two thirds in the highest possible resolution. Planetary geodesy researchers at the DLR Institute of Planetary Research – responsible for operating the HRSC – use the stereo image data to calculate digital terrain models. Here, an areoid system, a model reference ellipsoid, is used to derive the elevation shown in each pixel. So far, the HRSC has been on active duty throughout 4165 orbits, recording the surface of Mars across a visual field extending for 50 by 200 kilometres.

At present, five orbiters circle Mars: besides Mars Express, we find NASA' s atmospheric research satellite MAVEN (in orbit since September 2014), the Mars Reconnaissance Orbiter (2006) and the Mission 2001 Mars Odyssey, the 'Methuselah' among the Mars spacecraft and MOM (Mars Orbiter Mission, or: Mangalayaan – ISRO [Indian Space Research Organisation], in orbit since September 2014). Then there is the Mars Science Laboratory, fitted to Rover Curiosity (busily exploring Gale Crater since 2012). But there is more. On the surface is the smaller NASA Rover Opportunity, which landed on the Red Planet just a few weeks after Mars Express arrived. It has also been operational for over 10 years, namely since January 2004 – clocking up over 40 kilometres of distance travelled, a new world record on a celestial body other than Earth itself. But it is Mars Express that holds the overall distance record around the Red Planet. In an elliptical orbit, with distances ranging between 240 and 11,000 kilometres from the planet's surface, it has travelled 400 million kilometres – and the spacecraft will fly its 13,936 orbit on Christmas Eve.

Animated HRSC stereo image data from Becquerel Crater

The film sequence shown here is based on HRSC image data taken from four overflights above Becquerel Crater, put together to form a mosaic (orbits 3253_1, 5368, 5350 and 5332). The average image resolution is approximately 17 metres per pixel. Planetary scientists at Freie Universität Berlin involved in the Mars Express mission used the HRSC image data to produce the animation.

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Becquerel Crater is located in the Arabia Terra region, the transitional zone from the Southern Highlands of Mars to its Northern Lowlands, and has a diameter of 167 kilometres. Like many other craters in this region, the interior of Becquerel shows interesting sedimentation phenomena. The light-coloured deposits in the centre of the crater, rising to form a larger mound, are particularly noticeable. They are reminiscent of the 5500-metre central mountain Aeolis Mons in Gale Crater, This is also the current location of the NASA rover Curiosity. Spectrometer measurements by the CRISM experiment on board the NASA Mars Reconnaissance orbiter show that this sedimentation consists of sulphurous rock, in which some of the minerals contain water, i.e. hydroxyl molecules (OH-), in their crystal structure. Back on Earth, most sulphate minerals of this kind – which include gypsum, for example – form as a residue when water evaporates.

The accumulation of these layered deposits in Arabia Terra indicates that the processes involved in the formation of this area must have stretched across wide expanses. The scientists can well imagine that a combination of material brought in by the wind – which may also have contained volcanic ash – and warm groundwater rising from depressions such as asteroid craters might have produced this sedimentation. The deposits seem to follow a certain rhythm, which may reflect seasonal variations or periodic changes in the inclination of the planet's rotational axis.

Attempts to explain these features are the subject of intense debate among scientists. It is very probable that water must have been present when the sedimentation formed. But the dearth of more precise analysis of these sulphate layers on Mars means that all eyes have now turned to Curiosity: the Rover may indeed deliver decisive information in the coming months when it begins analysing specimens of similar sediment layers on Aeolis Mons. Age determination based on crater size frequency measurements shows that the deposits are around 3.5 to 3.8 billion years old. This was a transitional phase in the history of Mars, when it changed to become the cold and dry planet we see today.

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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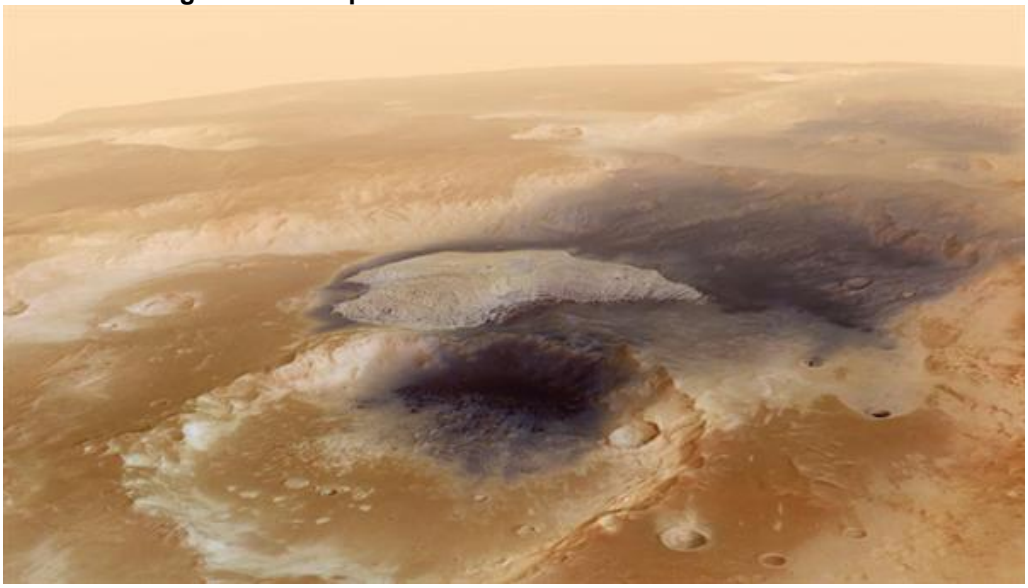
Animation: Flight over Becquerel Crater



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