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Parting ways with Vesta

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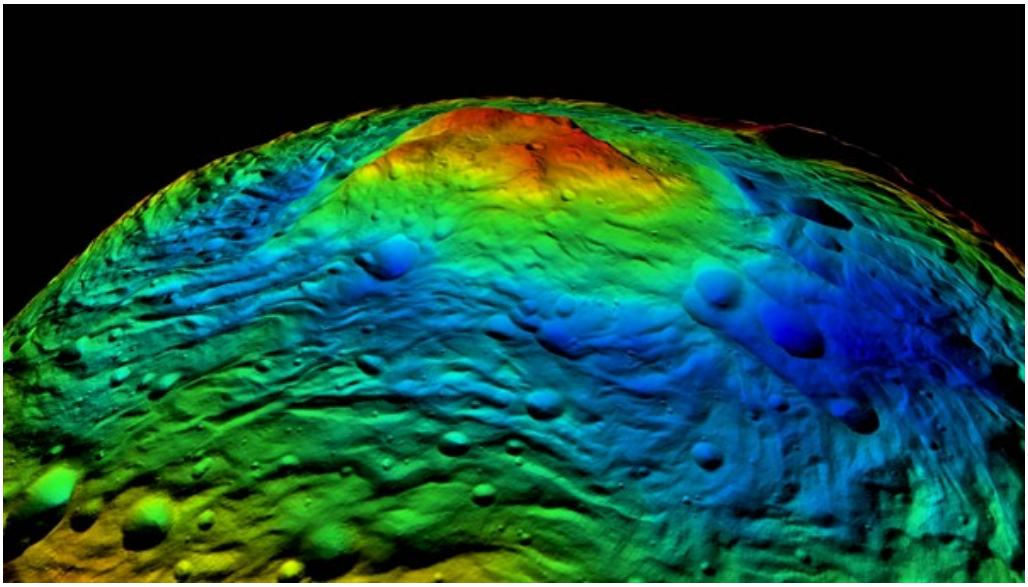
Dawn spacecraft on its way to Ceres, the largest asteroid to be explored

A giant impact crater on its south pole; deep grooves around its equator; dark material on the craters that puzzles planetary researchers; and a mountain more than twice the height of Mount Everest. The Vesta asteroid that the Dawn spacecraft has been orbiting since July 2011 with a German camera system on board has continuously been surprising scientists. "The expectations for this mission have been more than fulfilled," states planetary researcher Ralf Jaumann from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR). But it is now time to part ways; since early September, the spacecraft has been gradually leaving its orbit to continue its flight path to the dwarf planet Ceres. Beneath its icy crust clad in dark carbon-heavy compounds, scientists anticipate the discovery of an ocean of water.

The first image of the Vesta asteroid was acquired from a distance of 975,000 kilometres - at which time Vesta was only visible as a small dot. Since then, planetary researchers have been able to view Vesta from an altitude of just 175 kilometres and have gained some initial insights: "We know, for example, that Vesta is what we refer to as a differentiated body, akin to a planet structured in three layers - core, mantle and crust," explains Jaumann. Furthermore, the spectral signatures of the asteroid have confirmed that a certain rare kind of meteorite discovered on Earth originated on Vesta. Vesta's intrinsic features have succeeded in astonishing scientists: this celestial body has suffered two massive collisions at its south pole, which have created two enormous and overlapping basins. Round the Equator, collision impacts have formed a system of grooves or deep trenches. "It is very unusual for such major impacts to occur twice in the same location." But this remarkable fact also has implications for scientists and for their research: instead of viewing an intact crust, planetary researchers are able to look at an actual field of debris. "These collision impacts have destroyed the original crust, and the resultant debris has also covered parts of the intact crust," explains Jaumann. "We see eruptive masses that are barely one to two billion years old - and for planetary geologists, that is remarkably young. Debris and eruptive material spread almost right across the asteroid like a giant heap of rubble. We now need to reassemble this heap like we would a jigsaw puzzle."

Puzzle for the planetary researchers

The German camera on board the spacecraft acquired more than 28,000 images, which indicate the presence of dark material on and inside numerous craters. Where does this dark material come from? And what processes took place on Vesta in the past? "This observation yields many puzzles", states Jaumann emphatically. Even the large number of hydrogen protons that the scientists on the Dawn team discovered on Vesta throws up questions. Some could have reached Vesta through the solar wind - "but there are significantly more hydrogen protons on Vesta than we were expecting." The planetary geologists do not have any conclusive explanation for the different and, in some cases, very unusual crater shapes either. "We are only slowly gaining an understanding of all this."

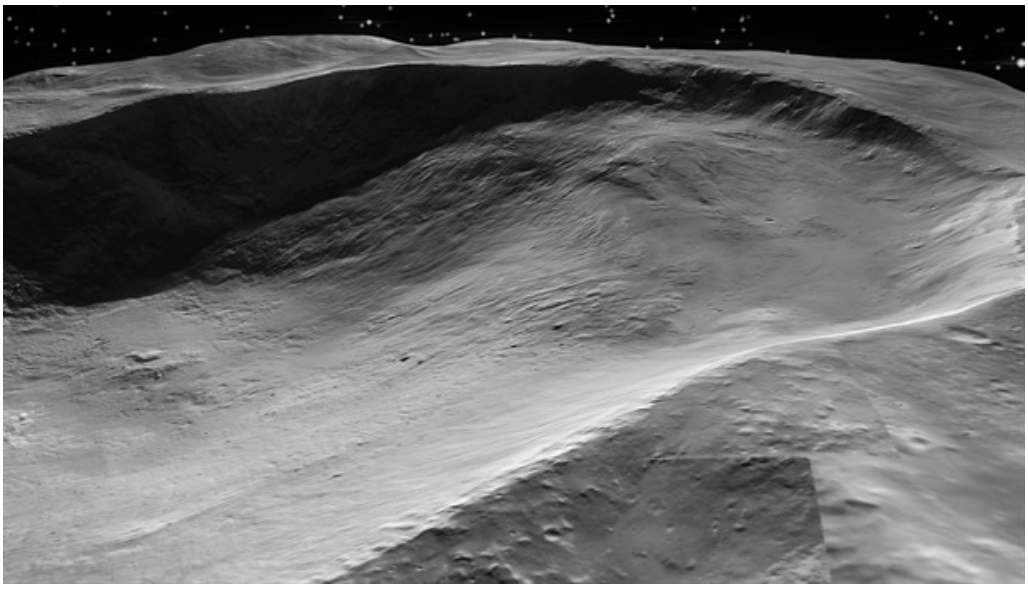


The Rheasilvia impact basin on Vesta's south pole. This false colour topographic map of Vesta's south pole shows parts of the 500-kilometre Rheasilvia impact basin in shades of blue. In the centre of the structure is a striking 20-kilometre high mountain shown in green, yellow and red tones. The global surface topographic model of Vesta was generated by DLR scientists using thousands of individual images through stereo photogrammetry. Credits: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

"Until Vesta's past can be explained, generations of researchers are going to be analysing the data that has been acquired," comments Jaumann. "So far, we have only scratched the surface." During the year that Dawn orbited Vesta, DLR researchers measured and mapped out its entire surface. Even though Vesta is smaller than a planet, the speed at which geologists, physicists and photogrammetrists at DLR completed this measurement task constitutes a record in its own right. Now the findings regarding the topography have to be considered in the context of results, for example in conjunction with gravitational and spectral measurements. "There are still many questions to which we have yet to find an answer."

Next target: Ceres

With the flight to Ceres, the largest asteroid discovered to date, and which was recently granted the status of 'dwarf planet' by the International Astronomical Union, a new chapter in the Dawn mission is opening. For the first time, a spacecraft will leave the orbit of one body to fly to another one and observe it from an orbital position. In February 2015, Dawn is scheduled to reach its new destination, 415 million kilometres from the Sun. Ceres is an object that could hardly be less similar to Vesta: while Vesta has a solid rocky crust, Ceres' internal rocky core is surrounded by an outer layer of ice. This layer might also contain water. It is even possible that this dwarf planet could have an incredibly thin atmosphere. "To date, no spacecraft has ever orbited a celestial body of this nature," states Jaumann emphatically.



Landslides in Marcia crater. Marcia is a 58-kilometre diameter crater near Vesta's equator. The topography of the crater is a bit unusual, as it does not have the typical bowl shape, like that of a crater

on the Moon. This is likely the result of mass movements in the interior of the crater. Material from Marcia's right edge slid to its interior, forming a shallower slope. The image shows details up to a size of 70 metres. Credits: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

The mission

The Dawn mission to Vesta and Ceres is managed by NASA's Jet Propulsion Laboratory (JPL) in Pasadena, which is a division of the California Institute of Technology, for NASA's Science Mission Directorate in Washington DC. The University of California, Los Angeles, is responsible for overall Dawn mission science. The camera system on the spacecraft was developed and built under the leadership of the Max Planck Institute for Solar System Research in Katlenburg-Lindau, Germany, with significant contributions from the German Aerospace Center (DLR) Institute of Planetary Research in Berlin and the Institute of Computer and Communication Network Engineering in Braunschweig. The Framing Camera project is funded by the Max Planck Society, DLR, and NASA/JPL.

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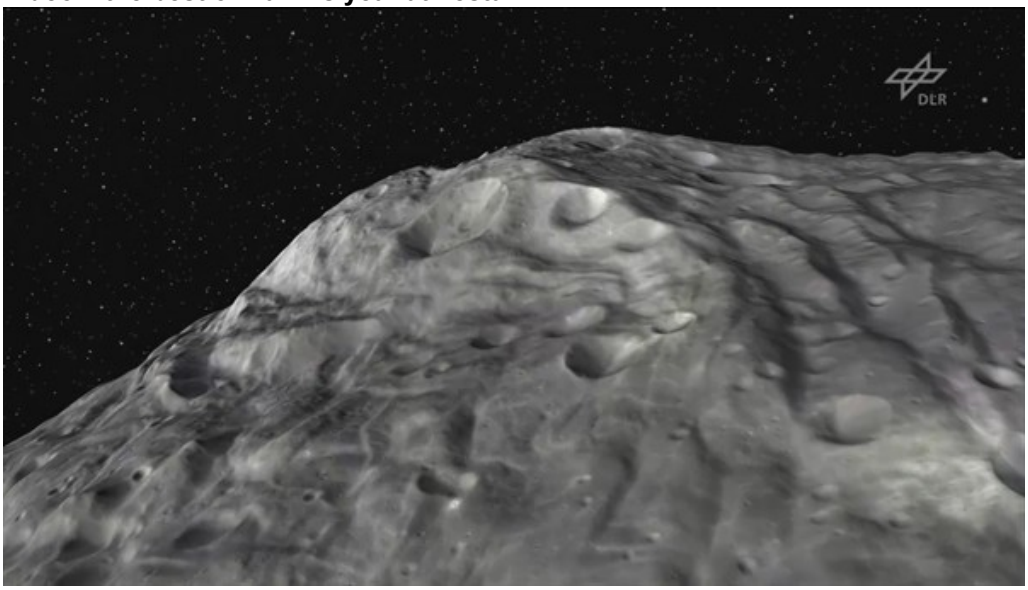
Video – the best of Dawn's year at Vesta



From the more than 28,000 images acquired by Dawn between July 2011 and August 2012, DLR scientists computed a global digital surface model of Vesta. Ralf Jaumann, head of DLR's Dawn scientific team, explains a few spectacular observations with the help of this virtual flight over Vesta. The animation was computed by DLR using the highest resolution images acquired on this mission, and shows details down to a size of just 70 metres.

Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

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