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Research into Venus: traces of a turbulent past

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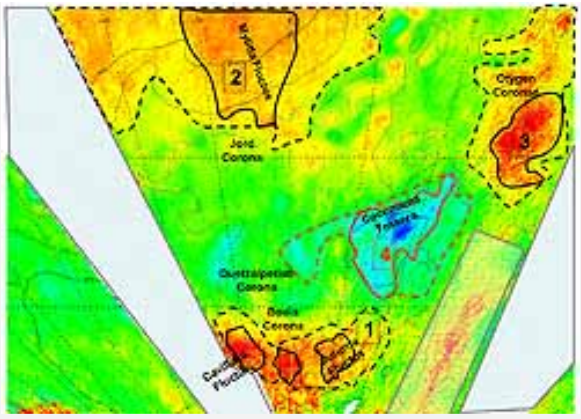


Temperature variations near the South Pole of Venus

Varying temperatures measured in the volcanoes of Venus give pointers to their history

As is the case on the Earth, the surface temperature on Venus changes in relation to topographical height: in the lowland plains, the temperature is higher, while in the mountains it is lower. Armed with the knowledge of how high a region is, it is possible to forecast the temperature there. In the Lada Terra uplands, close to the South Pole, it was possible to prove the existence of minor variations in the forecast temperature. Scientists from the German Aerospace Center (DLR) succeeded in this endeavour in collaboration with colleagues from Finland, Italy and France, using readings from the European Space Agency's Venus Express space probe. The researchers attributed these variations in temperature to differences in the composition of the solidified lava, which could be ascribed to the fact that the volcanoes were created at different times.

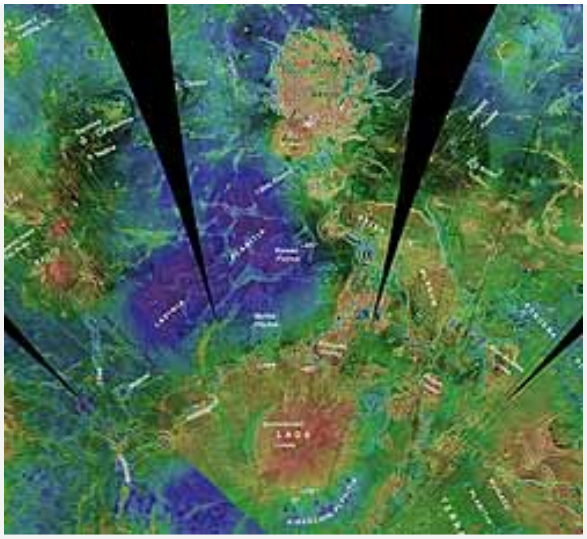
Once, lava flows with a length of almost 800 kilometres spread over the surface of Venus, an exotic, strange world, where today, across the entire planet, white-hot temperatures of around 460°C are no exception. No less exotic are the descriptions of the structures on Venus - without exception named after female figures from mythology with enchanting names such as Quetzalpetlatl Corona, Mylitta Fluctus or Cocomama Tessera. A group of European researchers is currently trying to shed light on the secrets of the surface temperature of our planetary neighbour.

The landscapes of Venus are characterised by igneous rock spewed out of giant volcanoes many hundred million years ago across surfaces so large that many of them are bigger than Germany. What is for sure is that the planet was radically transformed by a planet-wide volcanic catastrophe more than 500 000 000 years ago. Molten rock flowed out of several thousand volcanoes and cooled, covering all existing structures. The researchers are thus particularly interested in finding the answers to several questions: Are there still active volcanoes on this near planetary neighbour, or was the catastrophe that befell Venus one final, short-term volcanic event? Why on earth did this planet, superficially so similar to our own, develop so differently?

A Breath of Venus

Venus Express may have the answers to these questions. The probe is observing the planet from the safety of an orbital path. The volcanoes of Venus is a topic which has been occupying geophysicists Dr. Jörn Helbert and Nils Müller of the DLR Institute of Planetary Research. In collaboration with several research colleagues, they have, in part, been able to gain access to the volcanic history of a region on the southern hemisphere of Venus, and have now published their results in *Geophysical Research Letters*. As the planet is veiled in a dense atmosphere which fogs the conventional camera's view of the volcanic landscape, the research group is trying to detect Venus's secrets with an infrared spectrometer called VIRTIS (Visible and Infrared Thermal Imaging) on board Venus Express. In comparisons between the Earth and Venus, terms such as 'volcanic activity' and 'greenhouse effect' have an important role to play: a film showed these phenomena clearly. In the film, the DLR scientists Helbert and his French colleague Jean-Loup Bertaux, of the Centre National de la Recherche Scientifique in Paris, use terrestrial atmospheric and volcano phenomena to point out the similarities and differences between these two sister planets of the inner Solar System.

Temperature maps of the 'invisible' surface of Venus



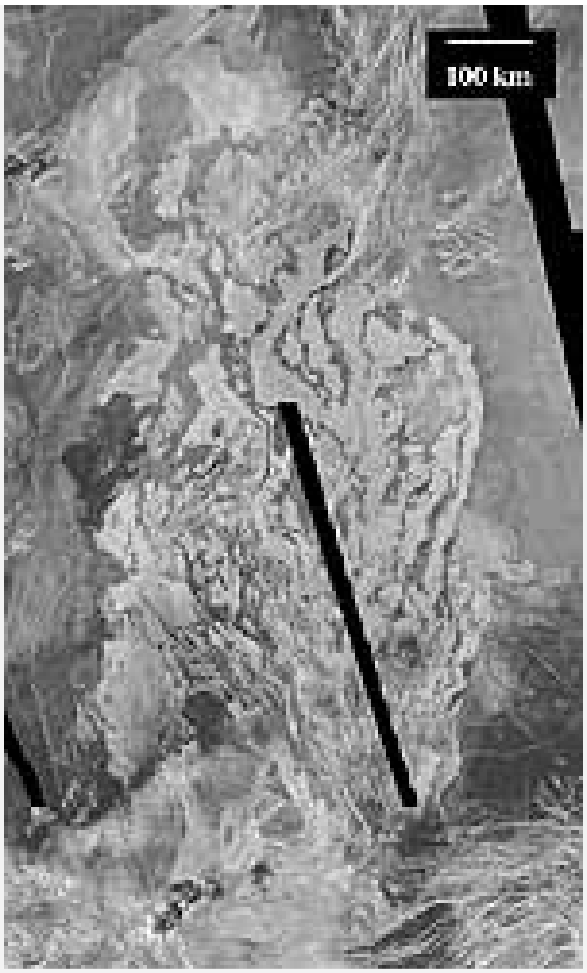
Topographical map of the southern hemisphere of Venus

For a little over two years, Venus Express has been observing the densely-clouded planet. "With the data we have gleaned, we have been able to map out the temperature differences throughout the southern hemisphere", explains Jörn Helbert, one of the scientists involved with the project under the auspices of the VIRTIS Spectrometer team. "This map makes it possible for us to see differences in the composition of the volcanic landscape; hence we can develop ideas about how they might have been formed." The VIRTIS experiment onboard Venus Express provides data which could answer many questions. For one thing, it is set up to analyse the structures and dynamics of the atmosphere of Venus to various extents over various wavelengths of visible light and infrared. Another aspect is the

possibility of 'seeing' the surface of Venus even in the very narrow wavelength bands of the electromagnetic spectrum between 1.0 and 1.2 µm (thousandths of a millimetre) through so-called 'atmospheric windows', avoiding the heat radiated by the hot rocks.

"The heat radiation which the sensors receive from the surface of Venus is, of course, significantly dispersed by the clouds. This 'noise' is a distortion of the original signal, and must first be disregarded in the measurements, which is quite a feat given the complexity of the atmosphere of Venus", explains Nils Müller, a member of Jörn Helberts' VIRTIS team at DLR. Once the researchers had sifted through the data for several months, searching for an interpretation, they began to recognise variations in the readings. These variations from the otherwise very homogenous average temperature on Venus correlated with significant geological structures mapped out using radar readings by NASA-probe Magellan in the 1990s.

Evidence of older and younger volcanoes, though not of active volcanic activity



Lava flows in the Mylitta Fluctus region

The data acquired by VIRTIS shows that the best-surveyed area stretches along the zero meridian from 50 degrees latitude south to near the South Pole. From the Lada Terra Highlands, it was possible to take a total of 297 infrared pictures in the course of two consecutive Venusian nights (or 243 days on Earth). "This enabled us to make the most detailed temperature map of this area to date", enthuses Helbert, "and if you take into account the topographical maps of the Magellan mission, then you can see that the anomalies in surface temperature really do match the contours of volcanic complexes in this region." From various heat rays, the scientists were able to unlock a range of material which could have been deposited at different times. It follows, then, that in the area studied, the structure of the Cocomama Tessera is probably the eldest, followed by the Quetzalpetlatl Corona volcanic complex, Otygen Coronae, and the Juturna Fluctus, and Mylitta Fluctus solidified lava flows.

"Nonetheless, we have two different explanations for the temperature differences observed relative to the previously calculated average values", explains Helbert. Firstly, the cause of the differences in temperature could be accounted for by the solidified lava flows; the lava comes, after all, from the depths of the planet and could have a different mineralogical or physical composition to native material on the surface. But it could also be the case that the differences observed are the result of millions of years of interaction with the aggressive atmosphere of Venus.

"The model in which the influence of the atmosphere plays the leading role has a number of limitations, so we tend to ascribe the various surface characteristics of the structures to an 'endogenous' cause: in other words, that their source can be found in volcanic processes", according to Helbert, "apart from which we will fortunately be receiving plenty new readings between now and the expected end of the Venus Express mission in May 2009 which may well help us to raise the veil on the secret of the volcanoes of Venus."

Origin of the names used in this article for structures on the surface of Venus

The names were given by the International Astronomical Union; source: US Geological Survey.

Quetzalpetlatl Corona:	Quetzalpetlatl is in the Aztec goddess of fertility; coronae (singular: *corona*, from the Latin for crown) are large, crown like volcanic features in the crust of Venus. They were probably created by plumes of rising hot material from the mantle which pushed the crust upwards into a dome shape, which then collapses in the centre as the molten magma cools and leaks out at the sides, leaving a crown-like structure: the corona.
Otygen Coronae:	"Mother Earth" in Mongolian mythology
Mylitta Fluctus:	Sumerian deity of the Moon and fertility; Fluctus designates solidified lava flows.
Juturna Fluctus:	Roman goddess of springs, consort of Jupiter.
Cocomama Tessera:	Peruvian Quechua goddess of happiness; a Tessera is an area of polygonal terrain.
Lada Terra:	Slavic goddess of love; the Terrae are major land masses on Venus.

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