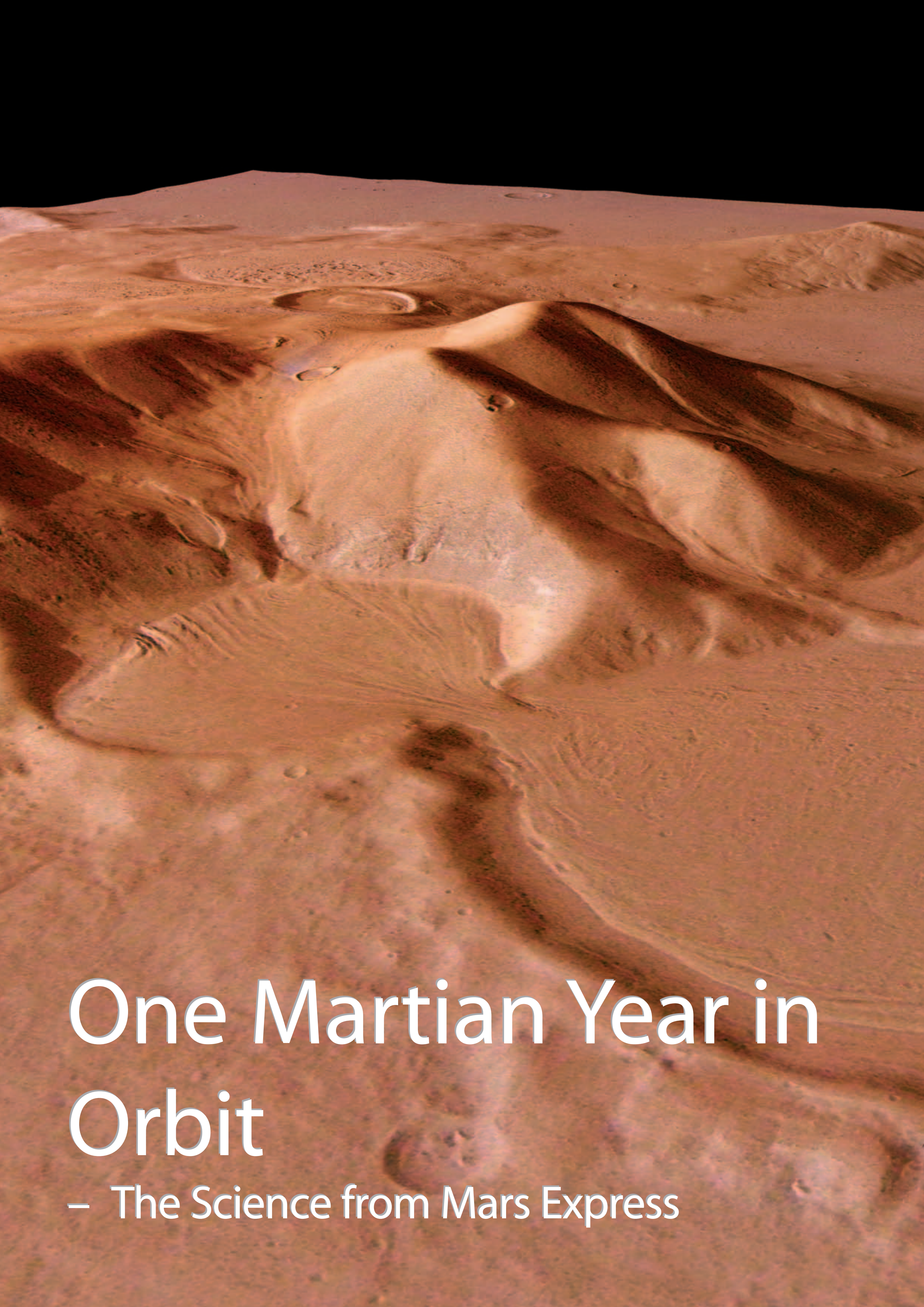

One Martian Year in Orbit

– The Science from Mars Express

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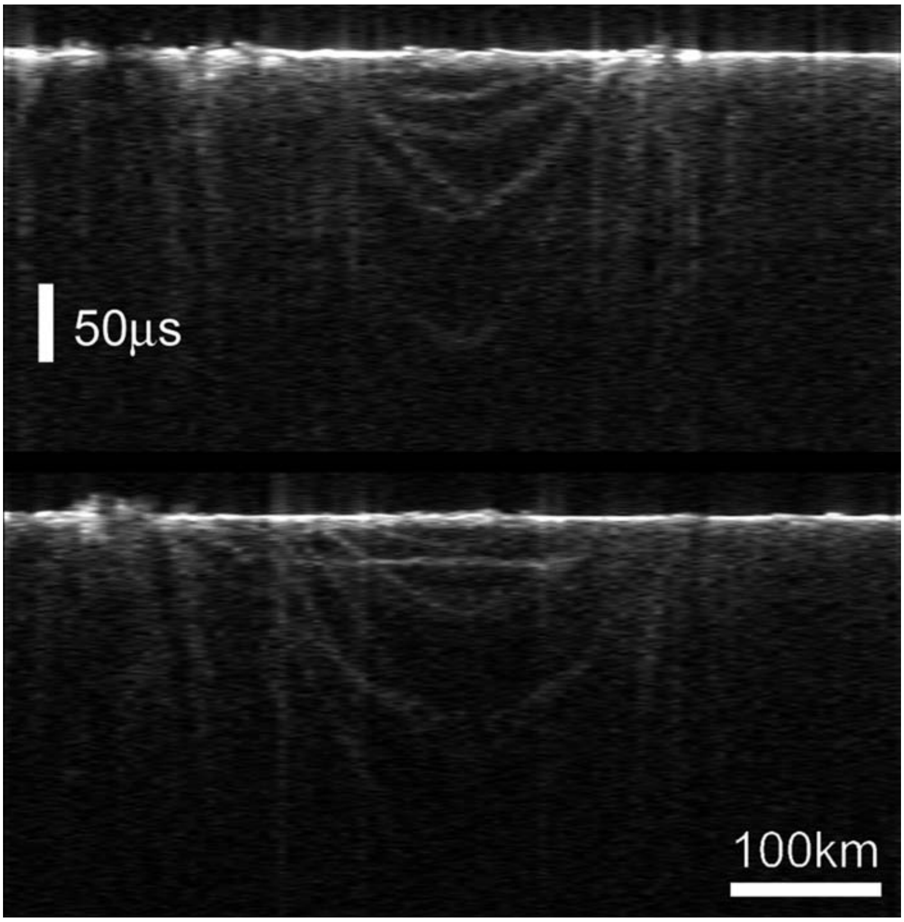
A perspective view from Mars Express's HRSC of an unusual 'rock glacier'. Ice-rich material seems to have flowed from a small, 9 km wide crater into a larger, 16 km wide crater below. The ice may have precipitated from the atmosphere only a few million years ago (ESA/DLR/FU Berlin/G. Neukum)

Mars Express, launched in June 2003 and in orbit around Mars since December that year, has been continuing its investigations, painting a new picture of the 'Red Planet'. This includes the first-ever probing below the surface of Mars, new geological clues with implications for the climate, newly-discovered surface and atmospheric features and, above all, the presence of abundant water ice on this world.

In November 2005 it was announced that information about the deep subsurface of Mars had, for the first time in the history of planetary exploration, been provided by the MARSIS radar. The subsurface of Mars had been so far unexplored territory.

First results revealed an almost circular structure, about 250 km in diameter, shallowly buried under the surface of the northern lowlands of the Chryse Planitia region in the mid-latitudes on Mars. Scientists have interpreted it as a buried basin of impact origin, possibly containing a thick layer of water-ice-rich material.

To date, the MARSIS team has not observed any convincing evidence for liquid water in the subsurface, but the search has only just begun. However, substantial quantities of liquid water must have been stably present in the early history of Mars, as OMEGA, the visible and infrared mapping spectrometer, is finding in many places, including abundant water ice in the polar caps.



Two MARSIS 'radargrams', spaced about 50 km apart, show echoes from a 250 km diameter circular structure in the subsurface of Mars, interpreted to be a buried impact basin. In the lower image, a linear reflector is seen parallel to the surface, which may come from the floor of the basin (ESA/NASA/ASI/G. Picardi)

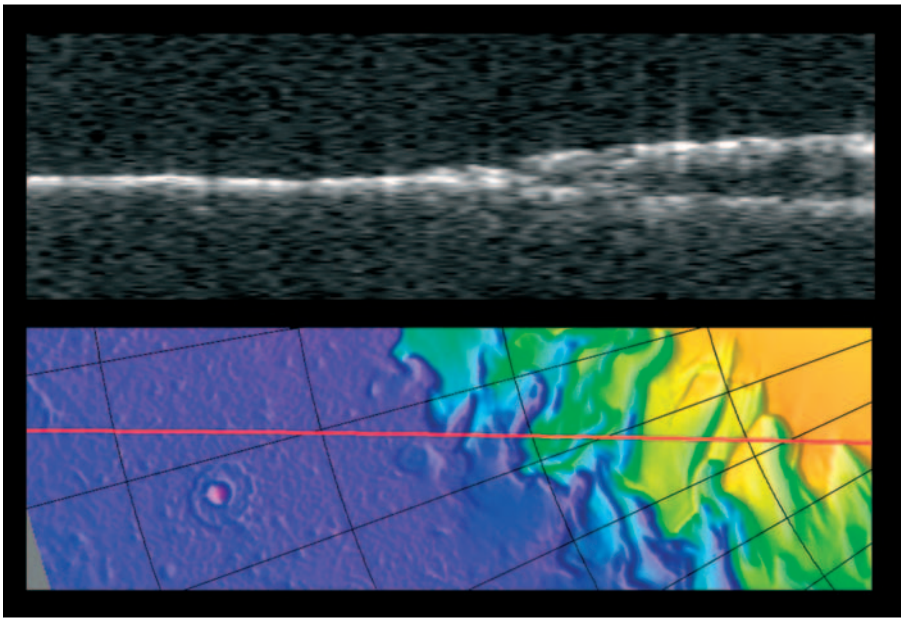
Data collected by OMEGA unambiguously reveals the presence of specific surface minerals that imply the long-term presence of large amounts of liquid water on the planet. This instrument has provided unprecedented maps of water and carbon dioxide ice in the polar regions, and determined that the minerals, alteration products such as phyllosilicates, correspond to abundant water in the early history of Mars, while other minerals, called post-Noachian products (sulphates), suggest a colder drier planet with only episodic water on the surface.

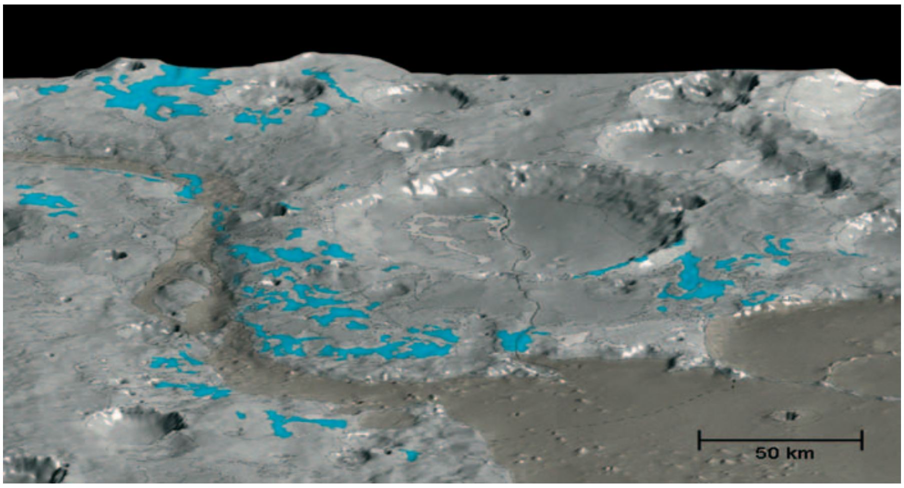
MARSIS has also performed its first sounding of the Martian ionosphere – the upper part of the atmosphere – and found a number of unexpected features. MARSIS scientists have discovered a number of oblique echoes, different from the vertical echoes normally expected from the upper interface of the ionosphere.

By comparing the MARSIS data with maps of the Martian crustal magnetic fields, scientists noted that the areas of ionosphere producing these echoes correspond to areas of strong magnetic fields in the crust of the planet.

A MARSIS radargram (top) of layered deposits at the Martian north pole. The lower image shows the groundtrack on a MOLA topographic map, covering an area 458 km wide and with 2 km elevation between the lowest surface (magenta) and the highest (orange).

The echo splits into two where the track crosses from the smooth plains onto the elevated layered deposits. The upper trace is the echo from the surface of the deposits. The lower trace is the boundary between the lower surface of the deposits and the underlying material. The material in between is thought to be nearly pure water ice, about 1.8 km thick (ESA/NASA/ASI/G. Picardi)





Over this HRSC perspective view of Marwth Vallis, OMEGA has mapped the water-rich minerals (blue). Ancient hydrated clay-rich minerals have been exposed by erosion, tracing an early era when water was present (ESA/OMEGA/HRSC/J.P. Bibring/G. Neukum)

Other unexpected echoes have also been recorded by MARSIS. For example, unusual reflections recorded in the night-side of Mars that would be impossible in a horizontally stratified atmosphere, may indicate the presence of low density 'holes' in the ionosphere, like those observed in the night-side of Venus.

Also in the ionosphere, the MaRS radio-science experiment has discovered a previously unseen third ionospheric layer. This layer, whose existence was predicted but not detected before, is non-continuous and sporadic. Scientists believe its origin may be due to the interaction of the ionosphere with incoming meteorites.

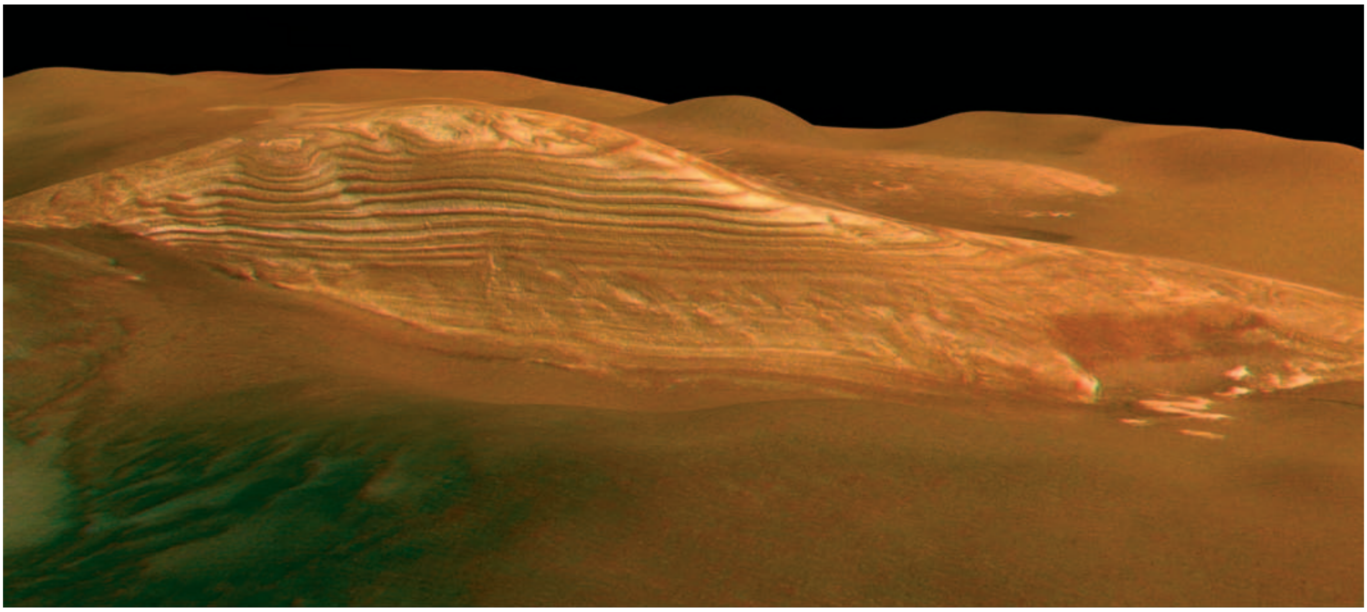
The HRSC has so far covered 25% of the Martian surface at a resolution of better than 20 metres per pixel, and over 50% at better than 50 metres per pixel, all in colour and stereo images. These spectacular images are shedding light on Martian climate history, for example, how the glacier remnants we see today were formed, and about the conditions on the planet when this happened.

SPICAM has provided the first complete vertical profile of carbon dioxide density and temperature and discovered the existence of ‘nightglow’ as well aurorae not just over the polar regions but also regions with paleomagnetic signatures.

The ASPERA instrument has identified solar wind scavenging of the upper atmosphere down to about 270 kilometres altitude as one of the main culprits of atmospheric degassing.

The PFS is now back in operation after a malfunction, reported a few months ago. The PFS was unable to produce scientific data from July to September 2005. A recovery was made possible by using internal instrument redundancy, and PFS started to take new measurements routinely in early November 2005.

The instrument had been successfully investigating the chemical composition of the Martian atmosphere since the beginning of 2004, when Mars Express began orbiting the Red Planet. It was the first instrument ever to make direct 'in situ' measurements of methane in the atmosphere of Mars, and provided first indications of traces of formaldehyde, both candidate ingredients for life.



Close-up HRSC perspective view of a 'sulphate' mountain in Juventae Chasma (ESA/DLR/FU Berlin/G. Neukum)