Study of clays suggests watery Mars underground

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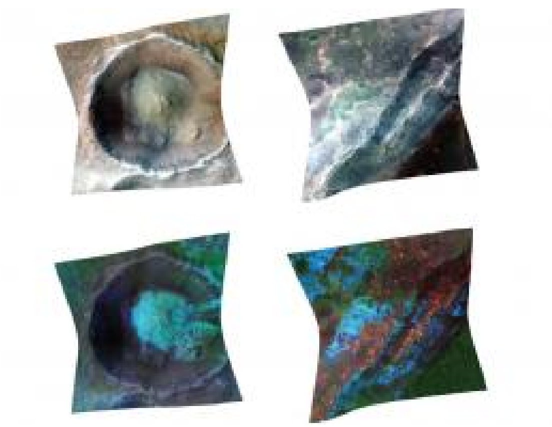

Impact cratering and erosion combine to reveal the composition of the Martian underground by exposing materials from the subsurface. Investigation of exposed clay minerals at thousands of Martian sites by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on NASA's Mars Reconnaissance Orbiter suggests a long period of wet, warm conditions, mostly underground. Infrared light indicates terrains of different composition in false-color infrared images (top) of a crater (left) and an escarpment (right). Each of the scenes is about 6 miles (10 kilometers) wide. The lower images of the same sites show how distinctive absorption bands permit identification and mapping of specific minerals. In the lower images, iron-magnesium clays are mapped in blue. These are the most common clays on Mars, occupying large sections of the deep crust and mostly formed by subsurface water. These clays are beneath unaltered volcanic layers that contain the mineral olivine (green). The site shown in the image on the right also contains aluminum clays (red), which formed by waters near the surface. These clays are uncommon on Mars but are sometimes located on top of iron-magnesium clays in a distinctive stratigraphy, indicating formation later in time. These two example sites, out of thousands where CRISM has observed clay minerals, are at 10.65 degrees south latitude, 98.22 degrees east longitude (left pair) and 22.06 degrees north latitude, 74.63 degrees east latitude (right pair). In the top two images, the false color comes from presenting observed brightnesses in three different wavelengths of invisible infrared wavelengths -- 2,529 nanometers, 1,506 nanometers and 1,080 nanometers -- as red, green and blue, respectively, composited into color images. In the bottom two images, colors are assigned to absorption-band characteristics: infrared frequencies at which the materials on the Mars surface are less bright compared to their brightness at other frequencies. The data presented as red are pixel-by-pixel absorption-band depths at 2,210 nanometers, the data presented as green are broad absorption-band depths near 1,000 nanometers, and the data presented as blue are the absorption-band depths at 2,300 nanometers. These color data were then overlain and merged with the brightness at 770 nanometers to show the relationship of detected minerals with underlying topography.Image credit: NASA/JPL-Caltech/JHUAPL

(PhysOrg.com) -- A new NASA study suggests if life ever existed on Mars, the longest lasting habitats were most likely below the Red Planet's surface.

A new interpretation of years of mineral-mapping data, from more than 350 sites on Mars examined by European and NASA orbiters, suggests Martian environments with abundant liquid water on the surface existed only during short episodes. These episodes occurred toward the end of a period of hundreds of millions of years during which warm water interacted with subsurface rocks. This has implications about whether life existed on Mars and how the Martian atmosphere has changed.

"The types of clay minerals that formed in the shallow subsurface are all over Mars," said John Mustard, professor at Brown University in Providence, R.I. Mustard is a co-author of the study in the journal *Nature*. "The types that formed on the surface are found at very limited locations and are quite rare."

Discovery of clay minerals on Mars in 2005 indicated the planet once hosted warm, wet conditions. If those conditions existed on the surface for a long era, the planet would have needed a much thicker atmosphere than it has now to keep the water from evaporating or freezing. Researchers have sought evidence of processes that could cause a thick atmosphere to be lost over time.

This new study supports an alternative hypothesis that persistent warm water was confined to the subsurface and many erosional features were carved during brief periods when liquid water was stable at the surface.

"If surface habitats were short-term, that doesn't mean we should be glum about prospects for life on Mars, but it says something about what type of environment we might want to look in," said the report's lead author, Bethany Ehlmann, assistant professor at the California Institute of Technology, Pasadena, and scientist at NASA's Jet Propulsion Laboratory, also in Pasadena. "The most stable Mars habitats over long durations appear to have been in the subsurface. On Earth, underground geothermal environments have active ecosystems."

The discovery of clay minerals by the OMEGA spectrometer on the European Space Agency's Mars Express orbiter added to earlier evidence of liquid Martian water. Clays form from the interaction of water with rock. Different types of clay minerals result from different types of wet conditions.

During the past five years, researchers used OMEGA and NASA's Compact Reconnaissance Imaging Spectrometer, or CRISM, instrument on the Mars Reconnaissance Orbiter to identify clay minerals at thousands of locations on Mars. Clay minerals that form where the ratio of water interacting with rock is small generally retain the same chemical elements as those found in the original volcanic rocks later altered by the water.

The study interprets this to be the case for most terrains on Mars with iron and magnesium clays. In contrast, surface environments with higher ratios of water to rock can alter rocks further. Soluble elements are carried off by water, and different aluminum-rich clays form.

Another clue is detection of a mineral called prehnite. It forms at temperatures above about 400 degrees Fahrenheit (about 200 degrees Celsius). These temperatures are typical of underground hydrothermal environments rather than surface waters.

"Our interpretation is a shift from thinking that the warm, wet environment was mostly at the surface to thinking it was mostly in the subsurface, with limited exceptions," said Scott Murchie of Johns Hopkins University Applied Physics Laboratory in Laurel, Md., a co-author of the report and principal investigator for CRISM.

One of the exceptions may be Gale Crater, the site targeted by NASA's Mars Science Laboratory mission. Launching this year, the mission's Curiosity rover will land and investigate layers that contain clay and sulfate minerals.

NASA's Mars Atmosphere and Volatile Evolution Mission, or MAVEN, in development for a 2013 launch, may provide evidence for or against this new interpretation of the Red Planet's environmental history. The report predicts MAVEN findings consistent with the atmosphere not having been thick enough to provide warm, wet surface conditions for a prolonged period.

Provided by JPL/NASA