Clay Studies Alter View of Early Mars Environment

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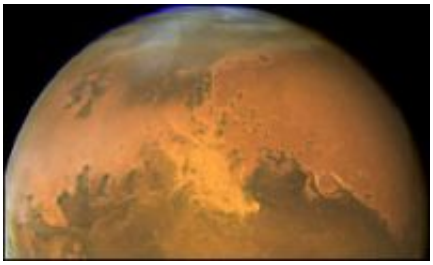

A study of the thermodynamics of clays found on Mars suggests that little carbon dioxide could have been present during their formation, which contradicts a popular theory of the early Martian atmosphere and will send researchers looking for other explanations for clay formation.

Vincent Chevrier of the University of Arkansas and François Poulet and Jean-Pierre Bibring of the Université Paris-Sud in Orsay, France, reported their findings in the journal *Nature*.

Gullies, valleys and clay formations found on Mars seem to point to a wet past for the Red Planet. Almost all clays formed on earth do so in the presence of water or under extremely humid conditions. These clay remnants of ancient Mars had previously led scientists to hypothesize that the earliest era on the planet, the Noachian period, had a carbon-dioxide-rich atmosphere that created a warm, wet surface with liquid

water -- ideal for creating clays.

Chevrier used thermodynamic calculations to examine possible historic conditions on the planet. These calculations look at the equilibrium conditions of the clay deposits on Mars with respect to different relevant other mineral phases -- carbonates, sulfates, iron oxides -- to extrapolate the surface environment at the time of their formation. He made the assumption that the clays would form on the surface of Mars in the presence of liquid water as they do on Earth.

In a carbon-dioxide-rich environment, clay formation would be accompanied by carbonate formation, but current studies of Mars have found no such compounds. Chevrier's calculations show that, given current conditions, the carbon dioxide pressure would have been low in the Noachian atmosphere.

"If you had a thick atmosphere of carbon dioxide, you should have abundant carbonates," Chevrier said. "So far no one has seen even a grain of carbonate."

Despite this evidence that carbon dioxide did not provide a warm, wet atmosphere, it is possible that other greenhouse gases, such as methane, helped create the ancient conditions that shaped modern-day Mars. It also is possible that impacts generated heat and energy that could have warmed the Mars surface, creating liquid water. However, both of these hypotheses present their own enigmas: If methane was present, where did it go? And how do you relate impacts to the formation of clays? On Mars, thousands of square kilometers are covered by clay deposits up to 100 meters thick - not the hallmark of a single impact event.

Another possibility is that some of these chemicals - the carbonates and the methane - may be present deep below the surface of Mars. To address the question of the underground presence of these materials will

require a Mars rover with a probe. Until then, the history of the early Martian atmosphere remains an enigma.

"Thermodynamics can give you the conditions, but not the process," Chevrier said.

Source: University of Arkansas

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