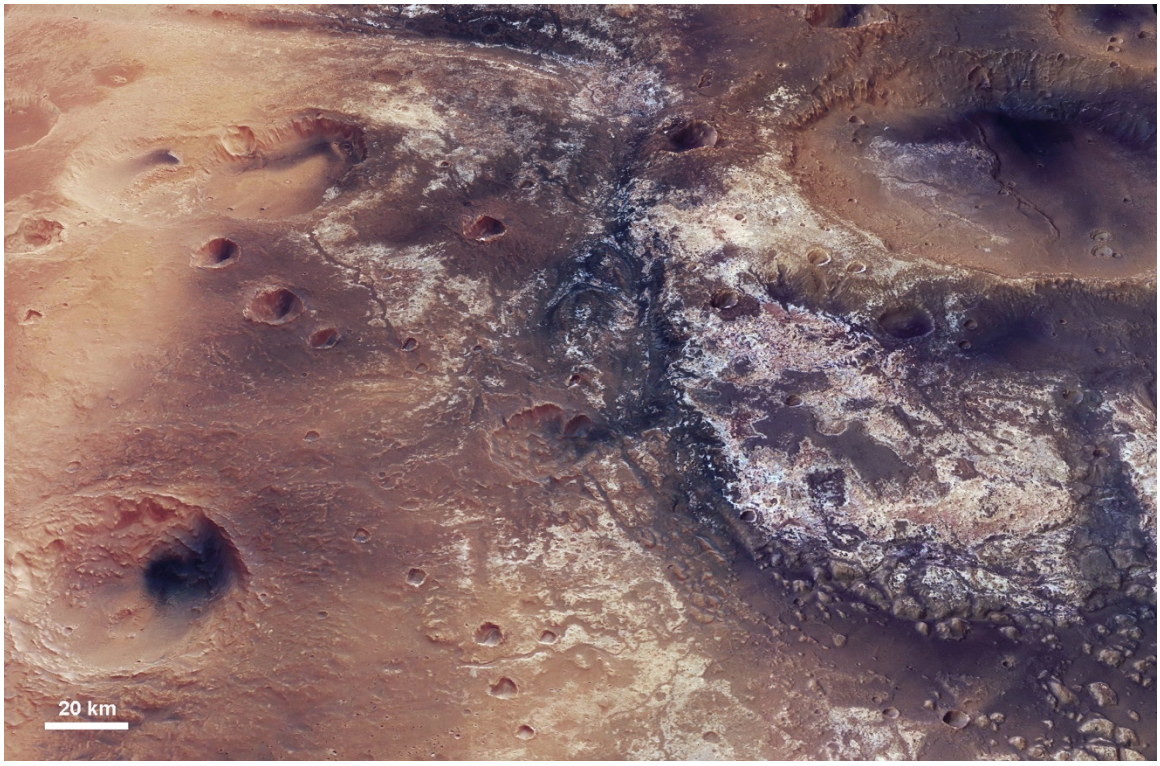
**Supplementary Information**

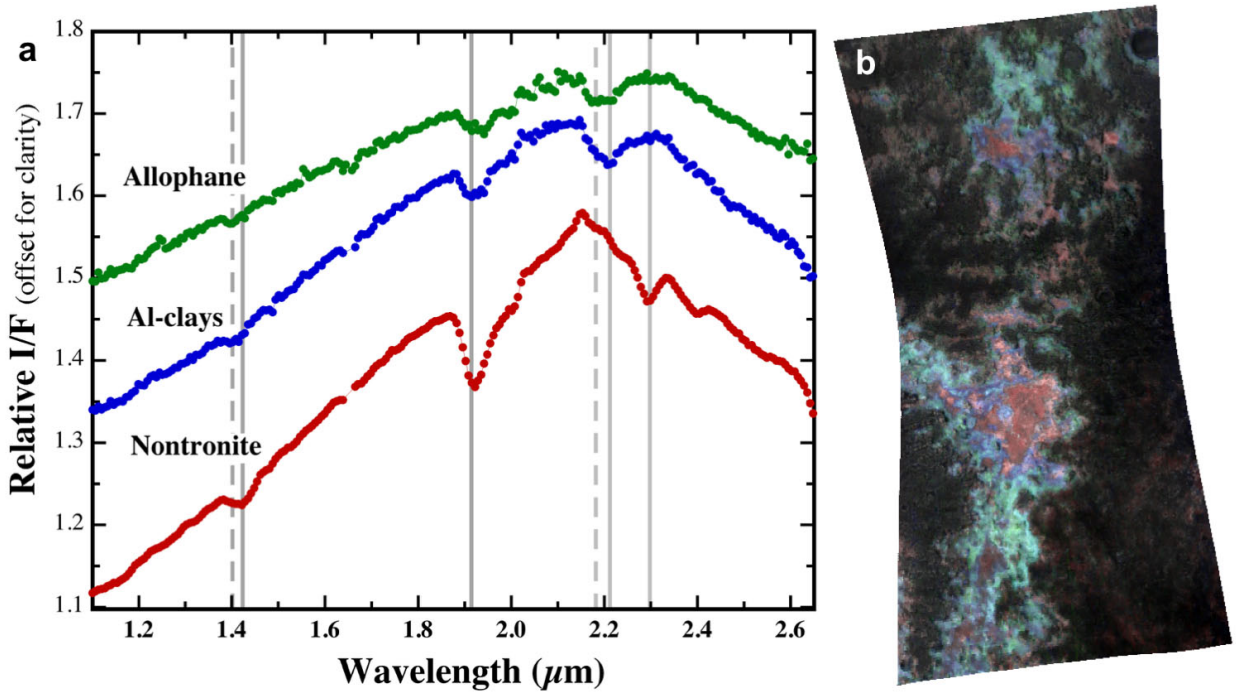
# Surface clay formation during short-term warmer and wetter conditions on a largely cold ancient Mars

Janice L. Bishop*[1,2], Alberto G. Fairén[3,4], Joseph R. Michalski[5], Luis Gago-Duport[6], Leslie L. Baker[7], Michael A. Velbel[8,9], Christoph Gross[10], Elizabeth B. Rampe[11]

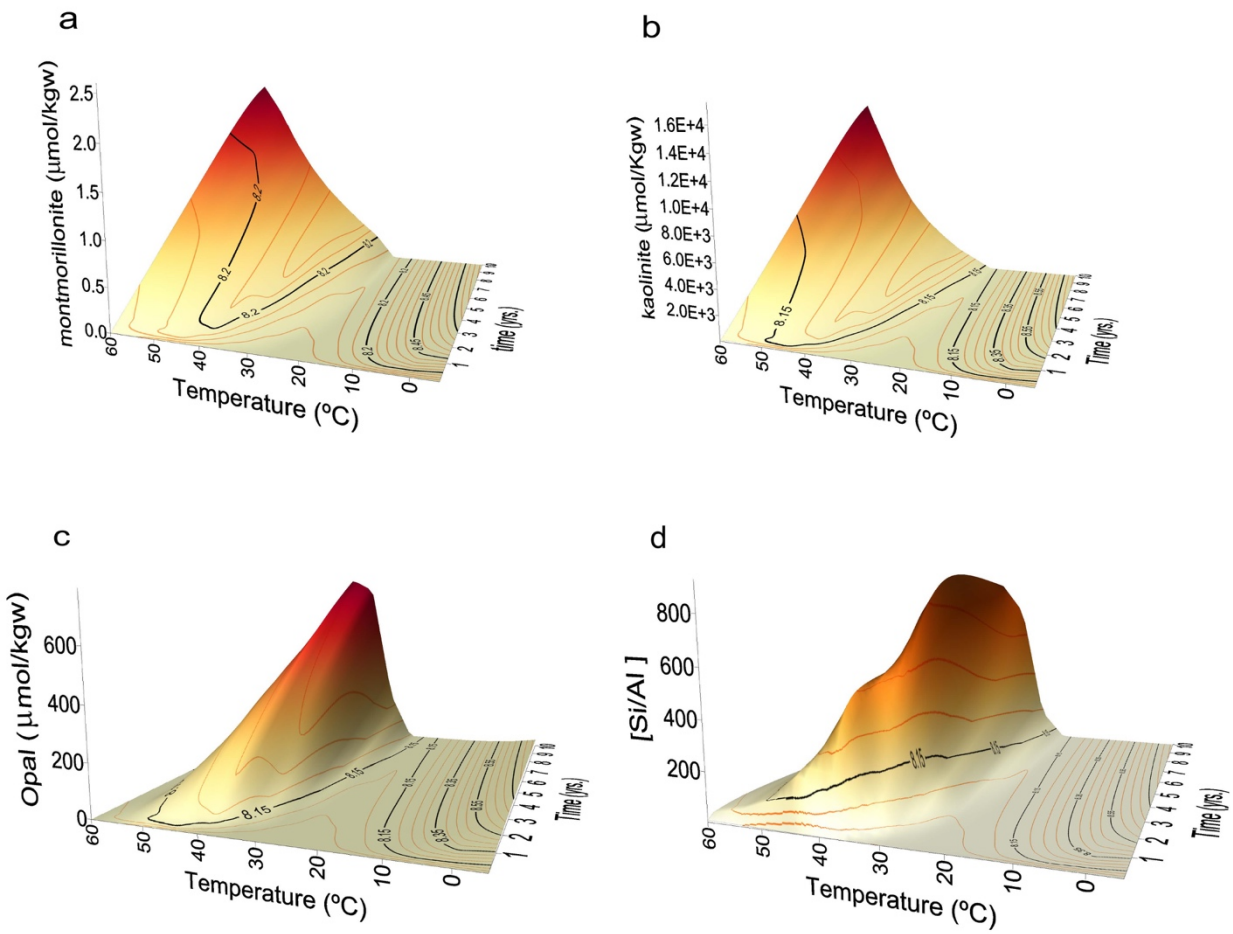
[1]SETI Institute, Mountain View, CA.
[2]NASA-Ames Research Center, Moffett Field, CA.
[3]Centro de Astrobiología (CSIC-INTA), Madrid, Spain.
[4]Cornell University, Ithaca, NY.
[5]University of Hong Kong, Hong Kong, China.
[6]University of Vigo, Vigo, Spain.
[7]University of Idaho, Moscow, ID.
[8]Michigan State University, East Lansing, MI.
[9]Smithsonian Institution, Washington, DC.
[10]Freie Universität Berlin, Berlin, Germany.
[11]NASA-JSC, Houston, TX.




**Supplementary Figure 1. HRSC stereo view of light-toned outcrops near the Mawrth Vallis channel cut by fluvial surface features.** This image illustrates light-toned phyllosilicate-rich material on both sides of the Mawrth Vallis channel. Fluvial features carved by water flowing through the channel and out of impact craters often do not include light-toned phyllosilicates (5x vertical, view towards S).




**Supplementary Figure 2. Relative CRISM spectra of the dominant spectral types in the Mawrth Vallis region.** Example spectra are shown of the nontronite-bearing material in the thick, lower phyllosilicate unit, the upper Al-phyllosilicate unit, and the allophane-type poorly crystalline aluminosilicate unit at the top of the clay profile. These spectra are from 5x5 pixel regions of interest in an MTRDR calibration version of CRISM image HRL000043EC. Gray lines highlight spectral features used to identify the aluminosilicates.




**Supplementary Figure 3. Formation rates of Al-rich phyllosilicates on Mars.** The crystallization kinetics of several phyllosilicates were investigated. The Al-rich phyllosilicates a) montmorillonite and b) kaolinite form increasingly faster above 30-40 °C. Poorly crystalline c) opal and d) aluminosilicates such as allophane or imogolite formed readily at ~25-35 °C in these models. These reactions were performed in a natural carbonate-bearing environment near pH 8, although on Mars the Al-rich phyllosilicates likely formed in a neutral or slightly acidic system. Dissolution experiments performed at lower pH levels occurred more slowly and include more parameters, but provided similar outcomes in terms of temperature. Kaolinite formed faster than montmorillonite in all of our models.