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The watery past of Mars unveiled through remote sensing of clay minerals

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Aqueous minerals, clays in particular, are key witnesses to the watery past of Mars. Their intense scrutiny by the still nascent Mars clay community is warranted by the constraints they provide on the (near) surface environments in which they formed. Also, they are indirect tracers of both the basaltic and more evolved ancient crusts, have the potential to retain and preserve organic matter on geological time scales, and are prospective resources for future human exploration.

A decade of orbital and increasingly in-situ investigations of the clay mineralogy of Mars has revealed blanketing aqueous alteration involving a variety of formation and diagenetic mechanisms, and an evolution with time. Mars may have experienced a global clay-forming era early in its history (circa 4 Ga, probably since earlier times), which transitioned to more water-limited, transient environments as the hydrological activity of Mars waned.

Open, fiercely-debated questions remain: did the bulk of alteration involve meteoric waters in open-system environments, or was it restricted to the sub-surface under a mostly frozen climate, save for episodic climatic excursions. Also of critical importance, the organic matter retention and preservation potential of Martian versus terrestrial clay-bearing environments have yet to be fully assessed.

As more data is sent back, and as new generations of instruments are made available, simple models to explain the bulk of the aqueous history of Mars become less realistic. In addition to being a complex system, Mars remains poorly constrained as we only have access to the time-integrated, heavily disrupted record. Disentangling that record to extract both global trends and local excursions has proven exceedingly challenging. As Mars clay studies progressively transition from a purely exploratory approach to more systematic investigations, it may become possible to resolve those long-lasting debates.

Here, a review of current knowledge of Mars clay mineralogy and formation contexts will be provided, and new results from a global scale clay characterization campaign will be presented. Collectively, these suggest that the bulk of the clay minerals as observed today have been formed or deposited in a sedimentary context widely at Mars.