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Widespread Surface Weathering on Early Mars: possible implication on the Past Climate

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The recent discovery of widespread hydrous clays on Mars with OMEGA/Mars Express and CRISM/MRO indicates that diverse and widespread aqueous environments existed on Mars, from the surface to kilometric depths [1, 2]. The study of the past habitability and past climates of the planet requires assessing the importance of sustained surface water vs. subsurface water in its aqueous history.

Vertical sequences of Al-rich clays on top of Fe/Mg-rich clays in the top tens of meters of the surface are identified on Mars [3-6] (see figure 1) and interpreted as possible weathering profiles, similar to cases of pedogenesis on Earth (e.g. [7, 8]).
A global study of these clay sequences has recently been published by Carter et al. [9]. This following work presents detailed geological analysis, performed for each identified candidate, in order to constrain their age and origin.

With the increasing availability of CTX and HiRISE stereoimages, we investigate the thickness of the altered sequences, the age of the altered units and the different geological contexts to further understand the weathering process(es), and their possible implication on the past climate.

The types of geologic settings where the interpreted weathering profiles are observed are much varied: from basin floor to plateaus, in apparent massive rocks to finely layered rocks. Besides, the number and variety of sequences is/was likely larger. However, in term of chronology, the alteration seems to have stopped in a relatively limited period of time for the studied cases, between 3.8 and 3.6 Ga. This would point to a formation due to a global process that enabled liquid water at the surface and pedogenesis in various regions, on various terrains, from late Noachian to early Hesperian. This global process would imply regular, widely distributed ice or precipitations in large regions of Mars at that time.
If weathering occurred before that time, during the early or middle Noachian, the sequences may have been erased by the more intense erosion of that time. Also, it is difficult to date older terrains by crater counting on small surfaces.

These observations make a strong constrain concerning the past habitability of Mars: liquid water has been widely available at the surface of the planet, in contact with different rocks, until the early Hesperian time.

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