CHRONOLOGY OF DEPOSITION AND ALTERATION IN THE MAWRTH VALLIS REGION, MARS.

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Introduction: The early history of Mars has enabled extensive alteration at the surface of Mars, detected in particular through the observation of phyllosilicates by imaging spectrometers around Mars [1, 2, 3]. The eroded plateaus around Mawrth Vallis display some of the largest outcrops of phyllosilicate-rich rocks on Mars [1, 2, 4]. Mawrth Vallis dissected the Martian highlands, just at the dichotomy boundary between the Noachian highlands and the younger, northern lowlands. A large, thick, layered clay-rich unit is present throughout the inter-crater plateaus, and clay-rich layers have also been identified in parts of the Mawrth Vallis and Oyama crater floors [e.g. 4]. A landing site on the plateau between Oyama crater and Mawrth Vallis, was particularly studied after its selection in the final four candidate sites for the MSL mission.

The age of the alteration and its relationship with other processes such as fluvial activity is fundamental for establishing the timing of aqueous activity in this region, and on Mars. We have investigated the ages of the regional plateau, of key surfaces of the inter-crater plateau, and of Oyama crater's floor to constrain the age of the clay unit and its alteration.

Geological context of the clay-rich outcrops: Most of the inter-crater plateaus show a similar compositional stratigraphy: below an unaltered dark capping unit (around 10 m thick) are the light-toned clay-bearing layered rocks. The lower-part of this layered unit appears rich in Fe-smectites, while the upper-part is enriched in Al-clay minerals, through a probable late leaching process at the surface [e.g. 5, 6, 7].

The large impact craters of the region (> 20 km in diameter) as the Oyama crater (around 100 km in diameter) in the center of the studied region likely originated from impacts in an already (partly) formed clay-rich unit as the highest parts of their rims, when free of dark cap, are clay-rich [4]. The inter-crater clay-rich unit has likely been reworked – valleys and inverted valleys are observed across the plateau – and redeposited in local lows: the Oyama crater floor is the largest example [4]. Layering inside Oyama is different from the stratas on the plateau, indicating that these two clay-units were not deposited together. Moreover, we also see in Oyama Al-clay rocks on top of Fe-smectite stratas, as on the plateau, but the Al-clay rocks are thinner in Oyama [8]: this would indicate that the alteration creating this upper Al-clay zone was still on-going at the time or after the deposition of the stratas inside Oyama.

Crater counts: A first regional crater count of the largest craters of the region was made over a ~500 km x ~500 km large area, centered on Mawrth Vallis (area 1 in figure 1), with craters larger than 1 km in diameter, to determine the formation of the regional plateau. We used the craterstat software developed by [9] to calculate model ages from the observed crater size-frequency distribution. To constrain the end of the alteration in the region, and of the deposition of the layers of the main inter-crater clay unit, a crater count was made over the Oyama crater floor (area 2 in figure 1).

Dating the unaltered dark cap that covers the plateaus and was deposited after the surface alteration gives an additional constrain on the time of the end of the alteration, but determining the deposition of this dark cap is more difficult. Large pre-existing craters have been simply mantled by this unit, while small craters are filled by sand originating from the erosion of the cap itself. When analyzing the crater distribution, we may date events before the deposition of the unit when looking at large craters, or resurfacing after the deposition when looking at smaller craters. We made crater counts over some parts of the dark cap (area 3 and 4 in figure 1).

Conclusions: The chronology of events concerning the clay unit is pictured in figure 2. According to the cratering model results, the main layered unit was deposited between 4.0 Ga and 3.8 Ga ago. Surface alteration likely stopped no later than 3.7 Ga ago. This work provides useful boundaries for constraining the time period of water activity in this region. This preserved window into early phases of aqueous activity on Mars gives us a unique chance to study an aqueous environment of exobiological interest in the early solar system.

References: [1] Poulet F. et al. (2005) *Nature*, 438, 623-627. [2] Bibring J.-P. et al. (2006) *Science*, 312, 400-404. [3] Mustard J. F. et al. (2008) *Nature*, 454, 305-309. [4] Loizeau D. et al. (2007) *JGR*, 112, E08S08. [5] Loizeau D. et al. (2010) *Icarus*, 205, 396-418. [6] Wray J. J. et al. (2008) *GRL*, 35, L12202. [7] Bishop J. L. et al. (2008) *Science*, 321, 830. [8] Carter J. (2010) PhD thesis. [9] Michael G. G. & Neukum G. (2010) *EPSL*, 294, 223-229.

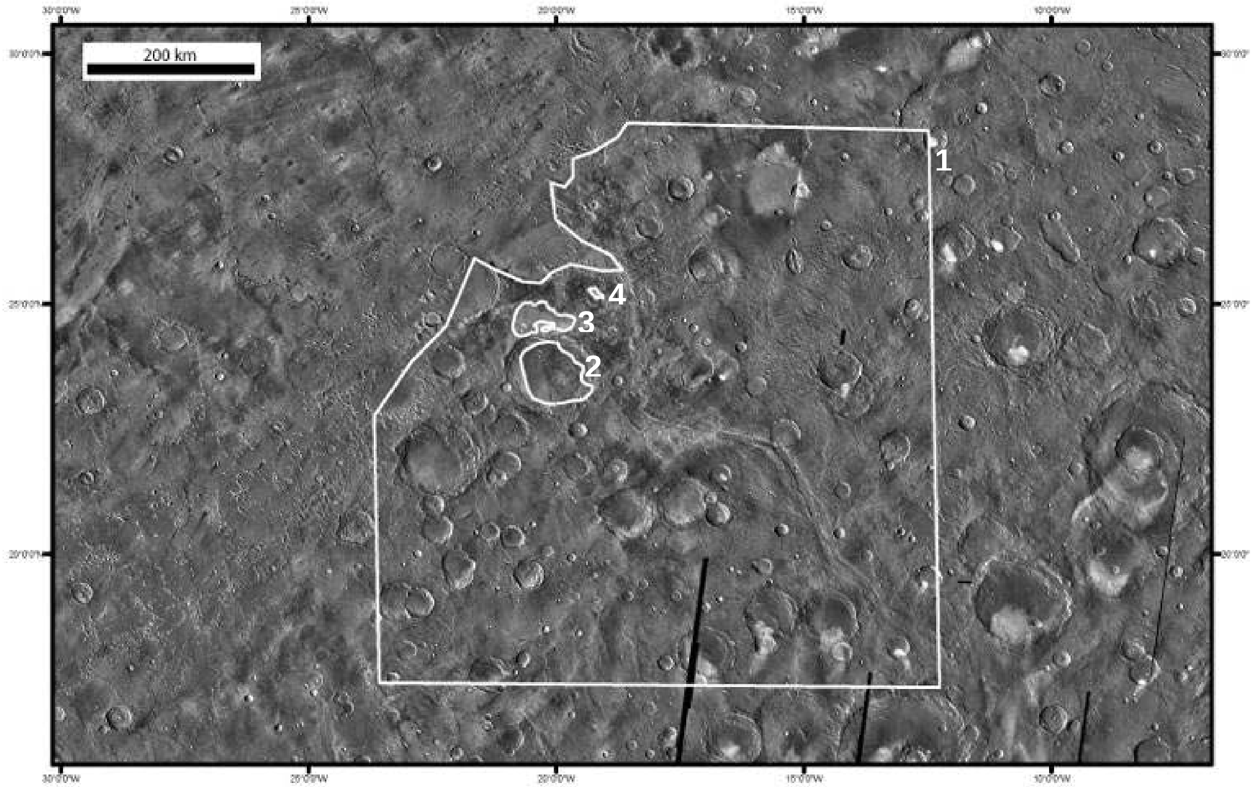

Figure 1: Counting areas over the region of Mawrth Vallis. The largest delimited area (1) corresponds to the regional count. Area (2) is on Oyama crater floor, and areas (3) and (4) are on the cark cap.

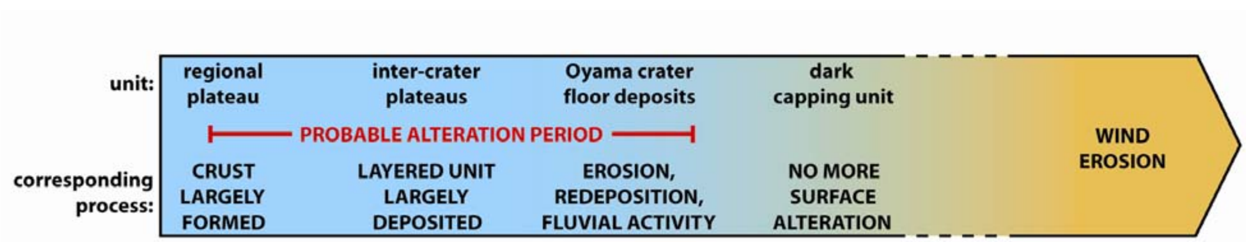

Figure 2: Chronology of the different dated units in the Mawrth Vallis region (top) and corresponding formation/alteration processes (bottom).