Geophysical Research Abstracts
Vol. 14, EGU2012-7172-1, 2012
EGU General Assembly 2012

Chronology of deposition and alteration in the Mawrth Vallis region of Mars

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The Mawrth Vallis area displays some of the largest and most altered phyllosilicate-rich outcrops. Mawrth Vallis is located 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. Additional clay-rich layers are also observed in parts of the Mawrth Vallis and the nearby Oyama crater floors. The main clay-unit displays a complex deposition and alteration history. The alteration took place before or during the layers deposition, with probable leaching after the deposition, fluid circulation through large veins, and some sulfate deposits. The surface of the clay unit has also been eroded by water activity.

Determining the age of the alteration and its relationships 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, of the Oyama crater's floor, and of Chryse Planitia deposits in the Mawrth Vallis mouth to constrain the age of the clay unit and its alteration.

According to the cratering model results, the main layered unit on the plateaus of Mawrth Vallis was deposited prior to 3.8 Ga ago, and suffered erosion and redeposition, in Oyama crater and possibly in Mawrth Vallis. Surface alteration stopped no later than 3.7 to 3.6 Ga ago, which is the age of the dark, non-altered material capping the region, and of the dark deposits in Mawrth Vallis mouth.

This work provides useful boundaries for constraining the time period of water activity in this region: alteration was possible until the late Noachian, but stopped at the surface at the transition with the Hesperian. It may indicate more globally that later clay deposits on Mars were altered before the Hesperian and reworked, or altered underground, in more local environments. 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.