Geophysical Research Abstracts
Vol. 15, EGU2013-7414, 2013
EGU General Assembly 2013

Correlating mineralogical and morphological records for a better understanding of past habitable conditions on Mars

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Both mineralogical and morphological datasets show a past Mars (Noachian and Hesperian periods, >3 Ga) distinct from present one, with enhanced fluvial activity and widespread hydrated minerals. However, recent interpretations and climate models favour early Mars as being as cold as recent periods with geothermal and impact effects being predominant, even in the Noachian period. One significant problem is that record of the Noachian surface is partial because of the >3 billion years of subsequent processes that modified the surface. Nevertheless, by studying preserved mineralogical assemblages in key locations and correlating those observations to morphology, it is possible to distinguish the signature of surface processes such as pedogenesis and perennial lacustrine activity, especially in the Noachian period after the Late Heavy Bombardment, 3.7 to 4.0 Ga. Subsequent activity in the Hesperian period (3.7 to 3.0 Ga) still displays well developed fluvial activity with local lakes and presence of hydrated minerals, but with a more regional signature suggesting transient and localized environment in a relatively colder period. This helps us to draw a past evolution that requires significant aqueous activity, from a globally wetter Noachian period towards more transient and localized environments in the Hesperian. A classification of these environments taking into account their age, and the duration and availability of water is proposed to rate the interest of potential exobiological niches targeted for future in situ missions.