

Aqueous Alteration on Mars

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The occurrence of extensive valley networks and layered deposits of phyllosilicates and sulfates during the late Noachian/Hesperian periods (approx. 3-4 Gyrs) indicates a past martian climate that was capable of maintaining liquid water at the surface. The planet's climate drastically changed after these early "episodes" of water to a drier and colder environment during the Amazonian period (past 3.0 Gyrs). The objective of this paper is to describe aqueous alteration/weathering scenarios on Mars based on observations returned by rover and lander missions.

The chemistry of most outcrops, rocks, and "soils" that have interacted with water has not been extensively changed from average Mars crustal basaltic composition. Little chemical variation suggests closed hydrologic systems were prominent on early Mars and/or the water/rock ratios were low. Open hydrologic systems occur at local scales, e.g., high Si and Ti rocks and "soil" deposits around a volcanic feature in Gusev crater.

Geochemical and mineralogical indicators for aqueous alteration include jarosite and other Fe-sulfates at several locations suggesting acid-sulfate alteration conditions. High Si and Ti rocks, sediments, and "soil" deposits are consistent with basaltic residues extensively leached by extremely acidic fluids. Variations in the Fe/Mn ratio of fracture veins infilled with sulfate-rich materials suggest changes in redox and/or pH conditions of the migrating fluids.

The increase of nanophase iron oxides and salts with depth in several "soil" pits excavated by the Spirit rover's wheel in Gusev crater suggests the translocation/mobilization of these phases by liquid water. This "pedogenic" process is the result of limited water movement through the surface sediments during the Amazonian period; however, it is likely that paleosols exist on Mars that formed during the early "wetter" history of the planet. Soil scientists have the opportunity to continue to (and should) be involved in the exploration of the Red planet.