

A view of Martian weathering from microns to hundreds of kilometers

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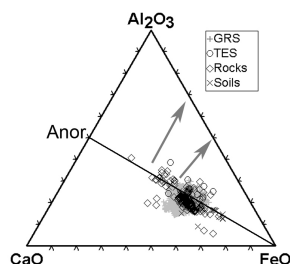
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Aqueous processes have left indelible marks on the morphology of the Martian surface. The geochemical effects are visible in Martian meteorites, at the landing sites of robotic missions, and from orbit (Thermal Emission Spectrometer on Mars Global Surveyor; Gamma-Ray Spectrometer on Mars Odyssey, OMEGA on Mars Express). The nakhlite meteorites show clear evidence for aqueous alteration: alteration veins with elevated S concentrations, dissolution of phosphates (producing relatively high abundances of REE in alteration veins), dissolution of residual glass (marked by high abundances of Cs and Rb in alteration phases), and incipient alteration in olivine. These observations are consistent with short-duration alteration by acidic fluids. Landing site data show that the secondary mineralogy is dominated by Mg- (with minor Fe- and Ca-) sulfates and iron oxides, not the clay minerals and Al-hydroxides common in terrestrial weathering. Typical terrestrial alteration follows paths like the arrows on diagram. In contrast, on Mars the alteration process is dominated by olivine dissolution and formation of iron oxides, probably in an environment rich in sulfuric acid at low water/rock ratio. Such conditions allow for rapid dissolution of phosphates and olivine, but, if time is short and water/rock is low, inhibits dissolution of pyroxene and plagioclase, not dissimilar to the record in the nakhlites. The global data from TES and GRS show that this process is not unique to the few landing sites: it appears to be a Mars-wide weathering style. The uniformity of K/Th measured by GRS is consistent with little dissolution of plagioclase or formation of aluminous alteration products.



This record reflects conditions from the mid-Noachian. Models of regolith evolution that include impact, volcanism, and aqueous alteration suggest that most alteration material was produced by 4 Gy. The lack of evidence in the highlands for alteration under neutral-pH and high water/rock (GRS and TES global data) suggests that such conditions were rare, even early in Martian history, although the identification of phyllosilicates (e.g., nontronite or chamosite) by OMEGA suggests that more Earth-like conditions prevailed sometimes.

Temporal increase in iron oxide inputs into a shallow marine carbonate sediment system: A sediment, porewater and geomicrobiological study

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Discovery Bay, a carbonate-dominated embayment in north Jamaica, has been subject to inputs for 40 years of iron-rich bauxite sediment associated with the local mining and transport of processed bauxite. As such, this site is an ideal natural laboratory to study the records and impacts of iron oxide inputs upon geochemical, diagenetic, and microbial processes in tropical carbonate sediments.

The iron contents in these sediments vary from 1500 µg/g in shallow (5m) sites to over 6000 µg/g in deeper water (20m) sites as a result of the preferential deposition of fine-grained iron oxide-rich bauxite material in deeper water. Down-core increases in Fe record the increased inputs into the bay. The presence of iron oxides markedly alters the chemical processes taking place within Discovery Bay, with a shift from dominance of bacterial sulphate reduction at non-impacted (Fe-poor) sites, to a dominance of bacterial Fe(III) reduction in Fe-rich bauxite-impacted sediments. These different carbon oxidation pathways results in contrasting styles of CaCO₃ grain dissolution and preservation.

Iron oxides within all impacted sediments display a high potential reducibility, from 40% to 80% dithionite-extractable Fe(III). Experimental analysis of the potential susceptibility to, and rates of, bacterial Fe^{III} reduction, utilising Discovery Bay sediment and *Shewanella putrefaciens* CN32 (a known Fe(III)-reducer) have confirmed the high bacterial reducibility of iron oxides within the sediment. Up to 70% of initial Fe^{III} in the sediments was reduced over 15 days. Current research, using molecular 16s rRNA techniques, will determine the shifts in bacterial communities in the sediment as a result of these iron oxide inputs.