The sulfates at Meridiani appear to have formed elsewhere and been transported to Meridiani, mainly by the wind. The same may be true for sulfate deposits that occur at other locations, particularly those in the north pole. For the bulk of the sulfate deposits at Meridiani, the MER science team favors a playa-like source, similar to that inferred for the upper part of the Endurance section, but no extensive sources have been identified. Because of the large volume of the etched Meridiani unit (roughly 10^5 km^3), a playa source, fed either by surface runoff or by groundwater, would imply the processing of large amounts of water. Evaporation of waters from the large floods appears to be ruled out because of timing and failure to detect evaporites in the northern plains. Another possibility is that the sulfates do not form by evaporation but are instead primary weathering products. By this scenario, acid fogs or other forms of acidic precipitation form easily erodible, sulfate-rich weathering rinds that are eroded by the wind and ultimately accumulate in eolian sedimentary deposits. By this mechanism discrete bodies of water are not required.

Much of the discussion above on Meridiani applies equally well to other sulfate-rich deposits such as those in Valles Marineris. We saw above that faulting could have caused groundwater eruptions into the canyons, where the water could have been contained. Evaporation of successive groundwater eruptions could have led to the accumulation of the thick sequences of sulfates observed, or the sulfates could have been brought in by the wind. Jarosite has not been detected in the canyons so the case for acid conditions is weaker than that at Meridiani, as would be expected if the groundwater was buffered by a reaction with basalt. Nevertheless, the evaporative origin of the sulfate deposits in the canyons is not proven. We have compelling evidence of movement of sulfur-rich particles by the wind in Meridiani and around the north pole, and the Valles Marineris deposits could similarly have been deposited by the wind.

While the precise ages of the sulfate-rich deposits are uncertain, most (although not the north polar deposits) are upper Noachian or Hesperian in age. Where the deposits occur in Noachian terrain, as in Meridiani, they are at the top of the section. Although phyllosilicates are detected in Noachian terrains where craters have ejected materials from deeper in the section, sulfates are not. There appears to be a transition from a mainly phyllosilicate-producing era in the middle and lower Noachian to a sulfate-producing era in the upper Noachian and Hesperian. Bibring et al. (2006) suggested that the transition was due to massive eruptions of sulfur that accompanied the formation of Tharsis, an origin that may be at odds with the conclusions of Phillips et al. (2001) that Tharsis was largely built by the end of the Noachian. Another possibility is that the enhanced sulfur activity is the result of the eruptions that formed the widespread Hesperian lava plains. Yet another possibility is simply that sulfate-rich deposits become more visible in transitioning from the Noachian to the Hesperian because as the pace of processes such as impacts, volcanism, and fluvial erosion slows, the results of evaporation and eolian activity become more evident.

Thus, the planet underwent a major change in transitioning from the Noachian to the Hesperian. Rates of impact and erosion declined dramatically. The rate of valley formation also steeply declined although not to zero. Surface conditions changed such that the rate of weathering to produce phyllosilicates declined but sulfate-rich deposits became more evident. In contrast the rate of formation of large floods increased,