WEATHERING WITHIN MASSIVE LOW-LATITUDE ICE DEPOSITS ON MARS: A MECHANISM TO LINK SULFATE AND PHYLLOSILICATE FORMATION. J. R. Michalski and Paul B. Niles. 1Institut d’Astrophysique Spatiale, Bâtiment 121, Université Paris Sud, Orsay Cedex, 91405, France. joseph.michalski@ias.upsud.fr, 2Astromaterials Research and Exploration Science, NASA Johnson Space Center, Houston, TX 77058

Introduction: One of the mysteries of Mars is the mechanism by which large and numerous deposits of sulfate-rich and phyllosilicate-rich sedimentary rocks were generated. Hypotheses proposed to explain the origin of layered, sulfate-rich sediments at the Meridiani Planum site include: a) alteration by acidic fluids in a shallow and intermittently wet groundwater/playa/sebkha system[1], b) alteration of soils by acidic volcanic gases [2], c) reworking of sulfate-rich material by impact base surge [3], and d) acidic weathering within massive low-latitude ice deposits [4].

We favour the ice-weathering model because this scenario can best explain the geologic and geochemical observations made from orbit and the surface. In addition, this model is in accord with an emerging picture of Mars in which ice-related processes have driven many aspects of sedimentation through time [5].

The ice weathering model and sulfate formation: Niles and Michalski [4] proposed that sulfate deposits in the Meridiani Planum area, and possibly elsewhere on Mars, formed through weathering in massive ice deposits. Weathering within ice deposits would have occurred in the following manner: During periods of high obliquity or polar wander, massive amounts of ice would have been deposited at what are now low latitude locations; this ice would have been rich in dust generated by volcanic and impact processes and acidic aerosols snowed out during dust and ice deposition. Radiative heating would cause the formation of small pockets or films of water around dust and aerosols trapped in the ice (Figure 1). Around these grains, small volumes of highly acidic fluids would have altered fine-grained silicate dust grains to secondary silicates and sulfate minerals. The low surface temperatures would force any fluids present within the ice toward extremely acidic conditions and the physical barrier of the ice itself would lead to cation-conservative chemical weathering within a closed system (i.e. the bulk mineralogy would be changed drastically, but the bulk chemistry would not change).

After the ice had sublimated (and melted in part), the remaining material would be a significant quantity of fined grained, chemically weathered, sulfate-bearing, siliclastic sediment similar in composition to Meridiani sediments. These materials would then have been reworked into large scale eolian deposits proximal to the ice as the ice deposit was retreating. During gradual burial during eolian reworking, the deposits would have dehydrated and undergone limited dia-
likely have been alkaline due to increased water-rock interaction and increased dilution of the acid present in the ice deposit. Thus, the mineralogical stratigraphy could be explained by this alkaline groundwater system leaching of rocks in the uppermost part of the stratigraphic section to form Al-rich clay minerals, and alteration of the materials to Fe/Mg-rich clay minerals in the deeper section, where groundwater saturation persisted and/or reducing conditions prevailed.

**Age:** While the ages of the phyllosilicate deposits and sulfate deposits are generally considered to be different [11], we point out that in this model the age of the alteration events that formed the sulfate minerals and the phyllosilicate deposits would be equivalent. However, because of later episodes of physical reworking, the age of the sedimentary rocks in which the sulfate grains exist would be younger. Therefore, this model may be a consistent explanation to describe how sulfates formed in relation to how phyllosilicates formed through a common and realistic mechanism earlier in Mars history. In fact, the sulfate grains and ice deposits may be old enough that their origin is not inconsistent with the period when true polar wander is likely to have occurred on Mars [12-13].

**References:**