Elemental Gains/Losses associated with Alteration Fractures in an Eolian Sandstone, Gale Crater, Mars

D. W. Ming, A. S. Yen, R. Gellert, B. Sutter, J. A. Berger, L. M. Thompson, M. E. Schmidt, R. V. Morris, A. H. Treiman, and the MSL Science Team

The Mars Science Laboratory rover Curiosity has traversed up section through ~100 m of sedimentary rocks deposited in fluvial, deltaic, lacustrine, and eolian environments (Bradbury group and overlying Mount Sharp group). The Stimson formation unconformably overlies a lacustrine mudstone at the base of the Mount Sharp group and has been interpreted to be a cross-bedded sandstone of lithified eolian dunes. Unaltered Stimson sandstone has a basaltic composition similar to the average Mars crustal composition, but is more variable and ranges to lower K and higher Al. Fluids passing through alteration "halos" adjacent to fractures have altered the chemistry and mineralogy of the sandstone. Elemental mass gains and losses in the alteration halos were quantified using immobile element concentrations, i.e., Ti (taus). Alteration halos have elemental gains in Si, Ca, S, and P and large losses in Al, Fe, Mn, Mg, Na, K, Ni, and Zn. Mineralogy of the altered Stimson is dominated by Ca-sulfates, Si-rich X-ray amorphous materials along with plagioclase feldspar, magnetite, and pyroxenes. The igneous phases were less abundant in the altered sandstone with a lower pyroxene/plagioclase feldspar. Large elemental losses suggest acidic fluids initially removed these elements (Al mobile under acid conditions). Enrichments in Si, Ca, and S suggest secondary fluids (possibly alkaline) passed through these fractures leaving behind X-ray amorphous Si and Ca-sulfates. The mechanism for the large elemental gains in P is unclear. The geochemistry and mineralogy of the altered sandstone suggests a complicated diagenetic history with multiple episodes of aqueous alteration under a variety of environmental conditions (e.g., acidic, alkaline).