Geophysical Research Abstracts
Vol. 14, EGU2012-1499, 2012
EGU General Assembly 2012

Late Hesperian hydrothermal alteration at Majuro crater, Mars

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Impact craters cover a large portion of the surface of Mars and could constitute a significant exobiology research target as their formation provided heat sources for aqueous processes. To date, only rare examples of hydrothermal alteration in craters have been reported on Mars while many studies have focused on modeling their effect. Using data from the Mars Reconnaissance Orbiter and Mars Express probes, we report the presence of hydrated minerals, mainly Fe/Mg phyllosilicates, with vermiculite as best-fit, that are found in an alluvial fan. This fan is located inside a crater located in NE Hellas region and dated to the Late Hesperian by crater counts and crosscutting relationships. The stratigraphic position of the hydrated minerals and presence of small domes interpreted as hydrothermal vents indicate that the alteration occurred in the lower level of the alluvial fan and was triggered by bottom-up alteration. These observations are best explained by a combination of snow deposition and subsequent melting eroding crater rims and forming the fan, with impact warming, which triggered the alteration at the base of the fan. This example shows that phyllosilicates are able to form late in the Martian history, especially in local niches of strong exobiological interest. It also suggests that a similar process was possible in alluvial fans of other large impact craters including those at Gale crater.