American Mineralogist, Volume 99, pages 291–302, 2014

What Lurks in the Martian Rocks and Soil? Investigations of Sulfates, Phosphates, and Perchlorates

Alteration of Hawaiian basalts under sulfur-rich conditions: Applications to understanding surface-atmosphere interactions on Mars and Venus†

Molly C. McCanta[1,*], M. Darby Dyar[2] and Allan H. Treiman[3]

[1]Department of Earth and Ocean Sciences, Tufts University, Medford, Massachusetts 02155, U.S.A.
[2]Department of Astronomy, Mount Holyoke College, 50 College Street, South Hadley, Massachusetts 01075, U.S.A.
[3]Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, Texas 77058, U.S.A.

Abstract

A suite of Hawaiian basalts that were variably altered in the presence of SO_2-rich gases during the current summit eruptive episode at Halemaumau crater, Kilauea, were studied to determine their alteration phase assemblage and reactive pathways using electron microscopy, Mössbauer spectroscopy, and X-ray diffraction. The alteration conditions represent an acid fog environment. Alteration rinds on the basalts vary in thickness from tens of micrometers to the entirety of the rock and are composed of amorphous silica rims (85–95 wt% SiO_2) overlain by sulfates. Sulfate mineralogy consisted of gypsum, anhydrite, and natroalunite-jarosite. No phyllosilicates were observed in any alteration assemblages. Phenocrysts and glass were both observed to be extensively reacted during alteration. The Halemaumau samples may provide good analogs for basalt alteration on other rocky planetary bodies, i.e., Mars, Venus, and Mercury, where S is ubiquitous and low fluid/rock ratios are common.

Keywords: Sulfate, Halemaumau, basalt weathering, Mössbauer spectroscopy, Mars, Venus