IRON ISOTOPES IN PRODUCTS OF ACID-SULFATE BASALT ALTERATION: A PROSPECTIVE STUDY FOR MARS.

N. Dauphas[1] and R.V. Morris[2]. [1]Origins Laboratory, Department of the Geophysical Sciences and Enrico Fermi Institute, The University of Chicago, Chicago, IL 60637, USA. E-mail: dauphas@uchicago.edu. [2]NASA Johnson Space Center, Houston, TX 77058, USA.

Introduction: The Mars Exploration Rover *Opportunity* has revealed a rich mineralogy of iron-bearing phases at Meridiani Planum. The prevailing scenario for explaining this mineralogy is jarosite formation by sulfuric acid alteration of olivine-bearing basalt followed by oxidation-evaporation of the solution in an interdune environment. Jarosite was subsequently converted to hematite during a pH-raising recharge event [1, 2]. Iron isotopes in hematite/goethite concretions from the Navajo sandstone (a possible terrestrial analogue of Mars hematite deposits, [3]) are useful tracers of Fe transport and paleo-fluid circulations [4]. Morris et al. [5,6] identified a pattern of acid-sulfate alteration on Mauna Kea volcano (Hawaii) as a very good terrestrial analogue for understanding the formation of hematite spherules on Mars. Possible questions that can be addressed using Fe isotopes are: Did alteration occur in a closed system for Fe? If not, what was the scale and direction of the fluid flow? Are all spherules cogenetic? Did spherules grow in several pulses? What was the chemical pathway for the formation of jarosite (oxidative weathering of sulfides or acid-sulfate alteration of basalts?).

Results: We have analyzed the Fe isotopic compositions of the products of acid-sulfate alteration on Mauna Kea. Unaltered tephra have δ^{56}Fe≈+0.15 ‰ (relative to IRMM-014), similar to other OIBs. Jarosite-bearing tephra have more variable δ^{56}Fe, from ~+0.11 to +0.26 ‰. A hematite spherule concentrate extracted from HWMK745R [5] has heavy δ^{56}Fe (+0.42 ‰). Fe isotopic compositions of 15 individual hematite spherules ranging in diameter from 25 to 50 µm (33 to 261 ng Fe) were also analyzed. To our knowledge, these are the smallest natural objects ever analyzed for δ^{56}Fe by MC-ICPMS. The uncertainties of individual analyses increase as the Fe quantity decreases. All spherules, except one, appear to have identical compositions to the spherule concentrate.

Conclusions: The heavy δ^{56}Fe of jarosite-bearing tephra indicates that Fe isotopic fractionation occurred during basalt dissolution, partial oxidation, or jarosite deposition. The variable δ^{56}Fe values show that the rocks did not behave as closed systems for Fe. Electron microprobe analyses of hematite spherules revealed rims with higher (Al+Si)/Fe ratios than cores, suggesting multiple pulses of growth [5]. Hematite spherules have identical δ^{56}Fe, regardless of their diameters. The sharp zonations seen in cross-sections reflect changes in growth conditions rather than changes in the source of Fe. This study provides us with the opportunity to sharpen analytical tools and develop the scientific context for future sample return missions from Mars.

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