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LETTER

Developing vanadium valence state oxybarometers (spinel-melt, olivine-melt, spinel-olivine) and V/(Cr+Al) partitioning (spinel-melt) for martian olivine-phyric basalts

J.J. PAPIKE[1], P.V. BURGER[1,*], A.S. BELL[1], L. LE[2], C.K. SHEARER[1], S.R. SUTTON[3], J. JONES[4], AND M. NEWVILLE[3]

[1]Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque New Mexico 87131, U.S.A.
[2]JSC Engineering, Technology and Science (JETS), NASA Johnson Space Center, Mail Code JE-23, Building 31, Houston, Texas 77058 , U.S.A.
[3]Center for Advanced Radiation Sources, University of Chicago, Chicago, Illinois 60637, U.S.A.
[4]NASA/Johnson Space Center, Houston, Texas 77058, U.S.A.

ABSTRACT

A spiked (with REE, V, Sc) martian basalt Yamato 980459 (Y98) composition was used to synthesize olivine, spinel, and pyroxene at 1200 °C at five oxygen fugacities: IW-1, IW, IW+1, IW+2, and QFM. These run products were analyzed by electron microprobe, ion microprobe, and X-ray absorption near-edge spectroscopy to establish four oxybarometers based on vanadium partitioning behavior between the following pairs of phases: V spinel-melt, V/(Cr+Al) spinel-melt, olivine-melt, and spinel-olivine. The results for the spinel-melt, olivine-melt, and V/(Cr+Al) spinel-melt are applicable for the entire oxygen fugacity range while the spinel-olivine oxybarometer is only applicable between IW-1 and IW+1. The oxybarometer based on V partitioning between spinel-olivine is restricted to basalts that crystallized under low oxygen fugacities, some martian, all lunar, as well as samples from 4 Vesta. The true potential and power of the new spinel-olivine oxybarometer is that it does not require samples representative of a melt composition or samples with some remnant of quenched melt present. It just requires that the spinel-olivine pairs were in equilibrium when the partitioning of V occurred. We have applied the V spinel-olivine oxybarometer to the Y98 meteorite as a test of the method.

Keywords: Vanadium, oxybarometry, Mars, Yamato 980459, spinel, olivine, XANES