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EXPERIMENTAL CONSTRAINTS ON CO₂ AND H₂O IN THE MARTIAN MANTLE AND PRIMARY MAGMAS; John R. Holloway, Kenneth J. Domanik, and Peter A. Cocheo, Department of Geology, Arizona State University, Tempe, AZ 85281 USA

We present new data on the stability of hornblende in a martian mantle composition, on CO₂ solubility in iron-rich basaltic magmas, and on the solubility of H₂O in an alkalic basaltic magma. These new data are combined with a summary of data from the literature to present a summary of the current state of our estimates of solubilities of H₂O and CO₂ in probable martian magmas and the stability of hornblende in a slightly hydrous mantle. The new results suggest that hornblende stability is not sensitive to the Mg/(Mg+Fe) ratio (mg#) of the mantle, that is the results for terrestrial mantle compositions are similar to the more iron-rich martian composition. Likewise CO₂ solubility in iron-rich tholeiitic basaltic magmas is similar to iron-poor terrestrial compositions, the solubility of H₂O has been measured in an alkalic basaltic (basanite) composition for the first time and it is significantly lower than predicted for models of water solubility in magmas. The lack of mg# dependence observed in hornblende stability and on CO₂ solubility means that in many cases terrestrial results can be applied to martian compositions. This conclusion does not apply to other phenomena such as primary magma compositions and major mantle mineral mineralogy.

An iron-rich martian mantle composition (DW) based on the calculations of Dreibus and Wanke (1985) was prepared by sintering at 1 bar at an oxygen fugacity equivalent to the quartz-fayalite-magnetite buffer reaction (QFM). In order to synthesize amphibole peridotite, the DW mixture was sealed in Ag₇₀Pd₃₀ capsules with 10 wt% H₂O and run in an IHPV at 4 kb, 900 °C, QFM for one week. Experiments to determine amphibole stability and amphibole peridotite melting relations were performed in a non-end loaded, solid media piston-cylinder assembly with a 0.5" diameter cell assembly. Synthetic amphibole peridotite was loaded in Fe-saturated Pt capsules and run at 13, 18, 22, 26 and 28 kb at temperatures of 900-1500 °C. Oxygen fugacity in the piston cylinder runs was not controlled but was monitored using the Pt and Pd wire method and found to range from QFM at 13 kb to four log₁₀ units below QFM at 22 kb. Run products were characterized by X-ray diffraction and electron microprobe at an accelerating voltage of 15 kV and 10 nA beam current. Analyses were corrected using the Bence-Albee method. The results show that hornblende disappears under the following conditions: 13 kb, 1000-1100 °C; 18 kb, 1100-1200 °C; 22 kb 1000-1100 °C; and 1000 °C, 26 -28 kb. These results are consistent with recent studies of hornblende stability in terrestrial mantle compositions, eg. Wallace and Green (1991).

The solubility of CO₂ was determined by Pan and Holloway (1990) in the melt composition Eg derived by Longhi and Pan (1989). The solubilities determined are very close to those found in a terrestrial tholeiitic basalt with much higher mg# (Pan, et al., 1991) and we conclude that there is little, if any effect of mg# on CO₂ solubility.

The solubility of H₂O in a basanite magma was determined to evaluate the existing solubility models for alkalic compositions as these have never previously been measured. All experiments were conducted in an internally heated rapid-quench pressure vessel (Holloway, et al., 1992). Experimental charges were contained in Fe pre-saturated platinum capsules. Powdered natural basanite was loaded into each capsule along with

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known quantities of distilled or deionized water. Capsules were sealed by use of an arc welder. Oxygen fugacity was controlled by use of hydrogen-argon gas mixtures which also served as the pressure medium. Experimental charges were mounted in epoxy and polished for electron and ion microprobe analyses. Electron microprobe analyses of silicate glasses were run at an accelerating voltage of 15kV, a beam current of 10nA, and a 10 μ m beam size using Bence-Albee correction factors. Analyses of the platinum capsule material for iron were run at an accelerating voltage of 20kV, a beam current of 20nA with a 2 μ m beam size using ZAF correction factors. Doubly polished thin sections were made for some of the samples with thicknesses ranging from 20 to 70 μ m for use on a FTIR spectrometer. Mid-infrared spectra were gathered to determine water concentrations using the method of Stolper (1982). The results for 1200 °C and 200 bars pressure are 1.09 ± 0.9 wt % and for 1250 °C, 200 bars, 0.8 ± 0.3 wt %. These results are significantly lower than predicted by the model of Burnham (1975) and the results of Dixon, et al. (1991) for tholeiitic basalt.

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