CO₂ Solubility in Primitive Martian Basalts Similar to Yamato 980459 and the Evolution of the Martian Atmosphere

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Introduction

There is considerable evidence that liquid water was stable on the ancient Martian surface during at least some parts of the late Noachian and early Hesperian epochs. Yet there remains considerable uncertainty as to how this greenhouse was created and maintained and how it evolved to the current thin, modern atmosphere.

Experiments

Experiments were performed using a 0.5" piston-cylinder apparatus. The 2 mm Pt capsules were not pressurized to prevent Fe-loss. Conditions: 1600-1650 °C, 1.0-2.0 GPa, and a duration of 30 min.

FTIR Analysis

Data

Calculations

Holloway et al. [8] showed that the solubility of CO₂ in graphite saturation melts is only related to CO₂:

\[ C + O_2 \rightarrow CO_2 \]

where \( X_{\text{CO}_2} \) is the mole fraction of CO₂ in the assemblage.

Experimental CO₂ solubility in primitive Martian basalts similar to Yamato 980459 and the evolution of the Martian atmosphere.

Conclusions

- Experimentally-determined solubility of synthetic shergottite basalts confirm that the Martian mantle is incapable of degassing sufficient CO₂ to sustain a thick greenhouse atmosphere in the late Noachian.
- Models of Martian atmospheric evolution using only CO₂ should be reexamined and additional volatiles such as SO₂ and CH₄ should be considered.
- There is little effect of composition on CO₂ solubility in Martian basalts.
- NBOVT is an imperfect predictor of CO₂ solubility in MgO-rich silicate melts.

References


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In memory of the Spirit Rover

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Thanks for the rock analyses!