6.1.33

Dry magmatism on Mars

J.H. JONES

SR, NASA/JSC, Houston, TX 77058
(jjones2@ems.jsc.nasa.gov)

Several arguments have been put forward that some martian basalts, such as Shergotty and Zagami, formed from hydrous magmas [1]. These include (i): phase equilibria experiments that seem to require ~2 wt.% H_2O to produce liquids saturated in both pigeonite and augite; (ii) reverse zoning of Li and B in shergottite pyroxenes; and (iii) the general expectation that basaltic magmatism is an effective means of degassing planetary mantles.

However, the bulk of the evidence indicates that SNC magmas, especially shergottite magmas, were dry. Considering that there is only ~200 ppm H_2O in Shergotty and Zagami now, any degassing of these rocks is required to have been ≥ 99% efficient.

Experimental Constraints: There are two sets of experiments that pertain to shergottite petrogenesis. Stolper and McSween [2] performed one-bar gas-mixing experiments on powdered samples of Shergotty and Zagami. Dann et al. [3] performed 2 kbar H_2O-saturated experiments on a synthetic composition close to that of the Shergotty intercumulus liquid, as well as one-bar gas-mixing experiments on an augite-fortified version of that composition.

In both sets of experiments, the anhydrous gas-mixing experiments produce pyroxenes that most closely resemble those in natural shergottites. And the observation that water is not necessary to produce multiply-saturated liquids strongly suggests that the composition of the reconstructed intercumulus liquid was too MgO rich.

Light Lithophile Elements: The reverse zoning of Li and B is the best evidence that a fluid phase may have been lost from Shergotty and Zagami. However,, Cl and Br in the shergottite suite are nearly chondritic. Therefore, if a fluid was removed, it cannot have much fractionated these elements — contrary to experimental evidence [4].

The martian mantle: Unlike the Earth's mantle, the martian mantle is expected to be dry. Two early dehydration mechanisms are identified: (i) reactions of hydrous phases with metal prior to core formation; and (ii) subsequent depletion of incompatible elements (such as water) by the removal of basaltic components. Without plate subduction to rehydrate the martian mantle, it and basalts from it are likely to be dry.

References

[1] McSween H.Y. Jr. et al. (2001) *Nature* **409**, 487-490**.**

[2] Stolper E.M. and McSween H.Y. Jr. (1979) *GCA* **43**, 1475-1498.

[3] [10] Dann J.C. et al. (2001) *MAPS* **36**, 793-806.

[4] Bureau H. et al. (2000) *EPSL* **183**, 51-60.

6.1.34

The Martian mantle: An experimental study

D.W.BROMILEY AND B.J. WOOD

CETSEI, Dept of Earth Sciences, University of Bristol, Wills Memorial Bdg, Queens Road Bristol, UK. BS8 1RJ (D.W.Bromiley@bris.ac.uk, b.j.wood@bris.ac.uk)

Four models for the chemical composition of Mars have been used to investigate the mineralogy of the martian mantle via high pressure and temperature experiments; Morgan and Anders (1979), Dreibus and Wänke (1985), Ghosal et al. (1998) and Sanloup et al. (1999). The Dreibus and Wänke and Sanloup et al. models produce similar overall mantle compositions, both relatively FeO rich and MgO poor compared to the terrestrial mantle. The Morgan and Anders composition is relatively rich in Al_2O_3 and CaO, whilst the Ghosal et al. composition is very rich in MgO and poor in FeO.

Subsolidus piston cylinder experiments have been completed within a pressure range of 1.0-3.0 GPa for the four compositions, aimed at resolving the mineralogy and density at corresponding pressures within the martian mantle. The Morgan and Anders experiments reveal a shallow mantle consisting of olivine, clinopyroxene and orthopyroxene, with garnet developing between 2 and 2.5 GPa. The Sanloup et al. experiments feature an assemblage of olivine and intermediate pigeonitic pyroxene, with the pyroxene crystals showing significant compositional zoning in terms of CaO, Al_2O_3 and Na_2O. The Ghosal et al. experiments all exhibit a mineral assemblage consisting of olivine and orthopyroxene.

We are currently undertaking a series of experiments to establish the primary melt compositions resulting from the four hypothetical mantle compositions at pressures of 1.0 to 1.5 GPA. These primary melts will then be compared to inferred parental melt compositions for the SNC meteorites in order to establish a path of melt evolution. Further experiments aimed at synthesizing the mantle mineralogy at pressures of up to 25 GPa are also ongoing.

References

[1] Morgan J.W., Anders.E (1979) *GCA* **43,** 1601-1610.

[2] Dreibus G., Wänke H. (1985) *Meteorics* **20,** 367-381.

[3] Ghosal S., Sack R.O., Ghiorso M.S., Lipschutz M.E. (1998) *Contrib Mineral Petrol* **130**, 346-357.

[4] Sanloup C., Jambon A., Gillet P. (1999) *Physics of the Earth and Planetary Interiors* **112**, 43-54