

**ANHYDROUS MELTING OF A PRIMITIVE MARTIAN MANTLE: NEW EXPERIMENTS AT 1-2 GPa.**

M. Collinet<sup>1</sup>, E. Médard<sup>2</sup>, J. Vander Auwera<sup>1</sup> and B. Charlier<sup>3</sup>, <sup>1</sup>Département de Géologie, Université de Liège, Liège 4000, Belgium, [mcollinet@doct.ulg.ac.be](mailto:mcollinet@doct.ulg.ac.be), <sup>2</sup>Laboratoire Magmas et Volcans, Université Blaise Pascal – CNRS – IRD, Clermont-Ferrand F-63038, France, <sup>3</sup>Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139, USA.

**Introduction:** The surface of Mars is mainly covered by basalts that were produced during partial melting of the planet interior. Model compositions of the bulk silicate Mars have been proposed based on physical constraints and correlations between element ratios from Martian meteorites and chondrites [*e.g.* 1, 2]. Such models should represent the primitive Martian mantle from which surface basalts are derived. Here, we use an experimental forward approach on a Mars mantle composition to understand the diversity of the Martian basaltic magmatism.

We have performed new melting experiments from a synthetic equivalent of [1], the most largely accepted Martian mantle model. Other reasonable models give very similar compositions [2], and share key differences with the terrestrial mantle: low Mg#, high incompatible (Na, K, P) and compatible (Cr, Mn) volatile elements. Our experiments cover the P-T conditions previously investigated by [3] (1.5 GPa, 1300-1550 °C) and have been extended to 1 and 2 GPa. Recent development of melt extraction techniques allow a better characterization of experimental melts, particularly melts produced by low degrees of partial melting. Our experimental liquid compositions are compared to Martian basalts interpreted as possible primary magmas (*i.e.* unmodified after extraction from the source region; [4, 5]). Using these compositions and previous experimental studies [3, 6], the source region of basalts present on the Martian surface can be discussed.

**Experimental techniques:** Experiments were performed in a piston-cylinder apparatus at 1.0, 1.5 and 2.0 GPa. This pressure range covers plausible depths of melting (80-170 km) of the Martian mantle [4, 5]. Runs were equilibrated at temperature from 1200 to 1500 °C corresponding to degrees of melting between 5 and 40 %. The starting material was synthesized from oxide and silicate powders, and loaded in Pt-Graphite capsules. These capsules were then heated at 400°C for 12h before being welded shut in order to ensure anhydrous conditions. A layer of vitreous carbon spheres was added to extract the liquid and avoid quench modifications [7].

**Results and discussion:** For most major elements, our experiments extend the trends previously observed by [3]. An important exception is the higher SiO<sub>2</sub> content of our liquids (~ 51-53% at 1.0 GPa) for low de-

grees of melting compared to sandwich experiments of [3] (~ 46%). Predictions made using the pMELTS model [8] are also less rich in SiO<sub>2</sub> (~ 46-47%). For low degrees of melting, SiO<sub>2</sub> rich anhydrous basalts probably results from the high alkali content of the primitive Martian mantle used in our experiments [1] compared to the Earth mantle [*e.g.* 9]. Alkalis depolymerize silicate liquids by increasing the number of non-bridging oxygen in SiO<sub>4</sub> tetrahedra. This decreases the activity coefficient of silica that is compensated by an increase of the SiO<sub>2</sub> concentration in the liquid [10].

The Adirondack class basalts and the picritic enriched (LAR 06319 and NWA 1068) and depleted (Y 980459 and NWA 5789) shergottites represent possible primary Martian basalts [*e.g.* 5]. Slight compositional variations observed between these Martian basalts and our experimental liquids are used to discuss the diversity of mantle sources. The low Si content of Adirondack class basalts compared to our experimental liquids might require the presence of a depleted source region poorer in alkalis than the primitive mantle. The CaO/Al<sub>2</sub>O<sub>3</sub> ratio of shergottites (~1.2) is higher than the ones of Adirondack class basalts and experimental liquids (~0.8). Shergottites were probably derived from a mantle source depleted in Al compared to the primitive mantle and the source of Adirondack class basalts.

**References:** [1] Dreibus G. and Wanke H. (1985) *Meteoritics*, 20, 367-381. [2] Khan A. and Connolly J. A. D. (2008) *JGR*, 113, E07003. [3] Bertka C. M. and Holloway J. R. (1994) *Contrib. Mineral. Petr.*, 115, 323-338. [4] Monders A. G. et al. (2007) *Meteoritics & Planet. Sci.*, 42, 131-148. [5] Musselwhite D. S. et al. (2006) *Meteoritics & Planet. Sci.*, 41, 1271-1290. [6] Agee C. B. and Draper D. S. (2004) *EPSL*, 224, 415-429. [7] Wasylenki L. E. et al. (2003) *J. Petrol.*, 44, 1163-1191. [8] Ghiorso M. S. et al. (2002) *G-cubed*, 3, 1030. [9] Wanke H. and Dreibus G. (1988) *Philos. T. Roy. Soc.*, 32, 545-557. [10] Hirschmann, M. M. et al. (1998) *Geochim. Cosmochim. Ac.*, 62, 883-902.