

## Partial melting of Peridotite + CO<sub>2</sub> and origin of kimberlite melt in the deep mantle

SUJOY GHOSH, EIJI OHTANI AND KONSTANTIN LITASOV  
Department of Earth and Planetary Materials Science, Tohoku University, Sendai 980-8578, Japan

CO<sub>2</sub> rich magmas (carbonatite and kimberlite), play an important role in distribution of carbon in the deep Earth, are generated from melting of carbonated peridotite and eclogite in the Earth's deep mantle. Recent high pressure experimental studies suggest that near solidus partial melt of carbonated peridotite produces magnesiocarbonatitic melts (e.g. [1, 2]) up to 20 GPa.

In the present study we have investigated the behaviour of partial melting of carbonated peridotite from 10 to 20 GPa and temperature range from 1600 to 2100°C. Near solidus carbonatitic melt continuously transitions to carbonated silicate melt which is close to the composition of kimberlite melt in the presence of garnet ± olivine /wadsleyite/ringwoodite ± clinoenstatite.

Melt formed by 10-25% of the partial melting at 10-20 GPa has high MgO (26-34 wt.%) and FeO (7.0-10.4 wt.%) and low SiO<sub>2</sub> (18-36 wt.%) and Al<sub>2</sub>O<sub>3</sub> (0.5-1.3 wt.%) contents. It contains also 6-12 wt.% CaO, 0.6-2.0 wt.% Na<sub>2</sub>O and 0.1-0.3 wt.% K<sub>2</sub>O. The CO<sub>2</sub> contents in the melts determined by total deficit of electron microprobe analyses are 14-32 wt.%. The composition of partial melts is different from melts observed at lower pressures (3-6 GPa), which are enriched in SiO<sub>2</sub>, CaO and Al<sub>2</sub>O<sub>3</sub> [3-5] which is close to melilititic to basanitic ocean island basalts. Our new data suggest kimberlite-like melt can be generated by the partial melting of carbonated peridotite at pressure up to 20 GPa.

- [1] Dasgupta & Hirschmann (2006) *Nature* **440**, 659-662.  
[2] Ghosh *et al.* (2009, in press) *Chemical Geology*. [3] Hirose (1997) *Geophys. Res. Lett.* **24**, 2837-2840. [4] Dalton & Presnall (1998) *Contrib. Mineral. Petrol.* **131**, 123-135.  
[5] Brey *et al.* (2008) *J. Petrol.* **49**, 797-821.

## The differential migration of noble gases as leakage proxy in CO<sub>2</sub> geological storage

SOPHIE GIANNESINI<sup>1,2\*</sup>, ALAIN PRINZHOFER<sup>1,2</sup>,  
MANUEL MOREIRA<sup>1</sup>, CAROLINE MAGNIER<sup>2</sup>  
AND FREDERIC SCHNEIDER<sup>3</sup>

<sup>1</sup>Geochimie-Cosmochimie and ERT Stockage géologique du CO<sub>2</sub>, Institut de Physique du Globe de Paris, 4 pl. Jussieu, 75005 Paris, France

(\*correspondence: giannesini@ipgp.jussieu.fr)

<sup>2</sup>IFP, 1 av. de Bois Préau, 92500 Rueil-Malmaison, France

<sup>3</sup>Beicip-Franlab, 92500 Rueil-Malmaison, France

Increasing CO<sub>2</sub> spoils in the atmosphere and the subsequent environmental consequences led the scientific community to evaluate the feasibility of CO<sub>2</sub> storage in geological formations. Such a project requires the presence of a caprock, with low hydraulic conductivity, acting as a seal for the stored CO<sub>2</sub>. The carbon dioxide being a reactive gas, it is still difficult to predict if the seal will remain hermetic and a continuous monitoring of the stability of stored CO<sub>2</sub> appears an absolute condition.

Noble gases have been shown to be excellent tracers of CO<sub>2</sub> sources and of physical processes in natural analogues of a CO<sub>2</sub> storage. Moreover, we show with experimental studies coupled to modelling that noble gases constitute quantitative tracers of migration through porous media.

These experimental studies highlight that the pattern of noble gases and CO<sub>2</sub> arising from migration is typical of the porous media type and is influenced by solubility, by diffusion coefficients in the free water and by the surface interactions between the rock matrix and the considered solute. The pattern of the migrated gases being influenced particularly by physical interactions as adsorption that tend to retain the heavy noble gases, the lighter ones migrating faster. The major consequence of the differential diffusivity properties of noble gases appears on the elemental ratios. These latter evolve indeed according to CO<sub>2</sub> migration. The concomitant evolution of CO<sub>2</sub> and noble gas ratios during migration through the porous media was tested in a simple geological case of CO<sub>2</sub> storage. We considered the storage of CO<sub>2</sub> in gas phase (with atmospheric noble gases), one caprock and an above aquifer with noble gases equilibrating with air. The CO<sub>2</sub> leakage is measured in the aquifer. It appears that the elemental ratios of noble gases (as He/Ne or Ne/Kr for example) are sensitive to a very low leakage as 0.1% of the total stored CO<sub>2</sub>.

Noble gases appear as excellent proxies for CO<sub>2</sub> leakage out of a geological storage.