

# Carbonate mineral solubility in deep Earth

STEFAN FARSANG<sup>1\*</sup>, MARION LOUVEL<sup>2</sup>,  
MOHAMED MEZOUAR<sup>3</sup>, ANGELIKA D. ROSA<sup>3</sup>  
AND SIMON A. T. REDFERN<sup>1</sup>

<sup>1</sup>Department of Earth Sciences, University of Cambridge,  
Downing Street, Cambridge, CB2 3EQ, UK  
(\*correspondence: sf571@cam.ac.uk)

<sup>2</sup>Institut für Mineralogie, WWU Münster, 48149 Münster,  
Germany

<sup>3</sup>European Synchrotron Radiation Facility, 71 Avenue des  
Martyrs, 38000 Grenoble, France

Subduction of carbonate minerals is a key mechanism for transport of carbon to deep Earth. The solubility of carbonates in high-pressure and high-temperature subduction zone aqueous fluids controls how efficiently carbon recycles back to the atmosphere through dissolution in slab fluids, transfer to the mantle wedge, and consequent volcanic outgassing [1–4]. Petrologic evidence and extensive experimental work suggests that beside calcium carbonate a number of other metal carbonate minerals may coexist and remain stable in the subducting slab. The quantification of the solubility of these phases is therefore necessary in order to model the deep carbon cycle.

We have determined the aqueous solubility of dolomite [CaMg(CO<sub>3</sub>)<sub>2</sub>], magnesite (MgCO<sub>3</sub>), rhodochrosite (MnCO<sub>3</sub>), and smithsonite (ZnCO<sub>3</sub>) at subduction zone conditions (pressures up to ~8 GPa and temperatures up to ~500°C) by crystal volume computation and synchrotron X-ray fluorescence (XRF) spectroscopy at high temperatures and pressures *in situ* in the diamond anvil cell (DAC) at the European Synchrotron Radiation Facility (ID27 and BM23 beamlines).

Our results indicate that the studied carbonates are considerably less soluble in subduction zone aqueous fluids than calcium carbonate. This suggests that the amount of carbon recycled back to the atmosphere calculated based on the high solubility of calcium carbonate alone [5-7] may be overestimated.

[1] Frezzotti *et al.* (2011) *Nat. Geosci.* **4**, 703-706. [2] Ague & Nicolescu (2014) *Nat. Geosci.* **7**, 355-360. [3] Manning (2014) *Nat. Geosci.* **7**, 333-334. [4] Kelemen & Manning (2015) *PNAS* **112**, E3997-E4006. [5] Newton & Manning (2002) *Am. Min.* **87**, 1401-1409. [6] Facq *et al.* (2014) *GCA*, **132**, 375-390. [7] Facq *et al.* (2016) *Chem. Geol.* **431**, 44-53.