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## An experimental determination of the liquidus in the system $\text{CaCO}_3\text{-MgCO}_3$ and a thermodynamic analysis of the melting of carbonated mantle melting

Stefano Poli<sup>1</sup>, Sutao Zhao<sup>2</sup>, and Max W. Schmidt<sup>3</sup>

<sup>1</sup>Dipartimento di Scienze della Terra, Università degli Studi di Milano, Milano, Italy

<sup>2</sup>Institute of Geophysics & Geomatics, China University of Geosciences, Wuhan, China

<sup>3</sup>Department of Earth Sciences, ETH, Zuerich, Switzerland

The system  $\text{CaCO}_3\text{-MgCO}_3$  has been used since the '60s for reconstructing the petrogenesis of carbonated lithologies, notably of carbonatite magmas possibly generated in the Earth's mantle. Yet, experimental results at high temperatures and pressures remain contradictory, and a thermodynamic model for the carbonate liquid in this binary is still lacking.

We experimentally investigated the melting of aragonite and magnesite to pressures of 12 GPa, and of calcite-magnesite mixtures at 3 and 4.5 GPa, and at variable  $\text{Mg}/(\text{Mg}+\text{Ca})$  ( $X_{\text{Mg}}$ ). Results show that the melting of aragonite, and of magnesite have similar slopes, magnesite melting  $\approx 30$  °C higher than aragonite. The minimum on the liquidus surface is at  $X_{\text{Mg}} \approx 0.35\text{-}0.40$ , 1200 °C at 3 GPa, and 1275 °C at 4.5 GPa, which, when combined with data from Byrnes and Wyllie (1981) and Müller et al. (2017), imply that minimum liquid composition remains approximately constant with pressure increase. We present the first thermodynamic model for  $\text{CaCO}_3\text{-MgCO}_3$  liquids, retrieved from the experimental data available. Although carbonate liquids should be relatively simple molten salts, they display large non-ideality and a three-component (including a dolomite component), pressure dependent, asymmetric solution model is required to model the liquidus surface. Attempts to use an end-member two-component model fail, invariably generating a very wide magnesite-liquid loop, contrary to the experimental evidence.

The liquid model is used to evaluate results of experimentally determined phase relationships for carbonated peridotites modelled in  $\text{CaO-MgO-SiO}_2\text{-CO}_2$  (CMS- $\text{CO}_2$ ), and  $\text{CaO-MgO-Al}_2\text{O}_3\text{-SiO}_2\text{-CO}_2$  (CMAS- $\text{CO}_2$ ). Computations highlight that the liquid composition in the CMS- $\text{CO}_2$  and CMAS- $\text{CO}_2$  and in more complex systems do not represent "minimum melts" but are significantly more magnesian at high pressure, and that the pressure-temperature position of the solidus, as well as its  $dP/dT$  slope, depend on the bulk composition selected, unless truly invariant assemblages occur. Calculated phase relationships are somewhat dependent on the model selected for clinopyroxene, and to a lesser extent of garnet.

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Müller I.A., Müller M. K., Rhede D., Wilke F.D.H. and Wirth R. (2017) Melting relations in the system  $\text{CaCO}_3\text{-MgCO}_3$  at 6 GPa. *Am. Mineral.* 102, 2440-2449.