The liquidus surface in the system CaCO$_3$–MgCO$_3$ at high pressure:
revisiting conditions for the minimum

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Phase relationships along the join CaCO$_3$-MgCO$_3$ received considerable attention as a reference system for melting of a carbonated mantle, although data on the location of the liquidus surface are very limited.

Multianvil and piston cylinder experiments were performed on mixtures of reagent-grade CaCO$_3$ and pure natural magnesite as starting materials, from 1150 °C to 1700 °C, at 3.5 and 4.2 GPa. Two Pt capsules were simultaneously loaded in each run, in order to assess internal consistency of solid-liquid relationships. A Fe$_2$O$_3$ sleeve close to graphite furnace was used to trap hydrogen diffusion to the capsule expected by Soret effect.

At 4.2 GPa, 100% liquid was bracketed at 1250°C for compositions at $X_{Mg} = 0.3$ and 0.4 ($X_{Mg} = Mg/(Mg+Ca)$). Although hydrogen diffusion cannot be excluded, complete melting provides a strong constrain on the liquidus surface. At 1250 °C, magnesite + liquid, and Mg-calcite + liquid were recovered for bulk composition $X_{Mg} = 0.6$ and $X_{Mg} = 0.2$, respectively. Magnesite + liquid field were found to occur down to 1225 °C. The solvus magnesite + dolomite has been intersected at 1200 °C for a bulk $X_{Mg} = 0.6$. Subsolidus dolomite was found for bulk $X_{Mg} = 0.3$, whereas dolomite + liquid occurs at $X_{Mg} = 0.35$ in the same experiment, using paired Pt-capsules. At 3.5 Gpa, experiments suggest a larger temperature range for dolomite-liquid assemblage.

Byrnes and Wyllie [1] retrieved the minimum in the binary CaCO$_3$-MgCO$_3$ at 2.7 GPa, 1300 °C, and $X_{Mg} = 0.42.$, and Buob et al. [2] at 6.0 GPa, 1370 °C, and $X_{Mg} = 0.5$. Because a positive dP/dT slope of the solidus is expected for most compositions in this binary, the new data we provide suggest an overestimation of melting temperatures in [1].

A preliminary thermodynamic model for the liquidus surface is explored here.