The *T-X* phase diagram Na_2CO_3–$CaCO_3$ at 3 GPa

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Phase relations in the system Na_2CO_3–$CaCO_3$ have been studied at 3 GPa and 800–1525 °C. The system has one intermediate compound, $Na_2Ca_3(CO_3)_4$, at 800 ºC, and two intermediate compounds, $Na_2Ca(CO_3)_2$ and $Na_2Ca_3(CO_3)_4$, at 850 ºC (Fig. 1a). $CaCO_3$ crystals recovered from experiments at 950 °C and 1000 °C are aragonite and calcite, respectively. Maximum solid solution of $CaCO_3$ in Na_2CO_3 is 20 mol% at 850 ºC. The Na-carbonate–$Na_2Ca(CO_3)_2$ eutectic locates near 860 °C and 56 mol% Na_2CO_3. $Na_2Ca(CO_3)_2$ melts incongruently to $Na_2Ca_3(CO_3)_4$ and a liquid containing about 51 mol% Na_2CO_3 at ˜ 880 °C. $Na_2Ca_3(CO_3)_4$ disappears above 1000 °C via incongruent melting to calcite and a liquid containing about 43 mol% Na_2CO_3. At 1050 °C, the liquid, coexisting with Na-carbonate, contains 87 mol% Na_2CO_3. Na-carbonate remains solid up to 1150 °C and melts at 1200 °C (Fig. 1c). The Na_2CO_3 content in the liquid coexisting with calcite decreases to 15 mol% as temperature increases to 1300 °C. $CaCO_3$ remains solid up to 1500 °C and melts at 1525 °C (Fig. 1d).

Considering the present and previous data, a range of the intermediate compounds on the $CaCO_3$-Na_2CO_3 join changes as pressure increases in the following sequence: $Na_2Ca(CO_3)_2$, $Na_2Ca_2(CO_3)_3$ (0.1 GPa) → $Na_2Ca(CO_3)_2$, $Na_2Ca_3(CO_3)_4$ (3 GPa) →$Na_4Ca(CO_3)_3$, $Na_2Ca_3(CO_3)_4$, $Na_2Ca_4(CO_3)_5$ (6 GPa) (Fig. 1b). Thus, the nyerereite stability field extends to the shallow mantle pressures, whereas the shortite stability field terminates somewhere between 0.1 and 3 GPa. Consequently, findings of nyerereite and shortite among daughter phases in the melt inclusions in olivine from the sheared garnet peridotites are consistent with their mantle origin.

Fig. 1. (a) The system Na_2CO_3–$CaCO_3$ at 3 GPa. (b) Comparison with previous data at 0.1 GPa (Cooper et al. 1975) and 6 GPa (Shatskiy et al. 2013). (c) Na_2CO_3 melting. (d) $CaCO_3$ melting. Arg = aragonite; Cal = calcite; Na_2 = solid solution of $CaCO_3$ in Na_2CO_3; Na_4Ca = $Na_4Ca(CO_3)_3$; Na_2Ca = $Na_2Ca(CO_3)_2$; Na_2Ca_3 = $Na_2Ca_3(CO_3)_4$; Na_2Ca_4 = $Na_2Ca_4(CO_3)_5$; L = liquid; F = CO_2 fluid.

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