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.

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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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