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High-pressure high temperature behaviour of $Na_2^{13}CO_3$

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The available analytical data on mineralogy of syngenetic inclusions in superdeep diamonds from the Juina area (Brazil) provided important information on the general chemical composition of the parental medium for the host diamonds and included minerals. Carbonate micro- and nano-inclusions of calcite Ca[U+FFFD]$_3$, dolomite $CaMgCO_3$, nyerereite $Na_2Ca(CO_3)_2$, and nahcolite $NaHCO_3$ were identified among the heterogeneous suite of primary inclusions. Chemical and PT conditions of syngenetic formation of the superdeep diamonds and mineral inclusions therein may be discovered using high-pressure experiments focused onto study of chemical stability of carbonate components, involved into the diamond-forming processes, and their melts.

We study high-pressure high-temperature behavior of sodium carbonate $Na_2^{13}CO_3$, stability of the melt and its decomposition in static high pressure experiments at pressures of 0.01 to 46 GPa and temperatures of 300 to 3000 K using diamond anvil cell technique with laser heating. After laser heating the samples were recovered and observed with Raman-spectroscopy and electron microscope. Recrystallization of $Na_2^{13}CO_3$ were carried out in a multianvil (MA) apparatus at pressures of 14 and 20.0 GPa and temperatures up to 2400 K.

We observed formation of ^{13}C-graphite and ^{13}C-diamond on decomposition of the $Na_2^{13}CO_3$melt at pressures 21 – 46 GPa GPa and temperatures above 2100 K. Both ^{13}C-graphite and ^{13}C-diamond were formed from carbon of sodium carbonate $Na_2^{13}CO_3$ melt. Thus, there is a two-step reaction with primary decomposition of carbonate melt on Na_2O + $^{13}CO_2$and the following decomposition of $^{13}CO_2$ on ^{13}C - diamond and oxygen O_2.

The congruent melting of sodium carbonate was confirmed in the range of temperatures 1400 – 2100 K at 46 GPa and 1400 – 2500 K at 14 GPa. In the experiments in diamond anvil cell in room temperature and at pressures 0.01 – 46 GPa sodium carbonate has not phase transition. The experimental results were applied to construction of the phase diagram of Na_2CO_3up to 46 GPa and 3000 K.

The obtained results allow to determine the phase relationship of sodium carbonate Na_2CO_3 at extremely high pressures and temperatures. However, they are important for determining the conditions of diamond crystallization in carbonate-containing material of the transition zone and lower mantle, as well as the geochemical evolution of the components of the Na in-depth material.