The origin of calcite and aragonite in the UHP dolomitic marble from the Kokchetav massif: Trace element constraints

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One of the most pressing questions revolves around the possibility of carbonate melting at mantle depth in the sediment part of the subducted slab. The confirmation of this melting comes from findings of former carbonatite melt inclusions associated with diamond in the UHP rocks from the Kokchetav massif (Korsakov & Hermann, 2006).

Herein we present the major and trace element composition of Ca-carbonates from aragonite-bearing UHP dolomitic marble from the Kokchetav massif (northern Kazakhstan), to provide new information on the formation of aragonite and Mg-calcite. Dolomitic marble consists of calcite (30 wt.%), dolomite (20 wt.%), garnet (10 wt.%), and clinopyroxene (25 wt.%) with secondary and accessory sulfides, aragonite, apatite, phlogopite, titanite, and talc. K-bearing clinopyroxene was identified as an inclusion in garnet porphyroblast of dolomitic marble. Two types of Mg-calcite-bearing inclusions coexist with aragonite in one growth zone of garnet porphyroblasts. Type-A inclusions represent normal mineral inclusions, while Type-B inclusions show crown-like boundary and decrepitation features. These inclusions were previously interpreted as the inclusions of former carbonatite melt (Korsakov & Hermann, 2006). X_{Mg} (Mg/[Mg+Ca]) in calcite from Type-A mineral inclusions coexisting with aragonite inclusion in one garnet growth zone reaches 0.065 implying their simultaneous crystallization during a retrograde metamorphic stage at ~2.3 GPa and ~870 °C, where the P-T estimates were derived from the intersection of Mg-calcite isopleths (Hermann *et al.*, 2016) with the Kokchetav massif P-T path.

Aragonite from inclusions in garnet is characterized by high LREE concentrations (La=30-50 × PM) and positive Sr anomalies. Calcite from Type A inclusions (mineral inclusions) shows low LREE concentrations (La = 2–20 × PM) and positive Sr anomalies and, thus, represents calcite crystallized simultaneously with garnet and aragonite (P ~ 2.3 GPa and T ~ 870 °C). Calcites from Type B inclusions divide into two groups: calcites from the first group show the same LREE and Sr concentrations as mineral inclusions and, thus, represent calcite, trapped as a solid phase by garnet. The second group shows higher LREE concentrations (La = 30–50 × PM) and negative Sr anomalies. We believe that calcite from the second group crystallized from carbonate melt inside the inclusion. Since calcite from Type B inclusions belongs to both groups, most likely these inclusions were enclosed by garnet as the combined inclusions consisting of calcite and carbonate melt.

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Hermann, J., Troitzsch, U., Scott, D., 2016. Experimental subsolidus phase relations in the system $CaCO_3$–$CaMg(CO_3)_2$ up to 6.5 GPa and implications for subducted marbles. *Contributions to Mineralogy and Petrology* 171, 1-17.