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The temperature and compositional dependence of disordering in Fe-bearing dolomites

Ettore Franzolin,[1] Marco Merlini,[2] Stefano Poli,[2,*] and Max W. Schmidt[1]

[1]Institute of Geochemistry and Petrology, ETH Zurich, 8092 Zurich, Switzerland
[2]Dipartimento di Scienze della Terra, Università degli Studi di Milano, 20133 Milano, Italy

Abstract

Dolomite occurs in a wide range of rock compositions, from peridotites to mafic eclogites and metasediments, up to mantle depths of more than 200 km. At low-temperatures dolomite is ordered ($R\bar{3}$), but transforms with increasing temperature into a disordered higher symmetry structure ($R\bar{3}c$).

To understand the thermodynamics of dolomite, we have investigated temperature, pressure, kinetics, and compositional dependence of the disordering process in Fe-bearing dolomites. To avoid quench effects, in situ X-ray powder diffraction experiments were performed at 300–1350 K and 2.6–4.2 GPa. The long-range order parameter *s*, quantifying the degree of ordering, has been determined using structural parameters from Rietveld refinement and the normalized peak area variation of superstructure Bragg peaks characterizing structural ordering/disordering. Time-series experiments show that disordering occurs in 20–30 min at 858 K and in a few minutes at temperatures ≥999 K. The order parameter decreases with increasing temperature and X_{Fe}. Complete disorder is attained in dolomite at ~1240 K, 100–220 K lower than previously thought, and in an ankeritic-dolomite$_{s.s.}$ with an X_{Fe} of 0.43 at temperatures as low as ~900 K. The temperature-composition dependence of the disorder process was fitted with a phenomenological approach intermediate between the Landau theory and the Bragg-Williams model and predicts complete disorder in pure ankerite to occur already at ~470 K.

The relatively low-temperature experiments of this study also constrain the breakdown of dolomite to aragonite+Fe-bearing magnesite at 4.2 GPa to temperature lower than ~800 K favoring an almost straight Clapeyron-slope for this disputed reaction.

Keywords: Carbonates, high pressure, synchrotron, dolomite