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An experimental study of the breakdown of dolomite in H_2O at 700 °C, 100 MPa

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Abstract

The occurrence of periclase in contact-metamorphosed dolomite rock at modest temperature and pressure indicates an infiltration of H_2O because of the otherwise high temperature required for the reaction dolomite → periclase + calcite + CO_2. We conducted experiments on the breakdown of dolomite in the presence of H_2O at 700 °C, 100 MPa. Grains of dolomite, 175–250 μm in radius, were heated for up to 32 days (32 d). Rims of multigrain calcite and periclase formed around dolomite cores, with ~50% of the dolomite replaced in 32 d. The growth of the rim is similar to that for previous experiments conducted with cores of dolomite rock and follows a square root of time ($\sqrt{t}$) relation. The decrease in dolomite-core radius with $\sqrt{t}$ suggests that the rate is controlled by diffusion of CO_2 and H_2O through the reaction rim. The results can be modeled by the topochemical or "shrinking-core" model, in which the unreacted grain core radius shrinks as $r = r_0 - \sqrt{\kappa t}$ with a kinetic parameter κ of $6.76 \pm 0.6 \times 10^{-4}$ $\mu m^2/s$ (0.0213 mm^2/y). The model predicts that dolomite grains up to 2 mm in radius would disappear in <200 y. In a rock undergoing metamorphism at the conditions of the experiments, the reaction zone grows to a width ranging from <2 mm to >800 mm, depending on the radius of the grains in the rock. The porosity grows rapidly, and CO_2 is released abundantly at the beginning of the reaction near the leading edge of the periclase isograd. The shrinking-core process occurs as long as the intergranular fluid is H_2O rich, requiring a modest minimum flux sufficient to displace the evolved CO_2. The common replacement of periclase by brucite observed in nature was not seen in our experiments. Rather, the quench phase was the magnesium-carbonate hydrate nesquehonite, suggesting the brucite forms only in very CO_2-poor fluid.

Keywords: Dolomite stability, experimental investigation, fluid-rock interaction