Self-accelerating dolomite-for-calcite replacement and displacive zebra veins: Dynamics of burial dolomitization

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Burial dolomites are huge masses of replaced limestone with small patches of zebra veins. Dolomitization is carried out by deep acid $MgCl_2$-rich, dolomite-undersaturated brines at a moving reaction front 1-100 cm thick.

At the core of dolomitization dynamics is this feedback: Each growth increment of dolomite in the current position of the front replaces an equal volume of calcite (Nahon & Merino, *Amer J Sci* 1997), which must increase the local pore-fluid concentration of Ca^{++}, which in turn increases the rate of the *next* increment of dolomite-for-calcite replacement.

That Ca^{++}-mediated feedback (1) makes dolomitization self-accelerating; (2) eventually switches the dolomite growth from replacive to displacive because dolostone is strain-rate-softening, generating sets of displacive self-organized zebra veins (Merino, Canals & Fletcher, *Geologica Acta*, in press, www.geologica-acta.com); (3) makes the latest dolomite crystals in a displacive vein *lower* in $\delta^{18}O$ than the replacive ones of which they are overgrowths; also, it makes them extra-calcic and *saddle-shaped*; and (4) the feedback stops itself precisely thanks to the displacive growth phase, since the displacive growth no longer increases Ca^{++} concentration in the pore fluid. (5) Toward the end of the whole process, as the $MgCl_2$ supply stops for good, the pore fluid must be very Ca^{++}-rich and very supersaturated with respect to calcite: Formation of calcite veins is predicted, and perhaps dedolomitization too. (6) Another feedback operates during dolomitization: The production of dissolution porosity by the acid $MgCl_2$-rich brine at the front triggers the *reactive-infiltration instability* (Chadam et al, *IMA J Appl Math* 1986), which forces the front to become scalloped in a cascade of scales. Predictions (2)-(6) are confirmed by observations.

Three errors have bedeviled previous models: that dolomitization happens *via* 2calc + Mg^{++} = dolo + Ca^{++}, that the incoming solution is supersaturated with dolomite, and that the white zebra veins are cements filling preexisting voids. When the white veins are recognized as displacive and the physics of replacement is correctly grasped, the geodynamics of dolomitization falls into place without *ad hoc* assumptions. Quantitative, continuity-based modeling of the dynamics described above is in progress.