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The Origin of Replacement Dolomite, Dolomites, Northern Italy: Part 1

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Massive dolomite typically forms at depth and elevated T through replacement of limestone by its reaction with flowing dolomitizing fluid. Details of the physical mechanisms of flow, and the chemical reactions remain unresolved. Our integrated mapping, stable isotope, and major- and trace-element study of the Triassic Latemar buildup addresses these issues. The Latemar is an ideal study area because dolomitization was arrested with both dolomite and unreacted limestone well-exposed in 3D. Boundaries between the dolomitized and undolomitized regions are sharp (usually <10 cm wide) and are easily mapped because of a color difference between limestone and dolomite. The distribution of dolomite was mapped on buildup- to m-scales to define the flow channels of dolomitizing fluid. Dolomite at lower elevations occurs as brecciated columns or vertical sheets; at higher elevations dolomite occurs mainly as horizontal, bedding-parallel sheets and tubes, and less commonly as vertical breccia pipes and sheets parallel to fractures and margins of dikes. The distribution of dolomite images an orthogonal lattice of interconnected vertical and bedding-parallel flow channels. The $^{87}\text{Sr}/^{86}\text{Sr}$ of Latemar dolomite is 0.7076-0.7079 and fluid inclusions in dolomite have salinities 3.6-5.1 wt % NaCl equivalent [1], implying seawater or seawater-derived fluid was the agent of dolomitization. Dolomite has $\delta^{18}\text{O} = 21.5\text{-}27.4\text{‰}$ (VSMOW), corresponding to $T = 52\text{-}88^\circ\text{C}$ (assuming equilibration with fluid of $\delta^{18}\text{O} = 0$). Calcite in limestone has $\delta^{18}\text{O} = 23.3\text{-}28.4\text{‰}$, corresponding to $T = 25\text{-}52^\circ\text{C}$. Dolomite has $\delta^{13}\text{C} = +1.9$ to $+4.4\text{‰}$ (VPDB), and calcite has $\delta^{13}\text{C} = +1.1$ to $+4.0\text{‰}$. Calcite in limestones has average $X_{\text{Ca}} = 0.987$, $X_{\text{Mg}} = 0.013$, and $X_{\text{Fe}} < 0.001$ (microprobe analysis). Typical dolomite has $X_{\text{Ca}} = 0.537$, $X_{\text{Mg}} = 0.457$, and $X_{\text{Fe}} = 0.006$, although dolomite that occurs in high-T regions is more enriched in Fe: $X_{\text{Ca}} = 0.520$, $X_{\text{Mg}} = 0.464$, and $X_{\text{Fe}} = 0.016$. The presence of Fe in dolomite, as well as Mn- and Zn-enrichment from preliminary LA-ICPMS data, indicates that Triassic seawater alone was not the dolomitizing fluid. We suggest a mixture of Triassic seawater and hydrothermal fluid produced by the reaction of seawater with hot, mafic rocks of the adjacent Predazzo volcanic-intrusive complex that was active during dolomitization.

Reference

[1] Wilson, E. N. et al., (1990) *Am. J. Sci.*, 290, 741-796.