Low-Grade Metamorphism of Carbonate-Bearing Rocks and Veins and Clumped Isotope Research

Contact persons

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Context

An exciting new development in stable isotope geochemistry over the past decade is the measurement of "isotopic clumping" in molecular CO_2 and in crystallized carbonate from which the CO_2 is extracted by acid digestion. This "clumping", which refers to the tendency of having the heavy but rare stable isotopes of carbon and oxygen occurring together in the same molecule of CO_2 relative to their stochastic abundance within the same phase (expressed as Δ^{47}-measurements), is thermodynamically favored (Eiler and Schauble, 2004). The measurement of isotopic clumping thus has the great advantage over conventional measurements of isotopic compositions of CO_2 in that it provides a single-mineral, thermodynamically based geothermometer. Given knowledge on the temperature of carbonate crystallization, the isotopic composition of fluids in equilibrium with the carbonate can then also be determined.

Objectives and Methods

In the realm of low-temperature diagenetic but also low-grade regional and contact metamorphic settings, neotectonism, as well as ore deposit research, the use of Δ^{47}-measurements provides exciting new research avenues to help understand the petrologic evolution. For example, clumped isotope compositions measured for marbles, carbonatites as well as limestones and dolomites that have also been influenced by diagenesis and low-grade metamorphism apparent temperatures of crystallization were between 175 and 300 °C. As peak metamorphic temperatures for marbles are clearly higher, the temperatures obtained may represent final blocking temperatures to internal re-ordering or solid-state diffusion. The converse of this is that the clumped isotope thermometry can provide a new set of constraints on the extents and mechanisms of post-depositional modifications of carbonate. In contrast, retrograde hydrothermal veins may well preserve their clumped isotope composition and hence give temperatures of carbonate crystallization within the veins, which in turn constrains the fluid-rock interactions. These possibilities are to be evaluated in the context of both regional and contact metamorphic domains within the Alps, as well as for retrograde hydrothermal vein carbonates.

Literature

Eiler, J.M., 2007. “Clumped Isotope” geochemistry. The study of naturally occurring, multiply-substituted isotopologues. Earth and Planet. Sci. Lett. 262, 309-327.

Ferry, J.M., Passey, B.H., Vasconcelos, C., Eiler, J.M., 2011. Formation of dolomite at 40 to 80 ºC in the Latemar carbonate buildup, Dolomites, Italy, from clumped isotope thermometry. Geology 39, 571 - 574.

Site WEB

Choice of orientation

2) Geochemistry, Alpine tectonics, Ore Deposits

22.01.2016