American Mineralogist, Volume 82, pages 392–404, 1997

Timing and mechanisms of carbon isotope exchange in granulite-facies calc-silicate boudins, Rauer Group, East Antarctica

IAN CARTWRIGHT,[1] IAN S. BUICK,[2] AND SIMON L. HARLEY[3]

[1]Victorian Institute of Earth and Planetary Sciences, Department of Earth Sciences, Monash University, Clayton, Victoria 3168, Australia
[2]Victorian Institute of Earth and Planetary Sciences, School of Earth Sciences, LaTrobe University, Bundoora, Victoria 3083, Australia
[3]Department of Geology and Geophysics, Grant Institute of Geology, University of Edinburgh, West Mains Road, Edinburgh EH9 3JW, U.K.

ABSTRACT

Mineralogically zoned, decimeter-diameter calc-silicate boudins enclosed within paragneisses from Little Italy Island, Rauer Group, east Antarctica underwent granulite-facies metamorphism (P = 700–900 MPa, T = 840 ± 40 °C) followed by near-isothermal decompression to 200–400 MPa. During decompression several mineral reactions occurred in the presence of a pore fluid ($X_{CO_2} \approx 0.4$). The calc-silicate boudins show a general increase in calcite $\delta^{13}C$ values from core (as low as −17‰) to rim (−9 to −10‰); by contrast, $\delta^{18}O$ values show little variation across the boudins. The $\delta^{13}C$ profiles are similar to those predicted to result from diffusion within a sphere that is surrounded by a homogeneous reservoir. Diffusion of carbon isotopes probably occurred synchronous with the post-peak metamorphic mineral reactions. At that time, centimeter-scale diffusion would have been facilitated by the presence of the fluid, while isotopic exchange between the minerals and the fluid would have been promoted by recrystallization. For metamorphic porosities of $10^{-5} - 10^{-3}$, the $\delta^{13}C$ profiles could have formed in a few thousand to hundreds of thousands of years. Small (millimeter to centimeter) scale variations in $\delta^{13}C$ values that may have been initially present within the boudins would have been homogenized on much shorter timescales than those required to form the profiles. The calculated timescales may reflect the time over which metamorphic recrystallization occurred and a reaction-enhanced porosity was present. Graphite formed locally in the paragneisses only at margins of the boudins probably reflects the local escape of CO_2-bearing fluids from the boudins into relatively low f_{O_2} rocks.