Geophysical Research Abstracts
Vol. 18, EGU2016-15314, 2016
EGU General Assembly 2016
© Author(s) 2016. CC Attribution 3.0 License.

Strain rate and shear stress at the grain scale generated during near equilibrium antigorite dehydration

José Alberto Padrón-Navarta (1), Andréa Tommasi (1), Carlos J Garrido (2), David Mainprice (1), and Maxime Clément (1)

(1) Géosciences Montpellier, Géosciences Montpellier, Montpellier, France (padron@gm.univ-montp2.fr), (2) Instituto Andaluz de Ciencias de la Tierra, CSIC & UGR, Avenida de las Palmeras 4, 18100 Armilla, Granada, Spain

Dehydration reactions are an outstanding case of mineral replacement reactions because they produce a significant transient fluid-filled porosity. Because fluids are present, these reactions occur by interface-coupled dissolution–precipitation. Under poorly drained conditions corresponding to foliated metamorphic rocks, they generate fluid pressure gradients that evolve in time and space eventually controlling fluid migration [1]. Despite the general agreement on this fact, we still lack of a precise knowledge of the complex coupling between the stresses generated during the reaction and the timescales for mineral growth and how they ultimate control the rate of fluid migration. Constraining these rates is challenge because the timescales of the feedback between fluid flow and mineral growth rates at near equilibrium are beyond the current experimental capabilities. For instance, numerical simulations suggest that the draining times of a dehydration front by compaction are in the order of 10–100 ky [1] difficult to translate into experimental strain rates. On the other hand, the natural record of dehydration reaction might potentially provide unique constrains on this feedback, but we need to identify microstructures related to compaction and quantify them.

Features interpreted as due to compaction have been identified in a microstructural study [2] of the first stages of the antigorite dehydration at high-pressure conditions in Cerro del Almirez, Spain (ca. 1.6–1.9 GPa and 630–710 °C). Compaction features can be mostly observed in the metamorphic enstatite in the form of (1) gradual crystallographic misorientation (up to 16°) of prismatic crystals due to buckling, (3) localized orthoenstatite(Pbca)/low clinoenstatite ($P2_1/c$) inversion (confirmed optically and by means of Electron Backscattered Diffraction) and (4) brittle fracturing of prismatic enstatite wrapped by plastically deformed chlorite. The coexistence of enstatite buckling and clinoenstatite lamellae has not been previously reported and offers an unique opportunity to estimate a lower bound for the strain rates and local shear stresses generated during the grain growth and coeval compaction. Estimated values based on experimental creep rates on pyroxene aggregates [3] result in strain rates in the order of 10^{-12} to 10^{-13} s^{-1} and shear stresses of 60–70 MPa. Lower shear stress values (20–40 MPa) are retrieved using the thermodynamic model clinoenstatite inversion of Coe [4] in combination with the hydrostatic high-pressure experimental data on the stability of low clinoenstatite ($P2_1/c$). These data suggest that, under low deviatoric stress, fluid extraction and compaction near equilibrium in natural systems are only marginally higher than the strain rate of the solid matrix. These observations support the relatively long residence time of fluids in dehydration fronts and the necessity to further explore and quantify the feedback between mineral grain growth and fluid migration.

[1] Connolly (2010) Elements 6(3):165–172; [2] Padrón-Navarta et al. (2015). Contrib Miner Petrol 169:35 [3] Raleigh et al. (1971). J Geophys Res 76(17): 4011–4022; [4] Coe (1970). Contrib Miner Petrol 26(3):247–264