

Rheology of fine-grained dolomite at large strains.

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Dolomite $\text{CaMg}(\text{CO}_3)_2$ is a very common mineral in the Earth's crust comprising about 10% of all sedimentary rocks and may therefore play an important role in crustal geodynamic processes. Yet in comparison to the extensive work on calcite, dolomite deformation has received little attention; the conditions that favour different deformation mechanisms have not been determined and flow laws describing high temperature creep have not been reported. More over field observations indicate that dolomite shows an interesting deformation behaviour, while is stronger than calcite at low temperature, it appears to become weaker at elevated temperatures and a relative rheological switch may occur. Around the thermal aureole of the Adamello pluton (North Italy), boudins and ptygmatic folds suggest that dolomite was weaker than calcite.

We produced and deformed up to large strains (γ up to 10) synthetic aggregate of dolomite using a Paterson apparatus equipped with torsion facilities. Flow strength was systematically measured as a function of strain-rate and temperature.

The fabrication of the starting material followed two steps: first cold uniaxial pressing to compact the loose powder and second Hot Isostatic Press (H.I.P.) to sinter the material. HIPping conditions were held constant for 18 hours at 700°C temperature and 170MPa confining pressure provided by Argon gas. The use of synthetic samples for rock deformation studies offers the possibility to control chemical composition and starting microstructure of the material in order to improve the reproducibility of the results.

The resulting material is a homogeneous fine-grained aggregate with an interconnected porosity of 0.9% and density of 2779.7 Kg/m^3 . The initial fabric was measured with the EBSD technique and resulted in a weak preferred orientation of the crystals compatible with the direction of stress applied during the cold-pressing. Cylindrical samples were then deformed in torsion at confining pressure of 300MPa, temperature ranging between 600 and 800°C and strain rate between $1 \times 10^{-6} \text{ s}^{-1}$ and $6 \times 10^{-4} \text{ s}^{-1}$.

The experimental data were fitted to a flow law of the form:

$$\dot{\gamma} = A\tau^n d^{-m} \exp\left(\frac{-Q}{RT}\right)$$

Where $\dot{\gamma}$ is shear strain rate, τ is the shear stress, Q is the activation energy, T is the absolute temperature, R is the gas constant, A is a material parameter and n and m are stress and grain size exponents respectively. The n (= 1.3) and Q (368 KJ/mol) values were experimentally determined while the pre-exponential term A (= 10^{15}) and the grain size exponent m (= -2.6) were estimated by fitting the experimental data to the flow law using a non-linear least squares regression.

Preliminary microstructures analyses carried out under optical and electron microscopy confirm that deformation was accommodated by grain-size sensitive creep involving grain boundary sliding.

The extrapolation of these laboratory measurements to natural conditions may be used to predict and model the mechanical behavior of entire carbonate platforms (e.g. Dolomites in North Italy) during tectonic events.