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Mechanical and microstructural response to multiple deformation events: insights from torsion experiments on Carrara marble.

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Rocks are commonly subjected to tectonic deformation, with the result that they undergo a change of shape (strain). Field observations show that upper crustal shear zones often localize in calcite-rich rocks; it is commonly thought that shear zones remain inherently weak in respect of the surrounding rocks and that they are susceptible to reactivation, thus the observable microstructures might be the result of several deformation events.

We performed a new set of torsion experiments on Carrara marble with the aim of better understanding the evolution of rheology, fabric and microstructures under complicated strain path.

The present study extends the earlier works on experimental deformation of Carrara marble to tests with complicated strain path, with the aim of answering the following key questions:

- how do the steady-state mechanical properties of the resulting mylonites compare with those of the protholiths?
- may dynamic recrystallisation alone lead to localisation of strain in a monophase material?
- what information can we infer from microstructures of a material which under-

went multiple deformation events?

Experimental conditions were: 300 MPa confining pressure, 727° C temperature, 3*$10^{-4}s^{-1}$ shear strain rate, shear strain between 1 and 5 plus symmetric opposite of equal amount. Each sample underwent two symmetric shear strain steps. Once reached the desired shear strain, the sense of torsion was inverted and the experiment went on until the starting position was attained again.

Quantitative microstructural analysis has been carried out on thin sections using UTH-SCSA ImageTool and EBSD analysis: it is not possible to recognize the sense of shear from the less deformed samples ($\gamma = \pm$ 1 and $\pm$ 2), while in largely sheared samples ($\gamma = \pm$3, 4 and 5) recrystallization mechanisms create an evident foliation with sense of shear oriented in agreement with the latest torsion direction.