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Micro-scale strain mapping technique: a tool to quantify strain partitioning during creep deformation

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Several deformation mechanisms interact to accommodate plastic deformation. Quantifying the contribution of each to the total strain is necessary for establishing a better link between observed microstructures and mechanical data, as well as to allow more confident extrapolation from laboratory to natural conditions.

In this contribution, we present the experimental and computational technique involved in micro-scale strain mapping (MSSM). The MSSM technique relies on analyzing the relative displacement of initially regularly spaced markers after deformation. We present several microfabrication techniques that permit us to pattern various rocks with micrometric and nanometric metal markers, as well as the challenges faced in working at high temperatures and pressures. A Hough transform algorithm was used to detect the markers and automate as much as possible the strain analysis. The von Mises strain is calculated for a set of n-points and their relative displacements, which allow us to map the strain at different length scales.

We applied the MSSM technique to study strain partitioning during deformation creep of Carrara marble and San Carlos olivine at a confining pressure, *Pc*, of 300 MPa and homologous temperatures of 0.3 to 0.6.

We measured the local strain and strain heterogeneity produced during creep deformation of split cylinders of Carrara marble under conventional triaxial loading to inelastic strains of 11 to 36% at a strain rate of 3x$10^{-5}$$s^{-1}$, *Pc* = 300 MPa and $400^o < T < 700^o$C. We conclude that the evolution of deformation structures in marble takes place over a substantial interval in strain and that the duration of this interval depends on strain rate, temperature, and pressure.

Our first results on strain mapping of olivine deformed at T = 1150^{o}C and *Pc* = 300 MPa demonstrate promise for characterizing intragranular strain and better defining the contribution of grain boundary sliding to the total strain.