Geophysical Research Abstracts
Vol. 17, EGU2015-8599, 2015
EGU General Assembly 2015

Three-Dimensional pore space and strain localization distribution in Majella limestone.

Yuntao Ji (1), Stephen Hall (2), Patrick Baud (3), Teng-fong Wond (4,5)

(1) State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration, Beijing 100029, China (jiyuntao@ies.ac.cn), (2) Division of Solid Mechanics, Lund University, Lund Sweden and European Spallation Source AB, Lund, Sweden, (3) Institut de Physique du Globe de Strasbourg (UMR 7516 CNRS, Université de Strasbourg/EOST), Strasbourg, France, (4) Department of Geosciences, Stony Brook University, NY 11790-2100, USA , (5) Earth System Science Programme, Faculty of Science, The Chinese University of Hong Kong

Brittle-ductile transition in porous rock is a topic of importance in many geological applications. Traditionally pore space in rock is characterized using optical and scanning electron microscopes (SEM). Advances in 3-dimensional imaging techniques such as X-ray computed tomography (CT) and laser scanning confocal microscopy have furnished enhanced perspective on pore geometry complexity. In particular, X-ray CT has been used widely for characterizing porous clastic rocks such as sandstone, whose void space is dominated by relatively equant pores connected by throats that are sufficiently large for direct imaging by X-ray microCT.

However, standard techniques for CT imaging are not directly applicable to a carbonate rock because of the geometric complexity of its pore space. In this study, we first characterized the pore structure in Majella limestone. MicroCT data was partitioned into three distinct domains: macropores, solid grains and an intermediate domain made up of voxels of solid embedded with micropores below the resolution. A morphological analysis of the microCT images shows that both the solid and intermediate domains in Majella limestone are interconnected as it has been previously reported in a less porous limestone. We however show that the macroporosity in Majella limestone is fundamentally different, in that it has a percolative backbone which may contribute to significant enhancement of its permeability.

We then present the first application of 3D-volumetric Digital Image Correlation (DIC) to a very porous limestone. If images of a rock sample are acquired before and after deformation, then DIC can be used to infer the displacement and strain fields. In our study, four Majella limestone samples were triaxially compressed at confining pressures ranging from 5 MPa to 25 MPa and another under hydrostatic conditions up to 60 MPa. For each of these five samples, two CT images were acquired before and after the deformation. We then used the TomoWarp code to perform 3D volumetric DIC on the pairs of images to derive the permanent displacement field and the full 3D strain tensor field of each sample. Our DIC analysis has revealed the structure of high-angle compacting shear bands in the transitional regime in Majella limestone. Our DIC data also indicate an increase of geometric complexity with increasing confinement - from a planar shear band, to a curvilinear band, and ultimately a diffuse multiplicity of bands, before shear localization is inhibited as the failure mode completes the transition to delocalized cataclastic flow.