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Acoustic emissions in rock deformation experiments under micro-CT

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The study of acoustic emissions (AE) generated by rocks undergoing deformation has become, in the last decades, one of the most powerful tools for boosting our understanding of the mechanisms which are responsible for rock failures. AE are elastic waves emitted by the local failure of micro- or milli-metric portions of the tested specimen. At the same time, X-ray micro computed tomography (micro-CT) has become an affordable, reliable and powerful tool for imaging the internal structure of rock samples. In particular, micro-CT coupled with a deformation apparatus offers the unique opportunity for observing, without perturbing, the sample while the deformation and the formation of internal structures, such as shear bands, is ongoing.

Here we present some preliminary results gathered with an innovative apparatus formed by the X-ray transparent pressure vessel called ERDμ equipped with AE sensors, an AE acquisition system and a micro-CT apparatus available at the University of Toronto. The experiment was performed on a 12 mm diameter 36 mm long porous glass sample which was cut on a 60 deg inclined plane (i.e. saw-cut sample). Etna basaltic sand with size $\sim$1 mm was placed between the two inclined faces forming an inclined fault zone with $\sim$2 mm thickness. The sample assembly was jacketed with a polyefin shrink tube and two AE sensors were glued onto the glass samples above and below the fault zone. The sample was then enclosed in the pressure vessel and confined with compressed air up to 3 MPa. A third AE sensor was placed outside the vessel.

The sample was saturated with water and AE were generated by varying the fluid and confining pressure or the vertical force, causing deformations concentrated in the fault zone. Mechanical data and AE traces were collected throughout the entire experiment which lasted $\sim$24 hours. At the same time multiple micro-CT 3D datasets and 2D movie-radiographies were collected, allowing the 3D reconstruction of the deformed sample at different stages and the 2D visualization (5 frames per seconds) of the ongoing deformation, respectively.

The present contribution demonstrates that it is possible to combine different powerful techniques to better constrain the variables involved in deformation experiments to gain insight into the failure processes. The developed technique will be beneficial for the study of rock-mechanics and rock-physics for instance in the field of applied seismology.