



Mechanical and Field Studies of Deformation Localization in Rocks,

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MEETING

Mechanical and Field Studies of Deformation Localization in Rocks

Refining Constitutive Characterization of Geomaterials and Identifying Their Rupture Mechanisms in Natural Conditions; Montpellier, France, 7–8 September 2011

PAGES 171–172

Results from rock testing and geological observations of different types of deformation bands and fractures highlight the problem of understanding the underlying formation mechanisms from granular (micro) to outcrop scale. Particularly puzzling are recently discovered compaction and dilatancy bands that are completely antipodal features. Both are narrow (several grain diameters thick), generally not planar but rather irregular and zigzagging (depending on the observation scale) bands that can form in the uniformly stressed rocks. The difference between them is that the compaction bands form at a relatively high pressure (mean stress) normal to the maximal compressive stress. The material within the compaction bands undergoes volume reduction due to the more dense grain packing and/or crushing. Conversely, the dilatancy bands form at low pressure and normal to the least compressive stress. The material within them undergoes a volume increase due to grain rearrangements and/or formation of intra-granular and intergranular microfractures. The dilatancy bands can become opened fractures with further deformation.

Both bands and fractures have practical importance in geological reservoirs, which motivated a workshop uniting university and petroleum-industry researchers. The main aim

was to raise the communication level between rock mechanics experimentalists, theoreticians, numerical modelers, and geologists and, where possible, to synergize the research between these different communities.

One day of the workshop consisted of presentations that emphasized mechanical studies. Microphysical processes and properties were shown to control rock capacity to form localized compaction bands in carbonates (T.-F. Wong, State University of New York at Stony Brook) and sandstones (P. Baud, Université de Strasbourg), which show very different behaviors. The use of acoustic emissions in combination with microstructural observations in porous sandstones and basalts clarify the initiation and evolution of deformation localization and rupture (J. Fortin, Ecole Normale Supérieure (ENS), Paris). True three-dimensional tests in different porous geomaterials together with previously inaccessible information on the initiation of the deformation localization and its “postbifurcation” evolution at all scales were presented by P. Bésuelle (Université de Grenoble). This information is crucial for constraining theoretical models and numerical simulations of the instabilities that result in deformation localization and rupture. The known limits of the classical bifurcation analysis (both theoretical and numerical) and their possible extensions were presented (P. Bésuelle and Y. Leroy, ENS).

Bridging the gap between investigations of material failure in the laboratory and in natural (geological) conditions appears to be a major challenge (S. Raynaud and G. Vasseur, Géosciences Montpellier (GM)). Numerical simulations of outcrop-scale deformation bands provide details on the constitutive behavior of the geological material: Well-characterized geological sites can be considered as natural rock mechanics laboratories where the processes develop on large (natural) spatial and time scales. Physical modeling links real rock testing and geological processes (A. Chemenda, Géoazur; J.-P. Petit, GM).

To reinforce the links between laboratory and theoretical studies and geological processes, one day was devoted to analyzing relevant outcrops: compactive shear bands in Orange quarries, and limestones at Tavel, the source of the samples thoroughly studied in laboratory tests (P. Baud and T.-F. Wong et al.). At the latter site the emphasis was put on the sample selection with a view to geological applications. Observations of spectacular plumose patterns in the jointed pelites of the Lodève Permian basin triggered discussion on their origin. A new interpretation is dilatancy banding (which has emerged from recent experimental and field studies (C. Jorand et al., *Tectonophysics*, 2012, in press, and references therein)), contrasting with the classical mixed-mode fracture mechanics models. Interpretations clearly depend on the scale of analysis. It was concluded that the collaborative efforts of scientists with diverse backgrounds is essential more than ever to progress. Combining the experimental and numerical studies with the analysis of geological features at various scales in areas with well defined loading history deserves rigorous development.

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