



Field, Experimental, and Numerical Studies of Deformation Localization Bands

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MEETING

Field, Experimental, and Numerical Studies of Deformation Localization Bands

Characterization and Formation Mechanisms of Deformation Localization Bands (Shear, Compaction, and Dilatancy): Field and Experimental Data, Theoretical Analysis and Numerical Models; Montpellier, France, 9–10 May 2011

PAGES 364–365

The origin of fractures and discontinuities in rocks has been for decades a subject of common interest in both the academic world and industry, as these features influence hydrocarbon reservoir production. Fractures (notably joints) and deformation bands are usually analyzed on a separate basis. Joints have commonly been interpreted as mode I fractures using fracture mechanics, whereas the bifurcation theory has been used for deformation bands. This diversity was called into question by the research carried on by the Geo-FracNet consortium sponsored by Total and Shell International. New findings (A. I. Chemenda et al., *J. Geophys. Res.*, 116, B04401, doi:10.1029/2010JB008104, 2011, and references therein) suggest that at least a part of joints could have been formed as dilatancy (dilation) bands, i.e., due not to the strong effective tensile stress concentration at the opening fracture tip but to the porosity increase and decohesion (perigranular and/or intragranular grain breakage) of the material within a band several grains thick. The band (material damage and dilatancy within it) can propagate along the strike without opening and can eventually be opened.

These experimental and field-based results and their potential industrial

importance led to a workshop that united academic and industrial researchers (Total, Shell, and Badley Ashton) from different countries. Its main aim was to confront different approaches and define the objectives for future collaborative research.

During a field trip the origin of deformation bands was discussed around the example of a spectacular band network in sands (Orange, Provence). In the Lodèvre area a dense joint network in low-porosity rocks (dolomiticite) was examined, and scanning electron microscope (SEM) images of a section of embryonic joints from this site showing a dilatancy band structure were discussed (see Figure S1 in the online supplement to this *Eos* meeting report (http://www.agu.org/journals/eo/v092/i042/2011EO420005/2011EO420005_suppl.pdf)). The relation of the dilatancy bands to the plumose morphology of their borders (characterized by delicate diverging ridges and grooves) in both field examples and experiments was discussed.

Presentations were oriented toward detailed field analysis of deformation bands from the United States and France, with emphasis on grain-scale structure (R. Schultz, University of Nevada; R. Soliva, Geosciences Montpellier (GM)) and impact on permeability (C. Wibberley, Total). Polyaxial as well

as conventional compression and extension tests on synthetic granular rock analog materials were shown to be complementary to the rock tests and an efficient tool for investigation of the deformation localization mechanism. SEM images, as well as theoretical and finite difference numerical analyses of the experimental results, suggest that most natural fractures and bands may result from constitutive instabilities and unstable postbifurcation evolution or propagation of deformation (A. Chemenda, University of Nice Sophia Antipolis; J.-P. Petit, GM). A way to relate the macroconstitutive material properties used in the continuum models to the microphysics (grain interaction) of the localization phenomenon could be the use of discrete element numerical models (A. Taboada, GM).

Discussions were aimed at the convergence of field and physical or numerical studies for reservoir structure prediction. It was suggested that observations should concentrate on the grain scale, where the distinction between sharp and tabular discontinuities tends to vanish. The evolution from elementary bands to band clusters and to faults deserves more study. Numerical models now allow the generation of quite realistic three-dimensional localization band systems in three dimensions. Further progress is hampered in particular by the limitation of the existing constitutive models. Adjusting constitutive formulations that take into account all types of data appears to be an indispensable approach, and this was dealt with at the workshop “Refining Constitutive Characterizations of Geomaterials and Identifying Their Rupture Mechanisms in Natural Conditions,” which was held in southern France on 7–8 September 2011.

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