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Fracture patterns and Magnetic fabric in the "Chaudrons fault-propagation fold" (SE Pyrenees, France): Implications for fracture-related permeability in convex traps.

Francesco Salvini*, Laurent Louis**, Christine Souque**, Stefano Tavani*, Pascale Leturmy**, Philippe Robion** and Dominique Frizon de Lamotte**

* Università "Roma Tre"
** Université de Cergy-Pontoise, CNRS UMR 7072, Avenue du Parc, 95 031 Cergy Cedex, France

Fracturing and strain associated to the development of fault-related folds often play an important role in the compartmentalisation of reservoirs. Two general end-member models usually apply in this case. The fixed-hinge model implies that fracturing intensity relates to the curvature induced in the hangingwall rocks. Active hinge model has more recently proposed, is strongly influenced by the kinematics of the fault, namely the deformation recorded at the front of the propagating fault and the deformational history of hanging-wall rocks during their movement above non-planar faults. These two models produce often very different results in the prediction of the spatial distribution of deformation in the hangingwall. Predictive tools for active-hinge tectonics allow to predict the relative intensity and spatial distribution of fracturing and strain in hangingwalls. Still some difficulties resides in converting these results into quantitative evaluation of fracturing, such as their dimensions, spacing, and other rock properties. We present preliminary results from a research project focussing on the comparison of the spatial distribution of brittle deformations with numerical models (HCA modelling) and strain with magnetic fabric in well exposed fault-related folds of the Pyrenees.

The "Chaudrons fold" locates in the Corbières transfer zone (NE Pyrenees) and consists in an E-W trending, 3 km wide anticline where outcropping rocks range in age from Upper Cretaceous to Eocene. Older outcropping terms are represented by lacustrine limestones conformably covered by "Vitrolian" (Lower Eocene) clastics (conglomerates and silicoclastic continental deposits). Middle Eocene is again represented by lacustrine limestones. Folding in the region occurred during Upper Eocene. The "Chaudrons fold" is characterised by a steep forelimb and a flat roof. Its geometry fits very well with a fault-propagation fold and a tentative kinematic scenario following this model will be given. The back of the fold is offset by normal faults formed during a Late Oligocene-Miocene event.

Deformations (pervasive fractures and cleavage sets) have been carefully measured in the "Vitrolian" clastics along two continuous transects: the first one along the forelimb to the crest transition and the second along the roof. In addition, we have collected 77 core-samples in the same stratigraphic level in order to perform anisotropy of magnetic susceptibility (AMS) measurements. This method is demonstrated to be an efficient tool to record strain within rocks. It appears as complementary to fracture analysis because it gives an access to the matrix properties.

The fracture pattern has been characterised by the dimensions of the clasts in between adjacent fractures, as produced by the interference of anastomosed fractures with bedding. The aspect ratio of these clasts has been used to monitor the spatial variation of the fracturing intensity along the fold. Results show a progressive increase of the deformation intensity going from the crest (where the cleavage reduces to non-penetrative small fractures normal to bedding) towards the forelimb (where the cleavage is penetrative and oblique to bedding). The found fracture distribution as well as the bedding/cleavage angular relationships matches with an active-hinge model agreeing with the proposed kinematic scenario. AMS measurements show that the matrix follows the same bulk evolution with a strain increase from the crest to the forelimb. This evolution is underlined by progressive changes of magnetic foliation and lineation attitudes. Magnetic foliation is parallel to cleavage and changes from perpendicular to oblique relative to bedding. Magnetic lineation changes from parallel to the cleavage-bedding intersection to a direction at right angle.

As a conclusion, we expect that, both at fracture and matrix scales, reservoir similar to the “Chaudrons” fold (i.e. developed within fault-propagation folds) will have higher permeability along the steep forelimb rather than in the crest zone. Measurements of other physical properties (electrical conductivity, permeability and acoustic velocity) are planed to confirm these expectations.