Geophysical Research Abstracts
Vol. 14, EGU2012-14266, 2012
EGU General Assembly 2012

Influence of chemistry and climate on large induced large scale stresses in anisotropically fractured carbonates.

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We will explore a simple model coupling for carbonate rocks the fracture density and orientation, the water chemistry and transport, the dissolution reactions and the expected irreversible rock deformation. Adding elasticity and boundary conditions, plus an estimation of the water source composition in the formation, we will estimate orders of magnitudes of the stress changes that can be expected from these processes in sedimentary basins over long times. We will in particular examine whether such intrinsic deformation mechanism can give a hint to explain the observed anisotropic stresses, in orientation and magnitude, in zones above the C.O.X. argillite formation in the Paris Basin, where the horizontal stress anisotropy has been shown to be important, whereas stress decoupling from the deep crustal roots should be effective, and no strong anisotropy would be expected in the absence of active deformation mechanism.

In the Paris basin, the analysis of log cores shows that fractures and joints, up to meter-long ones, are common anisotropic features present in the carbonate rocks. Dissolution of calcite along these oriented features removes material with an a priori oriented flux reflecting this structural anisotropy, resulting in a non-isotropic deformation associated to this dissolution.
We will present a simple model where dissolution and transport of dissolved calcite is associated with the deformation of the carbonate rock. Estimating the reaction constants, the chemical composition variation of the meteoric water, the rock permeability and the fracture density from observations around the Bure underground laboratory, we will estimate the order of magnitude of the deformations expected from these types of mechanisms. Such estimates have already been performed for dissolution along stylolites, e.g. by Clark, 1966; Renard et al., 2004; Schmittbuhl et al., 2004; Koehn et al., 2007. We will adapt these to reflect the anisotropic feature of the fractures present in the carbonate rocks. In contrast to the mechanisms described in the work of Gunzburger and Cornet (2007), we propose here to take into account the anisotropy of the dissolution surfaces, leading to the possible anisotropy of the resulting deformation (whereas the latter mechanisms resulted in axisymmetric stresses).
This will be translated into stresses with simple hypothesis for the boundary conditions. The order of magnitude of the results will then be confronted to the stress observed and reported by Wileveau et al. [2007].
We will describe a simple mechanico chemical coupling model for the deformations associated to calcite dissolution in anisotropically fractured carbonate rocks. This model, properly upscaled, can serve as a basis for multiphysics simulations, in continuous models described by finite elements, or in network based models. It can also help to estimate orders of magnitudes of the expected effects on the stress, and

compare these to the observations.

Clark, S. P. J. 1966. Handbook of Physical Constants. Geological Society of America, New York.
Cornet, F.H. and Röckel, T. 2011. Vertical stress profiles and the significance of “stress decoupling”, submitted
Gunzburger Y., Cornet F.H., 2007; Rheological characterization of a sedimentary formation from a stress profile inversion; Geophys. Jou. Int.; 168, pp 402-418.
Koehn, D., Renard, F., Toussaint, R. & Passchier, C. W. 2007. Growth of stylolite teeth patterns depending on normal stress and finite compaction. Earth and Planetary Science Letters 257(3-4), 582-595.
Renard, F., Schmittbuhl, J., Gratier, J. P., Meakin, P. & Merino, E. 2004. Three-dimensional roughness of stylolites in limestones. Journal of Geophysical Research-Solid Earth 109(B3)
Schmittbuhl, J., Renard, F., Gratier, J. P. & Toussaint, R. 2004. Roughness of stylolites: Implications of 3D high resolution topography measurements. Physical Review Letters 93(23).
Wileveau, Y., Cornet, F.H., Desroches, J. and Blümling P., 2007. Complete in situ stress determination in an argillite sedimentary formation.- Physics and Chemistry of the earth, 32, 866-878, Elsevier