

## Séance technique du 27 Octobre du CFMR

Animée par Ahmad Pouya

Le congrès ISRM 2011 à Pékin a suscité un grand nombre de propositions de communications sur les travaux de Mécaniques des Roches français dont 18 ont pu être sélectionnés en vue d'une présentation à ce congrès. Le CFMR consacre sa séance du 27 octobre à la présentation d'une partie de ces travaux afin de permettre l'échange et discussions avec les auteurs aux personnes n'ayant pas pu se rendre à Pékin. Les contraintes de temps et de disponibilité des auteurs ont conduit à inscrire la présentation de 6 de ces communications dans le programme de la séance.

14 h : **Introduction**, Ahmad Pouya

14h10 : **1<sup>er</sup> Partie : Expérimentation et observation**

- **Creep closure rate of a shallow salt cavern**

P. Bérest, J.F. Béraud & V. de Greef<sup>1</sup>, B. Brouard<sup>2</sup>, E. Hertz & C. Lheur<sup>3</sup>

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- **Mine by experiment performed in the Callovo-Oxfordian claystone at the Meuse Haute Marne Underground Research Laboratory (France)**

Gilles Armand, Aurélien Noiret, Martin Cruchaudet, Nathalie Conil

*National Radioactive Waste Management Agency, Centre de Meuse Haute-Marne, Bure, France*

- **Experimental analysis of deformation mechanisms induced by desiccation in Tournemire argillites using DIC method**

S. Hedan<sup>a</sup>, P. Cosenza<sup>a</sup>, V. Valle<sup>b</sup>, A.L. Fauchille<sup>a</sup>, P. Dudoignon<sup>a</sup>, J. Cabrera<sup>c</sup>

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15h10-15h20 : **Pause**

15h20-16h20 : **2<sup>ème</sup> Partie : Modélisation numérique**

- **Hydromechanical modeling of an underground excavation with an elastoviscoplastic behavior law and regularization**

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• **Hydraulic stimulation of geothermal wells: Modeling of the hydro-mechanical Behavior of a Stimulated Fractured Rock Mass**

S. GENTIER, X. RACHEZ, M. PETER-BORIE, A. BLAISONNEAU  
*Department of Geothermal Energy, BRGM, 3 Av., Claude Guillemin, BP 6009, 45060 ORLEANS Cedex2 (FRANCE)*

• **Post-closure hydromechanical behaviour of a backfilled cavity**

N. Dufour & H. Wong  
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## Résumés

### Creep closure rate of a shallow salt cavern

P. Bérest, J.F. Béraud & V. de Greef<sup>1</sup>, B. Brouard<sup>2</sup>, E. Hertz & C. Lheur<sup>3</sup>

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**ABSTRACT:** Cavern creep closure rate was recorded in the SG13-SG14 salt cavern of the Gellenoncourt brine field operated by CSME at Gellenoncourt in Lorraine, France. Cavern compressibility and the evolution of cavern brine temperature first were measured. In this shallow cavern (250-m deep), which had been kept idle for 30 years, cavern-brine thermal expansion can be disregarded. To assess cavern closure rate, a 10-month brine-outflow test was performed, followed by a 6-month shut-in test. During the tests, brine outflow or pressure evolution is influenced by atmospheric pressure changes, ground temperature changes and Earth tides. From the average pressure-evolution rate, it can be inferred that the steady-state cavern closure rate is slower than  $10^{-5}$ /yr or  $3 \times 10^{-13}$ /s.

### Mine by experiment performed in the Callovo-Oxfordian claystone at the Meuse Haute Marne Underground Research Laboratory (France)

Gilles Armand, Aurélien Noiret, Martin Cruchaudet, Nathalie Conil

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**ABSTRACT:** In the frame work of feasibility study of deep repository in a claystone, it is interesting to perform in situ Mine-by experiment in order to characterize excavation-induced damage and determine relationships governing the behavior of a rock mass. This paper presents the concept of the mine-by experiment performed at the main level of the Meuse Haute-Marne underground research laboratory in the Callovo-Oxfordian claystone. The support is ensured by an 18 cm thick fibre reinforced shotcrete shell, interrupted by 12 yieldable concrete wedges in order to let squeezing of the drift. The first hydro mechanical results recorded during the digging of a 60 m long circular drift are presented and discussed.

### Experimental analysis of deformation mechanisms induced by desiccation in Tournemire argillites using DIC method

S. Hedan<sup>a</sup>, P. Cosenza<sup>a</sup>, V. Valle<sup>b</sup>, A.L. Fauchille<sup>a</sup>, P. Dudoignon<sup>a</sup>, J. Cabrera<sup>c</sup>

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**ABSTRACT:** The hygro-mechanical behaviour of Tournemire argillite was studied by measuring the deformation induced by a desiccation process. The used non-invasive method called “Digital Image Correlation” (DIC) enables easily the measurements of strain fields during a physical transformation. A set of samples taken from the Tournemire site was submitted to a desaturation process in an oven at five temperatures: 40°C; 80°C, 105°C, 150°C and 200°C. Strain results have shown that the observed deformation mechanisms are mainly controlled by the rock heterogeneities (inducing strain localizations). The microcracks induced by desiccation were parallel to the bedding planes and located at the interface between non-clayey grains/heterogeneities (here calcite nodules) and the clay matrix. After a few hours of heating, a closure of these microcracks associated with a decrease of strain localizations was observed.

## **Hydromechanical modeling of an underground excavation with an elastoviscoplastic behavior law and regularization**

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**ABSTRACT:** In the context of nuclear waste storage in deep geological formation, a hydromechanical modeling in saturated conditions has been effectuated, using in the same time an elastoviscoplastic behavior law (*L&K* model) and a regularization method (second gradient of dilation). While classical Biot's framework is followed for the hydromechanical coupling, the mechanical *L&K* model offers a coupling between instantaneous and delayed behavior and a variation of dilation often related to a softening. The regularization method allows to avoid mesh dependency and numerical localized results. The application of this approach on a gallery of the underground research laboratory of Bure shows a good agreement between numeric results and *in situ* data.

## **Hydraulic stimulation of geothermal wells: Modeling of the hydro-mechanical Behavior of a Stimulated Fractured Rock Mass**

S. GENTIER, X. RACHEZ, M. PETER-BORIE, A. BLAISONNEAU  
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**ABSTRACT:** The concept of Enhanced Geothermal System has the necessity to increase the local permeability around the wells in low permeability fractured rock masses. The hydraulic stimulation used at various depths in the wells of the Soultz-sous-Forêts geothermal site (France) has yielded an effective and irreversible increase in permeability, which is associated with microseismic events. The understanding of the mechanisms that lead to local increases in permeability is essential to the development of this technique. A 3D Distinct Element Method model was developed, with a specific hydro-mechanical coupling, where flow takes place only in the fractures and the rock matrix is impermeable and deformable. The constitutive law of the fault zones is a Mohr-Coulomb law for the mechanical part with an independent associated dilatancy law for the hydraulic part. The results obtained clearly indicate how an irreversible increase in the permeability is caused by the shearing that occurs in the fault zones during the hydraulic stimulation tests. The location of this shearing in the fault zones results from the combination of the in-situ stresses, their orientations, and their interconnections.

# Post-closure hydromechanical behaviour of a backfilled cavity

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**ABSTRACT:** The safety assessment of a radioactive waste disposal facility in a deep geological formation requires to consider its hydromechanical behaviour, especially in the post-closure phase when the cavities are backfilled. The linings are subsequently no longer maintained and their mechanical integrity slowly decreases. If the host-rock is saturated with water and subject to creep, a new hydromechanical equilibrium will result between the host-rock and the backfill and it is important to check whether this phenomenon could enhance the dissemination of radioactive elements. In this paper, this question is tackled by developing in Cast3M software a numerical model coupling hydromechanics and damageable viscoplasticity. Application of this modelling to simple cases is validated by comparison with quasi-analytical solutions. The model is then applied to the case of a circular gallery excavated in a poro-viscoplastic medium, taking into account different phases of construction. The effects of lining failure mode (sudden or slow) and of the initial compaction of the backfill on water pressures are assessed.