

## Numerical computations of chemo-mechanical coupling for CO<sub>2</sub> geological storage

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### Abstract:

The geological storage of CO<sub>2</sub> is considered as one of the solutions to the problem of global warming. The most possible scenarios of geological behavior of soil in the long term conditions has to be precisely defined to avoid catastrophic damages in the future. Chemical properties of saline water in the aquifer after the CO<sub>2</sub> injection becomes more acidic with time. Therefore, chemical degradation of rock occurs, which leads to modifications of its mechanical properties (chemo-mechanical coupling) [1]. In this paper an incremental model of chemo-mechanical coupling using homogenization approach (asymptotic expansion method [2,3]) is proposed. The paper is focused on the numerical computations for the X-ray tomography image of carbonate rock microstructure [4]. The chemical degradation of the microstructure is obtained as a homogeneous dissolution in each direction (Fig.1. – Fig.2.)

For every porosity state numerical computations to obtain full, orthotropic elasticity tensor are performed. Therefore, the degradations functions for all components of the rigidity tensor were defined (Fig.3.). Moreover, results of numerical calculations of diffusion, tortuosity and permeability tensors are presented [5,6]. The link between geometrical properties and mechanical and transport parameters are discussed. The numerical analysis of the carbonate rock sample in long term conditions shows the increase of porosity and associated mechanical weakening of the rock. Moreover, the increase of diffusion, tortuosity and permeability tensors elements with time were observed. Finally, the solution of the one-dimensional macroscopic problem of soil settlement due to chemical dissolution of rock at constant load is presented. The method is universal, in the sense that the non-dimensional time scale is used.

### REFERENCES

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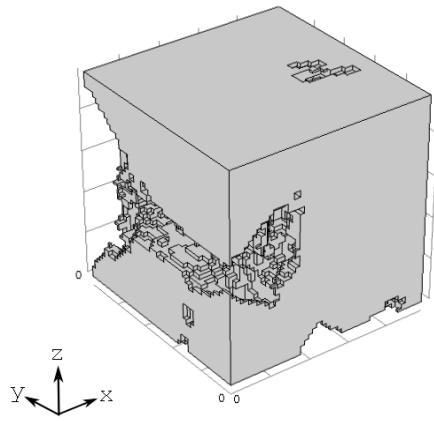


Fig. 1. Initial geometry of solid space [7].

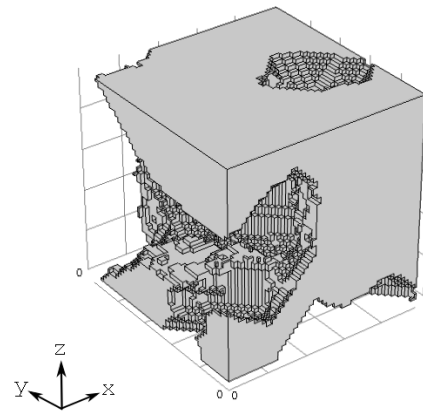
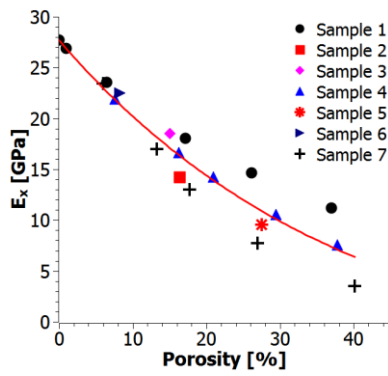
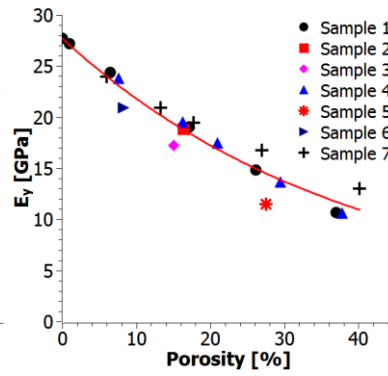


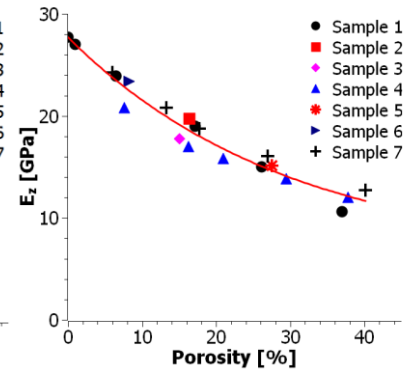
Fig. 2. Final geometry of solid space [7].



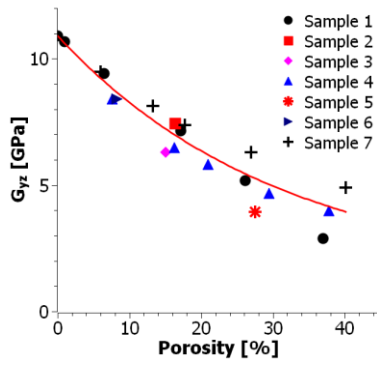
(a) Young modulus  $E_x$



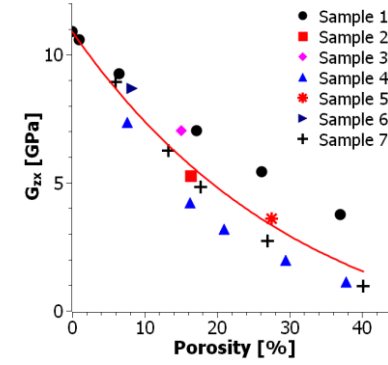
(a) Young modulus  $E_y$



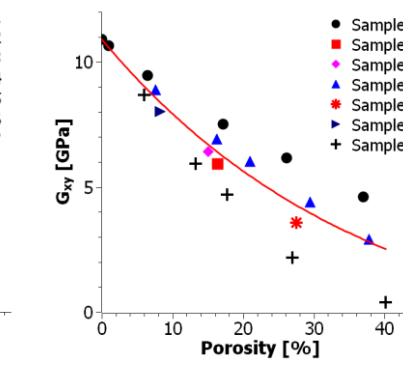
(a) Young modulus  $E_z$



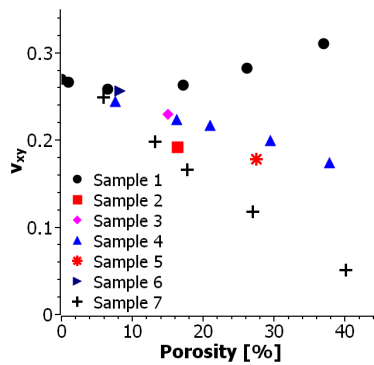
(d) Shear modulus  $G_{yz}$



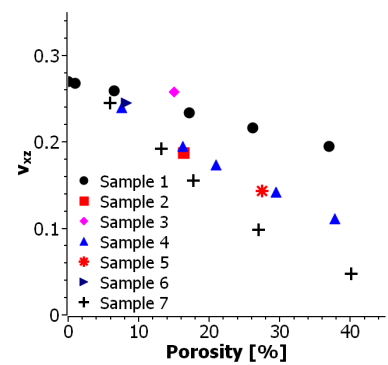
(e) Shear modulus  $G_{zx}$



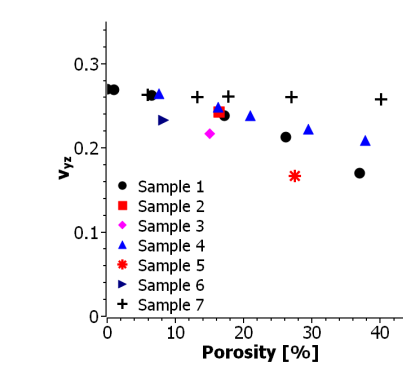
(f) Shear modulus  $G_{xy}$



(g) Poisson ratio  $V_{xy}$



(h) Poisson ratio  $V_{xz}$



(i) Poisson ratio  $V_{yz}$

Fig. 3. The degradation functions of the engineering parameters [7].