A New Conceptual Model of Compaction Creep in Carbonate Rocks

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ABSTRACT

Rocks subject to compressional or shear stresses can deform slowly and irreversibly during time. In large scale this can be observed as compacting reservoirs due to fluid (hydrocarbon or water) production[1] and creeping faults at strike-slip plate boundaries[2].

We created a simple conceptual micromechanical model of compaction creep in rocks under hydrostatic conditions. This model combines microscopic fracturing and pressure solution and if scaled up to macroscopic scale by a statistical approach it can be used to predict strain rate at core scale. The model uses no fitting parameter and has few input parameters: effective stress, porosity, pore size distribution, temperature and water saturation. Internal parameters are Young's modulus, interfacial energy of wet calcite and the dissolution, diffusion and precipitation rates of calcite, all of which are measurable independently. We specifically investigated how to obtain good pore size distribution data from X-ray tomography and built a deep learning neural network to extract pore volume information from the tomography images.

The model was tested against existing long-term creep experiments and it was able to predict the magnitude of the resulting strain under largely different effective stress, temperature, water saturation and fluid chemistry conditions.

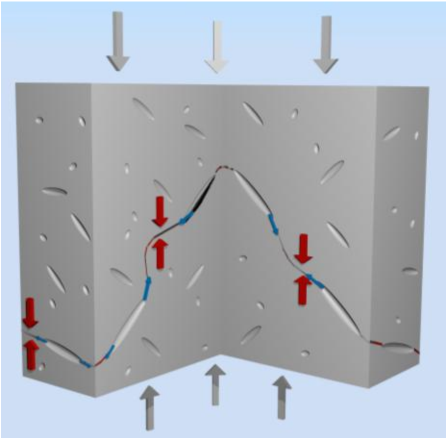

Fig. 1 The illustration of the micromechanical model of compaction creep

References

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