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A model of compaction creep in carbonates

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Rocks in compressional stress conditions are subject to long-term creep deformations. We created a simple conceptual micomechanical model of creep in rocks combining microscopic fracturing and pressure solution. This was then scaled up to macroscopic scale by a statistical mechanical approach to predict strain rate at core scale. The model uses no fitting parameter and have a 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 dissolution rates of calcite, all of which are measurable independently.

Existing long-term creep experiments were used to verify the model which was able to predict the magnitude of the resulting strain in largely different effective stress, temperature and water saturation conditions. The model was also able to predict the compaction of a producing chalk reservoir with a good agreement. Further generalization of the model might function as a general theory of long-term creep of rocks in compressional settings.