Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.15232

Modeling Pressure Solution as Coupled Geometry, Geomechanics and Reactive Transport

MENGSU HU AND CARL I STEEFEL

Lawrence Berkeley National Laboratory

Presenting Author: mengsuhu@lbl.gov

This work presents recent collaborative effort with Carl Steefel—a pioneer in the field of reactive transport and computational geosciences. Pressure solution plays an important role in engineering and natural Earth systems where solid interfaces are often stressed while immersed in reactive fluids. Although not always widely recognized, pressure solution involves tight coupling between the geometry and thermal-hydro-mechanical-chemical (THMC) processes that include dissolution of minerals at interfaces that are subject to high contact stress, diffusive transport of the dissolved species in the pore space, and precipitation on relatively lower stressed interfaces. As a result of pressure solution, the geometry of the solid interfaces and fluid chemistry are typically changed, leading to further changes in THMC processes in the system. In this study, we present the recent work on modeling pressure solution where we rigorously consider the coupling of the evolving geometry and the THMC processes. We first consider the compaction of a loosely packed salt aggregate [1]. Then we examine the impacts of geometry and temperature on pressure solution in a natural salt rock [2]. This modeling capability is achieved by linking a geomechanical code based on the numerical manifold method (NMM) to CrunchFlow- a reactive transport code that was developed by Carl Steefel. Based on this first quantitative MC model, we found that sharp corners of mineral grains can dominate the contact dynamics, microfracturing, and pressure solution during compaction, thus governing the structural changes of the system. Pressure solution, which preferentially dissolves sharp corners and edges, can lead to relatively high porosity loss in the system, and thus plays an important role in the creep of salt. We show that the dynamic changes of granular salt systems involving grain relocation and pressure solution can occur repeatedly and continuously during long-term creep [1]. Where temperature gradients are present, we found nonetheless that the grain geometry plays an even more important role because it determines the stress distribution and thus the local pressure solution processes [2].

References

[1] Hu, Steefel, & Rutqvist (2021), JGR Solid Earth 126, e2021JB023112.

[2] Hu, Steefel, Rutqvist & Gilbert (2022), RMRE. https://doi.org/10.1007/s00603-022-03162-6