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Multicomponent multiphase reactive fluid flow in viscoelastoplastic porous media: localization patterns of fluid flow and strain

Lyudmila Khakimova[1,2], Nikolai Belov[1,3], Artyom Myasnikov[1], Anatoly Vershinin[1,8], Kirill Krapivin[1], Anna Isaeva[4], Vladimir Dobrozhanskiy[5], and Yury Podladchikov[1,6,7]
[1]Faculty of Mechanics and Mathematics, Lomonosov Moscow State University, Moscow, Russia
[2]Skolkovo Institute of Science and Technology, Petroleum Engineering, Moscow, Russian Federation (lyudmila.khakimova@skoltech.ru)
[3]Institute for Problems in Mechanics, Russian Academy of Sciences, Moscow, Russia
[4]Department of Physics, Moscow State University, Moscow, Russia
[5]Phystech School of Aerospace Technology, Moscow Institute of Physics and Technology, Russia
[6]Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland
[7]Swiss Geocomputing Center, University of Lausanne, Lausanne, Switzerland
[8]Institute of Physics of the Earth, Russian Academy of Sciences, Moscow, Russian Federation

This work is devoted to developing the self-consistent thermo-hydro-chemo-mechanical reactive transport model to predict and describe natural and industrial petroleum processes at different scales.

We develop a version of the front tracking approach for multicomponent multiphase flow in order to treat spontaneous splitting of discontinuities. We revisit the solution for the Riemann problem and systematically classify all possible configurations as functions of initial concentrations on both sides of the discontinuity. We validate the algorithm against finite volume high-resolution technics and high-order spectral finite elements.

To calculate the parameters of phase equilibria, we utilize an approach based on the direct minimization of the Gibbs energy of a multicomponent mixture. This method ensures the consistency of the thermodynamic lookup tables. The core of the algorithm is the non-linear free-energy constrained minimization problem, formulated in the form of a linear programming problem by discretization in compositional space.

The impact of the complex rheological response of porous matrix on the morphology of fluid flow and shear deformation localization is considered. Channeling of porosity waves and shear bands morphology and their orientation is investigated for viscoelastoplastic both shear and bulk rheologies.