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Gas transport in porous geological media with contract of properties, and irregular distribution of pores.

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In this work, we perform multiscale modeling of gas transport through the heterogeneous solid having irregular pore structure and contrast of properties on different spatial scales. We assume that the solid consists of inorganic material (clay, sand) with organic (kegogen) inclusions imbedded into it. There exist a contrast of properties and spatial scales between the matrix and inclusions. The pore sizes vary from micro to nanometers, permeability and diffusivity can differ by several orders of magnitude. We consider filtration and molecular diffusion as mechanisms for the free gas transport, and surface diffusion as a main mechanism of gas transport through nanoporous organic inclusions. The irregularities of porous structure we characterize by their deviations from the regular (periodic) distribution.
Multiscale analysis is applied to mass balance equations, the equation of state for free gas, and an isotherm of adsorption. We focus on the upscaling from pore-scale to the core-scale and then from core-scale to reservoir scale.
As a result of upscaling, we get a macroscopic equation describing gas transport through an effective medium. It turns out that macroscale parameters characterizing gas transport depend on diffusivity, permeability, and porosity of components of the system, the amount of inclusions and their spatial distribution. We investigate sensitivity of macroscale parameters to deviations in pore distributions from their averaged values. We also determine the distribution of gas concentration through the production time and evaluate the production rate as a function of time.

References

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