NOVEL APPROACHES FOR MODELING MIGRATION AND TRAPPING AT GEOLOGIC SCALE

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In this contribution, we take a comprehensive view on modeling of CO2 storage. Starting with the governing equations for two-phase, two-component flow in porous media, we survey the development of macro-scale equations, and their capabilities in terms of modeling transient systems and increasingly complex physical descriptions. We phrase this discussion in the context of simulation on geological data sets, which take the form of large synthetic case studies, analysis of prospective storage formations, as well as analysis of data made available from the Utsira (Sleipner) injection.
In particular, we discuss large-scale models that allow for hysteresis in fine-scale constitutive relationships, while also including mass transfer between phases and (upscaled) convective mixing. These models are thus capable of describing the dominant trapping mechanisms during the short-to-medium term: Structural traps, residual saturation, and dissolution. When considering the models in detail, we note that large-scale models represent physics in slightly different ways than fine-scale models. This leads to expanded constitutive relationships, with concomitant extra considerations for the numerical implementation.
Our talk will emphasize the construction of large-scale models for increasingly complex problems, while highlighting some of the mathematical and numerical issues that appear. After a review of benchmarking and verification problems, we then show the application to a large range of data sets of practical importance.