XFEM-Level set model for CO2 sequestration

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ABSTRACT: Sequestration of CO2 in deep geological formations involves coupled thermo-hydro-mechanical processes. In this study a numerical model based on the averaging theory and the double porosity model is developed to simulate this process. An advanced numerical procedure, based on coupling between the Level-set method and the extended finite element method has been used. The main idea is that the level set method captures the CO2 plume front, and the partition of unity models the discontinuity at the front. The evolving front is defined by a level-set function, which is advected with a local flow velocity. A streamline upwind Petrov-Galerkin method is applied to stabilize the numerical oscillations in the advection of the CO2 front. The discontinuity in the saturation field is modeled by decomposing the element into a continuous part and a discontinuous part. The latter is enhanced by the use of a local enrichment function which is calculated from the level-set function. This procedure results in an efficient numerical scheme that is stable and effectively mesh-independent. Numerical implementation of the method is discussed and example problems are performed to demonstrate the computational efficiency of the model.