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Effect of Permeability Heterogeneity on Storage Capacity Estimation in CO_2 injection

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One of the big uncertainties when estimating the CO_2 storage capacity of a geological formation stems from the effect of geological heterogeneity, which can e.g. cause fast flow paths and counteract gravity segregation. Furthermore, in particular the horizontal continuity of layering and/or the horizontal correlation length of the permeability fields are difficult to determine, as the investigation boreholes by necessity are far apart.

We present results from a simulation study of CO_2 injection into a reservoir layer where the statistical properties such as standard deviation, correlation lengths of the permeability field are systematically varied. Capillary heterogeneity is linked to the heterogeneous permeability field according to the Leverett scaling function. In all cases a predefined injection pressure is applied and the spreading of CO_2 is simulated until the plume reaches a spill point, representing a fracture or other leaking features. The storage capacity of CO_2 following such scheme is defined as the reservoir volume behind the plume front that is occupied by CO_2. For each set of statistical parameter values a large number of realizations are run to allow convergence of the output statistics. From the results the storage capacities are determined; the dependence of the term and its particular 'heterogeneity capacity factor' is related to the statistical characteristics of the permeability field.