Table 3: Geological parameters for four different cases selected for visualization.

Case	Faulted	Lobosity	Barrier	Aggradation	Progradation
Case 1	no	one-lobe	medium	medium	down-dip
Case 2	no	two-lobe	medium	low	up-dip
Case 3	no	one-lobe	high	high	up-dip
Case 4	no	one-lobe	high	high	down-dip

compartments in which the pressure increases during injection and then remains high. Heterogeneity also affects the gravity segregation process more than in the other two trends because of faults and a high barrier coverage.

We also see the effect of curvature in the relative permeabilities by comparing the two plots in Figure 4. Higher range of pressure variations is observed during injection for the nonlinear relative permeability runs. Moreover, nonlinear relative permeability gives lower mobility which leads to higher pressure build-up during injection. This means that longer time is required for the pressure to be released through the open boundaries after injection and more cases therefore follow the second and third trend. More details about the bottom-hole pressure are given in a companion paper [3], which also discusses more realistic constraints on the injection operation.

3.2 Plume migration

The direction in which the CO_2 plume moves in the medium will primarily impact the amount of residual (and structural) trapping, but as we will see later, also significantly change the extent to which the plume contacts the caprock, which again affects the risk for leakage through breaches and holes in the caprock. When evaluating the safety of a long-term storage operation, there are several potentially conflicting aspects that need to be considered with regard to plume migration. On one hand, we prefer the plume to spread out laterally to enhance residual trapping and mixing of CO_2 and brine; the amount of residual trapping is positively correlated with the sweep efficiency of the CO_2 plume, i.e., the percentage of the aquifer volume that has been in contact with CO_2. On the other hand, one typically wants to confine the plume to the smallest volume possible to simplify monitoring operations, minimize the contact with potential leakage points, and minimize the risk of leakage and contamination into other aquifers. However, if a big movable plume connects with a leakage pathway through the caprock, large volumes of CO_2 may escape, and for this reason, it may be better if the injected CO_2 splits into many small plumes. To investigate these aspects, we will study the number of plumes and their volumes.

3.2.1 Boundary fluxes

Because we have chosen to inject a relatively large amount of CO_2corresponding to one fifth of the aquifer's pore volume, it is to be expected that the pressure and saturation fields will interact strongly with the model boundaries, which in some cases will lead to substantial loss of CO_2 across the boundaries. The model has open boundaries on three sides, which are modeled by imposing huge pore-volume multipliers in the outer cells, while no-flow boundary conditions are imposed along the top faulted side. Using large pore-volume multipliers to represent open boundaries enables volumes of CO_2 to leave and later re-enter the aquifer. (In addition, this method will contribute to eliminate effects from Dirichlet type boundary conditions). The flux out of the open boundaries can be considered as a measure of the lateral movement of the plume, and reflects the relative difficulty of forcing the injected CO_2 up-dip towards the crest compared with driving it down-dip through the nearby open boundaries.

The lower boundary is closest to the injection point and hence the most likely place where injected CO_2 volumes will escape. Figure 6 shows plots of the CO_2 flow across this boundary at the end of injection versus the flow across the boundary at the end of simulation. Toward the end of injection, most cases have positive flux values, which means that parts of the main plume connected to the injection point have been forced to leave the domain in the down-dip direction by the increased injection pressure. However, after injection stops, many cases have small negative fluxes, which means that a small volume of CO_2 reenters the domain. Once again, we observe that cases with low aggradation