Table 2: Geological parameters from the SAIGUP project included in this study. The last column reports markers used to distinguish different parameters in the plots.

Parameter	Levels	Marker
Lobosity	flat, one-lobe, two-lobe	square, circle, diamond
Barrier	low(10%), medium(50%), high(90%)	small, medium, large
Aggradation	low(parallel layering), medium, high	blue, green, red
Progradation	up-dip, down-dip	first half, second half
Fault	unfaulted, open faults, closed faults	thin, medium, thick

direction of the model.

Progradation – denotes the direction of the depositional dip. Two types are considered here: up and down the dominant structural dip. Because the model is tilted a little, this corresponds to the lobe direction from flank to crest or vice versa.

Fault – are represented by three different parameters in the SAIGUP study: fault type, intensity, and transmissibility. Herein, we limit our study to compartment faults of medium intensity and consider three parameter choices: no faults, open faults, and closed faults.

Table 2 lists the markers (shape, size, color, thickness) that will be used to signify different parameter values in plots of simulation results later in the paper.

We will consider storage of forty million cubic meters of supercritical CO_2, which amounts to approximately 20% of the total pore volume in the aquifer. The CO_2 will be injected from a single well over a period of thirty years, and after the injection period, seventy years of plume migration is simulated for all cases. Hydrostatic boundary conditions are imposed on the sides, except at the faulted side on the crest, and no-flow boundary conditions are imposed on the top and bottom surfaces.

If the medium was homogeneous and of sufficient permeability, one would expect that the injection would create one big plume that moves upward because of the gravity force until it accumulates under the structural trap of the cap-rock, i.e., migrating from the injection point and upward to the crest of the aquifer. The idea is therefore to inject as deep as possible to increase the travel path and the volume swept by the plume before it reaches the crest. To this end, the injector is placed down in the flank and only completed in the three lowest layers of the aquifer. The formation and early migration of the plume will crucially depend on the complex interaction between the injected CO_2 and the heterogeneity inside the reservoir; that is, whether the CO_2 encounters low permeability rocks in the vicinity of the well bore, or whether high permeability pathways are available to enable plume migration away from the injection point. The fixed well position was chosen manually based on a number preprocessing simulation runs and held fixed for all model realizations. This way, we avoid introducing an additional parameter into the simulation study. On the other hand, we may also introduce certain artifacts, like exaggerated pressure responses if the well hits a low-permeable area, that would have been avoided if the well position was optimized for each realization. A more comprehensive study should, of course, also have investigated possible effects and impacts of different well positions and completion strategies to increase the robustness of the observations.

The injected CO_2 is assumed to be a supercritical fluid with density 700 kg/m^3 and viscosity 0.04 cP. The supercritical fluid is modeled as a dead oil with a formation factor of 1.1 at 0 bar and 0.95 at 400 bar. (The assumption of (almost) constant properties is reasonable since pressure and temperature effects will typically counteract each other at relevant depth ranges.) Brine is assumed to be slightly compressible ($3.03 \cdot 10^{-6}$ psi^{-1}) with density 1033 kg/m^3 and viscosity 0.4 cP. The rock compressibility is set to $3 \cdot 10^{-7}$. For both fluids, we will use Corey-type relative permeability functions

$$k_{rCO_2} = (1-S)^{\alpha}, \quad k_{rw} = S^{\alpha}, \qquad \alpha = 1, 2$$

where S denotes the saturation of brine normalized for end points 0.2 and 0.8.

Relative permeabilities for CO_2-brine systems have been thoroughly discussed in the literature; [4, 5, 22] summarize 35 experiments on sandstone and carbonate rocks and more experiments can be found in [1, 47, 53]. There are also papers that analyze the impact of the relative permeability (e.g., [10, 31, 32]), and investigate the endpoint and hysteresis effects, see e.g., [49, 28]. In many