Table 4: Geological and simulation model specifications. Averaged values are arithmetic averages and belong to a selected geological model (shown in Figure 1).

Parameter	**Value**
Model dimensions	3 km $\times$ 9 km $\times$ 80 m
Geological grid resolution	$80 \times 240 \times 80$
Simulation grid resolution	$40 \times 120 \times 20$
Simulation grid resolution	$40 \times 120 \times 20$
Average of lateral permeability	181 mD
Average of Vertical permeability	26.8 mD
Average of porosity	0.145

the injection operation. The open boundaries are modeled by exaggerating the two last cells at the boundaries. The second last cell pore volume is magnified 10^3 times and the pore volume of cells at the boundary is multiplied by 10^6. These values are calculated such that no considerable pressure change occurs in the out-most cells at the boundary. No-flow boundary condition is applied on the top and bottom of the model. Moreover, the evaluated side on the crest is located at a large fault displacement and is considered as a close boundary.

We use one injection well in the model to study the medium response to the pressure imposed by the a single injection point. Also, it is easier to study the CO_2 plume evolution in a model with one injector. However, using only one injector does not describe the impact of well location in the model and the outcome of the study can be different if we choose a different location for the injector. We studied various locations in a homogeneous model to choose an injection point that allows a relatively long travel path for the injected CO_2. We inject in the flank and the injected CO_2 travels upward to the crest due to the buoyancy force. If the medium is homogeneous, following the injection we expect one big plume to be constructed and this plume to move up due to the gravity force until it accumulates under the structural trap beneath the cap rock. The well is opened to flow in the last four cells in the vertical direction, i.e., in the lowest layer of the model.

To reduce the effect of well location , one can inject through a number of wells distributed in the medium. To evaluate the impact of injection location and the interaction of the injector with the local heterogeneity, we can try the study for many simulations with different injection locations. This will dramatically increase the number of detailed flow simulations and it is not considered in this study.

Slightly compressible supercritical CO_2 is considered and we seek to inject a volume of 4×10^7 m^3, which amounts to 20% of the total pore volume of the models. After the injection period, early plume migration is simulated in all of the studied cases and the simulation ends at 100 years. We use Corey-type quadratic functions for relative permeability, with end points 0.2 and 0.8 in both phases.

In this study, two injection strategies are implemented. In the first strategy (which is similar to the one used in [1]), the entire CO_2 volume is injected within 30 years at a constant volumetric rate. In the second strategy, we set an operational pressure constraint on the injector and continue injecting with appropriate rates to keep the pressure within the limit. We do some pressure response calculations to see the propagation of pressure pulses