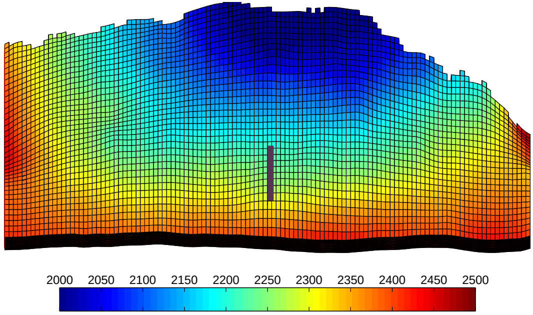
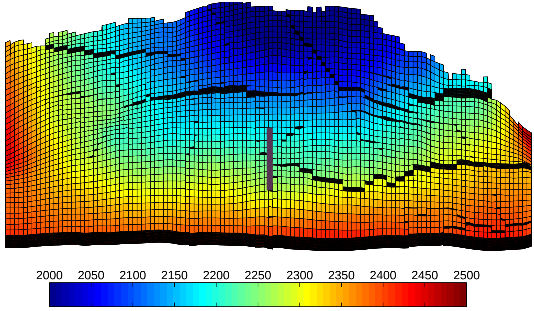


(a) Unfaulted grid.



(b) Faulted grid.

Figure 2: Models used in the study. Depth in meter is shown by color.

shown in Figure 1. In addition to the features shown in Figure 1, we also consider faulting levels: unfaulted, open faults, and close faults. In subsequent plots, each of these features are represented with codes such as shape, size and color which are explained in Table 1. For more details refer to [1].

3 Injection scenario

We define a CO_2 injection scenario to be implemented for all cases in which we use an injector down in the flank and hydrostatic boundary conditions on the sides, except the side near the crest (see Figure 2). No-flow boundary conditions are imposed on the top and bottom surfaces of the model. Model dimensions are: 9km $\times$ 3km $\times$ 80m. The well is completed only in the four layers in all cases. The idea is to inject as low as possible to increase the travel path and the volume swept by the plume. 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.

Slightly compressible supercritical CO_2 is considered and we seek to inject a volume of 40MM 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.

Low well injectivity can result in high pressure in the system. 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 in the medium for both strategies.

In the pressure-constrained strategy, the injector operates with the priority of injecting a volumetric rate of 3650 m^3/day. A pressure constraint of 400 bar is set on the injector. If the well bottom-hole pressure goes higher than that and violates this restriction (to maintain the target injection rate), the priority changes to keep the 400 bar by reducing the injection rate. The well continues operation switching between these priorities until a total CO_2 volume of