Herein, we will use the same SAIGUP geological realizations to perform detailed analysis of how geological variations impact the pressure buildup and propagation in aquifers. The spatial extent of the SAIGUP models, 9 km $\times$ 3 km $\times$80 m, is considerably smaller than the extent of large aquifers. To compensate for the size, we consider open boundary conditions by exaggerating the pore volume of the cells at the boundaries of the model. This choice of boundary modeling results in an early relaxation of the pressure in the medium when the pressure pulse arrives at the boundary. Overall, the pressure values reported in our study can therefore be expected to be higher if they were modeled in a larger model. This study complements [2, 1], in the sense that we herein analyze the sensitivity of pressure to the same geological parameters. In addition to the injection scenario used in [2, 1], we examine a different injection scenario with more realistic well control for the injection operation. Our study shows that details in the geology can have a pronounced effect on the pressure development, which demonstrates the importance of realistic and detailed geological modeling when designing CO_2 storage operations and monitoring the pressure development in the aquifer. To the best of our knowledge, this is the first pressure study in the context of CO_2 storage that considers the geological uncertainty in the form of a parametrized set of structural and sedimentological variables.

2 Geological parameters

In the SAIGUP study, six rock types were included to model a shallow-marine system. Each rock type was modeled at appropriate scales to honor the interaction of flow with various heterogeneity types at different spatial scales (Figure 1). Each facies was upscaled in a number of stages and finally all the rock types were mapped on a fine-grid geological model. Some of the meter-scale facies were modeled in three dimensions to capture anisotropy. Variation within each rock type was modeled either deterministically by considering a periodic pattern or modeled internally by stochastic population. Channels were modeled on the fine grid and went through two stages of upscaling. Tests showed that when upscaled, models with different grid resolutions produced similar results. The specifications of the rock types are given in Table 1. For more detail of the SAIGUP sedimentological modeling see [7].

Table 1: The facies used in the SAIGUP geological modeling and their modeling scales.

Facies name	**X Scale**	**Y Scale**	**Z Scale**
Offshore transition zone	0.5 m	0.5 m	0.5 cm
Lower shoreface	0.5 m	0.5 m	0.5–2.0 cm
Upper shoreface	0.5 m	0.5 m	0.2–0.5 cm
Coastal plane	75 m	—	—
Offshore	75 m	—	—
Channels	0.04–1 m	0.04–1 m	0.5 cm

The wave and fluvial depositional processes acting at the shoreline control the plan-view shape, the channel abundance in the delta plain, and the abundance of mud-drapes. These parameters were characterized and summarized as three different types of shorefaces. A wave-dominated deposition produces a straight plan-view shape, very few channels, and no dipping