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Hydrocarbon reservoirs with rocksalt caprocks: time dependence of subsidence effects and the influence of the rocksalt creep model

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Rocksalt is the caprock for a large number of hydrocarbon reservoirs. Understanding its response to extraction-induced stress perturbations can therefore be very important when calculating the resulting deformation and associated subsidence above such fields. We investigate how flow in the rocksalt leads to time-dependent deformation of the ground surface using numerical models that simulate the mechanical response of the subsurface. Rock mechanical experiments have demonstrated that rocksalt can flow by linear creep or power-law creep, depending on stress and grain size among others. Given that we often do not have data from cores that constrain these quantities, we investigate the two rocksalt flow laws as alternatives. Here, we focus specifically on differences in the surface imprints of these two types of flow. Mechanical models for linear creep show that the rocksalt exhibits two time scales in response to the reservoir pumping. The first, and shortest, time scale reflects flow that is driven by relaxation of stresses in the vicinity of the reservoir. At the surface, this results in maximum subsidence that is increasing with time. The second time scale reflects closed-conduit flow within the rocksalt layer that is driven by mean stresses equilibration. Interestingly, this results in a decrease in the maximum subsidence above the reservoir.