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Modeling ground surface uplift during CO_2 sequestration: the case of In Salah, Algeria.

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Observable ground deformation, common in storage projects, carries useful information on processes occurring at the injection depth. The Krechba gas field at In Salah (Algeria) is one of the best known sites for studying ground surface deformation during geological storage. Being the first industrial-scale on-shore CO_2 demonstration project, the site is well known for satellite-based ground-deformation monitoring data of remarkable quality. In this work, we carry out coupled fluid flow and geomechanical simulations to understand the uplift at three different CO_2 injection wells (KB-501, KB-502, KB-503). Previous numerical studies focused on the KB-502 injection well, where a double-lobe uplift pattern has been observed in the ground-deformation data. The observed uplift patterns at KB-501 and KB-503 are different, but also indicate the influence of deep fracture zone mechanical responses. The current study improves the previous modeling approach by introducing an injection reservoir and a fracture zone, both responding to a Mohr-Coulomb failure criterion. In addition, we model a stress-dependent permeability and bulk modulus, according to a dual continuum model. Mechanical and hydraulic properties were determined through inverse modeling by matching the simulated spatial and temporal evolution of uplift to the corresponding InSAR observations as well as by matching simulated and measured pressures. The numerical simulations are in excellent agreement with observed spatial and temporal variation of ground surface uplift, as well as with measured pressures. The estimated values for the parameterized mechanical and hydraulic properties are in good agreement with previous numerical results, although with uncertainty.