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Inversion of surface subsidence data for detection of undepleted reservoir compartments: a field study

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Hydrocarbon production induces subsidence due to the decrease in pore pressure in the reservoir which causes the reservoir to compact. The surface area affected by the compaction of the reservoir extends beyond the size of the reservoir, roughly as far as the reservoir is deep. At any point on the surface the measured subsidence is a result of the compaction over a large area of the reservoir.
The Roswinkel gas field is situated in the northeastern part of the Netherlands and has been in production since the 1980's. Prior geomechanical modelling of the Roswinkel field has revealed deviations from the predicted elliptical shape of the subsidence bowl. The Roswinkel gas field has a complicated geology with multiple faults in two major directions constituting a large number of reservoir compartments. The deviation from the predicted elliptical shape of the subsidence may indicate undepleted compartments in the reservoir, thus comprising additional economic value.
We use a previously developed linearized subsidence inversion method to infer the possibility of undepleted compartments in the reservoir. The method uses all available prior knowledge, combined in the prior model covariance matrix and the data covariance matrix. The prior model covariance matrix contains the spatial and temporal correlations between model parameters and is based on Monte Carlo simulations with the geological uncertainty in the permeabilities across the faults and the transmissibility of the acquifer as input. The data covariance matrix incorporates the spatial and temporal correlations, and the standard deviations of the data. This implementation of geological uncertainty in the inversion provides us with a better estimate of the sealing characteristics of the faults in the reservoir as well as the possibility of remaining gas potential.