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Subsurface characterisation and modeling of a CO2 test site in south Scania, Sweden, with special emphasis on the treatment of hydrogeological heterogeneity

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The south Scania site is one of the five test sites included in the MUSTANG project (EU FP7 programme) with an objective to understand - by means of experimental and simulation studies - the spreading and trapping of injected CO_2 in different type saline formations. The geological setting of the site is an example of a typical multilayered sequence commonly found in sedimentary basins all over the world. It is analyzed here as an example of such sequence of primary and secondary traps and seal units. Particular emphasis is given for the characterization and quantification of the geological heterogeneity, in terms of what can be described in deterministic terms and where a stochastic representation is needed.

For constructing the conceptual model, detailed hydrogeological and hydrogeochemical data is available in one deep well originally drilled for geothermal investigations, including an extensive hydrogeological testing programme. In addition, comprehensive data sets and analyses exist in 15 adjacent wells, allow definition of the characteristics of different lithological units and boundary layers with some confidence. The geology is dominated by a relatively thick (1200–1600 m) sequence of Upper Cretaceous strata, overlying a 400–600 m thick Lower Cretaceous, Jurassic and Triassic sequence of claystone and sandstone layers. Eight lithologic units have been mapped and characterised, the primary trap aquifer for this study being about 10 m thick sandstone and secondary traps having thicknesses between 10 and 50 metres, with lower overall permeabilities than the primary target. The primary seal consist of a several hundred meters thick limestone and the intermediate seals of claystone and mudstone. The lateral correlations of the layers between wells are based on lithological descriptions of cuttings, biostratigraphical analyses and geophysical well log correlation.

One of the challenges for modeling the spreading of injected CO_2 is to understand and to be able to quantify the characteristics of the horizontal heterogeneity and continuity of the layers between the boreholes. For this purpose, both a deterministic and a probabilistic/stochastic approach are used here to describe 1) the distribution of the depositional settings and 2) the properties (heterogeneity) within the units, in particular in terms of the distribution of the permeability values. Importance of the choice of the approach is discussed based on preliminary model simulations of CO_2 injection using the various assumptions.