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Determination of petrophysical properties of geothermal reservoirs in southern Denmark by integrating information from well logs and reflection seismic data

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As part of the efforts to reduce CO_2 emission, geothermal energy is an important source for future energy production in Denmark, and several research programs deal with this specific subject e.g. "The geothermal energy potential in Denmark – reservoir properties, temperature distribution and models for utilization", funded by the Danish Strategic Research Council and "GEOPOWER" which is part of an EU INTERREG-program focused on southern Denmark and northernmost Germany. For geothermal energy to be economically sustainable porous and permeable rocks needs to be present at a depth where the temperature is sufficiently high. Utilization of geothermal energy in Denmark and plans for the future are concentrated on low enthalpy basin reservoirs for district heating.
Major modeling studies are carried out to establish the temperature distribution in the Danish subsurface. This project deals with the reservoir properties. The geothermal reservoir exploited so far in the southern Danish area is restricted to the lower Jurassic-Triassic Gassum Formation. The Gassum Formation is a shallow marine to fluvial deposit composed of sandy to silty sediments, occasionally with coal layers, i.e. a lateral and stratigraphically heterogeneous rock. This formation is encountered only in deep hydrocarbon exploration wells and in wells of the Sønderborg Geothermal plant. Due to the very low number and low density of wells and the limited rock material recovered during drilling, the knowledge of lateral variations of reservoir properties in terms of porosity, permeability and thickness, is limited and so far unsatisfactorily mapped. The main risks in the utilization of geothermal energy from the subsurface of Denmark are therefore regional, as well as local, variations in the production potential of warm water, whereas the temperature can be assessed fairly precisely due to the thermal models available.
Here we use petrophysical wells logs available from hydrocarbon exploration wells for determination of reservoir characteristics in combination with a neural network seismic attribute analysis (courtesy of OpendTect) of seismic reflection data available in the area which are both 2D and 3D industrial seismic data, recently acquired. By this combined data analysis we develop procedures for reducing the risk of drilling tight reservoirs as well as for getting a better understanding of the geological evolution of potential geothermal reservoir units.