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An analysis of the lithology to resistivity relationships using airborne EM and boreholes

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We present a study of the relationship between dense airborne SkyTEM resistivity data and sparse lithological borehole data.

Understanding the geological structures of the subsurface is of great importance to hydrogeological surveys. Large scale geological information can be gathered directly from boreholes or indirectly from large geophysical surveys. Borehole data provides detailed lithological information only at the position of the borehole and, due to the sparse nature of boreholes, they rarely provide sufficient information needed for high-accuracy groundwater models. Airborne geophysical data, on the other hand, provide dense spatial coverage, but are only indirectly bearing information on lithology through the resistivity models. Hitherherto, the integration of the geophysical data into geological and hydrogeological models has been often subjective, largely un-documented and painstakingly manual.

This project presents a detailed study of the relationships between resistivity data and lithological borehole data. The purpose is to objectively describe the relationships between lithology and geophysical parameters and to document these relationships.

This project has focused on utilizing preexisting datasets from the Danish national borehole database (JUPITER) and national geophysical database (GERDA). The study presented here is from the Norsminde catchment area (208 sq. km), situated in the municipality of Odder, Denmark. The Norsminde area contains a total of 758 boreholes and 106,770 SkyTEM soundings. The large amounts of data make the Norsminde area ideal for studying the relationship between geophysical data and lithological data.

The subsurface is discretized into 20 cm horizontal sampling intervals from the highest elevation point to the depth of the deepest borehole. For each of these intervals a resistivity value is calculated at the position of the boreholes using a kriging formulation. The lithology data from the boreholes are then used to categorize the interpolated resistivity values according to lithology. The end result of this comparison is resistivity distributions for different lithology categories. The distributions provide detailed objective information of the resistivity properties of the subsurface and are a documentation of the resistivity imaging of the geological lithologies. We show that different lithologies are mapped at distinctively different resistivities but also that the geophysical inversion strategies influences the resulting distributions significantly.