Enhancing the quality of 3D subsurface models by integrating geophysical data sets

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Airborne geophysical data are widely used in geology and hydrogeology, because these extensive multiparameter data sets can complete the limited database of the shallow subsurface. However, a direct coupling between geophysical and geological models is often missing and results in an ineffective interpretation and use of airborne geophysical data.

The aim of our AIDA sub-project SP5 (Model development and evaluation of results) is the development of new inversion and modelling approaches to enhance the user oriented interpretation of the geophysical shallow subsurface data and the development of realistic geological 3D subsurface models. Existing data sets of the BGR and partner sub-projects will be selected as input for the inversions and simulations. These data sets will be integrated into one model. Subsequently this model will be adjusted to include the inversion and simulation results.

The Cuxhaven tunnel valley was chosen as the first model area. This Elsterian tunnel valley has a complex Middle Pleistocene to Holocene fill (Wiederhold et al. 2005). The database includes a dense coverage of helicopter-borne electromagnetic (HEM), magnetic and radiometric data, 2D seismic reflection profiles, gravimetric data and numerous borehole logs (Siemon 2005; Rumpel et al. 2009).

At first a geological 3D subsurface model was generated based on borehole logs and 2D seismic reflection profiles in GOCAD®. Subsequently the HEM data were integrated into the geological 3D subsurface model. For that reason the electrical resistivity-depth profiles of HEM data were initially analysed by means of different geostatistical methods to create a continuous subsurface 3D electrical resistivity model by interpolation. To test the accuracy of the model, it was compared to borehole logs and 2D seismic sections. Finally the geological 3D subsurface model will be adjusted to the electrical resistivity models. This allows for accurate understanding of lithological distribution and in turn facies distribution which is integral to the understanding of its potential rock reservoir quality.

Using this approach it will be possible to determine variations in lithologies in the electrical resistivity model. The resistivity of clay is distinctly less than that of sand and gravel. However, gradual transitions in grain size may lead to uncertainties in the interpretation of the HEM data.

The major result of this study will be a high-accuracy geological 3D subsurface model with very low geometrical uncertainties.

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