Geophysical Research Abstracts
Vol. 16, EGU2014-3467, 2014
EGU General Assembly 2014

Combined geophysical and petrophysical characterization to support a hydrogeological model of a coastal environment

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Global warming affects the water cycle by changing precipitation/evaporation and raising sea level. Especially groundwater systems in sensitive environments, such as coastal areas or barrier islands, have to be evaluated with respect to the potential reduction of water quality, e.g. salinization by saltwater intrusion (Hinsby et al., 2012). To assess these hazards using groundwater modeling we need a strong base of hydraulic and hydrogeological information. The use of integrated geophysical methods, in combination with a petrophysical characterization, provides a reliable architecture for groundwater modeling.

Within the EU-project CLIWAT, we investigated the hydrogeological situation of the North Sea island of Föhr in Schleswig-Holstein (Germany). The island was mainly formed during glaciations in Pleistocene Series, especially Saalian and Weichselian Stages. These deposits remain as a Geest core in the southern central part, and house a freshwater lens that is used for the local water supply. To investigate the architecture of the fresh water lens, we carried out several surveys with airborne electromagnetic (AEM), seismic reflection, and borehole methods. To enhance the AEM resistivity model we inverted the data with a-priori constraints from seismic reflections (Burschil et al., 2012a). This constrained inversion leads to, among other things, a separation of two aquifers by resistivity data. Additionally, from borehole logs, vertical seismic profiles (VSP), and nearby AEM inversion point models we are able to petrophysically characterize different lithological categories regarding resistivity and seismic velocity.

Subsurface glacial structures, e.g. buried valleys and a push moraine complex, are mapped down to 150 m below sea level. Below this rather horizontal features indicate Tertiary layers. Geophysically determined petrophysical values were correlated with lithological categories to enhance the interpretation of geophysical data. In this way, we expose the complex disorder of Pleistocene till and sand, as well as Pliocene sand and Miocene clay, in the uppermost 150 m. All results are implemented in a hydrogeological 3D model as base for groundwater modeling and to forecast climate change effects (Burschil et al., 2012b).

References

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