GEOSUM: a step towards an integrated concept in three dimensional subsurface modelling

Members of the Integrated Working Group for **Geo**-scientific **Su**rveying and **M**odelling in 3D

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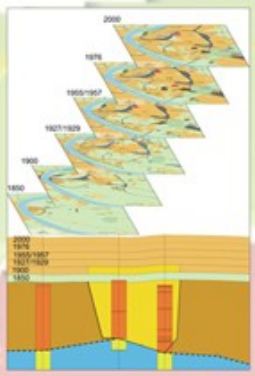
A growing stress on natural resources in modern societies, due to concurrent usage, environmental and engineering factors, as well as contamination, natural and man made hazards, demands new time and cost reduced surveying and investigation strategies in urban and regional areas. One attempt to fulfil these tasks and a step towards a sustainable management of natural resources is to provide urban and regional planers, including decision and policy makers, with detailed, easy to understand, already interpreted, geo-scientific three dimensional models of the shallow and medium deep subsurface. These 3D models should take into account and incorporate all the available geo-scientific data, ranging from archaeological, historical geographical, morphological to geological, geochemical, geotechnological and geophysical factors and parameters.

Modelling-concept for artificial ground - examples from the eastern district of Cologne

The geo-environment of urban areas has been modified by anthropogenic- landscaping since pre-historic times. This anthropogenic heritage, represented by artificial ground, has to be systematically addressed, characterized, quantified and qualified in order to understand the complexity of the urban subsurface for a sustainable city planning and management, environment protection and urban engineering.



Hybrid 2D and 3D modelling, combining the distribution of artificial ground and technogenic relief forms.

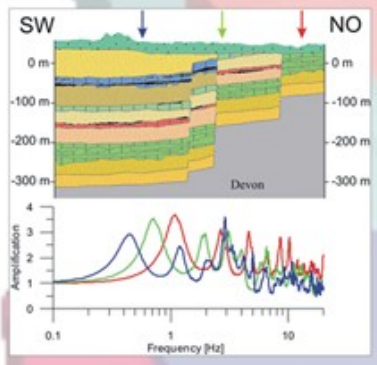
Upper Pliocene and Lower Pleistocene in the Lower Rhine Embayment: contributions to stratigraphy and fluvial history.

The current project studies the succession of Pliocene and Lower Pleistocene age in the Lower Rhine embayment by means of sedimentology, petrography (heavy minerals), palaeo- and rockmagnetics, geochemistry (ICP-MS), palynology and grain morphology (SEM). The aim of the research is to establish a new integrated lithostratigraphic concept for the area under consideration.

Open-cast mine Hambach: Deposits of the Upper Pliocene Kieseloolithe Formation, overlain by sands and clays of Reuverian age and superimposed by Lower Pleistocene sediments.

Influence of the local geology on amplitude, duration and frequency content of earthquake ground motion

The aim of an ongoing PhD-project af the Department of Earthquake Geology is to examine the influence of the local geology on amplitude, duration and frequency content of earthquake ground motions with a new detailed geological 3D-model. Of particular interest is the nonlinear behaviour of the unconsolidated sediments, which are modelled with a randomized version of SHAKE91.

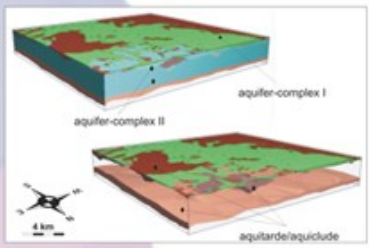


Top: SW-NO profile across topographic map 5007 (Cologne). The colored arrows mark soil profiles, which were used for calculations of the transfer function of unconsolidated sediments, as gravel, sand, clay and lignite coal (black). Bottom: Transfer functions of the three soil profiles. Median values of 1000 calculations each with randomly varied soil parameters (density, shearwave velocity and damping).

The GEOSUM working group was formed in 2004 and its members come from different geo-scientific disciplines: Quaternary Geology, Applied Geophysics, Applied Geomorphology and Earthquake Geology, working on different aspects of the surface and shallow subsurface, from archaeology and historical geography, geomorphology, stratigraphy, sedimentary geology, hydro and engineering geology to earthquake geology and geophysics. The aim of the GEOSUM working group is to establish best practice guidelines and holistic software-tools for the integration of 2D and 3D geo-scientific data sets into the surveying, investigation and modelling processes.
The usage of the GSI3D (Geological Surveying and Investigation in 3D) methodology and software-tool enables to establish integrated, state of the art, dynamic 3D models of the shallow and medium deep subsurface. Subsequent, task orientated, analysation functionalities deliver a wide range of thematic 2D and 3D products, e.g. for investigations on exploration capabilities and contaminated (mega-)sites, hydro geology, engineering geology, risk assessment or brownfield regeneration, in ready-to-use formats as the fundament for an integrated subsurface decision support, managment and monitoring system.

Hydrological research and flow modelling based on GSI3D subsurface models

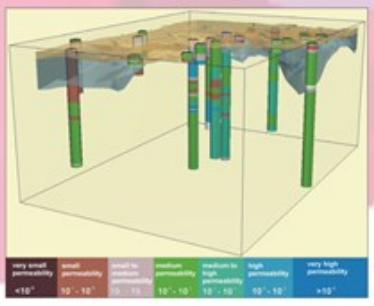
The 3D subsurface model, founded on the GSI3D methodology, is used as the conceptual basis for creating hydrogeological maps and models as well as for ground water flow modelling in Ostfriesland/N-Germany. The ground water flow modelling program MODFLOW is bound to GSI3D directly, so that all modelling results can be analysed and visualized in one 3D subsurface model.



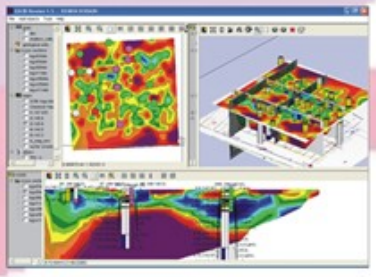
Extraction from a hydro-stratigraphical model of Ostfriesland/N-Germany

Analysation of coupled geo-scientific parameters and integration in 3D geological subsurface models

The usage of regional 3D geological subsurface models in engineering geology, hydrogeology, mining industry and urban geology requires a refinement from the regional view to higher resolutions. This can be realised by adding parameters from interdisciplinary measurements and investigations and by evaluating property estimates from measured data. The objective of the current research is the analysis of the geostatistical behaviour of geo-scientific parameters and their dependencies by using methods from multivariate geostatistics. To ensure an appropriate usage and understanding of the 3D geological subsurface model and the integration of interdisciplinary data, it is necessary to evaluate the whole spectrum of dependent uncertainties simultaneously. The results from these analysis will be finally used for volume calculations and visualisation methods in two and three dimensions.



An integrated view of a permeability classification based on the hydrostratigraphical base table of the state Geological Surveys of Germany and two different aquitards derived from a 3D geological subsurface model of Ostfriesland (orange: Drenthe Till Formation; blue: Lauenburg Facies). The potential kf-values are calculated from lithological bore log descriptions. The lithological heterogeneity of the till is represented by a wide range of permeability classes.



Geophysics in co-operation with
a) geo-chemistry (upper left; horizontal view; electrical resistivities and chemical concentrations),
b) geology and geo-chemistry (bottom; vertical view; electrical resistivities and bore holes consisting of stratigraphy + chemical concentrations) and
C) geology (upper right; 3D-view; vertical and horizontal resistivity results and bore hole data).

Calibration of geophysical data on contaminated sites based on visualisation functionalities in GSI3D

Geophysics support (hydro-) geological and chemical investigations by verifying the interpolation of data sets, e.g. between boreholes. GSI3D also allows the calibration of geophysical measurements at boreholes to improve the inversion results. This integrated attempt, by combining geophysical and geological data sets via the visualisation functionalities of GSI3D, generates the basis for a more detailed 3D model of the subsurface.

in co-operation with

INSIGHT lithosphere applied 3D geological surveying