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High resolution 3D stratigraphical geological models - concepts and options

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3D geological models are developed on different levels of information for different purposes reaching from conceptual models for genetic purposes on a regional scale over applications in sedimentology to high resolution models for mining and structural geology and parameter models in hydrogeology and engineering geology.
The databases can be as manifold as the purposes: Borehole data and logs, geophysical data and geological surface and lithological maps have to be integrated to get a suitable model. Base of most of the models is the stratigraphical model, which can actually be built digitally with a high resolution. The resolution depends basically on the vertical and horizontal heterogeneity of the sedimentary layers and therefore e.g. glacial and fluvial sediments are prone to higher resolution than marine sediments – for unconsolidated rocks as well as for hard rocks. The result of an almost "truth" real world scenario of the geological setting obtained by the given data as well as different modeling philosophies and software tools make it not easy to say, what is the most reliable model result. In most of the cases the modeler is using only one software tool. So it becomes very important to be aware about the requirements and limitations of the modeling work to do.
During the last 15 years high resolution geological modeling techniques were tested in several projects of different settings: Quaternary glacial sediments cover wide parts of Northern Germany. They overlay the tertiary sedimentary succession of different continental sediments including lignite seems and shallow marine depposits. The used geological modeling techniques were tested on local to regional scales with a horizontal resolution of 10 to 50 m, and project areas with a lateral extent of 20 km^2, 80 km^2, 135 km^2, and 1600 km^2 and 2 Mill km^2 (Gossel et al. 2010). The set of model layers are in the range from 12 to 26 individual stratigraphic layers within one model. The area of Halle city represents a complex scenario of the geological setting. It is covered by hard rock sediments and volcanics from the Carboniferous to the Upper Trias, which are also tectonically thrusted. Especially the Lower Permian rocks with volcanics and fanglomerates are prone to high resolution modelling approaches. The hard rocks and consolidated sediments from the Mesozoic are additionally overlain by a thin set of tertiary and quaternary sediments, as described before.
The diversity of modelling tools is quite high and they differ in several technical and methodological aspects: Interpolative vs. constructive modelling approaches, proofs of (stratigraphical) consistancy, uniqueness of surfaces (one-to-one in horizontal and vertical dimensions), graphical capabilities, restrictions in memory allocation, effectivity of algorithms and interfaces to geological databases and other modelling tools are only a few decision criteria. As shown in regional scale models in Lower Saxony, the Bitterfeld area (Wycisk et al. 2002, Wycisk et al. 2008), the town of Halle, and the valley of the lower Werra the most striking features are the interfaces to the bore hole data and geological maps. The possibility of implementation of background information, e.g. direction of channels, major flow regimes in the Quaternary, and the post-mining landfill structures of the tertiary lignite require a high technical modeling level as well as a well trained expert of stratigraphy to come to a real world scenario. The interactive capabilities play an important role in cases of unclarified stratigraphical assignments, e.g. in sandy series of glacial or fluvial sediments. For local scale models as shown for small catchments in Saxony the technical requirements are not so high but the importances of interfaces to databases and interactive modelling approaches increase.

Gossel, W., Sefelnasr, A. & Wycisk, P. (2010): Modelling of paleo-saltwater intrusion in the northern part of the Nubian Aquifer System, Northeast Africa - Hydrogeology Journal 18(6): 1447-1463; Springer.
Wycisk, P., Fabritius, H., Ruske, R., Weiß, H. (2002): Das digitale geologische Strukturmodell Bitterfeld als neuer Baustein in der Sanierungsforschung.- Grundwasser, 7: 165-171; Springer.
Wycisk, P., & Hubert, T, & Gossel, W., & Neumann, C. (2008): High-resolution 3D spatial modelling of complex geological structures for an environmental risk assessment of abundant mining and industrial mega sites. Computers & Geosciences. 35(1):165-182; Elsevier.