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3D Stratigraphic Modeling of Central Aachen

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Since 1980s, advanced computer hardware and software technologies, as well as multidisciplinary research have provided possibilities to develop advanced three dimensional (3D) simulation software for geosciences application. Some countries, such as USA1) and Canada2) 3), have built up regional 3D geological models based on archival geological data. Such models have played huge roles in engineering geology2), hydrogeology2) 3), geothermal industry1) and so on.

In cooperating with the Municipality of Aachen, the Department of Engineering Geology of RWTH Aachen University have built up a computer-based 3D stratigraphic model of 50 meter' depth for the center of Aachen, which is a 5 km by 7 km geologically complex area. The uncorrelated data from multi-resources, discontinuous nature and unconformable connection of the units are main challenges for geological modeling in this area.

The reliability of 3D geological models largely depends on the quality and quantity of data. Existing 1D and 2D geological data were collected, including 1) approximately 6970 borehole data of different depth compiled in Microsoft Access database and MapInfo database; 2) a Digital Elevation Model (DEM); 3) geological cross sections; and 4) stratigraphic maps in 1m, 2m and 5m depth.

Since acquired data are of variable origins, they were managed step by step. The main processes are described below:
1) Typing errors of borehole data were identified and the corrected data were exported to Variowin2.2 to distinguish duplicate points;
2) The surface elevation of borehole data was compared to the DEM, and differences larger than 3m were eliminated. Moreover, where elevation data missed, it was read from the DEM;
3) Considerable data were collected from municipal constructions, such as residential buildings, factories, and roads. Therefore, many boreholes are spatially clustered, and only one or two representative points were picked out in such areas;
After above procedures, 5839 boreholes with -x, -y, -z coordinates, down-hole depth, and stratigraphic information are available.
4) We grouped stratigraphic units into four main layers based on analysis of geological settings of the modeling area. The stratigraphic units extend from Quaternary, Cretaceous, Carboniferous to Devonian. In order to facilitate the determination of each unit boundaries, a series of standard code was used to integrate data with different descriptive attributes.
5) The Quaternary and Cretaceous units are characterized by subhorizontal layers. Kriging interpolation was processed to the borehole data in order to estimate data distribution and surface relief for the layers.
6) The Carboniferous and Devonian units are folded. The lack of software support, concerning simulating folds and the shallow depth of boreholes and cross sections constrained the determination of geological boundaries. A strategy of digitalizing the fold surfaces from cross sections and establishing them as inclined strata was followed.

The modeling was simply subdivided into two steps. The first step consisted of importing data into the modeling software. The second step involved the construction of subhorizontal layers and folds, which were constrained by geological maps, cross sections and outcrops.

The construction of the 3D stratigraphic model is of high relevance to further simulation and application, such as 1) lithological modeling; 2) answering simple questions such as “At which unit is the water table?” and calculating volume of groundwater storage during assessment of aquifer vulnerability to contamination; and 3) assigned by geotechnical properties in grids and providing them for user required application.

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References:

1. Janet T. Watt, Jonathan M.G. Glen, David A. John and David A. Ponce (2007) Three-dimensional geologic model of the northern Nevada rift and the Beowawe geothermal system, north-central Nevada. Geosphere, v. 3; no. 6; p. 667–682
2. Martin Ross, Michel Parent and René Lefebvre (2005) 3D geologic framework models for regional hydrogeology and land-use management: a case study from a Quaternary basin of southwestern Quebec, Canada. Hydrogeology Journal, 13:690–707
3. Martin Ross, Richard Martel, René Lefebvre, Michel Parent and Martine M. Savard (2004) Assessing rock aquifer vulnerability using downward advective times from a 3D model of surficial geology: A case study from the St. Lawrence Lowlands, Canada. Geofísica Internacional Vol. 43, Num. 4, pp. 591-602