MO2GEO: An OpenSource Software Approach for Geological Modelling

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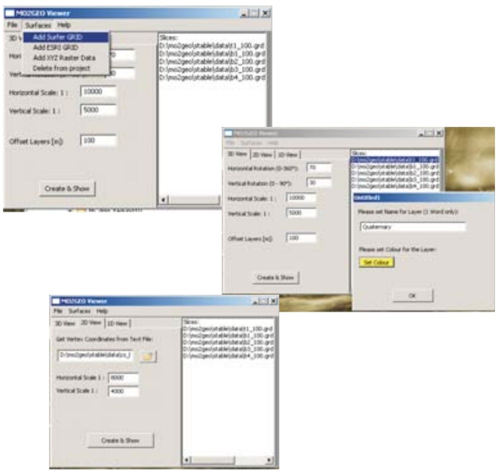
Abstract

The software tool MO2GEO combines geological field tools and visualization tools. Step by step it will be improved by analytical tools and new visual and data based modelling approaches. The first tool is a field tool that will on the first hand serve for the data assembly of boreholes, wells and hydrogeological measurements just as commercial software like HGA™ (SWS 2010) or GeODin ™ (FUGRO 2010). Additionally it will also be possible to use it for geological mapping and the registration of special geological features like tunnels (engineering geology), cliffs, quarries and excavations for buildings. The standards of coding are open for own extensions or a completely new thesaurus based on local layer names and/or national standards. The viewer is mainly a visualization tool for models that were elaborated with highly specialized tools and should be communicated to a wide range of users.

Introduction

Applied geological and hydrogeological models always need field data as a main input. In the past two geological investigation methods were considered by software tools to facilitate a further analysis. Geological mapping gives information about the geological entities at the surface. For this purpose GIS tools and techniques are used widely in recent mapping projects (USGS 2011, Clark 2011). On the other hand borehole analysis gives information in the vertical direction and for this purpose special tools were developed (SWS 2010, FUGRO 2010). The combination of both is rarely used. In most geological modeling tools the original borehole data have to be reorganized to fit to proper topological demands of the modeling tools (Smith 2005, Mallet 2002). The proposed methods e.g. Houlding (1994), Caumont et al. (2009) are not implemented in the modeling tools. Additionally there are other observation points that can enhance the information: Geophysical data, perhaps combined with remote sensing, cliffs, tunnels, excavations etc. Most of these information sources are not included in software tools as GSI3D™, Move3D™, HGA™, SURPAC™. In a first step the field tool of MO2GEO is used for the registration of various field data. It has the advantages to be compact, platform independent, flexible and OpenSource. Flexibility is mainly reached by the possibility to extend the standards and even adopt project oriented or national/local codings.

The viewer system was created for transparency reasons. Most of the geological models are developed with expensive and highly sophisticated tools. Thus, the results can often not be communicated to other scientists or the public. For this purpose an OpenSource tool was developed that allows for some exploration of models prepared in a predefined way.



Methods

The tools are developed in C++ with the wxWidgets toolkit for the GUI development and with plain OpenGL graphics to be platform independent, compact and easy to maintain by diverse developers. They are linked either to ASCII files or to a PostgreSQL database to be transparent and serve also for PostGIS applications.

Field Module

As shown in the figure, the module is structured into the field data registration of:

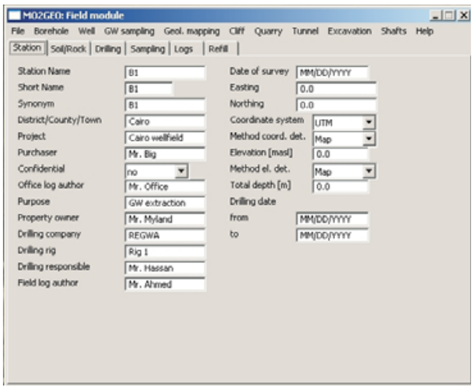
- Boreholes
- Wells
- Groundwater sampling
- Geological mapping
- Cliffs
- Quarries
- Tunnels
- Excavations for buildings and
- Shafts

In the future more features for the registration of geophysical data are planned but also other topics are possible.

For the boreholes and the mapping two strategies are followed: In the field the registration of lithology and some other parameters as water content, drilling progress, water levels during and after drilling are recorded and in mapping some measurements of tectonics in form of fissures, fractures and perhaps also faults are the main observable information. The geologist afterwards will interpret this in terms of genesis, stratigraphy and additional applied topics. The lithological description has to follow standards (e.g. EN ISO 14688-1 2002, EN ISO14689-1 2003, BS 5930 2010, ASTM D2487-06el 2006) and use common coding but in some cases an extension of these standards is necessary.

For the registration of drilling techniques, diameters and casing of the borehole an official standards exists for oil and gas indutry (WITSM) but not for water supply drillings. Sampling, logging and refill are additional topics that should be registered.

In the field module the data are saved in ASCII files in structured document folders for each project so that a transfer to other projects is simple.



Viewer Module

The viewer module shown in figure 2 allows the creation of cross sections and virtual boreholes that are derived from a pseudo 3d model. Input data are ASCII GRIDs that can be exported from OpenSource GIS or commercial software. The GRIDs are connected to 3d layers and via additional routines the values are used for the generation of the cross sections or virtual boreholes. The lines for cross sections are imported via an ASCII format (BNA format) that can also be exported from OpenSource GIS. The same procedure and data format can be used for a virtual borehole but here also a manual data input is possible.

Results and discussion

The demand for both tools is very high but the user structure is quite different. The field tool is mainly used by universities, companies and geological surveys. It is used to ensure the quality of data acquisition and a standardised way of registration and data quality. The viewer tool is used also in universities but also in the public (e.g. schools) to visualise and explore 3d models.

Conclusion and perspectives

The free use of standards is most important for the interoperabilty of geological databases. This should be reflected in the publication and implementation of software tools.

The further development will focus on the geological modelling process. The integration and interoperability of modules can be imagined based on the capabilities of the viewer: The visualisation tool for cross sections can be reused for the structural geologial modelling and the borehole module is used for the visualisation of the virtual boreholes as well as for the visualisation of the field data.

An additional tool for the connection of GIS data with the numerical groundwater flow modelling tool MODFLOW is recently developed (see figure below).

The software MO2GEO is meant to be used mainly by scientists but the established tools prove their acceptance also in public and applied project work.

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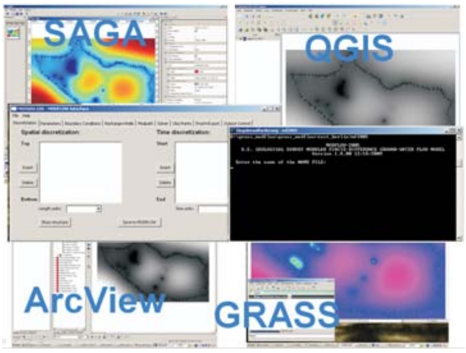
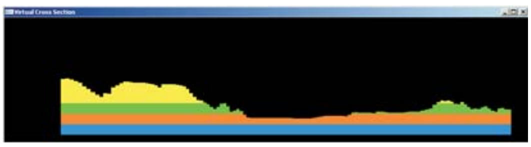
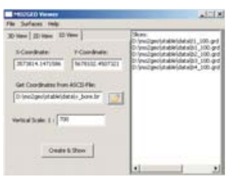
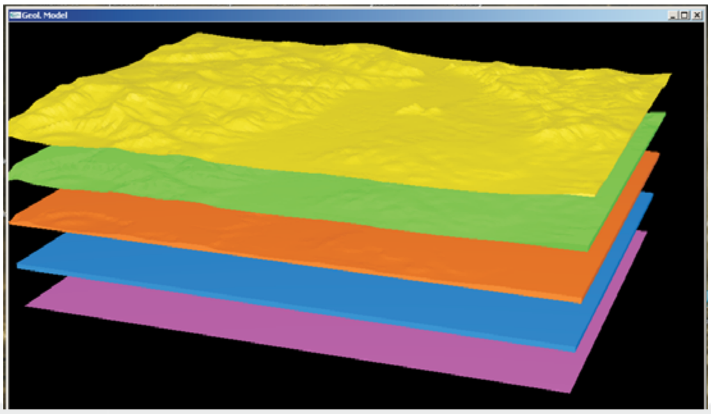
GIS-MODFLOW Interface

The GIS-MODFLOW Interface uses OpenSource GIS like Quantum GIS, SAGA or GRASS as a pre- and postprocessor for the numerical groundwater modelling tool. This tool is preliminary and only supports the basic modules of MODFLOW. A coupling to the MO2GEO viewer is planned.









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