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.

1 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 to give a better model of the underground structures. 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™. This is also reflected in standards for mapping and registration of borehole data. In a first step the field tool of MO2GEO is used for the registration of various field data. Afterwards these data will be seamlessly integrated in a structural modelling tool. It has the advantages to be compact, platform independent, flexible and OpenSource. Small and platform independent is necessary because netbooks and laptops are widely used for field work. Flexibility is mainly reached by the possibility to extend the standards and even adopt project oriented or national/local codings. For field work it is necessary not to be constrained to big database management systems. These systems insure data safety, but in the field it is necessary to have the data in an easy to handle data structure and to transfer the data afterwards to a database management system. Safety is most important for laboratory data and the preparation for the subsequent modeling process. Therefore at this point the connection to an OpenSource database management system is needed and the data have to be transferred.

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.

2 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.

Most of the modules are standalone tools which are connected to each other and rarely need additional libraries such as the OpenGL library.

2.1 Field module

As shown in figure 1 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. Most important in terms of further analysis is a 4d information (3d localization and the time of registration).

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 (as well as in the borehole recording) some measurements or assumptions about the tectonics in form of fissures, fractures and perhaps also faults are the main observable information. The geologist afterwards (but perhaps also in the field) will interpret this in terms of genesis, stratigraphy and additional applied topics, e.g. hydraulic conductivity/permeability, shear strain and porosity. 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 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. The good practice of drilling companies should be included here. Sampling, logging and refill are additional topics that should be registered. All this is supported by the field module.

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. For the analysis and further interpretation by a geologist the data can be transferred to a more safe OpenSource database management system (PostgreSQL). For the interpretation procedure a switch from the relational database to a hierarchical database is possible.

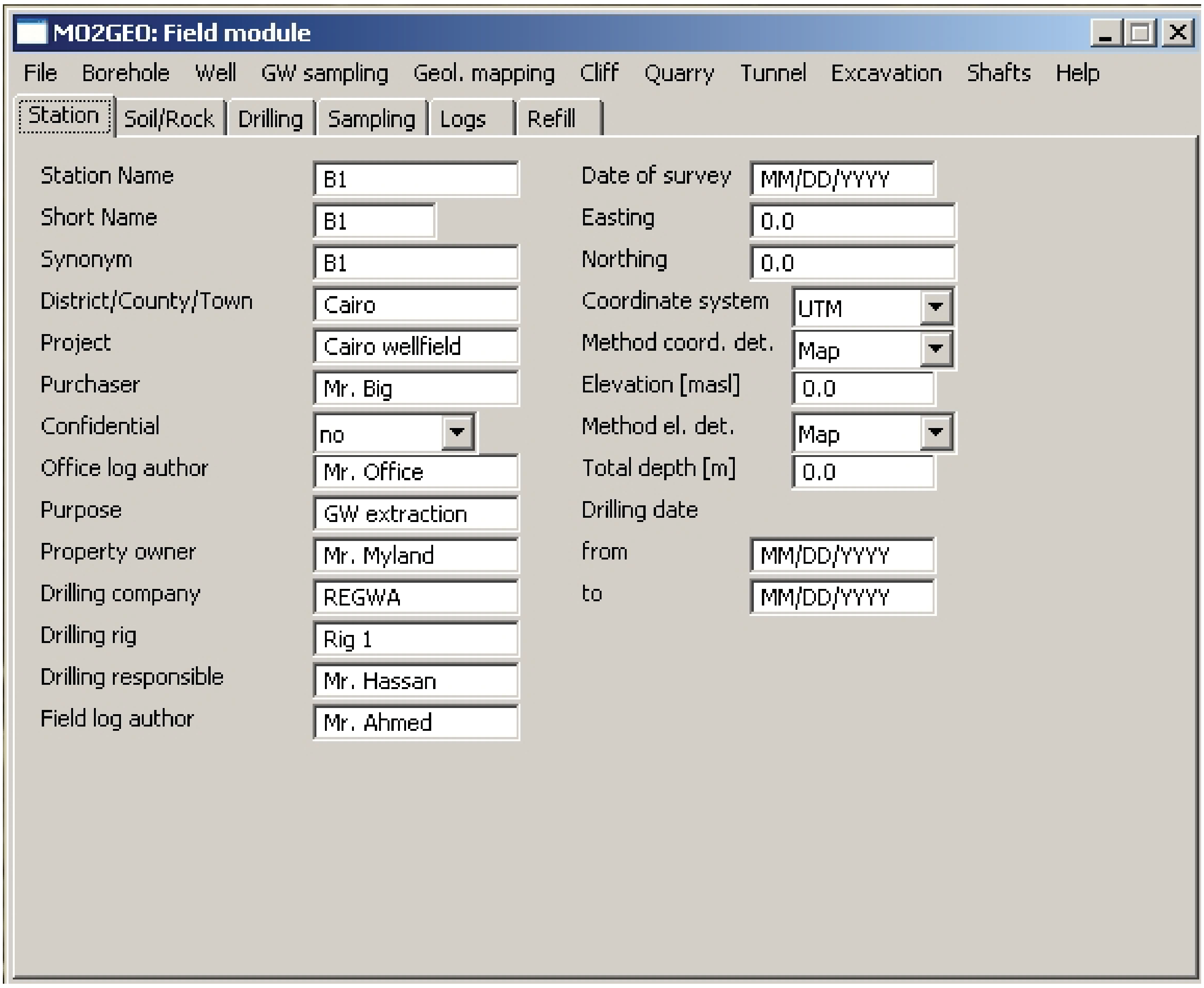

Figure 1: Snapshot of the field module

2.2 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.

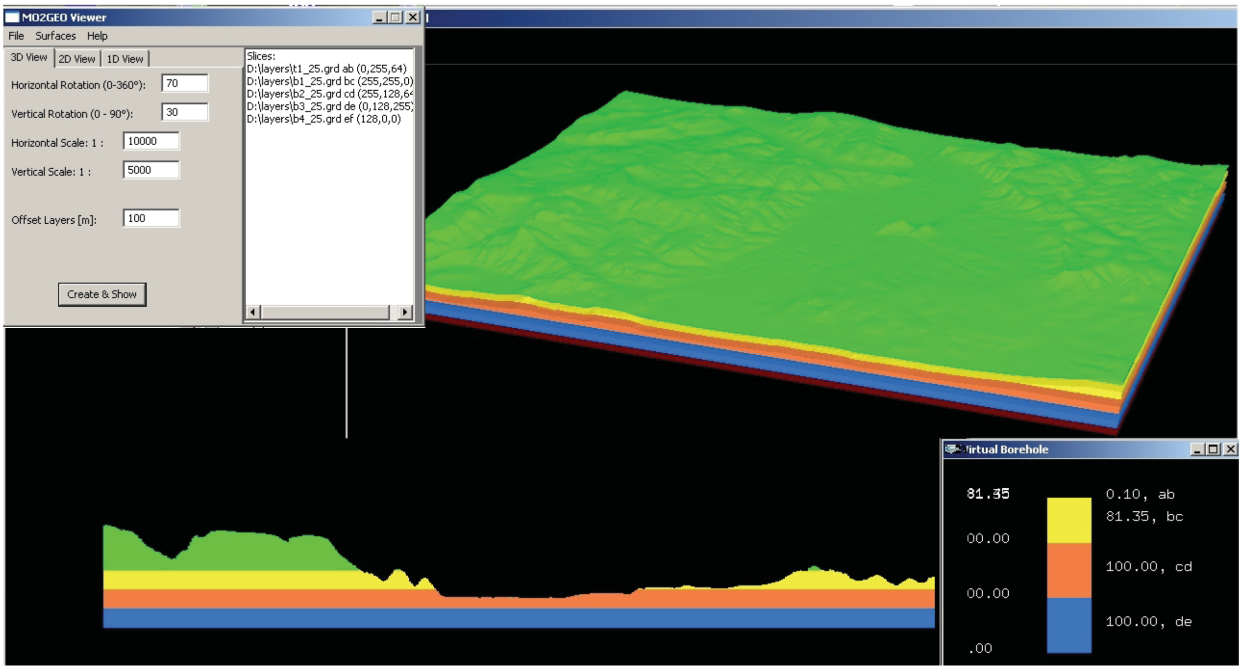

Figure 2: Snapshots of the viewer module: Graphical user interface, 3D view, cross section view and virtual borehole

3 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. The tool 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.

The software tools are ready to use but for some applied projects they certainly need an adaptation. The tools support the extension of the thesaurus and the coding of data and they are flexible in terms of importing new data formats. The practical applicability has been proven by the Egyptian drilling company REGWA and the Martin Luther University Halle.

4 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 two main modelling approaches will be included as there are the geostatistical approach and the structural modelling approach. For both methods the analytical part of MO2GEO has to be extended and certain methods have to be developed in a new way. 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.

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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