EFECT*: A tool for pore pressure projection and data management

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*EFfective StrEss guided Drilling Completion Toolkit

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Fundament I: Pore pressure in the Bavarian Molasse basin

A tool is only as useful as the material it works with. EFECT is built in parallel with the development of a quality-ranked database of pore pressure in the Bavarian Molasse basin.

The database contains 449 pore pressure measurements from 25 hydrocarbon and geothermal wells from 1955 to 2013. The database contains a variety of data types that allow to draw conclusions about the pore pressure. These include repeat formation testers, maximum mud weights, drillstem tests, productivity tests, shut-in drill pipe pressures, and kill mud weights.

These pore pressure data are available through “scout reports” (BEA & TUM.GTT, 2024). A superset of the data, as well as the data's expressiveness for pore pressure prediction, is discussed by Shatyrbayeva *et al.* (2023).

A future goal is to provide the pore pressure database alongside the World Stress Map (Heidbach *et al.*, 2016) infrastructure as a World Pressure Map, and consequently extend the database to a global scope. To this end, a unified pore pressure data quality ranking scheme is work in progress.

Offset well map

The map shows the locations of all offset wells within the database, as well as the location of the target well. Its function is to browse the data set and set the available wells into a geographic context. A web map service (WMS) raster can be displayed as a background (here: topography)

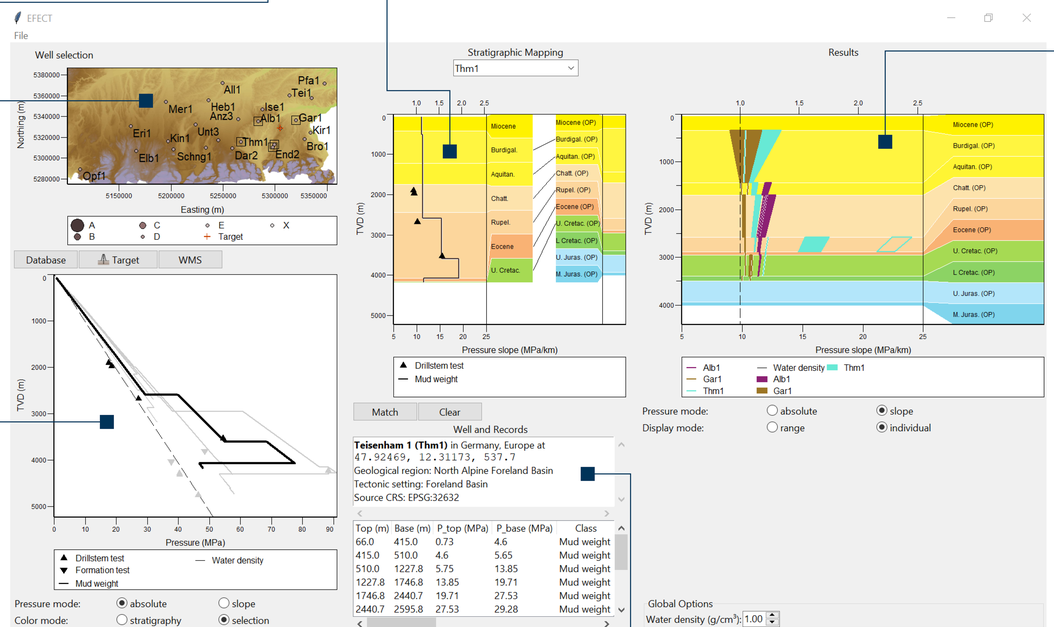
WMS by Geodatenzetrum (Federal Agency for Cartography and Geodesy, Germany)
https://sgx.geodatenzentrum.de/wms_dgm200_inspire

Stratigraphy Mapping

The central control area for the pore pressure prediction. The top dropdown controls which of the currently selected wells to display. The figure shows, by TVD, the offset well's stratigraphy on the left and that of the target well on the right. In between, the user can choose to map stratigraphic units of the offset well to stratigraphic units of the target well, indicating that the records of that offset well unit should be used to predict the pore pressure in the selected target well unit. Wells can be iterated among the currently selected (see “Offset well map”) via the dropdown. The current well is synchronized with the “Well and record table”.

Regional pressure model

A view of all pressure data from the selected offset wells, plotted over true vertical depth. This graph can help to obtain a general overview of regional pore pressure trends with depth. Coloring of the data can be chosen to highlight the currently displayed well (here: Thm1) or to show the stratigraphic units of the data.



Results: pore pressure prediction

This figure displays the pore pressure prediction results from the current offset well selection and stratigraphy mappings. Each data record is projected onto the selected range in the target well (here full mapped stratigraphic units). Point data map to lines while interval data map to trapezoids. An alternative prediction visualization based on a Bayesian interpretation of pore pressure-indicating data is work in progress.

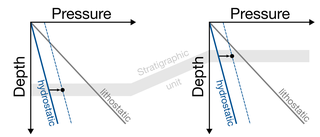
The prediction aims to help geothermal developers prevent pressure-related drilling problems, which may help improve operation safety and reduce cost (Drews *et al.*, 2022).

Well and record table

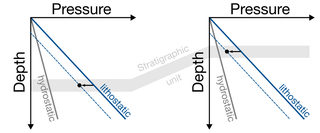
Combines a compact view of the well attributes (identifier, location, tectonic setting, CRS) with a table that lists all data from the input database for the currently selected well, that is, all the records and their numeric values from the current well.

Fundament II: Pore pressure prediction algorithms

EFECT is based on two geological models for pore pressure that lead to prediction equations, i.e. translation of the offset well pore pressure to the target well. Both models reflect geologic processes that define pore pressure within a crustal volume encompassing the offset and target well, e.g. a common stratigraphic unit.



One model assumes a hydraulic connection from the offset well to the target well. The pore pressure follows a common hydrostatic potential with a constant offset: the **constant overpressure (OP)**.



The second model assumes that pore pressure follows the lithostatic stress with an offset, the **constant vertical effective stress (VES)**. This model is appropriate if a formerly connected pore volume is disconnected during its geologic history, at which point pore pressure is frozen relative to the overburden.

References

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