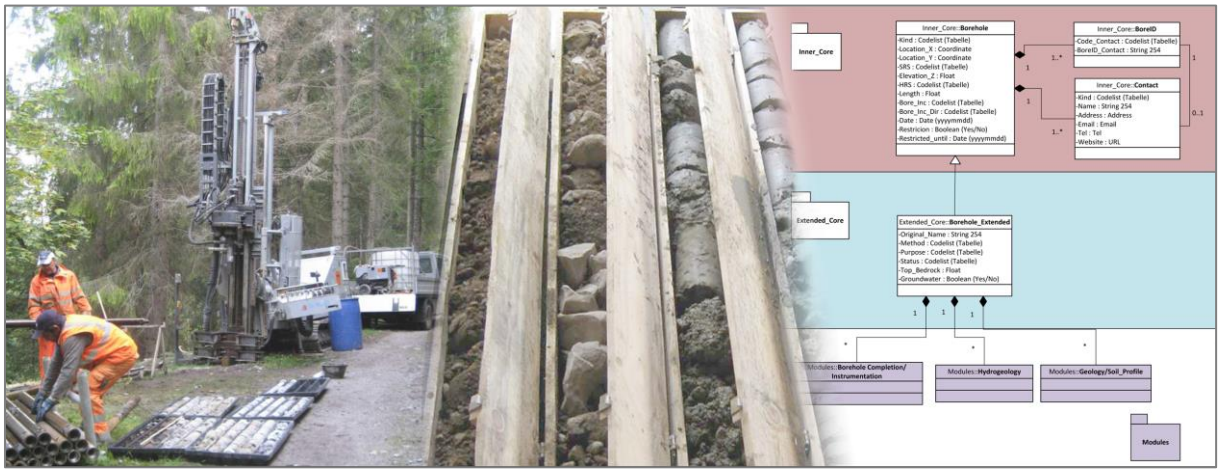
Borehole data model: structuring of digital borehole data



Drilling rig in operation and fresh drill cores in the foreground (left), drilling core in wooden boxes (center), UML class diagram of the borehole data model (photos: S. Brodhag).

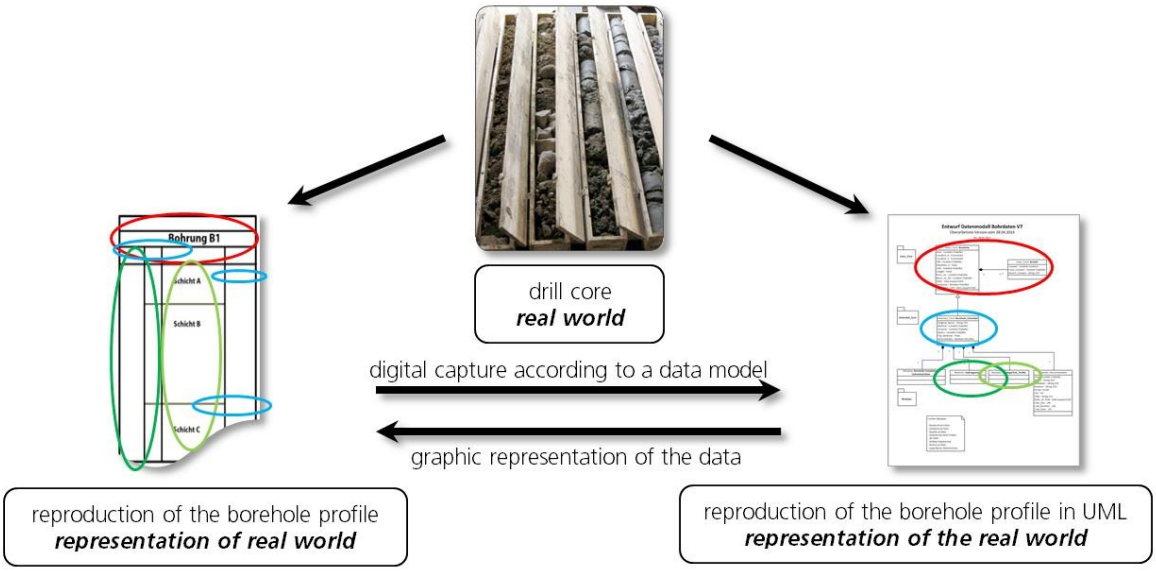
As a result of greater and more diverse utilization of the subsurface, administrative and public circles are increasingly focusing on our knowledge about the subsurface. Borehole data from drilling operations are one of the main sources of the relevant information and form the basis for 3D modeling of the subsurface. Digitization of these data paves the way for a modern and efficient management of the subsurface. Swiss-wide standards, guidelines and recommendations already exist for the analog recording and presentation of graphical borehole profiles, but they have not yet been established for the structuring of digital borehole data. Therefore the Swiss Geological Survey, in collaboration with representatives from the federal government, cantons, private sector and universities, developed the "borehole data model" as the first recommendation for structuring basic digital borehole data.

How are borehole data produced?

Boreholes are initiated for different reasons and for different purposes, such as assessment and remediation of contaminated sites, geotechnical engineering, research, exploitation of geothermal energy, prospection of mineral resources and groundwater, etc. Depending on the subsurface characteristics and the purposes of the investigation, drilling methods are chosen, which together with the drilling depth, offer various insights into the structure of rock bodies. The borehole data are recorded and interpreted from a technical viewpoint by the drillmaster and from a geological viewpoint primarily by geological specialists.

What is a data model?

In general, a model depicts the very complex reality. In order to enable this depiction, the reality must be generalized and idealized. A real borehole is depicted as a borehole profile on paper e.g. according to existing standards (e.g. SN 640 034) and recommendations (e.g. Canton of Basel-Landschaft). A data model of borehole data defines the digital data from the borehole according to federal recommendations for geodata models. The data are structured by themes, classes and attributes in tables of a so-called object catalog and are listed in hierarchical order. A data model in graphical form can be modelled e.g. in a UML class diagram. A data model is not a database, but it can serve as the basis for a database.



The drill core can be depicted as an image of the borehole profile (left) or through a data model describing the borehole profile, e.g. in UML format (right). The image of the borehole profile can be generated from the data model description, or vice versa.

How is the borehole data model structured?

The structure of the borehole data model comprises an inner core, an extended core and several modules:

- The *inner core* describes the most basic properties that define a borehole. If properties such as depth or coordinates are not specified, re-utilization of the borehole data would make no sense.
- The *extended core* complements the inner core with some important and basic attributes, such as drilling method, purpose of drilling and whether groundwater has been reached.
- The inner and extended cores are complemented with *modules*, which give detailed information on topics associated with a borehole. Examples are geological profiles, borehole development and instrumentation, results of borehole measurements as well as geotechnical, hydrogeological, geophysical and geothermal parameters.

Why is a common data model of borehole data important?

- A data model facilitates the *exchange* of borehole data and makes the search for them more efficient because similar data are structured in the same way. Thereby the focus is on the exchange and the *use* of the data.
- A data model *structures* and *harmonizes* data. It sets the *level of detail* of the data content and demands precise definitions, which thereby set the data's *standard of quality*. It also shows the relationships and dependencies among the data.
- Through the structuring, harmonization and quality standards, it forms a *"common language"*, which allows all stakeholders to understand, process and interpret the data faster and more efficiently.
- Structuring of the data also has an impact on the entire *"life cycle" of the data collection*: from acquisition and storage, to exchange/distribution and finally to utilization and interpretation/re-utilization. A differentiated transfer of borehole data through *access restrictions* at different levels is also possible.
- Finally, the standardized structuring as characters or strings provides the data with a *sustained interpretability*. Technically they cannot become obsolete and they need no constant updating.

What's next?
Up to now the inner core and the extended core of the present borehole data model have been developed. With this the borehole data model is still far from completion. More topics associated with borehole data are currently under development and will be added as modules to the borehole data model. Examples are document information (report, author, date, etc.), borehole development and instrumentation, geological profiles, hydrology, geothermal and geotechnical data, borehole measurements and their results, quality of the acquired data, and 3D path of the hole and drilling process.

Links:

- Topic data modeling:
  - Recommendations of the federal government and the IKGEO for modeling geodata
  - Federal basis modules
  - Conceptual data models in the OGC Standards Baseline
  - UML
  - Interlis, Interlis 2
- Data models of the Swiss Geological Survey:
  - The basis for uniformly structured geological vector datasets of Switzerland: Geology Data Model
- Boreholes:
  - Boreholes
  - Drilling methods
  - Bohrhole profiles in the internet (PDF)
- Regulations, guidelines and standards
- Geological Information Center of the Federal Office of Topography swisstopo