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BDFGeotherm: the Database of Geothermal Fluids in Switzerland

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ABSTRACT

The motivation to build BDFGeotherm database was to put at the disposal of the geothermal community a comprehensive set of data on the deep fluids of Switzerland and of some neighbouring areas. Researchers, engineers and all persons wanting to know the type and properties of geothermal fluids existing in a given area or underground system can find in BDFGeotherm a wealth of information which are generally widely dispersed and often difficult to reach.

The BDFGeotherm database has been built under Microsoft ACCESS code and consists of nine tables connected with a primary key: the field "Code". A selection of parameters has been chosen from the following fields: general and geographical description, geology, hydrogeology, hydraulics, hydrochemistry and isotopes and finally geothermal parameters. Data implemented in BDFGeotherm are in numerical or in text format. Moreover, in the field "Lithological log", one can visualize and save bitmap images containing lithological logs of boreholes.

A total of 185 thermal springs or deep boreholes from 71 geothermal sites are implemented in BDFGeotherm. Among the 56 Swiss sites, a large majority of them are located in the northern part of the Jura range and in the upper Rhone valley. Some sites, in Germany (6), France (3) and Italy (6), were selected for the following reasons: located near Swiss hot springs or deep boreholes, having similar geological features or representing a significant geothermal potential.

Many types of queries could be realised, using any fields of the database and the results can be put into tables and printed or exported and saved in other files.

1. INTRODUCTION

Many data exist on geothermal fluids in Switzerland. These data come from deep boreholes realized either for geological evaluations, geothermal prospects, oil exploration, thermal centres as well as thermal springs and fluids outflow from tunnel-drainage systems. All these data are contained in many papers and reports, often not published and not very accessible to potential users of this information.

The objective of this project was to gather the maximum amount of data on deep fluids and to integrate them in a relational database. This database can be useful to all geothermal projects planning to prospect, to produce or to inject fluids at depth, in any geological formations having some potential permeability as well as projects based on the enhanced geothermal systems technology (EGS). This tool will be also used to estimate and forecast the chemical composition of the geothermal fluids. The interest is obvious for the studies related to the risks of mineral deposits or corrosion in boreholes and in surface installations, and also for studies on interactions between rocks and thermal waters.

Geographically, all Switzerland was covered, knowing that the distribution of data is quite heterogeneous (figure 4). Other sites were selected outside Switzerland because they are located near the border, they have hot springs, deep boreholes or similar geological features with areas in Switzerland and they represent an interesting geothermal potential. Geologically, each formation containing groundwater, from the crystalline basement to the tertiary sediments, was taken into account. Moreover, all the thermal and subthermal springs whose temperature is higher or equal to 15°C, or between 10 and 15°C if the production yields are important, were included into this database.

The selected parameters concern the following fields: geography, geology, hydrogeology, hydraulics, hydrochemistry and geothermal parameters. The structure of the multiparameters and interactive BDFGeotherm database is built with the software Microsoft ACCESS. The language used in this database is French.

2. PROJECT DEVELOPMENT

The BDFGeotherm database was built between October 2006 and May 2007. In detail, this project proceeded according to the following steps:

- Choice of the parameters to be taken into account in the database. This first stage consisted in defining a detailed list of the parameters likely to be present in the database

- Preparation of the database structure. The previously defined parameters were gathered in several fields: description, geology, hydraulics, chemistry, isotope, geothermal parameters and bibliography.

- Selection of geothermal fluids. The choice criteria were defined by temperature (>15°C) and by high production yield if temperature was between 10 and 15°C.

- Bibliography search and data implementation. Books, reports and publications collected allowed the implementation and validation of data in BDFGeotherm.

- Writing of the user's manual. The user's manual of BDFGeotherm was written to guide users in their investigations. This manual presents the methods for search, adding, exporting and exploiting of data.

- Testing and finalization of the database (current phase).

3. STRUCTURE OF THE DATABASE

The database of the geothermal fluids in Switzerland consists of 9 tables numbered from 1 to 6 and then from 7.1 to 7.3, 77 fields and 185 recordings corresponding to all of groundwater points indexed in BDFGeotherm (figure 1 and table 1).

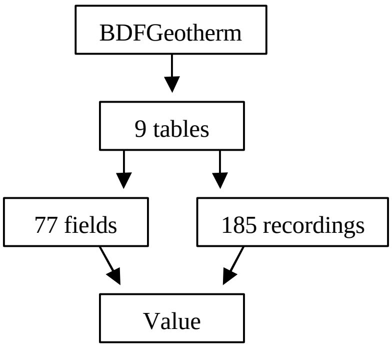

Figure 1: Organization of BDFGeotherm database.

Table name	*List of fields*
1.Description	Code, site name, country, canton, coordinates X and Y, altitude, type and name of groundwater point, year of realisation, depth, primary and secondary use of fluid.
2.Geology	Code, surface formation, age of surface formation, reservoir formation, age of reservoir formation, regional and local tectonics, lithological log.
3.Hydraulics	Code, flow rate, surface and maximum measured temperature, permeability, production type, static and dynamic water levels.
4.Hydro-chemistry	Code, name and sampling date, simplified and detailed geochemistry type, temperature, conductivity, pH, Ca, Mg, Na, K, Li, Sr, HCO_3, SO_4, Cl, F, SiO_2, TDS (Total Dissolved Solids), ionic balance, TDS variability, comments.
5.Isotope	Code, name and sampling date, ^{18}O, ^{2}H, ^{3}H, residence time, altitude of infiltration, comments.
6.Geothermal parameters	Code, surface and maximum measured temperature, temperature minimum and maximum reservoir, reservoir depth, geothermal gradient and geothermal potential.
7.1.Author	Number of author, author.
7.2.Table-links	Code, number of author and reference.
7.3.Biblio-graphy	Number of reference, reference.

Table 1: Structure of BDFGeotherm database.

The first two tables are used to describe the geographical and geological conditions of the sites concerned by the fluid samples. Tables 3 and 6 include especially numerical data on thermal fluids where as tables 7.1 to 7.3 show the list of authors and bibliographical references related to the sites. To avoid problems of no-recognition of character strings during queries, all field names and all values are written without accent and special characters.

In order to start a search of data contained in several tables, they are related with the fields “Code”, “No.author” and “No.bibliography” representing primary keys of the database BDFGeotherm. The code is used to identify a groundwater point. For example, the borehole P600 in Lavey-les-Bains will be defined by the code “LAVEY-P600”.

4. SEARCH OF DATA

4.1 Search of data contained in one table

The simplest search of data consists in selecting the information contained in several fields of a single table. For example, we can make a request on all the springs and boreholes indexed in BDFGeotherm. The result of this search will give a new table with the selected fields as well as the totality of recordings. This table can be recorded in BDFGeotherm or exported to another database.

It is possible to reduce the number of recordings while inserting selected criteria into the query. For example, we wish to realize an inventory of boreholes deeper than 500 m and located in the canton of Aargau in Switzerland. The result of this request shows that 7 boreholes exceeding 500 m and present in Aargau are recorded in BDFGeotherm (Table 2).

Site name	*Geology*	*Formation temp. (°C)*	*Depth (m)*
Böttstein	Hercynian gneisses	60	1326
Kaisten	Hercynian granites	58	1306
Leuggern	Hercynian granites	66	1689
Riniken	Permian sandstones	70	1369
Schafisheim	Hercynian granites	85	1892
Schinznach-Bad	Triassic limestones	45	891
Zurzach-Bad	Hercynian gneisses	45	701

Table 2: Example of a search of boreholes exceeding 500 m depth in the canton of Aargau.

4.2 Search of data contained in several tables

It is possible to realize a search of data contained in several tables in a single request (figure 2). To do this, the user must select tables then fields wanted in a new query and check that each table is linked with the field “Code”. If this link is not established, the users have to do it manually.

4.3 Bibliography search

The BDFGeotherm database consists of 3 tables gathering the 65 literature references used for the development of this database. References and authors are classified and numbered alphabetically in two independent tables. Table

"7.2-Table-links" is used to make different links between these numbers, thus it is essential for realization of requests of bibliography search type.

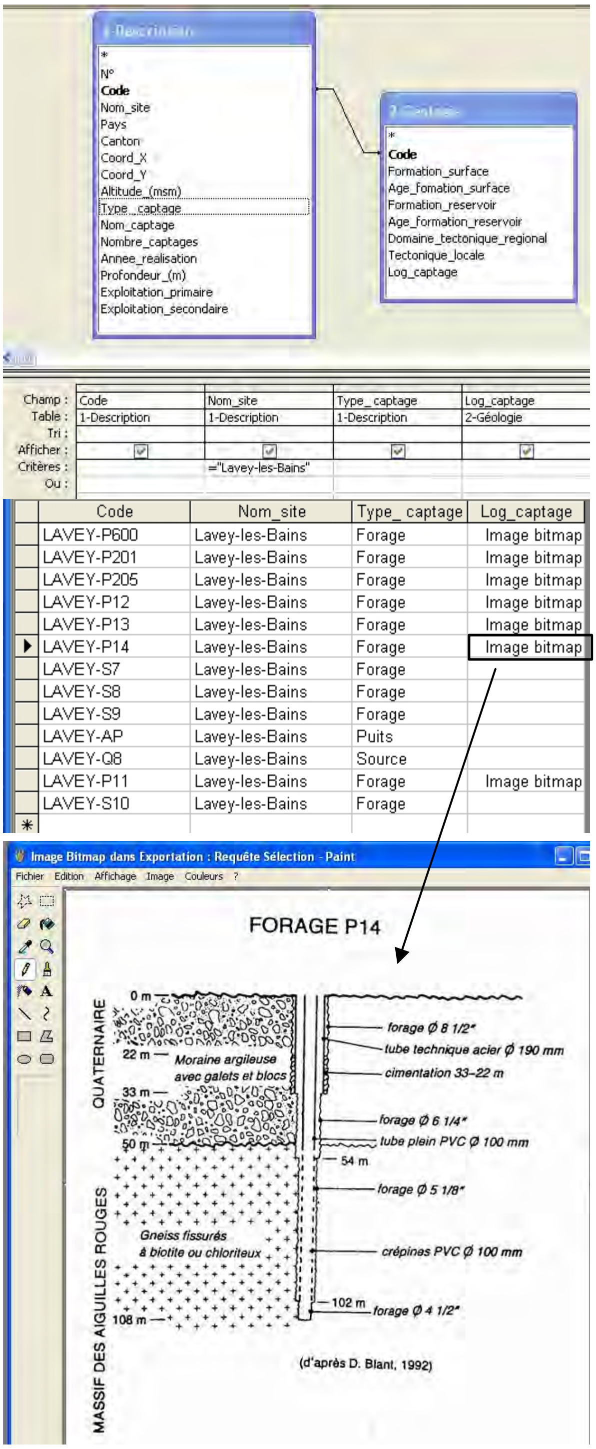

Figure 2: Realization and result of the query. Search of lithological logs in Lavey-les-Bains (Switzerland).

To realize a bibliography search of a given site or groundwater point, we need to add tables "1-Description", "7.1-Author", "7.2-Table-links" and "7.3-Bibliography" in a new request and to join fields "Code", "No.author" and "No.bibliography" between each table (figure 3).

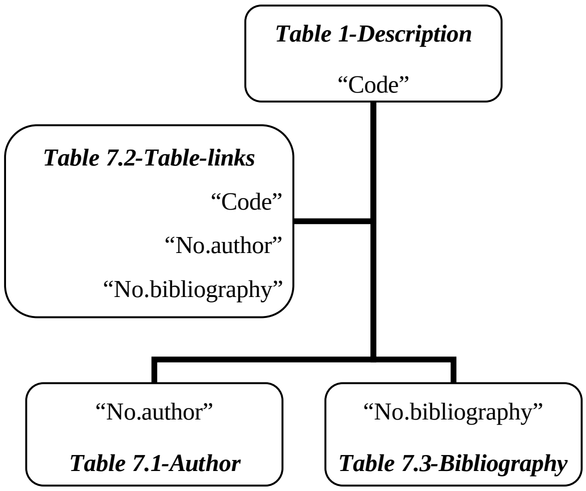

Figure 3: Relation between tables for bibliography search of a given site or groundwater point.

5. ADDING DATA

5.1 Addition of data in a site or a groundwater point already indexed

The bibliography consulted for the elaboration of BDFGeotherm database is present in the table "7.3-Bibliography". Of course, this reference list is not exhaustive and there exist certainly other reports and papers on geothermal fluids of Switzerland which were not consulted. Users, having other bibliographical references, can add data to their version of BDFGeotherm. The step corresponding to this addition type is simple because one just has to enter new data in the chosen cells and to save it.

5.2 Addition of a new groundwater point

5.2.1 Addition of a new groundwater point in an existing site

In case a geothermal project realizes new boreholes, they can be recorded in BDFGeotherm. The addition of a new spring or borehole in a site already indexed is done as follows:

- Insert the name of the new spring or borehole in all fields "Code" while starting by the first 5 letters of the site where groundwater point is located. For example, REINA-F2 for a new borehole F2 drilled at Reinach in the canton of Basel-Land.

- Choose "Reinach" in the drop-down list of the field "Site name", enter data available of the new spring or borehole and save the database.

5.2.2 Addition of a new groundwater point in a new site

If a new site is under investigation yet, it is necessary to insert a new site name. This step requires more handling because the site name must appear in the drop-down list of the field "Site name".

5.3 Addition of pictures in the field « Lithological log »

Due to time restriction and documents availability, not all the lithological logs of boreholes and cross-sections of tunnels could be included in this database. Users have the possibility to insert or to update pictures from the field "Lithological log" while going to the menu "Insert a picture".

6. EXPORTING DATA

Exporting data from an ACCESS database is possible from a table or a query. The extension of the exported file can be preserved or modified from drop-down list of standard menu “File type”.

7. EXPLOITING DATA

Search and exploitation of data contained in BDFGeotherm are useful to any geothermal projects of low, medium and high energy. Prospect, production and injection of geothermal fluids coming from all potentially aquifer geological formations are various subjects which users will be study.

The user’s manual presents with BDFGeotherm database proposes four examples showing various themes and giving to users some directions to search information for their own geothermal project:

- Search of information for realization of a new borehole.
- Prediction of chemical composition of thermal waters.
- Study of the local or regional geothermal potential.
- Realization of maps with a GIS (Geographic Information System).

8. CONCLUSION

BDFGeotherm database was built to collect the maximum of information on geothermal fluids of Switzerland and neighbouring regions. Consulted books, publications and reports often do not give complete information (isotopic analysis and geothermal or hydraulic, etc.). For this reason, a significant number of fields contain only few. Users will be able to complete or to introduce new information into BDFGetherm database with their own documentation and projects on-going.

Search, addition, exporting and exploitation of data with Microsoft ACCESS are simple and one user’s manual is provided with this database to guide users in their investigations. This manual describes all steps to be followed for an optimum use of this database. Finally, various practical cases of geothermal projects are given as examples.

ACKNOWLEDGMENTS

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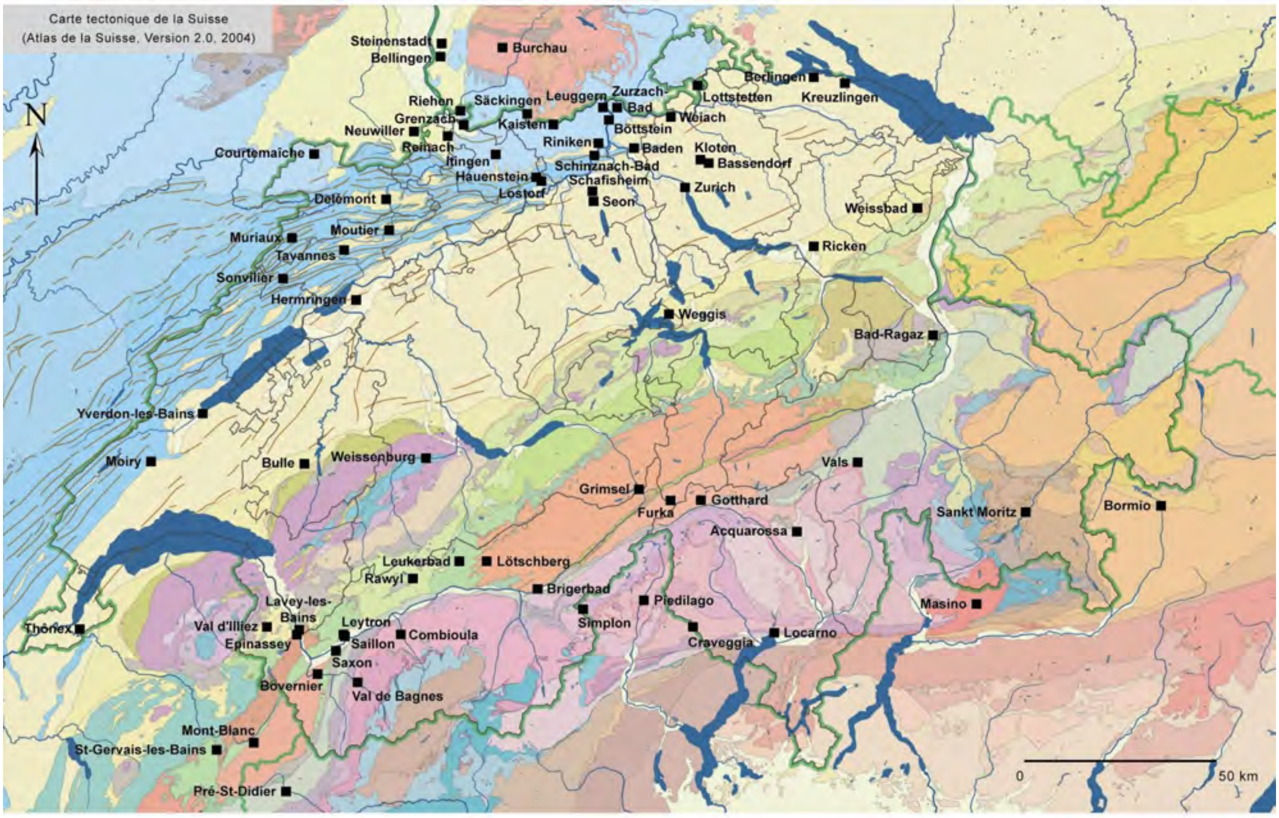

Figure 4: Localisation of the sites indexed in BDFGeotherm.