INTERNATIONAL SUMMER SCHOOL
on Direct Application of Geothermal Energy
Under the auspice of:
Division of Earth Sciences
3EMAK
GtV

Chapter 3.3

The Swiss Deep Heat Mining Project
The Basel exploration drilling

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A Deep Heat Mining plant is feasible in Switzerland

The conditions for the construction and successful operation of such a plant are particularly attractive in northern Switzerland, because of the significant potential of heat consumption and of the known geological and geothermal conditions. The two main requirements for site selection are a temperature of 200°C at a depth of about 5 km and local heat consumers connected to a large heat network distribution.

Building a Deep Heat Mining plant will not require the development of essentially new technologies. For decades, electric power has been generated economically from geothermal fields all over the world. The deep drilling technology (5-6 km) into hot and hard rock is available, representing a combination of experiences gained in the oil and mining industries, with specific high temperature tools and knowhow from geothermal industry.

A selection of ten potential sites in Switzerland have been evaluated. On the basis of logistics, heat distribution and geological criteria, two sites are under detailed appraisal in Basel and in Geneva

Specifications for the Deep Heat Mining pilot plant

Parameters	Characteristics
Underground system	1 injection well and 2 production wells connected to the reservoir Reservoir: stimulated volume of fractured crystalline rock
Surface installation	Circulation pumps Heat exchanger (binary cycle system) Steam turbine Electricity generator Cooling system Connection to the power grid Connection to the district heating network
Depth of the wells	About 5000 m
Temperatures	200°C in the fractured reservoir 170°C at the production wellhead 70°C at the injection wellhead

Flow rate	70 kg/sec
Output power	3 MW electric and 20 MW thermal
Energy production	Power: 20'000 MWh/year Heat: 80'000 MWh/year
Milestones	1996: beginning of the DHM project, concept 1997-98: preliminary studies, site selection 1999-01: site preparation, drilling of 1st exploration well, evaluation of the crystalline basement 2003-04: drilling of 1st deep well, reservoir definition 2005-06: drilling of wells 2 +3, production tests 2007-08: long-term flow test and concept of the pilot plant 2009-10: building of the pilot plant, start of power production
Future potential	Creation of new DHM sites in Switzerland World-wide application of the DHM technology

The areas of responsibility of the DHM consortium is the identification and scientific evaluation of potential DHM sites, the creation and promotion of new projects, their scientific supervision and their quality control.

The different steps of the Deep Heat Mining project are closely related to the development of the European Hot Dry Rock programme in Soultz-sous-Forets, Alsace, France.

Deep Heat Mining: friendly energy from the earth's interior

Deep Heat Mining: power and heat generation from deep enhanced geothermal systems: a new energy project in Switzerland.

Geothermal energy is the only renewable source of energy which can be tapped round the year and the day with no need of storage facilities.

Deep Heat Mining: the project was initiated and is partly financed by the Federal office of energy (OFEN) since 1996. Private and public institutions support the activities of the project.

After the selection of a first adequate site in the city of Basel and the drilling of the necessary boreholes, the objective is to create a deep fractured reservoir and to build a pilot plant delivering electricity and heat.

The modular concept of a Deep Heat Mining pilot plant is composed of one injection well and two production wells. The cold water is pumped down and circulates through the fractured reservoir. This natural heat exchanger delivers hot and pressurized water to the production wells. The energy is converted into power by means of a turbine-generator unit. The excess heat is used for space heating. The cooled water is then reinjected at depth. This closed-loop system provides CO2-free energy.

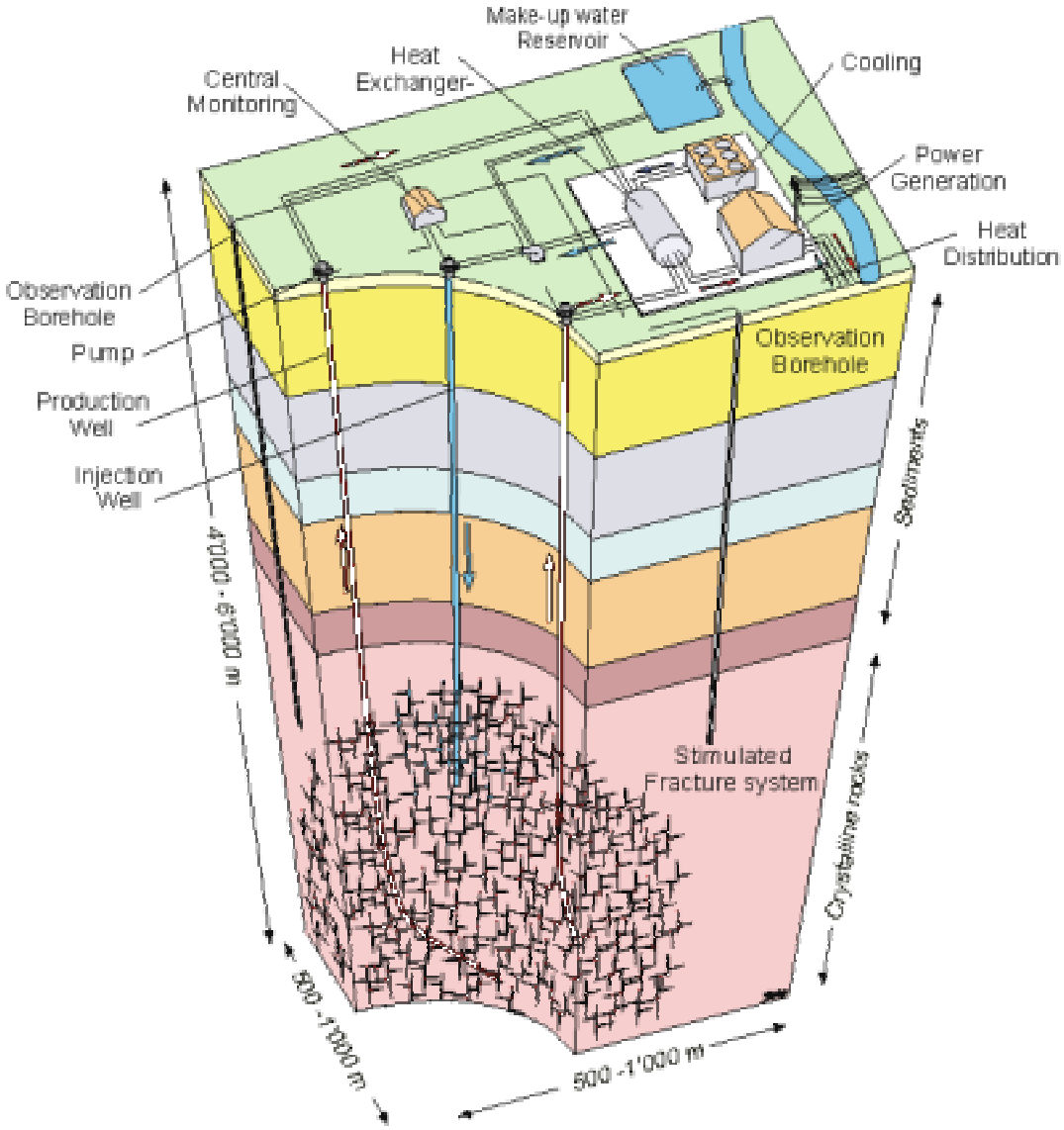
Main DHM project in Basel

For a number of practical, economic, political and geothermal reasons, the first Enhanced Geothermal System pilot plant in Switzerland will be situated in the Basel area. The city of Basel is a highly developed urban area, with numerous heat consumers, existing heat distribution networks and a strong policy towards renewable energies. Basel is located at the southeastern end of the Rhinegraben, a failed rift system. The sedimentary sequence filling the rift is relatively well known, but no drillhole has perforated the crystalline basement, foreseen at a depth of 2.2 ± 0.2 km. The geothermal gradient is estimated to reach 40°C/km.

Drilling of DHM-1 well in Otterbach, Basel

A first exploration borehole (DHM-1) has been spotted in Otterbach and drilling operations started in June 1999. Unfortunately, successive drilling problems stopped the penetration at 1537 m. After numerous fishing attempts to retrieve a broken casing string, the well DHM-1 was abandonned. In January 2001, a tempe-

rature log from surface down to 537 m has revealed a geothermal gradient of 4.2°C/100 m, which is slightly above the forecast. Later, DHM-1 borehole will be equipped as a seismic station by the Swiss Seismological Service.



Concept of the Deep Heat Mining System

Drilling of DHM-2 well in Otterbach, Basel

A new drilling programme has been set up, including a more powerful drilling rig as well as larger borehole and casing diameters. The well DHM-2 is realised on the same location in Otterbach, by UGS Co. from Germany. The rig, a IRI Franks 900 with a regular hook load of 138 tons, arrived on the site March 7 and drilling operations have started March 15, 2001.

Status at: June 17, 2001
Days since spudding: 94
Depth: 2755 m —–> Total Depth
Formation: crystalline basement
Current action: demobilization works
Average drilling rate: –
Drilling method: –
Current drilling diameter: –

Last drilling diameter: 5 7/8" (149 mm)
Cased down to: 2030 m.
1st casing: at 25 m, 22" (500 mm)
2nd casing: at 845 m, 13 3/8" (340 mm)
3rd casing: at 1540 m, 9 5/8" (244 mm)
4th casing: at 2030 m, 7" (178 mm)
Open hole section: 2030 to 2755 m, 5 7/8" (149 mm).

Preliminary results

Drilling, coring and logging operations of borehole DHM-2 in Otterbach can already be regarded as a success:

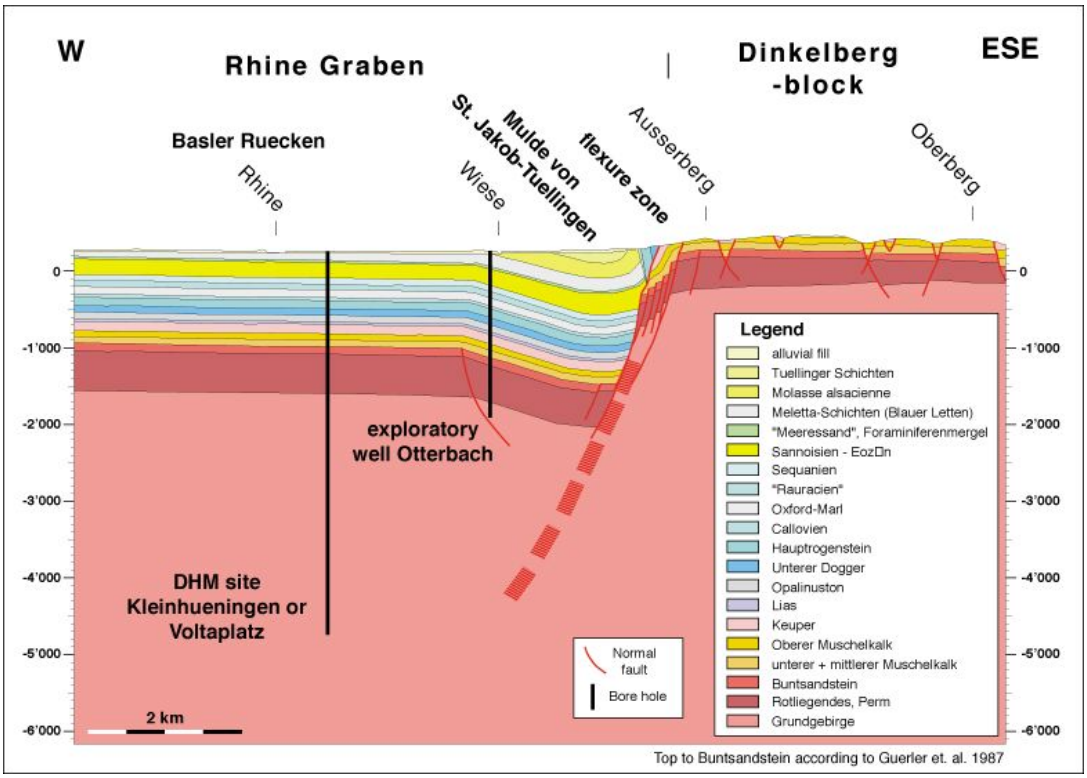
(1) preliminary temperature logs show a geothermal gradient of at least 38°C/km,
(2) cores recovered from unweathered crystalline basement display tight and fractured granite,
(3) remarkable geological findings will represent new and important references for the understanding of the southern Rhine graben.
(4) fracture system was mapped by newly developed borehole logging tools / a combina-tion of acoustic and electrical measurements.

Next operations:

addtional temperature logs and tests to follow after demobilization of drilling rig.

* core analysis of the granite and petrographical investigations,
* hydraulic tests, and stress measurements,
* fluid and gas sampling and analyses,
* obtaining enough information for the site selection of a first deep well at 5 km

Later, this borehole will be completed as the first of three seismic monitoring wells located around and above the future deep fractured reservoir.



Cross section across the Rhine Graben margin at Basel (Haering 1999).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