Geophysical Research Abstracts, Vol. 7, 03666, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03666

Probing a fault zone on the kilometre scale – Experience from massive pumping and injection tests in the 4 km deep KTB pilot hole, Bavaria

J. Erzinger (1), **H.-J. Kümpel** (2), S. Shapiro (3) & KTB-VB Science Team

(1) GeoForschungsZentrum Potsdam, Germany, (2) Leibniz Institute for Applied Geosciences, Hannover, Germany, (3) Free University of Berlin, Germany (kuempel@gga-hannover.de / Fax: +49-511-643-3665)

The "Kontinentale Tiefbohrprogramm der Bundesrepublik Deutschland (KTB)" had revealed a wealth of geoscientific data and brought up new results of unrivalled quality and broadness. Yet, the scientific potential of the 4.0 km deep pilot hole and the 9.1 km deep main hole drilled between 1987 and 1994 has by no means been fully exploited. Features of particular interest are two dominant fault systems encountered at 4.0 and 7.2 km depths, respectively, in the crystalline formations. A new series of experiments is focusing on transport processes of energy and fluids in these fault systems. The KTB drill site allows to study relevant parameters of such continental structures on the kilometre scale.

The first major experiment was a one-year fluid production test in the KTB pilot hole (June 2002 - June 2003). A total volume of 22,300 m^3 of saline crustal fluids were produced from the open hole section (3850 m - 4000 m, approx. 120˚C). Final draw down was 605 m below surface - at fluid yield of 54 l/min. Fluid outlet temperature, water pressure at the submersible pump (depth 1283 m), pH and redox values, electrical conductivity and the amount of dissolved gases were monitored and recorded online. The separated gas phase was analyzed on site in real-time. Several working groups have performed further investigations including deep biosphere studies. In addition, the KTB main hole was equipped with a seismometer installed at 4000 m depth and two water level sensors.

The volume ratio of gas to water was close to one, 98% of the gas phase is nitrogen and methane. Electrical conductivity of the fluid was rather constant at 86 mS/cm as were the values for pH (7.5). 222Rn activity was 5500 Bq/m^3. Fluid level in the main hole - at 200 distance from the pilot hole - steadily fell from zero to 50 m below surface, indicating some hydraulic connection between the pilot and the main hole. Analyses of three interim recovery tests appear to indicate that the fault zone reservoir is infinite; hydraulic transmissivity is around 3 x 10^{-13} m^2. Induced seismicity was virtually zero.

After 12 months of hydraulic recovery, we have started a one year fluid injection test in the pilot hole (June 2004). Within the first six months, 50,000 m^3 of fresh water have been injected into the fault zone at 4 km depth. Injection rate so far was 200 l/min on average, at about 100 bar injection pressure. After four months of silence, induced seismicity has started in October 2004 and appears to increase slowly. Also in October 2004, the main hole, clearly reacting on the injection in the pilot hole, has become artesian and produces some 1 m^3 of water per day. Further investigations include repeated large scale DC measurements, nanoradian-monitoring of the surface deformation field, and repeated high resolution active seismics to find out whether the massive hydraulic 'inflation' of the fault zone can be imaged from the surface. The injection test is planned to continue until mid 2005. Similar hydraulic testing is foreseen for the 7.2 km deep fault system in the years coming.