KTB Deep Crustal Lab

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Objectives

The main objective of the Continental Deep Drilling Program of the Federal Republic of Germany (KTB) is basic research on the nature of geophysical structures and phenomena, the stress field and thermal structure of the earth's crust, fluids and mass- and energytransport in the depth. Up to know knowledge has been based on detailed surface investigations and laboratory measurements on drilled material. The crustal segment beneath KTB is characterized by a layer of high electrical conductivity at 10 km and a zone of high seismic reflectivity together with high seismic velocities beneath. Using borehole measurements together with the results of extensive laboratory investigations detailed information of the compostion and physical state of the drilled profile is available, however questions dealing with processes and the nature of geophysical structures and phenomena remain open. These questions may be answered by special experiments after cmpletion of drilling. By combining experiments in the pilot hole and the KTB main hole with detailled surface studies representative in-situ values for larger rock units can be obtained and surface effects can be eliminated or minimized.

Time is the most important parameter for further planning. Stationary physical field values as a function of depth can be determined after reaching equilibrium long after reaching the target depth. Both drill holes offer the unique possibility of carrying out long-term investigations of seismolgical and tidal effects at all dephts (Crust, Mantle and Core) which cannot be registered from the surface. Within the framework of the planned investigations measurements over long periods at fixed depths (i.e. deformation, time-dependencies) or regular measurements of depth profiles (i.e. temperature) are necessary.

Depth of installation

A guideline for the depth of installation of the measuring devices is primary the geoscientific problem i.e. a geochemically or geophysically interesting horizon or the optimal reduction of surface effects. The concept includes different depth intervals - following the target depth of pilot hole, main hole and shallow drillholes

in the surroundings of the location. The installation depth is constrained by the technical feasibility of the experiments. Experiences down to 4000 m gained in the pilot hole can be used for the development of measuring tools for greater depth and higher temperature in the main hole.

Definition of depth laboratory and depth observatory

As already mentioned, the concept includes registration of time dependant variations at fixed depth and measurments of depth profiles at given time intervals. The measured value will be exited either by natural effects (i.e. electromagnetic or seismic events) or will be directly stimulated by changing the boundary conditions (i.e. by suppling an electrical current, lowering the mud level by continous pumping).

Depth observatory: Registration of time dependent variations under "natural" conditions at fixed depth.

Depth laboratory: Experiments, unique or regular, with defined change of the boundary conditions.

The depth laboratory also includes long-time experiments which influence the "natural" boundary conditions over a given time period (i.e. pumping test). Also included are registrations of depth profiles of physical and chemical parameters.

General technical aspects and problems

- Special techniques of data transfer from downhole to the surface have to be developed. The construction of the cable, signal type (analoge or digital) and whether the signals must be transferred continously or not have to be discussed and coordinated for each different experiment.
- A logging unit with extensive equipment must be available (i.e. data aquisition). In addition laboratory capacities must be available for chemical analyses of gases and fluids.
- A number of experiments need to be cooled down due to the higher temperature at greater depth.
- Fishing jobs, in the case of lost downhole equipment.

Main topics of proposed experiments

Temperature and heat transport

- Depth dependany of the stationary temperture field
- Heat flow and heat production as a function of depth
- Depth dependency of the heat flow on advective, paleoclimatic and structural influences

Seismology and Seismics

- Improved localization of earth quakes
- Signalshape as a function of depth
- Separation of teleseismic and local effects
- Cross-hole seismic tomography
- Verification of the "Erbendorf"-body

Electric and magnetic field

- Nature and position of the high conductivity layer at 10 km
- Anisotropy of the high conductivity layer

Stress and deformation

- Registration of the low-frequency deformation field
- Magnitude and orientation of the stress-field
- Rigid-ductile transition
- Rheology of the earth's crust

Fluids, pore pressure and permeability

- Composition and origing of deep crustal fluids
- Geohydraulics
- Hydraulic communication between pilot hole and main hole
- Fluid/rock interaction

Milestones and time schedule (prelimenary)