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KTB Borehole Logging Data

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German Continental Deep Drilling Program

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1. Abstract

This report describes the KTB Borehole Measurements Data of the German Continental Deep Drilling Program (Kontinentales Tiefbohrprogramm der Bundesrepublik Deutschland), operated by the GFZ German Research Centre for Geosciences. Extensive borehole measurements were performed during the active drilling phase of the KTB pilot and main hole (1989-1994). This report provides the full description of the logging data. Please read it thoroughly to avoid inappropriate or wrong use of the data.

The terms borehole measurements, downhole logging, and logging are used synonymously here. The KTB logging data files contain the final processed versions of the geoscientific borehole logging data from logs in the two KTB boreholes:

Boreholes	Geographic Coordinates (WGS84)
KTB-Oberpfalz VB (KTB Vorbohrung/Pilot Hole or **KTB-VB**)	49.8153 N, 12.118 E
KTB-Oberpfalz HB (KTB Hauptbohrung/Main Hole or **KTB-HB**)	49.8152 N, 12.1205 E

Keywords: borehole logging, downhole measurements downhole data, reference gamma ray, trajectory, temperature profile, composite log

The data described in this report are published as:

Kueck, J.; Conze, R.; Bram, K.; Draxler, H.; Zoth, G.; Kessels, W.; Hänel, R. (2021): KTB Borehole Measurements of the German Continental Deep Drilling Program. GFZ Data Services. https://doi.org/10.5880/GFZ.KTB.BM.ALL

Individual data publications within this data compilation are:

- Borehole geometry and orientation: https://doi.org/10.5880/GFZ.KTB.BM.bgl (Kueck et al., 2021a)
- Composite logs: https://doi.org/10.5880/GFZ.KTB.BM.composite (Kueck et al., 2021b)
- Geochemical logs: https://doi.org/10.5880/GFZ.KTB.BM.glt (Kueck et al., 2021c)
- Gravimetry: https://doi.org/10.5880/GFZ.KTB.BM. gravimetry (Kueck et al., 2021d)
- Magnetic susceptibility and field: https://doi.org/10.5880/GFZ.KTB.BM.magnetic (Kueck et al., 2021e)
- Spontaneous potential and induced polarization: https://doi.org/10.5880/GFZ.KTB.BM.spip (Kueck et al., 2021f)
- Structures from borehole images, foliation, fracs, faults, joints: https://doi.org/10.5880/GFZ.KTB.BM.structures (Kueck et al., 2021g)
- Temperature: https://doi.org/10.5880/GFZ.KTB.BM.temperature (Kueck et al., 2021h)

2. Introduction

2.1. The KTB Program

The _KTB (Kontinentales Tiefbohrprogramm der Bundesrepublik Deutschland) was the German Continental Deep Drilling Program with drilling operations from 1989 to 1994. Two boreholes, one 4 and the other 9.1 km deep, served as a telescope into the earth's interior to allow for in-situ observation of physical and chemical processes and calibration of surface experiments. The physico-chemical aim was to reach a temperature of 300°C which was expected at a depth of c. 10,000 m at a pressure of approximately 3,000 bar when mechanical properties of rocks change significantly.

2.2. KTB - a view into the interior zones of a mountain chain

One of the major goals of the KTB was the elucidation of structure and evolution of the interior zones in a former mountain chain. The drill site near Windischeschenbach, (NE Bavaria, Germany) is at the structural boundary between the Saxothuringian and Moldanubian, two major tectono-stratigraphic units of the Hercynian fold belt of the Variscan Orogen in Central Europe. This boundary was regarded as a suture zone formed by the closure of a former oceanic basin c. 320 million years ago. This process gave way to a continent-continent collision and the formation of a mountain chain comparable to the today's extension of the Himalayan mountain chain. Today, the high mountain relief is eroded and, therefore, once deeply buried rocks are exposed at the surface. Therefore, this area is an ideal place for the study of deep-seated crustal processes. Furthermore, detailed geophysical surface experiments during pre-site survey studies revealed that the drill site is characterized by an anomalous high electrical conductivity and pronounced gravimetric and magnetic anomalies at drillable depth of about 10 km.

2.3. KTB - an investigation into the future of our planet

Key questions to be addressed by continental deep drilling include the evaluation of fundamental processes occurring in the lithosphere, the outer skin of our planet and resource base for mankind. KTB's major research topics were:

- Evaluation of geophysical structures and phenomena
- Investigation of the thermal structure of the continental crust
- In-situ investigation of rock-fluids and their contribution to formation of ore deposits
- Elucidation of structure and evolution of the continental crust
- Determination of the earth's stress field

Furthermore, the establishment of a long-term depth laboratory was an initial goal of the KTB which has been realized by the GFZ German Research Centre for Geoscience since 1996.

The KTB drilling and research activities formed a German key contribution to worldwide efforts on understanding our planet and supported the founding of the International Continental Scientific Drilling Program, ICDP.

2.4. Key results

Surface and sample investigations have shown that the rock pile drilled is a steeply dipping highly deformed orogenic stack whose major amphibolite facies overprint is of Caledonian age. Late-stage Tertiary faulting created the current block structure while the Hercynian impact such as granitic intrusions is minor. Borehole logging, tests and key experiments have revealed a higher than expected geothermal gradient of 28°/km with about 270°C and close to ductile conditions at 9100 m, a variable and close-to-fail stress regime in accord with models, and a large reservoir of saline deep fluids existing in a fracture-dominated reservoir down to at least 9 km depth.

Since 1996, GFZ operates the KTB Deep Crustal Lab at the same place. Within the lab's activities, the two stable, large-diameter steel-cased, wells are geophysically monitored. Furthermore, the KTB Deep Crustal Lab is a place for in-situ high temperature/ pressure testing of logging and downhole monitoring equipment and even for long-term observation methods provided with two deep boreholes including a complete downhole logging infrastructure, workshops and offices (Harms and Kueck, 1996, 2020).

3. KTB Data and publications

The KTB comprises the two 9.1 km (KTB-HB; main hole) and 4 km (KTB-VB; pilot hole) deep, water-filled boreholes in crystalline basement rocks with their well heads just 200 m apart from each other (Emmermann & Lauterjung, 1997). The data obtained during the drilling operations as well as extensive geological and geophysical investigations of the surrounding area are available via the KTB Website and successively published with digital object identifiers (DOI) via GFZ Data Services. The different type and contents of data comprise information from internal and external KTB working groups, KTB final experiments and measurements in KTB surrounding area. Each group performed different measurements and are further separated into sub-disciplines:

3.1. Internal KTB working groups:

- Borehole Measurements
- Drilling Engineering
- Geology, Petrology, Tectonics (Reflected Light Microscopy, Cutting Analysis, Cutting Sampler Analysis, Lithological Profiles, Tectonic Elements)
- Geochemistry (Gas Chromatography, Gas Mass Spectometry, Gas Radon Measurements, Infrared Spectometry (IRS), X-Ray Diffractometry (XRD), X-Ray Fluorescence (XRF), Ion Chromatography (IC), Atomic Emission Spectometry (ICP-AES))
- Geophysics (Density, Electrical Resistivity, Gamma Spectroscopy, Inner Surface, Natural Remanent Magnetization, Permeability, Porosity, Relaxation, Susceptibility, Ultrasonic Velocities, Thermal Conductivity)
- Rock Mechanics (Compressive Strength, Relaxation, Tensile Strength)

3.2. KTB final experiments 1994

- Fluid/Hydraulic experiment (complete set of fluid test data, mechanical gauges data, memory gauges data, surface read out data)

- Hydrofrac/Seismic-Experiment (complete set of hydrofrac data, mechanical gauges data, memory gauges data, surface data from Halliburton Compupac, surface data from MeSy acquisition system, data files from Pinnacle's postfrac-evaluation)

3.3. External KTB working groups

- Geology, Petrology, Tectonics (Structural analysis)
- Geochemistry (Isotopic geochemistry, Gas Mass Spectometry)
- Petrophysics (Geothermics, Permeability, Electrical Resistivity)

3.4. Measurements in KTB surrounding area

- Geoelectrics (Electromagnetic Deep Sounding 1987 & 1989, Helicopter-Electromagnetics 1991)
- Seismics (Integrated Seismics Oberpfalz 1989 (ISO89))

Publications of the KTB downhole logging data and/or of results based on the data have to be cited: Logging data were obtained under grants RG8604, RG8803 and RG 9001 of the Federal Ministry of Research and Technology of Germany and are provided by the GFZ German Research Centre for Geosciences, Potsdam, Germany, as successor of the KTB Project Management.

4. General Remarks on KTB Borehole Measurements Data

Extensive borehole measurements were performed during the active drilling phase of the KTB pilot and main hole. The following text contains the full description of the logging data given here. Please read it thoroughly to avoid inappropriate or wrong use of the data.

The terms *borehole measurements, downhole logging,* and *logging* are used synonymously here.

4.1. Contents

The KTB logging data files contain the final processed versions of the geoscientific borehole logging data from logs in the two KTB boreholes:

- KTB-Oberpfalz VB (KTB Vorbohrung/Pilot Hole or KTB-VB)
- KTB-Oberpfalz HB (KTB Hauptbohrung/Main Hole or KTB-HB).

Here only the acronyms KTB-VB & KTB-HB are used. In total there are more than 140 logging data files from the KTB-VB and more than 230 logging data files from the KTB-HB.

The maximum logging depth was 4001 m in the KTB-VB and 9085 m in the KTB-HB.

There is no sonic waveform data available.

There is no electrical or acoustic borehole wall image data available. However, the spatial orientation of planar structures (foliation, faults, fractures, joints) gained by manual sine structure picking from these electrical images are included.

4.2. Data Format

The file names of the KTB borehole measurements data always begin with:

- KTB-VB-BM-.... for the pilot hole KTB-VB
- KTB-HB-BM-.... for the main hole KTB-HB

followed by the type of data, sometimes the borehole bit size, and the logging section.

Examples:

- file *KTB-VB-BM-Sonic-DLL-DIL-MSFL-6inch-28-4001m* is a composite log containing sonic, laterolog-, induction-, and MSFL resistivity data from the section 28-4001m in the KTB-VB;
- file *KTB-HB-BM-NGS-Sonic-LDT-14-75inch-4450-6018m* is a composite log containing natural gamma spectrum, sonic and density data from the section 4450-6018 m of the KTB-HB that has a bit size of 14.75".

The data is provided in plain ASCII (128 characters) format. All data are listed as depth-dependent data files with *depth* being the master parameter in all files. The data delimiters are BLANK and/or TAB, decimal separator is PERIOD (".") and the absent value is indicated by "-999.25" (an absent value is a not existing value, i.e. a not measured value). Each file contains a header with information about the contents of the file. Due to historical reasons there exists no standard header style but a variety of header formats.

In the file headers of many but not all logs, mainly those that were not spliced from several logs, the labels *HB-nnnn* or *VB–nnnn* (the so called 'log/job number') are the definitive reference to identify a log within the original record of all KTB borehole measurements, which can be found in the KTB-Reports and in the KTB Borehole Measurements Catalog.

4.3. Corrections applied to the logging data

All data have been corrected and checked as best as possible:

- all data have been depth corrected relative to the reference gamma rays of KTB-VB or KTB-HB, by means of gamma-ray correlation which, of course, was possible only if the specific sonde string included a gamma ray sensor. The following logs were run without gamma ray sensor: SP-EP-Redox, GRAVIMETRY, IP-NLFB, FML-BS,
- if not stated differently in the file headers the borehole logging data were corrected for borehole effects (borehole enlargement, mud resistivity, mud temperature) to a standard borehole diameter of 6.5" in the KTB-VB and 8" in the KTB-HB using correction charts,
- data below 8640 m are depth corrected only, because caliper data could not be measured.

Please be aware when using logging data obtained from the KTB-HB section 6020-9085 m that this interval is characterized by considerable borehole enlargements and a rugose wall. Therefore, despite appropriate corrections, the data can still be affected in certain zones. This is more or less valid for all parameters but especially for those which are produced by pad-type tools, like e.g. the density (RHOB) and the photoelectric absorption factor (PEF). Particular attention is drawn to the fact that only cased hole logging data exist in the following intervals: 6840-795 m of hole5 (except for HFMS data) and 8510-9038 m of hole6.

4.4. Depth partitioning of the data files

There is a different way of partitioning the logging sections of pilot and main hole. The KTB-VB data of any sonde or measurement type are comprised in files each covering the entire length of the final borehole 0-4000 m. If parameters were logged consecutively in several sections these separate logs were spliced into one log of the parameters covering the entire KTB-VB length.

In contrast the KTB-HB logging data is subdivided into depth intervals, mostly according to the logging sections of the major logging sessions. One exception are the first three logging sessions in the KTB-HB, which were comprised in only one section covering the depth range 290-3000 m. Other exceptions of this convention are the reference GR logs, which are spliced logs reaching from surface to bottom of the KTB-HB branches of hole4 and of hole5/6. Furthermore, the processed orientation data derived from FMS/FMI logs and the corrected GPIT magnetic field data are given for the entire KTB-HB.

The KTB-HB was not drilled continuously but drilling problems repeatedly necessitated to abandon the lowermost hole section and to side track a new branch from the existing hole. This happened five times during the course of the KTB-HB drilling. The abandoned sections later on were no longer accessible and so logging could not be carried out in all of the abandoned sections.

KTB-HB	Depth range (m)	Drilling dates
hole1	0 - 5595.5	1990-10-06 - 1992-01-13
hole2	5525 - 6760.5	1992-01-17 - 1992-07-29
hole3	6461.5 - 7219.5	1992-09-15 - 1993-01-24
hole4	7144 - 8328.2	1993-03-23 - 1993-09-07
hole5	7390 - 8729.7	1993-10-19 - 1994-04-04
hole6	8625.2 - 9101	1994-07-05 - 1994-10-10

4.5. Overview of the available KTB logging data files

Borehole	Depth Section [m]		Measurements	Files
	20	4000	BGL, TVD, Trajectory	3
KTB-VB	20	4000	BGL single measurements	73
	0	4001	TEMP single measurements	59
	28	4001	Composite: Sonic-DLL-DIL-MSFL, STC	2
	25	4001	Composite: NGS-LDT-CNL-SP (incl. Ref. GR)	1
	25	3992	GLT	1
	30	3994	IP-NLFB	1
	500	3701	FML	1
	22	3980	SUS	1
	24	4000	SP EP Redox	1
	0	3850	GRAVIMETRY	1
	83	3992	Foliation	1

Borehole	Depth Section [m]		Measurements	Files
	0	9081	BGL, MULTISHOT, TVD, Trajectory	18
KTB-HB	0	8630	BGL single measurements	93
	0	8124	TEMP single measurements	75
	290	9085	Composite: NGS-Sonic-LDT-DLL-CNL, ARI	13
	0	9078	Reference GR	2
	3001	6011	GLT	2
	290	6018	IP-NLFB, IP-ELGI	3
	320	8618	FML, GPIT	5
	0	9075	SP EP Redox	7
	0	8400	GRAVIMETRY	1
	293	8613	Foliation	1
	293	8620	Fracs-Faults-Joints	1

For abbreviations please see chapter 5 *Description of Measurements and Sondes*

4.6. Measurements Names

Name	Description
BGL	borehole geometry log: caliper & orientation; logged during a logging session, i.e. together with the data from Composite files
TVD	true vertical depth
Trajectory	data for horizontal and vertical projection of the borehole pathway
MULTISHOT	borehole orientation from a multi shot sonde inside the drill string
BGL single	borehole geometry of the many single runs, data as measured
TEMP single	temperature of the drilling mud of the many single runs, data as measured, the data often includes mud resistivity
Composite	compilation of parameters from several logging sondes: spectral GR (NGS), density (LDT, HFDC), neutron porosity (CNL), sonic velocity (DSI, SDT, HSLT), electrical resistivity (DIL, DLL, ARI, MSFL)
Reference GR	continuous reference gamma ray KTB-HB, spliced from single runs
GLT	geochemical logging tool
IP_NLFB & IP-ELGI	induced polarization measured with NLFB sonde or with ELGI sonde
FML & GPIT	components of the magnetic field - from FML or GPIT sonde
SUS	magnetic susceptibility (KTB-VB only)
SP EP Redox	spontaneous potential, electrical potential, redox potential
GRAVIMETRY	borehole gravity meter: gravity, anomalies, density
Foliation	dip and dip direction of foliation
Fracs-Faults-Joints	dip and dip direction of fractures, faults, joints etc. (other than foliation), KTB-HB only

5. Description of Measurements and Sondes

5.1. Composite Logs

A composite log is a compilation of standard parameters from several logging sondes: spectral GR (NGS), density (LDT, HFDC), neutron porosity (CNL), sonic velocity (DSI, SDT, HSLT), and electrical resistivity (DIL, DLL, ARI, MSFL). These types of logs where typically run during the major logging sessions, which lasted several days. The data from KTB-VB pilot hole is comprised in two composite files, each spanning the entire length of the hole. They were composed by splicing of several shorter single logs with these standard parameters.

In the KTB-HB the composite logs are given for each major logging session, except the upper 3000 m where several logs were spliced and compiled in one composite file. The bit size of the borehole is given in the file name, e.g. 6 inch or 17-5 inch. Note: there was no density log run in the KTB-HB section 0-3000 m.

5.1.1. Composite Logs KTB-VB

Parameters	Log Section [m]	File Name: KTB-VB-BM- .....
sonic, resistivity: conductive, inductive, and micro	28-4001	Sonic-DLL-DIL-MSFL-6inch-28-4001m
GR spectrum, density, porosity, SP; includes SGR as reference GR for KTB-VB	25-4001	NGS-LDT-CNL-SP-6inch-25-4001m
STC sonic processing results by slowness time co-herence semblance analysis	25-3990	STC-SONIC-25-3990m

5.1.2. Composite Logs KTB-HB

Parameters	Log Section [m]	File Name KTB-HB-BM- ....
GR spectrum, sonic, resistivity: conductive	290-3000	NGS-Sonic-DLL-17-5inch-290-3000m
sonic, density, resistivity: conductive	6900-8130	Sonic-LDT-DLL-12-25inch-6900-8130
GR spectrum, sonic, resistivity: conductive, den-sity	3000-4510	NGS-Sonic-LDT-DLL-14-75inch-3000-4510m
GR spectrum, sonic, density	4450-6018	NGS-Sonic-LDT-14-75inch-4450-6018m
resistivity: conductive, 30° azimuthal electrodes	3020-6020	ARI-14-75inch-3020-6020m
GR spectrum, sonic, resistivity: conductive, den-sity	6011-7200	NGS-Sonic-LDT-DLL-12-25inch-6011-7200m
GR spectrum	6840-7840	NGS-cased-hole-12-25inch-6840-7840m
GR spectrum, sonic, resistivity: conductive	7795-8640	NGS-Sonic-DLL-8-5inch-7795-8640m
GR spectrum,sonic,porosity, logging inside 6.5" hole w/ casing, ID = 124.26 mm	8503-9037	NGS-Sonic-CNL-6-5inch-cased-hole-8503-9037m
GR spectrum, sonic, density	9040-9085	NGS-Sonic-HFDC-6-5inch-open-hole-9040-9085

5.1.3. Reference Gamma Ray KTB-HB

There is no separate file containing only the Reference-GR file of the KTB-VB. Instead please use the curve *SGR* from the file *KTB-HB-BM-NGS-LDT-CNL-SP-6inch-25-4001m.txt* as the KTB-VB GR reference.

5.1.4. Reference Gamma Ray KTB-HB

Parameters	Log Section [m]	File Name KTB-HB-BM- ....
reference GR (spliced), for final borehole, ending in hole #6, includes CH section 8630-9037m)	0- 9078	RGR-COMPLETE-0-9078m
reference GR (spliced), ending in hole #4	0-8100	RGR-hole4-0-8100m

5.2. Borehole Geometry and Orientation Data

5.2.1. BGL – Borehole Geometry Logs from Logging Series

The BGL delivers:

- two borehole diameter measurements in perpendicular directions (90 degrees)
- orientation of the sonde axis and of caliper arm#1 with regard to magnetic North
- deviation from vertical.

The measurement of the diameter of the borehole was always made using a 4-arm caliper tool, i.e. four arms coupled in pairs and these pairs placed perpendicular to each other on the logging tool. Variations in hole diameter cause the arms to close or open and this movement is recorded with a potentiometer. The spatial orientation was done with a compass and a pendulum. The parameter 'relative bearing' is the angle between tool high side (with respect to gravity) and caliper arm#1. It is essential to measure the borehole diameter and shape in order to determine borehole corrections and to assess the reliability of certain measurements.

The BGL tools were generally combined with a total gamma ray and auxiliary measurement system (AMS) that estimated mud resistivity, a coarse mud temperature and the tension at cable head. In the KTB-HB the BGL tool was combined with an SP sensor and a calibrated, high resolution temperature sensor at tool bottom (PT-1000, accuracy: 0.03 °C) as the so-called KTB-Kombisonde. In the deeper and hotter part of the KTB-HB the high temperature version of the FMS (formation micro scanner) was used for borehole geometry measurements.

Each here given BGL is the most representative geometry log within a logging series.

BGL - Borehole Geometry Log			
KTB-HB (Main Hole)		KTB-VB (Pilot Hole)	
C1	caliper 1 (between arm1 and arm3)	C1	caliper 1 (between arm1 and arm3)
C2	caliper 2 (between arm2 and arm4), perpendicular to caliper 1	C2	caliper 2 (between arm2 and arm4), perpendicular to caliper 1
BS	bit size	BS	bit size
AZIM	hole azimuth	AZIM	hole azimuth
DEVI	hole deviation from vertical	DEVI	hole deviation from vertical
P1AZ	pad 1 azimuth (azimuth of caliper arm1)		
RB	relative bearing (angle between high side of tool and caliper arm1)	RB	relative bearing (angle between high side of tool and caliper arm1)
MRES	mud resistivity		
MTEM	mud temperature		
HTEN	head tension (pulling force at cable head)		
GR	natural gamma ray activity		

Apart from the above the file KTB-HB-BM-MULTISHOT-8633-9080m contains only directional data (AZIM & DEVI), which was measured with a multi-shot orientation tool run inside the drill string because below 8630 m no BGL was measured. Therefore, no caliper information is available from this deepest borehole section.

5.2.2. Borehole Trajectory – horizontal projection of the borehole pathway from orientation data

The pathway of the borehole, the borehole trajectory, was calculated from the borehole azimuth and deviation data using the tangential method. The EW value is the position of a point in the well on the East-West axis, the NS value respectively on the North-South axis. A cross plot of these values delivers the horizontal projection of the borehole trajectory.

Borehole Trajectory - horizontal projection of the borehole pathway			
KTB-HB (Main Hole)		KTB-VB (Pilot Hole)	
EW	East-West position, Easting	EW	East-West position, Easting
NS	North-South position, Northing	NS	North-South position, Northing

5.2.3. TVD – true vertical depth from orientation data

The true vertical depth TVD considers the borehole deviation from vertical. It is the vertical distance from a point in the well (i.e. the final depth) vertically to the surface. It is smaller than or equal to the measured depth (length) inside the borehole due to the hole deviation from vertical. As the path of KTB-VB considerably deviates from verticality the difference between measured length and TVD reaches more than 6 m at bottom. Because the KTB-HB was drilled nearly vertical to 7400 m, only below this depth the measured logging depth and TVD show larger differences, with ultimately more than 76 m at bottom. The bit size of the borehole is given in the file name, e.g. 6inch = 6" or 17-5inch = 17.5".

TVD - true vertical depth			
KTB-HB (Main Hole)		**KTB-VB (Pilot Hole)**	
TVD	true vertical depth	TVD	true vertical depth

5.2.4. BGL Logs, Trajectory and TVD representative for the major logging series

BGL Log, Trajectory and TVD KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
AZIM, DEVI, C1, C2, Cmin, Cmax, BS, P1AZ, RB, BO	22-4000	BGL-22-4000m
EW, NS	21-4001	Trajectory-21-4001m
TVD	21-4001	TVD-21-4001

BGL Log, Trajectory and TVD KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM- .....**
AZIM, DEVI, Cmin, Cmax, BS, P1AZ, BO	0-8633	BGL-Compilation-50cm-sampling-rate-0-8633m
AZIM, DEVI, C1, C2, Cmin, Cmax, BS, P1AZ, RB, BO, EW, NS, TVD	0-8640	BGL-Compilation-half-a-foot-sampling-rate-0-8640m
AZIM, DEVI, C1, C2, BS, P1AZ, SP, MTEM, MRES, GR	0-290	BGL-28inch-0-290m
AZIM, DEVI, C1, C2, P1AZ, BS, RB, SP, MTEM, MRES, GR	290-3000	BGL-17-5inch-290-3000m
AZIM, DEVI, C1, C2, P1AZ, BS, RB, SP, MTEM, MRES, GR	3000-6020	BGL-14-75inch-3000-6020m
AZIM, DEVI, C1, C2, P1AZ, BS, RB, SP, MTEM, MRES, GR	3000-4509	BGL-14-75inch-3000-4509m
AZIM, DEVI, C1, C2, P1AZ, BS, RB, SP, MTEM, MRES, GR	6020-7200	BGL-12-25inch-6020-7200m
AZIM, DEVI, C1, C2, P1AZ, BS, RB, SP, MTEM, MRES, GR	6840-7808	BGL-12-25inch-6840-7808m
AZIM, DEVI, C1, C2, P1AZ, BS, RB, MTEM, MRES, GR	7000-8108	BGL-12-25inch-7000-8108m
SP	6020-8108	BGL-SP-12-25inch-6020-8108m
XAZI, XDEV, DEVI, C1, C2, XC1, XC2, XP1A, BS, XRB, SP, MTEM, MRES, GR	7795-8640	BGL-8-5inch-7795-8640m
AZIM, DEVI	8633-9080	MULTISHOT-8633-9080m
EW, NS	0-8624	Trajectory-hole5-0-8624m

EW, NS	6472-6713	Trajectory-hole2-6472-6713m
EW, NS	7176-7214	Trajectory-hole3-7176-7214m
EW, NS	7411-8078	Trajectory-hole4-7411-8078m
EW, NS	8640-9068	Trajectory-hole6-MULTISHOT-8640-9068m
TVD	0-9080	TVD-0-9080m

5.2.5. BGL single measurements of KTB-VB

These BGL measurements here comprise all BGL logs performed. Most of them were run in-between logging series and hence are not representative for the caliper conditions during a logging series but may be used e.g. to investigate the temporal development of the caliper. For the caliper conditions during a respective logging series please see the files under 5.2.4 *BGL Logs, Trajectory and TVD representative for the major logging series*.

Single Borehole Geometry Logs (BGL) of KTB-VB Pilot Hole as measured in chronological order. The Log Number refers to the logging job number in the *KTB Borehole Measurements Catalog* of all KTB logging runs. Please note that the single Borehole Geometry Logs are not depth corrected to the reference GR (see Composite Logs) but are given here as logged.

Single BGL - Borehole Geometry Logs KTB-VB (Pilot Hole) as measured in chronological order			
Log Interval [m]	**Date measured [dd.mm.yyyy]**	**Log Number VB...**	File Name: **KTB-VB-BM- ....**
24-144	01.10.1987	7	BGL-007-24-144m
22-181	04.10.1987	9	BGL-009-22-181m
24-203	05.10.1987	13	BGL-013-24-203m
23-248	09.10.1987	16	BGL-016-23-248m
17-302	12.10.1987	19	BGL-019-17-302m
22-353	15.10.1987	21	BGL-021-22-353m
24-376	17.10.1987	23	BGL-023-24-376m
347-403	19.10.1987	25	BGL-025-347-403m
24-426	22.10.1987	27	BGL-027-24-426m
18-448	24.10.1987	29	BGL-029-18-448m
22-479	26.10.1987	32	BGL-032-22-479m
24-479	05.11.1987	69	BGL-069-24-479m
20-480	07.11.1987	72	BGL-072-20-480m
477-708	27.11.1987	83	BGL-083-477-708m
476-743	30.11.1987	84	BGL-084-476-743m
479-766	01.12.1987	86	BGL-086-479-766m
476-804	03.12.1987	87	BGL-087-476-804m

Log Interval [m]	Date measured [dd.mm.yyyy]	Log Number VB...	File Name: **KTB-VB-BM- ....**
721-821	05.12.1987	88	BGL-088-721-821m
461-866	08.12.1987	90	BGL-090-461-866m
475-917	13.12.1987	91	BGL-091-475-917m
471-995	20.12.1987	94	BGL-094-471-995m
474-992	04.01.1988	103	BGL-103-474-992m
475-840	08.01.1988	109	BGL-109-475-840m
469-1063	17.01.1988	112	BGL-112-469-1063m
475-1142	21.01.1988	114	BGL-114-475-1142m
475-1180	23.01.1988	116	BGL-116-475-1180m
473-1230	29.01.1988	118	BGL-118-473-1230m
469-1293	07.02.1988	121	BGL-121-469-1293m
476-656	11.02.1988	123	BGL-123-476-656m
475-1374	15.02.1988	126	BGL-126-475-1374m
468-1527	27.02.1988	130	BGL-130-468-1527m
449-1619	08.03.1988	146	BGL-146-449-1619m
448-1725	18.03.1988	148	BGL-148-448-1725m
448-1815	26.03.1988	150	BGL-150-448-1815m
451-1789	08.04.1988	153	BGL-153-451-1789m
1546-1697	15.04.1988	156	BGL-156-1546-1697m
1495-1722	20.04.1988	158	BGL-158-1495-1722m
460-1733	22.04.1988	159	BGL-159-460-1733m
1600-1743	23.04.1988	161	BGL-161-1600-1743m
445-1806	29.04.1988	162	BGL-162-445-1806m
452-1942	08.05.1988	164	BGL-164-452-1942m
453-2044	17.05.1988	166	BGL-166-453-2044m
448-2205	30.05.1988	168	BGL-168-448-2205m
450-2202	05.06.1988	184	BGL-184-450-2202m
451-2306	17.06.1988	190	BGL-190-451-2306m
451-2432	26.06.1988	192	BGL-192-451-2432m
452-2584	05.07.1988	194	BGL-194-452-2584m
1992-2640	09.07.1988	195	BGL-195-1992-2640m
2499-2667	13.07.1988	197	BGL-197-2499-2667m
2500-2689	15.07.1988	198	BGL-198-2500-2689m
450-2708	21.07.1988	201	BGL-201-450-2708m

Log Interval [m]	Date measured [dd.mm.yyyy]	Log Number VB...	File Name: **KTB-VB-BM- ....**
447-2790	01.08.1988	203	BGL-203-447-2790m
449-2791	05.08.1988	205	BGL-205-449-2791
2500-2821	12.08.1988	206	BGL-206-2500-2821m
451-2924	26.08.1988	210	BGL-210-451-2924m
444-3017	06.09.1988	213	BGL-213-444-3017m
451-2993	16.09.1988	231	BGL-231-451-2993m
472-3119	24.09.1988	238	BGL-238-472-3119m
451-3269	04.10.1988	239	BGL-239-451-3269m
450-3339	11.10.1988	244	BGL-244-450-3339m
453-3491	30.10.1988	250	BGL-250-453-3491m
452-3535	14.11.1988	252	BGL-252-452-3535m
448-3637	06.12.1988	256	BGL-256-448-3637m
449-3530	02.01.1989	273	BGL-273-449-3530m
447-3866	24.01.1989	283	BGL-283-447-3866m
426-4008	07.04.1989	296	BGL-296-426-4008m
450-4000	03.05.1989	320	BGL-320-450-4000m
442-3306	08.05.1989	322	BGL-322-442-3306m
459-3956	29.05.1989	333	BGL-333-459-3956m
448-4008	15.06.1989	340	BGL-340-448-4008m
436-4008	05.07.1989	345	BGL-345-436-4008m
285-3713	29.08.1989	348	BGL-348-285-3713m
397-4006	09.11.1989	351	BGL-351-397-4006m

5.2.6. BGL single measurements of KTB-HB

Single Borehole Geometry Logs (BGL) of KTB-HB Main Hole as measured in chronological order. The Log Number refers to the logging job number in the *KTB Borehole Measurements Catalog* of all KTB logging runs. Please note that the single Borehole Geometry Logs are not depth corrected to the reference GR (see Composite Logs) but are given here as logged.

Single BGL - Borehole Geometry Logs KTB-HB (Main Hole) as measured in chronological order			
Log Interval [m]	**Date measured [dd.mm.yyyy]**	**Log Number HB....**	File Name: **KTB-HB-BM- ...**
0-72	12.10.1990	1	BGL-001-0-72m
5-300	20.10.1990	3	BGL-003-6-300 m
0-249	27.10.1990	5	BGL-005-1-249m

Log Interval [m]	Date measured [dd.mm.yyyy]	Log Number HB....	File Name: **KTB-HB-BM- ...**
0-291	03.11.1990	13	BGL-013-1-291m
0-303	09.11.1990	21	BGL-021-1-303m
291-450	23.11.1990	37	BGL-037-291-450m
291-564	29.11.1990	40	BGL-040-291-564m
291-631	05.12.1990	41	BGL-041-291-631m
291-650	07.12.1990	42	BGL-042-291-650 m
291-730	15.12.1990	50	BGL-050-291-730m
291-762	20.12.1990	52	BGL-052-291-762m
291-761	21.12.1990	56	BGL-056-291-761m
291-760	22.12.1990	59	BGL-059-291-760m
291-850	29.12.1990	60	BGL-060-291-850m
291-894	03.01.1991	61	BGL-061-291-894m
291-933	07.01.1991	62	BGL-062-291-933m
291-1005	13.01.1991	63	BGL-063-291-1004m
291-1068	19.01.1991	64	BGL-064-291-1068m
291-1086	22.01.1991	65	BGL-065-291-1086m
291-1125	26.01.1991	66	BGL-066-291-1125m
291-1136	30.01.1991	67	BGL-067-291-1136m
291-1241	12.02.1991	68	BGL-068-291-1241m
1141-1531	24.02.1991	69	BGL-069-1141-1531m
291-1716	03.03.1991	70	BGL-070-291-1716m
291-1717	04.03.1991	77	BGL-077-291-1717m
1500-1774	10.03.1991	78	BGL-078-1500-1774m
1694-1793	13.03.1991	79	BGL-079-1694-1793m
1698-1820	16.03.1991	80	BGL-080-1698-1820m
1697-1859	20.03.1991	81	BGL-081-1697-1859m
1673-2020	24.03.1991	82	BGL-082-1673-2020m
2063-2069	06.04.1991	84	BGL-084-2063-2069m
2031-2397	12.04.1991	85	BGL-085-2031-2397m
1936-2715	28.04.1991	86	BGL-086-1936-2715m
2629-2768	04.05.1991	87	BGL-087-2629-2768m
2649-2890	15.05.1991	88	BGL-088-2649-2890m
291-3003	31.05.1991	91	BGL-091-291-3003m
1400-3003	01.06.1991	93	BGL-093-1400-3003m
291-3003	04.06.1991	104	BGL-104-291-3003m
3003-3293	04.07.1991	106	BGL-106-3003-3293m
3003-3498	17.07.1991	109	BGL-109-3003-3498m
3415-3793	07.08.1991	110	BGL-110-3415-3793m

Log Interval [m]	Date measured [dd.mm.yyyy]	Log Number HB....	File Name: **KTB-HB-BM- ...**
3691-3872	14.08.1991	111	BGL-111-3691-3872m
3699-3949	23.08.1991	112	BGL-112-3699-3949m
3867-4130	01.09.1991	114	BGL-114-3867-4130m
3003-4512	12.10.1991	115	BGL-115-3003-4512m
3003-4512	13.10.1991	117	BGL-117-3003-4512m
3003-4512	14.10.1991	120	BGL-120-3003-4512m
3003-4512	17.10.1991	125	BGL-125-3003-4512m
3003-5005	23.11.1991	128	BGL-128-3003-5005m
3003-5517	03.01.1992	131	BGL-131-3003-5517m
5384-5588	15.01.1992	136	BGL-136-5384-5588m
5266-5530	18.01.1992	137	BGL-137-5266-5530m
5381-5585	23.01.1992	138	BGL-138-5381-5585m
3004-5813	17.02.1992	140	BGL-140-3004-5813m
5729-5891	25.02.1992	141	BGL-141-5729-5891m
5497-5815	13.03.1992	143	BGL-143-5497-5815m
3005-4633	20.03.1992	158	BGL-158-3005-4633m
3003-6021	23.03.1992	161	BGL-161-3003-6021m
3005-5064	01.04.1992	171	BGL-171-3005-5064m
6000-6155	26.05.1992	186	BGL-186-6000-6155m
6019-6503	02.07.1992	187	BGL-187-6019-6503m
6462-6575	13.07.1992	188	BGL-188-6462-6576m
6274-6707	27.07.1992	189	BGL-189-6274-6707m
6019-6600	21.08.1992	196	BGL-196-6019-6600m
5948-6567	02.09.1992	197	BGL-197-5948-6567m
6020-6586	09.09.1992	199	BGL-199-6020-6586m
6019-6459	21.09.1992	201	BGL-201-6019-6459m
6019-6473	25.09.1992	202	BGL-202-6019-6473m
6019-6497	05.10.1992	203	BGL-203-6019-6497m
6019-6546	13.10.1992	204	BGL-204-6019-6546m
6019-6573	23.10.1992	206	BGL-206-6019-6573m
6019-6709	15.11.1992	207	BGL-207-6019-6709m
6019-7051	28.12.1992	208	BGL-208-6019-7051m
6700-7167	10.01.1992	209	BGL-209-6700-7167m
6019-7225	28.01.1992	210	BGL-210-6019-7225m
6019-7206	07.02.1993	214	BGL-214-6019-7206m
6019-7202	09.02.1993	215	BGL-215-6019-7202m
6019-7187	01.04.1993	221	BGL-221-6019-7187m
6019-7191	08.04.1993	222	BGL-222-6019-7191m

Log Interval [m]	Date measured [dd.mm.yyyy]	Log Number HB....	File Name: **KTB-HB-BM- ...**
6019-7197	13.04.1993	223	BGL-223-6019-7197m
6019-7280	03.05.1993	224	BGL-224-6019-7280m
6019-7285	22.05.1993	225	BGL-225-6019-7285m
6019-7498	04.06.1993	226	BGL-226-6019-7498m
6019-7563	23.06.1993	227	BGL-227-6019-7563m
6019-7721	07.07.1993	228	BGL-228-6019-7721m
6019-8084	27.07.1993	229	BGL-229-6019-8084m
6019-7528	04.10.1993	237	BGL-237-6019-7528m
6019-7417	23.10.1993	240	BGL-240-6019-7417m
6019-7492	02.11.1993	241	BGL-241-6019-7492m
6019-7795	30.11.1993	243	BGL-243-6019-7795m
7797-8046	02.01.1994	246	BGL-246-7797-8046m
7795-7886	02.02.1994	247	BGL-247-7795-7886m
7780-8630	29.04.1994	250	BGL-250-7780-8630m

5.3. Temperature Logs

Temperature logs acquired during the drilling phase were strongly influenced by the cooling and heating caused by the mud circulation. Hence there is no reference temperature log showing the undisturbed equilibrium temperature profile from the active drilling phase until 1994. The best available approximation to the equilibrium profile of the KTB-HB was measured in 1998: *KTB-HB-BM-TEMP-1996-1997-1998-2000*.

The temperature logs in the KTB-VB were run with a separate temperature sonde (PT-1000, accuracy: 0.03 °C, sensor at tool bottom). Later this temperature sonde and an additional steel SP sensor was mounted to the BGL sonde, forming the so-called KTB-Kombisonde. This allowed to measure TEMP downwards and BGL upwards, saving the separate TEMP logging run.

Many TEMP logs also include a measurement of the mud resistivity (MRES from the auxiliary measurement tool, AMS), the resistivity of the fluid in the borehole, which can indicate inflow zones of rock fluids with differing resistivity (Haak et al., 1997; Huenges et al., 1997; Kessels & Kück, 1995).

The TEMP single files always contain the temperature (TEMP...) and very often also HTEN, MRES, and GR.

5.3.1. TEMP single measurements of KTB-VB

Single Mud Temperature Logs of KTB-VB Pilot Hole as measured in chronological order. The Log Number refers to the logging job number in the *KTB Borehole Measurements Catalog* of all KTB logging runs.

Single TEMP- Temperature Logs KTB-VB (Pilot Hole) as measured in chronological order			
Log Interval [m]	**Date measured [dd.mm.yy]**	**Log Number VB...**	File Name: **KTB-VB-BM- ....**
12-447	23.10.87	028a	TEMP-028a-12-447m
12-447	23.10.87	028b	TEMP-028b-12-447m
3-479	26.10.87	031	TEMP-031-4-478m
1-468	27.10.87	034	TEMP-034-2-467m
1-479	27.10.87	038	TEMP-038-2-478m
1-469	29.10.87	044	TEMP-044-2-468m
1-479	01.11.87	053	TEMP-053-2-478m
1-478	05.11.87	068	TEMP-068-2-477m
391-570	19.11.87	077	TEMP-077-392-570m
391-644	23.11.87	079	TEMP-079-392-643m
395-707	27.11.87	081	TEMP-081-395-707m
395-766	01.12.87	085	TEMP-085-395-765m
440-866	08.12.87	089	TEMP-089-440-865m
465-993	20.12.87	093	TEMP-093-465-993m
463-1000	21.12.87	096	TEMP-096-463-999m
389-995	21.12.87	098	TEMP-098-390-994m
459-994	21.12.87	100	TEMP-100-460-993m
290-994	04.01.88	102	TEMP-102-290-993m
459-1557	27.02.88	129	TEMP-129-460-1557m
433-1525	28.02.88	133	TEMP-133-433-1525m
459-1531	29.02.88	136	TEMP-136-460-1530m
449-1525	02.03.88	142	TEMP-142-450-1525m
1187-1624	08.03.88	145	TEMP-145-1188-1624m
1311-1727	18.03.88	147	TEMP-147-1312-1726m
1390-1818	26.03.88	149	TEMP-149-1390-1818m
1639-1942	08.05.88	163	TEMP-163-1639-1941m
1682-2046	17.05.88	165	TEMP-165-1683-2046m
439-2207	30.05.88	167a	TEMP-167a-440-2207m
965-2208	30.05.88	167b	TEMP-167b-965-2207m
973-2204	30.05.88	170	TEMP-170-973-2204m
439-2204	01.06.88	175	TEMP-175-440-2204m
1755-2191	02.06.88	178	TEMP-178-1756-2191m
1785-2205	03.06.88	181	TEMP-181-1785-2204m
460-2205	04.06.88	183	TEMP-183-461-2204m
1784-2206	05.06.88	187	TEMP-187-1784-2205m
1882-2317	17.06.88	188	TEMP-188-1883-2316m
1786-2320	17.06.88	189	TEMP-189-1787-2319m
1974-2430	26.06.88	191	TEMP-191-1975-2430m

Log Interval [m]	Date measured [dd.mm.yy]	Log Number VB...	File Name: **KTB-VB-BM- ....**
2081-2583	05.07.88	193	TEMP-193-2081-2682m
2487-2923	26.08.88	209	TEMP-209-2487-2923m
1912-3014	05.09.88	211	TEMP-211-1912-3014m
460-3014	06.09.88	212	TEMP-212-460-3013m
2472-2891	06.09.88	215a	TEMP-215a-2473-2891m
2731-3027	06.09.88	215b	TEMP-215b-2731-3026m
1988-3020	08.09.88	221	TEMP-221-1988-3020m
2476-3024	11.09.88	226	TEMP-226-2477-3023m
1484-2989	14.09.88	228	TEMP-228-1485-2989m
2670-3119	24.09.88	237	TEMP-237-2671-3119m
2788-3266	04.10.88	240	TEMP-240-2788-3265m
2882-3338	11.10.88	241	TEMP-241-2883-3337m
2889-3335	11.10.88	242	TEMP-242-2890-3335m
2391-3484	29.10.88	248	TEMP-248-2391-3484m
1990-3246	30.10.88	249	TEMP-249-1990-3245m
3268-3439	07.11.88	251	TEMP-251-3268-3439m
3185-3524	14.11.88	253	TEMP-253-3186-3523m
3370-3809	03.01.89	274	TEMP-274-3371-3809m
3287-3861	24.01.89	282	TEMP-282-3287-3861m
0-4005	11.05.89	323	TEMP-323-0-4005m
0-2613	16.05.89	327	TEMP-327-0-2613m

5.3.2. TEMP single measurements of KTB-HB

Single Mud Temperature Logs of KTB-HB Main Hole as measured in chronological order. The Log Number refers to the logging job number in the KTB Borehole Measurements Catalog of all KTB logging runs. Please note that the Temperature logs are not depth corrected to the reference GR (see Composite Logs) but are given here as logged.

Single TEMP- Temperature Logs KTB-HB (Main Hole) as measured in chronological order			
Log Interval [m]	**Date measured [dd.mm.yy]**	**Log Number HB...**	File Name: **KTB-HB-BM- ....**
0-132	27.10.90	005a	TEMP-005a-0-131m
144-248	27.10.90	005b	TEMP-005b-145-248m
0-281	03.11.90	013	TEMP-013-0-281m
0-303	09.11.90	021	TEMP-021-0-305m
0-395	17.11.90	031	TEMP-031-0-396m
0-452	23.11.90	037	TEMP-037-0-453m
0-561	29.11.90	040	TEMP-040-0-562m
0-299	05.12.90	041	TEMP-041-0-299m
0-761	20.12.90	052	TEMP-052-0-762m
0-763	20.12.90	056	TEMP-056-0-763m
594-763	21.12.90	059	TEMP-059-60-763m
237-852	29.12.90	060	TEMP-060-24-852m

Log Interval [m]	Date measured [dd.mm.yy]	Log Number HB...	File Name: **KTB-HB-BM- ....**
266-889	03.01.91	061	TEMP-061-266-890m
280-934	07.01.91	062	TEMP-062-280-934m
0-1075	19.01.91	064	TEMP-064-0-1075m
0-1088	22.01.91	065	TEMP-065-0-1088m
0-1131	26.01.91	066	TEMP-066-0-1132m
266-1140	30.01.91	067	TEMP-067-266-1140m
0-1243	12.02.91	068	TEMP-068-0-1243m
0-1720	02.03.91	070	TEMP-070-0-1720m
275-1719	04.03.91	077	TEMP-077-275-1720m
1652-1776	10.03.91	078	TEMP-078-1652-1776m
1694-1794	13.03.91	079	TEMP-079-1694-1795m
274-2243	02.04.91	083	TEMP-083-274-2243m
48-3005	31.05.91	091	TEMP-091-48-3005m
0-3005	31.05.91	093	TEMP-093-0-3005m
192-3035	04.06.91	104	TEMP-104-193-3035m
2823-3300	04.07.91	106	TEMP-106-2823-3300m
2980-3510	17.07.91	109	TEMP-109-2980-3510m
3376-3793	07.08.91	110	TEMP-110-3377-3793m
3729-3945	14.08.91	111	TEMP-111-3730-3858m
3824-3945	23.08.91	112	TEMP-112-3824-3945m
3858-4135	01.09.91	114	TEMP-114-3858-4135m
0-4512	12.10.91	115	TEMP-115-0-4512m
0-4515	13.10.91	117	TEMP-117-0-4515m
0-4518	14.10.91	120	TEMP-120-0-4518m
0-4517	17.10.91	125	TEMP-125-0-4518m
2969-5014	23.11.91	128	TEMP-128-2969-5014m
2978-5523	03.01.92	131	TEMP-131-2978-5523m
5287-5592	15.01.92	136	TEMP-136-5287-5592m
2936-5531	18.01.92	137	TEMP-137-2936-5531m
5379-5591	23.01.92	138	TEMP-138-5379-5591m
5457-5702	04.02.92	139	TEMP-139-5457-5702m
5262-5819	17.02.92	140	TEMP-140-5263-5819m
5776-5895	25.02.92	141	TEMP-141-5777-5895m
2379-6023	13.03.92	143	TEMP-143-2379-6024m
2358-6024	15.03.92	146	TEMP-146-2358-6025m
2386-6024	16.03.92	148	TEMP-148-2387-6025m
2394-6024	17.03.92	152	TEMP-152-2395-6024m
2374-6024	19.03.92	155	TEMP-155-2375-6024m
2892-6024	20.03.92	158	TEMP-158-2892-6024m
2939-6022	23.03.92	161	TEMP-161-2939-6022m
2381-6005	26.03.92	167	TEMP-167-2380-6005m
2833-6145	01.04.92	171	TEMP-171-2833-6145m
20-5979	14.04.92	173	TEMP-173-20-5979m

Log Interval [m]	Date measured [dd.mm.yy]	Log Number HB...	File Name: **KTB-HB-BM- ....**
5941-6502	02.07.92	187	TEMP-187-5941-6502m
6768-7049	28.12.92	208	TEMP-208-6768-7049m
6886-7165	10.01.93	209	TEMP-209-6886-7165m
5918-7226	28.01.93	210	TEMP-210-5917-7226m
5934-7206	09.02.93	215	TEMP-215-5934-7206m
0-7207	10.02.93	216	TEMP-216-0-7207m
0-7211	11.02.93	217	TEMP-217-0-7217m
5-7207	12.02.93	218	TEMP-218-5-7207m
0-7211	17.02.93	219	TEMP-219-0-7211m
0-7005	02.03.93	220	TEMP-220-0-7005m
6769-8086	27.07.93	229	TEMP-229-6769-8086m
5643-8124	12.08.93	230	TEMP-230-5643-8124m
5798-8110	15.08.93	236	TEMP-236-5798-8110m
5952-7306	04.10.93	237	TEMP-237-5952-7306m
5938-7420	23.10.93	240	TEMP-240-5939-7420m
5933-7494	02.11.93	241	TEMP-241-5934-7494m
7743-8054	02.01.94	246	TEMP-246-7743-8055m
0-7797	27.02.94	249	TEMP-249-0-7798m
0-8640	1996, 1997, 1998, 2000	logged by GFZ KTB-Deep Lab after end of active drilling	TEMP-1996-1997-1998-2000

5.4. Electrical Logs

5.4.1. ARI (also called ALAT) – Array Resistivity Imager (Azimuthal LateroLog)

The ARI measures the electrical rock resistivity according to the same principle as the DLL. It determines the two resistivity measurements, LLs and LLd. In addition, 12 focused and oriented laterolog curves are recorded. In these curves the resistivity of 30 degrees sectors of the borehole circumference is measured. As it is a resistivity device, the azimuthal laterolog will function in a similar manner to existing electrode resistivity tools. It measures the current from an electrode, and take the potential difference close to the electrode relative to a remote reference. The potential difference divided by the current multiplied by a geometrical factor yields the resistivity. This is done for a number of electrodes distributed in an azimuthal array around the tool circumference.

The azimuthal resistivity information can be used for anisotropy analysis and also to create a coarse image of the borehole wall that can be used for structural interpretation.

At time the ARI was run in the KTB-HB it still had a development status, delivering correct laterolog readings but some azimuthal information was defect.

5.4.2. DIL – Dual Induction Log

DIL determines the electrical conductivity of the rock and is particularly suitable if there is non-conductive (oil based) mud in the borehole. The sonde contains two separated transmitter-receiver coils positioned along the sonde axis. The conductivity of the formation is calculated from the intensity of the re-induced current in the receiver coil. This current is created by a high frequency magnetic field, which is induced by the (lower) transmitter coil. This system is not suitable for formations with low rock conductivities less than $0.5 \cdot 10^{-3}$ S/m, equivalent to resistivities above 2000 Ohmm.

5.4.3. DLL – Dual Laterolog

The DLL determines the electrical resistivity of the formation in borehole sections with conductive mud (salt-water-base mud). It combines two Laterolog measurement systems with different penetration depths, which send a horizontally focused current into the formation. Where there are very high rock resistivities (10^4-10^5 Ohmm) the measuring current can no longer be effectively focused and the real resistance of the rock cannot be determined. In crystalline rock the Dual Laterolog can be used for locating fissured zones in close proximity to the borehole. The high temperature version, HDLL, was used in the deeper part of the KTB-HB.

5.4.4. IPL – Induced Polarization Log

The IP log may determine zones with high electrical chargeability, like zones that bear a high concentration of graphite, ore or saline fluid. The sonde measured the fading induced voltage after switching off a focused charge current.

Two different sondes were used from:

- ELGI Co., Budapest, Hungary
- Geological Survey of Lower Saxony (NLfB), Hannover, Germany

The IP logs are not depth corrected to the reference GR because the sondes had no GR sensor.

IP - Induced Polarization (sondes from NLfB, Hannover and from ELGI Co., Budapest, Hungary)			
KTB-HB (Main Hole)		**KTB-VB (Pilot Hole)**	
ETA	electrical chargeability of the rock (IP value)	ETA	electrical chargeability of the rock (IP value)
KIP	IP value at time = 0	-	
TAU	average decay time	-	
RHOA	rock resistivity	-	
IPxx or Vxx	IP voltage at time no. xx	-	
IPAV	IP voltage average	IPAV	IP voltage average (see KTB-Reports for detailed information)
IPMA	IP voltage maximum	-	
IPMI	IP voltage minimum	-	
U or V	input voltage	-	
I	Input current	-	
GR	gamma ray activity	-	

IP KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
ETA, IPAV	30-3994	IP-NLFB-30-3994m

IP KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM - .....**
RHOA, V, IP0,IP1, IP2, IP3, IP4, IP5, IP6, IP7, IP8, IP9, IPAV, IPMA, IPMI	290-2998	IP-NLFB-17-5inch-290-2998m
RHOA, V, IP0,IP1, IP2, IP3, IP4, IP5, IP6, IP7, IP8, IP9, IPAV, IPMA, IPMI	3000-4499	IP-NLFB-14-75inch-3000-4499m
V1, V2, V3, V4, V5, V6, V7, V8, V9, V10,V11, V12, V13, V14, V15, V16, I, GR, KIP, ETA, TAU, RHOA, U	3000-6018	IP-ELGI-14-75inch-3000-6018m

5.4.5. MSFL – Micro-Spherically Focused Log

The MSFL determines the electrical resistivity of the formation very close behind the borehole wall. In permeable formations this zone might be saturated with drilling mud (invaded or infiltrated zone). The MSFL has a low depth of penetration but a very high vertical resolution, hence even very thin layers or inhomogeneities (planar discontinuities, open faults, shear zones) can be identified. The MSFL usually is recorded combined with the DLL. The clamping arm-mounted measuring pad of the MSFL is pressed against the borehole wall.

5.4.6. SP – Spontaneous Potential, steel electrode, together with BGL SP-Redox – Redox potential, absolute measuring SP sonde

The electrical self- or spontaneous potential is measured between a stationary reference electrode at the surface and the moving measuring electrode in the borehole. SP is caused by the contact of liquids with different salinity (fluids/mud), the contact of fluids/mud with the rock on fracture surfaces or by fluid flow due to a pressure gradient into the formation. This offers the possibility to distinguish between permeable and non-permeable zones, which was successful in the KTB-HB.

The special SP-Redox or SPR sonde contains two electrodes, one Ag-AgCl electrode and one platinum electrode. The Ag-AgCl electrode measures the electrical potential free from disturbing local electrochemical disturbances. The platinum electrode measures the sum of the electrical potential and moreover an electrochemical potential at the electrode itself, the redox potential. Subtraction gives the desired redox potential. The surface electrode for both measurements was an Ag-AgCl electrode. SP-Redox sonde from the University of Frankfurt, Germany. The SP logs are not depth corrected to the reference GR because the sondes had no GR sensor.

SPR - SP/Redox sonde (Univ. Frankfurt)			
KTB-HB (Main Hole)		**KTB-VB (Pilot Hole)**	
EP...	electrical potential	EP...	electrical potential
RDOX/RDX...	redox potential	RDOX/RDX...	redox potential
SP...	spontaneous potential	SP...	spontaneous potential

SP KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
EP, RDOX, SP1, SPE, SPF	24-4000	SP-EP-Redox-24-4000m

SP KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM- .....**
SP_U, EP_U, RDXU, SP_D, EP_D, RDXD	0-290	SP-EP-Redox-28inch-0-290m
SP_U, EP_U, RDXU, SP_D, EP_D, RDXD	290-3000	SP-EP-Redox-17-5inch-290-3000m
SP_U, EP_U, RDXU, SP_D, EP_D, RDXD	3000-4504	SP-EP-Redox-14-75inch-3000-4504m
SPAU, EPAU, RDAU, SPAD, EPAD, RDAD, SPBD, EPBD, RDBD	3000-5999	SP-EP-Redox-14-75inch-3000-5999m
EP_U, RDXU, EP_D, RDXD	7795-8740	SP-EP-Redox-8-5inch-7795-8740
EP1U, RD1U, EP2U, RD2U, EP1D, RD1D, EP2D, RD2D	9035-9075	SP-EP-Redox-6-5inch-OH-9035-9075m
EP_U, RDXU, EP_D, RDXD	8604-9035	SP-EP-Redox-6-5inch-liner-5-5inch-8604-9035m

5.5. Sonic Logs

5.5.1. HSLT - Hostile Sonic Logging Tool; DSI - Dipole Shear Sonic Imager SDT -Sonic Digital Tool

A sonic log continuously measures the travel time of an ultrasonic pulse in the formation along a constant spacing. The primary signal corresponds to the high-frequency seismic P-wave (compressional wave), of which the velocity is calculated from the recorded travel times. A multi transmitter/receiver array arrangement allows for correction of borehole effects like rough wall or a tilted sonde position in the well.

This sonic measurement thus gives a formation velocity profile along the borehole. It is a sensitive indicator of the lithology and - for a homogeneous rock matrix - of the porosity of the formation being drilled through. Porosity and lithology determination are certainly the most important applications of the acoustic log, but are not the only ones. Together with the results of the geophone measurements, the seismic velocity-depth function, which can be calculated by integration of the sonic data, forms the basis for the time-depth conversion of the seismic reflection data. Together with the density data from the LDT log, synthetic seismograms can be calculated for the purpose of integrating results of the borehole measurements in the seismic reflection profiles.

The analogue and digital recordings of the wave trains (full waveforms) permit, in addition to the determination of the P-wave arrivals, an analysis of the complex S-wave arrivals and of amplitude attenuation, which in turn makes it possible to calculate rock mechanical parameters (e.g. Poisson's ratio, moduli of elasticity).

Three different sonde types were run in the KTB wells, depending on the temperature in the measuring interval. The KTB-VB and the KTB-HB to a depth of 7200 m were logged with digital recording sonic tools, SDT and DSI. The DSI was applied in the KTB-HB from 3000 m - 7200 m to improve the poor shear wave generation with the SDT, using a low frequency shear wave generator. The sonic logging tool for hostile conditions in the deeper part of the KTB-HB was the analogue recording HSLT, a BHC sonde type (Borehole Compensated Sonic).

5.6. Nuclear Logs

5.6.1. CNL – Compensated Neutron Log

A neutron source (americium-beryllium) irradiates the rock. The neutrons are slowed down by elastic and inelastic collisions with the atomic nuclei, with simultaneous reduction of the energy level. Here a distinction is made between epithermal neutrons (0.1-1 eV) and thermal neutrons (0.025-0.1 eV); at less than 0.025 eV the neutrons are captured. Both in the retarding process and in the capture reaction, gamma radiation is emitted. The CNL measures the gamma radiation caused by the thermal neutrons. A second sensor records the normal gamma radiation, which is deducted (=> compensated). Hydrogen atoms have the greatest effect since the mass of the proton is almost equal to that of the neutron. The measurement system therefore reacts to the hydrogen concentration in the rock (hydrogen index). In the case of clay-free rock completely saturated with water, the hydrogen index can be interpreted as a function of the porosity (neutron porosity index). Since crystal-bound water and retained water (adhesive water) are included in this function, the neutron measurement indicates the total porosity. The high temperature version, HCNL, was used in the deeper part of the KTB-HB.

5.6.2. GLT – Geochemical Logging Tool

The GLT provides in-situ elemental analysis by spectroscopic measurements of 10 elements. The KTB-VB data file gives the following relative abundances: aluminum, calcium, iron, gadolinium, silicon, titanium, magnesium, sulphur, potassium and from processing derived oxides. In the KTB-HB the results were quite poor so only a reduced parameter set is given here: aluminum, calcium, iron, gadolinium, silicon, titanium (potassium can be found on the NGS log).

The tool is made up of the following components: The Natural Gamma Spectrometer (NGS), the Aluminum Activation Clay Tool (AACT), the Gamma Spectrometer Tool (GST) and the Compensated Neutron Tool (CNT) to carry a special californium source.

The AACT is especially designed for the determination of aluminum. The californium source (Cf 252) produces low energy neutrons. These thermal neutrons are preferentially absorbed by aluminum, producing specific gamma radiation.

The GST measures the induced gamma ray backscatter produced by the interaction of atoms with high-energy (14 MeV) neutrons, generated by an electric neutron source (pulsed neutron accelerator). It is possible to give information on porosity because this system also responds to hydrogen concentration. To improve the poor spectral resolution, it was sometimes necessary to carry out stationary measurements in the borehole, comparable to long lasting measurements on drill cores. In the KTB-VB measurements also were done with a more sensitive germanium detector instead of the standard sodium-iodide detector.

The NGS sonde is described below (5.6.4). It is always mounted on top of the other sonde components, in order to be not affected by the radiation of the active sondes, as the measuring direction is always up.

GLT - Geochemical Logging Tool (Schlumberger)			
KTB-HB (Main Hole)		**KTB-VB (Pilot Hole)**	
W...	weight percent, e.g. WAL of aluminum	W...	weight percent, e.g. WAL of aluminum, except Gd in [ppm]
Al2O	absolute contents of oxides [percent]	Al2O	absolute contents of oxides [percent]
-		SIGM	neutron capture cross-section [barns]

GLT KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
WAL, WCA, WFE, WGD, WSI, WTI, WMG, WSUL, WPOT, SIGM, AL2O, CAO, FE2O, P2O5, SIO2, TIO2	25-3992	GLT-25-3992m

GLT KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM- .....**
WAL, WCA, WFE, WGD, WSI, WTI	3001-4444	GLT-14- 75inch-3001-4444m
WAL, WCA, WFE, WGD, WSI, WTI	4430-6011	GLT-14-75inch-4430-6011m

5.6.3. LDL – Litho-Density-Log (Gamma-Gamma Log) HFDC – High temperature Formation Density Compensated

The Litho-Density tool (LDT) is the successor of the Formation Density tool (FDT). In addition to the standard bulk density, it also measures another rock property, the photoelectric absorption index PEF (in old logs also called Pe). The HFDC was used in the deeper and therefore hotter sections of the KTB-HB.

The sonde works with a Cs 137 (cesium) source emitting gamma rays into the formation. The source and the two counter tubes are built into a pad which is pressed against the borehole wall by a clamping arm. The gamma backscatter (Compton scattering) from the near vicinity of the borehole wall is measured. With uniform borehole geometry and well-known gamma flux, the gamma backscatter is a direct measure for the bulk density of the formation. From the bulk density the porosity can be calculated if matrix density and density of the mud filtrate (salinity) are known. In addition, the LDT measures the photoelectric absorption index, which is a measure for the mean number of electrons per atom and can be used for determining lithological boundaries in the absence of rare heavy minerals.

5.6.4. NGS – Natural Gamma Spectrometer

NGS tools measure the natural gamma radioactivity within five discrete energy windows covering the specific zones in the gamma spectrum of K 40, U 238 and Th 232. These radiation flux densities are a direct measure of the concentration of the corresponding radioisotopes in the formation. Changes in the concentration ratio can indicate lithological changes. The NGS log is an important aid to geological correlation. In sediments it's possible to determine clay content in the presence of minerals containing Th or K. In the crystalline KTB rocks the NGS was very helpful in the 'core to log' correlation and to identify fracs and joints. These are often indicated in NGS logs by high gamma values of their hydrothermal mineralization (precipitation of uranium oxides). The high temperature version of the sonde, HNGS, was used in the deeper part of the KTB-HB.

5.6.5. Reference GR (RGR)

Continuous measurement of the total natural gamma radiation of the rock. The GR is the basis for the depth corrections of most borehole logs and also for the depth correlation of cores and cuttings. The reference GR logs here are spliced from several separate GR runs. In the KTB-HB use the reference Gamma Ray file: *KTB-HB-BM-RGR-COMPLETE-0-9078m*. There is another reference GR for the branch hole#4 of the KTB-HB. In the KTB-VB use SGR from the Composite Logs file: KTB-VB-BM-NGS-LDT-CNL-SP-6inch-25-4001m.

5.7. Gravimetry

5.7.1. BHGM – Borehole Gravity Meter

The Lacoste-Romberg borehole gravity meter sonde (EDCON, USA) measures the vertical component of the Earth's gravitational field by the movement of a spring balance. The density of the rock can be calculated from the corrected gravity gradient. The depth of investigation is much bigger than with the LDT and the integration volume of the measurement can be as much as some hundred cubic meters. From the BHGM measurements the density distribution and porosity models can be derived for more distant surroundings of the borehole (> 10 m).

BHG - Borehole Gravity Meter (EDCON)			
KTB-HB (Main Hole)		KTB-VB (Pilot Hole)	
TVD	true vertical depth	TVD	true vertical depth
GRAV	observed gravity	GRAV	observed gravity
BANO	Bouguer anomaly	BANO	Bouguer anomaly
RHO	density from BHGM	RHO	density from BHGM

GRAVIMETRY KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
TVD, GRAV, BANO, RHO	0-3850	GRAVIMETRY-0-3850m

GRAVIMETRY KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM- .....**
TVD, GRAV, BANO, RHO	0-8400	GRAVIMETRY-0-8400m

5.8. Borehole Magnetics

5.8.1. Magnetic Susceptibility

SUS – Magnetic Susceptibility Sonde (K-meter)

A magnetic susceptibility sonde consists of a system of coils in a non-magnetic, non-conductive housing. The transmitter coil, through which flows an alternating current at about 1000 Hz, generates an electromagnetic field. The receiving part is equipped with two coils, so that with the aid of a compensating circuit small changes in the mutual inductivity can be measured. The magnetic susceptibility of the rock is largely determined by the content and nature of its ferromagnetic minerals and thus permits, amongst other things, a lithological differentiation of the rock. The MSUS log is not depth corrected to the reference GR because the sonde had no GR sensor.

SUS - magnetic susceptibility, tool from Univ. of Munich, Germany			
KTB-HB (Main Hole)		**KTB-VB (Pilot Hole)**	
-	-	SUS	magnetic susceptibility in 10^{-3} SI

SUS - Magnetic Susceptibility KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
SUS	22-3980	SUS-22-3980m

5.8.2. Borehole Magnetometer

FML-BS – Fluxgate Magnetometer Log - Braunschweig

The measurements were carried out with three calibrated triaxial fluxgate magnetometers of high resolution in the sonde of the University of Braunschweig, Germany. The sonde determines the three cartesian components of the geomagnetic field.

FML sonde (Univ. Braunschweig, Germany)			
KTB-HB (Main Hole)		KTB-VB (Pilot Hole)	
BVER	magnetic field, vertical component	BVER	magnetic field, vertical component
BHOR	magnetic field, horizontal component	BHOR	magnetic field, horizontal component
BABS	magnetic field, total	BABS	magnetic field, total
AZIM	borehole azimuth	AZIM	borehole azimuth
DEVI	borehole deviation	DEVI	borehole deviation
GR	natural GR activity		

GPIT – General Purpose Inclinometer Tool (Schlumberger)

The GPIT is the standard device for sonde orientation in sonde strings of the Schlumberger Co. It contains three magnetometers and three accelerometers. With this sensor set-up it can determine even very small sonde movements which have to be corrected in some logs, e.g. in the high spatially resolving Formation MicroScanner log (FMS). In the deepest section of the KTB-HB, below 6000 m no logs with the FML-BS could be run, so the GPIT magnetometer readings give the only magnetic information of that section. The data are NOT calibrated for absolute values and contain some errors due to tool rotation. The data should be used only qualitatively. Some of the GPIT magnetic field data has been corrected as best as possible, but there still are some errors due to tool movement.

GPIT (Schlumberger, corrections made by Univ. Braunschweig)			
KTB-HB (Main Hole)		KTB-VB (Pilot Hole)	
Ftot	magnetic field, total	-	
Fx,Fy,Fz	magnetic field components, triaxial cartesian	-	
MAGZ	magnetic field, vertical component corrected	-	
MAGH	magnetic field, horizontal component corrected	-	
MAGG	magnetic field, total corrected	-	
GR	natural gamma activity (for depth correction)	-	

FML Magnetometer KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
Bver, Bhor, Babs, Devi, Azim	500-3701	FML-BS-500-3701m

FML Magnetometer KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM- .....**
Bver, Bhor, Babs, Devi, Azim GR	320-3007	FML-BS-14-75inch-320-3007m
Bver, Bhor, Babs, Devi, Azim GR	3020-6026	FML-BS-14-75inch-3020-6026m
FTOT, FX, FY, FZ	6015-7797	GPIT-8-5inch-hole5-6015-7797m
FTOT, FX, FY, FZ	7812-8618	GPIT-8-5inch-hole5-7812-8618m
magz, magh, magg, GR	6030-8630	GPIT-corrected-12-25inch-hole4-and-hole5-6030-8630m

5.8.3. Orientation of Structures on the Borehole Wall: Foliation and Fracs/Faults/Joints

The spatial orientation (dip and dip direction) of the foliation and of other planar structures as fractures, faults, joints (etc.) was determined manually by sine structure picking on FMS/FMI images. The Formation Micro Scanner (FMS) and its successor sonde the Formation Micro Imager (FMI), both by Schlumberger Co., are electrical borehole imager sondes that yield fully oriented images of the electrical resistivity contrast of the borehole wall. This is achieved with an array of micro electrode buttons arranged on each of four pads. The pads are each mounted to one of four caliper arms, therefore also an oriented 4-arm caliper is measured. The structural data are depth corrected to the reference GR (see Composite Logs) of the respective borehole.

Foliation KTB-VB (Pilot Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-VB-BM- .....**
DDIR, DIP	83-3992	Foliation-FMS-FMI-83-3992m

Foliation KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM- .....**
DDIR, DIP	293-8613	Foliation-FMS-FMI-293-8613m

Fracs-Faults-Joints KTB-HB (Main Hole)		
Parameters	**Log Section [m]**	File Name: **KTB-HB-BM- .....**
DDIR, DIP	293-8620	Fracs-Faults-Joints-FMS-FMI-293-8620m

6. List of Mnemonics and Units

6.1.1. Mnemonics

List of Log/Sonde Mnemonics in the KTB logging data files.

Mnemonic	Description
ARI (ALAT)	Array Resistivity Imager (Azimuthal LateroLog), electrical rock resistivity, 30°-wide azimuthal reading segments
AMS	Auxiliary Measurement Service, mud resistivity & temp., head tension
BGL	Borehole Geometry Log, borehole caliper & orientation
BGL single	borehole geometry log of the many single runs; depth as measured, i.e. not depth correlated
BHG	Borehole Gravity Meter, gravity, density
BHTV	Acoustic Borehole Tele Viewer, acoustic images and caliper of the borehole wall
BM	Borehole Measurements
BO	Borehole Breakout, stress induced lateral borehole wall enlargements
BS	Bit Size
CNL	Compensated Neutron Log, porosity
Composite	compilation of parameters from several logging sondes: spectral GR (NGS), density (LDT, HFDC), neutron porosity (CNL), sonic velocity (DSI, SDT, HSLT), electrical resistivity (DIL, DLL, ARI, MSFL)
DLL	Dual LateroLog, electrical rock resistivity, conductive
DIL	Dual Induction Log, electrical rock resistivity, inductive
DSI	Dipole Shear Sonic Imager tool, sonic log, two dipole sources for enhanced shear wave attenuation, elastic wave velocities
HFDC	Hi-Temp Formation Density Compensated for high temperatures, density from gamma-ray absorption
FML	Fluxgate Magnetometer Log, magnetic field components
FMS/FMI	Formation Micro Scanner/Imager, electrical borehole wall images, caliper, orientation
Foliation	Foliation dip and dip direction from manual sine structure picking on FMS/FMI images
Fracs-Faults-Joints	Fractures, faults, joints (etc.) dip and dip direction from manual sine structure picking on FMS/FMI images
GLT	Geochemical Logging Tool, elemental analysis by spectrometry of induced & natural radiation, maximum of 12 elements
GPIT	General Purpose Inclinometer Tool, contains 3D-magnetometer, non-calibrated
GR	total natural Gamma Ray
HSLT	Sonic Logging Tool for high temperatures, type BHC, Borehole Compensated Sonic, sonic log, elastic wave velocities
IP	Induced Polarization Log, electric chargeability of the formation
KTB-Kombi-sonde	combination sonde: BGL + SP + hi-res TEMP at tool bottom
LDL	Litho-Density Log, density from gamma-ray absorption

Mnemonic	Description
MSFL	Micro-Spherically Focused Log, electrical rock resistivity with high vertical resolution (absolute values) and very shallow penetration depth
MULTISHOT	hole orientation (AZIM,DEVI) from a multi shot sonde inside the drill string
NGS	Natural Gamma ray Spectrometry tool, spectrometry of the natural gamma radiation (U, Th, K)
RB	Relative Bearing
RGR or Reference GR	continuous reference gamma ray KTB-HB, spliced from single runs
SDT	Sonic Digital Tool, sonic log, elastic wave velocities, waveforms
Sonic	generic term for all type of sonic logs, e.g. SDT, HSLT, DSI
STC	sonic processing: slowness time coherence/semblance analysis
SP EP Redox	Spontaneous Potential & Redox potential, natural electric potentials
SUS	magnetic susceptibility, KTB-VB only
TEMP single	temperature of the drilling mud of the many single runs, data as measured, the data often includes mud resistivity

6.1.2. Units

Unit	Description
10-3	10^{-3} dimensionless magnetic susceptibility in SI system
API	gamma API, standardized total gamma ray activity according to the American Petroleum Institute
barn/cm3	1 barn = 10^{-28} m^2/cm^3
degC	degree Celsius = °C
deg	degree of an angle
g/cm3	gram per cubic centimeter (= g/cm^3)
lbf (pounds)	pound force, 1 lbf (equivalent 4.448222 N)
m	meter
mm	millimeter
mA	milliampere
mGals	mGal = milliGal = 10^{-3} cm/s^2
mV	millivolt
nT	nanotesla
ohmm	Ohm m
%	percent
ppm	parts per million
uR/h	1 µR/h = microRoentgen per hour = 10^{-5} milliSievert per hour (mSv/h)
us/m	µs/m = microseconds per meter (inverse velocity)
wt.-percent	weight percent (contents of an element)

7. References

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Kueck, J.; Conze, R.; Bram, K.; Draxler, H.; Zoth, G.; Kessels, W.; Hänel, R. (2021h): KTB Borehole Measurements: Temperature Logs of the German Continental Deep Drilling Program. GFZ Data Services. https://doi.org/10.5880/GFZ.KTB.BM.temperature

7.2. KTB-Reports

The findings of the KTB program were documented in a series of in total 46 KTB-Reports (see https://tinyurl.com/rmq66z5 for a full list) of which the following 24 reports describe KTB downhole logging or contain the downhole measured data. Those 11 reports in ***bold italic*** are focusing on downhole logging. The reports generally are in German, except where indicated EN in English.

No	Title	DOI
87-3	Arbeitsprogramm KTB-Bohrlochgeophysik & Messprogramm KTB-VB	https://doi.org/10.2312/ktb.87-3
87-4	KTB-VB Bohrlochmessungen 0-478 m	https://doi.org/10.2312/ktb.87-4
88-3	Elektromagnetische Tiefensondierung 1987, Abschlussbericht 1988	https://doi.org/10.2312/ktb.88-3
88-4	***KTB-VB Bohrlochmessungen 478-1529 m***	***https://doi.org/10.2312/ktb.88-4***
88-7	***KTB-VB Bohrlochmessungen 1529-3009 m***	***https://doi.org/10.2312/ktb.88-7***
88-8	Spannungsmessungen & Bohrlochstabilität	https://doi.org/10.2312/ktb.88-8
88-10	1. KTB Kolloquium 1988	https://doi.org/10.2312/ktb.88-10
88-11	***Bohrlochgeophysik, Forschung & Entwicklung, Berichte***	*https://doi.org/10.2312/ktb.88-11*
89-1	***KTB-VB Bohrlochmessungen***	***https://doi.org/10.2312/ktb.89-1***
89-3	2. KTB Kolloquium 1989	https://doi.org/10.2312/ktb.89-3
90-1	***KTB-VB Bohrlochmessungen***	*https://doi.org/10.2312/ktb.90-1*
90-4	3. KTB Kolloquium 1990	https://doi.org/10.2312/ktb.90-4
90-5	KTB-VB Hydraulische Untersuchungen	https://doi.org/10.2312/ktb.90-5
90-6a	***KTB-VB Bohrlochgeophysik: Langzeitmess- und Testprogramm***	***https://doi.org/10.2312/ktb.90-6a***
90-6b	***Integrated Seismics Oberpfalz 1989, Longterm Logging & Testing Program EN***	***https://doi.org/10.2312/ktb.90-6b***
90-7	KTB Selected Papers 1988-1989	https://doi.org/10.2312/ktb.90-7
91-1	Forschungsergebnisse DFG-Schwerpunktprogramm KTB 1986-1990	https://doi.org/10.2312/ktb.91-1
91-2	***KTB-HB Bohrlochmessungen 0-1720 m***	***https://doi.org/10.2312/ktb.91-2***
91-4	EFA-LOG	https://doi.org/10.2312/ktb.91-4
92-1	***KTB-HB Bohrlochmessungen 1720-4512 m***	***https://doi.org/10.2312/ktb.92-1***
92-5	Integrated Seismics Oberpfalz 1989, Data Evaluation & Interpretation OCT-1992 EN	https://doi.org/10.2312/ktb.92-5
93-1	***Borehole Geophysics EN***	***https://doi.org/10.2312/ktb.93-1***
93-2	6th KTB-Colloquium 1993 EN	https://doi.org/10.2312/ktb.93-2
94-1	***Borehole Geophysics final report EN***	***https://doi.org/10.2312/ktb.94-1***
94-2	Contributions to the 7. Annual KTB-Colloquium, Geoscientific Results ; Giessen 1.-2. June 1994	https://doi.org/10.48440/ktb.942
95-1	International Conference on Continental Scientific Drilling, GFZ Potsdam, Aug. 30. - Sept. 1. 1993; (Report of the Technical Working Group)	https://doi.org/10.2312/ktb.95-1
95-2	*KTB Hauptbohrung; Results of Geoscientific Investigation in the KTB Field Laboratory; Final Report: 0 - 9101 m*	*https://doi.org/10.2312/ktb.95-2*

8. Appendix

In the Appendix, we provide the full list of borehole-measurements related publications from the "old" KTB Website (https://data.icdp-online.org/sites/ktb/welcome.html) and an overview on the articles published in two KTB Special Issues

8.1. Geofluids Special Issue: long-term fluid production in the KTB pilot hole, Germany

Geofluids, 5(1), 2005, https://onlinelibrary.wiley.com/toc/14688123/2005/5/1

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8.2. JGR Special Section "The KTB Deep Drill Hole"

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