

7. Logging Series

J. K. Draxler

7. Logging Series

List of tools and tool combinations run in the borehole at different logging series:

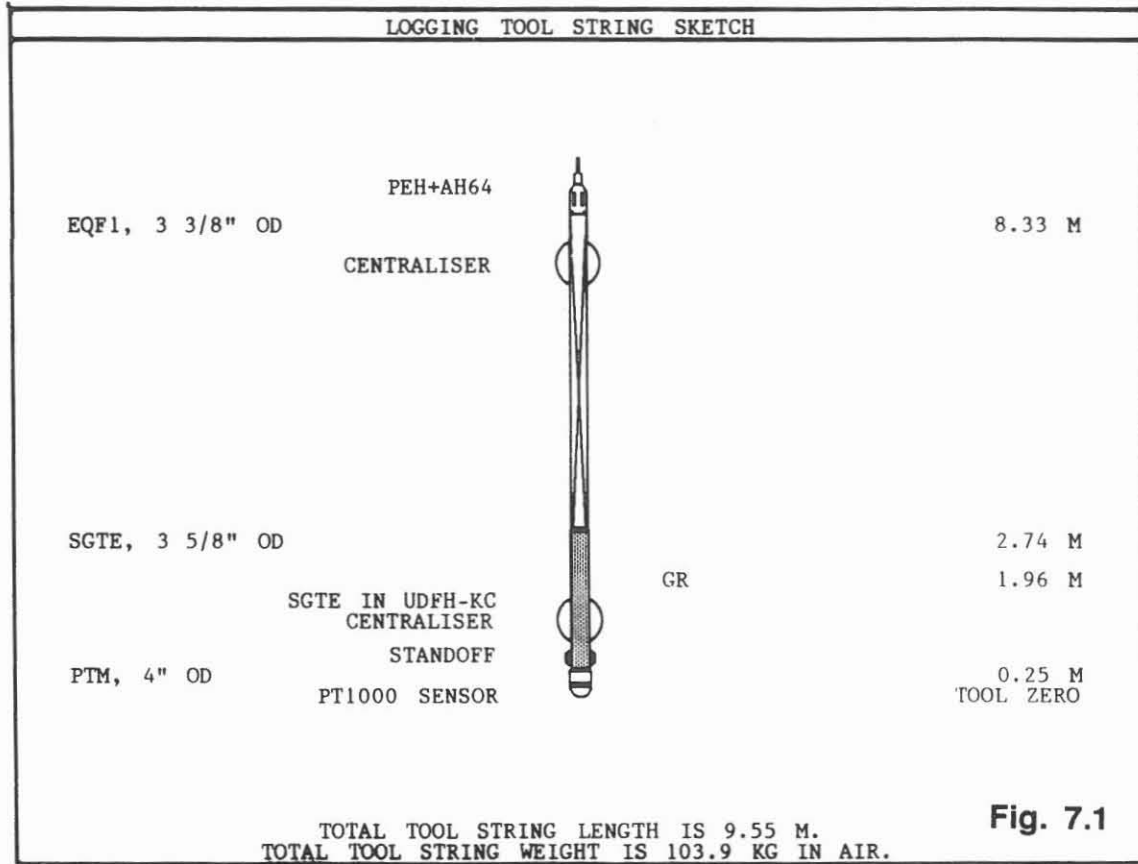
For each tool or combination the **Tool Sketch** will provide dimensions and distances for the different reference points of the sensors on the string.

All abbreviations starting with "H" indicate Hostile Environment Logging Tools (HEL) with 260° C temperature rating.

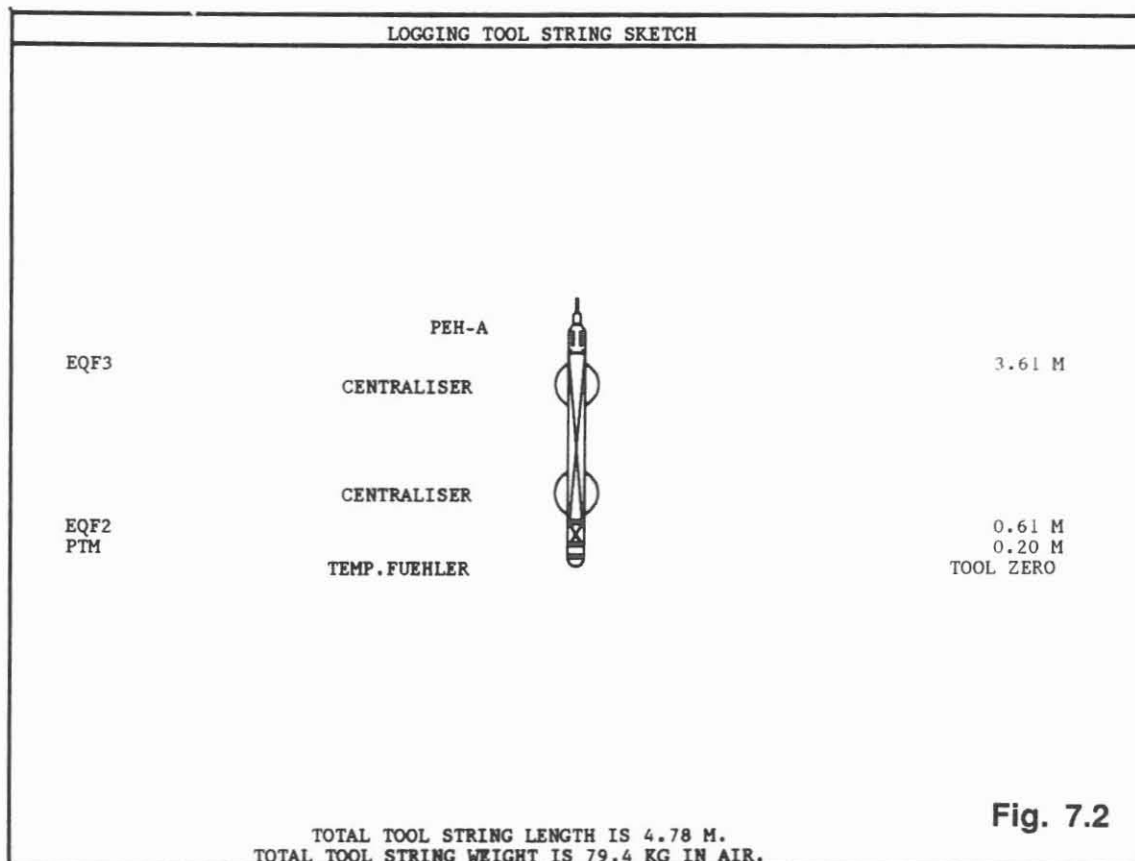
TEMP-GR	Temperature/Gamma Ray Fig. 7.1
TEMP	Temperature Fig. 7.2
BGL-TEMP-GR-AMS	Borehole Geometry Log/Temperature/Gamma Ray/Auxiliary Measurement Sonde Fig. 7.3
HDLL-HGR	HEL-Dual Laterolog/Gamma Ray Fig. 7.4
HNGL-HAMS-TEMP	HEL-Natural Gamma Ray Spectrometer/Auxiliary Measurement Sonde/Temperature Fig. 7.5
HGR-HAMS-TEMP	HEL-Gamma Ray/Auxiliary Measurement Sonde/Temperature Fig. 7.6
HSP-REDOX	HEL-Self Potential/Redox Potential Fig. 7.7
MFC-HGR-HAMS	Multi-Finger Caliper/HEL-Gamma Ray/Auxiliary Measurement Sonde Fig. 7.8
HBGL-HGR-HAMS-HTEMP-HSP	HEL-Borehole Geometry Log/Gamma Ray/Auxiliary Measurement Sonde/Temperature/Self Potential Fig. 7.9
BGTX-HGR-HAMS-TEMP	Borehole Geometry Tool (200° C)/HEL-Gamma Ray/Auxiliary Measurement Sonde/Temperature Fig. 7.10
HBGL-HNGL-HAMS	HEL-Borehole Geometry Log/Natural Gamma Ray Spectrometer/Auxiliary Measurement Sonde Fig. 7.11
LDL-CNL-NGL-MSFL-EDAC-AMS	Litho-Density Log/Compensated Neutron Log/Natural Gamma Ray Spectrometer/Microspherical Focused Log/Eccentralized Dual Axis Caliper/Auxiliary Measurement Sonde Fig. 7.12
DSI-GPIT-BGL-GR-AMS	Dipole Shear Sonic Imager/General Purpose Inclinator Tool/Borehole Geometry Log/Gamma Ray/ Auxiliary Measurement Sonde Fig. 7.13
DLL-BGL-TEMP-GR-AMS	Dual Laterolog/Borehole Geometry Log/Temperature/Gamma Ray/Auxiliary Measurement Sonde Fig. 7.14
HFMS-HGR-HAMS+Swiv.	HEL-Formation MicroScanner/Gamma Ray/Auxiliary Measurement Sonde + Swivel Fig. 7.15

HFMS-HGR-HAMS	HEL-Formation MicroScanner/Gamma Ray/ Auxiliary Measurement Sonde Fig. 7.16
HSLT-HGR-HAMS	HEL-Sonic Logging Tool/Gamma Ray/Auxiliary Measurement Sonde Fig. 7.17
HSLT-WF-HNGL-HAMS	HEL-Sonic Logging Tool with Waveform Recor- ding/Natural Gamma Ray Spectrometer/ Auxiliary Measurement Sonde with Hole Finder Fig. 7.18
HSLT-WF-HNGL-HAMS	HEL-Sonic Logging Tool with Waveform Recor- ding/Natural Gamma Ray Spectrometer/ Auxiliary Measurement Sonde for Cement Bond Logging (CBL) Fig. 7.19
HFDC-HCNL-HGR	HEL-Formation Density Compensated/Compen- sated Neutron Log/Gamma Ray Fig. 7.20
FS-HGR-HAMS	Fluid Sampler/HEL-Gamma Ray/Auxiliary Measurement Sonde Fig. 87.21

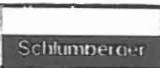
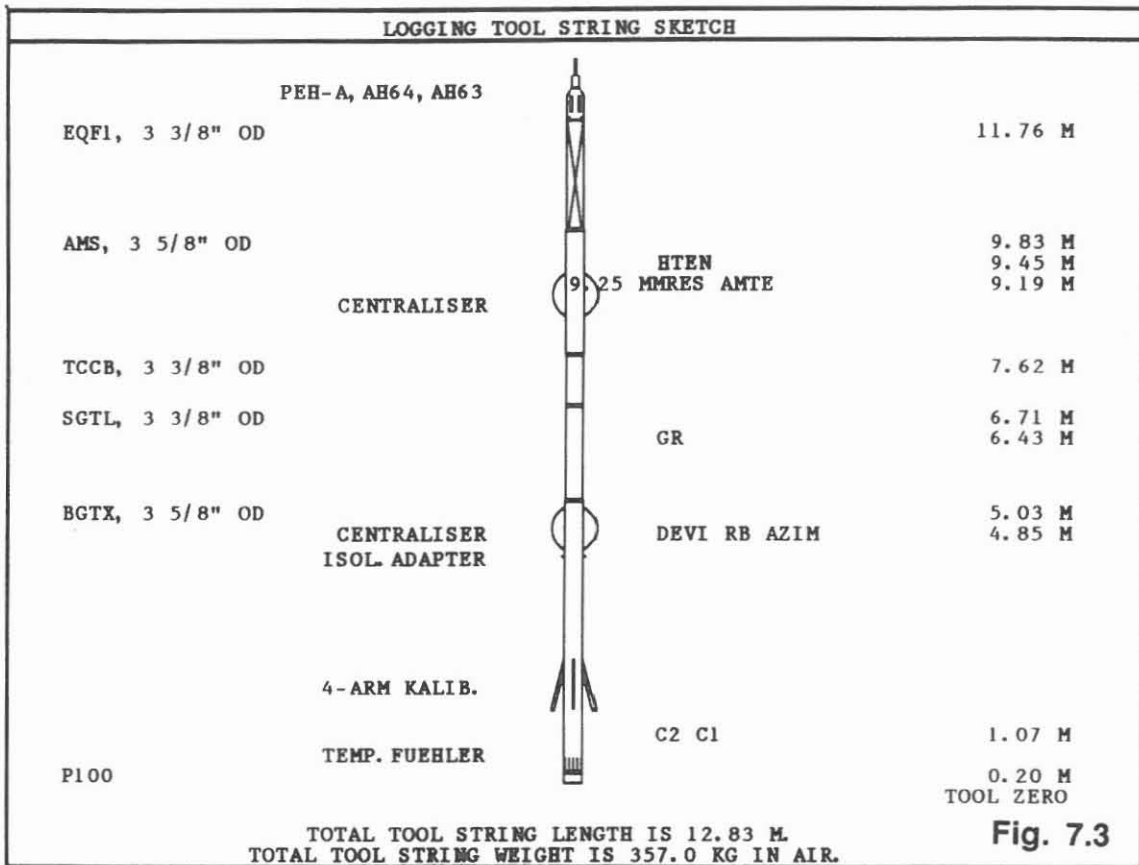
KTB Tool Sketch: TEMP-GR



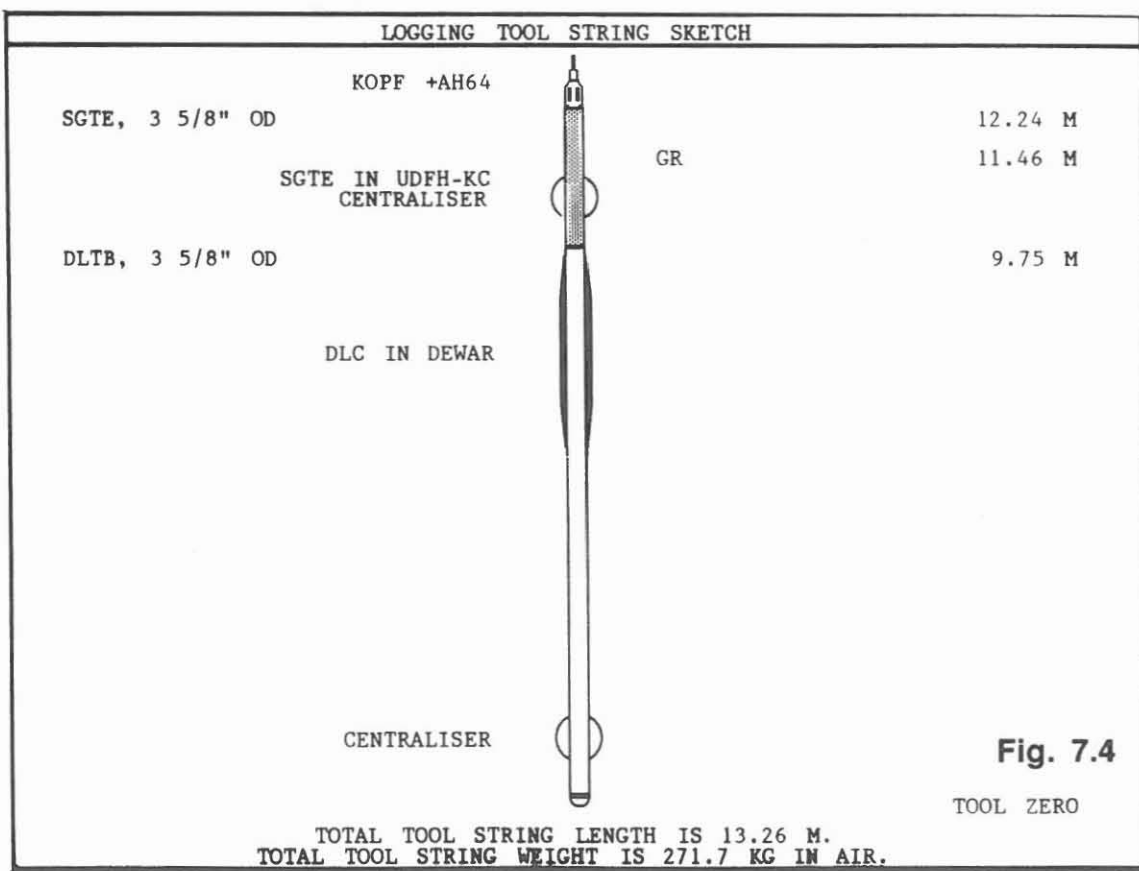
KTB Tool Sketch: TEMP



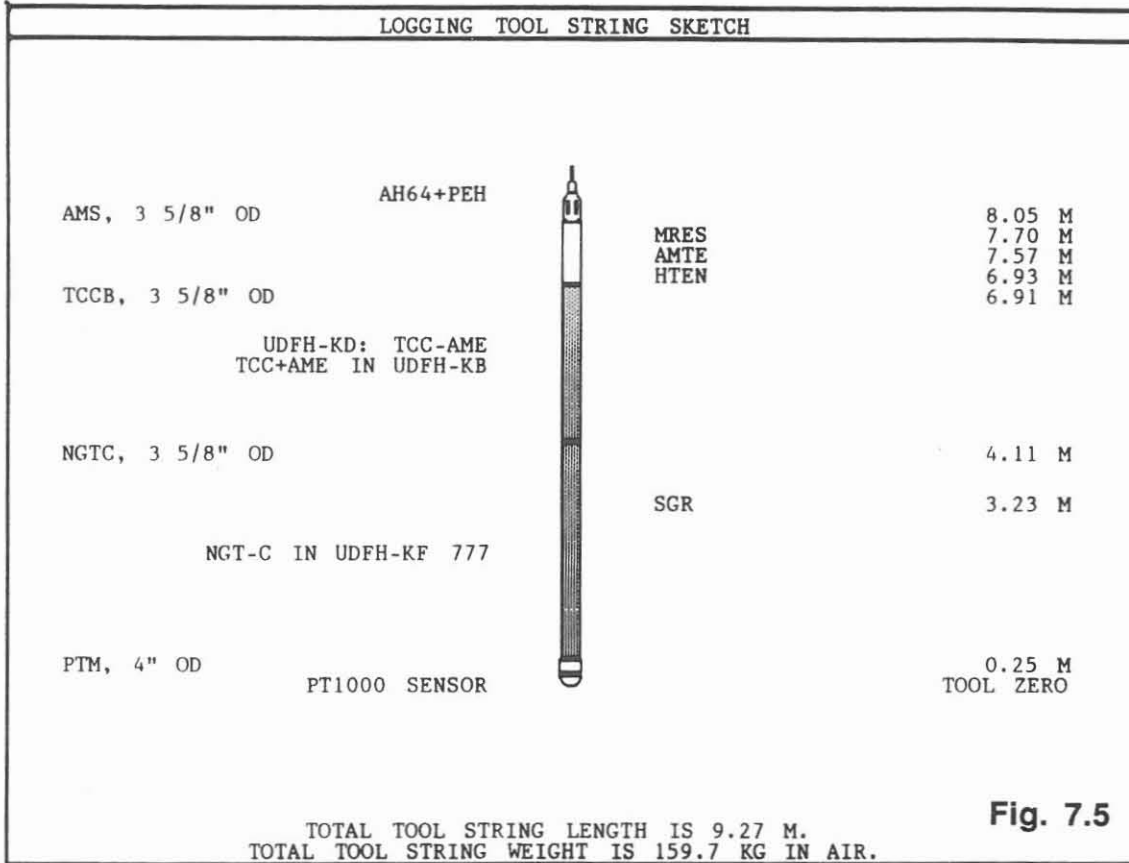
KTB Tool Sketch: BGL-TEMP-GR-AMS



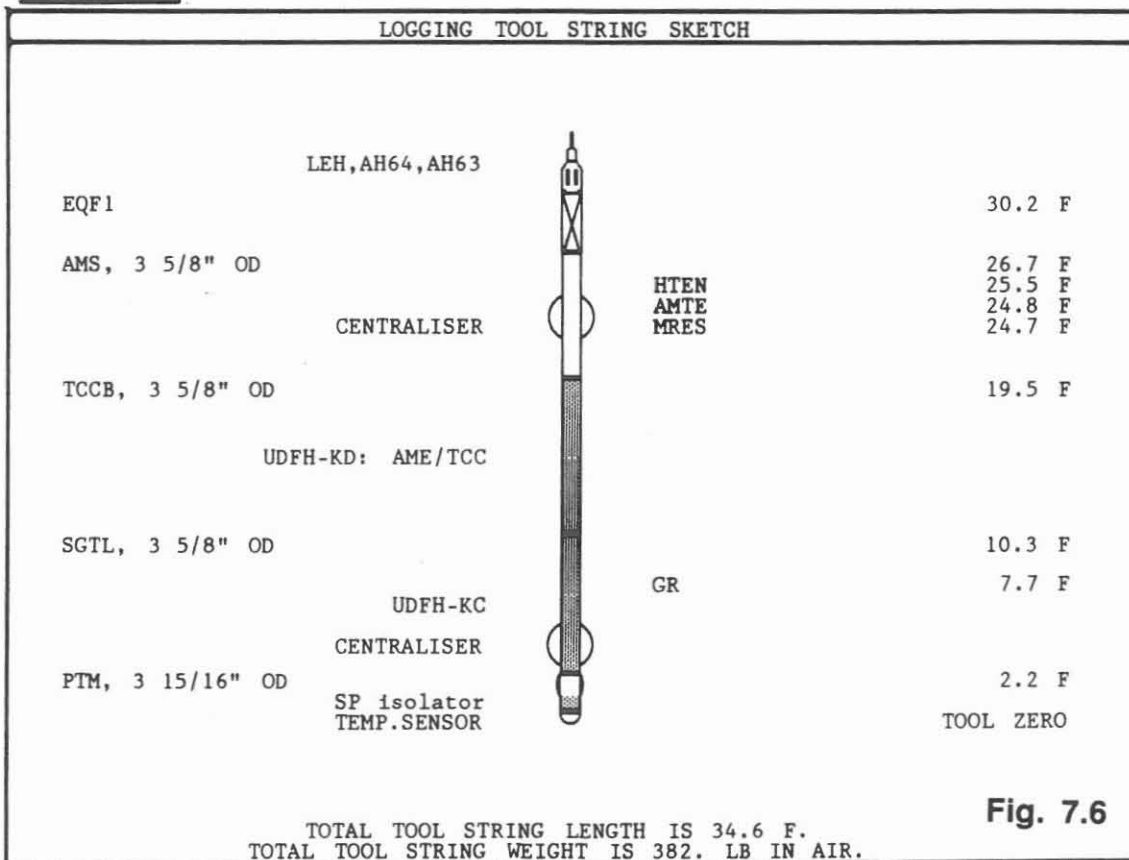
Tool Sketch: HDLL-HGR

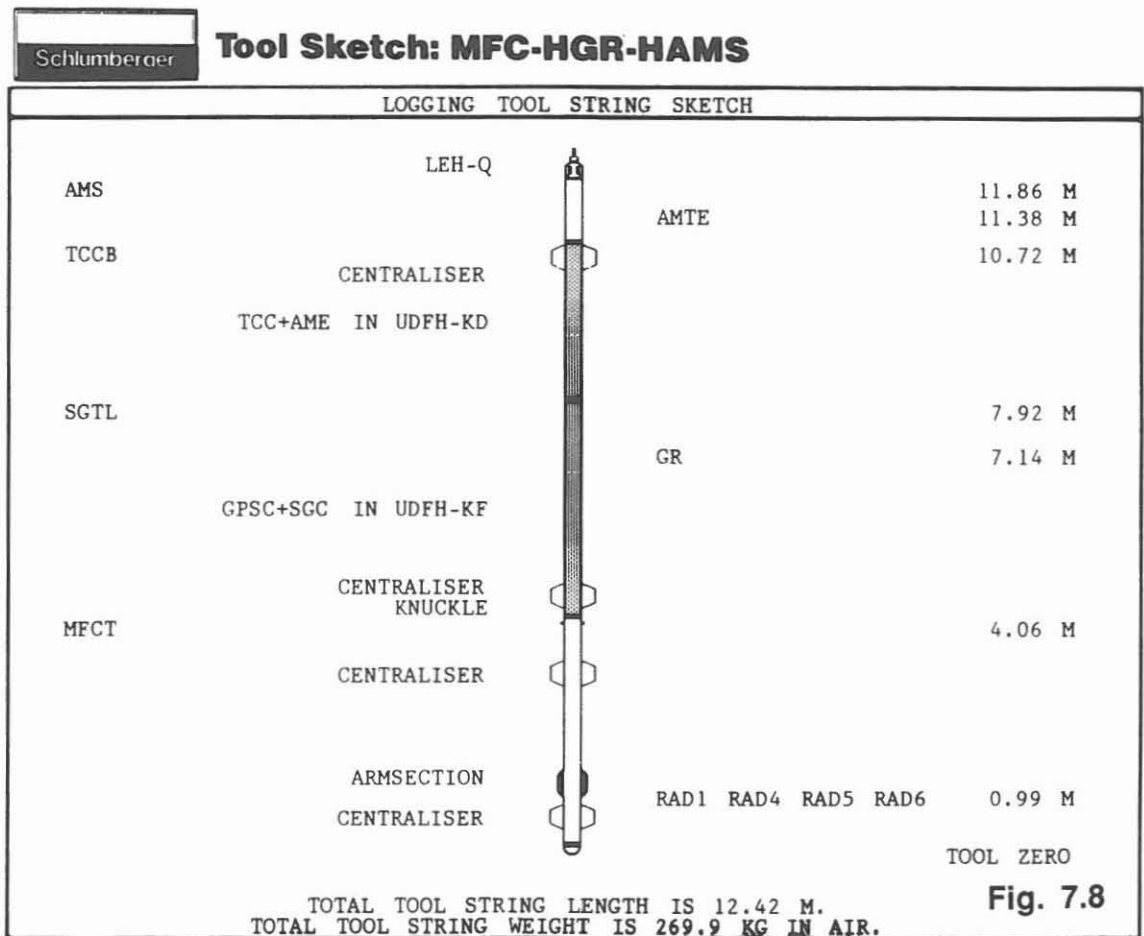
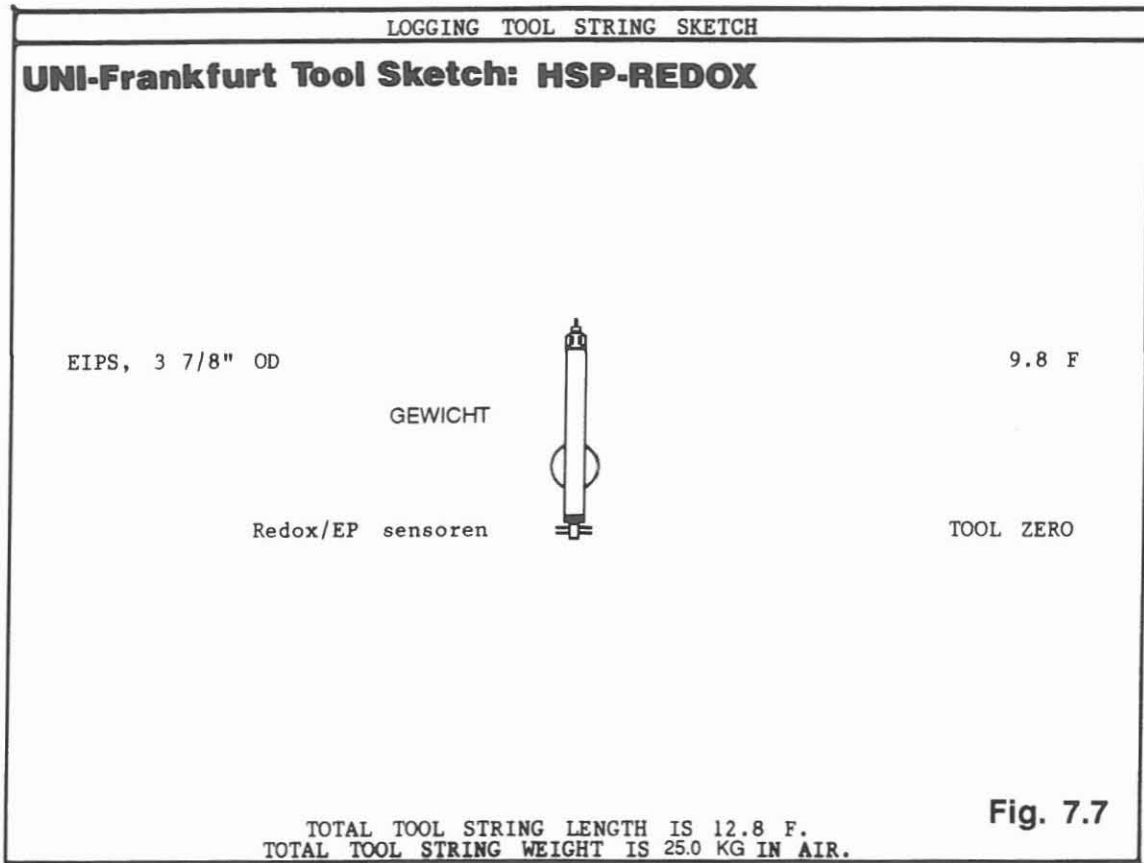


Schlumberger /KTB Tool Sketch: HNGL-HAMS-TEMP



Schlumberger /KTB Tool Sketch: HGR-HAMS-TEMP





LOGGING TOOL STRING SKETCH

Schlumberger / KTB

Tool Sketch: HBGL/HGR/HAMS/HTEMP/HSP

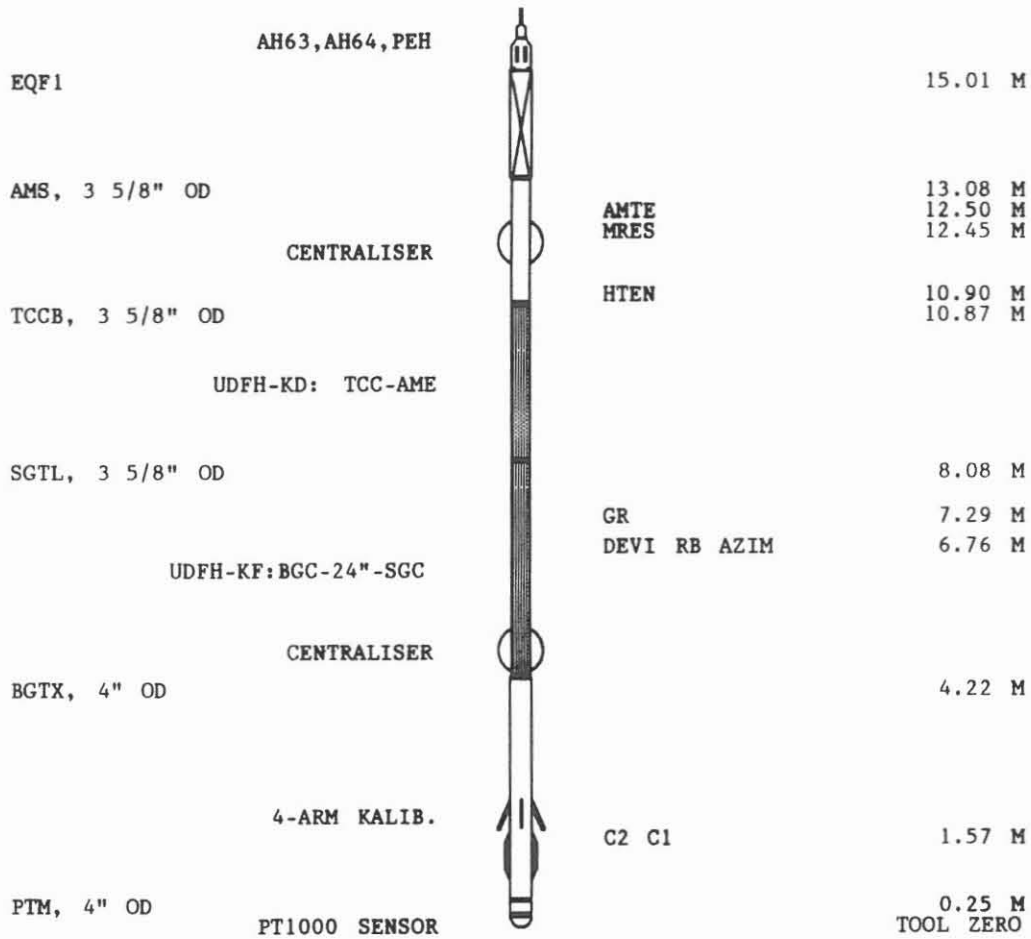
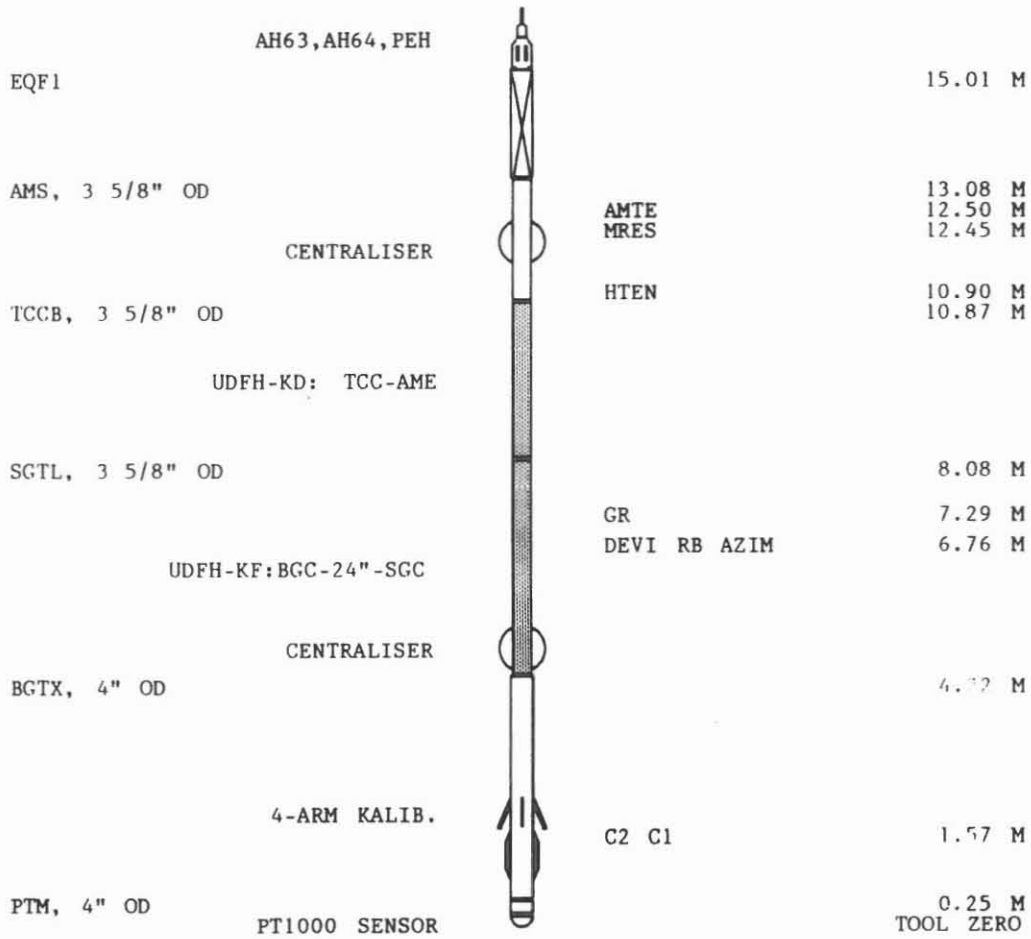


Fig. 7.9

TOTAL TOOL STRING LENGTH IS 16.33 M.
TOTAL TOOL STRING WEIGHT IS 286.2 KG IN AIR.

LOGGING TOOL STRING SKETCH

Schlumberger /KTB Tool Sketch:
BGTX-HGR-HAMS-TEMP



TOTAL TOOL STRING LENGTH IS 16.33 M.
 TOTAL TOOL STRING WEIGHT IS 286.2 KG IN AIR.

Fig. 7.10

LOGGING TOOL STRING SKETCH

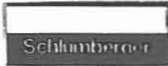
Schlumberger

Tool Sketch: HBGL/HNGL/HAMS

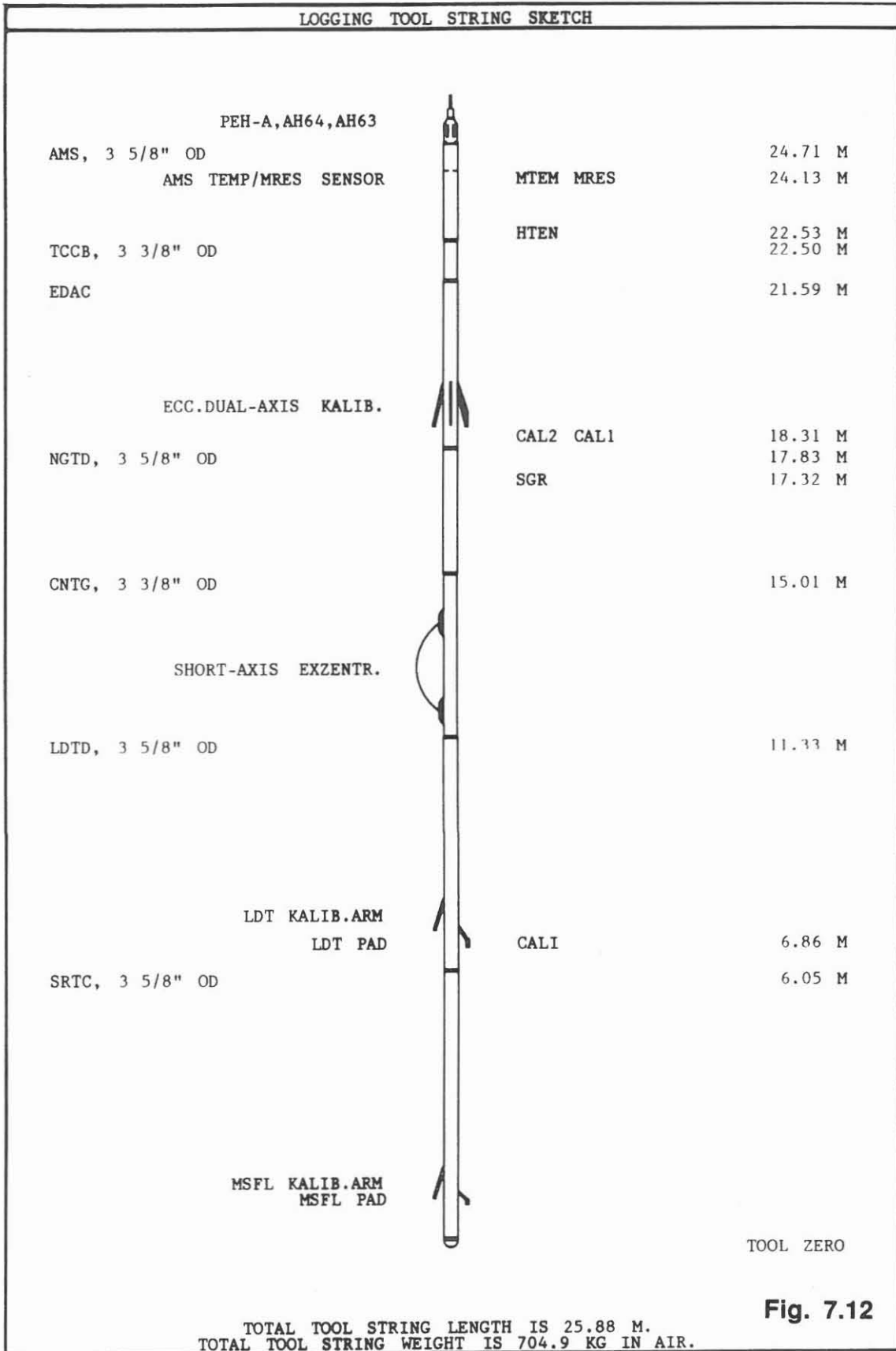
AMS, 3 5/8" OD	AH64+PEH		MRES	16.38 M
			AMTE	16.03 M
			HTEN	15.90 M
TCCB, 3 5/8" OD				15.27 M
	UDFH-KD: TCC-AME TCC+AME IN UDFH-KB			15.24 M
NGTC, 3 5/8" OD				12.45 M
	NGT-C IN UDFH-KF 777		SGR	11.56 M
GPIT, 3 5/8" OD				8.59 M
	GPIC IN UDFH-KC 772			
BGTX, 4" OD			DEVI RB AZIM	6.76 M
	BGC IN UDFH-KB 768		6.10 M	
	HDM-J 760 IN HDS SONDE			
	4-ARM KALIB.	C2 C1	1.60 M	
PTM, 4" OD	PT1000 SENSOR		0.25 M TOOL ZERO	

TOTAL TOOL STRING LENGTH IS 17.60 M.
TOTAL TOOL STRING WEIGHT IS 277.6 KG IN AIR.

Fig. 7.11



Tool Sketch: LDL-CNL-NGL-MSFL-EDAC-AMS



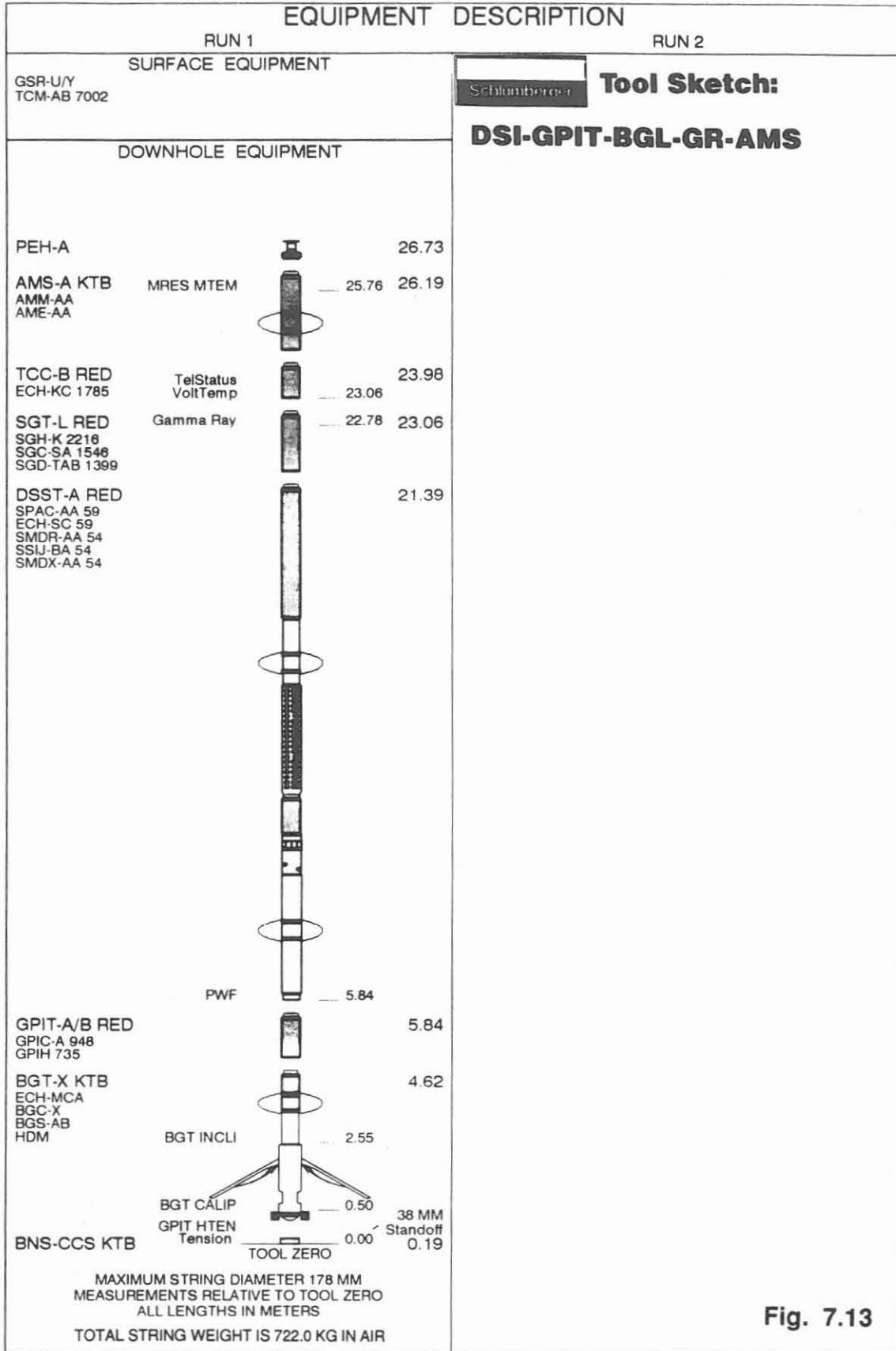


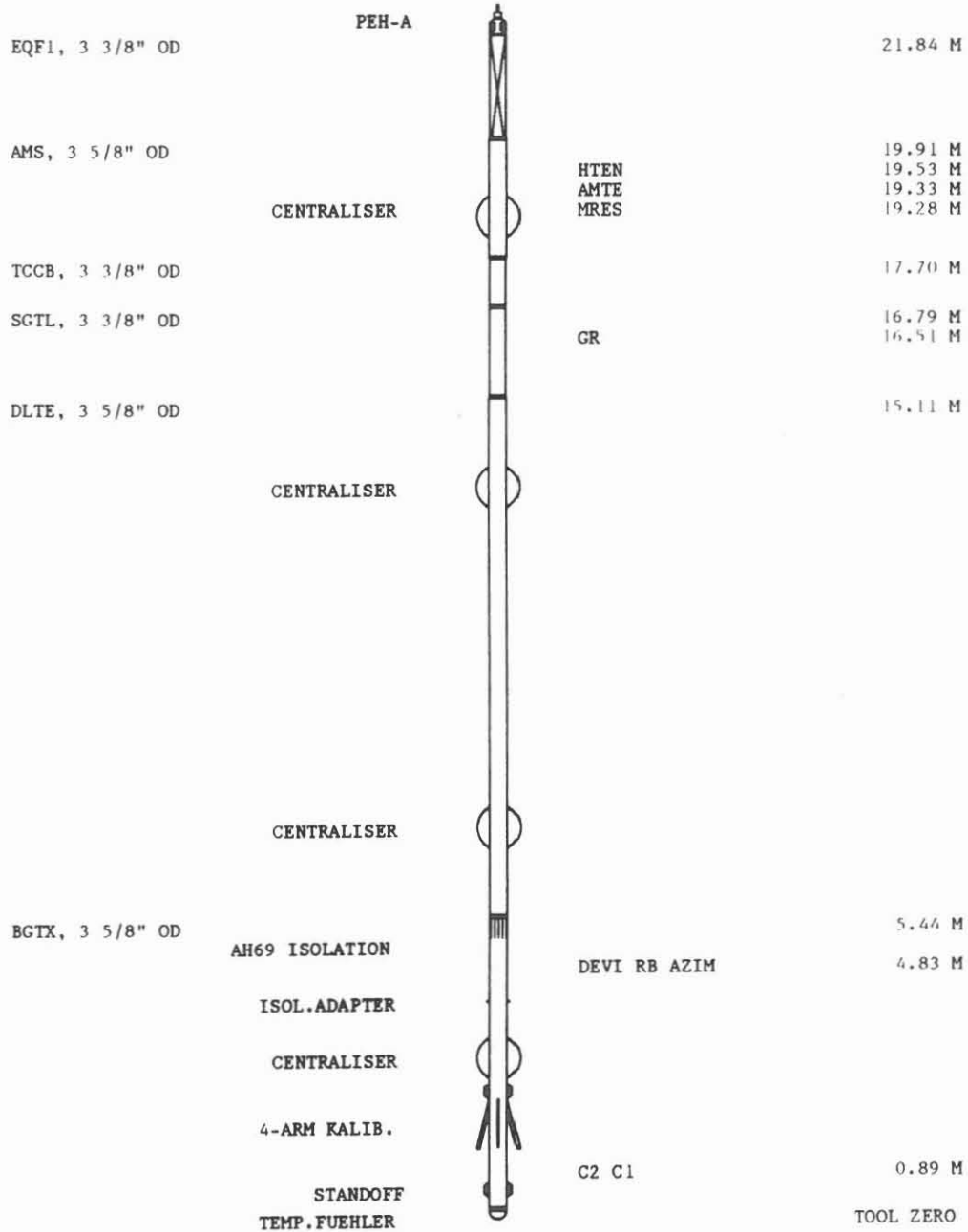
Fig. 7.13

LOGGING TOOL STRING SKETCH

Schlumberger

/KTB

Tool Sketch: DLL-BGL-TEMP-GR-AMS



TOTAL TOOL STRING LENGTH IS 22.61 M.
TOTAL TOOL STRING WEIGHT IS 619.6 KG IN AIR.

Fig. 7.14

LOGGING TOOL STRING SKETCH

Schlumberger

/KTB

Tool Sketch: HFMS-HGR-HAMS + Swivel

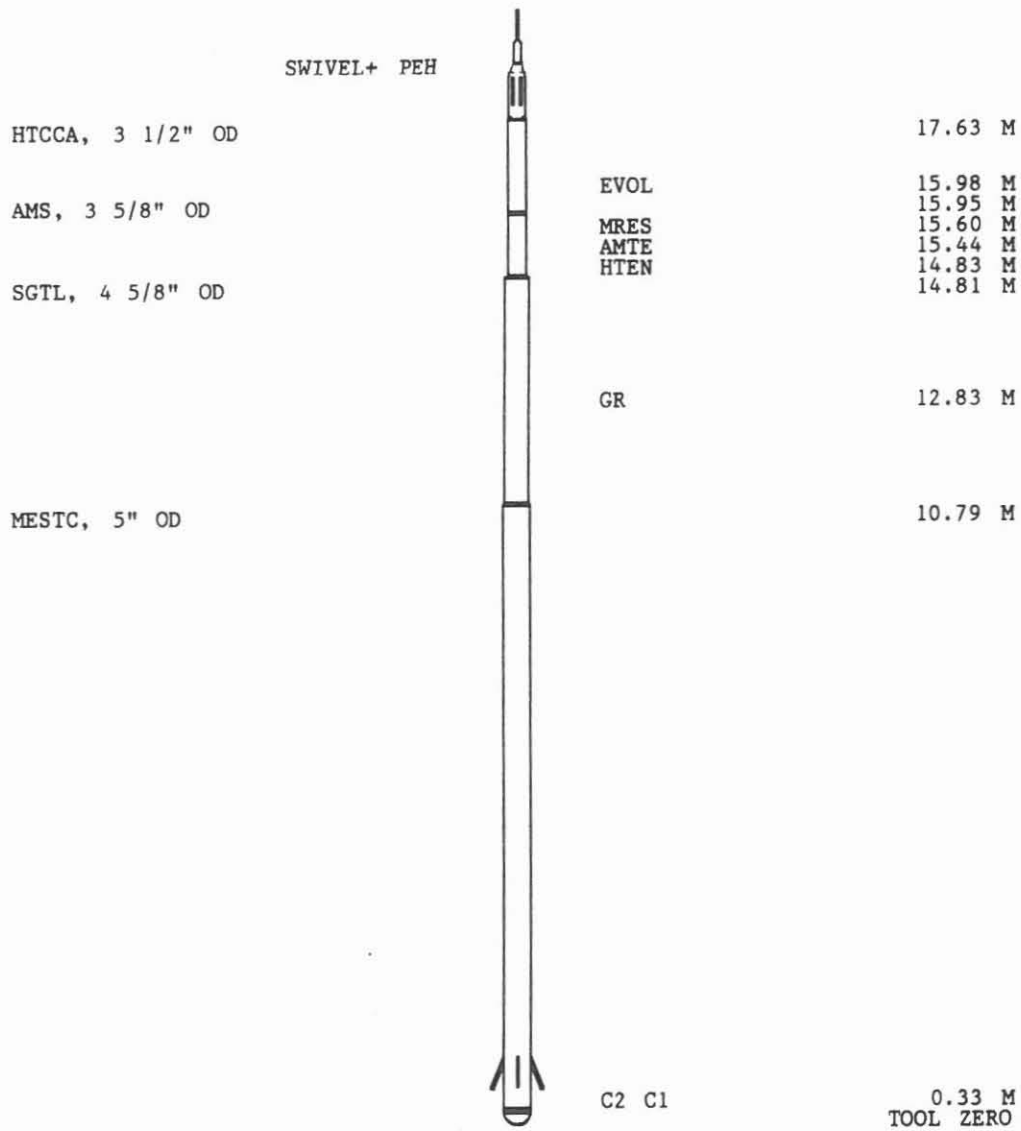


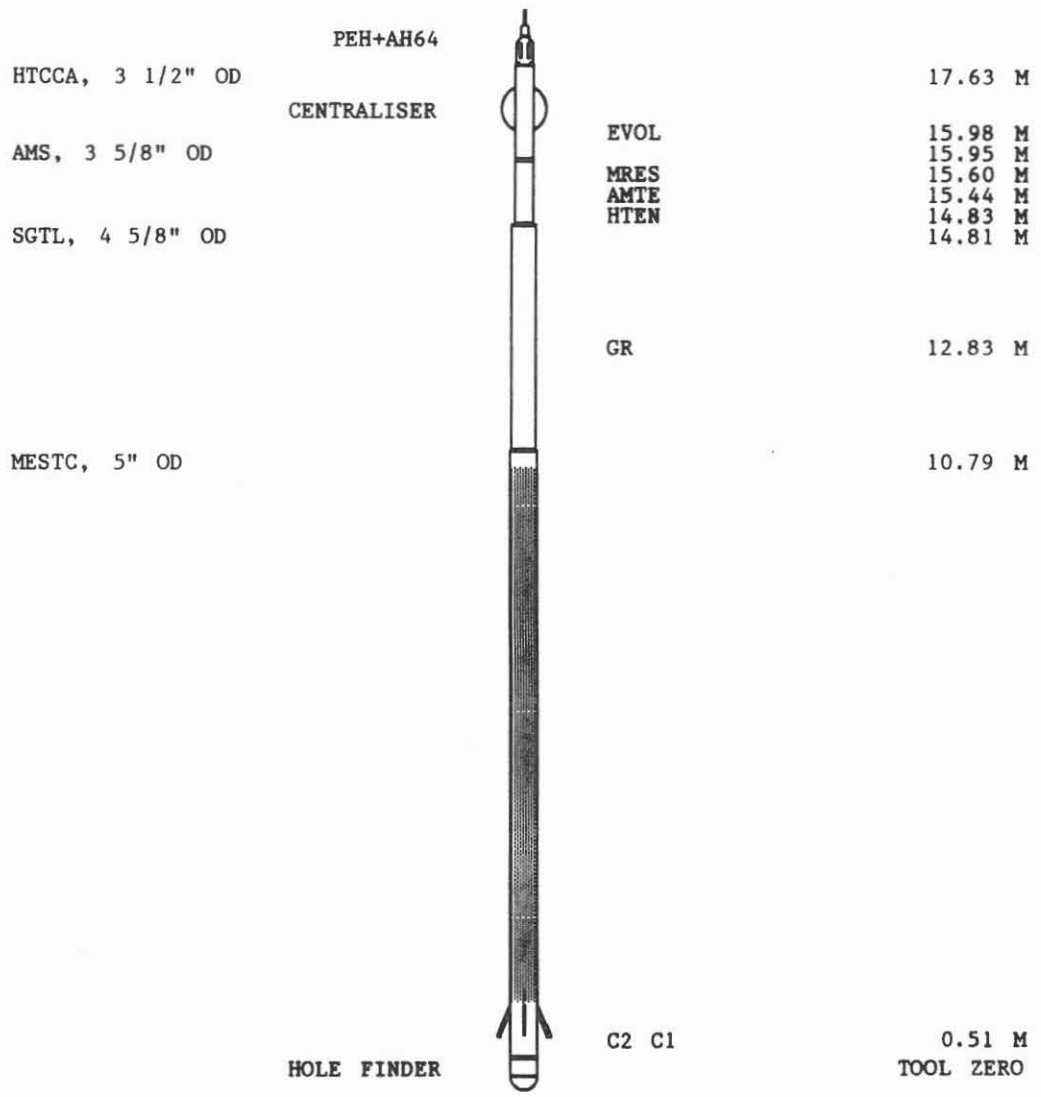
Fig. 7.15

TOTAL TOOL STRING LENGTH IS 19.66 M.
TOTAL TOOL STRING WEIGHT IS 345.6 KG IN AIR.

LOGGING TOOL STRING SKETCH

Schlumberger

Tool Sketch: HFMS/HGR/HAMS



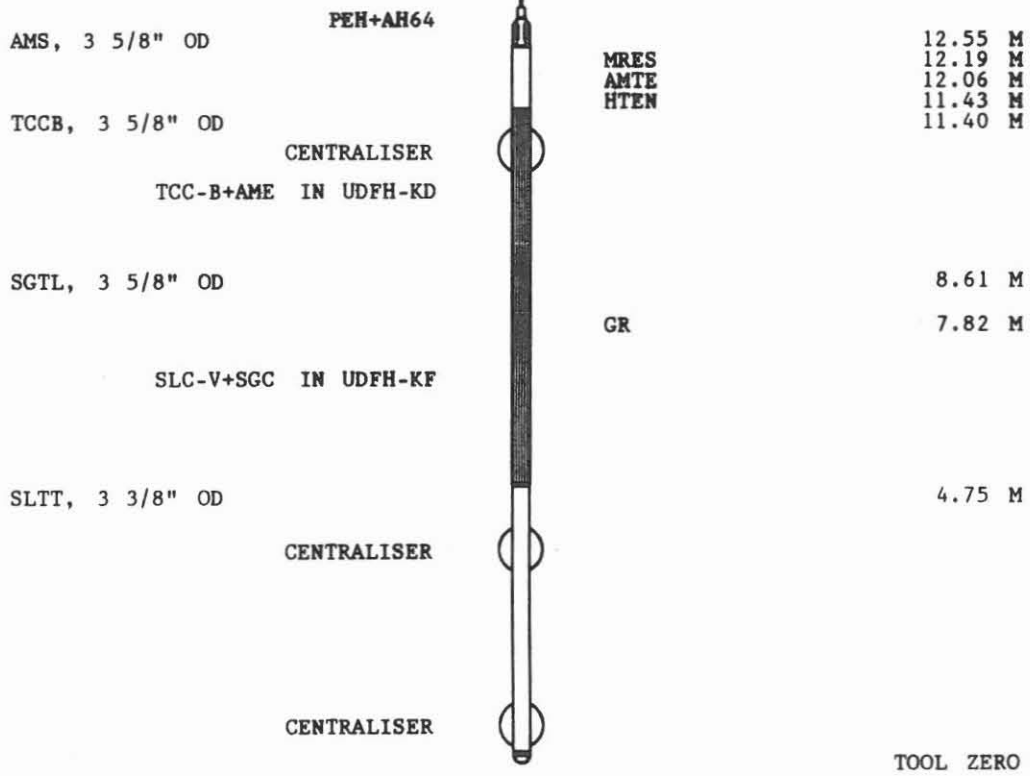
TOTAL TOOL STRING LENGTH IS 19.20 M.
 TOTAL TOOL STRING WEIGHT IS 616.4 KG IN AIR.

Fig. 7.16

LOGGING TOOL STRING SKETCH

Schlumberger

Tool Sketch: HSLT/HGR/HAMS



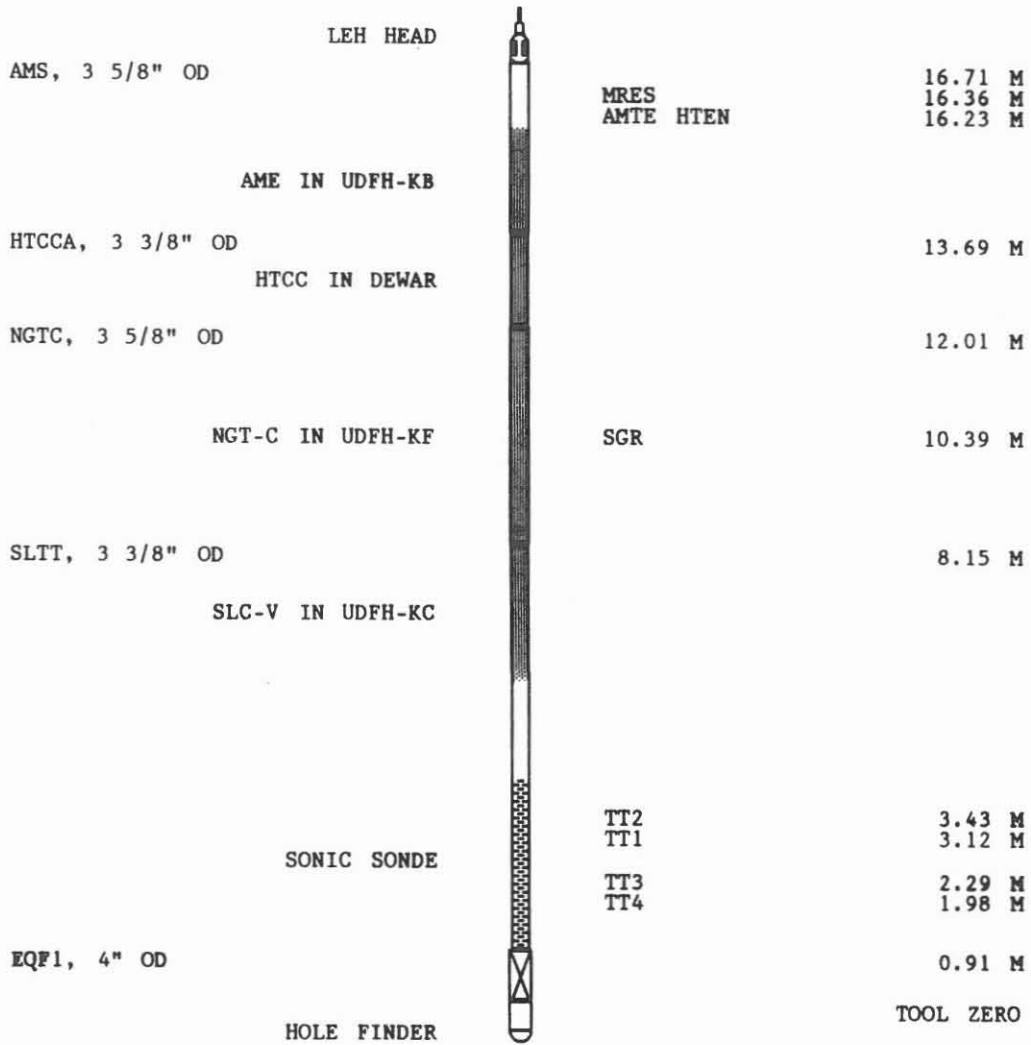
TOTAL TOOL STRING LENGTH IS 13.51 M.
TOTAL TOOL STRING WEIGHT IS 322.1 KG IN AIR.

Fig. 7.17

LOGGING TOOL STRING SKETCH

Schlumberger

Tool Sketch: HSLT-WF/HNGL/HAMS



TOTAL TOOL STRING LENGTH IS 18.44 M.
 TOTAL TOOL STRING WEIGHT IS 400.1 KG IN AIR.

Fig. 7.18

LOGGING TOOL STRING SKETCH

Schlumberger

Tool Sketch: HSLT/HNGL/HAMS

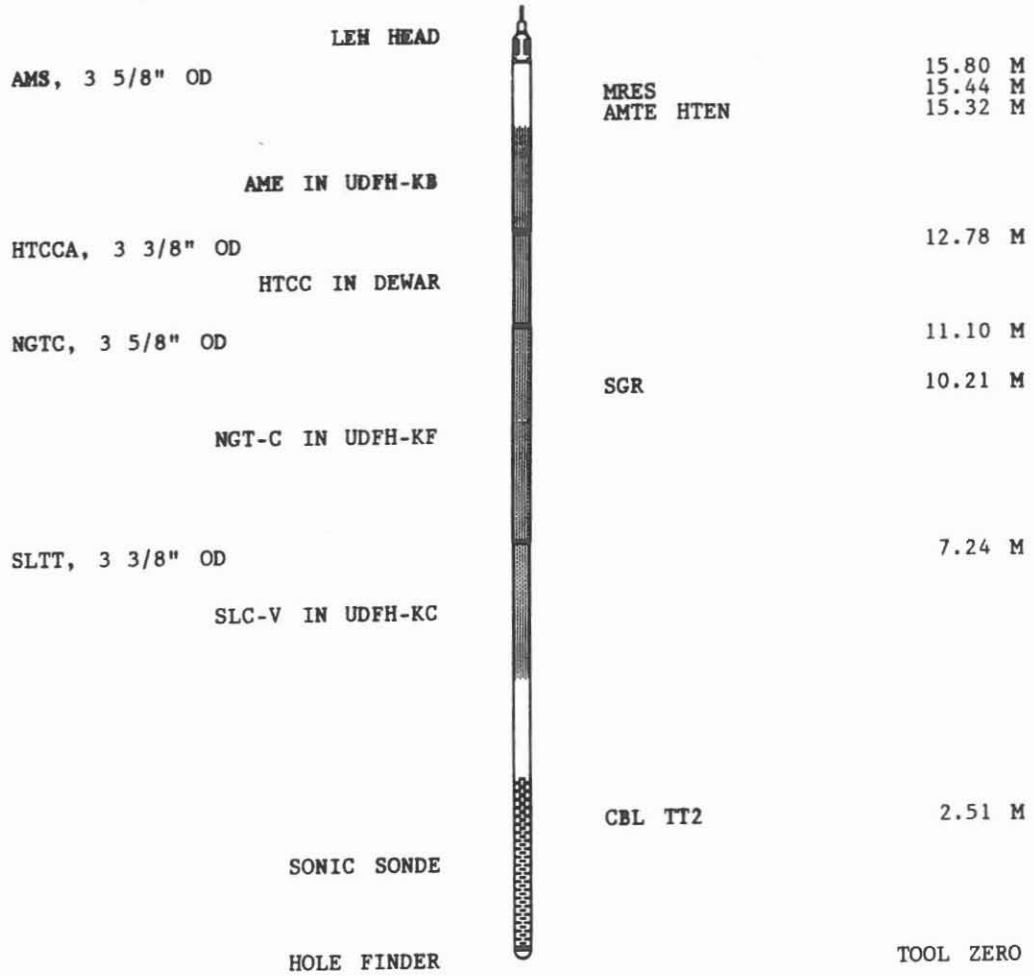


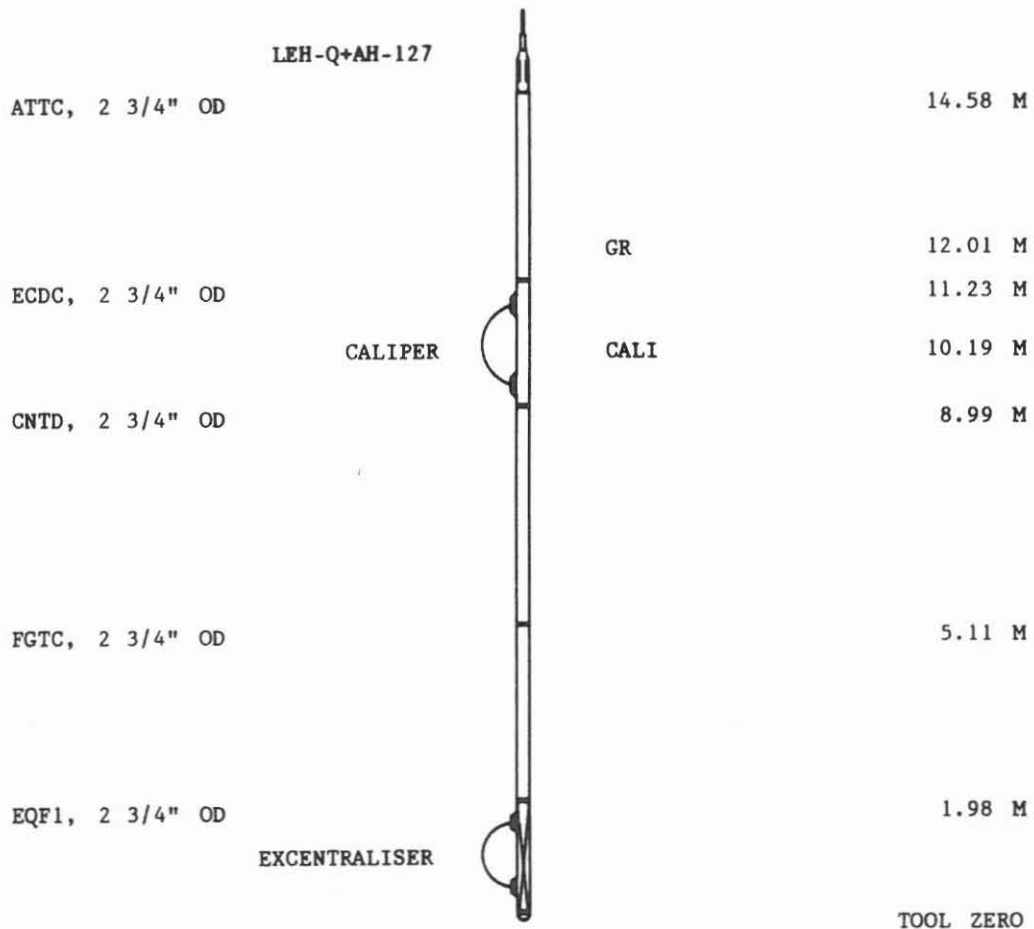
Fig. 7.19

TOTAL TOOL STRING LENGTH IS 16.76 M.
 TOTAL TOOL STRING WEIGHT IS 352.9 KG IN AIR.

LOGGING TOOL STRING SKETCH

Schlumberger

Tool Sketch: HFDC/HCNL/HGR



TOTAL TOOL STRING LENGTH IS 16.05 M.
 TOTAL TOOL STRING WEIGHT IS 285.8 KG IN AIR.

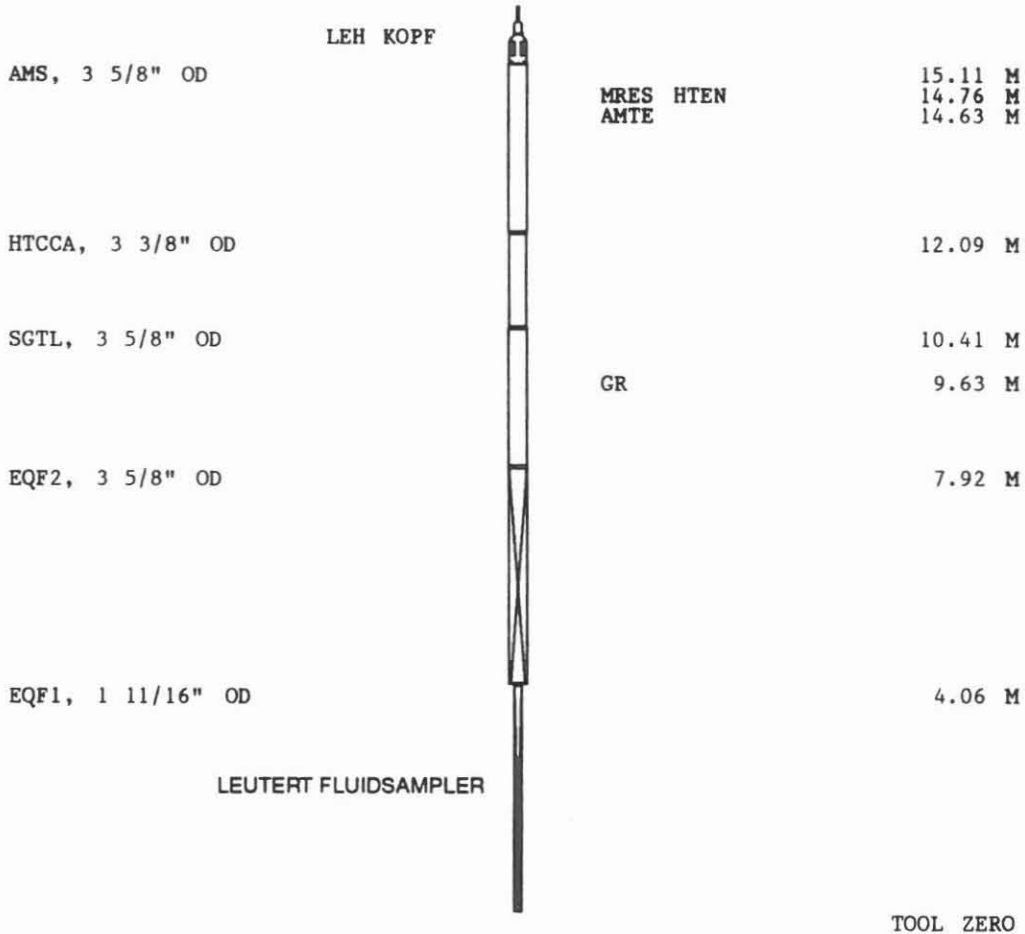
Fig. 7.20

LOGGING TOOL STRING SKETCH

Schlumberger

/ Leutert

Tool Sketch: FS/HGR/HAMS



TOTAL TOOL STRING LENGTH IS 16.13 M.
 TOTAL TOOL STRING WEIGHT IS 263.1 KG IN AIR.

Fig. 7.21

7. Logging Series at the following depth:

7219.5 m (borehole 3)
8108.0 m (borehole 4)
7790.0 m (borehole 5)
8729.7 m (borehole 5)
9101.0 m (borehole 6)

all depths are driller's depths

J. K. Draxler

7. Logging Series at 7219.5 m depth:
(borehole 3)

J. K. Draxler

7. Logging Series at 7219,5 m depth.

The logging operation covers the interval from 7219.5 m to casing depth at 6013.5 m (driller's depth). Due to a side-track at the depth of 6461.5 m the interval from casing shoe to this depth belongs to borehole 2 and down to final logging depth to borehole 3.

The total section was drilled with 12 1/4" (311.2 mm) bit size. Further information about the borehole are given on log heading **Fig. 7.22** enclosed.

The logging operation itself was started on January 28, 1993 with the standard Borehole Geometry Log/Gamma Ray/Temperature/Auxiliary measurement Sonde (BGL/GR/TEMP/AMS). Due to an electronic malfunction the azimuth reading failed after about 50 meters.

After this run the borehole was reconditioned. While reaming the borehole the drilling string was stuck several times, for short periods of time.

On February 2, 1993 the logging operation continued with the Litho-Density Log/Compensated Neutron Log/Natural Gamma Ray Spectrometer/Eccentralised Dual Axis Caliper/Microspherical Focused Log/Auxiliary Measurement Sonde (LDL/CNL/NGL/EDAC/MSFL/AMS). Due to the rather poor borehole caliper the "short axis logging technique" was applied by use of the EDAC tool. This tool rotates the density and neutron sensors into the short axis of the borehole and provides the necessary eccentricity.

The Dipole Shear Sonic Imager was run in combination with the General Purpose Inclinerometer Tool/Borehole Geometry Log/Gamma Ray (DSI/GPIT/BGL/GR). This combination was selected to record the deviation and orientation of the borehole - because it had failed on the attempt on January 28, - and, the orientation data can be used to orient the shear velocities.

Due to the poor borehole conditions the Borehole Televiewer (BHTV) survey performed with the tool from Deutsche Montan Technologie, Bochum, did not bring good results. Uneven tool movements were caused by sticking, overpull and sudden releases.

After this logging run the borehole was reconditioned and cooled again by circulation.

The Dual Laterolog/Borehole Geometry Log/Gamma Ray/Temperature/Auxiliary Measurement Sonde (DLL/BGL/GR/TEMP/AMS) was run on February 7, 1993.

After this log a test with steps of different pressures, applied to the open hole section of the borehole, followed.

To control the borehole a further Borehole Geometry Log in combination with Gamma Ray and with the Temperature/Auxiliary Measurement Sonde (BGL/GR/TEMP/AMS) was recorded.

The recuperation of the temperature was observed by recording three Temperature/Gamma Ray/Auxiliary Measurement surveys (TEMP/GR/AMS) between February 10, and 12, 1993.

When running the drill pipes into the borehole for continuation of the drilling operation the string broke at 655.2 m from surface when at 7195.0 m depth and fell 25 meters to bottom. The fishing operation was successful on the first attempt, but drilling could not be resumed as a large portion of the drilling string was damaged.

A further pressure test and two more temperature logs were made between February 18, and March 2, 1993, providing excellent long time temperature built-up data.

From this logging campaign examples have been selected and are presented.

Schlumberger

HB211 *NGS : RATIOS* 2/2/93



<p>COMPANY: NIEDERSAECHSISCHES LANDESAMT F. BODENFORSCHUNG</p> <p>WELL: KTB-OFF-HB</p> <p>FIELD: OBERPFALZ KREIS : NEUSTADT/WN LAND: BAYERN NATION: BRD LOCATION: NAABDEMENREUTH WINDISCHESCHENBACH</p> <p>LATITUDE: H 55 19 864,35 LONGITUDE: R 45 08 775,24</p> <p>PERMANENT DATUM: ACKERSOHLE ELEVATIONS- ELEV. OF PERM. DATUM: 513.8 M KB: LOG MEASURED FROM: ACKERSOHLE DF: 11.8 M 0.0 M ABOVE PERM. DATUM GL: 513.8 M DRLG. MEASURED FROM: ACKERSOHLE</p> <p>DATE: 2 FEB 1993 RUN NO: HB211</p>	<p>OTHER SERVICES- DSI BHTV(DMT)</p> <p>PROGRAM TAPE NO: 38.2 SERVICE ORDER NO: HB211</p>												
<p>DEPTH-DRILLER: 7219.5 M DEPTH-LOGGER: BTM. LOG INTERVAL: 7135.0 M TOP LOG INTERVAL: 6019.5 M</p> <p>CASING-DRILLER: 3000.0 M 6013.5 M CASING-LOGGER: 3000.5 M 6019.5 M CASING: 16" K55 13-3/8" OPEN HOLE WEIGHT: 72.0000 LB/F BIT SIZE: 17-1/2" 14-3/4" 12-1/4"</p>													
<p>TYPE FLUID IN HOLE: DEHYDRIL DENSITY: 1.06 G/C3 VISCOSITY: 98.0 S PH: 11.2 FLUID LOSS: 8.2 C3 SOURCE OF SAMPLE: UMLAUF RM: .850 OHMM AT 20.0 DEGC RMF: .890 OHMM AT 20.0 DEGC RMC: AT SOURCE RMF/RMC: PRESSE/PRESSE RM AT BHT: .219 OHMM AT 140. DEGC RMF AT BHT: .229 OHMM AT 140. DEGC RMC AT BHT: AT 140. DEGC</p> <p>TIME CIRC. STOPPED: 20:15 01 FEB 93 TIME LOGGER ON BTM.: 17:23 02 FEB 93</p> <p>MAX. REC. TEMP: 140.0 DEGC</p> <p>LOGGING UNIT NO: 701 LOGGING UNIT LOC: KTB RECORDED BY: KUEHR WITNESSED BY: DRAXLER</p>													
<p>REMARKS:</p> <p>MESSUNG MIT "SHORT AXIS" TECHN. DURCHGEFUERT (EDAC +EME-DA) BOHRLOCH STARK AUSGEBROCHEN. UND OVAL MEHRERE WIEDERHOLUNGEN AUSGEFUERT UM KURZE BOHRLOCHACHSE ZU VERMESSEN. SPUELUNGSZAUFZEITEN 98/157 SEC. CHLORIDE IN SPUELUNG :620 PPM WIEDERHOLUNGSFILES 129, 130,131 : MSFL KALIBER GESCHLOSSEN. ES WURDE IN DIESE KOMBINATION GEFAHREN: *MSFL-LDL-CNL-NGS-EDAC-AMS*</p>													
<p>EQUIPMENT NUMBERS-</p> <table border="0"> <tr> <td>TCM-AB 449</td> <td>TCC-B 001</td> <td>CNC-GA 74</td> <td>SRE-D 1905</td> </tr> <tr> <td>DRS-C 6794</td> <td>AMM-AA 906</td> <td>NSC-E 3720</td> <td>PGD-GB 702</td> </tr> <tr> <td>NGD-B 867</td> <td>NGC-C 2759</td> <td>GSR-JJ 815</td> <td>NSR-F 628</td> </tr> </table>		TCM-AB 449	TCC-B 001	CNC-GA 74	SRE-D 1905	DRS-C 6794	AMM-AA 906	NSC-E 3720	PGD-GB 702	NGD-B 867	NGC-C 2759	GSR-JJ 815	NSR-F 628
TCM-AB 449	TCC-B 001	CNC-GA 74	SRE-D 1905										
DRS-C 6794	AMM-AA 906	NSC-E 3720	PGD-GB 702										
NGD-B 867	NGC-C 2759	GSR-JJ 815	NSR-F 628										

Fig. 7.22

BGL/GPIT/GR/AMS (Borehole Geometry Log/General Purpose Inclinerometer Tool/Gamma Ray/Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0210	28.01.1993	5918.0 - 7225.0 m

Example: Section of log: 6968.0 - 7039.0 m, **Fig. 7.23**

Purpose for log:

Deviation, orientation and caliper control of the borehole. Measurements of borehole temperature and mud resistivity.

Operation:

The temperature and mud resistivity (salinity) are recorded going "in" the borehole. After reaching bottom the caliper arms are opened and the reading of the caliper-, deviation- and orientation sensors are recorded in addition to the other parameters coming "out" the borehole.

Depth scales: 1/1000 and 1/200; logging speed: 9 m/min.

Technical information:

This combination tool consists of the KTB four-arm caliper with pendulum deviation and compass orientation systems (BGL), the Schlumberger General Purpose Inclinerometer Tool (GPIT), with magnetometers and inclinometers, the KTB Gamma Ray (GR), mud resistivity, temperature and head tension sensors (AMS). The combination was run to correlate the response of both orientation and deviation systems.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Temperature AMS-Sensor	(DEGC)
AZIM	Azimuth	(DEG)
BS	Bit size	(MM)
C1	Caliper 1-3	(MM)
C2	Caliper 2-4	(MM)
DEVI	Deviation	(DEG)
GDV	Deviation (GPIT)	(DEG)
GHAZ	Azimuth (GPIT)	(DEG)
GP1A	Pad 1 Azimuth (GPIT)	(DEG)
GR	Gamma Ray	(GAPI)
GRB	Relative Bearing (GPIT)	(DEG)
HTEN	Head Tension	(LBF)
MRES	Mud Resistivity	(OHMM)
P1AZ	Pad 1 Azimuth	(DEG)
RB	Relative Bearing	(DEG)

TENS(LBF)	2000.0	12000.	GHZ(DEG)	-40.00	380.00	GPB(DEG)	-40.00	380.00
BS(MM)	0.0	1000.0	AZIM(DEG)	-40.00	380.00	RB(DEG)	-40.00	380.00
DEVI(DEG)	-1.000	4.0000	GR(GAP)	0.0	150.00	HTEN(LBF)	500.00	1500.0
C2(MM)	0.0	1000.0	GP1A(DEG)	-40.00	380.00	AMTE(DEGC)	0.0	5.0000
C1(MM)	0.0	1000.0	P1AZ(DEG)	-40.00	380.00	MRES(OHMM)	05000	15000
GDEV(DEG)	-1.000	4.0000				AMTE(DEGC)	100.00	200.00

Schlumberger /KTB

BGL/GPIT/GR/AMS

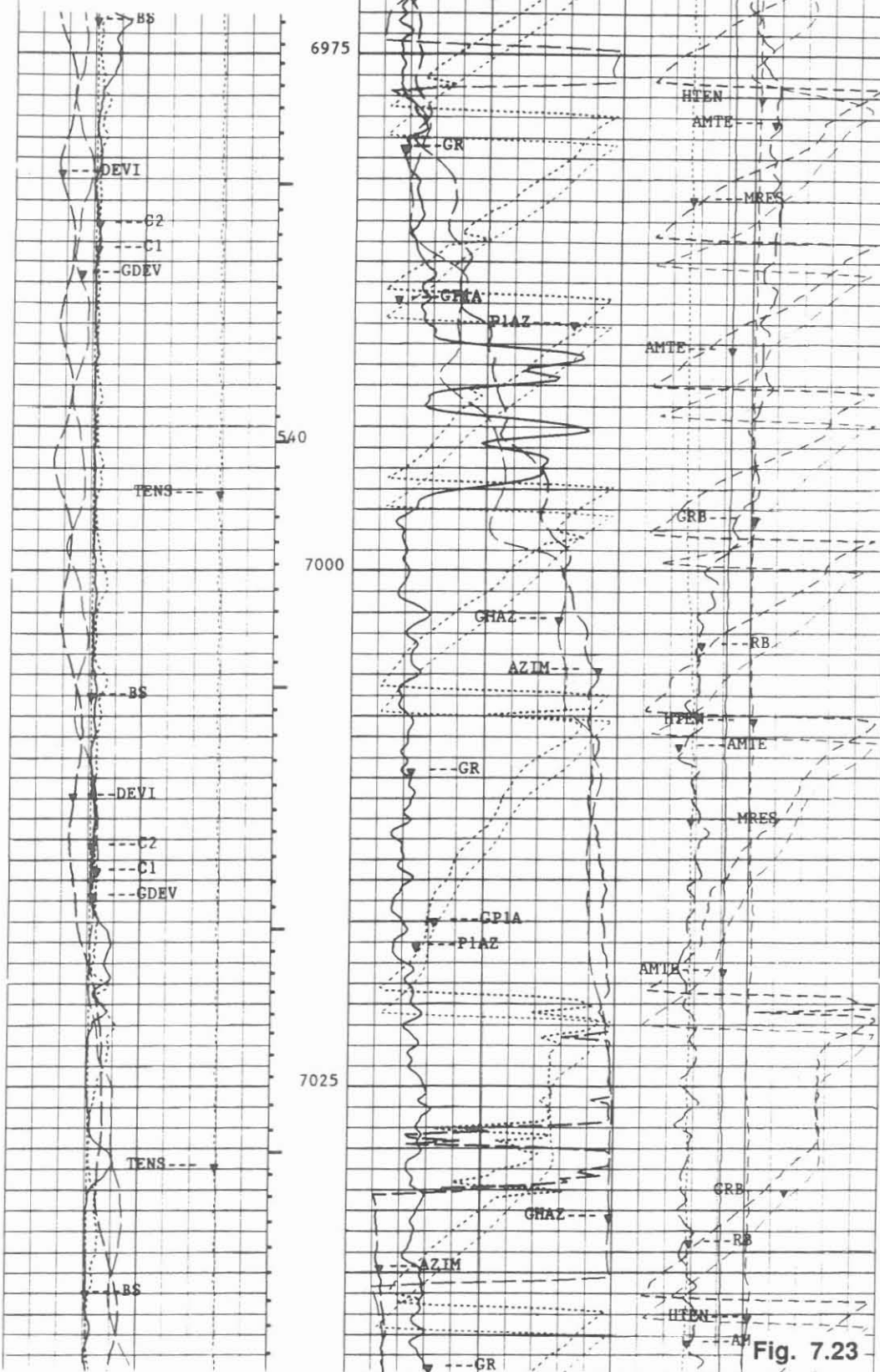


Fig. 7.23

LDL/CNL/NGL/EDAC/MSFL/AMS (Litho-Density Log/Compensated Neutron Log/Natural Gamma Spectrometer Log/Eccentralized Dual Axis Caliper/Microspherical Focused Log/Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0211	02.02.1994	6017.0 - 7154.0 m

Example: Section of log: 6932.0 - 7002.0 m, **Fig. 7.24**

Purpose of log:

This combination logging tool is deployed for the first time at KTB to obtain information on porosity, lithology, micro-resistivity and borehole trajectory. Two methods are used to measure porosity indirectly: bulk density and hydrogen index measured by neutron activation. Density, Neutron and Gamma Spectrometer respond to lithology. With the Micro-Resistivity measurement fractures or mineralized zones can be detected.

Operation:

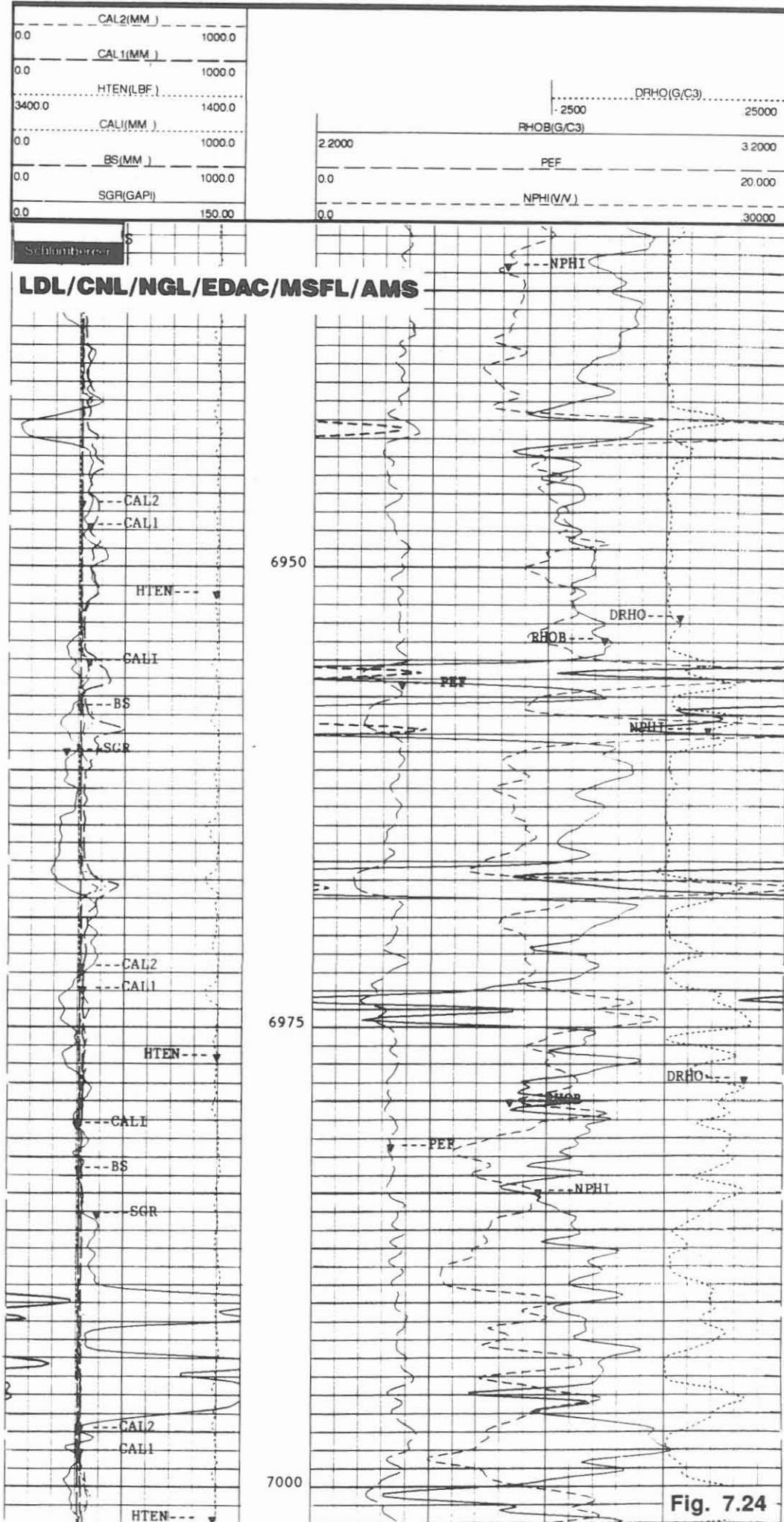
This combination tool has to be run eccentralized. The caliper arm of the density and an eccentralizer for the neutron is normally used. For this operation the "short axis logging technique" (EDAC) was applied. With this technique the sensors from the density, neutron and MSFL tools are forced to travel along the short axis of the ovalized borehole. The EDAC is supporting the "short axis logging". At the same time a 4-arm caliper is recorded. The MSFL was included to profit from the "short axis system". Data quality is increased significantly this way. In sections with circular washouts the data is strongly influenced and needs to be corrected. The example demonstrates this over the interval from 6955.0 - 6975.0 m. Depth scale: 1/200, 1/1000; logging speed: 6 m/min.

Technical information:

This is a nuclear logging string, it means chemical nuclear sources are used to activate the formation. For the density measurement a cesium-source is needed for gamma activation, while an americium-beryllium-source is used for neutron activation. The scale of the density and neutron record is different from sediments. The density is scaled from 2.20 to 3.20 g/cm³ and the neutron from 0.0 to 30 % (3000 V/V). The high neutron response is not due to porosity but is a clear indication of neutron absorbing minerals in the formation. Sampling rate: 6".

Mnemonics:

Mnemonics	Description	Units
BS	Bit Size	(MM)
CAL1	Caliper 1-3	(MM)
CAL2	Caliper 2-4	(MM)
DRHO	Density Correction	(G/C3)
HTEN	Head Tension	(LBF)
NPFI	Neutron Porosity	(V/V)
PEF	Photoelectric Factor	(B/E)
RHOB	Bulk Density	(G/C3)
SGR	Total Gamma Ray	(GAPI)



NGL-Spec. (Natural Gamma Spectrometer - Special Presentation)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0211	02.02.1993	6017.0 - 7154.0 m
(in combination with LDL/CNL/NGL/EDAC/MSFL/AMS)		

Example: Section of log: 6660.0 - 6730.0 m, **Fig. 7.25**

Purpose of log:

The registration of the natural gamma ray spectra is to resolve the total spectra into the three most common components of naturally occurring radiation: uranium, thorium and potassium. With the measurement of these three elements information about the mineral content of the formation can be obtained. Additional application of the log is in lithology evaluation, fracture detection, special radioactive mineral detection and heat generation due to radioactive decay.

Operation:

The log was recorded in above mentioned combinations. Final depth could not be reached due to adverse borehole conditions. It was run eccentralized for better response in the borehole of 12 1/4" bit size. The log records in track I the total gamma ray spectra (SGR) and the gamma ray minus the uranium component (CGR), a caliper curve (CALI) and the head tension (HTEN). In track II and track III are the single component curves presented.

Depth scale: 1/1000, 1/200; logging speed: 7 m/min.

Technical information:

A five-window spectroscopy analysing system is used to resolve for uranium, thorium and potassium content. As the results have large statistical variations Kalmann - filtering is applied. The single components are recorded. In addition the total spectra minus uranium is computed.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
CALI	Caliper	(MM)
CGR	Computed Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
POTA	Potassium Content	(%)
SGR	Spectroscopy Gamma Ray	(GAPI)
THOR	Thorium Content	(PPM)
URAN	Uranium Content	(PPM)

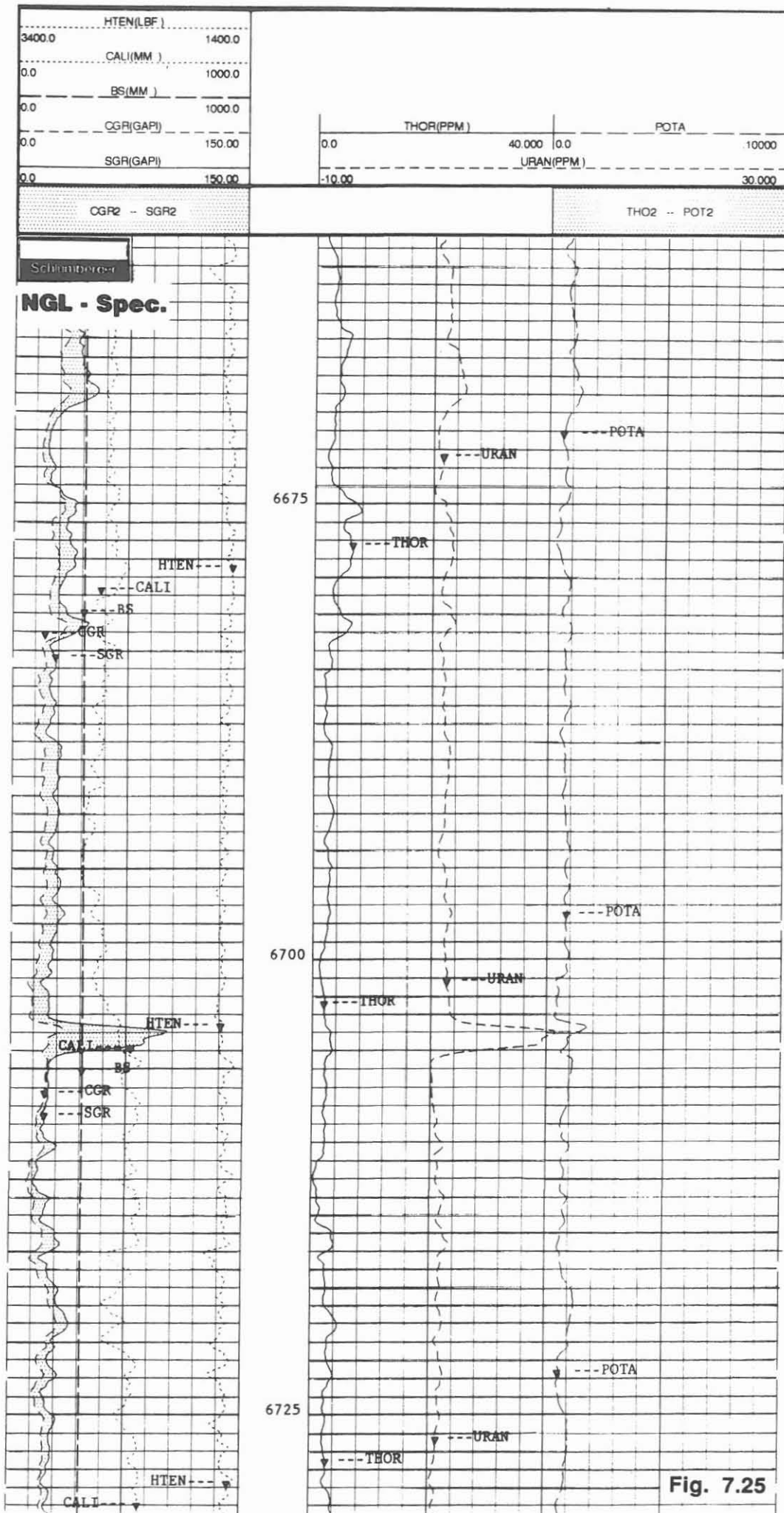


Fig. 7.25

NGL-Ratio (Natural Gamma Spectrometer - Ratio Presentation)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0211	02.02.1993	6017.0 - 7154.0 m (in combination with LDL/CNL/NGL/EDAC/MSFL/AMS)

Example: Section of log: 6605.0 - 6675.0 m, **Fig. 7.26**

Purpose of log:

The registration of the natural gamma ray spectra is to resolve the total spectra into the three most common components of naturally occurring radiation: uranium, thorium and potassium. With the measurement of these three elements information about the mineral content of the formation can be obtained. Additional application of the log is in lithology evaluation, fracture detection, special radioactive mineral detection and heat generation due to radioactive decay.

Operation:

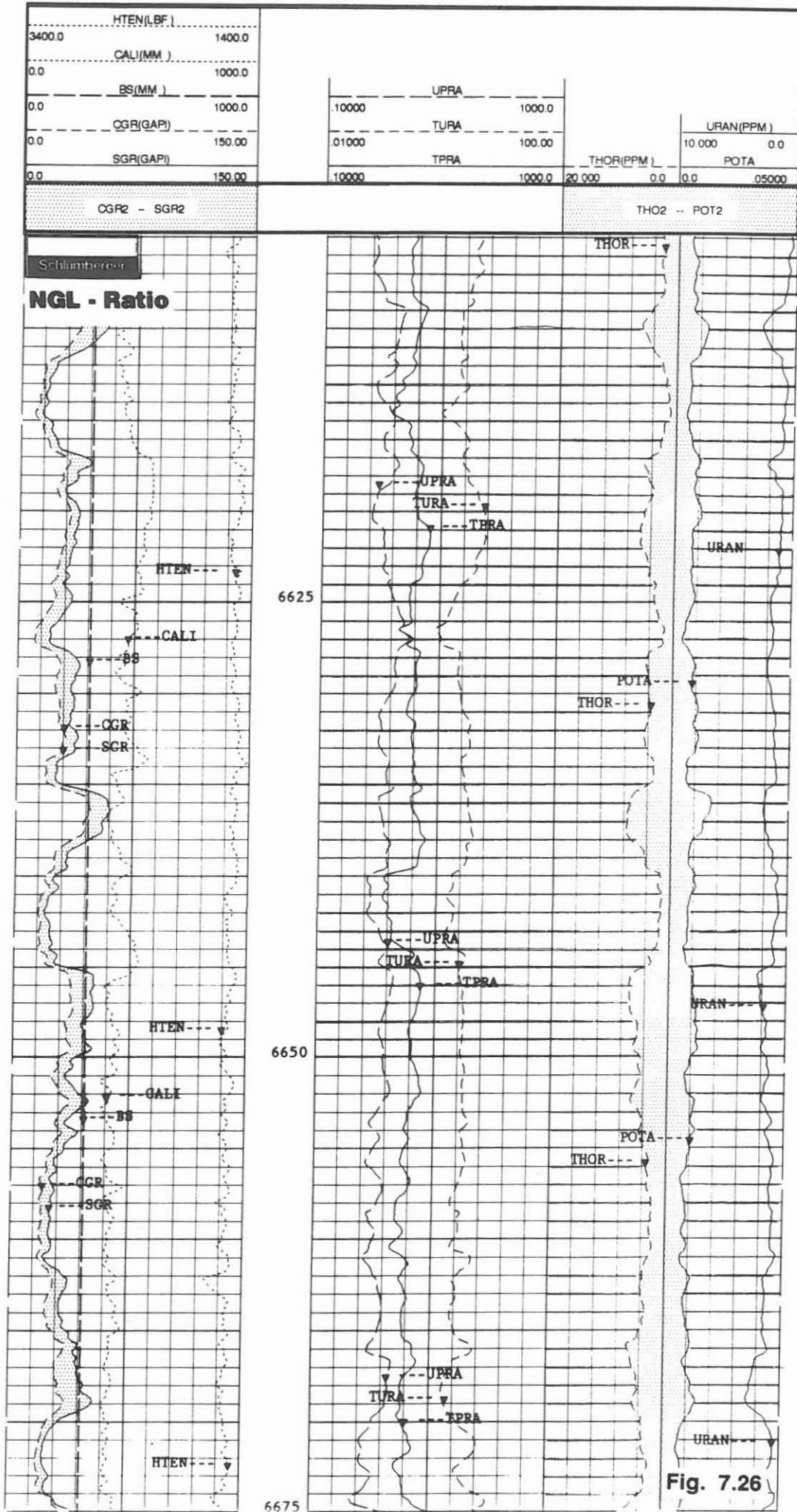
The log was recorded in above mentioned combination. Final depth of 7219.5 m could not be reached due to adverse borehole conditions. It was run eccentricized for better response in the borehole of 12 1/4" bit size. The log records in track I the total gamma ray spectra (SGR) and the gamma ray minus the uranium component (CGR), a caliper curve (CALI) and the head tension (HTEN). In track II are the ratios and in track III the single component curves presented. Depth scale: 1/1000, 1/200; logging speed: 7 m/min.

Technical information:

A five-window spectroscopy analysing system is used to resolve for uranium, thorium and potassium content. As the results have large statistical variations Kalmann - filtering is applied. The single components are used to compute the ratios. Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
CALI	Caliper	(MM)
CGR	Computed Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
POTA	Potassium Content	(%)
SGR	Spectroscopy Gamma Ray	(GAPI)
THOR	Thorium Content	(PPM)
TPRA	Thorium:Potassium Ratio	
TURA	Thorium:Uranium Ratio	
UPRA	Uranium:Potassium Ratio	
URAN	Uranium Content	(PPM)



MSFL/GR/CAL/AMS (Microspherical Focused Log/Gamma Ray/ Caliper/Auxiliary Measurement Sonde in combination with LDL/CNL/NGL/EDAC/MSFL/AMS)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0211	02.02.1994	6017.0 - 7154.0 m

Example: Section of log: 6483.0 - 6549.0 m, **Fig. 7.27**

Purpose of log:

The Microspherical Focused Log provides information on low resistivity zones, with a very high vertical resolution. Fractures filled with mud or zones of high conductive mineralisation, like graphite or pyrite, can be detected.

Operation:

The log was run in above mentioned combination taking advantage of the "short axis logging system" available through the EDAC sonde. This improved the logging results considerably

Depth scale: 1/1000, 1/200, logging speed: 7 m/min.

Technical information:

The MSFL is the well-known standard Micro-Resistivity tool. The other parameters, like SGR came from the NGL, CAL1,2 from the EDAC and HTENS, MRES, MTEM from the AMS. Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
BS	Bit size	(MM)
CAL1	Caliper 1-3	(MM)
CAL2	Caliper 2-4	(MM)
CALS	Micro-Resistivity Caliper	(MM)
HTEN	Head tension	(LBF)
MRES	Mud resistivity	(OHMM)
MSFL	Microspherical Focused Resistivity	(OHMM)
MTEM	Mud temperature	(DEG)

DSI/GPIT/BGL/GR/AMS (Dipole Shear Sonic Imager/General Purpose Inclinator Tool/Borehole Geometry Log/Gamma Ray/Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0212	03.02.1993	6019.0 - 7162.0 m

Examples:

List of Mnemonics and Units,	Fig. 7.28
Sections of logs: BHC Sonic Plot 6300.0-6670.0 m,	Fig. 7.29
DT-P-S-Stoneley 6438.0-6498.0 m,	Fig. 7.30
P-FMD 6952.0-7025.0 m,	Fig. 7.31
P&S Mode-STC 6453.0-6508.0 m,	Fig. 7.32
P&S Mode-VDL 6953.0-7032.0 m,	Fig. 7.33
Stoneley-STC 6426.0-6492.0 m,	Fig. 7.34
Stoneley-VDL 6940.0-7016.0 m,	Fig. 7.35
Lower Dipole-STC 6442.0-6505.0 m,	Fig. 7.36
Lower Dipole-VDL 6952.0-7028.0 m,	Fig. 7.37
Upper Dipole-STC 6423.0-6486.0 m,	Fig. 7.38
Upper Dipole-VDL 6955.0-7030.0 m,	Fig. 7.39
U. Dip. -P,S,St. 6980.0-7034.0 m,	Fig. 7.40
Dev.Azi.MRes.Tmp 6490.0-6840.0 m,	Fig. 7.41

Purpose of log:

With this tool the acoustic properties of formations are measured. Velocity correlation with seismic profiles in compressional and shear mode are possible. The velocities are determined using acoustic waveform measurements and slowness-time-coherence computations. The slownesses (inverse of velocities) have geophysical, petrophysical and rock mechanical applications like porosity estimation, fracture detection and wellbore stability calculations.

Operation:

Due to adverse borehole conditions final depth at 7219.5 m could not be reached. The log was recorded from 7162.0 m.

The tool combination requires the MAXIS 500 surface recording unit. For this operation the following recording modes have been logged in one single run in the borehole: First motion detection, P&S mode, upper and lower dipole and Stoneley mode.

The GPIT was run in combination to orient the dipole measurements. This could provide information about anisotropy and breakout orientation.

Depth scale: 1/200; logging speed: 1,5 m/min.

Technical information:

The Dipole Shear Sonic Imager (DSI) combines Mono- and Dipole measurement systems (for full description of the tool see KTB-Report 92-1, Chapter 9: New Tools). It enhances the measurements of compressional, shear and Stoneley waveforms

in all types of formations. The tool itself consists of a transmitter section housing one monopole and two dipole transducers. The dipole transducers are mounted perpendicular to each other. The monopole transducer operates at high frequency for compressional and shear wave propagation and at low frequency for Stoneley waves. Low frequency is used for the dipole transducers to create shear waves (for frequencies, - see below)

The receiver section consists of 8 receiver stations. Each receiver station contains two hydrophone pairs, which are mounted in line with the dipole transducers.

The signals received are separated for dipole detection and summed for monopole reception.

The waveform processing is done using the slowness-time-coherence technique (STC). A fixed window of pre-given time length is advanced across the array of waveforms. A coherence function is computed for each step and the similarity of the waveforms is measured. If the waveforms are similar the coherence will be very high. This will mean, that the detection of a specific component of the waveform (compressional, shear, Stoneley) has been possible and the respective slowness has been determined.

The digital first motion detection processing (DFMD) applies a threshold system for analysing waveforms. The time crossings of the first arrivals are selected and the given travel times are used for slowness computations.

The dipole waveform processing is used for true shear slowness detection. Depending on type of formation the detection might be influenced by distortion. Band pass filtering will then be required.

Borehole compensation is achieved by processing receiver array and pseudo-transmitter array waveforms and the average out of these waveforms. This will produce borehole compensated P and S results.

Acoustic bandwidth: 80 Hz - 5 KHz for Stoneley and dipole; 8 KHz - 30 KHz for high frequency monopole.
Sampling rate: 6".

Description of logs:

1. BHC Sonic Plot (Fig. 7.29). This plot is equivalent to the standard Sonic Log. It provides travel time data in borehole compensated registration. The log includes gamma ray data and the travel time integration.

2. DT-P-S & Stoneley (Fig. 7.30). This log gives the following data: DT (compressional) from first motion detection (DFMD); and from P&S computations; DT shear from

P&S, upper and lower dipole computations; and DT-Stoneley. In addition the integration of DT comp., the gamma ray, pad one azimuth, sonde deviation and ratio V_p/V_s is presented.

3. **P-FMD (Fig. 7.31)**. DT-Comp. is made via a threshold crossing dot array plot. All measurements are coming from first motion detection. Transit time and gamma ray are presented.
4. **P&S Mode-STC (Fig. 7.32)**. With the software available in the MAXIS 500 surface unit, first Slowness-Time-Coherence (STC) computations are made. P- and S-travel times for transmitter and receiver modes are computed and presented as colour plot. Gamma Ray, Peak Coherences, Waveform Depth and Waveform Gain are given in track I of the log.
5. **P&S Mode-VDL (Fig. 7.33)**. This log is a presentation as Variable Density Log (VDL). The waveforms are presented over 5000 μ sec in a grey-scale log. Gamma Ray is given in track I.
6. **Stoneley-STC (Fig. 7.34)**. This plot gives the Stoneley travel time computed by the Slowness-Time-Coherence (STC) function in a colour presentation. Information in track I is the same as in Fig. 7.32 - but for Stoneley-wave only
7. **Stoneley-VDL/Fig. 7.35)**. The Variable Density Log (VDL) of the Stoneley-waveforms over 10 000 μ sec shows characteristic "Chevron Pattern". These pattern are typical indications for irregularities of the borehole wall, like for example fractures. Presentation is made in a grey-scale log. Gamma Ray is given in track I.
8. **Lower Dipole-STC (Fig. 7.36)**. The shear wave created by the Lower Dipole is recorded and via the Slowness-Time-Coherence (STC) the shear travel time is computed and presented as colour plot. In track I the information is given as on Fig.7.32 - but for Lower Dipole.
9. **Lower Dipole - VDL (Fig. 7.37)**. Variable Density Log of Lower Dipole waveform presentation in grey-scale.
10. **Upper Dipole - STC (Fig. 7.38)**. Same as Fig. 7.36 - but for Upper Dipole.
11. **Upper Dipole - VDL (Fig. 7.39)**. Same as Fig. 7.37 - but for Upper Dipole.
12. **Upper Dipole - Transmitter-, Receiver- and Average-Log (Fig. 7.40)**. In track I gamma ray and in depth track caliper 1 and 2, sonde deviation and tool orientation are presented.

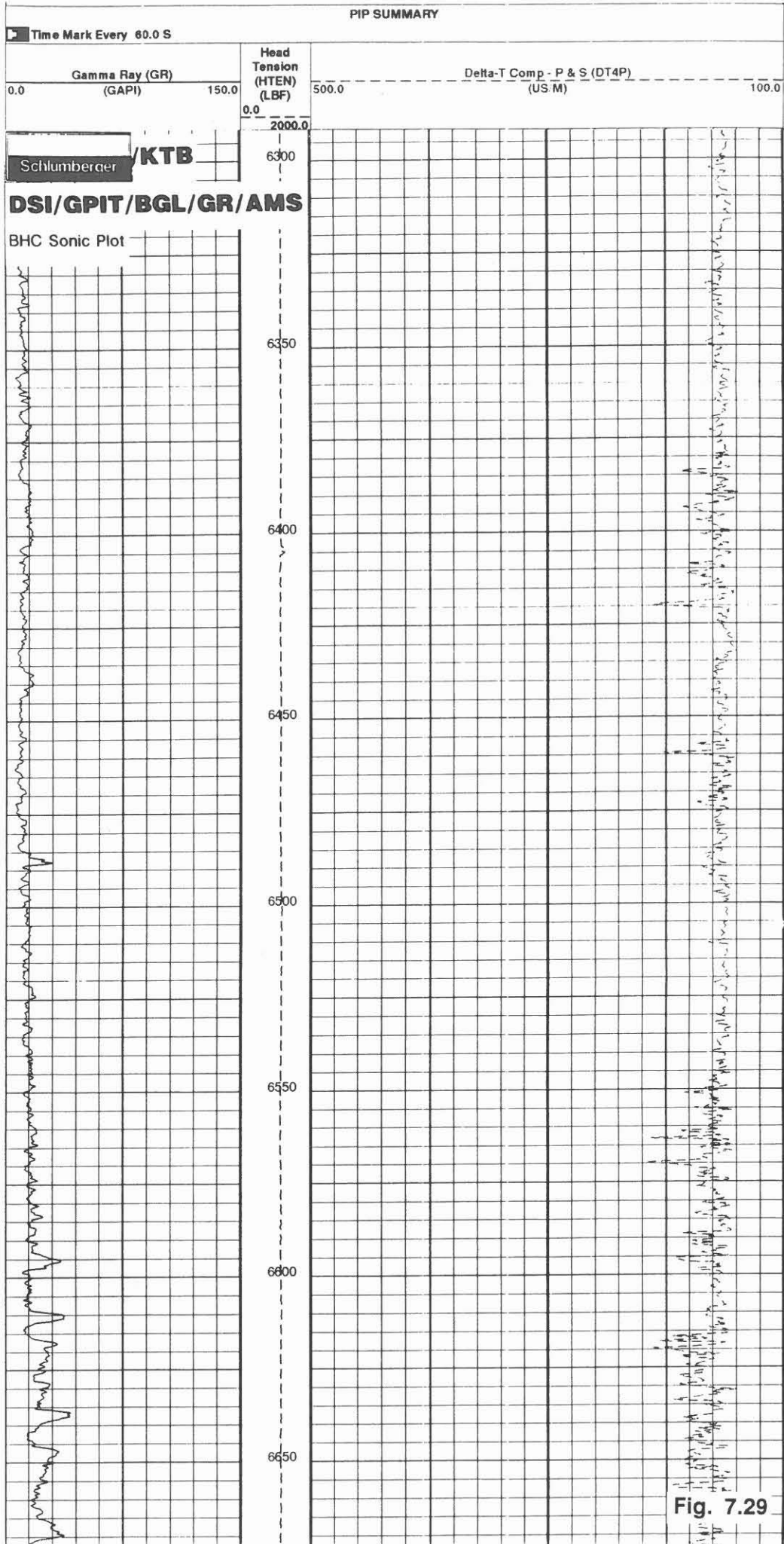
13. **Deviation, Orientation, Gamma Ray, Mud Resistivity and Temperature (Fig. 7.41).** In track I sonde deviation and hole deviation, in track II and III gamma ray, pad 1 azimuth, hole azimuth, mud resistivity and temperature are presented.

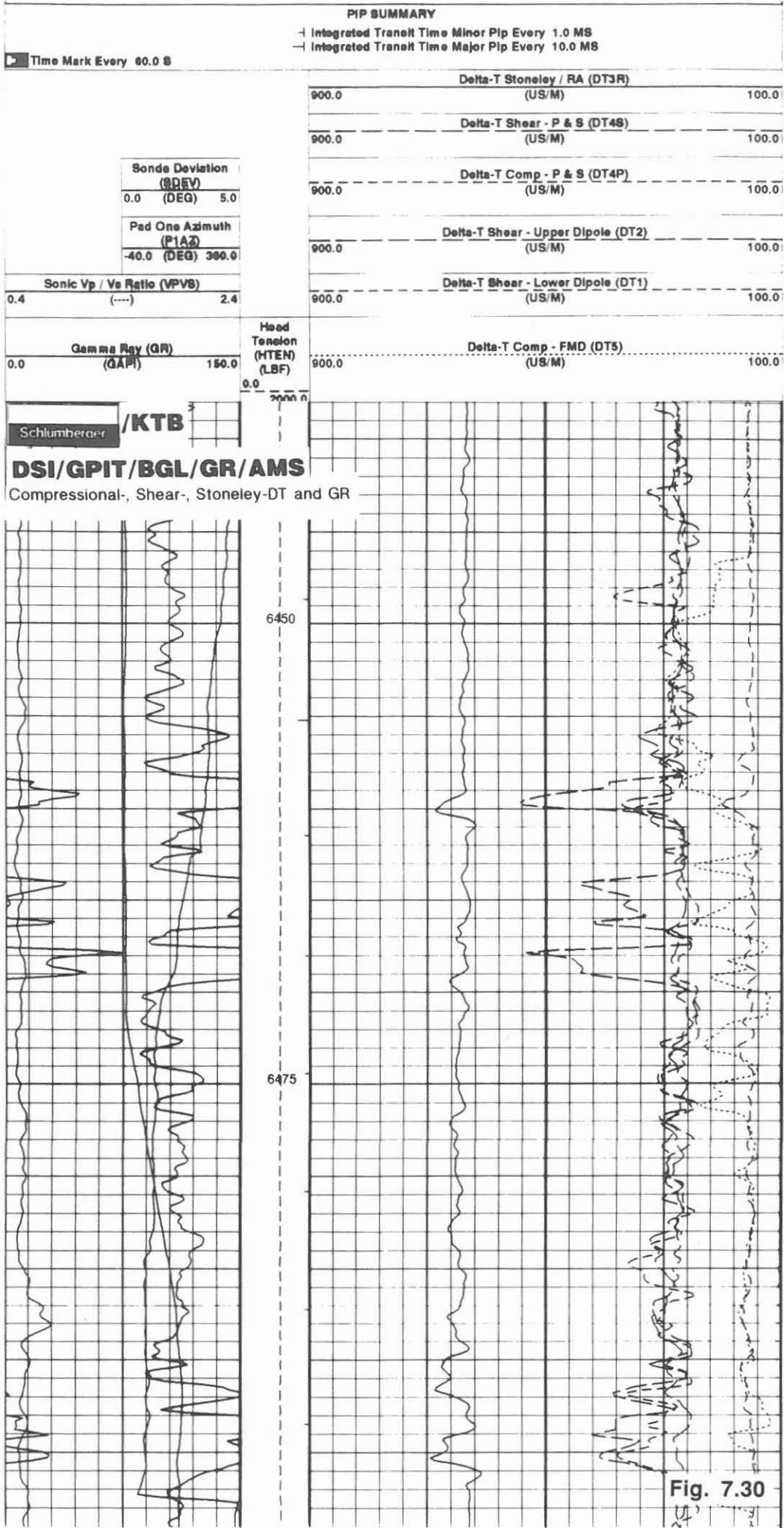
DSI Mnemonics & Units

Parameters

DLIS Name	Description	Value	
ACPP	Accelerometer PROM Presence	PRESENT	
AFMO	Accelerometer Filtering Mode	HAMMING	
ART	Accelerometer Reference Temperature	20	DEGC
BHS	Bore Hole Status	OPEN	
BHT	Bottom Hole Temperature (used in calculations)	155	DEGC
BILI	Bond Index Level for Zone Isolation	0.8	
BS	Bit Size	12.250	IN
BSAL	Borehole Salinity	620.0	PPM
CDTS	C-Delta-T Shale	100	US/F
COLL	Label Slowness Lower Limit - P & S Comp	40	US/F
COUL	Label Slowness Upper Limit - P & S Comp	180	US/F
CSTR	Compressive Strength of Cement	0	KPA
DPPM	Density Porosity Processing Mode	STAN	
DSHL	Label Slowness Lower Limit - Dipole Shear	75	US/F
DSHU	Label Slowness Upper Limit - Dipole Shear	775	US/F
DTCS	Comp Delta-T Source	PS_COMP	
DTF	Delta-T Fluid	189	US/F
DTM	Delta-T Matrix	58	US/F
DTSS	Shear Delta-T Source	UPPER_DIPOLE	
FCF	CBL Fluid Compensation Factor	1	
FMLL	Slowness Lower Limit - FMD	40	US/F
FMUL	Slowness Upper Limit - FMD	180	US/F
GCSE	Generalized Caliper Selection	BS	
GDEV	Average Angular Deviation of Borehole from Normal	1	DEG
GDT1	Gain Delta-T 1	800	US/F
GDT2	Gain Delta-T 2	800	US/F
GDT3	Gain Delta-T 3	800	US/F
GDT4	Gain Delta-T 4	160	US/F
GDT5	Gain Delta-T 5	160	US/F
GDT6	Gain Delta-T 6	160	US/F
GIN1	Gain Interval 1	15360	US
GIN2	Gain Interval 2	15360	US
GIN3	Gain Interval 3	15360	US
GIN4	Gain Interval 4	2560	US
GIN5	Gain Interval 5	2560	US
GIN6	Gain Interval 6	2560	US
GLM	GPIT Logging Mode	DIPM	
GOBO	Good Bond	2	MV
GRSE	Generalized Mud Resistivity Selection	AMS_RESIST	
GTSE	Generalized Temperature Selection	AMS_AVG_TEMP	
ICMO	Inclinometry Computation MOde	OPEN_HOLE	
ITTS	Integrated Transit Time Source	DTCO	
MAI5	Slowness Averaging Interval - FMD	42	IN
MAPP	Magnetometer PROM Presence	PRESENT	
MATR	Rock Matrix Type	SANDSTONE	
MCI	Minimum Cemented Interval	6.60692	M
MDEC	Magnetic Field Declination	0.730946	DEG
MDS5	Multishot Delta - T Scatter - FMD	20	US
M RTE	Magneto Reference Temperature	27	DEGC
MSA	Minimum Sonic Amplitude	2.33265	MV
RSMN	Label Shear/Comp Minimum Ratio - P & S	1.2	
RSMX	Label Shear/Comp Maximum Ratio - P & S	2.12	
RW	Resistivity of Connate Water	1.0000	OHMM
SAM1	Sonic Acquisition Mode 1 (lower dipole)	EVEN	
SAM2	Sonic Acquisition Mode 2 (upper dipole)	ODD	
SAM3	Sonic Acquisition Mode 3 (Stoneley)	EVEN	
SAM4	Sonic Acquisition Mode 4 (p & s)	EVEN	
SAM5	Sonic Acquisition Mode 5 (FMD)	EVEN	
SAM6	Sonic Acquisition Mode 6 (SFMD)	OFF	
SAMX	Sonic Acquisition Mode X (expert)	OFF	
SAS5	Sonic Array Status - FMD	255	
SFC1	Sonic Formation Character - Lower Dipole	SELECTABLE	
SFC2	Sonic formation Character - Upper Dipole	SELECTABLE	
SFC3	Sonic formation Character - Stoneley	SELECTABLE	
SFC4	Sonic formation Character - P & S	SELECTABLE	
SHLL	Label Slowness Lower Limit - P & S Shear	75	US/F
SHT	Surface Hole Temperature	-15	DEGC
SHUL	Label Slowness Upper Limit - P & S Shear	160	US/F
SLL1	STC Slowness Lower Limit - Lower Dipole	60.96	US/F
SLL2	STC Slowness Lower Limit - Upper Dipole	60.96	US/F
SLL3	STC Slowness Lower Limit - Stoneley	152.4	US/F
SLL4	STC Slowness Lower Limit - P & S	30.48	US/F
SPFS	Sonic Porosity Formula	RAYMER_HUNT	
SPSO	Sonic Porosity Source	DTCO	
STLL	Label Slowness Lower Limit - Stoneley	180	US/F
STUL	Label Slowness Upper Limit - Stoneley	780	US/F
SUL1	STC Slowness Upper Limit - Lower Dipole	518.16	US/F
SUL2	STC Slowness Upper Limit - Upper Dipole	518.16	US/F
SUL3	STC Slowness Upper Limit - Stoneley	762	US/F
SUL4	STC Slowness Upper Limit - P & S	182.88	US/F
TD	Total Depth	7171	M
TEMS	GPIT Temperature Sensor Used	BOTH	
TLCK	TLC Kit	OFF	
TWS	Temperature of Connate Water Sample	37.8	DEGC
WFM1	Waveform Mode 1	W1	
WFM2	Waveform Mode 2	W1	
WFM3	Waveform Mode 3	W1	
WFM4	Waveform Mode 4	W1	
WFMX	Waveform Mode X	W1	

Fig. 7.28





PIP SUMMARY

Time Mark Every 60.0 S

Transit Time-SAM5 (FTT5) (US) 0.0 2000.0

Gamma Ray (GR) (GAPI) 0.0 150.0
Head Tension (HTEN) (N) 0.0 2000.0
Threshold Crossing Dot Array (FTCS[0]) (US) 0.0 2000.0

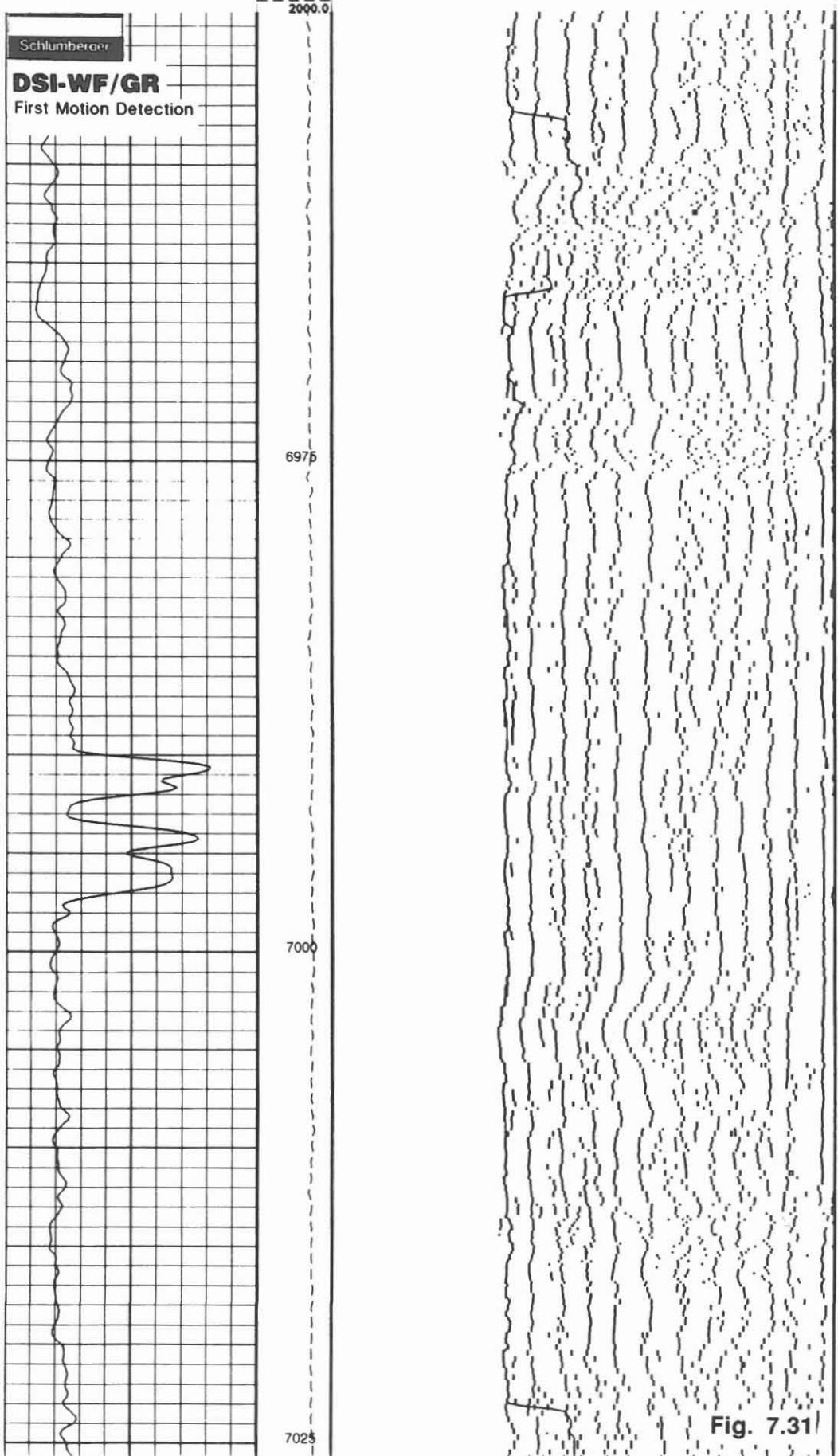


Fig. 7.31

PIP SUMMARY

Time Mark Every 60.0 S

Peak Coherence / TA - P & S Shear (CHTS)	-1.0	(----	9.0
Peak Coherence / RA - P & S Shear (CHRS)	-1.0	(----	9.0
Peak Coherence / TA - P & S Comp (CHTP)	0.0	(----	10.0
Peak Coherence / RA - P & S Comp (CHRP)	0.0	(----	10.0
Gamma Ray (GR) (GAPI)	0.0		150.0
SAM4 Waveform Depth (WFD4) (M)	0.0		25.0
SAM4 Waveform Gain (WFG4) (DB)	0.0		60.0
Delta Depth - SAM4 (DTD4) (M)	-2.0		2.0

Head Tension (HTEN) (N)
0.0
2000.0

		Min	Amplitude	Max
Rec.Array P&S Slow Proj. CVDL (SPR4)				
		100.0	(US/M)	600.0
Delta-T Shear - P & S (DT4S)	(US/M)	100.0	100.0	600.0
Delta-T Comp - P & S (DT4P)	(US/M)	100.0	100.0	600.0
Delta-T Shear / TA - P & S (DTTS)	(US/M)	100.0	100.0	600.0
Delta-T Shear / RA - P & S (DTRS)	(US/M)	100.0	100.0	600.0
Delta-T Comp / TA - P & S (DTTP)	(US/M)	100.0	100.0	600.0
Delta-T Comp / RA - P & S (DTRP)	(US/M)	100.0	100.0	600.0

Schlumberger /KTB

DSI/GPIT/BGL/GR/AMS

P & S Mode - STC

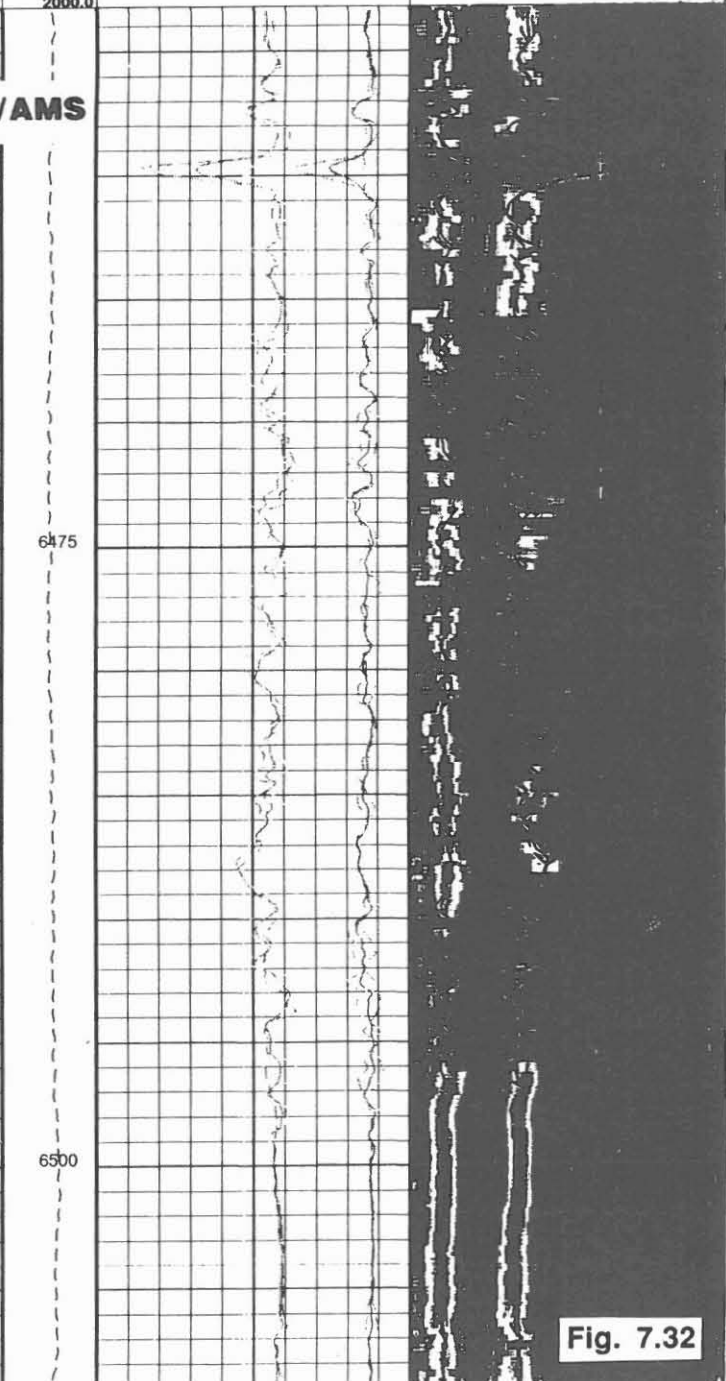
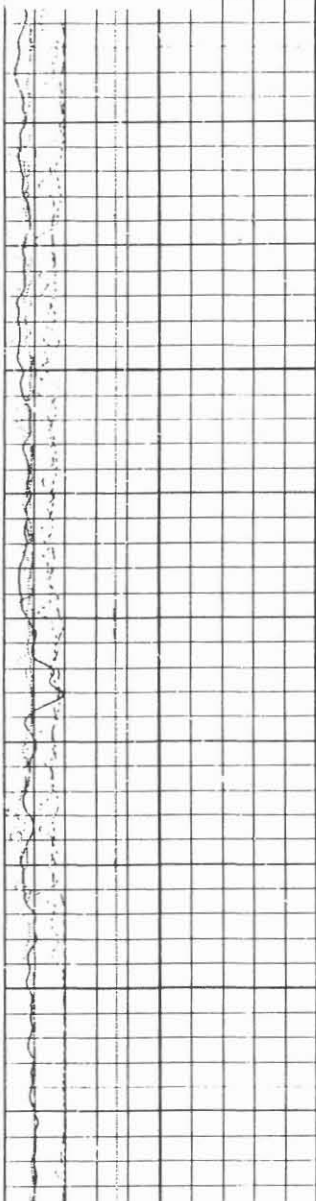


Fig. 7.32

PIP SUMMARY

Time Mark Every 60.0 S

Gamma Ray (GR)
(GAPI) 0.0 150.0

Head
Tension
(HTEN)
(N) 0.0 2000.0

Min Amplitude Max
SAM4 Waveforms VDL (WF4)
(US) 0.0 5000.0

Schlumberger

DSI-WF/GR
Compressional- and Shear-Wave

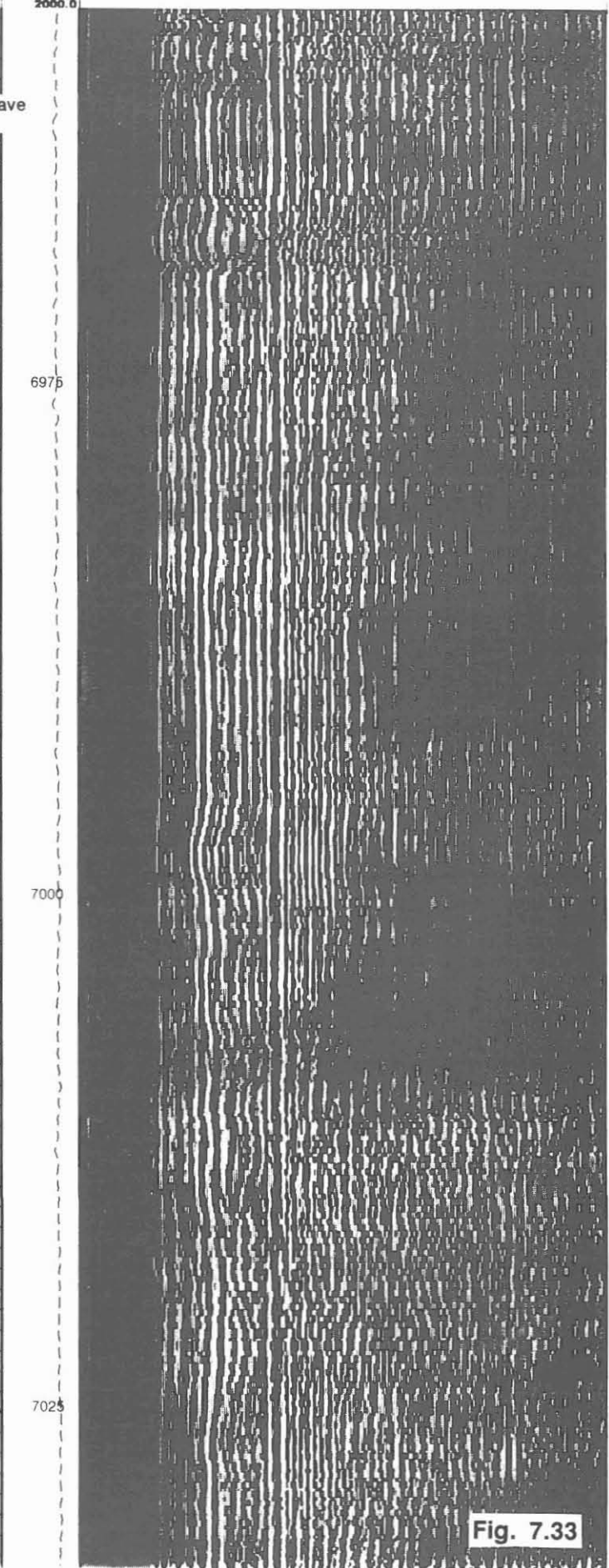
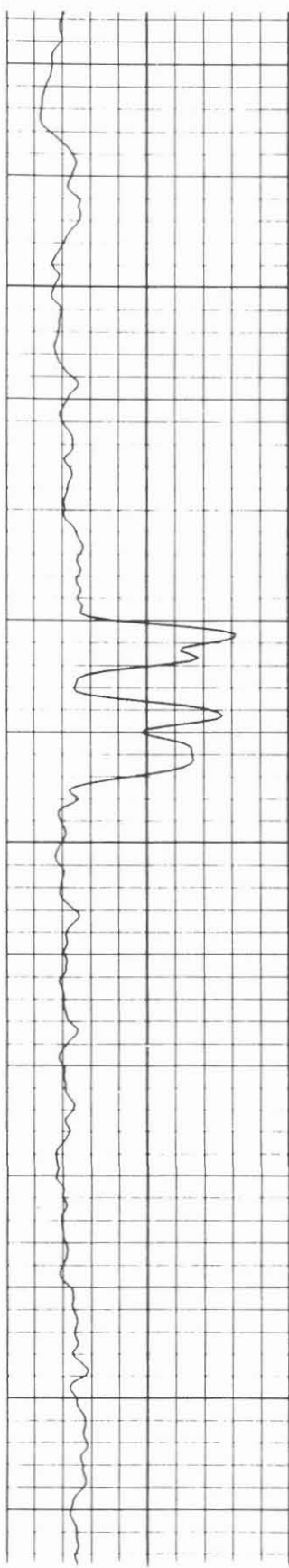
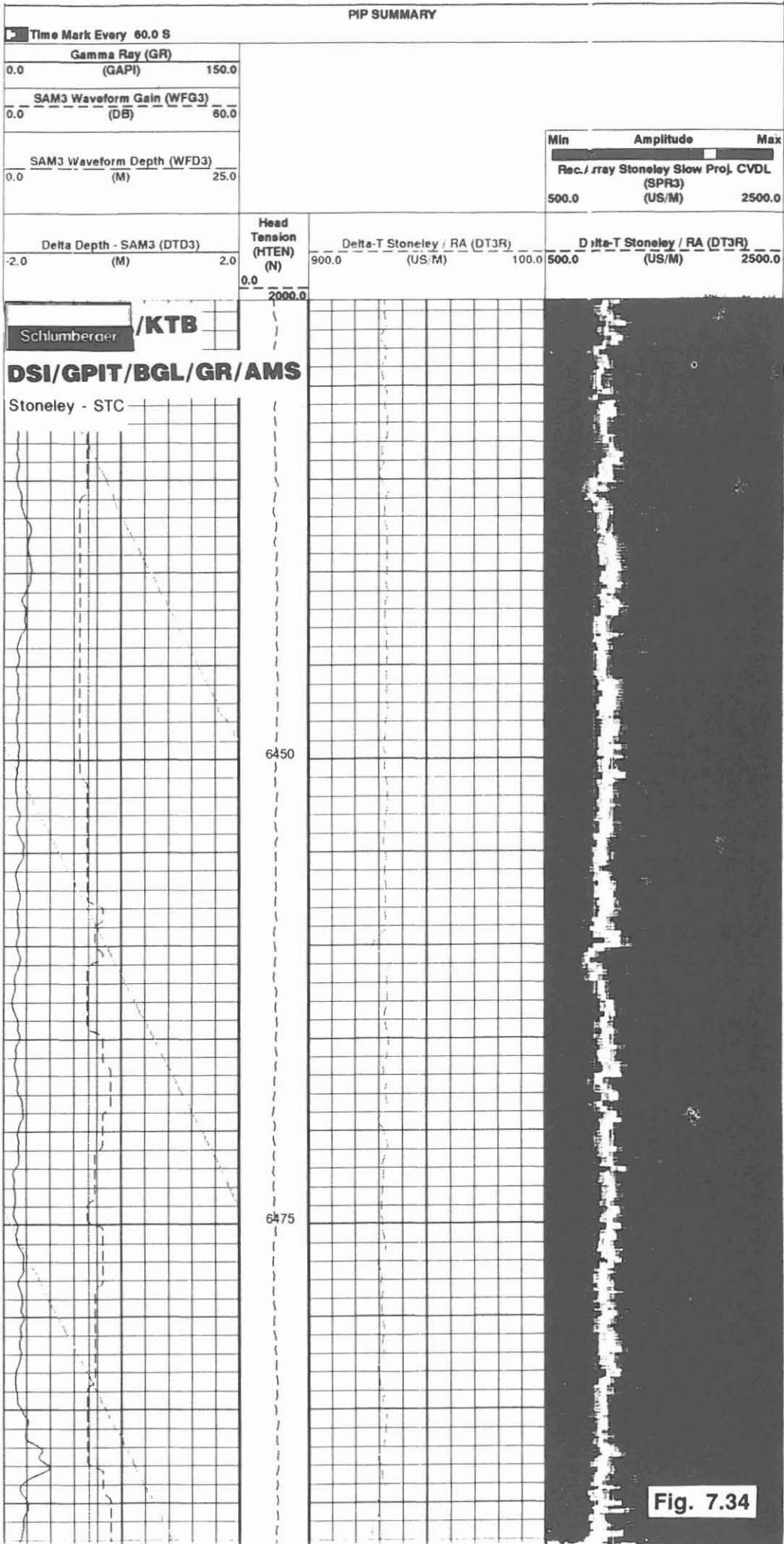


Fig. 7.33



PIP SUMMARY

Time Mark Every 60.0 S

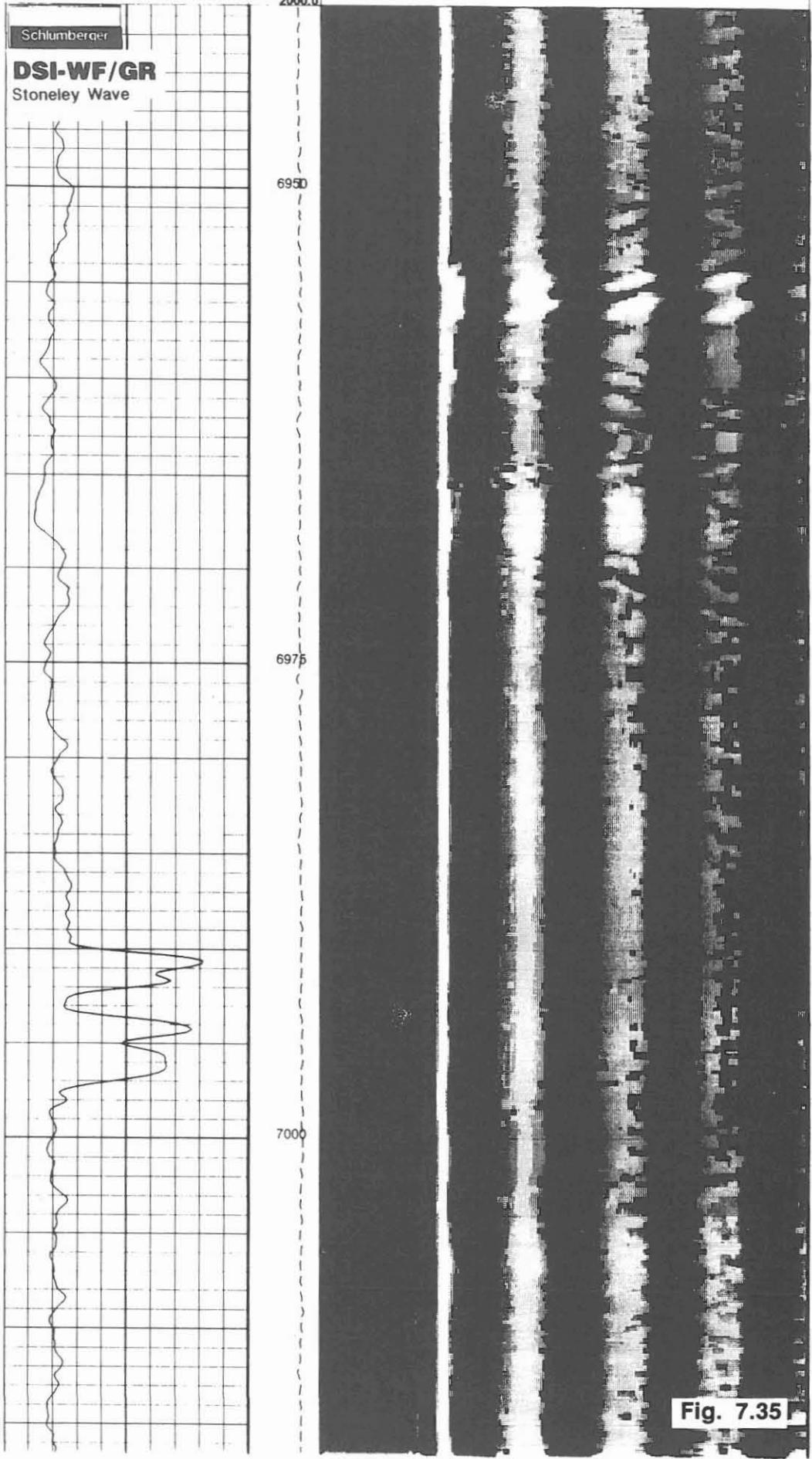
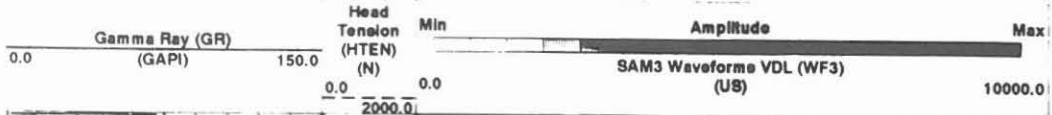
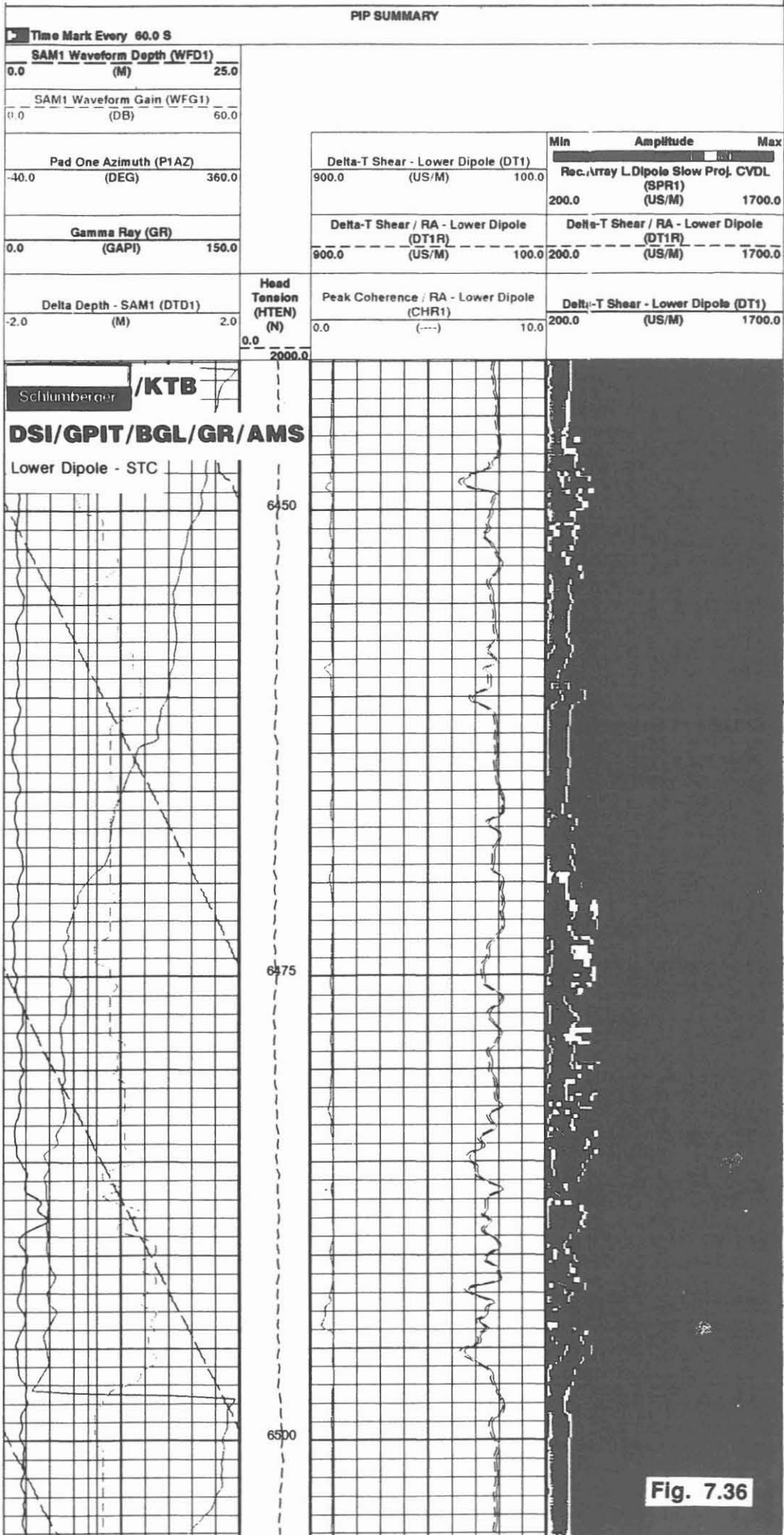


Fig. 7.35



PIP SUMMARY

Time Mark Every 60.0 S

Gamma Ray (GR)
(GAPI) 0.0 150.0

Head
Tension
(HTEN)
(N) 0.0

Min Amplitude Max

SAM1 Waveforms VDL (WF1)
(US) 0.0 10000.0

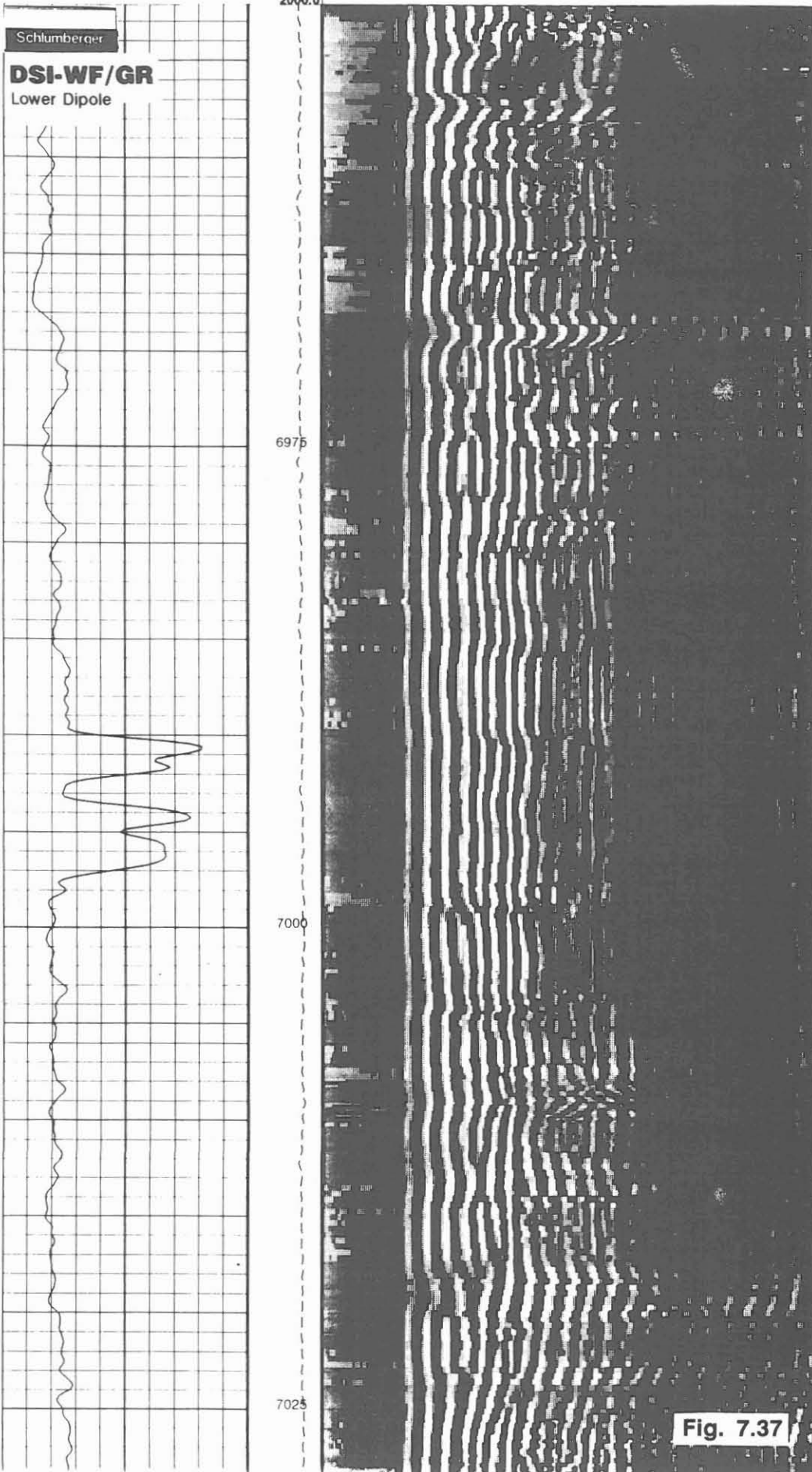


Fig. 7.37

PIP SUMMARY

Time Mark Every 60.0 S

SAM2 Waveform Depth (WFD2)
0.0 (M) 25.0

SAM2 Waveform Gain (WFG2)
0.0 (DB) 60.0

Pad One Azimuth (PIAZ)
-40.0 (DEG) 360.0

Gamma Ray (GR)
0.0 (GAPI) 150.0

Delta Depth - SAM2 (DTD2)
-2.0 (M) 2.0

Head Tension (HTEN) (N)

Delta-T Shear - Upper Dipole (DT2)
900.0 (US/M) 100.0

Min Amplitude Max
Rec./ray U.Dipole Slow Proj. CVDL (SPR2) (US/M) 200.0 1700.0

Delta-T Shear / RA - Upper Dipole (DT2R) (US/M) 900.0 100.0

Delta-T Shear / RA - Upper Dipole (DT2R) (US/M) 200.0 1700.0

Peak Coherence/RA-Upper Dipole (CHR2) (-) 0.0 10.0

Delta-T Shear - Upper Dipole (DT2) (US/M) 200.0 1700.0



DSI/GPIT/BGL/GR/AMS

Upper Dipole - STC

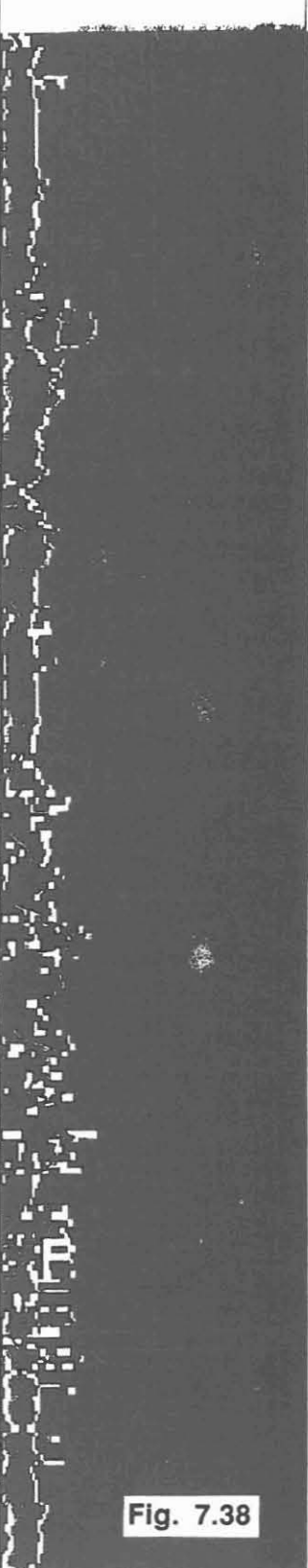
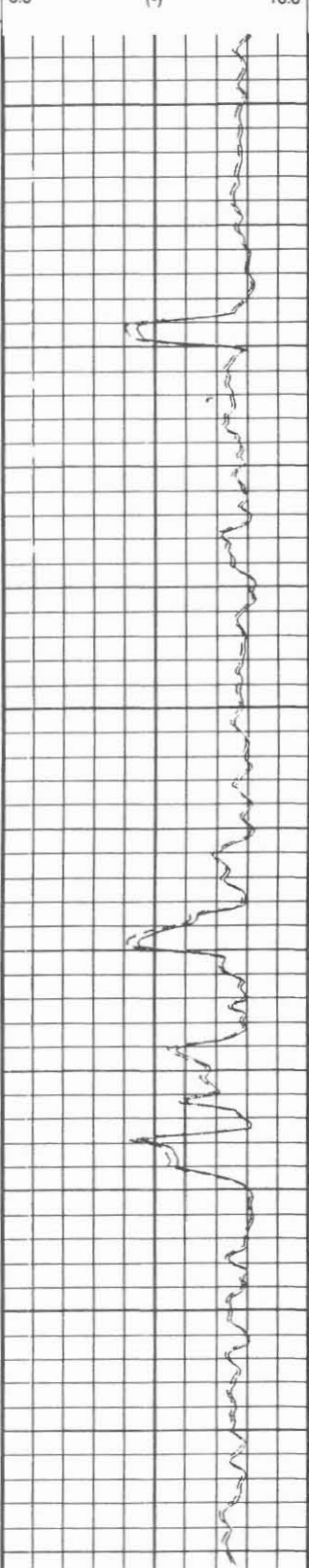
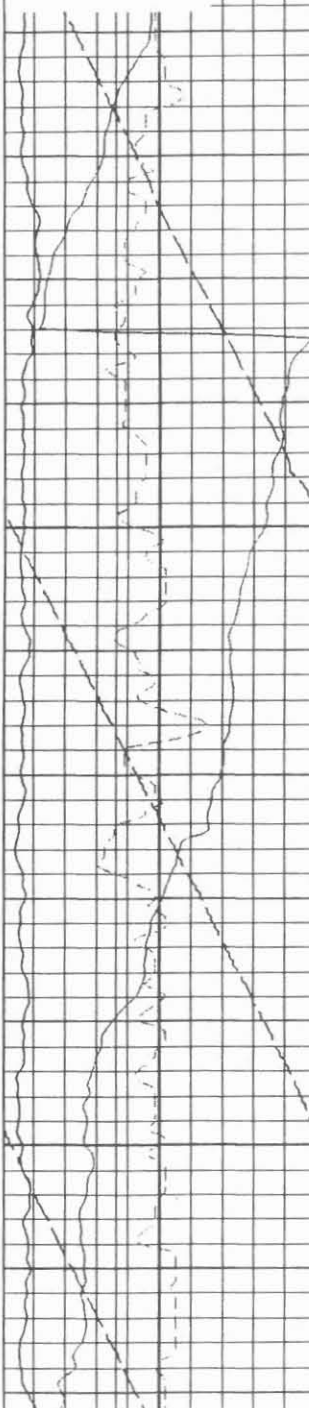
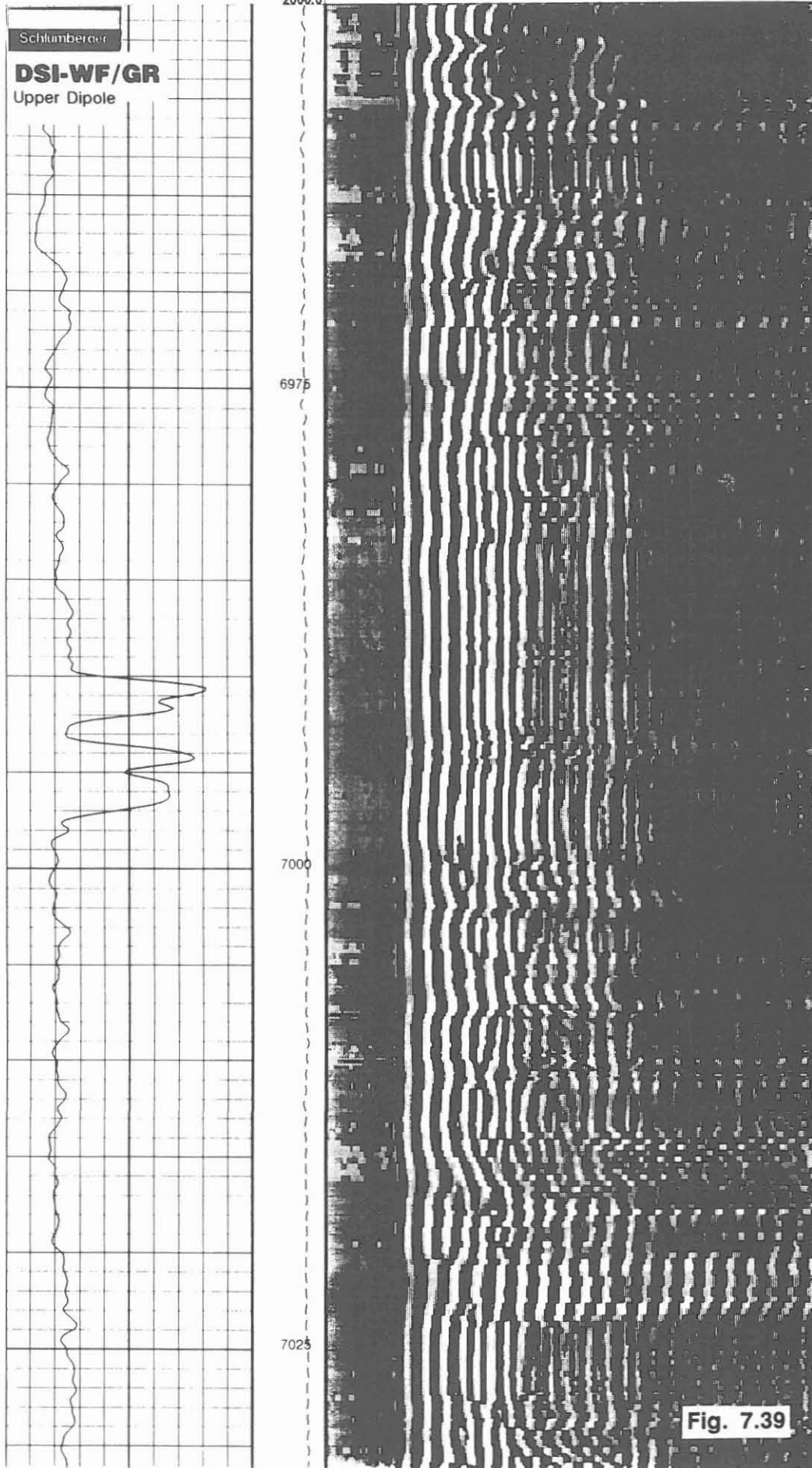


Fig. 7.38

PIP SUMMARY

▶ Time Mark Every 60.0 S

Gamma Ray (GR) (GAPI) 0.0 150.0
Head Tension (HTEN) (N) 0.0 2000.0
Amplitude 0.0 10000.0
SAM2 Waveforms VDL (WF2) (US)



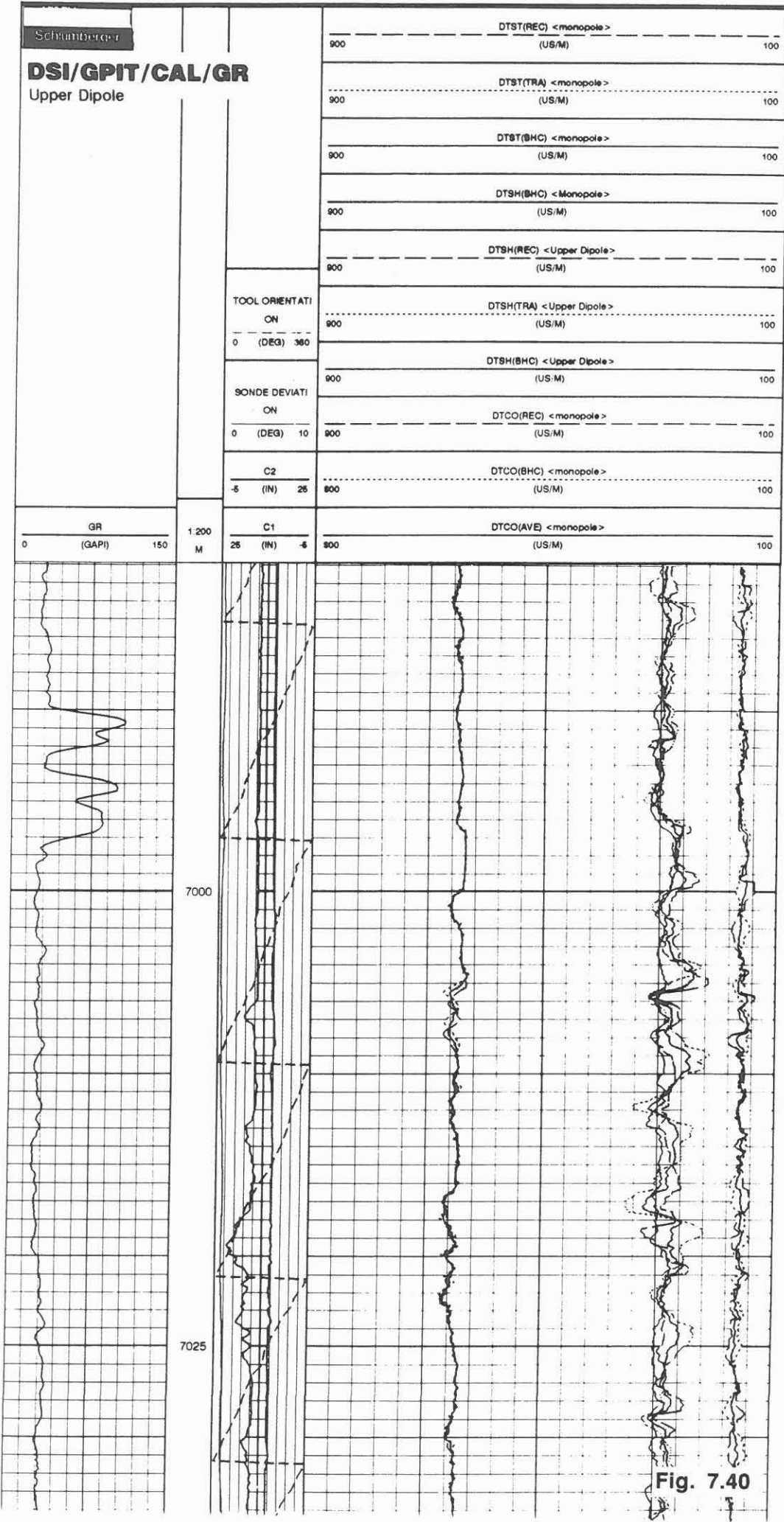
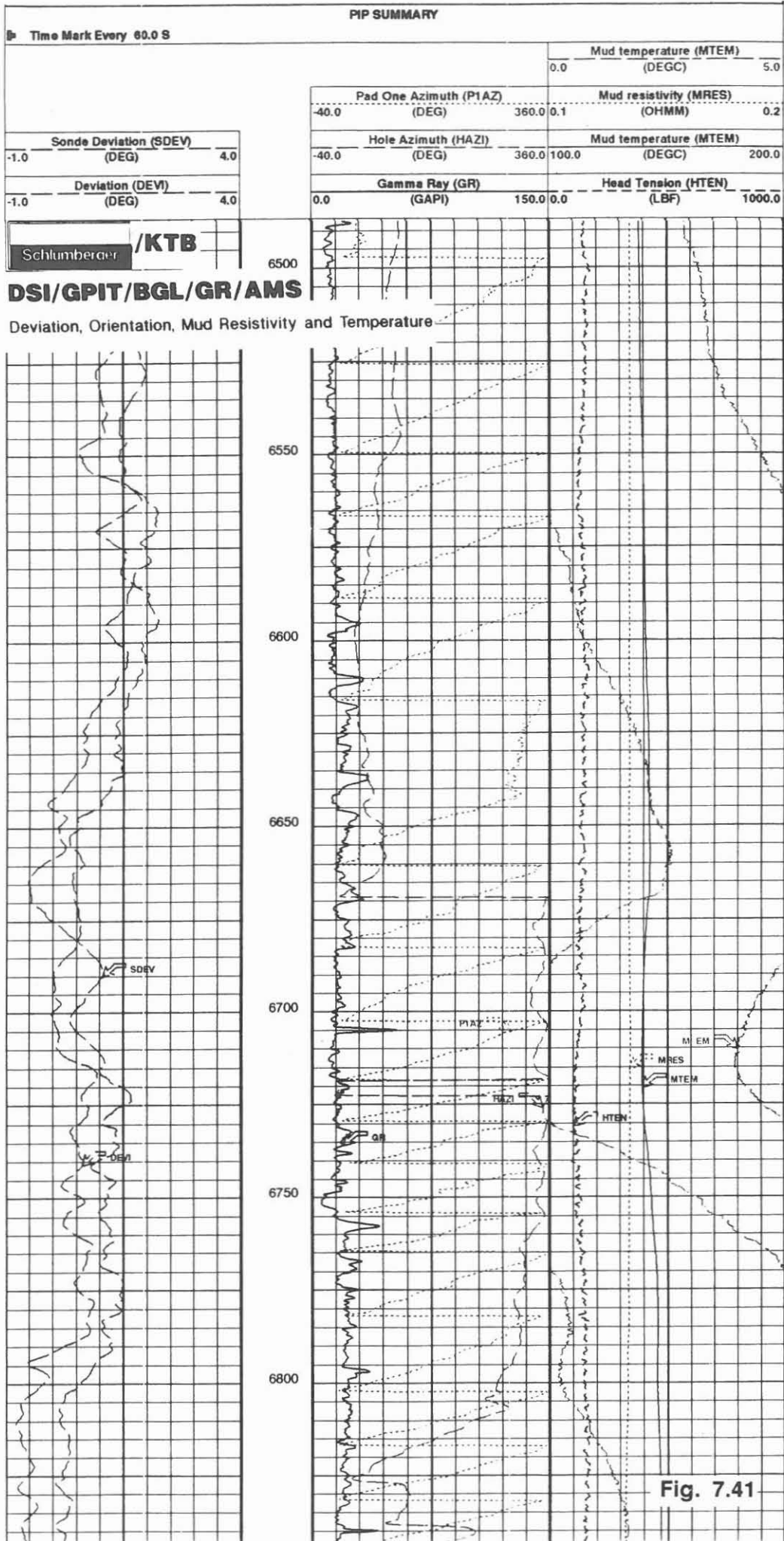


Fig. 7.40



BHTV (Borehole Televiewer)

Operator: Deutsche Montan Technologie (DMT), Bochum/KTB

Job No.	Date	Interval
HB-0213	04.02.1993	6022.0 - 7162.0 m

Example: Section of log: 7037.9 - 7040.8 m, **Fig. 7.42**

Purpose of log:

The Borehole Televiewer is an acoustic scanning device. The tool is used to detect fractures, fracture systems, faults and if the response is good, even the texture of the formation.

Operation:

For running the FACSIMILE tool the condition in the borehole was not ideal. The hole diameter was 12 1/2" with breakouts of different sizes practically over the total interval. The results obtained are not too good. The low logging speed resulted in an uneven movement of the sonde due to sticking and sudden releases.

The log was recorded without a Gamma Ray reference signal. Correct depth correlation of this record is difficult. Attempts have been made to use the acoustic caliper with moderate results.

Depth scale of the field record: approx. 1/25

Depth scale of the processed data: 1/40 and 1/10.

Technical Information:

For the prevailing conditions in the borehole the number of the acoustic impulses per rotation had to be reduced to 128. This low impulse rate certainly influenced the resolution of the record. The tool rotates with 3 revolutions per second and operates at a frequency of 1.3 MHz. The field record is registered on magnetic tape in digital form and analog on heat-sensitive paper.

The example presented gives processed results. In track I the reflected amplitude is presented and in track II and III twice the travel time.

Logging speed: 1.0 - 1.5 m / min.

Mnemonics and Units:

Mnemonics	Description	Unit
N,S,E,W	Orientation	(DEG)

2200 3200

N E S W N
| | | | |

DMT

BHTV

50 1500

N E S W N
| | | | |

50 1500

N E S W N
| | | | |

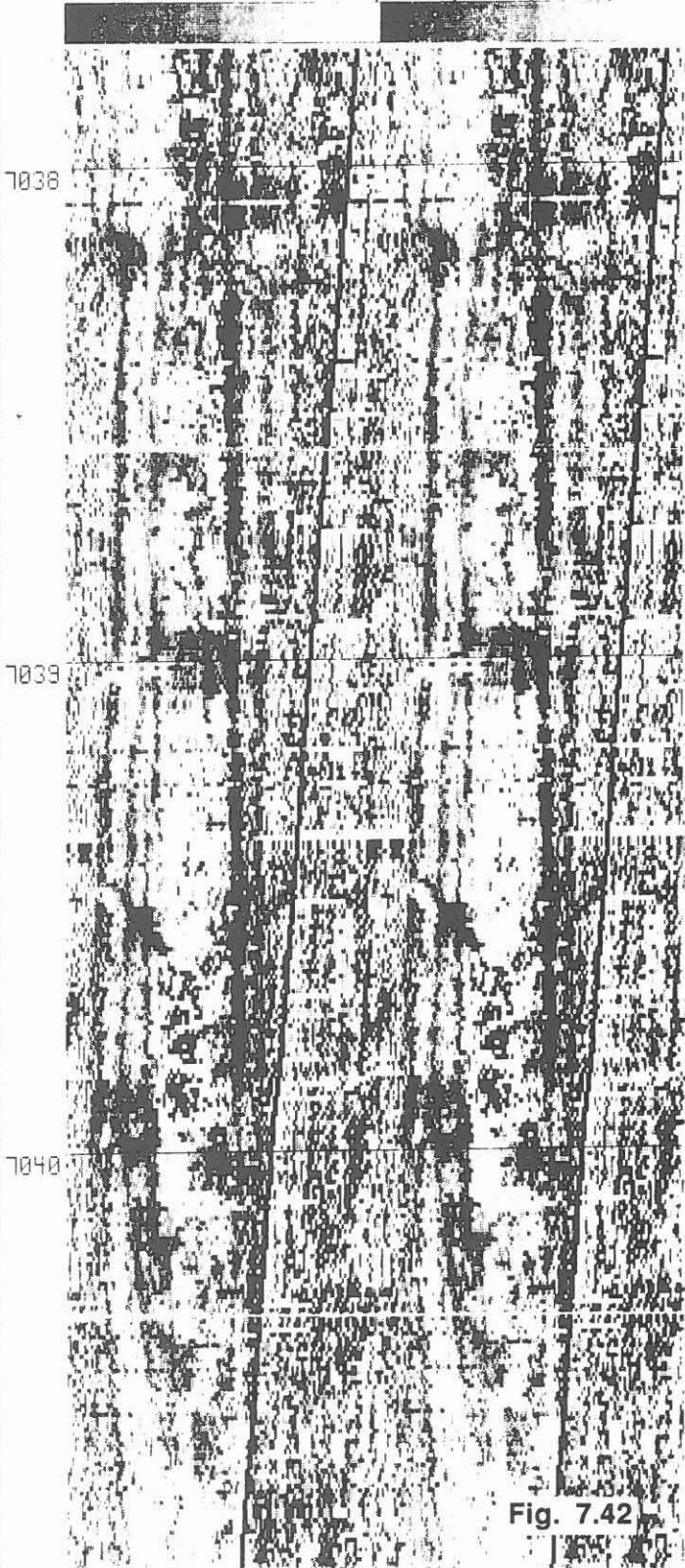
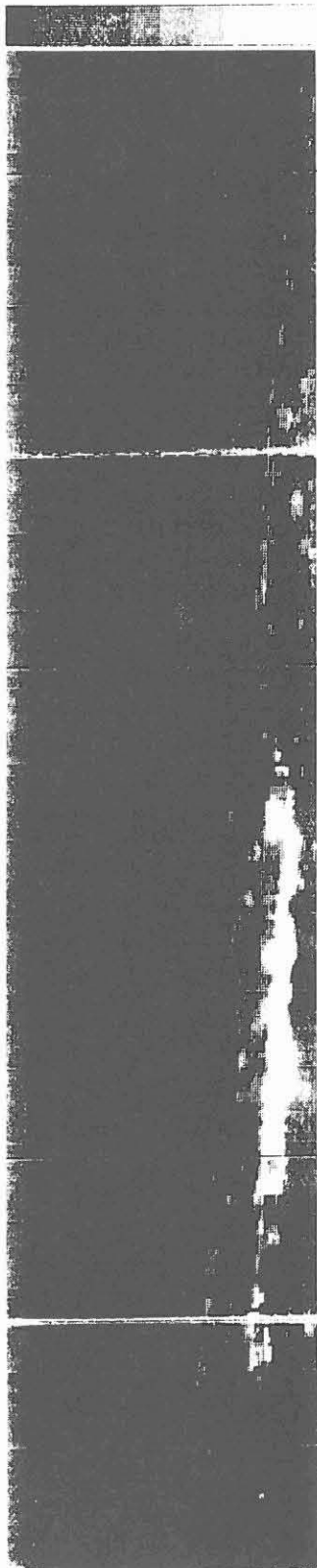


Fig. 7.42

DLL/GR/SP (Dual Laterolog/Gamma Ray/Self Potential)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0214	07.02.1993	6019.5 - 7206.0 m

Example: Section of log: 6967.0 - 7038.0 m, **Fig. 7.43**

Purpose of log:

This resistivity log was recorded to enhance the lithological profile by separating dense high resistive zones from sections of low resistivity. The zones of low resistivity could either be intervals with water-filled porosity, fracture systems or contain ore minerals or graphite.

Operation:

The Dual Laterolog was run in combination with a Gamma Ray for depth reference and the Self Potential to help in detecting mineralized and fractured zones. Because in these zones strong SP deflections have been observed.

The log was recorded with the standard resistivity scale 0.2 - 2000 Ohm m and with a "back-up scale" 2000 - 200 000 Ohm m. The log was recorded without software resistivity limit. Depth scale: 1/1000 and 1/200; logging speed 9.0 m due to GR.

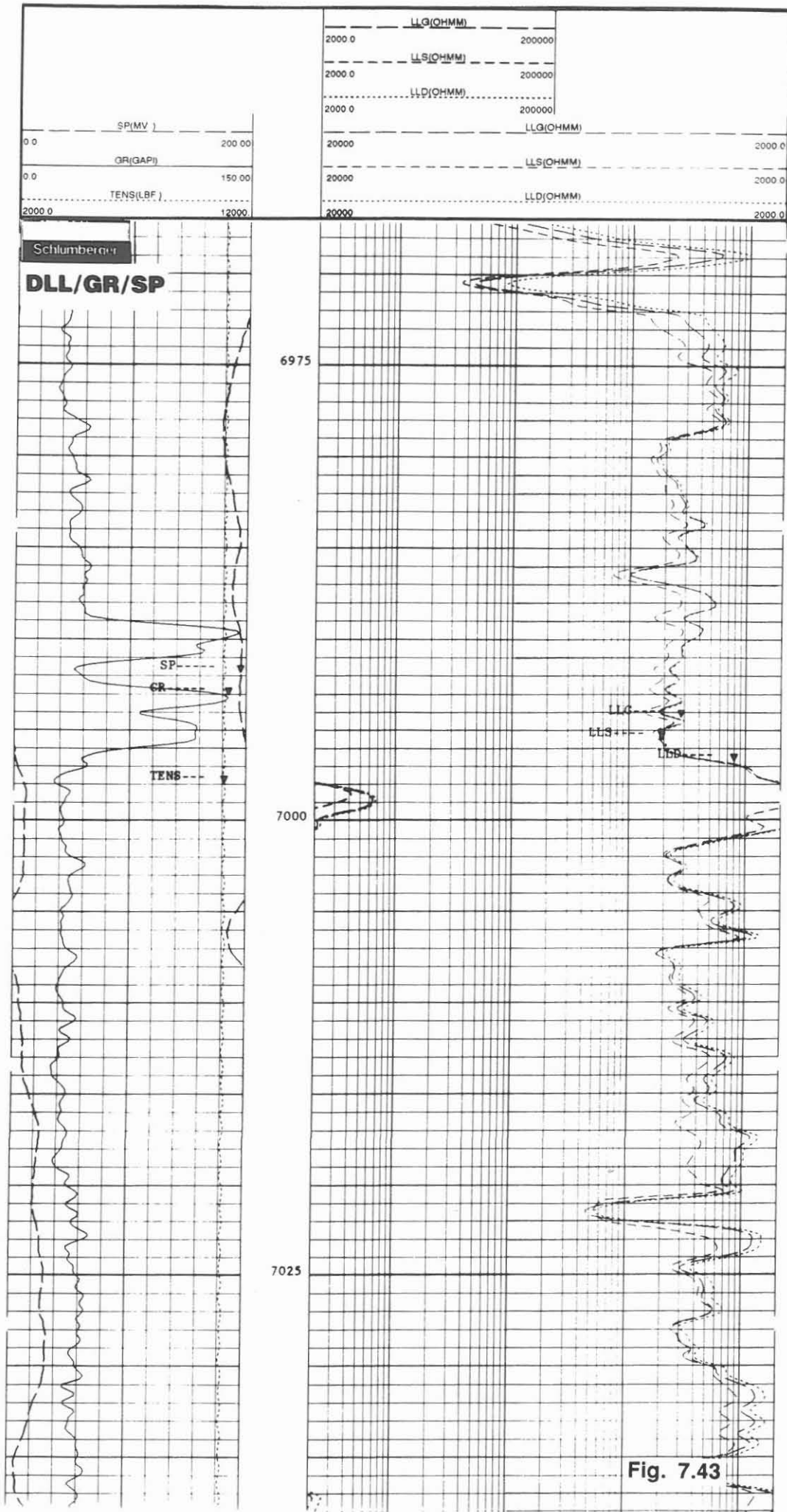
Technical Information:

The Dual Laterolog DLT-E was used. With the tool three resistivity curves are registered: LLS Laterolog-Shallow with a frequency of 270 Hz, LLD Laterolog-Deep and LLG Laterolog Groningen with a frequency of 32 Hz. The reference "N" for the LLD is placed on the cable, while for LLG on electrode VI on the bridle.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Descriptions	Units
GR	Gamma Ray	(GAPI)
LLD	Laterolog "deep"	(OHM M)
LLG	Laterolog "Groningen"	(OHM M)
LLS	Laterolog "shallow"	(OHM M)
SP	Self Potential	(MV)
TENS	Tension	(LBF)



TEMP/SP (Temperature/Self Potential)

Operator: KTB

Job No.	Date	Interval
HB-0216 - 0219	10.02 - 17.02.1993	0.0 - 7202.5 m
HB-0220	02.03.1993	0.0 - 6955.0 m

Example: Section of log: 6650.0 - 7025.0 m, **Fig. 7.44**

Purpose of log:

With temperature surveys run at pre-set time intervals the recuperation of the formation temperature is recorded. Due to the drilling process the formation surrounding the borehole is cooled by mud circulation. The built-up to the formation temperature is a slow process and requires several records over a longer period of time.

Operation:

The logs were recorded with the KTB Temperature and Self Potential sondes run in combination. To obtain optimum results, the logs were recorded from surface. In the open hole section temperature and high SP anomalies were recorded giving indications for fracture zones and/or layers with graphite or strong mineralisation.
Depth scale: 1/1000 only.

Technical Information:

The temperature probe from KTB is of the PT 1000 type. The SP sonde houses a well insulated steel electrode.
Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
SP	Self Potential	(MV)
TMP3	Temperature (° C)	(DEG)
TENS	Tension	(LBF)

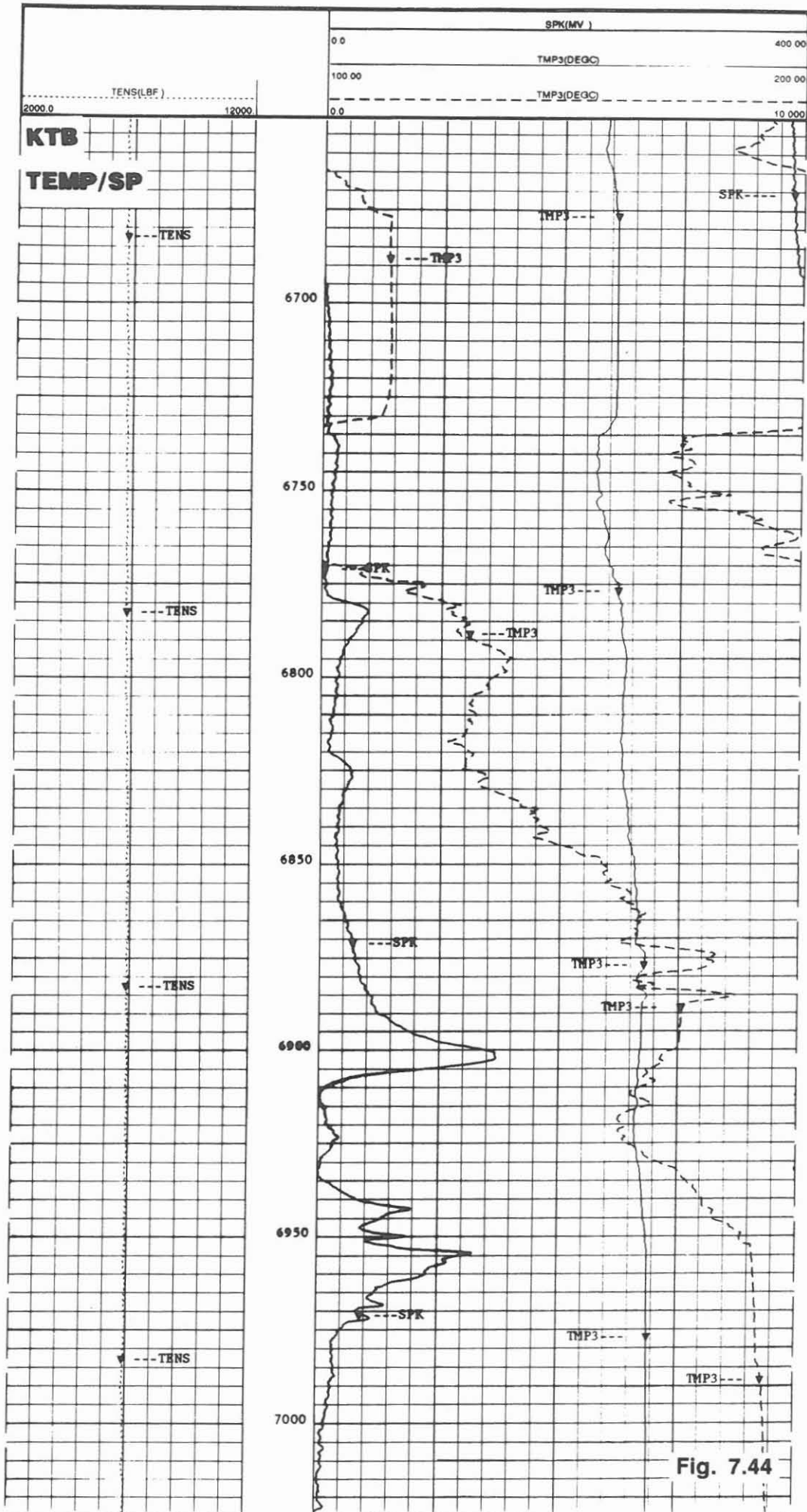


Fig. 7.44

7. Logging Series at 8108.0 m depth:
(borehole 4)

J. K. Draxler



7. Logging Series at 8108.0 m depth

The KTB drilling department had planned to drill at greater depth using high quality drill pipes of U-160 grade. Unfortunately, during the first attempts to drill with these pipes it was found that the steel was too brittle for this type of application. All drill pipes of this grade had to be re-worked to the lower grade of U-145. This had to be done at the factory, - meaning considerable time delay in the availability of the drill pipes necessary for further drilling.

To bridge to time and having close to 1000 meter of borehole not yet logged the decision was taken to run the next series of logs.

On August 12, 1993 the logging operation started with the Gamma Ray/Temperature Log (HGR/TEMP) using the Hostile Environment Logging tools (HEL-tools). On this run a temperature of 229° C was already recorded at the depth of 8106.0 m. The bottom of the borehole at 8108.0 m (driller's depth) could not be reached.

The next run was made with the new HEL-Formation MicroScanner Tool. This set of equipment, including as individual components the Auxiliary Measurement Sonde (HAMS), Gamma Ray (HGR) and the Formation MicroScanner (HFMS) was built by Schlumberger, Paris, for the KTB-operation. The tool tested full operational at surface, but gave indications of strong variability in power requirements and unstable sensor signal at the bottom of the borehole. After logging from 8110.0 m to 8096.0 m (logger's depth) the tool failed completely. When pulling the tool it regained stability and logging could be started at the depth of 7130.0 m until the tool failed at 6150.0 m. On surface it was found that the electrical insulation of the tool was damaged and the hydraulic sonde had suffered an oil leak.

The radioactive HEL-string Litho-Density Tool/Compensated Neutron Log/ Gamma Ray (HLDT/HCNL/HGR) was run next in the hole. The logging results are influenced by the poor borehole conditions in sections of breakout and caving. With this tool combination only the depth of 8096.0 m could be reached. At 7100.0 m the telemetry failed due to temperature.

The second control survey for the 13 3/8"/13 5/8" casing string with the Multi-Finger Caliper/Gamma Ray (MFC/GR) followed. No major damage or wear to the casing was recorded.

When running the combination of Sonic Logging Tool/Gamma Ray/Auxiliary Measurement Sonde (HSLT/HGR/HAMS) no signals could be received from the HGR and HAMS at total depth. Only the HSLT was operational and was logged as of 8096.0 m. No waveforms were recorded. Therefore, no evaluation for shear transit times can be made for this interval.

The Dual Laterolog/Gamma Ray/Self Potential (HDLL/HGR/SP) could be recorded, - but problems limited the recording to the deep laterolog readings "Laterolog Deep" (LLD) and "Laterolog Groningen" (LLG) only. The "Laterolog Shallow" (LLS) did read extremely low values and must be considered erroneous and are not further used.

With this run the combination HEL-Dual Laterolog/HEL-Gamma Ray/Self Potential was used (HDLL/HGR/SP). As HDLL tool only the DLT-C is available. For this type of tool no software exists to eliminate the resistivity cut-off at around 50 000 Ohmm for LLD and about 40 000 Ohmm for LLS readings. The net result is, that formations with possible higher resistivities are recognized as such, - but are recorded only with the permissible values of the limits given by the software: 40/50 000 Ohmm.

The logging series was terminated on August 15. 1993 by a second run with the Gamma Ray/Temperature tool (HGR/TEMP).

Additional information about the borehole, mud conditions etc. are given on log heading under **Fig. 7.45**

After this logging series drilling operations could resume. New loads of re-graded drill pipes had arrived.

Schlumberger

HB232 *LDL-CNL-GR* 13/8/93



<p>COMPANY: NIEDERSAECHSISCHES LANDESAMT F. BODENFORSCHUNG</p> <p>WELL: KTB-OPF-HB</p> <p>FIELD: OBERPFALZ KREIS: NEUSTADT/WN LAND: BAYERN NATION: BRD LOCATION: NAABDEMENREUTH WINDISCHESCHENBACH</p> <p>LATITUDE: H 55 19 864,35 LONGITUDE: R 45 08 775,24</p> <p>PERMANENT DATUM: ACKERSONHLE ELEVATIONS- ELEV. OF PERM. DATUM: 513.8 M KB: LOG MEASURED FROM: ACKERSONHLE DF: 11.8 M 0.0 M ABOVE PERM. DATUM GL: 513.8 M DRLG. MEASURED FROM: ACKERSONHLE</p> <p>DATE: 13-AUG-1993 RUN NO: HB232</p>		<p>OTHER SERVICES- FMS/GR/AMS TEMP-GR MFC-GR</p> <p>PROGRAM TAPE NO: 38.2 SERVICE ORDER NO: HB232</p>
<p>DEPTH-DRILLER: 8108.0 M DEPTH-LOGGER: 8106.0 M BTM. LOG INTERVAL: 8105.0 M TOP LOG INTERVAL: 7100.0 M</p> <p>CASING-DRILLER: 3000.0 M 6013.5 M CASING-LOGGER: 3000.5 M 6019.5 M CASING: 16" K55 13-3/8" OPEN HOLE WEIGHT: 72.0000 LB/F BIT SIZE: 17-1/2" 14-3/4" 12-1/4"</p>		
<p>TYPE FLUID IN HOLE: KTB-HT DENSITY: 1.21 G/C3 VISCOSITY: 302. S PH: 9.8 FLUID LOSS: 5.0 C3 SOURCE OF SAMPLE: UMLAUF</p> <p>RM: AT RMF: AT RMC: AT SOURCE RMF/RMC: PRESSE/PRESSE RM AT BHT: AT 229. DEGC RMF AT BHT: AT 229. DEGC RMC AT BHT: AT 229. DEGC</p> <p>TIME CIRC. STOPPED: 10:00 09/08/93 TIME LOGGER ON BTM.: 14:30 13/08/93</p> <p>MAX. REC. TEMP: 229.3 DEGC</p> <p>LOGGING UNIT NO: 701 LOGGING UNIT LOC: KTB RECORDED BY: J.HARRINGTON WITNESSED BY: DRAXLER</p>		
<p>REMARKS:</p> <p>CALIPER WOULD NOT OPEN ON BOTTOM. MAIN LOG IS A SPLICE OF BOTTOM SECTION WITH CALIPER CLOSED, TO SECTION WITH OPEN CALIPER. TELEMETRY DIED AT 7100 M, DUE TO TEMP. UNABLE TO LOG REPEAT SECTION. MAX. TEMP FROM TEMPERATURE-GR LOGGING.</p>		
<p>EQUIPMENT NUMBERS-</p> <p>TCM-AB 126 HLDT 25 CNT 311 HTCC-A 2005 . .</p>		

Fig. 7.45

HGR/TEMP (HEL-Gamma Ray/Temperature)

Operator: KTB

Job No.	Date	Interval
HB-0230	12.08.1993	5643.0 - 8095.0 m

Example: Section of log: 7730.0 - 8095.0 m, **Fig. 7.46**

Purpose of log:

With temperature surveys the temperature in the borehole and the recuperation of the formation temperature is recorded. This information is essential for the drilling department, as under high temperature conditions drilling tools, like downhole motors, can not be deployed any more. Due to the drilling process the formation surrounding the borehole is cooled by mud circulation. The built-up to the formation temperature is a slow process. Several records over a longer period of time are required to allow for extrapolation of true formation temperature.

Operation:

The log was recorded with the KTB Hostile Environment Logging (HEL) Gamma Ray in combination with the Temperature sonde. A strong temperature increase up to 215° C was recorded at total depth indicating a relatively low cooling effect due to fast drilling.

Depth scale: 1/1000 only.

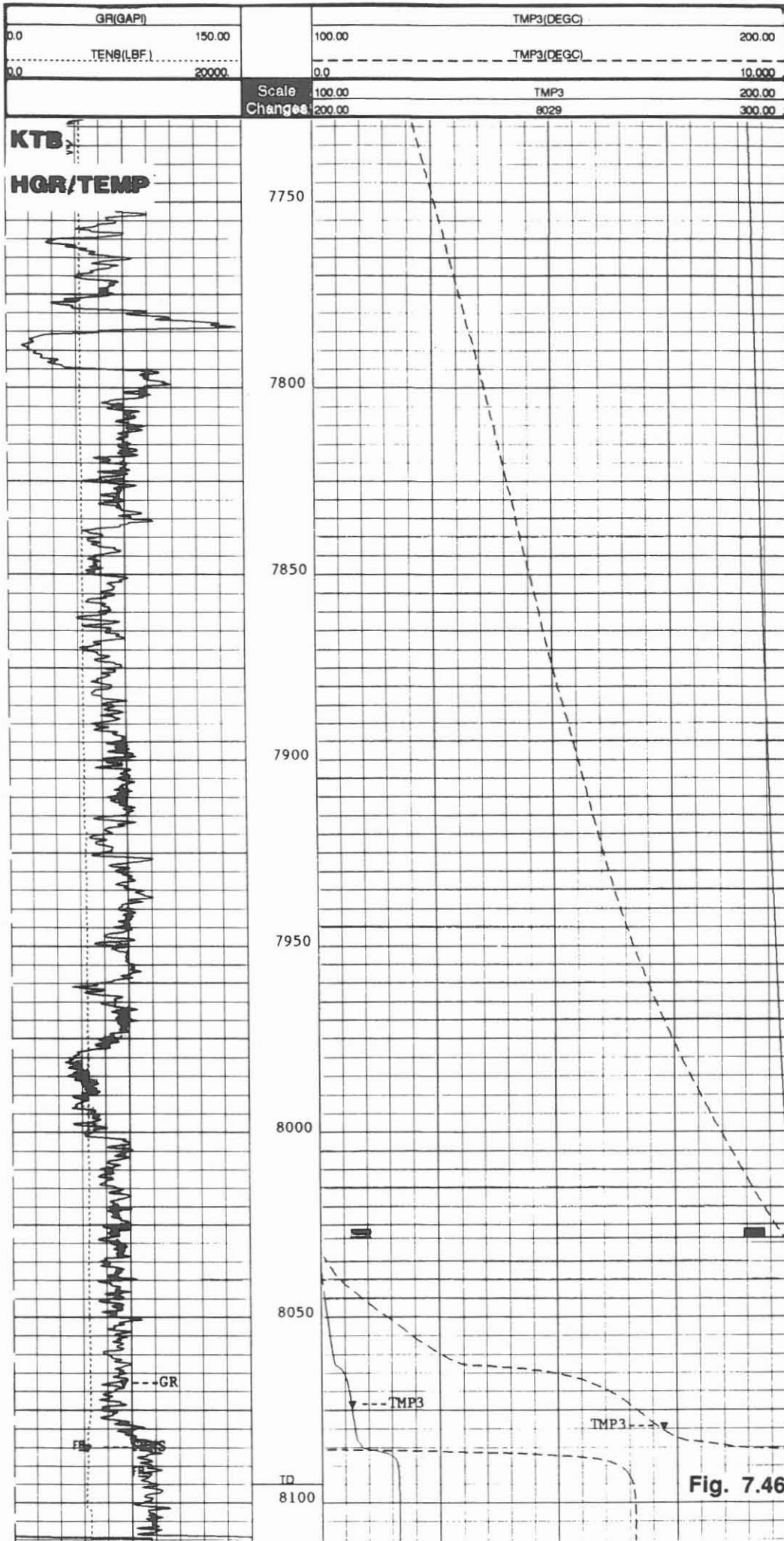
Technical Information:

The Temperature probe from KTB is of the PT 1000 type. The HEL-Gamma Ray is the standard SGT-C tool protected by a dewar against high temperatures.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
GR	Gamma Ray	(GAPI)
TMP3	Temperature (° C)	(DEG)
TENS	Tension	(LBF)



HFMS/HGR/HAMS (HEL-Formation MicroScanner/HEL-Gamma Ray/
HEL-Auxiliary Measurement Sonde)

Operator: KTB

Job No.	Date	Interval
HB-0231	12.08.1993	6150.0 - 8106.0 m

Examples:

Sections of logs: Quality Control curve plot,
6989.0 - 7043.0 m **FIG. 7.47**
Caliper, Deviation, Orientation,
Temperature plot
6965.0 - 7037.0 m **Fig. 7.48**
Processed FMS Images plot,
6987.0 - 6998.6 m **Fig. 7.49**

Purpose of Logs:

To obtain information for the geologists about structure, texture, foliation and tectonic features, like slickensides, shear planes, folds, faults and for the detection of fractures and fracture systems. In addition, the borehole trajectory, caliper, temperature and mud resistivity is recorded, providing essential information for drilling operations.

Operation:

The borehole was drilled with 12 1/4" bit size. In this rather large borehole the change from Formation MicroImager (FMI) to HEL-Formation MicroScanner (HFMS) resulted in the loss of circumferential scanning coverage from about 50 % to 25 %.

The resistivity Quality Control log is recorded and displayed in real-time (Fig. 7.47). This plot gives information about the performance of the tool, the fast data and the borehole trajectory. Via play-back other plots can be made on location, like the Deviation, Orientation, Temperature plot (Fig. 7.48) or later in the computing centre the Processed FMS Images plot (Fig. 7.49).

Depth scale of the field records: 1/200, 1/1000, (1/40 on request).

Depth scale of processed data from computing centre: 1/40, 1/10.

Logging speed: 4 - 6 m/min depending on hole conditions.

Technical Information:

Due to borehole temperatures >175° C the Formation Micro-Imager (FMI) could not be deployed any more. The replacement is the Hostile Environment Logging (HEL) Formation Micro-Scanner Tool specially designed and manufactured by Schlumberger for KTB. This tool includes the resistivity measuring, orientation and deviation systems, gamma ray, mud temperature, mud resistivity and head tension sensors. The

total tool is built for withstanding 260° C temperature. Local modifications have been made to run the tool as borehole geometry tool only (HBGL). The HEL-Gamma Ray (HGR) and HEL-Auxiliary Measurement Sonde (HAMS) can be combined with other tools.

Sampling rate: "slow channels": 6", "fast channels": 0.1"

Mnemonics and Units:

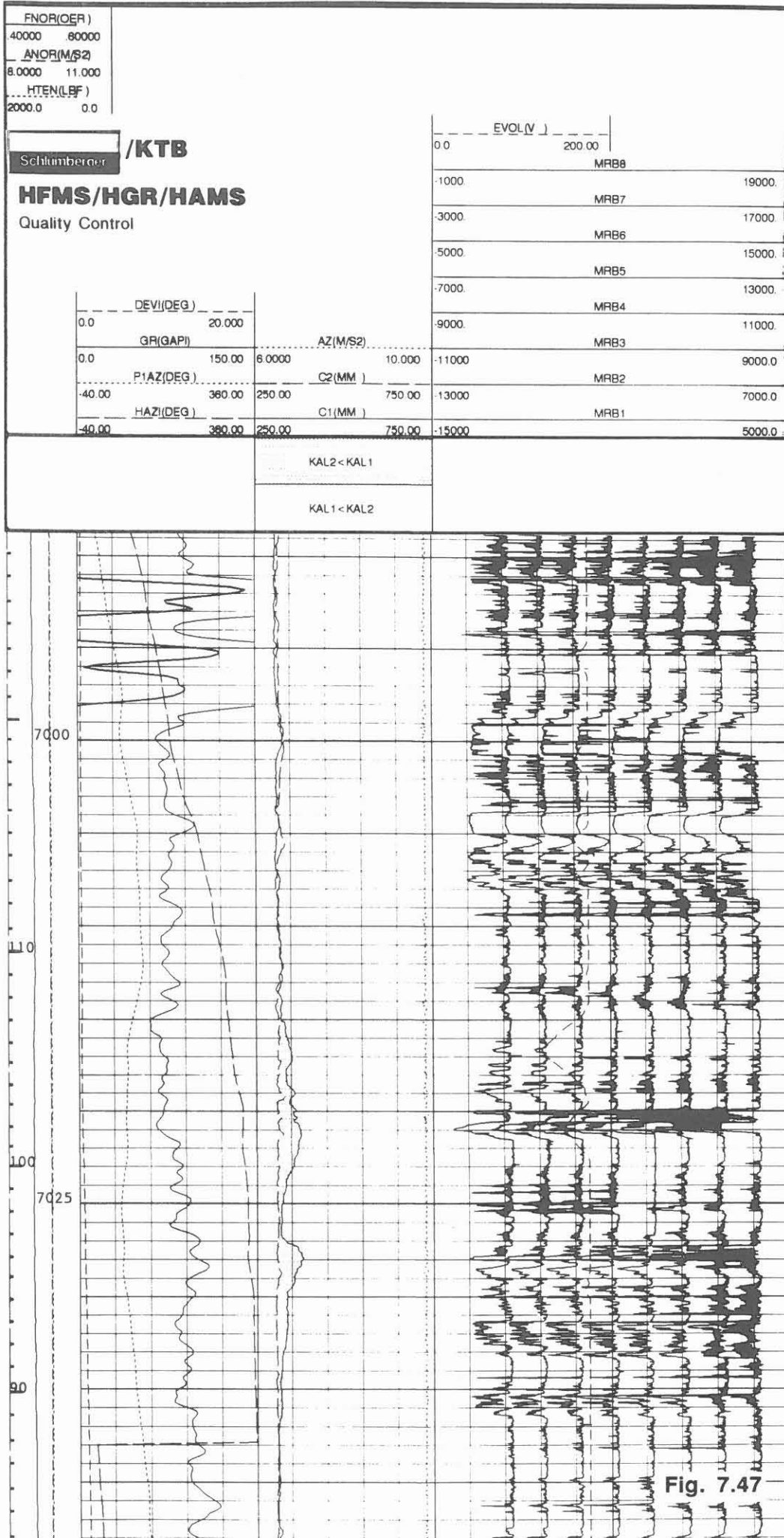
Mnemonics	Description	Units
AMTE	Averaged Mud Temperature	(DEGC)
ANOR	Accelerator Computed Norm	(M/S2)
AZ	Slow Accelerometer Z Component	(M/S2)
BS	Bit Size	(MM)
C1,C2	Caliper 1-3, Caliper 2-4	(MM)
DEVI	Deviation	(DEG)
EVOL	EMEX voltage	(V)
FNOR	Magnetic Field Computed Norm	(OER)
GR	Gamma Ray	(GAPI)
HAZI	Hole Azimuth	(DEG)
HTEN	Head Tension	(LBF)
KAL2<KAL1	Shading Code	
KAL1<KAL2	Shading Code	
MRB1-MRB8	Micro-Resistivity Button 1-8	(relative res.)
MRES	Mud Resistivity	(OHMM)
P1AZ	Pad 1 Azimuth	(DEG)
RB	Relative Bearing	(DEG)

Description of Plots:

Resistivity Quality Control plot (Fig. 7.47): This real-time plot serves as quality control during the logging operation. The responses of the resistivity electrodes, the four-arm caliper, deviation and orientation systems, voltage, tool movement in the borehole etc. are recorded and observed on the screen during logging. It is possible to step-through the arrays of resistivity electrodes to control the response.

Caliper, Deviation, Orientation and Temperature plot (Fig. 7.48): This plot gives the borehole trajectory and caliper data, with the gamma ray as depth reference. The temperature record provides first information about the temperature condition in the borehole.

Processed Formation MicroScanner Images plot (Fig. 7.49): This plot is made at the computing centre, after the data has been processed. It represents the final results of the recorded data and can be used for making the interpretation and analysis about the structure, texture, foliation, fractures and fracture systems.



TENS(LBF)		RB(DEG)		HTEN(LBF)	
4000.0	14000.	-40.00	360.00	600.00	1800.0
BS(MM)		AZIM(DEG)		AMTE(DEGC)	
0.0	1000.0	-40.00	360.00	0.0	5.0000
DEVI(DEG)		GR(GAPI)		MRES(OHMM)	
0.0	20.000	0.0	150.00	10000	20000
C2(MM)		PIAZ(DEG)		AMTE(DEGC)	
0.0	1000.0	-40.00	360.00	100.00	200.00
C1(MM)					
0.0	1000.0				



HFMS/HGR/HAMS

Caliper, Deviation, Orientation and Temperature

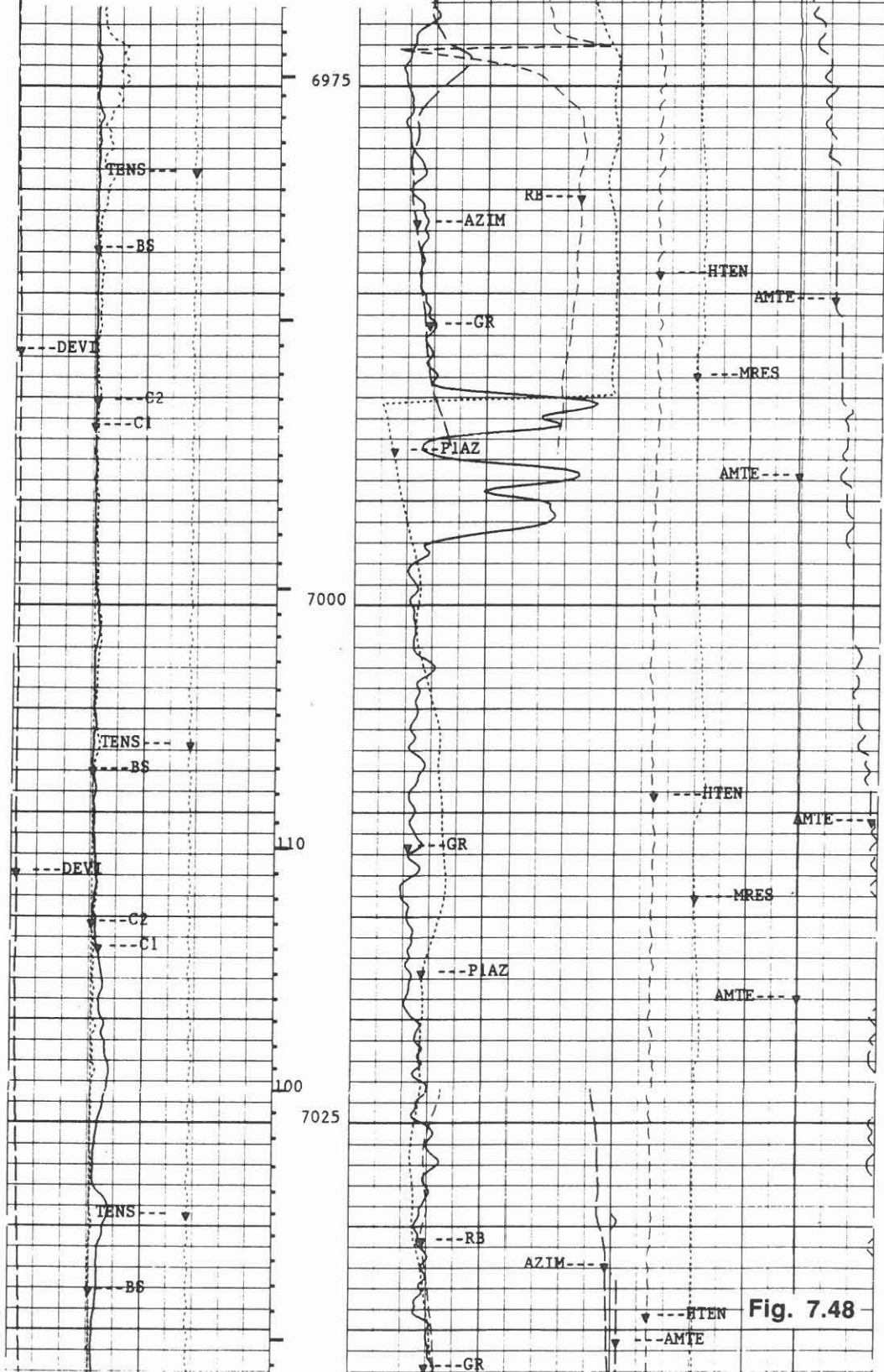
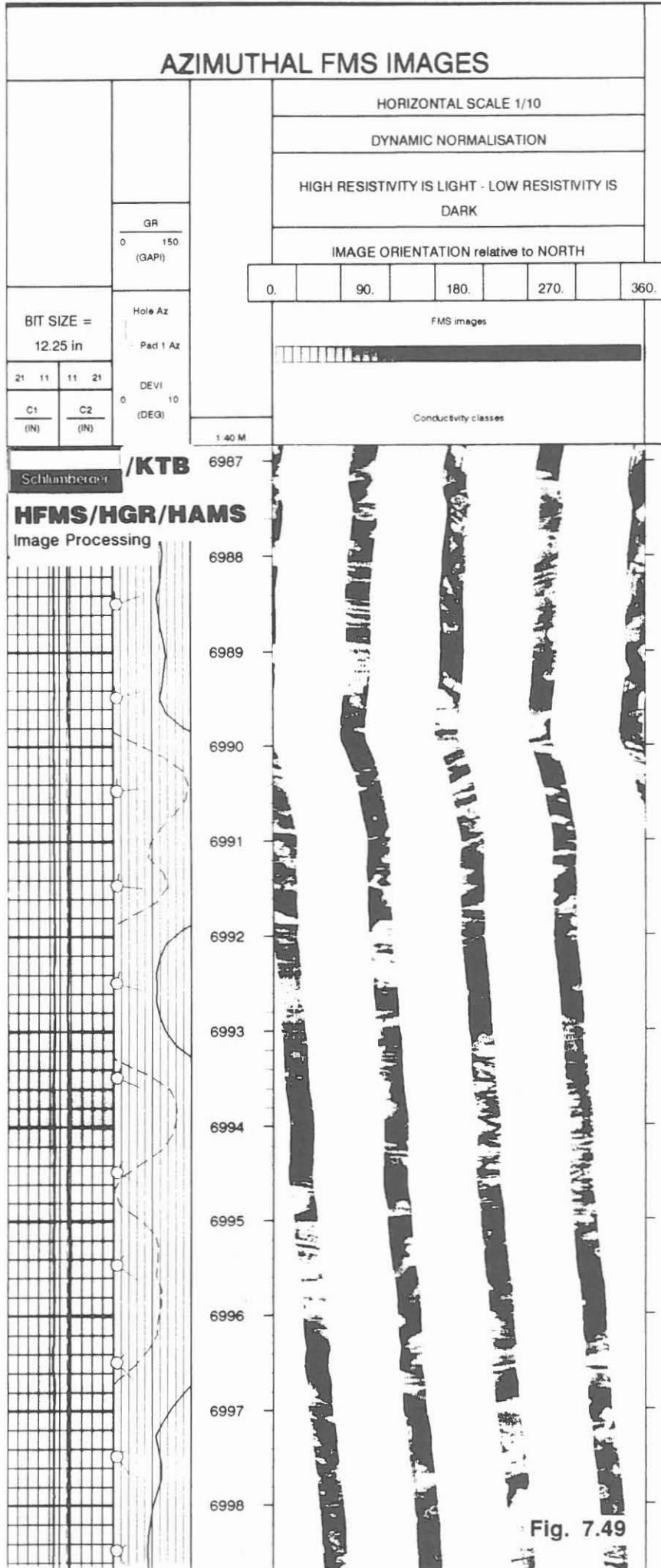


Fig. 7.48



HLDL/HCNL/HGR (HEL-Litho-Density Log/HEL-Compensated Neutron Log/HEL-Gamma Ray)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0232	13.08.1993	7100.0 - 8106.0 m

Example: Section of log: 7891.0 - 7965.0 m, **Fig. 7.50**

Purpose of log:

With the Litho-Density/Compensated Neutron/Gamma Ray log lithology information is obtained. In addition, if formation matrix density is known porosity estimates can be made. These logs are ideally suited for constructing the geological profile crossed by the borehole.

Operation:

The temperature limit for the use of the standard logging tools has been exceeded. The application of the Hostile Environment Logging Tools (HEL) became necessary. The response of these tools is equivalent to the standard tools. The record is influenced by bad hole conditions. Depth scale 1/1000, 1/200; logging speed: 9.0 m/min

Technical information:

The HEL-tools are logging tools which have all electronic components and other temperature sensitive systems housed and protected in dewars. For this combination, all individual tools have this protection and are rated to operate at temperatures up to 260° C. Sampling rate: 6".

Mnemonics and Units

Mnemonics	Description	Units
DRHO	Bulk Density Correction	(G/C3)
GR	Gamma Ray	(GAPI)
NPFI	Neutron Porosity	(V/V)
PEF	Photoelectric Factor	
RHOB	Bulk Density	(G/C3)
TENS	Tension	(LBF)

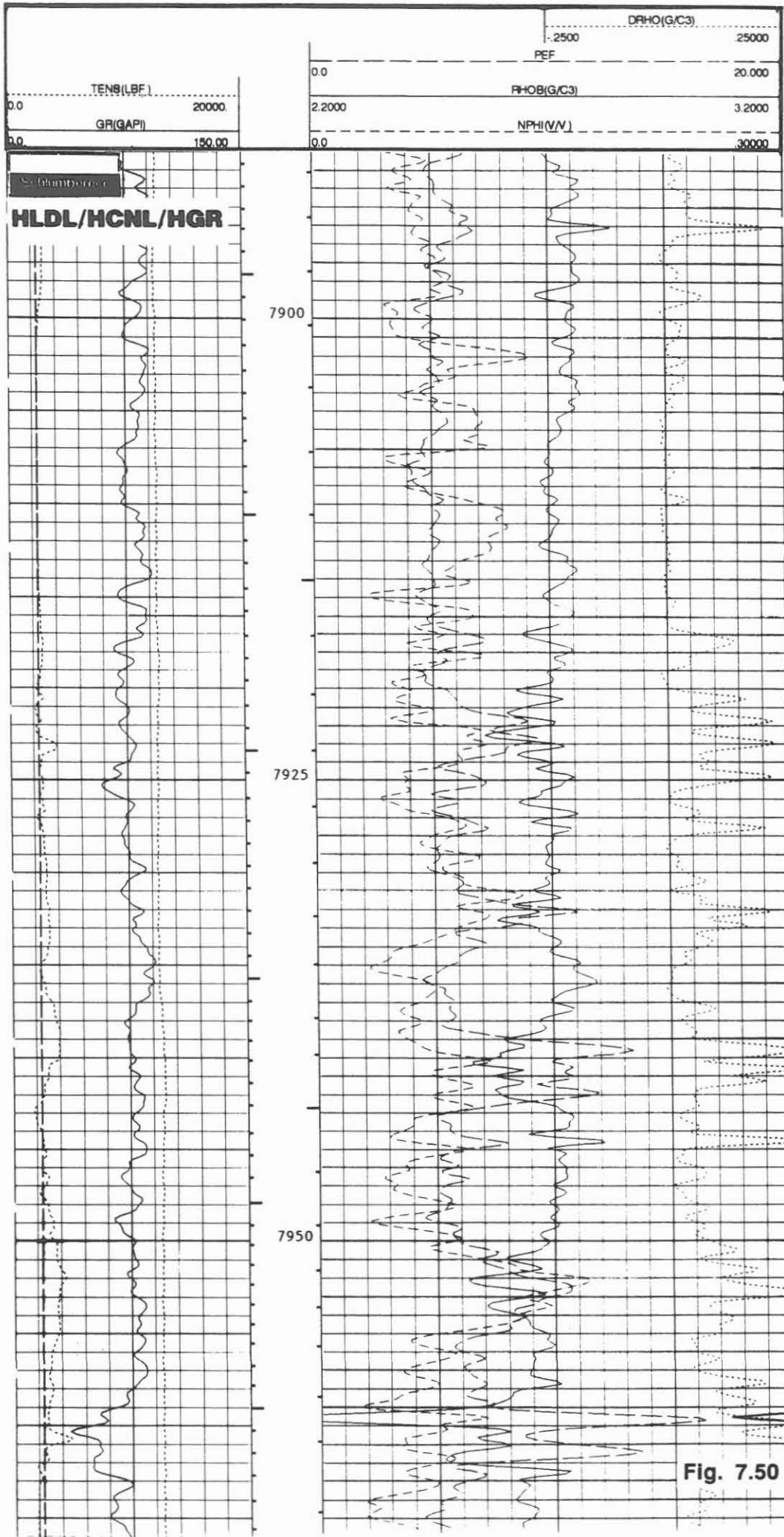


Fig. 7.50

MFC/GR (Multi-Finger Caliper/Gamma Ray)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0233	13.08.1993	0.0 - 6018.0 m

Example: Section of log: 960.0 -1025.0 m, **Fig. 7.51**

Purpose of log:

This is the second record of the Multi-Finger Caliper log in the 13 3/8"/13 5/8" casing string. On 24.04.1992 the first record ("zero"-reference) was registered straight after setting the casings. With this control run damage or wear should be detected.

Operation:

The log was recorded from casing shoe at 6018.0 m up to surface. During the log the tool had to be closed several times due to debris collected.

In reference to the "zero"-record no major damage, corrosion or wear could be detected.

Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min

Technical information:

An array of 72 independent fingers, mounted around the circumference of the tool, ride on the inner surface of the casing and record any anomalies. For three sectors of 120° each the minimum and maximum caliper signals are recorded. In addition, the minimum and maximum signal of the total circumference are registered too.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
GR	Gamma Ray	(GAPI)
ICR	Inner Casing Radius	(MM)
MNRD	Minimum Radius	(MM)
MXRD	Maximum Radius	(MM)
OCR	Outer Casing Radius	(MM)
RAD1-6	Minimum/Maximum Radius	(MM)

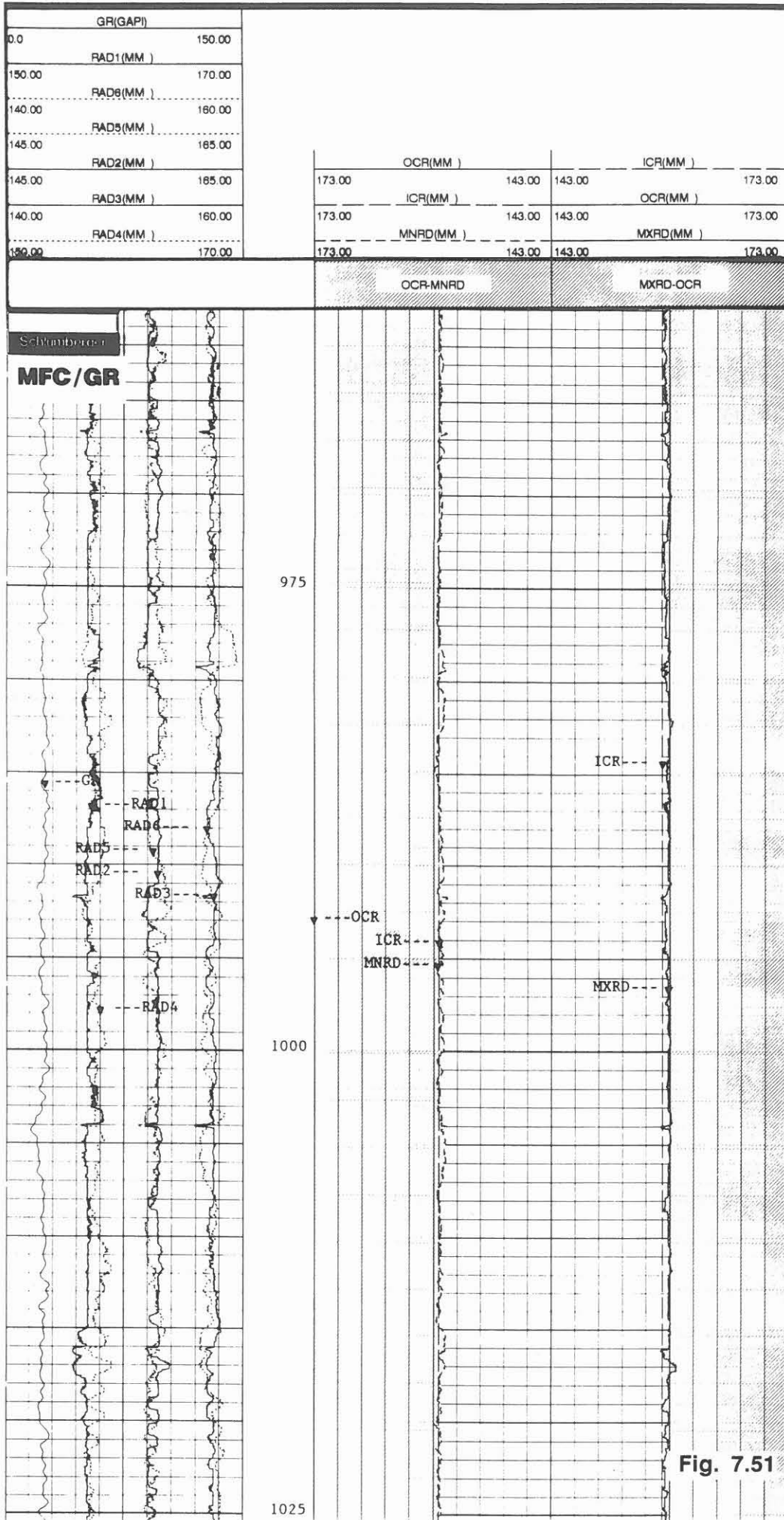


Fig. 7.51

HSLT (HEL-Sonic Logging Tool)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0234	14.08.1993	7009.0 - 8096.0 m

Example: Section of log: 7971.0 - 8950.0 m, **Fig. 7.52**

Purpose of log:

With the Sonic Logging Tool the acoustic properties of the formations are measured. The transit time record can be used for correlation with seismic data after conversion to velocities. The estimation of in situ porosity, fracture detection and calculations of wellbore stability parameters are possible.

Operation:

On this logging run the Gamma Ray and Auxiliary Measurement Sonde failed. Only the Sonic signals could be recorded. Depth correlation with other logs was done directly as no Gamma Ray is available.

Depth scale 1/200, 1/1000; logging speed: 15 m/min.

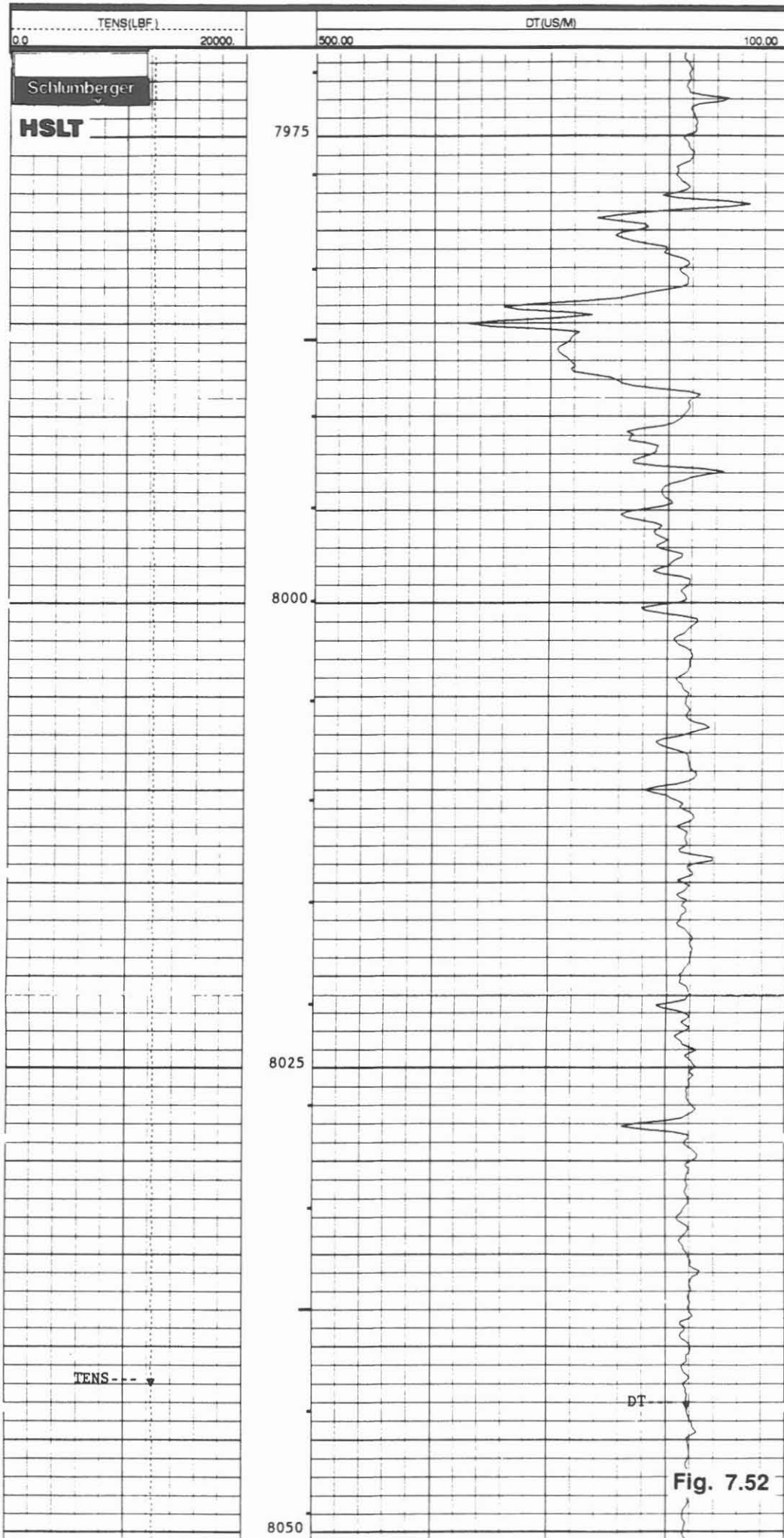
Technical information:

The tool used for this log was the Hostile Environment Logging (HEL) tool. This is the equipment rated for 260° C operations. On this run no waveforms were recorded. The evaluation of the shear transit times could therefore not be made.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
DT	Transit Time	(US/M)
TENS	Tension	(LBF)



HDLL/HGR/SP (HEL-Dual Laterolog/Gamma Ray/Self Potential)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0235	15.08.1993	6019.0 - 8096.0 m

Example: Section of log: 7804.0 - 7876.0 m, **Fig. 7.53**

Purpose of log:

This resistivity log has been recorded to enhance the lithological profile by separating dense high resistive zones from sections of low resistivity. The zones of low resistivity could either be intervals with water-filled porosity, fracture systems or contain ore minerals or graphite.

Operation:

The Hostile Environment Logging (HEL) Dual Laterolog was run in combination with the HEL-Gamma Ray for depth reference and the Self Potential to help in detecting mineralized and fractured zones. Because in these zones strong SP deflections have been observed.

The log was recorded with the standard resistivity scale 0.2 - 2000 Ohm m and with a "back-up scale" 2000 - 200 000 Ohm m. The log was recorded with software resistivity limit, cutting the LLD/LLG resistivities at about 50 000 Ohm m. No special software is available to suppress this limit when log is recorded with the DLT-C tool.

Depth scale: 1/1000 and 1/200; logging speed 9.0 m due to GR.

Technical Information:

The Dual Laterolog DLT-C was used. This is the HEL-version of the Dual Laterolog. With the tool normally three resistivity curves are registered: LLS Laterolog-Shallow with a frequency of 270 Hz, LLD Laterolog-Deep and LLG Laterolog-Groningen with a frequency of 32 Hz. The reference "N" for the LLD is placed on the cable, while for LLG on electrode VI on the bridle. For this log the LLS could not be recorded due to malfunction of the tool. Only LLD and LLG are registered. Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Descriptions	Units
GR	Gamma Ray	(GAPI)
LLD	Laterolog "deep"	(OHM M)
LLG	Laterolog "Groningen"	(OHM M)
SP	Self Potential	(MV)
TENS	Tension	(LBF)

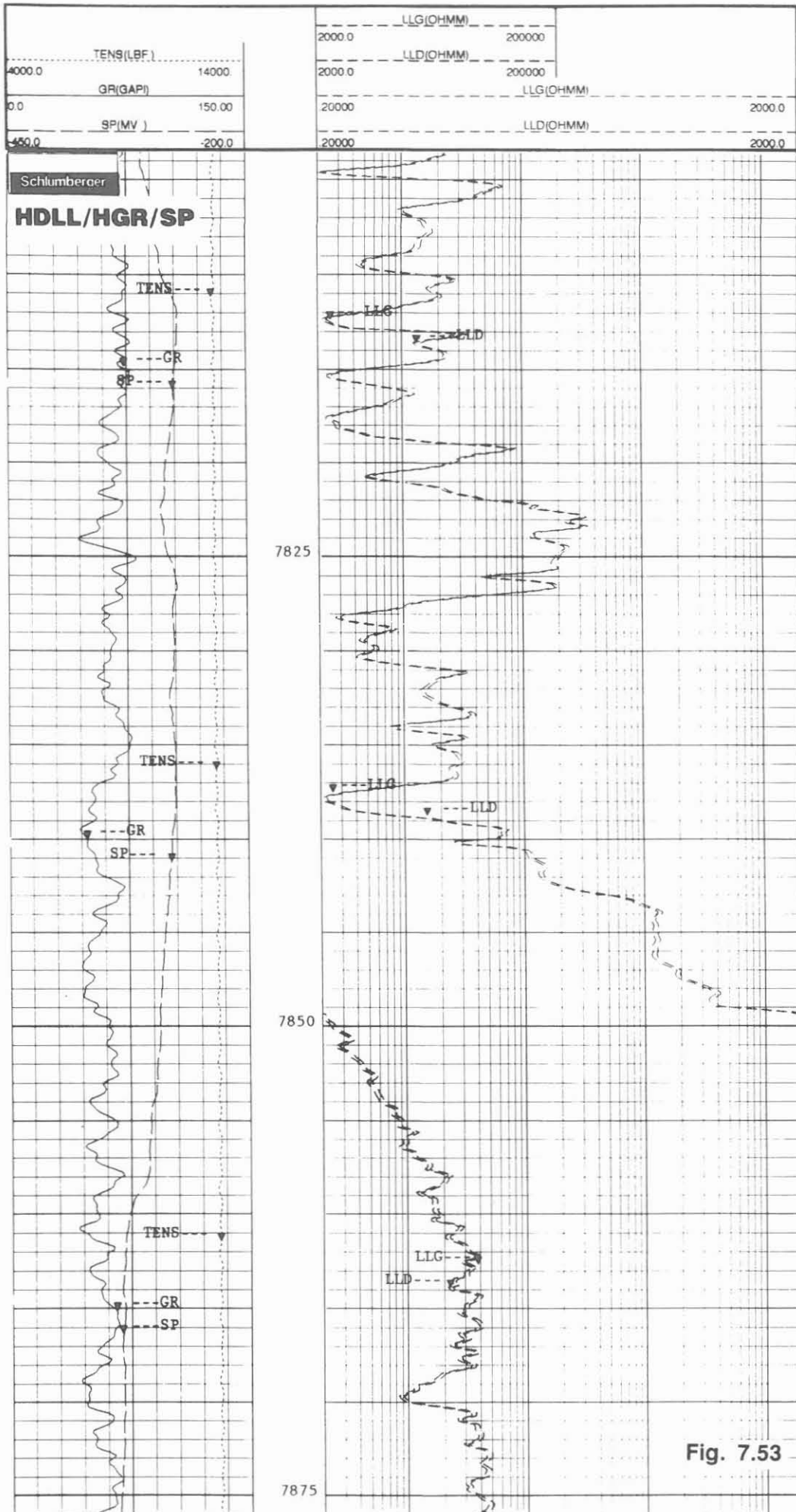


Fig. 7.53

7. Logging Series at 7790.0 m depth:
(borehole 5)

J. K. Draxler

7. Logging Series at 7790.0 m depth.

Due to the unsuccessful fishing operation and the necessary side-track at 7390.0 m depth a new borehole had to be drilled. To reduce the risk of loosing the hole again the decision was taken to drill to 7790.0 m only and set the 9 5/8" liner at this depth.

Before setting the casing logging operations had to be made. Experience had shown, that the borehole deteriorates with time. Out of this reason and the fact, that the interval down to 8108.0 m had been logged in the old hole already, this logging series was reduced to the minimum required:

Formation MicroScanner (HFMS/HGR/HAMS) for geological and structural information.

Borehole Geometry Log (HBGL/HGR/HAMS) for the drilling department to acquire the data about the hole trajectory and the caliper for the cement volume calculation.

Fluxgate Magnetometer survey, as this log can not be run after casings are set.

The Formation MicroScanner, using the HEL-tool, could be recorded from 7795.0 - 5937.0 m bringing a good overlap to the section from 7130.0 - 6150.0 m logged on August 12. 1993.

The HBGL/HGR/HAMS was logged with the locally modified tool combination for high temperature logging. When coming out of the borehole with the tool after the log was recorded, the anchoring of the lower sheave wheel on the capstan broke off the chassis. This resulted in a complete rupture of the logging cable at about 5400 m length. The sheared-off cable, with the logging tool still in the borehole, was squeezed tight on to the friction wheels of the capstan by damaged cable guide sheets and did not slip out. After some careful manipulations, the cable and the logging tool could safely be recovered from the well.

The third logging run, the Fluxgate Magnetometer from the University of Braunschweig had to be cancelled due to this incident with the logging cable.

The cable was spliced and the whole set-up with capstan and sheave wheel became operational again in less than two weeks. This was only possible to achieve by the restless efforts from the logging crew on location in close cooperation with Schlumberger Clamart, Vector Cable, Abbeville, France and the logging section of the KTB management group.

Information about the borehole conditions are given on log heading presented as **Fig. 7.54**.

Schlumberger

HB242 *HFMS-GR-AMS* 30/11/93



COMPANY: NIEDERSAECHSISCHES LANDESAMT F. BODENFORSCHUNG WELL: KTB-OPF-HB FIELD: OBERPFALZ KREIS : NEUSTADT/WN LAND: BAYERN NATION: BRD LOCATION: NAABDEMENREUTH WINDISCHESCHENBACH LATITUDE: H 55 19 864,35 LONGITUDE: R 45 08 775,24 PERMANENT DATUM: ACKERSOEHLE ELEVATIONS- ELEV. OF PERM. DATUM: 513.8 M KB: LOG MEASURED FROM: ACKERSOEHLE DF: 11.8 M 0.0 M ABOVE PERM. DATUM GL: 513.8 M DRLG. MEASURED FROM: ACKERSOEHLE		OTHER SERVICES- PROGRAM TAPE NO: 38.2 SERVICE ORDER NO: HB242
DATE: 30 NOV 1993 RUN NO: HB242		
DEPTH-DRILLER: 7790.0 M DEPTH-LOGGER: 7795.5 M BTM. LOG INTERVAL: 7795.5 M TOP LOG INTERVAL: 6019.5 M CASING-DRILLER: 3000.0 M 6013.5 M CASING-LOGGER: 3000.5 M 6019.5 M CASING: 16" K55 13-3/8" OPEN HOLE WEIGHT: 72.0000 LB/F BIT SIZE: 17-1/2" 14-3/4" 12-1/4"		
TYPE FLUID IN HOLE: KTB-HT DENSITY: 1.23 G/C3 VISCOSITY: 72.0 S PH: 9.4 FLUID LOSS: 6.2 C3 SOURCE OF SAMPLE: UMLAUF RM: AT RMF: AT RMC: AT SOURCE RMF/RMC: PRESSE/PRESSE RM AT BHT: AT 164. DEGC RMF AT BHT: AT 164. DEGC RMC AT BHT: AT 164. DEGC TIME CIRC. STOPPED: 02:00 29/11/93 TIME LOGGER ON BTM.: 01:31 30/11/93 MAX. REC. TEMP: 164.4 DEGC LOGGING UNIT NO: 701 LOGGING UNIT LOC: KTB RECORDED BY: KUEHR WITNESSED BY: DRAXLER/ZOTH		
REMARKS: RECORDED WITH XGAIN=3 AND XVOL=AUTO MESS-SONDE IST KTB HOCHTEMPERATUR STRANG. GEMESSEN MIT SAH-E SWIVEL ADAPTER. MAX OEFFNUNG DES HFMS KALIBERS IST 570 MM GELEGENTLICHES RAUSCHEN AUF KALIBER #1 DADURCH WURDE MEHRMALS VON KALIBER #1 UNTERMASS ANGEZEIGT. DASS KEIN UNTERMASS VORHANDEN IST. EINE STRECKE WURDE WIEDERHOLT MIT KALIBER#2 IN DIE KURZE ACH UM ZU ZEIGEN DASS KEIN UNTERMASS VORHANDEN IST. MAIN LOG IST 2.0 M ZU HOCH REGISTRISIERT.		
EQUIPMENT NUMBERS- TCM-AB 126 MEDS-C 800 ktb MEPC-KTB SGC-SA 463 SGD-TAB 3105 GPIC-KTB #1 AME-A 805 AMM-KTB #1 HTCC-AB 2005 SAH-E 796		

Fig. 7.54

HFMS/HGR/HAMS (HEL-Formation MicroScanner/HEL-Gamma Ray/
HEL-Auxiliary Measurement Sonde)

Operator: KTB

Job No.	Date	Interval
HB-0242	29.11.1993	6014.0 - 7795.0 m

Examples:

Sections of logs: Quality Control curve plot, 7739.0 - 7793.0 m	FIG. 7.55
Processed FMS Images plot, 7745.0 - 7756.0 m	Fig. 7.56

Purpose of Logs:

To obtain information for the geologists about structure, texture, foliation and tectonic features, like slickensides, shear planes, folds, faults and for the detection of fractures and fracture systems. In addition, the borehole trajectory, caliper, temperature and mud resistivity is recorded, providing essential information for the drilling operations.

Operation:

The borehole was drilled with 12 1/4" bit size. In this rather large borehole the change from Formation MicroImager (FMI) to HEL-Formation MicroScanner (HFMS) resulted in the loss of circumferential scanning coverage from about 50 % to 25 %.

The resistivity Quality Control log is recorded and displayed in real-time (Fig. 7.55). This plot gives information about the performance of the tool, fast data and the borehole trajectory. In the computing centre the data is processed later and the Processed FMS Images plot created (Fig. 7.56).
Depth scale of the field records: 1/200, 1/1000, (1/40 on request).

Depth scale of processed data from computing centre: 1/40, 1/10.

Logging speed: 4 - 6 m/min depending on hole conditions.

Technical Information:

Due to borehole temperatures >175° C the Formation MicroImager (FMI) could not be deployed any more. The replacement is the Hostile Environment Logging (HEL) Formation MicroScanner Tool specially designed and manufactured by Schlumberger for KTB. This tool includes the resistivity measuring, orientation and deviation systems, gamma ray, mud temperature, mud resistivity and head tension sensors. The total tool is built for withstanding 260° C temperature.
Sampling rate: "slow channels": 6", "fast channels": 0.1".

Mnemonics and Units:

Mnemonics	Description	Units
ANOR	Accelerator Computed Norm	(M/S2)
AZ	Slow Accelerometer Z Component	(M/S2)
C1,C2	Caliper 1-3, Caliper 2-4	(MM)
DEVI	Deviation	(DEG)
EVOL	EMEX voltage	(V)
FNOR	Magnetic Field Computed Norm	(OER)
GR	Gamma Ray	(GAPI)
HAZI	Hole Azimuth	(DEG)
HTEN	Head Tension	(LBF)
KAL2<KAL1	Shading Code	
KAL1<KAL2	Shading Code	
MRB1-MRB8	Micro-Resistivity Button 1-8	(relative res.)
PIAZ	Pad 1 Azimuth	(DEG)
RB	Relative Bearing	(DEG)

Description of Plots:

Resistivity Quality Control plot (Fig. 7.55): This real-time plot serves as quality control during the logging operation. The responses of the resistivity electrodes, the four-arm caliper, deviation and orientation systems, voltage, tool movement in the borehole etc. are recorded and observed on the screen during logging. It is possible to step-through the arrays of resistivity electrodes to control the response.

Processed Formation MicroScanner Images plot (Fig. 7.56): This plot is made at the computing centre, after the data has been processed. It represents the final results of the recorded data and can be used for making the interpretation and analysis about the structure, texture, foliation, fractures and fracture systems. Transparent overlays are used for the determination of dip and direction of the fractures, structure and foliation.

FNOR(OER)		40000 80000				EVOL(V)		0.0 200.00	
ANOR(M/S2)		8.0000 11.0000						MRB8	
HTEN(LBF)		2000.0 0.0						MRB7	
								MRB6	
								MRB5	
								MRB4	
								MRB3	
								MRB2	
								MRB1	
								5000.0	
DEVI(DEG)		0.0 20.000							
GR(GAPI)		150.00 6.0000		AZ(M/S2)		10.000			
PIAZ(DEG)		-40.00 380.00		C2(MM)		750.00			
HAZI(DEG)		-40.00 380.00		C1(MM)		750.00			
								KAL2 < KAL1	
								KAL1 < KAL2	

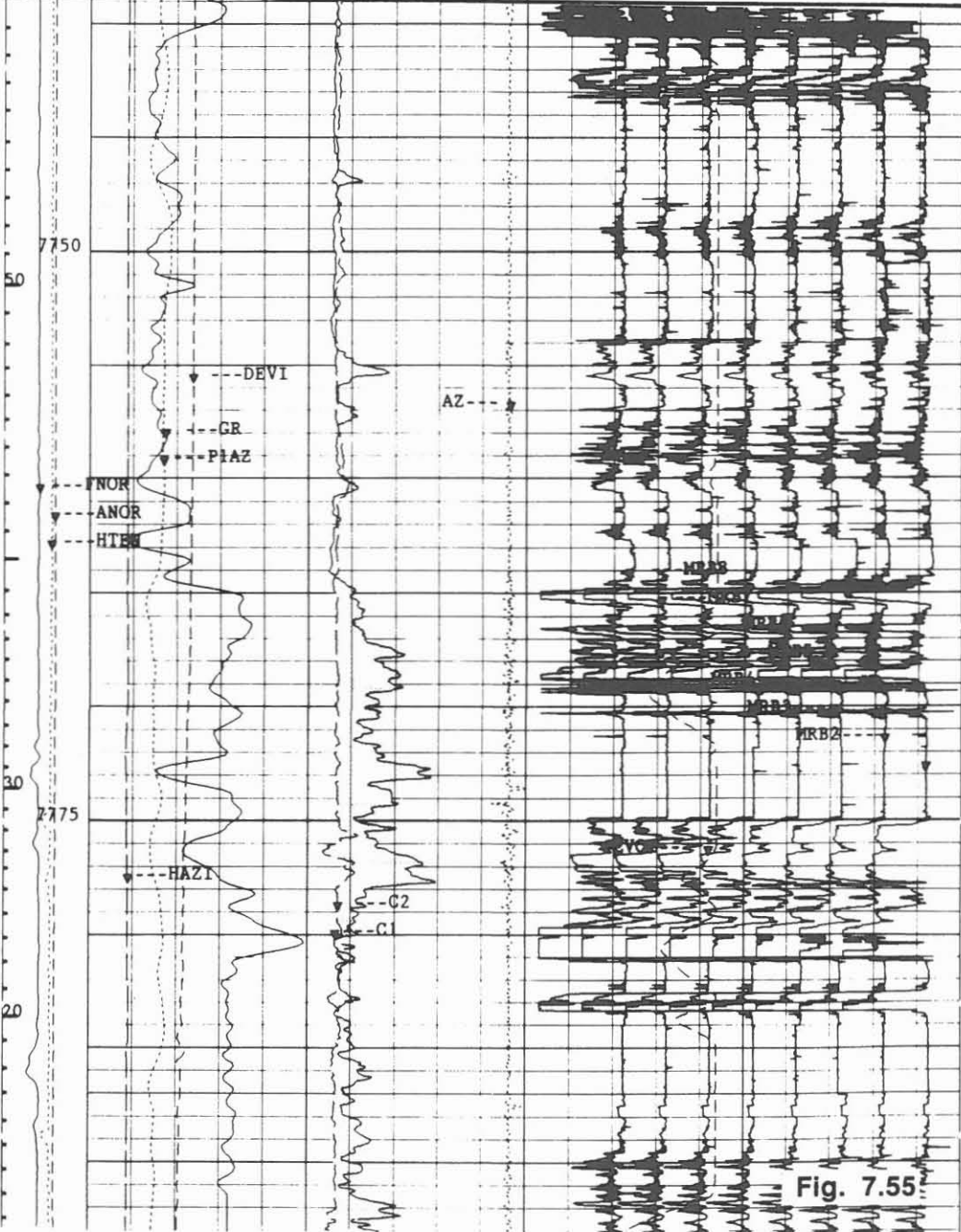


Fig. 7.55

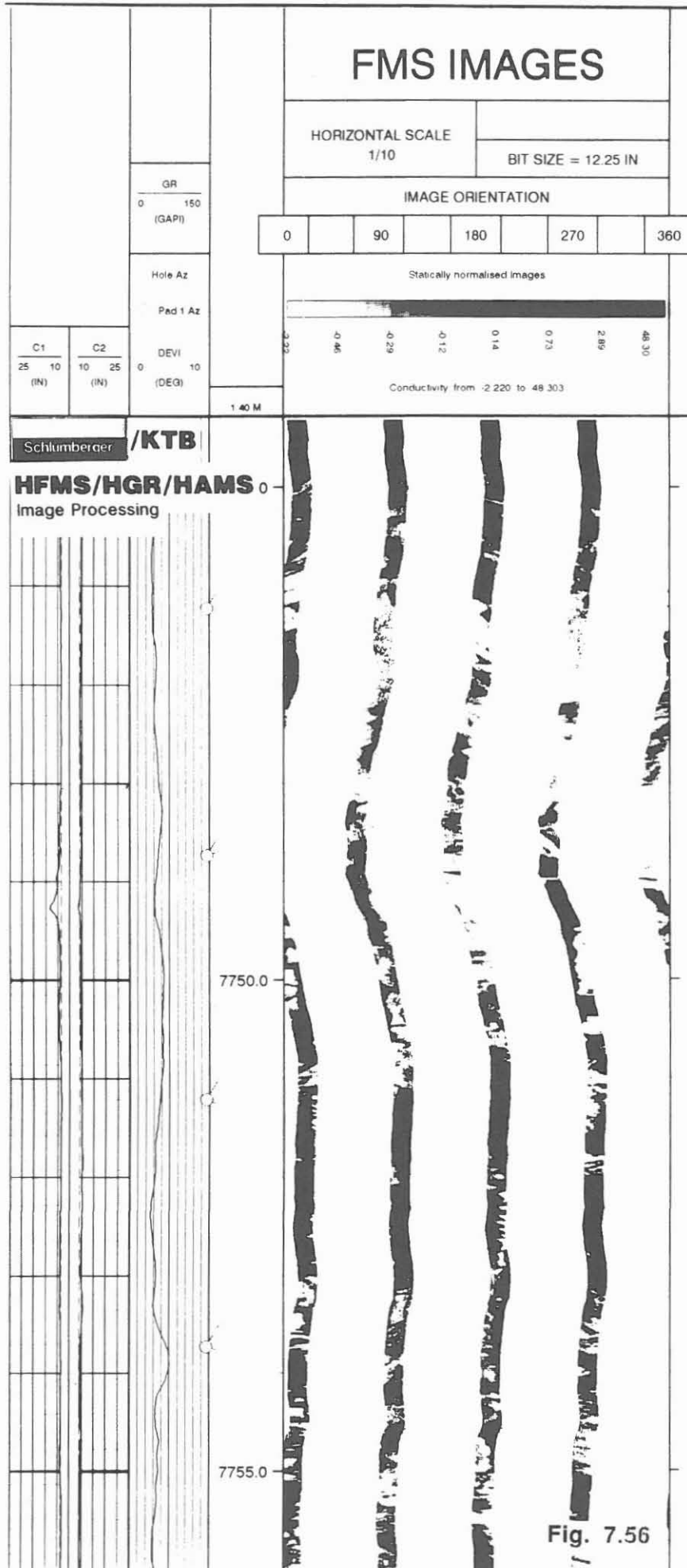


Fig. 7.56

HBGL/HGR/HAMS/SP (HEL-Borehole Geometry Log/HEL-Gamma Ray /HEL-Auxiliary Measurement Sonde/Self Potential)

Operator: KTB

Job No.	Date	Interval
HB-0243	30.11.1993	5937.0 - 7795.0 m

Example: Section of log: 7730.0 - 7795.0 m: **Fig. 7.57**

Purpose of log:

To control the trajectory and caliper of the borehole the Borehole Geometry Log is used. It gives hole deviation, orientation and caliper information. In addition the registration of the gamma ray is used as depth reference, mud temperature, mud resistivity and self potential measurements for the detection of fractures or zones with specially strong mineralisation.

Operation:

This log was run to control the condition in the borehole in preparation for running the 9 5/8" liner and obtain information about the cement requirement for cementing this liner.

Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min.

Technical Information:

The BGL-tool used was modified for high temperature conditions ($\geq 200^{\circ}$ C) locally. The standard GR was placed in a universal dewar housing. The GR-tool calibration was adjusted to compensate for the higher shielding due to the dewar.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
AZIM	Azimuth	(DEG)
BS	Bit Size	(MM)
C1,C2	Caliper 1,2	(MM)
DEVI	Deviation	(DEG)
GR	Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
MRES	Mud Resistivity	(OHMM)
PLAZ	Pad 1 Azimuth	(DEG)
RB	Relative Bearing	(DEG)
SP	Self Potential	(MV)
TENS	Tension	(LBF)

C1 > C2			
C1 < C2			
TENS(LBF.)		SP(MV.)	
4000.0	14000.	-200.0	0.0
BS(MM.)		HTEN(LBF.)	
0.0	1000.0	600.00	1800.0
DEVI(DEG.)		AMTE(DEGC)	
0.0	20.000	0.0	5.0000
C2(MM.)		MRES(OHMM)	
0.0	1000.0	05000	15000
C1(MM.)		AMTE(DEGC)	
0.0	1000.0	100.00	200.00
		RB(DEG.)	
		-40.00	360.00
		AZIM(DEG.)	
		-40.00	360.00
		GR(GAPI)	
		0.0	150.00
		PIAZ(DEG.)	
		-40.00	360.00

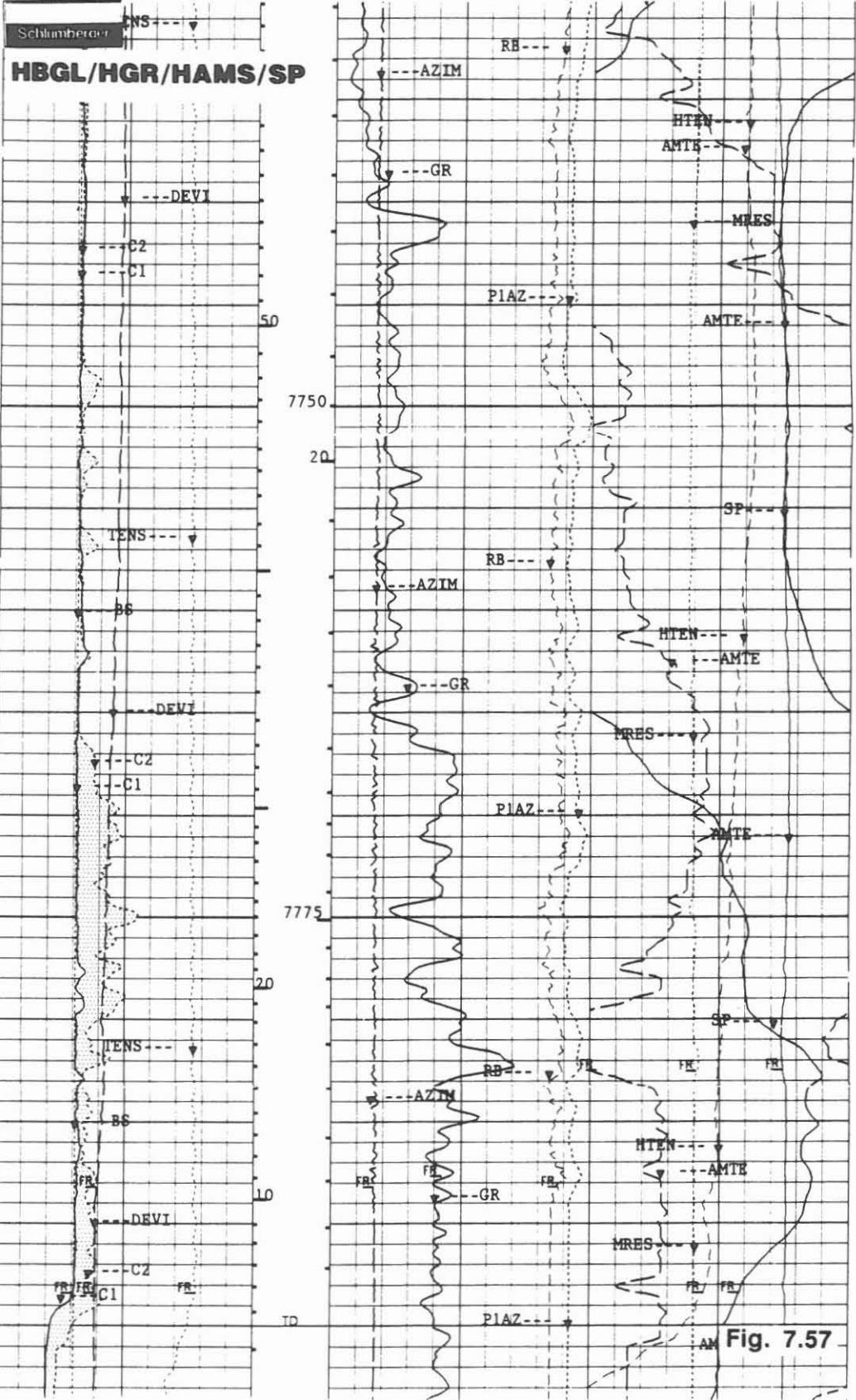


Fig. 7.57

7. Logging Series at 8729.7 m depth:
(borehole 5)

J. K. Draxler

7. Logging Series at 8729.7 m depth.

This logging series stretched over a period of close to 3 months. Starting with the HFMS/HGR/HAMS Log from 8624.0 - 7769.0 m on February 6, 1994, after an unsuccessful attempt to reach bottom on February 2, 1994, the series continued with the HTEMP/HSP survey for the drilling department inside the 13 3/8" casing and 9 5/8" liner on February 27, 1994. Then the series was interrupted until the end of April, due to severe unstable borehole conditions.

During this time the borehole could not be kept open and while attempting to clean the hole by reaming and re-drilling the drill string became stuck several times. Only by jarring and working on the string free pipe movement could be achieved. In all this time only once bottom at 8714.2 m could be reached and drilling continued to 8729.7 m. Further progress was impossible. After increasing the mud weight to 1.40 Kg/dm³ certain stability could be given to the borehole conditions. Not to loose the hole the decision was taken to case the open hole section with a 7 5/8" liner.

Before running the liner this newly drilled section had to be logged. The plan was to run the Sonic Log and the Dual Laterolog. For safety reasons the Litho-Density/Compensated Neutron Log was taken from the programme. The two logging runs could be made on April 30, 1994.

After reconditioning of the borehole the 7 5/8" liner was run, - but could not be set. For controlling the liner hanger the whole liner string had to be pulled back to surface. The necessary replacement of the liner hanger required several days.

To use this waiting time sensibly, additional borehole logging was made. The University Frankfurt was able to test the new HEL-REDOX sonde. The interval from 7852.0 - 6852.0 m not logged with the HNGL before, could now be recorded. In preparation to pressure work at a later time and to make certain the 7 5/8" liner hanger can be set, the 9 5/8" liner was checked for damage and wear by running the Multi-Finger Caliper. These logging operations were finished on May 11, 1994.

The log heading from April 30, 1994, gives the necessary information about the borehole conditions at that time, enclosed as **Fig. 7.58**

Schlumberger

HB252 *DLL-GR-SP* 30/4/94



<p>COMPANY: NIEDERSAECHSISCHES LANDESAMT F. BODENFORSCHUNG</p> <p>WELL: KTB-OFF-HB</p> <p>FIELD: OBERPFALZ</p> <p>KREIS: NEUSTADT/WN</p> <p>LAND: SAARLAN</p> <p>NATION: BRD</p> <p>LOCATION: NAABDEMENREUTH WINDISCHESCHENBACH</p> <p>LATITUDE: H 55 19 864,35</p> <p>LONGITUDE: R 45 08 775,24</p> <p>PERMANENT DATUM: ACKERSOHL ELEVATIONS- ELEV. OF PERM. DATUM: 513.8 M KB: LOG MEASURED FROM: ACKERSOHL DF: 11.8 M 0.0 M ABOVE PERM. DATUM GL: 513.8 M DRLG. MEASURED FROM: ACKERSOHL</p> <p>DATE: 30 APRIL 1994</p> <p>RUN NO: HB252</p>		<p>OTHER SERVICES- BGL-NGS-AMS BHC-GR-AMS -</p> <p>PROGRAM TAPE NO: 38.2 SERVICE ORDER NO: HB252</p>
<p>DEPTH-DRILLER: 8672.8 M</p> <p>DEPTH-LOGGER: 8638.5 M</p> <p>BTM. LOG INTERVAL: 8634.0 M</p> <p>TOP LOG INTERVAL: 7794.5 M</p> <p>CASING-DRILLER: 3000.0 M 6013.5 M 7784.0 M</p> <p>CASING-LOGGER: 3000.5 M 6019.5 M 7794.5 M</p> <p>CASING: 16" K55 13-3/8" 9-5/8 LINE</p> <p>WEIGHT: 72.0000 LB/F 47.0000 LB/F</p> <p>BIT SIZE: 17-1/2" 14-3/4" 12-1/4"</p>		
<p>TYPE FLUID IN HOLE: KTB-HT</p> <p>DENSITY: 1.40 G/C3</p> <p>VISCOSITY: 51.0 S</p> <p>PH: 9.6</p> <p>FLUID LOSS: 3.8 C3</p> <p>SOURCE OF SAMPLE: UMLAUF</p> <p>RM: .944 OHMM AT 28.0 DEGC</p> <p>RMF: .800 OHMM AT 28.0 DEGC</p> <p>RMC: AT</p> <p>SOURCE RMF/RMC: PRESSE/PRESSE</p> <p>RM AT BHT: .207 OHMM AT 205. DEGC</p> <p>RMF AT BHT: .175 OHMM AT 205. DEGC</p> <p>RMC AT BHT: AT 205. DEGC</p> <p>TIME CIRC. STOPPED: 18:00 28/04/94</p> <p>TIME LOGGER ON BTM.: 14:23 30/04/94</p> <p>MAX. REC. TEMP: 205.0 DEGC</p> <p>LOGGING UNIT NO: 701</p> <p>LOGGING UNIT LOC: KTB</p> <p>RECORDED BY: KUEHR</p> <p>WITNESSED BY: BLOCKSDORFF</p>		
<p>REMARKS:</p> <p>9-5/8" LINER KOPF 5893 M , ROHRSCHUH 7784 M (DRILLERTEUFE)</p> <p>SONDE ZENTRIERT GEFAHREN.</p> <p>MAX TEMP MIT 2 MAX. THERMOMETER GEMESSEN</p> <p>DATENREGISTRIERT MIT NORMALSOFTWARE DDBHC 38.2</p> <p>LLS AUSSERHALB MESSBEREICH, NICHT DARGESTELLT.</p> <p>.</p> <p>.</p> <p>.</p> <p>.</p>		
<p>EQUIPMENT NUMBERS-</p> <p>DLC-CA 733 DLS-C 734 DLM- 3857 NSM-A 1799</p> <p>SGC-JC 3450 UDFH-KC 772</p>		

Fig. 7.58

HFMS/HGR/HAMS (HEL-Formation MicroScanner/HEL-Gamma Ray/
HEL-Auxiliary Measurement Sonde)

Operator: KTB

Job No.	Date	Interval
HB-0248	06.02.1994	7769.0 - 8624.0 m

Examples:

Sections of logs: Quality Control curve plot, 8567.0 - 8620.0 m	FIG. 7.59
Caliper, Deviation, Orientation, Temperature plot 8562.0 - 8624.0 m	Fig. 7.60
Processed FMS Images plot, 8608.0 - 8620.4 m	Fig. 7.61

Purpose of Logs:

To obtain information for the geologists about structure, texture, foliation and tectonic features, like slickensides, shear planes, folds, faults and for the detection of fractures and fracture systems. In addition, the borehole trajectory, caliper, temperature and mud resistivity is recorded, providing essential information for the drilling operations.

Operation:

The borehole was drilled with 8 1/2" bit size. In this borehole the HEL-Formation MicroScanner (HFMS) gives a circumferential scanning coverage of about 36 %.

The resistivity Quality Control log is recorded and displayed in real-time (Fig. 7.59). This plot gives information about the performance of the tool and fast data about the borehole trajectory. Via play-back other plots can be made on location, like the Deviation, Orientation, Temperature plot (Fig. 7.60) or later in the computing centre the Processed FMS Images plot (Fig. 7.61).

The record suffered due to uneven tool movement because of poor borehole conditions.

Depth scale of the field records: 1/200, 1/1000, (1/40 on request).

Depth scale of processed data from computing centre: 1/40, 1/10.

Logging speed: 4 - 6 m/min depending on hole conditions.

Technical Information:

Due to borehole temperatures >175° C the Hostile Environment Logging (HEL) Formation MicroScanner Tool was used. This tool includes the resistivity measuring, orientation and deviation systems, gamma ray, mud temperature, mud resistivity and head tension sensors. The total tool is built for withstanding 260° C temperature.

This record represents the deepest HFMS log worldwide.

Sampling rate: "slow channels": 6", "fast channels": 0.1".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Averaged Mud Temperature	(DEGC)
ANOR	Accelerator Computed Norm	(M/S2)
AZ	Slow Accelerometer Z Component	(M/S2)
BS	Bit Size	(MM)
C1,C2	Caliper 1-3, Caliper 2-4	(MM)
DEVI	Deviation	(DEG)
EVOL	EMEX voltage	(V)
FNOR	Magnetic Field Computed Norm	(OER)
GR	Gamma Ray	(GAPI)
HAZI	Hole Azimuth	(DEG)
HTEN	Head Tension	(LBF)
KAL2<KAL1	Shading Code	
KAL1<KAL2	Shading Code	
MRB1-MRB8	Micro-Resistivity Button 1-8	(relative res.)
MRES	Mud Resistivity	(OHMM)
PlAZ	Pad 1 Azimuth	(DEG)
RB	Relative Bearing	(DEG)

Description of Plots:

Resistivity Quality Control plot (Fig. 7.59): This real-time plot serves as quality control during the logging operation. The responses of the resistivity electrodes, the four-arm caliper, deviation and orientation systems, voltage, tool movement in the borehole etc. are recorded and observed on the screen during logging. It is possible to step-through the arrays of resistivity electrodes to control the response.

Caliper, Deviation, Orientation and Temperature plot (Fig. 7.60): This plot gives the borehole trajectory and caliper data, with the gamma ray as depth reference. The temperature record provides first information about the temperature condition in the borehole.

Processed Formation MicroScanner Images plot (Fig. 7.61): This plot is made at the computing centre, after the data has been processed. It represents the final results of the recorded data and can be used for making the interpretation and analysis about the structure, texture, foliation, fractures and fracture systems. Transparent overlays are used for the determination of dip and direction of the fractures, structure and foliation.

		KAL2 < KAL1			
		KAL1 < KAL2			
FNOH(DEF) 40000 80000 ANOR(M/S2) 8.0000 11.000 HTEN(LBF) 2000.0 0.0					
		EVOL(V) 0.0 200.00 MRB8 -1000. 19000. MRB7 -3000. 17000. MRB6 -5000. 15000. MRB5 -7000. 13000. MRB4 -9000. 11000. MRB3 -11000. 9000.0 MRB2 -13000. 7000.0 MRB1 -15000. 5000.0			
DEVI(DEG) 0.0 20.000		GR(GAPI) 0.0 150.00		AZ(M/S2) 6.0000 10.000	
P1AZ(DEG) -40.00 360.00		C2(MM) 200.00 700.00			
HAZI(DEG) -40.00 360.00		C1(MM) 200.00 700.00			

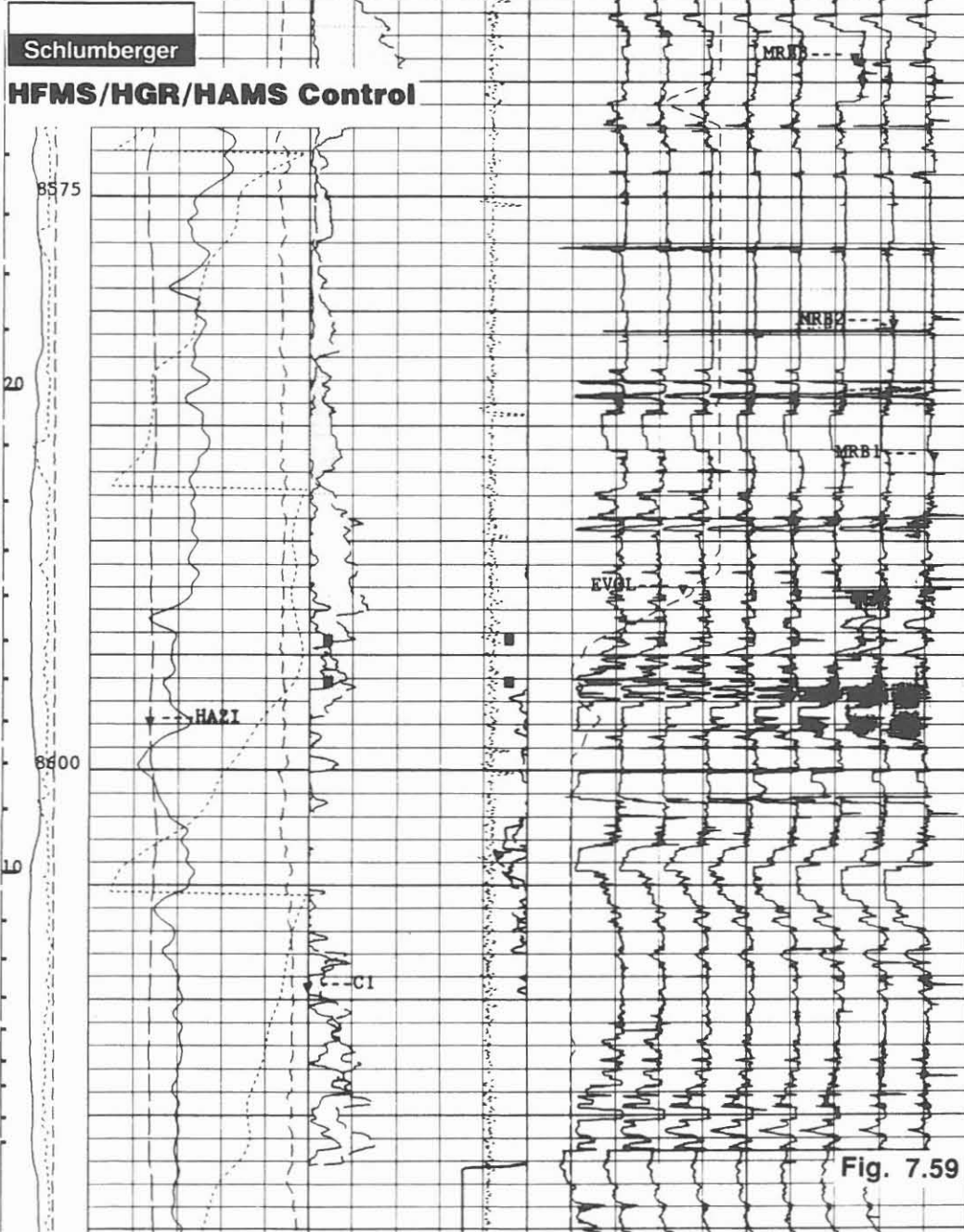
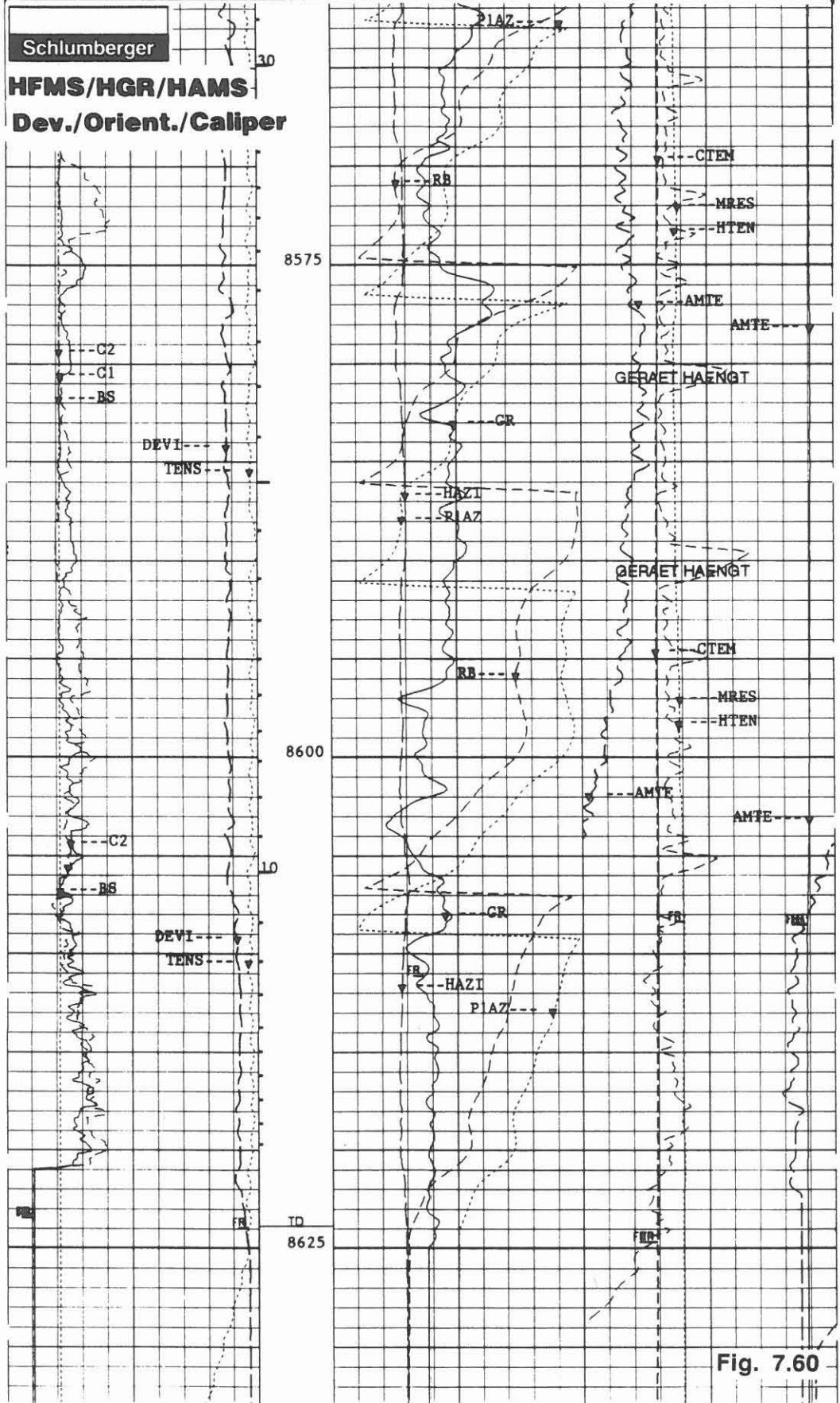
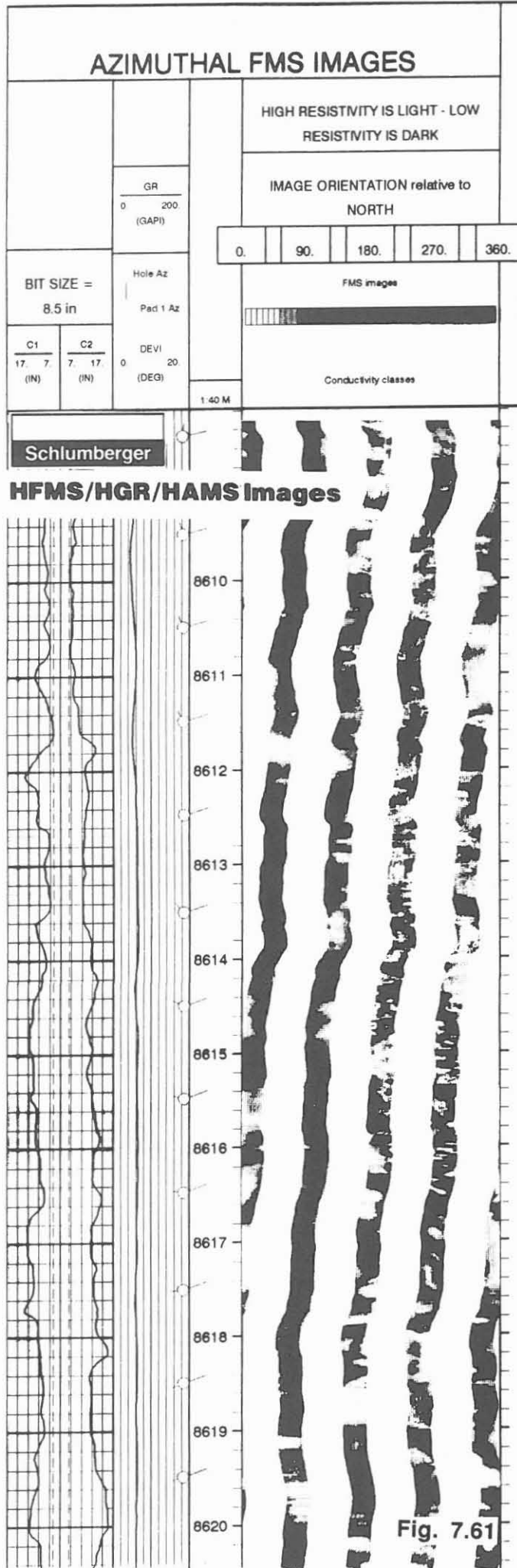


Fig. 7.59

C2(MM)	1000.0	FB(DEG)	360.00	CTEM(DEGC)	200.00
C1(MM)	1000.0	GR(GAPI)	150.00	MRES(OHMM)	20000
BB(MM)	1000.0	HAZI(DEG)	360.00	HTEN(LBF)	1600.0
DEVI(DEG)	20.000	P1AZ(DEG)	360.00	AMTE(DEGC)	5.0000
TENS(LBF)	14000			AMTE(DEGC)	200.00
4000.0					





HTEMP/HSP (HEL-Temperature/HEL-Self Potential)

Operator: KTB

Job No.	Date	Interval
HB-0249	27.02.1994	0.0 - 7784.0 m

Example: Section of log: 7405.0 - 7784.0 m, **Fig. 7.62**

Purpose of log:

This Temperature/Self Potential survey was run prior to a pressure test on request from the drilling department. The temperature conditions in the borehole should be recorded before the test.

Operation:

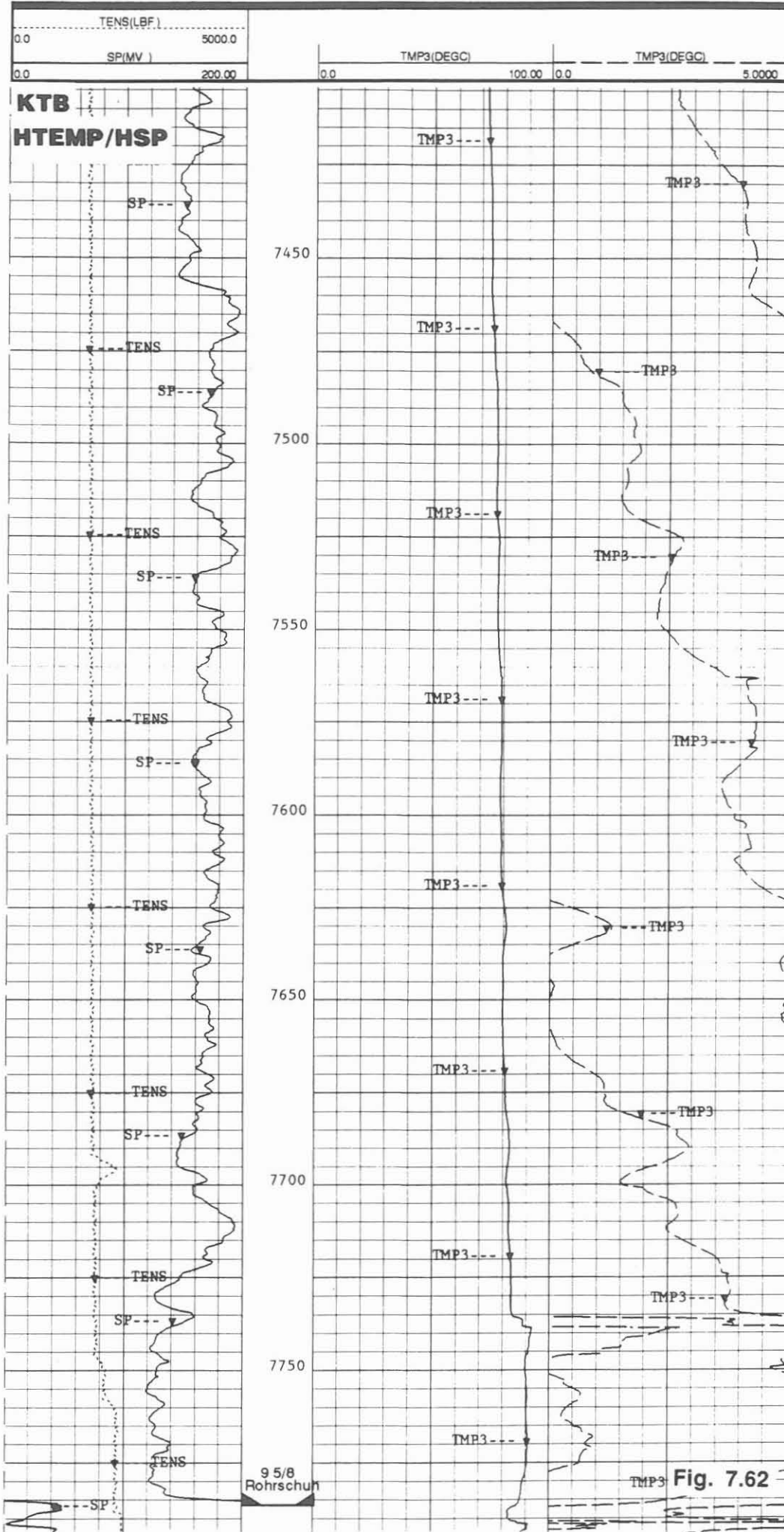
The logs were recorded with the KTB Temperature and Self Potential sondes run in combination. To obtain optimum results, the log was recorded from surface.
Depth scale: 1/1000 only.

Technical Information:

The temperature probe from KTB is of the PT 1000 type. The SP sonde houses a well insulated steel electrode.
Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
SP	Self Potential	(MV)
TMP3	Temperature (° C)	(DEG)
TENS	Tension	(LBF)



HBGL/HNGL/HAMS (HEL-Borehole Geometry Log/HEL-Natural Gamma Spectrometer/HEL- Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0250	29.04.1994	7777.0 - 8660.0 m

Example: Section of log: 8563.0 - 8630.0 m: **Fig. 7.57**

Purpose of log:

To control the trajectory and caliper of the borehole the Borehole Geometry Log is used. It gives hole deviation, orientation and caliper information. In addition the registration of the natural gamma spectra is to resolve the spectra according to the radiation coming from uranium, thorium and potassium. This information is helpful in lithology determination and fracture detection.

Operation:

This log was run to control the condition in the borehole after reaming and circulating. The mud weight was increased to 1.40 kg/dm³ to stabilize the critical borehole conditions. Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min.

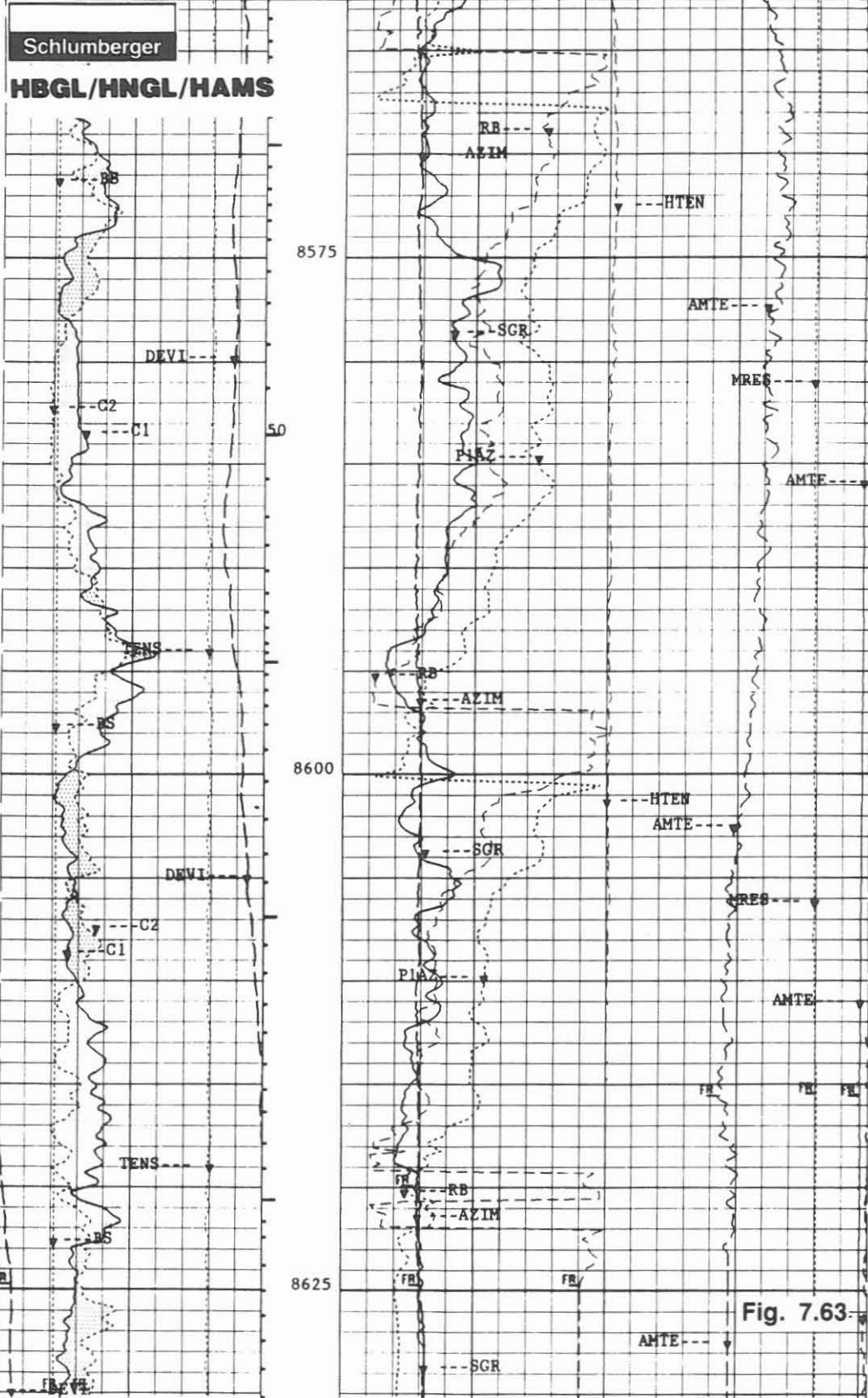
Technical Information:

The BGL-tool used was modified for high temperature conditions ($\geq 200^{\circ}$ C) locally. The standard NGL was placed in a universal dewar housing after being modified too. The NGL-tool calibration was adjusted to compensate for the higher shielding due to the dewar. Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
AZIM	Azimuth	(DEG)
BS	Bit Size	(MM)
C1,C2	Caliper 1,2	(MM)
C1>C2	Shading Code	
C1<C2	Shading Code	
DEVI	Deviation	(DEG)
SGR	Spectroscopy Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
MRES	Mud Resistivity	(OHMM)
RB	Relative Bearing	(DEG)
TENS	Tension	(LBF)

TENS(LBF)	4000.0	14000.			HTEN(LBF)	
BS(MM)	0.0	1000.0			800.00	1800.0
DEVI(DFG)	0.0	20.000	RB(DFG)		0.0	AMTE(DFGC)
C2(MM)	0.0	1000.0	-40.00	360.00	0.0	5.0000
C1(MM)	0.0	1000.0	AZIM(DFG)		05000	MRES(OHMM)
			-40.00	360.00	100.00	15000
			SGR(GAP)		100.00	AMTE(DFGC)
			0.0	150.00	200.00	200.00
C1 > C2						
C1 < C2						



HSLT/HGR/HAMS (HEL-Sonic Logging Tool/HEL-Gamma Ray/HEL-Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0251	30.04.1994	7780.0 - 8646.0 m

Examples:

Section of log: Standard presentation 8569.0 - 8637.0 m,	Fig. 7.64
Waveform log 8535.0 - 8601.0 m,	Fig. 7.65
Compressional and shear transit times, 8564.0 - 8637.0 m	Fig. 7.66
Waveform display from computing centre, 8054.0 - 8098.0 m	Fig. 7.67

Purpose of log:

With the Sonic Logging Tool the acoustic properties of the formations are measured. The transit time record can be used for correlation with seismic data after conversion to velocities. The estimation of in situ porosity, fracture detection and calculations of wellbore stability parameters are possible.

Operation:

This logging run was made with the Gamma Ray and Auxiliary Measurement Sonde. The Sonic signals could be recorded with waveforms. In the computing centre an attempt was made to extract the shear transit times from the waveforms using a modified Slowness Time Coherence method.
Depth scale 1/200, 1/1000; logging speed: 15 m/min.

Technical information:

The tool combination used for this log consisted of the Hostile Environment Logging (HEL) tools. This is equipment rated for 260° C operations. On this run the waveforms were recorded. The evaluation of the shear transit times could therefore be made.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Averaged Mud Temperature	(DEGC)
Cal 1, Cal 2	Caliper 1,2	(IN)
DT	Transit Time	(US/M)
DTCO (STC)	Transit Time Compressional (Slowness Time Coherence)	(US/M)
DTSH (STC)	Transit Time Shear (Slowness Time Coherence)	(US/M)
GR	Gamma Ray	(GAPI)

HTEN	Head Tension	(LBF)
MRES	Mud Resistivity	(OHMM)
TENS	Tension	(LBF)
VDL	Variable Density Log	(US)
WF	Waveforms	(US)

Description of Plots:

Standard Presentation, (Fig. 7.64): This is the plot recorded in the field in real-time. The transit time, gamma ray, mud temperature and mud resistivity curves are recorded directly. The tension from the surface instrument and the head tension from the sensor on the logging tool provide the information about the tool movement in the borehole.

Waveform Log, (Fig 7.65): The waveform log is recorded in real-time with the presentation of the Variable Density Log and superimposed the waveforms. For correlation purposes the Transit Time record is given. Average mud temperature, head tension and normal tension readings are given on log.

Compressional and Shear Transit Times, (Fig. 7.66): This is a log produced at the computing centre after analysis of the waveforms using the slowness time coherence software. The plot shows the computed curves in comparison to the record of the compressional transit time made in the borehole. In addition the ratio of the compressional to the shear velocities and the Poisson ratio is given. The gamma ray is presented as depth correlation curve. The caliper curves are spliced in from a different logging run (failed at 8609.0 m).

Computing Centre Waveform Display, (Fig. 7.67): This display gives the waveform record with the positions of the compressional and shear slowness time coherence determinations. In addition the gamma ray is given as depth reference and the reconstructed Variable Density Log from the waveforms.

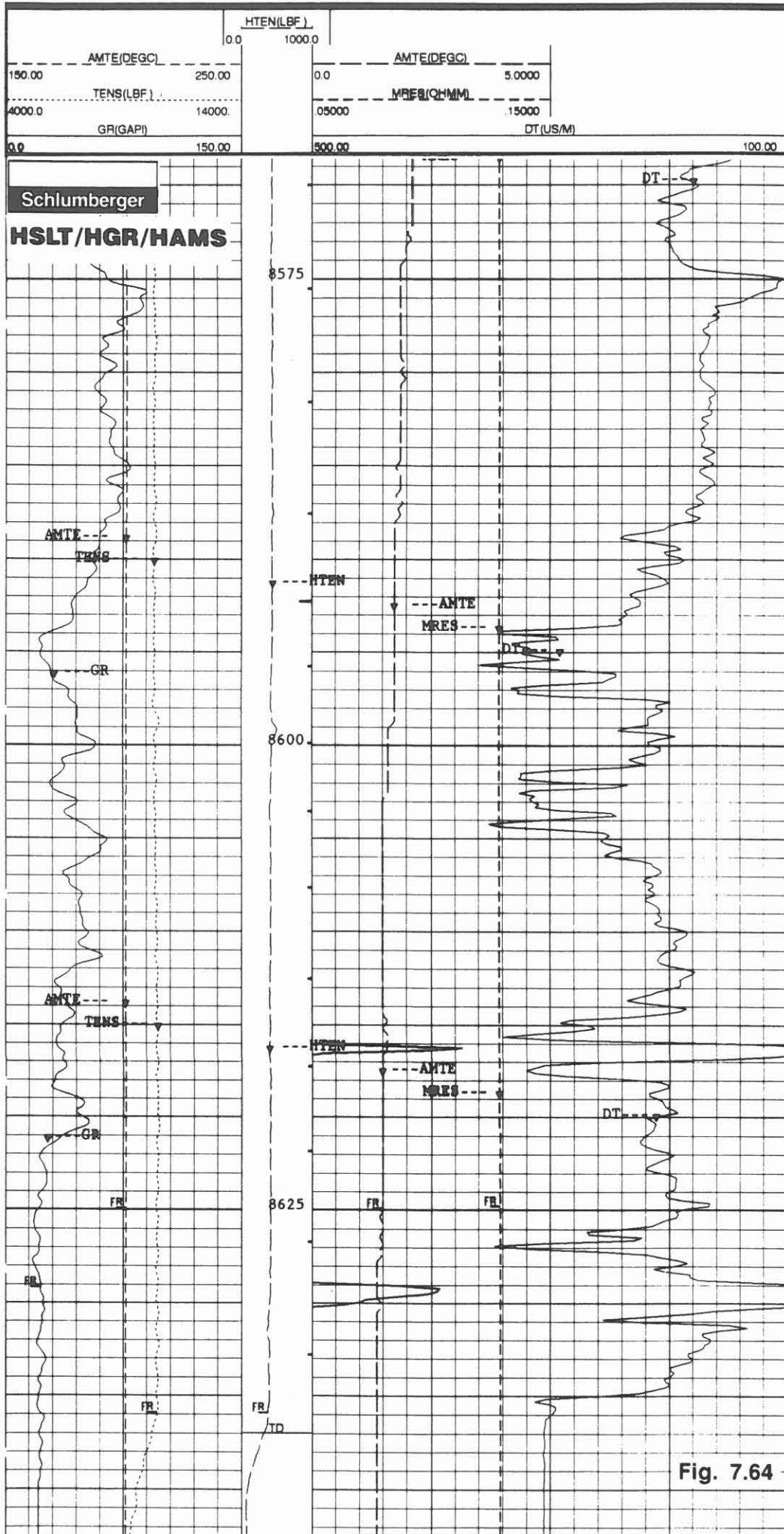
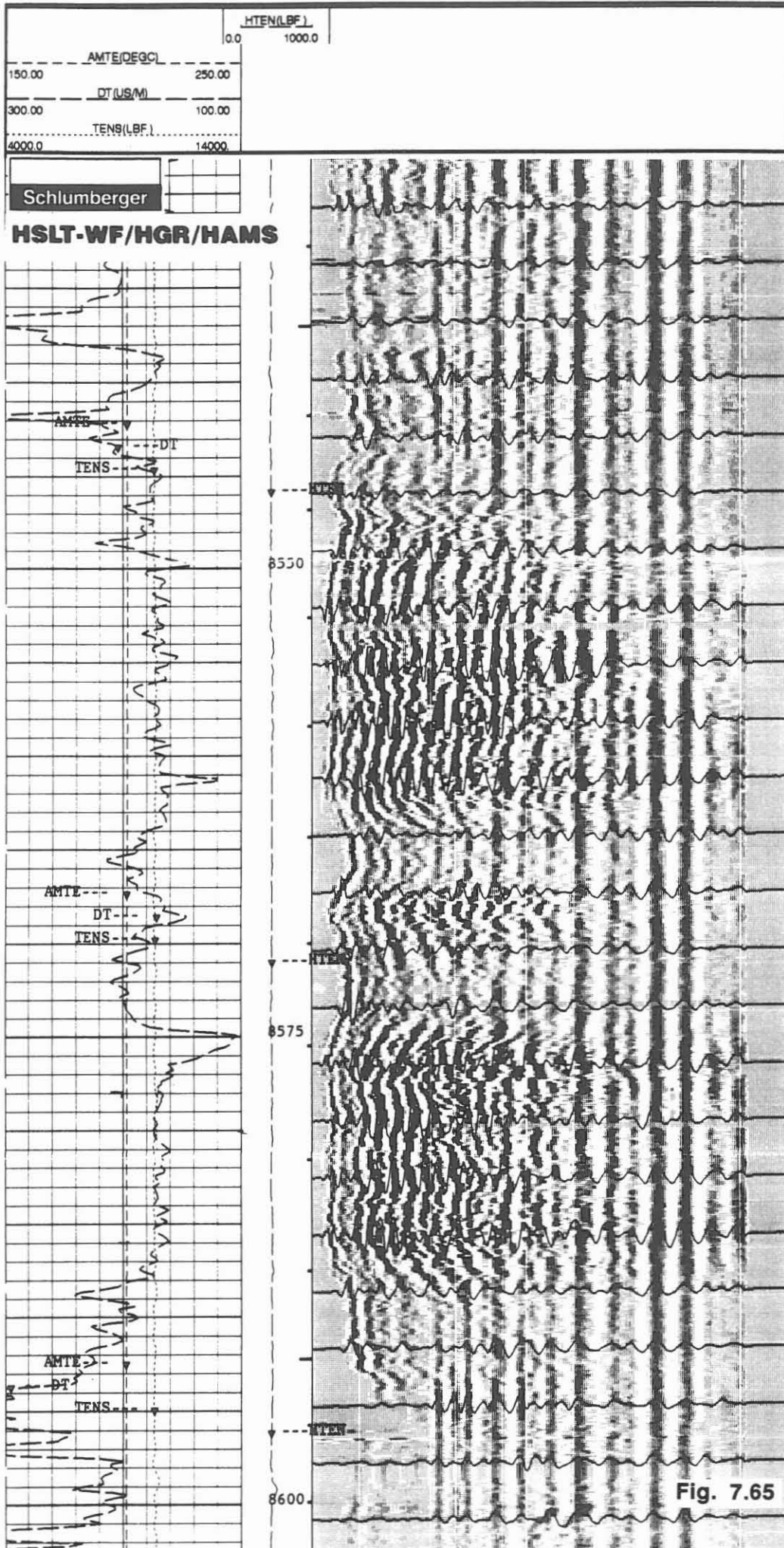
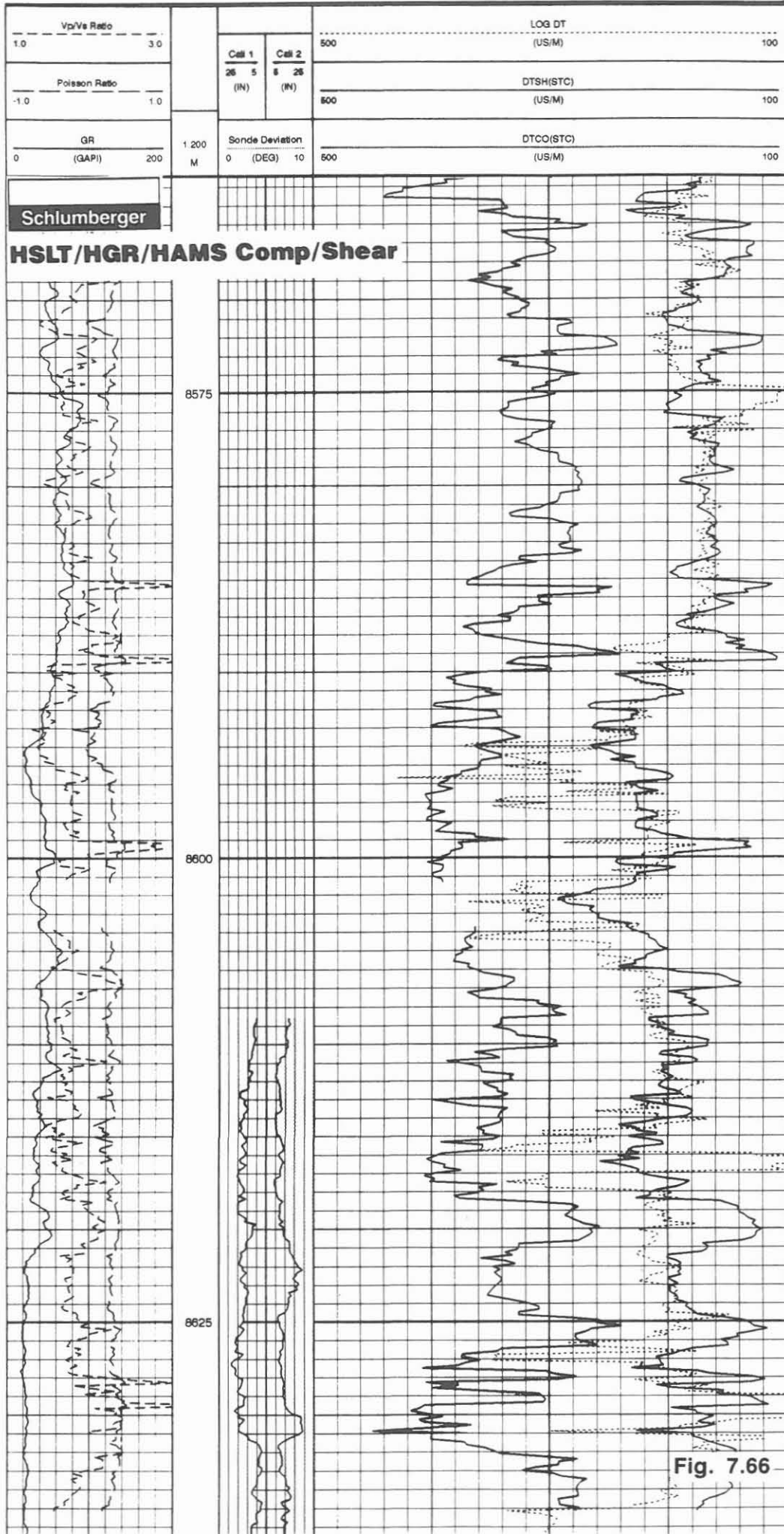
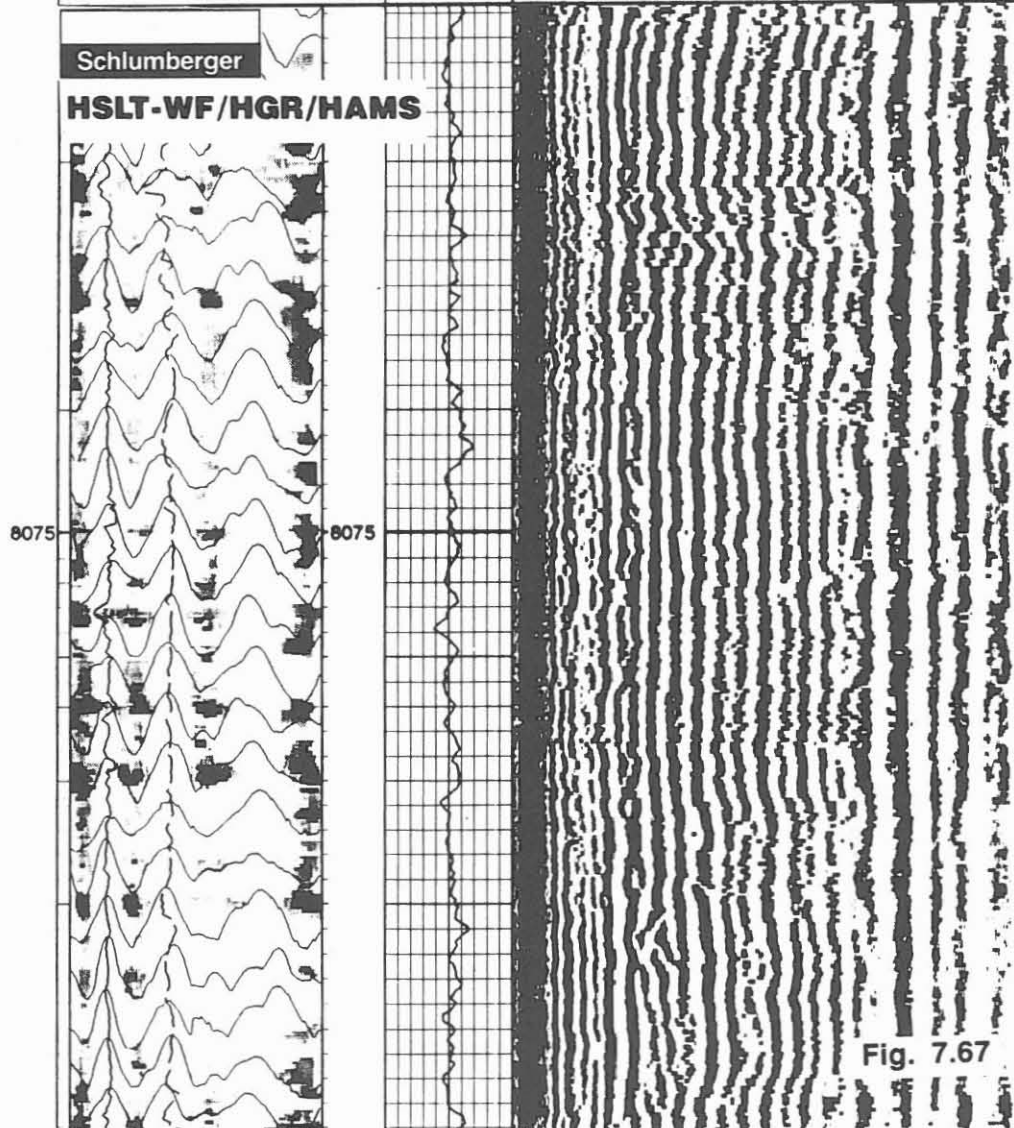
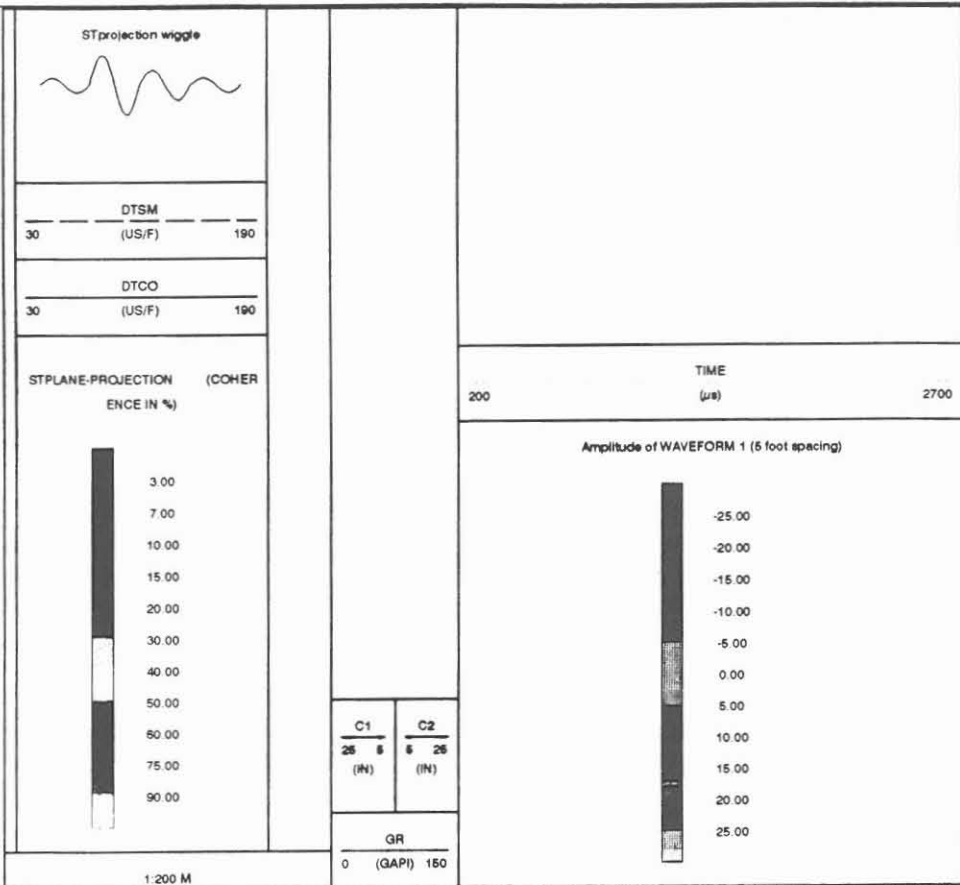


Fig. 7.64







HDLL/HGR/SP (HEL-Dual Laterolog/HEL-Gamma Ray/Self Potential)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0252	30.04.1994	7789.0 - 8647.0 m

Example: Section of log: 8561.0 - 8634.0 m, **Fig. 7.68**

Purpose of log:

This resistivity log has been recorded to enhance the lithological profile by separating dense high resistive zones from sections of low resistivity. The zones of low resistivity could either be intervals with water-filled porosity, fracture systems or contain ore minerals or graphite.

Operation:

The Hostile Environment Logging (HEL) Dual Laterolog was run in combination with the HEL-Gamma Ray for depth reference and the Self Potential to help in detecting mineralized and fractured zones.

The log was recorded with the standard resistivity scale 0.2 - 2000 Ohm m and with a "back-up scale" 2000 - 200 000 Ohm m. The log was recorded with software resistivity limit, cutting the LLD resistivities at about 50 000 Ohm m. No special software is available to suppress this limit when log is recorded with the DLT-C tool.

Depth scale: 1/1000 and 1/200; logging speed 9.0 m due to GR.

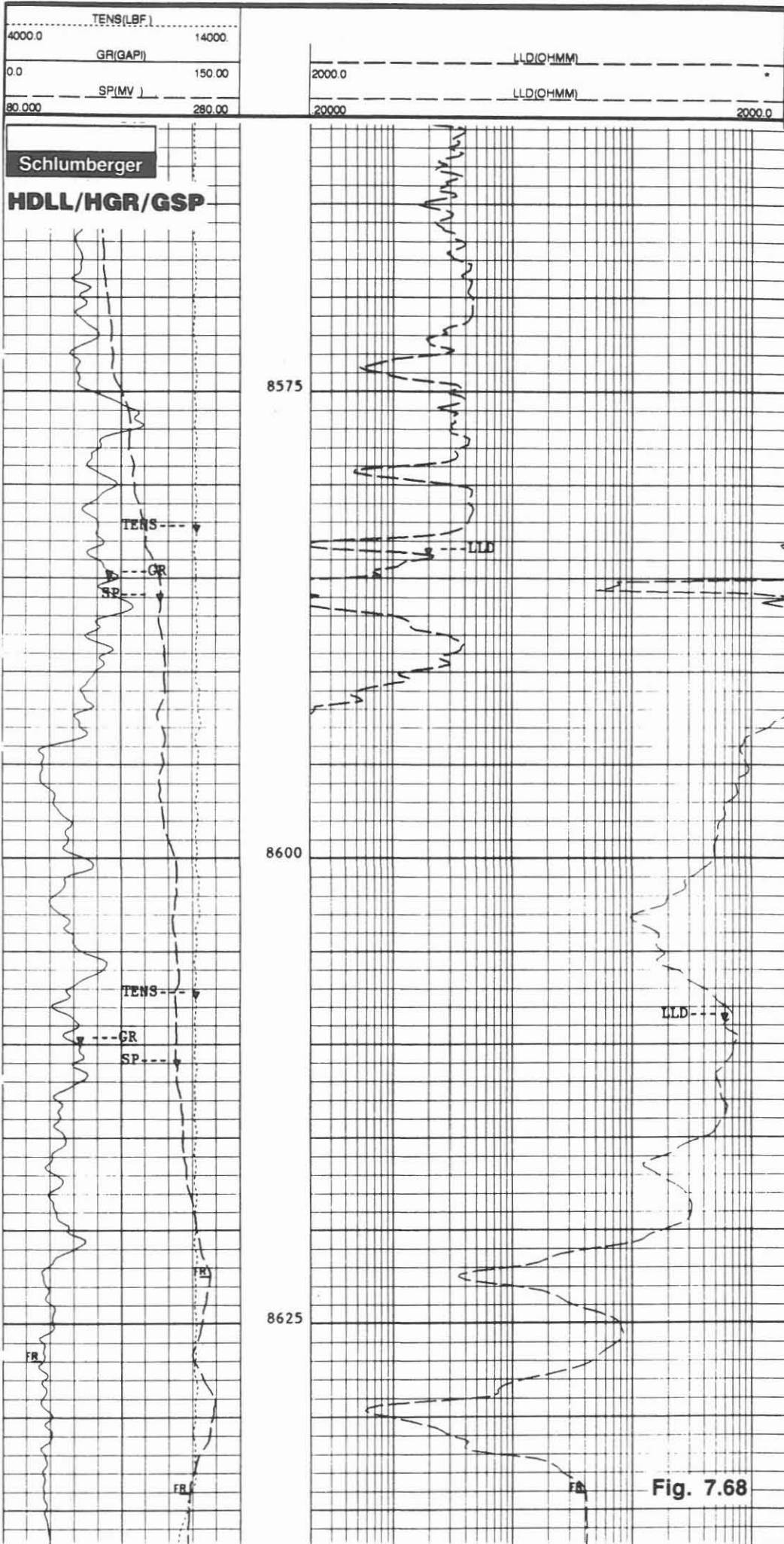
Technical Information:

The Dual Laterolog DLT-C was used. This is the HEL-version of the Dual Laterolog. With the tool normally three resistivity curves are registered: LLS Laterolog-Shallow with a frequency of 270 Hz, LLD Laterolog-Deep and LLG Laterolog-Groningen with a frequency of 32 Hz. The reference "N" for the LLD is placed on the cable, while for LLG on electrode VI on the bridle. For this log the LLS and LLG could not be recorded due to malfunction of the tool. Only LLD is registered.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Descriptions	Units
GR	Gamma Ray	(GAPI)
LLD	Laterolog "deep"	(OHM M)
SP	Self Potential	(MV)
TENS	Tension	(LBF)



HSP/REDOX (HEL-Self Potential/REDOX Potential)

Operator: KTB/University Frankfurt

Job No.	Date	Interval
HB-0253	07.05.1994	7741.0 - 8740.0 m

Example: Section of log: 8350.0 - 8735.0 m, **Fig. 7.69**

Purpose of log:

With the Self Potential/Redox Potential log zones with strong mineralisation or fluid filled fractures can be detected.

Operation:

This logging run was made after the unsuccessful attempt to set the 7 5/8" liner. The borehole was reconditioned for this log. No gamma ray was recorded with this log.

Depth scale: 1/1000 only, logging speed: 25 m/min

Technical Information:

For this log the Hostile Environment Logging (HEL) sonde from the University Frankfurt was deployed. This up-graded sonde performed well.

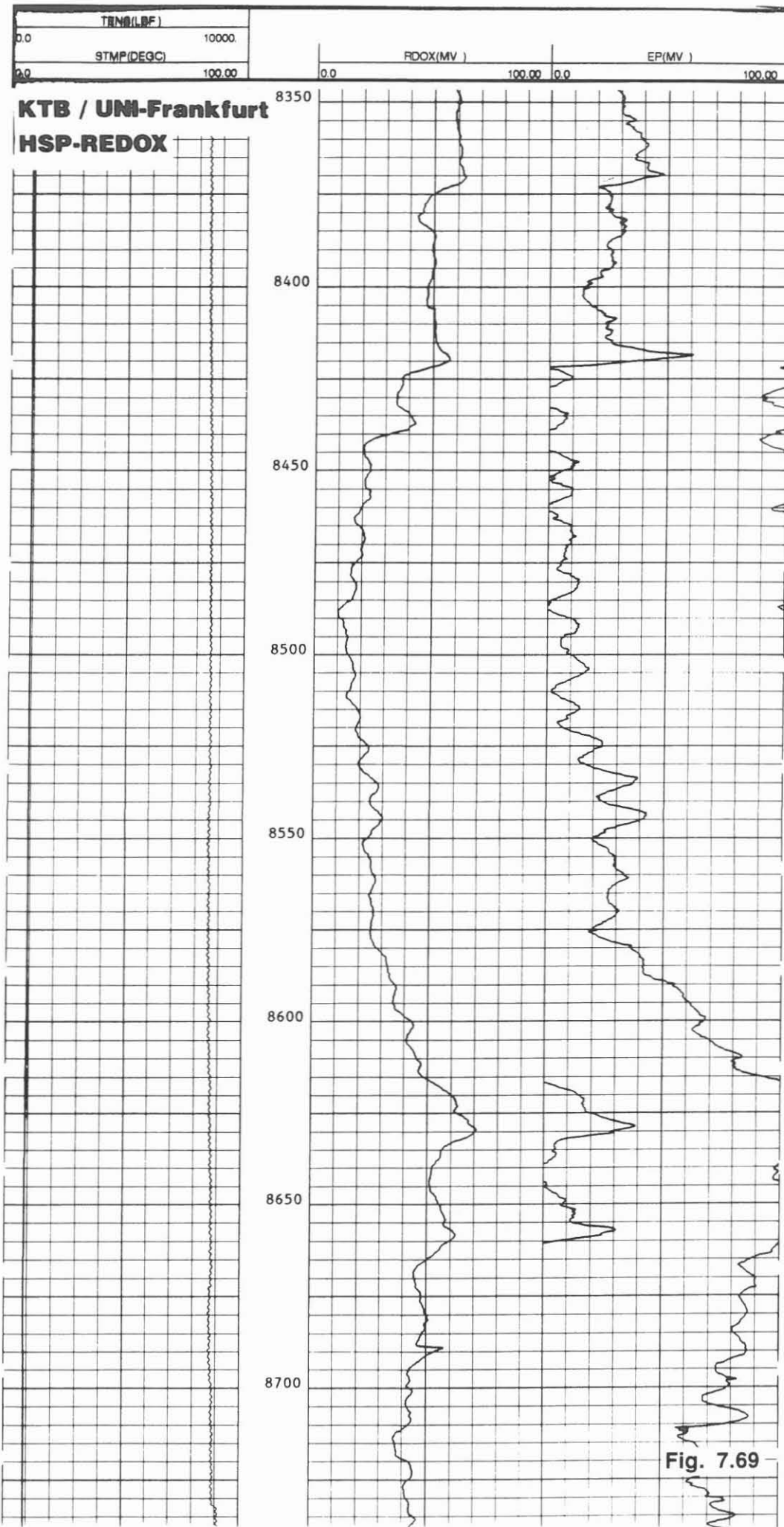
The REDOX Potential can be calculated from the Platinum Sensor Potential value minus the Electrical Potential:

(REDOX=RDOX-EP)

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
EP	Electrical Potential	(MV)
RDOX	Platinum Sensor Potential	(MV)
STMP	Sensor Temperature	(DEGC)
TENS	Tension	(LBF)



HNGL/HAMS (HEL-Natural Gamma Spectrometer Log/HEL- Auxiliary Measurement Sonde - Special Presentation)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0254	08.05.1994	6852.0 - 7852.0 m

Example: Section of log: 7755.0 - 7825.0 m: **Fig. 7.70**

Purpose of log:

The registration of the natural gamma spectra is to resolve the spectra according to the radiation coming from uranium, thorium and potassium. The information is helpful in lithology determination and fracture detection.

Operation:

This log was run to complete the record for the total borehole. Unfortunately this record had to be made through casing as the interval was not logged before in open hole.

The log records in track I the total gamma ray (SGR), the gamma ray minus the uranium component (CGR), temperature and tension, in track II and III are the single component curves for uranium, thorium and potassium presented.

Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min.

Technical Information:

The tool used was modified for HEL-conditions locally. The standard NGL was placed in a universal dewar housing. The tool calibration was adjusted to compensate for the higher shielding due to the dewar

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
CGR	Computed Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
POTA	Potassium Content	(%)
SGR	Spectroscopy Gamma Ray	(GAPI)
THOR	Thorium Content	(PPM)
URAN	Uranium Content	(PPM)

		HTEN(LBF)			
		0.0	1000.0		
0.0	CGR(GAPI)	150.00			
	SGR(GAPI)				
0.0	TENS(LBF)	150.00			
4000.0	AMTE(DEGC)	14000			
150.00		250.00			
		THOR(PPM)		POTA	
		0.0	40,000	0.0	10000
		URAN(PPM)		30,000	
		-10.00			
CGR < SGR					

Schlumberger

HNGL/HAMS-Spec.

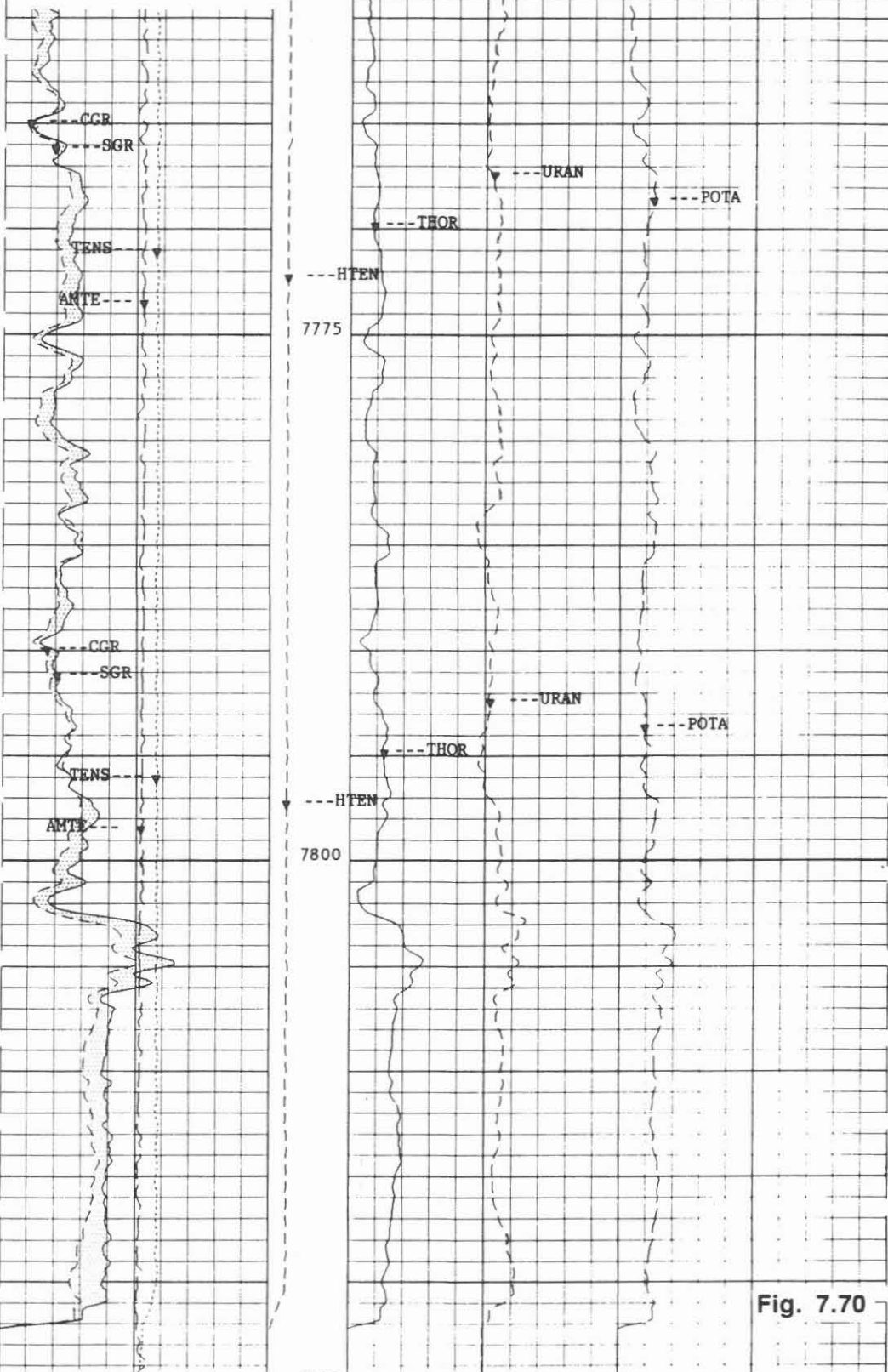


Fig. 7.70

HNGL/HAMS (HEL-Natural Gamma Spectrometer Log/HEL- Auxiliary Measurement Sonde - Ratio Presentation)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0254	08.05.1994	6852.0 - 7852.0 m

Example: Section of log: 7737.0 - 7807.0 m: **Fig. 7.71**

Purpose of log:

The registration of the natural gamma spectra is to resolve the spectra according to the radiation coming from uranium, thorium and potassium. The information is helpful in lithology determination and fracture detection.

Operation:

This log was run to complete the record for the total borehole. Unfortunately this record had to be made through casing as the interval was not logged before in open hole.

The log records in track I the total gamma ray (SGR), the gamma ray minus the uranium component (CGR), temperature and tension, in track II the ratios uranium:potassium, uranium:thorium and thorium:potassium and in track III are the single component curves for uranium, thorium and potassium presented.

Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min.

Technical Information:

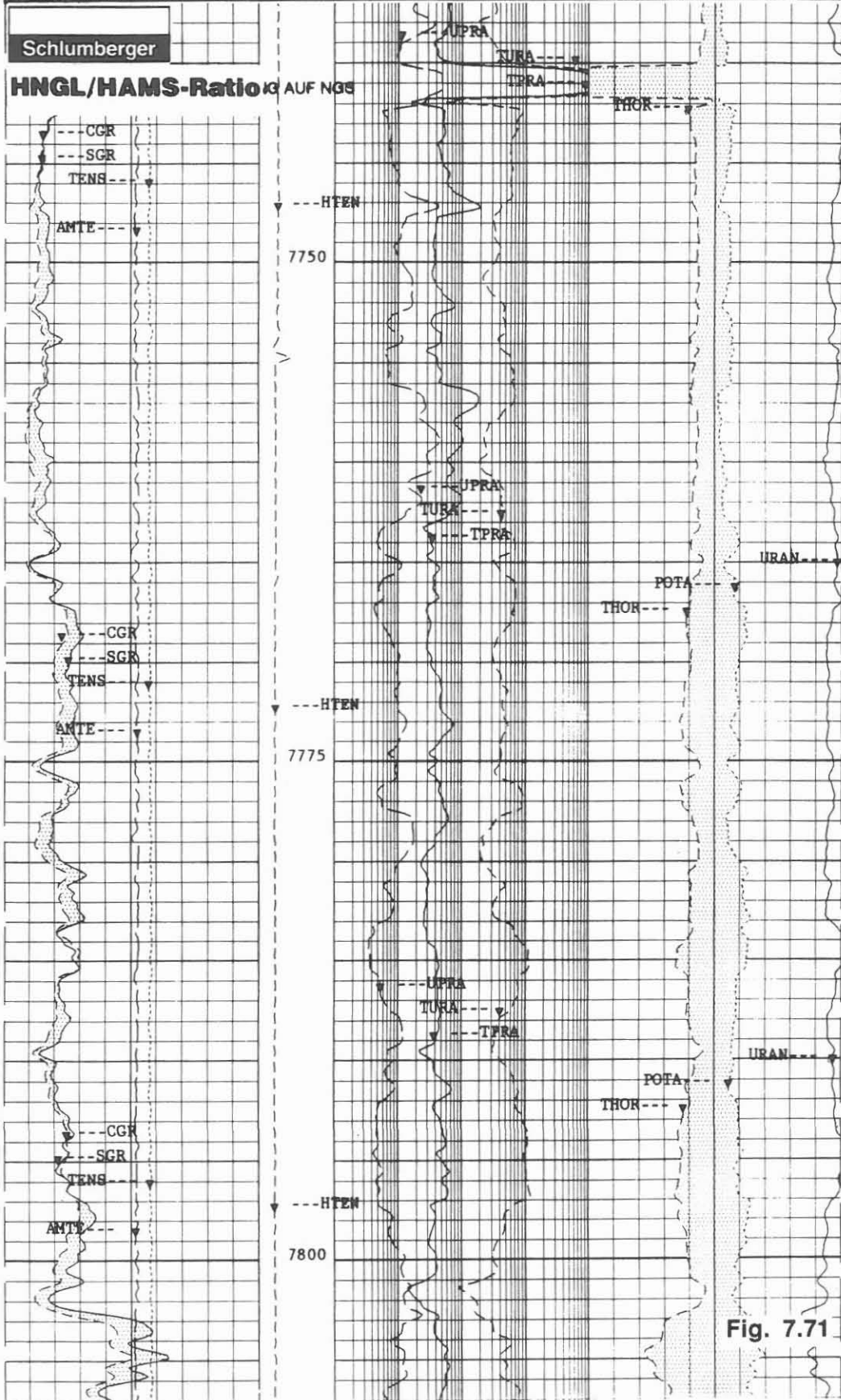
The tool used was modified for HEL-conditions locally. The standard NGL was placed in a universal dewar housing. The tool calibration was adjusted to compensate for the higher shielding due to the dewar.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
CGR	Computed Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
POTA	Potassium Content	(%)
SGR	Spectroscopy Gamma Ray	(GAPI)
THOR	Thorium Content	(PPM)
TPRA	Thorium:Potassium Ratio	
TURA	Thorium:Uranium Ratio	
UPRA	Uranium:Potassium Ratio	
URAN	Uranium Content	(PPM)

		HTEN(LBF.)							
		0.0	1000.0						
CGR(GAPI)		0.0	150.00	UPRA		10000		1000.0	
SGR(GAPI)		0.0	150.00	TURA		01000		100.00	
TENS(LBF.)		4000.0	14000	TPRA		10000		1000.0	
AMTE(DEGC)		180.00	250.00	THOR(PPM)		20.000		0.0	
				URAN(PPM)		10.000		0.0	
				POTA		0.0		0.0	
				THOR < POTA		0.0		0.0	
				CGR < SGR					



MFC/HGR/HAMS (Multi-Finger Caliper/HEL-Gamma Ray/HEL-Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0255	11.05.1994	7198.0 - 7790.0 m

Examples:

Section of log: Temperature and Gamma Ray presentation 7410.0.0 -7780.0 m, **Fig. 7.72**
Multi-Finger Caliper presentation 7644.0 - 7718.0 m **Fig. 7.73**

Purpose of log:

This is the first record of the Multi-Finger Caliper log in the 9 5/8" liner string. With this control run damage or wear of the 9 5/8" liner should be checked as the liner will be exposed to high pressures during the hydraulic frac experiment.

Operation:

The log was recorded from liner shoe at 7790.0 m up to the liner hanger. During the log the tool had to be closed several times due to debris collected. At some stage the tool could not be closed completely and radius 2 became inoperational. When on surface one damaged finger was found causing the problem.

No major damage, corrosion or wear could be detected.

Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min

Technical Information:

An array of 60 independent fingers, mounted around the circumference of the tool, ride on the inner surface of the casing and record any anomalies. For three sectors of 120° each the minimum and maximum caliper signals are recorded. In addition, the minimum and maximum signal of the total circumference are registered too.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
GR	Gamma Ray	(GAPI)
ICR	Inner Casing Radius	(MM)
MNRD	Minimum Radius	(MM)
MXRD	Maximum Radius	(MM)
RAD1-6	Minimum/Maximum Radius	(MM)
TENS	Tension	(LBF)

Description of Plots:

Temperature and Gamma Ray plot (Fig. 7.72): This plot gives these two curves. A maximum temperature of 188° C was recorded well above the temperature limit of the caliper tool.

Multi-Finger Caliper plot (Fig. 7.73): The nominal inner diameter of the 9 5/8" liner, radius 1,3,4,5,6 and the gamma ray curves are given on this plot. For an optical presentation the curves ICR,RAD4,5,6 and ICR,RAD1,3 are shown as casing profile. RAD2 could not be recorded due to a bent finger. The gamma ray is used as depth reference.

TENS(LBF)	0.0	AMTE(DEGC)	10.000
GR(GAPI)	150.00	AMTE(DEGC)	200.00
Scale Changes	0.0	AMTE	10.000
	0.0	7791	5.0000

Schlumberger

MFC/HGR/HAMS Temp./GR

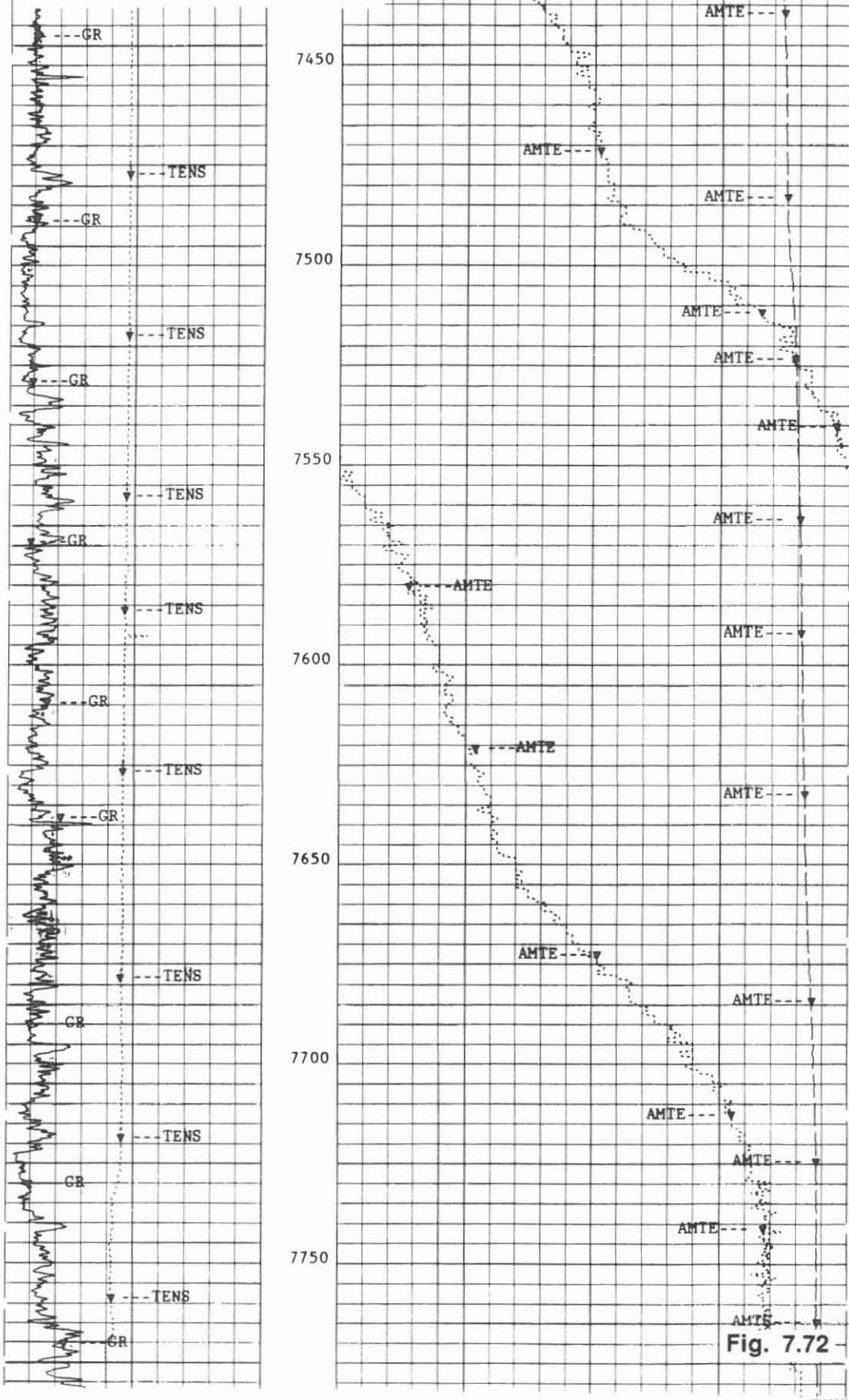
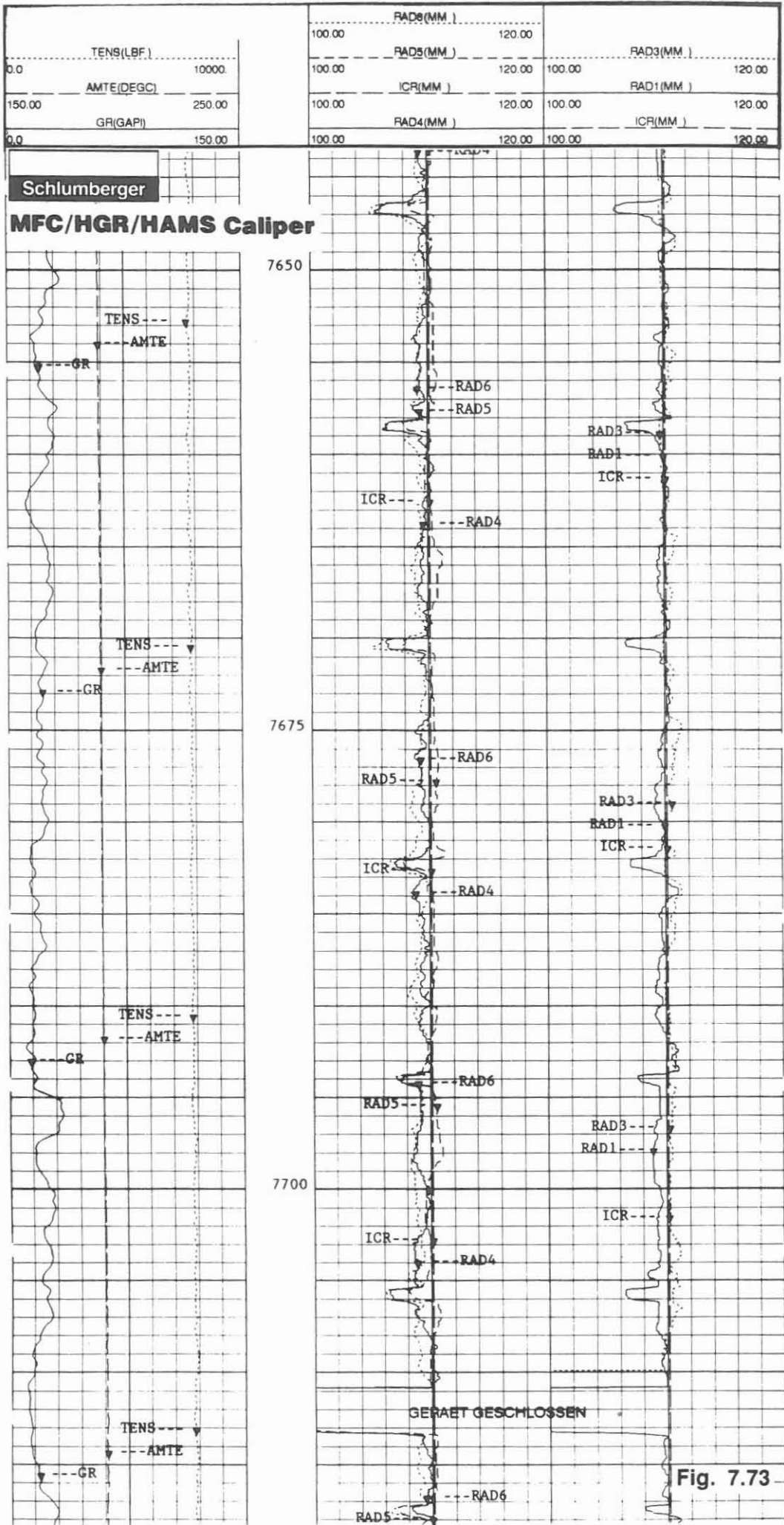


Fig. 7.72



7. Logging Series at 9101.0 m depth:
(borehole 6)

J. K. Draxler

7. Logging Series at 9101.0 m depth (final depth).

The borehole was side-tracked through a pre-cut window in the 7 5/8" liner and drilled to a depth of 9101.0 m when stability problems started again. The drilling string became stuck several times and could only be freed by jarring. With the drill pipes the bottom of the hole could not be reached any more. In this situation it was decided to condition the borehole to a depth of 9085.0 m only and try to log the open hole section from this depth to 8634.8 m, the lower depth of the window.

On the first run with the HSLT/HNGL/HAMS-combination the tool hit a bridge at the depth of 8667.0 m. On the second run, with the shorter HNGL/HAMS-tool, the instrument stopped at the same depth.

After running the drill pipes and cleaning the hole with great difficulties down to the depth of 9085.0 m by re-drilling and circulating, the decision was taken to set a 5 1/2" liner to protect the borehole. The liner was set and cemented at a depth of 9030.0 m. The liner shoe was drilled out and the remaining open section of the borehole was reconditioned down to 9085.0 m depth for logging.

On the first logging run with the HSLT/HNGL/HAMS-combination the tool could not pass the 7 5/8" liner hanger. On the second run, with the HFDC/HCNL/HGR-combination, a string with a smaller outside diameter, a depth of 8587.0 m in the 5 1/2" liner could be reached.

Again the borehole had to be cleaned by running the drilling string and circulate.

At last, in the time from November 25 - 26, and December 3 - 5, 1994, the final logging operation could be made:

On the first run the HSLT-WF/HNGL/HAMS was recorded in open hole with the Gamma Ray Spectrometer in the liner up to the depth of 8345.0 m. After running the tool down to the liner shoe again and switching it over to Cement Bond Mode, the CBL was recorded over the 5 1/2" liner.

The second run was made with the HFDC/HCNL/HGR. In the open hole all three logs were recorded, while in the cased section only neutron and gamma ray were recorded.

With the REDOX-sonde from the University Frankfurt the electrical potential and the signal from the platinum sensor were recorded in the open hole section. After this record the sonde remained stationary at the depth of 9065.0 m for about 20 hours in the borehole for the Dipole-Dipole Experiment. During this time the maximum temperature of 249.5° C was recorded.

The trial to run the Fluxgate Magnetometer from the University Braunschweig failed due to transmission problems over the 9500 m logging cable.

During the following Fluid Test, - a drill stem production test over the open hole section - a run with two Fluid Samplers in tandem was made. Fluid produced from the formation should be collected. During the test about 4.9 cubic meters of fluid were produced. But, this volume produced did not replace the mud volume below the test valve. As the test valve was the restriction in the string, the Fluid Sampler could not pass.

The two sample chambers were filled with borehole fluid. The analysis indicated mainly cushion fluid.

After pulling the test string, a further run with the Fluid Sampler was made down to the open hole section. From the mud resistivity measurement clear indications of fluid with a higher salinity than the mud had entered the borehole. A sample of this fluid could not be collected. The sampling tool had collapsed under the pressure and temperature conditions in the borehole.

With this last run the logging operations in the KTB-Oberpfalz HB were terminated.

Information about the borehole condition on November 26, 1994, are given on log heading enclosed as **Fig. 7.74.**

Schlumberger

HB263 *FDC-CNL-GR* 26/11/94

CSU Logging

<p>COMPANY: NIEDERSAECHSISCHES LANDESAMT F. BODENFORSCHUNG</p> <p>WELL: KTB-OFF-HB</p> <p>FIELD: OBERPFALZ</p> <p>KREIS: NEUSTADT/WN</p> <p>LAND: BAYERN</p> <p>NATION: BRD</p> <p>LOCATION: NAABDEMENREUTH WINDISCHESCHENBACH</p> <p>LATITUDE: H 55 19 864,35</p> <p>LONGITUDE: R 45 08 775,24</p> <p>PERMANENT DATUM: ACKERSOEHLE ELEVATIONS- ELEV. OF PERM. DATUM: 513.8 M KB: LOG MEASURED FROM: ACKERSOEHLE DF: 11.8 M 0.0 M ABOVE PERM. DATUM GL: 513.8 M DRLG. MEASURED FROM: ACKERSOEHLE</p> <p>DATE: 26 NOV 1994</p> <p>RUN NO: HB263</p>		<p>OTHER SERVICES- BHC/WF-NGS CBL SP-REDOX</p> <p>PROGRAM TAPE NO: 38.2 SERVICE ORDER NO: HB263</p>												
<p>DEPTH-DRILLER: 9101.0 M</p> <p>DEPTH-LOGGER: 9085.0 M</p> <p>BTM. LOG INTERVAL: 9082.0 M</p> <p>TOP LOG INTERVAL: 8600.0 M</p> <p>CASING-DRILLER: 7784.8 M 8665.0 M 9031.0 M</p> <p>CASING-LOGGER: 9037.0 M</p> <p>CASING: 9-5/8"LINE 7-5/8"LINE 5-1/2"LINE</p> <p>WEIGHT:</p> <p>BIT SIZE: 12-1/4" 8-1/2" 6-1/2"</p>														
<p>TYPE FLUID IN HOLE: KTB-HT</p> <p>DENSITY: 1.35 G/C3</p> <p>VISCOSITY: 120. S</p> <p>PH: 9.8</p> <p>FLUID LOSS: 13.0 C3</p> <p>SOURCE OF SAMPLE: UMLAUF</p> <p>RM: 1.180 OHMM AT 18.0 DEGC</p> <p>RMF: .810 OHMM AT 18.0 DEGC</p> <p>RMC: AT</p> <p>SOURCE RMF/RMC: PRESSE/PRESSE</p> <p>RM AT BHT: .175 OHMM AT 246. DEGC</p> <p>RMF AT BHT: .120 OHMM AT 246. DEGC</p> <p>RMC AT BHT: AT 246. DEGC</p> <p>TIME CIRC. STOPPED: 12:00 24/11/94</p> <p>TIME LOGGER ON BTM.: 01:00 26/11/94</p> <p>MAX. REC. TEMP: 246.0 DEGC</p> <p>LOGGING UNIT NO: 701</p> <p>LOGGING UNIT LOC: KTB</p> <p>RECORDED BY: KUEHR</p> <p>WITNESSED BY: DRAXLER</p>														
<p>REMARKS:</p> <p>9-5/8" LINER KOPF 5893 M , RS 7784.8 M (DRILLERTEUFE)</p> <p>7-5/8 " LINER KOPF 7695.7 , FENSTER 8625-8629 M (DRILLERTEUF)</p> <p>5-1/2" LINER KOPF 8544 , RS 9031 M (DRILLERTEUFE)</p> <p>MAX. TEUFE 9101 M WURDE AUCH NICHT MEHR MIT BOHRSTRANG ERREICHT (LOCH WURDE NUR BIS 9080 M BEFAHREN)</p> <p>SONDE EXZENTRIERT GEFAHREN GERAET BEI 8600 AUSGEFALLEN</p>														
<p>EQUIPMENT NUMBERS-</p> <table> <tr> <td>ATM-AA 130</td> <td>ATC-CB 21</td> <td>HEH-B 30</td> <td>FGC 06</td> </tr> <tr> <td>FGH-B 150</td> <td>GSR-J 5342</td> <td>SFT-139 19</td> <td>ECD-C 32</td> </tr> <tr> <td>CNC-DA 86</td> <td>CNH-CA 147</td> <td>NSR-L 3020</td> <td>AH-127</td> </tr> </table>			ATM-AA 130	ATC-CB 21	HEH-B 30	FGC 06	FGH-B 150	GSR-J 5342	SFT-139 19	ECD-C 32	CNC-DA 86	CNH-CA 147	NSR-L 3020	AH-127
ATM-AA 130	ATC-CB 21	HEH-B 30	FGC 06											
FGH-B 150	GSR-J 5342	SFT-139 19	ECD-C 32											
CNC-DA 86	CNH-CA 147	NSR-L 3020	AH-127											

Fig. 7.74

HSLT/HNGL/HAMS (HEL-Sonic Logging Tool/HEL-Gamma Ray Spectrometer Log/HEL-Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0262	25.11.1994	8345.0 - 9083.0 m

Examples:

Section of log: Standard presentation 9012.0 - 9083.0 m,	Fig. 7.75
Waveform/Variable Density Log 9020.0 - 9083.0 m,	Fig. 7.76

Purpose of log:

With the Sonic Logging Tool the acoustic properties of the formations are measured. The transit time record can be used for correlation with seismic data after conversion to velocities. The estimation of in situ porosity, fracture detection and calculations of wellbore stability parameters are possible.

Operation:

This logging run was made with the Gamma Ray Spectrometer and Auxiliary Measurement Sonde. The Sonic signals could be recorded with waveforms. The log was recorded in open hole from 9083.0 - 9038.0 m. Inside the 5 1/2" liner the Sonic Log was stopped at about 9000.0 m depth. Only the gamma ray spectrometer and the temperature were recorded up to 8345.0 m depth.

Depth scale 1/200, 1/1000; logging speed: 9 m/min.

Technical information:

The tool combination used for this log consisted of the Hostile Environment Logging (HEL) tools. This is equipment rated for 260° C operations. On this run the waveforms were recorded. An evaluation for shear transit time was made. Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Averaged Mud Temperature	(DEGC)
DT	Transit Time	(US/M)
HTEN	Head Tension	(LBF)
MRES	Mud Resistivity	(OHMM)
SGR	Spectrometer Gamma Ray	(GAPI)
TENS	Tension	(LBF)
TT1-4	Transit Time from Subcycle 1-4	(US)
VDL	Variable Density Log	(US)
WF	Waveforms	(US)

Description of Plots:

Standard Presentation, Fig. 7.75: This is the plot recorded in the field in real-time. The transit time, spectrometer gamma ray, mud temperature and mud resistivity curves are recorded directly. The tension from the surface instrument and the head tension from the sensor on the logging tool provide the information about the tool movement in the borehole.

Waveform Log, Fig. 7.76: The waveform log is recorded in real-time with the presentation of the Variable Density Log and superimposed the waveforms. For correlation purposes the spectrometer gamma ray record is given. In addition the transit times of the subcycles 1-4 and the average mud temperature, head tension and normal tension readings are presented on the log.

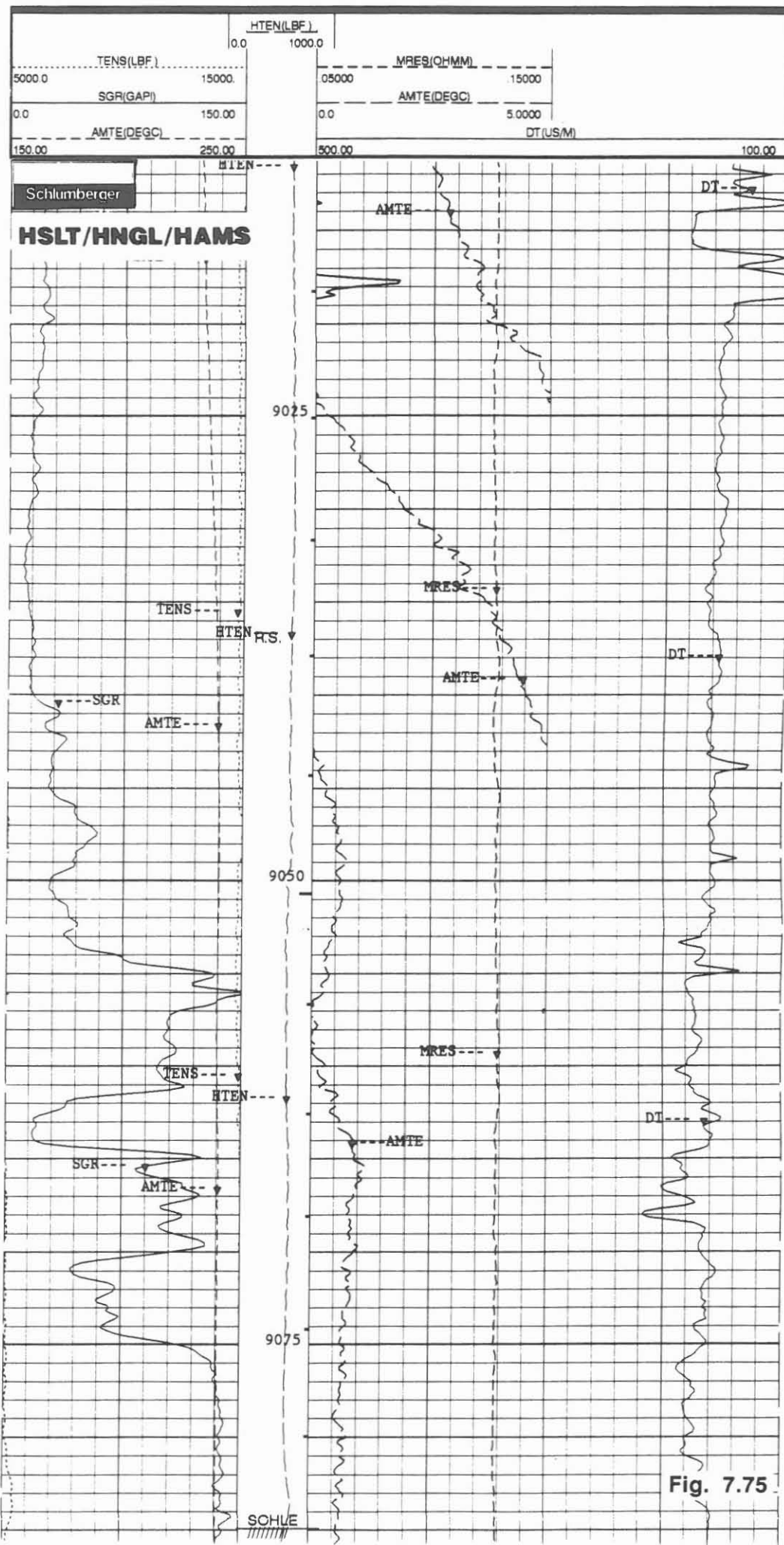
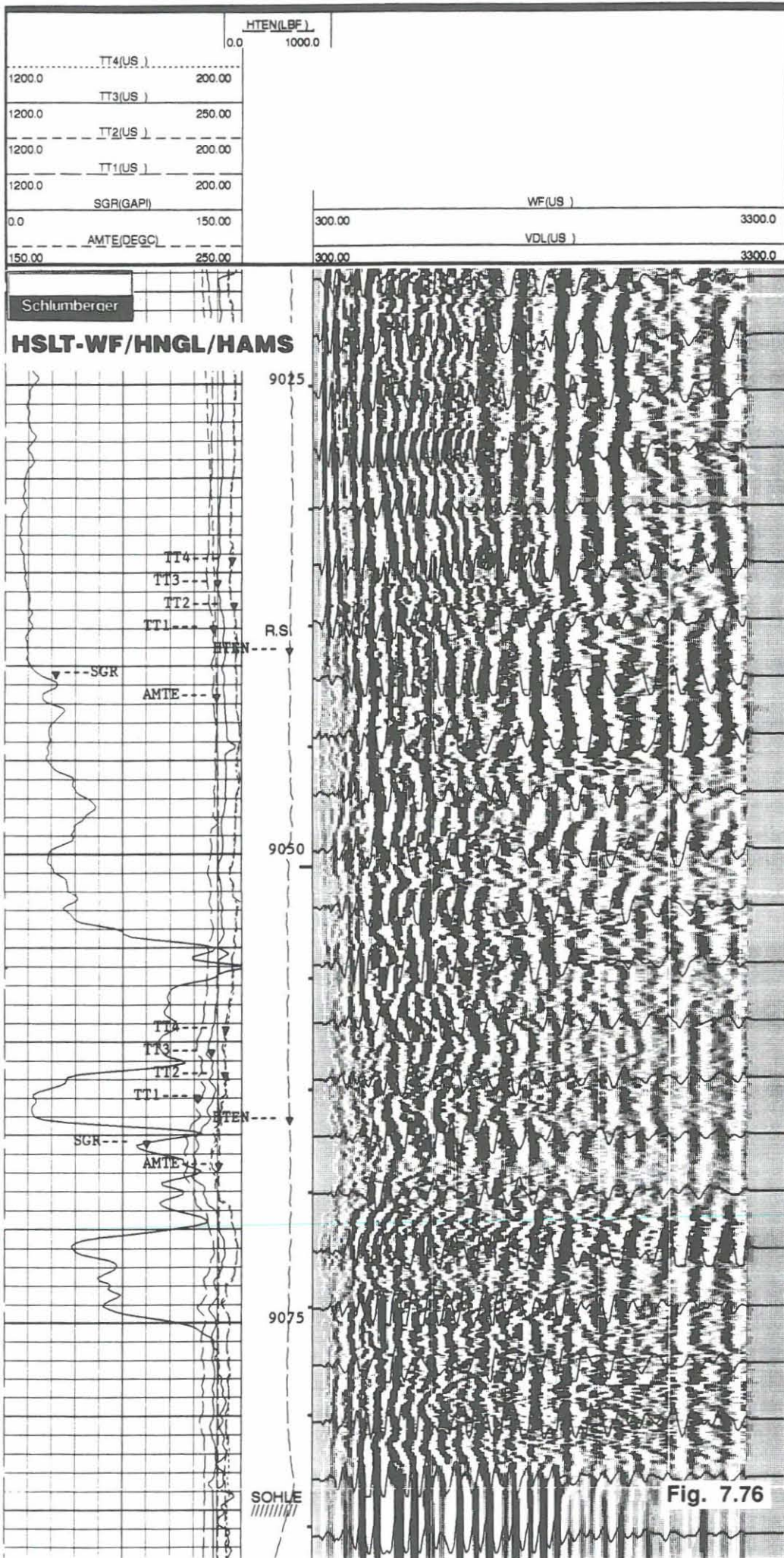


Fig. 7.75



HSLT/HNGL/HAMS (HEL-Sonic Logging Tool/HEL-Natural Gamma Spectrometer Log/HEL- Auxiliary Measurement Sonde - Special Presentation)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0262	25.11.1994	8345.0 - 9083.0 m

Example: Section of log: 9016.0 - 9083.0 m: **Fig. 7.77**

Purpose of log:

The registration of the natural gamma spectra is to resolve the spectra according to the radiation coming from uranium, thorium and potassium. The information is helpful in lithology determination and fracture detection.

Operation:

This log was run in combination with the HSLT. The log was recorded in open hole from 9083.0 - 9038.0 m and in the 5 1/2" and 7 5/8" liner up to 8345.0 m. It presents in track I the total gamma ray (SGR), the gamma ray minus the uranium component (CGR), temperature and tension, in the depth track the head tension and in track II and III are the single component curves for uranium, thorium and potassium. Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min.

Technical Information:

The HNGL-tool used was modified for HEL-conditions locally. The standard NGL was placed in a universal dewar housing. The tool calibration was adjusted to compensate for the higher shielding due to the dewar. Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
CGR	Computed Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
POTA	Potassium Content	(%)
SGR	Spectroscopy Gamma Ray	(GAPI)
THOR	Thorium Content	(PPM)
URAN	Uranium Content	(PPM)

		HTEN(LBF)			
		0.0	1000.0		
TENS(LBF)					
5000.0	15000.				
AMTE(DEGC)					
150.00	250.00				
CGR(GAPI)					
0.0	150.00				
SGR(GAPI)					
0.0	150.00				
				THOR(PPM)	POTA
				0.0	10000
				URAN(PPM)	
				-10.00	30.000

CGR2 - SGR2

Schlumberger

HSLT/HNGL/HAMS-Spec.

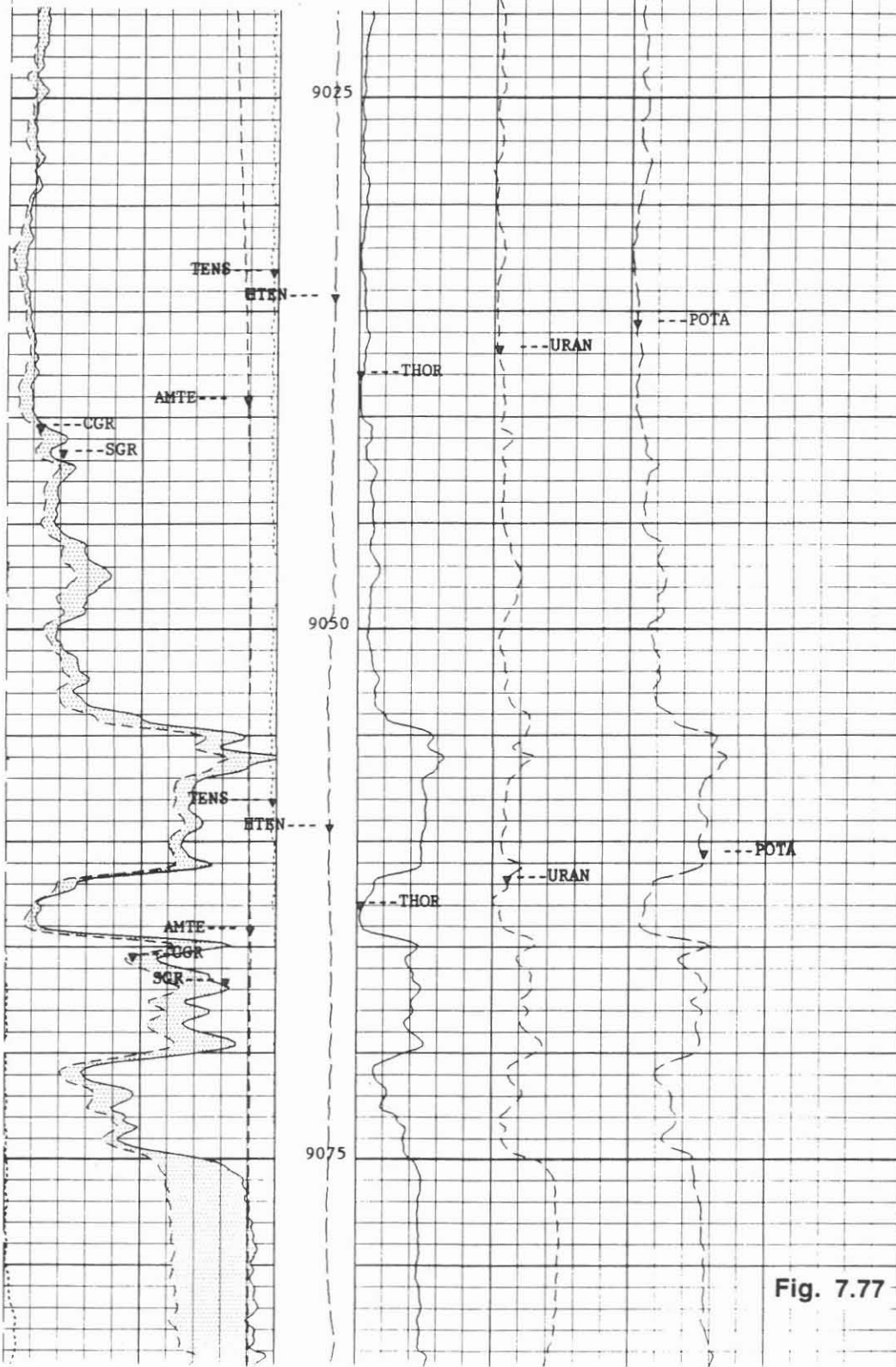


Fig. 7.77

HSLT/HNGL/HAMS (HEL-Sonic Logging Tool/HEL-Natural Gamma Spectrometer Log/HEL- Auxiliary Measurement Sonde - Ratio Presentation)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0262	25.11.1994	8345.0 - 9083.0 m

Example: Section of log: 9018.0 - 9083.0 m: **Fig. 7.78**

Purpose of log:

The registration of the natural gamma spectra is to resolve the spectra according to the radiation coming from uranium, thorium and potassium. The information is helpful in lithology determination and fracture detection.

Operation:

This log was run in combination with the HSLT. The record was made in open hole from 9083.0 - 9038.0 m and in the 5 1/2" and 7 5/8" liner up to 8345.0 m and presents in track I the total gamma ray (SGR), the gamma ray minus the uranium component (CGR), temperature and tension, in the depth track the head tension, in track II the ratios uranium:potassium, uranium:thorium and thorium:potassium and in track III are the single component curves for uranium, thorium and potassium.

Depth scale: 1/1000, 1/200; logging speed: 9.0 m/min.

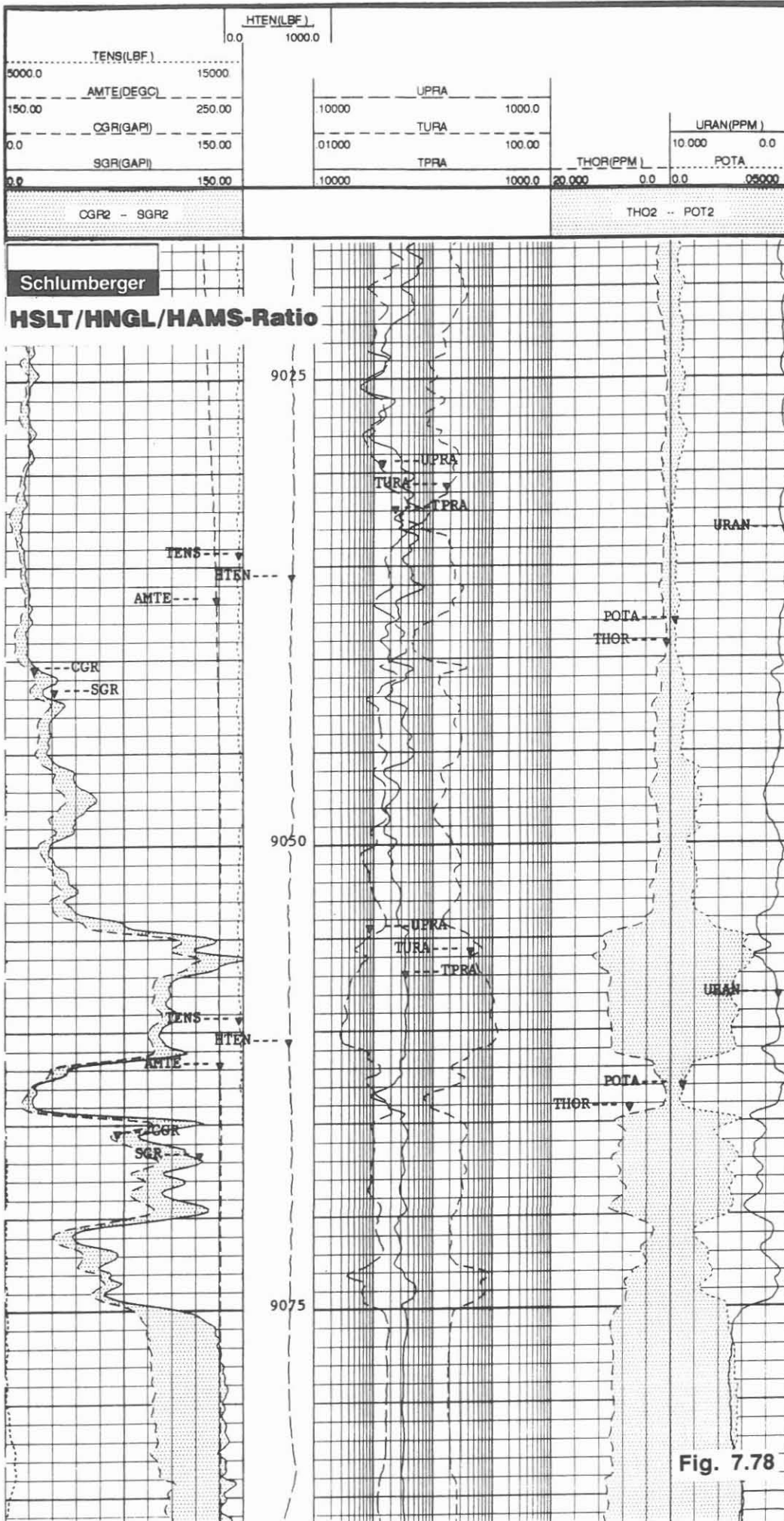
Technical Information:

The HNGL-tool used was modified for HEL-conditions locally. The standard NGL was placed in a universal dewar housing. The tool calibration was adjusted to compensate for the higher shielding due to the dewar.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
CGR	Computed Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
POTA	Potassium Content	(%)
SGR	Spectroscopy Gamma Ray	(GAPI)
THOR	Thorium Content	(PPM)
TPRA	Thorium:Potassium Ratio	
TURA	Thorium:Uranium Ratio	
UPRA	Uranium:Potassium Ratio	
URAN	Uranium Content	(PPM)



HSLT/HNGL/HAMS-CBL (HEL-Sonic Logging Tool/HEL-Gamma Ray Spectrometer Log/HEL-Auxiliary Measurement Sonde - Cement Bond Log)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0262	25.11.1994	8540.0 - 9060.0 m

Example: Section of log: Cement Bond Log/Variable Density Log, 8995.0 - 9060.0 m; **Fig. 7.79**

Purpose of log:

With the Cement Bond Log the quality of the cementation of the casing is checked.

Operation:

This logging run was made with the HSLT/HNGL/HAMS tool combination. After recording the standard Sonic Log, the tool was lowered to the depth of 9060.0 m and switched to Cement Bond Mode for recording the Cement Bond Log. Due to diameter restrictions the log was recorded without centralizer. Depth scale 1/200, 1/1000; logging speed: 9 m/min.

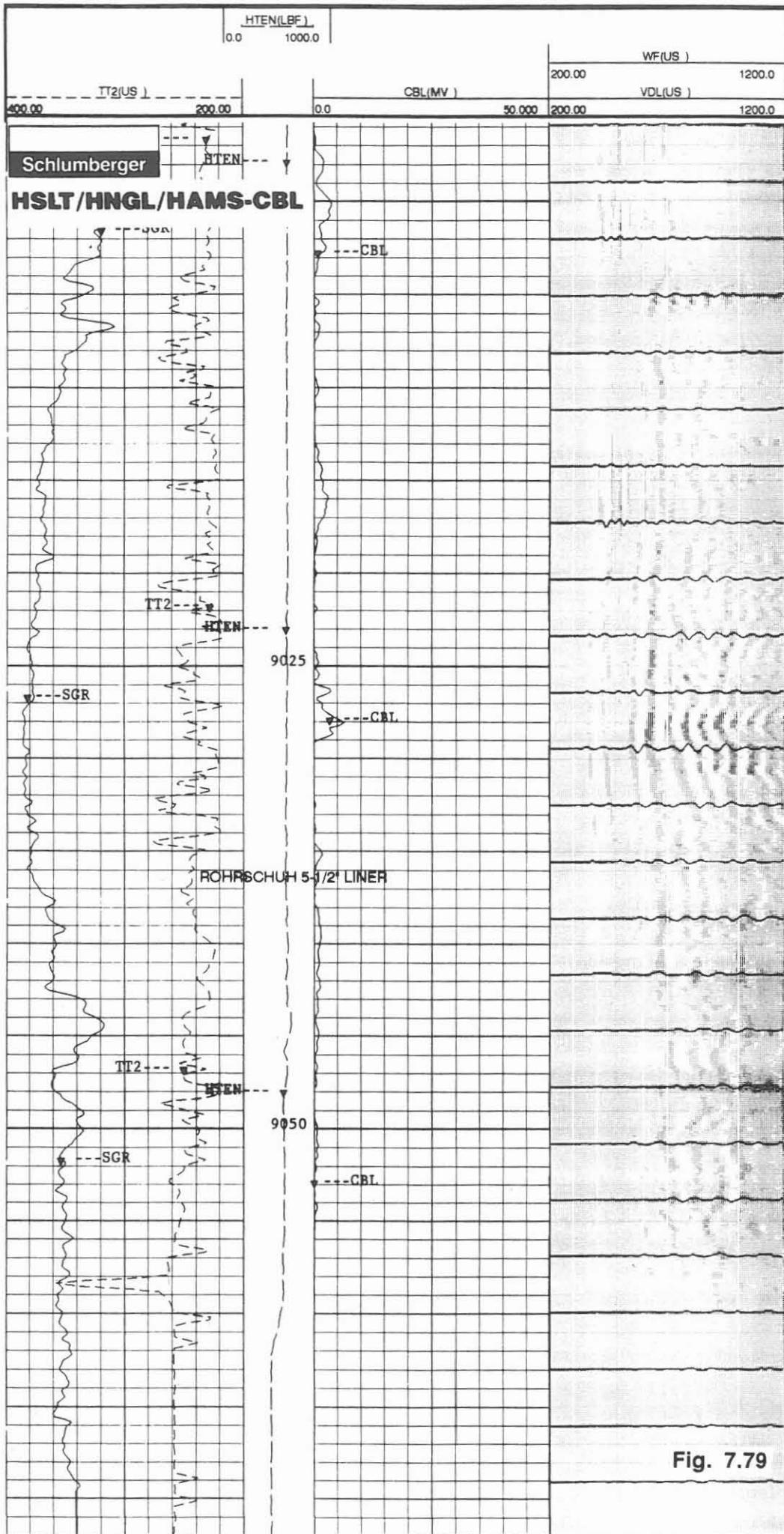
Technical information:

The tool combination used for this log consisted of the Hostile Environment Logging (HEL) tools. This is equipment rated for 260° C operations. The Cement Bond Log, being recorded without centralizers, suffers from this condition. The TT2 control curve indicates the critical response. For quality control the waveform and Variable Density Log should be used.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
CBL	Cement Bond Log	(MV)
HTEN	Head Tension	(LBF)
SGR	Spectrometer Gamma Ray	(GAPI)
TENS	Tension	(LBF)
TT2	Transit Time from Subcycle 2	(US)
VDL	Variable Density Log	(US)
WF	Waveforms	(US)



HFDC/HCNL/HGR (HEL-Formation-Density Compensated/HEL-Compensated Neutron Log/HEL-Gamma Ray)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-02263	25.11.1994	8600.0 - 9084.0 m

Example: Section of log: 9018.0 - 9084.0 m, **Fig. 7.80**

Purpose of log:

With the Formation-Density/Compensated Neutron/Gamma Ray log lithology information is obtained. In addition, if formation matrix density is known porosity estimates can be made. These logs are ideally suited for constructing the geological profile crossed by the borehole.

Operation:

The temperature limit for the use of the standard logging tools has been exceeded. The application of the Hostile Environment Logging Tools (HEL) became necessary. The response of these tools is equivalent to the standard tools. The log was run in open hole from 9084.0 - 9036.0 m. From liner shoe to 8600.0 m only the neutron and gamma ray was recorded. The caliper log is based on the one-arm caliper from the FDC-tool.

The record is influenced by bad hole conditions in the open hole section.

Depth scale 1/1000, 1/200; logging speed: 9.0 m/min

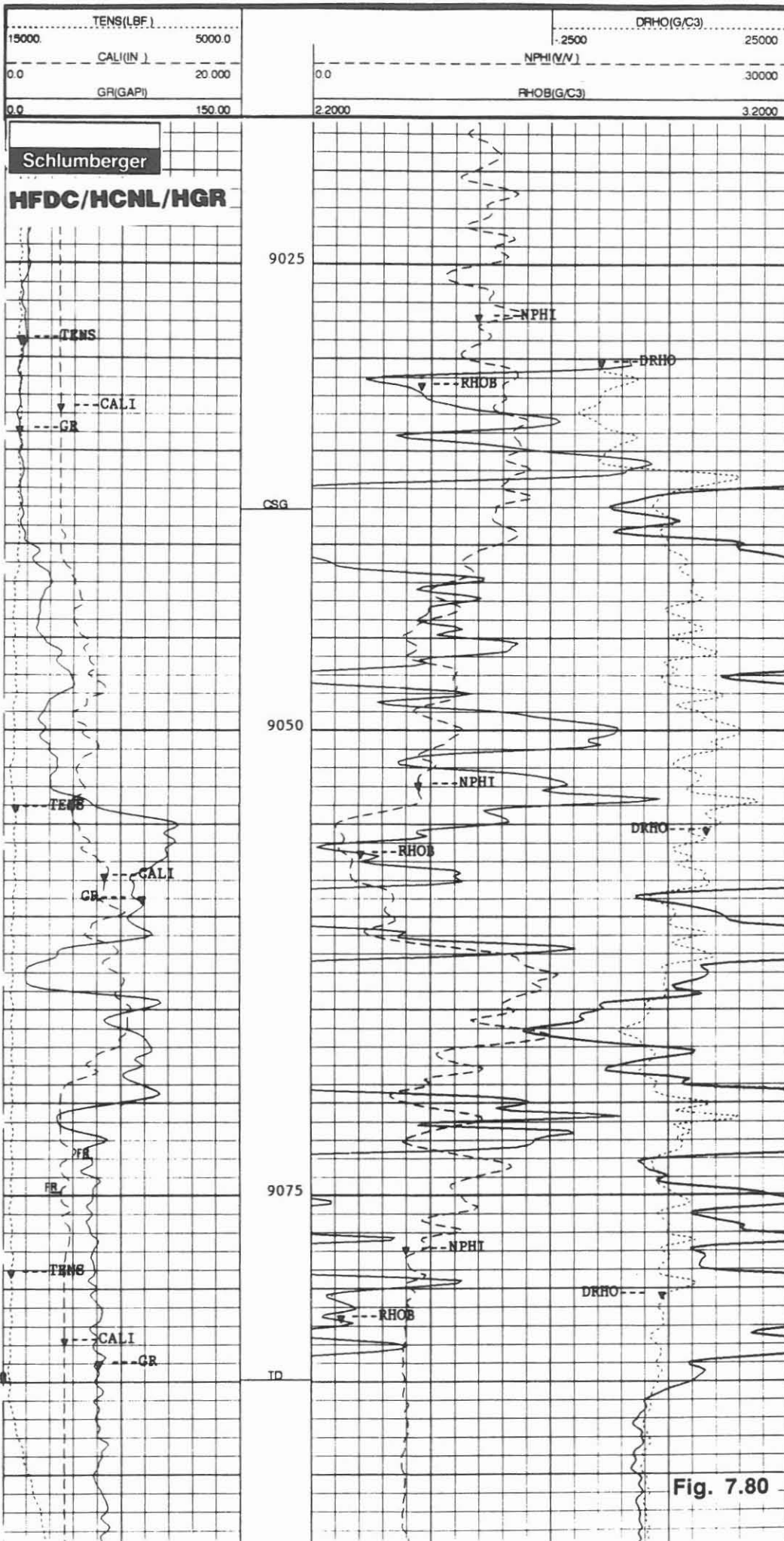
Technical information:

The HEL-tools are logging tools which have all electronic components and other temperature sensitive systems housed and protected in dewars. For this combination, all individual tools have this protection and are rated to operate at temperatures up to 260° C. Due to borehole diameter restrictions the complete combination tool had an outside diameter of 2 3/4" (69.85 mm).

Sampling rate: 6".

Mnemonics and Units

Mnemonics	Description	Units
CALI	Caliper	(IN)
DRHO	Bulk Density Correction	(G/C3)
GR	Gamma Ray	(GAPI)
NPFI	Neutron Porosity	(V/V)
RHOB	Bulk Density	(G/C3)
TENS	Tension	(LBF)



HFDC/HCNL/HGR (HEL-Formation-Density Compensated/HEL-Compensated Neutron Log/HEL-Gamma Ray - Neutron/Gamma Ray Log)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0263	25.11.1994	8600.0 - 9084.0 m

Example: Section of log: 8499.0 - 8575.0 m, **Fig. 7.81**

Purpose of log:

With the Neutron/Gamma Ray log lithology information is obtained. In addition, if formation matrix is known porosity estimates can be made.

These logs are ideally suited for constructing the geological profile crossed by the borehole.

Operation:

The temperature limit for the use of the standard logging tools has been exceeded. The application of the Hostile Environment Logging Tools (HEL) became necessary. The response of these tools is equivalent to the standard tools. After entering the liner shoe the Formation Density Log was switched off and only the Neutron and Gamma Ray Log was recorded up to 8600.0 m depth through the 5 1/2" liner.

Depth scale 1/1000, 1/200; logging speed: 9.0 m/min

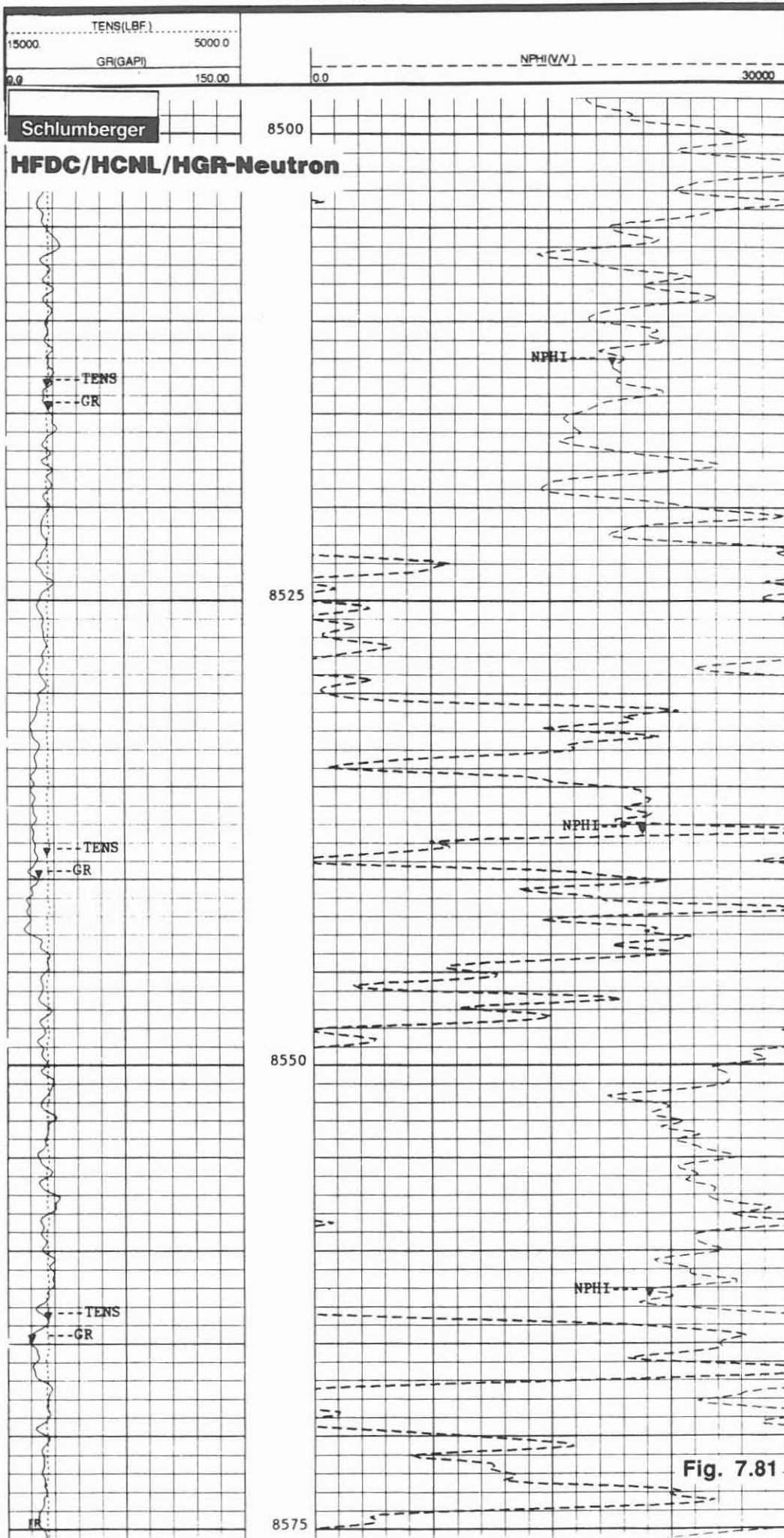
Technical information:

The HEL-tools are logging tool which have all electronic components and other temperature sensitive systems housed and protected in dewars. For this combination, all individual tools have this protection and are rated to operate at temperatures up to 260° C. Due to borehole diameter restrictions the complete combination tool had an outside diameter of 2 3/4" (69.85 mm).

Sampling rate: 6".

Mnemonics and Units

Mnemonics	Description	Units
GR	Gamma Ray	(GAPI)
NPFI	Neutron Porosity	(V/V)
TENS	Tension	(LBF)



HSP/REDOX (HEL-Self Potential/REDOX Potential)

Operator: KTB/University Frankfurt

Job No.	Date	Interval
HB-0264	26.11.1994	8604.0 - 9085.0 m

Example: Section of log: 9024.0 - 9085.0 m, **Fig. 7.82**

Purpose of log:

With the Self Potential/Redox Potential log zones with strong mineralisation or fluid filled fractures can be detected.

Operation:

This logging run was made over the open hole section of the borehole from 9085.0 - 9036.0 m and inside the 5 1/2" liner up to 8604.0 m depth. After this log the sonde remained stationary in the borehole for the Dipole-Dipole Experiment. Depth scale: 1/1000 only, logging speed: 25 m/min

Technical Information:

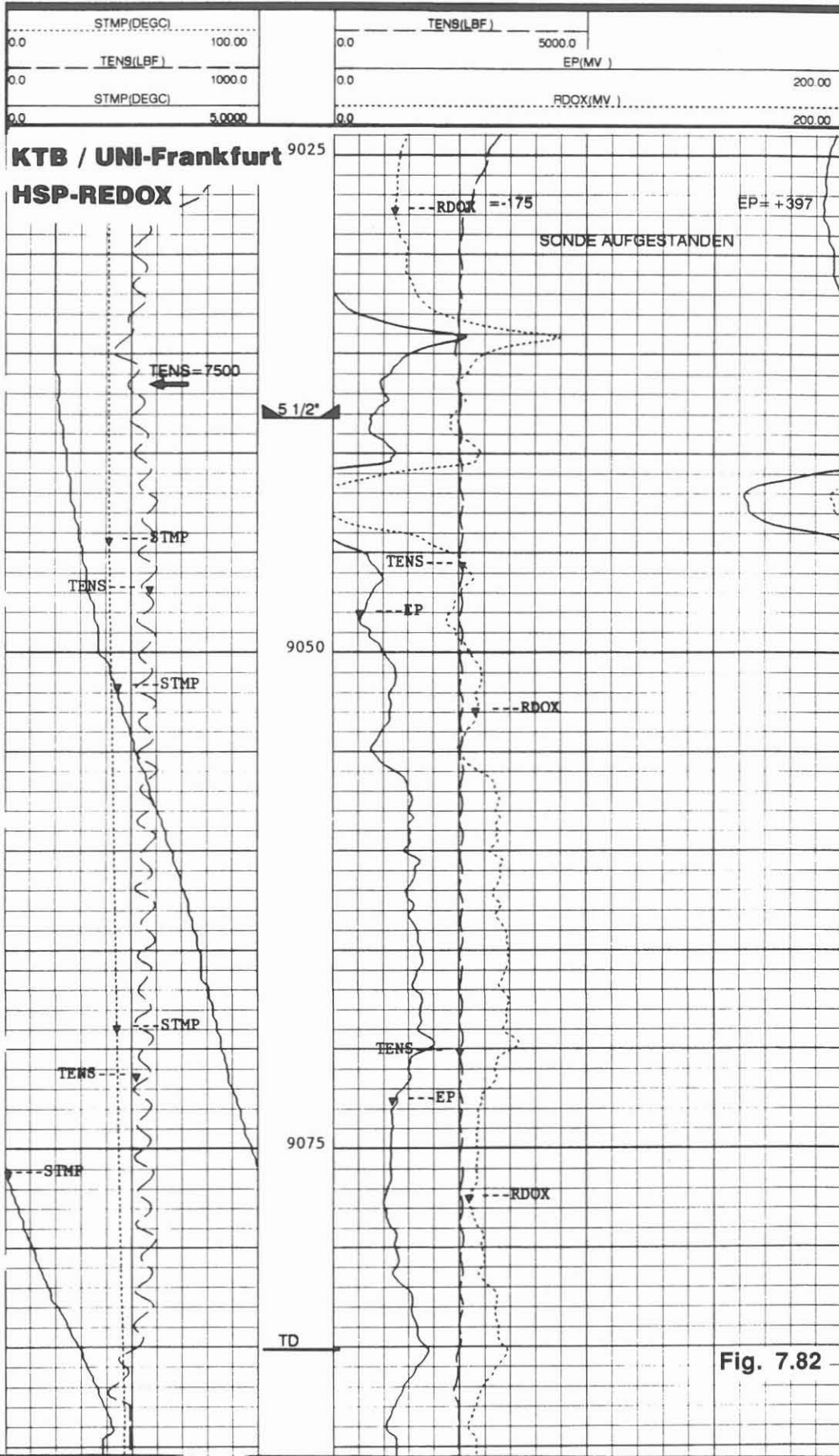
For this log the Hostile Environment Logging (HEL) sonde from the University Frankfurt was deployed. This up-graded sonde performed well.

The Redox Potential can be calculated from the value of the Platinum Sensor reading minus the Electrical Potential: (REDOX=RDOX-EP).

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
EP	Electrical Potential	(MV)
RDOX	Platinum Sensor Potential	(MV)
STMP	Sensor Temperature	(DEGC)
TENS	Tension	(LBF)



HFS/HCCL (HEL-Fluid Sampler/HEL-Casing Collar Locator)

Operator: Schlumberger Diepholz/Leutert/KTB

Job No.	Date	Interval
HB-0265	03.12.1994	7200.0 - 7659.0 m

Example: Section of log: 7310.0 - 7659.0 m, **Fig. 7.83**

Purpose of log:

With the Casing Collar Locator the movement and placement of the fluid sampler can be controlled.

Operation:

During the production test, made over the open hole section of the borehole from 9101.0 - 9036.0 m, two fluid sampler were run in tandem inside the test string of 5" drill pipes. The objective was to collect formation fluid produced. The samples should be taken straight above the test valve at a depth of 7659.0 m.

Depth scale: 1/1000 only; logging speed: 30 m/min.

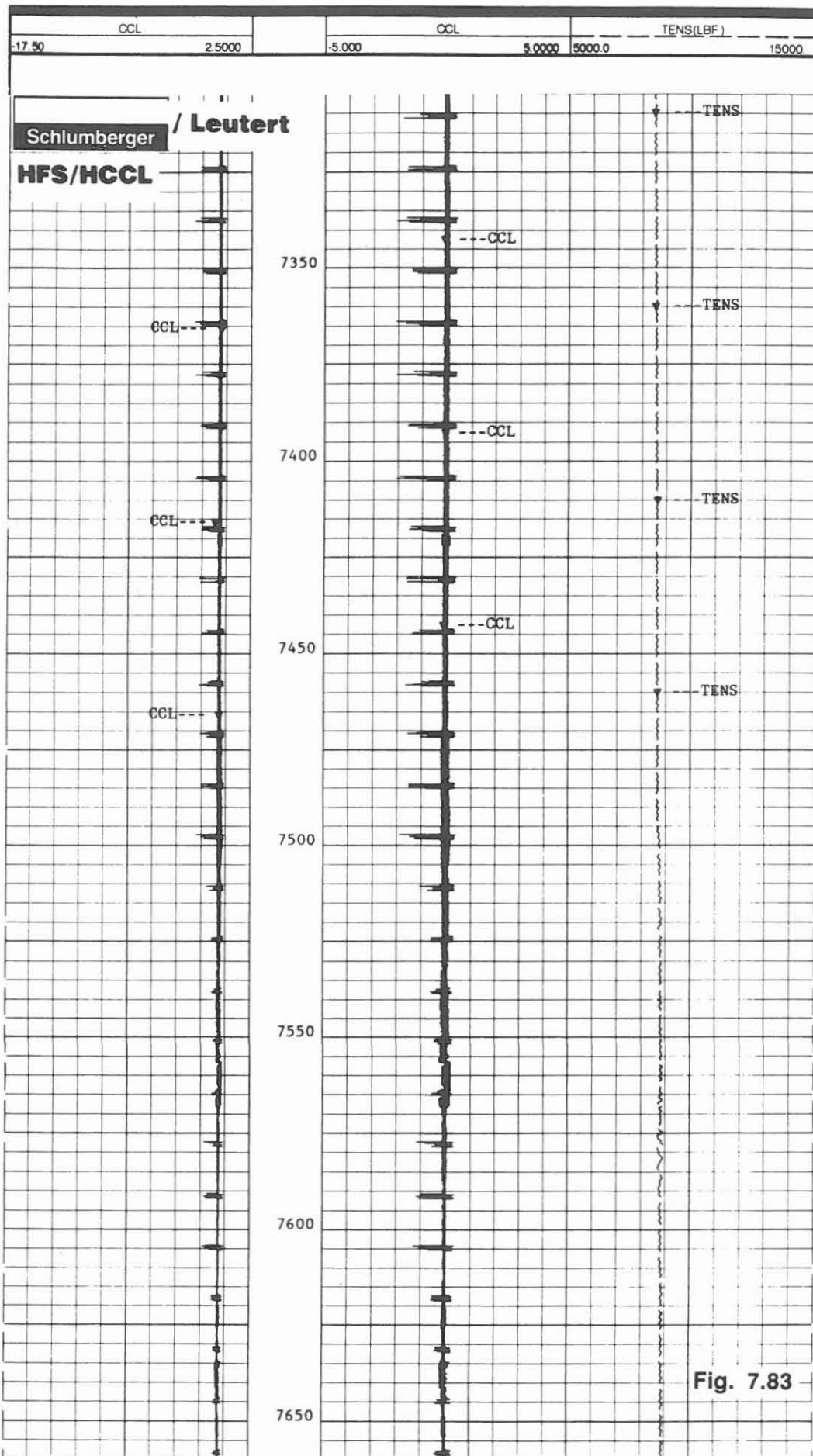
Technical Information:

The Leutert Fluid Sampler operates on the principle of fluid displacement. The opening and closing valves are clock controlled. On this operation two samples were collected. The fluid analysis did indicate, that the samples contained mainly cushion fluid. For additional comments on the operation see also Chapter 8: New Tools.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
CCL	Casing Collar Locator	
TENS	Tension	(LBF)



HFS/HGR/HAMS (HEL-Fluid Sampler/HEL-Gamma Ray/HEL-Auxiliary Measurement Sonde)

Operator: Schlumberger Diepholz/Leutert/KTB

Job No.	Date	Interval
HB-0266	05.12.1994	7670.0 - 9085.0 m

Example: Section of log: 8690.0 - 9070.0 m, **Fig. 7.84**

Purpose of log:

Combining the Fluid Sampler with the Gamma Ray and Auxiliary Measurement Sonde will allow the best placement of the sampler to collect the sample. Recording the mud resistivity, temperature and gamma ray will show best position for sampling.

Operation:

During the production test, made over the open hole section of the borehole from 9101.0 - 9036.0 m, formation fluid was produced. After pulling the test string the run with the Fluid Sampler was made to collect a sample from the open hole section of the borehole.

Depth scale: 1/1000 only; logging speed: 9.0 m/min.

Technical Information:

The Leutert Fluid Sampler operates on the principle of fluid displacement. The opening and closing valves are clock controlled. On this operation no sample was collected. The Fluid Sampler had collapsed under the pressure conditions in the borehole. For additional comments on the operation see also Chapter 8: New Tools.

Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Units
AMTE	Average Mud Temperature	(DEGC)
GR	Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
MRES	Mud Resistivity	(OHMM)
TENS	Tension	(LBF)

