7. Logging Operations at Casing Depth
6018.0 m (driller's depth)

J. K. Draxler

7. Logging Operations at Casing Depth 6018.0 m (driller's depth)

According to the operational plan for the KTB-HB borehole drilling with 14 3/4" bit continued to the depth of 6018.0 m. At this depth 13 3/8"/13 5/8" casings were set and cemented.

Before setting casings, the open section of the borehole was logged extensively.

A detailed plan was developed for this logging operation as the estimated formation temperature at this depth reached 175 °C, the temperature rating of standard logging tools. Tools from university institutes had a rating of 125 °C only and deployment was considered.

In addition, the geothermic working group requested a series of temperature records, over a period of pregiven time, for predicting the undisturbed formation temperature.

After setting casings, production tests can only be performed by perforating the casings. To avoid this and not take the risk of drill stem tests (DST) in open hole, a test was performed by lowering the mud level in the borehole and observe the inflow from the formation volumetric-, temperature- and salinity-wise.

To satisfy all requests from the scientific community and take into account the limits given by the rating of the logging tools and not to risk the borehole, the logging operation was split into two phases:

Phase 1:

Start of the logging operation after cooling the borehole by circulation while drilling and/or additional circulation.

The mud level in the borehole is to be kept constant and should be at surface. After running the first temperature log of the six temperature logs within this phase, the Fluxgate-Magnetometer (FML) from the University of Braunschweig (temperature rating 125 °C) was deployed. The tool performed satisfactory and the total interval was logged.

The Geochemical Logging Tool (150 °C rating) was next. Here again, the total interval was logged.

All logging tools requiring the MAXIS 500 logging unit were pooled together for operational and costs reason (DSI, FMI). The new prototype "Azimuthal Laterolog", - a MAXIS-tool, was run successful over the total open hole section.

The Borehole Televiewer (BHTV) from Deutsche Montan Technologie, Bochum, and the 3-D Magnetometer from the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, did perform at already elevated temperatures.

During this phase a good record of temperature built-up with time was logged allowing an extrapolation to the undisturbed formation temperature of 173° ± 2 °C. When starting the logging operation of phase 1 a bottom hole temperature of 111 °C was recorded. After 180 hours the temperature had reached 164 °.

Phase 2:

After reconditioning and cooling the borehole again by circulation, the drill pipes were pulled without filling the borehole with mud. By this procedure the mud level in the borehole was lowered to a calculated depth of 540 m. After observing the rise of the mud level for several hours, the logging operation continued. The Magnetic Susceptibility Tool (MS) from the University of Munich was run first (125 °C temperature rating). The interval from 2982.0 - 4278.0 m could be logged going "in" the hole, before the tool failed.

After running caliper, temperature, mud resistivity and self potential logs, several producing zones were detected and fluid samples were taken from these zones. The VSP was attempted with the new Combinable Seismic Imager (CSI) in combination with the General Purpose Inclination Tool (GPIT) from Schlumberger. After few stations the tool failed. The replacement tools of the same type failed too. The VSP was completed using the Seismic Acquisition Tool (SAT) without orientation system. This certainly degraded the results of the VSP.

With the Borehole Gravity Meter (BHGM) from EDCON, Denver, 120 stations were surveyed and brought good results.

The Mechanical Sidewall Coring Tool (MSCT) developed a problem in the hydraulic system after cutting the first core. Due to time constraints the continuation after repair was cancelled.

When running the Self Potential (SP) log at the end of phase 1 and at the beginning of phase 2, a cross-hole experiment between the pilot hole and the main hole was conducted. Electrical current was applied to both wells using the casing strings as electrodes. The change of potential was recorded in the open hole section of the main hole.

During phase 2 the logging operation was interrupted three times for work on the drilling rig. The standard travelling block (700 t) was exchanged for the heavy duty block (1000 t) required for running the 13 3/8"/13 5/8" casing string.

Table 7.1 is a detailed summary of the logging series phases 1 and 2. The time change from "Middle European Time" to "Middle European Summer Time" was made on Sunday, March 29th, 1992 (advance 1.00 hour).

After running the 13 3/8"/13 5/8" casing string to a depth of 6013.5 m (driller) the string was cemented. Due to the unfavourable conditions (very small clearance 14 3/4" borehole - 13 3/8" casing, no centralizer, tight crystalline formation) the decision was made not to run a Cement Bond Log - but record a temperature log for cement top detection. The cement top was found at 4350.0 m (lower than calculated - indicating loss of cement into fractures).

To control the possible wear of the 13 3/8"/13 5/8" casing string the "zero-reference" Multi-Finger Caliper log (MFC) was run from casing shoe to surface.

In addition, a Gamma Ray - Casing Collar Log (GR/CCL) was recorded inside the drill string to cross-correlate driller to logger depth. A difference of 6.3 m at 6000 m was observed, the logger being deeper than the driller. This difference represents the elongation of the 5"/5 1/2" drill string at 6000 m in mud of 1.04 g/cm^3 density.

After drilling the casing shoe the hole was drilled deeper with 12 1/4" bit size to 6031.0 m in preparation of a hydraulic frac-experiment. A four-arm caliper log (BGL) was recorded showing hole enlargements below the casing shoe. To obtain information about possible frac-orientation a Borehole Televiewer was attempted before the frac, but the tool failed. After the frac a second log was attempted, but the results produced were not conclusive. After the frac, flow from the formation was observed. The fluid sample collected from the interval showed higher salinity, confirming production from the fractured formation.

Drilling continued with 12 1/4" bit size after this frac-experiment.

The log heading from the first log (BGL-GR-AMS-TEMP-SP) of this series, gives the information of the conditions in the borehole at the beginning of the logging operation phase 1 (Fig. 7.1).

Tool sketches of most of the tools run during this series are presented on Fig. 7.2 - 7.12.

Sketches for third-party-tools are not available.

Examples and descriptions of the logs deployed during this series are given on Fig. 7.13 - 7.51 The sequence follows the operation outlined on table 7.1 The logs run after setting the casing follow the normal time sequence of operation.

Logging programme at casing depth 6000 m (phases 1 and 2)

(X) electrical cross-hole experiment
* completed operations

Starting time: Fr 13.03.92 09:45

Tool	Total [d-hh:mm]	Start	End
Phase 1			
* TEMP-GR-AMS-SP-BGL	6:30	Fr 13.03. 09:45	Fr 13.03. 16:15
* FML	16:00	Fr 13.03. 16:15	Sa 14.03. 08:15
* GLT	21:45	Sa 14.03. 08:15	Su 15.03. 06:00
* TEMP-GR	7:00	Su 15.03. 06:00	Su 15.03. 13:00
* LDL-CNL-NGS	17:00	Su 15.03. 13:00	Mo 16.03. 06:00
* TEMP-GR	7:00	Mo 16.03. 06:00	Mo 16.03. 13:00
* DSI-GR WF + GPIT	16:00	Mo 16.03. 13:00	Tu 17.03. 05:00
* FMI-GR	6:00	Tu 17.03. 05:00	Tu 17.03. 11:00
* ALAT-MSFL-GR + GPIT	11:45	Tu 17.03. 11:00	Tu 17.03. 22:45
* TEMP-GR	7:00	Tu 17.03. 22:45	We 18.03. 05:45
* BHTV	14:45	We 18.03. 05:45	We 18.03. 20:30
* 3D-MAGL (FML)	13:00	We 18.03. 20:30	Th 19.03. 09:30
* TEMP-GR	5:00	Th 19.03. 09:30	Th 19.03. 14:30
* IP	12:30	Th 19.03. 14:30	Fr 20.03. 03:00
* SP-Redox	9:45	Fr 20.03. 03:00	Fr 20.03. 12:45
* TEMP-GR-AMS-SP-BGL (X)	11:15	Fr 20.03. 12:45	Sa 21.03. 00:00
* Round trip/add.circulat.	1-21:00	Sa 21.03. 00:00	Su 22.03. 21:00
Phase 2			
* AMS-TEMP	2:15	Su 22.03. 21:00	Su 22.03. 23:15
* MS	4:15	Su 22.03. 23:15	Mo 23.03. 03:30
* BGL-GR-AMS-SP-TEMP	12:45	Mo 23.03. 03:30	Mo 23.03. 16:15
* SP-Redox	6:45	Mo 23.03. 16:15	Mo 23.03. 23:00
* FS-SP-AMS-GR (X)	6:30	Mo 23.03. 23:00	Tu 24.03. 05:30
* Travell. block demounting	10:00	Tu 24.03. 05:30	Tu 24.03. 15:30
* FS-SP-AMS-GR	7:00	Tu 24.03. 15:30	Tu 24.03. 22:30
* FS-SP-AMS-GR	9:00	Tu 24.03. 22:30	We 25.03. 07:30
* VSP	1-09:30	We 25.03. 07:30	Th 26.03. 17:00
* BGL-GR-AMS-SP-TEMP	12:40	Th 26.03. 17:00	Fr 27.03. 05:40
* Preparation of FS-tool	3:20	Fr 27.03. 05:40	Fr 27.03. 09:00
* FS-SP-AMS-GR	9:00	Fr 27.03. 09:00	Fr 27.03. 18:00
* BHGM	1-21:00	Fr 27.03. 18:00	Su 29.03. 15:00
* CET --->> CE summer time	1:00	Su 29.03. 15:00	Su 29.03. 16:00
* VSP	9:30	Su 29.03. 16:00	Mo 30.03. 01:30
* FS-SP-AMS-GR	7:30	Mo 30.03. 01:30	Mo 30.03. 09:00
* VSP	2-11:15	Mo 30.03. 09:00	We 1.04. 20:15
* Waiting time during VSP,	2:00	We 1.04. 20:15	We 1.04. 22:15
* Unloading of rig equipment	:00	We 1.04. 22:15	We 1.04. 22:15
* BGL-GR-AMS-SP-TEMP	9:30	We 1.04. 22:15	Th 2.04. 07:45
* Mounting of travell. block	14:30	Th 2.04. 07:45	Th 2.04. 22:15
* MSCT-GR	15:15	Th 2.04. 22:15	Fr 3.04. 13:30
Total time	21-03:45		

End of operation: Fr 3.04.92 13:30

Schlumberger

HB144 *GR-AMS MIT FML (UNI-BS)*13/3/92

CSU Field Log

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: 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

DATE: 13 MAR 92
RUN NO: HB144

OTHER SERVICES-
BGL, FML, GLT,
LDL-CNL-NGS,
FMI, ALAI-MSF
-GPIT, DSI,
FACSIM. BHTV
IP, SP-REDOX

PROGRAM
TAPE NO:
33.243A
SERVICE
ORDER NO:
HB144

DEPTH-DRILLER:	6018.0 M		
DEPTH-LOGGER:	6024.7 M		
BTM. LOG INTERVAL:	5815.5 M		
TOP LOG INTERVAL:	2950.0 M		
CASING-DRILLER:	290.0 M	3000.5 M	
CASING-LOGGER:	290.0 M	3000.0 M	
CASING:	24-1/2"K55	16" K55	OPEN HOLE
BIT SIZE:	28"	17-1/2"	14-3/4"

TYPE FLUID IN HOLE: DEHYDRIL
DENSITY: 1.04 G/C3
VISCOSITY: 6469 S
PH: 11.5
FLUID LOSS: 14.0 C3
SOURCE OF SAMPLE: UMLAUF
RM: 1.050 OHMM AT 18.0 DEGC
RMF: .920 OHMM AT 19.0 DEGC
RMC: 1.100 OHMM AT 19.0 DEGC
SOURCE RMF/RMC: PRESSE/PRESSE
RM AT BHT: .314 OHMM AT 111. DEGC
RMF AT BHT: .282 OHMM AT 111. DEGC
RMC AT BHT: .337 OHMM AT 111. DEGC

TIME CIRC. STOPPED: 00:00 13/3
TIME LOGGER ON BTM.: 21:37 13/3

MAX. REC. TEMP: 111.0 DEGC

LOGGING UNIT NO: 701
LOGGING UNIT LOC: KTB
RECORDED BY: KUEHR/DEGREFTE
WITNESSED BY: DRAXLER/ZOTH

REMARKS:

MAX TEMP VON VORHERGEMESSENE *BGL-GR-AMS-TEMP-SP* UEBERNOMME
GEBOHRT BIS 11:45 10/3/92 (2 METER GEKERNT)
DIESE MESSUNG WURDE FUER TEUFENKORRELATION GEFAHREN
ES WURDEN NUR GR UND MRES REGISTRIERT.
MESSGESCHWINDIGKEIT 12 M/MIN
SONDE MIT SWIVELADAPTERHEAD GEFAHREN.
MAGNETOMETER : .8 M UEBER UNTERKANTE SONDE.

Fig. 7.1

EQUIPMENT NUMBERS-

TCM-AB 449	TCC-B 190	SGC-SA 1247	AME-1720
-	-	-	-
SAH-E 796	-		

KTB

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

LOGGING TOOL STRING SKETCH

	PEH HEAD	
EQF1, 3 3/8" OD	SWIVEL	11.23 M
AMS, 3 5/8" OD		10.34 M
	HTEN	9.45 M
	MRES	9.19 M
	CENTRALISER	
TCCB, 3 3/8" OD		7.62 M
SGTL, 3 3/8" OD		6.71 M
	GR	6.43 M
BGTX, 3 5/8" OD		5.03 M
	CENTRALISER	DEVI RB AZIM 4.83 M
	ISOL. ADAPTER	
	4-ARM KALIB.	
		C2 C1 0.91 M
	TEMP. FUEHLER	AMTE 0.05 M
		TOOL ZERO

TOTAL TOOL STRING LENGTH IS 11.79 M.
TOTAL TOOL STRING WEIGHT IS 325.2 KG IN AIR.

Fig. 7.2

KTB/University Braunschweig

Tool Sketch: FML-GR-AMS

LOGGING TOOL STRING SKETCH

	PEH HEAD	
EQF1, 3 3/8" OD	SWIVEL	10.03 M
AMS, 3 5/8" OD		9.14 M
	MRES	8.00 M
	CENTRALISER	
TCCB, 3 3/8" OD		6.43 M
SGTL, 3 3/8" OD		5.51 M
	GR	5.23 M
		TOOL ZERO

TOTAL TOOL STRING LENGTH IS 10.59 M.
TOTAL TOOL STRING WEIGHT IS 200.5 KG IN AIR.

Fig. 7.3

LOGGING TOOL STRING SKETCH

Schlumberger

Tool Sketch: GLT

AMS, 3 5/8" OD		20.78 M
	HTEN	18.59 M
TCCB		18.57 M
NGTD, 3 5/8" OD		17.65 M
	SGR	17.14 M
CNTG, 3 3/8" OD		14.83 M
EXZENTRIERER		
ACTD, 3 5/8" OD		11.15 M
GSTA, 3 3/8" OD		8.33 M
	ADCG ADCZ	2.84 M
		TOOL ZERO

Fig. 7.4

TOTAL TOOL STRING LENGTH IS 20.78 M.
TOTAL TOOL STRING WEIGHT IS 589.7 KG IN AIR.

LOGGING TOOL STRING SKETCH

Schlumberger

Tool Sketch: LDL-CNL-NGL

	KABELKOPF/ AH64	
AMS		21.26 M
	HTEN	19.08 M
TCCB		19.05 M
NGTD		18.14 M
	SGR	17.63 M
CNTG		15.32 M
	CNT-EXZENTRIERER	
LDTD		11.63 M
	CALI	5.94 M
FLEX2		5.13 M
FLEX1		4.52 M
BGTX, 3 5/8" OD		3.91 M
	CME-MB 2 ARM EXZENT.	
	2-ARM BGT	
		TOOL ZERO

Fig. 7.5

TOTAL TOOL STRING LENGTH IS 22.33 M.
TOTAL TOOL STRING WEIGHT IS 559.3 KG IN AIR.

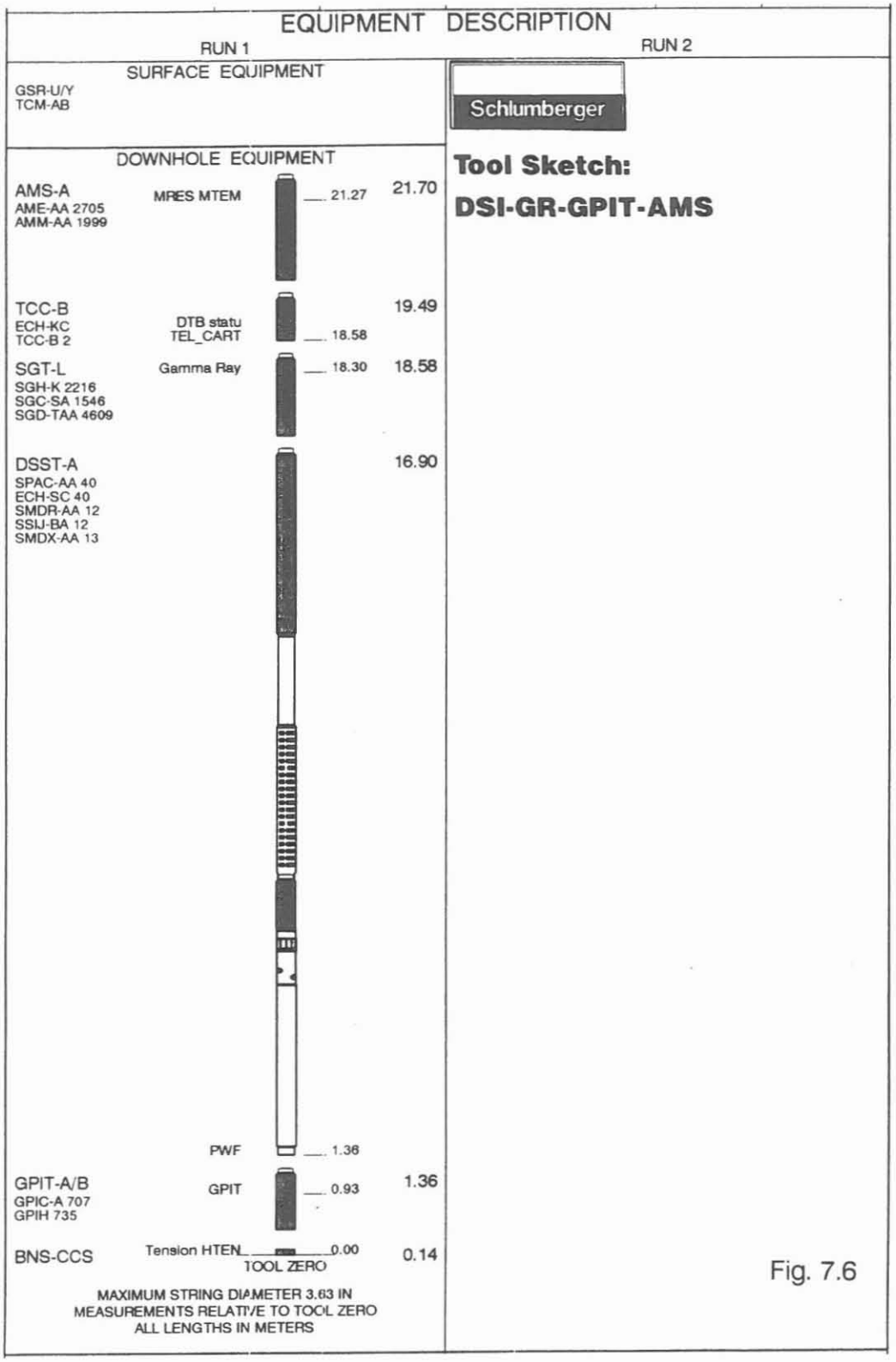

EQUIPMENT DESCRIPTION
RUN 1
RUN 2
SURFACE EQUIPMENT
GSR-U/Y
TCM-AB
Schlumberger
Tool Sketch:
DSI-GR-GPIT-AMS
DOWNHOLE EQUIPMENT
AMS-A
AME-AA 2705
AMM-AA 1999
MRES MTEM
21.27
21.70
TCC-B
ECH-KC
TCC-B 2
DTB statu
TEL_CART
18.58
19.49
SGT-L
SGH-K 2216
SGC-SA 1546
SGD-TAA 4609
Gamma Ray
18.30
18.58
DSST-A
SPAC-AA 40
ECH-SC 40
SMDR-AA 12
SSIJ-BA 12
SMDX-AA 13
16.90
PWF
1.36
GPIT-A/B
GPIC-A 707
GPIH 735
GPIT
0.93
1.36
BNS-CCS
Tension HTEN
0.00
0.14
TOOL ZERO
MAXIMUM STRING DIAMETER 3.63 IN
MEASUREMENTS RELATIVE TO TOOL ZERO
ALL LENGTHS IN METERS

Fig. 7.6

EQUIPMENT DESCRIPTION

RUN 1 | RUN 2

SURFACE EQUIPMENT

GSR-U/Y
DTM-A

DOWNHOLE EQUIPMENT

DTC-A
ECH-KN
DTC-A

TEL_CART — 12.70

13.00

FTB statu — 10.57

DTA-A
ECH-KE
DTA-A

10.57

ADAPTER — 9.35

SGT-L
SGH-K
SGC-SA
SGD-TAA

Gamma Ray — 9.07

9.35

FBST-A
FBCC-A
AH-185
GPIC-A
FBSC-A
FBSS-A

7.67

GPIT FBCC
PADS FBSC — 0.58

Tension — 0.00

TOOL ZERO

MAXIMUM STRING DIAMETER 5.00 IN
MEASUREMENTS RELATIVE TO TOOL ZERO
ALL LENGTHS IN METERS

Schlumberger

Tool Sketch: FMI-GR

Fig. 7.7

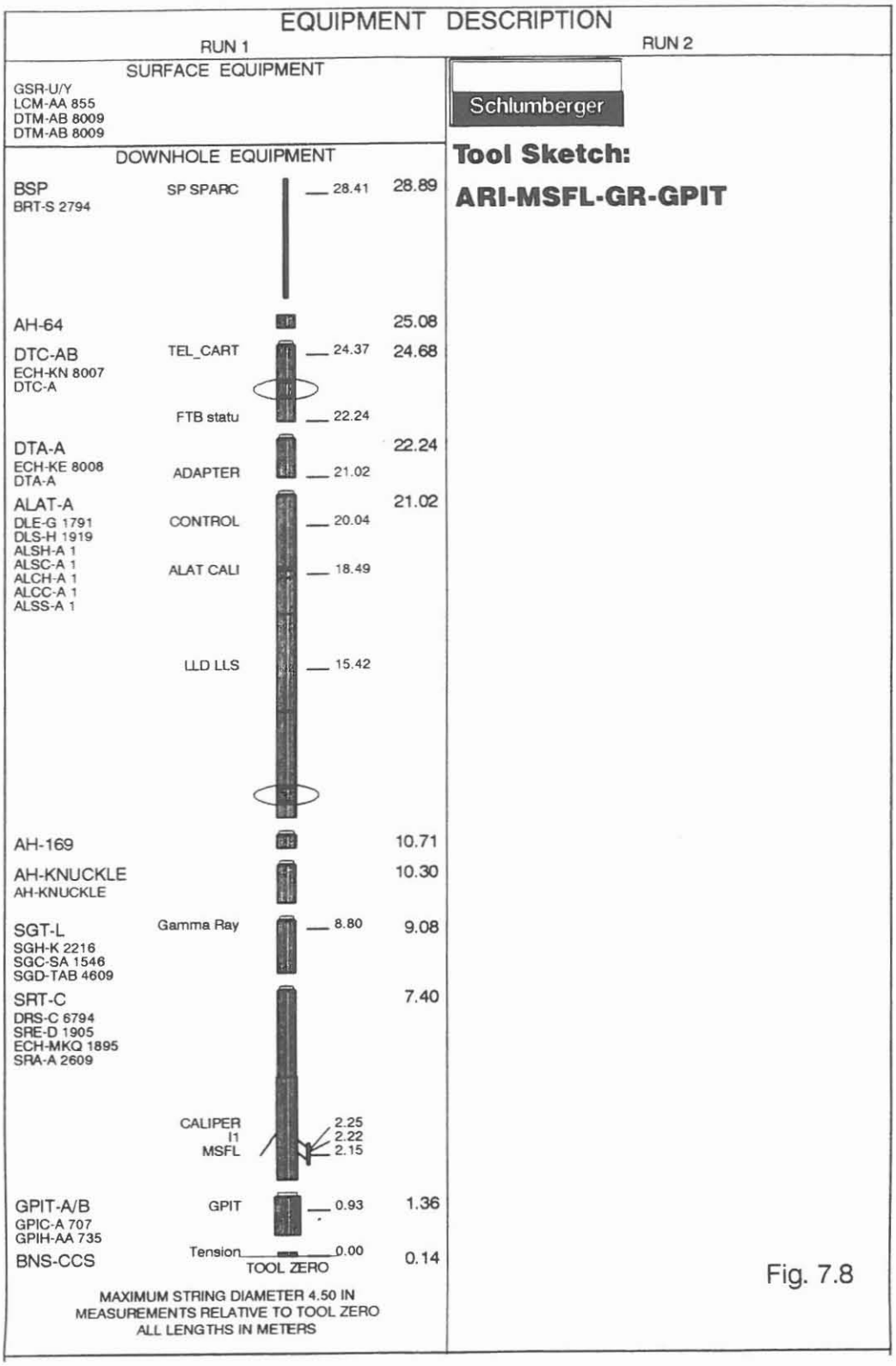

EQUIPMENT DESCRIPTION
RUN 1
RUN 2
SURFACE EQUIPMENT
GSR-U/Y
LCM-AA 855
DTM-AB 8009
DTM-AB 8009
DOWNHOLE EQUIPMENT
Schlumberger
Tool Sketch:
ARI-MSFL-GR-GPIT
BSP
BRT-S 2794
SP SPARC
28.41
28.89
AH-64
25.08
DTC-AB
ECH-KN 8007
DTC-A
TEL_CART
24.37
24.68
FTB statu
22.24
DTA-A
ECH-KE 8008
DTA-A
22.24
ADAPTER
21.02
ALAT-A
DLE-G 1791
DLS-H 1919
ALSH-A 1
ALSC-A 1
ALCH-A 1
ALCC-A 1
ALSS-A 1
21.02
CONTROL
20.04
ALAT CALI
18.49
LLD LLS
15.42
AH-169
10.71
AH-KNUCKLE
AH-KNUCKLE
10.30
SGT-L
SGH-K 2216
SGC-SA 1546
SGD-TAB 4609
Gamma Ray
8.80
9.08
SRT-C
DRS-C 6794
SRE-D 1905
ECH-MKQ 1895
SRA-A 2609
7.40
CALIPER
2.25
I1
2.22
MSFL
2.15
GPIT-A/B
GPIC-A 707
GPIH-AA 735
GPIT
0.93
1.36
BNS-CCS
Tension
0.00
0.14
TOOL ZERO
MAXIMUM STRING DIAMETER 4.50 IN
MEASUREMENTS RELATIVE TO TOOL ZERO
ALL LENGTHS IN METERS

Fig. 7.8

LOGGING TOOL STRING SKETCH

KTB

Tool Sketch: GR-TEMP

Fig. 7.9

TOTAL TOOL STRING LENGTH IS 5.84 M.
TOTAL TOOL STRING WEIGHT IS 56.7 KG IN AIR.

LOGGING TOOL STRING SKETCH

KTB/UNI-Frankfurt

Tool Sketch: SP-REDOX

Fig. 7.10

TOTAL TOOL STRING LENGTH IS 5.03 M.

KTB/Leutert

Tool Sketch: FS-GR-AMS

LOGGING TOOL STRING SKETCH

KABELKOPF

AMS, 3 5/8" OD — 8.94 M
HTEN — 8.56 M
AMTE — 8.36 M
MRES — 8.31 M

TCCB, 3 3/8" OD — 6.73 M

SGTL, 3 3/8" OD — 5.82 M
GR — 5.54 M

4 1/2" OD — 4.14 M

GEHAEUSE FUER MAX.
3 FLUIDSAMPLER

EINLASS FLUIDSAMPLER

TOOL ZERO

Fig. 7.11

TOTAL TOOL STRING LENGTH IS 10.06 M.

Schlumberger

Tool Sketch: MSCT-GR

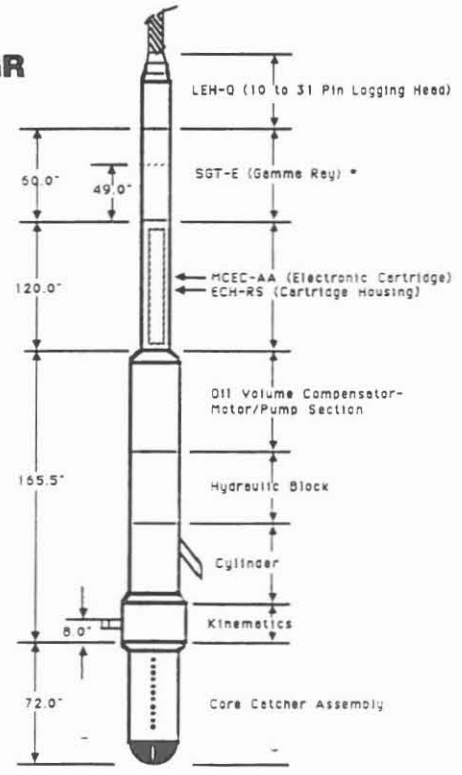


Fig. 7.12

BGL/GR/AMS/TEMP/SP (Borehole Geometry Log/Gamma Ray/Auxiliary Measurement Sonde/Temperature/Self Potential)

Operator: KTB

Job No.	Date	Interval
HB-0001-0076	KTB-Report 91-2	0.0 - 1720.0 m
HB-0077-0127	KTB-Report 92-1	1720.0 - 4512.0 m
HB-0143	13.03.1992	2400.0 - 6024.6 m

Example:
Section of log: 5964.0 - 6024.6 m, **Fig. 7.13**

Purpose for log:
Deviation, orientation and caliper control of the borehole. Measurements of borehole temperature, mud resistivity and self potential for inflow zone detection.

Operation:
The temperature, mud resistivity (salinity) and self potential 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: 15 m/min.

Technical information:
This combination tool consists of a Schlumberger four-arm caliper with pendulum deviation and compass orientation systems (BGL), gamma ray (GR), mud resistivity, temperature and head tension sensors (AMS) and two additional measurement systems - temperature and self potential - integrated by a modification made by KTB. With this tool modification it is possible to measure the temperature at the lowest depth reached as the sensor is at the bottom of the tool.
Data rate: set of data in increments of 6".

Mnemonics and Units:

Mnemonics	Description	Unit
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)
GR	Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
LC01	Mud Salinity (equivalent)	(PPM)
MRES	Mud Resistivity	(OHMM)
P1AZ	Pad 1 Azimuth	(DEG)
RB	Relative Bearing	(DEG)
SPK	Self Potential (contact)	(MV)

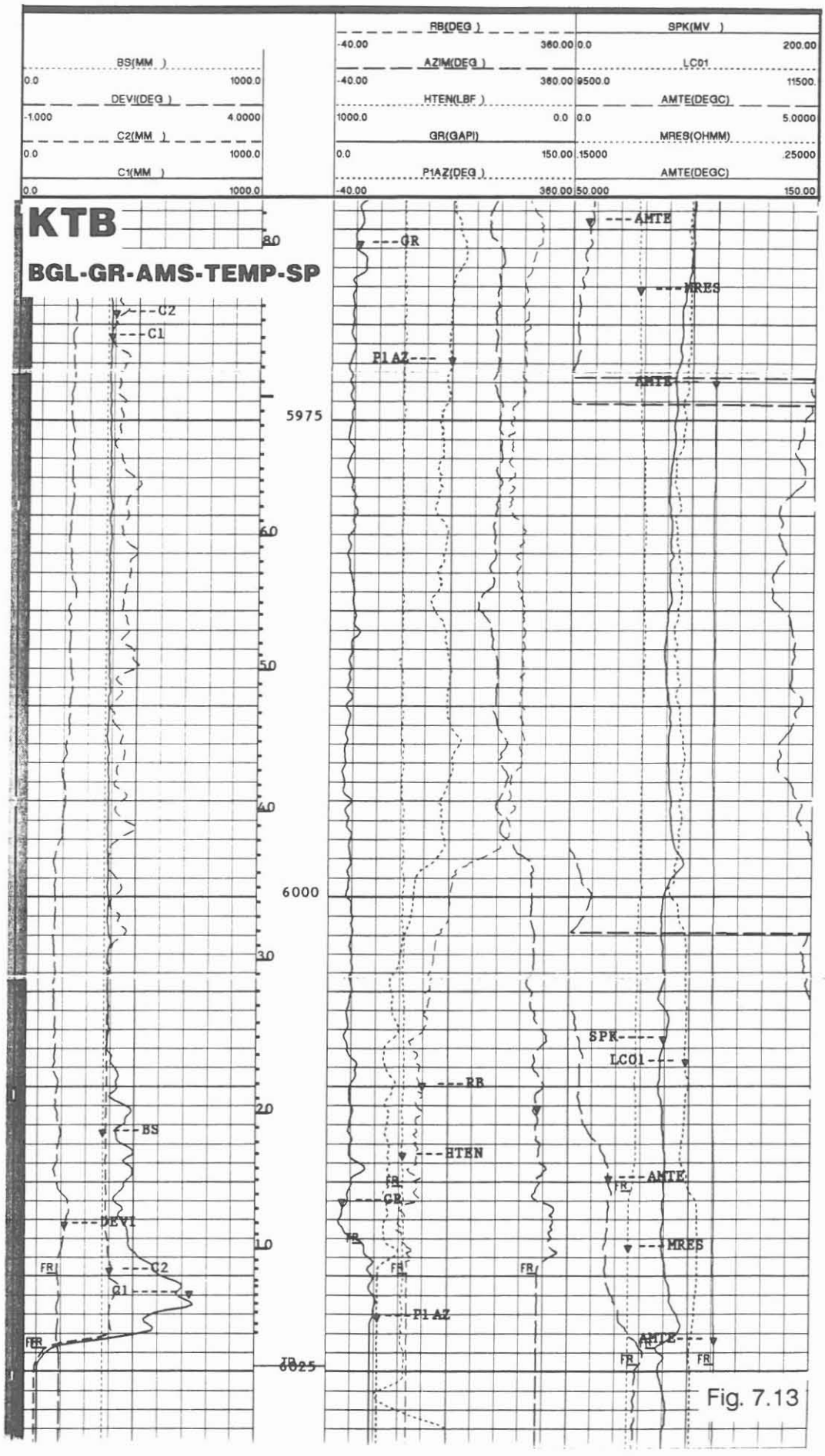

BS(MM)
0.0
1000.0
DEVI(DEG)
-1.000
4.0000
C2(MM)
0.0
1000.0
C1(MM)
0.0
1000.0
RB(DEG)
-40.00
360.00
AZIM(DEG)
-40.00
360.00
HTEN(LBF)
1000.0
0.0
GR(GAPI)
0.0
150.00
P1AZ(DEG)
-40.00
360.00
SPK(MV)
0.0
200.00
LC01
9500.0
11500.
AMTE(DEGC)
0.0
5.0000
MRES(OHMM)
.15000
.25000
AMTE(DEGC)
50.000
150.00
KTB
BGL-GR-AMS-TEMP-SP
5975
6000
6025
C2
C1
BS
DEVI
GR
P1AZ
RB
HTEN
AMTE
MRES
SPK
LC01
FR

Fig. 7.13

FML/GR/MRES (Fluxgate Magnetometer/Gamma Ray/Mud Resistivity)

Operator: University of Braunschweig/KTB

Job No.	Date	Interval
HB-0144	13.03.1992	2942.0 - 6023,0 m

Example:
Section of depth reference log only: 5600.0 - 5965.0 m, **Fig. 7.14**

Purpose of Log:
With this instrument three-dimensional measurements of the magnetic field are made. With the logs recorded in a borehole information can be obtained about the total magnetisation of the surrounding rocks. This will allow the detection of magnetic anomalies indicating also magnetic bodies not penetrated by the borehole.

Operation:
This newly developed magnetometer from the University of Braunschweig is run in combination with the GR and AMS (for MRES) from KTB. The responses of the magnetisation in the X, Y and Z-axis are measured. The sum represents the total magnetic field.
Depth scale: 1/1000; logging speed: 9 m/min.

Technical information:
The magnetometer is a digital tool and was designed and manufactured in such a way, that it can be connected to standard Schlumberger cable heads or tools (GR). Presently the tool has a temperature rating of 125 °C.

Mnemonics and Units:

Mnemonic	Description	Unit
GR	Gamma Ray	(GAPI)
MRES	Mud Resistivity	(OHMM)
TENS	Tension	(LBF)

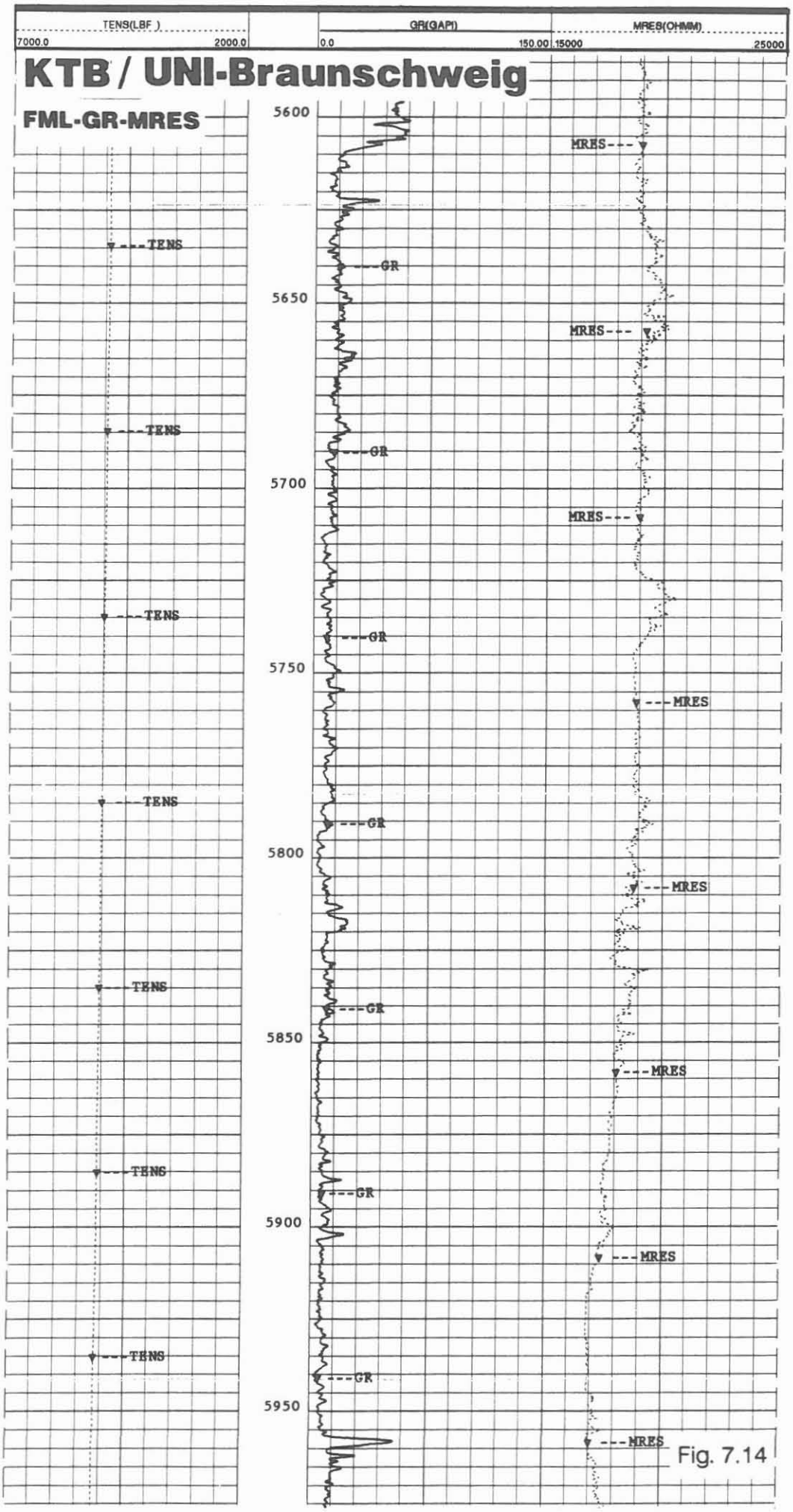

TENS(LBF)
7000.0
2000.0
GR(GAPI)
0.0
150.00
MRES(OHMM)
15000
25000
KTB / UNI-Braunschweig
FML-GR-MRES
5600
5650
5700
5750
5800
5850
5900
5950
TENS
GR
MRES

Fig. 7.14

GLT (Geochemical Logging Tool)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0118	KTB-Report 92-1	2994.0 - 4455.0 m
HB-0145	14.03.1992	4397.0 - 6023.0 m

Example:
Section of log: 5721.0 - 5789.0 m, **Fig. 7.15**

Purpose of log:
In situ elemental analysis by spectroscopic measurements will provide information about concentrations of 10 elements in the rock. Transfering elemental yields into oxide concentrations a continuous estimation of mineral composition of the rocks can be made.

Operation:
All relevant data is recorded digitally on magnetic tape. The analog data record presented on Fig. 7.15 is considered as quality record only and gives computed ratios from certain elements. The analysis of the recorded spectra in respect of the yields, in weight percent, of the elements Si, Ca, Fe, S, Al, Ti, Gd, Th, U, K is either done at the KTB logging centre on location, or the Schlumberger computing centre in Hannover. Further processing is done at KTB.
Depth scales: 1/100, 1/200; logging speed: 2 m/min.

Technical information:
This combination consists of the Gamma Ray Spectrometer (GST), Aluminum Activation Clay Tool (AACT), Natural Gamma Spectrometer (NGS) and a Compensated Neutron Tool (CNT) to carry a 252 Californium-source. This source and a neutron generator provide the energie for activating the formation. The log was recorded in "Capture Mode".
Data rate: 6".

Mnemonics and Units:

Mnemonics	Description	Unit
ALUM	Aluminum Indicator	
CSIG	Corrected Sigma	(CU)
HTEN	HEAD Tension	(LBF)
IIR	Iron Indicator Ratio	
LIR	Lithology Indicator Ratio	
PIR	Porosity Indicator Ratio	
SIR	Salinity Indicator Ratio	
SGR	Sum Gamma Ray	(GAPI)

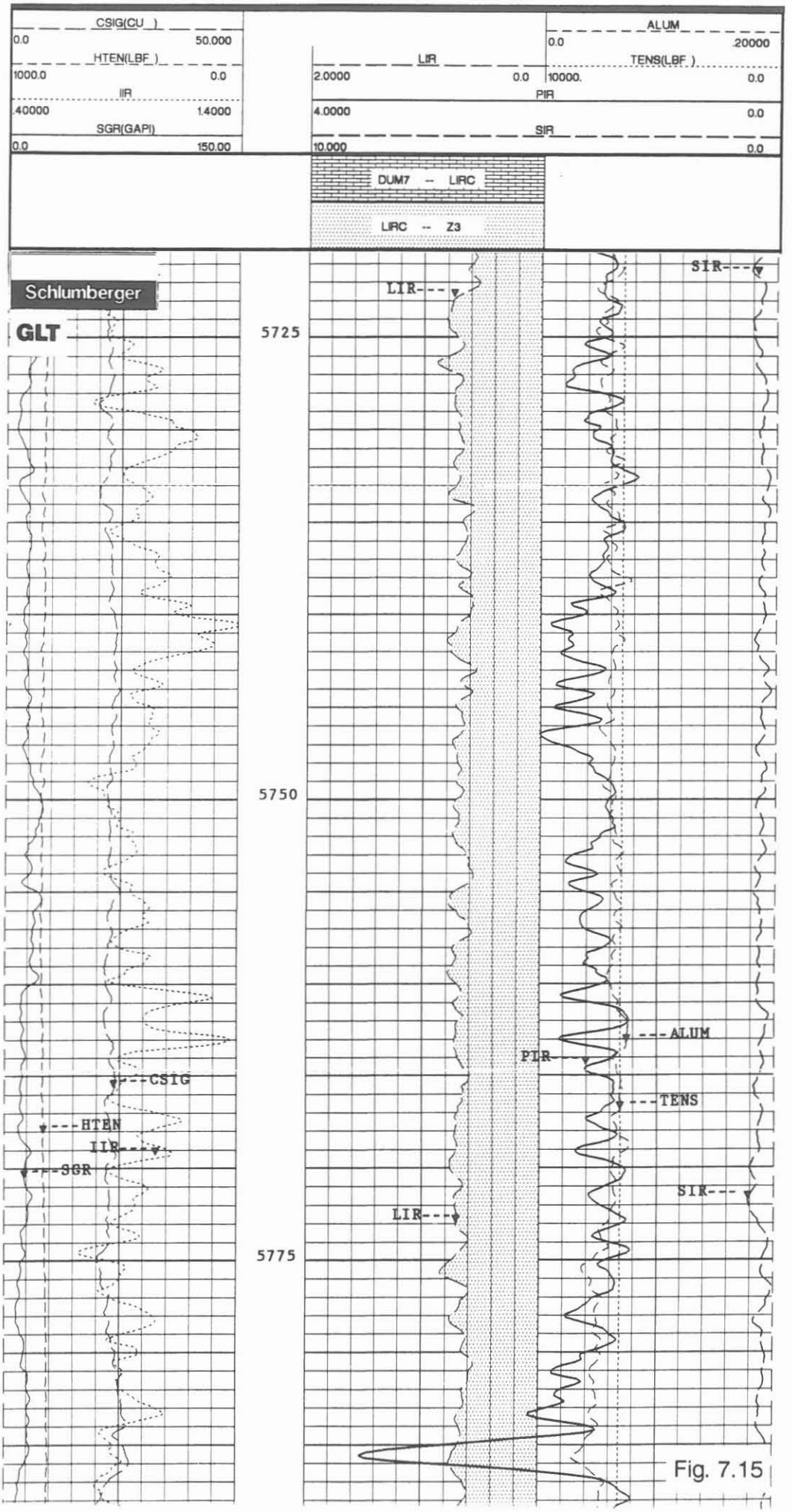

CSIG(CU)
0.0
50.000
HTEN(LBF)
1000.0
0.0
IIR
.40000
1.4000
SGR(GAPI)
0.0
150.00
LIR
2.0000
0.0
PIR
4.0000
0.0
SIR
10.000
0.0
ALUM
0.0
.20000
TENS(LBF)
10000.
0.0
DUM7 -- LIRC
LIRC -- Z3
Schlumberger
GLT
5725
5750
5775
LIR---
SIR---
---ALUM
PLR---
---TENS
---CSIG
---HTEN
IIR---
---SGR

Fig. 7.15

GR/TEMP (Gamma Ray/Temperature Log)

Operator: KTB

Job No.	Date	Interval
HB-0001-0076	KTB-Report 91-2	0.0 - 1720,0 m
HB-0077-0127	KTB-Report 92-1	1720.0 - 4512.0 m
HB-0146	15.03.1992	2365.0 - 6023.0 m

Example:
Section of log: 5635.0 - 6015.0 m, **Fig. 7.16**

Purpose of log:
During a logging series several temperature logs are recorded at pregiven time intervals. With the help of this sequence of temperature logs an estimation of the true formation temperature is possible by extrapolation.

Operation:
The temperature log is recorded going "in" the borehole. By this method "undisturbed" conditions are present. At the bottom of the hole stationary readings are recorded for a minimum of time, lasting for 30 - 45 minutes.

Technical information:
This tool is a simple combination of two KTB tools - a gamma ray and temperature section. This simple configuration is used for time sequence temperature logging operations.
Data rate: 6"; logging speed: 18 m/min.

Mnemonics and Units:

Mnemonics	Description	Unit
GR	Gamma Ray	(GAPI)
TEMP3	Temperature	(DEGC)
TENS	Tension	(LBF)

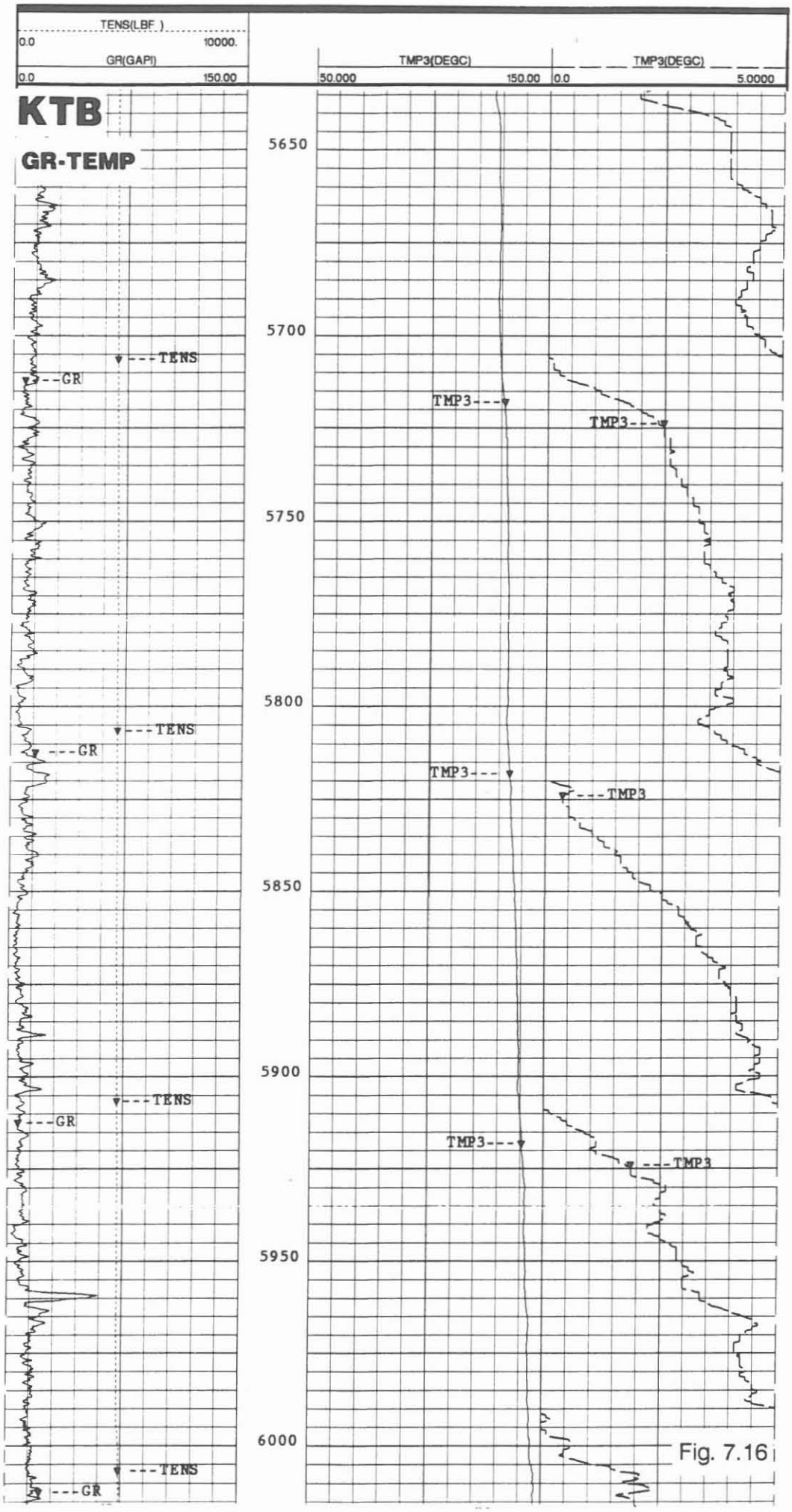

TENS(LBF)
0.0
10000.
GR(GAPI)
0.0
150.00
TMP3(DEGC)
50.000
150.00
TMP3(DEGC)
0.0
5.0000
KTB
GR-TEMP
5650
5700
5750
5800
5850
5900
5950
6000
---TENS
---GR
TMP3---
---TMP3

Fig. 7.16

LDL/CNL/NGL (Litho-Density-/Compensated Neutron-/Natural Gamma Spectrometer Log)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0116	KTB-Report 92-1	2995.0 - 4520.0 m
HB-0147	15.03.1992	4427.0 - 6024.0 m

Example:
Section of log: 5705.0 - 5770.0 m, **Fig. 7.17**

Purpose of log:
This combination logging tool is deployed to obtain information on porosity and lithology. 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. In addition, these measurements can be used to calculate the heat production rate due to radioactive decay.

Operation:
This combination tool has to be run excentralized. The caliper arm of the density and an excentralizer for the neutron is normally used. For this operation the "short axis logging technique" was applied. With this technique the sensors from the density and neutron tools are forced to travel along the short axis of the ovalized borehole. Data quality is increased significantly this way.
Depth scale: 1/200, 1/1000; logging speed: 6 m/min.

Technical information:
This is a nuclear logging string, it means mechanical 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/cm^3 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	Unit
BS	Bit Size	(mm)
CALI	Caliper	(mm)
DRHO	Density Correction	(G/C3)
HTEN	Head Tension	(LBF)
NPHI	Neutron Porosity	(V/V)
PEF	Photoelectric Factor	(B/E)
RHOB	Bulk Density	(G/C3)

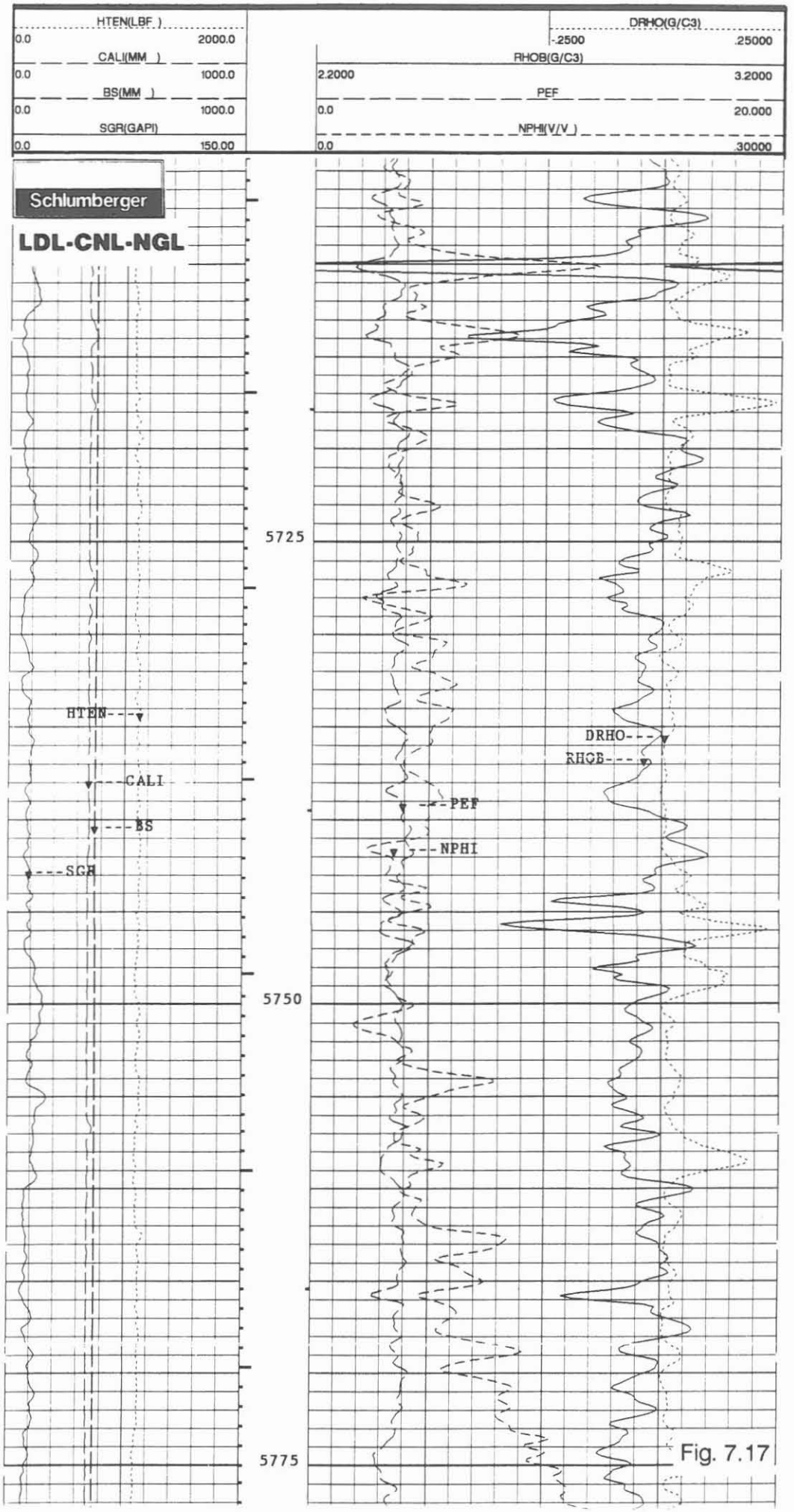

HTEN(LBF)
0.0
2000.0
CALI(MM)
0.0
1000.0
BS(MM)
0.0
1000.0
SGR(GAPI)
0.0
150.00
DRHO(G/C3)
-.2500
.25000
RHOB(G/C3)
2.2000
3.2000
PEF
0.0
20.000
NPHI(V/V)
0.0
.30000
Schlumberger
LDL-CNL-NGL
5725
5750
5775
HTEN
CALI
BS
SGR
DRHO
RHOB
PEF
NPHI

Fig. 7.17

CNL (Compensated Neutron Log - Epithermal Neutron)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0116	KTB-Report 92-1	2979.0 - 4520.0 m
HB-0147	15.03.1992	4427.0 - 6024.0 m

Example:
Section of log: 5712.0 - 5784.0 m, **Fig. 7.18**

Purpose of log:
Neutron logs are used for lithology determination and porosity evaluation. In crystalline rocks the porosity evaluation is difficult, as these types of rocks contain neutron absorbing minerals masking the primarily response to hydrogen content.

Operation:
The Compensated Neutron Log is recorded in combination with the Litho-Density (LDL) and Natural Gamma Spectrometer Log (NGL). The log itself presents two neutron curves: the epithermal neutron (ENPH) and the neutron porosity (NPHI). In addition, the total gamma rays (SGR), caliper (CALI), bit size (BS) and head tension (HTEN) are recorded.
Depth scales: 1/1000, 1/200; logging speed: 6 m/min.

Technical information:
The neutron measurement system requires a neutron source which bombards the formation with fast neutrons. The neutrons are slowed down mainly by hydrogen atoms in the formation. The slowed neutrons are counted by detectors - epithermal (intermediate) and thermal (slow) neutrons. Using two detectors for each system, borehole compensation is provided. Sampling rate: 6".

Mnemonics and Units:

Mnemonics	Description	Unit
BS	Bite Size	(MM)
CALI	Caliper	(MM)
ENPH	Epithermal Neutron	(V/V)
HTEN	Head Tension	(LBF)
NPHI	Neutron Porosity	(V/V)
SGR	Total Gamma Ray	(GAPI)

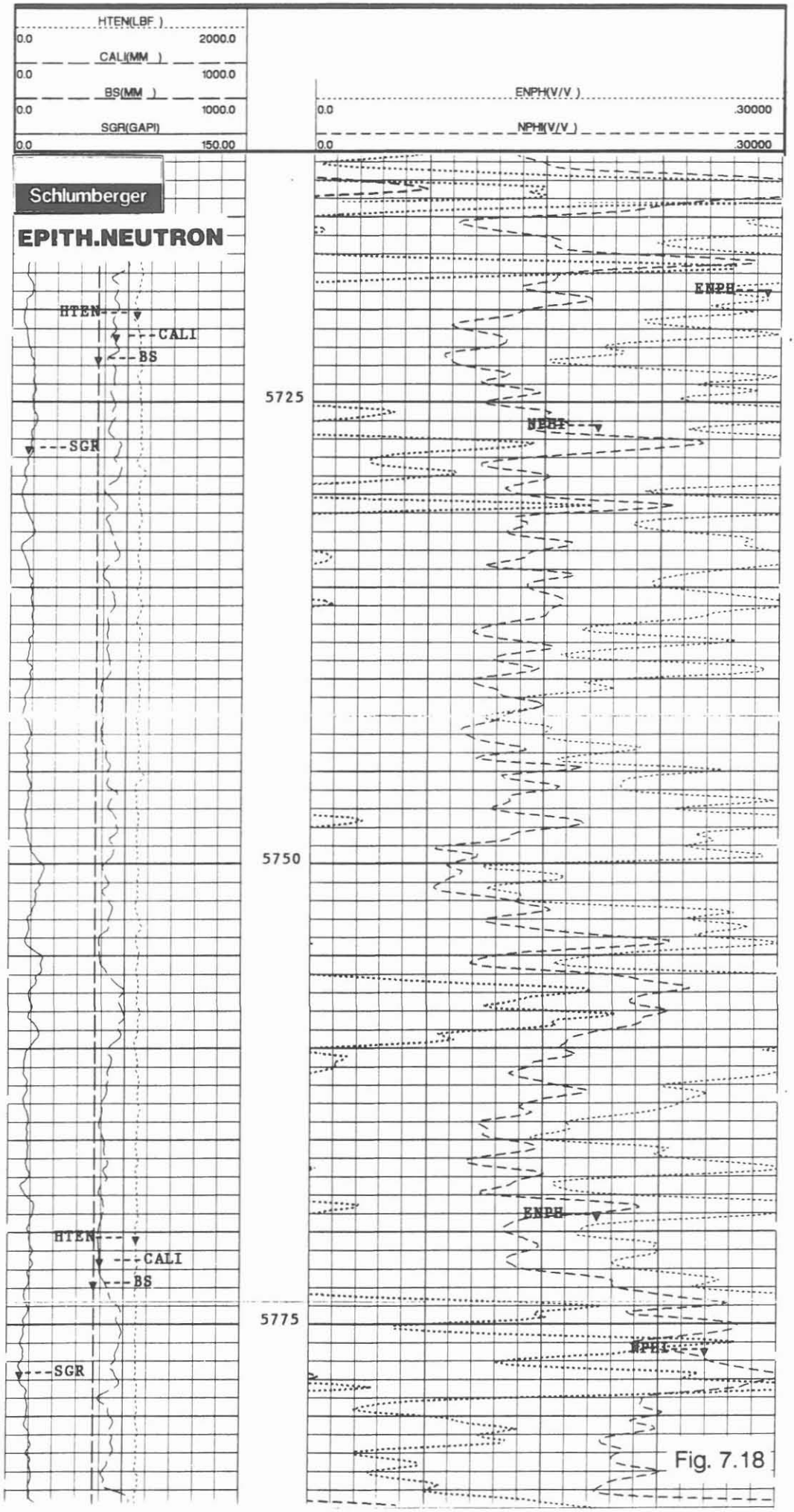

HTEN(LBF)
0.0
2000.0
CALI(MM)
0.0
1000.0
BS(MM)
0.0
1000.0
SGR(GAPI)
0.0
150.00
ENPH(V/V)
0.0
.30000
NPH(V/V)
0.0
.30000
Schlumberger
EPITH.NEUTRON
HTEN
CALI
BS
SGR
5725
5750
5775
ENPH
NPHI

Fig. 7.18

NGL-Ratio (Natural Gamma Spectrometer - Ratio Presentation)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0076	KTB Report 91-2	262.0 - 1719.0 m
HB-0095	KTB Report 92-1	700.0 - 3003.0 m
HB-0116	KTB Report 92-1	2979.0 - 4520.0 m
HB-0147	15.03.1992	4427.0 - 6024.0 m

Example:
Section of log: 5725.0 - 5795.0 m, **Fig. 7.19**

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 occuring 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 and special radioactive mineral detection.

Operation:
The log was recorded in combination with the Litho-Density and Compensated Neutron Logs. It was run excentralized for better response in the rather large borehole of 14 3/4". 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 than used to compute the ratios uranium:thorium, uranium:potassium and potassium: thorium and the difference total gamma ray minus uranium.
Data rate: 6".

Mnemonics and Units:

Mnemonics	Description	Unit
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:Potessium Ratio	
TURA	Thorium:Uranium Ratio	
UPRA	Uranium:Potessium Ratio	
URAN	Uranium Content	(PPM)

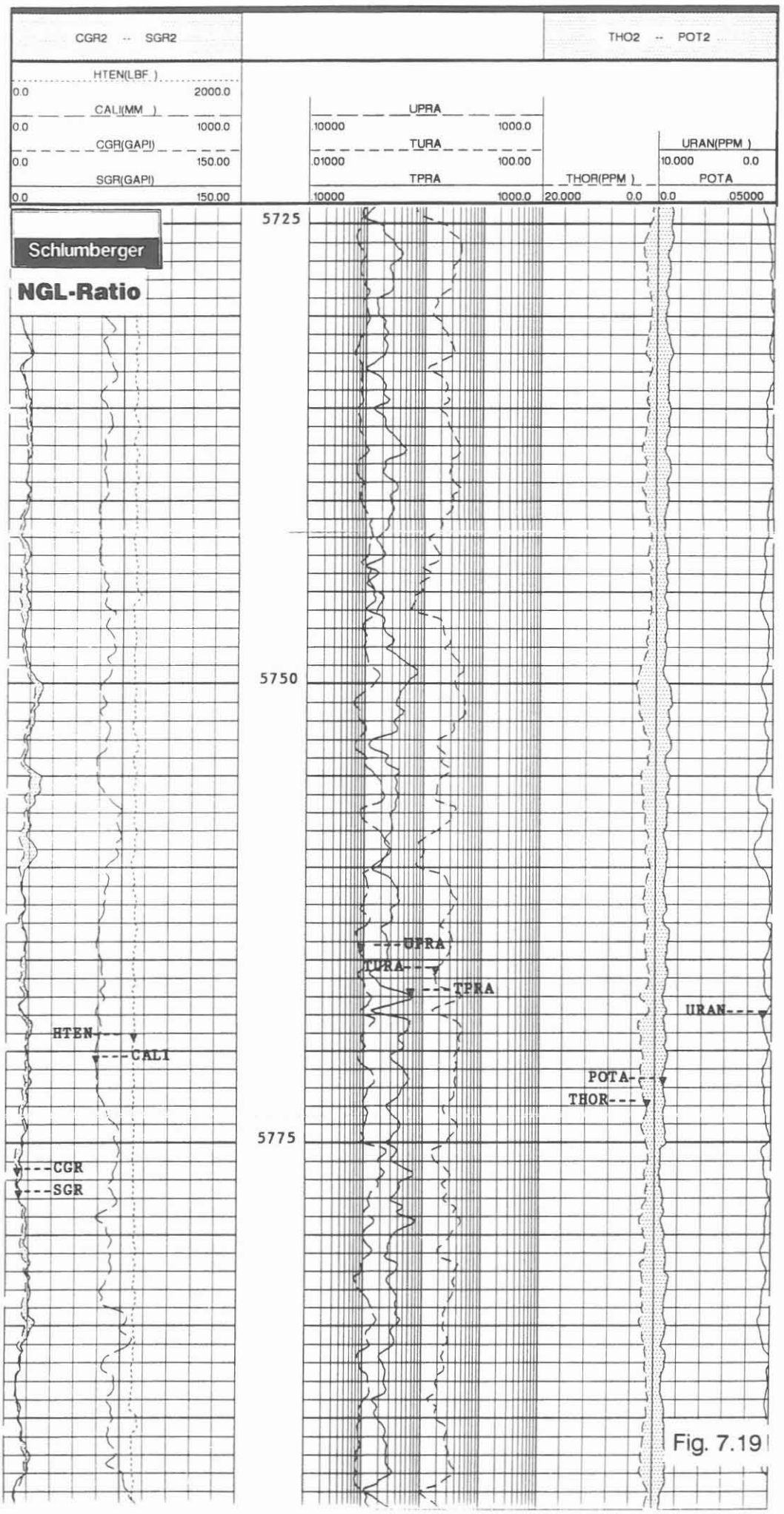

CGR2 -- SGR2
HTEN(LBF)
0.0
2000.0
CALI(MM)
0.0
1000.0
CGR(GAPI)
0.0
150.00
SGR(GAPI)
0.0
150.00
UPRA
10000
1000.0
TURA
01000
100.00
TPRA
10000
1000.0
THO2 -- POT2
THOR(PPM)
20.000
0.0
URAN(PPM)
10.000
0.0
POTA
0.0
05000
Schlumberger
NGL-Ratio
5725
5750
5775
---UPRA
TURA---
---TPRA
URAN---
HTEN---
---CALI
POTA---
THOR---
---CGR
---SGR

Fig. 7.19

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

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0076	KTB Report 91-2	262.0 - 1719.0 m
HB-0095	KTB Report 92-1	700.0 - 3003.0 m
HB-0116	KTB Report 92-1	2979.0 - 4520.0 m
HB-0147	15.03.1992	4427.0 - 6024.0 m

Example:
Section of log: 5721.0 - 5798.0 m, **Fig. 7.20**

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 occuring 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 and special radioactive mineral detection.

Operation:
The log was recorded in combination with the Litho-Density and Compensated Neutron Logs. It was run excentralized for better response in the rather large borehole of 14 3/4". 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 recordet. In addition the total spectra minus uranium is computed.
Data rate: 6".

Mnemonics and Units:

Mnemonics	Description	Unit
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)

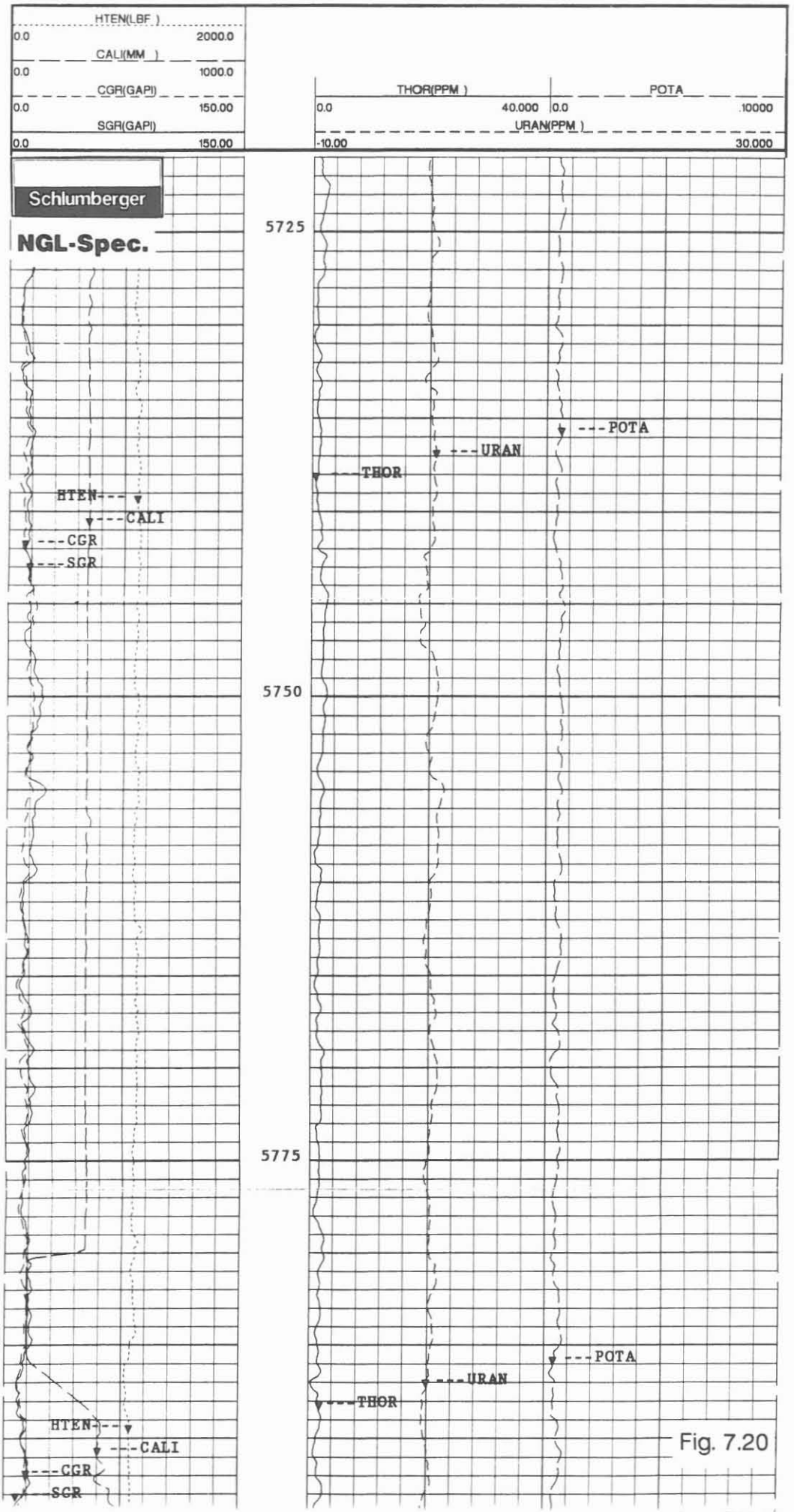

HTEN(LBF)
0.0
2000.0
CALI(MM)
0.0
1000.0
CGR(GAPI)
0.0
150.00
SGR(GAPI)
0.0
150.00
THOR(PPM)
0.0
40.000
POTA
0.0
.10000
URAN(PPM)
-10.00
30.000
Schlumberger
NGL-Spec.
5725
5750
5775
HTEN
CALI
CGR
SGR
THOR
URAN
POTA

Fig. 7.20

DSI/GR/AMS/GPIT (Dipole Shear Sonic Imager/Gamma Ray/Auxiliary Measurement Sonde/General Purpose Inclinometer Tool)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0119	KTB-Report 92-1	3000.0 - 4500.0 m
HB-0149	16.03.1992	4450.0 - 6020.0 m

Examples:

List of Mnemonics and Units,		**Fig. 7.21**
Sections of logs:	BHC Sonic Plot 5968.0-6012.0 m,	**Fig. 7.22**
	DT-P-S-Stoneley 5970.0-6014.0 m,	**Fig. 7.23**
	P-FMD 5948.0-6006.0 m,	**Fig. 7.24**
	P&S Mode-STC 5975.0-6014.0 m,	**Fig. 7.25**
	P&S Mode-VDL 5958.0-6014.0 m,	**Fig. 7.26**
	Stoneley-STC 5890.0-5948.0 m,	**Fig. 7.27**
	Stoneley-VDL 5880.0-5947.0 m,	**Fig. 7.28**
	Lower Dipole-STC 5964.0-6014.0 m,	**Fig. 7.29**
	Lower Dipole-VDL 5960.0-6016.0 m,	**Fig. 7.30**
	Upper Dipole-STC 5965.0-6014.0 m,	**Fig. 7.31**
	Upper Dipole-VDL 5960.0-6016.0 m,	**Fig. 7.32**

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 velocities) have geophysical, petrophysical and rock mechanical application like porosity estimation, fracture detection and wellbore stability calculations.

Operation:
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. 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.

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 pregiven 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 (compressionel, shear, Stoneley) has been possible and the respective slowness has been determined.

The digital first motion detection processing (DFMD) applies a treshold 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 than 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 frequencies: 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. 7.22). 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. 7.23). 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 and pad one azimuth is presented.

3. P-FMD (Fig. 7.24). DT-Comp. for transmitter and receiver mode and average is given. All measurements are coming from first motion detection. The coherence for transmitter and receiver modes are presented like gamma ray and integrated travel time.

4. P&S Mode-STC (Fig. 7.25). With the software available in the MAXIS 500 surface unit, the 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. 7.26). This log is a presentation as Variable Density Log (VDL). The waveforms are presented over 5000 μsec in a grey-scale log. Gamma Ray, Waveform Depth and Waveform Gain are given in track I.

6. Stoneley-STC (Fig. 7.27). This plot gives the Stoneley travel time computed by the Slowness-Time-Coherence (STC) function in a colour presentation. Information in track I is same as in Fig. 7.25 - but for Stoneley-wave only.

7. Stoneley-VDL/Fig. 7.28). The Variable Density Log (VDL) of the Stoneley-Waveforms over 10 000 μsec 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 and Waveform Depth/Waveform Gain are given in track I.

8. Lower Dipole-STC (Fig. 7.29). 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. 7.25 - but for Lower Dipole.

9. Lower Dipole - VDL (Fig. 7.30). Variable Density Log of Lower Dipole waveform presentation in grey-scale.

10. Upper Dipole - STC (Fig. 7.31). Same as Fig. 7.29 - but for Upper Dipole.

11. Upper Dipole - VDL (Fig. 7.32). Same as Fig. 7.30 - but for Upper Dipole.

Mnemonics and Units:

Mnemonics	Description	Units
See Fig. 7.21		

DSI Mnemonics & Units

Parameters

DLIS Name	Description	Value	
ACPP	Accelerometer PROM Presence	ABSENT	
AFMO	Accelerometer Filtering Mode	HAMMING	
ART	Accelerometer Reference Temperature	0	DEGC
BHS	Bore Hole Status	OPEN	
BHT	Bottom Hole Temperature (used in calculations)	140	DEGC
BILI	Bond Index Level for Zone Isolation	0.8	
BS	Bit Size	14.750	IN
BSAL	Borehole Salinity	-50000.0	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	160	US/F
CSTR	Compressive Strength of Cement	0	KPA
DO	Depth Offset	1.1	M
DPPM	Density Porosity Processing Mode	STAN	
DSHL	Label Slowness Lower Limit - Dipole Shear	60	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	56	US/F
DTSS	Shear Delta-T Source	LOWER_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	BIT_SIZE	
GDT4	Gain Delta-T 4	160	US/F
GLM	GPIT Logging Mode	STAN	
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	ABSENT	
MATR	Rock Matrix Type	LIMESTONE	
MCI	Minimum Cemented Interval	3.048	M
MDEC	Magnetic Field Declination	0.72734	DEG
MRTE	Magneto Reference Temperature	0	DEGC
MSA	Minimum Sonic Amplitude	0	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)	ODD	
SAM5	Sonic Acquisition Mode 5 (FMD)	ODD	
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	10	DEGC
SHUL	Label Slowness Upper Limit - P & S Shear	160	US/F
SLL1	STC Slowness Lower Limit - Lower Dipole	75	US/F
SLL2	STC Slowness Lower Limit - Upper Dipole	75	US/F
SLL3	STC Slowness Lower Limit - Stoneley	180	US/F
SLL4	STC Slowness Lower Limit - P & S	40	US/F
SPFS	Sonic Porosity Formula	RAYMER_HUNT	
SPSO	Sonic Porosity Source	DTCO	
STKT	STI Stuck Threshold	1.524	M
STLL	Label Slowness Lower Limit - Stoneley	120	US/F
STUL	Label Slowness Upper Limit - Stoneley	780	US/F
SUL1	STC Slowness Upper Limit - Lower Dipole	775	US/F
SUL2	STC Slowness Upper Limit - Upper Dipole	775	US/F
SUL3	STC Slowness Upper Limit - Stoneley	780	US/F
SUL4	STC Slowness Upper Limit - P & S	160	US/F
TD	Total Depth	6025	M
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. 7.21

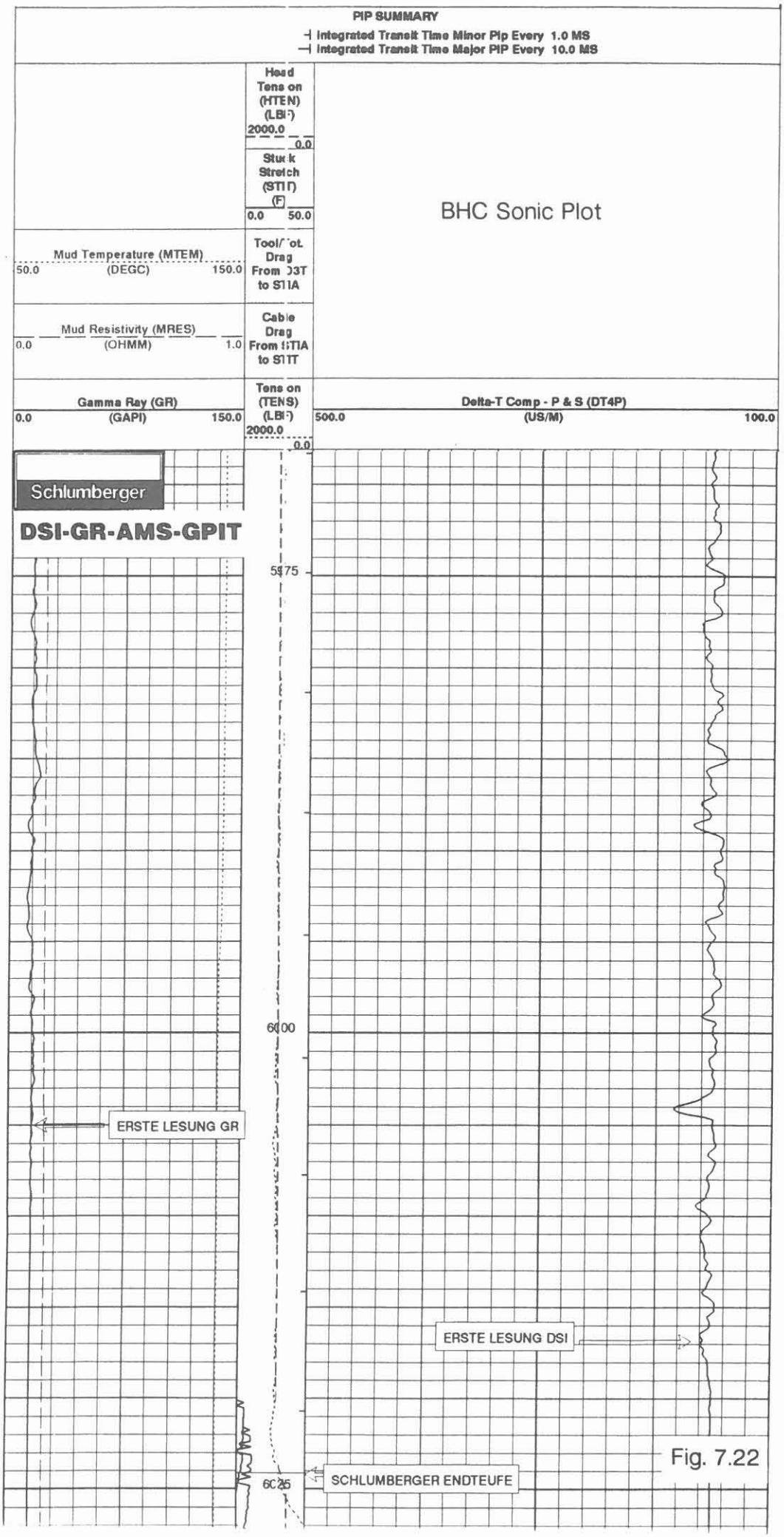

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Head Tension (HTEN) (LBF) 2000.0 0.0
Stuck Stretch (STIT) (F) 0.0 50.0
BHC Sonic Plot
Mud Temperature (MTEM) 50.0 (DEGC) 150.0
Tool Rot. Drag From DT to ST1A
Mud Resistivity (MRES) 0.0 (OHMM) 1.0
Cable Drag From ST1A to STIT
Gamma Ray (GR) 0.0 (GAPI) 150.0
Tension (TENS) (LBF) 2000.0 0.0
Delta-T Comp - P & S (DT4P) 500.0 (US/M) 100.0
Schlumberger
DSI-GR-AMS-GPIT
5975
6000
ERSTE LESUNG GR
ERSTE LESUNG DSI
6025
SCHLUMBERGER ENDTEUFE

Fig. 7.22

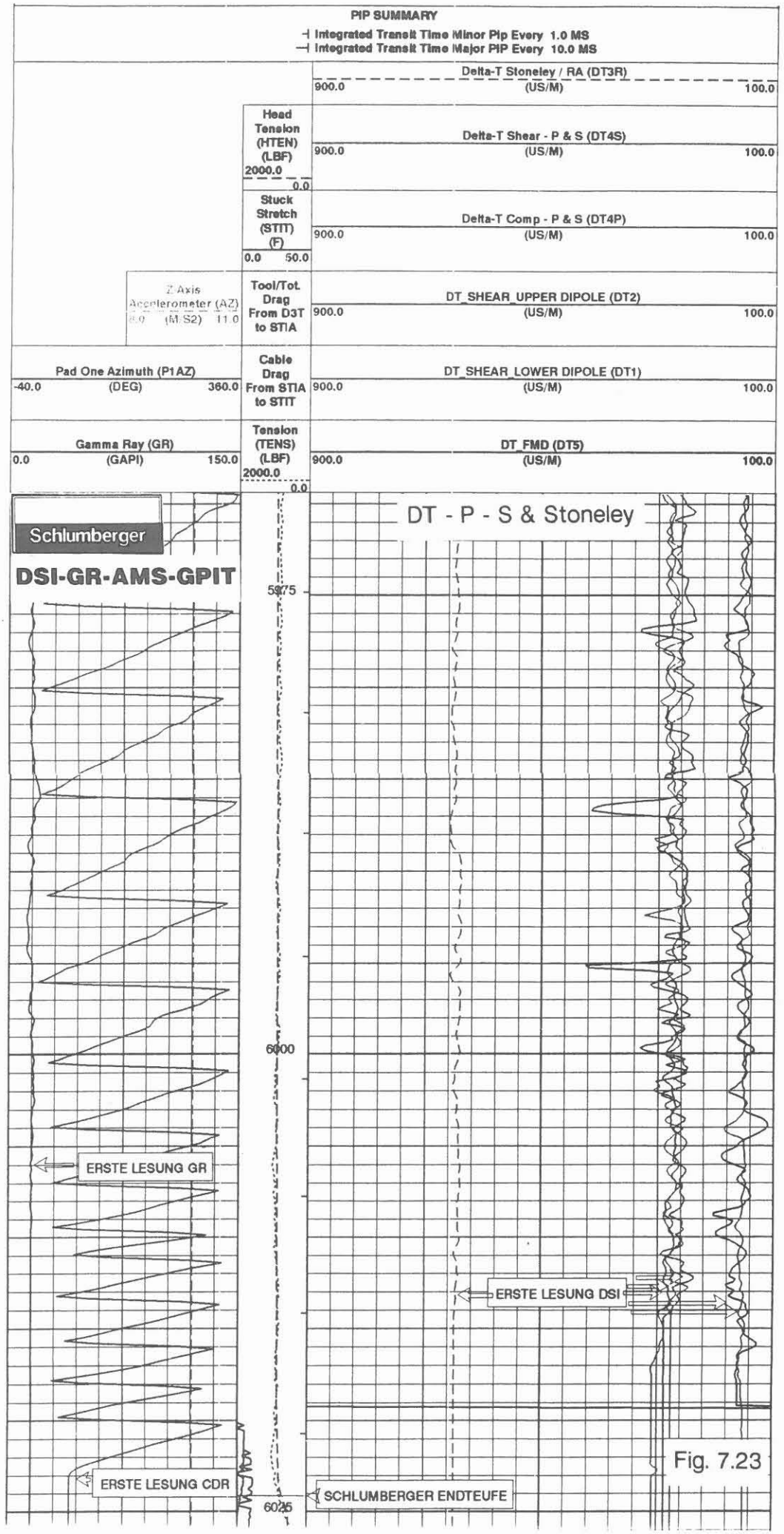

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Delta-T Stoneley / RA (DT3R)
900.0 (US/M) 100.0
Head Tension (HTEN) (LBF)
2000.0 0.0
Delta-T Shear - P & S (DT4S)
900.0 (US/M) 100.0
Stuck Stretch (STIT) (F)
0.0 50.0
Delta-T Comp - P & S (DT4P)
900.0 (US/M) 100.0
Z Axis Accelerometer (AZ)
8.0 (M/S2) 11.0
Tool/Tot. Drag From D3T to STIA
DT_SHEAR_UPPER DIPOLE (DT2)
900.0 (US/M) 100.0
Pad One Azimuth (P1AZ)
-40.0 (DEG) 360.0
Cable Drag From STIA to STIT
DT_SHEAR_LOWER DIPOLE (DT1)
900.0 (US/M) 100.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0 0.0
DT_FMD (DT5)
900.0 (US/M) 100.0
Schlumberger
DSI-GR-AMS-GPIT
DT - P - S & Stoneley
5975
6000
6025
ERSTE LESUNG GR
ERSTE LESUNG CDR
ERSTE LESUNG DSI
SCHLUMBERGER ENDTEUFE

Fig. 7.23

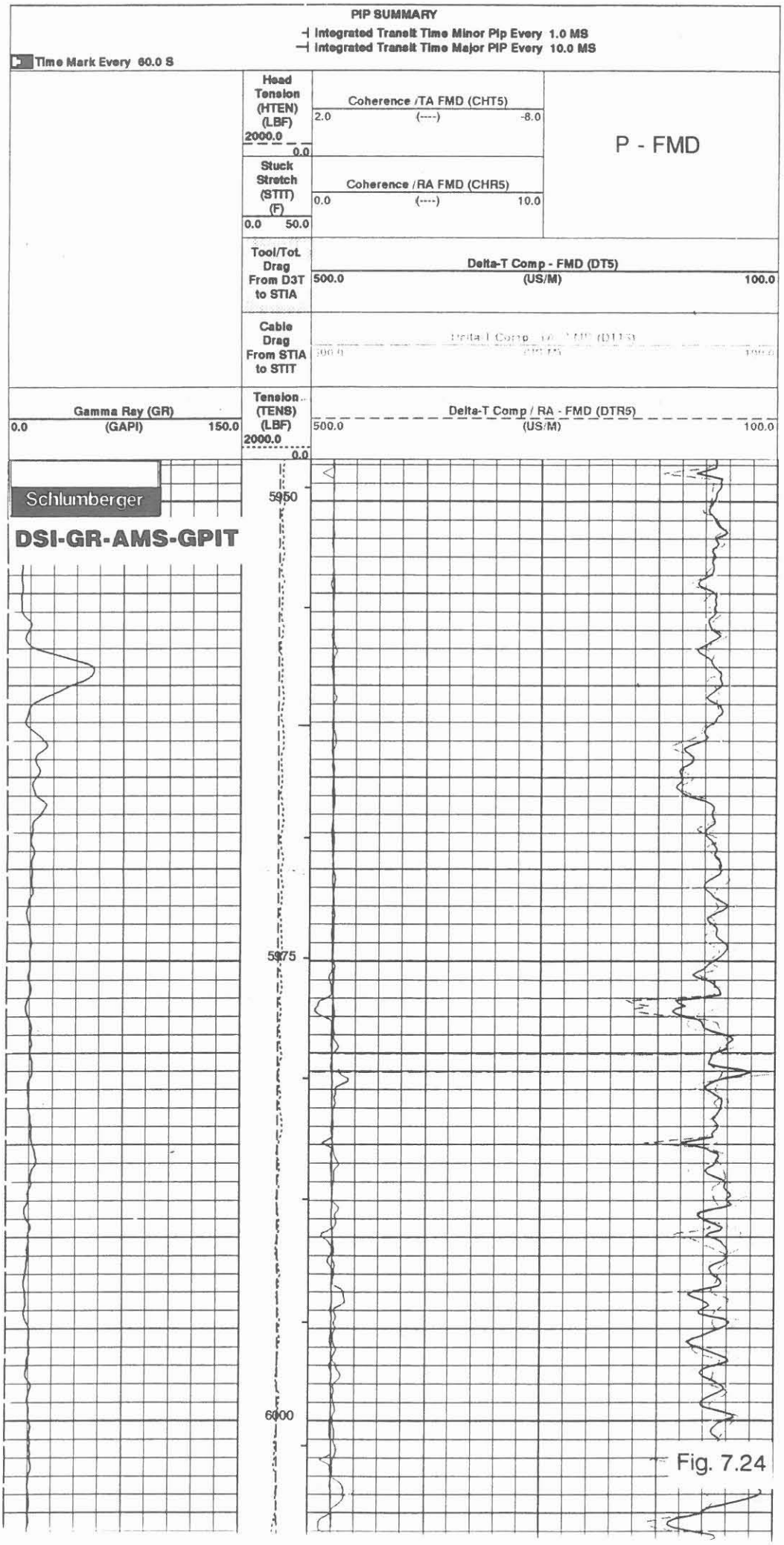

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Head Tension (HTEN) (LBF)
2000.0
0.0
Coherence /TA FMD (CHT5)
2.0 (----) -8.0
P - FMD
Stuck Stretch (STIT) (F)
0.0 50.0
Coherence /RA FMD (CHR5)
0.0 (----) 10.0
Tool/Tot. Drag From D3T to STIA
Delta-T Comp - FMD (DT5)
500.0 (US/M) 100.0
Cable Drag From STIA to STIT
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0
0.0
Delta-T Comp / RA - FMD (DTR5)
500.0 (US/M) 100.0
Schlumberger
DSI-GR-AMS-GPIT
5950
5975
6000

Fig. 7.24

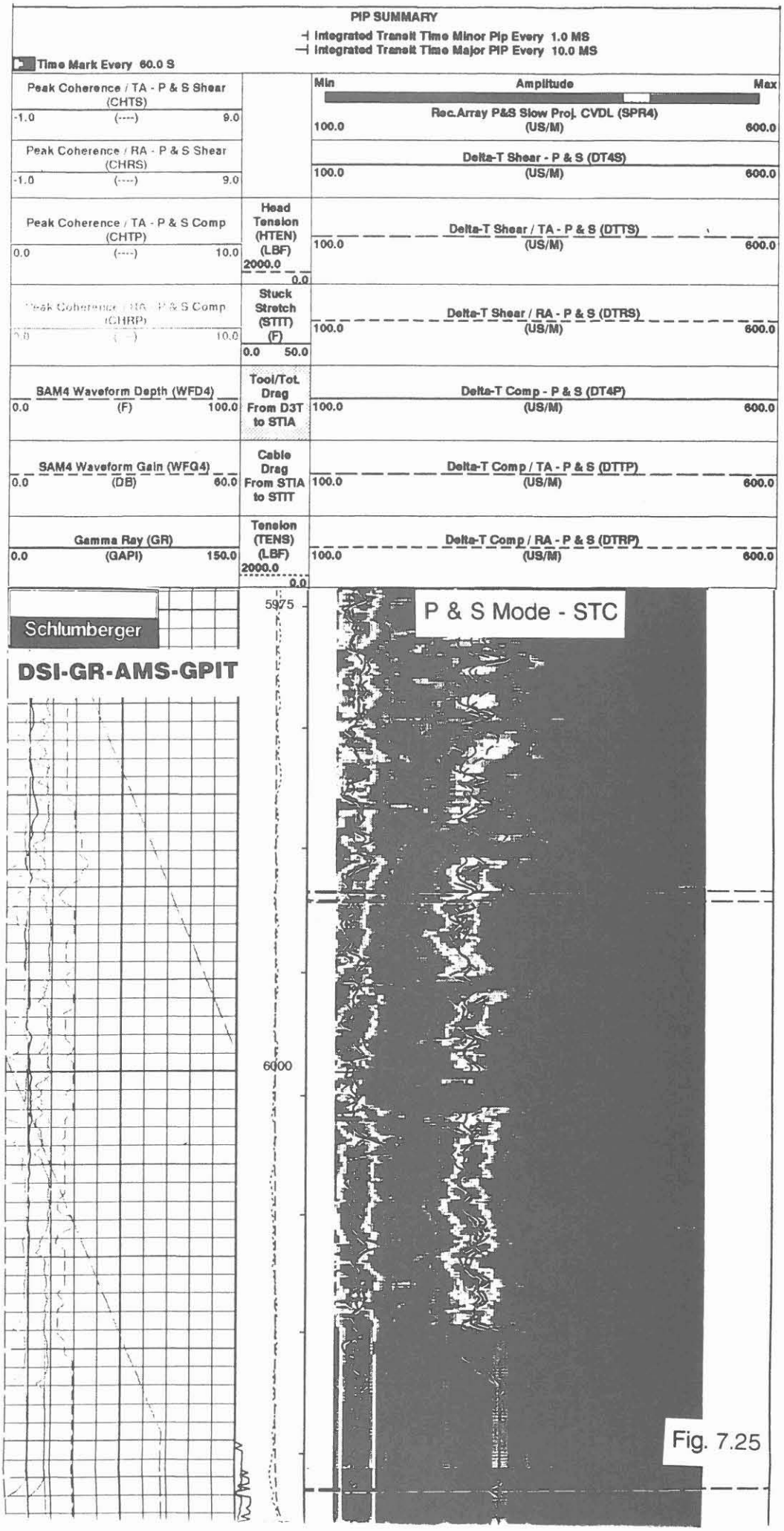

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Peak Coherence / TA - P & S Shear (CHTS)
-1.0 (----) 9.0
Peak Coherence / RA - P & S Shear (CHRS)
-1.0 (----) 9.0
Peak Coherence / TA - P & S Comp (CHTP)
0.0 (----) 10.0
Peak Coherence / RA - P & S Comp (CHRP)
0.0 (----) 10.0
SAM4 Waveform Depth (WFD4)
0.0 (F) 100.0
SAM4 Waveform Gain (WFG4)
0.0 (DB) 60.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
Head Tension (HTEN) (LBF)
2000.0 0.0
Stuck Stretch (STIT) (F)
0.0 50.0
Tool/Tot. Drag From D3T to STIA
Cable Drag From STIA to STIT
Tension (TENS) (LBF)
2000.0 0.0
Min Amplitude Max
Rec.Array P&S Slow Proj. CVDL (SPR4)
100.0 (US/M) 600.0
Delta-T Shear - P & S (DT4S)
100.0 (US/M) 600.0
Delta-T Shear / TA - P & S (DTTS)
100.0 (US/M) 600.0
Delta-T Shear / RA - P & S (DTRS)
100.0 (US/M) 600.0
Delta-T Comp - P & S (DT4P)
100.0 (US/M) 600.0
Delta-T Comp / TA - P & S (DTTP)
100.0 (US/M) 600.0
Delta-T Comp / RA - P & S (DTRP)
100.0 (US/M) 600.0
Schlumberger
DSI-GR-AMS-GPIT
5975
6000
P & S Mode - STC

Fig. 7.25

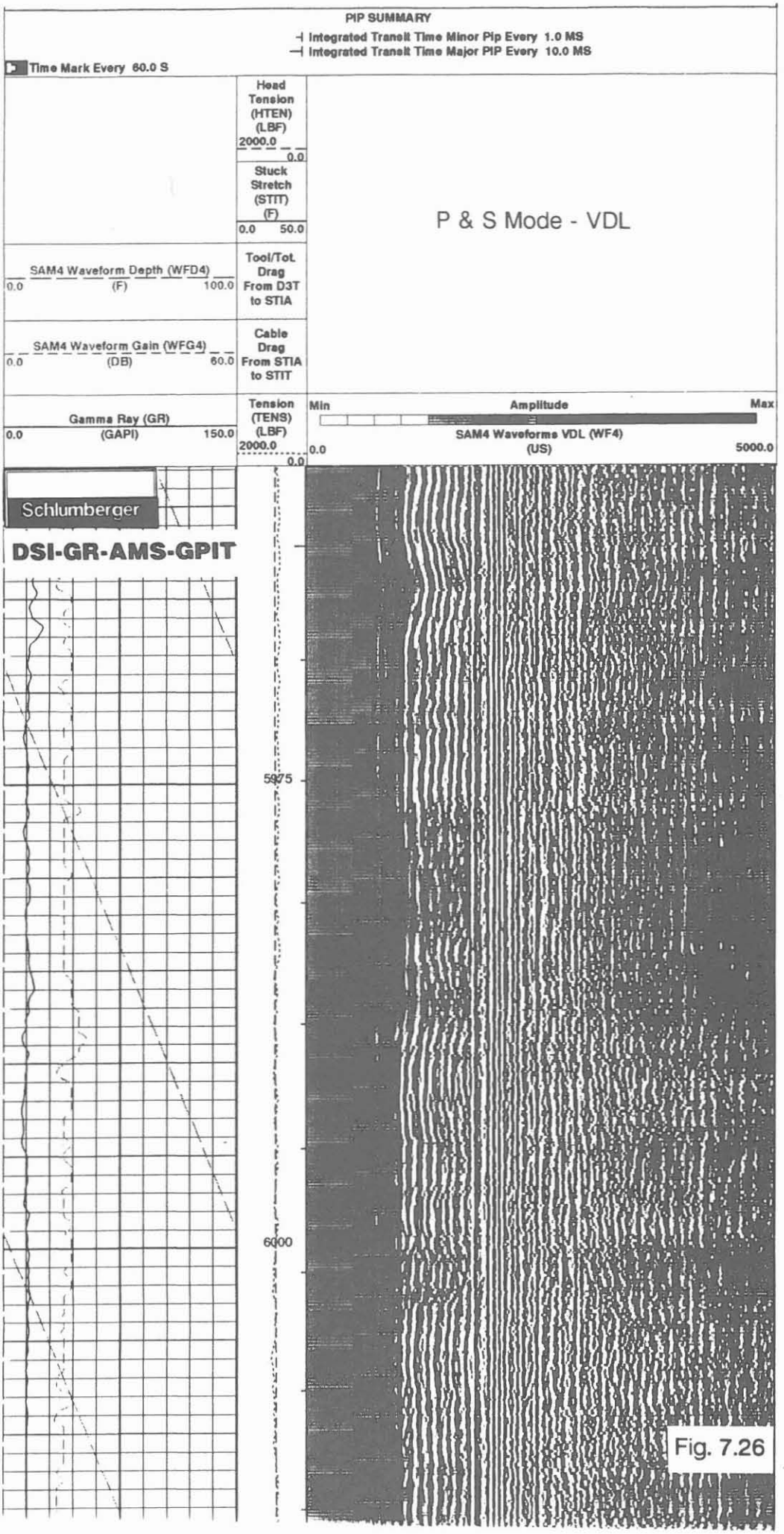
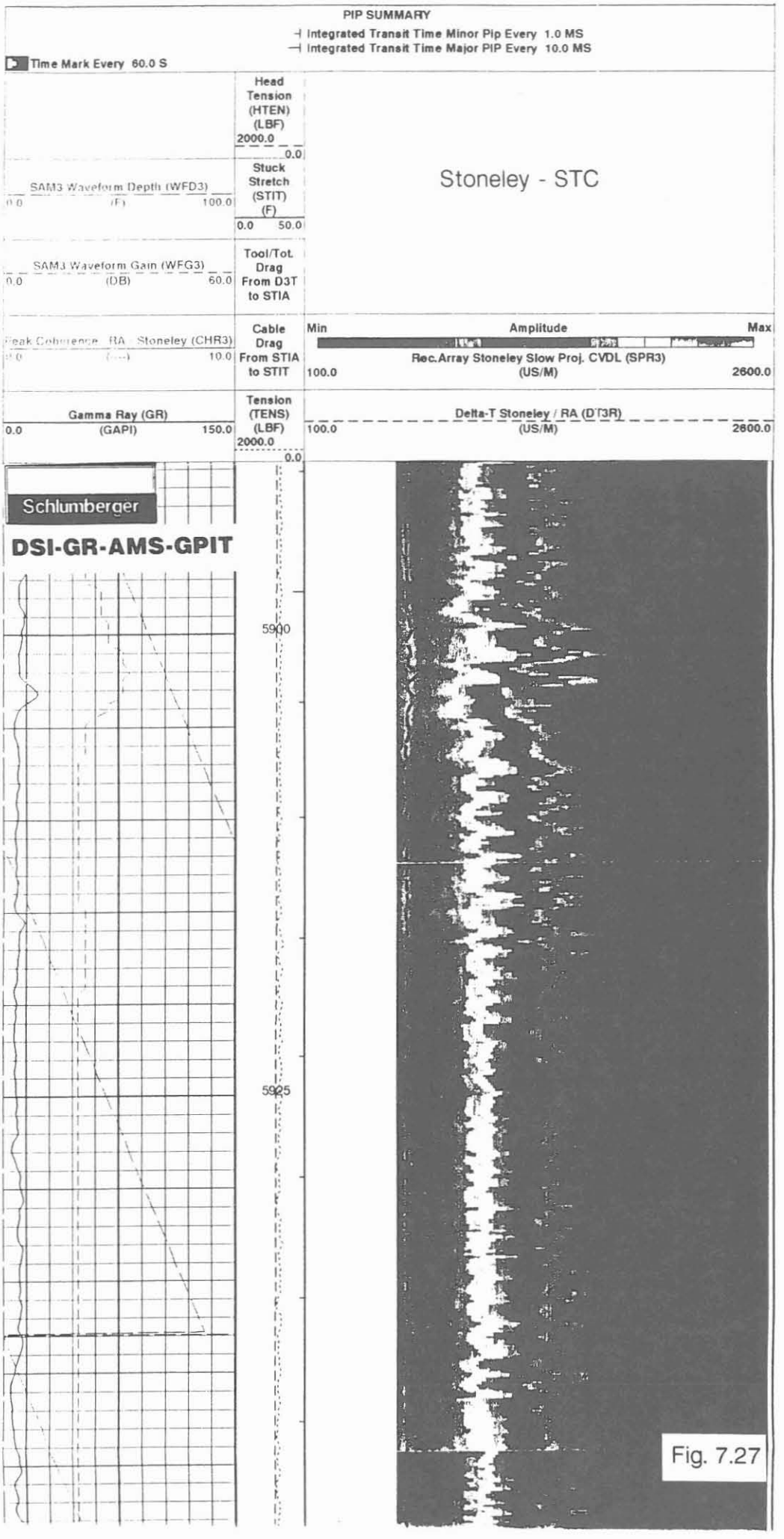

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Head Tension (HTEN) (LBF)
2000.0
0.0
Stuck Stretch (STIT) (F)
0.0 50.0
P & S Mode - VDL
SAM4 Waveform Depth (WFD4)
0.0 (F) 100.0
Tool/Tot. Drag From D3T to STIA
SAM4 Waveform Gain (WFG4)
0.0 (DB) 60.0
Cable Drag From STIA to STIT
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0
0.0
Min
Amplitude
Max
SAM4 Waveforms VDL (WF4)
0.0 (US) 5000.0
Schlumberger
DSI-GR-AMS-GPIT
5975
6000

Fig. 7.26


PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Head Tension (HTEN) (LBF) 2000.0 0.0
Stuck Stretch (STIT) (F) 0.0 50.0
Stoneley - STC
SAM3 Waveform Depth (WFD3) 0.0 (F) 100.0
SAM3 Waveform Gain (WFG3) 0.0 (DB) 60.0
Tool/Tot. Drag From D3T to STIA
Peak Coherence RA Stoneley (CHR3) 0.0 (---) 10.0
Cable Drag From STIA to STIT
Min Amplitude Max
Rec.Array Stoneley Slow Proj. CVDL (SPR3)
100.0 (US/M) 2600.0
Gamma Ray (GR) 0.0 (GAPI) 150.0
Tension (TENS) (LBF) 2000.0 0.0
Delta-T Stoneley / RA (DT3R) 100.0 (US/M) 2600.0
Schlumberger
DSI-GR-AMS-GPIT
5900
5925
Fig. 7.27

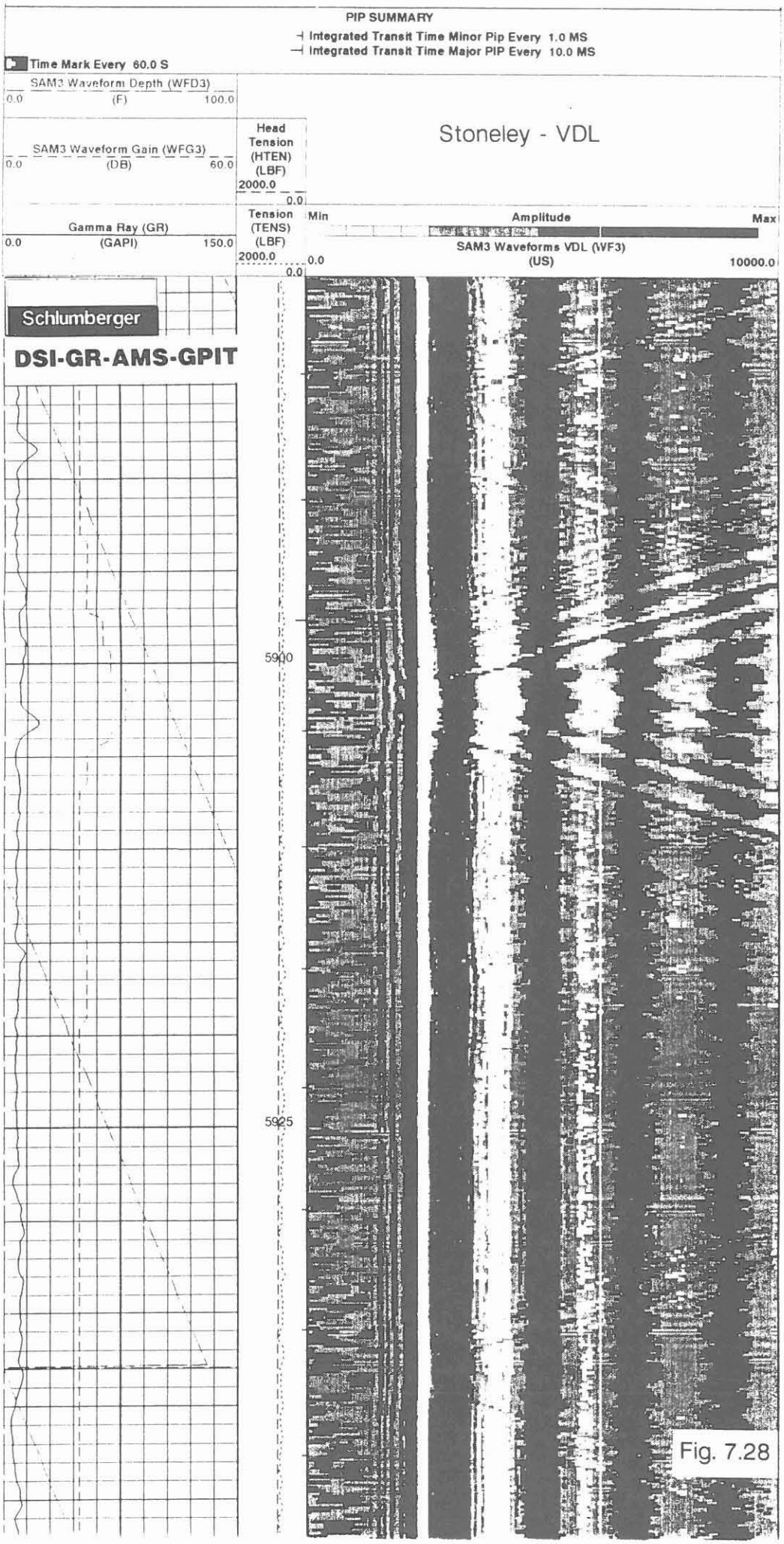

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
SAM3 Waveform Depth (WFD3)
0.0 (F) 100.0
SAM3 Waveform Gain (WFG3)
0.0 (DB) 60.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
Head Tension (HTEN) (LBF)
2000.0 0.0
Tension (TENS) (LBF)
2000.0 0.0
Stoneley - VDL
Min Amplitude Max
SAM3 Waveforms VDL (WF3) (US)
0.0 10000.0
Schlumberger
DSI-GR-AMS-GPIT
5900
5925

Fig. 7.28

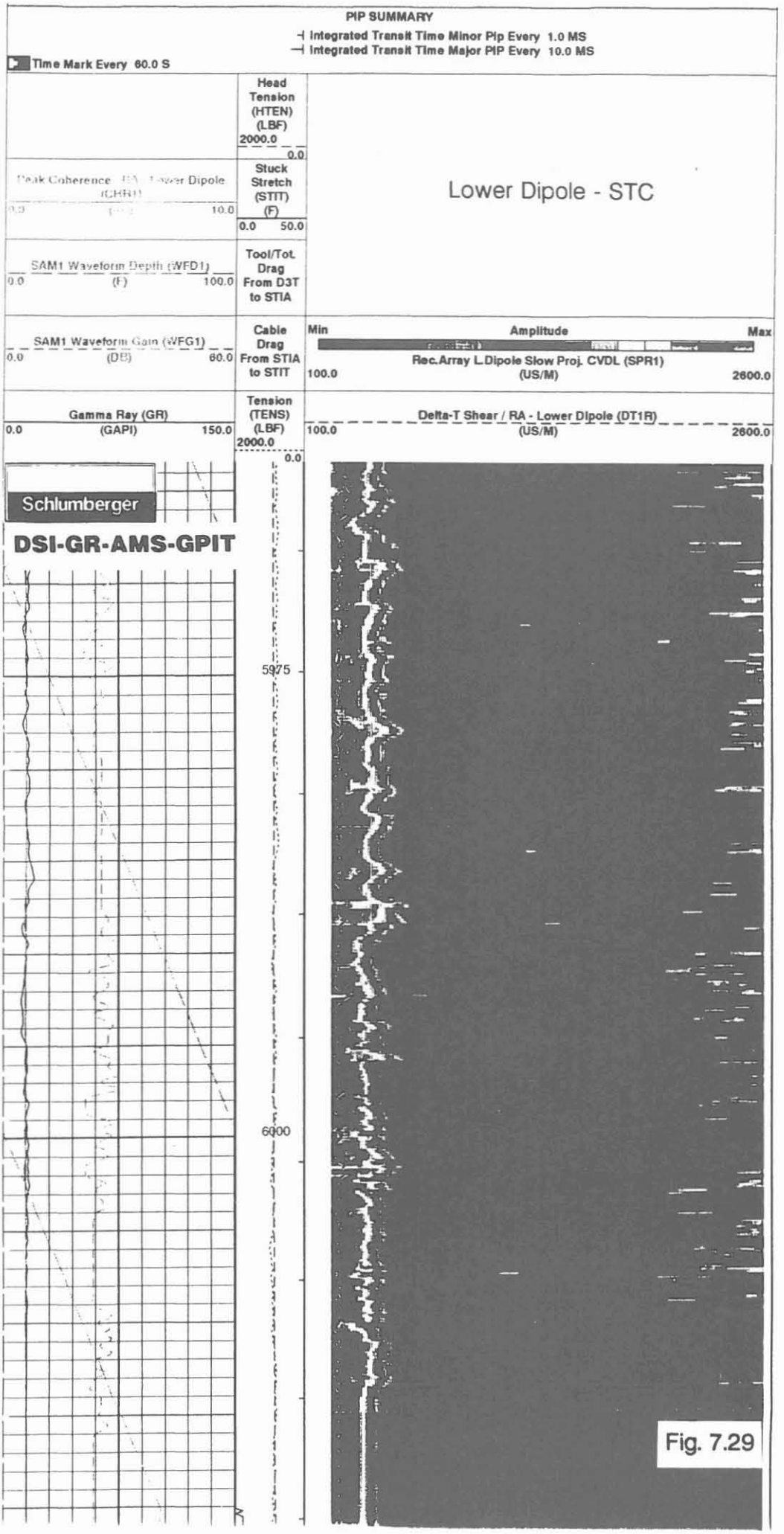

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Head Tension (HTEN) (LBF)
2000.0
0.0
Stuck Stretch (STIT) (F)
0.0 50.0
Lower Dipole - STC
Tool/Tot. Drag From D3T to STIA
SAM1 Waveform Depth (WFD1)
0.0 (F) 100.0
Cable Drag From STIA to STIT
Min Amplitude Max
SAM1 Waveform Gain (WFG1)
0.0 (DB) 60.0
Rec.Array L.Dipole Slow Proj. CVDL (SPR1)
100.0 (US/M) 2600.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0
Delta-T Shear / RA - Lower Dipole (DT1R)
100.0 (US/M) 2600.0
Schlumberger
DSI-GR-AMS-GPIT
0.0
5975
6000

Fig. 7.29

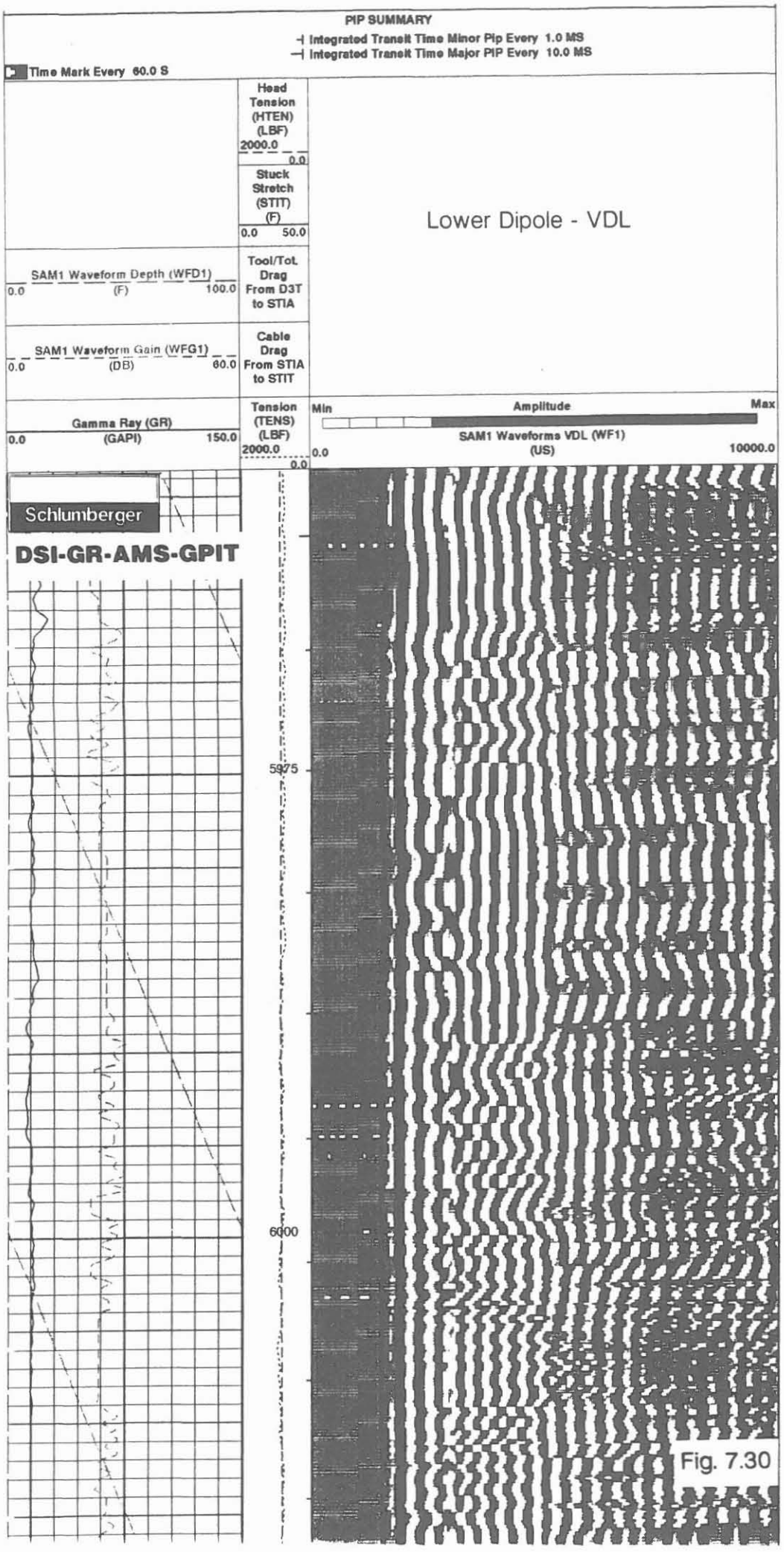

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Head Tension (HTEN) (LBF)
2000.0
0.0
Stuck Stretch (STIT) (F)
0.0 50.0
Lower Dipole - VDL
SAM1 Waveform Depth (WFD1)
0.0 (F) 100.0
Tool/Tot. Drag From D3T to STIA
SAM1 Waveform Gain (WFG1)
0.0 (DB) 60.0
Cable Drag From STIA to STIT
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0
0.0
Min
Amplitude
Max
SAM1 Waveforms VDL (WF1)
0.0 (US) 10000.0
Schlumberger
DSI-GR-AMS-GPIT
5975
6000

Fig. 7.30

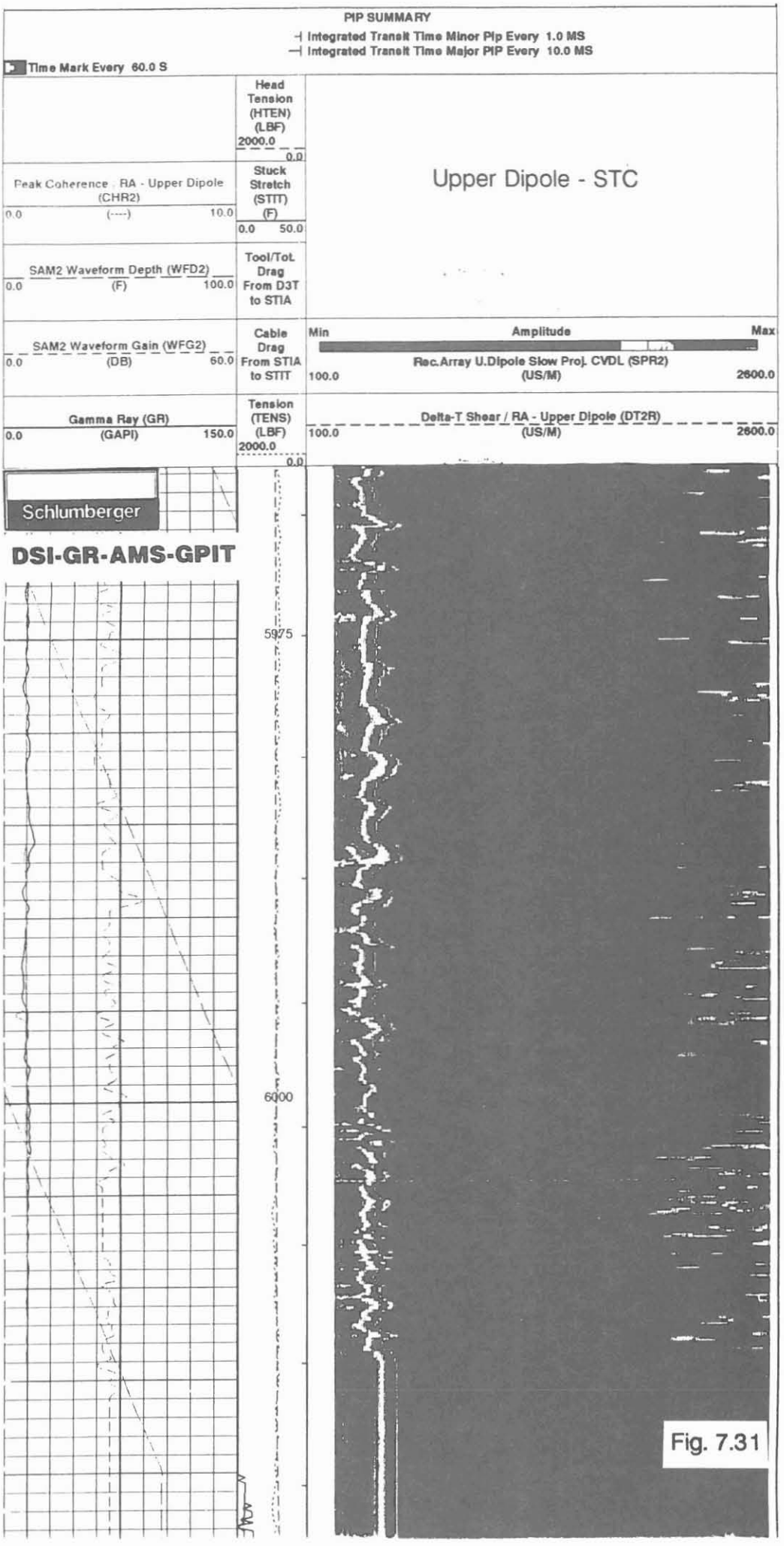

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Head Tension (HTEN) (LBF)
2000.0
0.0
Upper Dipole - STC
Peak Coherence : RA - Upper Dipole (CHR2)
0.0 (----) 10.0
Stuck Stretch (STIT) (F)
0.0 50.0
SAM2 Waveform Depth (WFD2)
0.0 (F) 100.0
Tool/Tot. Drag From D3T to STIA
SAM2 Waveform Gain (WFG2)
0.0 (DB) 60.0
Cable Drag From STIA to STIT
Min Amplitude Max
Rec.Array U.Dipole Slow Proj. CVDL (SPR2)
100.0 (US/M) 2600.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0
0.0
Delta-T Shear / RA - Upper Dipole (DT2R)
100.0 (US/M) 2600.0
Schlumberger
DSI-GR-AMS-GPIT
5975
6000

Fig. 7.31

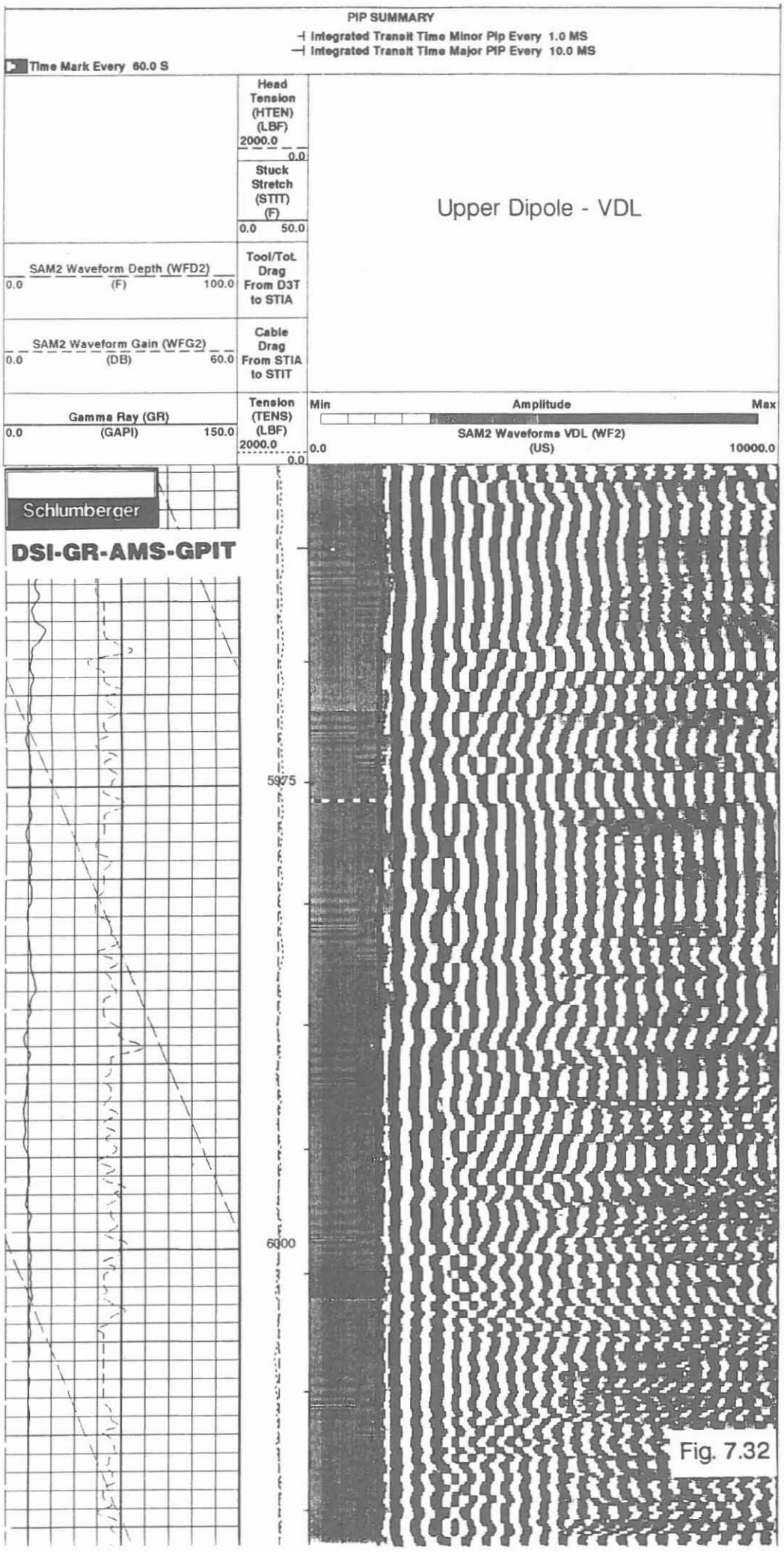

PIP SUMMARY
Integrated Transit Time Minor Pip Every 1.0 MS
Integrated Transit Time Major PIP Every 10.0 MS
Time Mark Every 60.0 S
Head Tension (HTEN) (LBF)
2000.0
0.0
Stuck Stretch (STIT) (F)
0.0 50.0
Upper Dipole - VDL
SAM2 Waveform Depth (WFD2)
0.0 (F) 100.0
Tool/Tot. Drag From D3T to STIA
SAM2 Waveform Gain (WFG2)
0.0 (DB) 60.0
Cable Drag From STIA to STIT
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0
0.0
Min
Amplitude
Max
SAM2 Waveforms VDL (WF2)
0.0 (US) 10000.0
Schlumberger
DSI-GR-AMS-GPIT
5975
6000

Fig. 7.32

FMI/GR (Formation MicroImager/Gamma Ray)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0001-0076	KTB-Report 91-2	0.0 - 1720.0 m
HB-0077-0127	KTB-Report 92-1	1720.0 - 4512.0 m
HB-0132	03.01.1992	3000.0 - 5505.0 m
HB-0150	17.03.1992	5450.0 - 6023.0 m

Example:
Sections of logs: Resistivity Curves Control Plot: 5700.0 - 5975.0 m, **Fig. 7.33**

Images Field Plot: 6002.4 - 6016.5 m, **Fig. 7.34**

Caliper, Deviation and Orientation Plot: 5959.0 - 6023.0 m, **Fig. 7.35**

Cyber Dip Plot: 5945.0 - 6012.0 m, **Fig. 7.36**

Accelerometer-Magnetometer Plot: 5962.0 - 6023.0 m, **Fig. 7.37**

Purpose of log:
To obtain information about structure, texture, foliation and tectonic features, like slickensides, shear planes, folds and for the detection of fractures and fracture systems.

Operation:
This new logging tool requires as surface instrumentation the MAXIS 500 logging unit. Making a temporary connection from this mobile unit to the stationary logging unit on location, the logs are recorded. In 14 3/4" borehole the measurement covers 43 % of the circumference of the borehole.

As real-time record the Resistivity Curve Control Plot Fig. 7.33 ist registered. This plot gives information about the tool performance quality. Via play-back the other plots are made on location, like Image Field Plot Fig. 7.34 and Caliper, Deviation and Orientation Plot Fig. 7.35.

Depth scales: 1/200, 1/40 (in the field); logging speed: 6 m/min.

Technical information:
This new logging tool from Schlumberger makes a resistivity scan of sections of the borehole circumference by applying electrode arrays, mounted on four caliper arms, against the wall. Every caliper arm carries a pad and flap with 24

electrodes each. Magnetometer and inclinometer measurements record not only the trajectory of the borehole but allow in combination with the resistivity records the evaluation of dip and strike direction of the formation.

The data rate from the 192 resistivity electrodes is enormous and requires the computer system of the MAXIS 500. From these "fast channels" a complete set of data are recorded at increments of 0.1" (2,5 mm). The "slow channels" (accelerometer, inclinometer, magnetometer data) are recorded at the standard rate of 6".

Mnemonics and Units:

Mnemonic	Description	Unit
BS	Bit Size	(MM)
C1	Caliper 1 - 3	(MM)
C2	Caliper 2 - 4	(MM)
DEVI	Deviation	(DEG)
EI	Emex Intensity	(AMPS)
EV	Emex Voltage	(V)
FBCR	FMI Correlation Resistance	(KOHMS)
GR	Gamma Ray	(GAPI)
HAZI	Hole Azimuth	(DEG)
P1AZ	Pad 1 Azimuth	(DEG)
TENS	Tension	(LBF)

Description of Plots:

Resistivity Curves Control Plot (Fig. 7.33): This real-time plot serves as quality control during the logging operation. The response of 16 resistivity electrodes, the four-arm caliper, the deviation and orientation, pad 1 azimuth, EMEX current and voltage, gamma ray, bit size, tension and a correlation resistance are recorded. During the logging operation it is possible to step-through the arrays of resistivity electrodes to control the response.

Images Field Plot (Fig. 7.34): Fast optical presentation of resistivity images are given by this plot. This plot is made from uncorrected raw data and is unscaled horizontally. Detailed feature detection (fractures, foliation etc.) is therefore limited, but a first approximation is possible (quality control).

Caliper, Deviation and Orientation Plot (Fig. 7.35): This plot gives the borehole trajectory and caliper data presented in profile simulating the short and long axis of an ovalized borehole. The gamma ray is plotted as depth correlation log.

Cyber Dip Plot (Fig. 7.36): Field evaluation of Dipmeter results. Evaluation gives first information of dip and strike of formations.

Accelerometer-Magnetometer Plot (Fig. 7.37): Control of Orientation and speed correction system. Release of stuck tool (like at 5996.0 - 5993.0 m, 5986.0 - 5983,0 m) clearly indicated by larger signals on X, Y and Z components.

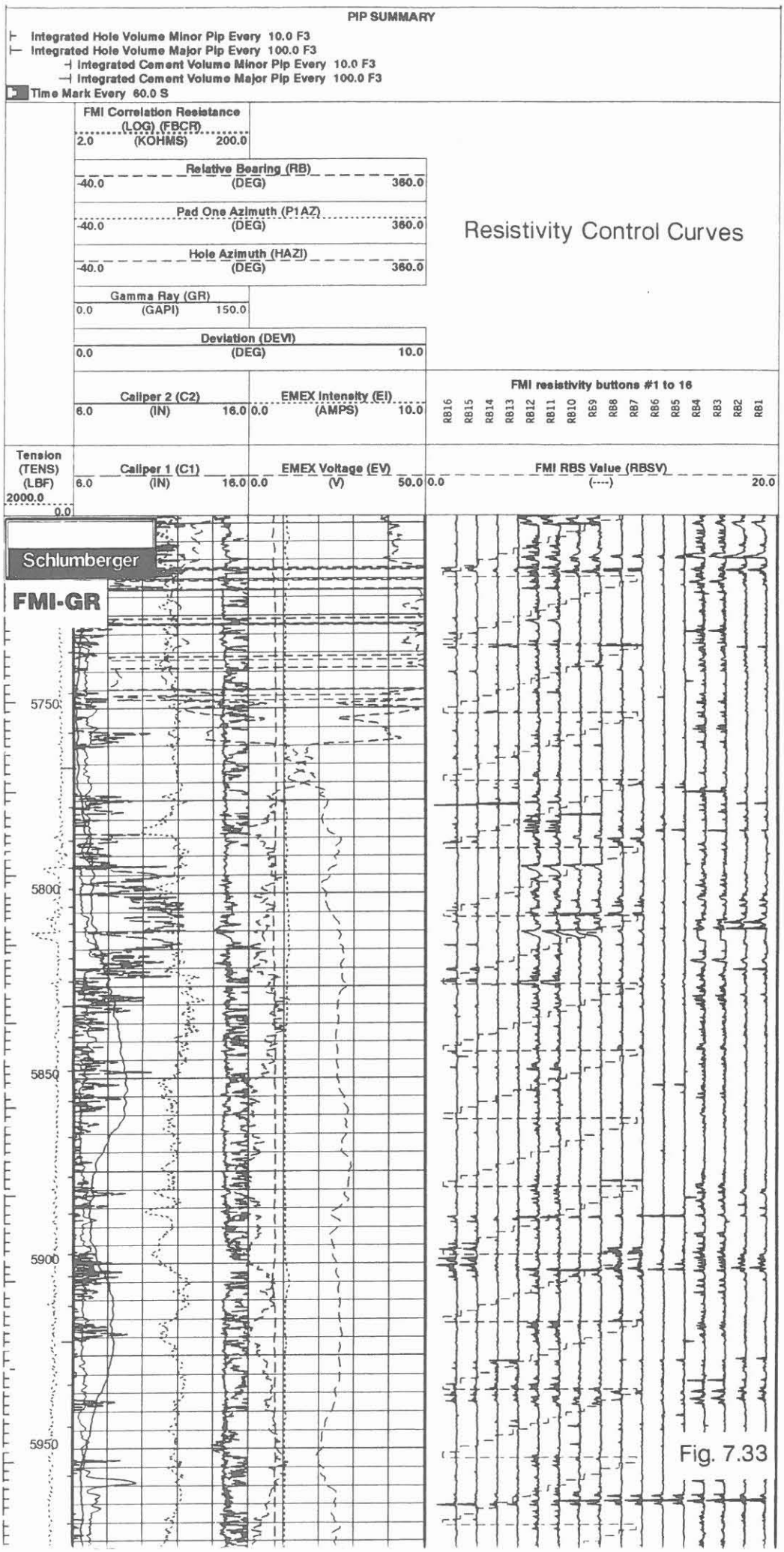

PIP SUMMARY
Integrated Hole Volume Minor Pip Every 10.0 F3
Integrated Hole Volume Major Pip Every 100.0 F3
Integrated Cement Volume Minor Pip Every 10.0 F3
Integrated Cement Volume Major Pip Every 100.0 F3
Time Mark Every 60.0 S
FMI Correlation Resistance (LOG) (FBCR)
2.0 (KOHMS) 200.0
Relative Bearing (RB)
-40.0 (DEG) 360.0
Pad One Azimuth (P1AZ)
-40.0 (DEG) 360.0
Hole Azimuth (HAZI)
-40.0 (DEG) 360.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
Deviation (DEVI)
0.0 (DEG) 10.0
Caliper 2 (C2)
6.0 (IN) 16.0
EMEX Intensity (EI)
0.0 (AMPS) 10.0
FMI resistivity buttons #1 to 16
RB16 RB15 RB14 RB13 RB12 RB11 RB10 RB9 RB8 RB7 RB6 RB5 RB4 RB3 RB2 RB1
Tension (TENS) (LBF)
2000.0
0.0
Caliper 1 (C1)
6.0 (IN) 16.0
EMEX Voltage (EV)
0.0 (V) 50.0
FMI RBS Value (RBSV)
0.0 (----) 20.0
Resistivity Control Curves
Schlumberger
FMI-GR
5750
5800
5850
5900
5950

Fig. 7.33

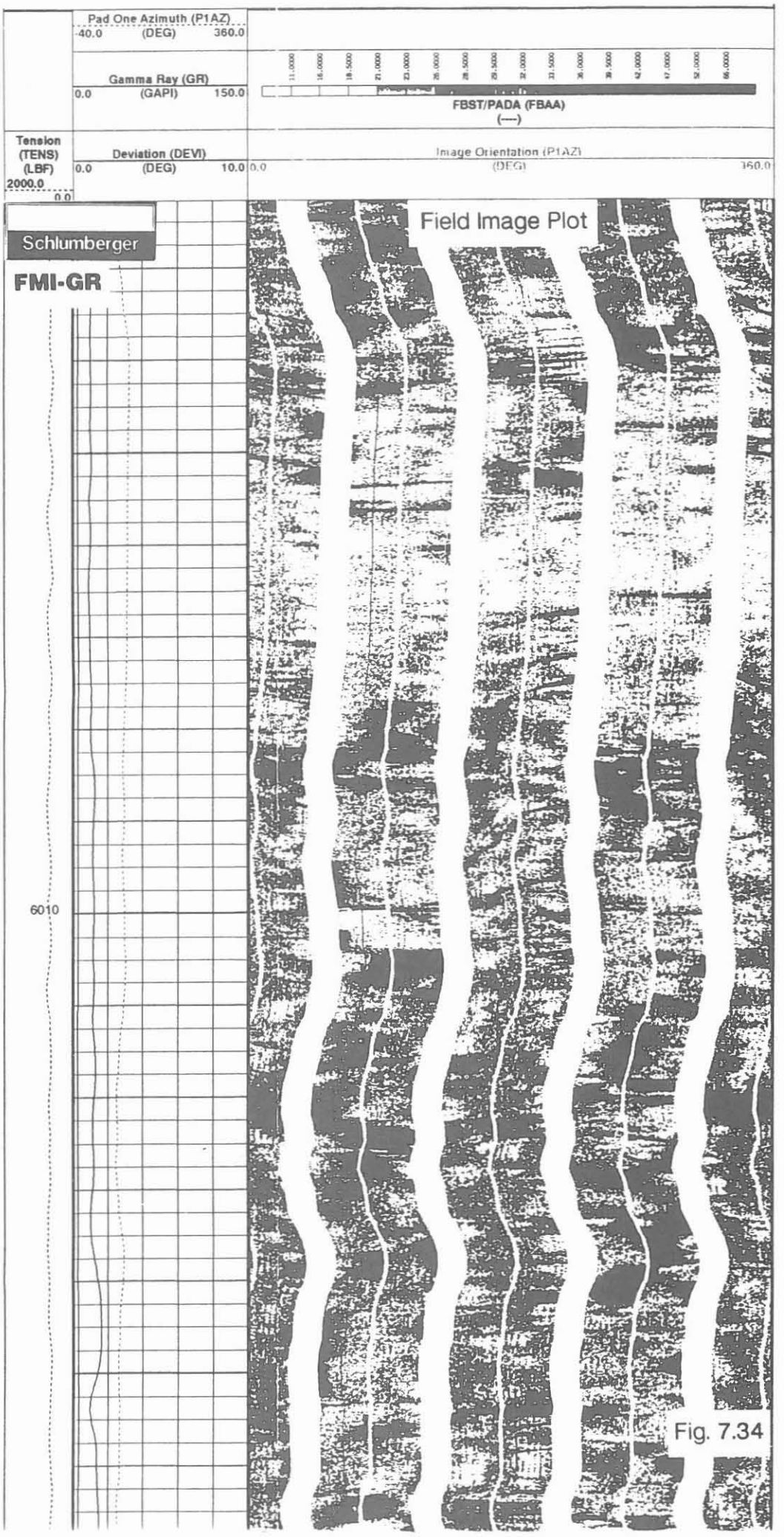

Pad One Azimuth (P1AZ)
40.0 (DEG) 360.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
FBST/PADA (FBAA)
(---)
Tension (TENS) (LBF)
2000.0
0.0
Deviation (DEVI)
0.0 (DEG) 10.0
Image Orientation (P1AZ)
0.0 (DEG) 360.0
Schlumberger
FMI-GR
Field Image Plot
6010

Fig. 7.34

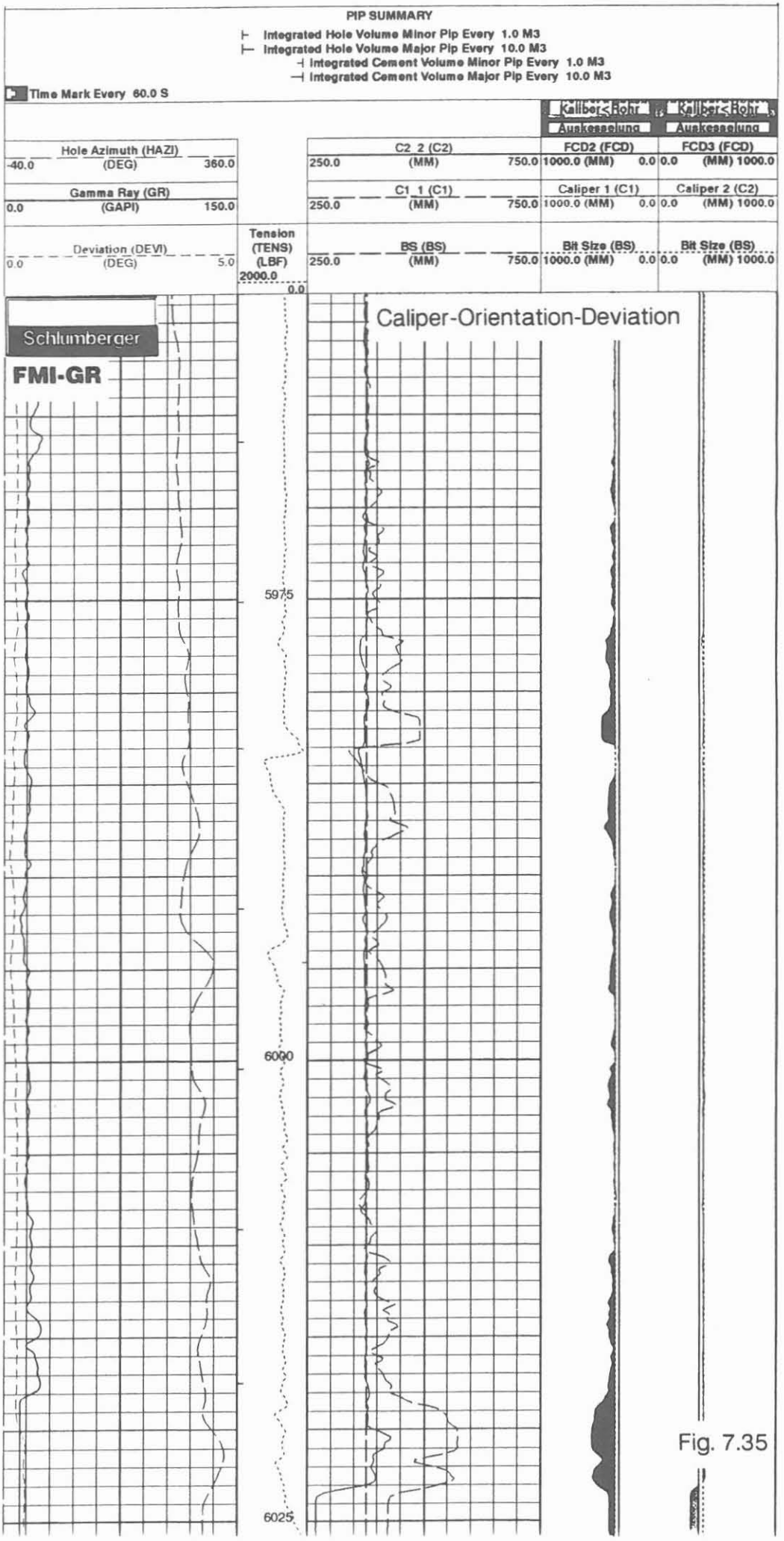

PIP SUMMARY
Integrated Hole Volume Minor Pip Every 1.0 M3
Integrated Hole Volume Major Pip Every 10.0 M3
Integrated Cement Volume Minor Pip Every 1.0 M3
Integrated Cement Volume Major Pip Every 10.0 M3
Time Mark Every 60.0 S
Kaliber<Rohr
Auskesselung
Hole Azimuth (HAZI)
-40.0 (DEG) 360.0
C2_2 (C2)
250.0 (MM) 750.0
FCD2 (FCD)
1000.0 (MM) 0.0
FCD3 (FCD)
0.0 (MM) 1000.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
C1_1 (C1)
250.0 (MM) 750.0
Caliper 1 (C1)
1000.0 (MM) 0.0
Caliper 2 (C2)
0.0 (MM) 1000.0
Deviation (DEVI)
0.0 (DEG) 5.0
Tension (TENS) (LBF)
2000.0
0.0
BS (BS)
250.0 (MM) 750.0
Bit Size (BS)
1000.0 (MM) 0.0
Bit Size (BS)
0.0 (MM) 1000.0
Schlumberger
FMI-GR
Caliper-Orientation-Deviation
5975
6000
6025

Fig. 7.35

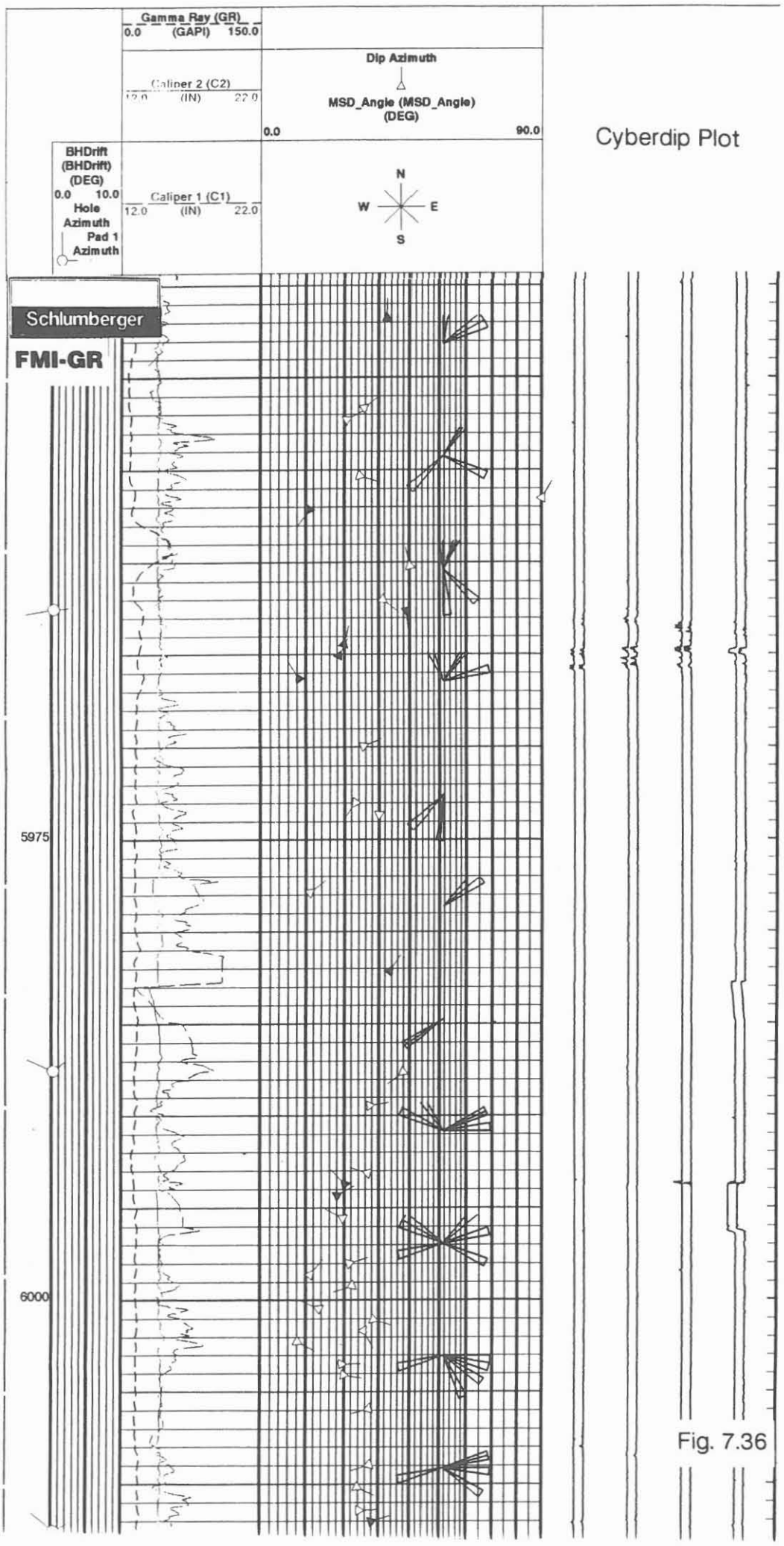

Gamma Ray (GR)
0.0 (GAPI) 150.0
Caliper 2 (C2)
12.0 (IN) 22.0
Dip Azimuth
MSD_Angle (MSD_Angle)
(DEG)
0.0 90.0
BHDrift
(BHDrift)
(DEG)
0.0 10.0
Hole
Azimuth
Pad 1
Azimuth
Caliper 1 (C1)
12.0 (IN) 22.0
N
W E
S
Cyberdip Plot
Schlumberger
FMI-GR
5975
6000

Fig. 7.36

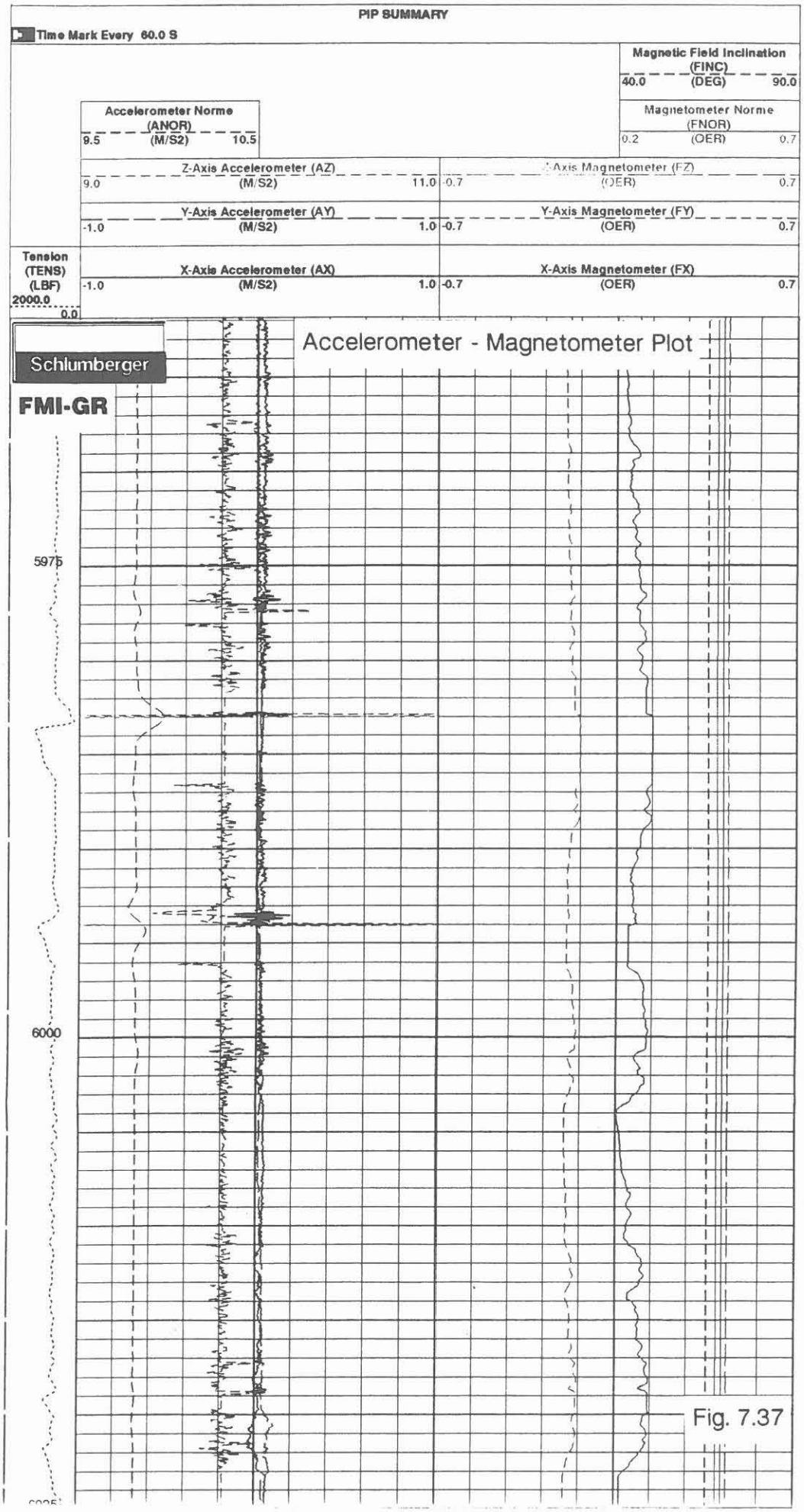

PIP SUMMARY
Time Mark Every 60.0 S
Magnetic Field Inclination (FINC)
40.0 (DEG) 90.0
Accelerometer Norme (ANOR)
9.5 (M/S2) 10.5
Magnetometer Norme (FNOR)
0.2 (OER) 0.7
Z-Axis Accelerometer (AZ)
9.0 (M/S2) 11.0
Z-Axis Magnetometer (FZ)
-0.7 (OER) 0.7
Y-Axis Accelerometer (AY)
-1.0 (M/S2) 1.0
Y-Axis Magnetometer (FY)
-0.7 (OER) 0.7
Tension (TENS) (LBF)
2000.0
0.0
X-Axis Accelerometer (AX)
-1.0 (M/S2) 1.0
X-Axis Magnetometer (FX)
-0.7 (OER) 0.7
Schlumberger
FMI-GR
Accelerometer - Magnetometer Plot
5975
6000

Fig. 7.37

ARI/MSFL/GR/GPIT (Azimuthal Resistivity Imager/Microspherical Focused Log/Gamma Ray/General Purpose Inclinometer Tool)

Operator: Schlumberger Paris - Diepholz/KTB

Job No.	Date	Interval
HB-0151	17.03.1992	3000.0 - 6022.0 m

Examples:
Sections of logs: DLL-MSFL Plot 5958.0-6022.0 m, **Fig. 7.38**
Azimuthal Resistivity Plot 5977.0-6005.0 m **Fig. 7.39**
Field Image Plot 5963.0-6000.0 m, **Fig. 7.40**

Purpose of log:
With this newly developed tool the standard resistivity measurement according to the Dual Laterolog principle is made. In addition, 12 focused and oriented Laterolog curves are recorded. These additional Laterolog curves will measure the resistivity of 30° sectors of the borehole circumference. From the data information about the structure, texture and anisotropy will be obtained. Due to the deeper investigation of the Laterolog the detection of open fractures, mineralised fault planes and slickensides will be possible.

Operation:
The standard Dual Laterolog (DLL) Microspherical Focused Log (MSFL) is combined with the new tool section carrying the array of the 12 sectoral focused resistivity sensing devices. For obtaining oriented resistivity measurements the General Purpose Inclinometer Tool (GPIT) is run in combination. For depth correlation the Gamma Ray recording is used.

The tool requires the MAXIS 500 surface unit. After recording the raw data in real time the different plots are made in playback mode. Data equalisation and normalisation is necessary for image presentations. These computations are done in the field with the MAXIS 500 unit.
Depth scale: 1/1000, 1/200; logging speed: 10 m/min.

Technical information:
A detailed description of the tool is given in chapter 8: "New Tools" of this report.

Description of logs:
DLL/MSFL Plot (Fig. 7.38). This plot was created in playback mode. It corresponds to an improved standard DLL/MSFL presentation giving four Laterolog resistivities: Laterolog Shallow (LLS), Laterolog Deep (LLD), Laterolog Groningen (LLG). High Resolution Laterolog (LLHR) and the Microspherical Focused Log (MSFL), in track I the Gamma Ray (GR) and the Accelerometer reading (AZ).

Azimuthal Resistivity Plot (Fig. 7.39). This record was registered in real time mode. The data recorded represents the resistivities recorded by the electrode array for the 12 sectors (RR01-RR12) and the High Resolution Laterolog (LLHR). In track I the Gamma Ray (GR) and the 12 caliper conductivities (CC01 - CC12) and pad 1 azimuth (P1AZ) are recorded.

Field Image Plot (Fig. 7.40). This record is made after data normalisation and equalisation in playback mode. Three Laterolog curves Laterolog Shallow (LLS), Laterolog Deep (LLD) and High Resolution Laterolog (LLHR) are presented with a resistivity scale shifted by one decade. In addition the processed data of the resistivity array is presented in form of the 12 resistivity curves.

The image transforms are given on the left side of the plot. First column "raw data" (ARI Raw Sta), middle column "normalized data" (ALAT Raw. Norm) and right column "equalized and normalized data" (ALAT Eq Norm).

Betweeen the image columns the Gamma Ray (GR), the Standard Caliper (CALS), the Back-up Caliper (CALB), the Deviation (DEVI), Hole (Hole AZ) and Pad 1 Azimuth (Pad 1 AZ) are given.

Mnemonics and Units:

Mnemonics	Description	Unit
ALAT	Azimuthal Laterolog	
ARI	Azimuthal Resistivity Image	
AZ	Accelerometer	(M/S2)
CCO1-CC12	Caliper Conductivity 1-12	(MMHO)
CALB	Caliper Back-up	(INCH)
CALS	Caliper Standard	(INCH)
CDR	Continuous Directional Recording	(DEG)
DEVI	Deviation	(DEG)
GR	Gamma Ray	(GAPI)
LLD	Laterolog Deep	(OHMM)
LLG	Laterolog Groningen	(OHMM)
LLHR	Laterolog High Resolution	(OHMM)
LLS	Laterolog Shallow	(OHMM)
MSFL	Micropherical Focused Log	(OHMM)
RR01-RR12	Azimuthal Resistivities 1-12	(OHMM)
P1AZ	Pad 1 Azimuth	(DEG)
TENS	Tension	(LBF)

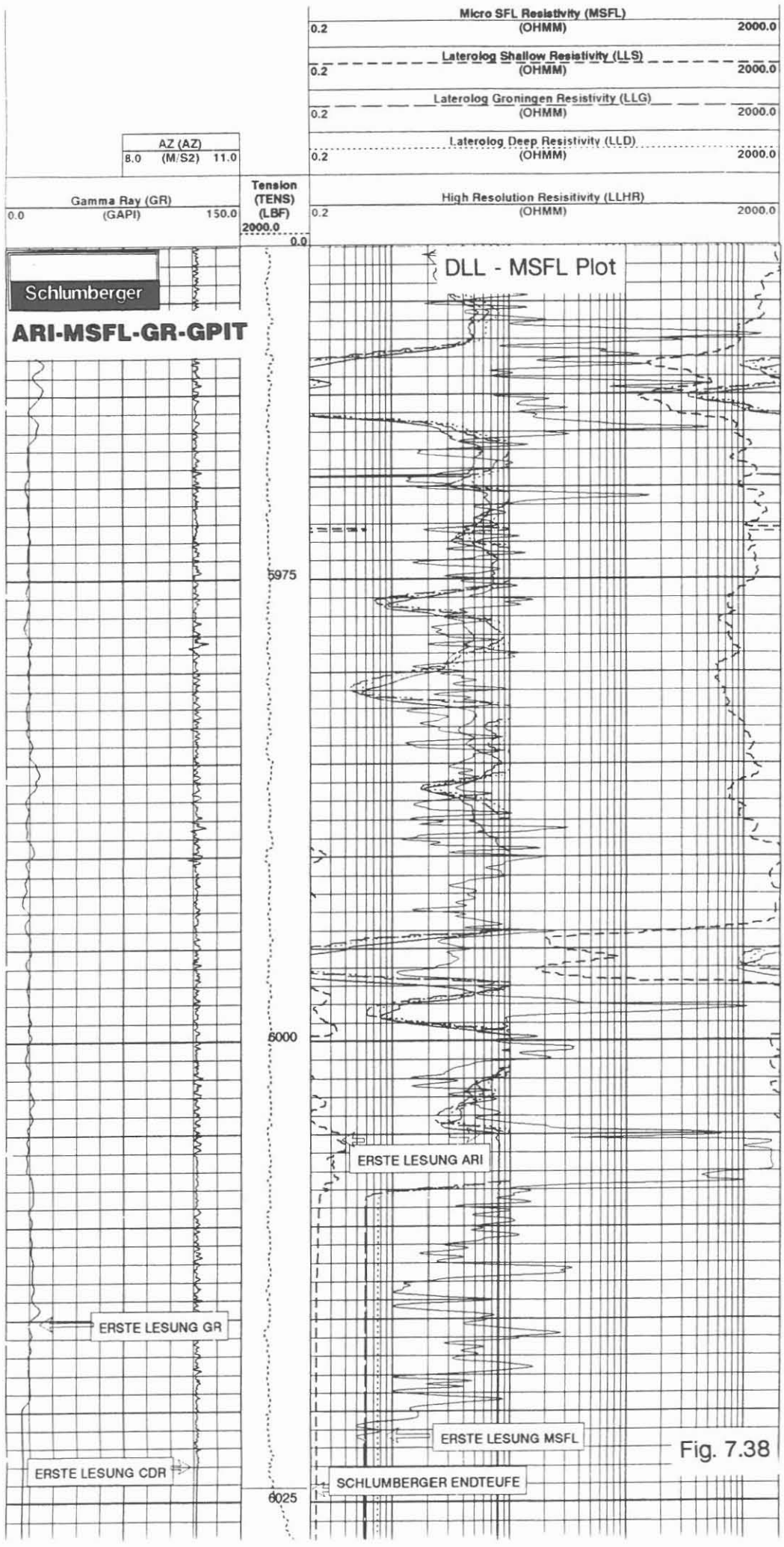

Micro SFL Resistivity (MSFL)
0.2 (OHMM) 2000.0
Laterolog Shallow Resistivity (LLS)
0.2 (OHMM) 2000.0
Laterolog Groningen Resistivity (LLG)
0.2 (OHMM) 2000.0
Laterolog Deep Resistivity (LLD)
0.2 (OHMM) 2000.0
AZ (AZ)
8.0 (M/S2) 11.0
Gamma Ray (GR)
0.0 (GAPI) 150.0
Tension (TENS) (LBF)
2000.0
0.0
High Resolution Resisitivity (LLHR)
0.2 (OHMM) 2000.0
Schlumberger
ARI-MSFL-GR-GPIT
DLL - MSFL Plot
5975
6000
6025
ERSTE LESUNG ARI
ERSTE LESUNG GR
ERSTE LESUNG CDR
ERSTE LESUNG MSFL
SCHLUMBERGER ENDTEUFE

Fig. 7.38

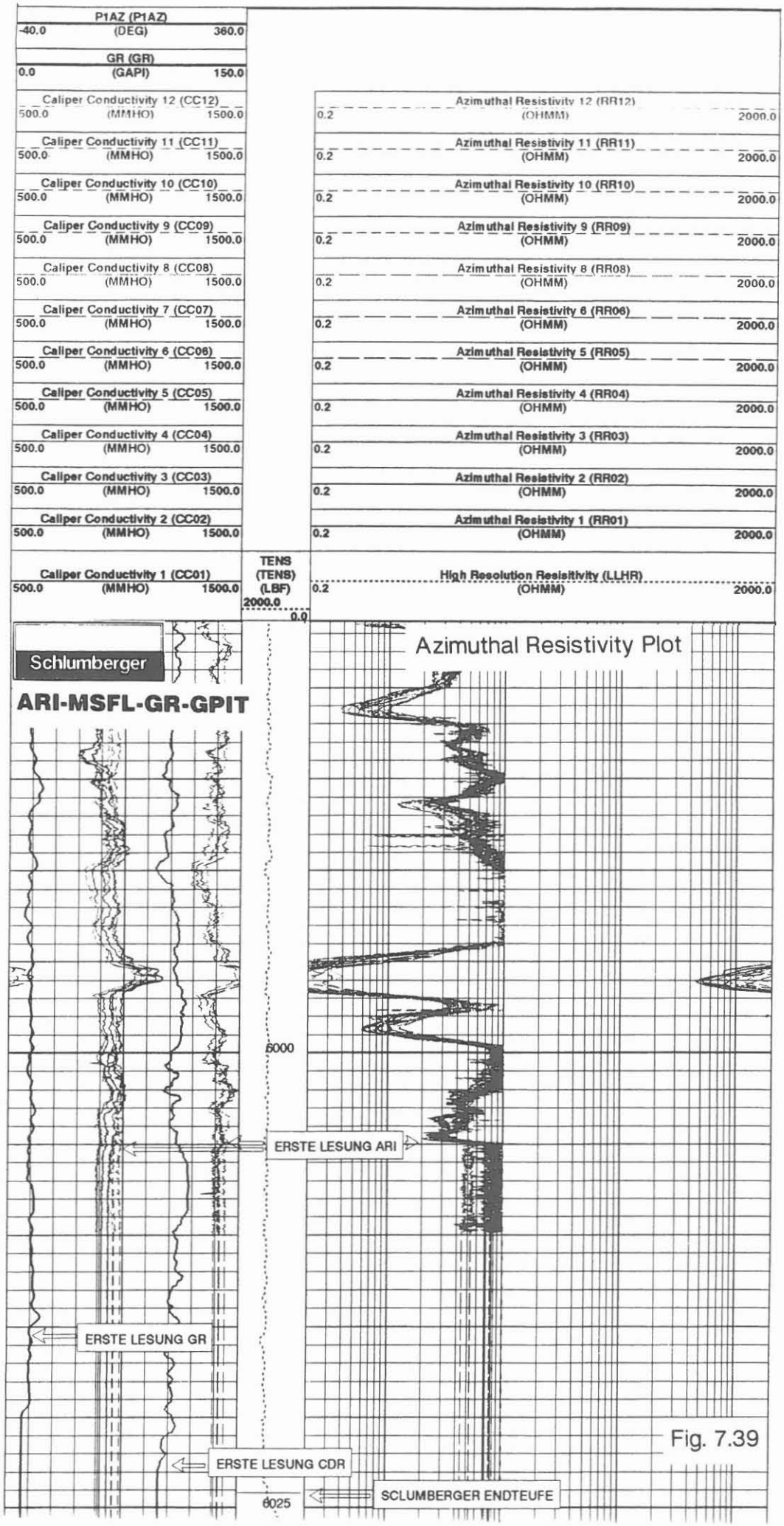

P1AZ (P1AZ)
-40.0 (DEG) 360.0
GR (GR)
0.0 (GAPI) 150.0
Caliper Conductivity 12 (CC12)
500.0 (MMHO) 1500.0
Caliper Conductivity 11 (CC11)
500.0 (MMHO) 1500.0
Caliper Conductivity 10 (CC10)
500.0 (MMHO) 1500.0
Caliper Conductivity 9 (CC09)
500.0 (MMHO) 1500.0
Caliper Conductivity 8 (CC08)
500.0 (MMHO) 1500.0
Caliper Conductivity 7 (CC07)
500.0 (MMHO) 1500.0
Caliper Conductivity 6 (CC06)
500.0 (MMHO) 1500.0
Caliper Conductivity 5 (CC05)
500.0 (MMHO) 1500.0
Caliper Conductivity 4 (CC04)
500.0 (MMHO) 1500.0
Caliper Conductivity 3 (CC03)
500.0 (MMHO) 1500.0
Caliper Conductivity 2 (CC02)
500.0 (MMHO) 1500.0
Caliper Conductivity 1 (CC01)
500.0 (MMHO) 1500.0
TENS (TENS) (LBF)
2000.0
0.0
Azimuthal Resistivity 12 (RR12)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 11 (RR11)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 10 (RR10)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 9 (RR09)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 8 (RR08)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 6 (RR06)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 5 (RR05)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 4 (RR04)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 3 (RR03)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 2 (RR02)
0.2 (OHMM) 2000.0
Azimuthal Resistivity 1 (RR01)
0.2 (OHMM) 2000.0
High Resolution Resistivity (LLHR)
0.2 (OHMM) 2000.0
Schlumberger
ARI-MSFL-GR-GPIT
Azimuthal Resistivity Plot
6000
ERSTE LESUNG ARI
ERSTE LESUNG GR
ERSTE LESUNG CDR
6025
SCLUMBERGER ENDTEUFE

Fig. 7.39

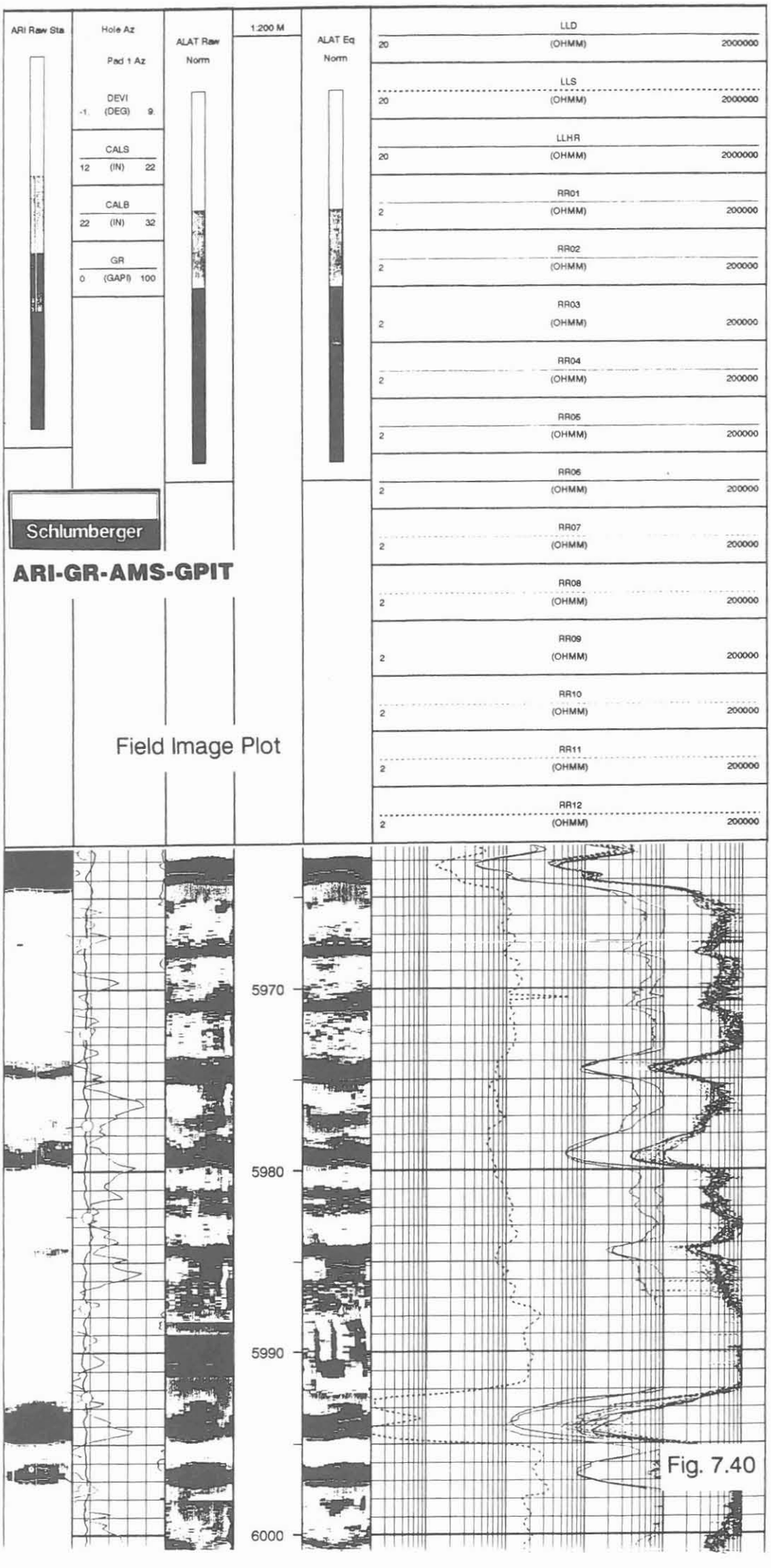

ARI Raw Sta
Hole Az
Pad 1 Az
DEVI
-1. (DEG) 9.
CALS
12 (IN) 22
CALB
22 (IN) 32
GR
0 (GAPI) 100
ALAT Raw
Norm
1:200 M
ALAT Eq
Norm
LLD
20 (OHMM) 2000000
LLS
20 (OHMM) 2000000
LLHR
20 (OHMM) 2000000
RR01
2 (OHMM) 200000
RR02
2 (OHMM) 200000
RR03
2 (OHMM) 200000
RR04
2 (OHMM) 200000
RR05
2 (OHMM) 200000
RR06
2 (OHMM) 200000
RR07
2 (OHMM) 200000
RR08
2 (OHMM) 200000
RR09
2 (OHMM) 200000
RR10
2 (OHMM) 200000
RR11
2 (OHMM) 200000
RR12
2 (OHMM) 200000
Schlumberger
ARI-GR-AMS-GPIT
Field Image Plot
5970
5980
5990
6000

Fig. 7.40

GR/IP (Gamma Ray/Induced Polarisation)

Operator: Hungarian Geophysical Institute Roland Eötvös, Budapest (ELGI)/KTB.

Job No.	Date	Interval
HB-0156	19.03.1992	3000.0 - 6024.0 m

Example:
Section of log: 5500.0 - 5885.00 m, **Fig. 7.41**

Purpose of log:
This type of log is used for special mineral detection like graphite and sulfides, which are normally associated with fault zones or slickensides. In addition, due to the sensitivity to saline fluids the response of the measurement could provide information about porosity and permeability.

Operation:
The tool was run in combination with the KTB-Gamma Ray sonde on the KTB cable.
Depth scale: 1/200, 1/1000; logging speed: 5 m/min.

Technical information:
The principle of the Induced Polarisation measurement is explained in detail in KTB-Report 87-3, pages 96-99. Interpretation reports are given in KTB-Reports 88-4 and 90-6a.
Data rate: 6".

Mnemonics and Units:

Mnemonics	Description	Unit
GR	Gamma Ray	(GAPI)
KAPA	Calculated chargeability at "zero time"	(%)
TAU	General time constant	(MS)
TENS	Tension	(LBF)

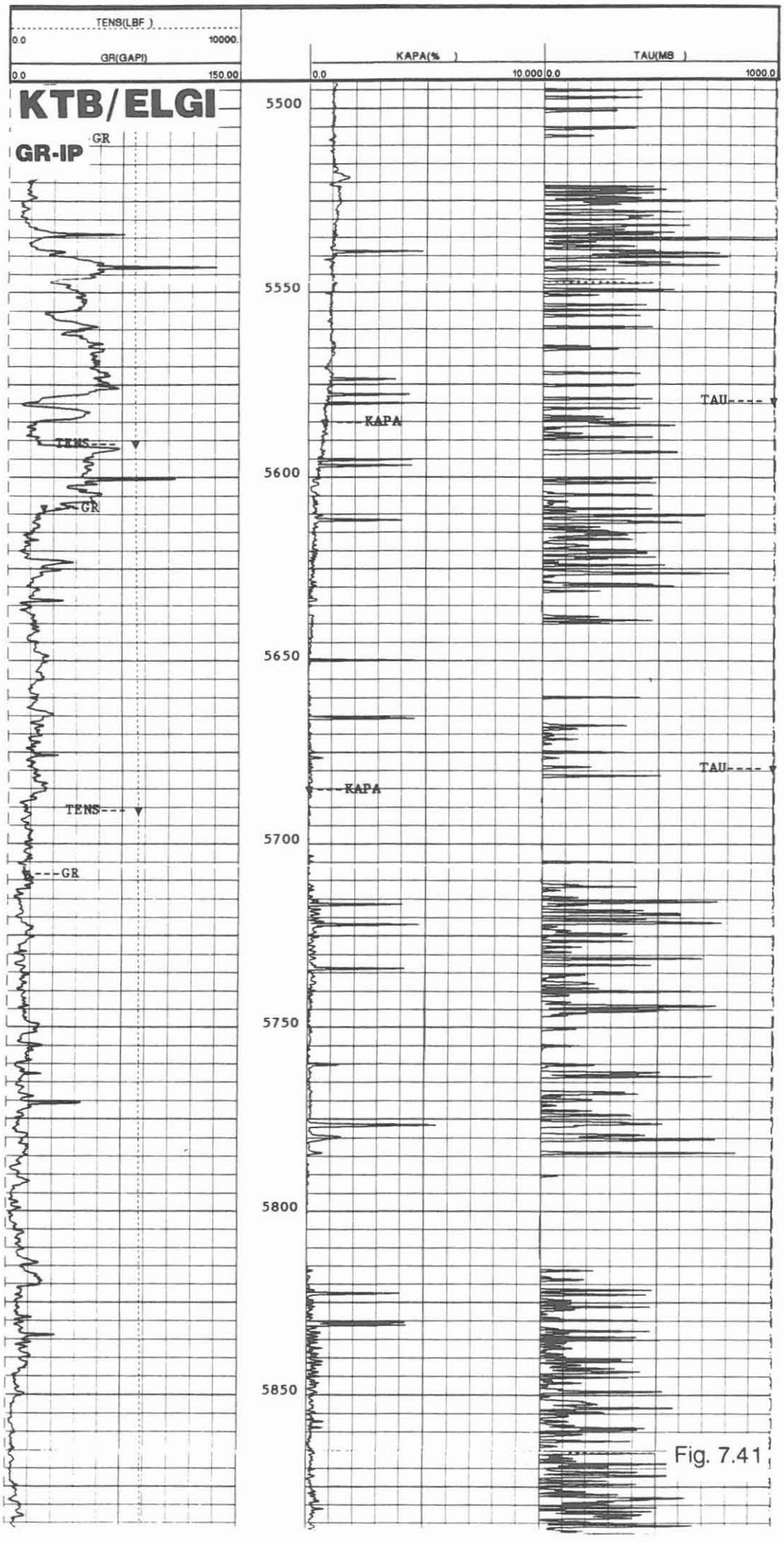

TENS(LBF)
0.0
10000.
GR(GAPI)
0.0
150.00
KTB/ELGI
GR-IP
GR
TENS
GR
TENS
GR
KAPA(%)
0.0
10.000
TAU(MS)
0.0
1000.0
5500
5550
5600
5650
5700
5750
5800
5850
KAPA
KAPA
TAU
TAU

Fig. 7.41

SP/REDOX/SAL/TEMP (Self Potential/REDOX Potential/Mud Salinity/Temperature)

Operator: University Frankfurt/KTB

Job No.	Date	Interval
HB-0100	KTB-Report 92-1	208.0 - 3003.0 m
HB-0157	20.03.1993	3000.0 - 6024.0 m

Example:
Section of log: 5200.0 - 5570.0 m, **Fig. 7.42**

Purpose of log:
With the record of the Self Potential, Redox Potential, Mud Salinity and Temperature indications are obtained for the detection of permeable zones, inflow of fluids to the borehole, mineralisation (graphite, pyrite) and an estimation of the formation water salinity can be made.

Operation:
The tool was developed by the University of Frankfurt and run on the KTB logging unit. As the tool is fully compatible with the logging unit, the data registration is made via the CSU. Depth scale: 1/200, 1/1000; logging speed: 25 m/min.

Technical information:
The Electrical Potential (EP) is recorded as the voltage difference (in mV) between a moving Ag-AgCl electrode in the borehole and a stationary electrode of the same material at surface.

The Spontaneous Potential (SP) measures the voltage difference (in mV) between a steel electrode in the borehole and a lead electrode on surface.

The voltage difference (PSP), measured in mV between a platinum electrode in the borehole and an Ag-AgCl electrode on the surface, is used for the computation of the REDOX potential. It represents the difference between PSP and EP. The salinity of the mud is computed from mud resistivity measurements using the standard conversion chart for NaCl equivalence.

Mnemonics and Units:

Mnemonics	Description	Unit
EP	Electrial Potential	(MU)
LCO1	Mud Salinity	(PPM)
REDOX	Redox Potential	(MV)
SP	Self Potential	(MV)
STMP	Temperature	(DEGC)
TENS	Tension	(LBF)

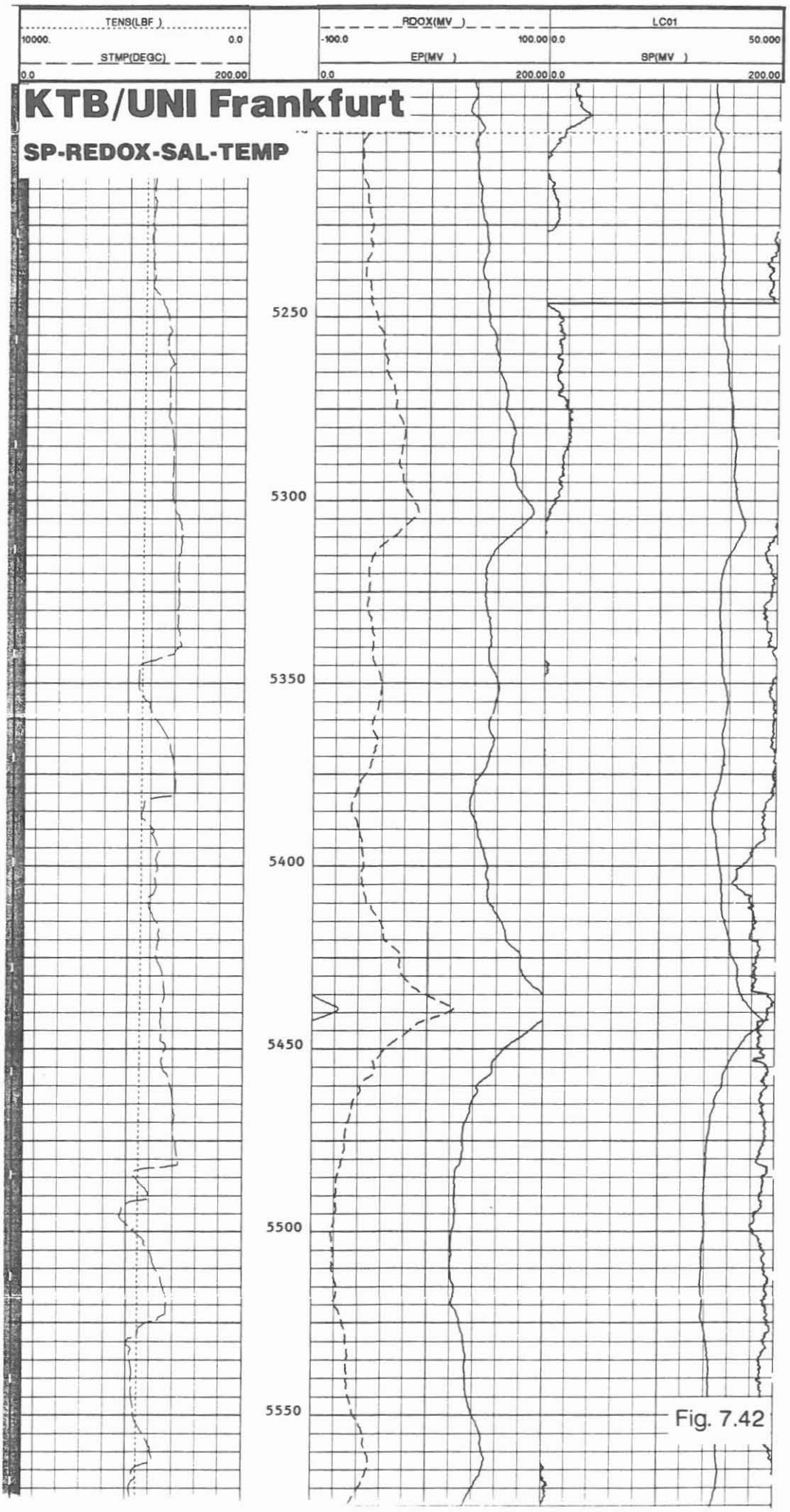

TENS(LBF)
10000.
0.0
STMP(DEGC)
0.0
200.00
REDOX(MV)
-100.0
100.00
EP(MV)
0.0
200.00
LC01
0.0
50.000
SP(MV)
0.0
200.00
KTB/UNI Frankfurt
SP-REDOX-SAL-TEMP
5250
5300
5350
5400
5450
5500
5550

Fig. 7.42

GR/AMS (Gamma Ray/Auxiliary Measurement Sonde)

Operator: KTB

Job No.	Date	Interval
HB-0159	22.03.1992	394.0 - 484.0 m

Example:
Section of logs: 455.0 - 482.0 m, **Fig. 7.43**

Purpose of log:
Record of the rise of the mud level during a production test.

Operation:
Decreasing the hydraulic pressure on the formation by lowering the mud level in the borehole will provoke production of formation fluids. The inflow volume is measured by the observation of the rise of the mud level in the borehole. An estimation of "productivity" can be made by measuring the volume versus time.
Depth scale: 1/200; logging speed: 10 m/min.

Technical information:
The measurements are made using the Auxiliary Measurement Sonde (AMS) recording temperature and mud resistivity. For depth control the Gamma Ray is recorded in combination.
Data rate: 6".

Mnemonics and Units:

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

KTB

GR-AMS (Mud Level Observation)

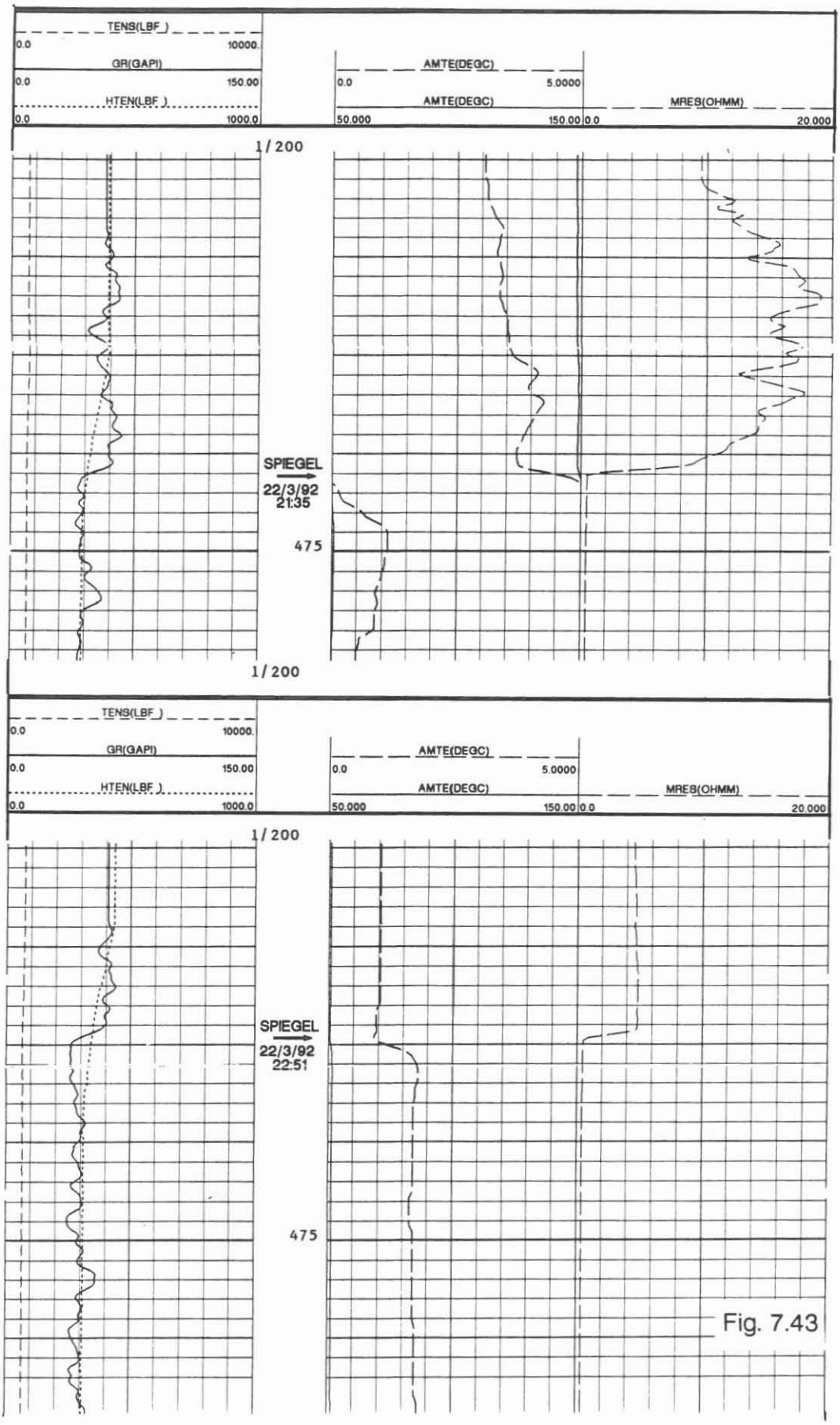


Fig. 7.43

SP/REDOX/SAL/TEMP (Self Potential/Redox Potential/Mud Salinity and Temperature)

Operator: University of Frankfurt/KTB

Job No.	Date	Interval
HB-0162	23.03.1992	2969.0 - 6000.0 m

Example:
Section of log 5265.0 - 5625.0 m, **Fig. 7.44**

Purpose of log:
This log had been recorded after a produktion test. By lowering the hydrostatic head inflow of formation fluid was provoked. With this log producing zones could be located.

Operation:
Log was recorded after the test going in the borehole. In comparison to log run on 19.03.1992 (Fig. 7.42), several producing intervals can be separated.

Technical information:
See explanation provided with log dated 19.03.1992 (Fig. 7.42).

Mnemonics and Units:

Mnemonics	Description	Unit
EP	Electrical Potential	(MV)
LCO1	Mud Salinity	(PPM)
REDOX	Redox Potential	(MV)
SP	Self Potential	(MV)
STMP	Temperature	(DEGC)
TENS	Tension	(LBF)

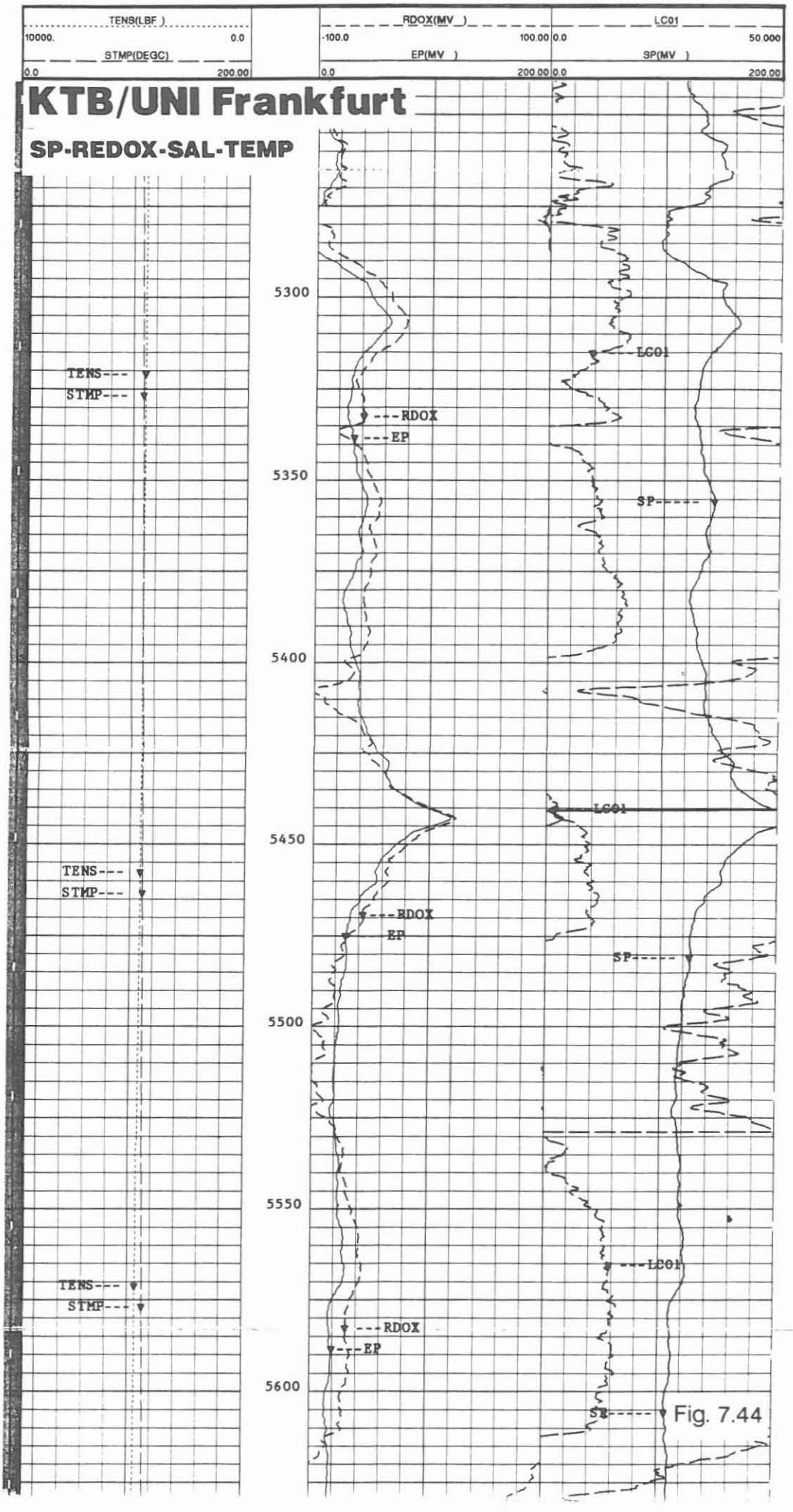

TENS(LBF)
10000.
0.0
STMP(DEGC)
0.0
200.00
RDOX(MV)
-100.0
100.00
EP(MV)
0.0
200.00
LC01
0.0
50.000
SP(MV)
0.0
200.00
KTB/UNI Frankfurt
SP-REDOX-SAL-TEMP
5300
5350
5400
5450
5500
5550
5600
TENS---
STMP---
---RDOX
---EP
LC01
SP-----

Fig. 7.44

FS/GR/MRES/TEMP (Fluid Sampler/Gamma Ray/Mud Resistivity/ Temperature

Operator: Leutert/KTB

Job No.	Date	Interval
HB-0094-0129	KTB-Report 92-1	701.3 - 4115.0 m
HB-0163-0165	23./24.03.1992	3162.5 - 5275.0 m

Example:
Section of log 5100.0 - 5450.0 m, **Fig. 7.45**

Purpose of log:
The log was run in combination with the fluid sampler to verify the best position for collecting the sample.

Operation:
During the production test formation water has entered the borehole. From mud resistivity and temperature logs the intervals of inflow can be detected. These zones are selected and fluid samples are collected at these depths. The log example clearly indicates a producing interval from 5270.0 - 5295.0 m. Two samples were taken from depth 5272.0 - 5275.0 m.
Depth scale: 1/1000; logging speed: 20 m/min.

Technical information:
The fluid sampler consists of a closed-in chamber which is run in the borehole either under internal vacuum or athmospheric pressure. At sampling depth valves are electrically operated to allow borehole fluid enter and being sealed in the chamber for retrieval. The sample, collected at in-situ conditions, is brought to surface for analysis.
Data rate: 6"

Mnemonics and Units:

Mnemonics	Description	Unit
ATEM	Temperature	(DEGC)
GR	Gamma Ray	(GAPI)
HTEN	Head Tension	(LBF)
LCO1	Mud Salinity	(PPM)
MRES	Mud Resistivity	(OHMM)

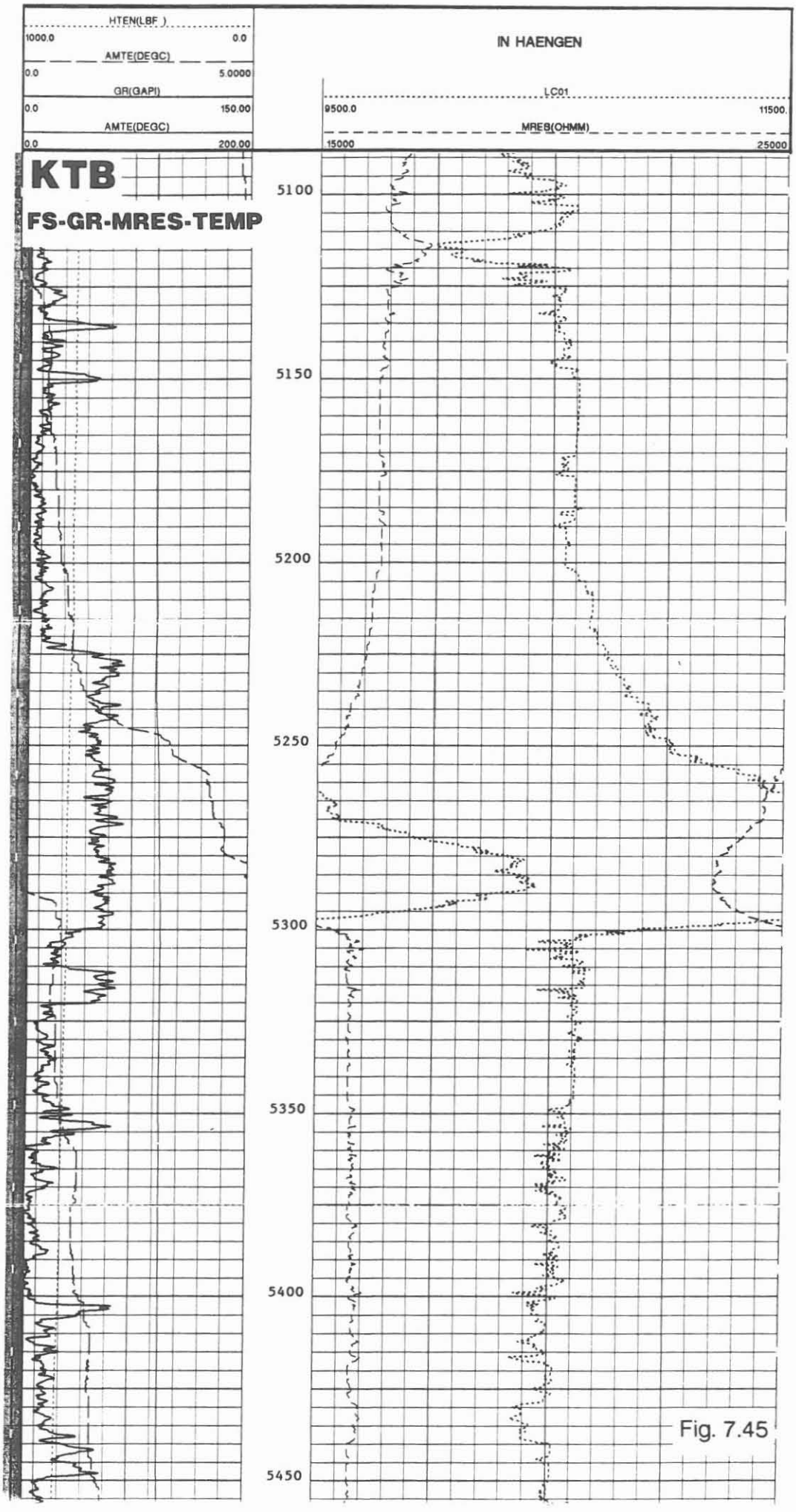

HTEN(LBF)
1000.0
0.0
AMTE(DEGC)
0.0
5.0000
GR(GAPI)
0.0
150.00
AMTE(DEGC)
0.0
200.00
IN HAENGEN
LC01
9500.0
11500.
MRES(OHMM)
15000
25000
KTB
FS-GR-MRES-TEMP
5100
5150
5200
5250
5300
5350
5400
5450

Fig. 7.45

VSP (Vertical Seismic Profile)

Operator: GECO-Prakla, Schlumberger Biberach/KTB

Job No.	Date	Interval
HB-0166	25.03.1992	3000.0 - 6000.0 m

Example:
Example of Stacked Field Records at 5887.5 m, 5900.0 m, 5912.5 m, **Fig. 7.46**

Purpose of log:
Vertical Seismic Profiles (VSP) are made to obtain detailed information about the structure being drilled. In addition, the link between surface seismic exploration and reality, verified by the borehole, can be established. This will improve the knowledge of the regional geology.

Operation:
A 3-component geophone is stationed at pregiven depth positions in the borehole to record the acoustic signals created by vibrators on surface. At each geophone position 5 - 10 vibrator sweeps are generated and the recorded signals are stacked and registered for further processing. For this operation 3 vibrators were used simultaneously. They were stationed about 200 m west of the drilling location.
Depth scale: stationary readings; logging speed: stationary readings.

Technical information:
The operation was started with the Combinable Seismic Imager (CSI) as downhole tool. The tool failed after only a few records. The tool was replaced by the Seismic Acquisition Tool (SAT). Unfortunately, this replacement caused the loss of the information of the tool orientation in space, as the SAT can not be combined with the General Purpose Inclinometer Tool (GPIT).
The surface reference 3-D geophones were located in a shallow borehole at 70 and 40 m depth, west of the main borehole and near the vibrator positions.
The reference borehole is called VSP 2, with coordinates:

H : 55 19 809.4
R : 45 08 590.4

The first vibrator station has the coordinates:

H : 55 19 852.1
R : 45 08 550.6

From this station the vibrators were moved in steps of 1.0 - 1.1 m seven times in the direction of 164°.

Mnemonics and Units:

Mnemonics	Description	Unit
TTIM	Transit time	(MS)
DX1	Z-Axis	
DY1	Y-Axis	
DZ1	Z-Axis	

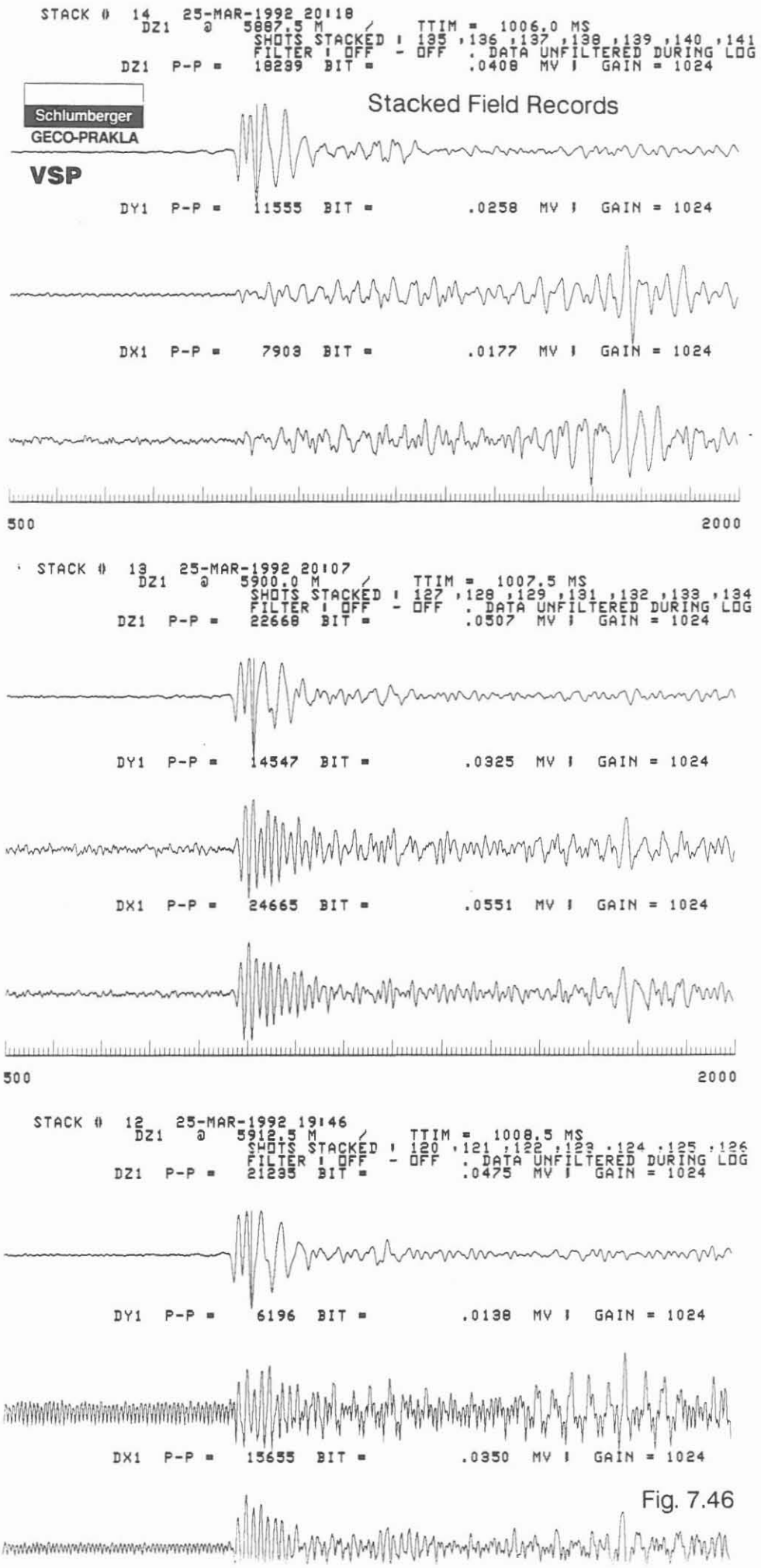

STACK # 14 25-MAR-1992 20:18
DZ1 @ 5887.5 M TTIM = 1006.0 MS
SHOTS STACKED : 135 ,136 ,137 ,138 ,139 ,140 ,141
FILTER : OFF - OFF . DATA UNFILTERED DURING LOG
DZ1 P-P = 18239 BIT = .0408 MV : GAIN = 1024
Schlumberger
GECO-PRAKLA
Stacked Field Records
VSP
DY1 P-P = 11555 BIT = .0258 MV : GAIN = 1024
DX1 P-P = 7903 BIT = .0177 MV : GAIN = 1024
500
2000
STACK # 13 25-MAR-1992 20:07
DZ1 @ 5900.0 M TTIM = 1007.5 MS
SHOTS STACKED : 127 ,128 ,129 ,131 ,132 ,133 ,134
FILTER : OFF - OFF . DATA UNFILTERED DURING LOG
DZ1 P-P = 22668 BIT = .0507 MV : GAIN = 1024
DY1 P-P = 14547 BIT = .0325 MV : GAIN = 1024
DX1 P-P = 24665 BIT = .0551 MV : GAIN = 1024
500
2000
STACK # 12 25-MAR-1992 19:46
DZ1 @ 5912.5 M TTIM = 1008.5 MS
SHOTS STACKED : 120 ,121 ,122 ,123 ,124 ,125 ,126
FILTER : OFF - OFF . DATA UNFILTERED DURING LOG
DZ1 P-P = 21235 BIT = .0475 MV : GAIN = 1024
DY1 P-P = 6196 BIT = .0138 MV : GAIN = 1024
DX1 P-P = 15655 BIT = .0350 MV : GAIN = 1024

Fig. 7.46

MSCT/GR (Mechanical Sidewall Coring Tool/Gamma Ray)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0103-0124	KTB-Report 92-1	510.0 - 4521.0 m
HB-0172	02.04.1992	4294.9 m

Example:
Record of coring operation at 4294.9 m depth, **Fig. 7.47**

Purpose of log:
Due to limited cores drilled, the possibility of drilling sidewall cores with the wireline tool provides the requested rock samples for the geologists.

Operation:
The MSCT was run to the depth of 4294.9 m and anchored to the formation. The drilling of the first sidewall core progressed very slow. After completion of the coring operation and releasing the tool, hydraulic problems developed and the tool could not be reset. Coring operation was interrupted after this first core.
Depth scale: stationary reading - record versus time.
Logging speed: time record (11 minutes for coring).

Technical information:
Technical details and a tool description is given in KTB-Report 90-1, pages 210-215.

Mnemonics and Units:

Mnemonics	Description	Unit
CMDV	Coring Motor Downhole Voltage	(V)
CMLP	Coring Motor Linear Position	(IN)
HMCU	Hydraulic Motor Current	(AMPS)
HMDV	Hydraulic Motor Downhole Voltage	(V)
HPPR	Hydraulic Pump Pressure	(PSTG)
LMVL	Lower Motor Voltage Limit	(V)
RPPR	Rotating Plate Pressure	(PSIG)
SST	Solenoid Status	
UMVL	Upper Motor Voltage Limit	(V)

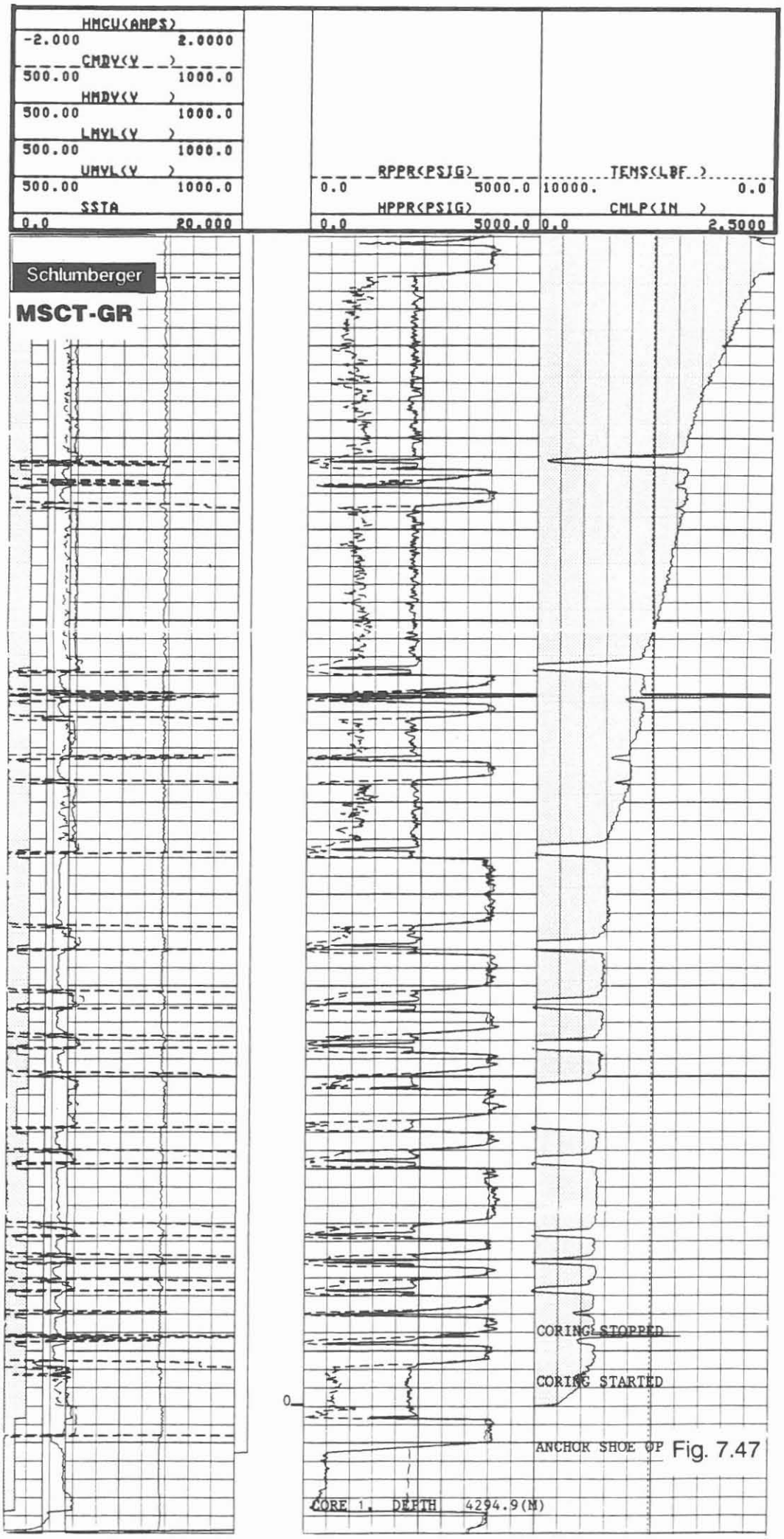

HMCU(AMPS)
-2.000
2.0000
CMDV(V)
500.00
1000.0
HMDV(V)
500.00
1000.0
LMVL(V)
500.00
1000.0
UMVL(V)
500.00
1000.0
SSTA
0.0
20.000
RPPR(PSIG)
0.0
5000.0
HPPR(PSIG)
0.0
5000.0
TEMS(LBF)
10000.
0.0
CMLP(IN)
0.0
2.5000
Schlumberger
MSCT-GR
CORING STOPPED
CORING STARTED
ANCHOR SHOE UP
CORE 1, DEPTH 4294.9(M)

Fig. 7.47

TEMP/GR/CCL (Temperature/Gamma Ray/Casing Collar Locator)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0173	14.04.1992	21.0 - 5979.8 m

Example:
Section of log: 4175.0 - 4550.0 m, **Fig. 7.48**

Purpose of log:
The temperature log was run after the cementation of the 13 3/8"/13 5/8" casing string to find the top of the cement.

Operation:
The log was recorded downwards. This procedure guarantees that the undisturbed temperature in the borehole is measured. During the hardening of cement, heat is generated. The temperature gradient will change over intervals with uncemented and cemented casings. In zones with caliper enlargements greater cement volumes will create temperature anomalies like shown on this log section.
Depth scale: 1/1000; logging speed: 5 m/min.

Technical information:
The tool combination included, in addition to the temperature sensor, the Gamma Ray for depth correlation and the Casing Collar Locator for recording the casing joints.
Data rate: 6"

Mnemonics and Units:

Mnemonics	Description	Unit
CCL	Casing Collar Locator	
GR	Gamma Ray	(GAPI)
TENS	Tension	(LBF)
TMP3	Temperature	(DEGC)

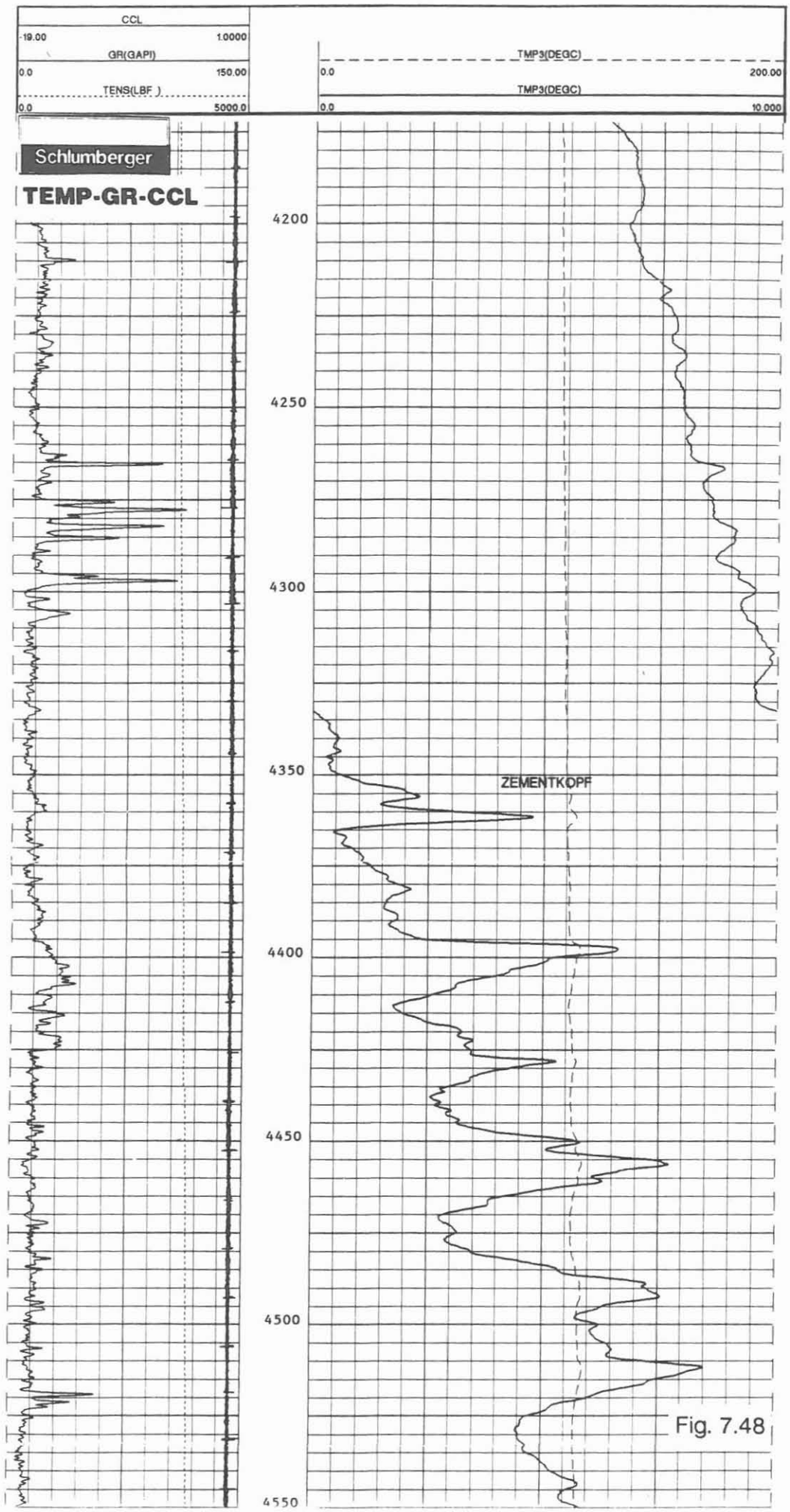

CCL
-19.00
1.0000
GR(GAPI)
0.0
150.00
TENS(LBF)
0.0
5000.0
TMP3(DEGC)
0.0
200.00
TMP3(DEGC)
0.0
10.000
Schlumberger
TEMP-GR-CCL
4200
4250
4300
4350
4400
4450
4500
4550
ZEMENTKOPF

Fig. 7.48

GR/CCL (Gamma Ray/Casing Collar Locator)

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0174	23.04.1992	0.0 - 6015.0 m

Example:
Section of log: 5605.0 - 5990.0 m, **Fig. 7.49**

Purpose of log:
This log was recorded to establish the depth correlation between "driller's depth" and "logger's depth".

Operation:
The log was recorded with a slimhole Gamma Ray/Casing Collar Locator Tool inside the drill pipes. This way, the depth correlation between the open hole reference: Gamma Ray and the drill pipes: Casing Collar Locator can be recorded. The difference in depth between driller and logger at 6000 m is 6.30 m, logger being deeper.
Depth scale: 1/1000; logging speed: 5 m/min.

Technical information:
For this through-drill pipe-operation the GR/CCL-tool with 1 11/16" outer diameter had to be deployed due to the small inner diameter in the drill collars.

Data rate: 6"

Mnemonics and Units:

Mnemonics	Description	Unit
CCL	Casing Collar Locator	
GR	Gamma Ray	(GAPI)
RCCL	Depth corrected CCL	
TENS	Tension	(LBF)

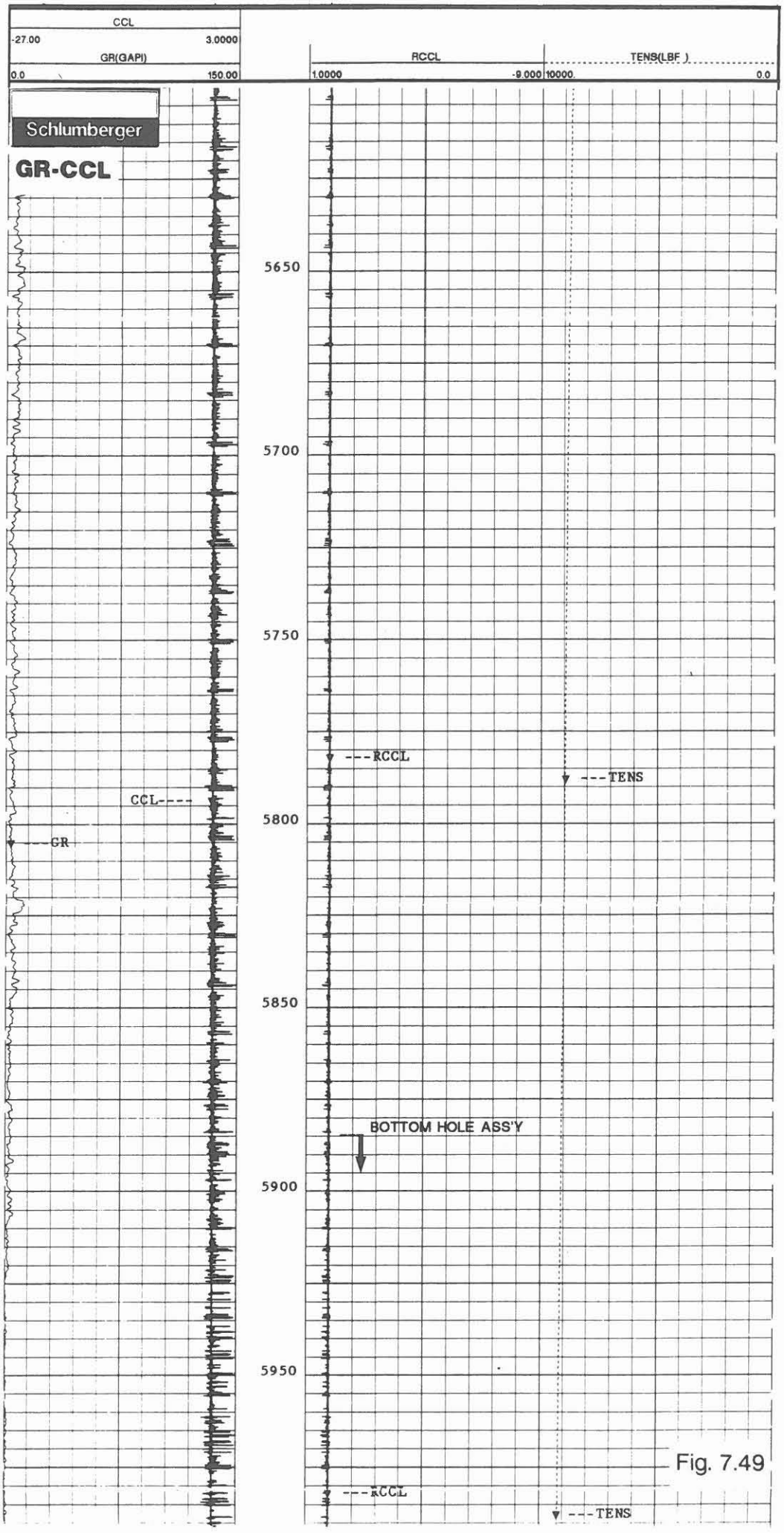

CCL
-27.00
3.0000
GR(GAPI)
0.0
150.00
RCCL
1.0000
-9.000
TENS(LBF)
10000.
0.0
Schlumberger
GR-CCL
5650
5700
5750
---RCCL
---TENS
CCL----
5800
---GR
5850
BOTTOM HOLE ASS'Y
5900
5950
---RCCL
---TENS

Fig. 7.49

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

Operator: Schlumberger Diepholz/KTB

Job No.	Date	Interval
HB-0175	24.04.1992	0.0 - 6018.0 m

Example:
Section of log: 5830.0 - 5895.0 m, **Fig. 7.50**

Purpose of log:
With this log corrosion and/or mechanical wear of the 13 3/8"/13 5/8" casing string will be determined using the time lapse technique with repeat surveys.

Operation:
The log was recorded as the "reference survey" in new casings. To detect corrosion or mechanical damage repeat surveys will be recorded and correlation to the "reference" will highlight these problems.

During the operation, the caliper tool had to be closed several times due to debris (cement) collected while logging. Depth scale: 1/1000, 1/200; logging speed: 9 m/min.

Technical informaton:
An array of 72 independent movable fingers, mounted around the circumference of the tool, ride at the inner surface of the casing and record any anomalies. For three sectors of 120° each the minimum and maximum caliper signals will be recorded. In addition, the minimum and maximum readings of the total circumference are recorded separately.

An interpretation of the logging results is presented in chapter 9 of this KTB Report.
Date rate: 6"

Mmemonics and Units:

Mmemonics	Description	Unit
DRIF	Drift radius	(MM)
GR	Gamma Ray	(GAPI)
MNRD	Minimum radius	(MM)
MXRD	Maximum radius	(MM)
OCR	Outer Casing radius	(MM)
RAD1-6	Radii 1-6	(MM)

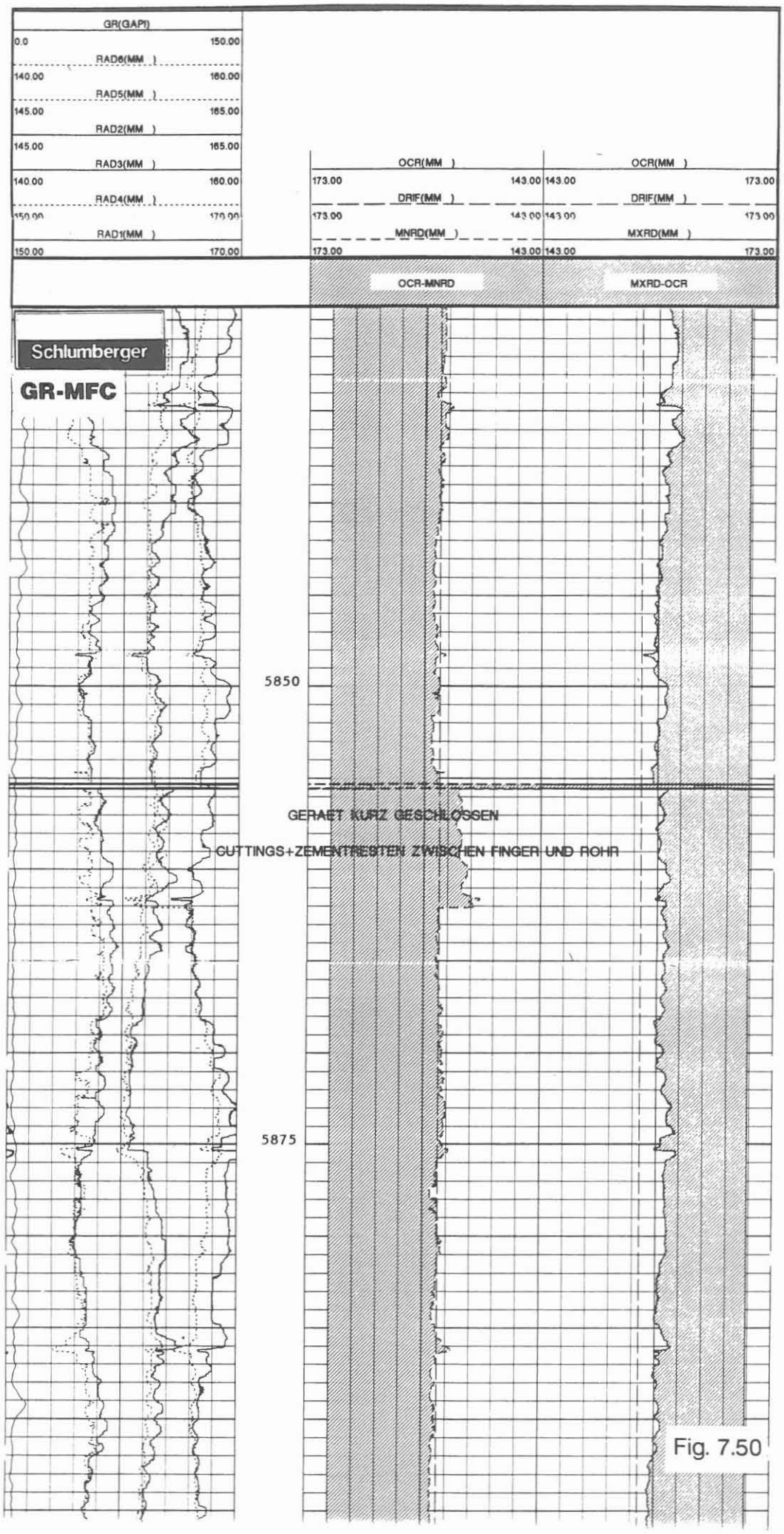

GR(GAPI)
0.0
150.00
RAD6(MM)
140.00
160.00
RAD5(MM)
145.00
165.00
RAD2(MM)
145.00
165.00
RAD3(MM)
140.00
160.00
RAD4(MM)
150.00
170.00
RAD1(MM)
150.00
170.00
OCR(MM)
173.00
143.00
DRIF(MM)
173.00
143.00
MNRD(MM)
173.00
143.00
OCR(MM)
143.00
173.00
DRIF(MM)
143.00
173.00
MXRD(MM)
143.00
173.00
OCR-MNRD
MXRD-OCR
Schlumberger
GR-MFC
5850
GERAET KURZ GESCHLOSSEN
CUTTINGS+ZEMENTRESTEN ZWISCHEN FINGER UND ROHR
5875

Fig. 7.50

BGL/TEMP/SP (Borehole Geometry Log/Temperature/Self Potential)

Job No.	Date	Interval
HB-0176	26.04.1992	5988.0 - 6033.0 m

Example:
Section of log: 6008.0 - 6033.0 m, **Fig. 7.51**

Purpose of log:
The reason for this log was to record the borehole condition below the casing shoe in preparation for the hydrofrac experiment.

Operation:
The Four-arm Caliper was run to record the borehole conditions below the casing shoe in the newly drilled section. This section was drilled in preparation for the hydro-frac experiment.
Depth scale: 1/200; logging speed: 10 m/min.

Technical information:
For the hydro-frac experiment correct depth and information about the borehole conditions were required.
Data rate: 6"

Mnemonics	Description	Units
AZIM	Azimuth	(DEG)
BS	Bite size	(MM)
C1,2	Caliper 1,2	(MM)
DEVI	Deviation	(DEG)
P1AZ	Pad 1 azimuth	(DEG)
RB	Relative bearing	(DEG)
SPK	Self Potential	(MV)
TENS	Tension	(LBF)

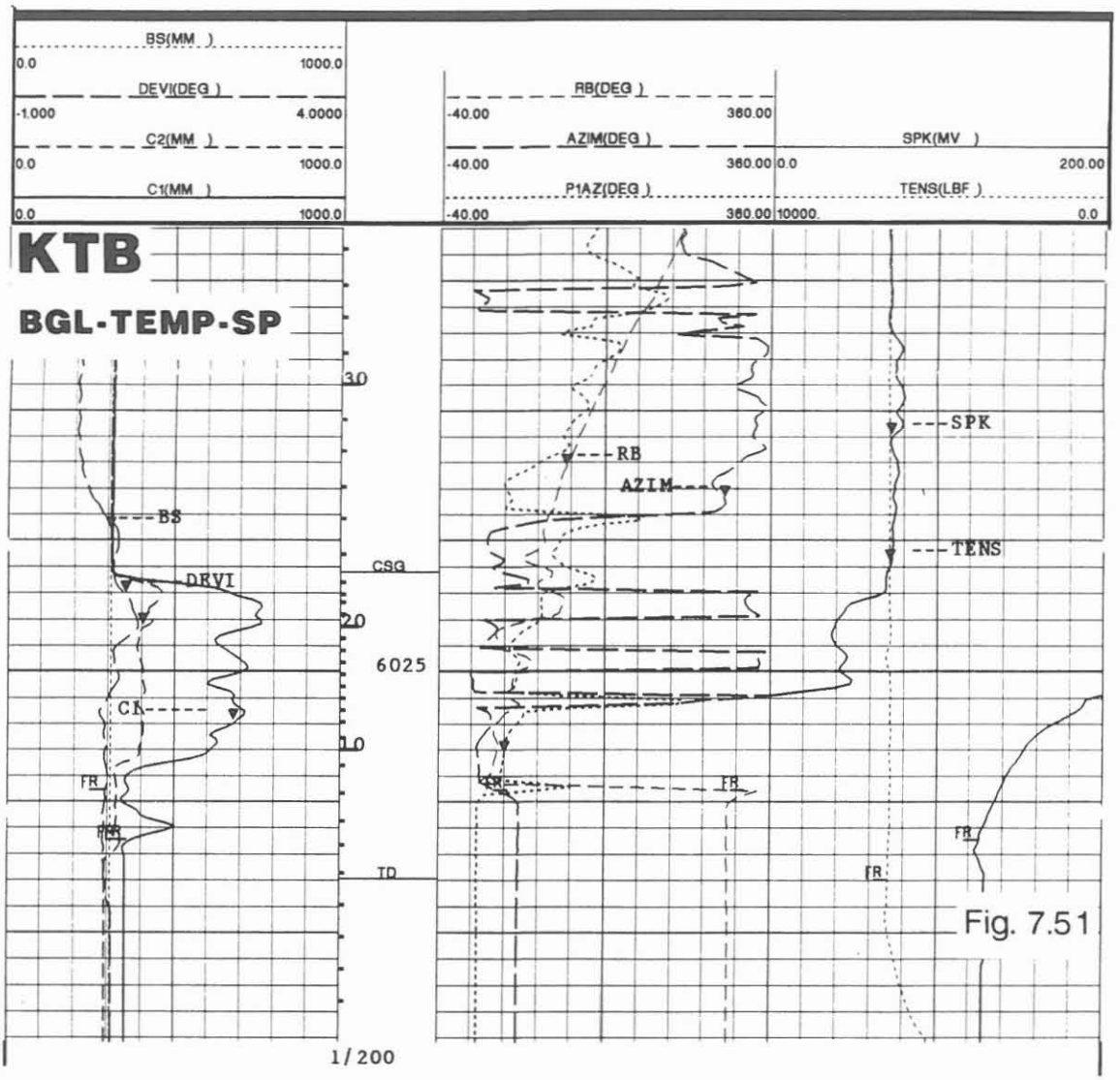

BS(MM)
0.0
1000.0
DEVI(DEG)
-1.000
4.0000
C2(MM)
0.0
1000.0
C1(MM)
0.0
1000.0
RB(DEG)
-40.00
360.00
AZIM(DEG)
-40.00
360.00
P1AZ(DEG)
-40.00
360.00
SPK(MV)
0.0
200.00
TENS(LBF)
10000.
0.0
KTB
BGL-TEMP-SP
3.0
2.0
1.0
BS
DEVI
C1
FR
CSG
6025
TD
SPK
RB
AZIM
TENS
FR
FR
FR
1/200

Fig. 7.51