

CORDAX LWT LOGGING WHILE TRIPPING

3102 MEMORY LOGGER (MEMBAT)

The 3102 Memory Logger records data acquired by the connected logging instruments. Sleep time, start time, logging duration, and sample rate are programmed into the logger before tool deployment. The Memory Logger contains a lithium battery which provides power for both the logger and connected tools during recording. The MEMBAT includes an accelerometer to record shock encountered during deployment/recording.

OPERATING PRINCIPLE

A PC and LWT Readout Box is used to program the MEMBAT and read data from memory after logging. The MEMBAT is connected to the downhole logging instruments and logging parameters programmed. It is then separated from the PC and LWT readout box and deployed downhole with the programmed logging tools. Beginning at the programmed start time, the logging instrument data is recorded to non-volatile memory against a real-time clock. Logging depth is recorded at the surface versus time by a PC and a Depth Processing Unit connected to the drilling recorder/encoder and hook load sensor. Depth is tracked electronically and monitored stand by stand. Once the depth/time record is merged with memory data, a depth indexed log can be played back, edited, displayed and printed. The onboard axial accelerometer enables analysis of forces on tools during pump-down deployment, logging, and well intervention.

SPECIFICATIONS

Weight: 6 kg (13.2 lbs)
Maximum Temp: 150 deg C (300 deg F)
Maximum Pressure: 100 MPa (14,000 PSI)

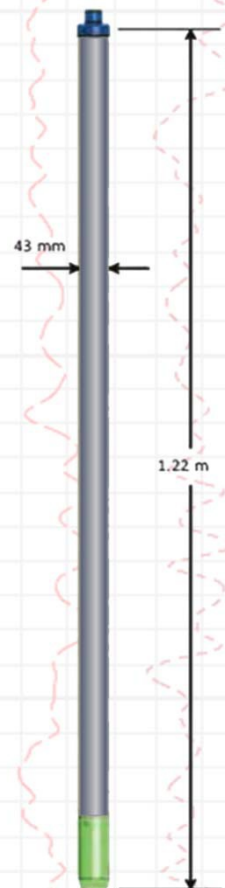
Battery Type: High-Temp Lithium
Battery Voltage (4 cell): 14.4 V
Battery Capacity: 24 Ah (60 hours)
Battery Max Temp: 150 deg C (300 deg F)

Sample Rate: 0.1/sec to 1/hr

Measured Data:

Supply Current: mA
Remaining Battery Capacity: Ah
Memory Logger Temperature: deg C
Battery Voltage: mV
Z-Axis acceleration: -8g to +8g

Operating voltage: 12-15 VDC
Operating current: 15 mA
Memory Size: 64 MB (scalable to 128 MB)



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LOGGING WHILE TRIPPING

1473 COMPENSATED DUAL NEUTRON (CN) & GAMMA RAY (GR)

The 1473 Compensated Dual Neutron / Gamma Ray is a combination slim borehole logging instrument providing porosity measurement and natural gamma radiation readings from within the steel LWT drill collar.

OPERATING PRINCIPLE

The 1473 Dual Detector Neutron instrument employs a chemical nuclear source and two thermal neutron detectors. The source emits neutrons which are slowed down and then captured, primarily by hydrogen atoms in the formation fluids. The detectors count the neutrons deflected back to the tool. The ratio of the short space over the long space count rate is processed to calculate the porosity which relates to the hydrogen content of the formation. Using a scintillation detector, the combined Gamma Ray tool measures the total natural radioactivity of the formation caused by the emission of gamma rays by unstable radioactive isotopes of elements in formation.

SPECIFICATIONS

Weight: 20 kg (44 lbs)
 Maximum Temp: 150 deg C (300 deg F)
 Maximum Pressure: 100 MPa (14,000 PSI)

Neutron Detector: He3
 Radioactive Source: AmBe - 592 GBq (15 Ci)
 GR Detector: NaI

Recorded Curves: SSRaw (cps)
 LSRaw (cps)
 GR (cps)

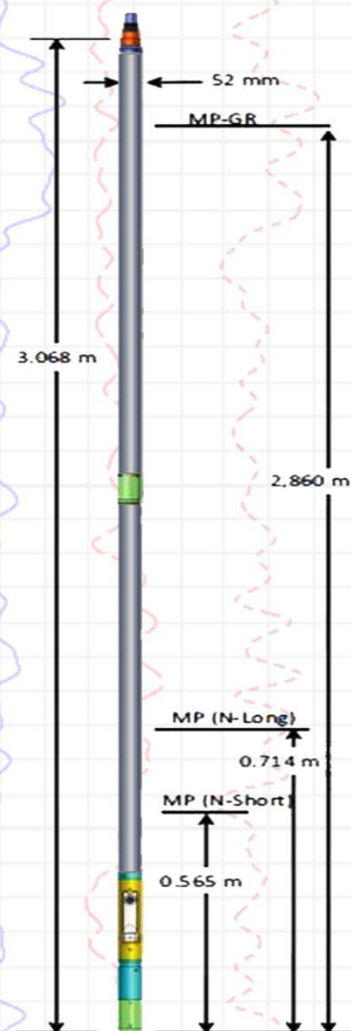
Calculated Curves: Count Rate Ratio (SS/LS)
 Matrix Neutron Porosity (PU)
 - Sandstone
 - Limestone
 - Dolomite
 GR (API)

LOGGING PARAMETERS

Logging Speed: 7 m/min (23 ft/min)
 Sample Rate: 1 sample / sec
 CN Depth of Invest.: 260 mm (10.0 in) @ 20PU
 CN Vertical Resolution: 570 mm (22.4 in)
 Minimum Hole Size: 125 mm (4.9 in)
 Maximum Hole Size: 250 mm (9.8 in)

Measurement Range: Porosity: 0-60%
 Gamma Ray: 0-400 API

Accuracy: Porosity:
 - 0-10 PU: +/- 0.5 PU
 - 10-30 PU: +/- 8%
 - 30-60 PU: +/- 10%
 Gamma Ray:
 - +/- 2% of measured values



CORDAX LWT

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1481 TRIPLE DETECTOR DENSITY (DEN)

The 1481 Triple Detector Density tool is a slim borehole logging instrument designed to provide omnidirectional formation density measurement through the proprietary LWT composite collar.

OPERATING PRINCIPLE

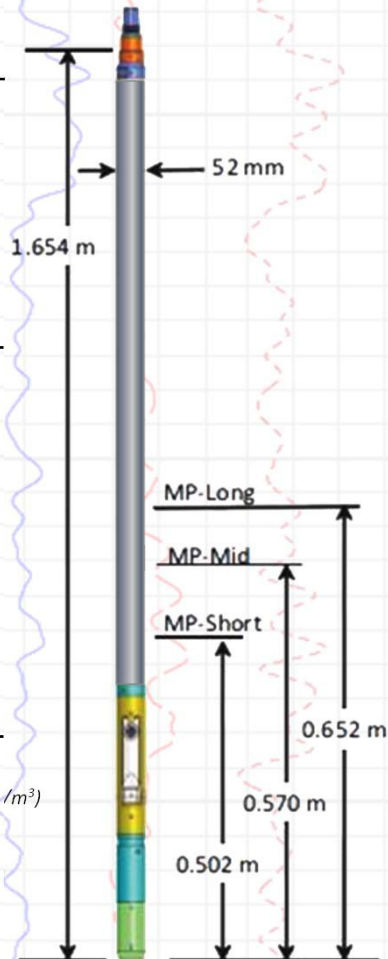
The 1481 Triple Detector Density contains a gamma ray source and three high-sensitivity scintillation detectors. Gamma radiation from the source is back scattered by the formation and is measured by three detectors equipped with proprietary shielding designed to optimize gamma ray collimation. Borehole effects are removed through computed stand-off and mud density measurement derived from relative readings of the multiple spaced detectors with reference to calibration and modeled responses. An apparent bulk density is then calculated from borehole compensated data as well as an average caliper and density correction.

SPECIFICATIONS

Weight:	15 kg (33 lbs)	Recorded Curves:	SSRaw (cps)
Maximum Temp:	150 deg C (300 deg F)		MSRaw (cps)
Maximum Pressure:	100 MPa (14,000 PSI)		LSRaw (cps)
Detector Type:	NaI	Calculated Curves:	SS density, borehole corrected
Radioactive Source:	Cs ₁₃₇ - 74 GBq (2 Ci)		MS density, borehole corrected
			LS density, borehole corrected
			Apparent Bulk Density (g/cc - kg/m ³)
			Average Caliper
			Density Correction

LOGGING PARAMETERS

Logging Speed:	7 m/min (23 ft/min)	Measurement Range:	Bulk Density: 1-3 g/cm ³ (1000-3000 /m ³)
Sample Rate:	1 sample / sec		
Depth of Invest.:	100 mm (3.9 in)	Accuracy:	Bulk Density: +/-0.23g/cm ³ (230 Kg/m ³)
Vertical Resolution:	448 mm (17.6 in)		
Minimum Hole Size:	125 mm (4.9 in)		
Maximum Hole Size:	250 mm (9.8 in)		



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1460 SPECTRAL GAMMA RAY (SGR)

The 1460 Spectral Gamma Ray Tool is a slim borehole logging instrument used for measurement of the isotope constituents of natural gamma radiation. It provides quantitative calculations of Potassium, Thorium, and Uranium.

OPERATING PRINCIPLE

The 1460 Spectrum Gamma Ray tool measures the entire gamma spectrum from 0 to 3000 keV. All detected gamma rays which exceed a threshold level energy are counted to produce the total gamma ray curve. A spectrum fitting algorithm uses all of the available counts to determine the quantitative content of the main three unstable isotopes contributing to the natural radiation emission (Potassium, Uranium, Thorium). Environmental corrections for KCl mud, hole size, and casing are applied through software.

SPECIFICATIONS

Weight: 8 kg (17.6 lbs)
 Maximum Temp: 150 deg C (300 deg F)
 Maximum Pressure: 100 MPa (14,000PSI)

Recorded Curves: Spectrum (256 channels)
 Total Gamma Ray: GR Raw (cps)

Detector Type: CsI crystal
 Spectrum Range: 0 - 4.2 MeV

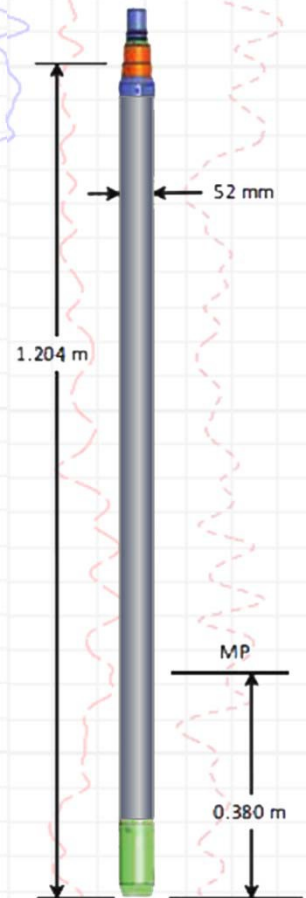
Calculated Curves: Gamma Ray (gAPI): GR
 Thorium Content (ppm) (Bq/kg): TH
 Uranium Content (ppm) (Bq/kg): U
 Potassium Content (%) (Bq/kg): K
 Potassium plus Thorium Content : KTh
 Ratio Uranium/Thorium: RUK
 Ratio Thorium/Potassium: RThK
 Ratio Thorium/Uranium: RThU
 Spectrum fitting quality indicator: ChiSq

LOGGING PARAMETERS

Logging Speed: 3 m/min (9.8ft/min)
 Sample Rate: 1 sample / 2 sec
 Depth of Invest.: 300 mm (11.8 in)
 Vertical Resolution: 150 mm (5.9 in)
 Minimum Hole Size: 125 mm (4.9 in)
 Maximum Hole Size: 250 mm (9.8in)

Measurement Range: GR: 0-3000 API
 K: 0-100 %
 U: 0-1000 ppm
 Th: 0-1000 ppm

Accuracy: GR: +/- 2% of measured values
 K: +/- 2% of measured values
 U, Th: +/- 3% of measured values



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1185 DUAL INDUCTION (DUIN)

The 1185 Slim hole Dual Induction instrument measures induction conductivity and calculates resistivity for deep and medium depths of investigation through the proprietary LWT composite collar.

OPERATING PRINCIPLE

Tuned transmitter coils induce an electromagnetic field in the borehole and adjacent formations. The magnitude of the magnetic field's ground loop current induces voltages in the receiver coils proportional to variations in the total localized conductivity which is then converted to resistivity. Corrections including geometric factor, borehole, skin effect, coil temperature, and salinity are applied through software during acquisition. The DUIN operates from inside the electrically invisible LWT composite drill collar.

SPECIFICATIONS

Weight: 8.2 kg (18lbs)
 Maximum Temp: 150 deg C (300 deg F)
 Maximum Pressure: 100 MPa (14,000 PSI)

Recorded Curves: Deep Conductivity (mmho): Cdeep
 Medium Conductivity (mmho): Cmedium
 Sonde Temperature (deg C): temp

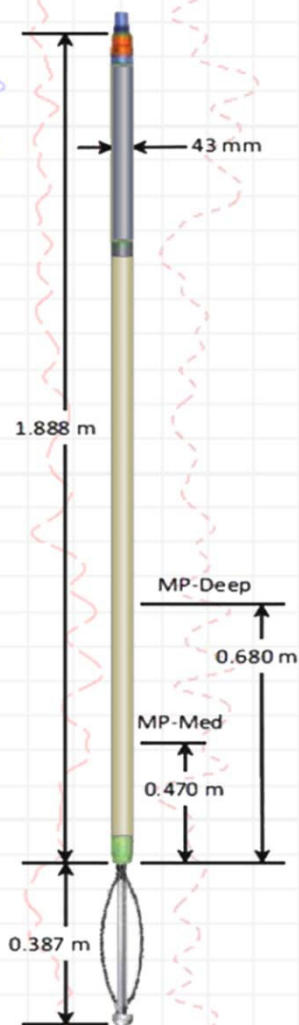
Receiver Coils: 2
 Transmitter Coils: 6
 - Deep: 1 emitting, 3 focusing
 - Medium: 1 emitting, 1 focusing
 Operating Frequencies (@ 10 mS/m):
 - Deep: 50 kHz
 - Medium: 100 kHz

Calculated Curves: Deep Resistivity (ohmm): Rdeep
 Medium Resistivity (ohmm): Rmedium

LOGGING PARAMETERS

Logging Speed: 12 m/min (23 ft/min)
 Sample Rate: 1 sample / sec
 Depth of Invest.: (@ Rt/Rm = 10)
 - Deep: 1.3 m
 - Medium: 0.65 m
 Vertical Resolution:
 - Deep: 1.3 m
 - Medium: 0.65 m
 Minimum Hole Size: 125 mm (4.9 in)
 Maximum Hole Size: 250 mm (9.8 in)

Measurement Range:
 - Conductivity: 10 - 2000 mS/m
 - Resistivity: 0.5 - 100 ohmm
 Accuracy:
 - Maximum Error: 5% (@ 2000 mS/m)



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PROPAGATION RESISTIVITY (RES-P)

OPERATING PRINCIPLE

(RES-P) uses the propagation of a radio frequency (RF) wavefront to determine the resistivity of the surrounding formation. What sets this tool apart from other propagation resistivity tools is that it is a probe style tool rather than a collar-based tool. Hence, a single tool can be used within various collars, and that the tool can be retrieved if necessary. The advantages are that the tool measures at various depths into the formation, is easy to operate, the risk of losing the tool is diminished, and the tool cost is much less than collar-based tools.

SPECIFICATIONS

Tool Weight: 61.5 kg (135 lbs) Maximum

Tool Length: 3.67 meters (12.04')

Max. Temp: 150 deg C (300 deg F)

Maximum Pressure: 20,000 PSI

Receiver: 2

Transmitter: 2

Recorded Capacity: 300 hours

LOGGING PARAMETERS

Logging Speed: 6.7 m/min (22 ft/min)

Measurement Range	Vertical Resolution	Depth of Investigation	Range	Accuracy
2 MHz Phase Shift	12" / 22"	18" / 26"	0.5 to 50 ohm-m	+/- 3%
			50 to 2000 ohm-m	+/- 0.5 ms/m
400 KHz Phase Shift	18" / 30"	24" / 35"	0.1 to 10 ohm-m	+/- 3%
			10 to 500 ohm-m	+/- 2ms/m
2 MHz Attenuation	22" / 40"	28" / 48"	0.5 to 25 ohm-m	+/- 5%
			25 to 50 ohm-m	+/- 2ms/m
400 KHz Attenuation	34" / 60"	40" / 75"	0.1 to 5 ohm-m	+/- 5%
			5 to 20 ohm-m	+/- 8ms/m

