भारतीय प्रौद्योगिकी संस्थान
(भारतीय खनि विद्यापीठ)
धनबाद

IIT ISM

INDIAN INSTITUTE OF TECHNOLOGY
(INDIAN SCHOOL OF MINES)
DHANBAD

GPC510 - Well logging

Semester - Winter 2025; Lecture-2

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TEACHING OUTLINE

Week 1/2

Tutorial 1 – Introduction, teaching overview, and assessment

Tutorial 2 – Well log definition, history, log format, types, units

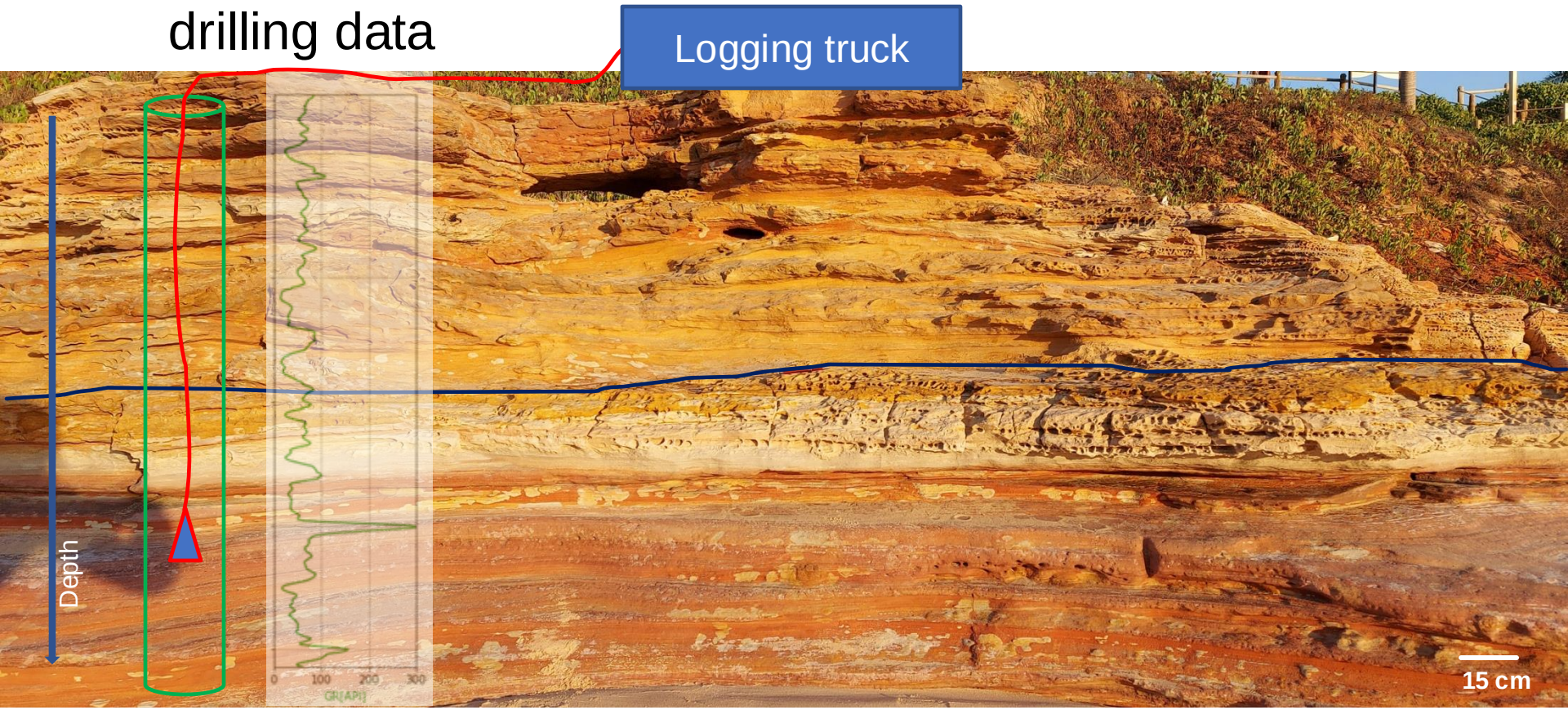
Tutorial 3 – Borehole effects, environmental impacts

AGENDA

- Introduction
- Definition of “well-log”
- Purpose of “well-log”
- History
- Logging units and operation
- Log types
- Log format

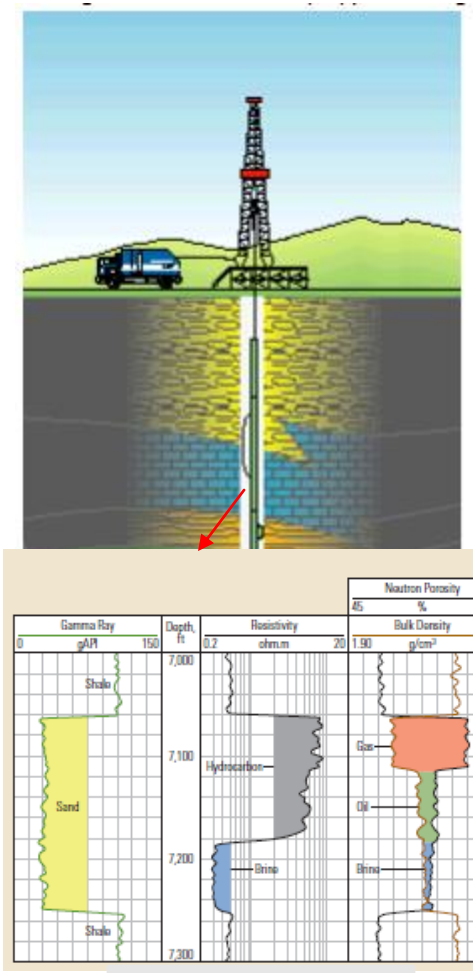
INTRODUCTION

- Study of rocks – Outcrop, surface geophysics, and drilling data



DEFINITION – WELL-LOG

- Continuous measurement of physical properties of subsurface rock formations in a drilled bore hole
- Can be referred as “wireline logs” or “well-logs”
- Traditionally, the recording of the measurements were stored on film, gridded paper, magnetic tape, etc
- Currently all are recorded in digital format, stored in cloud platform



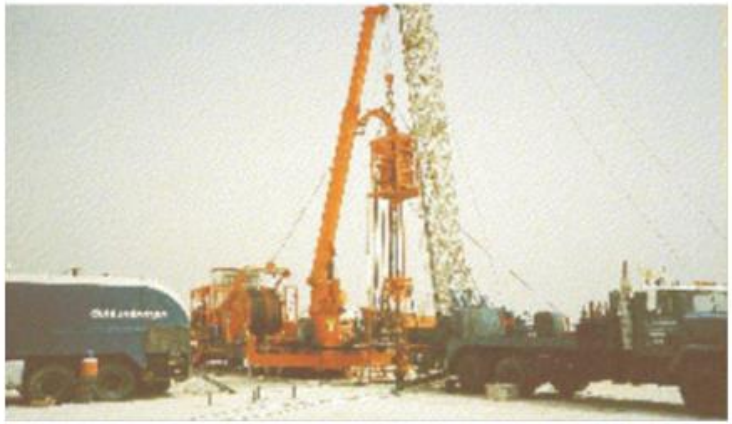
Ref: Schlumberger

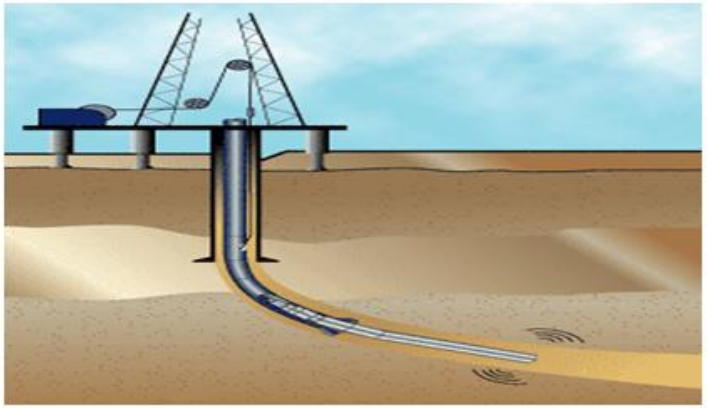
PURPOSE

- Understand geology of rock formation (composition, structure, organic content) forming sedimentary basin accumulating hydrocarbons
- Minerals grade/quality
- Geochemical characterization
- Depth to lithological boundaries
- Inter-borehole correlation
- Geological modelling
- Rock strength and in situ stress distribution
- Pore pressure estimation

HISTORY

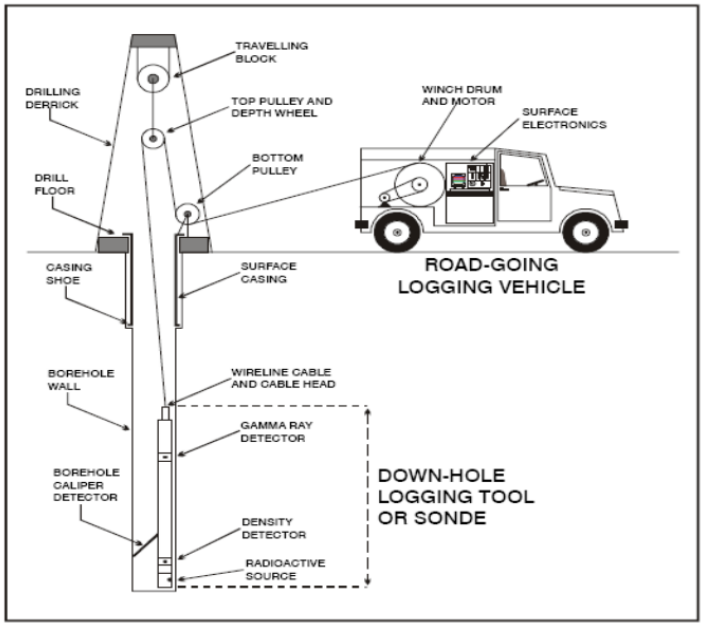
- First electric resistivity well-log acquired by Marcel and Conrad Schlumberger in 1927 (Location: Pechelbronn, France)
- A tool was used known as **SONDE**
- In 1929, commercial resistivity logging started in Venezuela, Russia and USA





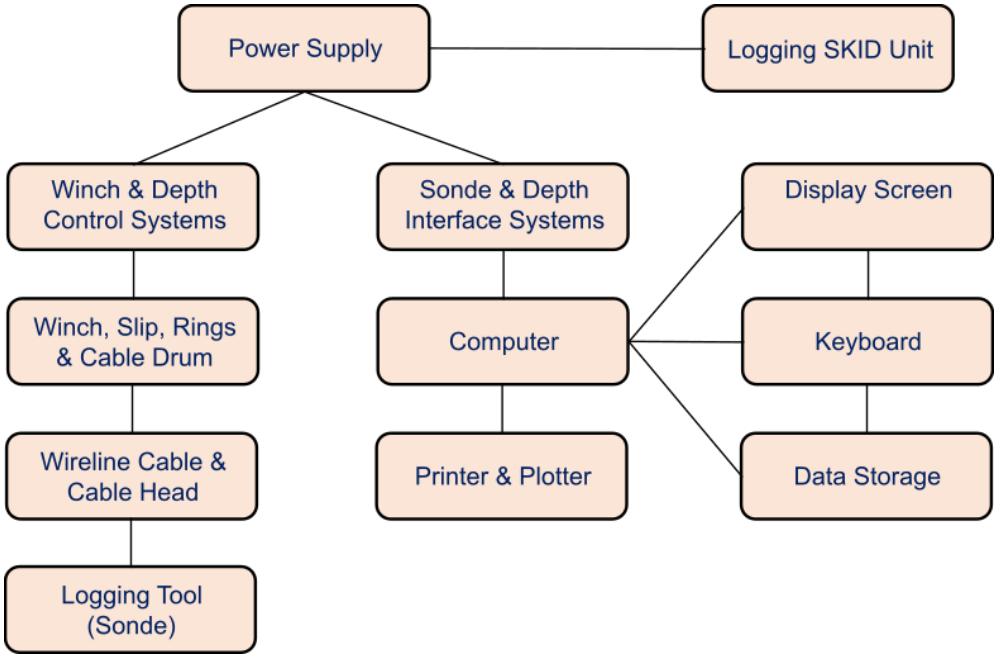
LOGGING UNITS

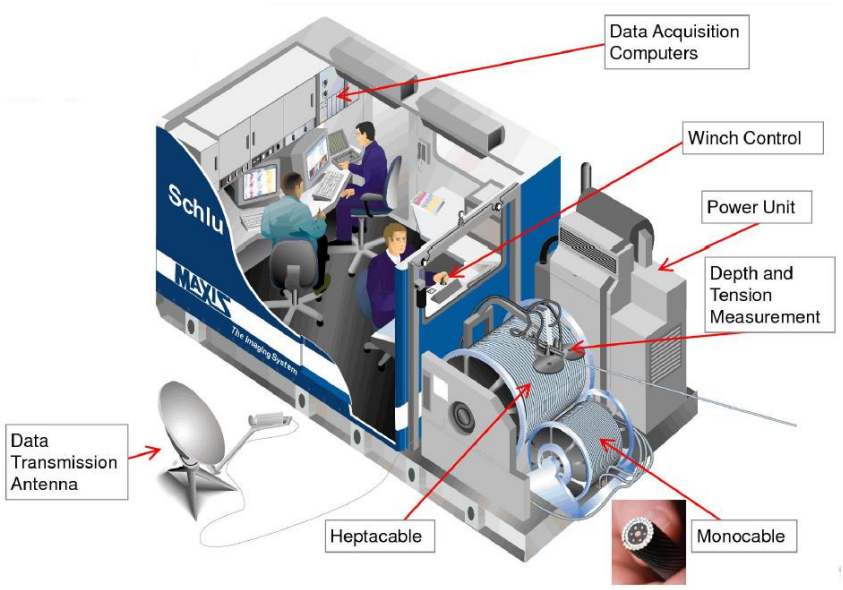
- Service companies use a variety of logging units (onshore or offshore) depending upon logging run. Each of the unit contains the following:
  - Logging cable/wire
  - Winch to raise and lower the cable
  - Self-contained 120-volt AC generator
  - Surface control panels
  - Set of downhole tools (sondes and cartridges)
  - Digital recording system



Example of a logging setup

HOW LOGGING OPERATION RUNS?





DRILLING & LOGGING ANIMATION

Drilling animation

https://www.youtube.com/watch?v=eBOtXD_UQSo

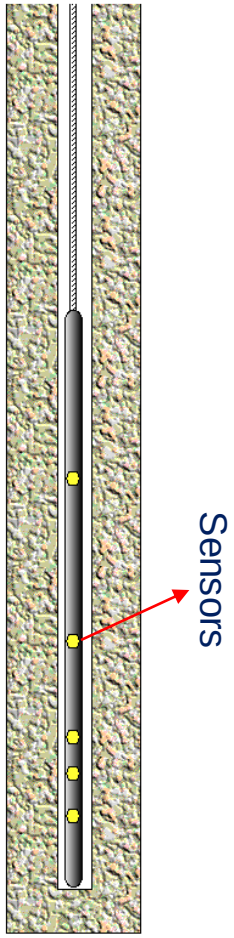
Drilling to completion:

https://www.youtube.com/watch?v=wjm5k6Kf-RU

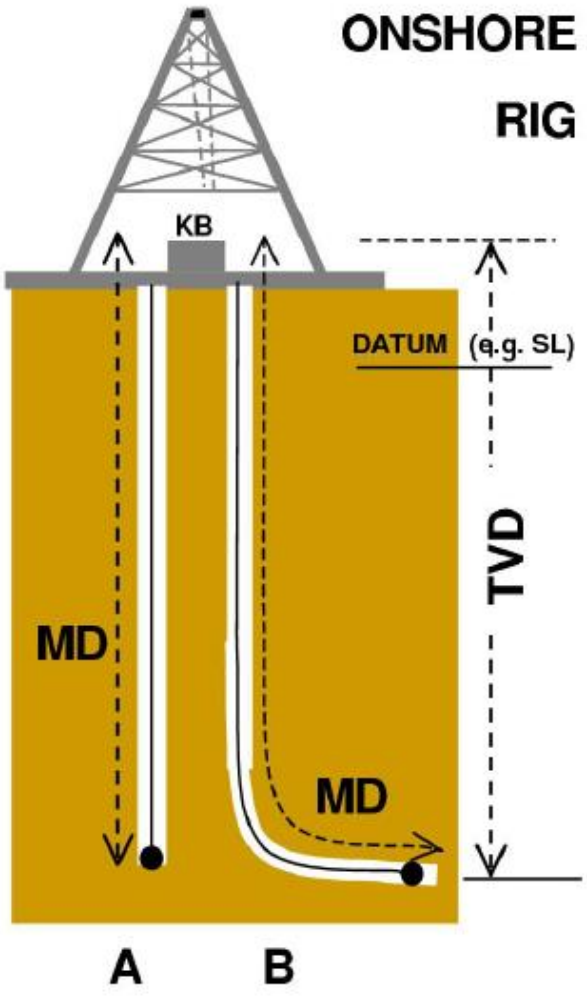
YouTube, 2013

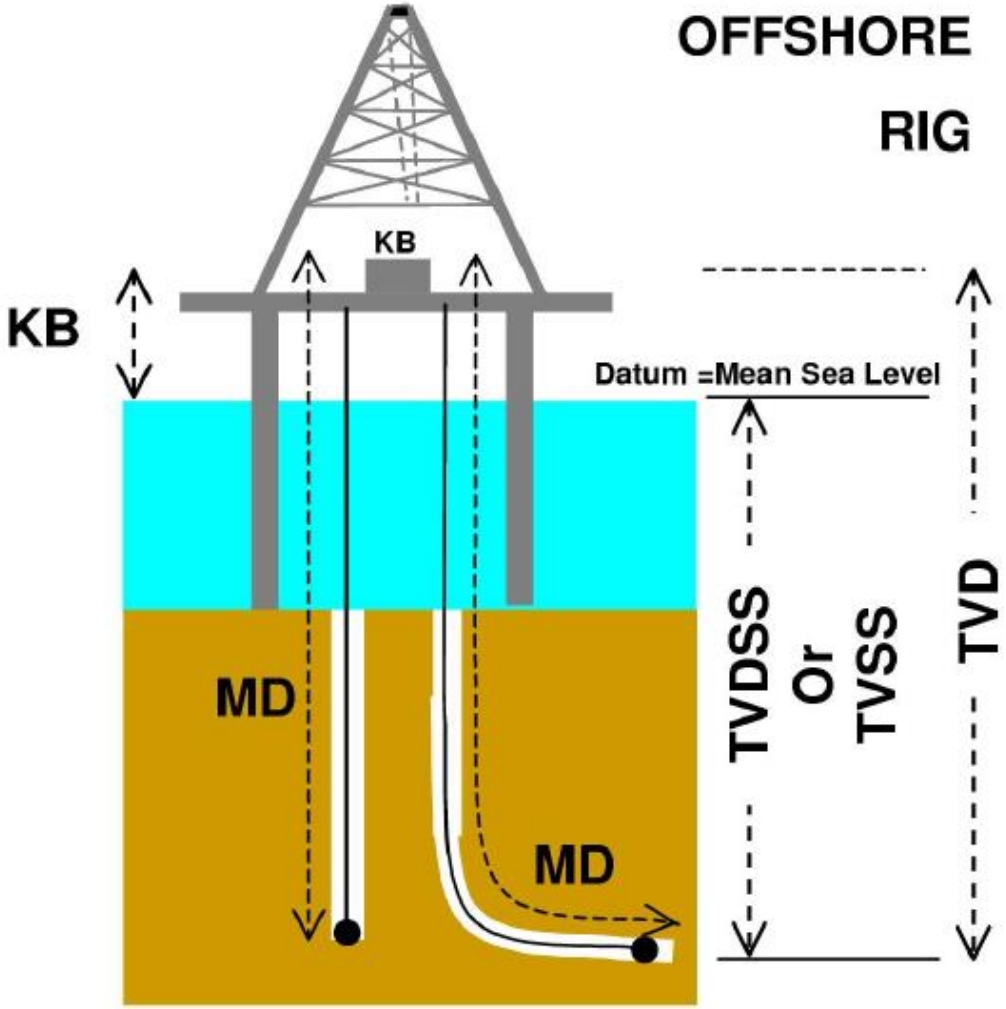
THE LOGGING RUN

- Logs are recorded when the tools are raised from bottom of the hole (easy maintenance of uniform cable tension, good depth recording)
- Total depth (TD) is measured with reference to ground level (GL) or Kelly Bushing (KL) of the drilling platform
- For an initial recording pass, the tool is raised upto 100 to 200 ft to generate " repeat section"
- The tool is lowered again to start logging "main run"
- The speed of logging tools varies (example: 1800 – 3600 ft/hr)



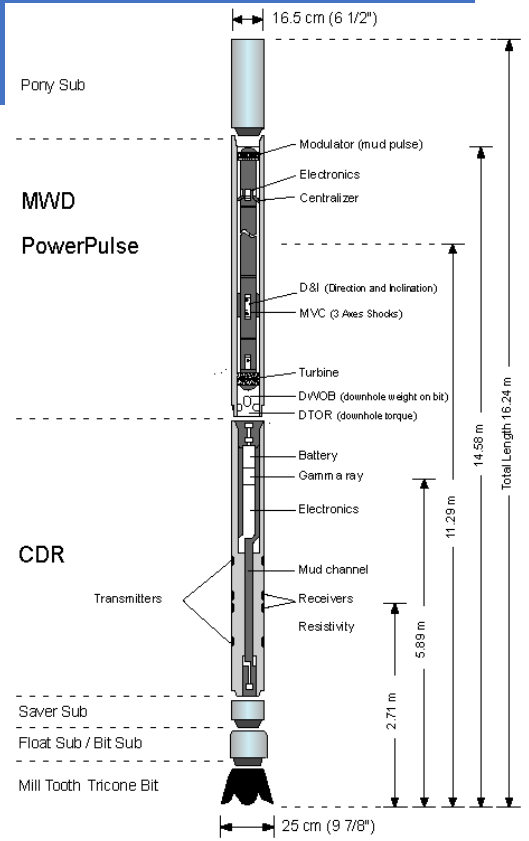
DEPTH MEASUREMENT





LWD – LOGGING WHILE DRILLING

- With the requirement of complex drilling scenario, like horizontal and directional drilling become common, logging measurement also changed
- If the drilled well-bore is beyond 60 degree, it is not possible to push the tools to retrieve physical measurement
- LWD sensors provide wireline-quality petrophysical data (resistivity, acoustic, density) while drilling
- Real time data can be transmitted via mud pulses to the surfaces which help to design well placement and drilling associated hazards
- The tool is battery powered and uses programmable read-only memory chips to store logging data until they are downloaded.
- The tool take measurements at evenly spaced time intervals and are synchronized with a system on the drilling rig that monitors time and drilling depth.



Radian® Azimuthal Gamma Ray tool (taken from Haliburton webpage); Leg summaries & Maps

TOOLS CLASSIFICATION

- Measurements are grouped into two types: (i) natural phenomena (passive system) (ii) induced phenomena (source + detector (s))

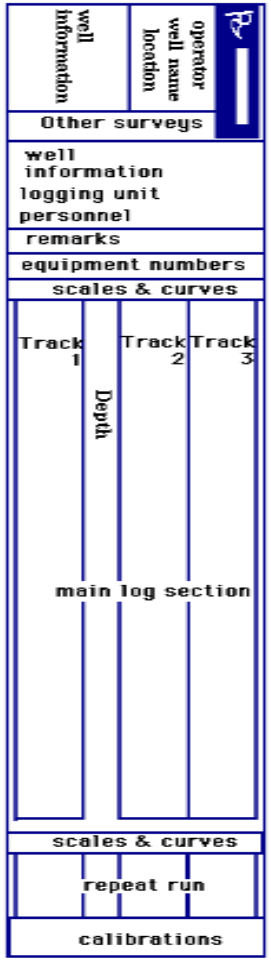
Tool Types	Schlum.	W. Atlas
Induction and/or Resistivity devices	DIL/DLL	DIFL/DLL
Micro resistivity	MSFL	ML
Litho-density and Neutron porosity	LDT/CNL	CDL/CNL
Acoustic	LSS	ACL
Caliper	CAL	CAL
Natural gamma	GR	GR
Spontaneous potential	SP	SP
Dipmeter	SHDT	HRDIP
Pressure testing devices	RFT	FMT
Rock and fluid sampling devices	CST	SWC

Passive

Refer to Table 2-1 (Book O. Serra, 1984); Web

LOG FORMAT

- At the top of the log is the header which records all necessary information required for data interpretation
- Main part contains the curves recorded during “main run” [log columns are referred as Track 1, 2, 3 etc]
- Curves are displayed either in linear or logarithmic scale
- Tail end of the log contains “repeat run” as quality control
- Log is ended with calibration part associated with the tests on the tools of that borehole



LOG HEADER - EXAMPLE

Schlumberger

Company: Bill Barrett Corporation

Well: Helman P 12-24
Field: Wildcat
County: Sherman State: Kansas

Platform Express
Triple Combo

LOCATION

NE NW SW Sec 24 T6S R40W
2514' FSL & 782' FWL

Elev.: K.B. 3633 ft
G.L. 3627 ft
D.F. 3632 ft

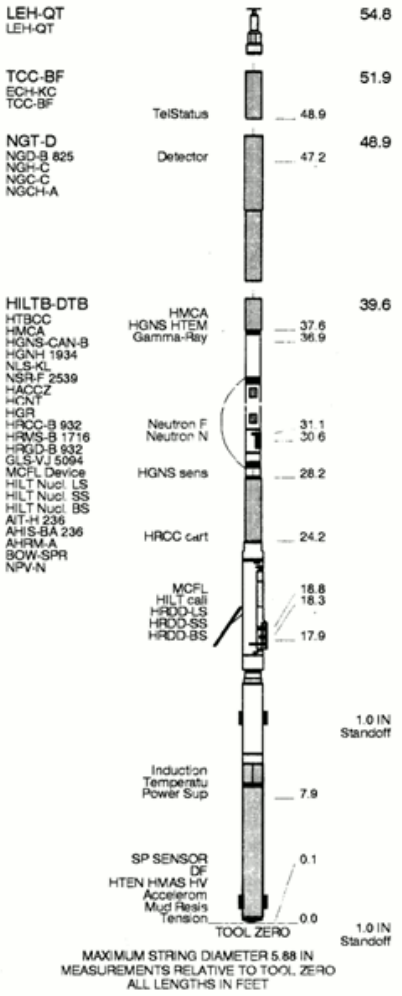
Permanent Datum: Ground Level Elev.: 3627 ft
Log Measured From: Kelly Bushing 6.0 ft above Perm. Datum
Drilling Measured From: Kelly Bushing

County: Sherman
Field: Wildcat
Location: NE NW SW Sec 24 T6S R40W
Well: Helman P 12-24
Company: Bill Barrett Corporation

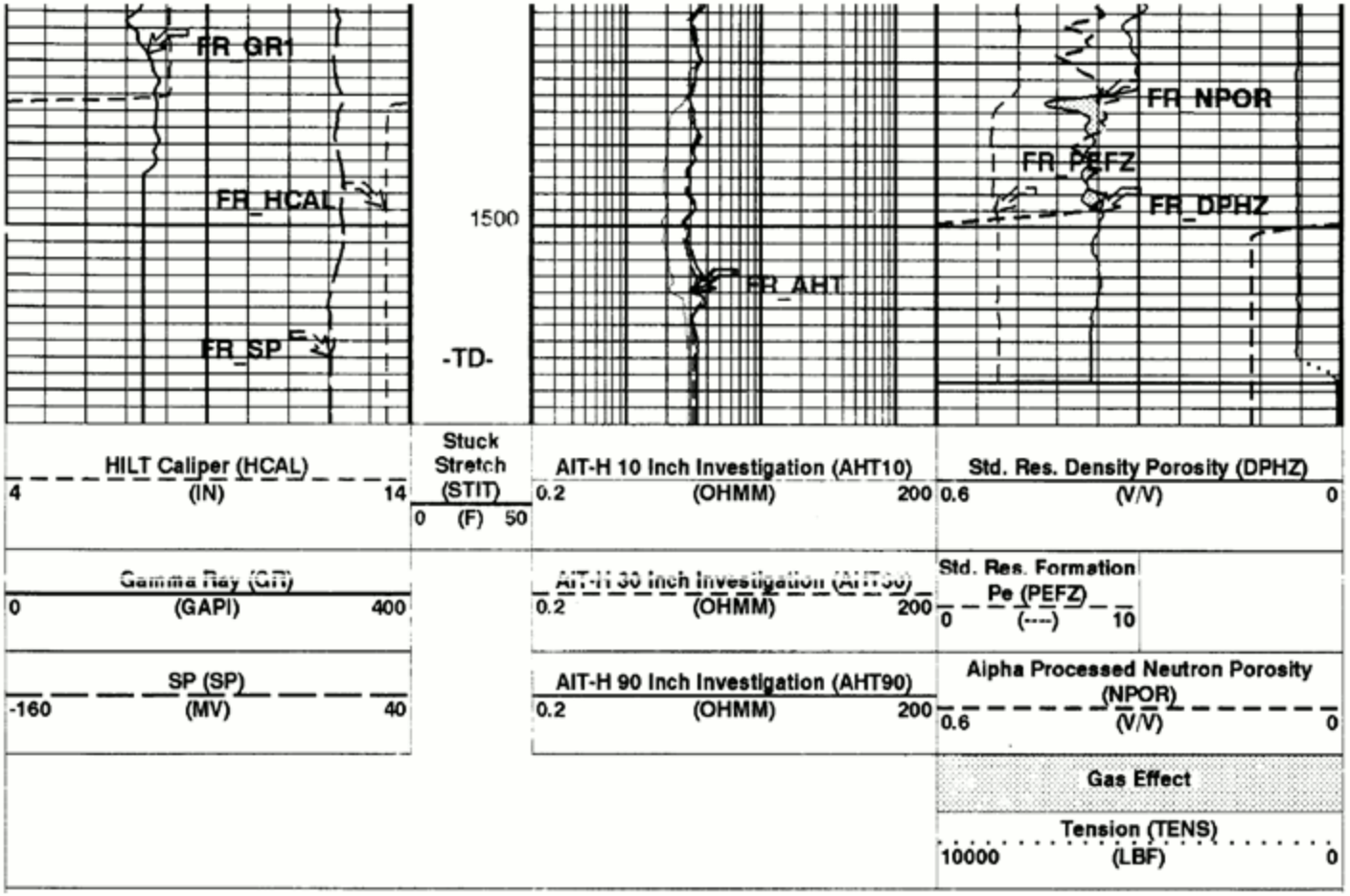
API Serial No.	Section	Township	Range
15-181-20639-00-00	24	6S	40W

Logging Date			23-Mar-2005				
Run Number			One				
Depth Driller			1520 ft				
Schlumberger Depth			1516 ft				
Bottom Log Interval			1508 ft				
Top Log Interval			431 ft				
Casing Driller Size @ Depth			8.625 in	@	428 ft	@	
Casing Schlumberger			431 ft				
Bit Size			7.875 in				
Type Fluid In Hole			KCL Polymer				
MUD	Density	Viscosity	8.7 lbm/gal	42 s			
	Fluid Loss	PH	7 cm3	7			
	Source Of Sample		AIT Mud Sensor				
RM @ Measured Temperature			0.138 ohm.m	@	42 degF	@	
RMF @ Measured Temperature			0.110 ohm.m	@	42 degF	@	
RMC @ Measured Temperature			0.166 ohm.m	@	42 degF	@	
Source RMF	RMC		Calculated	Calculated			
RM @ MRT	RMF @ MRT		0.088 @ 70	0.070 @ 70		@	@
Maximum Recorded Temperatures			70 degF				
Circulation Stopped	Time		23-Mar-2005	11:30			
Logger On Bottom	Time		23-Mar-2005	18:00			
Unit Number	Location		3055	Ft. Morgan, CO			
Recorded By			Max Phoon, Clayton Wong				
Witnessed By			Curtis Ditzell				

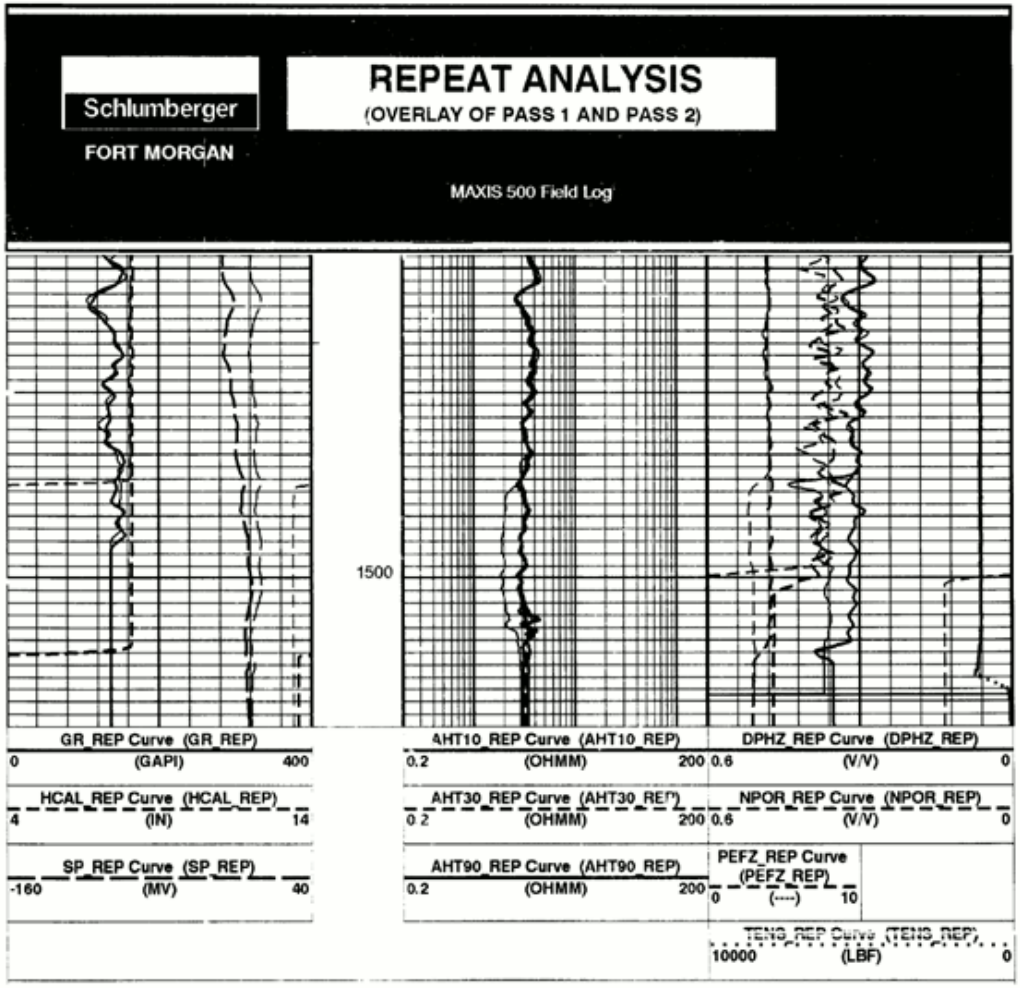
RECEIVED
OCT 20 2005
KCC WICHITA



LOG TAIL - EXAMPLE



REPEAT SECTION- EXAMPLE



END OF LECTURE