— University of Mosul —
College of Petroleum & Mining Engineering

Well Logging Engineering

Lecture One

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- ***Introduction:***
- ***Well logging*** is a method used for recording rock and fluid properties to find gas- and oil-containing zones in subsurface formations.
- The location of petroleum reserves requires an understanding of the nature of the rocks in which these reserves occur, and well logs are one of the primary sources for such data.
- Well logs are particularly useful in the description and characterization of sedimentary rocks and their pore fluids.
- ***Well log*** is a continuous record of measurement made in bore hole respond to variation in some physical properties of rocks through which the bore hole is drilled.

- **Objectives of wireline logging:**
- 1-Lithology identification
- 2-Determination of reservoir characteristics (e.g. porosity, saturation, permeability).
- 3-Identification the fluid type in the pore space of reservoir rock (gas, oil, water)
- 4-Identification of productive zones.
- 5-Determination of the depth and thickness of productive zones.
- 6-Locating reservoir fluid contacts.
- 7-Determination formation dip and hole angle and size.

- **Types of well logging**
- Typically well logging data are classified into three broad categories depending on well condition logged:
- a- **Open hole:**
- Log which done right away after drilling process completed prior to case the well.
- Logging While drilling (LWD)
- Logging After drilling (Wireline)
- b- **Cased hole:**
- Log done after well been cased, (analysis behind casing).
- c- **Production log:**
- Log done after well been produced or fluid flowing.

- **1.1 Logging While Drilling**
- Advances in drilling/logging technology have allowed the acquisition of log data via tools placed in the actual drilling assembly.
- These tools may transmit data to the surface on a real-time basis or store the data in downhole memory from which it may be downloaded when the assembly is brought back to the surface.

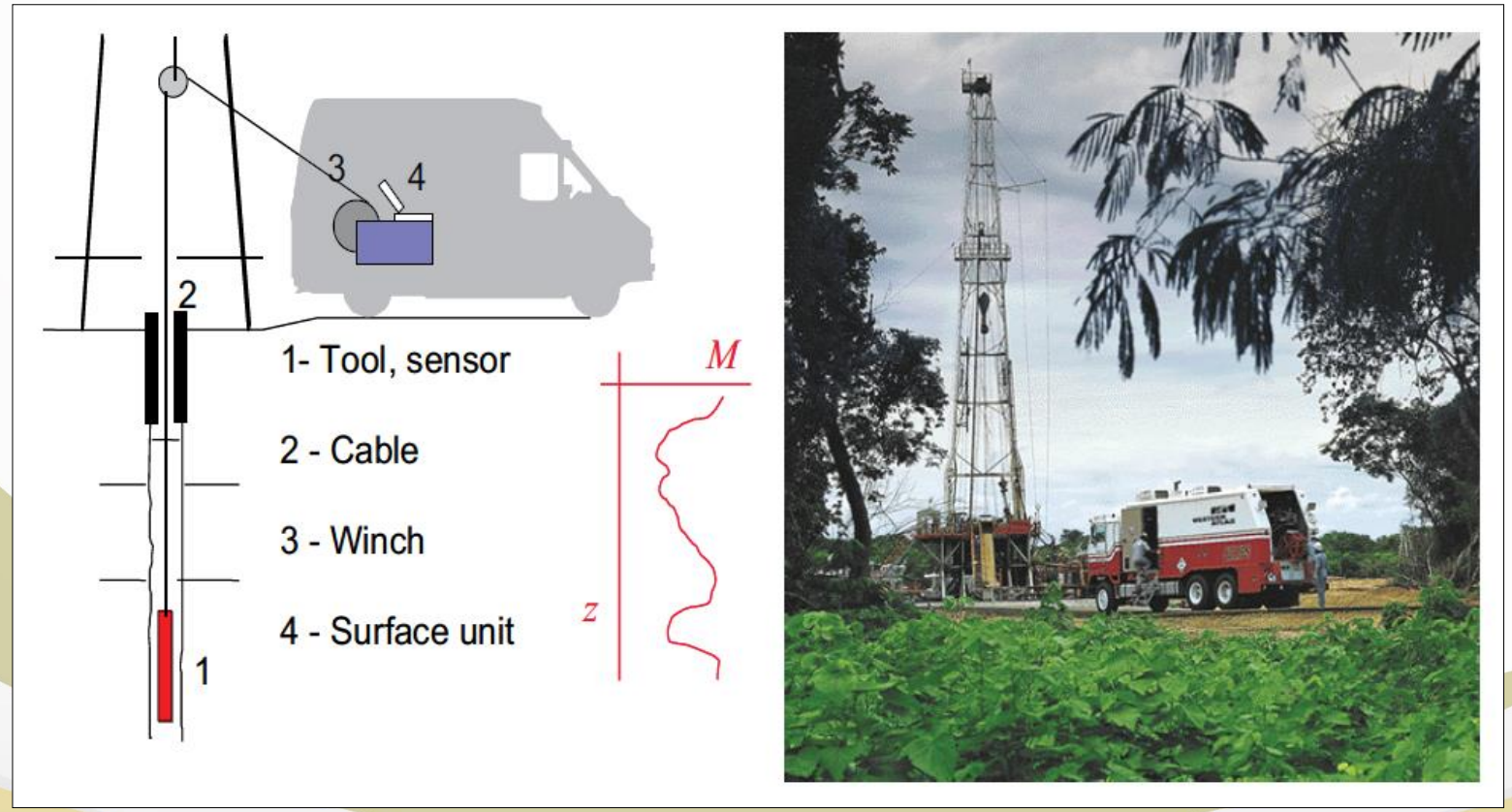
- **1.1 Logging While Drilling**
- LWD tools present a complication for drilling, as well as additional expense. However, their use may be justified when:
- ● Real-time information is required for operational reasons, such as steering a well (e.g. a horizontal trajectory) in a particular formation or picking of formation tops, coring points, and/or casing setting depths.
- ● Acquiring data prior to the hole washing out or invasion occurring.
- ● Safeguarding information in there is a risk of losing the hole.
- ● The trajectory is such as to make wireline acquisition difficult (e.g. in horizontal wells).

- **1.1 Logging While Drilling**
- LWD data may be stored downhole in the tools memory and retrieved when the tool is brought to the surface and/or transmitted as pulses in the mud column in real time while drilling.
- In a typical operation, both modes will be used, with the memory data superseding the pulsed data once the tool is retrieved.

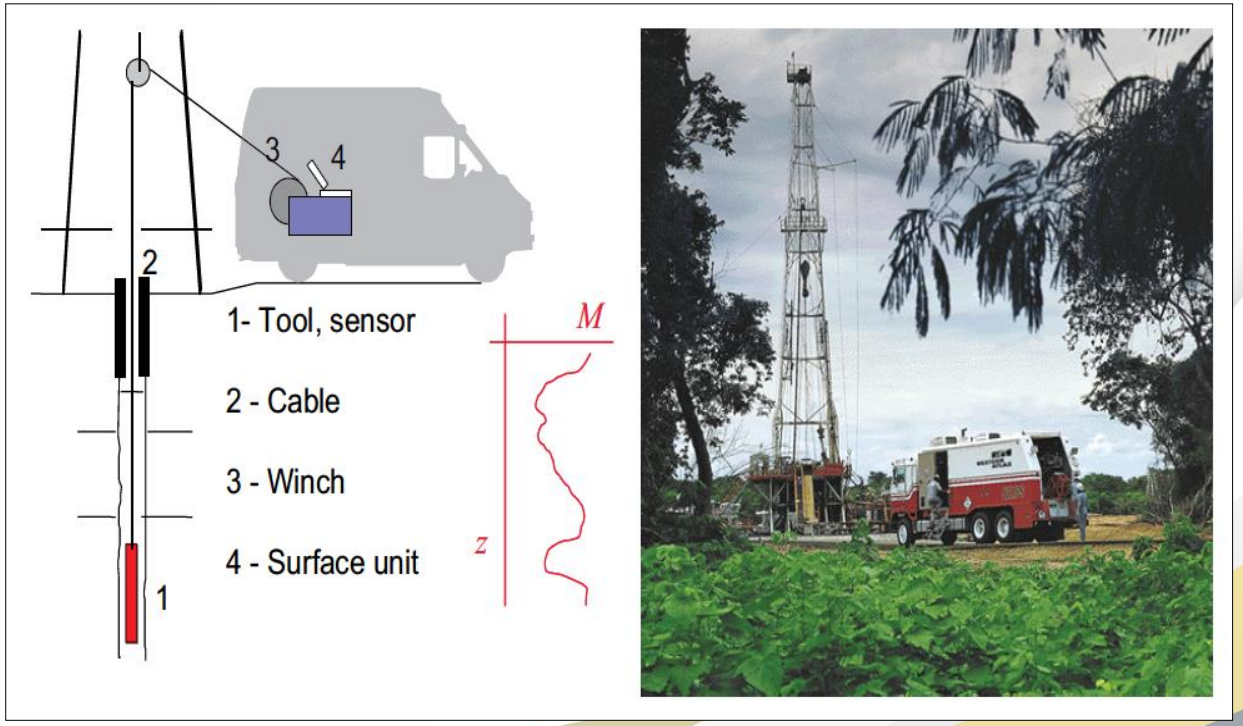
- **1.1 Logging While Drilling**
- However, factors that might limit the ability to fully use both sets of data are:
- *Drilling mode: Data may be pulsed only if the drillstring is having mud pumped through it.*
- *Battery life: Depending on the tools in the string, tools may work in memory mode only between 40 and 90 hours.*
- *Memory size: Most LWD tools have a memory size limited to a few megabytes. Once the memory is full, the data will start to be overwritten. Depending on how many parameters are being recorded, the memory may become full within 20 – 120 hours.*
- *Tool failure: It is not uncommon for a fault to develop in the tool such as the pulse data and / or memory data are not transmissible/ recordable*.

- **1.2 Wireline Openhole Logging:**
- Once a section of hole has been completed, the bit is pulled out of the hole and there is an opportunity to acquire further openhole logs either via wireline or on the drillstring before the hole is either cased or abandoned.
- **1.3 Wireline Cased Hole Logging:**
- When a hole has been cased and a completion string run to produce the well, certain additional types of logging tools may be used for monitoring purposes.
- **1.4 Production logging:**
- This tool, which operates using a spinner, does not measure any properties of the formation but is capable of determining the flow contributions from various intervals in the formation.

- **The field operation**
- Wireline logging is done from a logging truck, sometimes referred to as a “mobile laboratory” (Fig. 1).



- **The field operation**
- The truck carries the downhole measurement instruments, the electrical cable and winch needed to lower the instruments into the borehole, the surface instrumentation needed to power the downhole instruments and to receive and process their signals, and the equipment needed to make a permanent recording of the log.

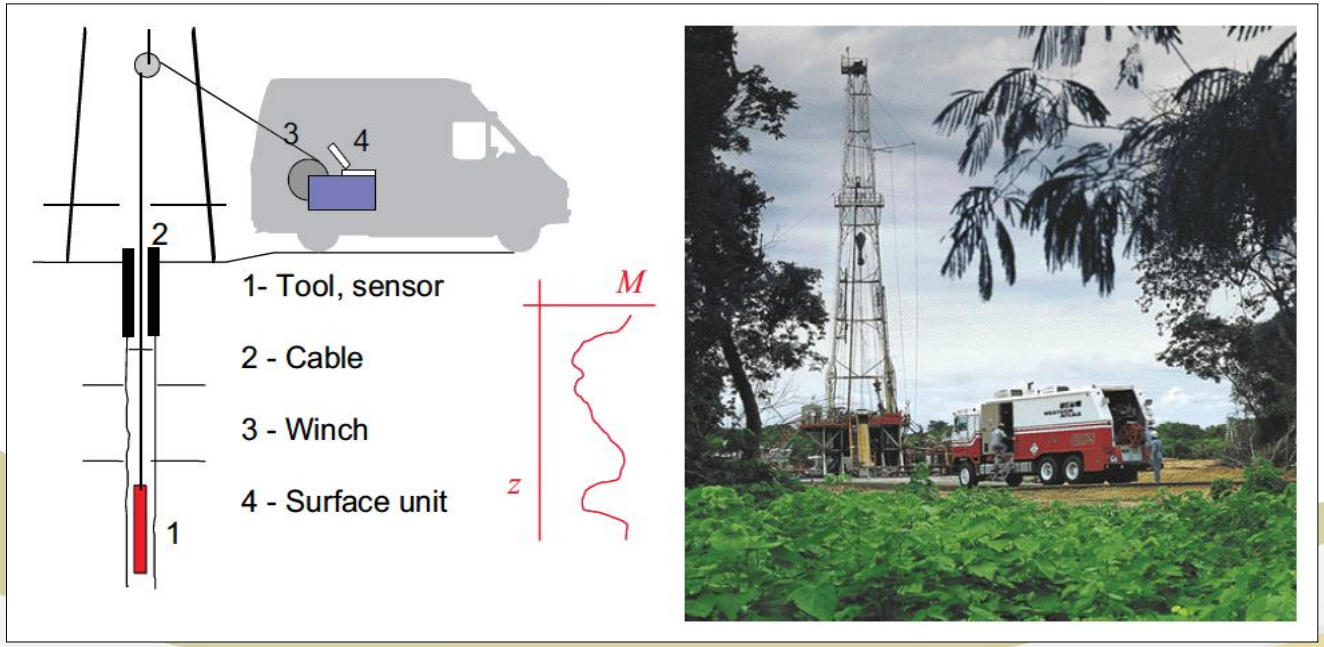


- **The field operation**
- The downhole measurement instruments are usually composed of two components:
- The first component contains the sensors used in making the measurement, called **sonde**.
- The type of sensor depends upon the nature of the measurement. Resistivity sensors use electrodes or coils; acoustic sensors use transducers; radioactivity sensors use detectors sensitive to radioactive; etc.
- The sonde housing may be constructed of steel and/or fibreglass.

- **The field operation**
- The second component of the downhole tool is the **cartridge**.
- *The cartridge contains the electronics that power the sensors, process the resulting measurement signals, and transmit the signals up the cable to the truck.*
- The cartridge may be a separate component screwed to the sonde to form the total tool, or it may be combined with the sensors into a single tool.
- That depends upon how much space the sensors and electronics require and the sensor requirements.
- The cartridge housing is usually made of steel. The downhole tool is attached to an electrical cable that is used to lower the tool into and remove from the well.

- **The field operation**
- Signal transmission over the cable may be in analog or digital form. The cable is also used to transmit the electrical power from the surface to the downhole tools.
- The surface instrumentation provides the electrical power to the downhole tools.
- More importantly, the surface instrumentation receives the signals from the downhole tools, processes and/or analyzes those signals, and responds accordingly.
- The desired signals are output to magnetic tape in digital form and to a cathode-ray tube and photographic film in analytical form.

- **The field operation**
- The photographic film is processed on the unit, and paper prints are made from the film.
- This continuous recording of the downhole measurement signals is referred to as the ***log***.



Thank You