



Overview of Well Logging Operations

By

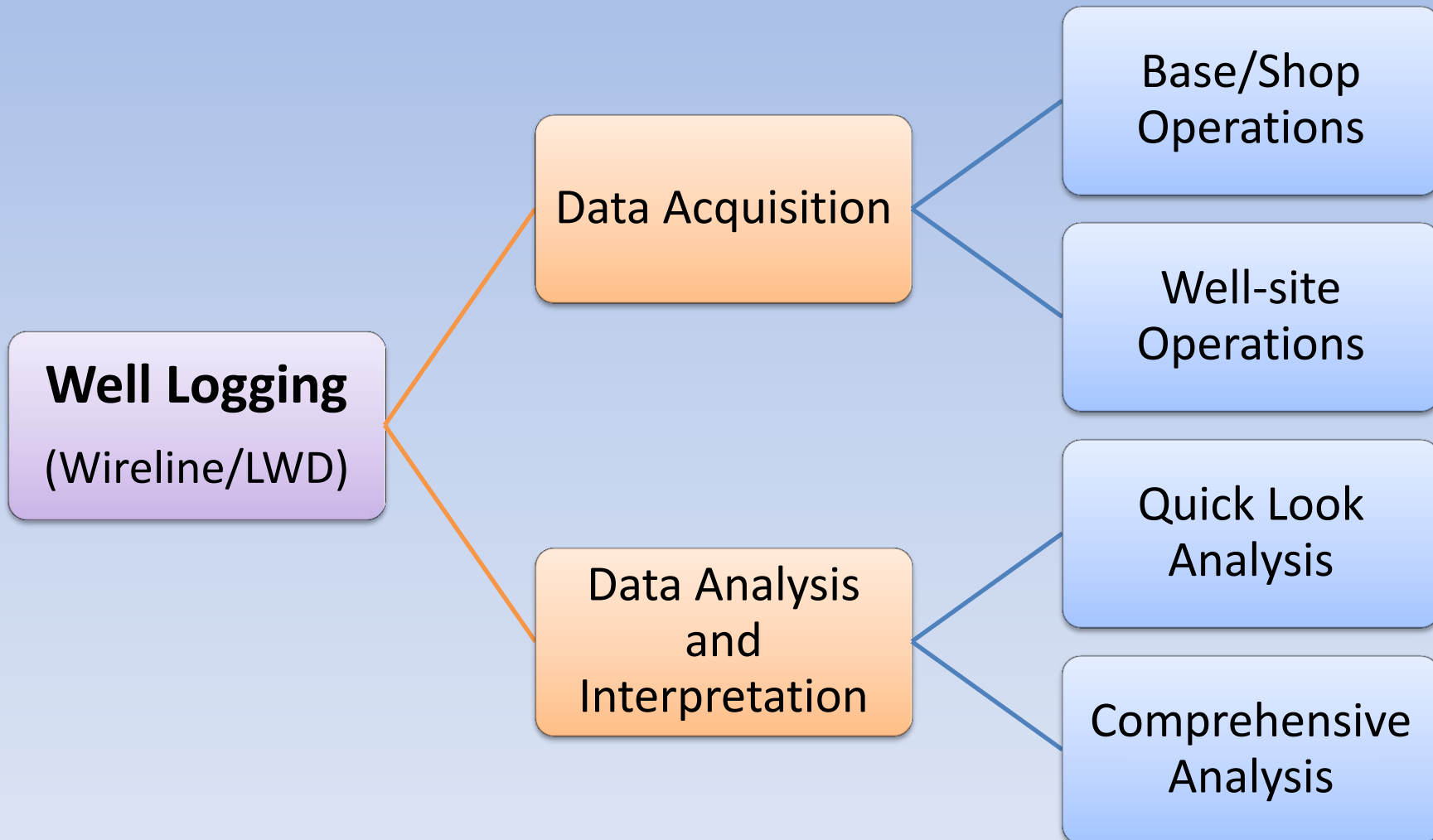
Abiodun Matthew Amao



Lecture Outline

- Introduction to Well Logging
- Types of Well Logging Jobs
- Operational Procedure
 - Base/Shop Operations
 - Well-site Operations Before Data Acquisition
 - Data Acquisition and Real Time QAQC
 - After Log Verification at the Well-site
- Data Delivery Formats
- Data Processing and Analysis
- Data Storage and Archive

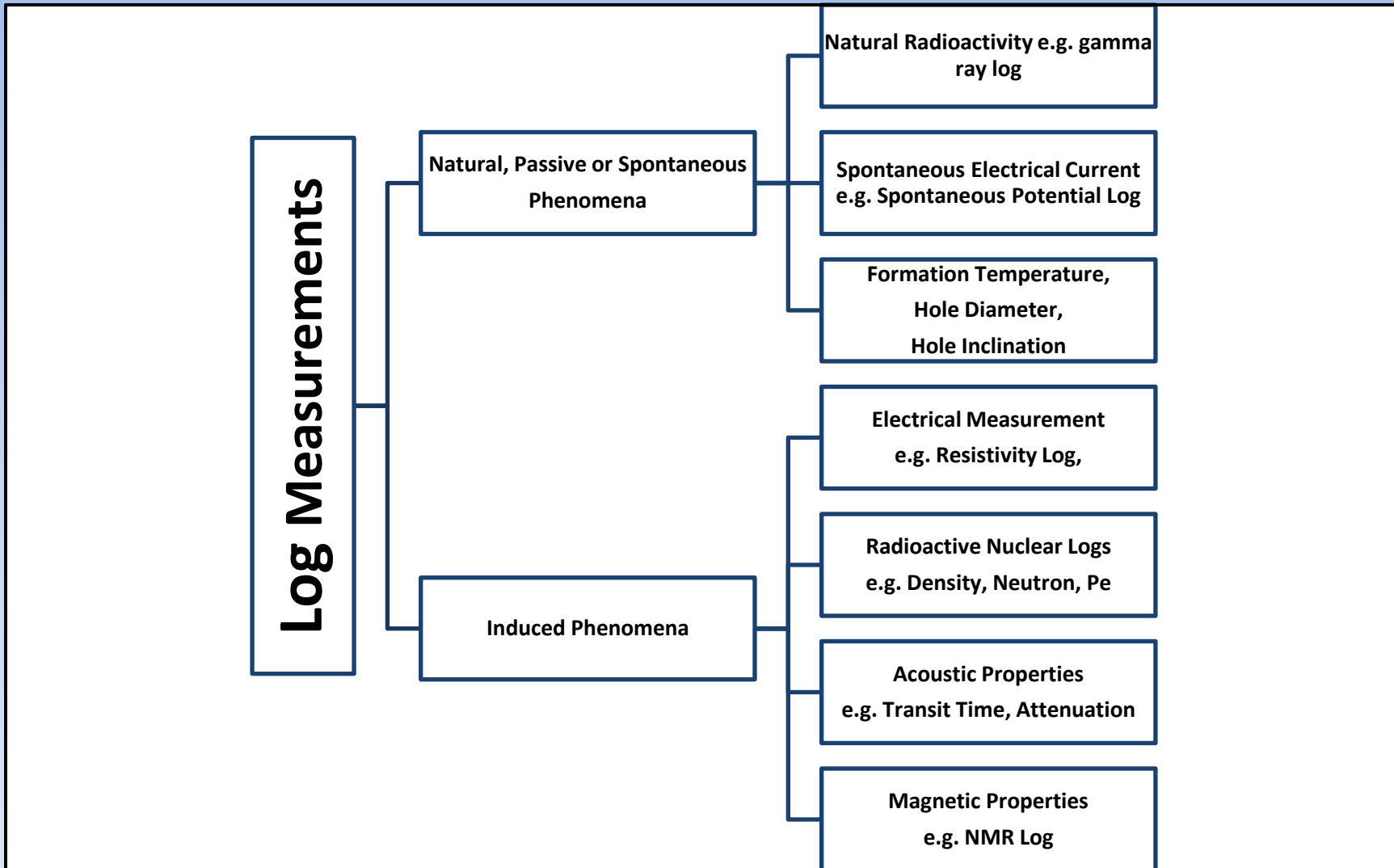
What is Well Logging?



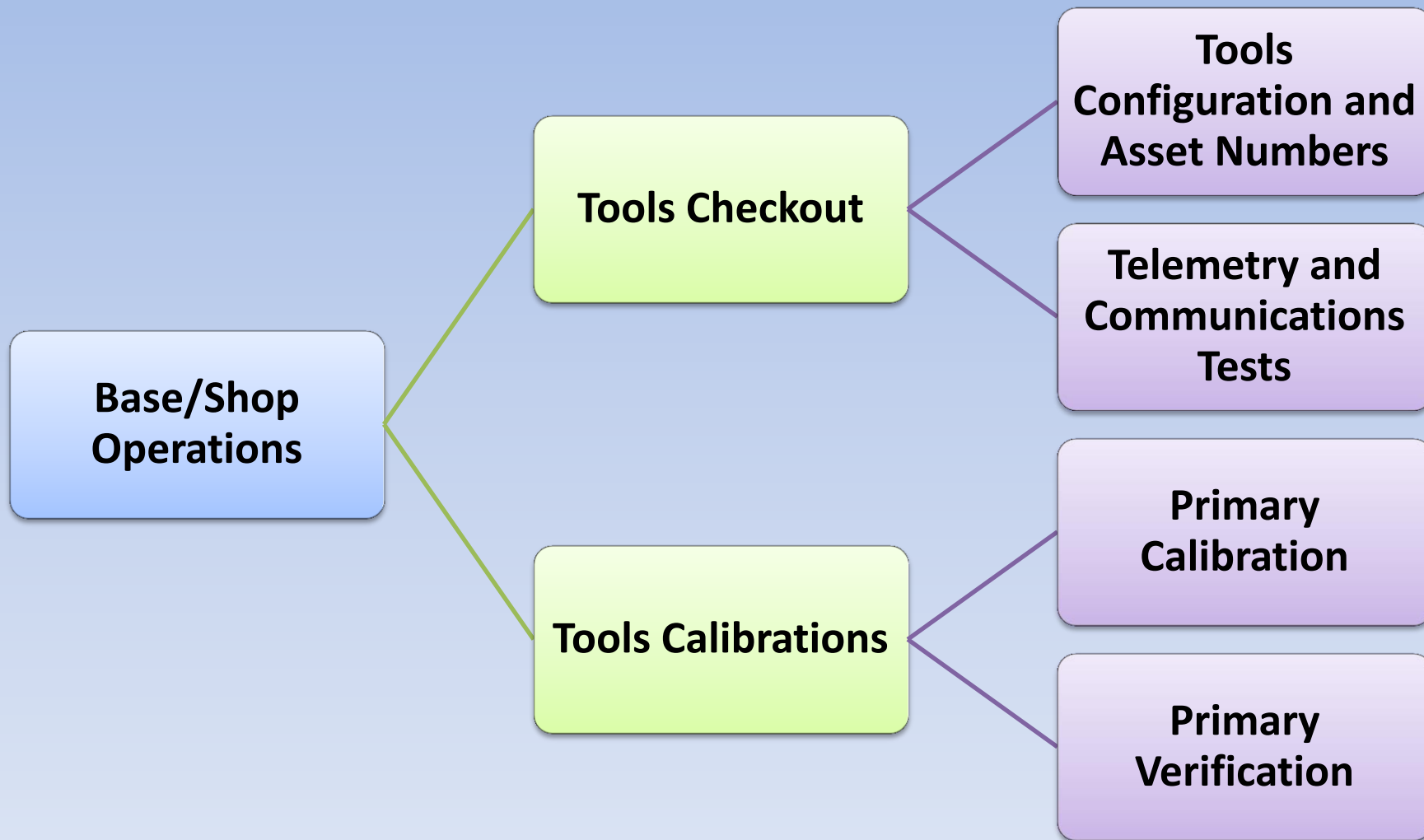
Types of Well Logging Jobs

- **Open Hole Jobs** (Immediately after drilling the interval, before setting the casing)
 - Wireline Logging
 - Logging While Drilling (LWD)
 - Measurement While Drilling (MWD)
- **Cased Hole Jobs** (Any logging after the casing has been set)
 - Cement Evaluation
 - Well Perforation
 - Corrosion Evaluation
 - Production Logs

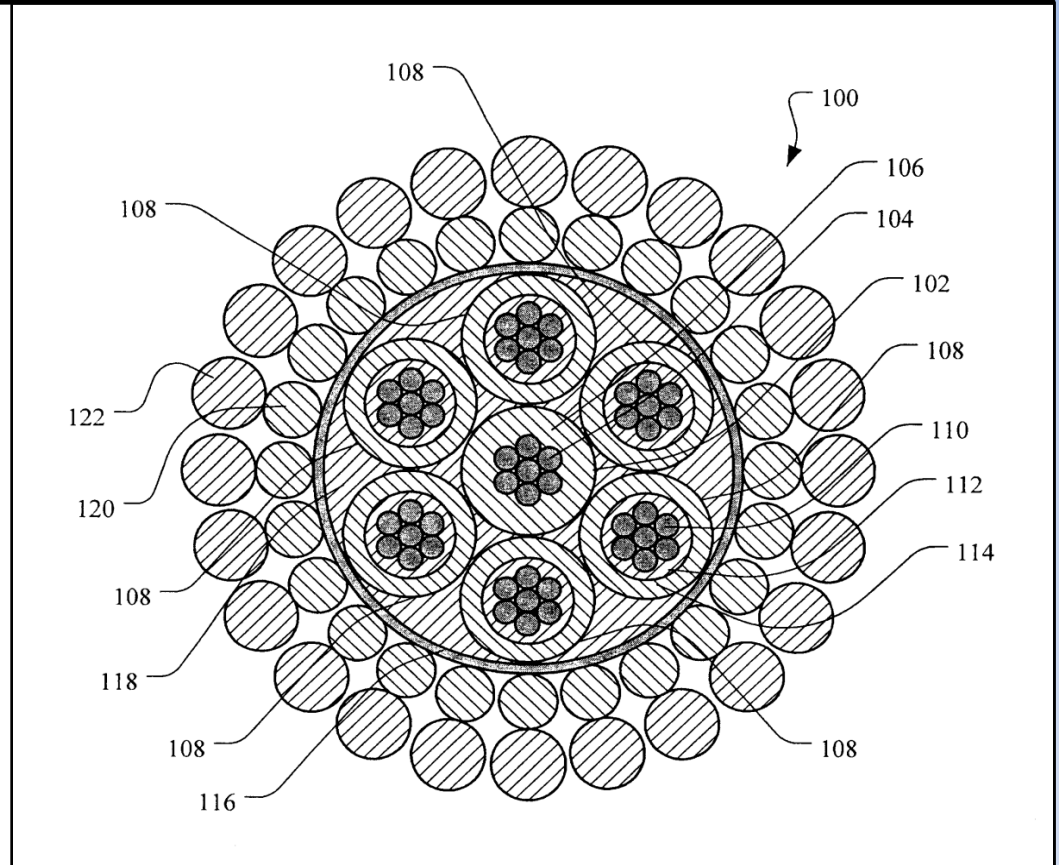
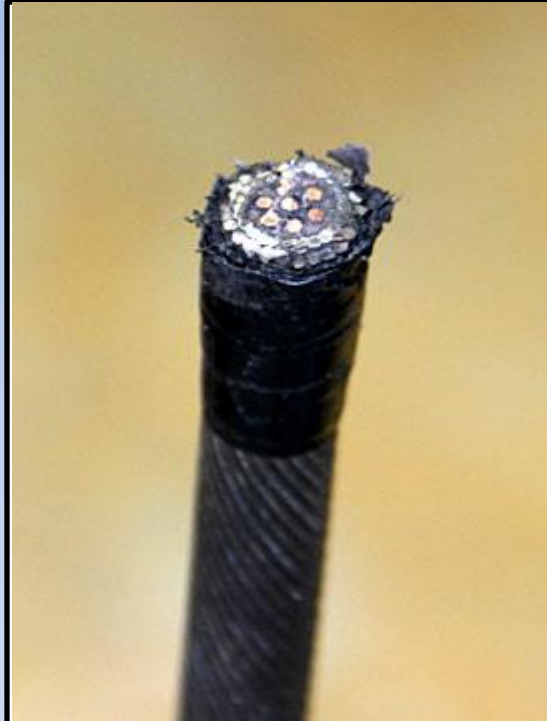
Classification of Log Measurements



Base/Shop Operations



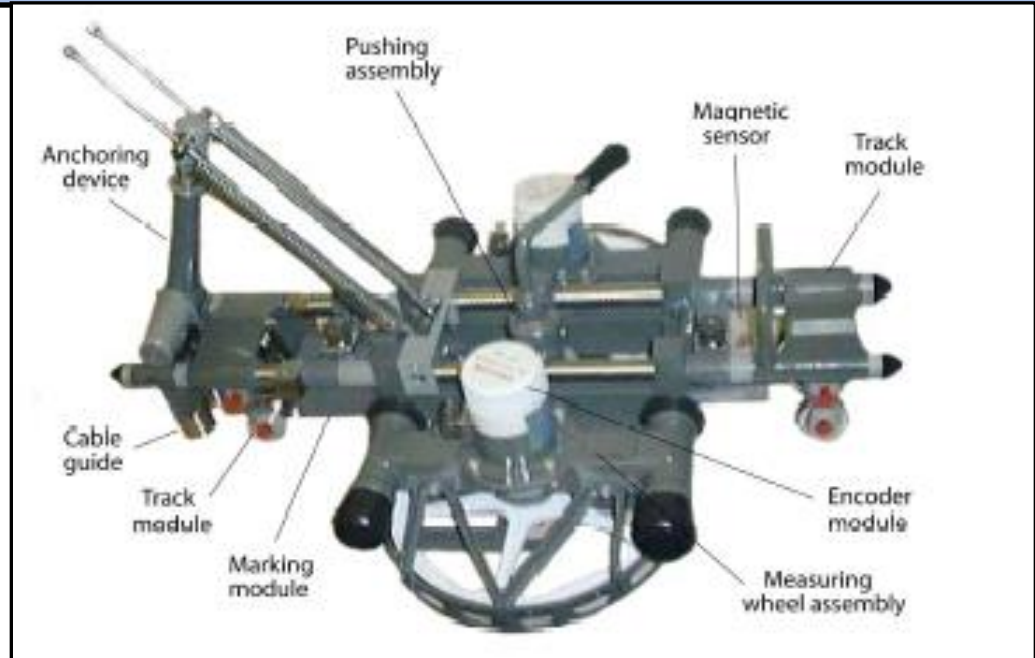
Wireline Cable



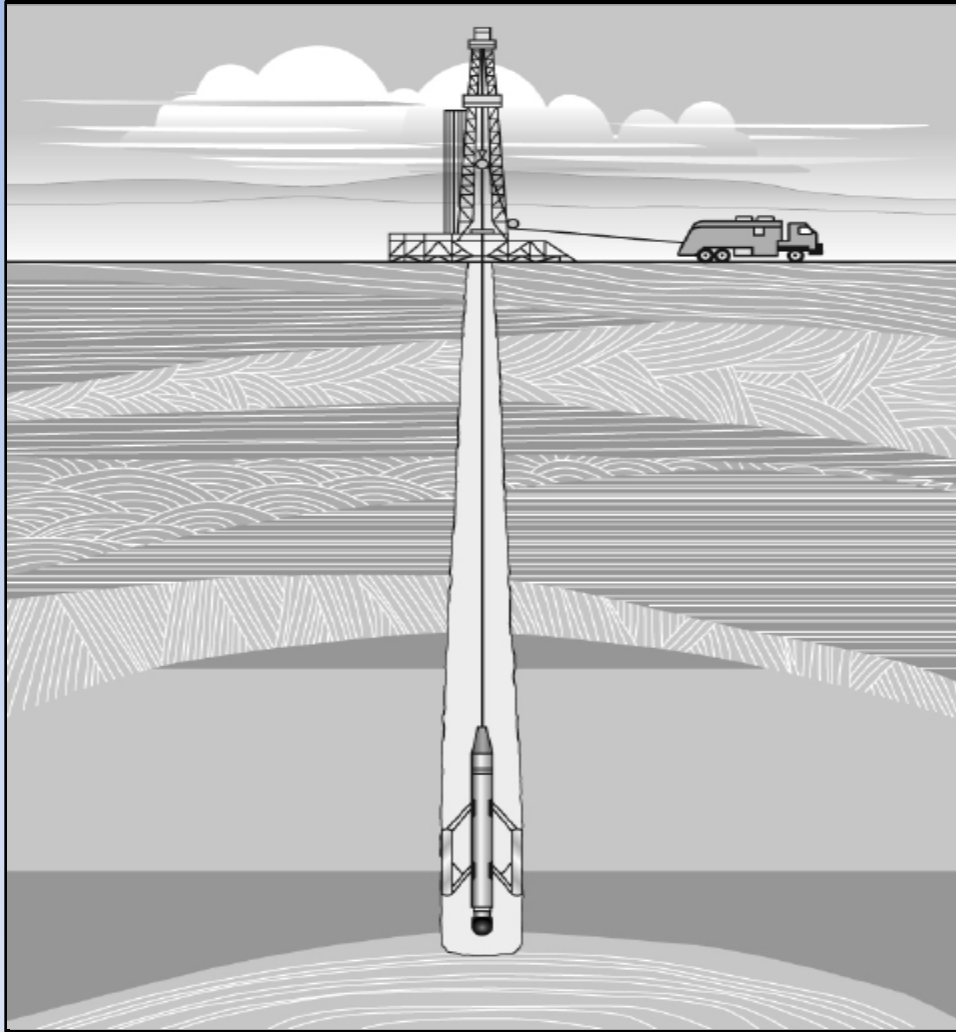
- *Transmits electrical power to tool**
- *Transmits command to tool and data to surface**
- *Steel armor is for tool string support down-hole**

Depth Measurement

- A fundamental data from well logging jobs
- Depth data has to be corrected for stretch in the cable, by the use of magnetic marks
- Depth measured by the use of device, the data acquisition software is triggered by the depth signal, based on the specified sampling per foot.
- Wireline usually gives a more accurate depth data because the data is less affected by human errors

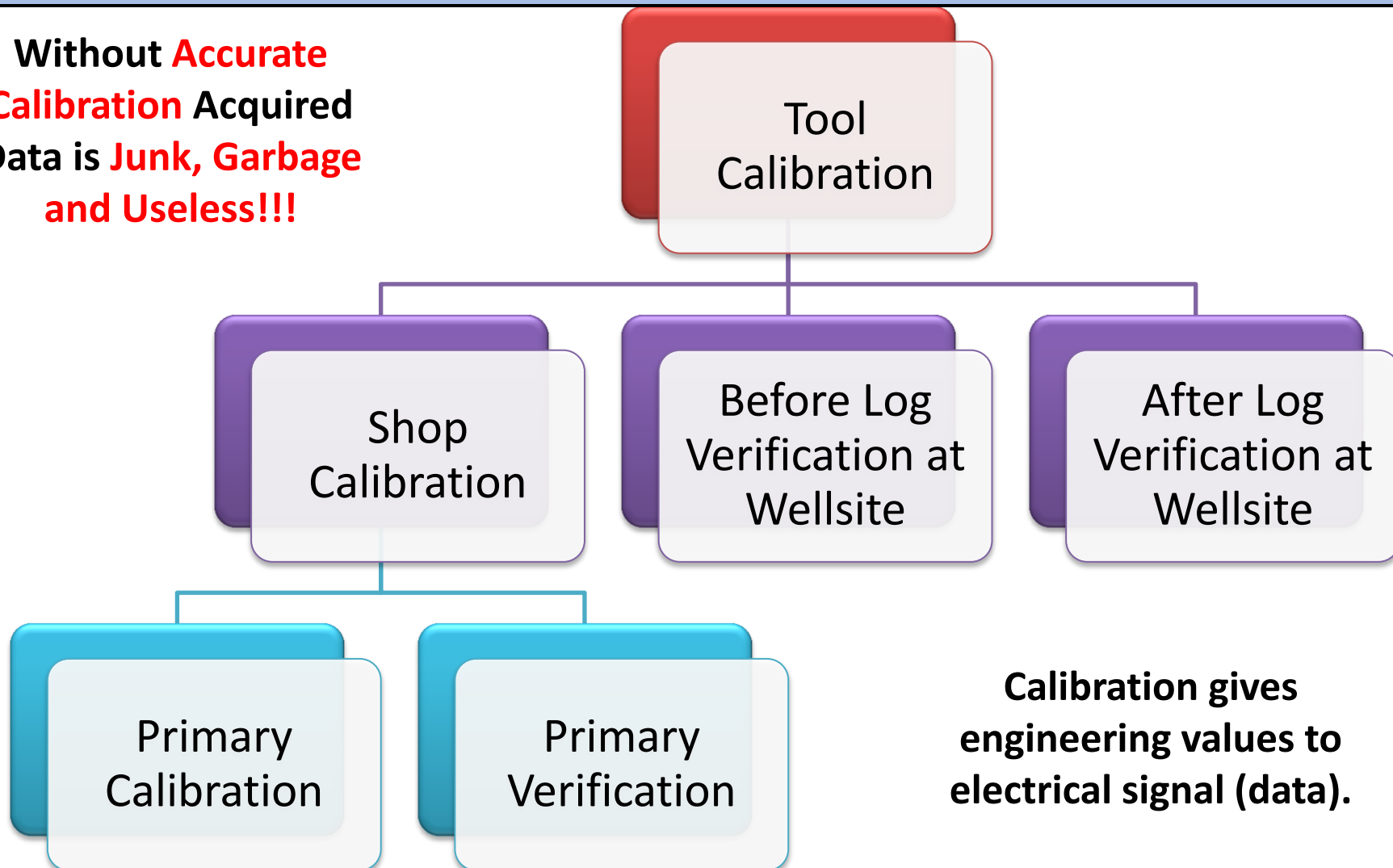


Logging Truck and Tools



Tool Calibration Routine

Without Accurate Calibration Acquired Data is Junk, Garbage and Useless!!!



Caliper Calibration: Class Example

When calibrating the **Caliper tool**, we use **two rings** that covers the hole size (size of drilling bit). Well-bores are not usually bit size due to washouts, mud cake etc, hence we need to log the size of the wellbore.

Tool Calibration

Given: Drilling Bit Size = 8"

In calibrating we use the following circular rings;

Small Ring Size: 6"

Big Ring Size: 12"

When the tool was powered, the arms were opened and the rings were measured, we recorded the following voltages;

Voltage reading on small ring = 8mV

Voltage reading on big ring = 20mV

Therefore, what would be the hole diameter at depths with the following readings;

- 10 mV,
- 12mV,
- 15 mV.

Tool Calibration Contd.

Primary Calibration

- API standard test pits
- Shop Calibration standards

Primary Verification

- Use Field verification Jigs
- Done in Shop after Primary cal.

Before Log Verification

- Done at well site before Logging; uses field jigs

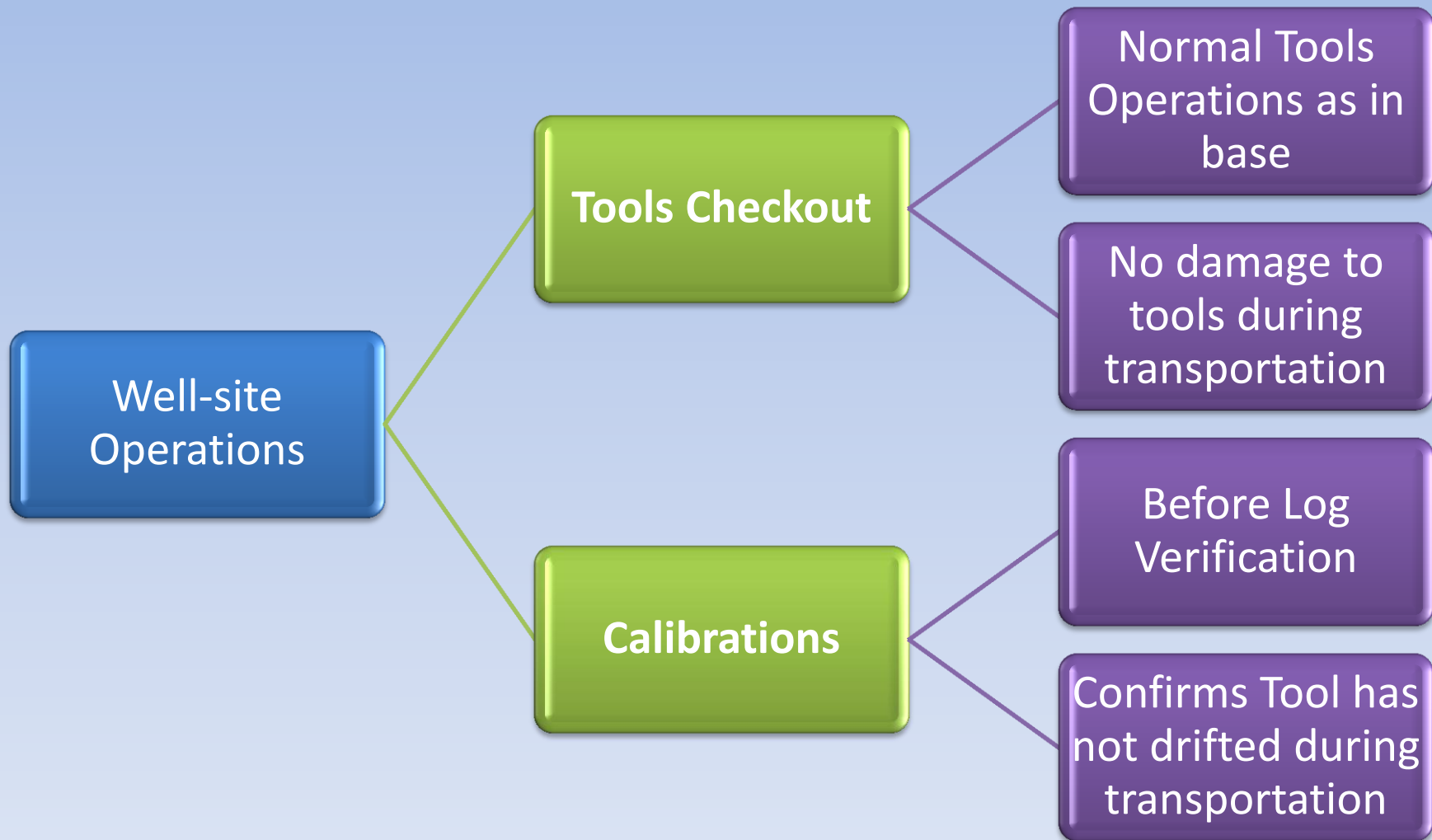
After Log Verification

Done after logging the well

Permits and Paperwork

- Logging operations requiring special permits;
 - **Explosives** use for perforation guns, parker setting tools etc. Explosives must be transported in special containers with the right paperwork for transporting hazardous materials
 - **Radiation tools**- Radioactive sources must be transported in lead shielded containers to prevent undue exposure to the populace. Asset number and type of sources must be included in the document during transportation.

Well-site Operations Before Data Acquisition



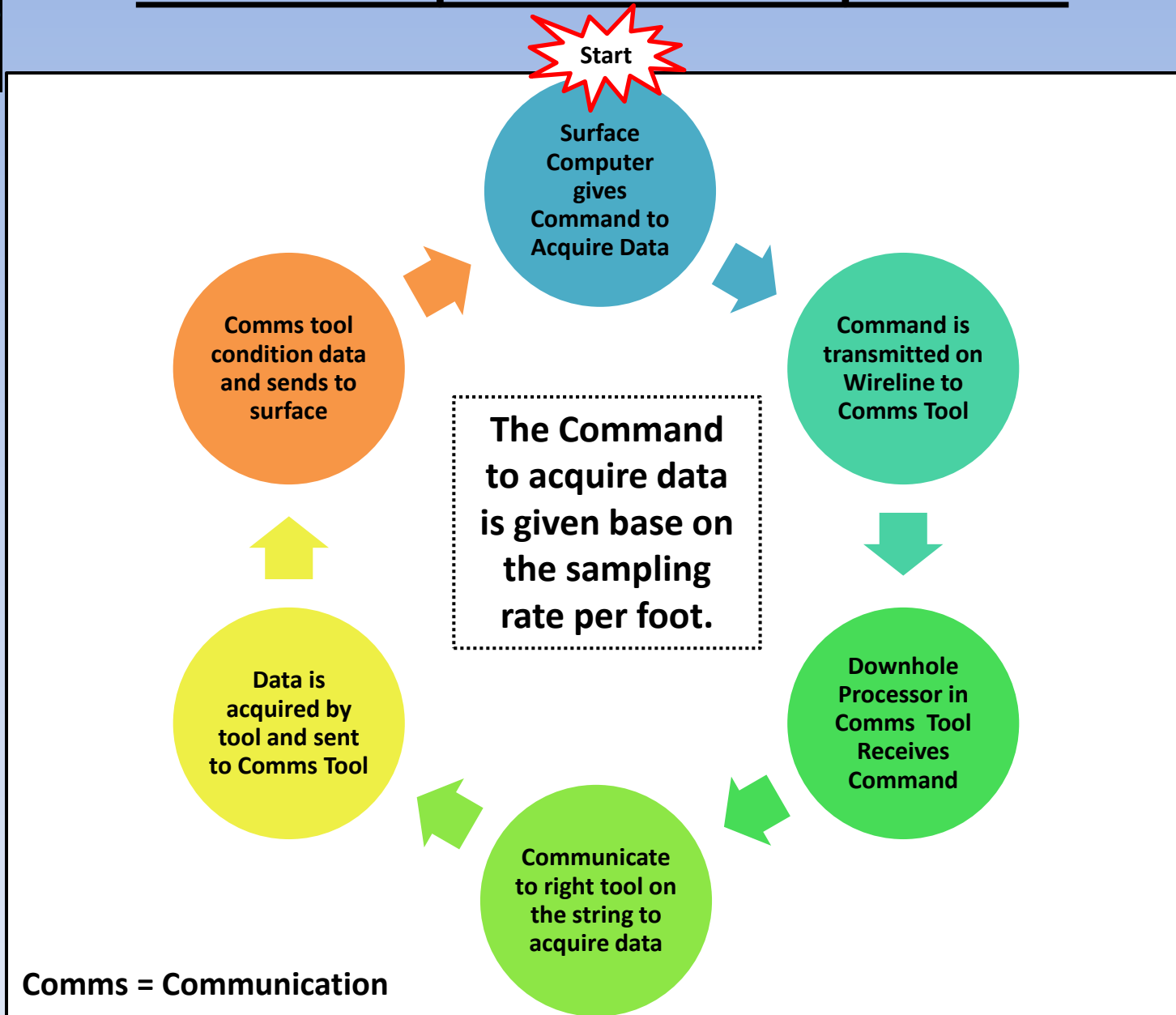
Logging Truck at a Wellsite



Data Acquisition (Logging)

- **Typical Sequence of a Logging Run**
 - Safety Meeting and Work Permits
 - Rig up Logging tools
 - Surface Checks
 - Load Radioactive Sources (If Using any)
 - RIH (Run-In-Hole)
 - Casing Checks e.g. Caliper tool
 - Log Repeat Section
 - Log Main Section
 - POOH (Pull-Out-Of-Hole)
 - Unload Radioactive Sources
 - ***After Log Verification***
 - Rig down logging tools

Data Acquisition Sequence

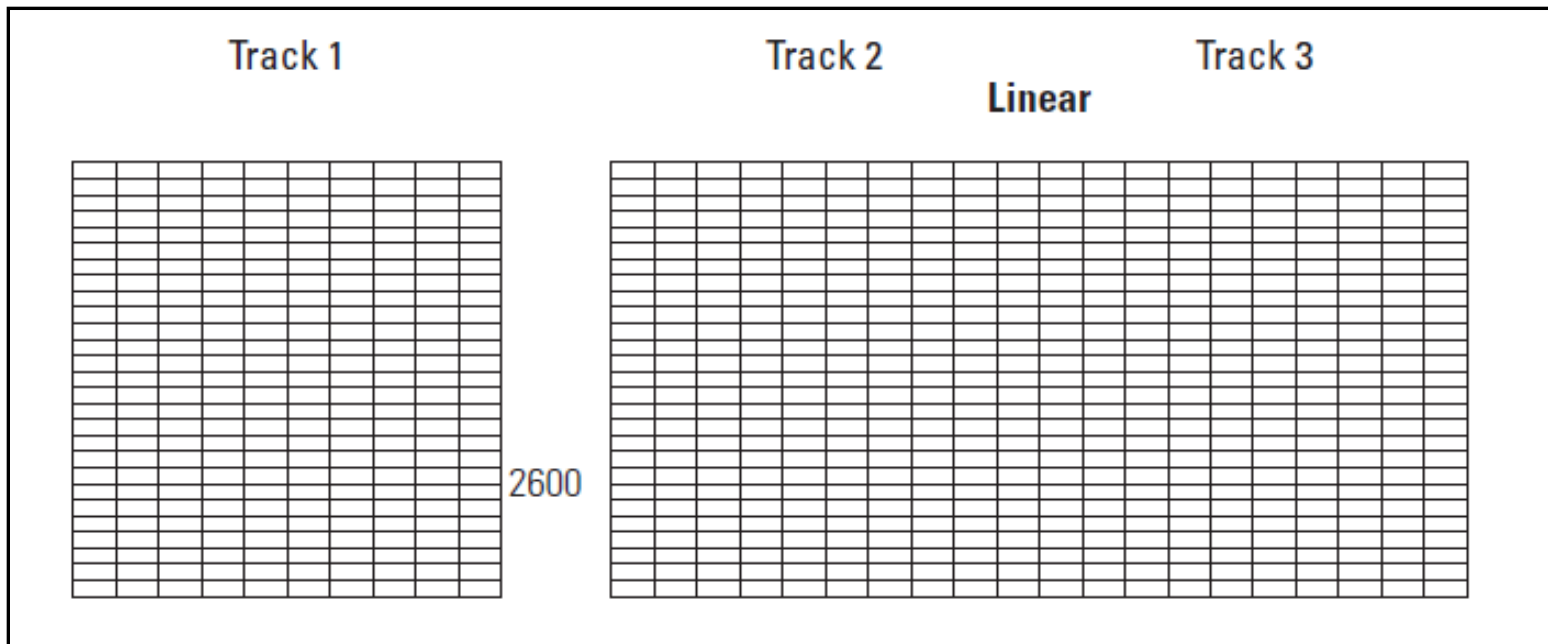


Real Time QAQC

- Some Quality Control Parameters and Indicators
 - Downhole before log verifications must be done
 - Log response in marker beds (known regional beds)
 - Borehole size anomalies
 - Accurate Depth control
 - Tool real time indicators should be checked
 - Sonic log should read the transit time for steel in casing (57us/ft)
 - Repeat section should tie-in with the main pass
 - Log header should reflect all pertinent logging information, tool configuration, problems etc.
 - Logging speed should be adhered to
 - After Log verifications should be done at the wellsite
 - Logs should be displayed on right scales

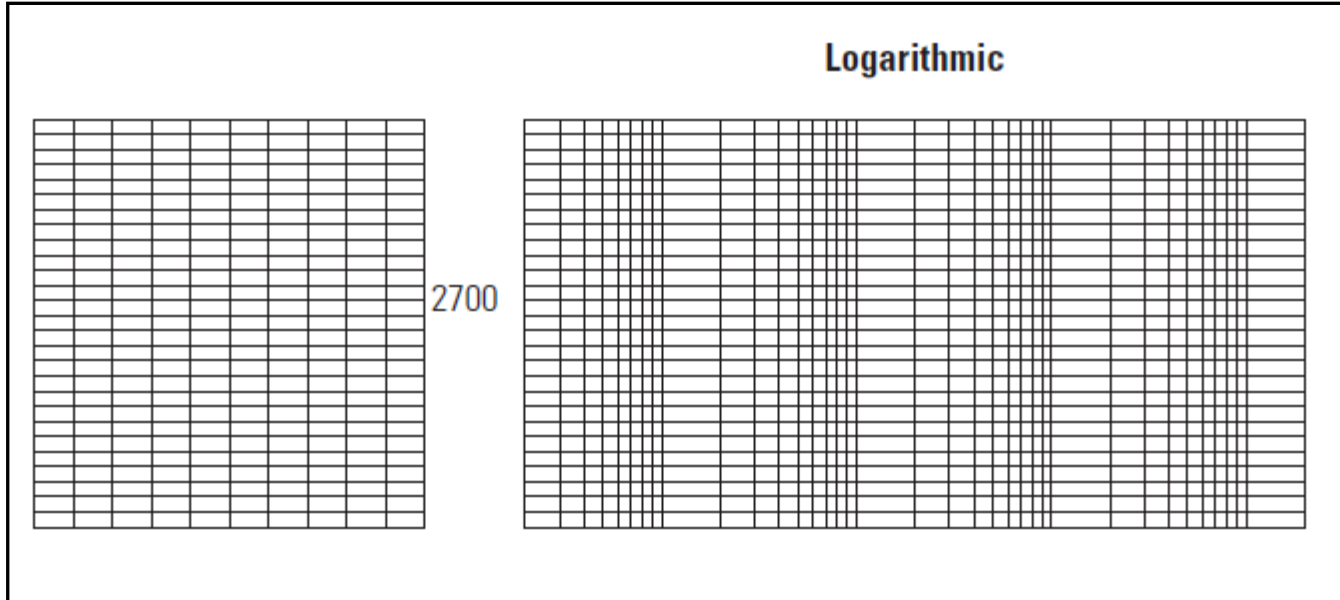
API Log Presentation Standards

LINEAR SCALE

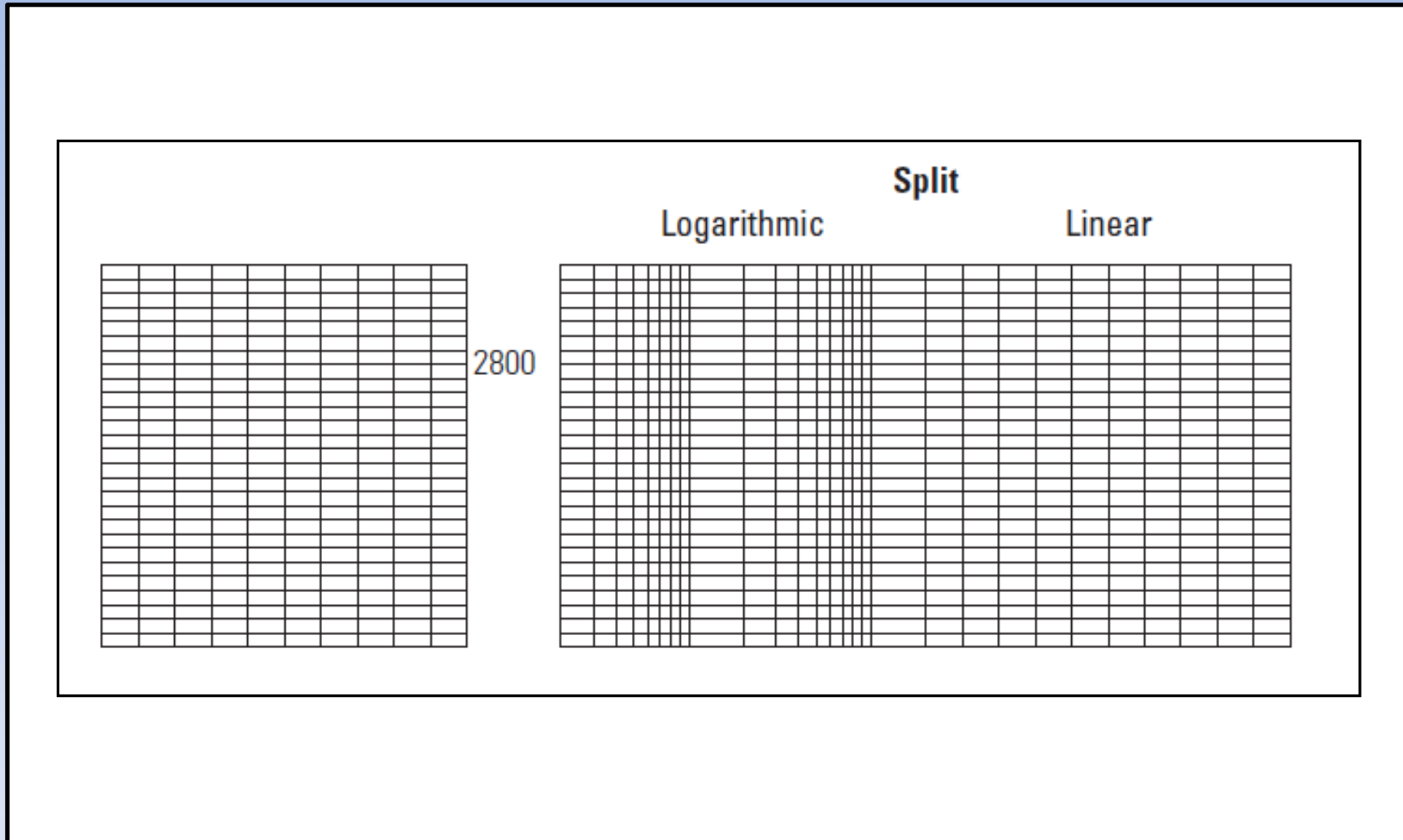


API Log Presentation Standards

Logarithmic Scale



Split-Logarithm and Linear





Example Paper Log



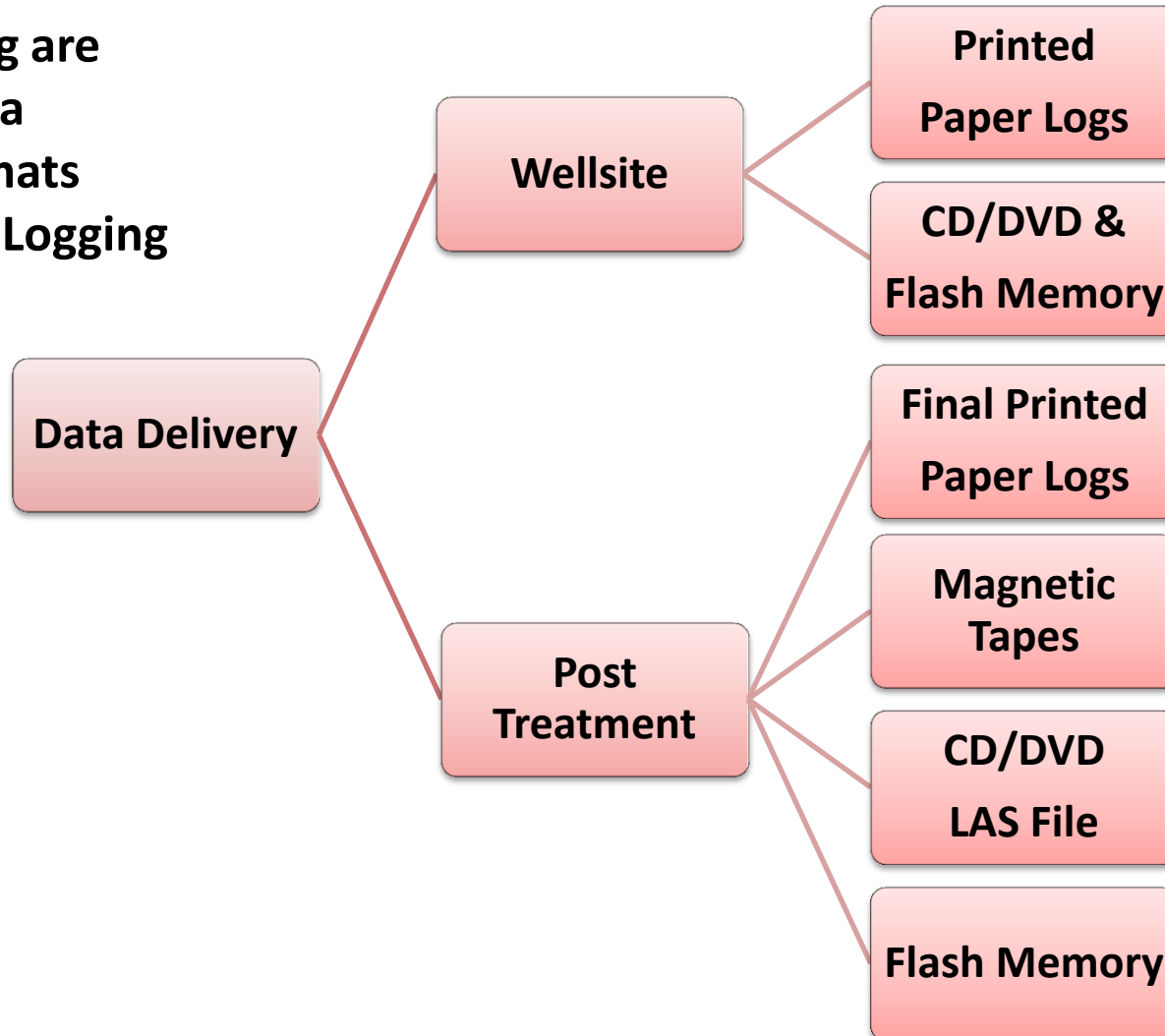
- Show Example Log
- Header
- Tool Configuration
- Scales
- Data
- Calibration
- **Example LAS File**

Factors Affecting Well Logs

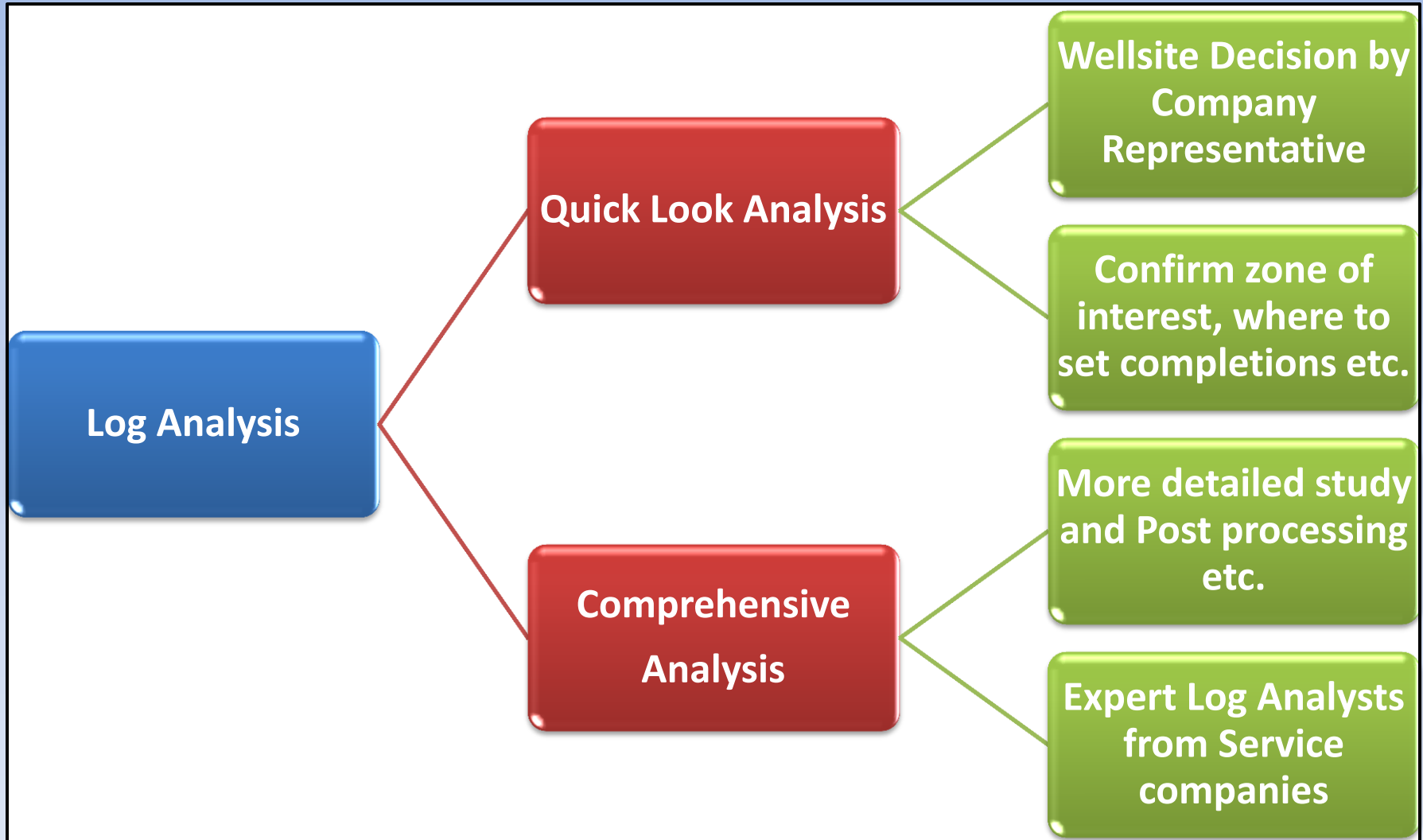
- Tool geometry
 - Tool diameter
 - Tool position while logging (Centered, eccentric)
- Depth of investigation
- Vertical Resolution
- Logging Speed
- Hole Condition

Data Delivery Formats

The following are standard data delivery formats used in Well Logging



Data Processing and Analysis



Data Storage and Archive

- Acquired log data is usually achieved and stored in special form by the operating company in form of paper logs, magnetic tapes, on computer hard drives etc..
- In some countries, the log data become available to the public after a period of time. E.g. In the US its 20 years.



Example Uses of Well Logs to Various Disciplines



Discipline	What they can get from Well Logging
Geophysicist	Are the tops where was predicted Are the potential zones porous as predicted from seismic data?
Geologist	Is the environment suitable for hydrocarbon accumulation? What are the reserves? Could the formation be commercial in offset wells?
Reservoir Engineer	How thick is the pay zone? How homogenous is the section? What is the volume of hydrocarbon? Will the well pay out and how long?
Drilling Engineer	What is the volume of cement? Where can you get a good packer seat for testing? Where is the best place to set a whipstock?
Production Engineer	Where should the well be completed? What kind of production rate can be expected ? Will there be any water production? How should the well be completed? Is the potential zone hydraulically isolated?



References

- Baker Atlas, Montrose Training Center Manual, 2001.
- Darwin V. Ellis and Julian M. Singer, “Well Logging for Earth Scientists”, Second Edition, Springer, Netherlands, 2008
- Serra O. “Fundamentals of well Log Interpretation I, The Acquisition of Logging Data”, Elsevier, 1978.
- Personal Experience



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