# WELLSITE CORE HANDLING PROCEDURES AND PRESERVATION

What will you learn from this lecture?

1- **Core handling procedures**
2- **Field sampling and analysis**
3- **Rock types and special considerations in sampling**

## 1- Core handling procedures

Wellsite core handling procedures and preservation should follow the best possible practices because the value of all core analysis is limited by this initial operation.

The main objectives of the core handling procedures are:

- Obtain rock material that is representative of the formation.
- Minimize physical alteration of the rock material during core handling and storage.

The major problems confronting those handling and preserving reservoir rocks for core analysis are as follows:

- Selection of a nonreactive preservation material and a method to prevent fluid loss or the adsorption of contaminants.
- Application of appropriate core handling and preservation methods based upon rock type, degree of consolidation, and fluid type.

Some terminologies associated with cores must be understood before taking any core handling procedure:

- **Fresh Core**: Any newly recovered core material preserved as quickly as possible at the wellsite to prevent evaporative losses and exposure to oxygen. The fluid type used for coring should be noted, e.g., fresh state (oil-based drilling fluid), fresh state (water-based drilling fluid).
- **Preserved core:** Similar to fresh core, but some period of storage is implied. Preserved core is protected from alteration by any of a number of techniques.
- **Cleaned core:** Core from which the fluids have been removed by solvents. The cleaning process (sequence of solvents, temperature, etc.) should be specified.
- **Restored-state core:** Core that has been cleaned, then reexposed to reservoir fluids with the intention of reestablishing the reservoir wettability condition.
- **Pressure-retained core:** material that has been kept, so far as possible, at the pressure of the reservoir in order to avoid change in the fluid saturations during the recovery process.

The basic core wellsite procedures are as follows:

### 1- Removal of the Core from a Standard Reusable Steel Inner Barrel

The core should be removed from the inner core barrel in a horizontal position whenever possible. Care should be exercised to minimize the mechanical shock during extraction. The core should be allowed to slide out of the core barrel by slightly elevating the top end of the core barrel. If the core will not slide a rod may be used to push the core from the barrel. It may be necessary to gently tap the core barrel with a hammer to initiate movement of the core. However, do not hammer the core barrel in a manner that imparts severe mechanical shock to the core.

### 2- Labeling and Logging of the Core

The core must be labeled and marked in such a way that the entire cored interval can be reassembled at some future time. The core should be protected from temperature extremes, moisture, and dehydration, i.e., direct sunlight, hot engines, rain, strong wind, and low relative humidity. Core preservation materials and equipment should be close to the core handling area to facilitate a rapid operation. Accurate measurements of recovery must be made and recorded. Any recovery in excess of the core cut should be reported.

The following **guidelines** are appropriate for laying out and marking the core:
**a.** The bottom of the core comes out of the barrel first and the first piece of core should be placed at the bottom of tray, box, or trough, with each succeeding piece being placed closer to the top.
**b.** Caution must be exercised in maintaining the proper sequence and core orientation to ensure that individual core segments are not out of place or turned upside down. Any portion of the core that is badly broken should be put in thick plastic bags and placed in its proper position.
**c.** Fit the core together so that the irregular ends match, then measure total recovery.
**d**. Do not wash the core. If excess drilling fluid is on the core surface, it may be wiped off with a clean drilling fluid saturated cloth and wrung out as often as needed.
**e.** With red and black indelible markers, taped together, stripe the core from top to bottom with parallel lines. The red line should be on the right as the individual performing the marking is facing from the bottom of the core towards the top. Arrows pointing toward the top of the core should be used to avoid confusion.
**f.** With an indelible marker or paint stick, starting from the top, draw a line across the core at each foot and label each line with appropriate depth.
**g.** To obtain reliable core analysis, speed is essential in removing, laying out, labeling, and preserving the core to minimize any alteration due to exposure.
**h.** The core should be preserved and placed in numbered containers for transportation to the laboratory. It is recommended that the entire core interval be preserved at the wellsite, with sampling being reserved for the controlled conditions at the laboratory.

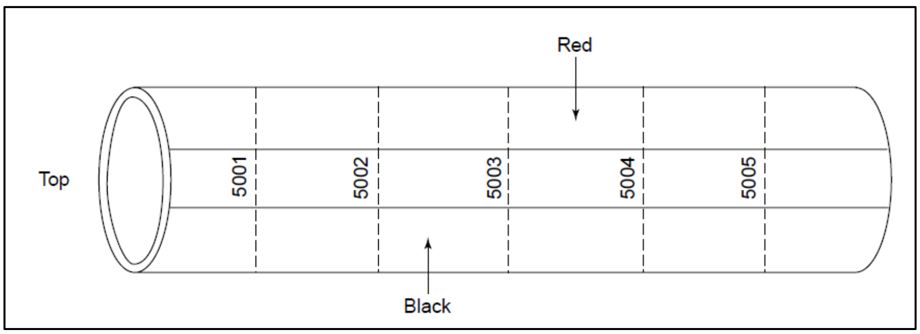


Figure: Core Marking

### 3- Handling Liners and Disposable Inner Barrels

Inner core barrel liners and disposable inner barrels improve the recovery of poorly consolidated or fractured formations. They are made of plastic, fiberglass, or aluminum and are rated to various temperatures. When coring unconsolidated or poorly consolidated formations, select the liner or disposable barrel to withstand the circulating temperature. Hard beds such as shale are best cored using either fiberglass or aluminum to prevent jamming and consequently poor core recovery. Certain coring fluid additives such as caustic react with aluminum barrels causing release of aluminum ions, that may react with the core to alter its surface properties. When coring a poorly consolidated formation, to avoid rock compaction it is advisable to cut short lengths, 30 feet or less depending upon the rock strength. In long lengths, the lower section of core may be over compacted and damaged by the weight of the overlying material. Damaged core is of limited use for core analysis. When coring fractured formations, short core lengths may also be beneficial to decrease the risk of jamming. The core barrel should be brought to the surface smoothly. During the last five hundred feet the core should be surfaced slowly to minimize gas expansion that can severely damage unconsolidated core if the pressure is reduced too quickly. Where gas expansion damage is expected, a perforated liner or a perforated disposable inner barrel can be used to provide a means for gas escape. All perforations must be sealed if the liner or disposable inner barrel is used as a core preservation container. Alternatively, the entire perforated section can be placed in plastic bags to prevent fluid loss.

### 4- Pressure-Retained Core

Pressure retaining core barrels are designed to obtain the best possible in situ fluid saturation. This method of coring offers an alternative to the conventional core barrel that loses pressure upon its retrieval to the surface. To enable the fluid saturations to be measured in the laboratory, the core must go through extensive handling. The core barrel assembly is placed in a special core service unit and the drilling fluid is flushed from the annulus between the inner and outer barrel using a nonreactive fluid while maintaining proper back pressure on the entire system. The entire core barrel assembly is then placed in a freezer box filled with dry ice.

## 2- FIELD SAMPLING AND ANALYSIS

The reasons of filed sampling include, but are not limited to, a) chip sampling for lithologic description and/or mineralogical determination, b) measurement of basic rock properties, c) fluid compatibility-completion testing, d) wettability studies, e) observation of oil fluorescence/cut, f) anelastic strain recovery measurements, and g) methane desorption studies for the analysis of coal.

### ➢ Transportation and Logistics

The transport method should be expedient and provide protection against damage from environmental changes, mechanical vibration, and mishandling. Other important factors to consider when choosing the mode of transport include,

a) distance and remoteness from the wellsite to the laboratory,
b) onshore or offshore conditions and terrain,
c) core material competence,
d) weather conditions,
e) type of preservation or packaging, and
f) cost.

In all methods of transportation, a transmittal letter or contents documentation form with pertinent shipping information should accompany the shipment. A separate copy of this letter should be sent to the recipient via surface mail or fax. All applicable U. S. Department of Transportation regulations should be followed in the shipment of core materials. When standard core boxes are used, they can be palletized, banded, and shipped as is. Cores, particularly those of unconsolidated materials, may be frozen or refrigerated at the wellsite for preservation and stabilization during transportation and storage. If freezing is used, the core must be entirely frozen before shipment to avoid mechanical damage. Frozen core is usually crated in insulated containers and packed with dry ice. Refrigerated core is usually shipped in self-contained refrigerator units. A temperature monitoring and recording device should accompany the core to ensure the desired conditions are maintained during transportation.

### ➢ Data Sheet

A suitable data sheet should be provided for and completed by the wellsite engineer or geologist, to supply as complete a record as possible of the conditions of coring. This information will be valuable in qualifying the interpretation of the core analysis data. Further, this record may suggest either that certain additional tests be run to supplement the basic tests, or that other tests would not yield significant data. This will result in the most useful analysis for the least time and cost. Below **figures** are example forms, and the use of these or similar forms is recommended.
It is important to have as much pertinent data as possible accompany the core material. The following is a list of desirable information:

**a.** Well identification, API well number, elevation, vendor names and contacts, as well as telephone/telefax numbers and addresses.
**b.** Drilling fluid type, contents, and measured data.
**c.** Core type and equipment used.
**d.** The formation(s) cored, with the top and bottom driller's depth.
**e.** Designation of critical coring information and any pertinent coring notes, i.e., total coring/trip time, difficulties, and recovery.
**f.** Formation water salinity and production fluid data.
**g.** Preservation guidelines. Exposure time.
**h.** Analysis requested.
**i.** Coring log and drilling records.
**j.** A core description.

**k.** Well logs and mud logs (if available).

*Prepared By:* ____________ *Date:* M M D D Y Y Core Number ____________

Operator ____________
Well Identification ____________
API Number ____________
County/State/Country ____________
Persons Requesting Work ____________
Report Results To ____________
Alternate ____________
Rig Contract ____________

Coring Company ____________
Contact/Phone ____________
Field/Reservoir ____________
❑ Vertical Well ❑ DeviatedWell ❑ Sidetrack
Legal Location/Block ____________
Phone ____________ Fax ____________
Phone ____________ Fax ____________
Phone ____________ Fax ____________
Phone ____________ Fax ____________

Core Analysis Company ____________
Contact/Phone ____________
Address ____________
____________
Elevations: ______ Ground/Mean Sea Level ______ Kelly Bushing ____
Address ____________
Address ____________
Address ____________
Address ____________

Coring/Drilling Fluid
Type/Contents ____________ Weight ______ ppg Funnel Viscosity ______ sec Water Loss _______ $cm^3$/30 min Chlorides _______ ppm pH _______ Tracer ____________

Type of Core
❑ Conventional ____________
❑ Sponge
❑ Pressure Retained
Inner Barrel Type ____________
❑ Oriented Barrel
❑ Other ____________
Sidewall: ❑ *Percussion or* ❑ *Mechanically Drilled Number Attempted* _____ *Number Recovered* _____

Analysis Planned
❑ Plug Size or ❑ Full Diameter
*Method*
❑ Fluid Saturation ____________
❑ Porosity ____________
❑ Grain Density ____________
❑ Permeability ____________
❑ Surface Gamma Log ____________
❑ Special Instructions ____________

*Transportation*
❑ By Service Company ____________
❑ Ground ____________
❑ Air ____________
❑ Other ____________
Carrier ____________
Date shipped ____________

Preservation
Method ❑ Plastic Laminate/Type ____________
❑ Freeze ❑ Dry Ice or ❑ Liquid Nitrogen
❑ Refrigerate _____ °F _____ °C
❑ Core Inner Barrel
❑ Core Wrap and/or ❑ Dip-Type ❑ Resination
❑ Other
Exposure Time/Climate ____________
Notes ____________
Laboratory/Long Term Preservation ____________
Special Instructions ____________
Post Core Analysis Instructions/Core Material Distribution ____________

Formation(s)
____________ Expected Core Point ____________
____________ Expected Core Point ____________
____________ Expected Core Point ____________

Depths (Drillers)
Interval Cut ____________
Interval Recovered ____________
Interval Cut ____________
Interval Recovered ____________
Interval Cut ____________
Interval Recovered ____________

Well Inclination ____________ Core Diameter ____________ Units ________
Total Core Recovered ____________ Bit Type ____________
Length Cored ____________ Units ______ Percent Recovery ____________
Coring Time ____________ Trip Time ____________
Estimated Connate Water Salinity _____ ppm Chlorides or Estimated $R_W$ ______ @ ______ ❑ °F ❑ °C
Estimated Production ❑ Oil
❑ Condensate
❑ Dry Gas

Notes ____________

Attach Coring log And Core Description

General Information
Analysis Requested Date [M] [M] [D] [D] [Y] [Y] API # ________ File # ________
Requested By: ________
☐ Full Diameter or ☐ Plug : Size ________ Units ________

*Method* *Special Instructions*
☐ Saturation ________
☐ Porosity ________
☐ Permeability ________
☐ Other ________

Objective of the tests as agreed by parties involved ________

Transportation and Inventory
Carrier ________ Date Shipped ________ Core Arrival Date ________
Core condition on arrival:
☐ Preserved ☐ Frozen ☐ Unpreserved ☐ Cleaned ☐ Other ________
Correlation Depths: Driller's ________ Log ________ TVD ________ Units ________
Allocation of the missing cored interval: ☐ Bottom ☐ Middle ☐ Top ________
Screening
☐ CT ☐ X-ray ☐ NMR ☐ Fluroscopy ☐ Other ________
Sample Handling
Core Gramma (yes/no, type) ________
Lab Preservation (prior to analyses) ________
Sampling Method
Sample Sleeve ☐ Yes ☐ No, Type ________
Nominal Sample Diameter/Length________ Units ________
Plugging/Trimming Fluid________
Treatment prior to testing (flushing, evaluation, resaluration, etc.) ________
Core Disposition (removed samples, storage location, preservation, etc.)________
Lab Analyst ________
Other Service
☐ Slab ☐ Resination ☐ Photo: ☐ BW ☐ Color ☐ U.V. ☐ Other ________
Supplementary Tests ________

Methods and Conditions
Cleaning: Methods / Conditions
☐ No Cleaning — Solvents ________
☐ Dean-Stark — Temperature ________ Units ________
☐ Soxhlet — Pressure ________ Units ________
☐ CO2/Solvent — Time ________
☐ Flow Through — Volume and Rate________ Units ________
☐ Others — Others ________
Drying: Methods / Conditions
☐ Convection oven — Temperature ________ Units ________
☐ Vacuum oven — Time ________
☐ Humidity oven — Relative Humidity % ________
☐ Others
Porosity: Methods

| Pore Volume | Grain Volume | Bulk Volume |
|---|---|---|
| ☐ Boyle's Law | ☐ Boyle's Law | ☐ Caliper |
| ☐ Saturation | ☐ Archimedes | ☐ Archimedes |
| ☐ Summation-Of-Fluids | ☐ BV-GV | ☐ Mercury Displacement |
| ☐ BV-GV | ☐ Other | ☐ GV+PV |
| ☐ Other | | ☐ Other |

Conditions/Fluids
Confining Stress (Magnitude and Type)________ Units ________
Gas ________ Liquid________
Pressure ________
Permeability: Methods / Conditions
☐ Steady State — Fluid Type ________
☐ Unsteady State — Confining Stress ________ Units ________
☐ Probe — Sleeve Durometer ________
☐ Empirical — Pore Pressure ________ Units ________
☐ Not Measured — Klinkenberg: ☐ Measured ☐ Empirical ☐ No Correction
☐ Others — Inertial Factor: ☐ Measured ☐ Empirical ☐ No Correction
Saturation: Methods / Conditions
☐ Distillation Extraction (DS) — Temperature ________ Units ________
☐ High Temperature Retort — Fluids ________
☐ Others — Water Density________ Units ________
Oil Density ________ Units ________
Correction for Salt: ☐ Corrected for Water Volume
☐ Corrected for Oil Weight ☐ Not Corrected
Quality Assurance: (Page number in report where the information is provided) ________
Comments/Remarks: ________
Data Anomalies: ________

## 3- ROCK TYPES AND SPECIAL CONSIDERATIONS IN HANDLING

The term "rock type" is used to describe the major distinguishing feature(s) of core material. This can refer to the degree of consolidation, presence of fractures or vugs, composition (shale), or physical properties (e.g., low permeability) of the rock. Geological descriptions of rock are more complex and classification schemes have been devised to categorize specific rock types with respect to texture, type of cementation, grain size, etc. Many special considerations must be taken into account when designing a wellsite core handling program.

- **Consolidated Rock**

Consolidated rocks are hardened as a result of cementation. They need no special treatment at the wellsite

- **Unconsolidated Rock**

Unconsolidated rocks have little or no cement and are essentially compacted sediments. Poorly consolidated rocks have minor cement but not enough to make them hard. These rocks are best cored using an inner core barrel liner or a disposable inner barrel. Care must be taken to prevent the core from disintegrating. This includes making sure the core is brought to the surface, laid down smoothly, and preserved in such a way that it will survive transportation.

- **Unconsolidated Rock—Light Oil and Gas**

It is critical to preserve unconsolidated cores containing light oil in an efficient and expedient manner. Any unnecessary movement of the core should be avoided. The two methods commonly used to preserve this rock type involve environmental methods, such as freezing or chilling and mechanical stabilization with epoxy, foam resin, etc. Unconsolidated core containing light oil is susceptible to significant fluid loss during handling at the surface.

- **Unconsolidated Rock—Heavy Oil**

The greatest difficulty in handling unconsolidated rocks that contain viscous heavy oil is prevention or minimization of delayed core expansion. The expansion is the result of slow gas evolution from the heavy oil, with no possibility of short-term drainage because of the low mobility to gas. Swelling of the rock may easily continue until the gas phase becomes continuous, and this may require volumetric expansion in excess of 6 percent to 8 percent.

- **Vuggy Carbonates**

Large vugs can weaken the core material and cause difficulties with recovery. In many cases, core recovery is reduced in friable vuggy intervals. Standard consolidated core preservation methods should be used on this rock type.

- **Evaporites**

Salt rocks are generally quite competent, and, except for their solubility, may be considered as consolidated rocks. Core containing salts in continuous sequences or as vug and fracture fillings should not be washed with fresh water under any circumstances. Because the physical properties of salt rocks can be altered by small changes in moisture content, cores containing salts must be immediately wiped to a surface dry state and preserved. Transportation and storage of cores containing salts must always be undertaken keeping the soluble nature of the material in mind.

- **Fractured Rock**

Many reservoir rocks are naturally fractured. Disposable inner barrels or liners made of aluminum or fiberglass are recommended for coring fractured rock.

- **Rocks Rich in Clay Minerals**

Clay minerals may be present in small quantities in rocks, yet have a major impact on rock properties. Some of the major concerns in rocks containing clay minerals include:

**a.** The presence of smectite (a swelling clay mineral), even in very small quantities (1 percent), is of importance in core handling because of swelling potential, high cation exchange capacity, and osmotic suction potential.

**b.** Interstitial clay minerals can be physically mobilized by changes in fluid content, chemistry, or mechanical disturbance, leading to pore throat blocking or changes in surface wetness characteristics of pores or other physical changes.

**c.** Clay minerals in contact with their natural pore fluids are in thermodynamic equilibrium, and exposure to other fluids will alter this leading to changes in clay mineral activity, exchangeable cations, and consequent changes in mechanical and flow behavior.

**d.** Smectitic shales and sandstones may swell when confining stress is removed if free water is available, even if the free water has properties identical to the interstitial fluids.

- **Shale**

there are special issues relating to handling highly fissile shale. These materials have fissility planes of low strength that may split spontaneously, even if core is handled with great care. Once a fissile shale core has split, it may be impossible to obtain specimens large enough for core analysis.

End of lecture