Planning a Coring Program

What are the big considerations?

- Complexities of planning a coring program
- Decisions to be made
- Factors influence the choices
- Tools to be chosen for specific coring tasks

What will you learn from this lecture?

1- Planning a Coring Program Objectives and Benefits
2- Core Analysis Focal Point
3- Design and Management

1- Planning a Coring Program Objectives and Benefits

General

A coring program is similar to many engineering projects. It begins with the premise that an investment will reap a reward. It progresses through a phase of exploring alternate sources of information; well tests, logs, previous cores, and cuttings or sidewall cores. Planning begins by listing the objectives of the coring program. This is best done by a team of petrophysical, reservoir, geological, drilling, and production personnel. When discussing objectives, every expenditure must ultimately lead to producing more oil or gas at a lower unit cost. Constraints in budget, location, and timing will be placed on the program. Hole size, hole angle, temperature, pressure, and rock type will influence the selection of the coring tools. Planning becomes an interactive process where consensus is built and a detailed program formulated.

Objectives

- **Geological Objectives**
  1. Lithologic information:
  (a) Rock type.
  (b) Depositional environment.
  (c) Pore type.
  (d) Mineralogy/geochemistry.
  2. Geologic maps.

3. Fracture orientation

- **Petrophysical and reservoir engineering**:

1. Permeability information:

(a) Permeability/porosity correlation.

(b) Relative permeability.

2. Capillary pressure data.

3. Data for refining log calculations:

(a) Electrical properties.

(b) Grain density.

(c) Core gamma log.

(d) Mineralogy and cation exchange capacity.

4. Enhanced oil recovery studies.

5. Reserves estimate:

(a) Porosity.

(b) Fluid saturations.

- **Drilling and completions**:

1. Fluid/formation compatibility studies.

2. Grain size data for gravel pack design.

3. Rock mechanics data.

A point to be discussed "Coring Fluids"?

<u>Planning Steps for a Coring Program</u>

- **A. Defining Objectives and Scope**
    - Establish the specific data needed from the coring program. Objectives could range from identifying reservoir quality to supporting geomechanical studies for wellbore stability.
- **B. Selecting the Coring Depths**
    - Decide on depth intervals based on seismic data, well logs, and drilling objectives. Choose depths with high reservoir potential to maximize information gathered.
- **C. Budget and Logistics**

- Coring can be costly and time-consuming, so budgeting must consider rig time, coring equipment, transport, and core analysis costs.

- **D. Choosing the Coring Equipment and Techniques**
  - Select between **conventional** or **sidewall coring**, depending on the project's requirements and limitations. Equipment considerations include core barrels, core bits, and surface handling systems.

- **E. Managing Risks and Challenges**
  - Anticipate common issues such as core recovery losses, wellbore stability, and time constraints. Implement strategies to minimize risks, like pre-conditioning the drilling fluid or utilizing specialized core barrels.

<u>Planning benefits</u>

- Quality improvement through planning and selection of the appropriate measurement suite;
- Consensus-driven identification of core analysis needs obviates the need for later (and more expensive testing);
- Defining time constraints so that the data can best impact on field development;
- Roles and responsibilities of team members are clearly defined;
- Improved sample selection and identification;
- Greater confidence in, and better utilisation of, core data;
- Improved project management;
- Easier and more efficient presentation of core analysis plans and results to partners.

2- CORE ANALYSIS FOCAL POINT

It has been customary in some companies that the geologist or the petrophysicists is responsible for arranging the coring and core analysis programme. In some companies, reservoir engineers or completion/drilling engineers are responsible for controlling their own core testing (e.g. capillary pressure and relative permeability testing; rock mechanics tests). Recurring themes in many core laboratory audits are that the vendors feel that they are too often faced with conflicting and contradictory instructions from within the operator's different discipline functions. A single, knowledgeable, core analysis focal point, who understands the applications and limitations of core analysis tests, should be appointed. This should ensure that the data quality requirements are maintained and, more importantly, that the data are fit for purpose.

The client focal point is the liaison between the client's different subsurface disciplines and the lab and is accountable for laboratory supervision and real-time quality control. The laboratory should also appoint a project manager with the key responsibilities of client expectation management; organising and controlling the work; and documentation of the project requirements, test specifications, lab worksheets and analysed data. Peer review of both intermediate and final data is essential before delivery to the client.

3- DESIGN AND MANAGEMENT

The key steps in designing and then managing a core analysis programme are:

- Appoint the company focal point for the programme.
- Review the existing or legacy core analysis database. Are the data valid? Are there areas of concern or anomalies or suspicious core data in the database that need to be resolved? How well does the core, log and test data agree for the well in question and reservoir in general?
- Design and cost the programme with the assistance of the laboratory.
- Prepare a justification to management.
- Meet with drilling and wellsite engineers to review and specify core drilling, core recovery and wellsite handling, storage and transportation procedures.
- Design and specify the test and reporting procedures to be adopted in the scope of work. Detail any modifications that may be required to the test programme (for example, to resolve any anomalous or inconsistent results, as the data become available). Specify deliverables, milestones and project reporting requirements.
- Select laboratory contractor. Do not base the selection solely on price unless there is an overriding justification for this. The focal point should audit the tendering laboratories and assess their capabilities to perform the work to the required standard.
- Review project at regular intervals. Review contractor performance against initially set goals, objective and deliverables. Analyse and check the contractor's data as soon as possible after they are received.
- Prepare a final report on the routine core analysis (RCA) and/or special core analysis (SCAL) studies which will reconcile the core data with other well and reservoir data, and provide appropriately interpreted and reliable core analysis data that can be used for petrophysical and reservoir simulation models.

Table1: Showing an example of a typical workplan of core analysis program.

Activity No.	Activity Description	Theme	Timeline			
			Week1	Week2	Week3	Week4
1	Review of existing core data if available	Preparation				
2	Review reports, academic papers, and any log data					
3	Collect core samples from the wellsite by the coring company based on Scope of Work (SoW) or Terms of Reference (ToR)	Sample Collection and Preservation				
4	Transport the collected core samples to the core laboratory					
5	Preserve the core samples in the lab's warehouse					

6	Core slabbing	Core Analysis				
7	Conduct porosity and permeability test using different devices					
8	Drafting, reviewing and finalizing the final report	Report Submission				

Regular monitoring of vendors' performance and the provision of, and checking, experimental data can ensure that any problems or unusual, anomalous or inconsistent results can be identified as soon as possible, so that they can be rectified before the test programme is completed. Thereafter, it is too late, and costs are often incurred in retesting which can lead to largely undeserved but lingering resentment over lab performance. Contractor supervision and quality control will ensure that complete records of the test methods and procedures together with laboratory experimental data are available, so that there is a complete audit trail. Laboratory RCA and SCAL reports must include a detailed description of the work performed; the equipment and procedures used; and details of the methods used by the lab in analysing the data. Understanding the plug history is essential in QC of the SCAL data—particularly in formations sensitive to stress cycling and rock/fluid incompatibilities—but deciphering plug records from standard SCAL reports can be challenging. Below Figure presents an example of a customizable single page plug sheet that charts the history of each sample through the plug preparation and testing sequence. Key results can also be captured by this format. More effective knowledge sharing—e.g. highlighting of unusual or anomalous data in the report text, tables and figures—will allow the client to gain and benefit from the lab's undoubted expertise and experience in similar lithologies. Relevant experimental data, details of appropriate instrument calibration data and the equations used to generate the analysed data from 'raw' measurements should also be provided. Labs often charge for compiling this information, and although the data might never be reviewed, they can prove invaluable in audit trailing and unitisation application. In Senergy's experience, labs have enthusiastic, committed and highly experienced senior management teams, but they tend to be reactive and not proactive. This is not helped by the traditional master (client)–servant (lab) relationship. Engaging the labs through regular meetings and lab visits during ongoing projects means that they become more aligned with, and involved in, the client stakeholder objectives and better understand how important their data really are in field development planning and decisions. This integrated approach will ensure that the end-user benefits from:

- appropriate and reliable core analysis data;
- improved integration of core test data with other well/reservoir data;
- cost savings through the elimination of wasteful or inappropriate testing.

Core plug history chart

Plug parameters:

Sample no.	No. S18
Depth (m)	xxxx.xx
Length (cm)	4.86
Diameter (cm)	3.65

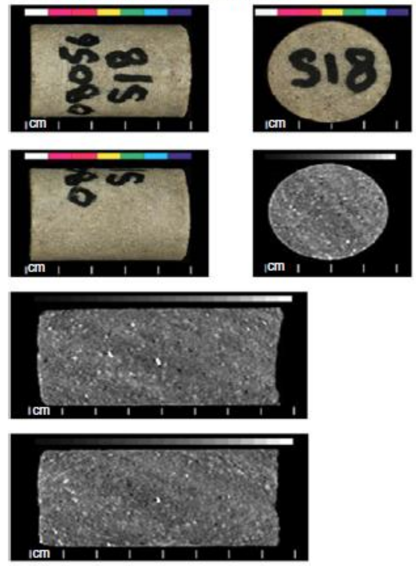
Plug base data (ambient):

Air permeability (mD)	234.5
Porosity (%)	16.3
Grain density (g/cc)	2.68

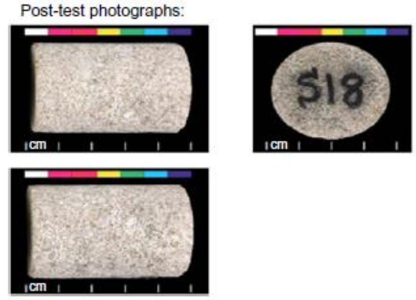
Study flow chart:

Sample preparation
CT scan and pre-test plug photography
Flow through cleaning
100% saturation in water
Effective permeability to water at ambient cond.
Cool solvent cleaning and humidity oven dry
Permeability and porosity at ambinet cond.
100% saturation in water
Archimedes porosity
Effective permeability to water at ambient cond.
Post-test plug photography
Report

Digital images: side and end face
Pre-test photographs and CT images:



Post-test photographs:



End of lecture