Multidisciplinary

Advances in geophysical core recovery and applications: an enhanced sidewall coring solution

Adizua Okechukwu Frank
Geophysics Research Group – GRG, Department of Physics, Faculty of Science, University of Port Harcourt, Port Harcourt, Rivers State, Nigeria
Correspondence Author: Adizua Okechukwu Frank
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Abstract
This short communication discusses an enhanced sidewall coring solution. The advantages of this approach over traditional techniques are explored, along with the manner in which it enhances core recovery in reservoirs that were previously thought to be unreachable and how it revolutionizes (transforms) the analysis of these cores after they have been retrieved to the surface. This makes it possible to build more accurate reservoir models, which in turn improves the goals of field development plans (FDP).

Keywords: coring, core recovery methods, enhanced sidewall coring, impossible zones, better reservoir models, Field Development Plan (FDP) objectives

Introduction

Coring is the technique of utilizing a specialized drilling equipment called a core barrel to remove cylindrical rock samples from underground formations. In geology and petroleum exploration, it is a method for obtaining undamaged rock samples for in-depth laboratory investigation. Coring is usually seen as a supplemental technique that offers useful information to support formation evaluation, rather than as a method for evaluating formations on its own. Although coring doesn't directly assess the attributes of the formation, the information gleaned from the extracted core samples is a useful tool for assessing the formation. Comprehensive laboratory investigation, encompassing measurements of porosity, permeability, rock structure, mineralogy, and mechanical properties of the rock, is made possible by the core samples procured through coring. Accurately describing the reservoir and its potential for producing hydrocarbons requires this data. Direct measurements of the properties of the rock can be obtained through core analysis, which also makes it possible to validate and calibrate other methods of evaluating the formation, including well logging. Geoscientists and reservoir engineers can verify the precision and dependability of the well log interpretations by contrasting the outcomes of core analysis with well log data. Coring can help identify specific geological features, such as bedding planes, fractures and lithological variations that may not be adequately captured by well logs alone. This information aids in understanding reservoir heterogeneity, compartmentalization, and the distribution of hydrocarbons within the reservoir.

Coring is usually intrusive, and involves the physical extraction of rock samples from the subsurface formations, which requires drilling and penetrating the rock. It is an invasive process that involves the use of a core barrel to cut and recover cylindrical samples of rocks from the wellbore. There is no technology or method from resources available to me at this time that can achieve non-intrusive coring. While advances in drilling technology and core recovery methods have reduced damage to surrounding rock and increased the efficiency of coring operations, coring is still a physical and invasive technique that involves drilling and extracting rock samples from the wellbore. Coring is different from non-intrusive techniques like remote sensing, seismic imaging, or well logging, which gather information without physically extracting samples from the subsurface. The purpose of this short communication is to discuss one of the latest advances in side wall coring solutions and highlight their superiority over conventional sidewall coring approaches. This is actually a review of a technology unveiled recently by Schlumberger which has generated a lot of interests.

Historical perspective of sidewall coring and its limitations/advantages

The US petroleum engineer George C. Clark is credited with creating sidewall coring. Clark applied for a patent in 1947 on a machine that could extract rock samples from a wellbore's wall without drilling a separate core hole. Without requiring more drilling, this device, which he called the "Clark Corer", made it possible to gather superior rock samples from the formation surrounding a wellbore. Because Clark's discovery made it possible to sample subsurface geology more accurately and representatively, it completely changed the petroleum business. Since then, sidewall coring has gained widespread industry acceptance and developed into a crucial instrument for the discovery and exploitation of oil and gas reservoirs. A method used in petroleum exploration and production to extract rock samples from a wellbore's sides is called enhanced sidewall coring. A coring tool that is lowered into the wellbore and spun against the well's sidewall is used to extract the samples. The method is improved because it makes it possible to gather excellent samples that are typical of the reservoir rock, which can reveal important details about the characteristics of the rock and its potential for producing oil and gas.

Sidewall coring is not without its limitations and failures, just like any other technique. The following are a few typical difficulties that may occur with sidewall coring:

- **Tool failure:** During the coring process, the coring tool may become broken or stuck, which could cause the sample to be lost or necessitate more time and resources to retrieve.
- **Poor sample quality:** A number of variables, including the kind of rock, the well's depth, and the coring equipment employed, might have an impact on the sample's quality. Data analysis and interpretation that is not correct can be caused by poor sample quality.
- **Sampling bias:** Because sidewall coring may only sample a limited portion of the wellbore, sampling bias may be introduced and the sample's representativeness may be reduced.
- **Cost:** Sidewall coring is a costly method, especially for intricate or deep wells.

Sidewall coring is still a popular and useful method for getting rock samples for petroleum exploration and production, despite these difficulties. In the petroleum sector, sidewall coring is the primary method for collecting rock samples. In order to assess the characteristics of the reservoir rock and ascertain the possibility of producing oil and gas, the technique is frequently employed in both exploration and production. Sidewall coring is an economical and effective way to collect rock samples since it is less invasive, takes less time, and requires less equipment than other sampling procedures. Samples collected by sidewall coring can yield important reservoir information such as the porosity, permeability, lithology of the rock, which can help companies make informed decisions about drilling and production.

Objectives of coring and core analysis

By supplying information that is indicative of the reservoir under in-situ conditions, coring and coring analysis aim to lower the level of uncertainty in reservoir evaluation. The basis for measuring necessary petrophysical qualities and concurrently acquiring additional data reliant on the rock of the reservoir is provided by advancements in coring and core analysis techniques. To reduce reservoir uncertainties that cannot be addressed by other data sources like well logging, well testing, or seismic, core-derived data have been merged with other field data. The constant demand to maximize field development has made the accuracy and consistency of core data more crucial. The need for novel coring and core analysis techniques is fueled in part by the business objectives, information value, and operating costs. In every stage of the petroleum business, core retrieval and analysis are crucial. The only method to obtain vertically continuous, unbroken samples is through the core for character changes and visual examination of deposition patterns. The presence, amount, distribution, and delivery of hydrocarbons can be conclusively proven using data from correctly analyzed cores that cannot be obtained from any other source. Cores give a guide to a complete comprehension of the future reservoir's pore systems. Data essential to assessing a hydrocarbon reservoir's productive potential are obtained through analyses of rock samples. Bit cuttings are samples of rock, of course, but they cannot provide more information than qualitative data due to their small size. The invention of coring techniques, which allow for the relatively substantial extraction of reservoir rock samples from the side of the borehole wall after drilling, or from the bottom during drilling, was prompted by the desire to retrieve and analyze bigger, uninterrupted chunks of reservoir rock.

Coring analysis methods

Many commonly used sampling and analysis procedures have been developed for the evaluation of core samples. The type of recovered core, its lithology, and the type of pore system all influence the technique choice. Core analyses go into a number of categories such as:

- Whole core analysis;
- Conventional or plug analysis; and
- Analysis of the sidewall core.

Continuous core analysis can also be done with entire core or conventional methods; however, conventional core analysis is more frequently employed. This method yields satisfactory results when the pores are generally uniform and employs a small sample to represent the time interval between core operations. Typically, conventional core plugs are collected once per foot, or three to four times each meter. More frequent sampling is necessary due to variations in lithology or pore system development. In order to identify net pay, hydrocarbon-water transition zones, contact levels, and formation boundaries, sample density must be sufficient. Either the most representative sample inside each foot can be chosen, or sampling can be done statistically at the midpoint of each foot. The entire length and largest sample size of the entire core throughout the specified interval are examined using whole core analysis. Large samples are required in heterogeneous formations where cracks, solution vugs, or randomly produced porosity systems account for the majority of the porosity and permeability. In these situations, the volume of each individual pore may be enormous compared to the size of standard core analysis plug samples. An observational full diameter, which is an entire core analysis variation, uses specific core lengths instead of the complete core. Any of the sidewall coring procedures can be used to recover cores for sidewall core analysis. When appropriate formations are sampled in sufficient detail, sidewall coring and analysis yield results that are satisfactory. By creating correlations between conventional and sidewall core values, data quality in wells with just sidewall cores accessible can be enhanced. This necessitates the collection of sidewall cores and conventional cores from the same interval in particular wells.

Features of a good coring solution

Improvements to sidewall coring systems frequently target lowering operational risks and expenses while simultaneously enhancing the coring process's accuracy, efficiency, and dependability. Potential advancement features of a good coring solution should include;

a) **Improved core recovery:** Improvements in core barrel design, cutting structure, and drilling fluid systems can facilitate improved recovery of continuous and undisturbed core samples, leading to better reservoir characterization. These are potential advancement features of a good coring solution.
b) **Advanced core analysis:** By integrating cutting-edge downhole analytical instruments for in-situ examination of the recovered cores, it is possible to assess fluid compositions and petrophysical characteristics in real time without having to retrieve the cores to the surface.
c) **Improves system reliability:** Improvements to coring systems and instruments, such as sturdy coring bits, better drilling settings, and enhanced telemetry systems, guarantee increased dependability and reduce failures during coring operations.
d) **Data integration and interpretation:** Comprehensive reservoir evaluation is possible by integrating the results of core analyses with additional wellbore data (such as logs and seismic information) through sophisticated data visualization, processing, and interpretation capabilities.
e) **Operational efficiency:** Increased tool reliability, shorter rig times, and automated coring procedures all contribute to more cost-effective and efficient operations.
f) **Safety consideration:** to reduce the hazards related to coring, safety features and protocols, such as non-explosive coring techniques or remote operating capabilities, are implemented.
g) **Eco-friendly solutions:** Combining techniques to reduce the environmental impact of coring operations with ecologically friendly drilling fluids.

Advantages and applications of the enhanced sidewall coring solution

In certain circumstances, sidewall coring has proven to be challenging. The operational constraints posed by unconsolidated formations, harsh and abrasive surroundings, and extreme overbalanced circumstances were addressed by Schlumberger recently, and this communication is based on their novel solution. The improved sidewall coring solution transforms the analysis of recovered to surface cores and enhances core recovery in reservoirs that were previously thought to be unreachable. All of this information may then be included into reservoir models using cutting-edge digital capabilities to enhance field development plan (FDP) objectives, comprehend the geology of your reservoir, and ultimately optimize its performance. (Schlumberger webinar by Sassi and Holtshopple, 2023) [2].

Advantages

- Provides details on the hydrocarbon kind, flow potential, lithology of the deposit, and petrology.
- Measurements of irreducible water saturation and hydrocarbon are provided by analysis.
- After zones of interest have been discovered via downhole logs, coring points may be chosen.
- A correlation device and standard logging depth can be used to achieve accurate positioning.
- Offers the fastest and most affordable way to form an assessment of the zones of interest.
- The field development strategy depends strongly on it.
- It enhances recovery.
- It delivers unparalleled consistency and performance (including automated weight on-bit contact) through automated coring.
- Better cuttings evacuation techniques.
- Impressive 60% increase in efficiency is delivered.

Applications

- Field development plan (FDP) optimization through lowering subsurface uncertainty.
- To evaluate reservoirs, one must comprehend reservoir producibility.
- Enhancing the design and construction of wells.
- The rationale for log calibration.
- Evaluating confinement for uses in carbon sequestration applications.

Conclusion

The improved sidewall coring technology maximizes reservoir optimization and comprehension with major advantages. Its capacity to recover formations that were previously unrecoverable offers important insights into the subsurface geology and makes more precise reservoir characterization possible. This technology overcomes the drawbacks of conventional coring techniques and enables a more thorough examination of the reservoir's characteristics, such as fluid saturation, permeability, and porosity. Making educated decisions about production tactics and well placement need this information. Furthermore, by locating unexplored areas and possible bypassed pay, the improved sidewall coring method enhances reservoir management. Increased hydrocarbon recovery and improved field development plans can result from this knowledge. The recovered cores can also be utilized for sophisticated laboratory analyses such petrophysical measurements, rock mechanics testing, and core flooding tests. These data help to optimize production processes and provide a better knowledge of reservoir behavior under various conditions. In order to improve reservoir performance and obtain a more precise understanding of the underlying geology, the enhanced sidewall coring system is a financially viable option. For oil and gas businesses looking to optimize the potential of their properties, it is a priceless instrument due to its capacity to recover previously unrecoverable formations.

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References

1. Arora AJ, Bihani AD, Padalkar CM, Punase AD, Patwardhan SD. Sidewall coring: Advanced in-situ freeze-core technique, IPTC – 146669, 2011.
2. Khaled Sassi, Hunter Holtshopple. Enhanced sidewall coring product live launch webinar/video series of June 2023 by Schlumberger. Houston, Texas, USA, 2023.
3. Lyne AM, Riva A, Gossenberg P. Early detection of biodegradable oil using NMR downhole logs and hydrocarbon GC-MS analysis of sidewall cores. MEOS, 2006.
4. Skopec RA, Collee PE, Van Puymbroeck L, Shallenberger LK. Downhole core preservation and improved reservoir evaluation, Journal of Petroleum Technology. 1995;47(5):399.
5. Tibbitts GA, Reed MG, Mccarter M. New coring systems reduces filtrate invasion in P. F. Worthington, ed., Advances in Core Evaluation: Gordon and Breach, New York, 1990, p55-78.