OFFSHORE WIRELINE CORING – CLOSING TECHNICAL AND ECONOMIC GAPS

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ABSTRACT

Wireline retrievable coring has advanced markedly in recent years in terms of system reliability, core quality, application range, safety and general oilfield acceptance — especially in the unconventional sector. The industry has yet to fully exploit the information benefits and economic savings of wireline coring technologies for conventional reservoirs, in particular for offshore applications.

To properly communicate the positive attributes of wireline coring systems and ask why it is not employed more frequently in place of conventional cores, sidewall cores or electric wireline logging, the historical challenges and objections should be clearly laid out and examined properly from three key aspects: safety, core quality and technical limitation. For example, misconceptions around core degradation while tripping are unfounded given current knowledge around tripping programmes and the trip management resources available. The industry needs to reconsider what was once perhaps true, otherwise the cost- and time-saving benefits of reducing or replacing several conventional core trips per well will not be capitalised upon.

21st century coring industry and related tubular, wireline handling / surface pressure control, and fishing companies have developed solutions that may be applied to overcome past challenges, such as large bore drillpipe, drill collars, hydraulic and mechanical jars to allow for a larger core diameter; rotating and circulating arrangements for wireline surface pressure control and minimisation of differential sticking; slimhole electric wireline logging systems conveyed through the corehead; drilling insert technology that allows cycling infinitely between coring, drilling or logging as desired; and non-critical path core surface logging options.

Recent application of wireline coring technology offshore not only proves cores of excellent condition are obtainable, but that even with extremely conservative tripping practices, substantial economic savings can be realised, whilst at the same time delivering more useable bulk volume samples than any other coring method.

HISTORICAL CHALLENGES AND OBJECTIONS

Wireline Coring, also referred to as Continuous Coring, is the method by which core samples are cut downhole, similar to conventional coring, with the key difference being the method for recovering the core. As the name suggests, wireline cores are retrieved through the bottom-hole-assembly and drill string to surface by a wireline winching unit, negating the requirement to trip the entire drill string and BHA; this translates to much faster tripping – commonly at a retrieval rate average of around 70m/min. Many modern oilfield wireline coring systems also allow for the downhole fitment of a drilling insert that permits drilling ahead conventionally to further reduce drill pipe trips to core point, between core points or to drill to total depth.

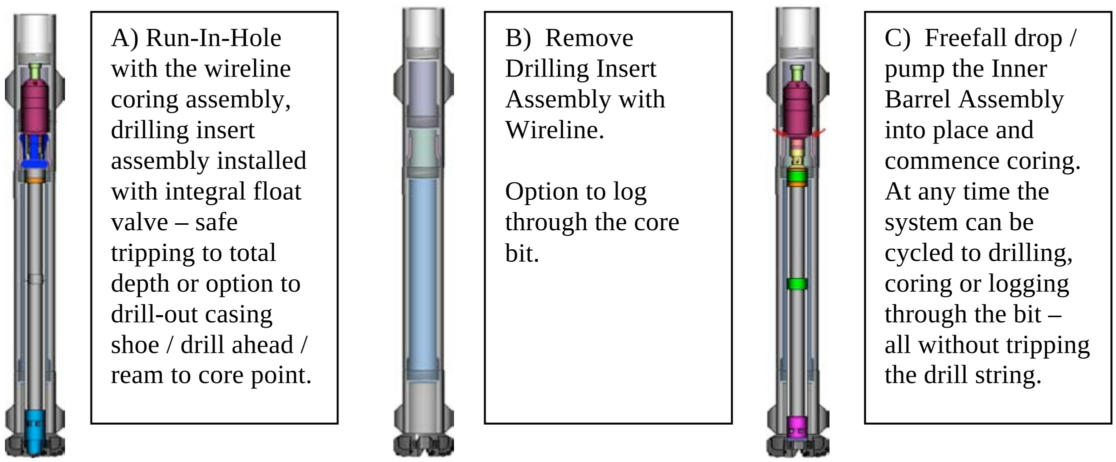

Figure 1. General Wireline Coring Operating Principle.

Perception is one of the largest challenges facing wireline coring acceptance in modern-day oilfield operations. Although large diameter rotary wireline retrievable coring technology was first introduced to the US oilfield in 1928 [1] and enjoyed popularity right up through the 1950s and 1960s [2], it was the mineral exploration sector that truly invested in and further developed the system for slimhole use from the 1950s onwards [3]. Some assume that wireline coring is non-oilfield in origin and therefore something to be viewed sceptically.

Numerous times in the late 20th century, there was some re-invention of small core diameter systems for operation within standard drill pipe and bottom hole assembly internal diameters, predominantly confined to use in land operations [4]. These systems saw limited success with many operators perceiving the 2 in. or smaller diameter cores [5, 6] to be of little analytical value. In addition to working within the confines of less than ideal diameter limitations, this translated to general system weaknesses, often evident when attempting long coring / drilling intervals (with drilling insert), hard or soft formation intervals, casing shoe drill-out, or limited inner assembly length capacity.

Operationally, wireline coring has often been at odds with established drilling practices, in particular concerning how to minimise the chances of differential sticking when the drillstring is stationary during the core retrieval process [7], swabbing when retrieving the core [6], and means to effect general well control / cure losses with the lack of a float valve and or circulation sub in the bottom hole assembly. Additionally, surface pressure control equipment and the ability to pass through certain diameters, maintain sufficient working pressure capacity, rig-up time / cost, and ambiguous industry guidelines are all additional factors that in the past have attempted to push wireline coring aside as being too challenging.

From a sub-surface perspective, the coring industry in general has preached the importance of engineered trip-out rates to avoid cores being retrieved back to surface too quickly and suffering irreversible damage from gas break-out, in addition to the associated safety aspects of allowing venting and dissipation of gases released during the trip out of hole [6].

INDUSTRY SOLUTIONS

Driven primarily by the unconventional sector since the turn of the century, general wireline coring system specifications, capacities, diameters and associated technologies and processes have in most cases solved the challenges mentioned above, but have not been communicated adequately across to the exploration and appraisal stakeholders concerned with conventional and offshore operations that could benefit the most economically from wireline retrievable coring technology.

The ability to cut and recover large diameter wireline cores of up to 3 ½ in. diameter and 56m in length has been made possible by the innovation and investment of some key coring service providers, along with the ever increasing range of proprietary drillstring connections with large internal diameters available on rental strings and engineering efforts to produce mechanical and hydraulic coring jars / drill collars.

Although not specifically designed for wireline coring, there are a number of modern surface pressure control systems with certified working pressures of up to 15,000psi that are beneficial for offshore operators considering wireline coring. There are a wide range of configurations that offer the ability to circulate, rotate and or reciprocate drillpipe whilst wire is within the drillstring, reducing risks of differential sticking, cuttings pack-off, swabbing, and enabling safe retrieval of the inner barrel assembly; and well control at any point in the coring process.

Properly developed, tested and critically reviewed operational procedures based off risk assessment and hazard analysis then provide the remainder of controls to ensure a safe coring operation that delivers quality core. Some general examples include properly calculated circulation periods after each core is cut, tripping drillstring back inside the casing shoe where warranted, pulling the inner assembly to surface against swabbing calculations and core decompression programme, removal of the inner assembly from the surface arrangement, and well control procedures at each stage of the process.

REDUCING WELL CONSTRUCTION TIME, WHILST OBTAINING MORE CORE

Aside from the time-saving benefits of wireline coring versus conventional coring – especially over long intervals or where multiple trips are required — there are other less tangible savings that are no less significant:

1. More core can be taken for the same cost or less. In a conventional coring scenario, a conventional drill bit is used to drill out the casing shoe and onto core point, a round trip is required to core, then post coring another conventional drill bit trip is required to drill the electric logging rathole (even more costly is a sidetrack to core scenario). With this method, core point may be selected incorrectly due to the formation tops uncertainty, resulting in a wasted trip to core formation of little value, or could also result in core point being picked low, missing critical formation information (e.g. reservoir seal.). With wireline coring, the assembly has the capability to drill out the casing shoe and ahead to core point (drilling mode). Where there is depth uncertainty, coring can commence high to be sure to capture the interval of interest. The operation is economically favourable to do this as a full trip is already saved before coring commences. Once coring is finished, the drilling insert can be reinstalled to allow for drilling to TD / logging rathole, all with a single BHA trip.

   If deemed necessary, an electric, wireline-conveyed logging tool may be run out of the bottom of the coring assembly [12] to identify positional markers, or to log the target formation a mere hour or two after coring it — without tripping drillpipe.

2. The underexplored possibility of inverse logging (logging the core on surface as opposed to logging the borehole) [8], or at minimum reducing the number of suites required, can all be conducted off critical path and delivered in semi-real time, allowing for logging as coring / drilling is still in progress. This would also be a major boon for decision making. As each wireline core is retrieved to surface it can be instantly logged on a core exposed to mud for a very short period of time, as opposed to formation logged days later downhole.

   Some basic surface logging examples available include [8] gamma ray, magnetic susceptibility, infrared mineralogy, ultraviolet fluorescence, nuclear magnetic resonance porosity, pyrolysis, gas chromatography, digital photography / video, resistivity, P-wave velocity, and X-ray diffraction, not to mention the opportunity for obtaining immediate trimmed plug samples with the absolute minimum of filtrate invasion.

3. Smoother, constant rate tripping of the core (profiled trip out programme) with no setting of slips is beneficial to avoid damage to weak formation cores.

4. By not tripping pipe as often, certain projects in populated areas may be able to maintain 24 hour operations through reduced noise pollution.

5. By reducing trips, wear and tear on the drillstring and rig equipment is reduced in addition to minimising the potential for personnel injury during one of the most hazardous rig operations, tripping the drill string.

6. Wireline coring can eliminate the need for sidewall cores by taking cores on the fly and providing wider coverage over the drilled / cored interval.

Wireline coring also allows for jammed or problem core runs to be aborted and addressed in a matter of an hour or two as opposed to a similar issue with a conventional coring system being measured in days.

FUTURE OF WIRELINE CORING

Long term, the future of conventional and in particular wireline coring system technology is clear: real-time logging capability whilst coring [9, 10, 11, 13]. Other electronic real-time transmitted measurements such as jam detection, core position, pressure, temperature, downhole dynamics and general inner barrel behaviour are all expected to be forerunner coring technologies in the near term.

CONCLUSION

Wireline retrievable coring has developed into a simple, robust and reliable option for operators to obtain a larger volume of quality core samples safely and economically. The status quo of how formation evaluation is commonly applied across the industry should be called into question. More physical samples are always preferable over inferred electric log interpretation data, notwithstanding the associated “flat time” critical path time taken to wireline log the well and the fact that the data is often taken from the reservoir section days after it was drilled. The cost savings are tangible and have been proven onshore in thousands of wells. Though offshore uptake has been limited to date, favourable results and positive upsides are reported in those instances [10, 11, 12, 14].

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