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Reducing Risk by Inclusion of Robust Subsurface Analysis for Plugging and Abandonment Campaigns*

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Abstract

Well abandonment is driven by economic decisions, namely when unit lifting costs are no longer profitable. Generally, governmental authorities require that well operators perform safe and environmentally compliant abandonment operations by establishing a permanent barrier to retain remaining hydrocarbons in their existing reservoirs and prevent the release of hydrocarbons to the surface. However, the regulator guidelines do not always articulate how these processes should be implemented, and it is therefore at the discretion of the operator to decide which, and how, processes are put into place. This in turn leads to an inconsistent response with little opportunity to share best practice and drive overall operational and cost efficiency. Therefore, there is a significant risk of failure to deliver a successful well abandonment due to the lack of standardization and experience.

Traditional Plugging and Abandonment (P&A) methods (a major component of decommissioning and restoration activity/risk exposure/cost) are often time consuming, costly, and have remained largely unchanged despite significant technological advances in the industry in other areas of the exploration and production supply chain. Approaches by operators to P&A procedures are currently disaggregated both, technically and commercially, which results in: higher risks, higher costs, sub-optimal operational performance, and lack of improvement by learnings. A way forward would be to develop a risk-based verification service to drive a safe, efficient, and affordable P&A process founded on a high-quality risk assessment matrix (RAM). A common platform/framework is needed to describe what needs to be verified and how, based on best practice in pore pressure and geomechanical prediction, risks can be quantified and managed to an acceptable level.

To help improve the process we present a way to re-think the plugging and abandonment design plan based on the geology, which controls the distribution of fluids and pressures, hence guiding the placement and number of well plugs.

Introduction

The challenging conditions facing today's oil and gas industry has focused on delivering efficiency improvements, building on cost reductions, and rationalisation of activity. Operators have positioned themselves to succeed longer-term in a, lower for longer price environment. With this, operators are now faced with the decision of extending or ending field life in a number of mature basins. Hence there is now a key focus on pre-decommissioning planning which is part of the pore pressure and geomechanical workflow. Mitigating uncertainty, enabling decision making, and justification as to safely and cost effectively decommission a field is now of paramount importance. The main objective is, therefore, to maximize efficiencies and reduce costs during the plugging and abandonment operations whilst maintaining operationally and environmentally safe activity. The current cost of such an operation is commonly compounded by the time critical activity requiring the platform life and all related utilities to be extended. Considering the numbers that will need to be abandoned in the near future, new or novel technologies and methods must be developed.

The P&A process itself is simple to summarise; to permanently isolate and seal a well. However, the long-term success of these abandoned wells is dependent on the sealing requirements, which become critical since the cost risk and environmental impact of returning to re-abandon the well is a major concern.

Designing a well abandonment program to deal with the virgin pressures may not be cost effective or required given the effects of production pressure depletion and in some cases induced strata compaction may need to be incorporation into the design basis. A geological assessment of the field, and its surrounding area, is needed to understand the potential for communication within/between reservoir horizons and the possibility for future fluid movement. At the pre-drill stage much of this information should be known, given that the assessment of the formation pressures, overburden, and fracture strength are required for well planning, but this assessment may only be applicable on a well-by-well basis. Throughout the life cycle of a field the state of a reservoir will change; pore pressures may become depleted and/or recharged potentially leading to fault reactivation, overburden may compact, and thermal changes may also occur. Therefore, having an understanding of the ambient pore pressures, recharge pressures, and the timescales over which these may occur, on both a regional and local scale, during the abandonment planning procedure will be invaluable.

North Sea Case Study

Background

The North Sea decommissioning market is of focus globally given the maturity of the basin. The UK Continental Shelf currently has the largest North Sea decommissioning market reflecting its relative scale and life cycle stage. Decommissioning activity is forecast on 349 fields across the UK, Norwegian, Danish, and Dutch Continental Shelves to 2025. Almost 2500 wells are forecasted to be plugged and abandoned across the North Sea up to 2025, with more than two-thirds in the UK. Oil and Gas UK forecast that total decommissioning spend on the UK Continental Shelf will be £17 billion between 2017 and 2025. Well plugging and abandonment will be the largest contributor of expenditure at almost 50% (£8.5 billion) of which the tax payer foots 50% of that cost and hence, the priority for the government to reduce costs-effectively, while maintaining high safety and environmental standards.

Globally, emerging decommissioning markets are Southeast Asia, Latin America, West Africa, the Arabian Gulf, Egypt, India, China, and Australia. Most national governments have begun an initial look at decommissioning, although most countries are decades behind European and US designs. For example, Brazil has removed <5% of its offshore platforms, 42% of which are >25 years old and a further 38% are 25-15 years old and hence over the next 10 years decommissioning will increase in demand. Therefore, the UK has now become a global focus for driving the decommissioning process. Key areas that are of focus include (but not limited to):

1) Governmental legislative framework
2) Experiences and lessons learnt on previous campaigns
3) Specialist tools and equipment's
4) Dedicated decommissioning contractors
5) Best practice on well abandonment and monitoring

Southern North Sea Case Study

Conventional approaches to a P&A campaign in the Southern North Sea (SNS) may dictate that a surface plug is required to separate the Upper Cretaceous and Triassic sands plus a secondary plug to separate the deeper Leman Sands (Figure 1). Within these formations the Cretaceous units are commonly normally pressured since they often sub-crop on the seabed and are hydrocarbon free. As such, there is little technical justification for placing a shallower barrier above the Cretaceous and Triassic Bunter. Furthermore, maybe the existing wells available were drilled over- or under-balanced and hence the virgin PPFG plans are invalid, specifically with changes in the reservoir and overburden during production. To prove this, a database was compiled with pressure data, rock property data, temperature, geological and burial histories, compaction behaviour, overpressure maps, fault and top seal integrity information, and structural and stratigraphic information in order to apply the knowledge within the regulatory framework in a way that will save time and money in a safe manner; that is the geological risk can be quantified and usefully communicated with the well examiner and regulator (Figure 2).

Conclusion

To help improve the plugging and abandonment process, reduce risk, while still providing a cost effective and safe solution, it is essential to explicitly consider the geological setting in the abandonment procedure rather than this process being viewed as simply an engineering problem. Plug and slot recovery and assignment must be considered as permanent, and the regional and local geology must be correctly verified. We have presented a case study from the North Sea as this is a mature area for oil and gas with numerous successful fields now entering the final stages of production requiring a P&A strategy.

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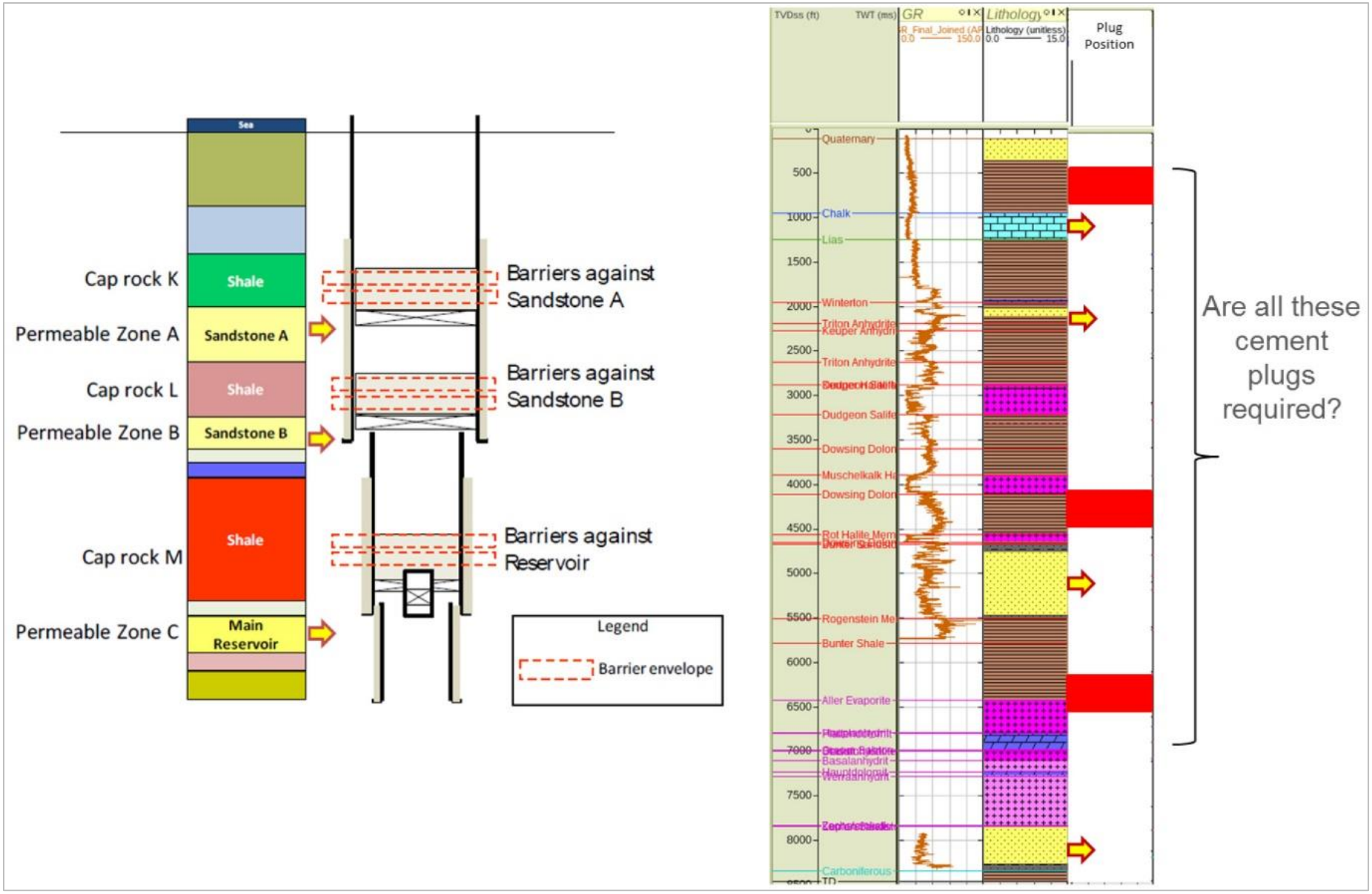

Figure 1. Plug placement UK guidelines for the abandonment of wells (courtesy of OGA 2015).

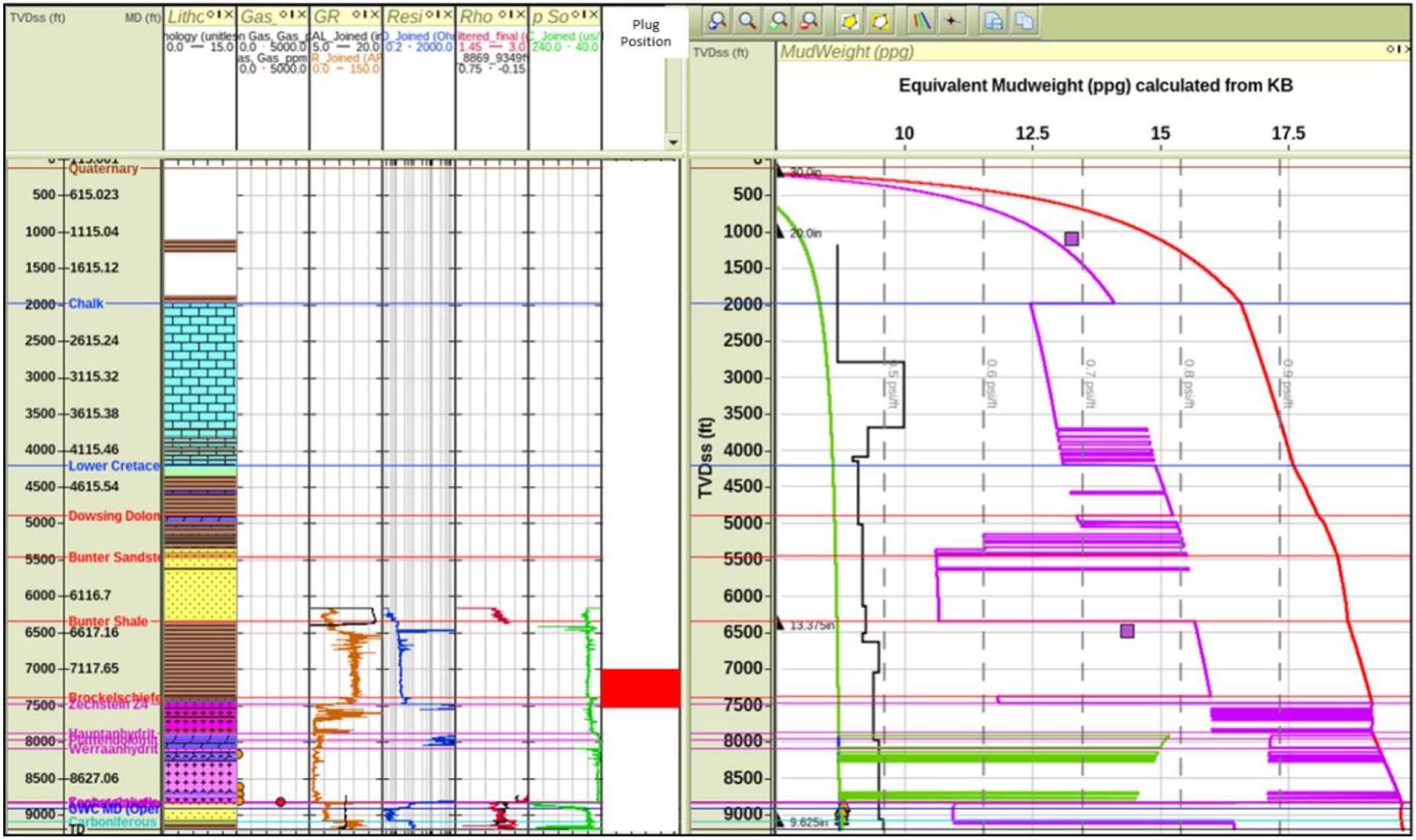

Figure 2. An example of a plug-plan summarizing all the relevant geological, geophysical, and drilling information to guide cement plug placement.

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