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The Integrated Use of new Wireline Technologies to Reduce Full Bore Core Requirements and Cost in the Canadian Oil Sands

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Summary

For 40+ years the industry has collected core from thousands of wells drilled to delineate the resource. It is the authors contention that with the use and proper application of newer formation evaluation wireline technologies available in the industry operators can save both time and money by reducing the number of wells cored, time taken to analyse the core and make development decisions. This paper will discuss the log response of these tools and comparison to core results in some example wells in the Ft McMurray area

Introduction

Wireline tools exist today that permit accurate determination of the formation weight bitumen percentage and the amount of water filled porosity in the rock. Tools exist today that permit an accurate measure of the primary elements in the rock and a robust estimate of the mineralogy from which lithofacies can be determined. Acoustic tools exist that permit mapping the log properties of the lithofacies back into the reservoir with ties to 3D seismic. The use of the mineralogical determined lithofacies when combined with image logs can be used to determine depositional environment.

While the industry has and is making use of most of these tools to a limited and varying extent, their consistent application in the full determination of the key reservoir properties that can be ascertained through the integration of all this data has not been extensively applied. The historic practice of falling back on core is an all too convenient but costly process

Methodology

Bitumen Content and Lithofacies - Pulsed neutron tools have been ran in the cased hole environment for estimating hydrocarbon content in the formation since 1963. The theory of the measurement is well known and in common use in the Industry so only a brief discussion of the theory of the measurement will be given.

The application of this technology in a wireline tool designed for use in open hole permits the use of a much larger detector to improve the count rates of the gamma rays emitted from the elements present in the formation as a result of their interaction with the neutrons with which the tool 's source bombards the formation. The energy levels of the gamma rays are characteristic of the element from whose nucleus it is emitted. In the open hole environment where the sonde is placed immediately opposite the formation and shielding is applied to the tool minimizing borehole effects this measurement is representative of the elemental weight percentages of the formation . Detailed information on the tool theory, design and processing can be found in the Pemper et al paper "A New Pulsed Neutron Sonde for Derivation of Formation Lithology and Mineralogy", SPE 102770, presented in San Antonio in 2006.

From the inelastic spectrum the tool is able to provide a formation weight percentage of elemental carbon (C) in the formation as well as much more robust measures of Magnesium (Mg) and Aluminium (Al) then were previously available to the industry. These measures when combined with the elements that are quantifiable through the use of the capture spectra permit for a more robust estimation of the lithology and mineralogy of the formation. In the relatively immature world of the shale resource plays this tool is being used to identify lithofacies and estimate organic carbon percentage. These same applications can be used in the oil sands environment.

When these measurements are combined with measurements available from the latest generation nuclear magnetic resonance tools a better a much greater understanding of both reservoir quality and fluid saturations (gas, oil water) can be made than was previously possible.

Lames parameters to calibrate well logs with 3D seismic – Papers have been presented previously that show the possibility of determination of Lame's parameters from dipole sonic data and using this data alongside the facies picked from core to map the facies back into oil sands reservoir with Lames parameters determined with 3D seismic. At least one presenter has cautioned the industry in their presentation to be careful to assure that they obtain good repeatable shear wave data when using the wireline log data. The slow travel times encountered in the oil sands reservoirs makes the shear wave measurement difficult and not all vendors tools offer the broad frequency band required to make a robust measure of the shear travel time in these slow formations. As a consequence the use of bad data may be impacting the wider use of this methodology. The paper will review the process previously described as well as compare the processing of shear data with different frequencies in oil sands wells to demonstrate the need for the use of tools with the proper frequency band.

Depositional Environment - The combination of the technologies discussed above for facie determination when combined with image data can be used to determine the depositional environment from logs alone without the need for core.

Examples

Figure 1 Oil Sand RockView / Dean Stark Comparison: Mineralogy is in percent formation weight. Elemental excess carbon and Dean Stark bitumen weight are scaled 0 to 25%

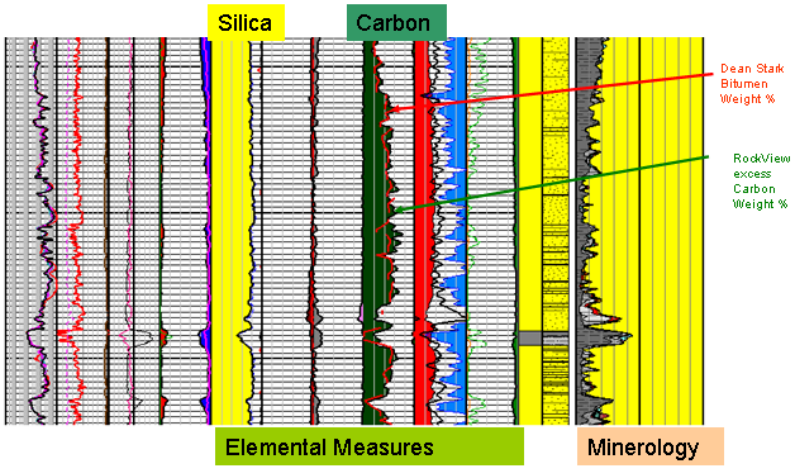


Figure 2 Five Well Comparison - of elemental excess carbon weight from spectroscopy tool to Core

Figure 3 RockView and NMR – the combination of these measurements permit identification of fluids saturations such as bond water%, free water%, total bitumen%, lighter hydrocarbon % and gas saturation %

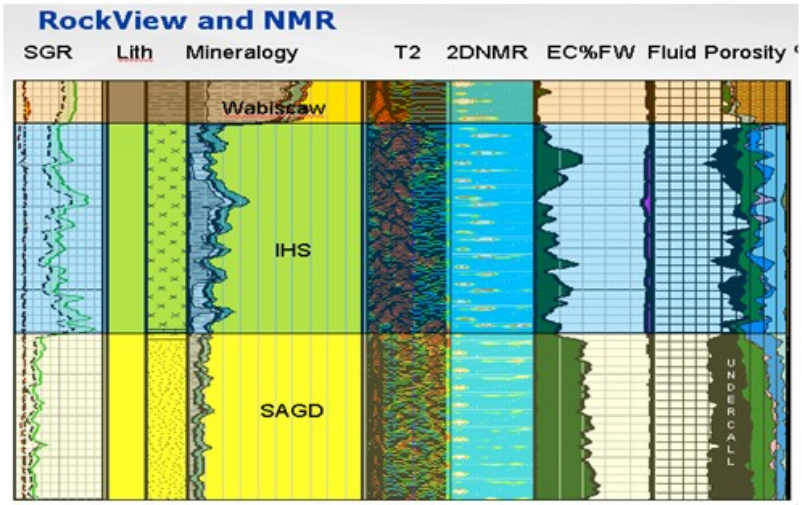
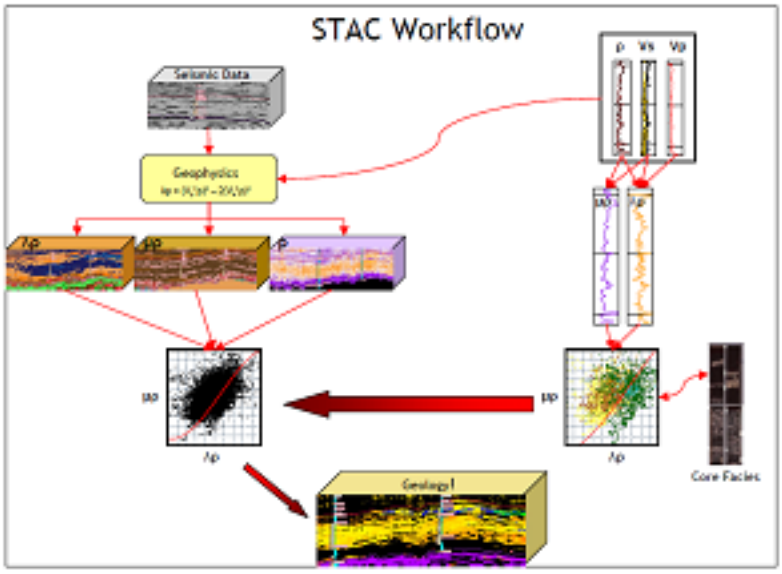


Figure 4 – Lame Parameter mapping from well bore to reservoir



Extract from Bellman Paper 2009 C3GEO

Figure 5 - Facie picks from Image logs

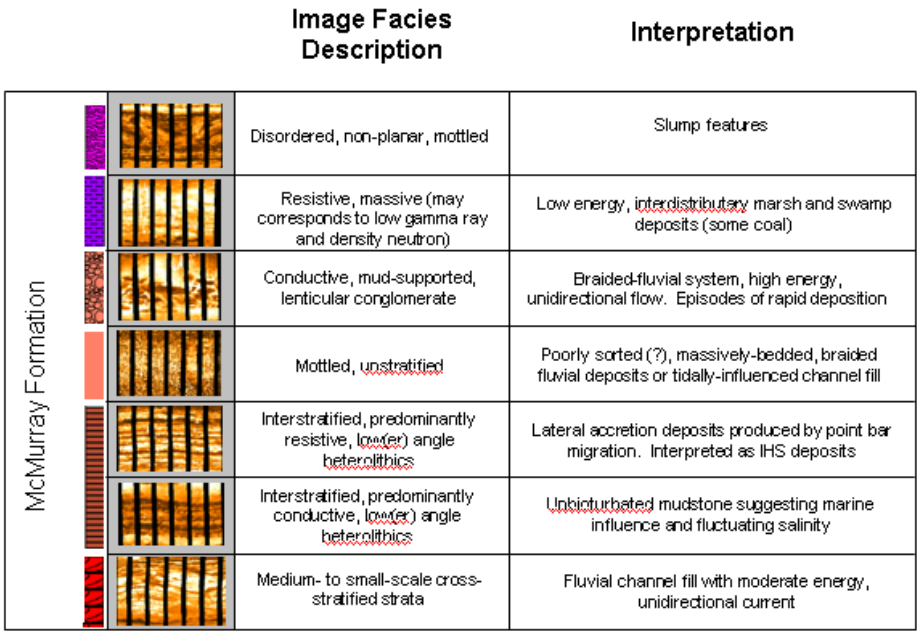
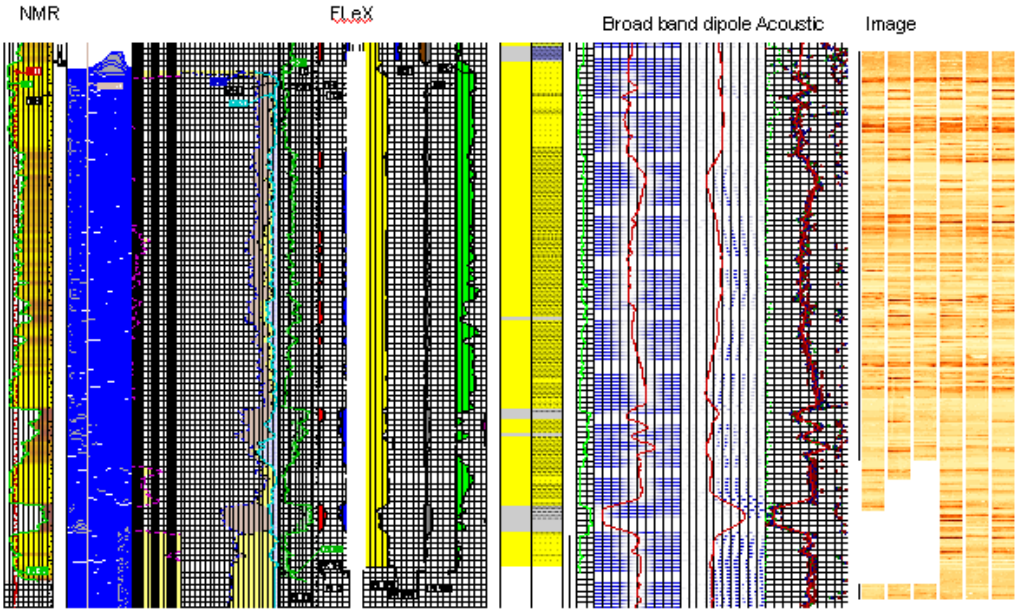


Figure 6 – The new generation Oil Sand Logging Suite



Conclusions

The introduction of a pulsed neutron spectroscopy measurement designed for the open hole environment along with better understanding and application of dipole acoustic and image data can provide a more cost and time effective way of analysing your oil sands reservoir than the core intensive use employed by the industry over the past 40 years

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