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How to Maximize Wellsite Information for Assessing Tight Hydrocarbon Opportunities

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SUMMARY

For many years mud rich lithologies were largely ignored at the well site. Mud rich formations or shales, were simply the rock that had to be penetrated in order to reach the reservoir target. However mud rich rocks when examined properly at the wellsite are very important when investigating tight hydrocarbon domains.
Mud rich formations can be characterized onsite to obtain quickly a first evaluation of the potential sweet spots. In further studies, these valuable first data accessible in the "mudlog", must be systematically considered and integrated to the working dataset. The rate of penetration (ROP), Rotary torque, onsite analysis (methyl blue tests, calcimetry, fluorescence, isotopic analysis…), cuttings description (mineralogy, lithology, size, shape and morphology) and gas show bring enough information to make a first evaluation of the mud rich formation properties (rock strength, fracture presence, flow unit, TOC presence, maturity…) and hydrocarbon potential.
The EAGE WS04 workshop will set out to look at the key characteristics of mud rich lithologies that can be identified at the well site and how some of these parameters can be determined. These parameters are integrated in a way that possible hydrocarbon potential can be identified so that follow up work can be initiated.

Introduction

For many years mud rich lithologies were largely ignored at the well site and often there was no geologist present to examine the cuttings. Mud rich formations or shales as they are commonly known (an incorrect term), were simply the rock that had to be penetrated in order to reach the reservoir target. However mud rich rocks when examined properly at the wellsite are very important when investigating tight hydrocarbon domains.
Where a geologist has been present to investigate such lithologies interpretations have since revealed potential sweet spots for developing unconventional hydrocarbons or as is preferred to call them tight oil or tight gas plays. Mud and organic matter are the common denominator for all tight hydrocarbon ('shale') plays. The depositional environment is therefore critical to obtain an overall understanding of the play. This includes sedimentology, stratigraphy, petrography, mineralogy, diagenesis, and organic geochemistry.
This workshop will set out to look at the key characteristics of mud rich lithologies that can be identified at the well site and how some of these parameters can be determined. These parameters are integrated in a way that possible hydrocarbon potential can be identified so that follow up work can be initiated.

Method

In older mud logs there often is no accompanying gamma ray to help in sorting the sand or silt or carbonate content in the clay (Figure 1). Other more basic parameters need to be called upon such as ROP, torque, gas, and even the 'd' (drilling) exponent which although used as a real time pore pressure alogarithm if used in the right way can also act as a sensitive lithology indicator.
Looking carefully at the lithologies many variations can be determined. Mineralogy is a key parameter such as percentage of silt, carbonate and kerogen. The rate of penetration can be used to correlate areas of higher or lower silt or carbonate content but this needs to be used carefully as effects such as bit wear or sudden increase in mud weight can cause incorrect interpretations.
Preliminary ternary diagrams (Figure 2) can be constructed at the wellsite to illustrate the type of clay being penetrated, though it is more accurate to use thin sections. Thin sections are very often not made at the well site and take time to prepare.
Mineralogy is important when later looking at rock strength for stimulation design. The clay type can be found by using techniques such as Methyl blue tests which determine the percentage of reactive smectite as compared to illite content. The cuttings size, shape and morphology gives an indication about the rock strength and fracture presence. A coating of calcite on the clay surface or evidence of slickeslides indicates either healed or partially open fractures. This again is important for stimulation design propant concentration and presence of potential flow units. Although the exact stimulation design will not be decided at this stage some idea on whether it is has a potential high Youngs modulus therefore low propant concentration or low modulus requiring higher concentration can be ascertained.
A calcimetry analysis will indicate the presence of limestones or dolomites or carbonate cement in the lithology. This too is a key piece of information when assessing rock strength. In addition a fractured dolomite interval or dolomitic interval could act as a potential flow unit in the tight lithology.
Tight hydrocarbons are produced predominantly from source rocks with a TOC value above 2%. This in itself is not easy to identify. The gas detection system used is important as this can reveal the ratio of heavy to light hydrocarbons in the lithologies. This can be correlated to the type of fluourescence found in the sample using UV light. While this may not indicate a TOC value it gives an indication on which areas may have higher TOC values than others and can be investigated further. A pale blue cut fluorescence from clay surfaces can indicate a source rock of low maturity or a gas prone lithology, whilst a pale to gold yellow fluorescence can mean a high TOC with potential for producing oil.
It is normal to capture head space gas for extracting carbon isotopes which help in determining the level of maturity in a source rock. This data is extracted after the well is drilled, but recently there are gas detection systems which can detect these isotopes in real time.
The WS04 workshop will look at some of these techniques using real examples from mud logs and selected drilled cuttings.

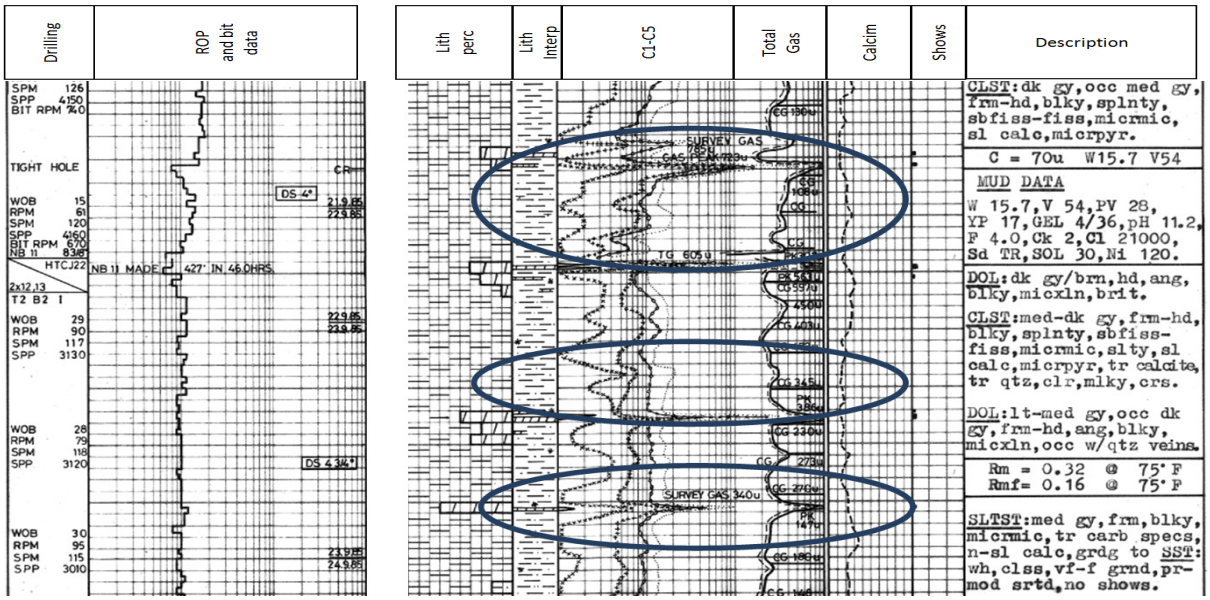

Figure 1 *Example mud log showing potential sweet spots in a mud rich lithology together with key parameters such as ROP, gas and shows.*

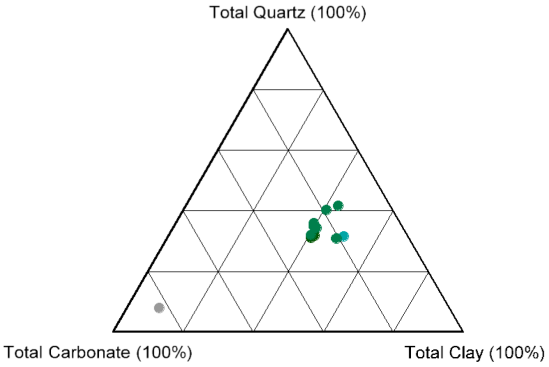

Figure 2 *Example Ternary diagram. Constructed from lithology percentages on mud logs*

Conclusion

Mud rich formations can be characterized onsite to obtain quickly a first evaluation of the potential sweet spots. In further studies, these valuable first data accessible in the "mud log", must be systematically considered and integrated to the working dataset. The rate of penetration (ROP), Rotary torque, onsite analysis (methyl blue tests, calcimetry, fluorescence, isotopic analysis…), cuttings description (mineralogy, lithology, size, shape and morphology) and gas show bring enough information to make a first evaluation of the mud rich formation properties (rock strength, fracture presence, flow unit, TOC presence, maturity…) and hydrocarbon potential.