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Optimizing petrophysical properties in unconventional reservoirs using integrated Novel NMR methodology with other Advanced downhole measurements (A Montney Example).

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Summary

Deriving petrophysical properties in an unconventional reservoir such as the Montney with conventional logs has proved to be very challenging on several fronts such as the accurate estimation of petrophysical properties such as effective and total porosity, producible and non-producible water, and hydrocarbon. In most cases, these wells are drilled with Oil-based which means that the induction tool would be the only preferred tool for such mud system although that environment is suited for a Lateralog resistivity. The impact of using the qualitative resistivity tools also ultimately affects the estimation of the water saturation.

This and several other issues such as uncertainty in estimating Archie's parameters a, m, n, and even connate water resistivity Rw renders resistivity approach less reliable approach to adequately quantify this tight reservoir. Another uncertainty lies in the fact that it is difficult to adequately establish from core Xray Diffraction (XRD) what portion of Clay such as illite are Mica and that affect the estimation of the effective porosity and reserves estimation.

Method / Workflow

The workflow comprises of first carrying out a detailed formation evaluation using Spectroscopy, NMR Porosity, and standard log measurements to obtain the mineralogy, porosity, and water saturation.

The use of Novel techniques from Nuclear Magnetic Resonance measurements(NMR) called Factor Analysis, analyses multiple T2 distribution peaks across the entire section of the NMR data and partitions it into known poro-fluids constituents. Patterns of poro-fluids signatures are then grouped to form poro-fluid facies by combining them with other petrophysical measurements.

The partitioned poro-fluids from the NMR factor analysis are then compared against standard petrophysical models from resistivity, Dielectric, and core results, and the workflow from these methods are individually tuned to enhance consistency across the multiple measurements(Fig1).

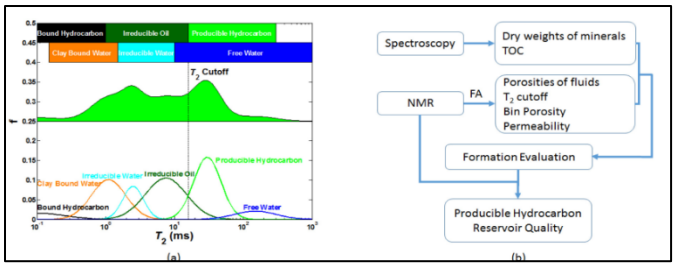

Fig 1: Schematic diagram of the NMR factor Analysis

Results, Observations, Conclusions

The combination of the NMR factor analysis coupled with other advanced downhole measurements such as Spectroscopy and Dielectric measurements have provided a realistic estimation of the following:

- Realistic estimation of clay bound water as against bound hydrocarbon effect
- Total and effective porosity in low porosity rock with minimal influence from mineralogy
- Multiple sources of validating Water saturation from resistivity (Core, NMR, and Dielectric measurements)
- Advance mineralogy from spectroscopy
- mineralogy, water-filled, and a better understanding of the producible/ non-producible fluids within the Montney reservoir in terms of reservoir quality (Fig 2).

This integrated approach provides an insight into the poro-fluid facies available within the Montney and the rock quality as well.

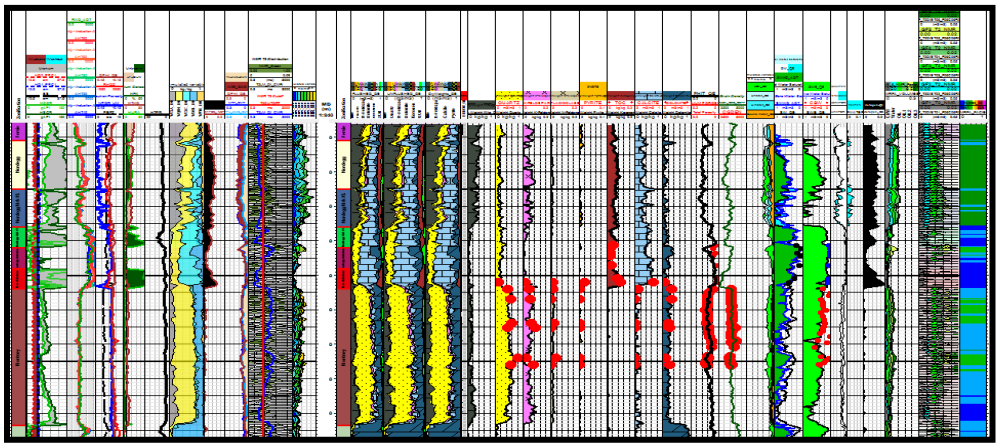

Fig 2 : Integrated Analysis using NMR Factor Analysis, Dielectric and Spectroscopy measurements

References

Jiang T., Jain V., Belotserkovskaya A., Nwosu N.,and Samira A ., 2015- Evaluating Producible Hydrocarbons and Reservoir Quality in Organic Shale Reservoirs using Nuclear Magnetic Resonance (NMR) Factor Analysis , SPE-175893-MS.