MAGNETIC SUSCEPTIBILITY SIGNATURE VIABILITY: AN INSIGHT IN IMPROVED PREDICTION OF PERMEABILITY IN WYTCH FARM

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SUMMARY

This research elucidates the viability of magnetic susceptibility signature in the prediction of permeability in Wytch Farm oil Field.Five suites of data including raw and processed measured Volume magnetic susceptibility of Sherwood reservoir core slabs integrated for the purpose of the research. All the permeability including that of repeated formation test correlated very strongly with the magnetically derived illite content with coefficients of determination R^2 greater than 0.7. Predicted Permeability ranges 0.2mD -5340mD which fall within the range of actual permeability (0.1mD -6000mD). The essentials of this research can enhance rapid and accurate permeability prediction for reservoir development and management in Wytch Farm.

Introduction

The Petroleum industry is very conservative amidst the expensive and time-consuming conventional technique of permeability measurements. Potter and Ivakhnenko (2008) used magnetic susceptibility signature for cheap and rapid prediction of permeability in some clastic reservoirs of North Sea oil field. Potter et al (2011) also employed it for characterisation of key petrophysical parameters including permeability in some carbonate reservoirs of the Middle East oil fields. None of such work accomplished in Wytch Farm oil field.

This research predicted permeability for Sherwood Sandstone reservoir in two wells A and B of Wytch Farm oil field (Figure 1) using magnetic susceptibility signatures. Apart from the conventional correlations between magnetically derived illite content (percentage) with either routine or special core analysis permeability correlation. It also included that of the repeated formation test as a novel.

Methods

I took three hundred and thirty four (334) volume magnetic susceptibility measurements using MS2 (Bartington Instrument) on cores from each wells in British Geological Survey core laboratory. In addition, I employed the two mineral mixture models (equation1) by Potter et al (2008) to quantify the magnetically derived illite content (MDI) in percent.

$$F_I = \frac{(\kappa_T - \kappa_Q)}{(\kappa_I - \kappa_Q)} \times 100\% \qquad (1)$$

Where κ_T = the total measured VMS, κ_Q = the volume susceptibility of Quartz and κ_I = the volume susceptibility of illite. All parameters measured in 10^{-5} SI unit.

I correlated MDI (%) with the Klinkenberg Air corrected horizontal core permeability and special core analysis permeability. In order to ensure accurate result, I normalized the RFT permeability and the MDI Feature scale normalization equation (2) before correlating them (en.m.wikipedia, modified by Waldir, 2014):

$$X' = \frac{(X_i - X_{\min})}{(X_{\max} - X_{\min})} \qquad (2)$$

$$Y' = a + \frac{(X_i - X_{\min})(b - a)}{(X_{\max} - X_{\min.})} \qquad (3)$$

Where X' = the normalised independent variable; $X_{\min}$ = the minimum variable; $X_{\max}$ = the maximum variable; and X_i = the ith variable; Y' = the normalized dependent variable and a&b = boundary constants.

I determined the strength of the correlation by the magnitude of the coefficient of determinations (R^2) and predicted permeability (mD) using the corresponding regression equation.

Results

Figure 2 showed that a small increased in magnetically derived illite evasively decreases the Klinkenberg permeability. Magnetically derived illite (MDI) content (%) and Klinkenberg corrected Air horizontal permeability correlated very strongly with a power coefficient of determination $R^2 \approx 0.8$.

In Figure 3, MDIcontent (%) and SCAL permeability very strongly correlated with a power coefficient of determination $R^2 \approx 0.9$ for Well B.

In Figure 4, normalized RFT permeability and normalized MDI very strongly correlated with a linear coefficient of determination $R^2 \approx 0.7$ for Well B.

Predicted permeability for Well A and Well B using the regression equations ranges from 0.2mD to 5340mD.

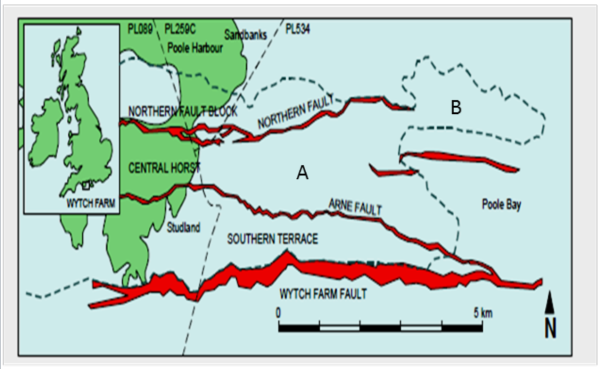

Figure 1: Location Map of Wytch Farm oil field showing Well A and B.

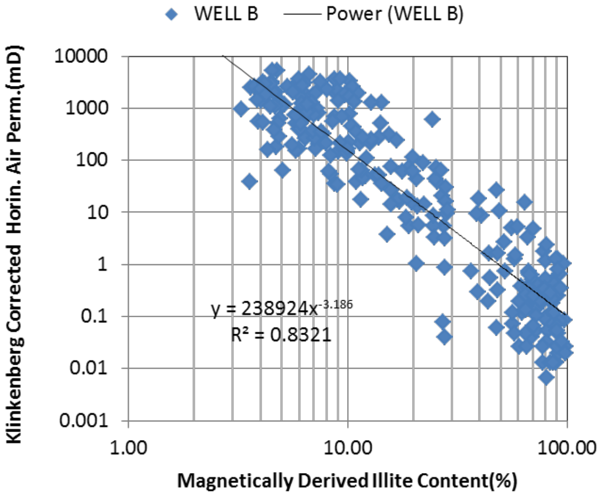

Figure 2:cross plot of MDI(%) vs Klinkenberg horizontal permeability (mD) for Well B.

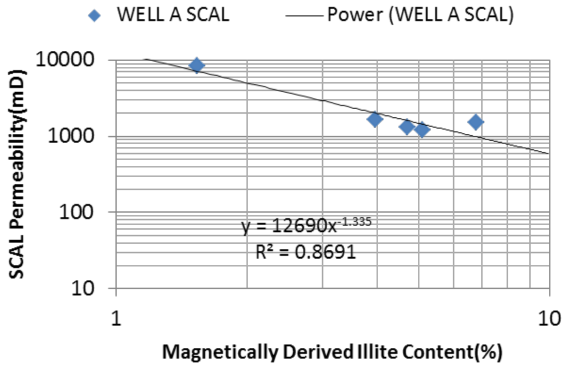

Figure 3:cross plot of MDI(%) vs SCAL permeability(mD) for Well A.

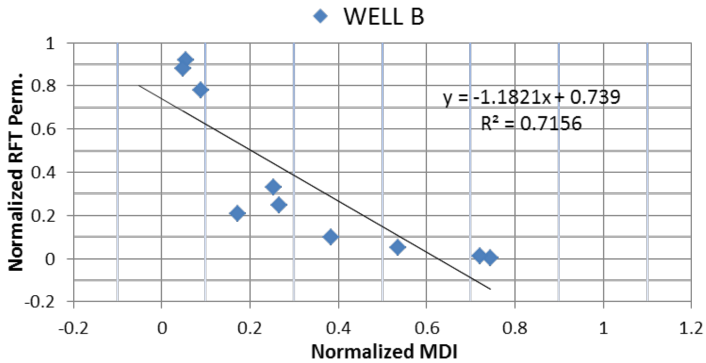

Figure 4:Cross plot of Normalized RFT permeability vs Normalized MDI for Well B.

Conclusions

Magnetic susceptibility Signatures proved viable as complementary tool for prediction of permeability in Sherwood reservoir of Wytch Farm oil field.

Predicted permeability ranges (0.2mD-5340mD) which falls within the range of actual permeability (0.1mD-6000mD) of Wytch farm. Therefore, the predicted permeability is accurate and geologically sensible.

References

Potter, D.K. and Ivakhnenko, O.P.2008. Clay Typing-Sensitive Quantification and Anisotropy in Synthetic and natural Reservoirs Samples Using Low – and High- Field Magnetic Susceptibility for Improved Petrophysical Appraisals. *Petrophysics*, vol.49, no.1, p.57-66.

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