MACHINE LEARNING TO PREDICT LARGE PORES AND PERMEABILITY IN CARBONATE RESERVOIR USING STANDARD LOGS

Abstract:

A study was conducted on more than 1000 wells across the Mishrif carbonate reservoir in the Rumaila field, located in Southeast Iraq, one of the giant reservoirs in the world. Whilst Rumaila has been producing for more than 50 years, there are billions of barrels yet to be recovered and Mishrif is anticipated to play a significant role in supporting field production for decades. Reservoir pressure has dropped due to historical production and large-scale water injection is being implemented to support and enhance future production rates and oil recovery.

One of the key subsurface challenges is to understand and characterise reservoir complexity and heterogeneity, with permeability being one of the key factors in understanding sweep behaviour and predicting production and injection rates. Rumaila has extensive surveillance programs and production logs, and saturation logs are used to refine static and dynamic models and to better characterise individual well performance. With more than 1,000 well penetrations to date, efficient management of wells is key to optimising production.

In 2020, a workflow was introduced (Ibrahim. B. Milad et. al., 2020) that utilised NMR logs, NMR core analysis and FZI techniques to predict large pores and permeability. The approach distinguished different pore types by estimating the relative proportion of large pores (Large Pores Index - LPI) from NMR data and using this as an input to prediction of FZI rock types and subsequently prediction of permeability. Results showed a significant improvement compared to more traditional approaches but could only be applied in modern wells with NMR data. The work presented in this paper extends this study to wells with no NMR, by using machine learning techniques, linear regression and python coding to predict changes in pore sizes and estimate the relative proportion of large pores in wells without NMR. The resulting Large Pores Index from Machine Learning (LPI_ML) was applied on more than 1000 wells to generate rock types and permeability estimates that demonstrate a significant improvement when compared with core data.

This improvement is reflected in better predictions of production and injection indexes, improved understanding of sweep behaviour and timing for water breakthrough across the field, leading to more optimal management of reservoir performance. Moreover, at a well level the new permeability model has resulted in enhanced completion decisions for well-work operations (additional perforation and re-perforation campaigns).

Bio:

Ibrahim B. Milad has 22 years of industry experience, he is currently a Senior Petrophysicist in BP. He studied Geology at Benghazi University 1998 and MSc.Geoscience at Herriot Watt University (2007). He worked as Geologist and Petrophysicist with Sirte Oil Company-Libya for 9 years. He then joined BP in 2009 and worked as Petrophysicist in a Libya exploration project, Access, and exploration (Australia, Spain and Iraq) and the Rumaila-Iraq project in several roles since 2012. Ibrahim is currently working for bp's global subsurface solutions team focusing on Middle East and Iraq. He is based in London.