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Petrophysical analysis of reservoir characterization for the Devonian-Mississippian lower middle Bakken member in the Viewfield pool, SE Saskatchewan

Kezhen Hu, Zhuoheng Chen,
Geological Survey of Canada, Calgary, Alberta
Chao Yang
Saskatchewan Ministry of the Economy, Regina, Saskatchewan

Abstract

The Viewfield Pool is located between TWP6-11 and R11W2- 6W2 in SE Saskatchewan (Fig.1). Over 2700 horizontal production wells with hydraulic fracturing have been drilled in the field with 174 new completions in 2013 (Kohlruss and Nickel, 2013; Cronkwright, et al., 2014). The main drilling target is Unit A, the lowest unit of the middle Bakken member, which mainly consists of dolomitic fine grained sandstone, dolomitic siltstone, and calcareous siltstone, with a small amount of silty wackestone (Christopher, 1961; Kohlruss and Nickel, 2009; Angulo and Buatois, 2011; Staruiala et al., 2013) (Fig.2). The Viewfield Bakken play has been described as a resource and/or unconventional play due to its extreme low permeability (Kohlruss and Nickel, 2012). The reservoir evaluation, such as accurate determination of porosity and permeability, has been always challenging because of the complexity of lithology and reservoir heterogeneity.

This study is based on conventional core analysis from 45 wells (Fig.3) and available advanced logging sets (e.g. nuclear magnetic resonance - NMR logs) from three wells acquired in the Viewfield pool. By a thorough analysis of conventional core measurements and NMR logs, we developed petrophysical models for unconventional reservoir porosity and permeability estimation using conventional well logs. Comparing computed porosity from well logs derived from the proposed approach with core porosity for the Unit A, the density model gives the best match, density-sonic model provides fair to good result, and single sonic log model gives reasonable porosity estimates. The NMR-based permeability equation (Fig.4) provides reasonable permeability estimation, which is comparable with core measurements.

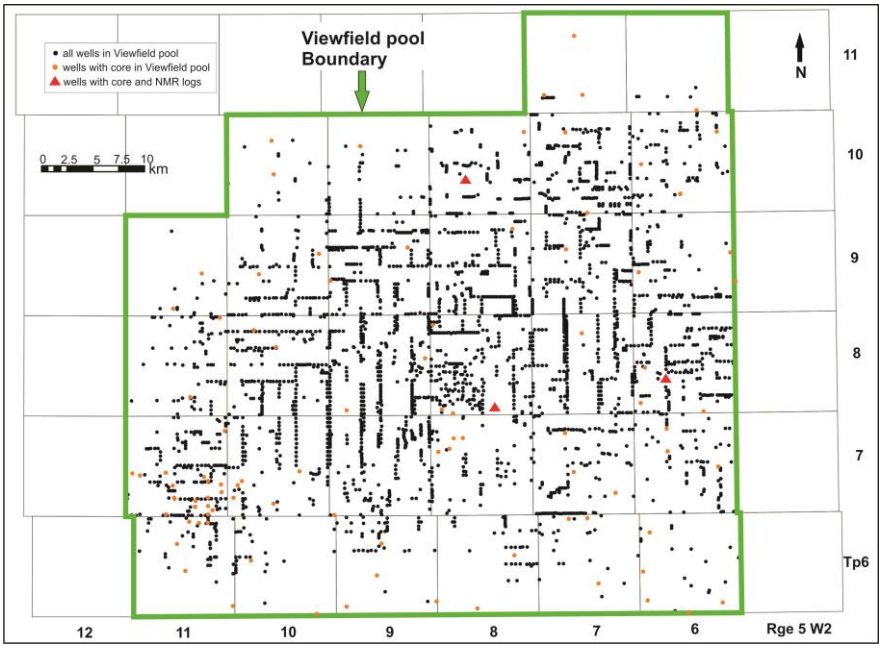

Figure 1. Map of the study area showing all the wells in the Viewfield pool in southeastern Saskatchewan (the Viewfield pool boundary is from Kohlruss and Nickel, 2013).

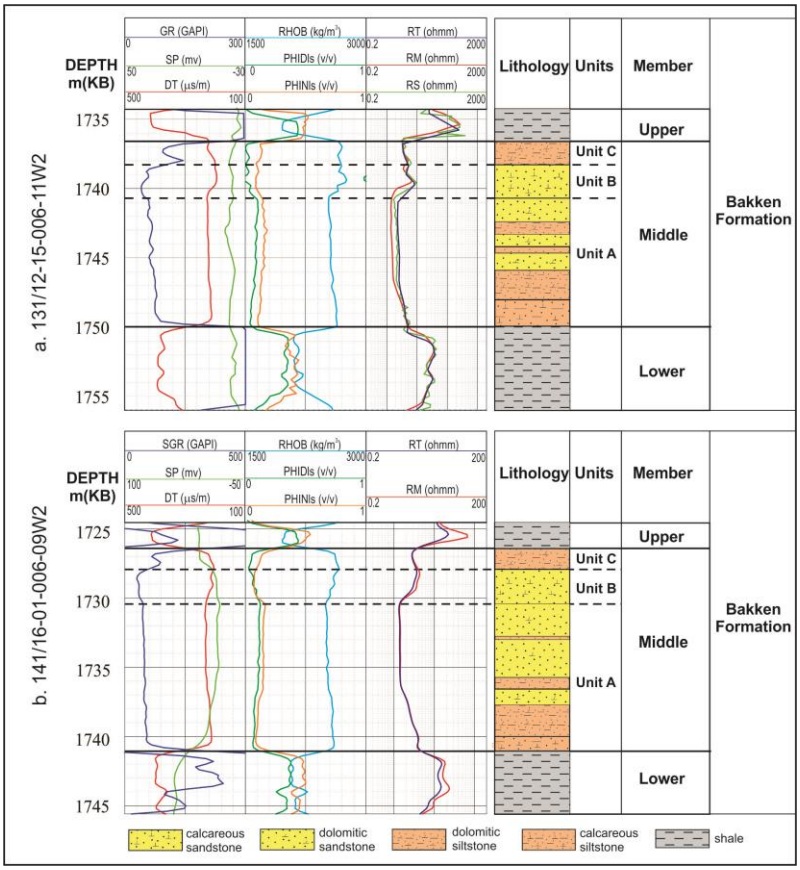

Figure 2. Examples showing log signatures on the Bakken Formation in the Viewfield pool of SE Saskatchewan. Unit A, B, and C, classified by Kohlruss and Nickel (2009), can be identified by using composite of well logs.

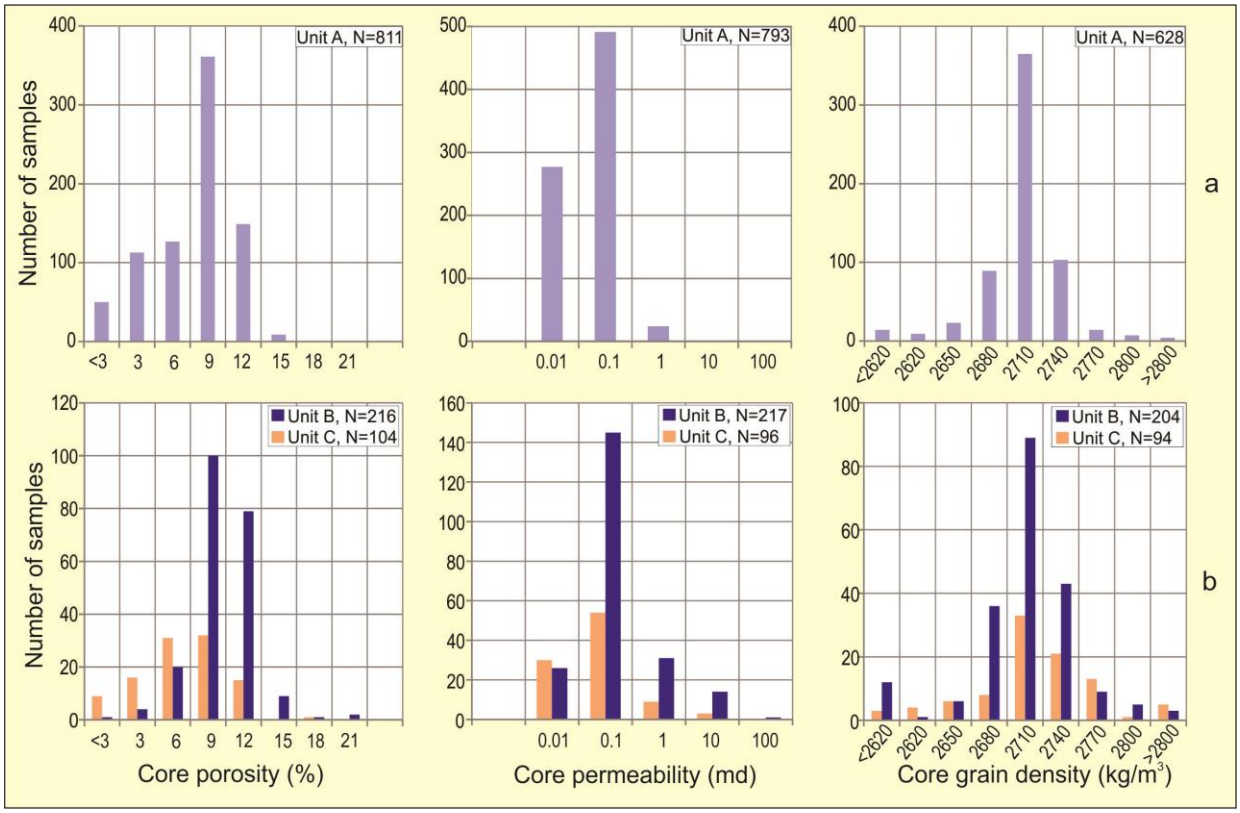

Figure 3. Distributions of core porosity, maximum permeability and grain density for the middle Bakken member in the Viewfield pool, SE Saskatchewan.

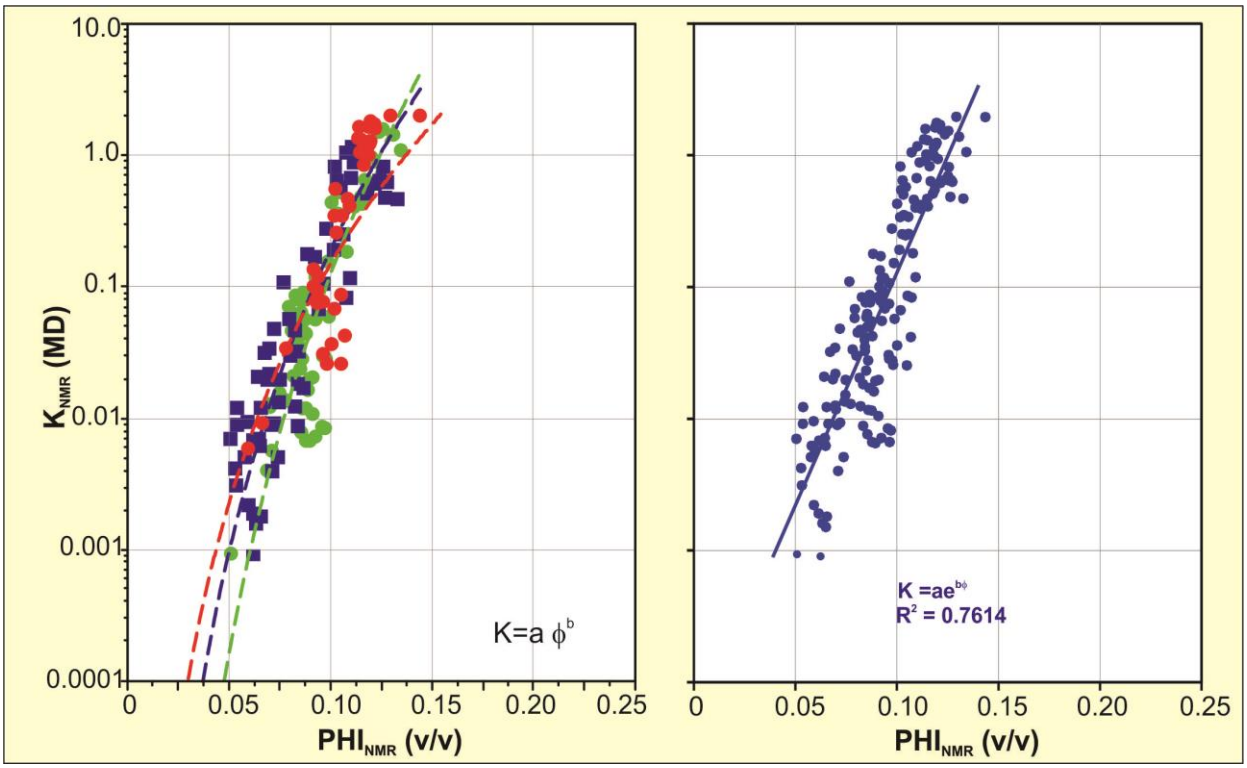

Figure 4. Good relationship exhibits between NMR permeability versus NMR porosity for the middle Bakken member from three wells in the Viewfield pool.

In this paper, we present the petrophysical models and demonstrate the method for porosity and permeability calculations from conventional logs through application examples of the middle Bakken reservoir in the Viewfield play. Correlations and distributions of basic petrophysical parameters are also discussed for the unconventional play in the Viewfield area.

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