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A Chemostratigraphic and Geomechanical approach for enhanced reservoir characterization and optimization from the Spirit River Group of the Western Canada Sedimentary Basin

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Summary

Using elemental data from core and rock cuttings a new approach for enhanced characterization and optimization has been developed and applied to the tight unconventional plays of the Lower Cretaceous Glauconitic and Wilrich-Falher members of the Spirit River Group in Alberta. A chemostratigraphic framework and mineral-derived rock mechanics indicate that the hydrocarbon producing Wilrich and Falher units have distinct and different geochemical signatures and varying geomechanical properties that can be utilised for geosteering and completion strategies.

Introduction

The Spirit River Group represents one of the most prolific reservoir successions in Alberta. Historically, the uppermost Falher 'A' and 'B' and Notikewan Members were the principal reservoirs, however new technology has extended production into the lower and 'tighter' Wilrich intervals. The key to enhanced production is a robust stratigraphic model for improved well bore placement and cost effective reservoir quality (RQ) modelling for hydraulic frac optimization using the latest geological data.

In this paper we present a workflow that not only presents a fresh look at the strata of the Spirit River based on elemental data from core and rock cuttings, but also the derivation of key rock mechanical properties.

Methodology

The workflow comprises four key steps: development of an initial geological and stratigraphic framework, acquisition of elemental data, mineral modeling and calibration, and derivation of geomechanical properties.

The first step is the development of an initial geological and stratigraphic framework based on wireline logs, core and well-log correlation.

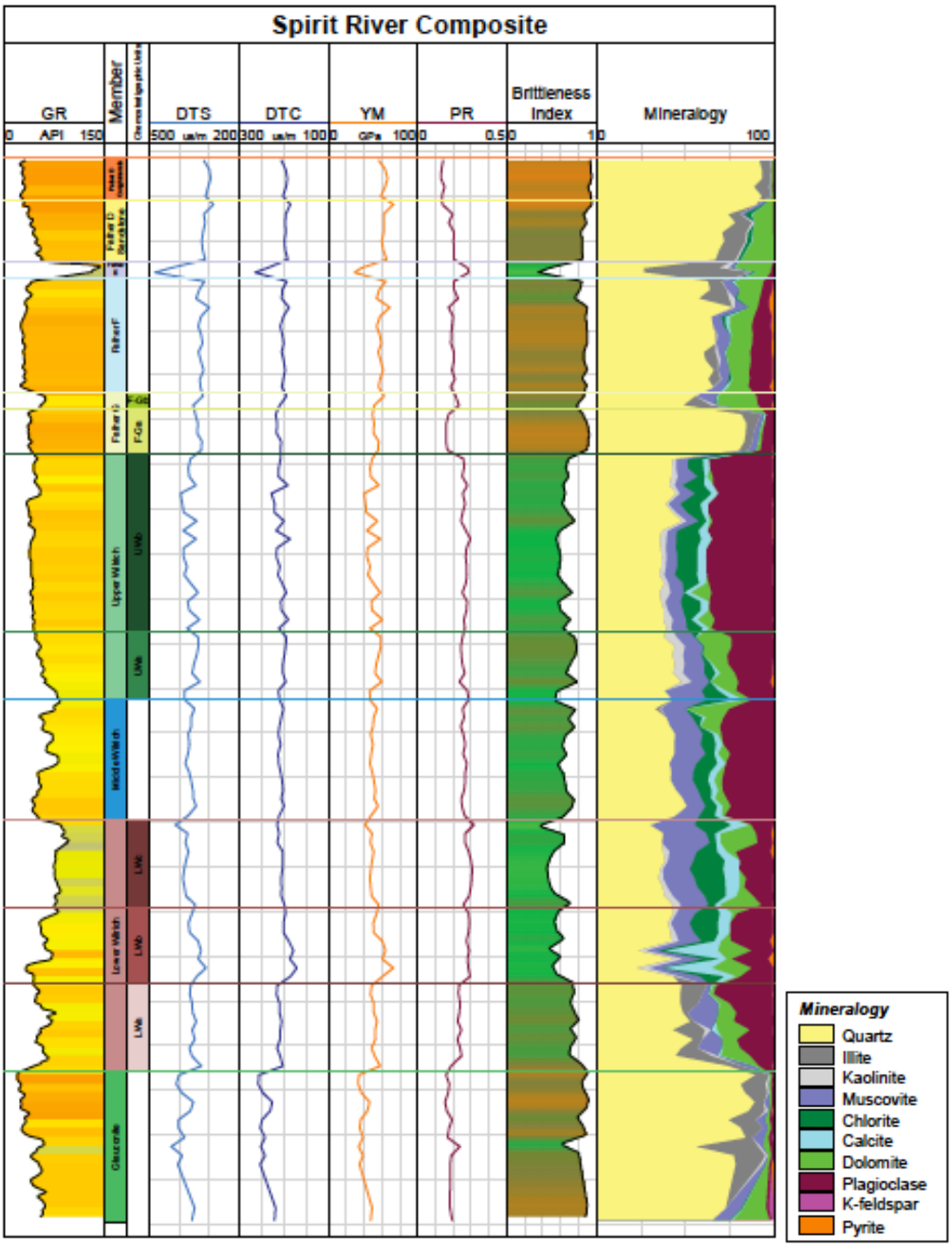
The next step is the acquisition of elemental data. This can be done on core and rock cuttings at wellsite using mobile XRF equipment or in the lab using XRF/ICP. The elemental data in this paper were acquired on core samples from seven wells and spliced together to form a representative composite section for the Spirit River. The elemental data were analysed and a chemostratigraphic framework was developed.

The following step is the creation of a mineral model from the elemental data. This model was checked and calibrated against XRD data. The final step in the workflow was the derivation of geomechanical properties from the mineral model. Compressional slowness (DTC), Shear slowness (DTS), Poisson's ratio (PR), Young's modulus (YM) and Brittleness Indices were produced.

Results

The chemostratigraphic analysis shows that the Glauconitic, Wilrich and overlying Falher units have different geochemical signatures and mechanical properties. The Wilrich sandstones are more lithic than those of the Falher and basal Glauconite, which are enriched in sodium (Na), iron (Fe) and rare earth elements. Significantly elevated sodium (Na) values are attributed to plagioclase abundance which appears to be a defining feature of the Wilrich member. By looking at the relationship between calcium (Ca), magnesium (Mg) and iron (Fe) we can better determine occurences of dolomite and chlorite. Higher iron oxide (Fe_2O_3) values in the Wilrich are indicative of chlorite, which is characteristically grain-rimming, preventing quartz overgrowths and keeps pore throats open. The boundary between the Falher and Wilrich is also defined by distinct changes in clay mineralogy, predominantly the relationship between illite/mica and kaolinite, heavy minerals and biogenic sillica.

The rock mechanical properties show subtle variations between the Glauconitic, Falher and Wilrich members. The more clay rich (as illustrated by elevated Al_2O_3 values) Wilrich is defined by higher DTC, DTS and Poisson's ratio and as a consequence is less 'brittle' than the more silica rich Falher, although both units could be considered "tight plays" in an unconventional sense.



Spirit River: Composite Geomechnical Properties

Conclusions

Elemental data can be used for multiple applications including stratigraphy, mineralogy, rock mechanics and reservoir quality for geosteering or completion optimization. The results of the analysis on select Spirit River cores indicate that the elemental data can confidently distinguish the Wilrich, Falher and Glauconitic units, which have very different geochemical signatures and geomechanical properties.

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