UNCONVENTIONALS

CASE STUDY

Ingrain Helped Quantify Organic Porosity and Predict Estimated Ultimate Recovery Using Cuttings

ZoneID® CALIBRATED HYDROCARBON PORE VOLUME ENABLES DEVELOPMENT OF ROBUST GEOLOGIC MODEL WITHOUT PILOT WELLS OR SIDEWALL CORING

EAGLE FORD SHALE, TEXAS

CHALLENGE

- In organic matter-supported resource plays, Gas Research Institute (GRI) calibrated petrophysics significantly overestimate effective porosity, resulting in significantly underestimated recovery factors
- Most of the hydrocarbon resource is likely to be stored in the porosity associated with organic matter (PAOM), which is not easily characterized with traditional formation evaluation techniques
- Due to budget constraints, the operator only had cuttings available for analysis from which advanced rock properties are challenging to obtain

SOLUTION

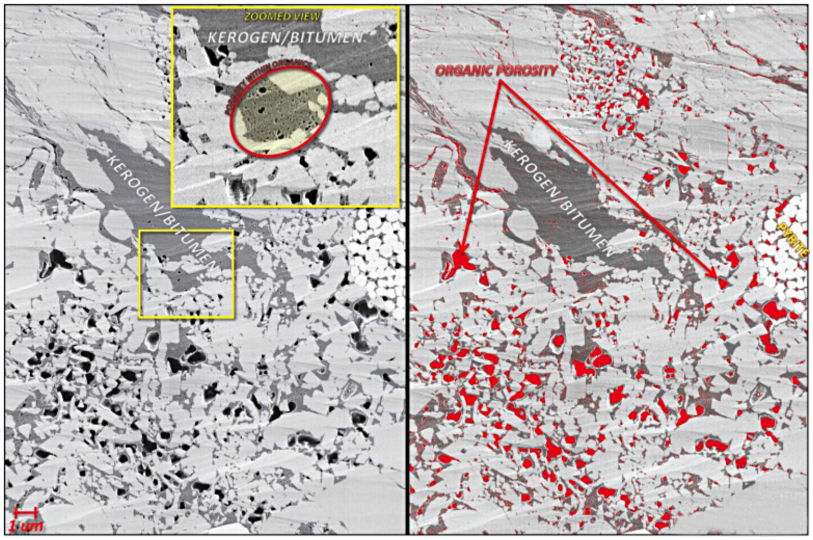
- Ingrain's ZoneID® service was used to quantify the distribution of the different volume fractions and pore morphology data sets on drilling cuttings, provide a direct measure of PAOM, and quantify apparent transformation ratio (ATR)
- PAOM was used to determine new hydrocarbon pore volume fractions (HCPV)
- Statistical analysis and empirical trends were built using apparent transformation ratio (ATR) and total organic carbon (TOC) to predict PAOM in offset wells where only TOC was available

RESULT

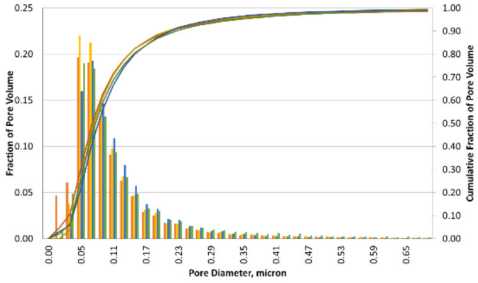
- The overall correlation of estimated ultimate recovery (EUR) vs. PAOM HCPV in this play was quite good considering all the factors that can affect recovery factor
- The ability to perform digital rock analysis (DRA) and Fourier Transform Infra-Red (FTIR) spectroscopy on drill cuttings provided a very economic platform to develop a robust geologic model without drilling pilots and taking core

OVERVIEW

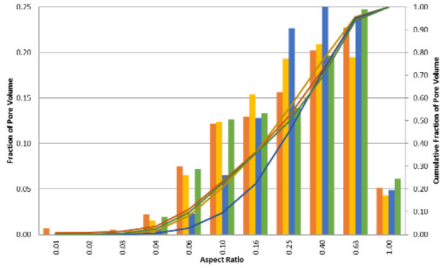
Ingrain's technology helped an operator in the Eagle Ford Shale build a more detailed delineation of the economic extent of the play using cuttings in a very short time frame. Specific input from the SEM analysis (ZoneID® service), porosity associated with organic matter (PAOM), pore size distribution, and aspect ratios that can also provide a model to calculate permeability were used to build a geologic model that correlated better to estimated ultimate recovery (EUR) calculations than Gas Research Institute (GRI) calibrated petrophysics.



Multiwell Total Pore Size Distribution



Multiwell Pore Aspect Ratio



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CASE STUDY

CHALLENGE

Based on this study, GRI-calibrated petrophysics overestimates effective porosity by 300% relative to PAOM determined from digital rock analysis (DRA), leading to questionable hydrocarbon pore volume calculations and recovery factors. This overestimation of effective porosity is believed to be from the inclusion of clay-bound water porosity using distillation-extraction GRI (crushed shale) analysis, while PAOM is assumed to be oil-wet and 100% oil saturated. Due to budget constraints, only cuttings were available for analysis; therefore, the ability to perform the ZoneID® service on drill cuttings from the laterals allowed the operator to keep the costs down relative to obtaining and evaluating full and sidewall core.

SOLUTION

Seventeen horizontal wells were chosen across the East Texas Eagle Ford play for SEM digital rock analysis (ZoneID service) and pyrolysis, providing a good spatial distribution for mapping. Fourier Transform Infra-Red (FTIR) spectroscopy data was gathered on the 17 in-depth study wells and on all 21 subsequent wells drilled by the operator, giving a more granular data set to map total organic carbon (TOC) and clay content. The amount of organic matter from SEM analysis (confirmed with FTIR) is used to calculate the apparent transformation ratio (ATR) of the organic matter, which correlates reasonably well with thermal maturity data from programmed pyrolysis tests across the oil window portion of the play. These inputs, in addition to a resistivity-constrained height (H), were then used to calculate volumetrics.

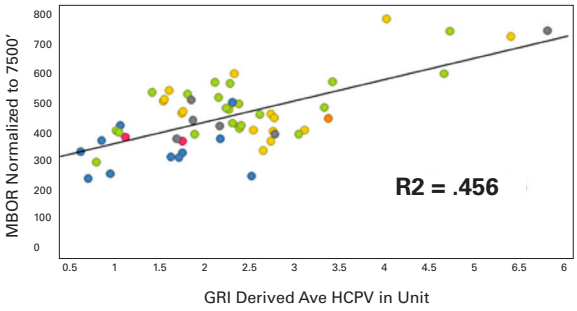
More information about this case study can be found in URTeC paper 2662352, *Quantifying Organic Porosity and Predicting Estimated Ultimate Recovery (EUR) in the Eagle Ford Formation.*

RESULT

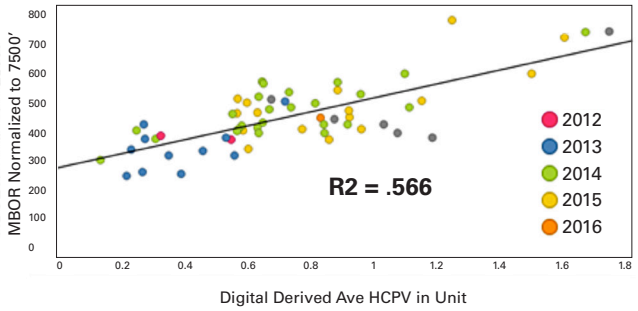
An improved correlation to EURs was found with ZoneID SEM derived directly from measured PAOM where S_o is assumed to be 100%, relative to the GRI-calibrated indirectly measured petrophysical model that corrects for clay-bound water. In response to the assumption that there is missing fracture porosity, please refer to the SEM figure. Additionally, continuous upscaling from 3-nm resolution to full core suggests that microfractures or maturation expansion fractures are not significant in this play.

The ability to perform DRA and FTIR on drill cuttings provided the client with a very rapid and economic platform to develop a robust geologic model in the Eagle Ford play without drilling pilot wells and taking core in this area.

EUR vs GRI Calibrated HCPV



EUR vs Digital Calibrated HCPV



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