Defining and Targeting Pay in Colorado Group Gas Shales, East Central Alberta

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Summary

The Colorado Group mudstones and shales of east Central Alberta locally produce economic quantities of natural gas. To understand and optimize exploitation of this resource, a robust core-calibrated log model was developed to find regions and strata that have sufficient gas-in-place and favorable geomechanical properties to facilitate optimum exploitation.

Introduction

The Colorado Group frequently shows hydrocarbon response on mud logs throughout the entire column. A core testing program was designed to quantify the distribution of gas-in-place, determine quantities of free and absorbed gas, determine fluid saturations and to quantify related rock mechanical properties. The Colorado Group is generally very soft and ductile. Relative rock brittleness is likely to be as important as free gas in the selection of potential completion intervals.

This paper outlines the work-flow undertaken in a three (3) well project designed to characterize the Colorado Group through the analysis of 675m of core and the resulting derivation of a common core-calibrated log model. The model was then applied to over 3600 wells covering a 228 township area to assess stratigraphic and geographic trends. The model was field-tested using 20 completions in four pilot wells.

Method

Three vertical wells were drilled, cored and cased through the Colorado section (~225m per well). Cores underwent laboratory testing to quantify geological, geochemical and geomechanical properties.

Core analysis tests were performed at consistent intervals to reduce sampling bias and maximize objective data collection to provide critical calibration data. Analysis included:

a. Shale rock properties (crushed rock porosity, permeability, fluid saturations, regain permeability);
b. Gas content (Adsorption and desorption testing);
c. Source rock properties (vitrinite reflectance, pyrolysis);
d. Petrology (thin section, XRD, SEM);
e. Geochemistry (gas analysis, isotopes);
f. Geomechanical (tri-axial, roller oven, Brazil, modified ring).

A total of 24 completion intervals were selected in the cored wells to test a range of variables and observe the resulting fracture behavior.

The data from each well was used to create core-calibrated log models, from which a common log model was created and applied over a large region. Trends showing free gas-in-place and rock brittleness (determined from mineralogy) were used to guide the selection of four pilot wells in which a total of 20 completion intervals tested the range of variables to confirm the applicability of the model.

Observations

The modeled gas saturation and rock brittleness vary both stratigraphically and geographically. These characteristics may be reflective of geological heterogeneity evident both in micro-scale bedding features observed in thin-sections, and large scale clinoform structures identified using well log correlations. Perforating response in pilot wells correlates positively to intervals exhibiting higher free gas saturation and brittleness. The log model appears to be accurate over a wide region.

Water saturation is very high (including structural, bound and any free-water components). Accurate determination of water content (S_w) is difficult and has a significant leveraging effect on determining accurate gas content. A 5.6% adjustment in S_w (from 90% to 95%) results in a corresponding gas content decrease of 50%.

Conclusions

A common core-calibrated log model for the Colorado Group appears to be accurate over a wide region. Identification of higher concentrations of free gas is supported by perforation response in the pilot wells. Areas of enhanced rock brittleness were not conclusively demonstrated to provide consistently better fracture behavior due to shale heterogeneity and uniform in-situ principle stresses.

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