

Rock-Eval pyrolysis and lithofacies characterization of the Kee Scarp/Canol contact in core (Norman Wells P32X, Devonian, Northwest Territories)

Mikhail Yakunin, undergraduate student, University of Calgary/Geological Survey of Canada

Pavel Kabanov, Geological Survey of Canada

Introduction

The Norman Wells oil field is located in the Mackenzie Plain of the Northwest Territories. It was discovered by Imperial Oil LTD in 1920. The reservoir rock (Kee Scarp Formation) is a Middle Devonian reef where conventional oil production has currently stopped (R.H. Kempthorne and J.P.R Irish). One of the source rocks was established to be the Canol Formation which occurs below and above the Kee Scarp reef. The bituminous shales of the Canol Formation cores were characterized using the Rock-Eval pyrolysis technique to identify the hydrocarbon potential of the rock. Currently the shales in the Mackenzie Plain are thoroughly studied to find good source rock for production of unconventional hydrocarbons (L.P. Gal and L.J. Pyle).

Material and Methods

The core from the Canol and Kee Scarp Formations of the well Norman Wells P32X was measured and sampled with NEB permission in the fiscal year of 2012-2013 (Kabanov, 2013). Thirteen Rock-Eval VI pyrolysis samples were done across the boundary of Kee Scarp Limestone and Canol Shale 755m MD (Kabanov, 2013). The Rock-Eval pyrolysis is very accurate for identifying the type and maturity of organic matter. Samples were collected from the core interval 753.0 - 758.1 m. The results of pyrolysis for each sample were plotted on a pyrogram where each peak of the curve represents a certain stage of the experiment.

Lithofacies

The strata of the Norman Wells subsurface reef complex are of Givetian - Frasnian age. The Hare Indian, Ramparts (also known as the Kee Scarp), Canol and Imperial formations make up the reef complex and consist of limestones, shales and sandstones. (Muir et al. 1984) The Hare Indian Formation is made up of the Bluefish Member consisting of black shales and the overlying Upper Member consisting of green shales and thin bedded limestones. The Ramparts Formation lies on top and is made up of the Shale Ramp in the lower portion and the Kee Scarp reef itself in the upper portion consisting of dark shaley limestone of the Carcajou Marker and the overlying limestone beds. The black shales of Canol Formation are deposited adjacent to the reef which onlap and drape over the reef. The shales and sandstones of the Imperial Formation overlies both the Kee Scarp reef and the Canol Formation. These deposits show that there were two major cycles of sedimentation during the build-up of this reef structure. The first major cycle includes the Hare Indian Formation and the Shale Ramp of the Ramparts Formation. The second major cycle includes the rest of the Ramparts Formation starting from the Carcajou marker as well as the Canol and Imperial Formations. The Ramparts Formation is of our greatest interest and according to Muir et al it consists of six facies – Shoal Limestones, Basin Foreslope-Toe Limestones and Shales, Foreslope Limestones, Reef Margin Limestones, Reef Flat Limestones and Reef Interior Limestones. These facies that can be distinguished based on rock textures, sedimentary structures and fossil assemblages (Muir et al. 1984) All of these characteristics will be talked about with more details later on.

Results of Pyrolysis measurements

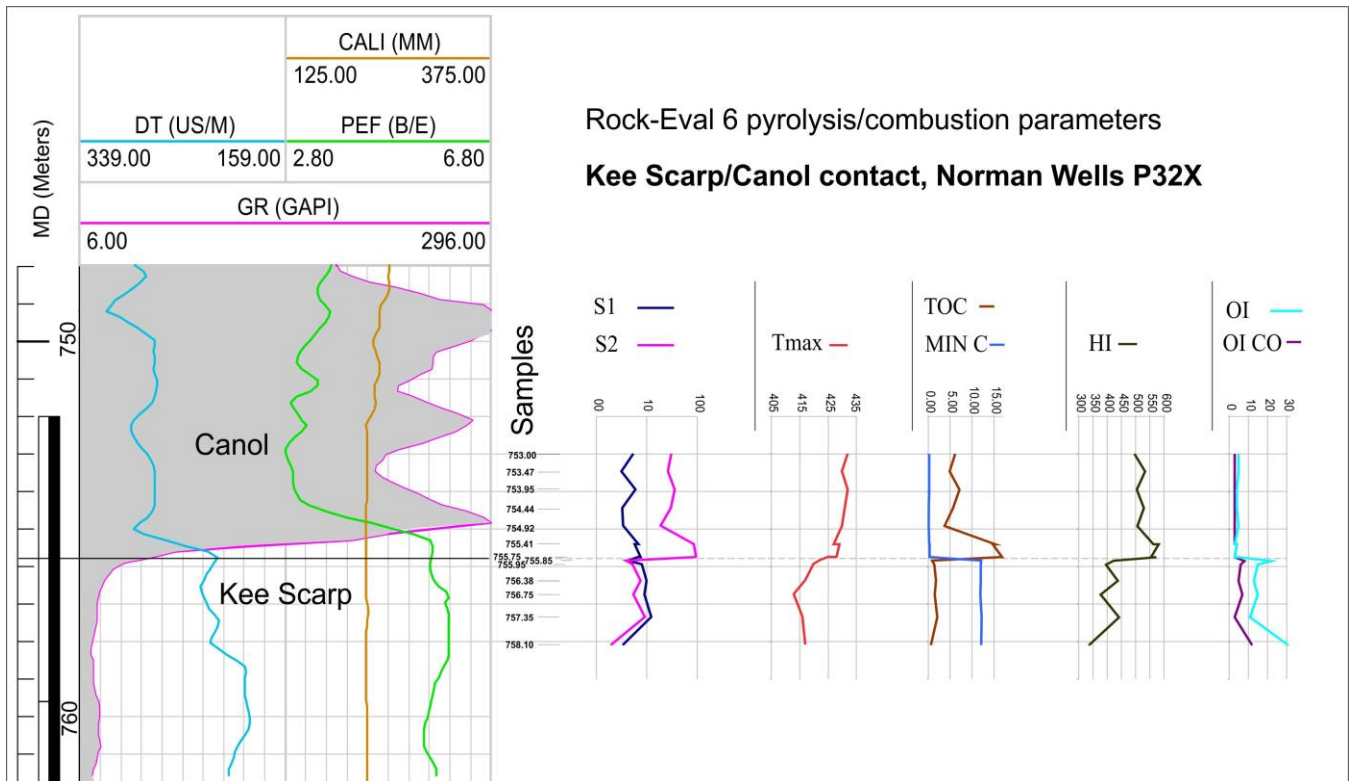


Fig. 1 Log section of Well Norman Wells P32X

The key parameters of the Rock-Eval pyrolysis measurements are shown against the log section on Figure 1. Such high TOC values (Median of 3.65%, average 1-8%) illustrate that Canol Shale could have very good hydrocarbon potential (Gal and Pyle 2012.) The hydrogen index (HI) also differs between the Canol Shale and Kee Scarp. The values are typically higher for the Canol formation. The Pseudo-van Krevelen cross plot of the HI vs OI for Canol Shale shows that the Canol Fm is a Type II (oil-prone) kerogen rich rock with traces of Type III (gas-prone) Kerogen. The Rock-Eval data corresponds with the Gamma, Interval Transit Time and Photoelectric Effect Factor Logs.

Conclusions

Our data concur with the results of ongoing exploration campaigns targeting the Canol Formation as a high quality source rock and tight reservoir. The base of the Canol Shale in the studied core contains abundant Type II kerogen and also contains some Type III kerogens, making testing for the formation oil and gas prone. This means that the Canol Shale thermally is mature and lies within the oil window.

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