

**PS An Integrated Methodology for Source Rock Characterization at
Different Thermal Maturity Levels to Better Estimate
In-Situ Liquid Hydrocarbons***

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Abstract

An integrated methodology to better estimate in-situ liquid hydrocarbons in potential self-contained source-reservoir rocks is proposed in this paper. The workflow first starts with sedimentology, sequence stratigraphy and basin analyses to define both rock heterogeneities and major time intervals of the entire sedimentary basin. High resolution correlations provide the frame to select time equivalent samples from a specific source rock interval. Spatial and temporal source rock characterization are addressed for better assessing the main source rock properties in a given basin and its local specificities. Once selected the samples, advanced laboratory characterization is mainly focused on the evolution of the traditional open-system pyrolysis methods and compares classical applications with new approaches recently developed for characterization of liquid rich rock samples. To obtain a better assessment of hydrocarbons still present within these rock samples, a specific pyrolysis program is then applied to characterize source-reservoir rock units: the Rock-Eval® Shale Play™ method. The Sh0, Sh1 and Sh2 parameters are used here to obtain a better quantification of free and adsorbed hydrocarbons, more accurate Rock-Eval T_{max} values for in-situ liquid hydrocarbon samples and correct original oil in place (OOIP) estimations of play oil assessment. An analytical methodology to identify potential producible free liquid hydrocarbons intervals in early exploration campaigns evaluating the thermal peak areas obtained before and after organic matter isolation is also tested in this integrated workflow. Furthermore, the evolution of kerogen bulk-kinetics is studied as a function of the thermal maturity (e.g. activation energy distribution and frequency factor). The proposed approach is additionally combined with CT-scanner, Nuclear Magnetic Resonance (NMR), He/NMR porosity and gas permeability measurements to predict potentially producible “free” oil intervals and pore network attributes in source-reservoir rocks. This methodology has been developed and tested at the IFPEN laboratory on different worldwide liquid-rich rock samples. Main results are illustrated here on a dataset derived from the Montney and Doig (Canada), Vaca Muerta and Yacoraite (Argentina) Formations to compare marine Type-II versus lacustrine Type-I kerogens. The effect of the structural setting, age, duration and depositional system on source rock potential is finally discussed.

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AN INTEGRATED METHODOLOGY FOR SOURCE ROCK CHARACTERIZATION AT DIFFERENT THERMAL MATURITY LEVELS TO BETTER ESTIMATE IN-SITU LIQUID HYDROCARBONS

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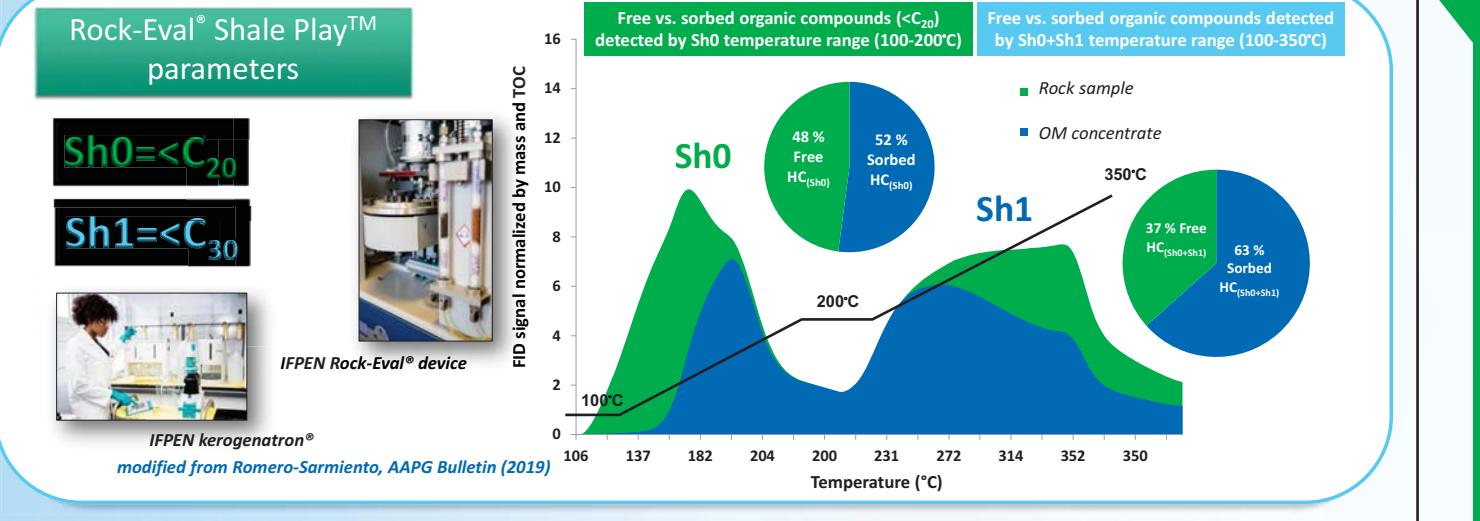
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Introduction

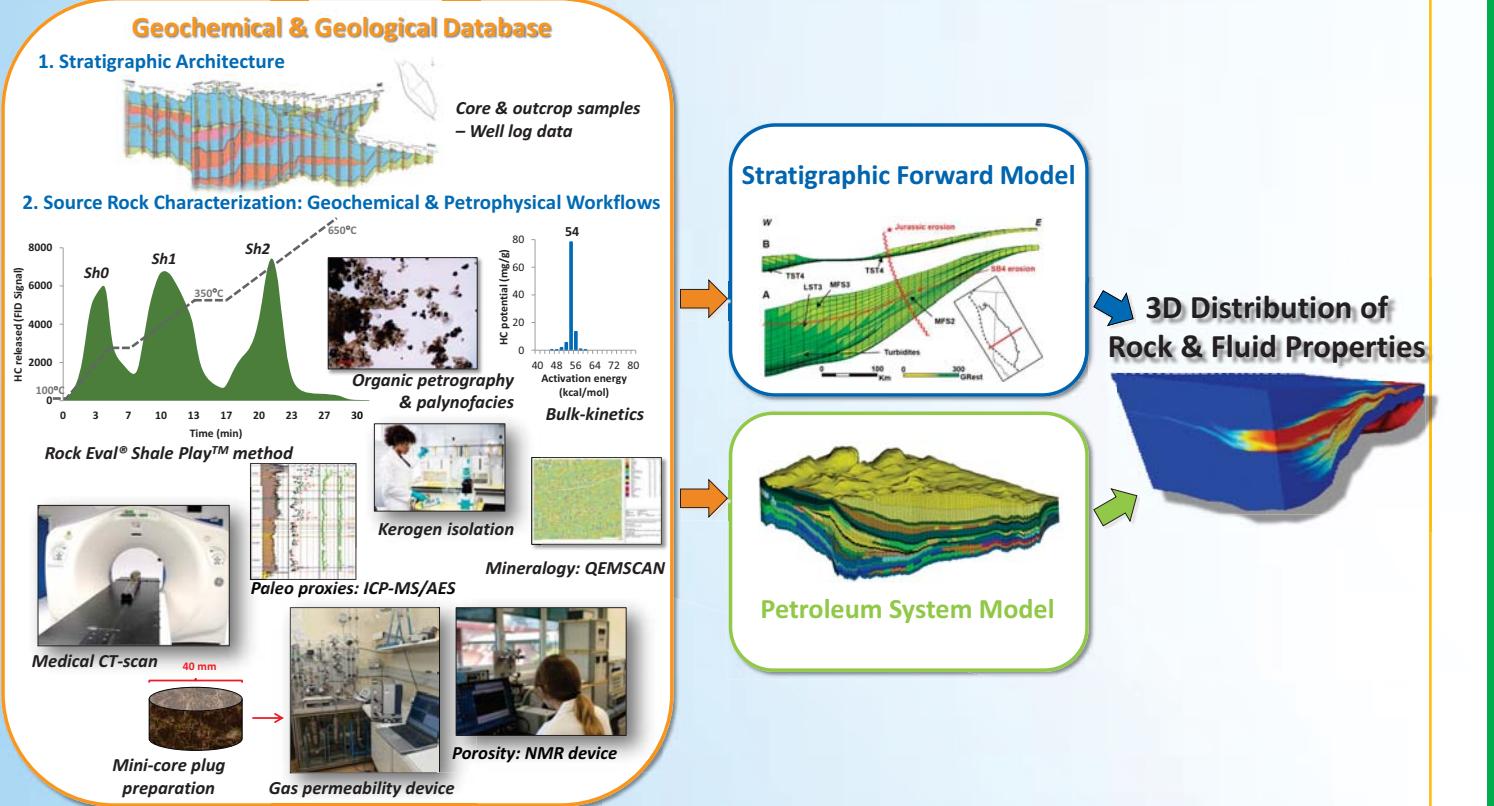
PROBLEMATIC: How to better estimate in-situ liquid hydrocarbons?

An integrated methodology to better estimate in-situ liquid hydrocarbons is proposed here. The workflow first starts with **sedimentology, sequence stratigraphy and basin analysis** to define both rock heterogeneities and major time intervals of the entire sedimentary basin. Then an **advanced source rock characterization** is performed including an analytical approach to identify potential producible free liquid hydrocarbons intervals evaluating the thermal Rock-Eval® Shale Play™ peak areas obtained before and after organic matter isolation.



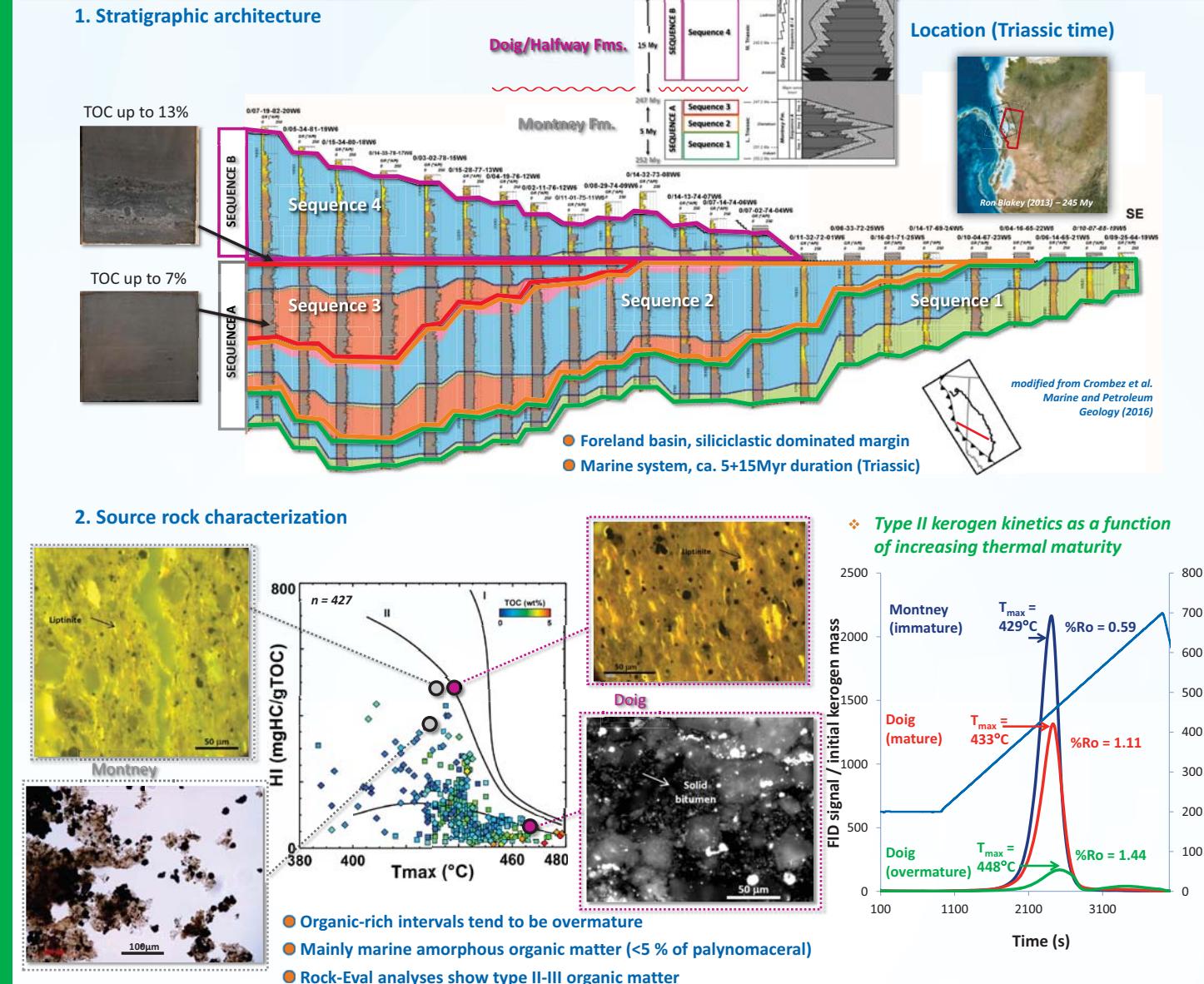
Method

Study embedded into a robust and integrated workflow



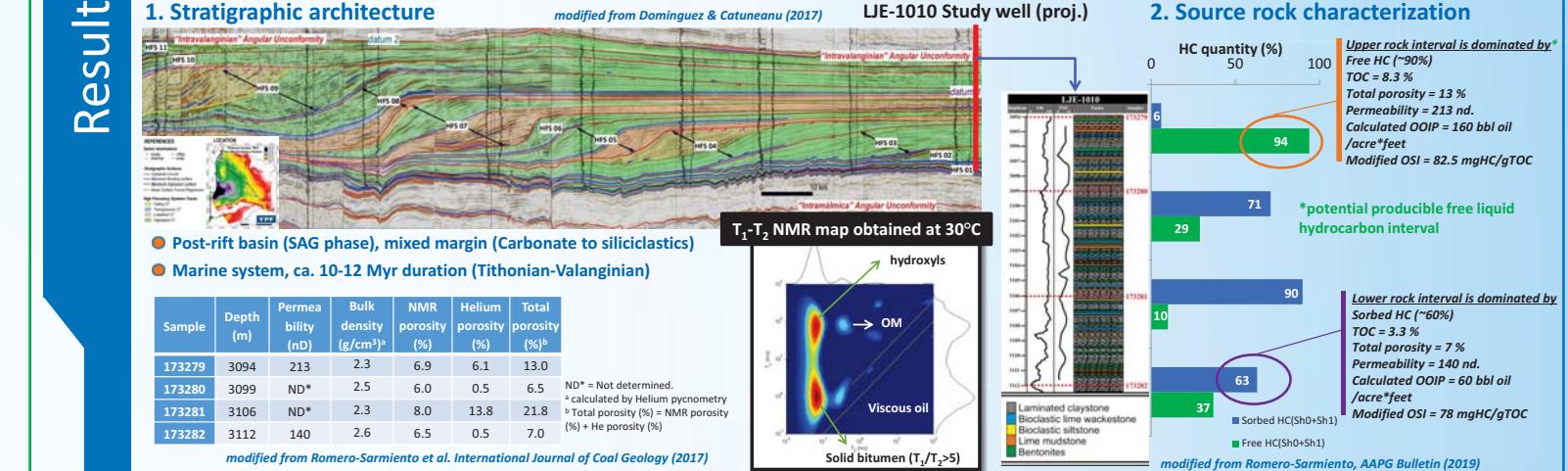
Results

Insights from the Triassic Montney-Doig Formations - Western Canada Sedimentary Basin

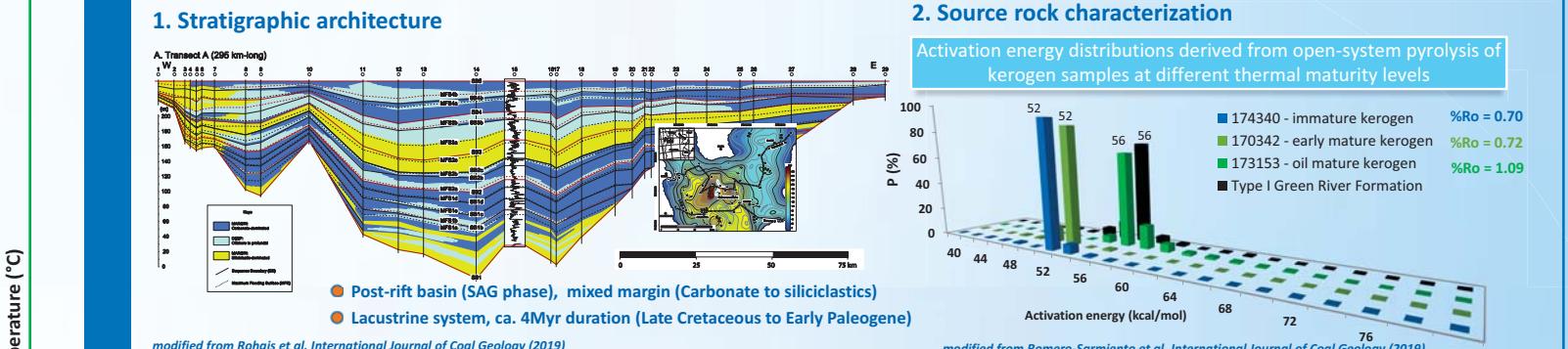


Results

Insights from the Vaca Muerta Formation - Neuquén Basin (Argentina)



Insights from the Yacoraite Formation - Salta Basin (Argentina)



Conclusions

- Structural setting, age, duration and depositional system play a main control on source rock properties for a given basin.
- Type II & I kerogen kinetics show both an increasing activation energy and loss of petroleum generation potential as thermal degradation proceeds.
- Sh0 & Sh1 parameters can now be used to obtain an improved estimate on the presence of oil in place (Accurate OOIP estimations).
- The integrated approach could be used to identify potential producible free liquid hydrocarbons intervals in early exploration campaigns.
- This methodology can be applied to all kind of sedimentary rock samples containing well-preserved liquid hydrocarbons.

ACKNOWLEDGEMENTS

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