# SOURCE ROCKS CHARACTERIZATION FROM VACA MUERTA FORMATION: IMPLICATIONS FOR UNCONVENTIONAL PETROLEUM RESOURCE ESTIMATIONS

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The Vaca Muerta Formation is currently regarded as the most prolific source rock interval for unconventional petroleum exploration in Argentina. In this study, we combine geochemical and petrophysical techniques to characterize these source rocks along a vertical profile. The investigated samples are derived from borehole LJE-1010 drilled in the Lowermost Jurassic Vaca Muerta Formation (Neuquén Basin – Argentina). First, all rock samples were analyzed by dual energy CT scanner to evaluate possible heterogeneities; this also helped in representative sample selection. Then the organic matter properties were investigated by organic petrography, open-system pyrolysis techniques (e.g. Rock-Eval Shale Play method vs. Source Rock Analyzer) and biomarker analyses as a function of the core depth. Finally, petrophysical characteristics and pore network attributes in shale were estimated by gas permeability (steady state method corrected for Klinkenberg effect) and Nuclear Magnetic Resonance (NMR) methods. All samples have oil-window maturity and are characterized by a network of solid bitumen. Based on Rock-Eval Shale Play data, the potentially producible oil present in the rock samples was estimated using the modified oil saturation index (OSI; Fig. 1).

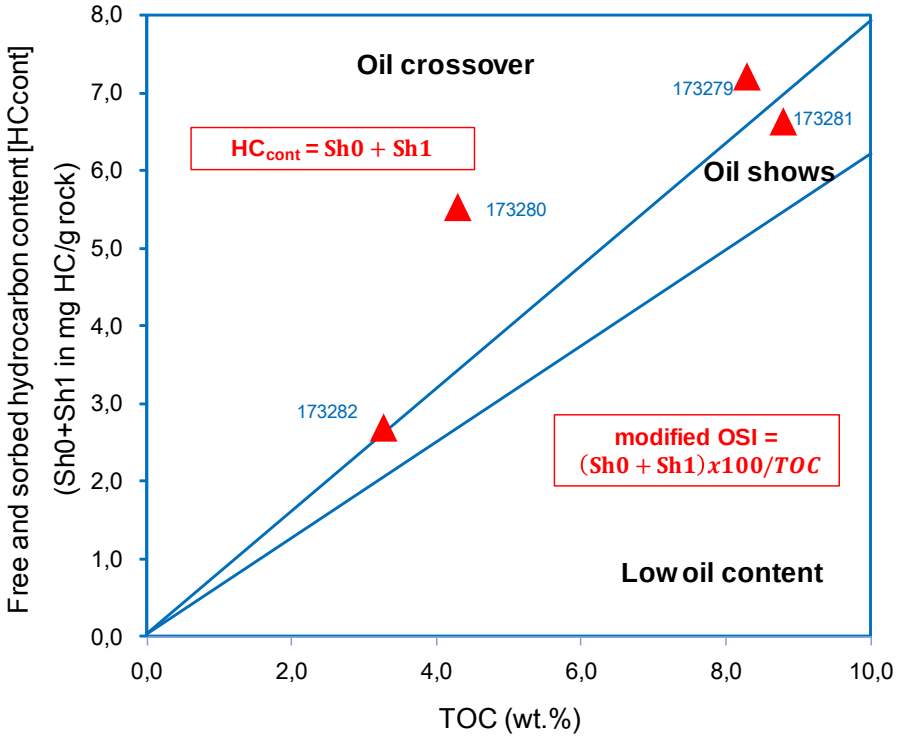


***Figure 1*** *Free and/or sorbed hydrocarbon content [HCcont] vs. TOC content from Vaca Muerta source rock samples (modified from Romero-Sarmiento et al., 2016).*

Results indicate that the oil crossover effect and potential productive oils occur within intervals showing higher TOC values (~ 4 & 8 wt.%). Most studied samples show an excellent oil-generation potential. We also demonstrate here that, using advanced NMR techniques ($T_1$-$T_2$ maps; Fleury and Romero-Sarmiento, 2015), the various hydrogen nuclei can be identified non-destructively and linked to Rock-Eval Shale Play data. Solid bitumen, oil and kerogen were clearly distinguished in the studied samples using $T_1$-$T_2$ maps obtained at different temperatures. Concerning the matrix bulk rock permeability, the presence of micro-crack originating from the stress release after in-situ coring may lead to severe overestimated permeability values. To avoid that, these fractures were therefore filled by epoxy resins and the obtained results showed that most deep samples are characterized by a permeability around 100 nanoDarcy (nD) whereas shallower samples containing also lower amounts of organic matter are more permeable (~250 nD).

## References

Fleury, M., Romero-Sarmiento, M.-F., 2015. Characterization of shales using $T_1$-$T_2$ NMR maps. Journal of Petroleum Science and Engineering 137: 55-62.

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