

Source rock and Geochemistry of the Central Atlantic margins: Geochemical characterization of Lower Jurassic organic-rich facies offshore Ireland

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1.Introduction

The Slyne Basin, a narrow Mesozoic basin located offshore Ireland, has been the subject of significant exploration with proven commercial hydrocarbon discoveries (fig. 1). While the Corrib gas field within the Slyne Basin is sourced from Westphalian Coal Measures, Lower Jurassic intervals are viable hydrocarbon source rocks of regional significance in the Irish offshore.

Stable carbon isotope chemostratigraphy is a tool with a high potential to characterize organic-rich facies. It can be applied to characterize and/or to trace changes in the various hydrocarbon reservoirs, from continental environments and atmosphere to oceans and organisms. In marine environments, and particularly in epeiric sea settings, these processes are governed by the complex interplay of local (different carbonate producers, transgressive–regressive cycles) and/or global (worldwide preservation of organic matter, variation of continental weathering, input of volcanogenic light CO₂) mechanisms (e.g. Silva et al., 2015).

This study is based in the reanalysis of the existing and available organic geochemistry dataset, but it also include the acquisition of novel geochemical data of selected cores and cuttings, and integration with known time-equivalent source rock outcrops in conjugate margins, namely Canada, Southern UK, Morocco, Portugal, and Spain.

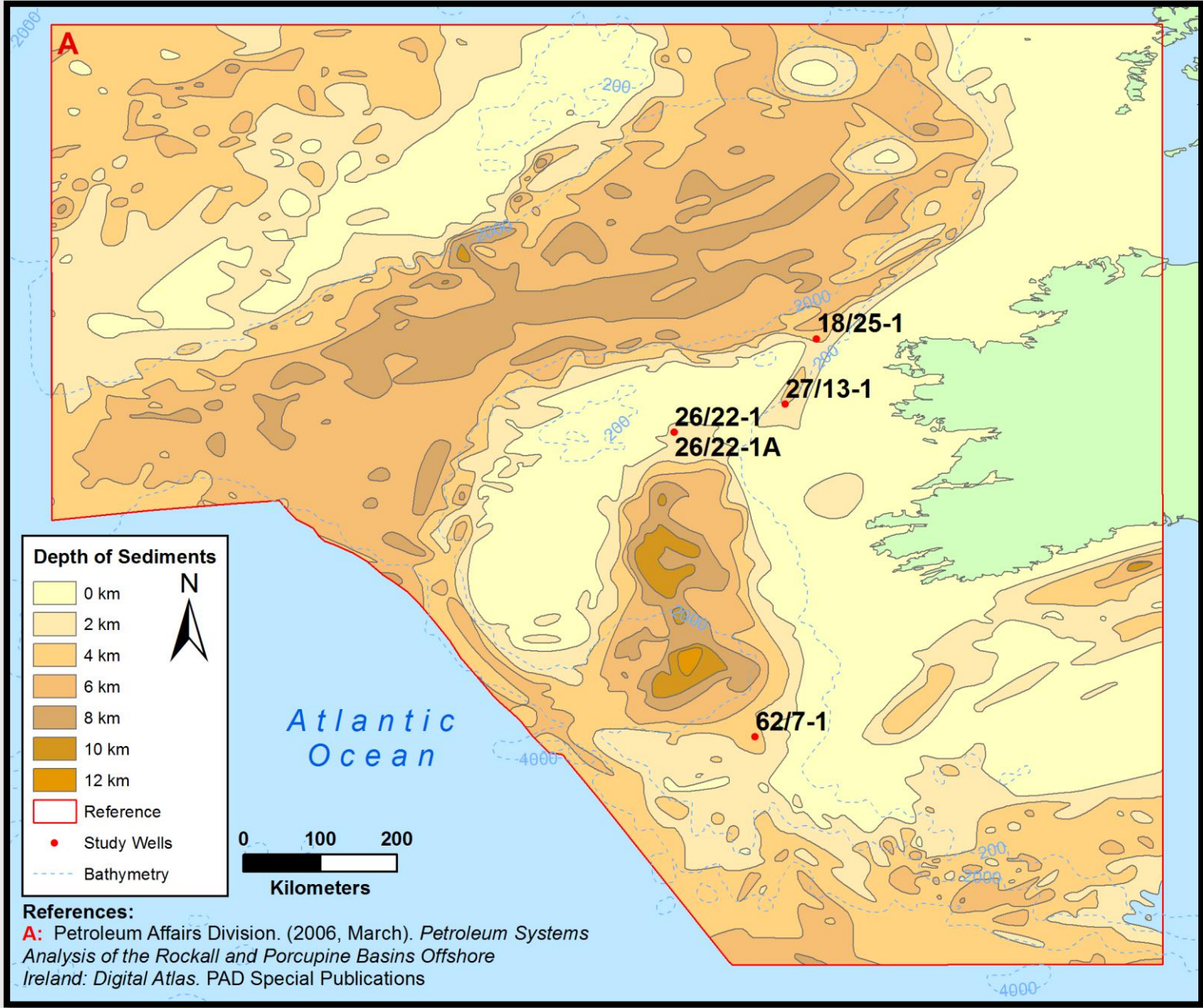


Figure 1: Depth to Basement and Offshore Wells Sampled

2.Materials and methods

In this study, we have analysed 17 cuttings samples from the interval between 2610– 2824 m of the well 18/25-1 (Slyne Basin) for elemental geochemistry, carbon and oxygen stable isotopes and calcareous nannofossils (fig. 2).

X-Ray Fluorescence was used to determine elemental composition, and thus determine depositional environment and conditions. Selected cuttings were analysed by Continuous Flow–Isotope-ratio Mass Spectrometry (carbonates) and Elemental Analysis- Isotope-ratio Mass Spectrometry (organic matter) to determine ¹³C/¹²C ratio and calculate δ¹³C, while calcareous nannofossils were determined using standard techniques.

3.Results

δ¹³C in carbonates varies from -5.16 to 2.22 ‰. A negative trend is observed from 2610 m to 2664 m. The determined δ¹³C tends to more positive values. The δ¹³C values determined in organic matter presents less variation: a negative trend is observed from 2610 m to 2688 m (-6.65 ‰) followed by a generally positive trend from 2694 m to 2824 m (+6.00 ‰). These δ¹³C range from -28.23 ‰ to -25.52 ‰.

Molybdenum values range from 6.791 ppm to 12.096 ppm while Uranium values range from 1.069 ppm to 1.614 ppm. CaO / Al₂O₃ values range from 0.218 to 8.386.

This interval has been dated as Aalenian – Hettangian/Upper Sinemurian, with Toarcian intervals confirmed by visual identification of calcareous nannofossils.

4. 18/25-1 Discussion and integration with previously acquired & published data

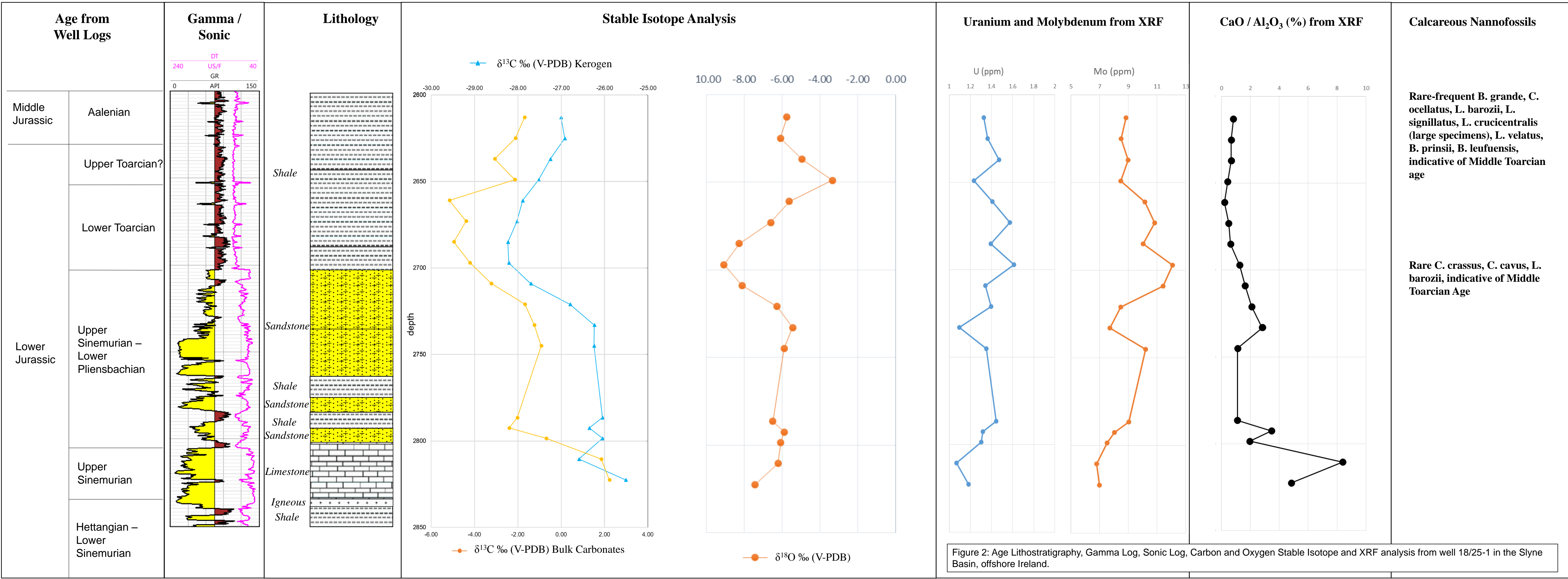


Figure 2: Age Lithostratigraphy, Gamma Log, Sonic Log, Carbon and Oxygen Stable Isotope and XRF analysis from well 18/25-1 in the Slyne Basin, offshore Ireland.

5.Final remarks

Of special interest in the Irish context are the Sinemurian–Toarcian organic-rich shales (e.g. Shannon et al., 2007), previously identified as being candidates for source rock in basins surrounding Ireland (PAD, 2006).

The obtained data is in the process of integration with pre-existing Total Organic Carbon, pyrolysis Rock-Eval and Vitrinite Reflectance data, in order to evaluate the origin of organic matter and potential to produce hydrocarbon. The negative excursion of the carbon isotope and oxygen isotope signature is thought to correspond to the T-OAE, while Molybdenum and Uranium content may indicate seawater conditions at the time of organic carbon development. Wells are composed mainly of shales, straying into the Wacke sub-type in some samples. As the samples become more sandy in signature, a change in depositional setting may be indicated (Herron, 1988). Noticing that the shale makeup is almost iron-rich is significant in determining depositional environment.

Ongoing investigation will discern the conditions that lead to the occurrence of this organic-rich facies offshore Ireland.

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Algeo, T.J., and N. Tribouillard, 2009. Environmental analysis of paleoceanographic systems based on molybdenum-uranium covariation. *Chemical Geology*, 268, 211–225.

Herron, M. M., 1988. Geochemical classification of terrigenous sands and shales from core or log data. *Journal of Sedimentary Petrology*, 58, 820–829.

Petroleum Affairs Division (PAD) 2006., *Petroleum Systems Analysis of the Rockall and Porcupine Basins Offshore Ireland Digital Atlas*. Petroleum Affairs Division Special Publication 3/06, 160 pp.

Shannon, P. M., et al. 2007. The evolution of the Porcupine and Rockall Basins, offshore Ireland: the geological template for carbonate mound development. *International Journal of Earth Sciences*, 96: 21-35.

Silva, R.L., Duarte, L.V., Comas-Rengifo, 2015. Chapter 13. [Carbon isotope chemostratigraphy of Lower Jurassic carbonate deposits, Lusitanian Basin \(Portugal\): Implications and limitations to the application in sequence stratigraphic studies](#). In: Ramkumar, M. (Ed). *Chemostratigraphy: concepts, techniques, and applications*. Elsevier, pp. 341-371.