EGI Oceans: Effective Source Rock Quality Prediction Using Machine Learning

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In Progress

Are you underestimating your petroleum system? We propose a unique, low-cost, and expeditious tool for assessing organofacies, generation potential, and phase on a basin scale, using existing data sets, without the need for additional detailed analyses.

VALUE

The project team is developing a machine learning (ML) model, trained using EGI Oceans Atlantic Margins data and worldwide data from the literature, as a means of predicting organofacies and organic matter (OM) composition in other basins or data sets. The methodology is designed to avoid the need for costly additional analysis (e.g., pyrolysis on isolated kerogen and palynofacies). It will also detect and correct for mineral matrix effect (MME), an artifact of anhydrous pyrolysis that can result in significant underestimation of generation potential (Figure 1).

The goal is to deliver an ML tool applicable to large data sets, not only on the Atlantic margins, but in other petroleum systems worldwide, delivering accurate information on generation potential and phase, and thus providing critical input to basin models.

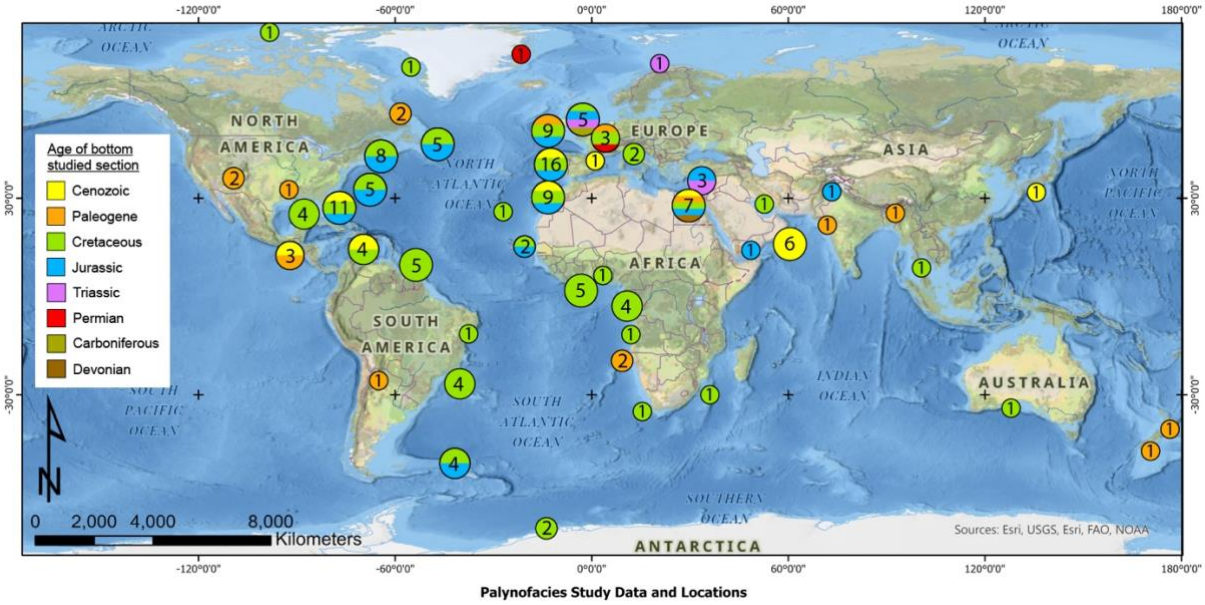

Figure 1. Location of studies with palynofacies.

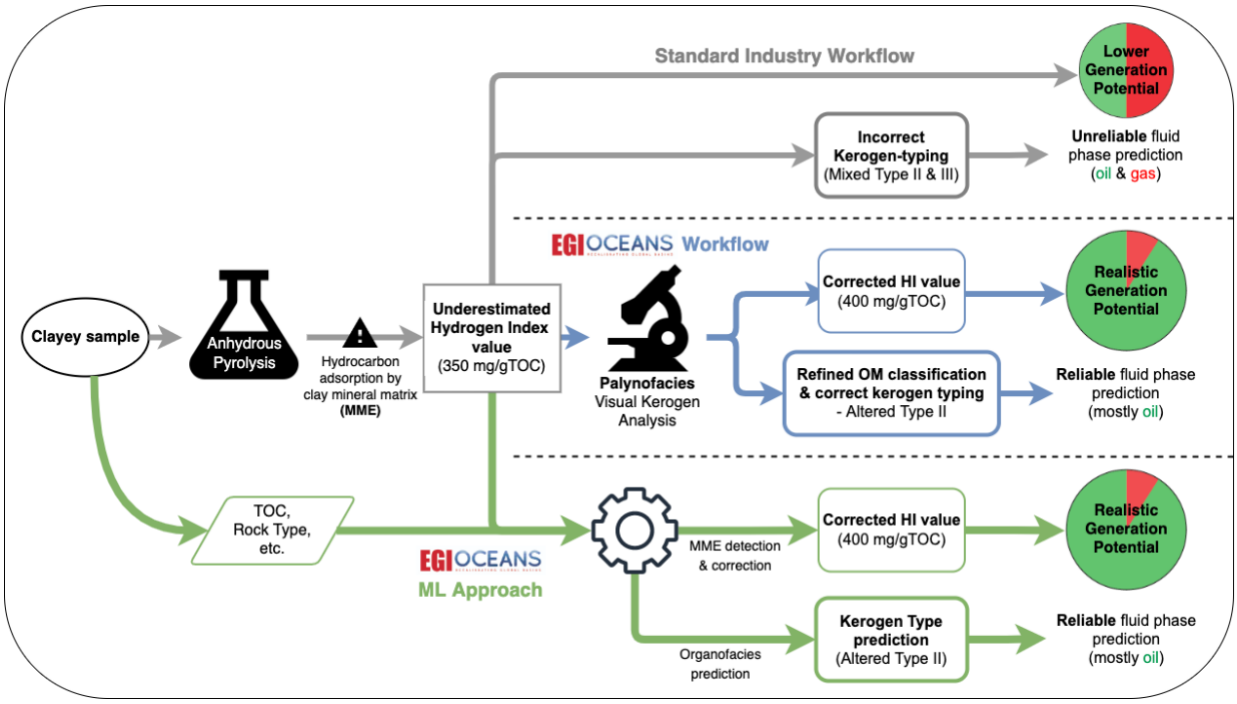

Figure 2. Comparison of the outcomes of standard and EGI Oceans workflows with the proposed ML model approach.

KEY DELIVERABLES

- A fully integrated ML model for organofacies prediction, which includes an MME

correction function

- A hierarchy of variables/factors (e.g., TOC, HI, microfossil diversity, rock type, lamination, etc.) influencing accurate organofacies and organic matter (OM) composition prediction
- Anonymous well data analysis within the ML model for each sponsoring company
- Maps with predicted organofacies and OM composition for IODP sites and industry wells in the South, Central, and North Atlantic for selected stratigraphic intervals
- Delivered as an application

Benefits to Sponsors

- This project will be of interest to groups seeking to more tightly constrain organofacies, and thus generation potential, in petroleum basins worldwide.
- Sponsors will have exclusive, first-use rights to the tool.
- It will also benefit those companies seeking to incorporate advanced ML/digitalization techniques into their exploration toolkit as a means of developing better predictive capability.

Background

Since 2013, the EGI Oceans team has performed three studies (I 01276, I 01229, and I 01350) cumulatively funded by 25 national and international companies. The studies focused on understanding the source rock systems in the South, Central, and North Atlantic oceans. In consultation with industry experts through EGI's corporate associate program, the EGI Oceans team created a new sample analysis workflow incorporating chronostratigraphy, paleoenvironment, bulk pyrolysis analysis, and palynofacies. The addition of visual kerogen analysis was identified as a crucial step, both reducing the risk of underestimating source rock potential due to the MME, and allowing more accurate organofacies determination (Figure 3). As by-products of the new workflow, the EGI Oceans team introduced new phase-specific Source Potential indices (SPI-oil and SPI-gas) and Gas Risk Index (GRI) to compare source rocks across the oceans (see Beti et al., 2021).

Using analytical data from over 21,000 organic geochemical samples generated and harvested through the previous EGI Oceans projects as a training dataset, this study aims to build an ML model that can predict the presence of MME and the detailed OM composition from a starting point of basic pyrolysis and sedimentary data (Figure 2). Up to

now, these key issues have been dealt with using lengthy and costly palynofacies analysis.

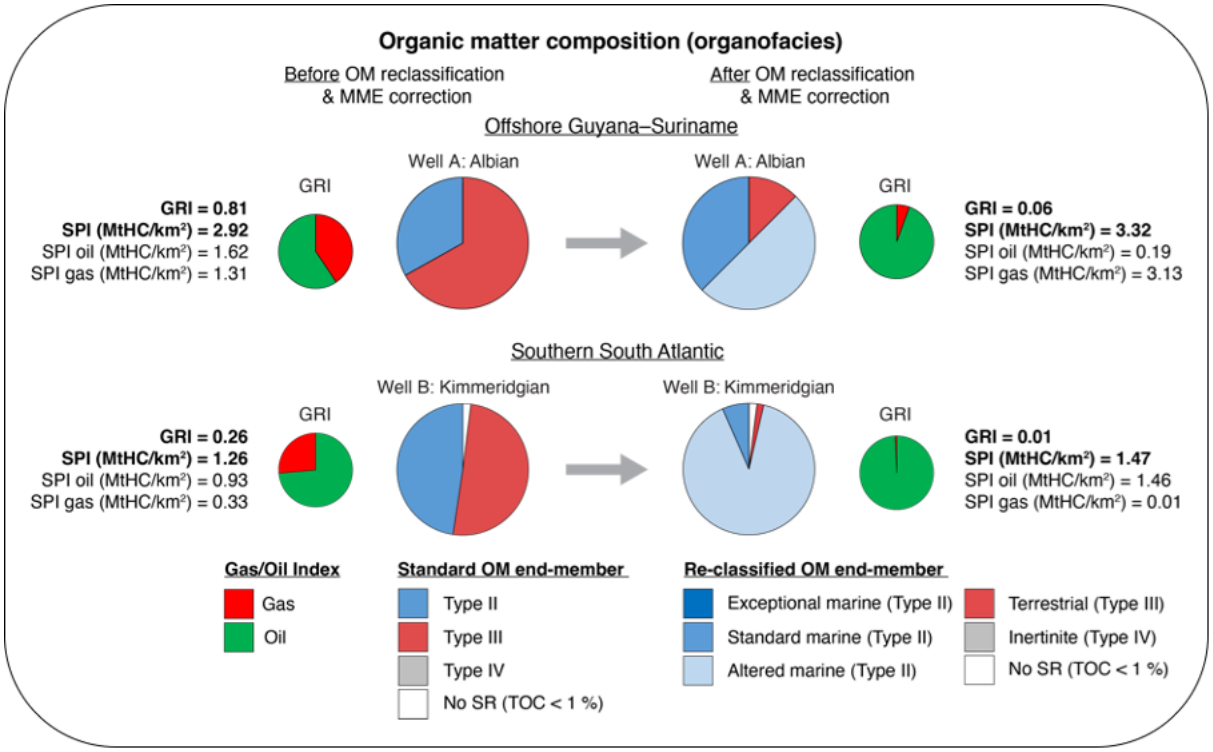

Figure 3. Organofacies, SPI, and GRI before and after OM end-member reclassification and MME correction.

Our proposed workflow for determining organofacies using an ML algorithm is presented in Figure 4. We demonstrated that a prediction accuracy of 85% can be attained with basic input variables in a surrogate dataset, using Naive Bayes while striking a balance between bias and variance. We will seek to improve the predictive power with more sophisticated algorithms. The input of data curated by the EGI Oceans team will almost certainly substantially increase the prediction accuracy of the ML algorithm. In this study, we propose to use EGI Oceans curated data sets, including TOC, HI, and rock type, to predict the organofacies and OM composition of source rocks. This ML algorithm will include a novel MME correction function to increase the prediction accuracy. The key aspect of the project is to attain the MME correction through existing data, commonly available in well reports.

Most importantly, from a starting point of only basic data, the work process described has the potential to more effectively characterize organofacies and generation potential. This process includes identifying source rocks whose potential has previously been significantly

underestimated due to MME and incorrect organofacies determination (Figure 3) and minimizes the risk of inaccurate fluid phase prediction.

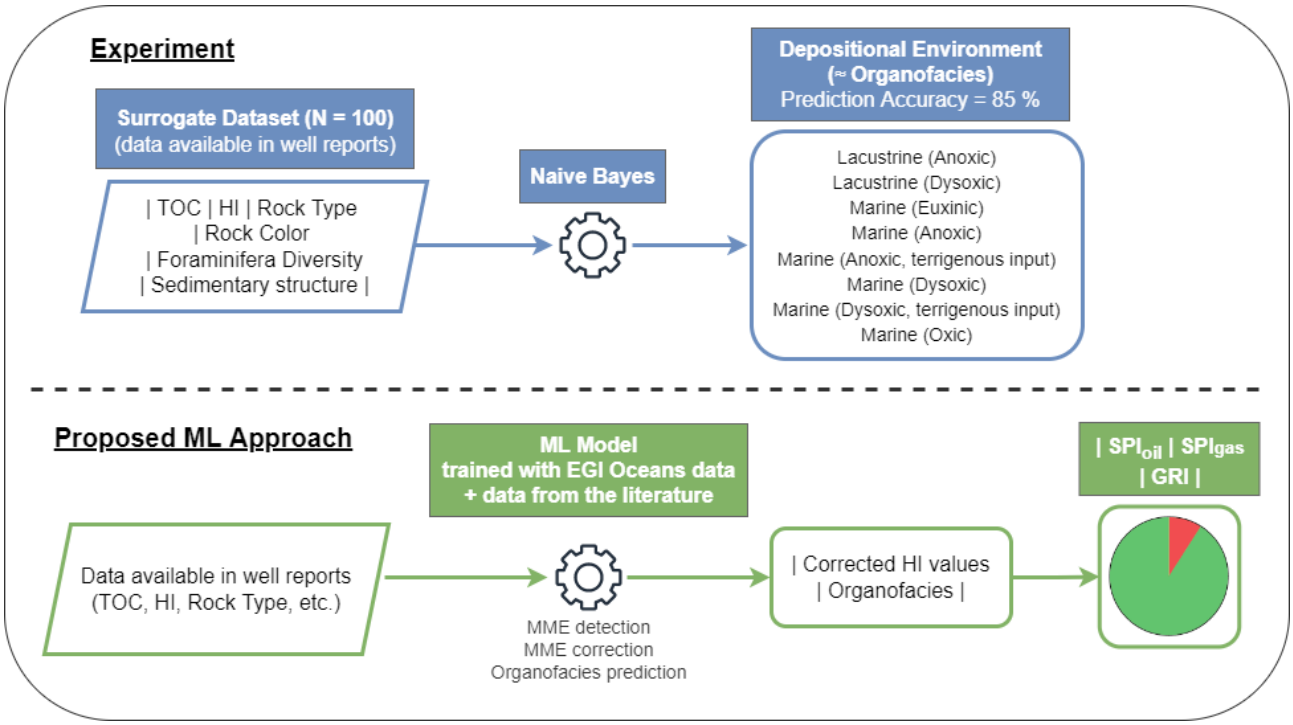

Figure 4. A schematic showing organofacies prediction accuracy of 85% using a surrogate dataset (blue) and a proposed ML model (green) involving MME correction and the EGI Oceans database to achieve organofacies, phase-specific SPI, and GRI prediction with higher accuracy.

Reference

- Beti, D.R., Garel, S., Setoyama, E., Behar, F., Ring, T.A., Kanungo, S., 2021. A new resource assessment workflow to achieve gas risk and phase-specific source potential indices. Mar Petrol Geol 131, 105136. https://doi.org/10.1016/j.marpetgeo.2021.105136

Research Team

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Dr. Tony Doré	Global Chief Scientist, Senior Advisor to the Director	Project Advisor

Additional EGI staff and expertise will be added as necessary.

Investment per Sponsor

$40K (USD)

Duration

9 months

EGI Technical Contact

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