Multi-scale Characterization of New Zealand's Coaly Source Rocks: Developing a Rock Physics Template for Improved Seismic Mapping and Reduced Uncertainty in Future Exploration

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ABSTRACT

Coals and carbonaceous ("coaly") mudstones are the primary sources of oil and gas in most of New Zealand's sedimentary basins. These types of petroleum source rocks are regionally significant, however; they are less common globally. Our ability to identify and characterize them in the subsurface is a critical component of prospecting for new oil and gas accumulations. Predicting their nature from geophysical measurements (i.e., seismic and wireline logs) is constrained by a lack of calibration between the geophysical attributes of coaly rocks and their physical properties. The aim of this project is to characterize the inorganic and organic constituents of coaly source rocks based on indirect geophysical field observations.

Rock Physics Templates (RPTs) combine geophysical measurements and rock properties and are used by industry and academia alike for the effective interpretation of lithology and fluids in the subsurface. They link the elastic properties of rocks (e.g., velocity and moduli) with their physical properties (e.g., porosity, fluid content, and clay content). To date, RPT usage has concentrated on sandstone and carbonate petroleum reservoirs, although they are increasingly being used to predict various characteristics of mostly marine clay-rich source rocks, the formations generating the oil and/or gas. Source rocks present a new suite of input parameters for a RPT as the constituent components and textures differ considerably. These formations represent amalgamations of inorganic and organic sediments. Recent advances in rock physics modelling have demonstrated improved methodologies for evaluating the solid and liquid matter, as well as the pore pressures, in clay-rich rocks containing organic matter.

This study will construct models specific to coaly source rocks for correlating their physical properties, geophysical signatures, and petroleum potential. New Zealand is an excellent location to conduct such a study as it hosts a near complete spectrum of coal ranks (peat through anthracite). Samples will be collected from each of these as well as adjacent lithologies (i.e., shaly coals and coaly mudstones) to experimentally measure and model the seismic signatures resulting from variations in organic versus inorganic sediments, coal rank, and wave anisotropy. The predictive power of the RPT will be enhanced through a scaling approach that integrates both well logs and seismic surveys.

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