ACS PRF# 57222-ND8 (formerly PRF# 66955)

Project title: Heat flow map of SE Asia including Papua New Guinea, Indonesia, Malaysia and the Philippines.

Principal Investigator: Kirsten Nicholson, Ball State University

Progress to date:

Although the focus region of this study remains the same, some aspects of the project have evolved. In 2014, Indonesia ranked 21st globally in oil production, with most of the oil produced in Sumatra. The region has been subjected to intense tectonic activity. Due to the tectonic complexity of the region, petroleum generation is often difficult to understand and predict. The current heat flow maps of the region are old and based on limited data. Hence, the generation of a new heat flow map of the region will allow researchers to better predict petroleum generation, which in turn can be used to identify new targets and potentially expand petroleum resources in the region.

In 2018-2019 we focused on digitizing and acquiring data (seismic lines, well logs, drilling geological reports) for two basins: the Gulf of Thailand Basin and Central Sumatra Basin as it is shown in the figure below. These two basins hold the most data we have available from the LBH dataset (in our department). To date the digitizing is roughly 60-70% complete, with more than 150 seismic lines inserted in Petrel so far from both basins.

Abstract: Total organic carbon (TOC) is a crucial attribute for predicting the potential hydrocarbon source rocks. The direct calculation of the TOC from the core is the most accurate method, yet cores are rarely found in most data, and It is a challenge to apply the direct method in each well in Tonga PT Mosesa Petroleum Block (TPTMPB), and the north the West Kampar Block (WKB), Central Sumatra basin (CSB). The workflow was divided into two techniques, based on the available data in the blocks, to calculate the TOC or estimate the potential hydrocarbon of Pematang Formation. Passey's ΔlogR method was applied in TPTMPB by using resistivity and sonic logs. This method requires an accurate determination of the non-source zones and the level of maturity (LOM). The integration between vitrinite reflectance (Ro), thermal alteration index (TAI) values (from the well reports), Burial history Curves (Lopatin's method), and Isotherms Construction techniques result-in valid LOM values. The layout and cross plot features in the Techlog-Schlumberger can quickly determine the resistivity/sonic baselines by determining the low resistivity shale zone from the petrophysics characteristics and logs. The two quantitative parameters, ΔDTx and ΔDTz, were calculated for all wells including WKB area where there is no geothermal data available. The ΔDTx and ΔDTz parameters are a unique approach that was developed based on the ΔlogR method. Since the level of maturity is not a part of ΔDTx and ΔDTz calculation, these parameters do not represent the TOC, yet they are equivalent to it. Thus, instead of abandoning the area that has no sufficient data to calculate the TOC, the ΔDTx and ΔDTz parameters were applied to identify the source-rock potential. The parameters show a remarkable fit with the few only core-TOC data.

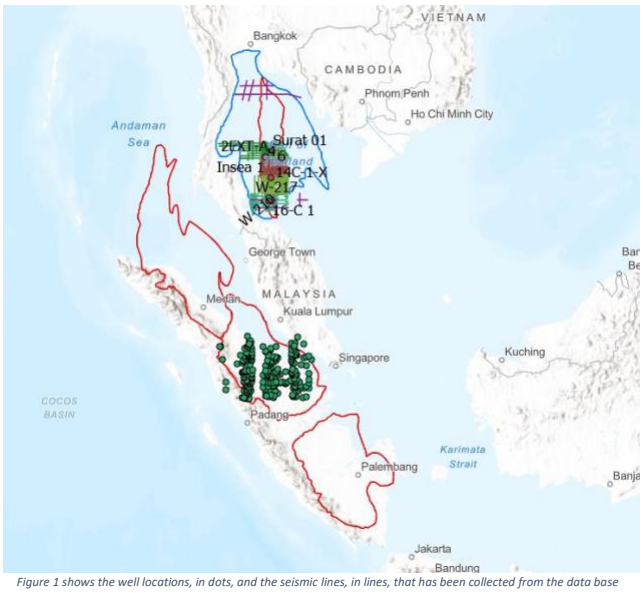

Figure 1 shows the well locations, in dots, and the seismic lines, in lines, that has been collected from the data base

Impact on my career and my student(s):

To date this PRF grant has supported three graduate (MSc), three undergraduate students and a PhD student. With students as the primary authors and presenters, we have submitted 6 conference abstracts, attended three conferences, and there is one manuscript in preparation. We hope to have one manuscript submitted by the end of 2019.

All three of the undergraduate students participating in the research have finished their degrees: two of them have continued on to MSc programs, while the third is now working on a PhD project. All three of the graduate students have successfully defended their thesis. One of the graduate students is now working in petroleum exploration, one is working in another field, and one has continued on to work on this project for a PhD thesis.

In terms of my career, this has given me a new research focus. I am hoping to submit another grant application and hope to attract new graduate students to continue this work. I have also received at $10,000,000.00 software grant from Schlumberger.

Publications - Refereed: * denotes a student author

Benkhayal*, A., Nicholson, K., Fluegeman, R., in preparation, Applying A Modified Method for Estimating Petroleum Source-Rock Potential Using Wireline Logs, With Application to Pematang Formation, Central Sumatra Basin, Indonesia.

Publications - Abstracts: * denotes a student author

Benkhayal*, A., Nicholson, K., Fluegeman, R., Grigsby, J. and Harbert, W., 2018, Estimating the distribution of total organic carbon (TOC) and level of organic maturity (LOM) in the absence of core data on Pemtang Formation, Tonga PT Mosesa Petroleum Block (TPTMPB), West Central Sumatra Basin, Geological Society of America Abstracts with Programs.

Pitcock*, R., Nicholson, K.N. and Benkayal, A., 2018, Geothermal heat flow in northern Indonesia. Geological Society of America North-Central Meeting. Power Plays 2018. Abstracts with Programs.

Ingram*, M., Fluegeman, R., Nicholson, K.N. and Malone, S., 2018, Basin analyses and hydrocarbon potential of the Bali Basin, with expanded geothermal heat flow map of Indonesia. Power Plays 2018. Abstracts with Programs.