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PSBurial and Thermal History Model to Evaluate Source Rock, in Tatau Province, Offshore Sarawak Basin, Malaysia*

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Search and Discovery Article #40706 (2011)
Posted March 7, 2011

*Adapted from expanded abstract prepared for a poster presentation at AAPG International Conference and Exhibition, Calgary, Alberta, Canada, September 12-15, 2010.

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Abstract

Hydrocarbons are produced from offshore Sarawak Basin. The province consists of Tertiary half-graben basin infilled with carbonaceous coal and clastic sedimentary rocks. This presentation will present burial history, maturation window, hydrocarbon expulsion, and subsidence history results of the area. The main points are the vertical extent of strata which can be the source rock for mature hydrocarbon generation and the thermal history of the source rock. According to the hydrocarbon exploration records and source rock study in the offshore Sarawak Basin, substantial oil and gas reserves are obtainable in the Lower Miocene and Oligocene age of the Cycle I/II strata. Four drilled sections of wells JL-1, JL-2, JL-3, JL-4, and JL-5 were chosen for modeling of hydrocarbon generation history. Oligocene lower coastal plain shale and Lower Miocene coaly/shale are the mature source rocks of Cycle I/II. They were selected because of their available data and obtained results from the model. All of them penetrated thick sedimentary sequences, including Oligocene and Lower Miocene source rock horizons. Maturity interval of the main oil generating source rocks are in the range of 0.75-1.1 vitrinite reflectance (VR %). The modeling of the wells characterizes the thermal and generation history of perspective source rocks in the study area but also the lateral continuation of the horizons within the discovered oil and gas fields. The research works on the stratigraphic sequence of each well's lithologies to optimize the model of the source rock due to the available geochemical, seismic, well, and heat flow. The technique which is important to develop the burial history, hydrocarbon maturation, and generation would be simulated by 1-D basin modeling (GENEX

4.0.3) specialized software to cover the full history of petroleum formation for the selected field. This result of the study provides an avenue for exploration of deep source rock reservoirs and exploiting effectively the existing petroleum system.

Introduction

Basin modeling is a technique that allows you to reconstruct the burial and temperature history of a sedimentary basin through time and to understand source rock maturation and subsequently hydrocarbon expulsion and migration (Espaitalie et al., 1988), (Welte and Yalcin, 1988), (Galushkin, 1990), and (Ungerer et al., 1990; Tissot, 1986, 1987; Lopatin et al., 1996; Magoon, 1995; Sweeny and Burnham, 1990).

According to previous studies (Madon, 1999; Hamdan, 2006), the source rocks in this area (Figure 1) have substantial oil and gas resources in Lower Miocene and Oligocene rocks of Cycle I/II strata. The source rocks for Cycle I/II are believed to be from Oligocene lower coastal plain shale and Lower Miocene coaly shale (Madon and Abu Hassan, 1999). However, the presence of oil in small quantities in the area warrants analysis on the effectiveness of oil generation within deep source rock in Cycle I/II.

Vitrinite reflectance (VR), total organic carbon (TOC), and kerogen type can be enhanced through geological conditions like deformation due to tectonics which gives high thermal conditions, and causes significant variations related to composition and depositional aspects on evaluating the maturity of organic matter. The effects of vitrinite reflectance anomaly can be significant in the interpretation of the depth to specify the mature hydrocarbon generation (Figure 5) and in the interpretation of the thermal history.

The source rock containing Type II and Type III kerogen with TOC in the range 0.5-2 % generates waxy crude and gas found in oil fields in Sarawak and Sabah Basins (Abolins, 2007a). An effective source rock would have generated and expelled petroleum; however, hydrocarbon source rock has never been proven because some level of uncertainties exist due to the unavailability of experimental data like hydrogen index (HI), oxygen index (OI), total organic carbon (TOC), vitrinite reflectance (VR) verses depth, and temperature verses depth data for the field (Madon and Abu Hassan, 1999). Thus, modeling of the source rock maturity range (Figure 4) and its efficiency in the selected JL wells of Tatau Province in Sarawak Basin, is necessary in order to evaluate the source rock in terms of the continuing occurrence of subsidence, erosion, and structural half grabens; to evaluate heat flow distribution in relation to source rock; and to determine the hydrocarbon generation timing, which were highly affected by the thermal condition of rifting.

Conclusion

The results of the thermal history model (Figure 3) show that the time (15 Ma) of subsidence is related to the peak source rock maturity to generate hydrocarbon and the total hydrocarbon generation potential of the deeper sediments in the area. Basin with low heat flow, which usually causes gradual subsidence of source rock through low thermal gradient, did not happen in this area. This field of study is a high heat flow (Figure 2) and rapid subsidence of the source rock. The source rock started to generate oil after the subsidence and comparing with the gas generated at this field is almost a similar ratio. The generation and expulsion of the hydrocarbon (Figure 5) indicates that the Sarawak Basin has high heat flow and geothermal gradient, but the liquid hydrocarbon is also higher than expected. The expulsion and probable maturation of the Oligocene to Miocene age subsurface lithology of the Sarawak Basin varies considerably as a function of the formation content, sedimentary thickness, erosion, and structural suitability for the petroleum system.

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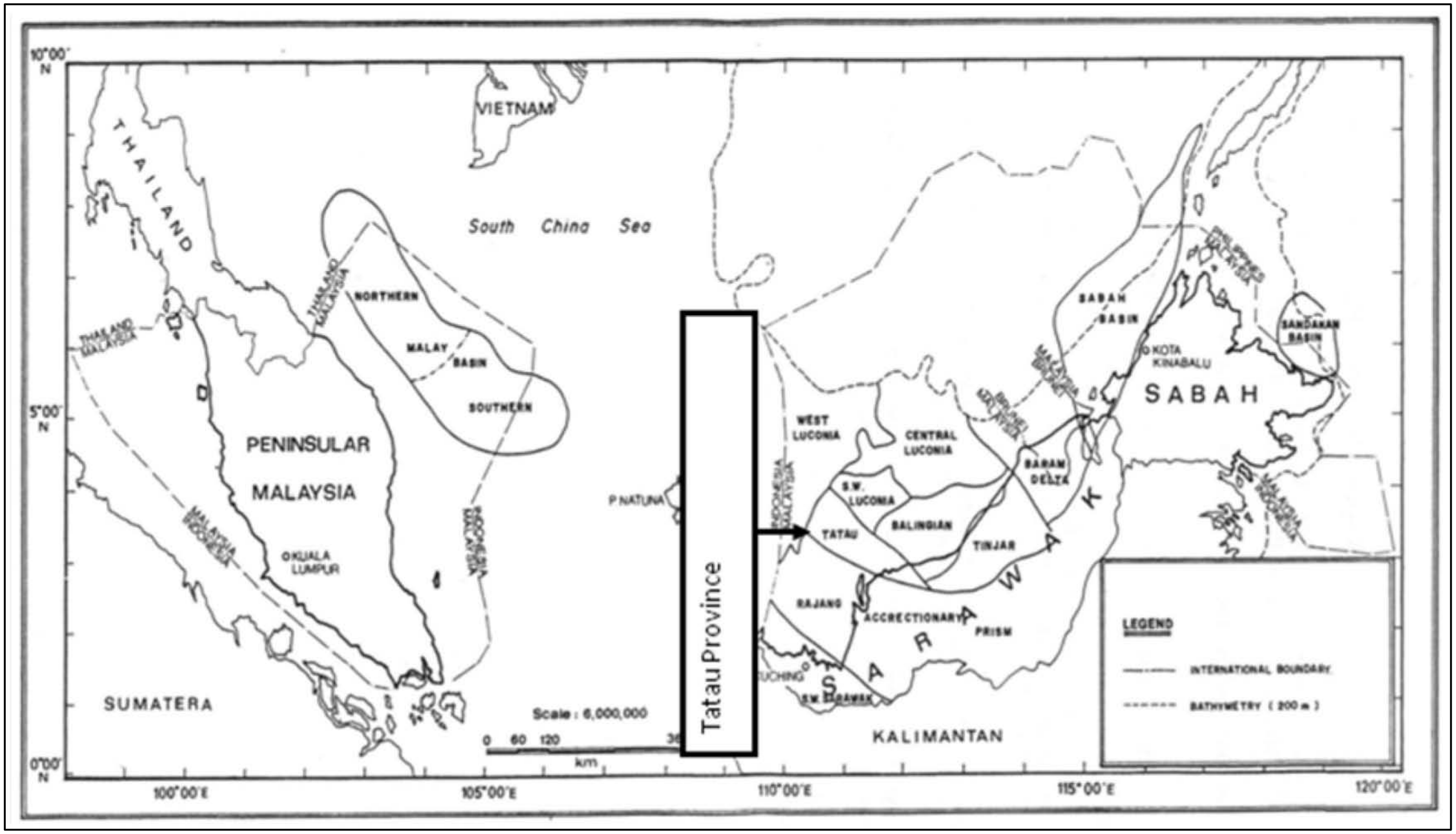

Figure 1. Regional Setting of Tatau Province (After Yusoff, 1990).

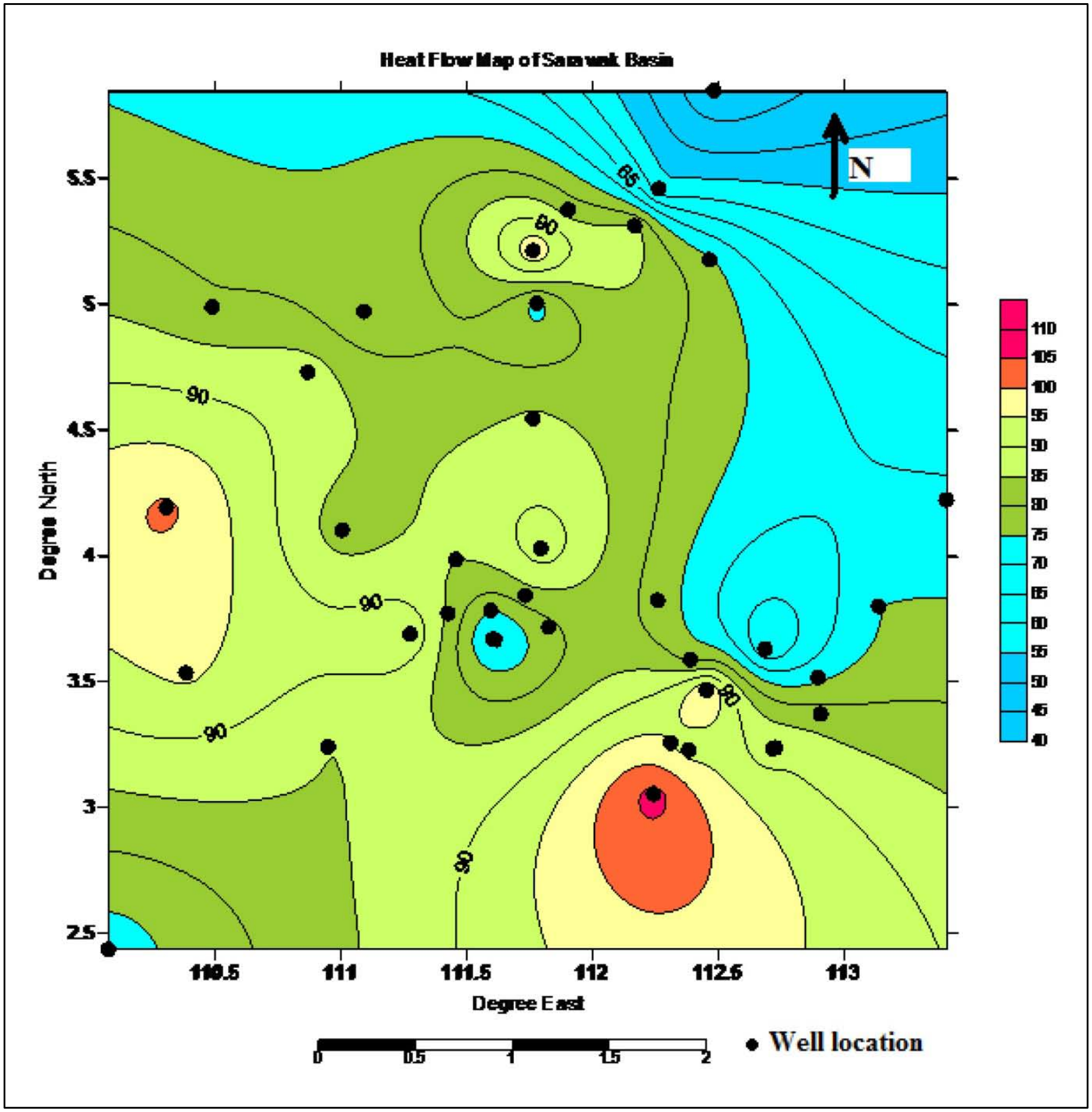

Figure 2. Present day Heat Flow in (mW/m2). Map of the Study Area.

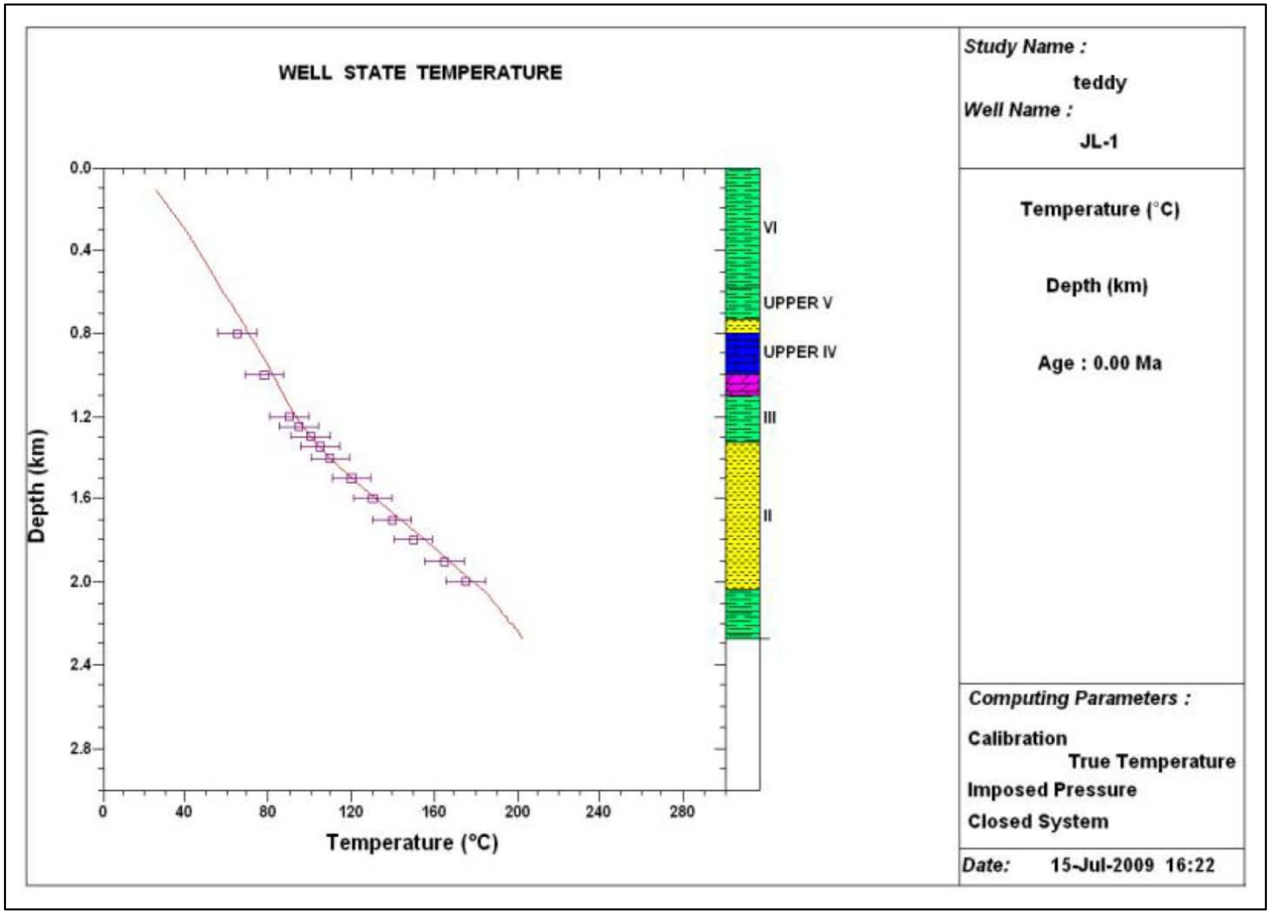

Figure 3. Well State Temperature of JL-1.

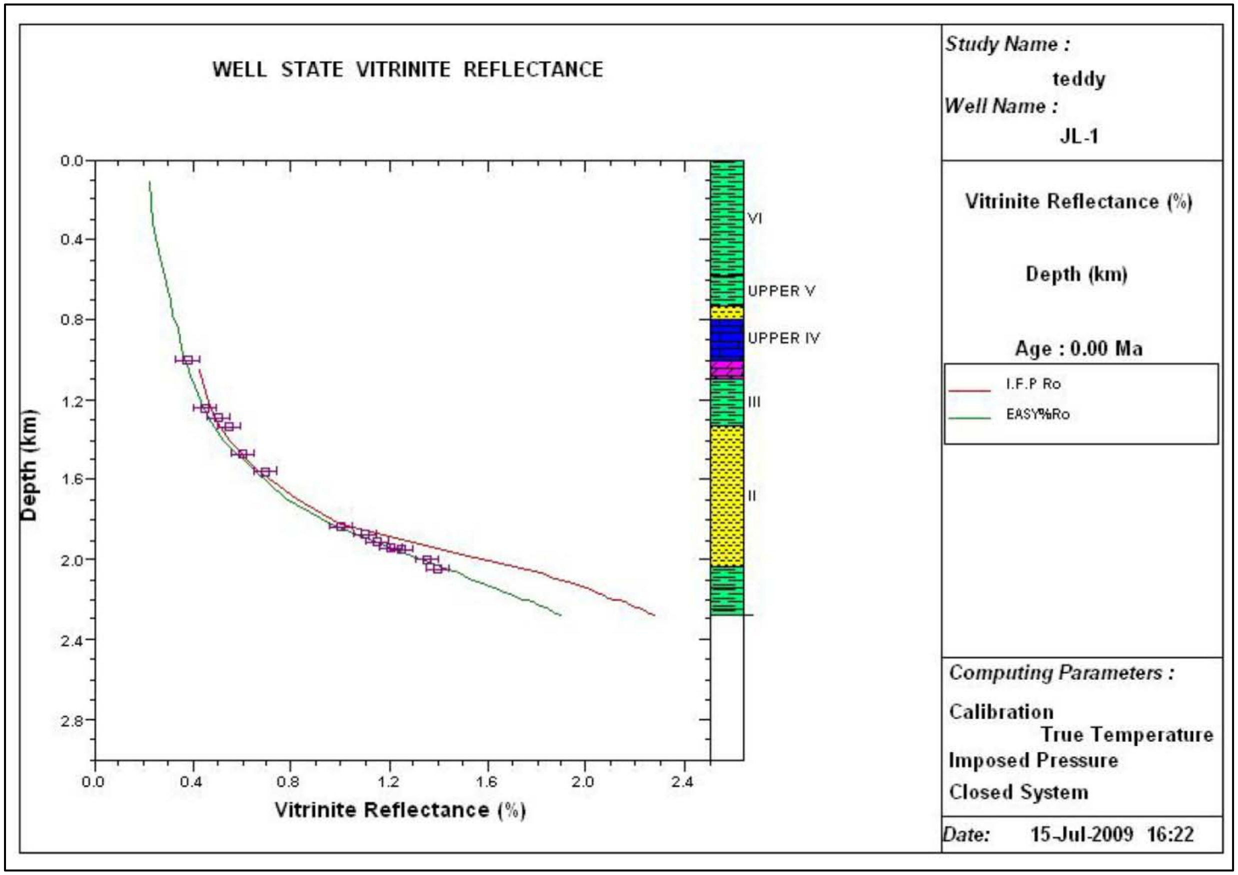

Figure 4. Vitrinite Reflectance of JL-1.

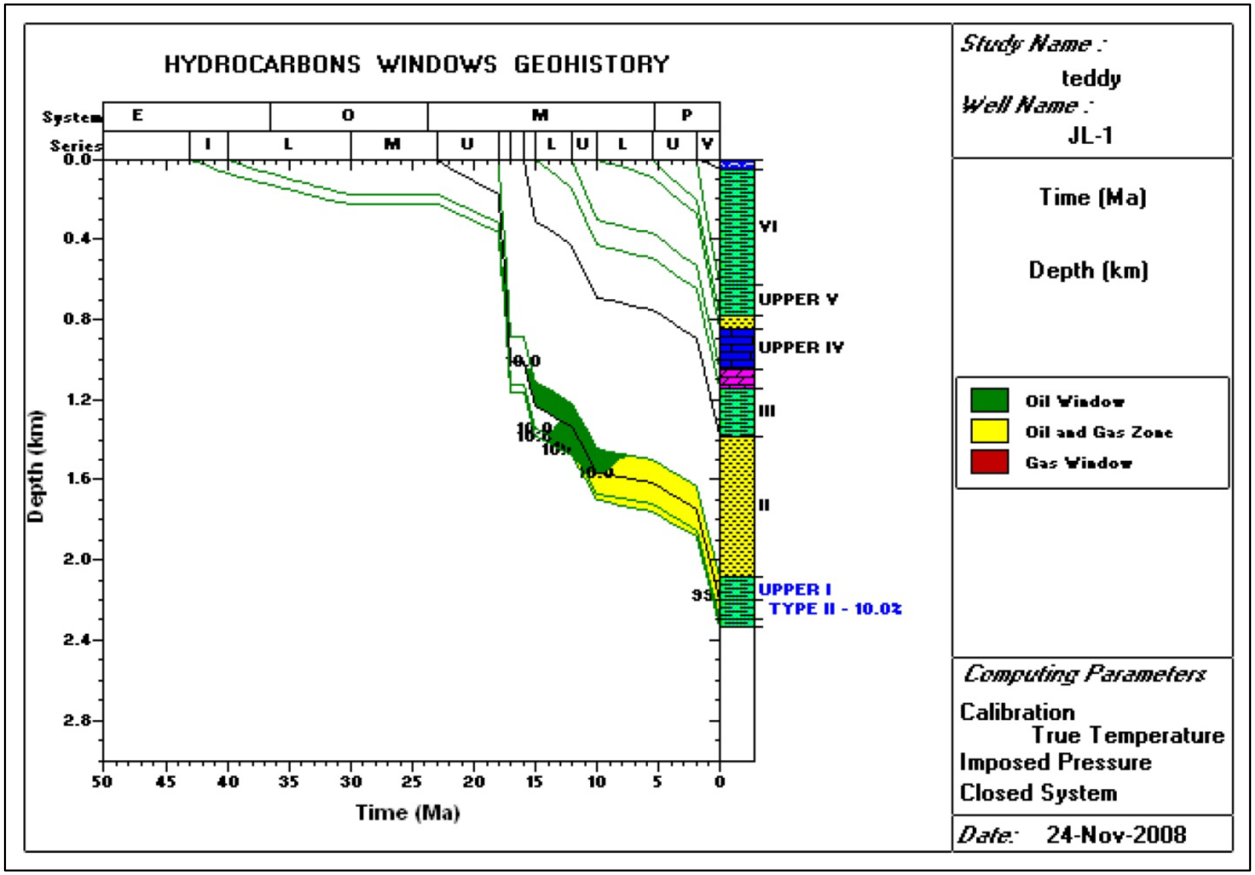

Figure 5. Hydrocarbon Window of JL-1.

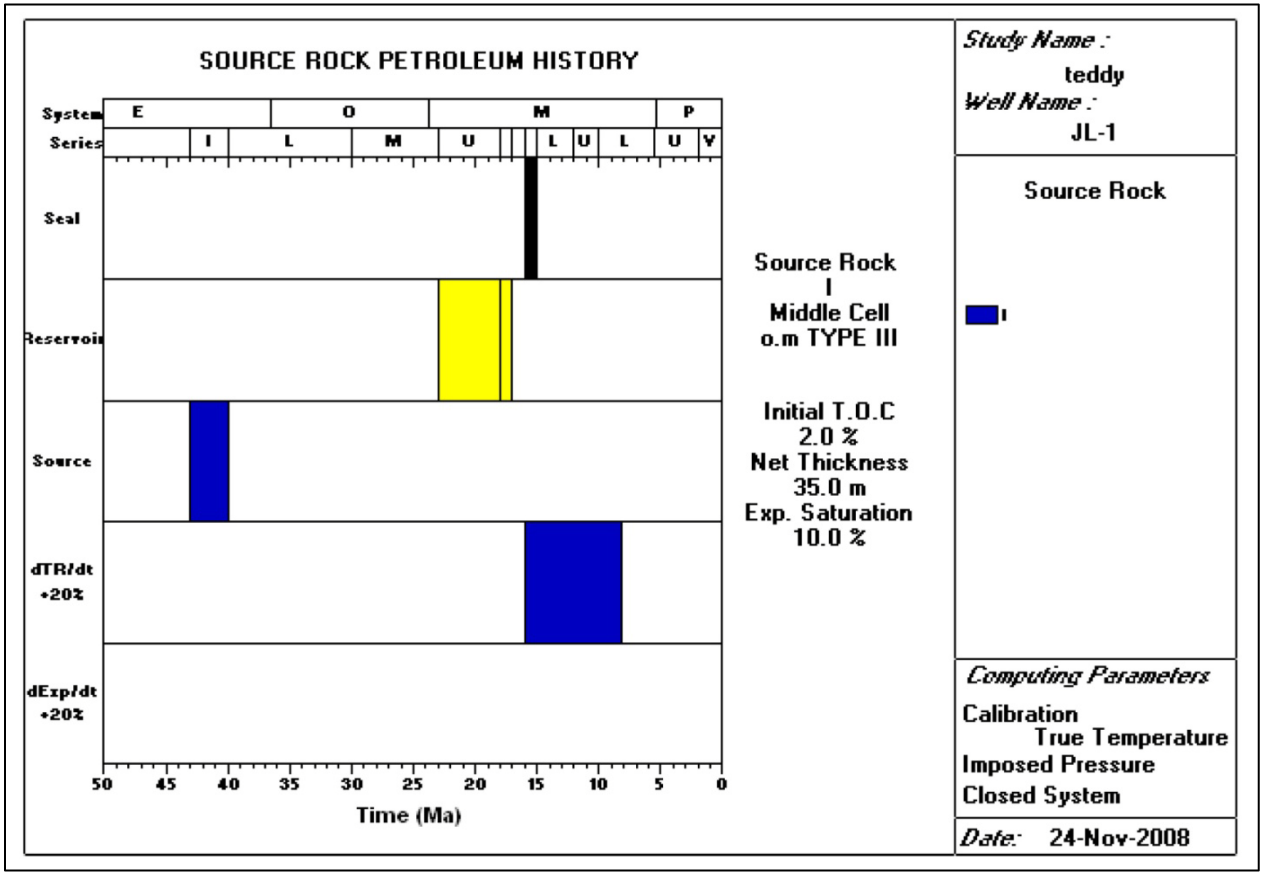

Figure 6. Source Rock History of JL-1.