

# **Shale Gas Resources of Lahat Formation at Topaz Area, Indonesia\***

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## **Abstract**

Shale gas is one of the alternative energy that has potential in Indonesia. Based on the Government's study, shale gas potency in Indonesia is around 574 TCF that is distributed in seven basins. It is bigger than CBM and conventional gas, which is about 453 TCF and 334.5 TCF respectively. Many oil and gas player (local and international) are interested to do an integrated study about shale gas resources.

The Topaz Area is located in the South Sumatera Basin that produces oil and gas from conventional method with the primary objective reservoir being the Baturaja Formation. Based on a study of the Topaz Area, the Early Oligocene Lahat Formation has shale gas potential resources to be developed. This formation acts as a source rock and reservoir in conventional method due to the sand and shale content. An integrated data such as geology, geochemical, geomechanical, and petrophysical from existing data can identify shale gas potency in this formation. Shale gas production per well can be calculated and predicted after the shale gas potential is identified. Analysis on parameters such as maturity, thickness, depth, TOC, kerogen type, and brittleness index; the shale gas potential in Lahat Formation can be identified.

Estimation of gas in place can be calculated from free gas and adsorb gas in the formation. Free gas is gas that is trapped in the rock matrix porosity and/or natural fractures which can be calculated by the Lewis equation, while adsorbed gas is gas stored mainly on the internal surfaces of the organic material. There are no core samples available in this target, so estimation of adsorbed gas is based on the Jarvie TOC vs Gas Content Chart.

From petrophysical parameters and well design (directional drilling and hydraulic fracturing), the profile production per well can be predicted. The first production is peak production that is supposedly from free gas which is trapped in pores and/or natural fractures in this formation. The plateau will be showed after  $\pm 3$  years production. Many wells are needed to maintain the production profile from one field.

## **Introduction**

Base on regional studies, the Talang Akar and Lahat Formations are believed to be the dominant source for commercial hydrocarbon in the South Sumatera Basin. At several areas, Talang Akar and Lahat indicate good potential to be an unconventional hydrocarbon. From existing data at Topaz Area, Lahat Formation is a good potential for unconventional hydrocarbon while the Talang Akar Formation is still immature (with  $R_o < 0.7\%$ ).

The few parameters used to identify a good potency at this area, such as: hydrogen Index  $> 100$  mg/g, thickness  $> 40$  m, TOC  $> 1$ , high maturity ( $R_o > 0.7$ ),  $T_{max} > 435^\circ\text{C}$ , depth: 1800 – 3050 m, and paleogeography: shale prone environment.

## **Method and/or Theory**

### **Geochemistry Analysis**

There are three important parameters for identify unconventional hydrocarbon source at this area, such as maturity, quality, and kerogen richness. All these parameters should be identify from geochemistry data. An existing data from PT-3 well shows the Lahat Formation starting at depth 1695 mMD, with kerogen Type I (71.4%) and II (28.6%). Good parameters for unconventional hydrocarbon indicated at 2125 mMD with TOC ranging 5-6%,  $S_1 = 1.69$ ,  $S_2 = 42.19$ ,  $T_{max} = 441^\circ\text{C}$ ,  $R_o = 0.7$ , and  $HI = 200 - 750$  ([Figure 1](#)). From that data, it can be identified that the Lahat Formation has potency to develop as shale gas in the Topaz Area. Burial history from the PT-3 well also indicates the Lahat Formation is already mature in the lower part with temperature more than  $110^\circ\text{C}$  ([Figure 2](#)).

To get TOC where geochemistry data does not exist, Passey “dLogR method” can be applied to calculate the TOC. Validation for this method can be done by comparing TOC value at depth 2125 mMD with the average result from the calculation, which is around 1.3% while from measurement is 5.63%. Due to the different numbers between the TOC value from “dLogR Method” and geochemistry data, then the “dLogR method” result cannot be used in the PT-3 well.

### **Seismic Interpretation**

Seismic interpretation have been derived from 1 (one) composite seismic reflection profiles to know the structural configuration of the area. Checkshot correction and well seismic tie have been done to tie the seismic data in domain time with the well data in domain depth, so we can interpret top formation (well marker) at the seismic data. [Figure 3](#) shows the Lahat Formation which has shale gas and shale oil potential resources was deposited above a half graben basement.

## Unconventional Hydrocarbon Map

Depth structure map from basement at Topaz Area overlain with maturity value ( $R_o$ ), shows the potential area for unconventional hydrocarbon resources. Total area for shale gas and shale oil potential in the Lahat Formation is 4,378.9 acres ([Figure 4](#)).

## Petrophysical Analysis

Petrophysics parameters are needed to assess shale gas in place, such as porosity, gas saturation, and kerogen density. From existing log data from the PT-3 well, parameters for shale gas in place calculation can be estimated. Petrophysical summary of the Lahat Formation parameters at depth 2125 - 2175 mMD are: Porosity = 3 %,  $S_w = 0.88$  %, and kerogen density = 2.62 gr/cm<sup>3</sup>. Based on shale gas parameters availability from the PT-3 well, the potential thickness for shale gas and shale oil generation and accumulation of the Lahat Formation is around 50 m ([Figure 5](#))

## Gas in Place

After analysis, all existing data and get all requirement parameters, gas in place can be calculated by the Lewis method and Jarvie TOC vs Gas Content Chart ([Figure 6](#)).

$$Gcfm = \frac{1}{Bg} \times [\phi_{eff}(1 - S_w)] \times \frac{\varphi}{\rho_b}$$

For adsorb gas calculation, there are no laboratory study about the Langmuir isotherm. The adsorbed gas assessment is based on the Jarvie TOC vs Gas Content chart. The result for adsorb gas from the Jarvie Chart of the Lahat Formation is approximately 80 SCF/TON .

The Downey method can be applied to calculate shale oil potency, using existing data from the PT-3 well.

Mass of S1:

$$= (Shale\ Volume * Average\ Bulk\ Density * S1 * 0.001) / 0.000000000811$$

Volume of S1 HS:

$$= \left( \frac{Mass\ of\ S1}{Density\ of\ Oil} \right)$$

OIP (BBL):

$$= (0.00000629 * Volume\ of\ S1)$$

The calculation result for shale gas potency at the Topaz Area is 146.8 BCF and for shale oil is 7.84 MMBO.

### **Production Simulation**

For this study, estimation of shale gas profile production using simulation (Fekete Evolution) with some parameters from G&G and assumption data based on Indonesia capability to drill horizontal wells. Shale gas has a different production type from conventional gas profile. Gas production will reach peak number at the first year. In this period, the production is supposedly dominated by free gas which occupies the pore and natural fracture of the shale formation. Within three years the production drops drastically around 60 - 80 % from peak production. After six years, the production of gas is dominated by sorbed gas.

Shale gas can be recovered from shale formations with a high organic content. Modern exploration and gas production technology, such as horizontal drilling and hydraulic fracturing, has enabled the extraction of shale gas.

The well profile scenario can be divided into three scenarios. Sensitivity is applied for horizontal length and fracture spacing. With the same number of fracs but different length and spacing, well capability to produce gas will be predicted.

Based on the simulation, the good performance for single well model is case 1 with horizontal length: 2000 ft and fracture spacing: 400 ft. The initial production from case 1 around 3.24 MMSCFD and the average plateau around 0.10 MMSCFD ([Figure 7](#)).

### **Conclusions**

1. Lahat Formation is a main target for unconventional hydrocarbon at Topaz Area which is located in South Sumatera Province.
2. Geochemistry data indicates unconventional hydrocarbon potency from PT-3 well begins at depth 2125 mMD with total sweet spot acreage 4,378.9 acres.
3. Based on calculation IGIP for the Lahat Formation is 146.8 BCFG and for Shale Oil is 7.84 MMBO.
4. The initial production from case 1 around 3.24 MMSCFD and the average plateau around 0.10 MMSCFD.
5. Based on seismic interpretation, Topaz Area has upside potential for shale gas and shale oil resources in depocenter of half graben.

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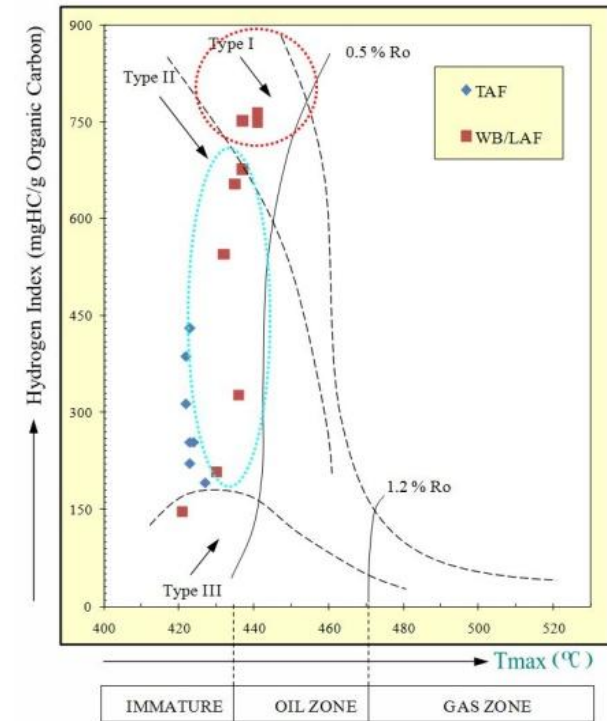
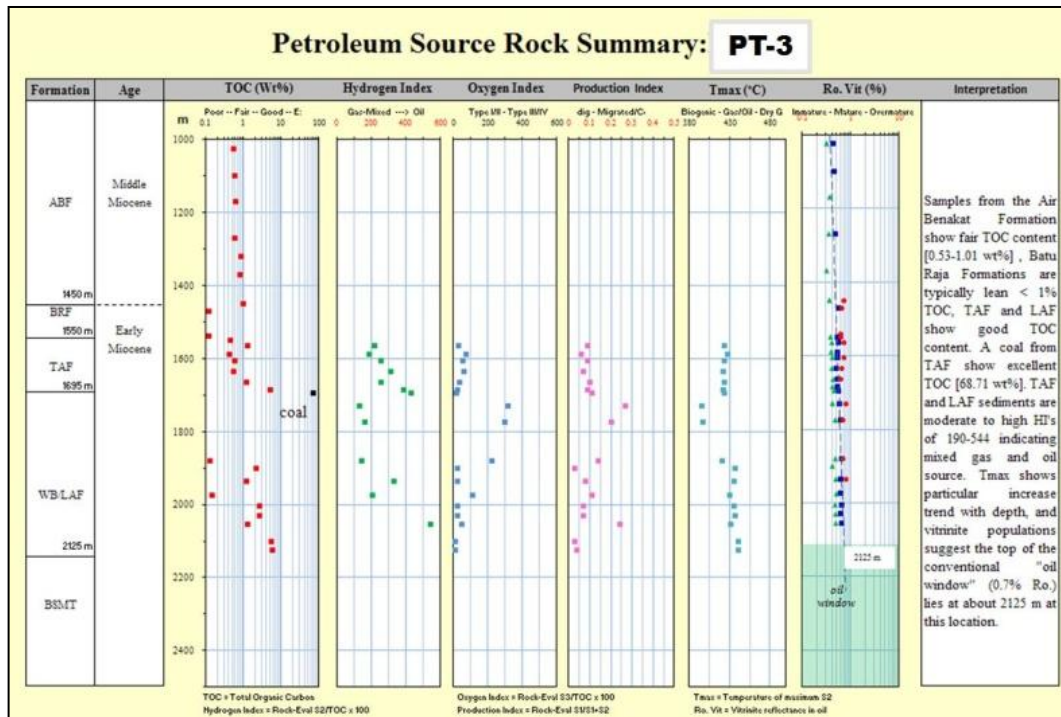


Figure 1. Geochemistry analysis PT-3 Well.

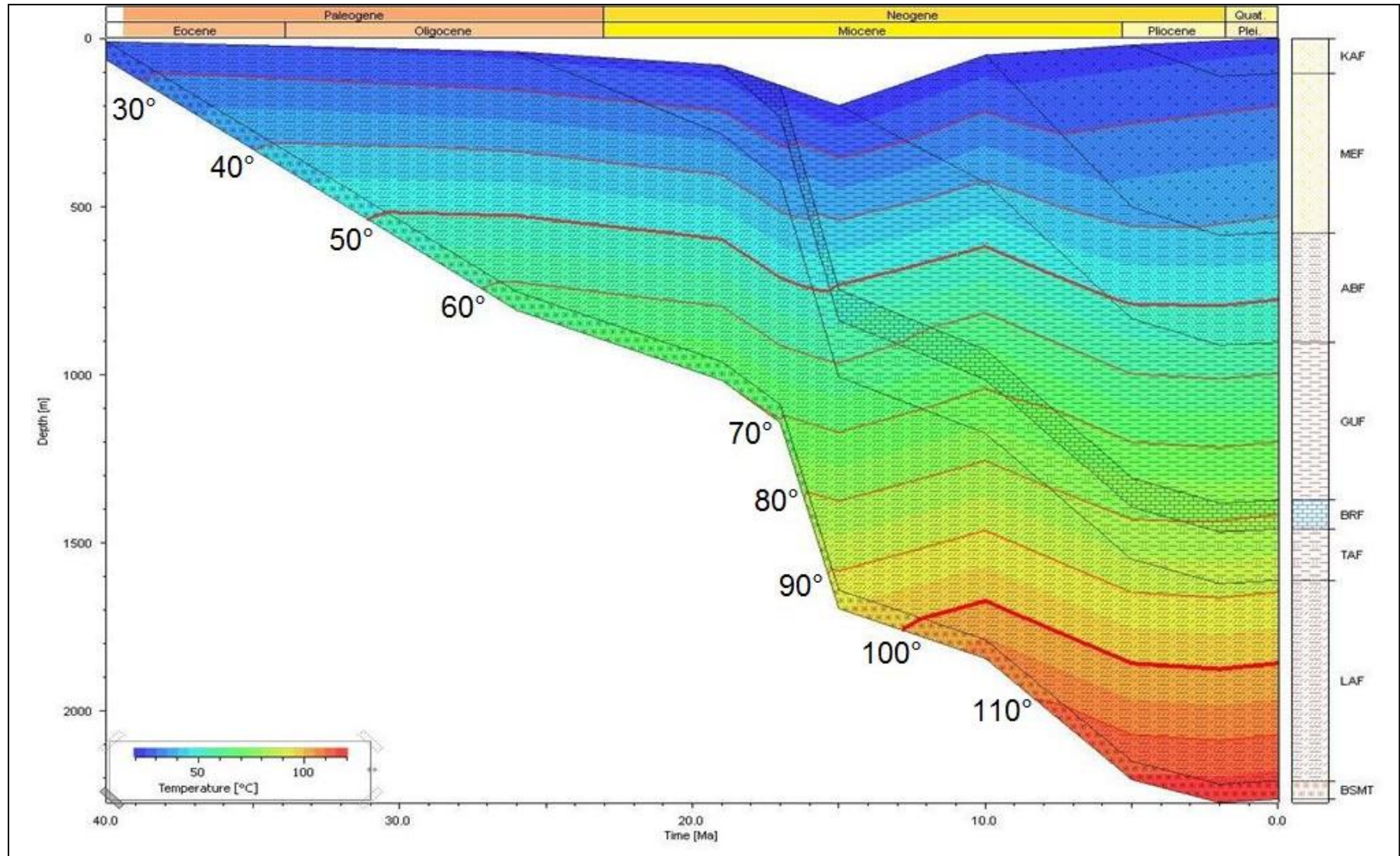


Figure 2. Burial history analysis PT-3 Well.

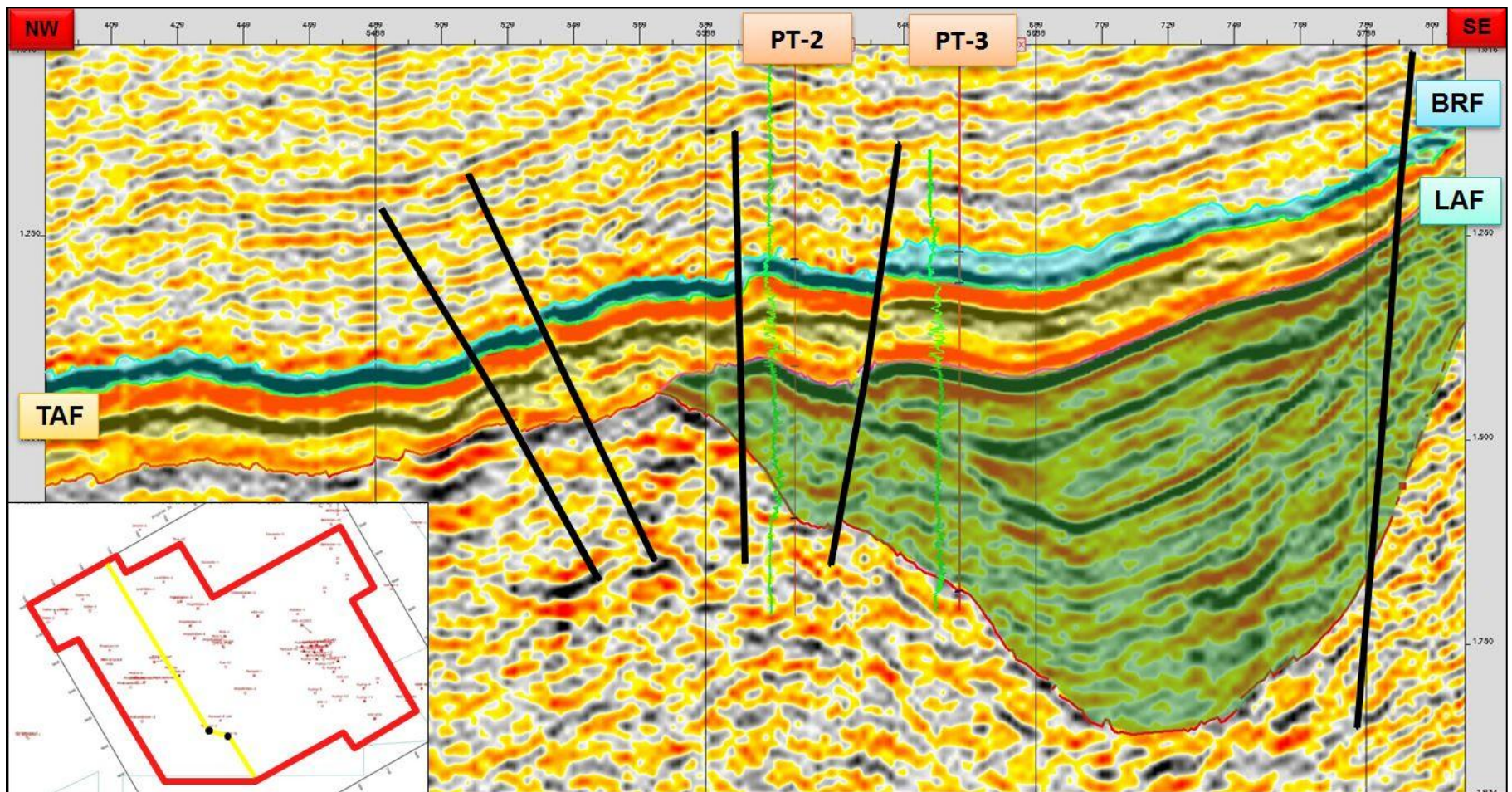


Figure 3. Seismic interpretation of Lahat Formation at Topaz Area.

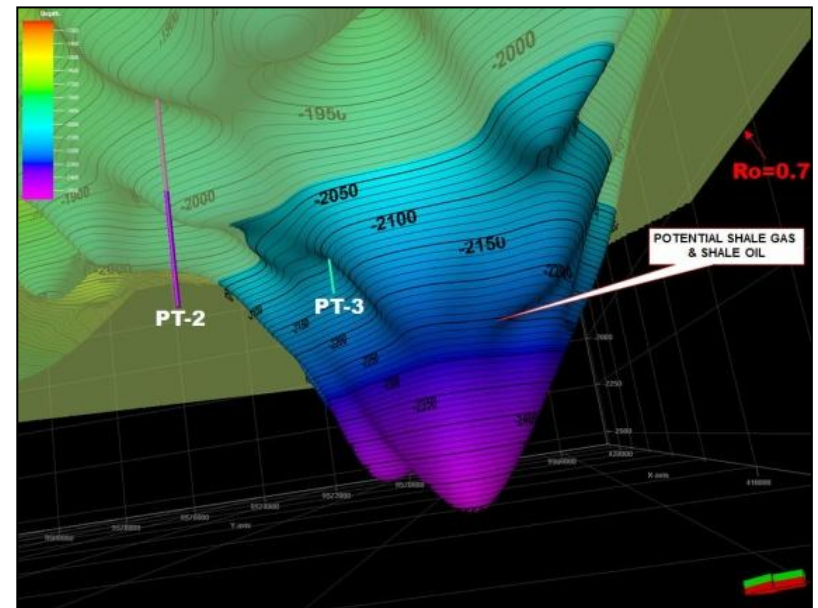
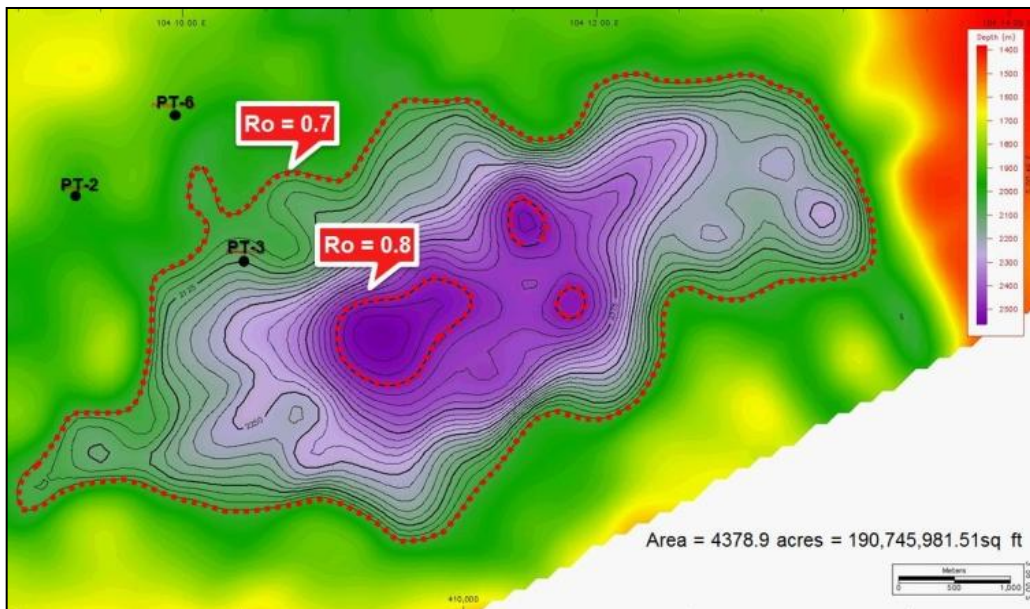


Figure 4. Unconventional hydrocarbon sweet spot for Lahat Formation at Topaz Area.

DB : IP\_PROJECT (25)

## PT-3

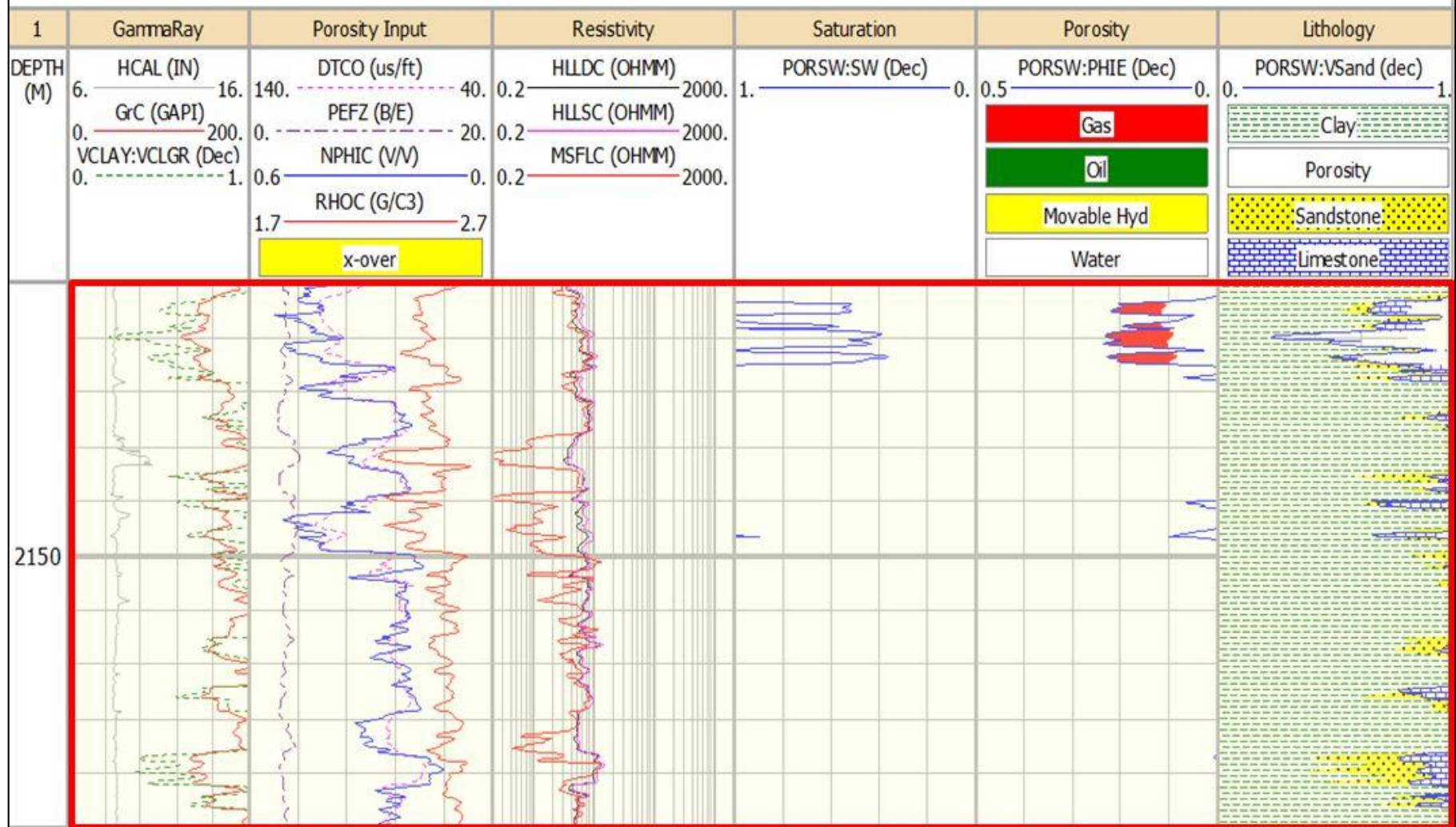
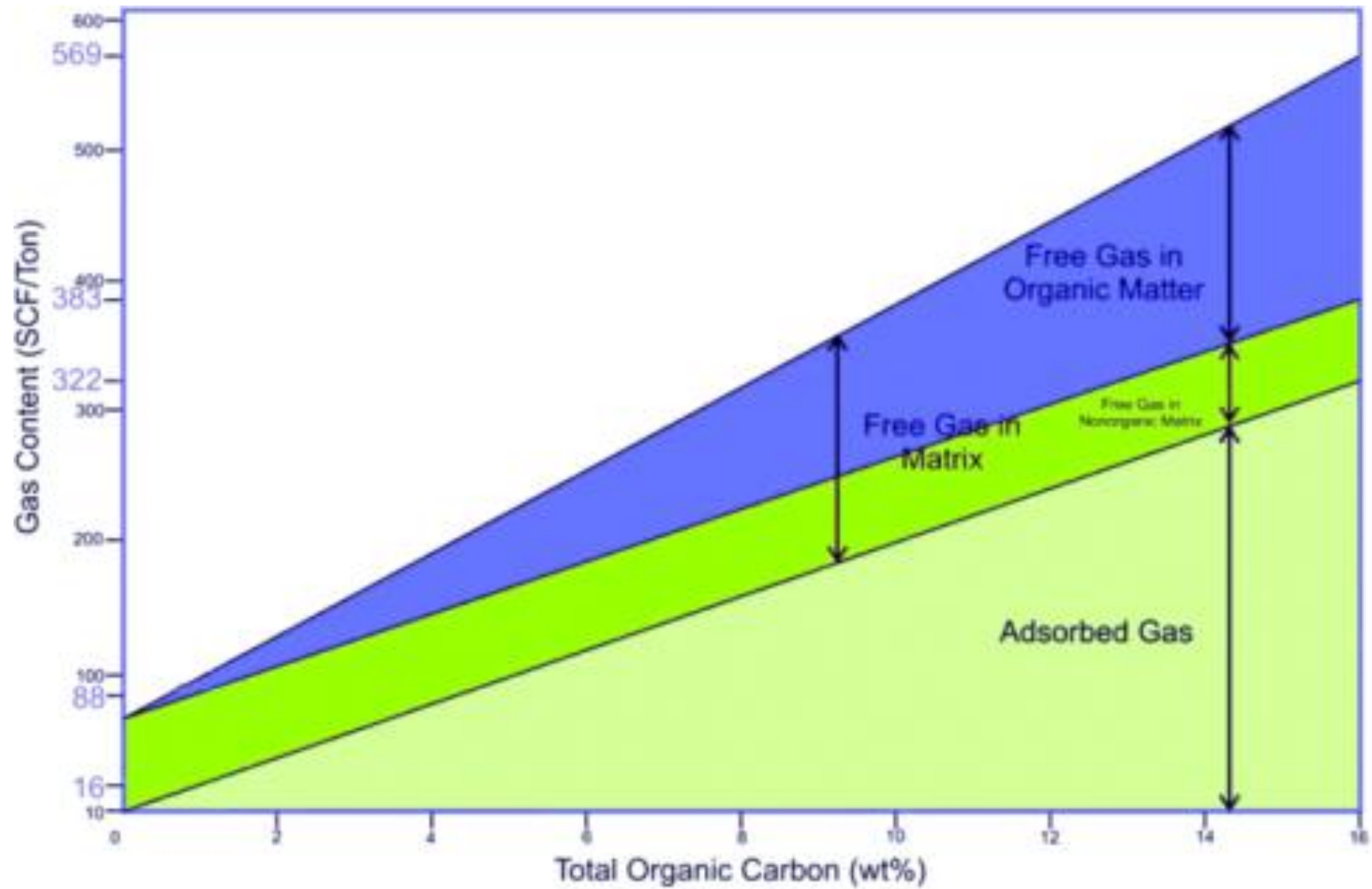


Figure 5. Petrophysical analysis PT-3 Well.



Data from Jarvie, PTTC Workshop, 2004

Figure 6. Jarvie TOC vs Gas Content chart.

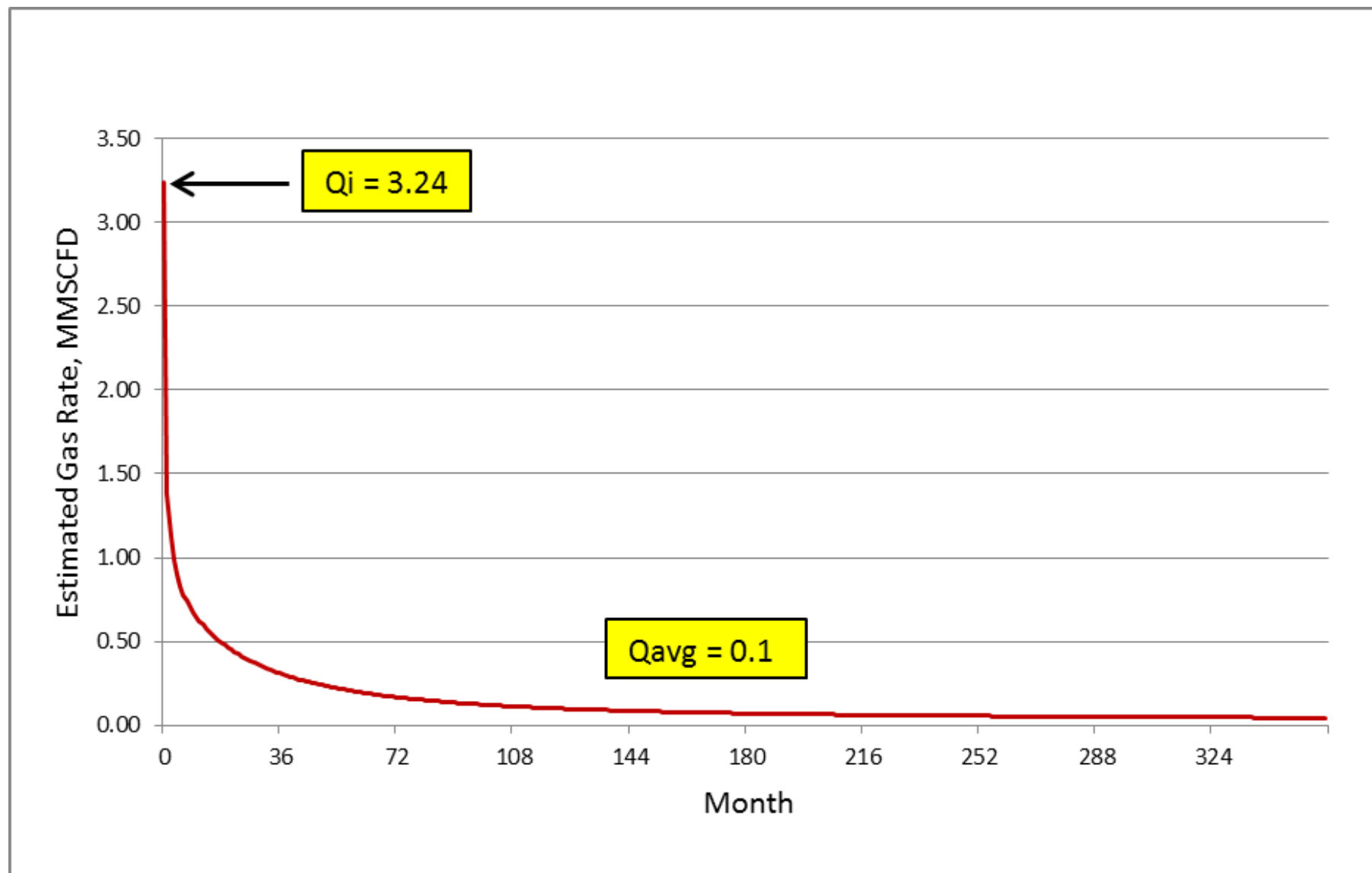


Figure 7. Estimated gas production profile (single well).