EA Heat Flow Distribution in Offshore West Java Basin: Implication for Petroleum System in Anggursi Block, North West Java Basin*

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Introduction

Anggursi area is operated by PT PHE. Anggursi area is located in the Offshore Northwest Java Basin (Figure 1). It is a well-known area for the most prolific petroleum exploration and production provinces in Indonesia. This working area has approximately 8 thousand square kilometers. The Anggursi area was relinquished by the previous operator, IIAPCO and BP ARCO. Based on the previous dry hole exploration wells drilled in the Anggursi area, the root cause of exploration failures is assumed to be caused by the lack of thermal heat flow in the basin. Consequently, mature source rock failed to generated petroleum within the northern part of the Anggursi Basin.

The variation heat flow distribution in the Offshore West Java is still yet to be fully understood. Model of heat flow in the offshore is important in terms of the petroleum system. According to Hall (2002), the South East Asian region has a high heat flow which is characterized by the many volcanic areas within the region. The heat flow distribution map of the western to middle part of Indonesian (Figure 2) shows that the area around the Anggursi area has a high heat flow. This study has been done to bring better understanding of heat flow and petroleum system correlation in the Anggursi area.

Well data set comprising all temperature data available from reliable bottom hole temperature and VR plots from Anggursi and surrounding area was examined. Our recent studies on geochemical and petrography analysis were performed to correlate the Paleo Heatflow and Recent Heatflow in the area. These studies suggest positive impact on petroleum generation by recent VR data. Predicting regional thermal maturity of the basin in Anggursi area comprehensively has become widely accepted component in the exploration system, and it is already proven in lowering petroleum exploration risk in the Anggursi area. Therefore, this study was conducted to determine the heat flow of the Anggursi area using gradient temperature and thermal conductivity data.

Methodology

The source rock maturation potential in the Anggursi area needs to be constrained with paleo temperature conditions and heat flow. There are two methods in determining the value of heat flow according to Powell et al. (1988): Interval Method (applied method) and the Bullard Method. The Interval Method uses gradient temperature and thermal conductivity. The heat flow formula used in the Interval Method is:

Heat Flow = Geothermal Gradient X Thermal Conductivity

Gradient temperature is determined from the depth temperature data with specific depth intervals. While, thermal conductivity used in this study is based on Suryatini, 2016 (Table 1).

Another method to determine the thermal conditions during the sedimentation process is to use Ro (vitrinite reflectance) data taken from the vitrinite reflection value.

Results and Discussion

Heat flow distribution map (Hall, 2002) shows the value of surface heat flow in the Anggursi area ranging from 80 - 120 mW/m^2. Heat flow study in the Onshore North West Java Basin shows the heat flow value in the area around the Anggursi area ranging from 26.42 to 94.05 mW/m^2 (Suryatini, 2016).

Based on Ro vs depth cross plot from Soputan-1 and SH-1 wells, there are two trends indicating erosion on Pre-TAF (Ro jump which indicates erosion) which proves the existence of different tectonic periods. Based on the distribution of heat flow maps, high heat flow value is correlated to high Ro (Figure 3).

The linear Ro line that is supposed to be linear is not visible above, due to erosion. Here are examples of linear erosion anomaly Ro (Sentfle and Landis, 1991) (Figure 4).

Gradient thermal and thermal conductivity data at the Anggursi wells are evaluated to validate source rock at Anggursi area. Based on heat flow map distribution (Figure 5), the southern part ranging from 70 - 140 mW/m^2 as a proven hydrocarbon producer (ONWJ Block at offshore and Pertamina EP at onshore) and the northern part (Anggursi area) has heat flow ranging from 90 - 190 mW/m^2. This shows the northern part of Anggursi area has the potential to produce hydrocarbon and vitrinite reflectance from Soputan-1 and SH-1 wells shows mature source rock (Figure 3).

Conclusion

1. Heat flow value in the offshore North West Java (90 – 190 mW/m^2) slightly higher compared to in the onshore West Java (70 – 140 mW/m^2).

2. Heat flow map in northern part of Anggursi area validated with paleo temperature from Ro data in the Soputan-1 and SH-1 well. It shows within the northern part of Anggursi area has high Ro value.
3. Mature potential source rock from this study show potential hydrocarbon within Anggursi area. Further exploration activity is needed
4. Additional real conductivity data needed to acquire in northern part Anggursi area

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Selected References

Balling, N., 1979, Subsurface Temperatures and Heat Flow Estimates in Denmark, *in* V. Čermak and L. Rybach (eds.), Terrestrial Heat Flow in Europe: Springer-Verlag, Berlin, p. 161-171.

Beck, A.E., 1988, Methods for Determining Thermal Conductivity and Thermal Diffusivity, in R. Haenel, L. Rybach, L. Stegena (eds.), Handbook of Terrestrial Heat Flow Density Determination with Guidelines and Recommendations from the International Heat Flow Commission: Kluwer Academic Publisher, Boston, p. 87-123.

Daly, M.C, B.G.D. Hooper, and D.G. Smith, 1987, Tertiary Plate Tectonics and Basin Evolution in Indonesia: Proceedings of Indonesian Petroleum Association, 16th Annual Convention, v. 1, p. 399-428.

Gresko, M., C. Suria, and S. Sinclair, 1995, Basin Evolution of the Ardjuna Rift System and Its Implications for Hydrocarbon Exploration, Offshore Northwest Java, Indonesia: Proceedings of the Twenty Fourth Annual Convention, Indonesian Petroleum Association, p. 147-161.

Hall, Robert., 2002, SE Asian Heat Flow, SE Asia Research Group, Department of Geology, Royal Holloway University, London, UK: IPA Newsletter, p. 20-21.

Noble, R.A., K.H. Pratomo, K. Nugrahanto, A.M.T. Ibrahim, I. Praseetya, N. Mujahidin, C.H. Wu, and J.V.C. Howes, 1997, Petroleum Systems of Northwest Java, Indonesia, *in* J.V.C. Howes and R.A. Noble (eds.), Proceedings of an International Conference on Petroleum Systems of SE Asia and Australasia: Indonesian Petroleum Association, p. 585-600.

Powell, W.G., D.S. Chapman, N. Balling, and A.E. Beck,1988, Continental Heat-Flow Density, in R. Haenel, L. Rybach, and L. Stegena (eds.), Handbook of Terrestrial Heat-Flow Density Determination: Solid Earth Sciences Library, v. 4, Springer, Dordrecht, p. 167-222. doi.org/10.1007/978-94-009-2847-3_5

Putra, S.D.H., N. Suryantini, and W. Srigutomo, 2016, Thermal Modeling and Heat Flow Density Interpretation of the Onshore Northwest Java Basin, Indonesia: Geotherm Energy, v. 4/12, 24 p. doi:10.1186/s40517-016-0052-x

Suryatini, 2007, Determination of Heatflow Values and Thermal Modeling of Western Java, Indonesia: Ph.D. Thesis, Kyushu University, Fukuoka, Japan.

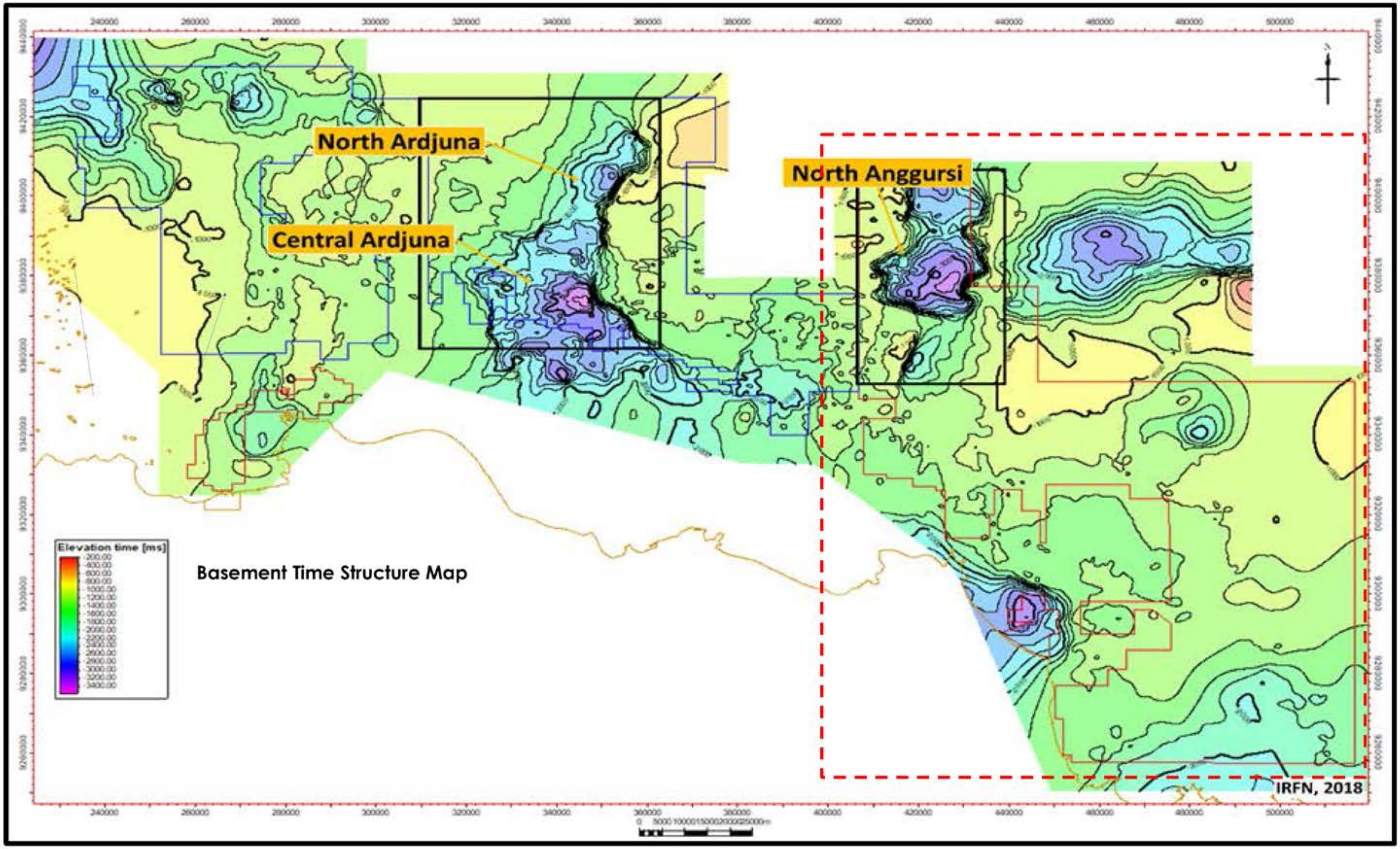

Figure 1. Offshore North West Java Basin (Anggursi Area inside the red dash Line).

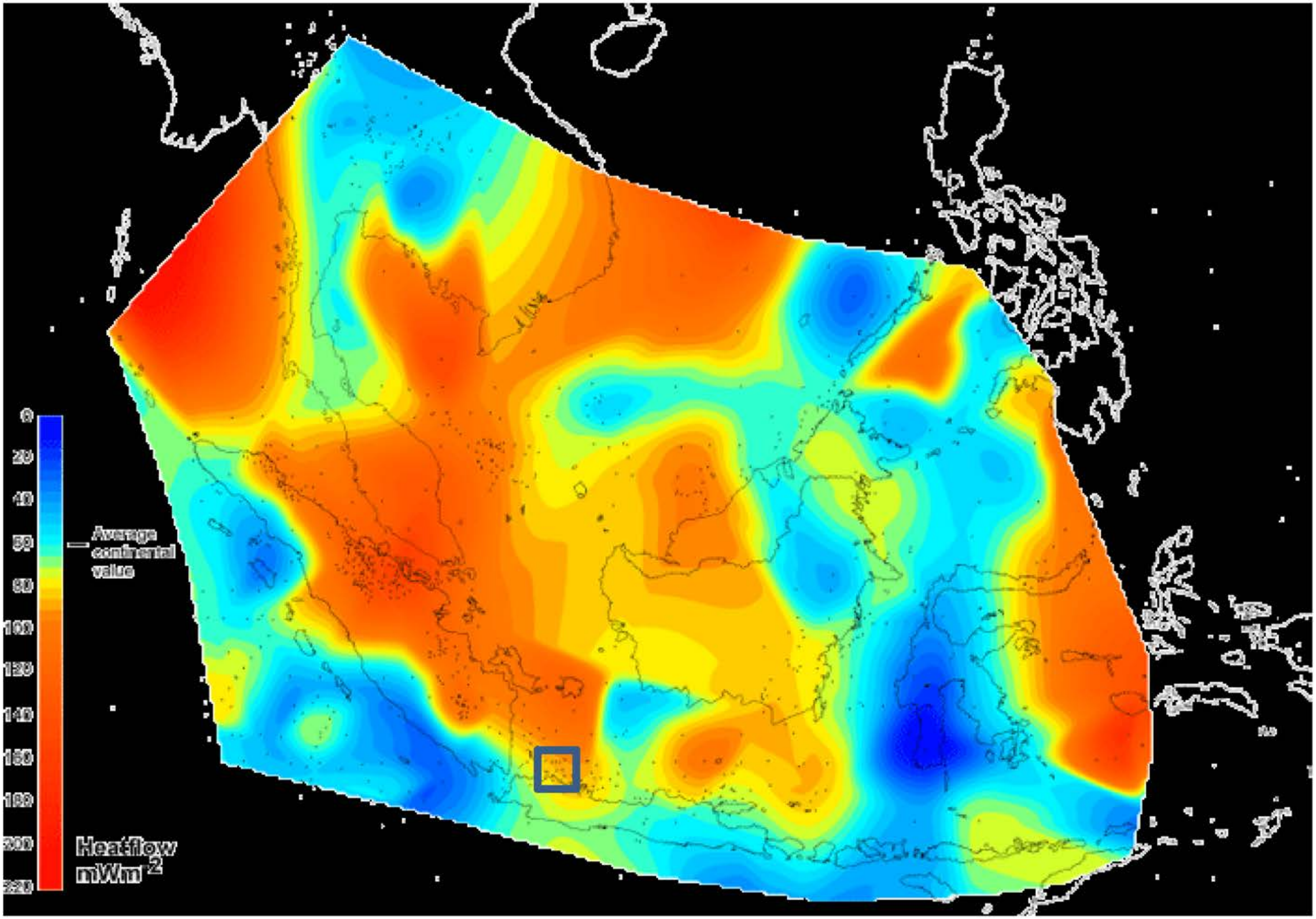

Figure 2. Heat Flow Map, Hall (2002).

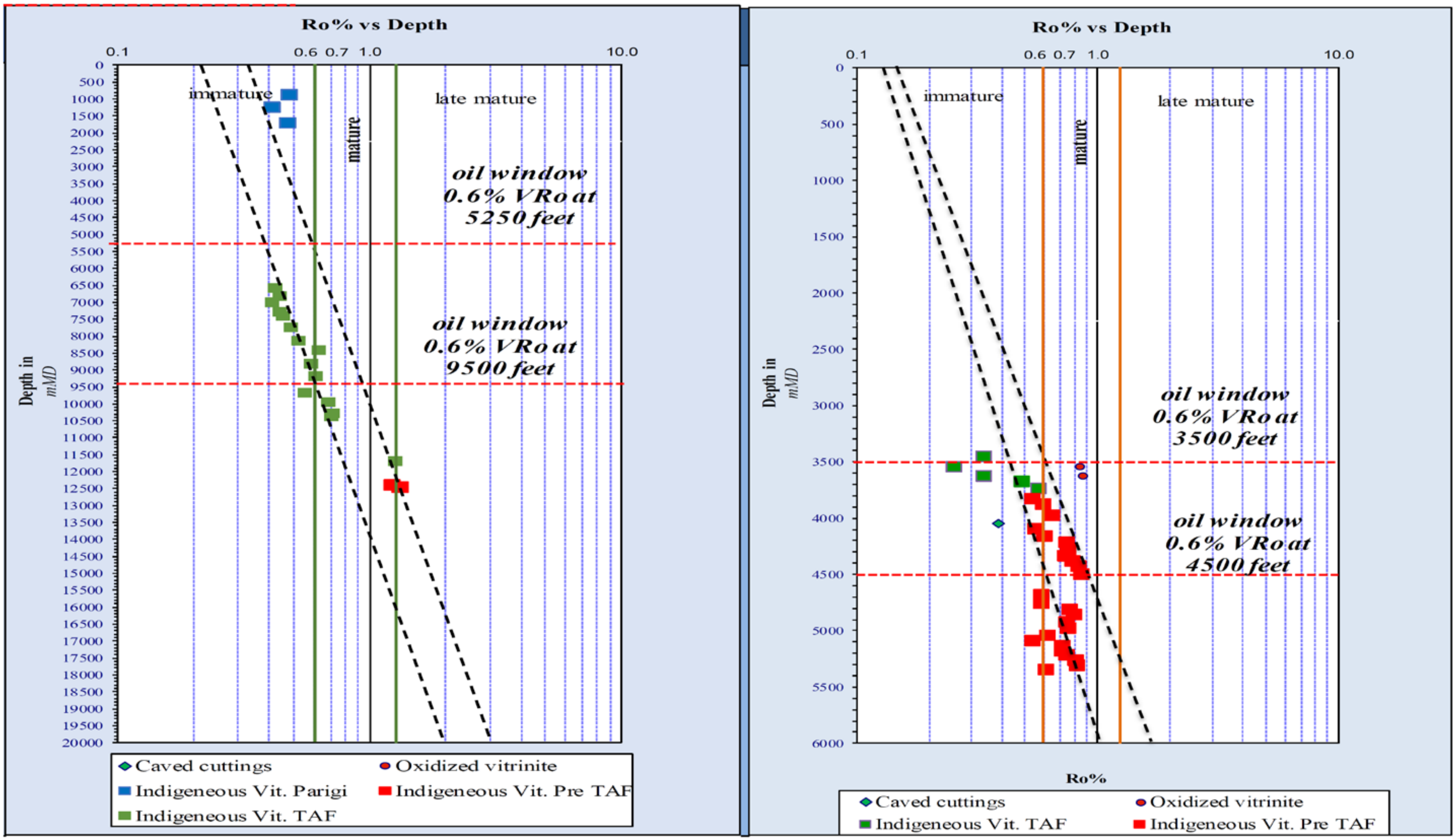

Figure 3. Ro SH-1 (left) and Ro Soputan-1 (right).

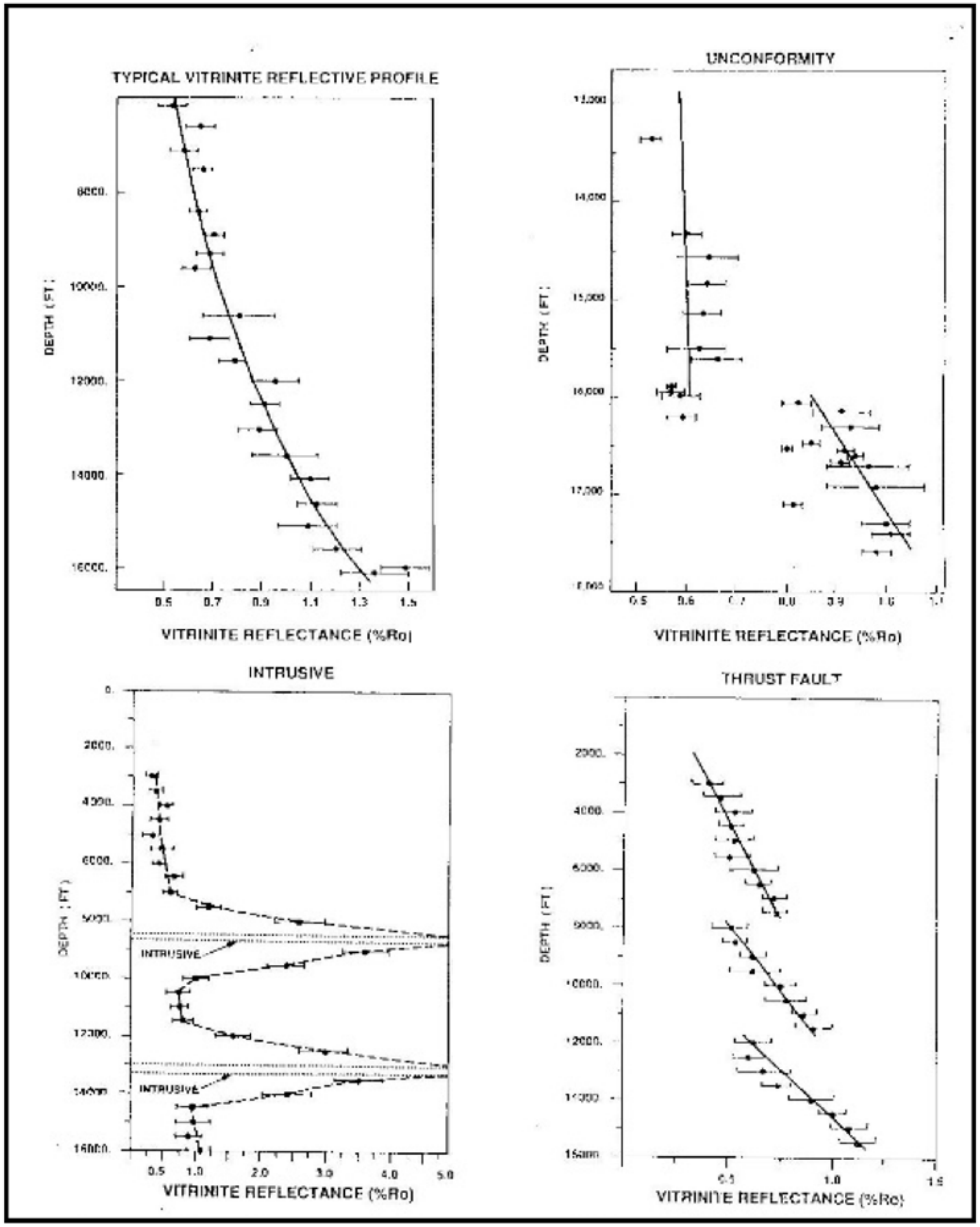

Figure 4. Erosion anomaly from Ro (Sentfle and Landis, 1991), based on Ro data Anggursi area interpret experienced series of erosion.

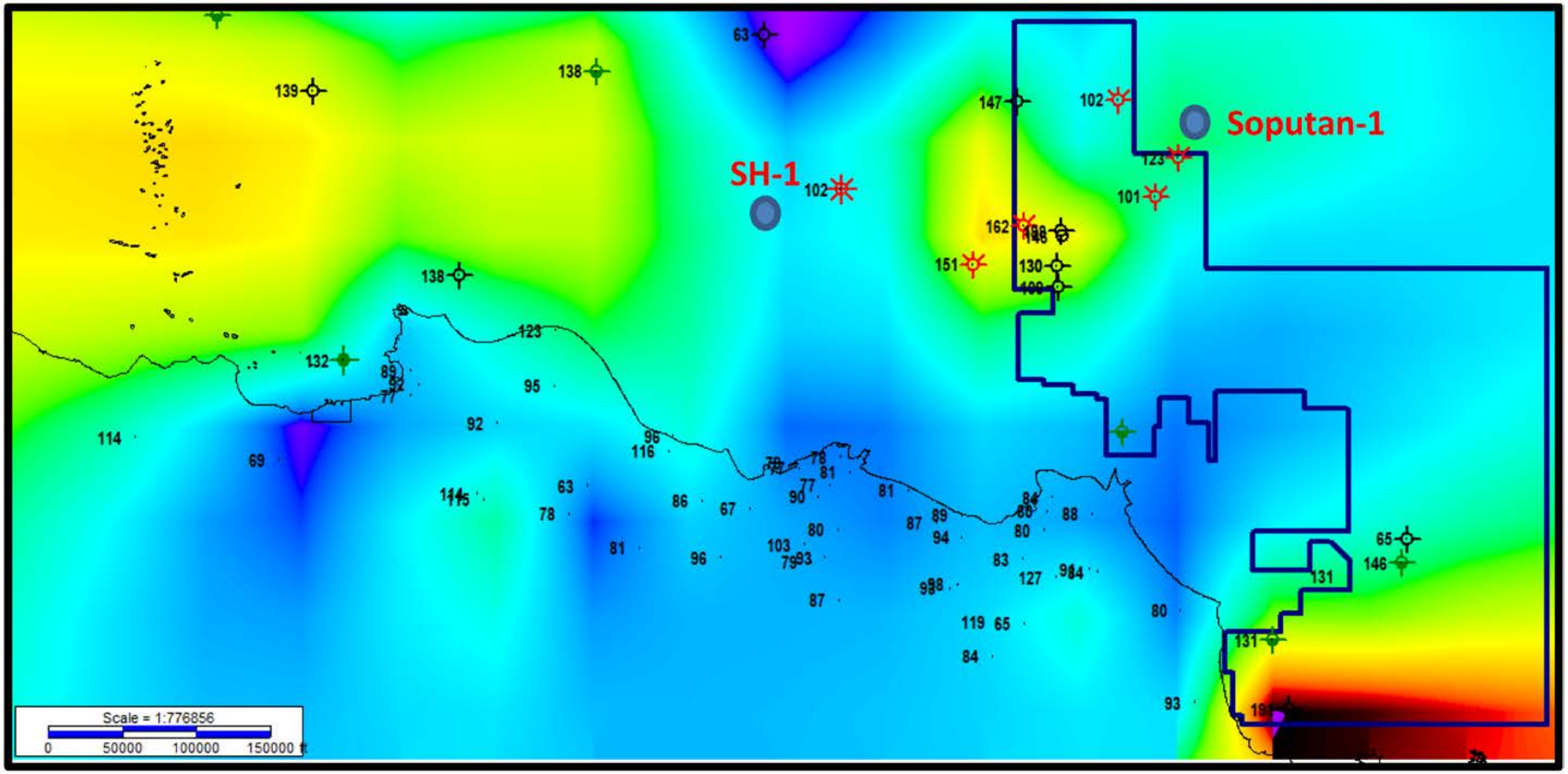

Figure 5. Heat Flow in Anggursi Area value (mW/m^2).

FORMATION	LITHOLOGY	λ ($W\ m^{-1}\ K^{-1}$
Cisubuh	Shale	1.73 ± 0.03
Parigi	Limestone	2.39 ± 0.09
Upper Cibulakan	Shale, Limestone	1.88 ± 0.18
Lower Cibulakan	Calc sand, Marl, Shale, Limestone	2.21 ± 0.17
Jatibarang	Volcanic	2.42
Basement	Metamorphic	2.79

Table 1. Thermal Conductivity (Suryatini, 2016).