Sandstone Reservoir Distribution Mapping of Bekasap Formation Using Seismic Attributes and Identification of Stratigraphic Trap in 'X' Field, Central Sumatera Basin

IOP Conf. Series: Materials Science and Engineering **546** (2019) 072009 doi:10.1088/1757-899X/546/7/072009

Sandstone Reservoir Distribution Mapping of Bekasap Formation Using Seismic Attributes and Identification of Stratigraphic Trap in 'X' Field, Central Sumatera Basin

Suwondo[1*], A. Haris[2], A. Riyanto[2], J. Wiyono[3]

[1]Department of Physics, Faculty of Science and Mathematics, Universitas Indonesia, [2]Geoscience Department, FMIPA, Universitas Indonesia, [3] STT MIGAS Balikpapan

*Corresponding author: bagus_wondo@yahoo.com

Abstract. The 'X' field is an oil-producing field in the Central Sumatra Basin. Central Sumatra Basin is the largest oil-producing sedimentary basin in Indonesia. The field is an area in the form of onlaping Bekasap Formation to the Basement High. The onlapping feature has potential for stratigraphic traps. This study aims to identify the potential stratigraphic traps for hydrocarbon accumulation, the distribution of sandstone reservoirs, facies types and the depositional environments. The data used in the study are 3D seismic data, well log, and core data. The research methods used including the analysis of electrofacies based on well log, seismic attributes, and conceptual geology model. The research shows that there is a stratigraphic trap in the form of intra-formation and regional traps. Intra-formation traps were formed vertically by the intersection of sandstone and shale lithologies and lateral facies changes, whereas the regional traps are formed by the shale layer of Telisa Formation and Bekasap Formation with onlapping on the Basement High. Based on AI inversion and RMS amplitude show the distribution of Top A sandstone reservoir is Northeast - Southwest on onlaping zone to the Basement High. The reservoir was deposited in depositional environment as wave dominated delta which is four facies associations: distributary channel, upper shoreface, lower shoreface, and offshore facies.
Keywords: reservoir, sandstone, facies, stratigraphic trap, and seismic attributes.

1. Introduction

The 'X' field is located in the Central Sumatra Basin with the Bekasap Formation onlaping on the Basement High. There is an onlapping feature become a potential stratigraphic trap. This field is an oil producer in the Central Sumatra Basin. For field development, it requires an understanding of reservoir distribution, facies and depositional environment of the target zone.

The Central Sumatera Basin is one of the largest oil and gas contributor basin for Indonesia. The abundant production comes from Tertiary sedimentary rock. This Basin is one of the basins located in back-arc on the Sumatera Island (Figure 1). The Central Sumatera Basin is bordered by the TigaPuluh High in Southern part and the Asahan Arch in Northern part. [1].

The Tertiary Stratigraphy of the Central Sumatera Basin, from old to young age consists of Pematang groups, Sihapas Group (Menggala Formation, Bangko Formation, Bekasap Formation and Duri Formation), Telisa Formation, Petani Formation, and Minas Formation. [3]. Longley et al.[4], divided the Central Sumatra Basin into four stage: Pre-Rift, Syn Rift, Post Rift, and SynOrogenesa-Orogenic Bed Periods. (Figure 2). The target study is Bekasap Formation.

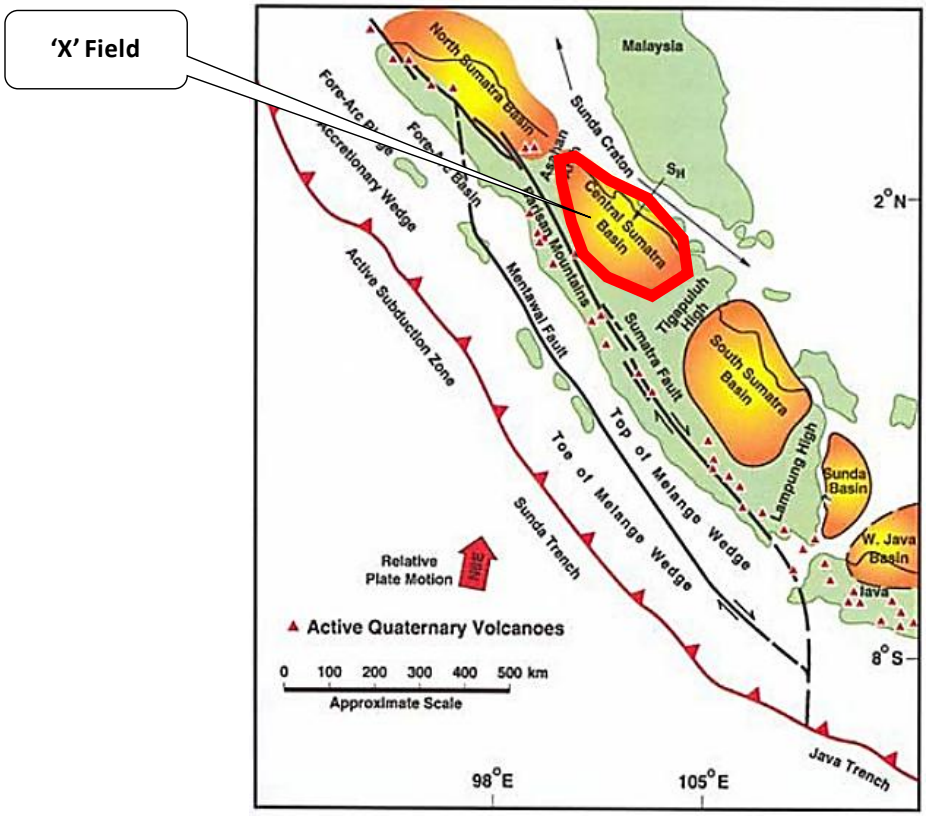

Figure 1. The 'X' Field is located in the Central Sumatra Basin. [2].

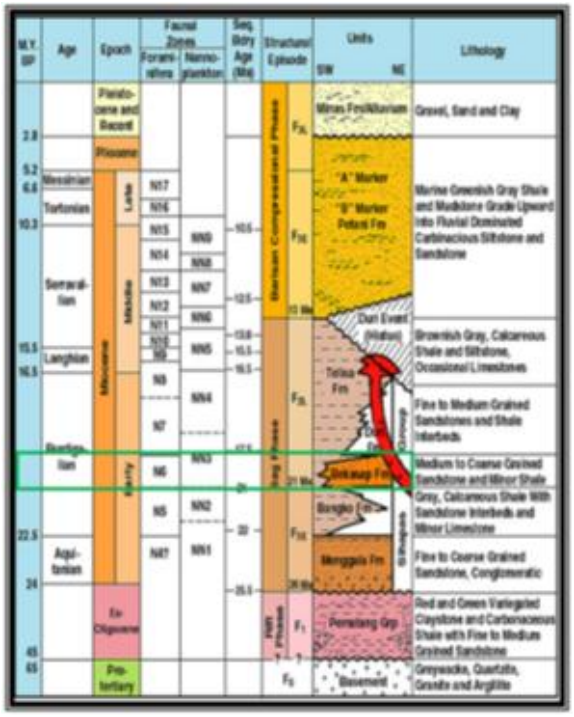

Figure 2. The stratigraphic column of Central Sumatra Basin. The target of study (Bekasap Formation) is shown by green box. [2].

2. Methods

The data availability are 6 well log data, mudlog data, well report, core and 3D seismic data. The method used in this study including well and seismic data analysis. Well data analysis was used to determine marker, lithology, and facies in well data. The markers were used for well correlation. The next step is crossplot analysis for distinguished between sand and shale of the zona target. The sand reservoir of target zone has low gamma ray and high accoustic impedance (Figure 3).

Crossplot gamma ray vs accoustic impedance of sandstone reservoir in the Top A Bekasap Formation (Figure 3). The characteristic of zona target has low gamma ray. Based on crossplot on well UI-3, low Gamma Ray is relatively related to High AI. The value of AI in zone target is around 18300-24800 gr / cc * ft / s (Figure 6). Sandstone character in Top A has high AI because these sandstones have relatively high density compared to the lower and higher layers.

Well-seismic tie step had been generated in UI-3 Well, with good correlation is 0.95 (Figure 4). Based on well seismic tie, the sandstone targets are in peak and trough (maximum and minimum amplitude). The next step is extracted accoustic impedance (AI) inversion and Root Mean Square (RMS) amplitude attribute seismic for identification of sandstone reservoir distribution. AI seismic inversion was used is model based inversion (Figure 5).

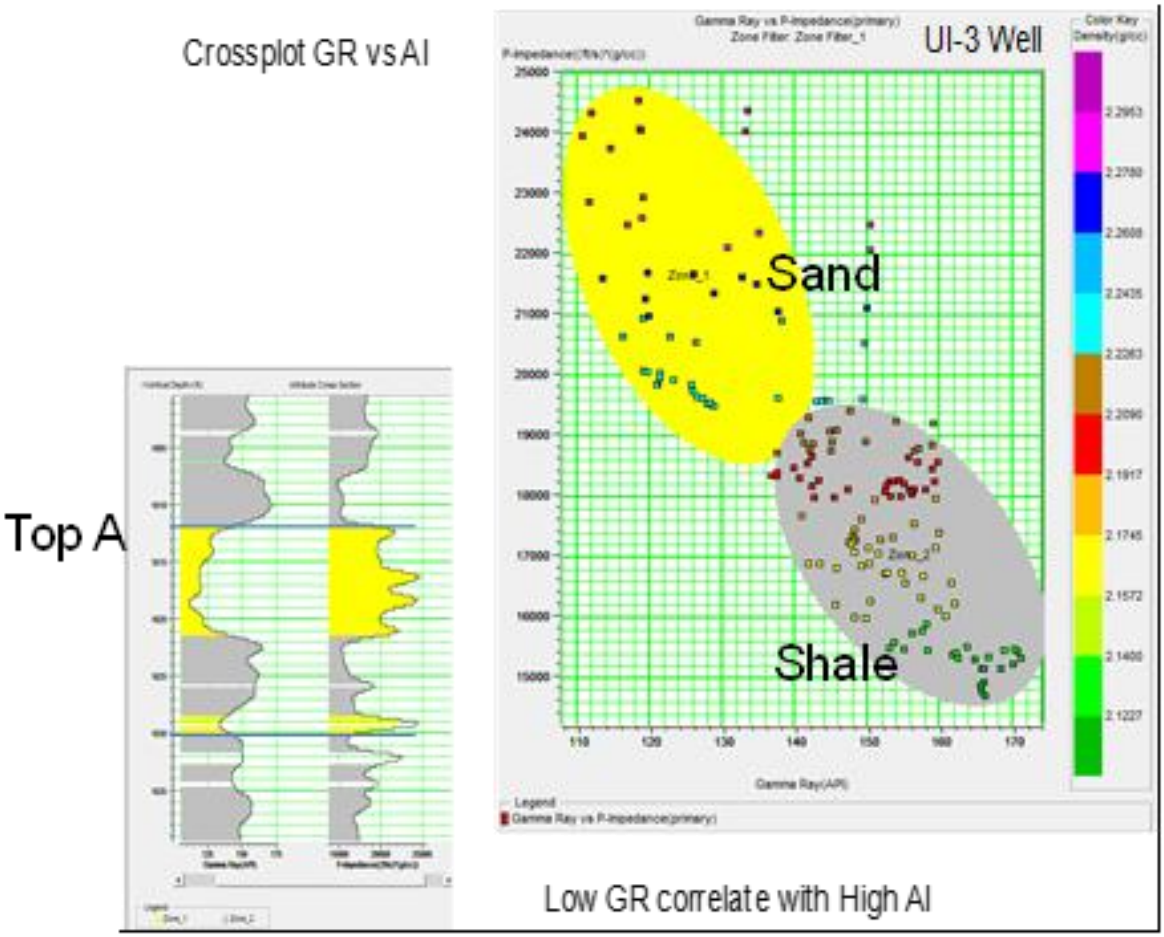

Figure 3. Crossplot gamma ray vs accoustic impedance at UI-3 well.

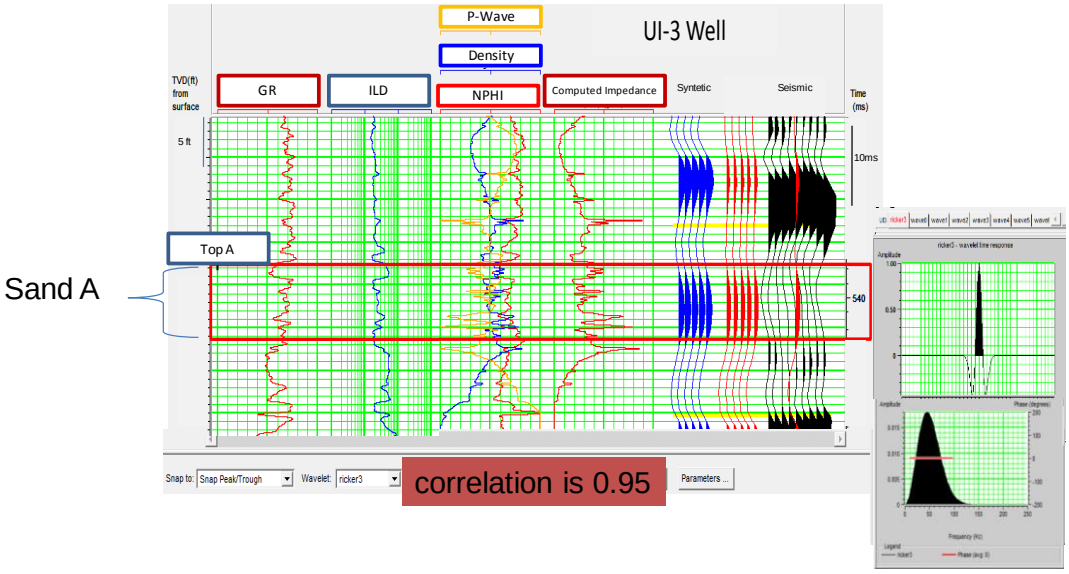

Figure 4. Well-seismic tie on well UI-3 with correlation 0.95

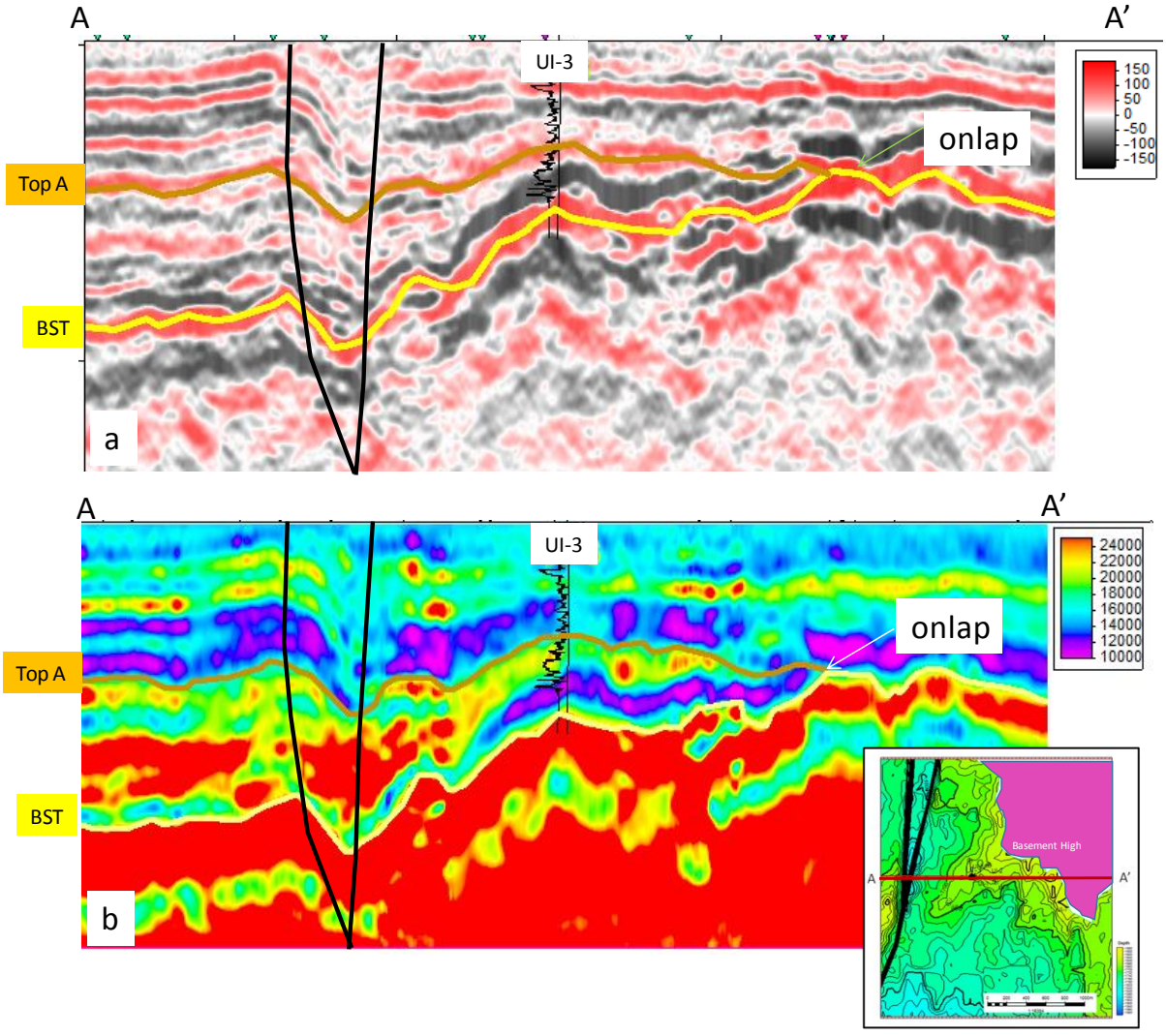

Figure 5. Section A-A'. a) Seismic amplitude, b) AI inversion

3. Results and Discussion

In this the study, facies analysis was constructed based on the gamma ray (GR) log pattern. The gamma ray log determine the radioactive content of rocks, fine grained sedimentary rocks such as claystone, siltstone have a high radioactive content, while coarser grained sedimentary rocks such as sandstones have relatively small radioactive content. Based on this approach according to Selley [5] in Walker [6], gamma ray logs can reflect variations in a large succession of grain sizes. A succession of large sizes of these grains can show changes in depositional energy. Each depositional environment produces different pattern of depositional energy). Gamma ray pattern analysis is controlled by core data of well UI-6. Top A Bekasap Formation has gamma ray log pattern, such as: blocky, bell and funnel. The shape of the pattern was interpreted as: Offshore, Shoreface and Distributary channel facies. The facies interpretation was delineated by well correlation (Figure 6).

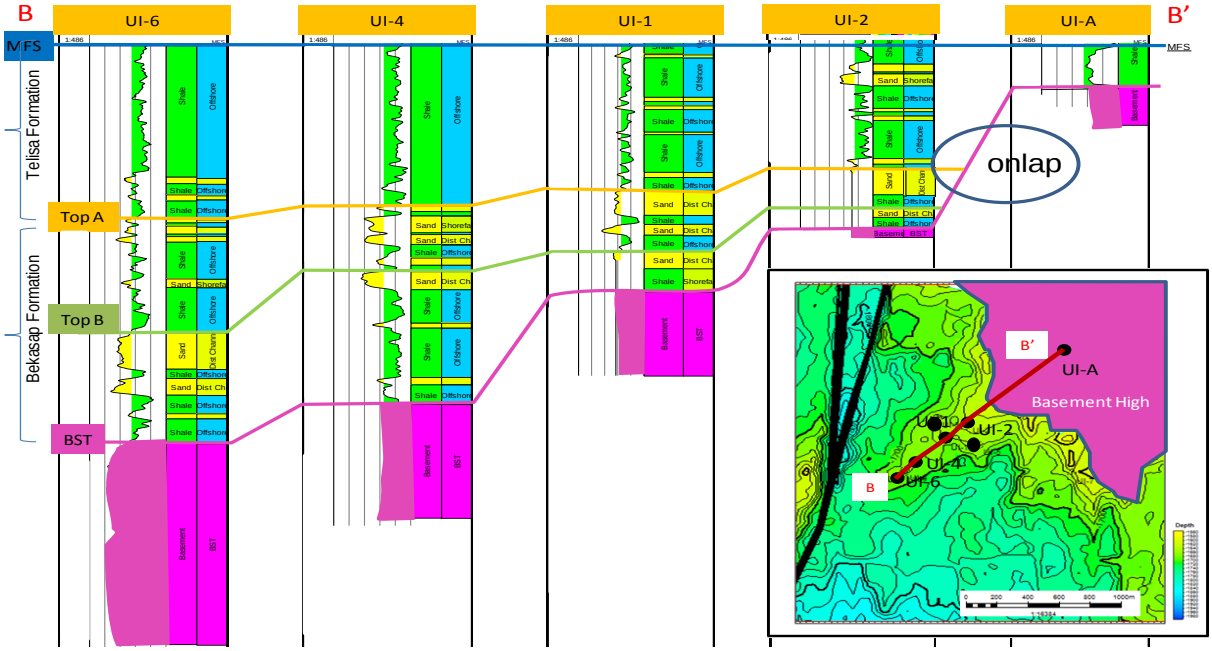

Figure 6. Well correlation is flatened based on MFS (Maximum Flooding Surface). It shows Top A or Top Bekasap Formation onlap to the Basement High.

3.1. Stratigraphic Trap Analysis

Well correlation B-B' has Southwest - Northeast trending (Figure 7) was flatened at MFS (Maximum Flooding Surface). Based on well corelation the Top Bekasap or Top A onlap on the Basement High. There are several facies in the Bekasap Formation, Such as: shale of offshore facies and sandstone of distributtary channel and shoreface facies, which it became seal and reservoir, respectively. Intra-formation shale of Bekasap Formation and regional seal of Telisa Formation became potential seal. The seismic section (Figure 5 & Figure 6) and well correlation (Figure 7) show onlapping Top A to the Basement High. The onlapping feature become a potential stratigraphic trap.

3.2. Seismic Atrributes Analysis

Acoustic impedance (AI) is typical of characteristic rocks which is the result of multiplication between density (ρ) and the speed of seismic waves (v) [7]. Mathematically the AI equation is as follows:

$$AI=\rho \times v$$

Which are,
AI = Accoustic impedance
ρ =density (g/cc)
v = velocity of wave (m/s)

According to Taner [8], root mean square (RMS) attribute are the seismic data which is possessed after stacking. The principle that computes the square root of the sum of squared amplitudes divided by the number of samples within the specified window used. Based on RMS Amplitude and AI inversion, the distribution of sandstones trend area was Southeast-Northwest direction (Figure 7). There is sandstone distribution in the Northern part of the field which can be new target for development.

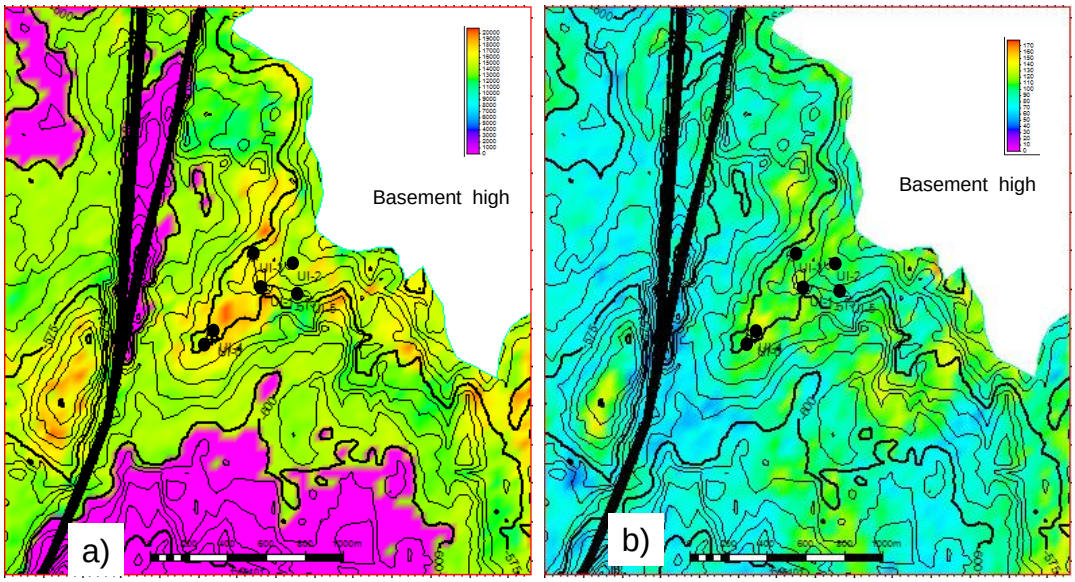

Figure 7. a) AI Inversion overlay with depth structure of Top A, b) RMS Amplitude overlay with depth structure of Top A.

Depositional environment analysis in this study based on well logs was validated by core data and seismic attribute. Whereas in seismic attribute analysis shows triangular morphology from the distribution pattern of sandstone reservoir (Figure 8) which is interpreted as delta. Based on delta classification by Galloway, W.E., [9], the depositional environments in the study area is interpreted as wave dominated delta.

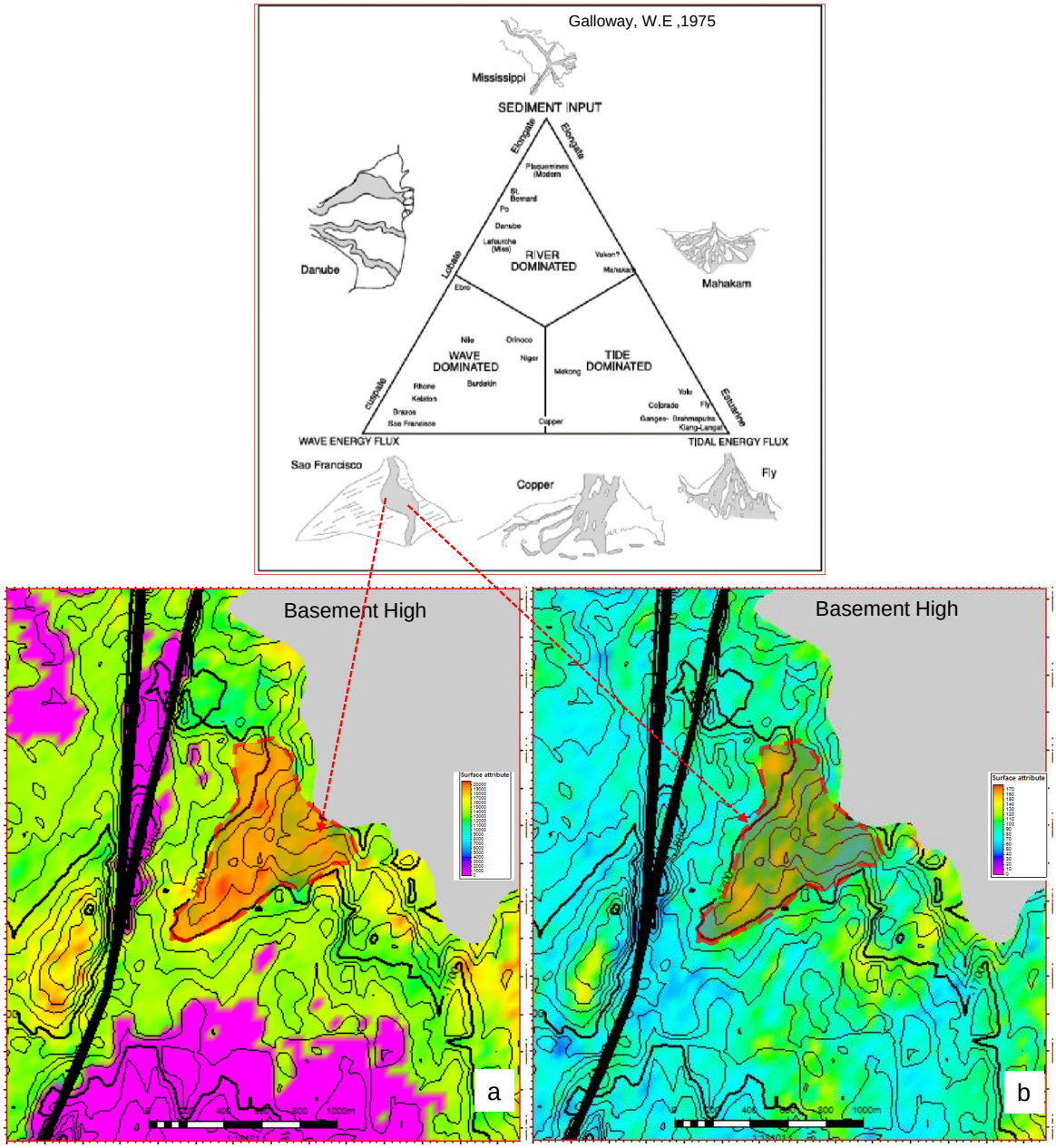

Figure 8. Seismic attribute analysis shows triangular morphology. a) AI Inversion overlay withdepth structure of Top A, b) RMS Amplitude overlay with depth structure of Top A

4. Conclusion

The stratigraphic trap developed in this field because the presence of intra-formation shale and onlapping feature of Bekasap Formation to the Basement High.AI Inversion can generate sandstone distribution of sand A in Bekasap Formation. Based on AI inversion and RMS amplitude attributes show the distribution of Top A sandstone reservoir trending is Northeast - Southwest on onlaping zone to the Basement High. The facies developed are distributary channel, upper shoreface, and lower shoreface and offshore deposited in wave dominated delta environment.

Acknowledgment
The authors, especially Suwondo gratefully acknowledge the financial support of LPDP, Ministry of Finance of the Republic of Indonesia.

References
[1] Pertamina BPPKA. 1996. Petroleum Geology of Indonesian Basins: Principles, Methods, and Application, Vol II: Central Sumatera Basin.
[2] Heidrick & Aulia Karsani. 1993. *A Structural and Tectonic Model of the Coastal Plains Block, Central Sumatra Basin, Indonesia. Proceedings of the 22th Annual Convention*. Jakarta.
[3] Mertosono, S., Nayoan, G.A.S. 1974. *The Tertiary Basinal Area of Central Sumatra*. Proceedings Indonesian Petroleum Association, Third Annual Convention, Jakarta
[4] Longley, I.M., Barraclough, R. Bridden, M.A. & Brown, S. 1990. *Pematang lacustrine petroleum source rocks from the Malacca Strait PSC, Central Sumatra, Indonesia*. Indonesian Petroleum Association, Proceedings of the 19th Annual Convention. Jakarta.
[5] Selley, R.C. 1978. *Ancient Sedimentary Environments 2nd edition. Chapman Hall.* London
[6] Walker, R.G., James, N.P. 1992.*Facies Model Response to Sea Level Change*. Geological Association of Canada-Department of Earth Science. Canada.
[7] Sukmono, S. 1999. *Interpretasi Seismik Refleksi.* Laboratorium Geofisika Reservoar Departemen Teknik Geofisika ITB. Bandung.
[8] Taner, T. M. 2001. *Seismic Attributes*. Rock Solid Image. USA.
[9] Galloway, W.E. 1975. *Process framework for describing the morphologic and stratigraphic evolution of deltaic depositional systems, in Broussard, M.L., ed., Deltas, Models for Exploration.* Houston Geological Society. Texas.