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SOUTH NATUNA BASIN RECONFIGURATION BASED ON RECENT SEISMIC AND GRAVITY SURVEYS

(Konfigurasi Kembali Cekungan Natuna Selatan Berdasarkan Survei Seismik Saat ini dan Data Gravity)

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ABSTRAK

Pusat Survei Geologi telah melakukan survei seismik di bagian selatan Laut Natuna untuk memperoleh informasi geologi bawah permukaan yang berhubungan dengan potensi sumber daya energi. Area penelitian terletak di bagian barat sebagian dan di luar wilayah Cekung Singkawang (BG, 2008), dan dipisahkan oleh punggungan batuan metamorf. Survei seismik 2D menunjukkan 3 satuan batuan, yaitu batuan sedimen laut dangkal, sedimen Tersier batuan dan batuan sedimen Pra-Tersier, dengan kedalaman sedimen Pra-Tersier kurang dari 2000 ms. Interpretasi data seismik menunjukkan pola struktur graben yang membentuk sub-cekungan, reflektor kuat terlihat dalam data seismik record, dapat membedakan endapan pre-rift, syn-rift dan post-rift. Ada 2 sumur, yaitu Datuk 1X dan Ambu 1X. Datuk 1X memiliki kedalaman 1187 meter, dan Ambu 1X memiliki kedalaman 880 meter yang dilintasi garis seismik. Kedua sumur tersebut telah diperoleh batu pasir berumur Tersier yang menutupi batuan dasar pra-Tersier. Data anomali gravity di wilayah lintasan seismik menunjukkan nilai anomali antara 10 sampai 54 mgal yang membentuk punggungan anomali dan cekungan, Punggungan anomali punggungan membentuk sebagai antiklin, sedangkan cekungan anomali membentuk sebagai antiklin. Sinklin dan antiklin cenderung berarah barat daya - tenggara, dengan pola melebar dan menyempit. Berdasarkan model geologi kedalaman batuan sedimen relatif dangkal antara 1500 hingga 2000 meter. Sedang integrasi antara data seismik, gravity dan geomagnetik menunjukkan penemuan cekungan baru yang belum pernah dipereoleh sebelumnya. Akhirnya, integrasi data seismic, dan data gravity telah menemukan cekungan baru yang belum pernah dideliniasi sebelumnya. Juga menunjukkan adanya kemenerusan struktur geologi regional dari daerah studi sampai Cekungan Natuna Barat yang terkenal kaya potensi hidrokarbon.

Kata Kunci: *Data seismik, data gravity dan sub cekungan*

ABSTRACT

The Geological Survey Center has conducted a seismic survey in the southern Natuna Sea region to obtain geological information below relating to the potential energy resources of the area. The area research is located in the western part and outside the Singkawang Basin area (BG, 2008), which is separated by a Metamorf ridge. 2D seismic survey results show 3 different rock units, namely shallow marine sedimentary rocks, tertiary sedimentary rocks and pre-Tertiary sedimentary rocks, with pre-Tertiary sediment depths of less than 2000 ms. Interpretation of seismic data shows the pattern of graben structures that form sub-basins. strong reflectors seen in seismic record can distinguish pre-rift, syn-rift and post-rift deposits. There are 2 wells, namely Datuk 1X and Ambu 1X. Datuk 1X has a depth of 1187 meters, and The Ambu 1X has a depth of 880 meters that is crossed by a seismic line. Both drilling has obtained Tertiary aged sandstone that covers pre-Tertiary bedrock.Gravity anomaly data in the seismic region shows anomaly values between 10 to 54 mgal which form the anomaly ridge and basinThe ridge anomaly extends as an anticline, while the anomaly basin also rises to form a syncline. Sincline and anticline trending southwest - southeast, with widening and narrowing patterns.Based on its geological model, the depth of the sediment is relatively shallow between 1500 to 2000 meters. While the integration between seismic, gravity and geomagnetic data shows the discovery of new basins that have never been described before. Finally, the integration of seismic and gravity data succeed discovers a new basin which has never been delineated before. In addition, it shows the continuity of the regional geological structure spanning from the studied area to the West Natuna Basin which is well known to be rich in hydrocarbon potential.

Keywords: seismic data, gravity data and sub basin.

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I. INTRODUCTION

One of the duties and functions of the Center for Geological Survey, Agency of Geology, Ministry of Energy and Mineral Resources is to provide services and provision of geological and geophysical data to stakeholders who carry out activities in the oil and gas sector. In order to support the achievement of these objectives it is necessary to hold several activities that can provide an overview or condition of the frontier area as a new working area. Seismic data acquisition and processing will provide up-to-date, more accurate and reliable information.

2D seismic acquisition survey is located in the southern Natuna Sea which includes Singkawang Regency, Pontianak Regency, Bengkayang Regency, Sambas Regency in West Kalimantan Province, and Natuna Regency, Anambas Regency in Riau Islands Province. 2D seismic acquisition path length is 1800 meters which consists of 8 line seismic acquisition (Figure 1).

The purpose of this paper is to map the boundary of the sedimentary basin in this area, and to determine the structural configuration for the preliminary exploration of the potential of oil and gas.

II. GEOLOGY OVERVIEW OF SOUTH NATUNA SEA

Mainland eastern Asia (with Sundaland at its core) comprises a complex assembly of continental blocks, arc terranes, suture zones and accreted

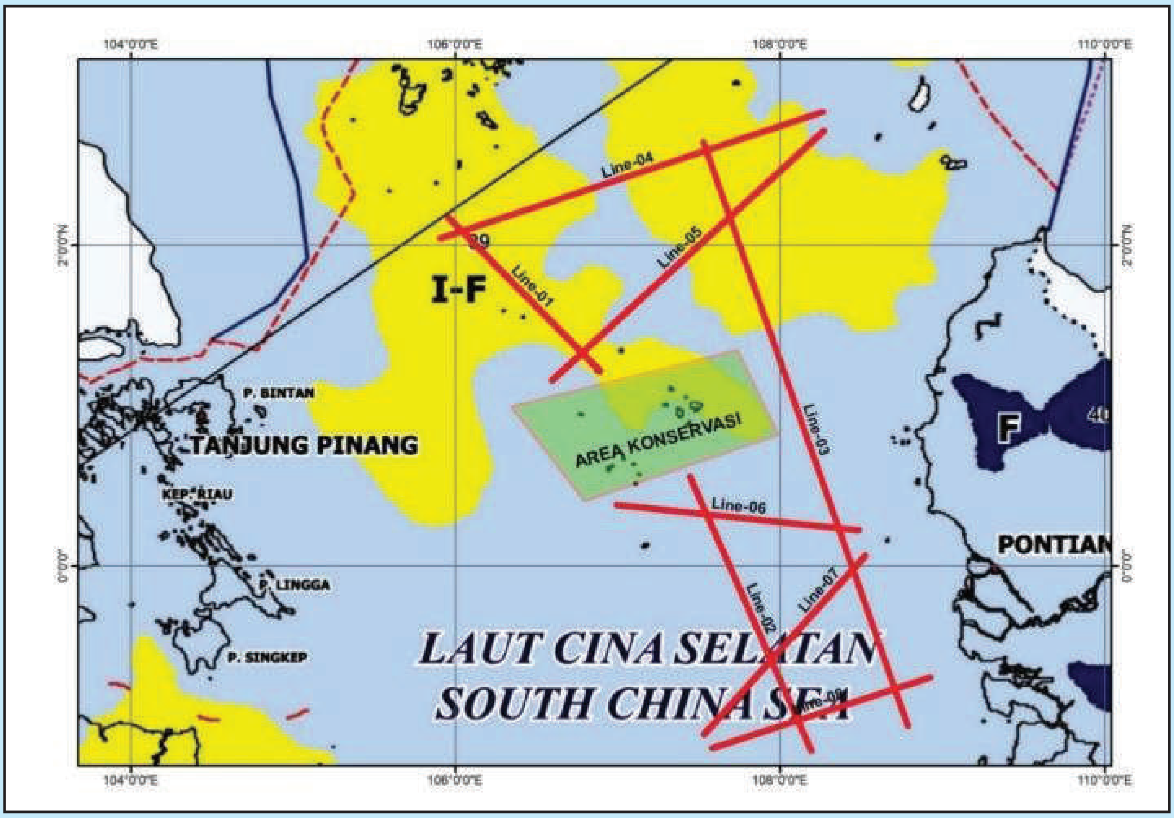

Figure 1
Map location of marine 2D seismic acquisition in the South Natuna Sea.

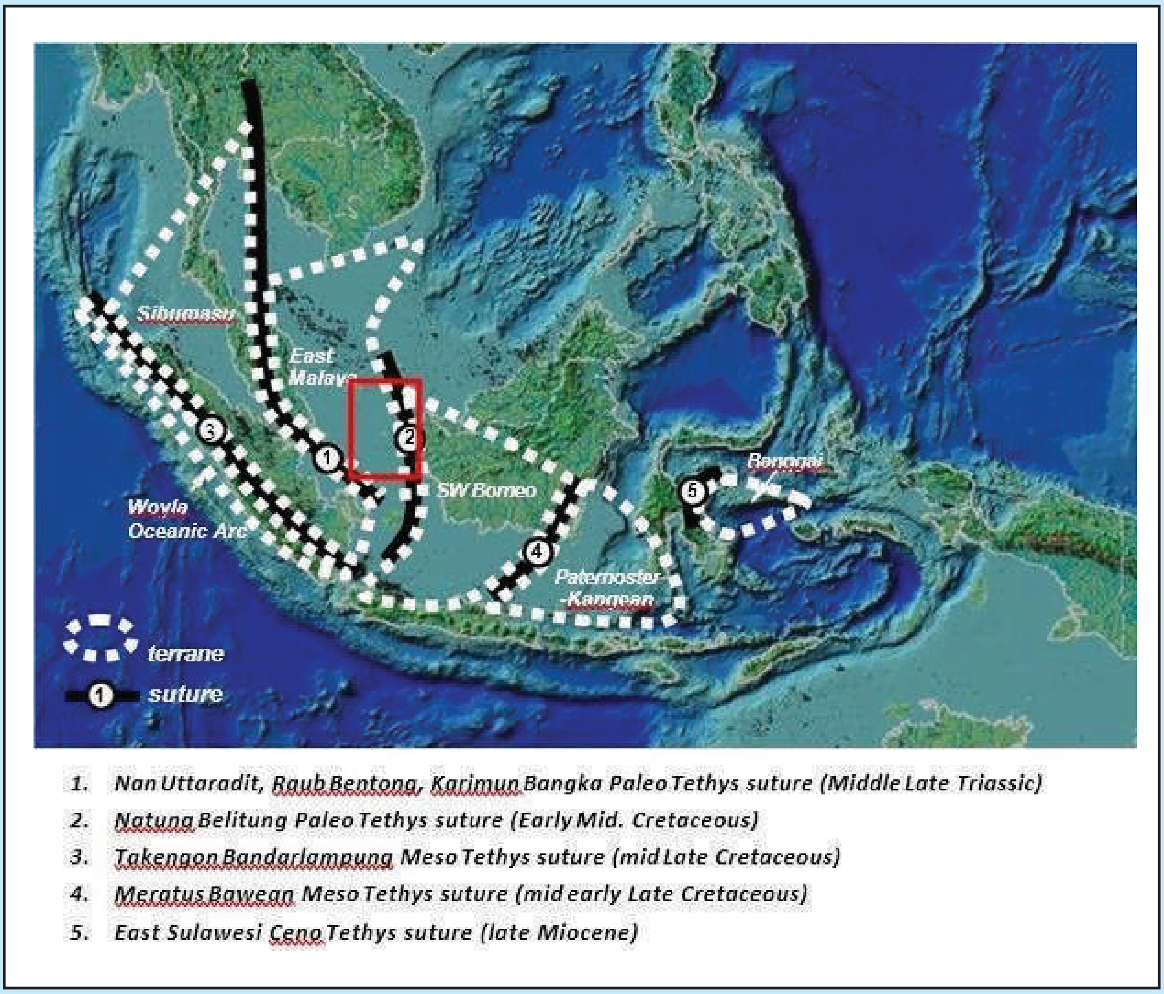

Figure 2
Summary of terranes and sutures of Indonesia (Satyana, 2010).

continental crust (Metcalfe, 2011)**.** This is a concern for tectonic evolution in the research area.

South Natuna Sea is located on the colliding microcontinent, SW Borneo was a terrane drifting form northern Gondwanaland and collided East Malaya (Hall, 2009). The result of the collision is the existence of suture of Paleo-Tethys from Natuna to Belitung area (Satyana, 2010) (Figure 2). Hall et al. (2009) suggested that the age of collision was 110 Ma (mid-Cretaceous) based on radiolaria in rocks associated with basic igneous rocks that represent accreted oceanic crust and sedimentary cover, the age of high pressure– low temperature (HP–LT) metamorphic rocks in accretionary complexes, ages of subduction-related magmatism, ages of post-collisional rocks, and the widespread paucity of magmatism in Sumatra, Java and Borneo.

The origin of west Borneo is still poorly data to know. Southwestern Borneo may be the eastern part of Triassic Sundaland, or it could be a continental block added in the Early Cretaceous, at a suture that runs south from the Natuna Islands. The Paleozoic is represented mainly by Carboniferous to Permian metamorphic rocks, although Devonian limestones have been found as river boulders in eastern Kalimantan. Cretaceous granitoid plutons, associated with volcanic rocks, intrude the metamorphic rocks in the Schwaner Mountains of southwestern Borneo (Hall, 2009).

BP Migas (2008) states that there are Bangka Basin in the southern part of the research area. Bangka Basin is a sedimentary basin with status non discovery hydrocarbon. The Bangka Basin geometry extends along west-east. The north is bordered by the Natuna Sea, west of the West Bangka Basin, to the south by Bangka Island and Belitung Island, while the eastern border is Borneo Island.

III. RESULT AND DISCUSSION

Information on the boundary of the basin, the depth of the basement, structure and highs in the Singkawang Basin, it is necessary to obtain initial information about the size / dimensions of the basin regionally with gravity or geomagnetic methods. Furthermore, the results of this survey were followed up with surveys with higher resolutions such as Magnetotelluric and seismic surveys.

Gravity data is obtained from topex data as free air anomaly gravity, then terrain correction is performed to get bouguer gravity anomalies.

The contour map of gravity anomalies, with values ranging from 10 mgal to 54 mgal, gives an overview of surface geological conditions such as the direction of geological lineament, anticline, syncline and normal fault or reverse fault. Overview of the gravity anomaly contour pattern, this pattern shows the highs and basin, the value obtained anomaly highs above 30 mgal while the basin anomaly under 30 mgal. High anomalies that form the anticline trending northwest - southeast, whereas basin anomalies that form syncline with direction parallel to the anticline. The red line is a new undefined basin in the South Natuna Sea with an area of 3670 km^2 (Figure 3).

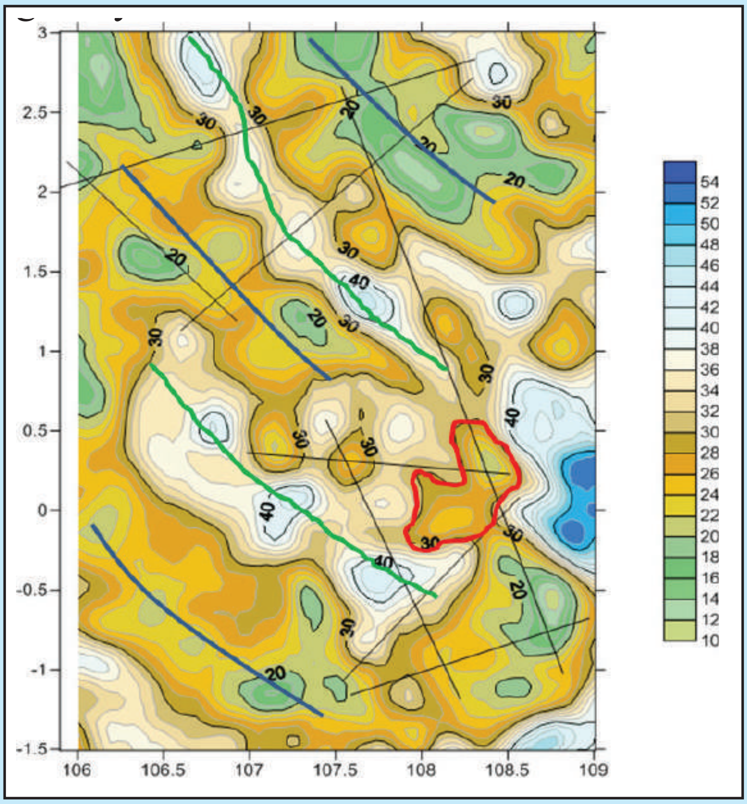

Figure 3
High anomalies (green) and basin anomalies (blue), red line as the boundary of the new basin.

Magnetic data obtained anomalous values range between -300 nT to 260 nT, the area is almost entirely occupied by anomalous values below 0 nT. It shows that the area is occupied by non-magnetic components such as granite rocks. Based on the data from Datuk-1X well, granite rocks are the basement as the lowest layer (Figure 4).

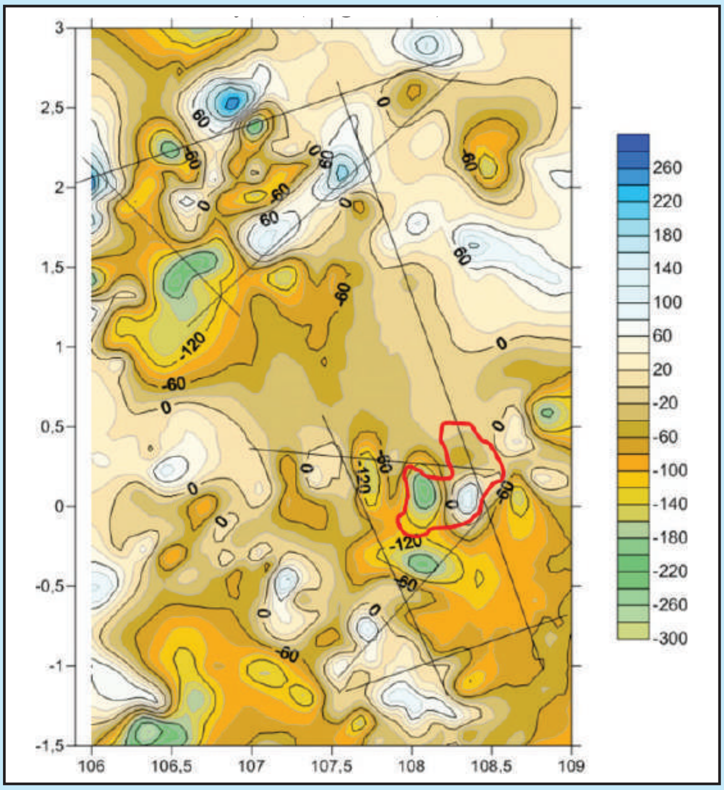

Figure 4
Geomagnetic Anomaly Map in Singkawang Offshore.

The area study is a frontier area with sparse well control and only 2-D seismic from which to conduct exploration surveys. The main seismic stratigraphy/ horizons were interpreted, both in the processed 2D seismic data

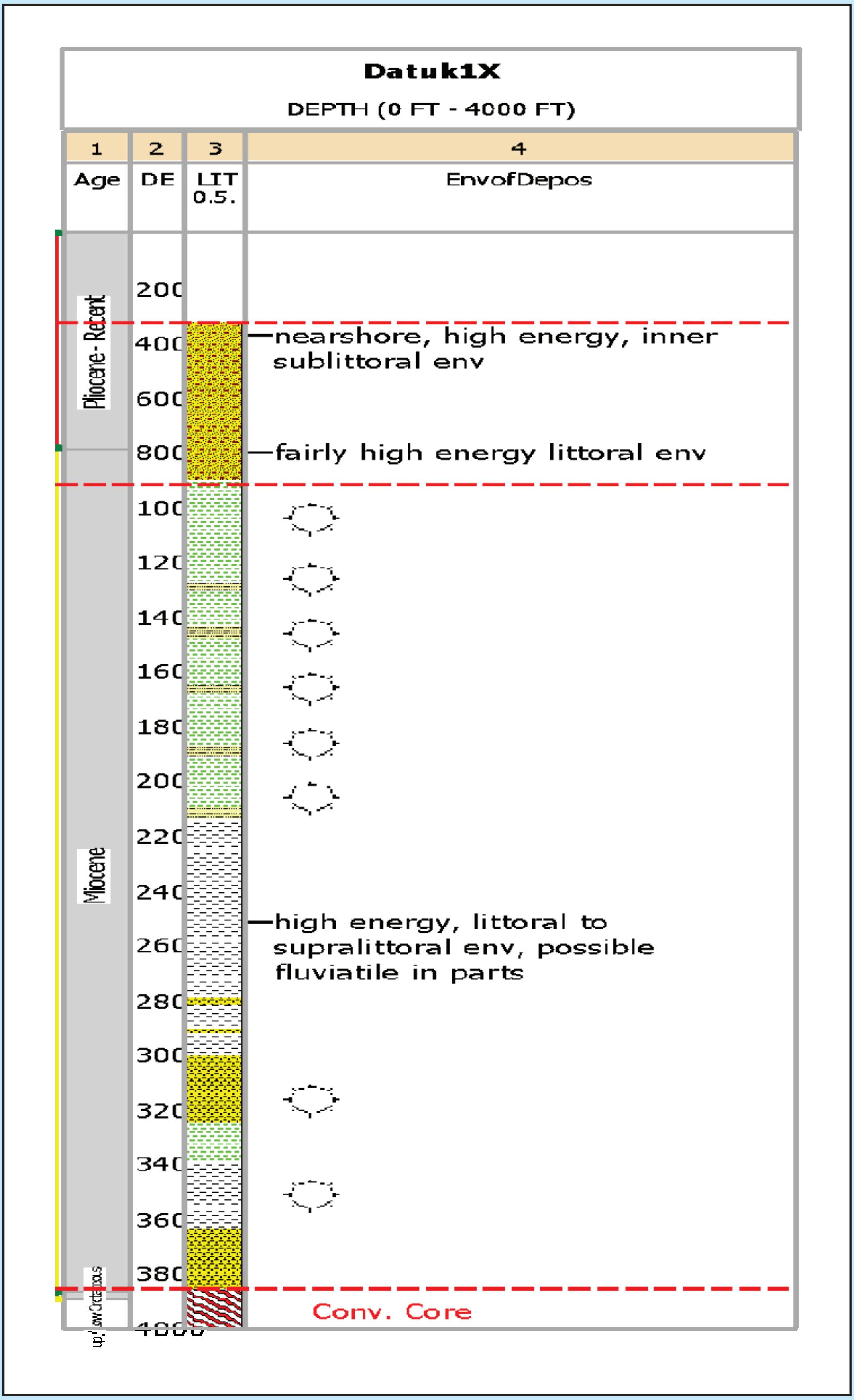

Figure 5
Well stratigraphyc Interpretation

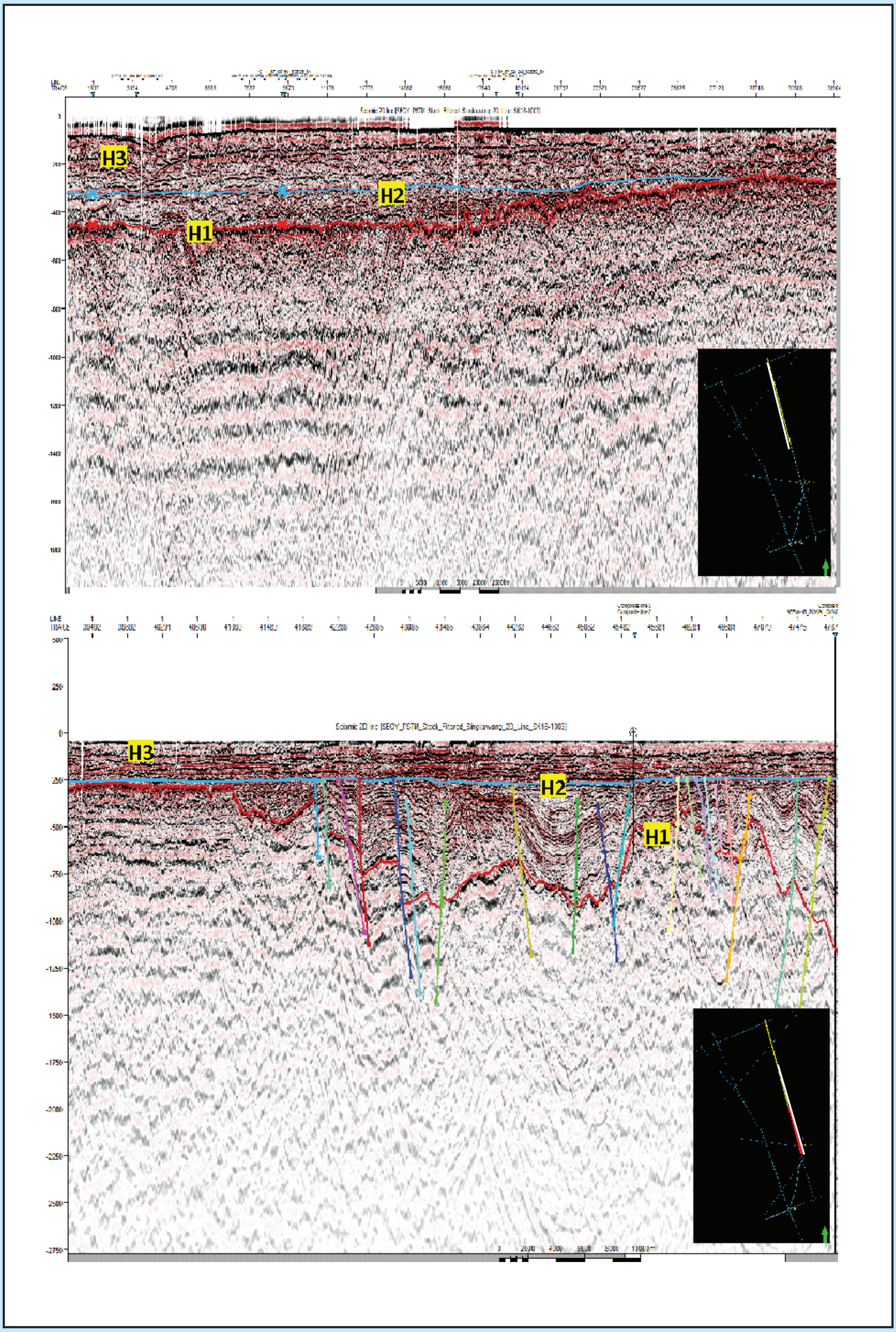

Figure 6
Interpreted seismic section of 2D Line with marked horizon and faults in time domain.

and in the well data (cutting, well logs), and good correlation stratigrafi were obtained.

Well stratigraphy model is done by the cutting sample description and biostratigraphyc laboratory analyses. The sediment of the basin can be divided into three fascieses. Granit cretaceous (> 3900 ft), clay to siltstone with calcareous sandstone insert (900 ft – 3900 ft), and Argillaceous sandstone Pliocene - recent (<900 ft) (Figure 5).

Seismic Interpretation is done by the delineation of discontinuities based on seismic reflection termination (onlap, downlap, top, and truncation) to subdivide seismic data into genetic reflection packages, also referred as seismic sequences and system tracts. The 2D seismic data are divided into three horizons (H1– H3).

Graben and half-graben structure can be detected with basement surfaces deepened as H1. The basement rocks were buried under thick sections of the Miocene sediments in graben / half graben during the Miocene time. Most of them are claystones, shales intercalation of calcareous sandstone (H2). The Miocene layers were affected by a number of normal faults that extend downward and are thought to be inherited from older tectonics. Regressive shallow water deltaic facies are found in the Pliocene – Recent, the sequence is predominantly argillaceous sandstone (H3) (Figure 6). This event took place during the Miocene as shown by seismic-wells calibrations.

The seismic lines interpretation has shown a Graben and half-graben structure with low and high angle normal faults to form syncline of a North West – South East direction respectivelly in the relatively shallow part of the West Kalimantan Sea. The deepest section of syncline (depocentre) up to 9000 ft was derived from interpreting the seismic sections through using the well logging information. This has confirmed the results of gravity interpretation in the restricted study area.

The study demonstrates how gravity interpretation can be enhanced when integrated with seismic data and borehole information in order to reveal the structural configurations.

IV. CONCLUSIONS

The integration of seismic and gravity data succeed discovers a new basin which has never been delineated before. The new basin has a location north of the Bangka basin, with value gravity anomaly ranging from 18 mgal to 30 mgal like a half graben basin. The well stratigraphy informs this basin has deposited Oligocene to Pleistocene marginal marine sedimentary rocks. The seismic response confirms the delineation of these sedimentary rocks to be thrown across the basin which is increasingly thickened towards the depocenter of basin.

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