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# Generation Provenances of Lower Miocene Petroleum Classtic Formation in Cuu Long Basin

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**ABSTRACT**

The study focuses on examining the formation and deposition process of sedimentary formations containing oil and gas in the sedimentary basins on Vietnam's continental shelf. Determining the distribution trend, characteristics, and scale of these sediments is of great importance. By analyzing field samples, lithologic data, references, documents, and conducting geological-geophysical research, the author has investigated the formation process of lower Miocene sediments with oil and gas in the Cuu Long basin. Through the study of identified characteristics, distribution scale, sedimentological features, and seismic data, the author has shed light on the process of formation and the trend of hydrocarbon accumulation in the lower Miocene sedimentary basin of the Cuu Long Basin. The predominant trend of sediment deposition distribution is observed from the continental portion of the Dalat Zone towards the Cuu Long Basin, cutting through it in a west-east direction. Furthermore, the research reveals that the lower Miocene sandstone in the Cuu Long Basin can be divided into two sequences: BI.2 and BI.1, both originating from granitoid sources. These findings also contribute to our understanding of the evolution of magma-sediment processes in the studied area and its surrounding regions. Additionally, tectonic extensions and climate changes, which lead to sea-level rise during the lower Miocene sequence, create favorable conditions for the deposition and accumulation of sedimentary particles.

## Introduction

Understanding the process of formation and deposition of oil and gas-containing granular sedimentary formations in sedimentary basins on the continental shelf of Vietnam is a major factor in the study and determination of distribution trends, characteristics and scale of sedimentary formations in general and Miocene sediments in particular. The Cuu Long Basin is a sedimentary basin with exploration activities that have been deployed very early, even before 1975. It exhibits potential for hydrocarbon accumulation mainly within the lower Mioxene, Oligocene, and basement rocks [1-4]. It is worth noting that so far, the total oil and

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gas production from the Miocene formations of most of the sedimentary basins ranks second among the promising petroleum plays (only after the oil in basement) [5]. The Nam Con Son and Phu Khanh sedimentary basins, especially the Cuu Long basin, are considered to represent the role and scale of the late Miocene sedimentary formations of the continental shelf of Vietnam [6], so these basins are objects and the ideal area to establish the relationship between the intrusive magmatic formations on the continent area and the offshore granular sedimentary formations (Fig. 1).

On the basis of collecting and evaluating positive results from previous studies, the research team has formed ideas, established a framework as well as speculated on the relationship between intrusive magma formations on the continent area with offshore granular sedimentary formations, including research results of a number of closely related research projects, typical results in the country as well as in the world such as: the infilling of the Cuu Long Basin from the Late Oligocene to the early Miocene is primarily composed of sediment derived from the Dalat Zone on the mainland, which is determined through the analysis of fragmented samples [5]; the tectonic history of the East Sea extension is the primary factor in reconstructing the Mesozoic tectonic framework of the Panthalassa and Tethyan subduction systems, which contributed to the complex tectonic setting of Southeast Asia as observed today [7]; the early Miocene depositional environment is determined based on the presence of pollen and spore fossils, which indicate a transition from fluvial (alluvial) environment to a shallow marine environment [8]; the geological evolution of Vietnam and its surrounding regions is divided into eight periods [9]; late Mesozoic volcanic rocks in Vietnam are primarily found in the Dalat region [10]; the felsic belt from the Dalat region typically has a Northeast-Southwest direction and traverses through early Cretaceous volcanic-plutonic rocks [11].

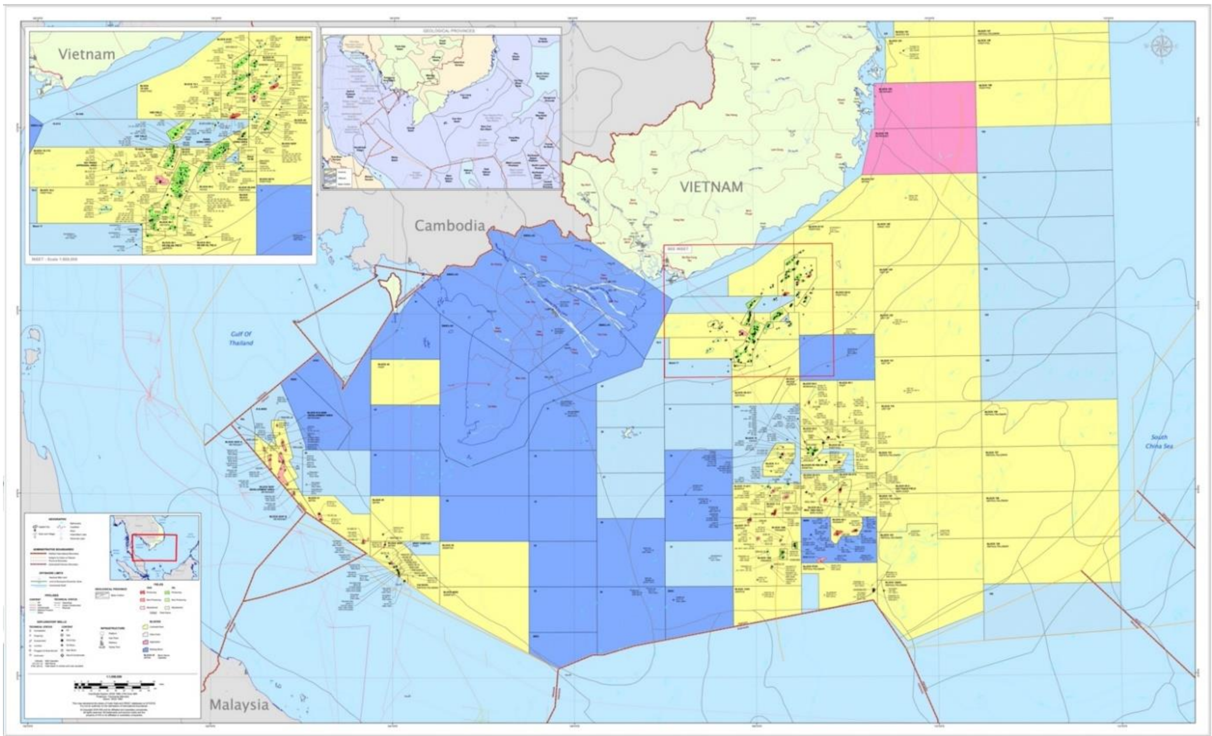



**Fig. 1**. Geographical map of the study area - Cuu Long Basin [1]

Studies on Cuu Long basin has been studied by many domestic and foreign scientists [5, 11, 12]. These studies have presented the geological evolutionary history of Vietnam and adjacent areas as the process of the India-Western Australian edge of the Eastern continent of Gondwana breaking up and separating into Vietnam - China and Indo-Chinese regions from Devon;

Sibumasu area from Permian. They governe the events of plate tectonic convergence, collision and accretion... forming the eastern margin structure of Eurasia, and at the same time with the successive expansion and closing of the Peleotethys, Mesotethys oceans, Cenotethys and the formation of the South China Sea in the center oceanic crust [13-16].

The Cuu Long Basin reservoir rocks comprise of the granitoid fractured basement pre-Cenozoic, Oligocene sandstone, Lower Miocene sandstone, Oligocene exclusive rock [8]. Which the great oil and gas potential as well as there is a possibility of discovering new fields, event small but large enough for commecialize when taking advantage of the existing infrastructure, so it is necessary to continue to expand the exploration activities.

Magmatic activity on the continent and sediments on the continental shelf in Southeast Vietnam occurs quite strongly, not only onshore but also on the seabed, on the continental shelf of Vietnam [17]. Although there have been many studies on this issue, so far it can be seen that these works are either only studying magma activity on the mainland, the continental part or only studying on the seabed and on islands or study nearshore sediments and shelves in the continental shelf [18].

In fact, 3D seismic data and wells, especially those of recent years, have shown that many faults continued to extend into the Lower Miocene (corresponding to the BI.1 sequence) in many areas in the Cuu Long basin such as Block 16-2, Block 15-2/01, Block 09-2/09 [19]. This indicates that the rift creation period ended on the whole basin during the Lower Miocene (Fig. 2).

The author believes that the model of the the rift creation period in the Cuu Long basin with 2 stretching phases from the Lower Eocene - Upper Oligocene and the Lower Oligocene - Lower Miocene is completely consistent with the geological evidence mentioned above [9]. The Cuu Long Basin was formed in the Paleocene-Eocene period on subsided areas and experienced two phases of rifting: the first phase occurred during the Eocene-Oligocene period with a primarily northwest-southeast direction, and the second phase of rifting occurred from the late Oligocene to the early Miocene with a predominantly northeast-southwest direction [19].

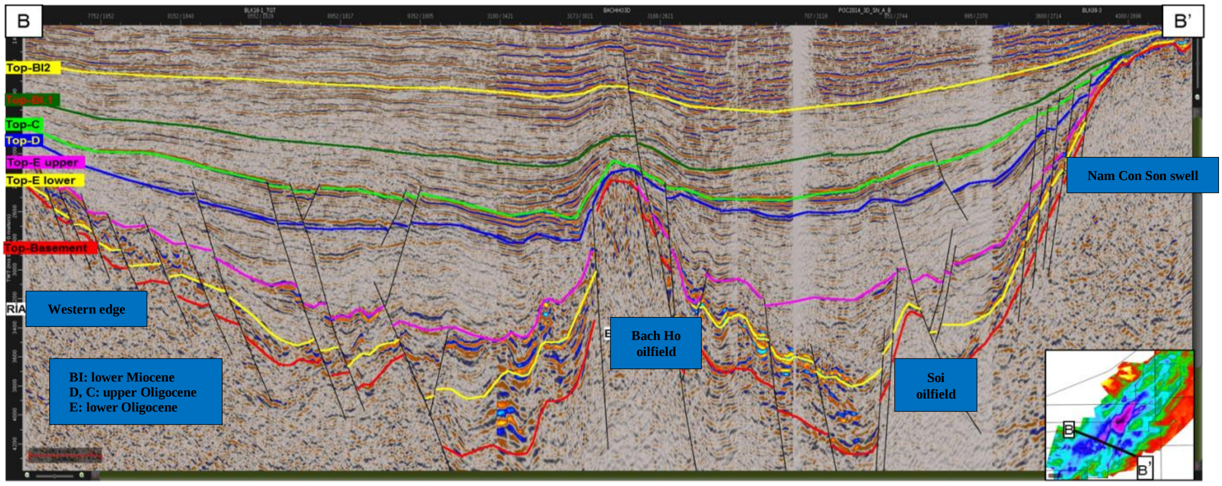



**Fig. 2**. The seismic cross-section of the Cuu Long basin shows that the tectonic faulting activities related to the basin spreading process continued in the early phase (BI.1) of the Lower Miocene in many areas in the East - East South, Central and Western Cuu Long Basin [19]

The Cuu Long Basin is a sedimentary basin in which exploration activities have been deployed very early. Based on the scale, historical landmarks and exploration results, the search and exploration history of the Cuu Long basin can be divided into five periods, which are summarized in Table 1 [1].

**Table 1**. History of exploration and production of Cuu Long basin and the study area

| Giai đoạn | Exploration work has conducted | | Exploratory search results |
|---|---|---|---|
| | **Seismic survey** | **Well** | |
| Before 1975 | ~15,000 km 2D . seismic (Ray Geophysical Mandrel, Mobil) | BH-1X (Mobil) | - Identify the Cuu Long basin.<br>- Oil detection in the Lower Miocene.<br>- Confirming the prospect and potential of oil and gas of Cuu Long basin. |
| 1975 - 1979 | > 16.000 km 2D . seismic (CGG, Geco, Deminex) | 6 Wells (Deminex: 4 GK; PVN: 2 GK) | - Identify the main reflector layers in Cuu Long basin.<br>- Confirm the existence of reservoir rocks in the Lower Miocene and Oligocene. |
| 1980 - 1988 | > 10.000 km 2D | 04 Wells (VSP) | - Establish stratigraphic units in the basin: B, C, D, E and F.<br>- Detecting industrial oil and gas flows in fractured granitoid basement.<br>- Exploiting the lower Oligocene and Lower Miocene reservoirs |
| 1989 - 2005 | >21.000 km 2D; >7.300 $km^2$ 3D | About 300 Wells (VSP accounts for more than 70%) | A series of oil and gas discoveries have been made in the Cuu Long basin and put into operation the fields of: STĐ, SV, RĐ, CNV... with the main geological objects: fractured granite basement before the Cenozoic, Oligocene and Miocene. |
| From 2005 - present | >42.000 km 2D; >9.300 $km^2$ 3D (chủ yếu do VSP, JOCs, PSCs and PVEP) | >400 Wells TD, TL and KT of JOCs, PSCs, VSP and PVEP | - A series of small-marginal oil and gas discoveries in traditional reservoirs: pre-Cenozoic fractured basement protrusions and convex Oligocene to Middle Miocene .<br>- Detecting oil and gas in stratigraphic traps of the upper Oligocene in the Southeast region of the basin (Ca Tam, Song Ngu, Kinh Ngu Trang Nam). |

## Research Methods

On the basis of research results of field samples in the field, analysis of petrographic documents, synthesis and study of references, exploitation of documents, geological - geophysical research, according to the results of exploration – appraisal of PetroVietnam Exploration Production Corporation and other operation companies such as Rosneft, Vietsovpetro Joint Venture, Lam Son Joint Operating Company, Japan Vietnam Petroleum, ... the author has conducted a study on the formation process of lower Miocene sediments containing oil and gas in Cuu Long basin integrated by seismic data interpretation method, well geophysical interpretation method, core sample analysis method and lithology data analysis method. (Table 2)

**Table 2**. Quality statistics of research documents

| Type of Document | Quantity | Quality Evalution | Notes |
|---|---|---|---|
| **Seismic Documentation** | **~ 2000 km 2D seismic** (block 02/10 & block 09-2/09) | Medium | |
| | **3D seismic before 2005: ~ 2000 $km^2$**<br>(5 cubes of 3D seismic data in block 09-1, 09-2, 09-3, 02 & 15-2) | From medium to good | The documents are all reprocessed with an area smaller than the original area. The reprocessed is better quality than before. |
| | **3D seismic from 2005-2015: ~ 2800 $km^2$** | From pretty to good | Some documents seismic in the period 2005-2010 were |

| | | | |
|---|---|---|---|
| | (4 cubes of 3D seismic data in block 09-2/09, 09-3/12 và 02/10) | | reprocessed to focus on the sedimentary sequences |
| **Well Documentation** | **Documentation of 32 wells** of blocks 09-1; 09-2, 09-2/09; 02; 02/97; 02/10, 15-2, 09-3, 09-3/12 are used, including 23 wells in the period 2005-2015 (20 wells after 2010) | The quality of the data is quite good, especially since many wells after 2005 have many useful documents for research such as core samples, FMI/STAR.... | 82 m core samples and dozens of side wall core in Oligocene E 15 wells have Image Log (FMI/STAR) of which 13 wells are after 2005. |
| **Specimens of Intrusive Macma collected from the field** | ~ 30 rock samples, stretching from the South Central to the South, mainly from Binh Thuan to Vung Tau. | From pretty to good | |
| **Documentary Slices of Lithology** | ~ 200 lithological thin slices, including the mainland and evenly spread out in blocks in the Cuu Long Basin | From pretty to good | |

Based on the research object and research scope, combining data collected from the practice of exploration and exploitation as well as original research results, the author has determined the research process to evaluate the Provenance of lower Miocene sediments containing oil and gas in Cuu Long basin is as follows (Fig. 3):

- Identify key, feasible points (Block, prospect structures, field) of the study area.
- Research to determine the specific characteristics of the reservoir according to direct evidence (core samples) as the basis for checking and matching indirect datasets.
- Research to determine the specific characteristics of the reservoir according to the data set showing the synchronization at medium and large scale.
- Research to determine the detailed characteristics of the reservoir according to a set of data showing the intrinsic nature, sustainable sites at a small and micro scale.
- Combination of research results, interpretation to determine the provenance of the Lower Miocene formation, the Cuu Long basin taking into account the reliability of the research results.

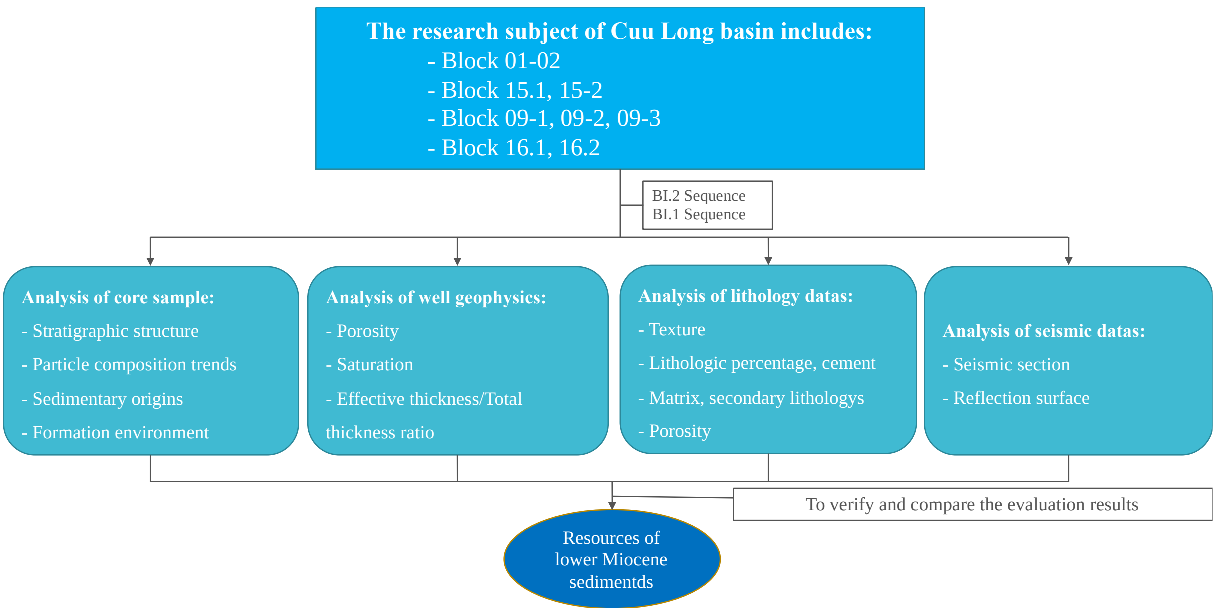


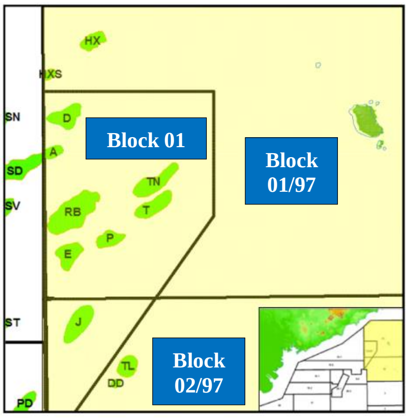

**Fig. 3.** Research process to assess the resources of lower Miocene sediments in Cuu Long basin

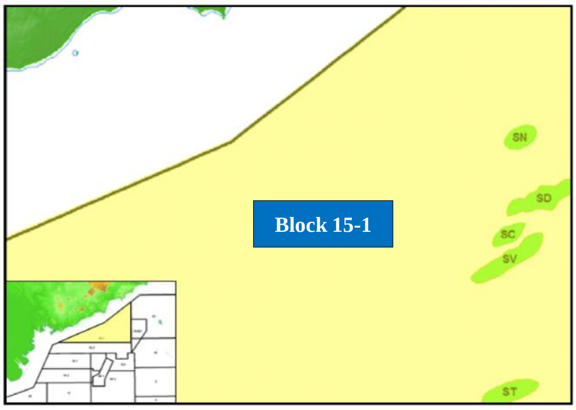
## Research results on Lower Miocene sandstone in the Cuu Long Basin

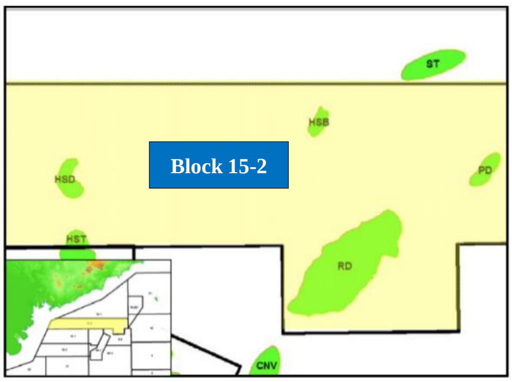
Cuu Long Basin includes blocks 01-02, 15.1, 15-2, 09-1, 09-2, 09-3, 16.1, 16.2 and 17 [1]. In this scope the characteristics of the Lower Miocene sandstone in the Cuu Long of each block according to the BI.2 and BI.1 sequence based on the results of the available lithological and geophysical analysis of the wells, combined with the results of the analysis and interpretation of the new documents by the author himself. Except for block 17, because it is located on the southwest basin of the basin and the documents are very limited, it has not been evaluated.

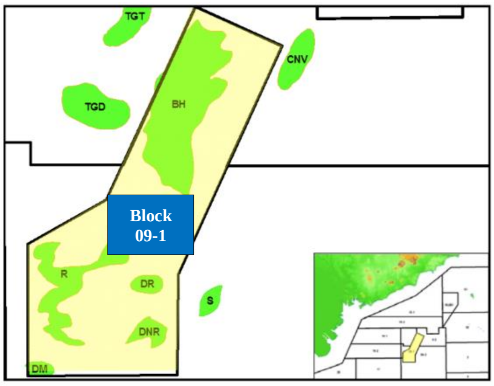
**Table 3**. Summary of Blocks in the Cuu Long Basin

| Block | North | Southern | Center | West | East |
|---|---|---|---|---|---|
| **01-02** | Ho Xam (HX), Diamond (D) and Azurit (A) | Jade (J) Thang Long (TL), Dong Do (DD) | Ruby (RB), Emerald (E), Pearl (P) | | Topaz (T) |
| **15.1** | Su Tu Nau (SN), Su Tu Den (SD), Su Tu Chua (SC), Su Tu Vang (SV) and Su Tu Vang (ST) | | | | |
| **15.2** | Rang Dong (RD), Phuong Dong (PD), Hai Su Trang (HST), Hai Su Den (HSD), Hai SU Bac (HSB) | | | | |
| **09-1** | Bach Ho (BH) | Rong Center (TTR) | Northeast Rong (DBR) | | East Rong (DR) and Southeast Rong (DNR) |
| **09-2** | Ca Ngu Vang (CNV) | | Ca Ong Doi (COD) | | |
| **09-3** | Doi Moi (DM) | | | | Soi (S) |
| **16-1** | Te Giac Trang (TGT), Te Giac Cam (TGC), Te Giac Vang (TGV), Voi Vang (VV), Voi Trang (VT) and Ngua O (NO) | | | | |
| **16-2** | Ba Den (BĐ) and Tam Đao (TD) | | | | |



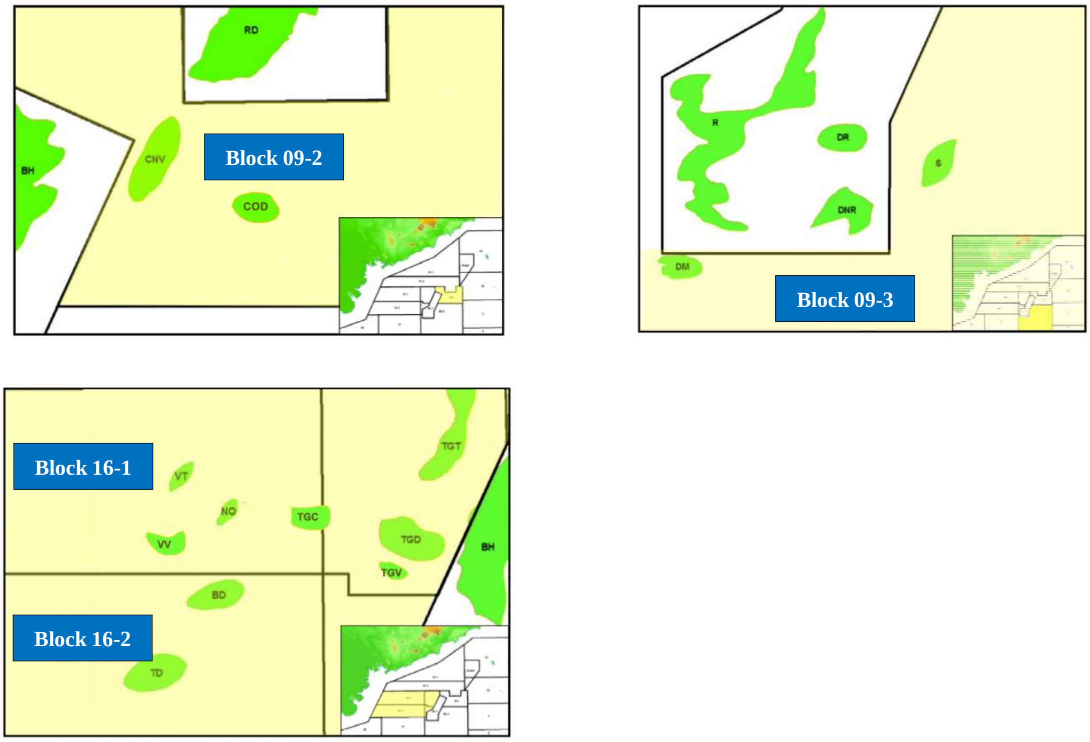



**Fig. 4**. Distribution diagrams of Blocks [1]

## Analysis of Core Sample, Well Geophysics, and Lithology Datas in Block 01-02

Located in the northeast of the Cuu Long basin, 140km from Vung Tau, including the Ho Xam (HX), Diamond (D) and Azurit (A) formations in the North; Ruby (RB), Emerald (E), Pearl (P) in the center; Jade (J) Thang Long (TL) Dong Do (E) in the South and Topaz (T) in the East (Fig. 4).

## Sequence BI.2

With an average thickness of 300-400m, only the southeast edge is thin (150m), including above is the Rotalia clay with a thickness of several tens of meters to more than 100m, below are interlocked clays, some places have erupting rock sets (P, T).

The results of core sample analysis showed that there are horizontal and wavy sublayers in the central area, in the East, mainly composed of thin oblique layers, lenses, and smooth upward sedimentary rhythm, the presence of of Pachydemus (Fig. 5). Sediments are mainly derived from granitoid rocks, transported near the source, deposited in the delta to coastal environment.

The results of the well logging analysis (Fig. 6) show that good storage capacity is concentrated in the central area with porosity 18-19%, water saturation 45-50% and effective thickness/thickness ratio [20]. total thickness 50-65%. Meanwhile, the northern and southern fringes have lower storage capacity with porosity of 15-17%, water saturation of 50-57% and effective thickness/total thickness ratio of 10-38%.

Sandstone is milky white, sometimes light gray, with average grain size varying from 0.3-0.6mm, selectivity from poor, moderate to very poor (So: 0.7-2.17), almost symmetric distribution, slightly skewed towards coarse grain (Sk: -0.17-0.17), the sharpness of the graph is from moderate to very sharp (Kg: 1.09-1.45), grain shape from angle edge-semi-angular-semi-circular edge, mostly semi-circular edge (medium Ro 0.58), grain contact mostly point and float (Fig. 7). Sandstone of Arkos type in the central and eastern areas, in the North and South is mainly Grauvac fenspat (Fig. 8), consisting mainly of quartz (average 29-38%), k-feldspar (average). 8-17%), plagioclas (average 5-16%), mica (average 1.5-4%), rock composition consisting mainly of granitoid intrusive rocks (average 11%), eruptions, little quaczite, silicon, clay. Cement and secondary minerals (average 11-20%) are mainly clays (kaolinite, chlorite, illite and very little illite-smectite-according to XRD analysis, Fig. 9) and carbonate (North and Southeast).

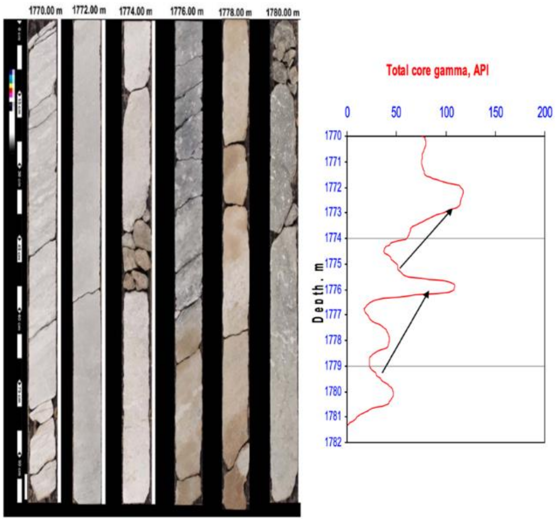



**Fig. 5**. Oblique layered structure, the sedimentary rhythm gradually smoothes upwards [6]

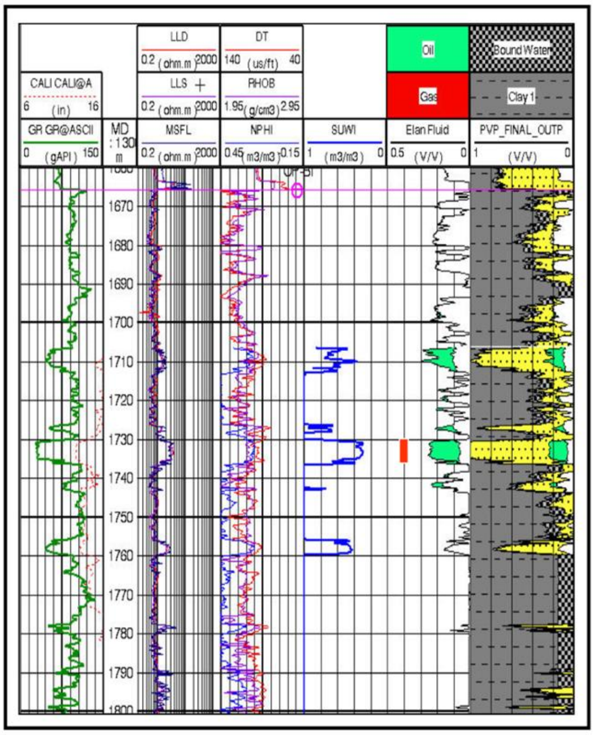



**Fig. 6**. The results of geophysical interpretation of the BI.2 sequence RB well [6]

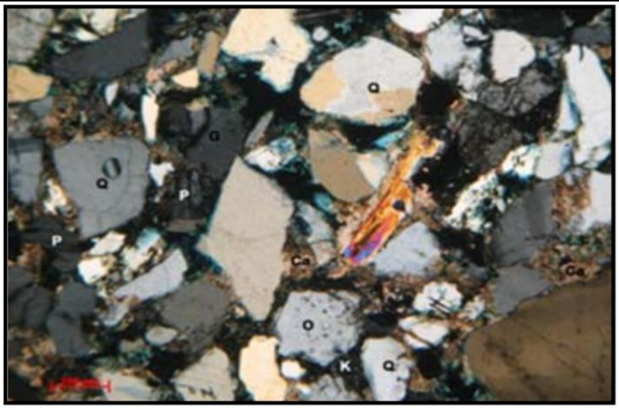



**Fig. 7**. Arkos sandstone, medium to coarse grain size, poorly selected, consisting of quartz (Q), octoclase (O), granite intrusions (G), calcite cement (Ca) and kaolinite (K), 2 Nicol

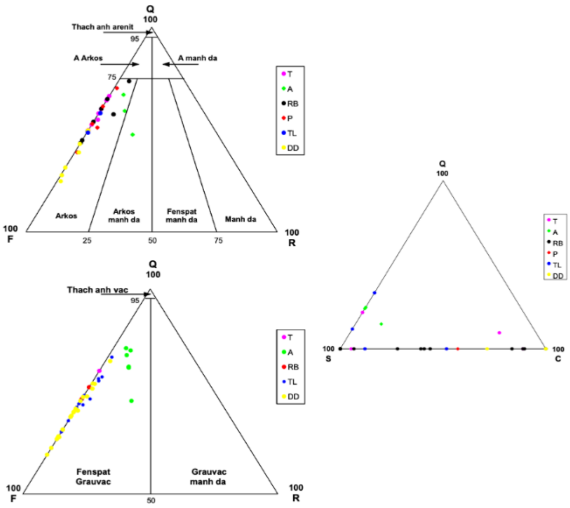



**Fig. 8**. Sandstones are mainly Arkos (Above - matrix<15%) and Fenspat Grauvac (Under - matrix>15%), clay cement and carbonate (Right)

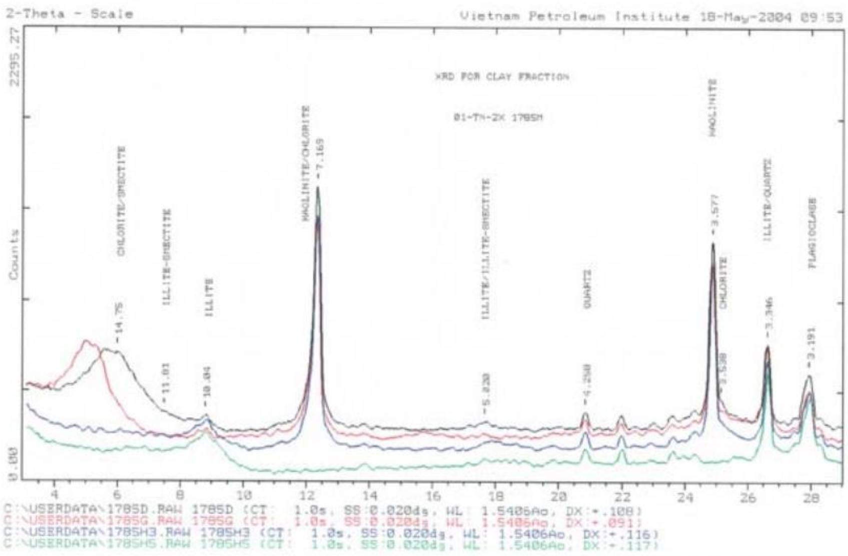



**Fig. 9**. Clay minerals are mainly kaolinite, little illite, chlorite, smectite and mixed layer of chlorite-smectite, illite-smectite

## Sequence BI.1

It has an average thickness of 50-100m in the northern and southeastern fringes to 300-400m in the central area, consisting of interlaced clays with a sand ratio of up to 70-80%.

The analysis results of the core sample show that the structure is mainly diagonally layered, with the sedimentary span gradually smoothing upwards. Thus, sediments are derived from granitoid rocks, transported near the source, deposited in the environment of alluvial plains, river deltas, and coastal areas.

The results of the well logging analysis (Fig. 10) show good storage capacity at the southern edge with porosity 18-19%, water saturation 47-56% and effective thickness/total thickness ratio. 30-40%. Whereas the other area has a lower storage capacity with porosity 15-17%, water saturation 50-57% and effective thickness/total thickness ratio 10-35%.

Sandstone transparent-opaque, gray to dark brown, average grain size from 0.3-0.7mm, selectivity from poor to medium (So: 0.95 to 1.83), distributed almost in symmetrical, slightly deviated towards fine grain (Sk: -0.13-0.53), medium to sharp pointed graph (Kg: 0.8-1.2) especially with very sharp sample (Kg>5), bead shape from angular - semi-angular - semi-circular edge (medium Ro 0.57-0.6), particle contact is mainly point, line and float. The sandstone is of the Arkosian type and the Fenspat Grauvacin the central, eastern and southern regions, while the northern sandstone is of the Arkosian flake type (Fig. 11), consisting mainly of quartz (average 34-37%). -feldspar (average 11-13%), plagioclase (average 6-7%), mica (average 1-5%), rock fragment composition consisting mainly of granitoid intrusive rocks (average 6-14%), sometimes up to 35%), eruption, little quaczite, silicon, clay. Cement and secondary minerals (9-30%) are mainly clay (kaolinite, chlorite, illite and very little illite-smectite – Figs. 12 and 13) and carbonate (in the North, there are a few samples with high carbonate content mutant 30-40%).

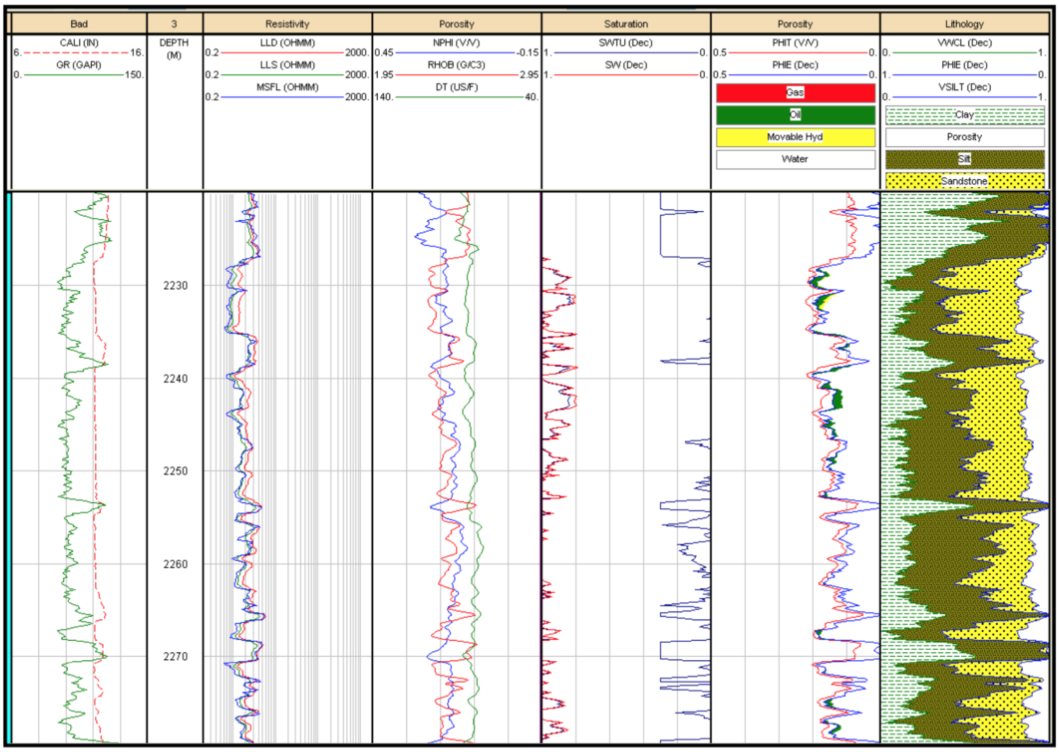



**Fig. 10**. Geophysical interpretation results of BI.1 sequence RB well [6]

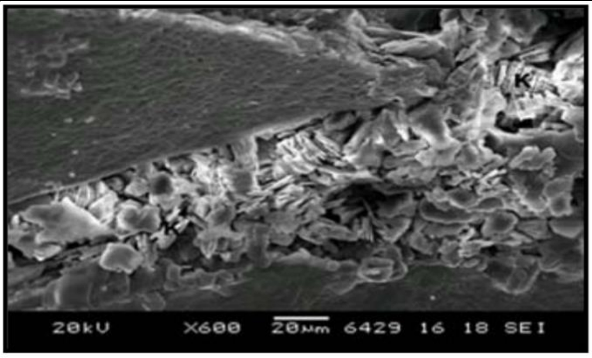



**Fig. 11**. Kaolinite (K) clay, face-to-face superimposed arrangement

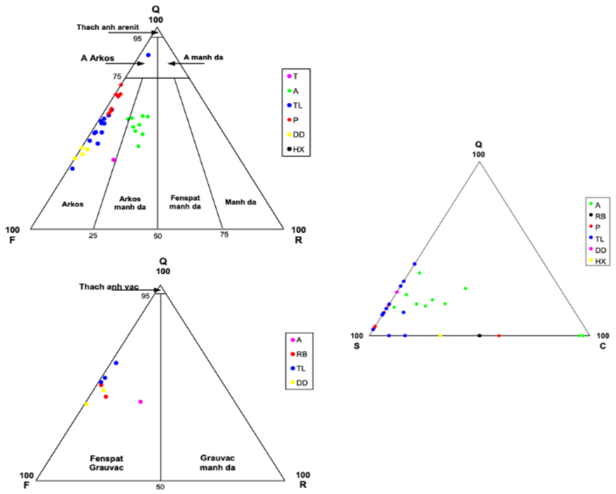



**Fig. 12**. Sandstones are mainly Arkos and Arkos shards (above-matrix<15%) and Fenspat Grauvac (below–matrix>15%), clay-cement (right)

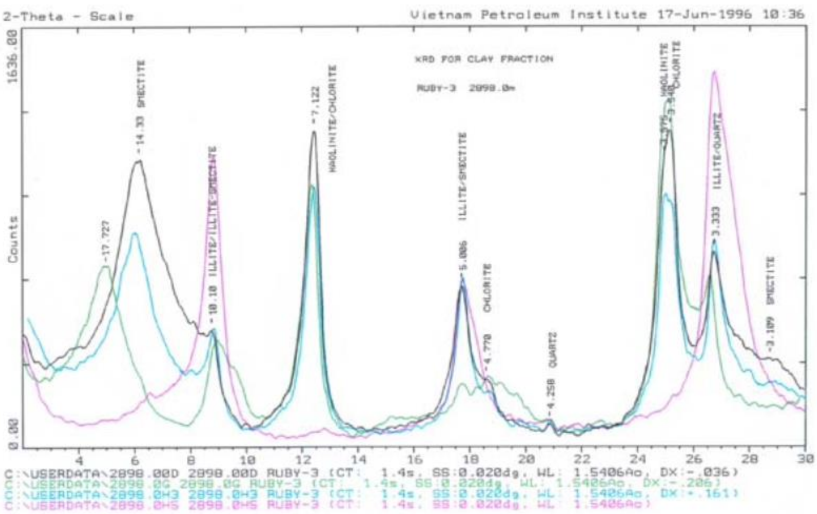



**Fig. 13**. Clay minerals are mainly kaolinite and smectite, little illite, chlorite and mixed illite-smectite layer

Similar study for another subjects including 15.1, 15-2, 09-1, 09-2, 09-3, 16.1, 16.2. The summary results of core sample, well geophysics, and lithology datas analysis in the study are as follows:

- BI.2 sequence sandstone has fine to medium grain size, sometimes coarser. The total content of cement and matrix is from 4-28%, deposited in the environment mainly from deltas to shallow seas. Sandstone has a intermediate porosity (12-27%), high water saturation (39-100%) and wide range of net to gross thickness (NTG) ratio from 0 to 80% (Table 4).

- BI.1 sequence sandstone has fine to medium grain, total cement and matrix content from 9-30%, deposited in the environment mainly from rivers and deltas. Sandstone has a porosity of 13-24%, a water saturation of 30-100% and an effective thickness/total thickness ratio of 0-70% (Table 5).

**Table 4**. Summary of sandstone characteristics BI.2 sequence

| Block | Thickness (m) | particle size (mm) | Selectivity (So) | Round grinding coefficient (Ro) | Symmetry coefficient (Sk) | Kurtosis coeficient (Kg) | Rock name | Cement and Matrix (%) | Environment | Porosity (%) | Water Saturation (%) | NTG (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **01-02** | 300-400 | 0,25-1 | 0,70-2,17 | 0,58 | -0,17-0,17 | 1,09-1,45 | A, FG | 11-20 | CT, VB | 15-19 | 45-57 | 10-65 |
| **15-1** | 250-400 | 0,2-0,3 | 0,41-1,37 | 0,56 | -0,23-0,11 | 0,92-1,42 | A, AM, FG | 5-28 | CT, VB | 17-27 | 39-80 | 0-61 |
| **15-2** | 330-560 | 0,1-0,6 | 0,49-1,8 | 0,57 | -0,021-0,12 | 0,9-1,23 | A | 12-17 | S, CT, VB | 17-23 | 45-59 | 22-80 |
| **09-1** | 300-600 | 0,23 | 2,6 | 0,3-0,4 | | 0,77 | A | 11 | VB-BN | 14-18 | 50-60 | 10-36 |
| **09-2** | 300-700 | 0,15-0,25 | 0,8-2,1 | 0,62 | -0,18-0,63 | 0,62-1,45 | A, FG | 20-25 | CT, BN | 13-19 | 60-100 | 5-25 |
| **09-3** | 100-400 | 0,3-0,5 | 1,09-1,95 | 0,57 | -0,22-0,09 | 0,92-1,26 | A, FG | 24-25 | VB-BN | 13-21 | 48-60 | 28-32 |
| **16** | 200-700 | 0,1-0,3 | 0,5-1,7 | 0,62 | -0,18-0,7 | 0,9-1,9 | A, FG | 4-20 | VB | 12-13 | 60-100 | 0-20 |

**Table 5**. Summary of sandstone characteristics BI.1 sequence

| Block | Thickness (m) | particle size (mm) | Selectivity (So) | Round grinding coefficient (Ro) | Symmetry coefficient (Sk) | Kurtosis coefficient (Kg) | Rock name | Cement and Matrix (%) | Environment | Porosity (%) | Water Saturation (%) | NTG (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **01-02** | 50-400 | 0,3-0,7 | 0,95-1,83 | 0,57-0,6 | -0,13-0,53 | 0,80-1,20 | A, LA, FG | 9-30 | S, CT, VB | 15-19 | 47-52 | 10-40 |
| **15-1** | 110-220 | 0,2-0,5 | 0,54-2,48 | 0,52 | 0,03-0,19 | 1,09-1,13 | A, AM, FG | 20-23 | S-CT | 17-23 | 55-100 | 0-16 |
| **15-2** | 200-340 | 0,14-0,5 | 0,7-1,45 | 0,54 | -0,06-0,24 | 0,83-1,70 | A, AM | 9-25 | S, CT | 19-22 | 30-55 | 55-70 |
| **09-1** | 110-600 | 0,18-0,31 | 1,9-2,3 | 0,3-0,5 | | 0,74-0,79 | A, AM | 11-17 | CT, BN | 15-21 | 45-62 | 15-61 |
| **09-2** | 185-400 | 0,12-0,25 | 0,7-2,3 | 0,56 | -0,08-0,39 | 0,70-1,30 | A, FG | 19-25 | S | 13-21 | 60-100 | 0-25 |
| **09-3** | 300-600 | 0,5-0,8 | 1,06-1,92 | 0,69 | -0,04-0,18 | 0,92-1,20 | A, FG | 17-20 | S-CT | 16-24 | 46-56 | 22-32 |
| **16** | 160-830 | 0,1-0,3 | 0,32-2,3 | 0,61 | -0,47-0,46 | 0,69-1,70 | A, AM, FG | 10-21 | S | 15-21 | 40-90 | 0-59 |

**Notes**: A: Arkos, AM: Arkos rock fragment, FG: Fenspat Grauvac, S: river, CT: delta, VB: coastal, BN: shallow sea

## Results of Seismic Aata Analysis

The main faults are mainly distributed east-northeast direction, with considerable length and amplitude [21]. On the structural map, they are distributed parallel to each other, some of them merging together, and in turn, they are intersected by other faults [22] (Figs. 14 and 15)

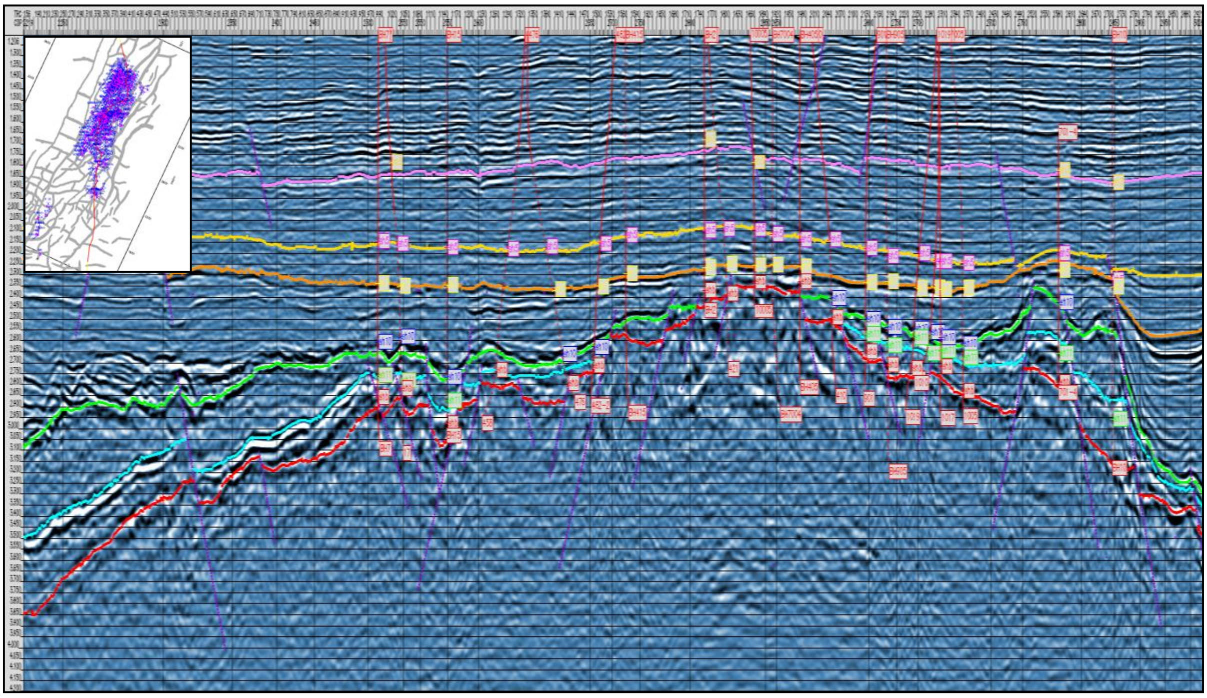


**Fig.14**. The seismic cross-section along the WT oilfield, Block 09-1 [1]

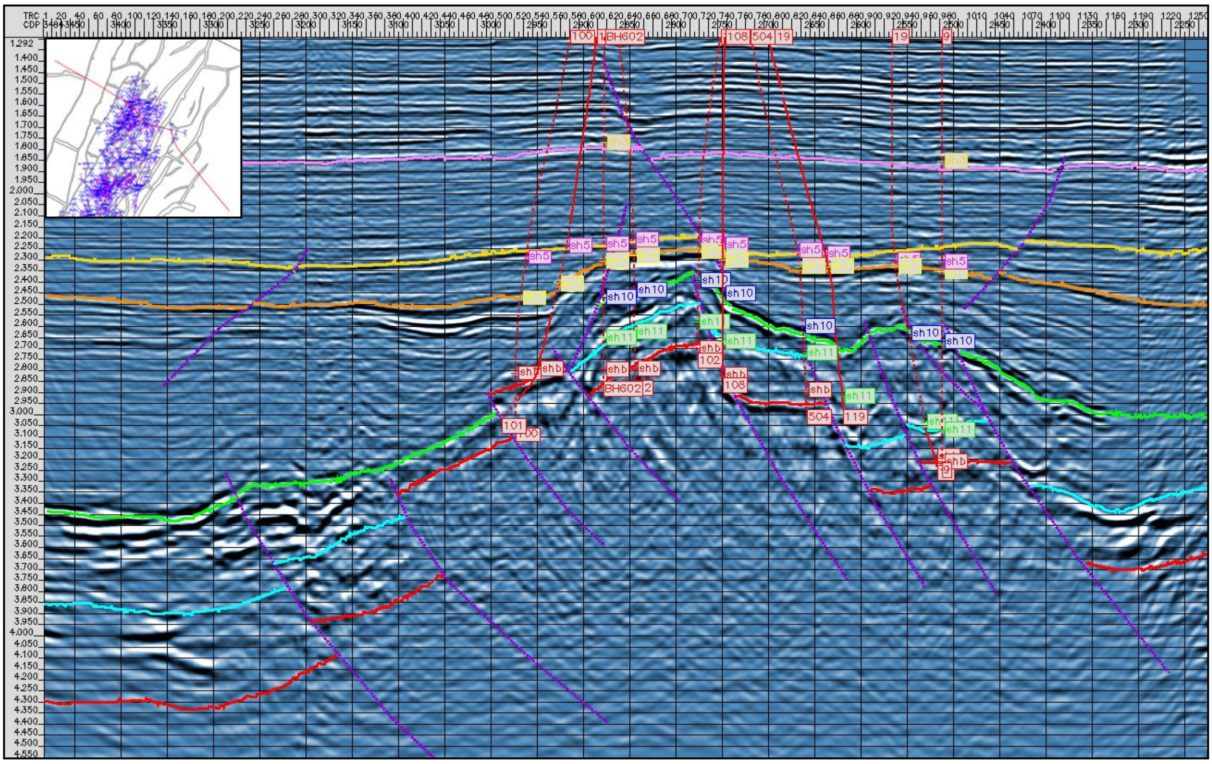


**Fig. 15**. The seismic cross-section across the North Dome, WT oilfield [1]

Within the research area, the focus is primarily on the western-northwestern part of the Miocene play, bounded by the SH-5 and SH-7 seismic horizons. The northwestern block is adjacent to a normal fault in the eastern, oriented towards the northern block. According to the seismic data, the interior of the block exhibits significant reverse faulting, with two short and horizontal normal faults. The footwall surface is a steeply inclined plane dipping towards the west (Fig. 16).

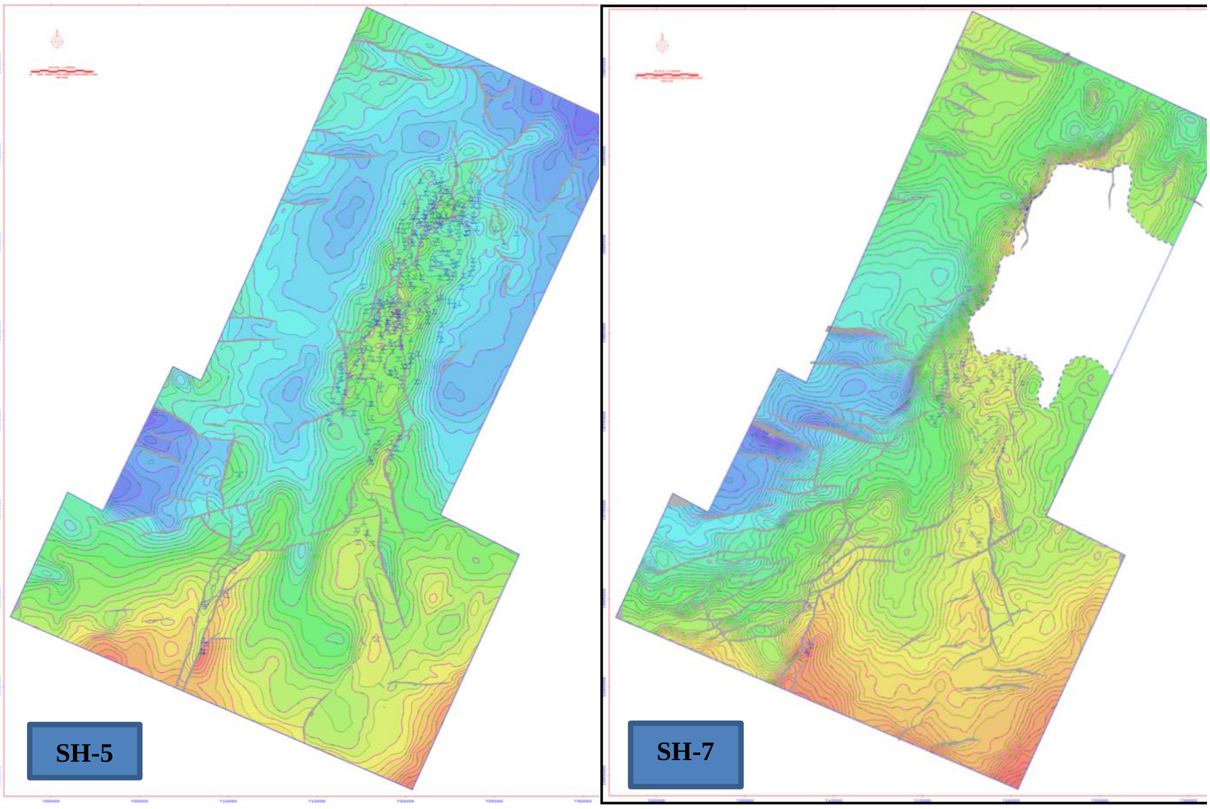



**Fig. 16**. The structural map of the SH-5 & SH-7 horizones, WT oilfield [1]

Based on the study of identified characteristics, distribution scale, sedimentological features, and seismic data, it has elucidated the process of formation and the trend of hydrocarbon accumulation in the lower Miocene sedimentary reservoir of the Cuu Long Basin [23, 24, 25]. The trend of sediment deposition distribution is predominantly from the continental portion of the Dalat Zone towards the Cuu Long Basin, in a west-east direction cutting through the Cuu Long Basin (Figs. 17 and 18).

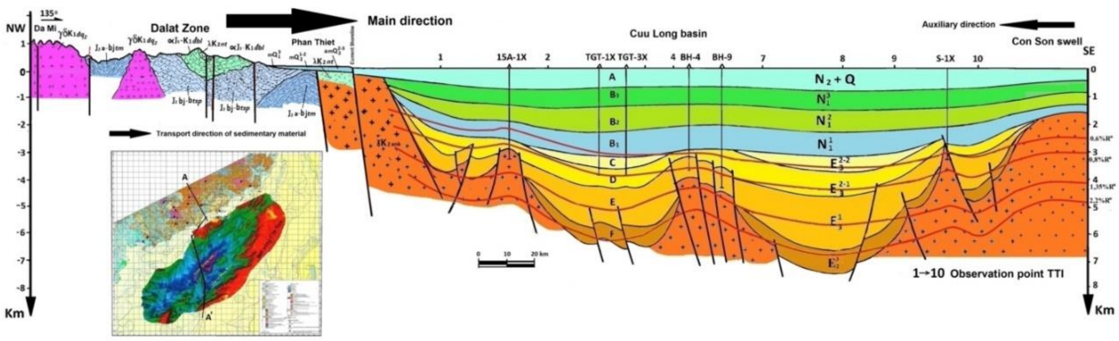



**Fig. 17**. Cross-section through the Da Lat zone - Cuu Long basin - Con Son swell

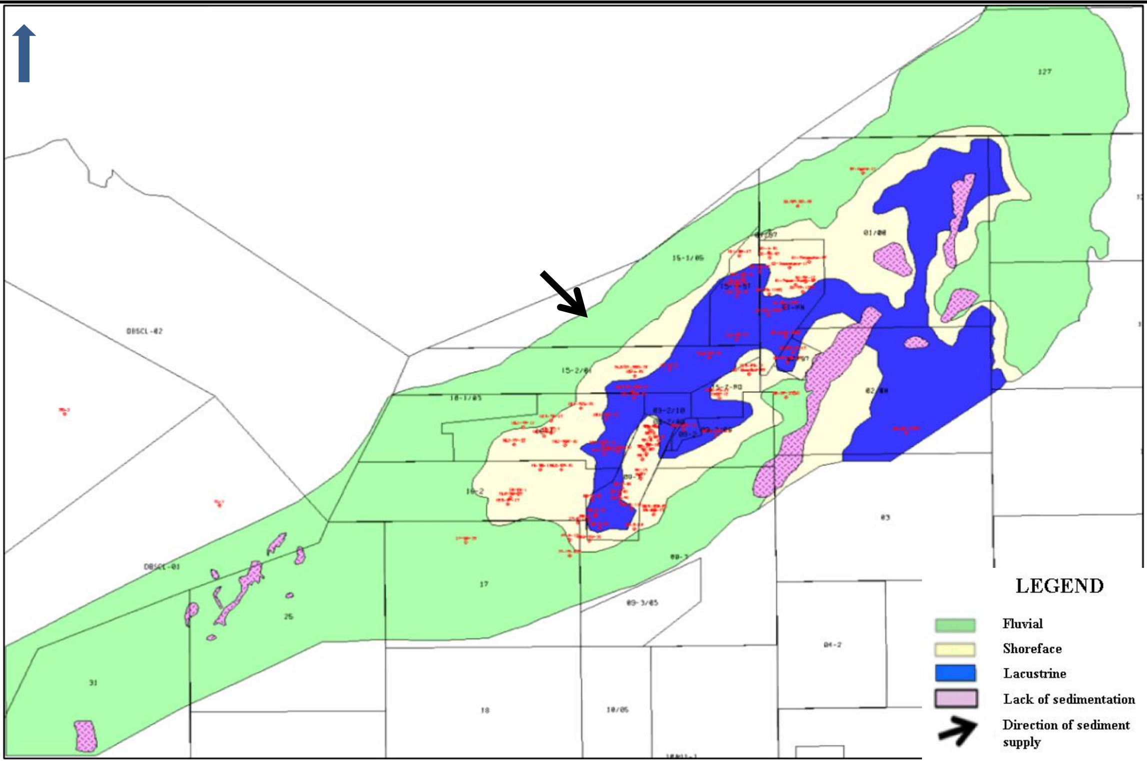



**Fig. 18**. The trend of transportation and deposition of sedimentary materials in the research area

## Conclusion

The research results contribute to elucidating the process of magma-sediment evolution in the studied area and its surrounding regions. The magma block in the research area consists mainly of brittle granite that is easily fragmented, with many unstable minerals. Additionally, tectonic extension and climate changes causing sea-level rise in the Miocene sequence create conditions for the deposition and accumulation of sedimentary particles. Through this process, the evolution of magma and the formation of the lower Miocene sedimentary in the research area are clearly demonstrated.

The analysis of seismic stratigraphy and lithostratigraphy has determined the characteristics of the Miocene sedimentary in the Cuu Long Basin, providing an overall understanding of the research area. It analyzes the morphological characteristics and predicts the spatial distribution scale of these within different lithostratigraphic units.

The lower Miocene sedimentary rocks in the Cuu Long Basin mainly originate from intruded granite magma, predominantly consisting of Arkose and Felspathic Grauwacke with quartz, feldspar, rock fragments, cement, and matrix comprising clay and carbonate minerals. There are few secondary quartz particles, and the particle shape ranges from sub-angular to sub-rounded. The trend of sediment deposition distribution is predominantly from the continental portion of the Dalat Zone towards the Cuu Long Basin, in a west-east direction cutting through the Cuu Long Basin.

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