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Hydrocarbon Geology of Cuu Long Basin - Offshore Vietnam

Abstract

The Cuu Long basin is a Tertiary rift basin locating at the Southern shelf of Vietnam. It covers an area of approximately 250 x 100 km. The basin was formed during the rifting at Early Oligocene. Late Oligocene to Early Miocene inversion intensified the fractures of granite basement and made it become an excellent reservoir.

In spite of some discoveries in the Oligocene-Miocene clastics and volcanic sections, fractured granite basement is still the main target of Cuu Long basin. Tectonic activities play a key role in creating and enhancing the fractures in the basement. Five major oil fields are being produced predominantly from the basement. The Bach Ho (White Tiger) is a giant oil field with recoverable reserve is 1.0 - 1.4 mmmbbls. The other oil fields are Rong (VSP), Rang Dong (JVPC), Ruby (Petronas) and Su Tu Den (CLJOC). Their recoverable reserves range from 100 to 400 mmbbls. The tops of these basement structures are usually at 2500 to 3000 mSS with about 1000-1500 m oil column. Recently, another discovery was made by Hoan Vu JOC on the Ca Ngu Vang prospect whose basement top is 3700 mSS. This is the deepest basement structure in Cuu Long basin that found oil. The DST flow rates at the main producing zone (4430 mSS) are 2600 bopd, 6.8 mmscfd and without water.

The basements are usually overlied directly by a prolific and pervasive Upper Oligocene source rocks. Geochemical data from many wells in the basin suggested that the oils found in the basin are of this source rocks.

The poster will introduce the controls of the fractured reservoir in the basement of Cuu Long basin, the method to predict the fracture occurrence and review the other factors of the petroleum system in the basin.

1. Geologic Setting of the Cuu Long basin:

The Cuu Long basin comprises of four major structures: 1) The Southwest susbasin basin; 2) The Southeast subbasin; 3) The Central horst; 4) The Northern subbasin (Figure 1). The Southwest subbasin, located at the west of the Central horst, has E-W trending structure, deepening to the east; the Southeast subbasin located at the east of the Central horst, dominant by NE-SW, ENE-WSW and E-W trending structures. The Central horst, which separates these two subbasins, comprises of E-W and N-S trending faults (at Rong structure) and NE-SW and E-W trending fields (at Bach Ho structure). The Northern subbasin is dominant by the NE-SW trending faults and very minor E-W fault system. The thickest sediment of this section may be up to 8000m. The current oil fields are aligned along the NE-SW Central horst.

The tectonic evolution history of the Cuu Long basin can be summarized as the following:

a. Pre-Tertiary plutonism: Plutonism occurred widespread during Mesosoic as a result of the northwestwards directed subduction of the Proto-Pacific plate under the East Asian continent to form Jurassic-Late Cretaceous magmatic bodies of granite-granodiorite. The sub-latitude and sub-longitude oriented fracture systems are expected to form in the pluton during this time.

b. Rifting phase - The initiation of the Cuu Long basin: The Cuu Long basin is a pullapart basin formed as a result of the extrusion the and subsequent clockwise rotation of the Indochina block during the convergence between the India

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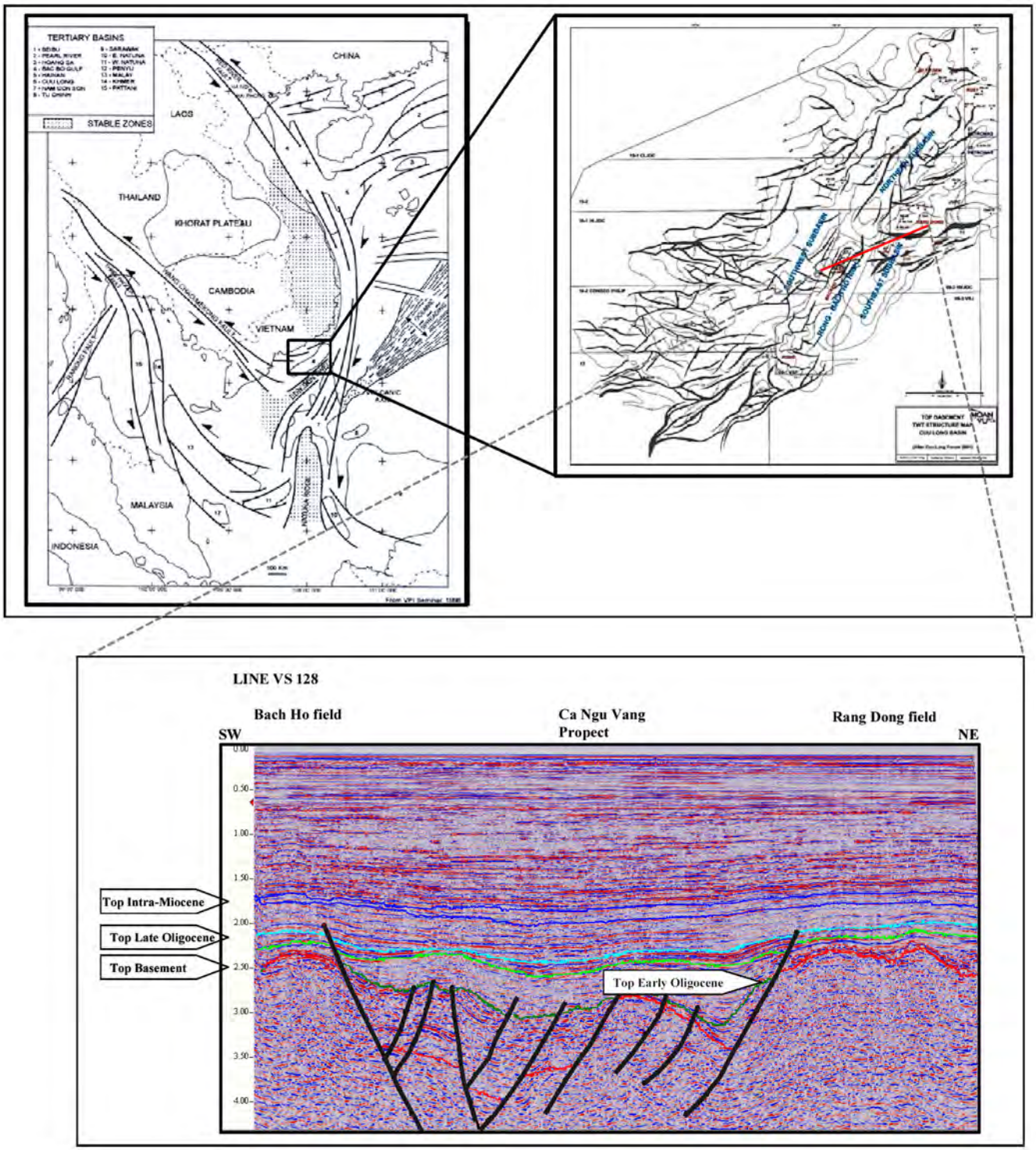

Figure 1

and Eurasia plates since Eocene. The basin has NE-SW orientation. The successive of lateral extrusion and rotation during Oliogcene developed a secondary EW trending normal faults.

c. The Post-rift period: Inversion occurred locally in Cuu Long basin since Late Oligocene to Early Miocene. The stress field polarity is reversed from the NW-SE tension to NW-SE compression. It is this stage that creates the excellent

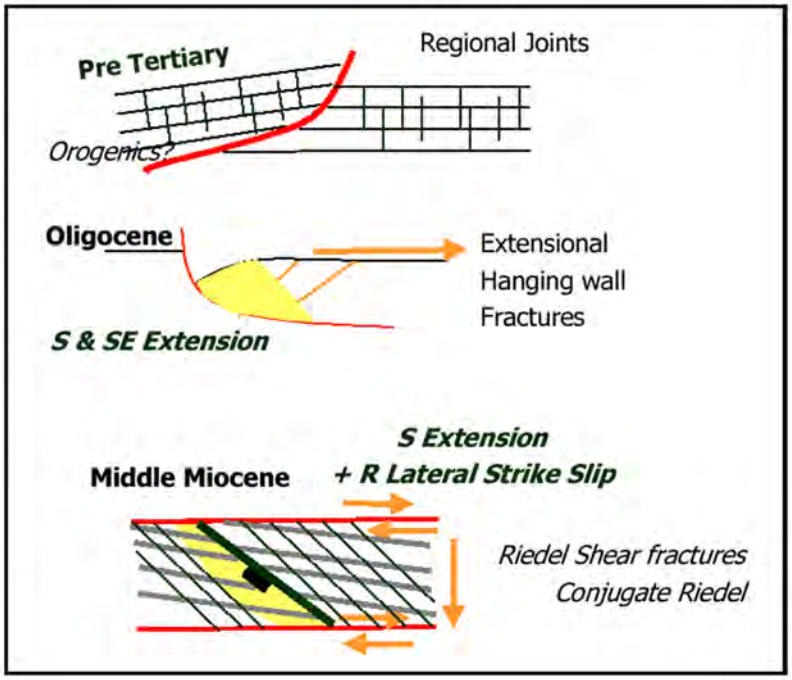

Figure 2

fractured reservoir inside the basement. Since Middle Miocene, the basin underwent passive subsidence without any tectonic disturbance, except the volcanic activities occurred at some places in the Cuu Long basin. The present-day maximum NNW-SSE in-situ stress recorded by many wells in the basin indicates that the compression continues to date.

The development of the fracture system is summarised as in Figure 2

3. Stratigraphy:

The stratigraphy of the Cuu Long basin is summarized as Figure 3

3. Petroleum System

a. Play concept: The following figure illustrated the play concept of the Cuu Long basin (Figure 4)

b. Source Rocks: The effective source rocks comprise Late Oligocene shale that covers pervasively though out the basin and the interbedded shale of the Early Oligocene section. They contain mostly kerogen type I/II generated from lacustrine origin. The average TOC from more than 1% up to nearly 10%; The hydrogen index ranges from 300 to more than 600 mg/gTOC (Figure 5)

c. Fractured Basement Reservoir

Fractured basement reservoirs are the unique characteristics of the Cuu Long basin, although there are other oil discoveries in the clastics and volcanics plays. The first oil discovery in basement was made by Vietsopetro in the Bach Ho field in 1988. Oil was stored in the macro-fractures, micro-fractures and vuggy pores. The matrix porosity of the magmatic body is negligible. Fractures inside the basement may originate from one or a combination of the following factors: 1) The cooling of the magmatic body 2) Tectonic activity 3) Hydrothermal processes and 4) Weathering and exfoliation. However, the tectonic activity and the hydrothermal processes are practically the main factors that control the porosity of the fracture systems. Recent studies (Cuong, T. X. 2001; Schmidt, J. et al., 2003)

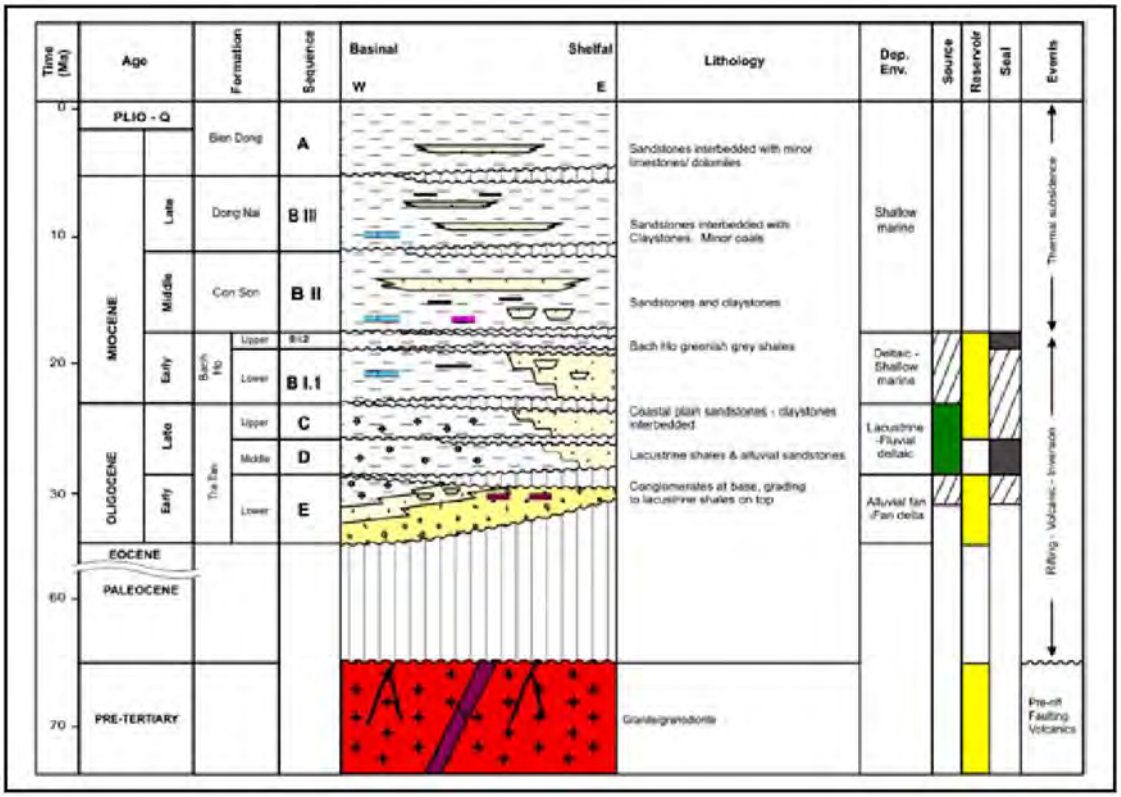

Figure 3

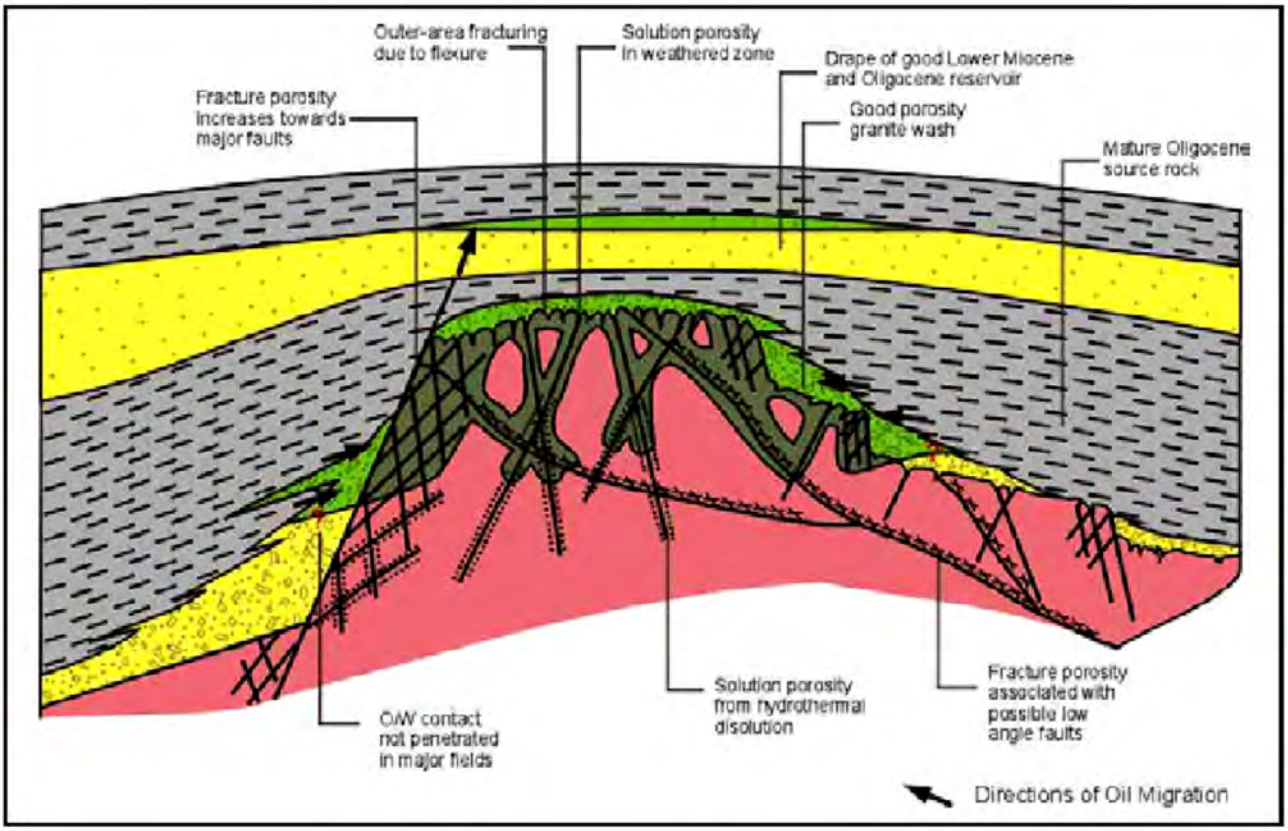

Figure 4

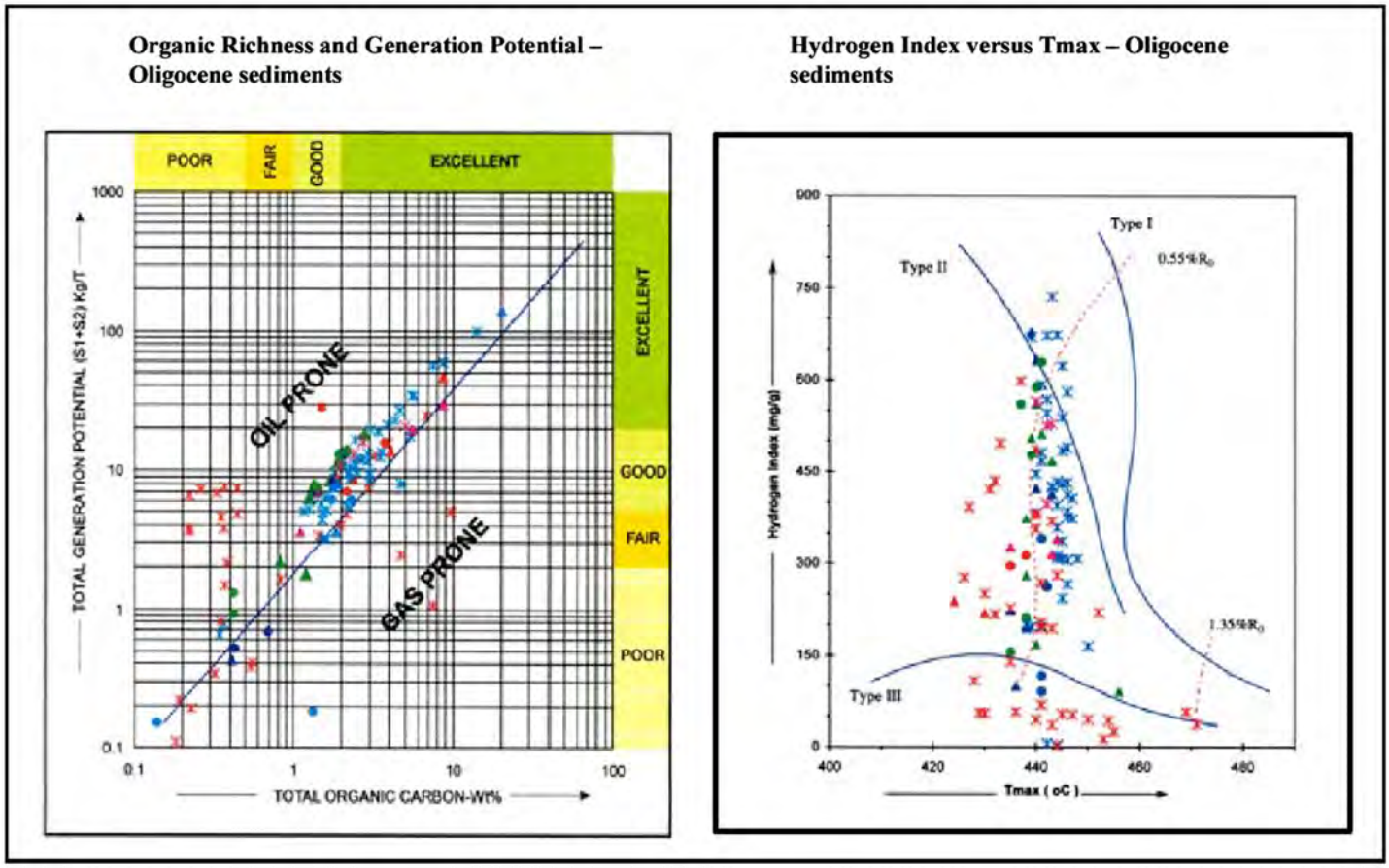

Figure 5

proved that the compression event that occurred during Late Oligocene had reactivated the pre-existing faults/fractures and created effective porosity inside the granite basement. The compression is probably resulted at the restraining band of a strike-slip motion along the E-W trending lineaments.

Most fractures inside the basement are of high dip angles (40-75º). Their strike directions vary from one field to another, or even within one field. The permeability of these reservoirs are normally very good to excellent (tens to thousands mD). Wells in fractured basement usually flow at very good rates (up to 14,000 bopd) The depth of the top of the basement reservoir is another issue. The basement tops of current oil fields are about 2500 - 3000 mss. Their oil columns range from 1000-1500 m.

Hoan Vu JOC has recently strike oil at 4430 mss in the granite basement of the Ca Ngu Vang prospect, whose top is at 3700 mss. It seems that the depth of top of basement is not a critical factor for exploring the oil in the basement.

4. Summary of Oil fields in Cuu Long Basin

Bach Ho (White Tiger) field: This is a giant oil field with reserves up to 1.0 - 1.4 mmm bbls. Current production of this oil field is 250,000 bopd; 90% of which come from the basement reservoir; the remaining comes from Oligocene and Miocene clastics.

Rong (Dragon) field: located at the southern end of the Bach Ho field. Oil was produces from both basement and volcanics section. The estimated reserve is about 40 mmbbls.

Ruby fields: The Ruby field locates at the northeast part of the basin. Oil is produced dominantly from the Miocene sandstones and the Oligocene volcanics. Current production is about 20,000 bopd.

Rang Dong fields: Oil is produced from mainly the fractured basement. A minor amount from the Miocene sandstones reservoir. Current production is about 60,000 bopd.

Su Tu Den fields: Oil was discovered in the Su Tu Den prospect in both basement and Oligocene and Miocene clastics reservoir. The field is planned to give first oil at the end of this year.

Ca Ngu Vang Prospect: this is the deepest basement reservoir that flowed at considerable rate (2600 bopd and 6.8 mmscfd). The Hoan Vu JOC is now carrying out the appraisal of this prospect. The preliminary reserves of this prospect is 90 mmbbls.

5. Acknowledgements

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6. References:

Chang S. J., and Long N. T., 2001, An Observation on The Fracture Systems of The Southern Vietnam, Technical Forum 2001

Cuong, T. X., 2001, Reservoir Characterisation of Naturally Fractured and Weathered Basement in Bach Ho Field, Technical Forum 2001

Dong, L. T. et al.,2001, Basement Fractured Reservoir of Bach Ho Oil Field - A Case Study, Technical Forum 2001

Schmidt J. et al. 2003, Tectonic Development of The Cuu Long Basin, Vietnam