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New Observations on the Evolution of the Bogor Basin, West Java : Opportunities for Turbidite Hydrocarbon Play

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ABSTRACT

Recent detailed field studies in the Sumedang area and regional re-interpretation indicated new observations on the evolution of the Bogor Basin. The basic ingredient is that the Bogor Basin in its history ever received sediments from the northern provenance of the Northern Platform. This differs with Martodjojo (1984)'s conclusions stating that all Bogor's sediments were sourced from the south. Turbiditic sediments of the upper Middle Miocene Cinambo, lower Pliocene Subang and Bantarujeg are examples of the exposed sediments in the area sourced from the north provenance. Older north-sourced sediments than those formations may also present. Lowstand levels in the Northern Platform has eroded the Talang Akar, Baturaja, Cibulakan, and Parigi sediments. The sediments were transported southward by submarine channels through the slope area between the platform and the Bogor Basin and were deposited in ponded basins possibly formed on the slope area and as submarine fans on the floor of the basin. The Baribis normal fault deforming the slope area had accommodated the transport of these gravity-flow sediments. The fault was inverted to become a back-arc thrust verging to the north in the Pleistocene.

These new observations open the windows of opportunities for hydrocarbon exploration in the Bogor Basin. This is based on the analogue with the proven productive turbidite play like that in the Makassar Strait and other deep-water plays. Prolific reservoirs and good sources of the sub-basins of the Northern Platform like those in the Pasir Putih (Pasir Bungur and Kepuh) and Jatibarang had partly been eroded in lowstand levels, transported, and deposited as gravity flow sediments within the Bogor basin. With stratigraphic and structural trap formation, sealed by good top and lateral seals, charged by hydrocarbons generated within the basin, then these transported sediments will become good hydrocarbon prospects. Detail model of sedimentology and petroleum system of the Bogor Basin is required to justify the turbidite play, then seismic surveys and exploration drilling will prove the concept. This will influence all turbidite plays in the whole Java area.

SARI

Penyelidikan geologi detail lapangan di wilayah Kabupaten Sumedang baru-baru ini dan penafsiran ulang regional menghasilkan suatu pemikiran baru tentang evolusi Cekungan Bogor. Inti pemikiran baru ini adalah bahwa di dalam perkembangannya Cekungan Bogor pernah menerima sedimen dari sumber sedimen di sebelah utara yaitu Paparan Utara. Pemikiran ini berbeda dengan kesimpulan Martodjojo (1984) yang menyatakan bahwa semua sedimen pengisi Cekungan Bogor berasal dari selatan. Contoh sedimen turbidit tersingkap di daerah Sumedang yang berasal dari sumber utara adalah sedimen Cinambo berumur Miosen

Tengah bagian atas, sedimen Pliosen Bawah Subang dan Bantarujeg. Sedimen turbidit berumur lebih tua dari yang tersingkap ini yang berasal dari utara diperkirakan terdapat juga di Cekungan Bogor. Sedimen-sedimen ini berasal dari Formasi Talang Akar, Baturaja, Cibulakan, Parigi di Paparan Utara yang tererosi pada saat kedudukan muka laut rendah, diangkut ke selatan melalui saluran-saluran bawah laut, melewati daerah lereng yang membatasi Paparan Utara dan Cekungan Bogor, dan diendapkan di cekungan-cekungan lokal daerah lereng yang mungkin terbentuk atau sebagai kipas bawah laut di dasar Cekungan Bogor. Sesar normal Baribis yang terdapat di daerah lereng berpengaruh dalam pengendapan sedimen turbidit ini. Sesar ini kemudian teraktifkan kembali pada saat Plistosen menjadi sesar naik belakang busur volkanik.

Pengamatan baru tentang evolusi Cekungan Bogor ini telah membuka peluang eksplorasi hidrokarbon untuk cekungan ini. Hal ini didasarkan kepada kesamaan model konsep eksplorasi dengan wilayah yang sudah terbukti produktif seperti konsep turbidit di Selat Makassar dan di kawasan sedimen laut dalam lainnya. Sedimen-sedimen berkualitas reservoir dan batuan induk di Paparan Utara seperti di Sub-Cekungan Pasir Putih (Pasir Bungur dan Kepuh) dan Jatibarang sebagian tererosi pada saat kedudukan muka laut rendah, kemudian diangkut, dan diendapkan di Cekungan Bogor. Sedimen-sedimen berkualitas reservoir ini kemudian akan membentuk perangkap-perangkap hidrokarbon oleh proses-proses stratigrafi dan struktur berikutnya. Penyekatan perangkap akan dilakukan oleh sedimen-sedimen halus setempat. Perangkap-perangkap ini kemudian akan terisi oleh hidrokarbon yang dihasilkan batuan induk rombakan dari Paparan Utara yang kemudian matang. Suatu pemelajaran detail sedimentologi dan sistem hidrokarbon Cekungan Bogor diperlukan guna memperkuat konsep turbidit Cekungan Bogor ini. Kemudian, suatu survey seismik dan pengeboran eksplorasi akan membuktikan kebenaran konsep ini. Hasil eksplorasi turbidit di Cekungan Bogor akan menjadi data penting untuk eksplorasi endapan sejenis lainnya di seluruh Pulau Jawa.

INTRODUCTION

Java Island can basically be divided into three physiographic setting trending west-east parallel with the island's axis, namely : Northern Platform, Central Depression, and Southern Uplifts. The Central Depression was called by van Bemmelen (1949, 1970) as Bogor-North Serayu-Kendeng Zone *(Figure 1)*. In West Java, the focus of this paper, the Bogor Zone is typified by anticlinorium of strongly folded Neogene strata with many volcanic intrusions. Its western part trends west-east, while its eastern part assumes a more WNW-ESE direction, giving it a slightly arcuate outline, convex to the north. Its eastern part is crowned by young volcanoes, such as the Sunda Complex, north of Bandung, and the Ciremai.

Martodjojo (1984) introduced the name of Bogor Basin which is slightly different with the Bogor Zone of van Bemmelen (1949, 1970). The Bogor Basin is not a proper physiographic unit, it is a more tectonic-sedimentary province. The presence of gravity-flow sediments or turbiditic sediments become the basis of this province. According to Martodjojo (1984), the turbidite in West Java is not confined within the physiographic Bogor Zone, but extending southward to include the part of the Southern Mountains. The depositional area of gravity-flow sediments in West Java is called the Bogor Basin. Martodjojo (1984) detailed the geologic evolution of the Bogor Basin.

In terms of hydrocarbon (oil and gas) exploration, the Bogor Basin, has been hindered by oil companies. Hydrocarbon exploration in West Java was started in 1876 (it was also the first exploration for the whole Java area), at Madja just to the north of the northern border of the

Bogor Basin. Until the present day, after almost 150 years, not a company farms in the Bogor Basin. On the other hand, oil and gas have been explored and produced in the Ciputat-Kepuh-Pasir Bungur-Cipunegara-Jatibarang Sub-Basins of the NW Java Basin to the north of the Bogor Basin (Noble *et al*., 1997). Is the Bogor Basin with no hydrocarbon resources ?

This paper summarizes our study on the hydrocarbon potential of the Bogor Basin. New paradigm or model is presented. This is based on the new interpretation of the tectonic/structural and sequence stratigraphic studies of the NW Java and Bogor Basins. New proven success model of turbidite play in the Makassar Strait gives an analogue. Field study in the Sumedang area, northern part of the Bogor Basin, shows positive results of this play.

MARTODJOJO (1984) : EVOLUTION OF THE BOGOR BASIN

Martodjojo (1984) made a geologic research of West Java, especially the Bogor Basin, for his doctoral (Ph.D.) degree. His research was based mainly on geologic field studies carried out by himself, his students from Institute of Technology Bandung and University of Padjadjaran, Bandung and Geological Survey of Indonesia (P3G – Pusat Penelitian dan Pengembangan Geologi), Bandung. The additional data he used included : seismic, magnetic, gravity, and satellite data, and published literatures. Stratigraphy, sedimentology, structure, and tectonics of West Java and especially the Bogor Basin were examined in the research.

Martodjojo (1994) divided the Java's sedimentary domain into two parts : platform/shelf and turbidite sediments *(Figure 2)*. Martodjojo (1984) defined that West Java, based on its sedimentary pattern, can be divided into three sedimentary provinces : (1) Continental Platform Province, (2) Banten Sedimentary Province, and (3) Bogor Basin Province. The Bogor Basin is bounded to the north and west by the Continental Platform and Banten Province, respectively. To the south, the basin is bordered by the positive gravity anomaly to the south off Java island. To the east, the border is arbitrary and actually continues into the depression zone of the South Serayu Basin.

Turbiditic gravity flow sediments dominate the sedimentary pattern of the Bogor Basin *(Figure 3)*. The oldest rock unit included into the basin is the Late Cretaceous to Early Eocene melange complex. This rock complex partly forms the basement of the West Java and acting as pre-rift complex of the Bogor Basin. In the Middle Eocene, the Bogor Basin formed by rifting as also undergone by all sedimentary basins to the east and south of the Sundaland (example : Barito and East Java Basins). The proper Bogor Basin was a forearc basin in this period located relatively in front of volcanic arc situated in the present Java Sea and behind the non-volcanic arc composed by the Ciletuh and Bayah Formations. Sediments of Ciletuh Formation were deposited as pond deposits at lower trench's slope. The deposition of the Ciletuh Formation continued into the nonmarine to shallow marine Bayah Formation showing a regressive succession. Both the Ciletuh and Bayah Formations were interpreted by Martodjojo (1984) as accretionary prism of the outer non-volcanic arc. The Eocene inner volcanic arc was situated at the present Java Sea. During this period, outer nonvolcanic arc high-forearc basin-continental platform-inner volcanic arc form parallel morphotectonic units trending SW-NE.

The Bogor Basin subsided in the Oligo-Miocene to accommodate the uplifts in the northern continental platform and southern Jampang Plateau. Since the end of the Eocene the southern non-volcanic arc has been uplifted and continued into the Oligocene as the Jampang Plateau. The subsidence of the Bogor basin at its southern margin was accommodated by the

Cimandiri Fault which down to the north into the Bogor Basin. Batuasih marls were deposited in the southern Bogor Basin *(Figure 3)*. At the rim of the Cimandiri Fault or at the southern margin of the Bogor Basin, carbonate reefs grew distributed in SW-NE direction from present Sukabumi through Rajamandala to Gunung Kromong (Majalengka). To the north of the fault, the basin was deeper and present Purwakarta area situated at the deepest part of the basin. The Bogor Basin was available for turbiditic gravity flow if there were sediments eroded from the northern and southern highs.

In the Early Miocene, turbiditic gravity flows for the Bogor Basin were established. Volcanic arc had migrated to the south of the present Bogor Basin trending west-east parallel with the present axis of the Java Island. The Bogor Basin became the backarc basin. The volcanic arc was interpreted mostly as submarine volcanic arc. The arc had contributed significant volcaniclastic sediments into the Bogor Basin called as the Citarum Formation (Martodjojo, 1984) *(Figure 3)* which killed the growth of the Oligo-Miocene Rajamandala reefs.

Significant tectonic change due to the migration of the volcanic arc to the south into the west-east direction had changed drastically the morphotectonic setting of West Java. The shallow Continental Platform – deep Bogor Basin – shallow Jampang Plateau form basic configuration. From the north to the south the configuration included : exposed Sundaland – shallow Continental Platform (present Northwest Java Basin) – deep Bogor Basin- shallow Jampang Plateau. The transition from the Continental Platform to the Bogor Basin was a slope area near the present Purwakarta. Structures of the West Java changed into the WNW-ESE direction.

During the Middle Miocene, the Bogor Basin received turbiditic gravity flows of Saguling Formation (Martodjojo, 1984) *(Figure 3)*consisting of breccias intercalated with sands and clays. To the north of the Bogor Basin, the Continental Platform was still stabile forming a shallow epicontinental platform with shallow marine sediments. To the south, the Jampang Plateau was uplifted by regional reverse faults of Cikalong and Gunung Walat (Martodjojo, 1984, 1994) trending WNW-ESE *(Figure 4)*. Bogor Basin was still a deep backarc basin in this period. In the upper Middle Miocene, several regional lobes of deep-sea turbiditic fans developed into the Bogor Basin from southern areas. In the western Bogor Basin (present Karawang, Bogor, and Purwakarta), the fans compose the Bantargadung Formation *(Figure 3)*. In the eastern part of the Basin, the fans are included into the Cinambo Formation consisting of breccias and sands (Martodjojo, 1984). Continuing subsidence of the basin since the Early Tertiary had caused the basin to narrow forming a long deep basin into the shape like we know today as physiographic Bogor Zone (van Bemmelen, 1949, 1970).

In the Late Miocene, thrust and reverse faults deformed the Bogor Basin. Several regional faults were : Saguling, Jatigede, Cirata, and Cimapag-Cihoe-Pangipiran (present southern Karawang) (Martodjojo, 1984, 1994) trending WNW-ESE *(Figure 4)*. The Bogor Basin was uplifted and volcaniclastic sediments of Cantayan Formation were deposited consisting of breccias, sands, and clays. In the eastern part of the basin, the turbiditic sediments were still deposited forming the Halang Formation *(Figure 3)*.

Started in the Mio-Pliocene the magmatic arc of Java shifted northward and partly occupied the Bogor Basin in West Java. The Bogor Basin was no longer a backarc basin. Parts of the Bogor Basin were land areas. No sediments younger than the Cantayan Formation are found possibly due to erosion in the Late Pliocene (Martodjojo, 1984). However, Pliocene shallow marine sediments equivalent with the Kaliwangu Formation are found in the eastern part of the Basin.

The whole West Java, mainly the southern and central parts, was uplifted in the Plio-Pleistocene. Alluvial and volcanoclastic sediments were mainly deposited in the northern areas forming the Citalang Formation (Early Pleistocene). The Citalang and the Kaliwangu Formations were faulted by the Baribis reverse fault in the Pleistocene *(Figures 3, 4)*. The geology of West Java in the Late Pleistocene time was similar with that of today.

NEW OBSERVATIONS ON EVOLUTION OF THE BOGOR BASIN

Gravity Flows from the Northern Platform : Sumedang Field Studies

Turbiditic gravity flows dominated the sedimentary pattern of the Bogor Basin during the Miocene. The provenance of the sediments was Oligo-Miocene magmatic arc to the south of Java Island. Submarine pyroclastic deposits forming deep-sea fans developed to the north into the Bogor Basin started in the Early Miocene. The deep-sea fans prograded northward and were younger northward up to the Late Miocene. The gravity flows were from southern high area (Martodjojo, 1984). During the Miocene, the Bogor Basin was between two high areas : (1) Northern Platform (presently forming the oil basins of West Java) and (2) Southern Uplift. Martodjojo (1984) discussed the stratigraphic and structural setting of the Northern Platform. However, he never examined that this high area can contribute sediments into the adjacent Bogor Basin situated right to the south of it. In the light of present knowledge of sequence stratigraphy, the provenance of sediments for Bogor Basin from northern area is very possible. Field studies in the Sumedang area showed this.

Field studies (measured sections) carried out on the Cinambo Formation at the Cinambo and Cicacaban Rivers, Sumedang Regency area, showed new evidence on the origin of the sediments. The Cinambo is the oldest sediments (N14-15, Middle Miocene) exposed in this area *(Figure 10)*. The formation consists of interbedded sandstones and shales and locally is intercalated with calcareous breccias with components of limestone and claystone debris. The formation is strongly deformed. The formation is interpreted as deep-sea deposits of submarine slope or shelf break slope down to basin floor fan based on lithofacies and biofacies analyses.

Based on provenance study including physical properties of rock components of limestone and claystone, paleocurrent of flutecast direction and other current-indicating sedimentary structures such as current lamination, it is concluded that the Cinambo turbidites derived from the Northern Platform. The paleocurrent direction has been structurally restored into the horizontal deposition. The sediments were transported in northeast-southwest trending and sourced from the northeast area. The main Cibulakan of the Jatibarang Basin comprising present Indramayu and Majalengka areas is considered to source the Cinambo sediments *(Figure 10)*. During the N13-N15, the basin was in non-marine fluvial environment within the lowstand edge based on eustatic curve. The main Cibulakan was eroded and the debris sediments were transported into the Bogor Basin. In this period, the Walat Fault was still at the southern West Java trending west-east from Sukabumi to Papandayan *(Figure 4)*. This fault caused the lowstand sea level during this period. There was no turbidite deposits from the south or they limited only in southern area like in Bandung.

Different with the Cinambo Formation, the Late Miocene (N16-N17) Halang Formation is turbiditic deposits sourced from the southern provenance . The breccias of the formation is dominated by the andesitic fragments considered to derive from the Southern Mountains which was prograding to the north coeval with northward thrust progradation (Saguling Fault). This thrust progradation had caused sea transgression in the Northern Platform and Parigi carbonates were deposited during the period. The basinal pelagic sediments were deposited in the Bogor Basin.

During N18, the Cirata thrust uplift took place *(Figure 4)*. This shallowed the depocenter of the Bogor Basin. Post-lifting extension then caused lowstand sea level in the Northern Platform. The Parigi carbonates were eroded and the sediments were deposited as slope turbiditic sediments into the Bogor Basin and known as the Subang Formation *(Figure 10)* in western Sumedang and Bantarujeg turbidites in Majalengka area. The characteristics of Subang Formation are similar with the Cinambo Formation which is typified by dominant limestone and claystone debris.

During N19, Cirata uplift was stronger and eventually the Bogor Basin and the Northern Platform formed one shelf area. The shallow marine of Cisubuh sediments were deposited in the Northern Platform and the N20-age Kaliwangu lagoonal to shallow marine sediments were deposited in the eastern Bogor Basin *(Figure 10)*. Entered the N 21 period, the thrust uplift prograded northward and lastly inverted the long-lasted Baribis normal fault to become back-arc thrust. The Bogor basin was higher than the Northern Platform and sediments transported to the north from the mountainous Bogor Zone like the Citalang Formation.

Inverted Baribis : from Normal Fault to Back-Arc Thrust

Baribis reverse fault, the northernmost fault of the northward-prograding reverse faults of West Java (Martodjojo, 1984; 1994) *(Figure 4)*, has occupied the margin between the Northern Platform and the Bogor Basin since the Paleogene. The fault trends WNW-ESE from around Purwakarta through Majalengka to the south of Ciremai Mount. The fault can actually be traced far more to the west into the Banten Block in the Serang area forming the northern border of the Bogor Basin.

Seismic sections from the Northern Platform to the Bogor Basin, structural reconstruction, and stratigraphic histories from the Northern Platform to the Bogor Basin lead to the conclusion that the Baribis Fault is an inverted fault. The fault was a normal fault until the Pleistocene time occupying the slope area connecting the Northern Platform and the Bogor Basin. When the northward progradation of the West Java regional thrusts reached its northernmost position, the normal Baribis Fault was reactivated to reverse its slip to become inverted reverse fault verging to the north *(Figure 5)*. Seismic data show that the Talang Akar Formation crossing the fault still indicate a normal slip, but shallower horizons from the Baturaja into the Cisubuh show reverse slips. This indicate that the Baribis Fault was ever a normal fault and then inverted. Presently, the Baribis reverse fault form the western sector of the Java back arc thrust which regionally continues eastwards through Central Java-East Java to the Flores Sea. The fault had accommodated the transport of sediments from the Northern Platform into the Bogor Basin.

OPPORTUNITIES FOR TURBIDITE HYDROCARBON PLAY

Deep-water (turbidite) exploration is increasingly important and today contributes 14 % of world's oil and gas reserves. The largest area with highest potential is in Mexican part of the Gulf of Mexico having 15 BBO (billion barrels of oil). In Indonesia, there are potential of as large as 5 BBO of unexplored deep-water areas. In term of exploration, it is a challenge to search for new targets (Soejanto, 2001).

Lessons from the Makassar Strait Discoveries

The Makassar Strait, including basins of Outer Kutei -North Makassar Strait, represents the most intensively and successfully explored deep-water basin in Indonesia. The focus of exploration in this basin has shifted to the deep-water and was awarded with oil and gas discoveries such as West Seno, Merah Besar, Ranggas, Gendalo, Gula, and Gandang. These discoveries may represent 15 % of Kutei reserves at present but exploration with this play is taking place so that the number is likely to increase (Kusumastuti *et al*., 2001).

The reservoirs thus far proven are the Pliocene and Late Miocene sediment gravity flows, with the deep-water discoveries located in different depositional systems in an upper to lower slope setting (Kusumastuti *et al*., 2001) *(Figure 8)*. Seismic interpretation showed that a number of low areas so-called mini basins (ponded basins), which were formed by shelf-edge listric normal faulting, was identified on the slope environment (Inaray *et al*., 2001). Several wells drilled on the upper slope environment and seismic data along with the present day bathymetric profiles led us to the interpretation that during the Miocene, lowstand significant sands were transported by turbidity currents through deeply incised slope canyons should have been confined in these continental slope mini basins. Merah Besar field discovery in 1996 and West Seno field discovery in 1998 proved this interpretation and significantly provided inputs to the exploration of Upper Miocene, slope environment, confined turbidite sands of deep-water Kutei Basin (Inaray *et al*., 2001).

Dunham and McKee (2001) concluded that the key elements of the hydrocarbon system are simple anticlinal four-way closures that contain thick laterally extensive sand bodies. Most significantly, the sands were deposited prior to structural growth, with the result that the sands do not thin over the crests of the structures. Abundant Pliocene and Miocene sands existed on the Kutei shelf should have been deposited in the basin during the lowstands and before the Pliocene structural growth.

The source rocks are thought to comprise highly unusual, re-deposited terrestrial source particles and other organic matter transported into the deep-water by Early to Late Miocene (post-rift) sediment gravity flows and thus deposited in close juxtaposition with reservoir sandstones at a number of stratigraphic levels. Hydrocarbon charge could also through deep-penetrating faults. These source rocks are therefore very different from the terrestrial organic matter thought to be the primary source for the fields in shallow water and onshore. Top seals formed by thick hemipelagic claystone sections. Trapping geometries in the deep-water are related to thin-skinned extensional and contractional structures, often with a significant stratigraphic component (Kusumastuti *et al*., 2001; Dunham and McKee, 2001).

A significant lesson to be learned from this successful deep-water exploration : the presence of abundant sand on shelf clearly point to the high probability of significant deep-water sands in basin.

Potential Bogor Turbidite Play

All proven productive turbidite plays in the world have the following processes in common : erosion and transportation of reservoir and hydrocarbon source sediments from the updip productive areas, deposited in the slope or basin floor areas in the deep-water setting, and later form structural or stratigraphic traps. This condition occurred in the Bogor Basin when the prolific source and reservoir-quality sediments were eroded from the productive Pasir Putih and Jatibarang Basins in the Northern Platform and were transported and deposited into the slope and floor of the Bogor Basin and therefore, have potential to become hydrocarbon prospects. The transport and deposition of the sediments are modelled in *Figure 8* and *Figure 9*.

The Pasir Putih (Pasir Bungur and Kepuh) and Jatibarang sub-basins are included into the prolific Northwest Java Basin *(Figure 6)*. Onshore and offshore sub-basins of Northwest Java contain at least ten active petroleum systems which have given rise to more than 150 separate oil and gas fields. The expected ultimate reserves of the region amount to over 4 BBOE, which represents about 14 BBOE in-place (Noble *et al*., 1997).

In Jatibarang Sub-Basin, deltaic Talang Akar provides the major source *(Figure 7)*. The Jatibarang volcanics are an important reservoir in this area. Many shallower units are also charged and have good reservoir properties. The Pasir Putih Sub-Basin, including the Pasir Bungur and Kepuh, is part of a broad low lying area. The Talang Akar Formation is well developed, adequate thicknesses of coal are present. These coals serve as the primary source for hydrocarbons. Besides the usual clastic reservoir units in the Talang Akar and Upper Cibulakan, a Mid-Main Carbonate is well developed along the Rengasdengklok ridge and is an important reservoir in this area (Noble *et al*., 1997).

Other sub-basins of Northwest Java Basin located to the north of the Bogor Basin are the Ciputat and Cipunegara sub-basins *(Figure 6)*. In the Ciputat Sub-Basin, the Talang Akar Formation thins considerably and is largely made up of main limestones. Some coaly and shaley facies are present. In the Cipunegara Sub-Basin, the Talang Akar source rocks are the most important, and multiple reservoir horizons are charged from this source (Noble *et al*., 1997).
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The presence of productive shelfal sub-basins to the north of the Bogor Basin is important for the hydrocarbon potential of the Bogor Basin. As has been discussed, during the lowstands, the reservoir- and source-quality rocks of these sub-basins can provide transported reservoirs and sources deposited in the slope and floor areas of the Bogor Basin *(Figure 10)*. Lessons learned from the proven turbidite play in the Makassar Strait and the presence of proven shelfal petroleum systems to the north of the Bogor Basin can lead to the consideration that the turbidite play of the Bogor Basin is prospective.

Lowstand levels occurred for several times in the Ciputat to Jatibarang sub-basins eroding the formations *(Figure 10)*. Transported sediments with reservoir- and source-quality could be deposited in the Bogor Basin composing the petroleum system. Cinambo, Subang, and Bantarujeg turbiditic sands provide the reservoirs and/or sources. Other north-provenance turbiditic sediments are possible and older than the Cinambo. Period of P21-P22 was important for erosion from the North Platform, transportation, and deposition of sediments within the Bogor Basin. Debris sediments deposited as middle fan turbidite usually have good sorting, porosity, and permeability. Sources deposited in the lower fan turbidite could generate hydrocarbons upon mature and migrate updip into the reservoirs of the middle fan turbidite. The presence of the Baribis normal fault at the slope area could accommodate the sediments transport from the Northern Platform into the Bogor Basin. Ponded basins could develop in this slope area and become the sites for sands entrapment.

The source rocks are re-deposited terrestrial to non-marine source particles and other organic matter transported into the deep-water by gravity flows. Hydrocarbon charge could also through deep-penetrating faults like the inverted Baribis normal fault. Top seals formed by thick hemipelagic claystone sections. Trapping geometries are both thin-skinned extensional and contractional structures, often with a significant stratigraphic component.

By model, analogue, and presence of the active petroleum system in the Northern Platform; the turbidite play of the Bogor Basin is promising. Detail model should be resulted in to justify exploration activities such as seismic survey. This paper concludes that the new observations on the Bogor Basin evolution has implications for hydrocarbon potential

CONCLUSIONS

- Recent detail field studies in the Sumedang area and regional re-interpretation indicated new observations on the evolution of the Bogor Basin. The basic ingredient is that in its history the Bogor Basin ever received sediments from the northern provenance of the Northern Platform. The turbiditic upper Middle Miocene Cinambo, lower Pliocene Subang and Bantarujeg formations are examples of exposed sediments in the area sourced from the north provenance.

- The Baribis normal fault deforming the slope area had accommodated the transport of gravity-flow sediments during the Oligocene to Pliocene. The fault was inverted to become a back-arc thrust in the Pleistocene.

- The new observations on the evolution of the Bogor Basin opens the windows of opportunities for hydrocarbon exploration in this area. Prolific reservoirs and good sources of the sub-basins of the Northern Platform had partly been eroded, transported, and deposited as gravity flow sediments within the Bogor basin. With stratigraphic and structural trap formation, sealed by good top and lateral seals, charged by hydrocarbons generated within the basin, then these transported sediments will become good hydrocarbon prospects.

- Detail model of sedimentology and petroleum system of the Bogor Basin is required to justify the turbidite play, then seismic surveys and exploration drilling will prove the concepts. This will influence all turbidite plays in the whole Java area.

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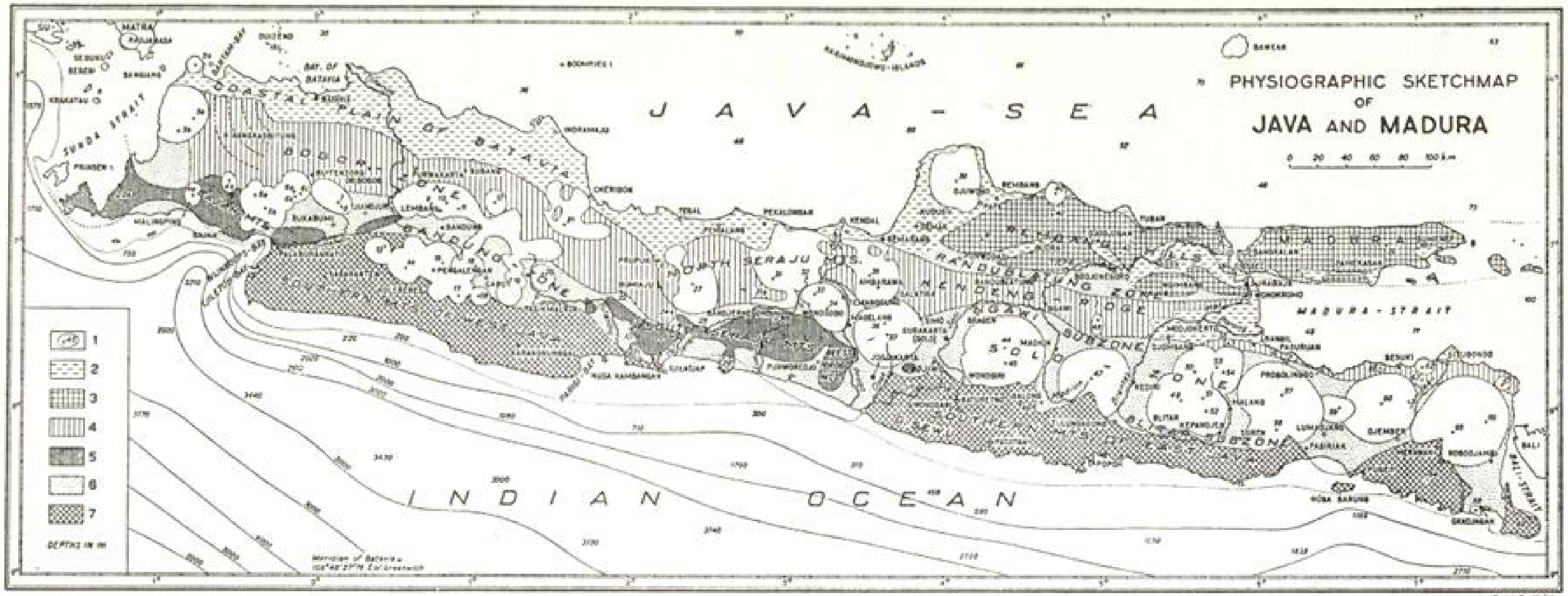

van Bemmelen (1949, 1970)

LEGENDS OF PHYSIOGRAPHIC ZONES

1. Quaternary volcanoes
2. Alluvial plains of northern Java
3. Rembang Madura anticlinorium
4. Bogor, North Serayu, and Kendeng anticlinorium
5. Domes and ridges in the central depression zone
6. Central depression zone of Java and Randublatung Zone
7. Southern Mountains

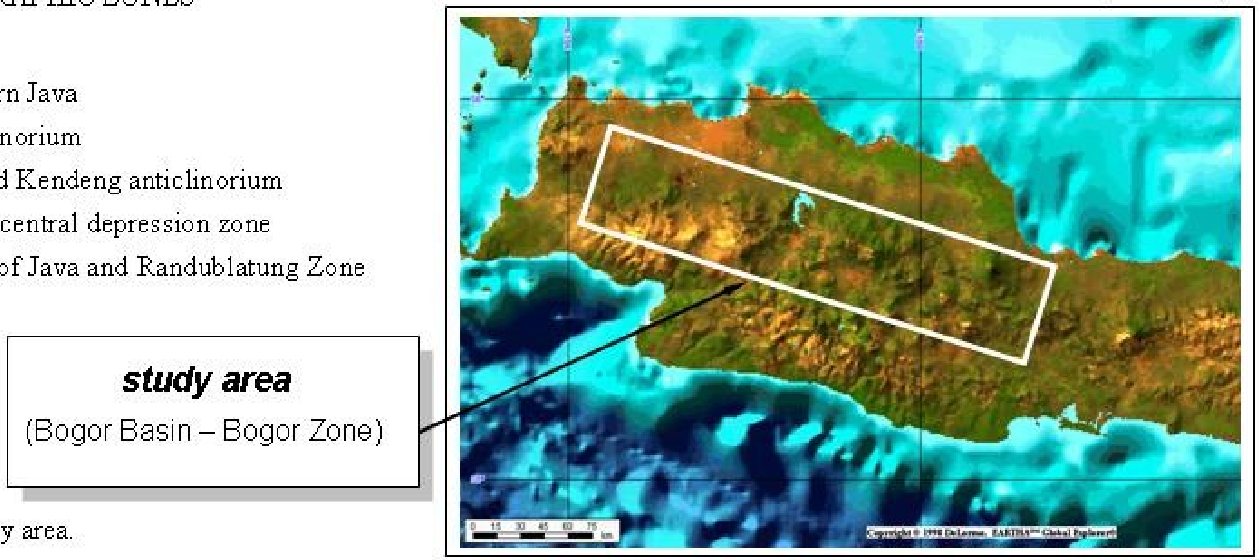

Figure 1 Location of the study area.

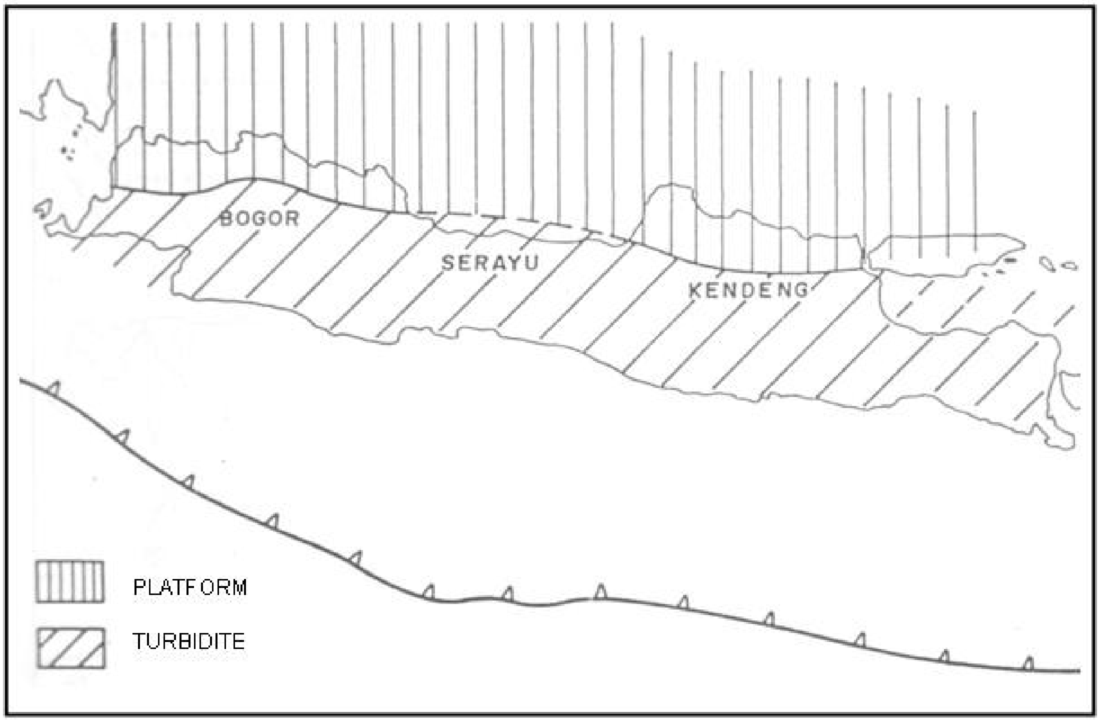

Figure 2 Sedimentary domains of platform and turbidite deposits in Java Island (Martodjojo, 1984; 1994)

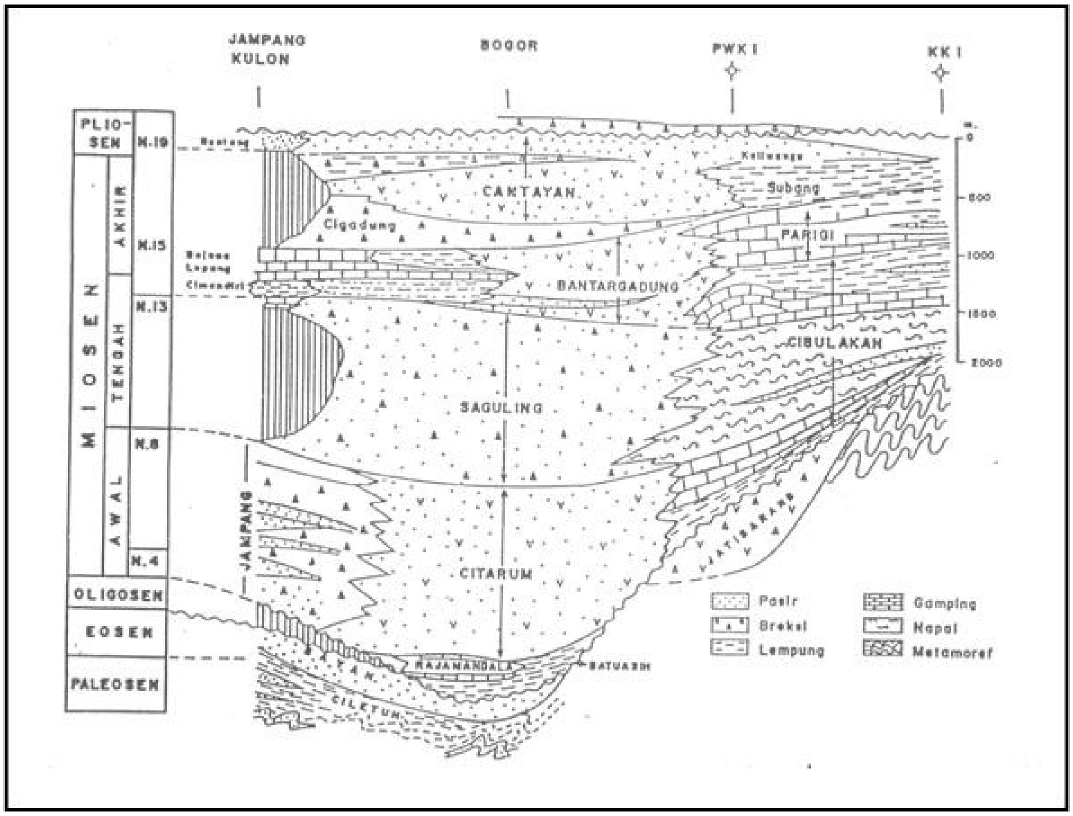

Figure 3 Restored stratigraphic section across south-north of West Java (Martodjojo, 1984; 1994)

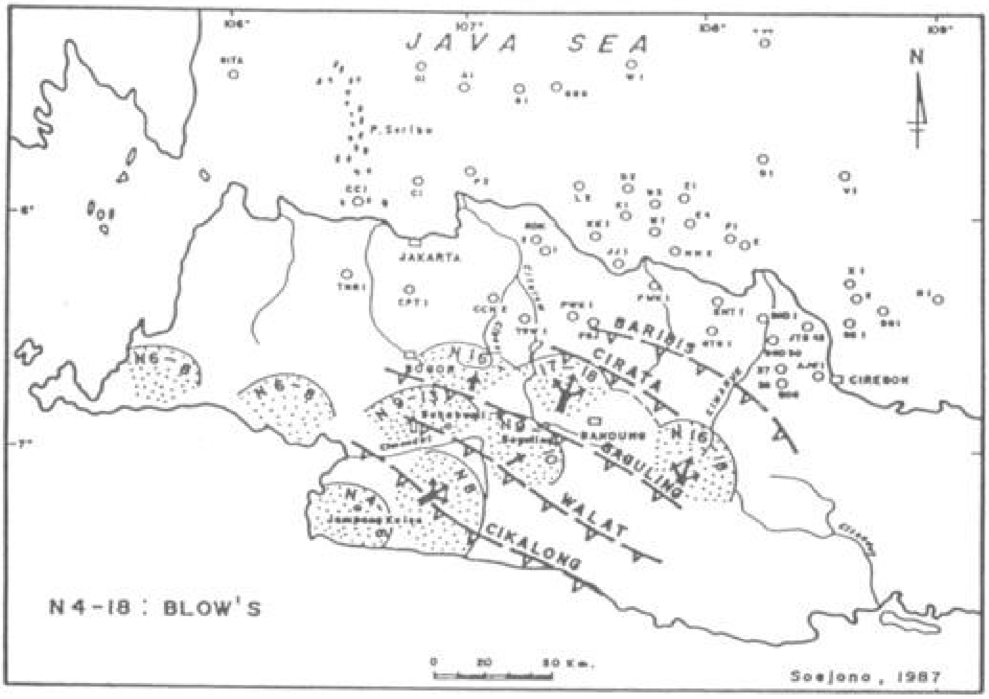

Figure 4 Prograded deep-sea fans and related thrust faults of West Java (Martodjojo, 1984; 1994)

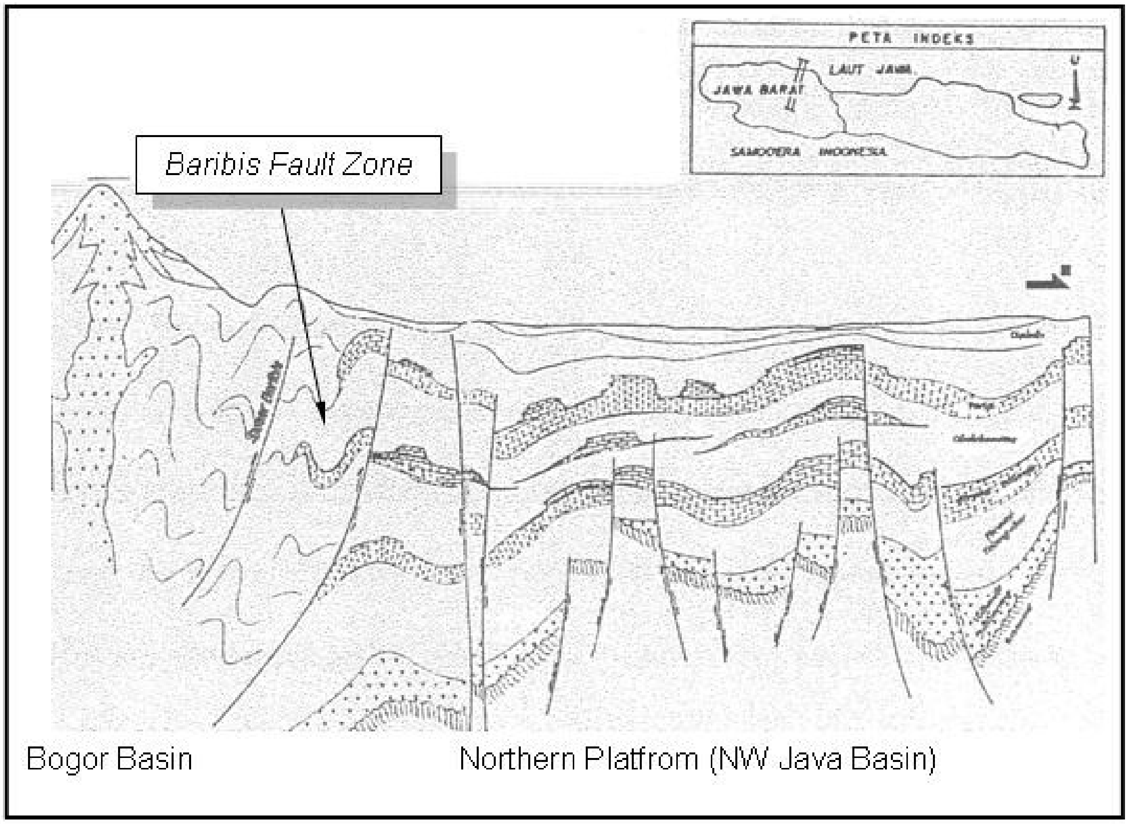

Figure 5 Inverted Baribis Fault positioned on the margin between the Northern Platform and the Bogor Basin (Supriyanto aand Ibrahim, 1993)

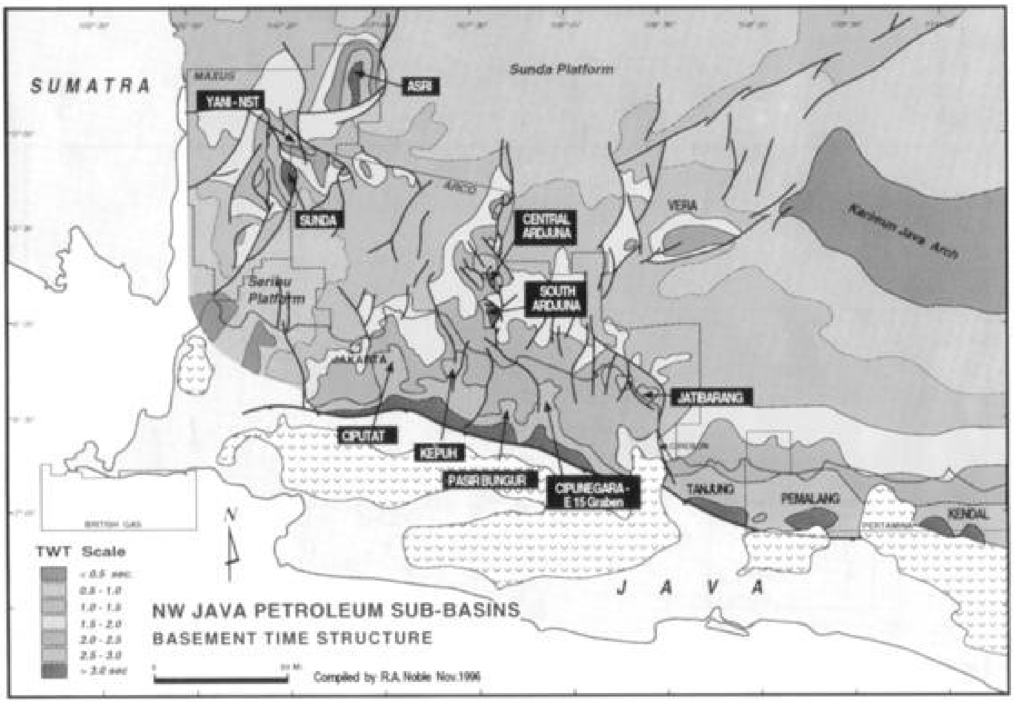

Figure 6 Basement time structure map of NW Java Basin showing petroleum sub-basins (Noble *et al.,* 1997)

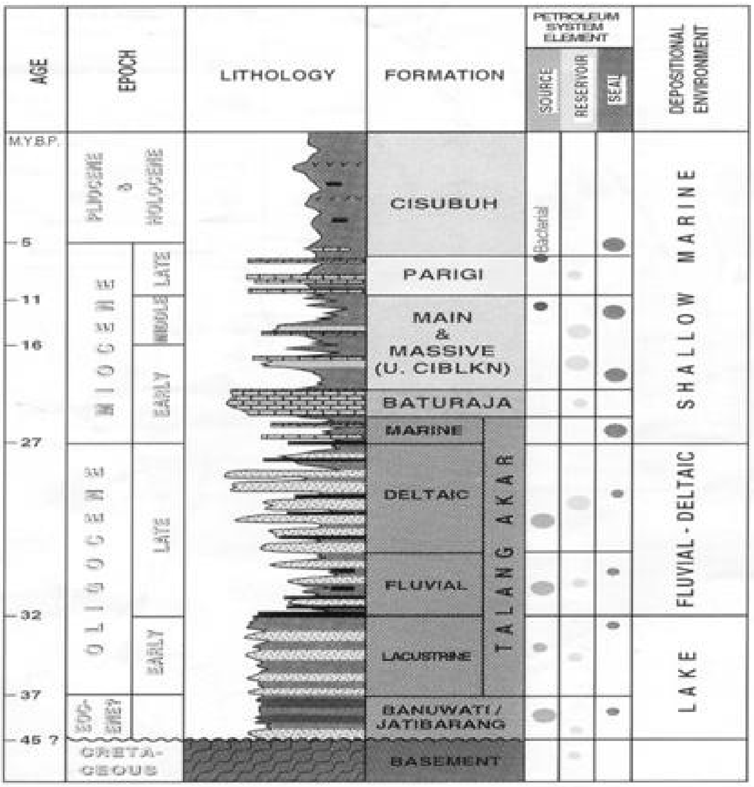

Figure 7 Generalized stratigraphic and petroleum system element of NW Java Basin (Noble *et al.,* 1997)

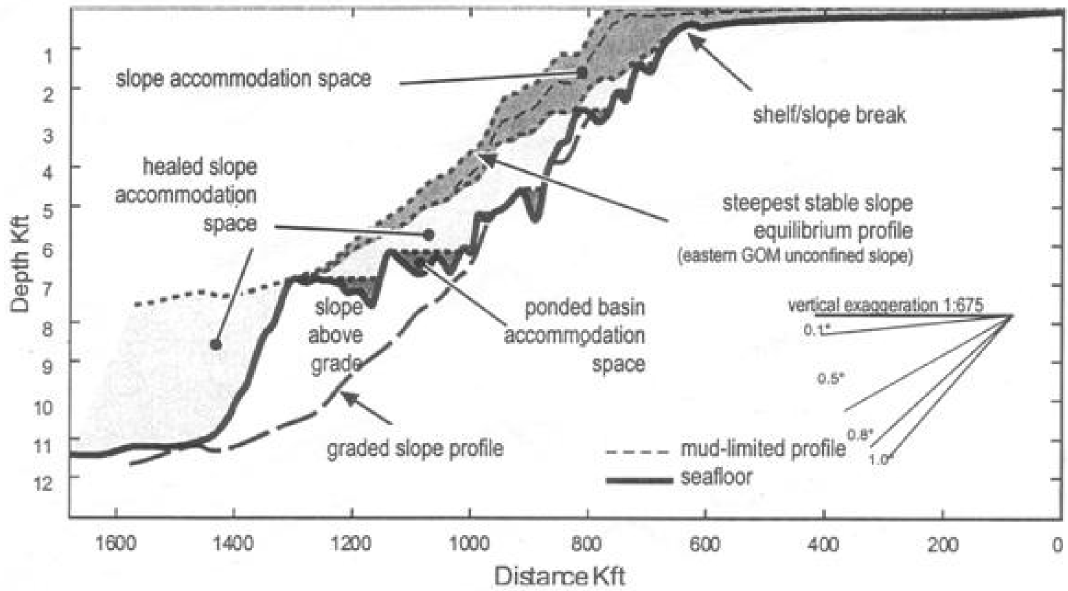

Figure 8 Accommodation spaces for sediments developing on the slope profile (Prather, 2001).

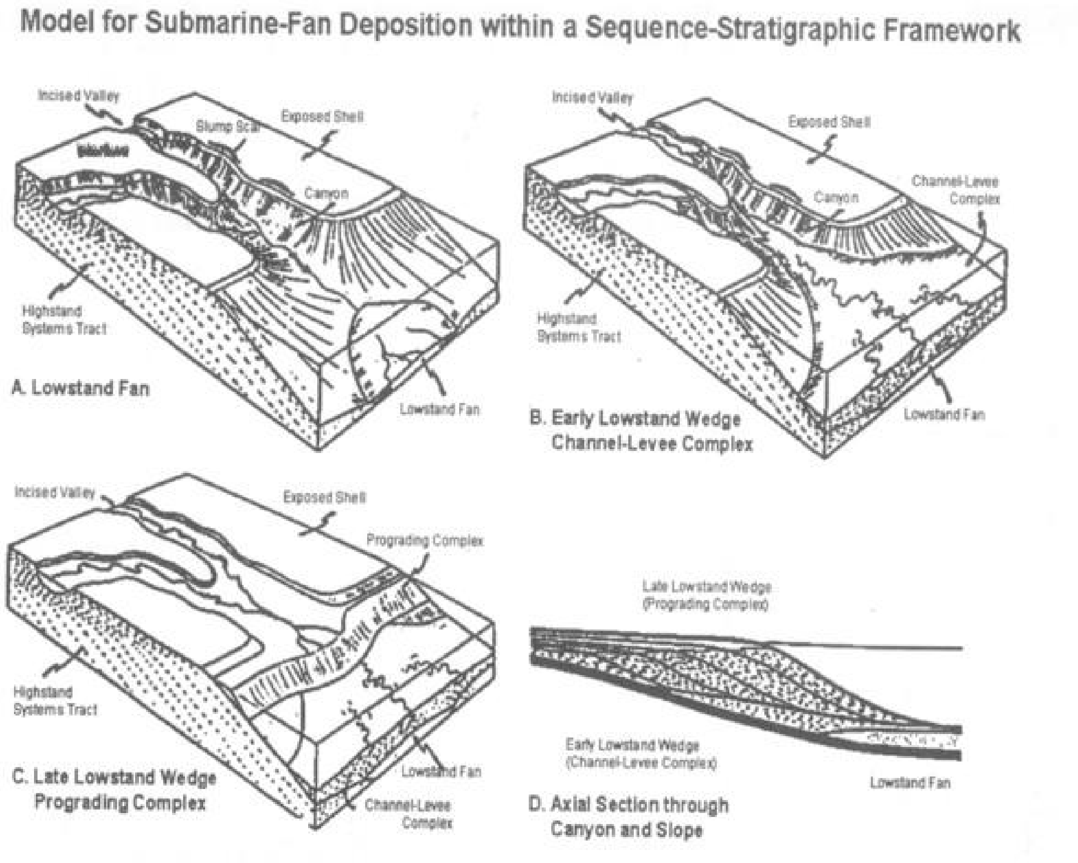

Figure 9 Models for sub-marine fan deposition (Posamentier *et al.*, 1991*in* Nugrahanto *et al.*, 2001).

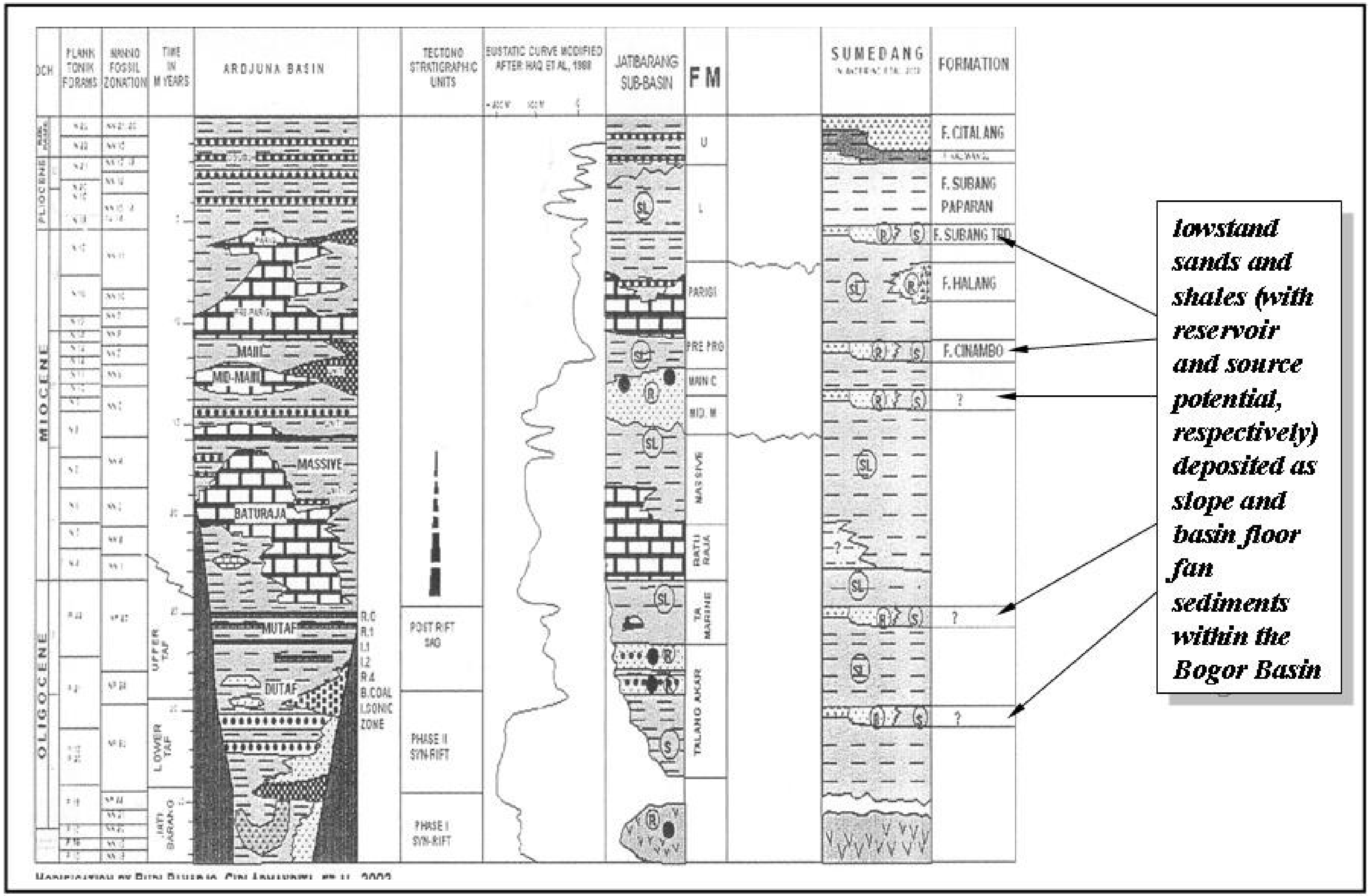

Figure 10 Origin of lowstand sands and shales in the Bogor Basin (Sumedang case) from the sub-basins in the Northern Platform. These lowstand deposits will become good reservoirs and sources and hydrocarbon prospects with good petroleum system.