STRATIGRAPHY REVIEW OF KUNINGAN AREA IN RELATION TO THE PETROLEUM POTENTIAL

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ABSTRACT

The West Java area is part of back arc basin comprising a number of North-South oriented half graben and sub-basin situated at the southernmost edge of the Sunda Platform. The area chosen for this study is called as Kuningan Area, located at the Bogor Trough, which has a complete sequence of rifting events. However, limited wells are available; therefore, a basin fill history could not be identified.

It is predicted that this area has a hydrocarbon potential. Play concepts in the Northwest Java Basin, especially focused on syn-rift and post-rift sediments, whilst in the past they concentrated on carbonate build-ups on structural highs and the Jatibarang volcanics.

In the offshore of NW Java Basin, to the north of this area, the proven oil and gas province are scattered in the several sub-basins such as Northwest Java Basin and Arjuna Basin. A number of different plays as shown in structural cross section in W-NE direction of the West Java Basin show the presence of extensive block faulting in the basement forming graben-like structures. The deposition of carbonate build-up is clearly indicated as Baturaja Formation in the lower part and Parigi Formation in the upper part. It is hoped that this configuration extends to the Kuningan Area which is mostly covered by thick Quaternary volcanic rocks.

Key words*: hydrocarbon potential, Northwest Java Basin..*

INTRODUCTION

General Interset of Petroleum Potential of Kuningan Area

The Kuningan Area is envisaged as part of the Northwest Java Basin (eastern part of Bogor Zone) which represents the southern flanking slope of the Basin (Fig. 1). The Kuningan area is part of Tertiary back-arc basin of Java, and it is mostly covered by volcanic products of Quaternary age, however outcrops exposed amongst these volcanic products indicates that the area is basically underlain by Tertiary sedimentary rocks. Gravity data also indicated the value of Bouger anomaly reaches -25 mGals and is interpreted as deep sedimentary basin up to 3 Km (Fig. 2). Based on those studies, it is believed that the Kuningan area has good potential of the petroleum prospectivity.

Exploration activities in the surrounding Kuningan Area are very intensive, such as in the associated graben systems of onshore West Java. To the east and southeast of the area, some exploration wells have been drilled by several operators to test hydrocarbon potential in the area, e.g. Lundin Banyumas and PERTAMINA that holds a concession in most of the onshore West and Central Java.

More recently in the Citarum Block to the west, at the time beings, Ranhill Oil Company (BPREC) is doing drilling activity in the Jonggol Area, and the conclusive result is in progress after several drilling problems, however there are reported minor gas shows. The intensive exploration in the surrounding Pertamina's Area to the south through detail study upon reconstruction the basin development of the area, will encourage the area to be taken as new exploration area.

Stratigraphic development indicates every stratigraphic unit play a significant role in build-up the petroleum systems of the Kuningan area as proved in the NW Java Basin (located to the north of Kuningan Area) (Figure 2); however the development of every unit is very influenced by tectonic development of the basin as a whole. From this point of views, the petroleum prospectivity of the Kuningan Area is remaining showing possibility for petroleum prospects.

Exploration History

The first exploration wells in Indonesia were drilled by an entrepreneur Jan Reerink, near Madja Jan Reerink in 1871 made the first drillings for oil in the East Indies (Fig 3). The oilseeps are connected with 5 m thick lenses of ash tuff between dark marly clay shales. The local population still collects some oil from the seeps. This first attempt for exploitation of the mineral oil by drilling failed due to the unfavorable facies and the complicated structure.

Jan Reerink is a son of a rice huller, Reerink kept a 'toko' or general store in Cirebon, on the north coast of Java. However he had a dream of finding petroleum in the Madja area, south of Cirebon. After obtaining the backing of 'Nederlandsche Handel Maatschappij' he visited the United States and Canada where he collected personnel and drilling equipment. He then returned to Cirebon where he began drilling at the Cibodas location in December 1871.

He used a 'Pennsylvania' style rig, with a rope to run the drill bit. No casing was available, so total depth was 125 feet only. Power was supplied by that cheapest of generators-water buffaloes. He drilled three more wells at Cibodas, and found sub-commercial oil in two of them. Reerink returned to North America and purchased steam equipment to replace the buffalos. In 1874 he began his second drilling campaign with two steam-drilled wells at Cibodas, and three more at Panais, Madja and Cipinang, which unfortunately were all unsuccessful.

Between 1870 and 1876 the Nederlandsche Handel Maatschappij spent Fl. 225,000 and Reesink himself Fl. 50,000. As many 'wildccatters' after him, Reerink wanted to continue but the company would not spend any more money. On July 31, 1876 Reerink returned to his store, his dream shattered, but he must be remembered as the first true explorationist in Indonesia, with his 'seed money from Nederlandsche Handel Maatschappij, the predecessor of Royal Dutch Shell.

The second phase of exploration in West Java began about 1910 in the Northwest Java basin. So far this deep basin has only been explored in its northern, shallower parts. It has yielded nine fields with a cumulative production of nearly 80 million barrels of oil. No significant results were achieved during early campaigns, until 1931, when the BPM began a large-scale shallow stratigraphic drilling program, employing the counterflush coring method. Several shows provided the impetus for a deep rotary drilling program during 1938 to 1942. It was during this phase that the first commercial oilfield was discovered, at Randegan in 1939. Oil was also found at Rengasdengklok, perhaps earlier, but this was not commercial.

Following World War II and the post-war turmoil, exploration was finally resumed in 1967 by PERTAMINA. The first well, Djatibarang-44, discovered a major field in a very unusual reservoir, the Jatibarang Volcanics, a complex mixture of tuffs, basalts, andesites and volcaniclastics which are difficult to interpret on logs. Fractured tuffaceous sands provide the principal reservoir, dated as Eocene-Oligocene.

Although the Jatibarang field has produced 72 million barrels of the onshore West Java total cumulative production of around 80 million barrels of oil, eight smaller accumulations have been discovered. Reservoirs in the smaller fields consist largely of porous carbonate buildups of the Cibulakan. Oil generation is postulated to have been from the Lower Cibulakan Formation Talang Akar lacustrine shales and coals.

METHOD AND DATA

The first component of the assessment process involved analysis of the published geologic and geophysical data to identify areas of hydrocarbon potential and to ascertain the areal and stratigraphic extent of potential petroleum source rocks, reservoir rocks, and traps within these areas.

Published and proprietary reports and information were compiled to better understand the depositional and tectonic history of each province and assessment area, to identify the areas of hydrocarbon potential, and to better establish the petroleum geologic framework on which the plays would be defined.

The scope of this study of Petroleum Potential of Kuningan Area ranged from studies of the regional geology and tectonics of an area to detailed existing exploration history. Potential petroleum generative sources were identified through the use of published and proprietary geochemical studies and proprietary data from exploratory and development drilling. Hydrocarbon indications from exploratory and production wells were used along with analyses of well data to identify potential petroleum source rocks and to estimate source-rock properties.

Potential hydrocarbon reservoirs and possible migration pathways from source to reservoir were identified primarily through the use of published exploratory well data and interpretations of seismic-reflection profiles. Reservoir-rock properties and the presence of trapping mechanisms were appraised by using information from published well-log/report analysis and from analogous stratigraphic units in producing areas.

Identification of potential areas was based primarily on existing interpretation and subsurface mapping of proprietary seismic-reflection data. Where feasible and appropriate, the interpretations were modified to incorporate new data and ideas. In the case of Kuningan areas, interpretations were based on published sparse seismic-reflection data, and although those interpretations could be used to identify depositional and structural trends, they could not be used to identify individual prospects, just to give an over view of possible presence of hydrocarbon in the Kuningan areas.

Regional Geology

Physiographically, West Java can be divided into four major blocks (van-Bemmelen 1949);

- Coastal Plain of Batavia (Dataran Pantai Jakarta)
- Bogor Zone (Zona Bogor)
- Bandung Zone (Zona Bandung)
- Southern Mountain Zone (Zona Pegunungan Selatan)

The study area is mainly situated in the Bandung Zone, and some parts in Bogor Zone and Quaternary Volcanics. Van-Bemmelen (1949) suggested that Bandung Zone is an inter-montane depressions extending in elongate shape from Pelabuhan Ratu in the west through Cimandiri Valley and ends in Segara Anakan to the east with 20 - 40 km width. He also considered that Bandung Zone was centre of West Java Geantiklin which latter on collapse due to the uplifting and filled by young volcanic products of Quaternary age. The products are mainly andesitic to basaltic volcanic rocks. In the north of study area, the main Quaternary volcanoes which are part of the Bandung Zone from west to east are; G. Gede, G. Pangrango, G. Tangkuban Perahu, G. Beser, and G. Cakra Buana.

Tectonic Setting

The Indonesian archipelago was formed as a result of the interaction of the three major plates; the Indo-Australian Plate, Eurasian Plate, and Pacific Plate. The Indo-Australian Plate subductes beneath the southern margin of the Eurasian Plate since the Early Cretaceous. In the Neogene the interaction of those three major Plates formed the Sunda-Banda Arc extending from Sumatra, Java and Lesser Sunda Islands. However, the subduction-related magmatism along the Sunda-Banda Arc has been active at least since the Eocene.

There are two major periods of magmatism recorded in this arc; the Late Eocene - Early Miocene and the Late Miocene - Pliocene or even to Quaternary. The Early volcanic activity produced what is called in the literature as "old andesite" exposed extensively along south coast of Sumatra to Java Islands. This old andesite corresponds to what is called as Jampang Formation in the Bogor Basin Province in West Java by Martodjojo (1984). The second magmatism activity produced a series of volcanic and pyroclastic rocks of medium to high K calc-alcalic composition and formed a belt known as Bandung Zone where young volcanoes are widespread as presence in the north of survey area.

K-Ar age determinations combine together with the results from petrographical and geochemical analysis (Sunardi, 1997) allow clarifying the detail differentiation of the volcanic rocks specially to identify the tectonic setting of ancient volcanic sequences. This is done with the correlation of particular geochemical characteristics of modern volcanic rocks with their specific tectonic setting (Wilson, M.,1994). It seems that there exist the temporal chemical variation of the volcanic rocks in the Bandung area, which could be classified into three different volcanic activity, the Pliocene (4.1 Ma to 2.8 Ma), Early Pleistocene (1.1 Ma to 0.21 Ma) and Late Pleistocene (0.16 Ma to 0.039 Ma) volcanic activities. Instead of these three stages of volcanic activity, it can be also stated that the Upper Pliocene (1.73 Ma) occurred in the Southern volcanic range of Bandung area, which is represent by Cicadas (CDS) locality (Sunardi, 1997).

The notion of three volcanic activities is confirmed on the basis of the present data.

Though the first activity (Pliocene volcanics) may have started much later than the oldest age found in the frame of present study (Bellon *et.al.* (1989). Since the Early Pleistocene and Late Pleistocene volcanic activities are different by means of geochemical characteristics, instead of the results on the determination of radiometric ages, a chronological classification will be adopted elsewhere for chronostratigraphical classification in the Bandung area. Correlation between changes in chemistry with time seems likely to be present in analytical data. Hereafter, we apply classification of the rocks following the K-Ar ages. These are the Pliocene Volcanics including one sample of ~1.7 Ma the Old Quaternary Volcanics, the Early Pleistocene Volcanics and the Middle to Upper Pleistocene Volcanics.

One of the tectonic phenomena resulted from the plate interaction is the Cretaceous subduction extending from Java to the Java Sea and finally up to the Southeast Kalimantan. This Cretaceous subduction is the most tectonic feature believed in most geologist work in Indonesian Region (Hamilton 1979, Katili 1981). This line (cretaceous subduction) is the basis in dividing the Java and Java Sea into two major provinces, they area West and East Java (Martodjojo 2003).

The major structural element in West Java is in NW-SE direction as constrained from geological and geophysical data. Suwijanto (1978) interpreted the major NW-SE structural alignments in West Java based on Citra Landsat. Whereas gravity data in West Java also show the major NW-SE contour lineaments in the subsurface (Figure 2). Those results are in agreement with the structural patterns derived from

Landsat imagery interpretation in the survey area and also from field of observation.

Martojojo (1984) divided West Java into several tectonic provinces based on the sedimentation characteristics as follows; Northern Basinal Area, Bogor Trough, Southern Slope Regional Uplift and Banten Block. Banten Block is the most western part of the Java Island and lies close to Sumatra. Further division by Martodjojo (2003) divided the Banten Block into Seribu Carbonate Platform in the north, Rangkas Bitung sedimentary sub basin, and bayah High in the south and to the west there are low and high called Ujung Kulon and Honje High as well as Ujung Kulon and West Malingping Low. Several highs and lows characterize the Banten Province bounded by N-S to NW-SE growth faults. Bayah and Honje High constitute Tertiary structural Highs comprising mainly of volcanoclastics of Miocene age, and the Honje High is interpreted to form in response to the movement along the Sumatra strike-slip faults forming graben systems in N-S direction as seen in Sunda Strait. Whereas, the Bayah High lying to the south of Rangkas area comprises large anticline trending in E-W direction.

Regarding to global tectonic activity in Java, there are three structural trends, they are Meratus (trending in NE-SW direction), Sunda (trending in N-S direction) and, Java (trending in E-W direction) trends (Pulunggono dan Martodjojo, 1986). From this point of view, the Kuningan area shows the Sunda and Java trends. Sunda trend indicated by several strike slips that trends N-S, where Java trend regards to the development of thrust faults and folds with E-W trends.

These N-S trend major faults was first founded at the Sunda Basin by seismic study in western part of West Java offshore, further study shows that these faults can be traced to the most north of West Java (Todd dan Pulunggono, 1971), and it is believed that this structure are known as deepseated faults of old structure.

Sunda trend in N-S direction was formed in Paleogen (Eocene-Late Oligocene, 53-32 ma). Extensional pattern of the fault movement can be correlated with the Eocene-Oligocene rifting along old basement breaks of N-NNE strike process for Sumatra specifically for the Central Sumatera basin (Heidrick & Karsani, 1993) it seems that these trends continue to develop in the west and north part of Java represented by faults that separates the Sunda and Arjuna basin.

Deep-seated N-S trend controls the Paleogene basin formation in Java (basin forming tectonics). The onset of sedimentation after Paleogene basin forming was characterized by terrestrial to shallow marine sediments represented by Bayah or Walat Formation. Outcrops of this formation is not exposed in the study area, but exposed about 50 km to the south part of the study area.

Gravity data of Bouger Anomaly of the Java Island Block show that the Kuningan Area has NW-SE orientations, and also show the presence of low gravity values reaching 0 mGals. Whereas Residual Gravity shows the area has low anomaly up to -25 mGals. This residual clearly indicated the presence of low areas amongst high areas or can be interpreted as basin pods. Model of density contrast of 0.25, 0.15, 0 and – 0.15 made up to 3 Km depth also supports the presence of this sedimentary pods.

From those gravity data, it can be interpreted that the Kuningan Aea as block faulting areas with highs and lows in which the lows reach 3 Km and has the potential of the presence of petroleum systems. Geological cross section also supports this interpretation where the model shows the presence of thick sedimentary basin cross the Kuningan Area (Fig. 4).

Stratigraphy

Martodjojo (1984) divided West Java into three major sedimentary provinces on the basis of sedimentary characteristics during Tertiary, as follows;

- Continental Shelf Province (Mandala Paparan Kontinen)
- Bogor Basin Province (Mandala Cekungan Bogor)
- Banten Province (Mandala Banten)

The study area is part of Bogor sedimentary Province. This sedimentary province is characterized by gravitational flow sediments containing fragments mostly of igneous rocks and sediments such as andesites, basalts, tuffs, and limestones. The study area is mostly built by young and old volcanic products and is interpreted to overlie the igneous and sedimentary units below.

Pannekoek 1946 (quoted from Martodjojo 1984) underlined the important of two morphological generations; those are Pre-Late Miocene morphology and Resent morphology. The boundary between these two morphology generations is an unconformity. The first consists of Jampang and Saguling formations, whilst the latter consists of Beser and Bentang formations (Martodjojo 1984).

The stratigraphy of the area as infer from Regional geological map of the Garut and Pameungpeuk Quadrangle, Jawa (Alzwar et al. 1992) consists of undifferentiated old volcanics (QTv), Tuffaceous breccia (Tpv) and Young volcanics (Qyc and Qyp), and several sedimentary and carbonate rocks of Oligocene to Pliocene.

Local Stratigraphy

The oldest rock exposed in Kuningan Area is of Oligocene in age, it is occurred as clastic and carbonate rocks, which is represents a syn-rift and block faulted tectonics during Paleogene. The structure of the sedimentary rocks is NE-SW to N-S directions, which is placed in an oblique position to the present E-W stretching arc system. Eocene volcanic rocks are found in the subsurface of North West Java Basin. It inclines to the south and strikes NE-SW directions. Clastic sediments were deposited during the Eocene in the North West Java Basin. During the Oligo-Miocene an offshelf carbonate platform was developed in the southern mountain area. During the Early Miocene, a volcanic activity occurred in the present day southern mountain area. This was interpreted from the existence of a thick pile consisting of alternation of volcano-sedimentary rocks in the area (Jampang Formation, formerly also known as the Old Andesite Formation (van Bemmelen, 1948). In the North West Java basin, a back-arc basin was developed in this age, which was filled up by turbidite and debris flows from the volcanoes in the southern area. To the north, the volcaniclastic sediments grade into normal shelf sediments (the present-day NW Java petroleum basin).

During Middle to Late Miocene axis of the volcanically active arc migrated toward the north. In contrast, a carbonate offshelf platform is thought to have been developed. The carbonaceous rock unconformably overlies the older volcanic rocks.

Stratigraphy of the study area is based on regional mapping. It consists dominantly of intrusive and extrusive rocks of young and old volcanic products, and also approximately 15% of Tertiary sedimentary rocks from Oligocene to Pliocene. In the literature, this old volcanic products is called as un-differentiated old volcanics. The difference between those two products is difficult to be judged in the field but from the position to the

Young Volcanoes. The young volcanic products normally lie in the foot (lower part) of Young Volcanoes; whilst the old volcanic products are normally lie to the south of it. However, literature study indicates that on the top of high topography normally is occupied by tuff or andesitic intrusion which is interpreted to be young volcanic products.

Further observation suggest that the so called undifferentiated old volcanics as inferred from regional map can still be divided into old volcanic products and Jampang Formation. This separation is based on the degree of alteration and mineralization in the rocks in addition to the rock deformation. The Jampang Formation is recognised by more intense in alteration and mineralization and rock deformation forming fractures and faults but the boundary between them is very blurred and cannot be judged clearly.

The young volcanic rocks are composed of andesitic to volcanic breccia and tuff. Tuffs are normally occurred at the top of the mountains forming steep topography. This is interpreted to be the products of young volcanoes of Quaternary age. The rocks are hardly altered.

The rock composition of the old volcanic rocks of Old Quaternary and probably Middle Miocene are nearly the same with those of young volcanic products except lithologically it is more compact and hard, and also in some location the andesite rocks were altered into argillic, prophilitic and silicification phases.

From the mineralisation point of view the old volcanic have hardly mineralization both in quartz veins or altered zone whereas the Jampang Formation show mineralization. The mineralization associated with quartz veins become the indication of Jampang Formation of Middle Miocene volcanic products. This can be seen in Western Block where quartz veins associated with sulphide minerals ranging from few centimeters to twenty centimeters occurred.

Petroleun System

a. Source Rock

In North West Java Basin, there are three (3) primary source rock types such as lacustrine shales (mainly oil-prone), fluvio-deltaic coals and shales (oil and gas prone and marine claystoneslbacterial gas). Many authors stated that the Talang Akar Formation have the best source rock potential in the North West Java Basin. Gordon (1985) reported that the coal and carbonaceous shales of the Talang Akar Formation to be an excellent source rocks for hydrocarbons generated within the offshore sub-basin area. It was indicated that the hydrocarbons derivation from terrestrial plant material. The other possibility of the hydrocarbon source rock is syn-rift lacustrine black shales sediments of the Jatibarang Formation (Jatibarang and Tugu Barat Fields). Oil and gas have produced commercially from fractured volcanoclastics in the Jatibarang Field. There is evident that some of oil is sourced from lacustrine.

b. Reservoir

Several reservoirs have produced oil and gas in the North Java Basin. The Jatibarang Formation is one of the reservoir units that oil and gas come from fractured vulcanoclastics. The other reservoir is extensively the Baturaja Formation developed across the North West Java and South Sumatra Basins.

This unit contains of shelf limestones, coral reefs and bank complex and have well to excellent hydrocarbon potential. Leaching of fresh water formed porosities and permeability. The Upper Cibulakan clastic is an important reservoir too, which forms the main oil in the Massive and Main sandstones. This member is a prolific reservoir with excellent hydrocarbon potential, which is found in sufficient thickness. The porosity of this reservoir is approximately 30% with the permeability up to 500 mD. The Parigi carbonates build-ups are another reservoir with good porosities within the North West Java Basin.

This reservoir is typically very porous and often contains large amounts of gas. The Parigi Formation has the best reefal build-ups and porosity development of all Tertiary carbonates. The Upper Parigi is a widespread platform/bioherm unit, which varies in thickness up to 150 m in offshore and 500 m in onshore. The reservoir development in Parigi carbonates arises through the presence of vugular, moldic and intergranular porosity distributed through the carbonates section.

c. Seal

Sealing intervals in the North West Java Basin are the Upper Talang Akar shales, Middle Baturaja shales, Middle Miocene mudstones of the Upper Cibulakan Formation, and Cisubuh shales.

d. Migration Pathway

The pathways for hydrocarbon migration may occur laterally andlor vertically out of the source rock. Lateral migration takes place within strata units with good horizontal permeability. Vertical migration occurs when the migration direction is perpendicular to bedding. Lateral migration pathways are typically established in beds that continuity of permeable units. In the North West Java, the major conduits for lateral migration are predominantly north south oriented of the Talang Akar Formation. Vertical migration is very prevalent in this region, with most areas showing propensity for multiple stacked reservoirs. Faults provide the main conduits for vertical migration with rapid transport of fluids coinciding with periods of active tectonics and fault movement.

e. Trap Styles

Structural styles and trapping mechanisms are similar in all of the North West Java Basin. The main structural features are anticlinal domes and tilted fault block traps. Due to the large amount of sands and coarse clastics in the reservoir sections,fault traps often establish cross-fault sealing relationships. Stratigraphic traps have been found where sands unit on-lap and drape basement highs. These traps have typically been restricted to the Talang Akar interval, although stratigraphic pinch-outs of other reservoir units are likely. The carbonate build-ups within the Baturaja, the Mid-Main Upper Cibulakan, and the Parigi Carbonates also provide good traps.

RESUME AND DISCUSSION

Northwest Java Petroleum Prospect & Play

The North West Java Basin consists of several plays (Suyono et.al, 2005); they are Jatibarang Play, Baturaja Play, Upper Cibulakan Play, and Parigi Play (Figure 5). The Jatibarang Play comprises of volcanoclastic flows .and tuffs. Oil - and gas are produced from its fractured, with structure is an E-W trending anticline and cut by N-S trending normal faults. The Baturaja Play is represented by carbonates platform/reef complex, which developed over palaeohighs. This build-up is a type of trap for oil and gas and combined with drape over basement highs. The main reservoirs consist of coral algal reef with secondary porosity is formed by leaching of water. The other Upper Cibulakan Play consists of sandstones sourced from the north and deposited as sand ridges in shelf environment with faulted anticlines and pinch-out of sand bodies. The sand reservoirs are the primary producing horizons. The Parigi Play is widespread platform bioherm unit and known to contain large quantities of gas and offer the best opportunity for new reserves at reasonable cost. The Parigi build-ups are well developed in both onshore and offshore areas. The reservoir developed rise through vugular, moldic and intergranular porosity that distributed throughout the carbonates interval.

CONCLUSIONS

1. The Kuningan Area is part of Bogor Trough which is part of Tertiary back-arc basin experiencing block faulting during Paleogene.
2. The Kuningan Area is mostly covered by Quaternary volcanic rocks, but underneath is approximately 3 km thick sedimentary rocks of Eocene up to Pliocene.
3. Gravity data also support the presence of thick sedimentary units in the Kuningan Area.
4. Based on this study it is predicted that the Kuningan Area has an encouraging potential petroleum system for hydrocarbon prospectivity potential.
5. More geological and geophysical data have to be conducted to understand basin evolution and petroleum systems as well as play concepts.

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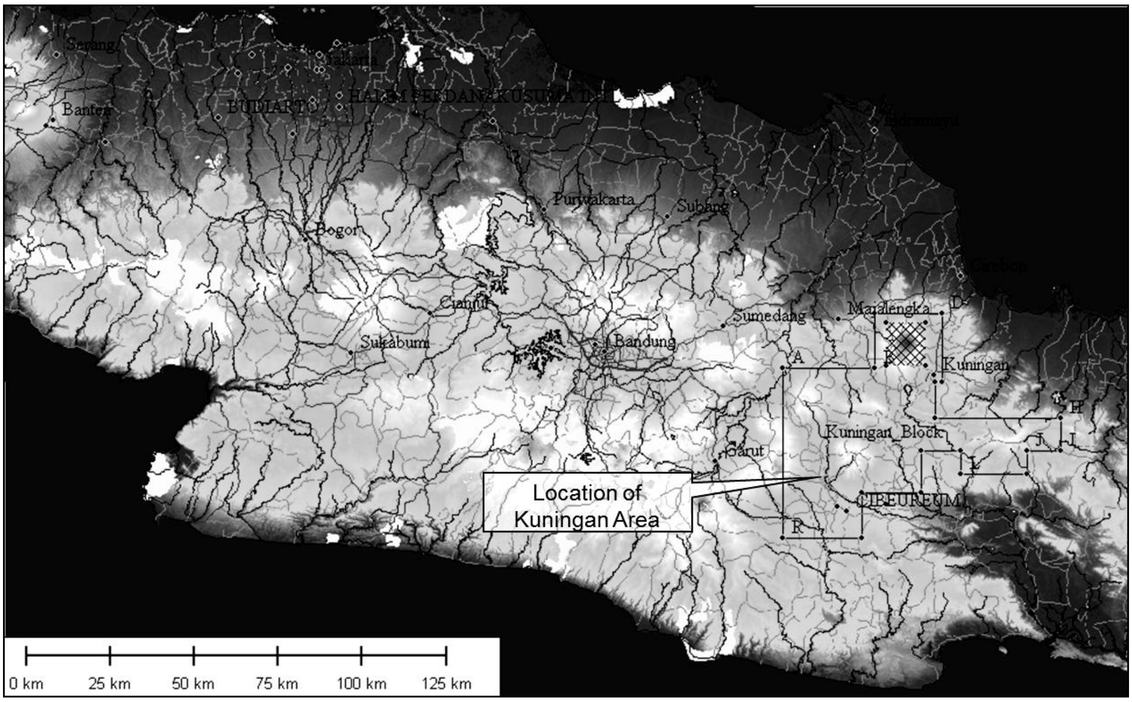

Figure 1. The KuninganArea is located approximately 183 km SE of Jakarta and 13 km south of Cirebon, at the most eastern part of West Java Province

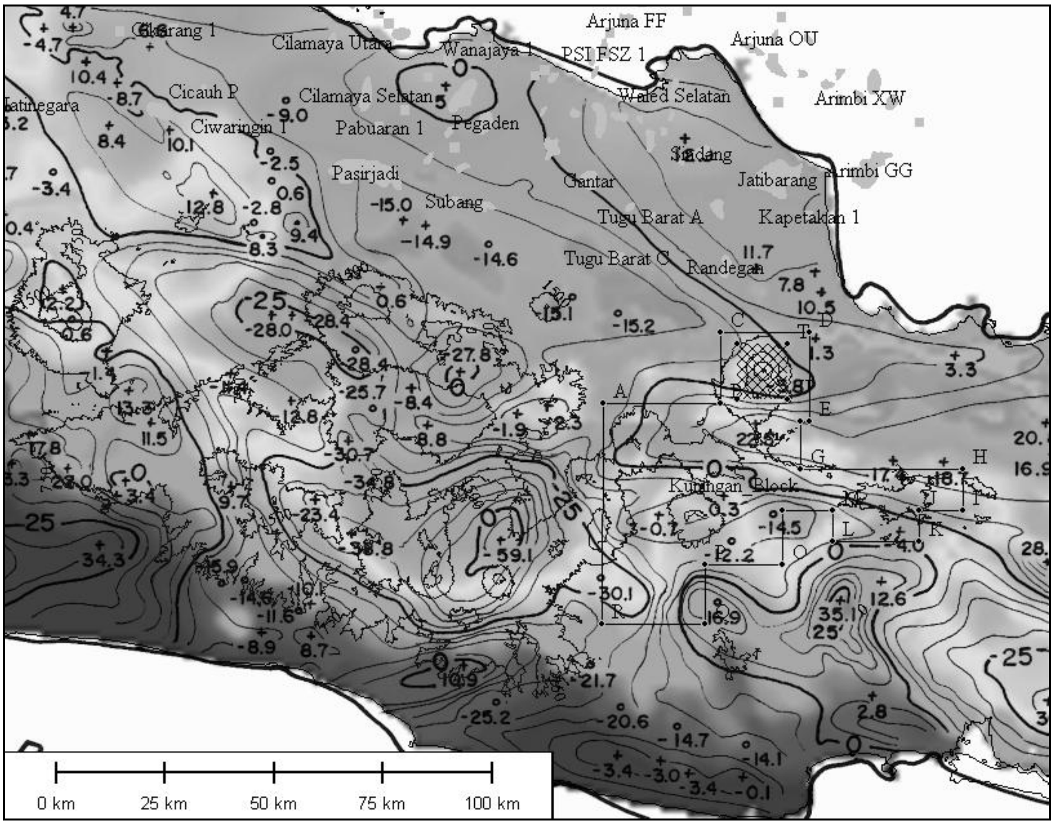

Figure 2. Producing basin to the north, marked by the presence of many fields. 750 m contour lines overlay on 2'nd degree residual gravity and colored Boguer anomaly background

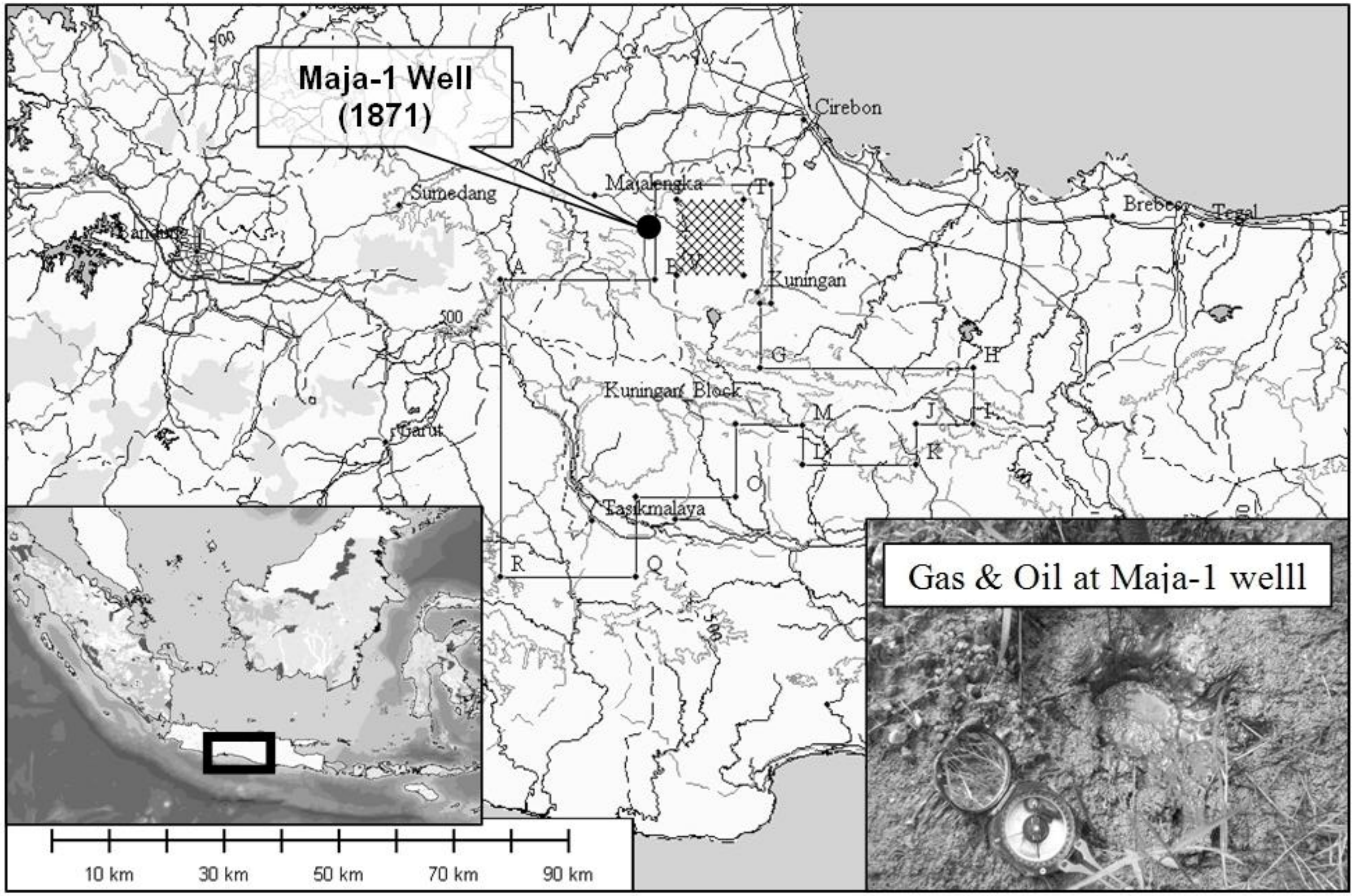

Figure 3. Jan Reerink, near Madja in 1871 made the first drillings for oil in the East Indies. The oilseeps are connected with 5 m thick lenses of ash tuff between dark marly clay shales. The local population still collects some oil from the seeps.

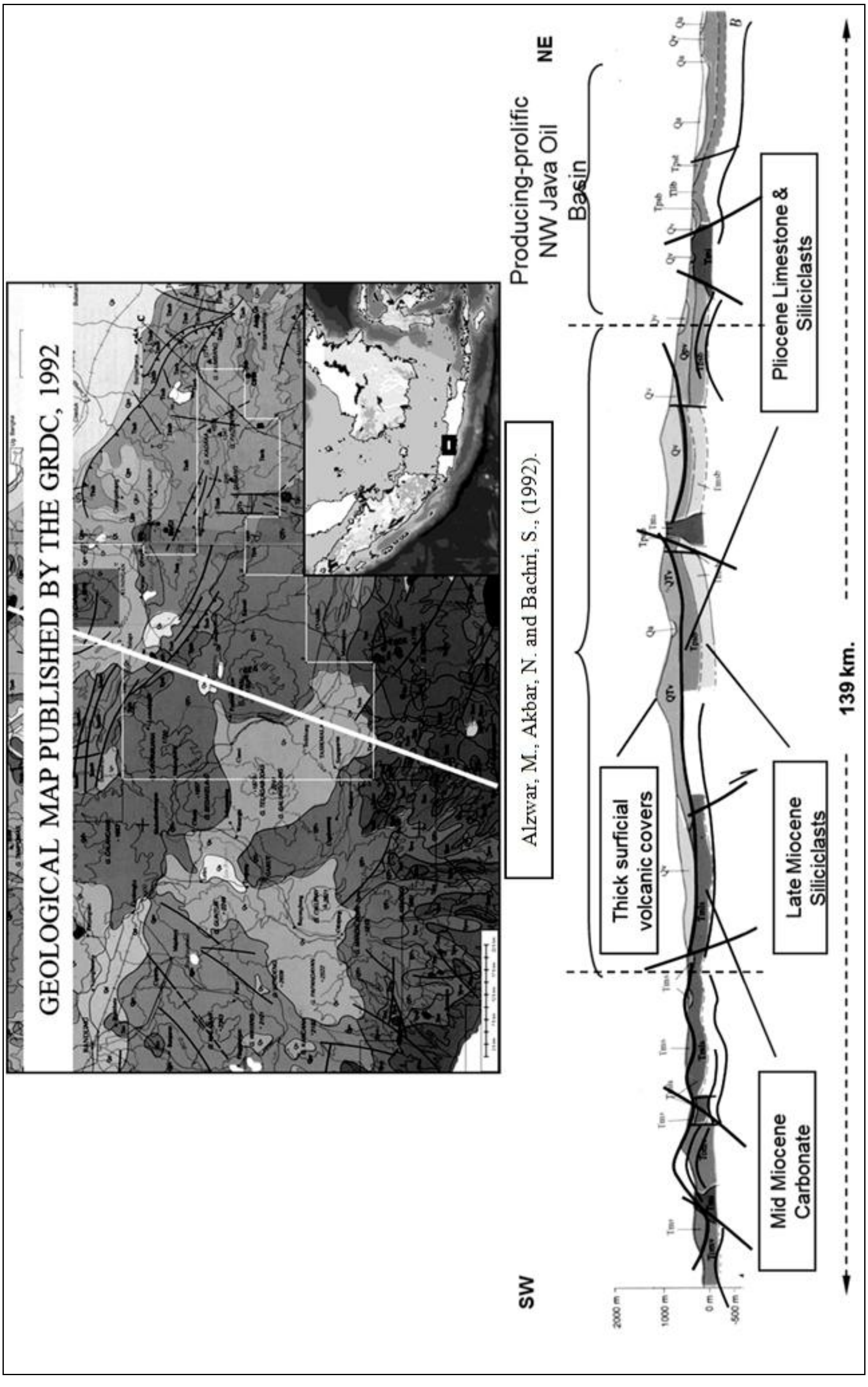

Figure 4. Geologic Cross Section across the Kuningan Area

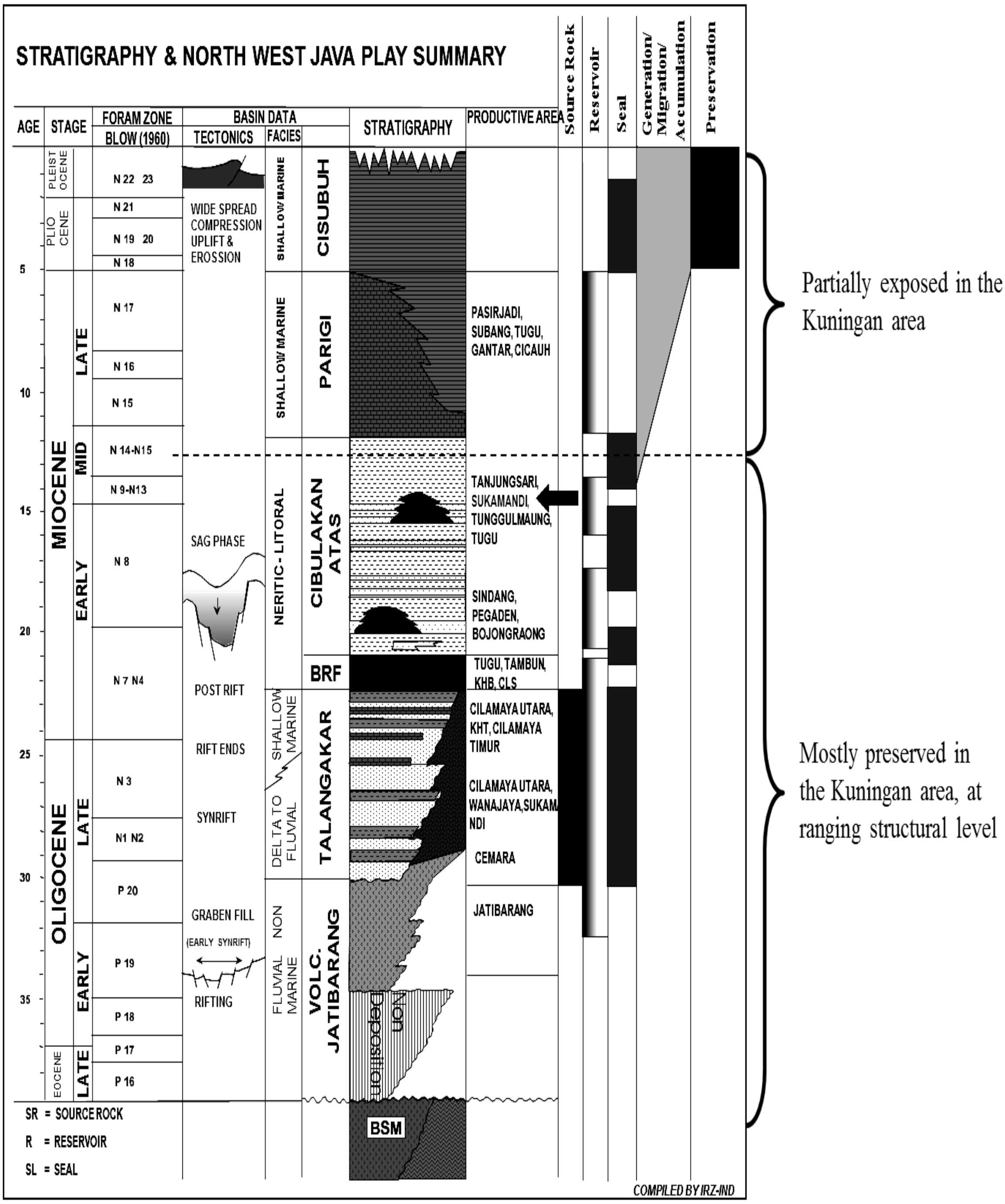

Figure 5. Generalized stratigraphy of Northwest Java Basin
(Suyono et.al, 2005)