East Java Basin Carbonate Reservoirs: Time Control on Reservoir Character

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ABSTRACT

The East Java Basin is a prolific back-arc basin in Indonesia, and it hosts significant hydrocarbon accumulations within Cenozoic carbonate reservoirs. This study explores the link between carbonate age, fossil assemblages, and reservoir characteristics. The oldest reservoir, the Ngimbang Formation, is dominated by large foraminifera and interbedded shales, exhibiting limited vertical growth potential. Conversely, the Oligo-Miocene Kujung Formation, rich in coral reefs, boasts the basin's highest hydrocarbon content. Pliocene Globigerina sands offer excellent reservoir quality due to both inter- and intra-granular porosity, but their distribution is restricted. This work analyses the variations in reservoir properties (porosity and permeability) that are influenced by the distinct fossil assemblages across the formations. Additionally, comparisons of formation geometries and their impact on hydrocarbon trapping are addressed. By understanding these factors, the paper explores the potential for identifying hidden reservoirs within the basin for future exploration.

Keywords: *East Java Basin, Ngimbang, Kujung, Mundu*

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INTRODUCTION

The East Java Basin (EJB), also known as the Northeast Java Basin, occupies the southeastern margin of Sundaland, Indonesia (Figure 1). It encompasses onshore areas of East Java and Madura Island, extending offshore into the East Java Sea. The western boundary is defined by the Karimun Java Arc, while the eastern limit stretches to the Kangean Islands, with a total east-west extent of approximately 250 km. Water depths within the basin exhibit significant variability. Nearshore areas are generally shallow and flat, while the eastern offshore regions can reach 1 km water depth.

Cenozoic sediments fill the basin, thicker in the south (>2 Sec TWT or about 6 km, Figure 2) and thinning northward. The northern part of the basin comprises a complex NE–SW trending troughs, separated by ridges and arches (Figure 1; Nawawi et al., 1996; Darman and Yuliong, 2020; Lunt, 2013). The southern part is dominated by E-W lineaments. The two systems are primarily separated by the RMKS (Rembang-Madura-Kangean-Sakala) strike-slip fault system (Satyana et al., 2004; Doust and Noble, 2008).

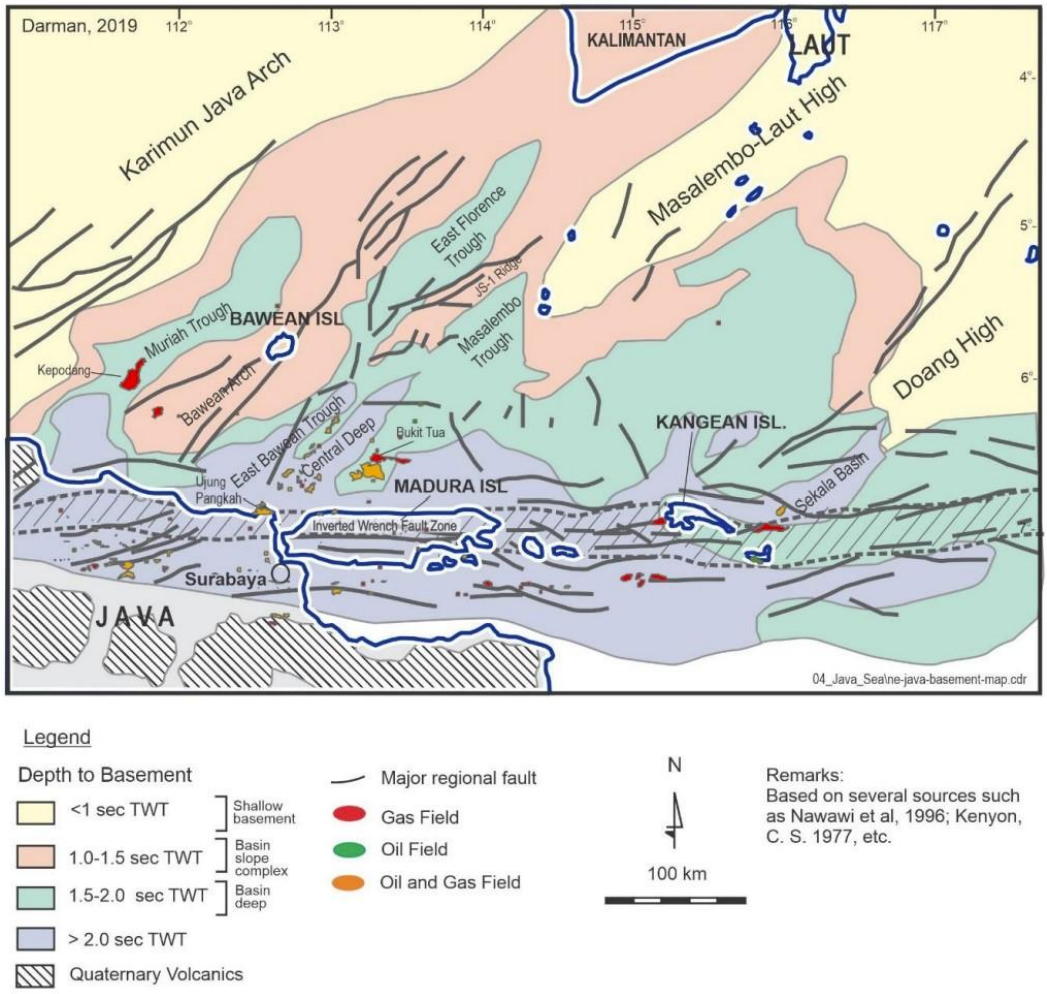


Figure 1: *Regional map of NE Java Basin (after Darman & Yuliong, 2020) showing the structural trend and the depocenters of the basin. The southern part of the basin is bounded by Quaternary Volcanics. The section on Figure 2 is shown by A-A' dash line.*

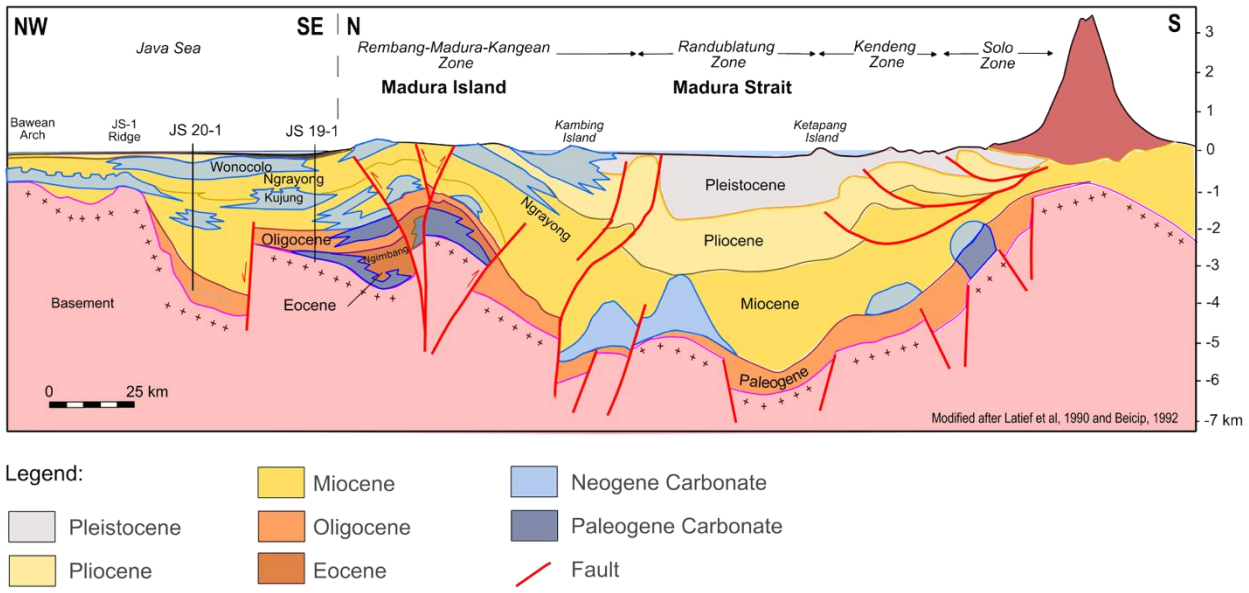


Figure 2: *Regional cross section of the East Java Basin, from onshore with Quaternary volcano in the south to the Bawean Arch in the northwest (modified after Latief et al., 1990 and Beicip, 1985). See Figure 1 for location map. The thickest sediments were accumulated in Madura Strait.*

Oil and gas production from the basin commenced in late 1800s and the exploration is active until now. Most hydrocarbons in the area are found in Cenozoic carbonate reservoirs. These carbonate intervals, composed primarily of fossil assemblages, exhibit dissimilarities and variations across different geologic ages. Fossil composition, especially coral components, crucially shapes reservoir geometry and increase hydrocarbon potential, occurring in specific ages (Markello, 2007; Leprieru et al., 2021). Corals, which are invertebrates, typically form compact colonies and grew well in the area. Similarly, the 'globigerinid sands', which is an excellent reservoir type, only occur in the younger interval. Globigerina sand is a type of sediment composed mainly of the calcareous shells of foraminifera, particularly the genus Globigerina.

This study was part of the Indonesia's 'ministerial decree project,' aimed to enhance exploration efforts, leveraging MDR (Migas Data Repository) and contributions from operators like Pertamina. The project was conducted in 2023, with an objective to understand the hydrocarbon potential of carbonates in the East Java Basin across different geological ages.

Regional Geological Setting

The East Java Basin formed during early Cenozoic era. Pre-Cenozoic metamorphic and volcanic rocks defined the basin's basement. Back-arc extension in the Paleocene epoch created northeast-trending ridges and troughs. An early syn-rift system with half-graben features developed during the early Paleogene (Figure 2). Early to Middle Eocene sediments filled depressions, overlain the Mesozoic basement. A carbonate platform developed in the basin's western part during the Late Eocene, and some of them directly overlying the basement.

A late Oligocene unconformity (Figure 3) separates the Ngimbang Cycle from the overlying Oligo-Miocene Kujung Cycle. This shift marked an initial regression followed by a major transgression, facilitating further carbonate buildup. The Kujung Cycle is overlain by a clastic-dominated Ngrayong Cycle. Quartz-rich sandstones were commonly deposited in the East Java Basin during the Late to Middle Miocene (Khaing et al., 2017). Deep marine sands of the Ngrayong Cycle were also deposited in the Tuban area (Ardhana et al., 1993).

The tectonic setting remained relatively stable from the Late Miocene through Pliocene and Pleistocene. However, things became more complex approaching the eastern Indonesian Timor region, where a true continental collision eventually occurred. In the middle Pliocene, another major structural event impacted the Rembang area. The southern region underwent significant uplift with minimal erosion, primarily along a narrow east-west trend that later formed the Kendeng Zone. This event also resulted in numerous folds developing in the basin's northwestern corner.

DATA AND ANALYSIS

This regional study was conducted as part of an Energy and Mineral Resources ministerial decree project in 2023. The objective of the project is to accelerate and optimize exploration effort in West Indonesia. The project was started by integrating a comprehensive dataset. The primary data source of this exercise is the KKPJM (Komitmen Kerja Pasti PHE Jambi Merang) project, which is the regional study conducted by Pertamina using their financial commitment in Jambi Merang PSC. KKPJM project includes seismic data (2D and 3D), well data (exploration and production), and lead & prospect information.

The seismic data covers onshore and offshore areas of the East Java Basin (EJB), acquired between 1967 to 2019. The 2D data quality varies from fair to good, while the 3D data acquired in the last decade is of good quality. Notably, recent high-resolution 3D seismic acquired in 2020 provide excellent vertical resolution for interpreting thin layers and stratigraphy, significantly surpassing the capabilities of pre-1990 2D seismic data.

The study also benefits from a vast repository of 581 well data, obtained from Pusdatin (MDR) and supplemented by information from S&P (formerly called IHS), eSDC SKK Migas, and various publications. Additionally, reference materials from BEICIP (1985), Robertson Research, and other relevant sources strengthen the analysis.

PETROLEUM SYSTEM AND HYDROCARBON ACCUMULATION

Five petroleum systems have been recognized in the East Java Basin. Their elements have been discussed by many authors (e.g., Howes and Tisnawijaya, 1995; BPPKA, 1999; Satyana and Purwaningsih, 2002, 2003; Doust and Noble, 2008; Koesoemadinata, 2020). These petroleum systems and their associated hydrocarbon accumulation pools are illustrated in Figure 3.

The map in Figure 4 shows the distribution and magnitudes of the oil and gas fields in East Java Basin. Figure 5 shows the creaming curve of each carbonate play in the East Java Basin.

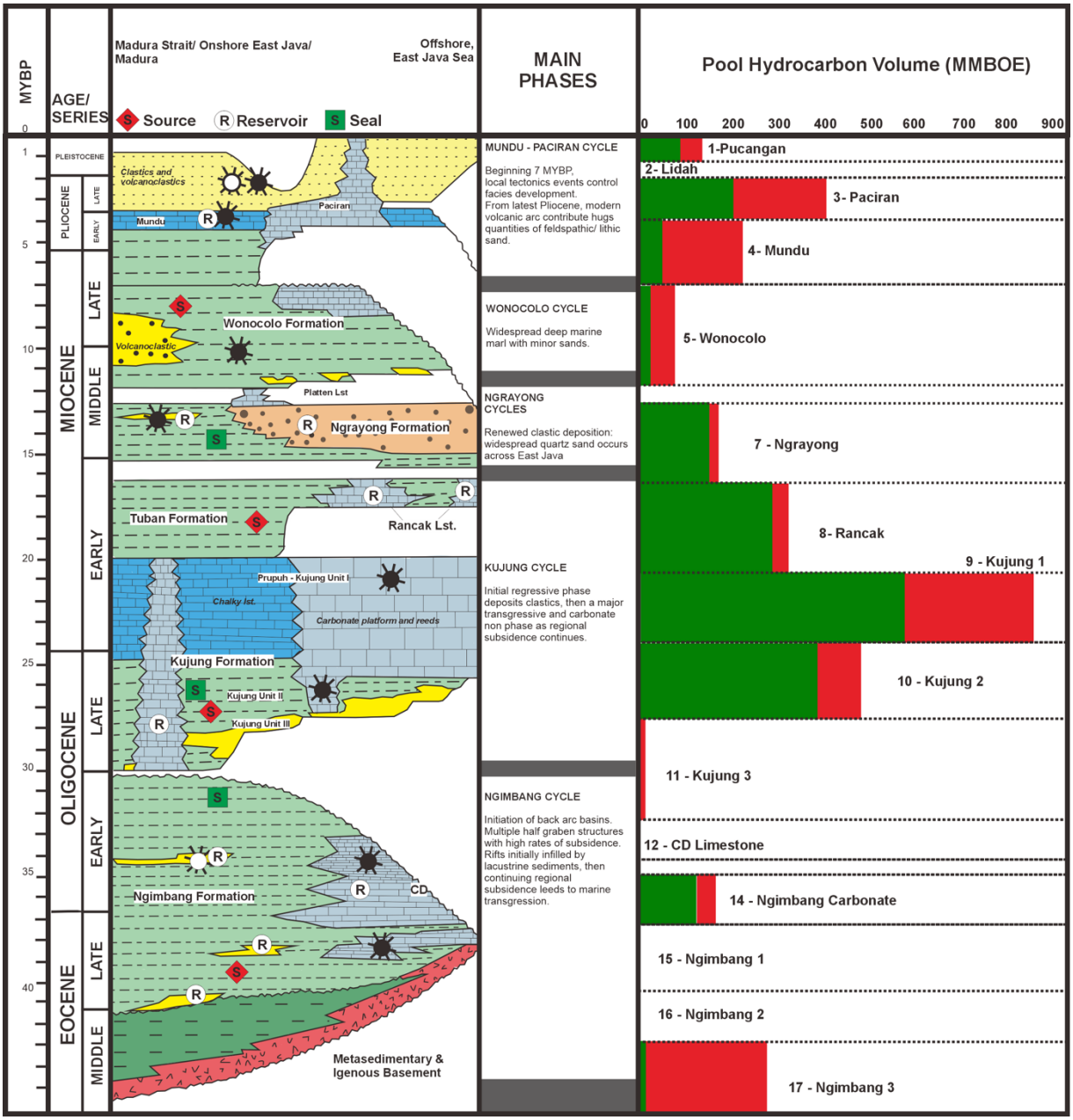


Figure 3: *Stratigraphy of East Java Basin after Mudjiono and Pireno (2002), showing the petroleum system components in the basin. The hydrocarbon pool chart on the right is based on Rystad database, where green represents the total oil accumulation and red is for gas total accumulations for each formations.*

Ngimbang petroleum system is the oldest system in the basin, occurs mainly in Rembang area onshore Java and offshore in the Kangean region north of Bali. Middle Eocene Ngimbang shale was recognized as non-marine source rocks with lacustrine deposits and coals. This formation has been long recognized as proven source of East Java oil and thermogenic gas. Both clastic and carbonate in Ngimbang Formation are proven reservoirs in the basin. The Middle Eocene Ngimbang Clastic reservoirs contain mainly gas whilst the carbonate equivalent, which is relatively younger, contain more oil (Figure 3).

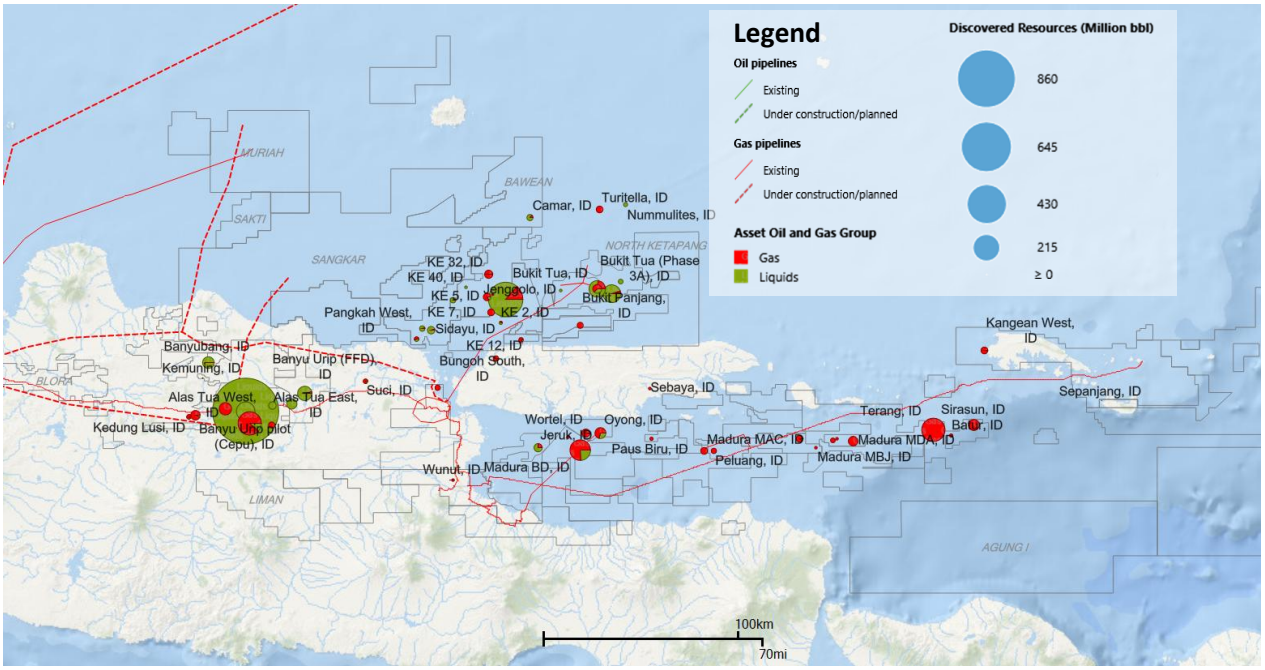


Figure 4: *A distribution map of the hydrocarbon accumulation in East Java Basin. The pipeline infrastructures and the current valid concessions show the up and mid-stream activities in this region (Source: Rystad Energy UCube Exploration, version 2024-06-04).*

The Kujung system is the most prolific in the basin (Figures 3 & 5), present in both the Rembang and Madura areas. The Kujung Carbonates act as the main reservoirs and are charged by the Early Oligocene Ngimbang source rock (also known as CD Formation) and local Late Oligocene Kujung marine source rocks. The Early Oligocene CD Formation contains organic matter predominantly composed of terrestrial humic kerogen Type III. In contrast, the Kujung Formation source rocks are confined to coals and carbonaceous shales of the Kujung II and Kujung III members. Interestingly, although deposited in a mainly marine environment, the kerogen is mostly terrestrially derived and contains biomarkers from higher plants (Satyana and Purwaningsih, 2002; 2003).

In late Early Miocene or the youngest section of Kujung system or cycle, there is a shaly source rock within the Tuban Formation. This formation is still immature to generate hydrocarbon but has relatively high Total Organic Carbon. Further confirmation by gas isotope analysis from proven reservoirs indicates biogenic source contribution (Purnama et al., 2018), Rancak carbonate reservoir, which developed in late Early Miocene above the Kujung Formation, is the secondary play in this system and charged by Oligo-Miocene source rocks.

The Ngrayong Cycle in Middle Miocene is a clastic dominated system. Quarzt sandstone occurs widely across East Java, including Madura Island (Surjono and Gunawan, 2018; Ardhana, 1993), but its sand quality decreases eastward to Madura Island. The reservoirs in this interval are charged by nearby older source rock, and they mainly contained oil.

The Wonocolo Cycle developed in Mid to Late Miocene. Generally, it is a widespread deep marine marl with minor sandstones. Some volcanoclastic deposit in this cycle contain gas with minor oil. This cycle

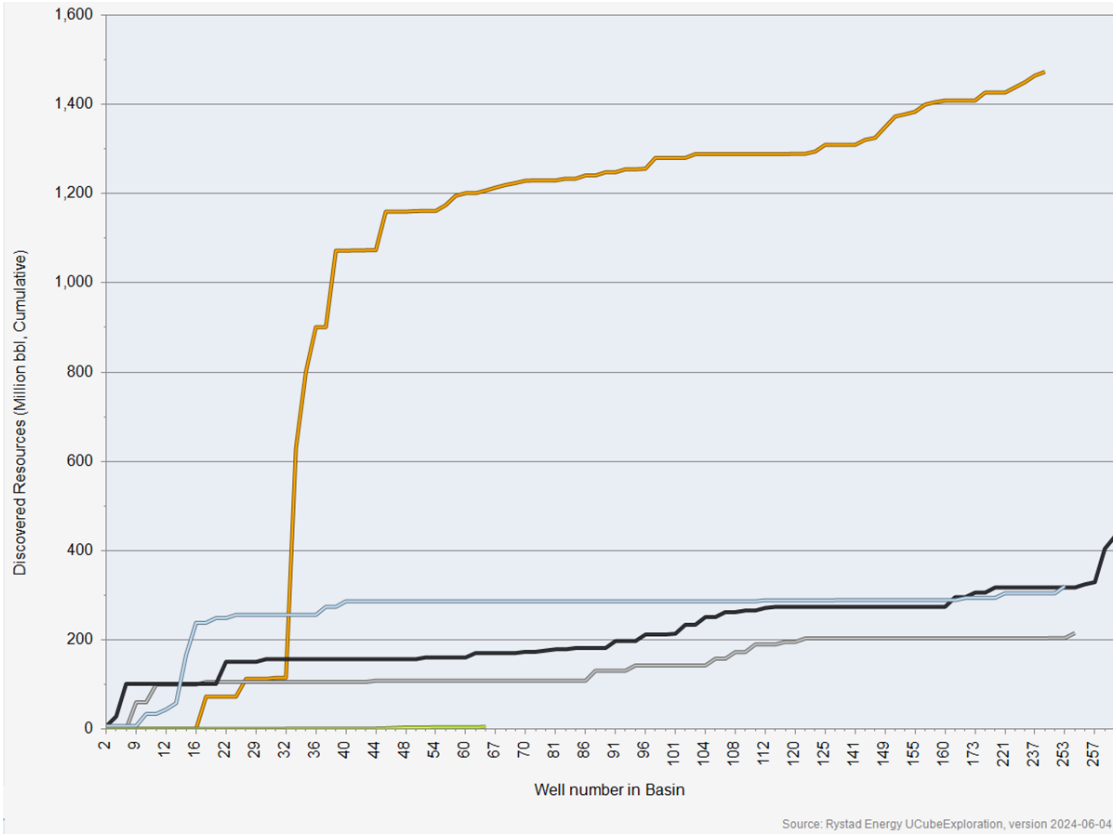


Figure 5: *A creaming curve of the main carbonate play in the East Java Basin. The Oligo-Miocene Kujung Cycle is the most prolific in the basin and it is fairly mature. The Paleogene Ngimbang Cycle creaming curve has been flat for some time but recently there was a significant discovery by Hidayah-1 well and it is believed to have more hidden potential. The Plio-Pleistocene carbonate play is in its mature stage with less hydrocarbon accumulation compare to the other two plays (Source: Rystad Energy UCube Exploration, version 2024-06-04).*

contains much less hydrocarbon, compared to the other cycles (Figure 3).

The youngest cycle in the East Java Basin is called the Mundu-Paciran Cycle (Figure 3). The Mundu carbonate of East Java Basin is a prolific oil and gas reservoir target. The reservoirs consist of more than 85 % foraminifera bioclast, and worth 3.5 TCF of Gas (Mansyur et al., 2019; Figure 5). The Paciran limestone is more dolomitic deposited in an open marine environment (Putri et al., 2023). Due to its exposures, this formation is affected by cementation and diagenesis processes.

CARBONATE STRATIGRAPHY AND DISTRIBUTION

Carbonate reservoirs constitute a significant portion of the hydrocarbon potential in the East Java Basin. Stratigraphically, they occur within three main zones: the Eocene-Oligocene Ngimbang Cycle (approximately 46-30 Ma), the Oligo-Miocene Kujung Cycle (approximately 30-16 Ma), and the Plio-Pleistocene Paciran-Mundu Cycle (approximately 4.5 Ma to present) (Figure 3). Each cycle has distinct reservoir characteristics and distribution patterns,

influencing their potential as hydrocarbon reservoirs.

Ngimbang Cycle

The oldest carbonate reservoir in the East Java Basin comprises Late Eocene to Early Oligocene limestones deposited during the basin's late synrift phase. These Paleogene carbonates are referred to as the Ngimbang Cycle (Figure 3 & 6A) for consistency within this study. While the Eocene portion is commonly named the Ngimbang Formation (e.g., JOB Pertamina-Trend Tuban, 1989 in Lunt, 2019; Siemers et al., 1992; Darmawan and Wijaya, 2022), the Oligocene interval is also known as the "CD" Limestone Formation (e.g., Kenyon, 1977; Arisandy et al., 2015).

The Ngimbang Cycle consists of platform carbonates deposited in a shallow marine environment. Notably, these carbonates underwent subaerial exposure and fracturing, which enhanced their ability to store oil and gas by promoting the development of secondary porosity (Siemers et al., 1992). Accumulations of Ngimbang Cycle carbonates have been identified in the Well JS 19, Bukit Panjang, JS-44, and JS-8 ridge areas of the Northern Platform, extending eastward to West Kangean near Sakala Island. These accumulations form a linear belt with excellent reservoir characteristics, situated close to the RMKS line (Figure 6A).

The Ngimbang Carbonate core samples of West Kangean field revealed a generally homogeneous carbonate section with localised occurrences of shale and muddy coal units. Petrographic analysis indicated a low-porosity sequence dominated by moderately recrystallised carbonate mud. Importantly, a network of fractures and stylolites, likely generated by diagenetic processes, significantly contributes to the overall reservoir porosity.

Seismic data characterises the Ngimbang Carbonate by a parallel-mound shape with contorted, variably continuous reflections. Darmawan and Wijaya (2022) observed seismic undulations in the southern (distal) basin interpreted as a carbonate growth stage dominated by aggradation and back-stepping. In contrast, the northern (proximal) shelf displays a platformal seismic signature, reflecting a more gradational depositional setting.

Kujung Cycle

The Kujung Carbonate Cycle (Late Oligocene-Early Miocene) comprises primarily the Kujung Formation, with additional carbonate units equivalent to the Tuban Formation known as the Rancak Limestone (Figure 3). This cycle contains the primary reservoir in East Java Basin and it has been discussed by several authors e.g. Satyana and Darwis, (2001), Satyana (2002), Purwaningsih et al., (2002), and Satyana and Djumlati (2003). Significant hydrocarbon discoveries were made from these carbonates (Figures 3 & 5).

The Kujung Formation itself consists of three units (Figure 3): Kujung III (basal clastic-rich regressive sequence), Kujung II (transgressive shallow-water carbonates and calcareous shales with localized buildups), and Kujung I (also called Prupuh Member; high-energy clean limestones and common pinnacle reefs).

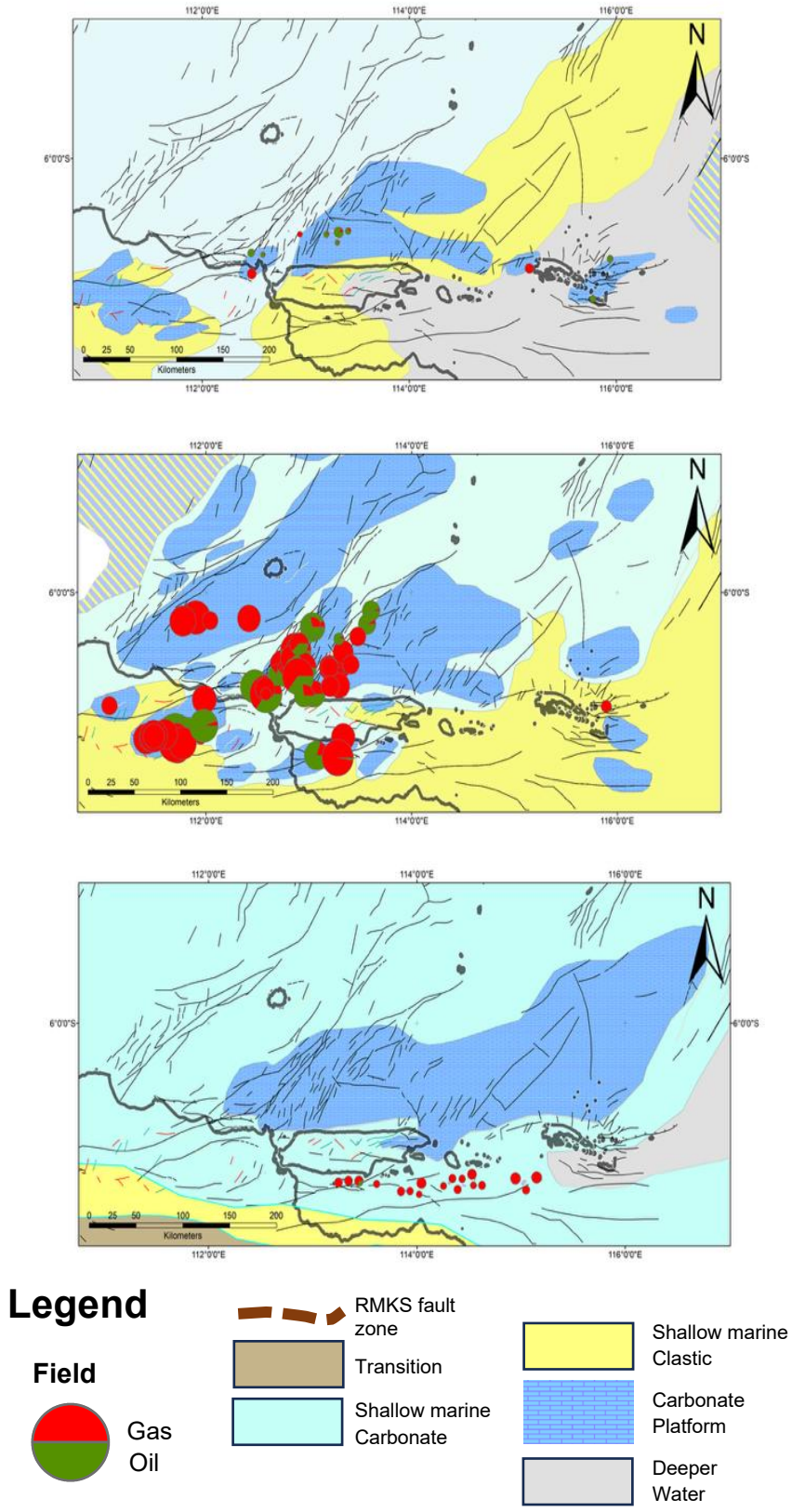


Figure 6: *Carbonate platform distribution and the discovered fields in each carbonate cycle in the East Java Basin. Carbonate platform is after KKPJM study (2022).*

Notably, tectonic uplift along the Rembang-Madura-Kangean-Sakala (RMKS) Zone (Figure 6B) tilted the ridges southwestward, causing drowning and growth cessation of western reefs on each high (Satyana & Purwaningsih, 2003). This differential development resulted in a distribution pattern of reefs across the basin, including the Rembang Reef (West Cepu High), Kedung Tuban, Banyu Urip, and other reefs on the East Cepu High, as well as Gondang, Grigis, and Telaga reefs on the Kemendung Ridge, and Banjarsari, Porong, and others on the "BD" Ridge.

The Rancak Carbonate was deposited above the Kujung Formation during Early Miocene, approximately between 18 Ma and 16 Ma (Figure 3). This formation consists of shallow-water limestones that were deposited during a period of marine transgression. The limestones are often reefal in nature, built up by organisms such as corals and algae.

Mundu-Paciran Cycle

The Plio-Pleistocene Mundu-Paciran Cycle (Figure 6C) comprises the Paciran Limestone and the Mundu Formation. The Paciran Limestone, deposited on a ramp-type platform (Hadiyanto et al., 2010), represents the shallower, proximal facies. In contrast, the Mundu Formation consists of globigerinid sands deposited in a deeper-water setting, including contourites, channel fills, and submarine fans (Schiller et al., 1994). Notably, the Mundu reservoir is unique among East Java's offshore carbonates due to its composition of over 85% foraminiferal bioclasts (Mansyur et al., 2017 & 2019).

During the Plio-Pleistocene, an extensive carbonate platform flourished north of the RMKS line (Figure 6C). Mundu and Paciran reservoirs are encountered south of the line, with Paciran representing the shallower, proximal facies and Mundu representing the deeper, distal facies. Distinguishing these formations can be challenging due to a lack of clear lithological differentiation. Consequently, Edwin et al. (2013) emphasized the reliance on biostratigraphy and chronostratigraphy for accurate identification.

CARBONATE RESERVOIR CHARACTERIZATION

Ngimbang Cycle

Ngimbang Cycle carbonate platforms are primarily located onshore East Java, north of Madura Island, with extensions identified east of the RMKS line (Figure 6A). Reservoir porosity within the Ngimbang Cycle typically ranges from 11% to 20% (Figure 7), while permeability varies from 2.9 to 184 mD (Figure 7;

Carbonate Cycle	Formation/Lithology	Age	Porosity (%)	Permeability (mD)	Max Column (m)	Max Areas (kmsq)	Largest Field (MMboe rec.)
Ngimbang Cycle	Ngimbang Limestone/ CD Limestone	Late Eocene - Early Oligocene	11-20%	2.9-184 mD	243 (Sepanjang)	51.3 (W. Kangean)	243 (Pagerungan)
Kujung Cycle	Kujung Limestone	Late Oligocene - Early Miocene	12-28%	29-173 mD	396 (Banyu Urip)	170 (Kepodang)	993 (Banyu Urip)
	Rancak Limestone / Tuban Fm /Orbitoid Kalk	Early Miocene	11-17%	0.46-35 mD	250 (Sukowati)	170 (Kepodang)	171 (Sukowati)
Mundu Paciran Cycle	Paciran Limestone	Early Pliocene	23-33%	4-57 mD	148 (Oyong)	36.6 (Sirasun)	108 (Sirasun)
	Mundu Limestone	Pliocene	19-31%	10-896 mD			
	Lidah Limestone	Pleistocene	21-35%	6-78 mD			

Figure 7: *Properties of East Java Basin carbonate reservoirs (KKPJM database, 2023).*

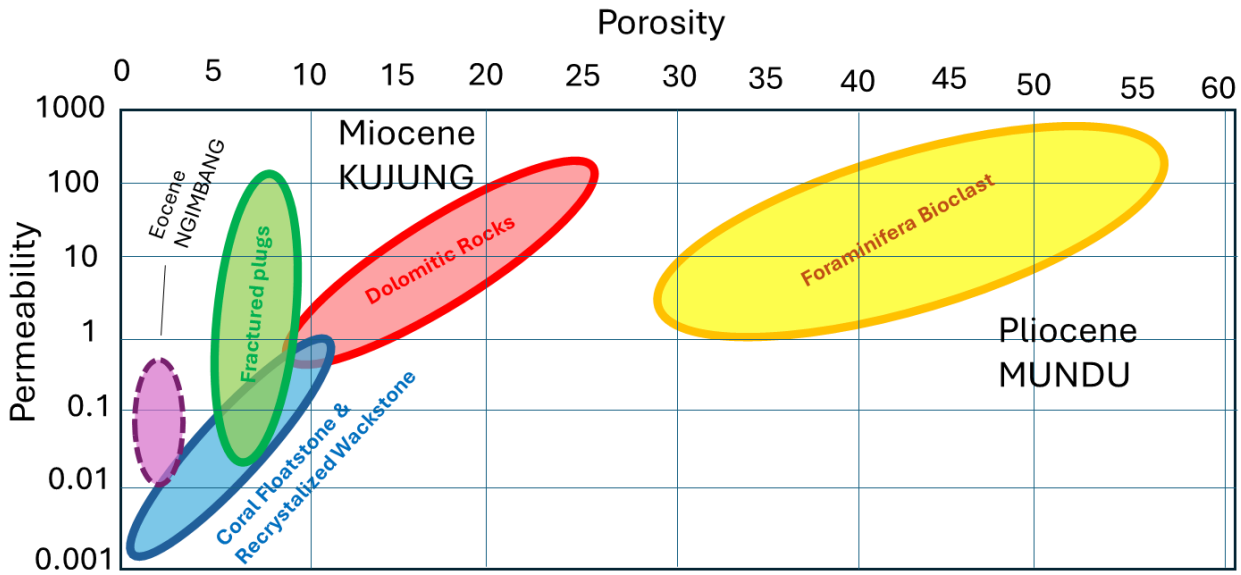


Figure 8: *Some East Java Basin reservoir properties groups based on core samples taken from Ngimbang (after Siemers et al., 1992), Kujung (after Haribowo, 2022) and Mundu Carbonate Formation (after Mansyur et al., 2017).*

simplified after KKPJM 2021 report). Notably, core analysis suggests a broader porosity range (1.0-12.6%).

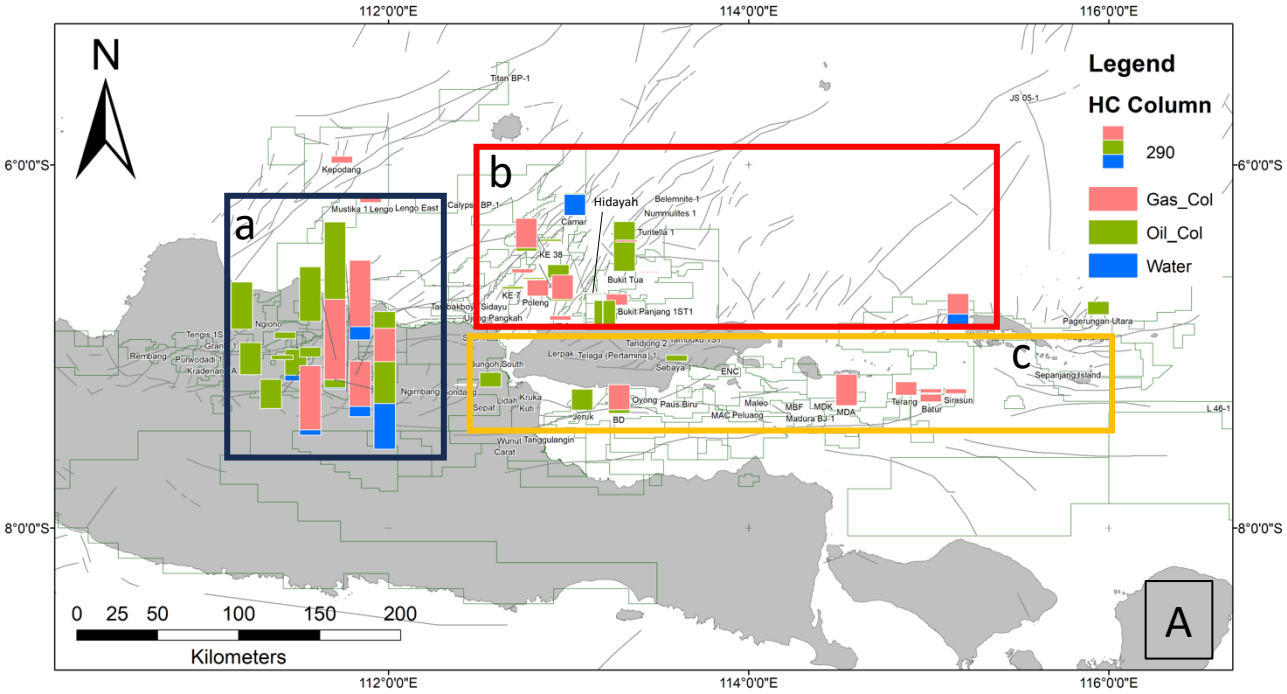
The cluster plot of the Ngimbang core plugs is shown in Figure 8 (Siemers et al., 1992). The Sepanjang Oil Field boasts the longest hydrocarbon column within the cycle, reaching approximately 243 meters. However, individual Ngimbang carbonate reservoirs are generally smaller in areal extent. While West Kangean Field is the largest, covering 51.3 km², most fields occupy areas less than 10 km² (Figure 9). Notably, both the Sepanjang and recent Hidayah (estimated reserves of 88.55 MMstb; Bernama, 2023) discoveries are situated north of the RMKS line (Figures 9 & 10).

Compared to other carbonate samples, this Eocene Ngimbang carbonate is considered to have the poorest reservoir quality (Figure 8). The fractures developed in Ngimbang carbonates, however, will improve the reservoir character (Siemers et al., 1992). The hydrocarbon column in Sepanjang and Hidayah are relatively long (~250 and ~200 meters). These carbonates in these two fields developed in a relatively small area (< 10 km²), located in the north of RMKS line (Figure 9A.b).

There are limited good quality seismic section across the fields with Ngimbang Carbonate. Hidayah Field, however, shows a relatively gentle relief compare to the Kujung Carbonates (Figure 11). The field is located about 2 second TWT below the surface and the relief is about 250 milliseconds.

Kujung Cycle

Kujung Cycle carbonate is the most prolific reservoir in the basin (Figures 3 & 5). This cycle composed of two reservoir groups which are the Kujung and Rancak Formation (Figure 7). Some literatures subdivided Kujung Formations into 3 parts (Figure 3), namely Kujung 3, Kujung 2 and Kujung 1 (e.g. Satyana and Djumlati, 2003; Luthfi et al., 2003). Kujung 3, which is the oldest part, was deposited in the Late Oligocene and contain minimum hydrocarbon. The most



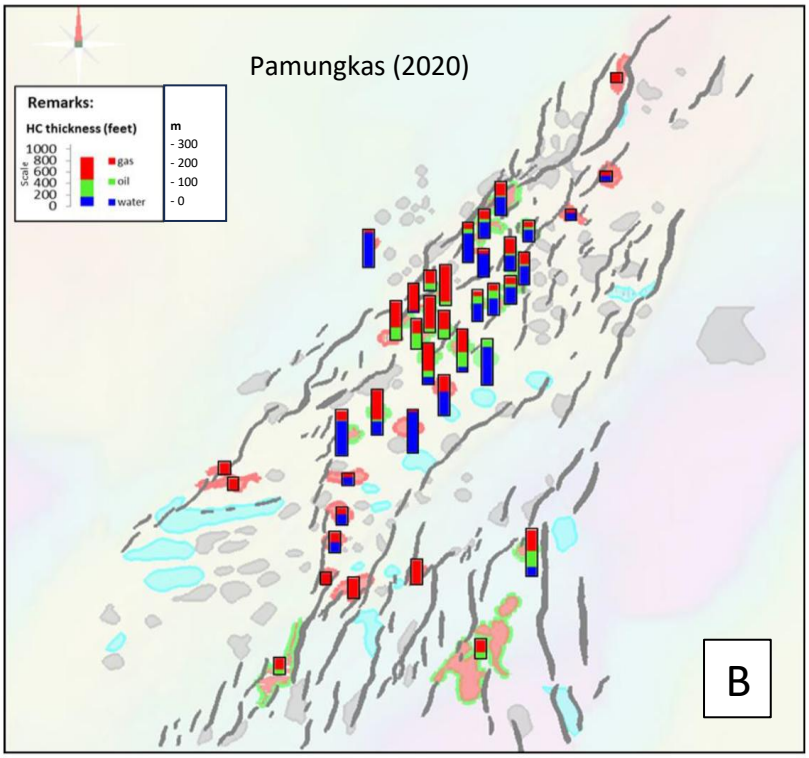


Figure 9A: *Hydrocarbon columns of carbonate fields in East Java Basin. a = Kendeng Area, dominated by Kujung Fm; b = North Madura Platform, consist of carbonate reservoirs of Kujung and Ngimbang cycles; c= South Madura area, mainly from Mundu-Paciran cycle carbonates.*

Figure 9B: *A zoom into the North Madura Platform, showing the hydrocarbon columns in this area.*

prolific intervals are the Early Miocene sections, which are Kujung 1 and followed by Kujung 2.

The primary porosity of the Kujung Limestone ranges from 12% to 28% with permeability ranging from 29 mD to 173 mD. Dolomitization process has improved the reservoir quality in this formation (Damatra, et al., 2017; Haribowo, 2022; Figure 8). Banyu Urip Field is the largest field in the basin (993 MMboe) with mainly Kujung carbonate reservoir. The hydrocarbon column in this field reaches up to 396 m column (Figure 7), mainly located in Kendeng Zone, onshore East

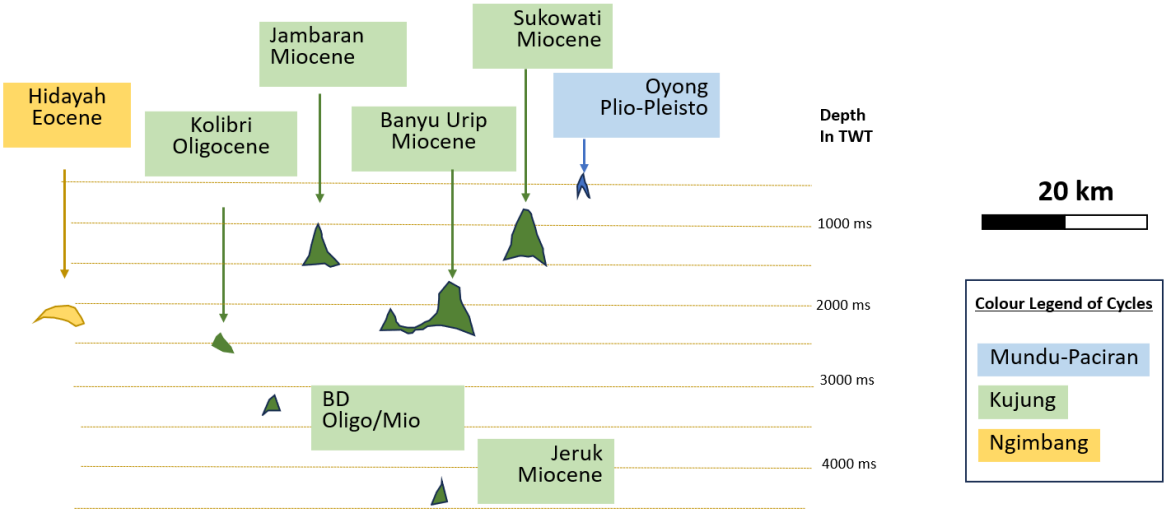


Figure 10: *A cartoon showing comparison of the morphology of key carbonate fields in the East Java Basin and their relative depth positions.*

Java (Figure 9A.a). Pamungkas (2020) also reported detail hydrocarbon column map of the fields in the north of Madura (Figure 9B), with shorter hydrocarbon column (< 300 m)

The secondary reservoir group in Kujung Cycle is the Rancak Formation (Figure 3). Other literatures and database recognize some hydrocarbons in layers containing the Orbitoid fossils, called "Orbitoid Kalk" (or OK for short) within Tuban Formation (Soeka et al., 1982; Koesoemadinata, 2020). Due to data limitation the reservoirs in the Tuban Formation and "Orbitoid Kalk" are grouped together with Rancak Formation (Figures 3 & 7).

The porosity range of the Rancak-Tuban group is range from 11% to 17% with permeabilities which range from 0.46mD to 35 mD. The largest field with this reservoir is the Sukowati Field (171 MMboe) and the hydrocarbon column here is up to 250 m (S&P Database).

The Oligo-Miocene Kujung Carbonates distinct themselves by their relief character. A compilation of several fields with Kujung Carbonate reservoirs seismic sections shows relatively steep build ups. Jimbaran, Banyu Urip and Sukowati can reach higher than 500 ms TWT on seismic. A section of Banyu Urip (Simo et al., 2012) shows about 900 meters high carbonate build (Figure 10),

Mundu-Paciran Cycle

The Mundu-Paciran Cycle (Plio-Pleistocene; Figure 3) represents the youngest carbonate sequence within the East Java Basin. The Mundu Formation, a key reservoir within this cycle, has attracted significant research due to its unique characteristics, primarily its high foraminiferal bioclast content (Luan and Lunt, 2021; Mansyur et al., 2017 & 2019; Schiller, 1994). While the Paciran and Lidah Formations are also part of the Mundu-Paciran Cycle, they play a less prominent role in the basin's petroleum system.

The exceptional reservoir quality of the Mundu Formation is evident in Figure 7, where its high permeability (up to 896 mD) is clearly distinguished. This is further emphasized in Figure 8, where the Plio-Pleistocene Mundu Formation, enriched

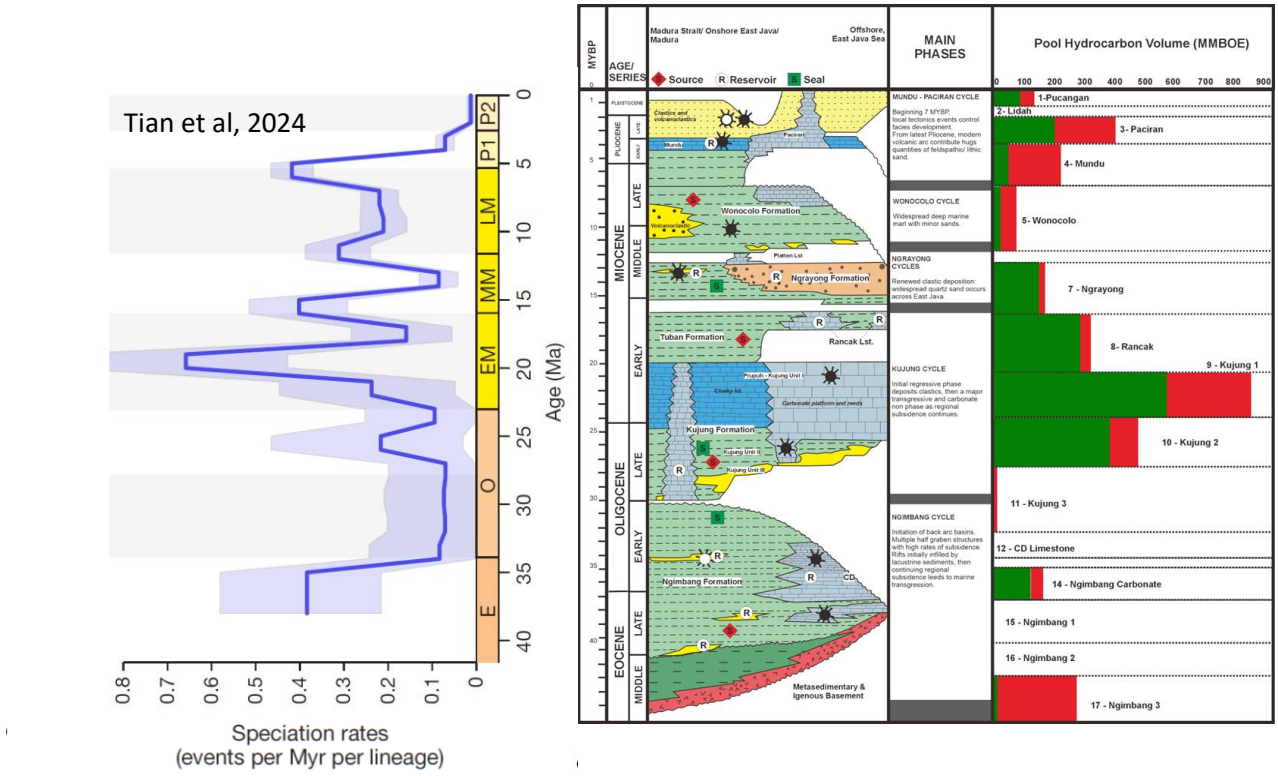


Figure 11: *A comparison of marine bio-diversity graph (after Tian et al., 2024) reflected by speciation rates through time (left) and the stratigraphy of East Java Basin (right) which also showing the hydrocarbon pool on each formation. Note that the speciation rate curve is more-less reflecting the hydrocarbon presence in East Java Basin.*

with foraminiferal bioclasts, occupies a distinct region with superior reservoir properties compared to other formations.

Mundu carbonate reservoirs are primarily concentrated south of Madura Island (Figure 9A.c). Notably, these fields are characterized by shorter hydrocarbon columns compared to other formations, with the Oyong Field holding the record at 148 meters (Figures 7, 9 & 10).

DISCUSSION

The Early Miocene Kujung carbonate is the largest contributor to the hydrocarbon accumulation in East Java Basin (Figures 3 & 5). Through the observations, the carbonate in this interval has the longest hydrocarbon column compared to other carbonates in the other formations. Figure 11 is a sketch to compare the carbonate morphology of some well-known fields in the area, which give a general overview of the carbonate morphology. Here we see the Oligo-Miocene Kujung has distinctive feature due to coral components in the body with significant vertical growth, which is also reflected in their hydrocarbon columns (Figures 9 & 10). The Miocene carbonate platform, which is inhabited by growth of localized carbonate build-ups, with some amalgamated into wider build-ups. It is characterized by up to 350 meters vertical thickness but often of small areal extent (< 1 km^2), forming pinnacle morphology (Pamungkas, 2019).

The reservoir bulk-rock-volume of the Kujung Formation is also significantly

larger than the others due to the abundant of corals (subphylum *Anthosoa* of the phylum *Cnideria*). Tian et al. (2024) studied the Cenozoic history of the biodiversity hotspots and included the speciation rates (species formed within a particular lineage) through time. Higher numbers of species may indicate increased biotic (competitive) interactions and expanded niche occupancy in a region, which conversely reduces ecological opportunities for speciation. The speciation rates almost mimicking the distribution of hydrocarbon in the basin (Figure 11).

Another paleo-diversity study by Leprieru et al. (2021) shows variations in number of coral reef patches and total coral reef area through time. Their results suggest that the development of a complex mosaic of reef habitats in the Indo-Australian Archipelago (IAA) during the Miocene, may have promoted cladogenesis, and provided a refuge from extinction. Indeed, in the Early Miocene (~ 23–16 Ma), the Australian plate made contact with the submerged Sundaland and this collision led to closure of the shallow reefs between Sundaland and Australia, which increased reef area and the complexity of coral reefs throughout the region.

CONCLUSION

Based on hydrocarbon pool statistics (Figure 3) and the Rystad's distribution of oil and gas fields (Figure 4), the East Java Basin predominantly contains oil. Most of the hydrocarbon in the basin are trapped within carbonate reservoirs. The character and property of the carbonate reservoirs varies through ages.

Coral reef development plays a critical role in the East Java Basin carbonate reservoirs, exhibiting a strong correlation with marine biodiversity fluctuations throughout geologic time. The Early to Middle Miocene epoch witnessed peak diversity, leading to significant coral growth. These coral-built carbonate pinnacles act as efficient hydrocarbon traps due to their localized, high-potential volume and inherent vertical growth pattern.

The Globigerina Sands of Mundu Formation occur in Pliocene. These reservoirs don't have a build-up geometry as the corals, but it has the world class reservoir. Unfortunately, the vertical and lateral distribution is limited.

However, a significant knowledge gap exists within the East Java Basin, with limited and potentially outdated data hindering comprehensive exploration. This suggests considerable unexplored potential. Future efforts targeting coral reef reservoirs would benefit from: 1) refined depositional environment maps for the Early to Middle Miocene, and 2) detailed seismic surveys in areas currently covered by low-resolution seismic or areas covered by sparse seismic (more than 5km x 5km). Acquisition of denser 2D seismic data, or ideally 3D surveys, would be crucial for pinpointing promising new prospects within this region.

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