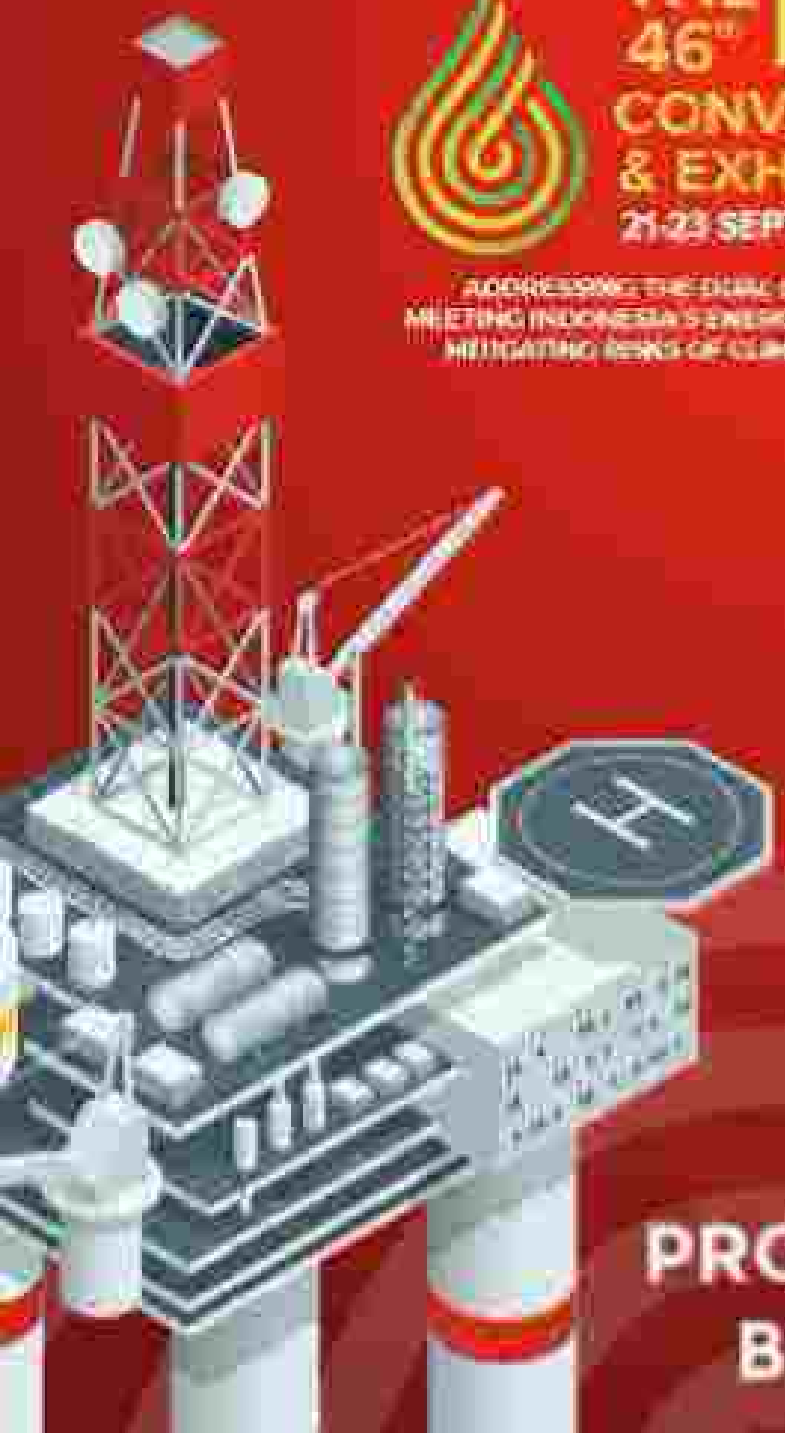
THE 46TH IPA CONVENTION & EXHIBITION

21-23 SEPTEMBER 2022

ADDRESSING THE DUAL CHALLENGE:
MEETING INDONESIA'S ENERGY NEEDS WHILE
MITIGATING RISKS OF CLIMATE CHANGE



PROGRAM BOOK

Indonesian Petroleum Association

ADDRESSING THE DUAL CHALLENGE OF MEETING INDONESIA'S ENERGY NEEDS WHILE MITIGATING RISKS OF CLIMATE CHANGE

THE 45TH IPA CONVENTION & EXHIBITION

20, 23 SEPTEMBER 2021

Program Book

Organized by:
INDONESIAN PETROLEUM ASSOCIATION

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FOREWORD

Welcome to the IPA Convex 2022!

The world is encountering a constant challenge. The oil and gas industry with no exception not only the recent troubling low oil price but also the accelerated energy transition. Furthermore, this situation is not getting any better with the new variant Omicron variant.

In 2020 and 2021, the IPA Convex adjusted and adapted to the situation by holding the convention and exhibition virtually. When Covid-19 was declared as a global pandemic, the IPA took the initiative to establish a new format for the convention and exhibition. This is the commitment from the IPA to fully support the industry and encourage the industry players in the middle of an uncertain situation.

This year, the IPA Convex will continue to support to the industry by holding the 46th IPA Convention and Exhibition 2022. This year's event will be held in hybrid concept which visitors can attend both at the Jakarta Convention Center and through virtual platform at https://ipa-virtualworld.com.

The global pandemic is not the only challenge the industry encountered. While the future is not certain to say it is always sure to embrace. The national energy needs and the pathway for the energy transition to maintain balance with the risks of climate change is also at our doorstep. Under the theme of the 46th IPA Convex 2022: **"Addressing the Dual Challenges: Meeting Indonesia's Energy Needs While Mitigating Risks of Climate Change"**

The IPA Convex 2022 will have panel discussions, special sessions, and technical presentations on the urgency of achieving Indonesia's energy needs in 2060 as well as the energy transition pathways in accordance to mitigate the risks of climate change.

The exhibition despite the pandemic situation and other careful consideration, will be held in a hybrid concept. A combination of offline activities at the Jakarta Convention Center and a new territory without borders and limits (the virtual exhibition). Audiences around the world are just one click away with no limit to the exhibition floorplan. They will have a broad new virtual networking experience with a global reach.

On behalf of the 46th IPA Convex Committee, please allow me to extend an invitation to all of you. Please join us at the Jakarta Convention Center annually to contribute and participate actively in the event. Whether you are exhibiting, speaking, sponsoring, attending the conference or visiting the exhibition. Please join us at the highly anticipated event of the oil and gas industry, where policymakers, investors, professionals, practitioners, and academics gather to discuss the issues in the oil & gas industry. We are hoping you will get the best experience of our hybrid convention and exhibition.

Look forward to seeing you in the 46th IPA Convex 2022!

Rakhmat Hidayatullah
IPA Deputy Chairperson

Kindly note that the information is valid as the date of printout (which is dynamic).
Hence, any information are subject to changes in the following days.

GENERAL INFORMATION

The 46th IPA Convention & Exhibition 2022 will be held in person at the Jakarta Convention Center and also on virtual platform [illegible] 21-23 September 2022.

A. EXHIBITION

Date : Wednesday - Friday, 21-23 September 2022
Locations : Main Lobby and Assembly Hall
The Exhibitions will showcase more than 60 exhibitors highlighting major industry projects and the latest in technology and services available to the oil and gas industry.

B. CONVENTION

TECHNICAL PROGRAMS

Date : Wednesday - Friday, 21-23 September 2022
Locations : [illegible]

HIGH LEVEL ROUNDTABLE TALK

Date : Wednesday, 21 September 2022 from 11.30 until 12.30
Location : Plenary Hall
Topics : "Indonesia's Upstream O&G Strategy to Support Energy Transition"

PLENARY SESSIONS

Date : Wednesday - Friday, 21-23 September 2022
Location : Plenary Hall

- Plenary Session I : Wednesday, 21 September 2022 from 13.00 until 15.00
  Main Stakeholder Partnership in Achieving Indonesia's NDC(R) and LTS-LCCR Targets
- Plenary Session II : Thursday, 22 September 2022 from 09.00 until 11.00
  "The Role and Commercialization of CCS/CCUS in Meeting Indonesia's Net Zero Target"
- Plenary Session III : Thursday, 22 September 2022 from 13.30 until 15.00
  National Gas Infrastructure Roadmap - Prospects and Challenges"
- Morning Talk : Friday, 23 September 2022 from 09.00 until 12.30
  "Securing the Future Holders of Indonesia's Oil and Gas Industry"

SPECIAL TALK I

Date : Wednesday - Thursday, 21-22 September 2022
Location : Plenary Hall

- Special Talk I : Wednesday, 21 September 2022 from 15.00 until 16.30
  "Why Major IOC's Still Invest in Indonesia"
- Special Talk II : Thursday, 22 September 2022 from 15.00 until 16.30
  "Upstream Addressing the Local Challenges Meeting Indonesia's Energy Needs while Mitigating the Risks of Climate Change"

TECHNOLOGY SESSION

Date : Wednesday, 21 September 2022 from 15.30 until 16.30
Location : Assembly Hall
Topics : "Energy Transition & CCS/CCUS Progress"

Kindly note that the information is still on the plan of technical sessions. Thus, any information are subject to changes at the moment.

GENERAL INFORMATION

C TALK

Date	Thursday 22 September 2022 from 9:00 to 12:30
Location	Assembly Hall
Topics	"Company Strategy to Address Energy Transition and Investment"

E. EVENTS AND SPECIAL FEATURES

OPENING CEREMONY

Date	Wednesday 21 September 2022
Time	(TBC)
Location	Plenary Hall

NIGHT OF ACHIEVEMENT

Date	Thursday 22 September 2022
Time	(TBC)
Location	Assembly Hall

CLOSING CEREMONY

Date	Friday 23 September 2022
Time	(TBC)
Location	Plenary Hall

M. OTHER FACILITIES

REGISTRATION COUNTER

Date	19 - 23 September 2022
Location	
Convention Registration	Conference Hall
Visitor Registration	Main Lobby Days Off Area

Exhibition

Day	Date	Exhibition	
		Pavilions	Exhibition Days
Monday	19-Sep-22	16.00 - 18.00	
Tuesday	20-Sep-22	10.00 - 18.00	
Wednesday	21-Sep-22	06.30 - 11.00	08.00 - 16.00
Thursday	22-Sep-22	07.00 - 11.00	08.00 - 16.00
Friday	23-Sep-22	07.00 - 12.00	08.00 - 16.00

Kindly note that the information is valid on the date of material issue. Updates and/or changes are subject to change at the discretion of IPA.

Convention Schedule

CONVENTION SCHEDULE

DAY 1 - WEDNESDAY, 21st SEPTEMBER 2022

[illegible]	[illegible]
[illegible]	OPENING CEREMONY
[illegible]	[illegible]
[illegible]	[illegible] Theme: Indonesia's Opportunities on [illegible] to support Energy Transition Invited Panelists: 1. [illegible] 2. Prof. Tutuka Ariadji, Director General of Oil and Gas 3. [illegible], IPA President Moderator: Sonia Wedya Wudiu, Kompas Group
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[illegible]	[illegible] Theme: Why Nigel [illegible] Investor Indonesia Invited Panelists: 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible] Moderator: [illegible]
[illegible]	TECHNICAL SESSION Theme: Energy Transition and CCUS Progress Invited Speakers: 1. Mary Mahajeerard - Vice President Upstream & Technology Operations of PT. Pertamina (Persero) 2. Rigel Al Nur Setiawan - Asset Consulting and Digital Solution Manager of Schlumberger 3. Taufik Bawazier - Digital O&G Manager for Asia, Schlumberger

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CONVENTION SCHEDULE

DAY 1 - WEDNESDAY, 21st SEPTEMBER 2022

Time	Description
10:00 - 17:00	PLENARY SESSION 1: Theme: Multi-Stakeholder Partnership in Achieving Achievement of MBDHS 2030 to SDGHD Targets 2030 Invited Panelists: 1. Dwi Soetjipto, Chairman of Sat Wiga 2. Tejoso Kecantja, Chairman of Fiscal Policy Agency 3. Marsan Abdurrahman, Vice Chairman ORI Commissioner VI 4. Sony Sulistio, IPA Board Moderator: Alfian Sinaga (Host), Senior O&C Practitioner

CONVENTION SCHEDULE

DAY 2 - THURSDAY, 22nd SEPTEMBER 2022

TIME	AGENDA
09:00 - 10:00	PLENARY SESSION 2 Theme: The Role and Collaboration of [illegible] in Realizing Indonesia's Net Zero Target Invited Panelists: 1. [illegible], CEO of [illegible] 2. Moderman Purba, CEO of Pertamina New Energy 3. Tong Lastiyo, Vice President, Asia Pacific Low Carbon Solutions, Schlumberger 4. Hidetaka Akimoto, Vice President of Japan External Trade Organization Moderator: Wijayu Asdiono, IPA Board
10:00 - 10:30	COFFEE BREAK Theme: Company Strategy in Achieving Energy Transition and Investment Invited Panelists: 1. Dharmawan Samsu, Chief Executive Officer, Pertamina Power Indonesia 2. Dolph Sabah Hillman, Executive Vice President & CEO Baker Hughes INCORPORATED 3. [illegible], Senior Vice President of Global Infrastructure Mubadala Investment Moderator: Nanik Dwihardiyanti, IPA Sponsorship Committee
10:30 - 11:00	FLORIN TIME
11:00 - 12:00	PLENARY SESSION 3 Theme: Natural Gas as Indonesia's Transition Fuel : Prospects & Challenges Invited Keynote: [illegible], Secretary General of National Energy Council Invited Panelists: 1. Jeffrey Mahendra, Deputy of Processing and Mega Project 2. Gunawan Hamzah, Executive Director of ISEI 3. [illegible], Director of Investment & Business Development PT. Pupuk Indonesia 4. [illegible], VP Commercial Asset [illegible] 5. Dwiyo Pranoto, IPA Board Moderator: Andhika Indrawan, Komite Migas

Kindly note that the information is valid as the date of [illegible] and is subject to change at the discretion of IPA.

CONVENTION SCHEDULE

DAY 2 - THURSDAY, 22nd SEPTEMBER 2022

TIME	AGENDA
[illegible]	SPECIAL TALK 2 Theme: Lean SCM: Addressing the Four Challenges, Meeting Indonesia's Energy Needs while Mitigating the Risks of Climate Change Invited Panelists: 1. Wiki Santoso, Head of Goods and Service Procurement Management Division, PKN Wijaya 2. Hardityono F. Hollo, Vice President of SCM and Business Support of Pertamina Indonesia 3. Dewan Ilyi, HPI Associate Member 4. Budiyanto, Chairman of Supplyindo Moderator: Feby Sutjiana, Chairman of the SCM Committee
[illegible]	BRIEF OF ACHIEVEMENT

CONVENTION SCHEDULE

DAY 3 - FRIDAY, 23rd SEPTEMBER 2022

TIME	ACTIVITY
09:00 - 11:30	MORNING TALK Theme: Securing the Future Leaders of Indonesia's Oil and Gas Industry Invited Panelists: 1. Fatar Yani Abdurrahman, Vice Chairman of MX Migas 2. Julius Wiratno, President Director of Medco Energi 3. Ramdani Hudiyakono, Senior D&T Practitioner, Former Head of SKK 4. Dandy Dwi, President of Kalimantan Cepu Gas 5. Angel Blanco, Senior Partner of Kern Ferry Moderator: Chig Nurtjahjo, IPA Board
12:00 - 14:00	LUNCH BREAK & DIRECTORY MEETING
14:00 - 16:00	CLOSING CEREMONY

The 46th IPA CONVENTION & EXHIBITION: POSTER PRESENTATION, Jakarta 21-23 September, 2022 "Addressing the dual challenge: Meeting Indonesia's Energy Needs While Mitigating Risks of Climate Change."

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21-23 SEPTEMBER 2022

Depositional Environment Based on Palynological and Foraminiferous Analysis of the Klasaman Formation in the Salawati Basin Klayili Area Klayili District Sorong Regency West Papua Province

Julianti*, David V. Mamengko**, Ailin A. Yarangga**, Deddy Kurniadi***, Abdul Khaliq***

Organizer : Indonesian Petroleum Association IPA

Co-organizer : Universitas Papua

ABSTRACT

The Salawati Basin, West Papua is a mature basin producing oil. One of these basins was filled by sediments from the Klasaman Formation consisting of shale, claystone, sandstone, especially in the northern part there are conglomerates, rarely coral reef limestone deposited in a deltaic to fluvial environment. An a analysis of the depositional environment in the Klasaman Formation provides knowledge on the facies development and depositional environment in the study area. The study was carried out by using the surface geological data such as measured stratigraphy section (MS) with approaches of palynology, foraminiferous and petrography analysis. The development of palynology studies in Indonesia, especially in Eastern Indonesia is still very minimal and can be improved along with the increasing number of oil and gas exploration moving to transitional environments. The results of the analysis show that the Klasaman Formation is Late Miocene-Pliocene (N18) with stratigraphy sorted from the oldest to the youngest units, namely carbonate sandstone units and conglomerate units. The geological structure that developed in the study area was controlled by a structure Klayili Normal Fault which causes a subsidence in the Northwest–North part of the study area and folding in the Southeast, namely Klayili Syncline. Overall facies development as a delta plain environment that show shallowing upward vertical succession with relatively dominant progradation process. Carbonate sandstone as the older unit was deposited in a lower delta plain environment as a tide dominated delta with mangrove vegetation to a peat swamp with freshwater vegetation. There are three facies associated with this unit which are distributary channel, marsh, and interdistributary bay. Conglomerate as the younger unit was deposited in the upper delta plain environment which is influenced by tide-fluvial dominated delta. Several facies associated with this unit are distributary channel, interdistributary bay, swamp, and crevasse splay.

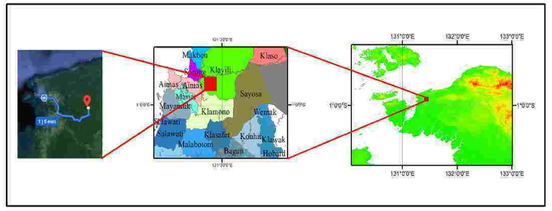
INTRODUCTION

The tectonics of Eastern Indonesia is controlled by the interaction between the Indo-Australian, Eurasian and Pacific Plates. The interaction between the movement of the Australian Plate and the Pacific Ocean Plate caused the movement of the left lateral strike slip fault (Satyana, 2011). The activation of the left lateral strike slip fault of Sorong caused the Salawati Basin to experience subsidence during the Pliocene, resulting in the deposition of the Klasaman Formation which was deposited in conformity overlie the Klasafet Formation.

The Klasaman Formation of Late Miocene-Pliocene age is one of the formations as candidate source rock such as claystone, shale and coal, which are especially found in the Lower Klasaman Formation. Related to this, research is conducted on facies development and depositional environment in the Klasaman Formation. The purpose of this study is to identify the development of facies succession and depositional environment, also to see and the implications for the presence of hydrocarbons in the Klasaman Formation.

METHODOLOGY

The study area is located in the Klayili Area, Klayili District, Sorong Regency, West Papua Province.



This research uses field data retrieval in the form of surface geological mapping and performs a measured stratigraphy section (MS).

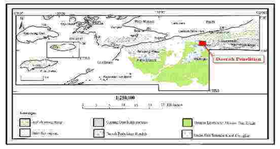
Research Stages:

a) Preliminary stage : literature study, secondary data gathering and reconnaissance.
b) Data collection : outcrop sample collection include MS and structure data.
c) Data processing and analysis :
- Laboratory analysis : Palynological analysis (Robertson research, 1984 and Lelono et al., 1996), foraminifera (Robertson, 1985 and Blow, 1986) and petrography (Wentworth, 1922 and Pettijohn, 1973).
- Studio analysis : creation of track and waypoint maps, MS profile, geological maps and schematic depositional environment diagram.

REGIONAL SETTING

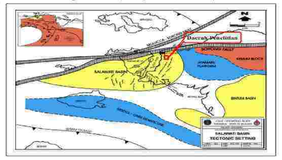
Regional Physiography

The study area is included in the physiographic unit of the Low Hills Region (Amri et al, 1990).



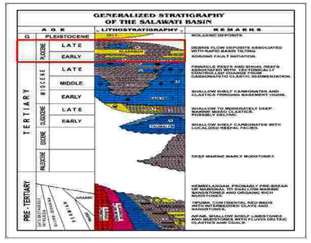
Regional Geological Structure

The regional geological structure of the study area is located in the Salawati Basin. The formation of the Salawati Basin was strongly controlled by the Sorong Fault (Satyana, 2002).

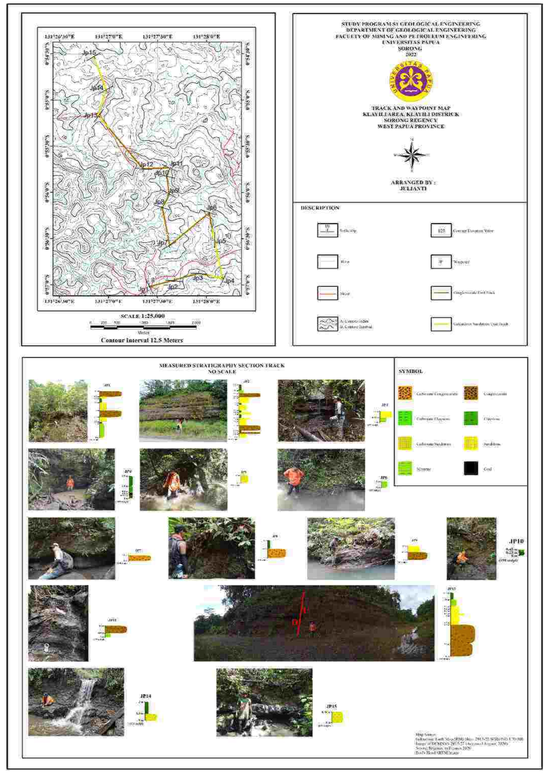


Regional Stratigraphy

The regional stratigraphy of the study area is included in the Klasaman Formation of Pliocene age (Satyana, 2002).

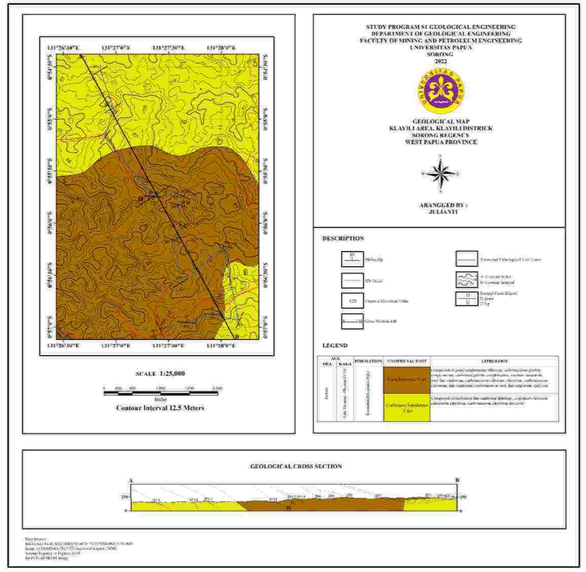


RESULTS AND DISCUSSION



Stratigraphic Sequence of the Study Area

Based on the results of the study, the stratigraphy of the study area consists of 2 unofficial units of Late Miocene–Pliocene age (Zone N18) which are sorted from oldest to youngest units, namely carbonate sandstone units and conglomerate unit. The study area was influenced by the Klayili Normal Fault with a fault plane N237°E/86° resulting in subsidence to the northwest-north direction. In addition, based on the reconstruction of the geological cross section of the study area there was an influence of the Klayili Syncline Fold structure relative to the direction of Southeast.



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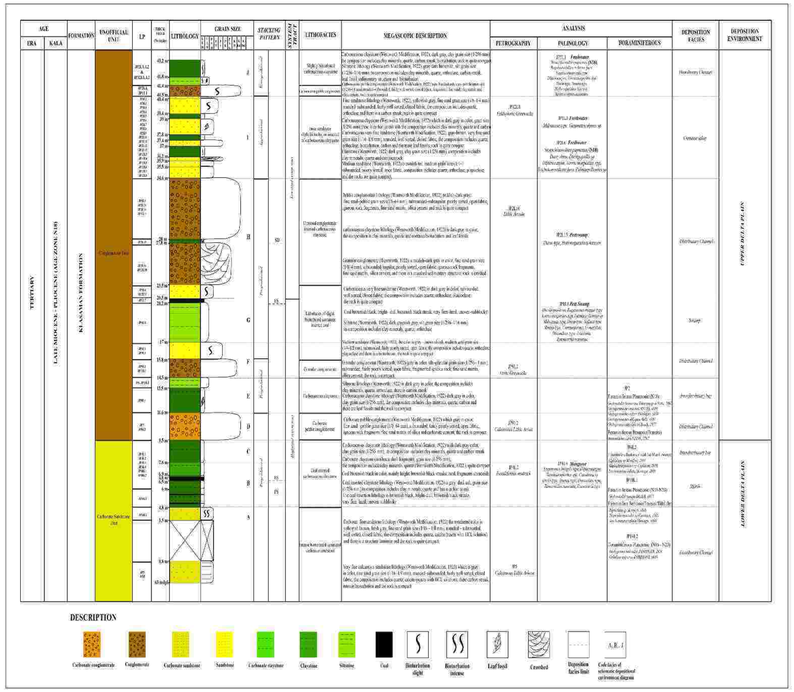
Julianti*, David V. Mamengko**, Ailin A. Yarangga**, Deddy Kurniadi***, Abdul Khaliq***

Organizer : Indonesian Petroleum Association IPA

Co–organizer : Universitas Papua

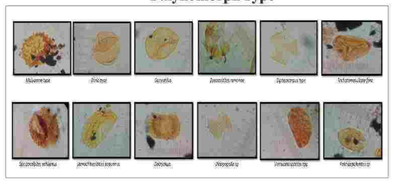
RESULTS AND DISCUSSION

Composite Stratigraphy

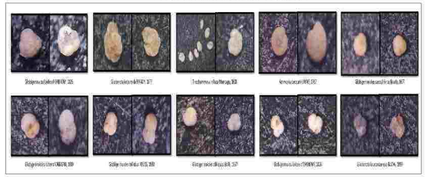


Depositional Environment Study Area

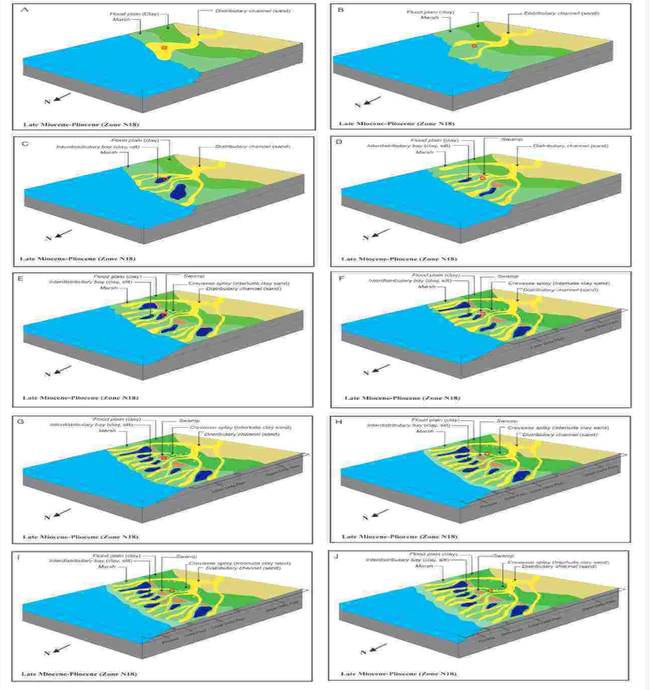
Palynomorph Type



Foraminiferous Fossils



Schematic Depositional Environment Diagram



The carbonate sandstone unit consists of 3 depositional facies, namely the distributary channel, marsh and interdistributary bay, in this unit there is a laminated sedimentary structure, carbon streak and intense bioturbation as well as mollusca shell fragments which characterizes marine influence. This is evidenced by the presence of benthic foraminifera including *Haplophragmoides sp* (Cushman, 1910), *Trochammina inflata* (Montagu, 1808) which is an abundant species and characterizes tidal marshes and mangrove (Kholiq, A, 2009), as well as *Elphidium sp* (Montfort , 1808) as an environmental marker that is influenced by tides (Mamengko, 2014). Meanwhile, based on the presence of palynomorph *zonocostites ramonae, excoecaria type* which is the dominant palynomorph as a mangrove (Robertson research, 1984). Based on petrography, the presence of glauconite and calcite minerals in this unit can indicate marine or a direct relationship between the transitional environment and shallow seas. Based on the characteristics of the stratigraphic sequence contained in the carbonate sandstone unit, this unit was deposited in a mangrove and was located in a lower delta plain which was dominated by tides (tide dominated delta).

In addition, based on the stratigraphic order of the study area, the conglomerate unit consists of 4 depositional facies, namely the distributary channel, interdistributary bay, swamp and crevasse splay facies. In this unit there is a slight bioturbation, crossbedding, the presence of a carbon streak and leaf fossils, this can indicate fluvial influence with the presence of abundant organic material. Meanwhile, based on the presence of palynomorphs in the form of *durio type, sallaca type, shorea type, camnosperma, gonystylus, halloragacidites harrisii* which is the dominant palynomorph as a characteristic of the *peatswamp* (Robertson research, 1984) and based on the presence of palynomorphs in the form of *dacrydium, dicolpopollis sp, terostenochlaenid, verrucatosporites spp, trichotomosulcate fora, Malvaceae type, Gemmatricolpites sp, Eugeissona insignis type* and *palmaepollenites sp* which are included in the vegetation environment freshwater (Robertson research, 1984). Based on petrography, the presence of glauconite and siderite minerals in minimal amounts characterizes a depositional environment where marine was not too intensive. Based on the characteristics of the stratigraphic sequence contained in the conglomerate unit, this unit was deposited in a peatswamp–freshwater vegetation environment and was located in an upper delta plain environment which was influenced by tide–fluvial dominated delta.

Overall, the facies development and depositional environment in the study area is a delta plain environment which shows vertical succession shallowing upward with a relatively dominant progradation process, namely the lower delta plain heading to the upper delta plain environment. The study area of the lower delta plain is coverage of areas affected by tides. In this area, a distributional channel depositional system developed after a regression (sea level drop), then came development of marsh along the distributary channel, when transgressive happened and entered the distributary channel excessively so that the material was carried over to the interdistributary bay. It then led to the upper delta plain with the development of the distribution channel and swamp, after that the effect of transgressive tides (sea level rises) and fluviatile influences entered the distribution channel in excess so that the carried material overflowed into the interdistributary bay, then next regression occurred and deposition made the formation of distributary channel. At the time of flooding in the delta, when the sediment supply was greater than the accommodation space, resulted in insufficient river valleys and tended to experience splitting so that a crevasse play was formed, after that distributary channel growth again then growing distributary channel again.

CONCLUSIONS

Based on the result of the study, it can be concluded as follow :

1. The stratigraphic sequence of the study area consists of 2 unofficial units of Late Miocene–Pliocene (N18) age, sorted from oldest to youngest, namely carbonate sandstone unit and conglomerate units. The relationship between the carbonate sandstone units is conformity below the conglomerate unit, the study area was influenced by the presence of the Klayili Normal Fault which resulted in a relative sinking in the Northwest–North part and there was an influence of Klayili Syncline on the southeastern part.
2. Overall, the facies development and depositional environment in the study area is a delta plain environment which is shown by vertical succession shallowing upward with a relatively dominant progradation process, namely the lower delta plain heading to the upper delta plain. Carbonate sandstone units was deposited in the mangrove vegetation environment and located in the lower delta plain environment which was dominated by tides (tide dominated delta), while the conglomerate unit was deposited in the peatswamp–freshwater vegetation environment and in the upper delta plain environment which was influenced by tide–fluvial dominated delta.
3. There are lithofacies such as carbonaceous claystone which can be interpreted as a facies with potential as a source rock for producing hydrocarbons, while lithofacies sandstone can be interpreted as a reservoir. However, this is still constrained by the age of the rock which is still young, even though it can be used as an oil generator zone in the study area.

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DEPOSITIONAL ENVIRONMENT BASED ON PALYNOLOGICAL AND FORAMINIFEROUS ANALYSIS OF THE KLASAMAN FORMATION IN THE SALAWATI BASIN KLAYILI AREA KLAYILI DISTRICT SORONG REGENCY WEST PAPUA PROVINCE

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ABSTRACT

The Salawati Basin, West Papua is a mature basin producing oil. One of these basins was filled by sediments from the Klasaman Formation consisting of shale, claystone, sandstone, especially in the northern part there are conglomerates, rarely coral reef limestone deposited in a deltaic to fluvial environment. An a analysis of the depositional environment in the Klasaman Formation provides knowledge on the facies development and depositional environment in the study area. The study was carried out by using the surface geological data such as measured stratigraphy section (MS) with approaches of palynology, foraminifera and petrography analysis. The development of palynology studies in Indonesia, especially in Eastern Indonesia is still very minimal and can be improved along with the increasing number of oil and gas exploration moving to transitional environments. The results of the analysis show that the Klasaman Formation is Late Miocene-Pliocene (N18) with stratigraphy sorted from the oldest to the youngest units, namely carbonate sandstone unit and conglomerate unit. The geological structure that developed in the study area was controlled by a reverse Klayili Normal Fault which cause a subsidence in the Northwest-North part of the study area and folding in the Southeast namely Klayili Syncline. Overall facies development as a delta plain environment that show shallowing upward vertical succession with relatively dominant progradation process. Carbonate sandstone as the oldest unit was deposited in a lower delta plain environment as a tide dominated delta with mangrove vegetation to a peat swamp with freshwater vegetation. There are three facies associated with this unit which are distributary channel, marsh, and interdistributary bay. Conglomerate as the younger unit was deposited in the upper delta plain environment which is influenced by tide-fluvial dominated delta. Several facies associated with this unit are distributary channel, interdistributary bay swamp, and crevasse splay.

INTRODUCTION

The tectonics of Eastern Indonesia is controlled by the interaction between the Indo-Australian, Eurasian and Pacific Plates. The interaction between the movement of the Australian Plate and the Pacific Ocean Plate caused the movement of the left lateral strike slip fault (Satyana, 2011). The activation of the left lateral strike slip fault of Sorong caused the Salawati Basin to experience subsidence during the Pliocene, resulting in the deposition of the Klasaman Formation which was deposited in conformity overlie the Klasafet Formation.

The Klasaman Formation of Late Miocene-Pliocene age is one of the formations as candidate source rock such as claystone, shale and coal, which are especially found in the Lower Klasaman Formation. Related to this, research is conducted on facies development and depositional environment in the Klasaman Formation. The purpose of this study is to identify the development of facies succession and depositional environment, also to see and the applications for the presence of hydrocarbons in the Klasaman Formation.

METHODOLOGY

The study area is located in the Klayili Area, Klayili District, Sorong Regency, West Papua Province (Figure 2). This research was field data retrieval in

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the form of surface geological mapping and performs a measured stratigraphy section (MS). This research is divided into preliminary stage, data collection, processing and data analysis. The preliminary stage consist of a literature study and secondary data gathering as well as conducting reconnaissance. Data collection primarily consist of outcrop sample collection which include measured stratigraphy section (MS) and geological structure data. The data processing and analysis stage is divided into 2, namely laboratory analysis and studio analysis. Laboratory analysis is in the form of palynological analysis (Robertson research, 1984 and Lelono et al., 1996), foraminifera (Robertson, 1981 and Blow, 1986) and petrography (Wentworth, 1922 and Pettyjohn, 1973), while studio analysis consists of making track and waypoint maps, cross-sectional profiles of MS, geological maps and schematic depositional environment diagram.

REGIONAL SETTING

Regional Physiography

Based on the physiographic map of Socong and its surroundings (Amri et al, 1990), the study area is included in the physiographic unit of the Low Hills Region. The low hilly area extends to the west covering Salawati Island. This area occupies the central part of West Papua and these mores west to southwest around the Klasaman and Klamogan areas. Around the Klasaman area consists of hilly areas that resemble karst. The highest peak is on Salawati Island, which is 200 m above sea level.

Regional Geological Structure

Based on Satyana (2002), the regional geological structure of the study area is located in the Salawati Basin. The formation of the Salawati Basin was strongly controlled by the Sorong Fault. This fact caused a polarity reversal, regional seismic data and stratigraphic studies show that the layers of the Paleocene before the Pliocene thickened from North to South indicating the presence of a basin center (deep) in the South. In the Miocene-Pliocene, the basin tilted towards the West-Southwest and as a result, regional plate interactions changed in this region. The phenomenon shows the role of the Sorong Fault around the Salawati Basin.

In the middle of the Pliocene, there was a branching of the Sorong Fault which entered the Salawati Basin, and since this geological change had occurred in the Salawati Basin. The basin sank very rapidly in a south-southwest direction and due to tectonic compression, the northern and eastern parts of the basin were uplifted. To the north, due to the sinking of the basin, many normal faults descended to the north. The occurrence of these normal faults was related to the horizontal faulting of the Sorong Fault. This Northward sinking reversed the basin direction, and all depths located on the South-Southeast before the Pliocene moved to the North-Northwest after the Pliocene. The deposition of the Klasaman sediment occurred throughout the Pliocene as a result of this sinking. Throughout the sediment of the basin, the Klasaman Formation deposition continued and the generation of hydrocarbons also occurred through many faults caused by Sorong tectonics. During the Pliocene-Pleistocene, the Sorong tectonic stopped and was also the end of the polarity reversal of the Salawati Basin.

Regional Stratigraphy

According to Satyana (2002) and Amri et al., (1990) the study area belongs to the Salawati Basin, especially in the Klasaman Formation. Based on Amri et al (1990), the Klasaman Formation is Late Miocene to Pleistocene with a thickness of 200-4000 meters and its distribution is in a wavy to flat enough area on the Seibel Salawati Island (Visser and Hermes, 1962). The lithology is mudstone, shale, claystone, sandstone, and marly in the north of conglomerate, rarely coral reef limestone. Usually the layers of sandstone, limestone and conglomerate that are near the north are rather coarse, the top is rougher than the bottom. Its relationship is conformity with the Klasafat Formation, unconformity under the sole conglomerate, enriching the granite of Sorong, on par with the Sawakul Formation in the Bintuni Basin (Testuinfrac and Ranaki). The fossil content is foraminifera, mollusca and corals with a depositional environment from shallow sea to delta and terrestrial, while the upper part is mainly paralic and terrestrial. Meanwhile, based on Satyana (2002), the Klasaman Formation is Pliocene in age, consisting of deep-sea claystone with sandstone and limestone at the bottom and lignite. This formation marks a marine regression that occurred in the Sorong Fault area. It was deposited unconformity over the previous formation in a shallow marine facial environment. Due to the very intensive subsidence of the basin, the Klasaman Formation has a very significant thickness, reaching around 7,000-8,000 feet.

RESULTS AND DISCUSSION

Stratigraphic Sequence of the Study Area

Based on the results of the study, the stratigraphy of the study area consists of 2 unofficial units of Late Miocene–Pliocene age (Time:N19) which are sorted from oldest to youngest units, namely carbonate sandstone unit and conglomerate unit (Figure 4 & 5). The study area was influenced by the Klanth Normal Fault with a fault plane N277°E/6° resulting in subsidence to the northeast-north direction. In addition, based on the reconstruction of the geological cross section of the study area there was an influence of the Klanth Syncline Fold structure relative to the direction of Southeast (Figure 6).

1) Carbonate Sandstone Unit

The carbonate sandstone unit has a thickness interval of approximately 5–8.5 m and its distribution is relative to the North and Southeast directions of the study area. The carbonate sandstone unit consists of 3 lithofacies, namely the massive bioturbated laminated carbonate sandstone lithofacies consisting of carbonate fine sandstone lithology and coal-inserted carbonaceous claystone lithofacies consisting of coal insertion claystone lithology, coal, carbonate claystone and carbonaceous claystone. The relationship is continuity under the conglomerate unit.

Intensely bioturbated laminated carbonate sandstone lithofacies (0 – 4.8 m intervals)

These lithofacies are found in samples JP5–JP12 (interval 0 – 0.8 m) and JP14L2 (interval 1.5–4.8 m). Samples JP5 and JP11, megascopically is named carbonate fine sandstone (Wentworth Modification, 1922) the weathered color is yellowish brown, fresh gray; fine sand grain size (1/16 – 1/8 mm); rounded – subrounded, well sorted, closed fabric, the composition includes quartz, calcite (reacts with HCl, siltstone) and there is a structure laminate. Petrographically, this rock shows an appearance with a grain size of around 0.031 – 1.00 mm (coarse silt - coarse sand) and an average grain size of 0.18 mm (fine sand), subrounded-subangular, poorly sorted-moderately sorted, contact between grains form of floating point contacts, the mineral composition includes microcrystalline quartz (7%), K-feldspar (10%), plagioclase (12%), metamorphic lithic (polycrystalline quartz quartzite) (3%), sedimentary lithic (10%), unidentified fossil (2%), glauconite (3%), calcite (2%), opaque (3%), muscovite (2%), carbonate clay as matrix (5%) and calcite as cement (33%), hence the name of the rock is Calcareous Lithic Litharenite (Modified From Pettijohn, 1975). While the sample JP14L2 is named a very fine carbonated siltstone (Wentworth Modification, 1922) which is gray as color, fine sand grain size (1/16–1/8 mm), rounded-subrounded, fairly well sorted, closed fabric, the composition includes quartz, calcite (reacts with HCl, siltstone), there is intense carbon cracks bioturbation. A dominant classic is indicated based on the characteristics of the lithological sequence (Pettijohn, 1992).

Coal inserted carbonaceous claystone lithofacies (interval 4.8–6.5 m)

These lithofacies are found in samples JP14L1 (4.8–6 m intervals), JP4L2–JP10L2 (6.5–7.3 m intervals), JP4L2–JP10L2 (6.8–7.3 m intervals), JP4L1 (7.3 m–9.5 m intervals). Sample JP14L1 is named coal inserted claystone (Wentworth Modification, 1922) is gray-dark ash, grain size (1/256 mm) its composition includes clay minerals, quartz and has a carbon streak. The coal insertion lithology is brownish black, bright-dull, brownish black streak, very firm-hard, uneven-subblocky with a coal seam thickness of about 3–4 cm. Meanwhile, samples JP4L4 and JP10L2 is named coal with brownish black color, namely bright, brownish black streak, hard, fragment conchoidal with a coal seam thickness of about 4–10 cm. The presence of palynomorphs in the JP4L4 sample in the form of angiosperm pollen type *Alnipollenites verus*/angiosperm *Myrica* pollen type *Quercoidites microhenrici*/angiosperm *Quercus* pollen type *Quercoidites microhenrici*, especially *Quercoidites microhenrici* type which is the dominant palynomorph as a marker of the mangrove (Koesoemadinata, 1984). Samples JP4L2 and JP10L2 is named carbonate claystone (mollusca shell fragment), grain size (1/256 mm), the composition includes clay minerals, quartz (Wentworth Modification, 1922). Petrographically, this rock shows an appearance with a grain size of around 0.0039 - 0.25 mm (clay-fine sand) and an average grain size of 0.0236 mm (clay), rounded grain shape , very well sorted, contact between grains in the form of floating, porosity fracture (2%), its mineral composition includes microcrystalline quartz (3%), K-feldspar (18%), fossils (11%), carbon (2%), opaque (1%), muscovite (1%), carbonate clay (5%) and detritus clay (7%) as a matrix and silica cement (2%), hence the name fossiliferous

mudrock (Modified from Petrijohn, 1975). These two samples have the same presence of benthic foraminifers including *Haplophragmoides* sp (Cushman, 1910); *Trochammina inflata* (Montagu, 1808) including abundant species and as a marker of tidal marshes and mangrove (Khalil, 2009) and *Elphidium* sp (Linnaeus, 1806) as an environmental marker influenced by tides (Murray, 2014). While the presence of planktonic foraminifera is only in sample PPWL1 in the form of *Globororalia humilis* (BERMUDEZ, 1877) whose age range in the N18-N23 zone (Blow, 1969). This series of lithological characteristics may reflect the marsh (Dessel, 1992). In addition, sample PPWL1 (interval 7.5-9.5 m) is named carbonaceous claystone (Wentworth Modification, 1922) with dark gray color, clay grain size (1/256 mm), its composition includes clay minerals, quartz and carbon shreds belonging to the intertidal/estuary bay (Dessel, 1992).

3) Conglomerate Unit

The carbonate sandstone unit has a thickness interval of approximately 9.5–41.2 m and its distribution is relative to the East and Southeast directions of the study area. The conglomerate unit consists of 3 lithofacies, namely calcareous pebble conglomerate lithofacies, calcareous claystone lithofacies consisting of calcareous claystone and siltstone, granular conglomerate lithofacies, slight bioturbated coal inserted sandstone lithofacies consisting of medium sandstone, siltstone, coal, carbonaceous very fine sandstone, cross conglomerate insertion carbonaceous claystone lithofacies consisting of cross granular conglomerate, carbonaceous claystone and pebble conglomerate, bioturbation slight cross sandstone insertion of calcareous claystone lithofacies consisting of medium sandstone, claystone, carbonaceous very fine sandstone, carbonaceous claystone and fine sandstone, carbonaceous pebble conglomerate lithofacies and the slight bioturbated carbonaceous claystone lithofacies consisting of siltstone and carbonaceous claystone.

Carbonate pebble conglomerate lithofacies (9.5–11.6 m interval)

These lithofacies were found in samples PPWL2 and PP7 (9.5–11.6 m intervals). Megascopically, samples PPWL2 and PP7 is named carbonate pebble conglomerate (Wentworth Modification, 1922) which is gray in color, fine sand- pebble grain size (1/8–64 mm), unsorted, fairly poorly sorted, open fabric, igneous rock fragments, fine sand matrix of silica and carbonate cement. Petrographically, the rock shows an appearance with a grain size of around 0.125 – 3.36 mm (fine sand - granule) and an average grain size of 1.71 mm (granule), grain shape subrounded – angular, poorly sorted-very poorly sorted, contact between grains form of floating-grain contacts, the mineral composition includes monocrystalline quartz (1%), K-feldspar (17%), plagioclase (3%), metamorphic litter (polycrystalline quartz quartzite) (1%), sedimentary litter (19%), litic igneous rock (09%), unidentified fossils (3%), glauconite (1%), carbon (2%), opaque (2%), muscovite (1%), carbonate clay as matrix (1%) and calcite as cement (11%), hence the name of the rock is Calcareous Lithic Arenite (Modified From Pettijohn, 1975). The presence of foraminifera in the sample is very minimal, namely for benthic foraminifera there is only ammonia beccarii (LINNE, 1767), while for age determination there are several types of planktonic foraminifera with a small number in the form of *globororalia humilis* (Takayanagi & Saito, 1962), *globigerinoides trilobus* (REUSS, 1850), *ruber globigerinoides* Ortegui, 1836, *globigerinoides obliquus* (Bolli, 1957), *globigerina calculiformis* (Brady, 1877), but the age can be identified in the N18 zone (Blow, 1969). This series of lithological characteristics is included in the distributary channel (Dessel, 1992).

Carbonaceous claystone lithofacies (interval 11.6–14.5 m)

This lithofacies was found in sample PPWL1 (interval 11.6–13.3 m) and PP6–PP11.1 (interval 13.3–14.5 m). Megascopically, sample PPWL1 is named carbonate claystone (Wentworth Modification, 1922) dark gray in color, clay grain size (1/256 mm), the composition includes clay minerals, quartz, carbon and there are leaf fossils. In addition, there are samples PP6 and PP11.1 (interval 13.3–14.5 m) is named siltstone (Wentworth, 1922) is dark gray in color, the composition includes clay minerals, quartz, orthoclase, there is carbon shreds. This series of lithological characteristics is included in the distributary bay (Dessel, 1992).

Granular conglomerate lithofacies (interval 14.5–41.2 m)

These lithofacies are found in samples PPWL2 and

JP11L1 (interval 14.5–15.8 m). Megascopically, it is named granular conglomerate which is gray in color, silt–granular grain size (1/256– 4 mm), subrounded, fairly poorly sorted, open fabric, fragmented igneous rock, fine sand matrix, silica cement (Wentworth, 1922). Petrographically, this rock shows an appearance with a grain size of around 0.031-1.00 mm (coarse silt - very coarse sand) and average size of the grain is 0.45 mm (medium sand), grain shape subangular, poorly sorted, contact between grains in the form of floating. Its mineral composition includes monocrystalline quartz (15%), K-feldspar (2%), plagioclase (1%), metamorphic lithic (polycrystalline quartz/quartzite (10%)), igneous rock lithic (5%), glauconite (1%), carbon (3%), opaq (3%), muscovite (1%), detritus clay as matrix (35%) and silica (10%), and siderite (8%) as cement, hence the name lithic greywacke (Pettijohn, 1975). These lithological characteristics are included in the distributary channel (Diessel, 1992).

Lithofacies of slight bioturbated sandstone inserted coal (interval 15.8–23.5 m)

These lithofacies are found in samples JP2L1–JP9L1 (interval 15.8–17m), JP1L3 (interval 17–20.2 m), JP1L7 (interval 20.2–20.5 m), samples JP1L6 and JP2L17 (interval JP2L17), 20.5–23.5 m). Samples JP2L1 and JP9L1 is named medium sandstone (Wentworth, 1922), the color is brownish gray, the sand grain size is medium (1/4-1/2 mm), subrounded, rather poorly sorted, open fabric, the composition includes quartz, orthoclase, plagioclase and there is a bioturbation sediment structure. These lithological characteristics are included in the distributary channel facies (Diessel, 1992). Sample JP1L3 is named siltstone (Wentworth, 1922), dark greenish gray, silt grain size (1/256–1/16 mm) its composition includes clay minerals, quartz, orthoclase. The presence of palynomorphs in this sample of various types in the form of *dicolpopollis sp. eugeissona insignis type, verrucatosporites spp. psilatricolporites sp, lindsayae type, stenochlaena type, nypa type, calamus type, arenga type, cunninghamia geminata sp., dicolpites type, polypodiisporites, zalacca sp.*, but according to the type and number of palynomorph obtained, then the vegetation environment is in the peatswamp (Robertson research, 1994). Sample JP1L7 is coal brownish black, bright– dull, brownish black streak, very firm–hard, uneven–subblocky with a thickness of about 30 cm of coal seam. This series of lithological characteristics is included in the swamp (Diessel, 1992). While samples JP1L6 and JP2L17 is named carbonaceous very fine sandstone is dark gray in color, subrounded, well sorted, closed fabric, the composition includes quartz, orthoclase, plagioclase. These lithological characteristics are included in the distributary channel (Diessel, 1992).

Lithofacies of crossbedding conglomerate inserted carbonaceous claystone (interval 23.5–34.6 m)

These lithofacies are found in samples JP2L16 and JP12L10 (interval 23.5–27.8 m), JP2L15 (interval 27.8–28 m), JP12L9 (interval 28–34.6 m). Samples JP2L16 and JP12L10, megascopically is named granular conglomerate (Wentworth, 1922) are reddish-dark gray in color, grain size is fine-grained (1/8–4 mm), subrounded-angular, poorly sorted, open fabric, igneous rock fragments, fine sand matrix, silica cement, and there is a crossbedding sedimentary structure. Petrographically, this rock shows an appearance with a grain size of 0.0625-3.38 mm (very fine sand - granule) and an average grain size of 2.13 mm (Granule), subrounded - angular, poorly sorted sorting, contact between grains long contacts, dissolution porosity (3%), mineral composition includes monocrystalline quartz (8%), K-feldspar (3%), plagioclase (2%), metamorphic lithic (polycrystalline quartz/quartzite) (20%), sedimentary rock lithic (10 %), igneous lithic (32%), carbon (3%), opaque (3%), muscovite (1%), detritus clay as matrix (8%) and silica (3%), and siderite (2%) as the cement, the name of the rock is lithic arenite (Pettijohn, 1975). Sample JP2L15 is named carbonaceous claystone (Wentworth Modification, 1922) is dark gray in color, the composition is clay minerals, quartz and contains bioturbation and leaf fossils. The presence of palynomorphs in this sample in the form of a *stario type, haloragaceae* harvest vegetation environment peatswamp (Robertson research, 1994). Sample JP12L9 is named carbonaceous conglomerate (Wentworth Modification, 1922), reddish-dark gray, fine sand-pebble grain size (1/8–64 mm), subrounded-subangular, poorly sorted, open fabric, igneous rock fragments, fine sand matrix, silica cement, there is carbon streak. This series of lithological characteristics is included in the distributary channel (Diessel, 1992).

Lithofacies of cross sandstone slight bioturbation inserted of carbonaceous claystone (interval 34.6–40.5 m)

These lithofacies are found in samples JP12L4 (interval 34.6–35.9 m), JP12L6 (interval 35.9–36.2 m), JP2L6 (interval 37.4–37.8 m), JP12L5 (interval 39–3 ,4 m), JP12L3 (38–39.4 m interval), JP12L2 (39.4–40.5 m interval). Sample JP12L5 megascopically is named carbonaceous very fine sandstone (Wentworth Modification, 1922) which is dark brownish gray in color, very fine sand grain size (1.16–1.8 mm), rounded, well sorted, closed fabric, the composition includes quartz, orthoclase, there is carbon and the rock is moderate compact. Petrographically, this rock shows an appearance with a grain size of around 0.031-0.50 mm (coarse silt - medium sand) and average size of the grain is 0.087 mm (very fine sand), rounded–subrounded, poorly sorted–moderately sorted; contact between grains is the form of floating, point and long contact, there is primary fracture (2%), the mineral composition includes monocrystalline quartz (18%), K-feldspar (14%), plagioclase (8%), carbon (3%), opaque (1%), muscovite (3%), detritus clay as matrix (40%) and silica (3%), along with oxides (2%) as cement, hence the name feldspathic greywacke (Pettijohn, 1975). Sample JP12L5 is named medium sandstone (Wentworth, 1922) brownish red, medium grain size (1.4–2.0 mm), subrounded, poorly sorted, open fabric, composition includes quartz, orthoclase, plagioclase and the rocks are quite compact, there is also a crossbedding sedimentary structure which can indicate fluvial influence. Sample JP2L6 is named claystone (Wentworth, 1922) dark gray, clay grain size (1.256 mm), composition includes clay minerals, quartz and compact rock. The palynomorph content in this sample is *Acrostichum aureum*, *Rhizophora*, *Stenochlaena palustris*, *Dipterocarpus*, *Verrucatosporites* sp., *Polypodiaceoisporites favus* and *Polypodiisporites* sp which belongs to the freshwater vegetation environment (Kobchoo research, 1984), in addition to the presence of *Cicatricosisporites pannuensis* as an age index in zone NTP (Lelono, 1999). Sample JP12L2 is named carbonaceous very fine sandstone (Wentworth Modification, 1922), gray-brown, very fine sand grain size (1.16–1.8 mm), rounded, well sorted, closed fabric, the composition includes quartz, orthoclase, there is carbon and there are leaf fossils. Sample JP1L3 is named carbonaceous claystone (Wentworth Modification, 1922) which is dark gray in color, grain size (1.256 mm) there is carbon mixed with the components include clay minerals, quartz and carbon. The presence of palynomorphs in this sample was minimal, but could represent a feature of freshwater (Kobchoo research, 1984) in the form of *Verrucatosporites* sp. In addition, sample JP12L3 is named fine sandstone (Wentworth, 1922), yellowish gray, fine sand grain size (1.8–2.4 mm), rounded–subrounded, fairly well sorted, closed fabric, the composition includes quartz, orthoclase and there is a carbon streak. This series of lithological characteristics shows the channel splay facies (Diessel, 1992).

Carbonaceous pebble conglomerate lithofacies (interval 40.5–41.4 m)

This lithofacies is present in the sample JP2L3 (interval 40.5–41.4 m) is named carbonaceous conglomerate (Wentworth Modification, 1922) which is gray-black in color, clay-gravel grain size (1.256–64 mm), rounded–subrounded, fairly well sorted, closed fabric, fragmented fine sand, clay matrix and silica cement. This lithofacies is included in the distributary channel (Diessel 1992) which is followed by slight bioturbation carbonaceous claystone lithofacies.

Slight bioturbated carbonaceous claystone lithofacies (interval 41.4–43.2 m)

These lithofacies are found in samples JP12L2 (interval 41.4–41.8 m) and JP2L1 (interval 41.8–43.2 m). Sample JP12L2 is named siltstone (Wentworth Modification, 1922), dark brownish gray, silt grain size (1.256–1/16 mm), its composition includes clay minerals, quartz, orthoclase, carbon streak and there is a leaf fossil sedimentary structure and bioturbation. Sample JP2L1 is named carbonaceous claystone (Wentworth Modification, 1922), dark gray, clay grain size (1.256 mm), the composition includes clay minerals, quartz, streak carbon, and there is bioturbation. The presence of palynomorphs in this sample in the form of *Cyathidites minor*, *Verrucatosporites favus*, *Dipterocarpus*, *Verrucatosporites* sp., *Acrostichum aureum*, *Stenochlaena palustris*, *Spinizonocolpites baculatus*, *Polypodiisporites* sp which can identify a freshwater environment (Kobchoo 1984) because the palynomorph that represents the environment is more dominant than the other palynomorphs, besides the presence of *Papuacedrus stenoblandifolia* as an index of age determination in the NTP zone (Lelono, 1996).

Depositional Environment Study Area

The carbonate sandstone unit consist of 3 depositional facies, namely the distributary channel, marsh and interdistributary bay, in this unit there is a laminated sedimentary structure, carbon streak and intense bioturbation as well as mollusca shell fragments which characterizes marine influence. This is evidenced by the presence of benthic foraminifera including *Haplophragmoides sp* (Cushman, 1910), *Trochammina inflata* (Montagu, 1808) which is an abundant species and characterizes tidal marshes and mangrove (Rhoding, A, 2009), as well as *Elphidium sp* (Momfort , 1808) as an environmental marker that is influenced by tides (Murangiko, 2014). Meanwhile, based on the presence of palynomorph *rhizocolpites rumanae*, *rhizocorta type* which is the dominant palynomorph as a mangrove (Robertson research, 1984). Based on petrography, the presence of glauconite and calcite minerals in this unit can indicate marine or a direct relationship between the transitional environment and shallow sea. Based on the characteristics of the stratigraphic sequence contained in the carbonate sandstone unit, this unit was deposited in a mangrove area and was located in a lower delta plain which was dominated by tides (tide dominated delta).

In addition, based on the stratigraphic order of the study area, the conglomerate unit consists of 4 depositional facies, namely the distributional channel, interdistributary bay, swamp and crevasse splay facies. In this unit there is a slight bioturbation, crossbedding, the presence of a carbon streak and leaf fossils, this can indicate fluvial influence with the presence of abundant organic material. Meanwhile, based on the presence of palynomorphs in the form of *diporite type callista type, cheiria type, cannanoporites ponyalus, haliangiacites kenyon* which is the dominant palynomorph as a characteristic of the *peatswamp* (Robertson research, 1984) and based on the presence of palynomorphs in the form of *diporites, diporipollis sp, verrutricolpites, verrucatosporites type, rhizholomuriate flora, Malvacites type, Owenweberiolites sp, Tuberculina maljeri type* and *psilatriaperturates sp* which are included in the vegetation environment freshwater (Robertson research, 1984). Based on petrography, the presence of glauconite and siliceite minerals in mineral amounts characterizes a depositional environment where marine was not too intensive. Based on the characteristics of the stratigraphic sequence contained in the conglomerate unit, this unit was deposited in a peatswamp–freshwater vegetation environment and was located in an upper delta plain environment which was influenced by tide–fluvial dominated delta.

Overall, the facies development and depositional environment in the study area is a delta plain environment which starts retrial succession stationing spread with a relatively constant progradation process, namely the lower delta plain leading to the upper delta plain environment. The study area of the lower delta plain is coverage of areas affected by tides. In this area, a distributional channel depositional crosses developed after a regression (sea level drop), then came development of marsh along the distributor channel, when transgressive happened and extend the distributors channel excessively so that the material was carried over to the interdistributary bay. It then led to the upper delta plain with the development of the distributor channel and swamp, after that the effect of transgressive tides (sea level rises) and fortnightly influences extend the distributors channel to excess so that the carried material overflowed into the interdistributary bay, then sea regression occurred and deposition made the formation of distributary channel. At the time of flooding in the delta, when the sediment supply was greater than the accommodation space, resulted in insufficient river valleys and tended to experience splitting so that a crevasse play was formed, after that distributary channel growth again then growing distributary channel again.

Based on the cracking pattern from the interpretation of field data, it is divided into 3 phase from the bottom to the top stratigraphic sequence. The progradation phase which is characterized by relatively coarsening upward grain size in the interval 0–34.5 m, the aggradation phase is characterized by the formation of alternating deposits of coarse-grained and fine-grained material with relatively same thickness found at intervals of 34.5–40.5 m, and the retrogradation phase as the final phase that is formed with the fining upward grain size found in 40.5–47.2 intervals. The flooding surface of the study area which indicate the sudden addition of accommodation space is found at intervals of 4.5–6.5 m and intervals of 20.2–20.5 m right in the coal lithology. As well as the sequence boundary of the study area which shows a gradual reduction in accommodation space suddenly with the occurrence of low ash at intervals of 7.5–25 m between the conglomerate lithology. Meanwhile, based on the system tract of the study area, the high system tract (HST) are located at intervals of 0–20.5 m, low system tract (LST) were found at intervals of 20.5–40.5 m and transgressive system tract (TST) are

found at intervals of 40.5– 43.2 m.

CONCLUSIONS

Based on the result of the study, it can be concluded as follow:

1. The stratigraphic sequence of the study area consists of 2 unofficial units of Late Miocene–Pliocene (N18) age, sorted from oldest to youngest, namely carbonate sandstone unit and conglomerate unit. The relationship between the carbonate sandstone unit is conformity below the conglomerate unit, the study area was influenced by the presence of the Klayih Normal Fault which resulted in a relative sinking in the Northwest-North part and there was an influence of Klayih Syncline on the southeastern part.

2. Overall, the facies development and depositional environment in the study area is a delta plain environment which is shown by vertical succession shallowing upward with a relatively dominant progradation process, namely the lower delta plain leading to the upper delta plain. Carbonate sandstone units Was deposited in the mangrove vegetation environment and located in the lower delta plain environment which was dominated by tides (tide dominated delta), while the conglomerate unit was deposited in the pestswamp-mangrove vegetation environment and in the upper delta plain environment which was influenced by tide-fluvial dominated delta.

3. There are lithofacies such as carbonaceous claystone which can be interpreted as a facies with potential as a source rock for producing hydrocarbons, while lithofacies sandstone can be interpreted as a reservoir. However, this is still constrained by the age of the rock which is still young, even though it can be used as an oil generator zone in the study area.

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REFERENCES

Asikin, Sjk. 1992. *Peta Geologi Lembar Serang, Jawa Skala 1:100.000*. Center for Research and Development of Geological Bandung.

Haslebacher, P. 1974. *A Palynological Interpretation of Paleo-environment in South-East Asia*. Robertson research (Singapore). Page 113-127.

Koesoemadinata, Y. 2017. *Prinsip dan Aplikasi Stratigrafi*. Unpad Press: Bandung.

Krumbein, W.C., Sloss, W. 1951. *Atlas of rock-forming minerals in thin section*. Material from a Division of John Wiley & Sons, Inc: USA.

Kerr, PF 1959. *Optical Mineralogy*. McGraw Hill Book Company, Inc : USA.

Khalig, A. 2009. *Benthonic Foraminifera Age Zonation and Environment of Deposition*. Center for Research and Development of Oil and Gas Technology "Lemigas": Jakarta.

Khalig, A. 2011. *Zonasi Foraminifera Bentonik Batas Sub-Pliosen (Kuarter) Rungi*. Center for Research and Development of Oil and Gas Technology "Lemigas": Jakarta.

Khalig, A. 2016. *Penggunaan Foraminifera Plangtonik Secara Kualitatif Dalam Stratigrafi di Indonesia*. Center for Research and Development of Oil and Gas Technology "Lemigas": Jakarta.

Khalig, A. 2015. *Zonasi Foraminifera Bentonik Batas Sub-Pliosen (Kuarter) Rungi*. Center for Research and Development of Oil and Gas Technology "Lemigas": Jakarta.

Lelono, EB 2016. *Dry climate expressions on the paleowaves of Indonesia as recorded in its paleoassemblage*. Center for Research and Development of Oil and Gas Technology "Lemigas": Jakarta.

Lelono, EB 2007. *Zonasi Palen Tersier Indonesia Timur*. Center for Research and Development of Oil and Gas Technology "Lemigas": Jakarta.

Munsart T. A dan Ferm JC 1968. *A modification of procedures for petrographic analysis*. Tertiary Petrofacies center: University of Kentucky : USA.

Mamengko, DY, Muljana, B., Sardjaja, BT 2014. *Analisis Fasies Dan Lingkungan Pengendapan*

Formasi Manberamo "B" Di Cekungan Papua Utara Sebagai Kandidat Source Rock. University of Padjadjaran : Bandung.

Mamengko, DW, Sandjaja, BT, Mulyana, B, Panggabean, H, Haryanto, I, Lelono, EB, Misri, IT, Panuju, 2019, *Perkembangan Facies Sedimen Formasi Manberamo Bersumur Minyak Abar - Pliosen di Cekungan Papua Utara* Journal of geology and mineral resources Vol 20, No 1.

Morley, RJ 1993. *Biostratigraphic characterization of systems tracts in Tertiary sedimentary basins*. In: C.A. Caughey et al. (eds.) Proc. Int. Symposium on sequence stratigraphy in SE Asia, Jakarta 1991. Indon. Petrol. Assoc.

Morley, R., Lunt, P., Gatsal, TT *Introduction to Cenozoic Biostratigraphy of Indonesia* SE Asia pages 6-12.

Muller, J. 1968. *Palynology of the Pedawan and Plateau Sandstone Formations (Cretaceous-Eocene) in Sarawak, Malaysia*. Bataafse Internationale Petroleum Maatschappij : The Hague, Holland.

Nichols, G. 2009. *Sedimentology and Stratigraphy*. Blackwell Science Ltd : London. 2nd page 179-198.

Ovinda, Sunarsih, E., Hamdani, AR, Ruhimuddin, M., Triwidhia, A. 2018. *Facies and Sequence Stratigraphy Analysis of Klasaman Formation in the "X Well", Northern Salawati Basin, Papua Indonesia* Scientific Research Publishing: Jakarta.

Postuma, JA. 1971. *Manual of Planktonic Foraminifera*. Elsevier, The Hague, Amsterdam.

Ramadhan, R., Ngadie, R., Arbama, Tegi, Bangun, 2018. *Studi Stratigrafi Berdasarkan Hasil Analisis Data Paleontologi pada Sumur T, Cekungan Salawati Selatan*. University of Diponegoro, PPPTB-BIG Lemigas: Jakarta.

Sayoga, ASI, Pamungkas, MDH, Ngadmo, BDP 2002. *Evolution Of The Salawati Structure, Eastern Indonesia : A Pivotal Strong Fault Deformation*. Badan Pelaksana Kegiatan Hulu Migas: Gd. Ciputra Tower, Jakarta.

Setiadi, I, Margiyoso, 2018. *Interpretasi Geologi Bawah Permukaan dan Delineasi Cekungan Salawati Wilayah Sorong dan Sekitarnya Berdasarkan Analisis Spektral Serta Pemodelan 2D dan 3D Data Gaya Berat*. Journal of Geology and Mineral Resources : Bandung.

Schlee, PA 1973. *A Color Illustrated Guide to Carbonate Rock Constituents, Textures, Cements, and Porosities*. The American Association of Petroleum Geologist : USA.

Schlee, PA 1973. *A Color Illustrated Guide to Constituents, Textures, Cements, and Porosities of Sandstone and Associated Rocks*. The American Association of Petroleum Geologist : USA.

Sujono, SS, Sunjaya, DH 2018. *Sedimentologi*. Yogyakarta : UGM Press. Page 159-199.

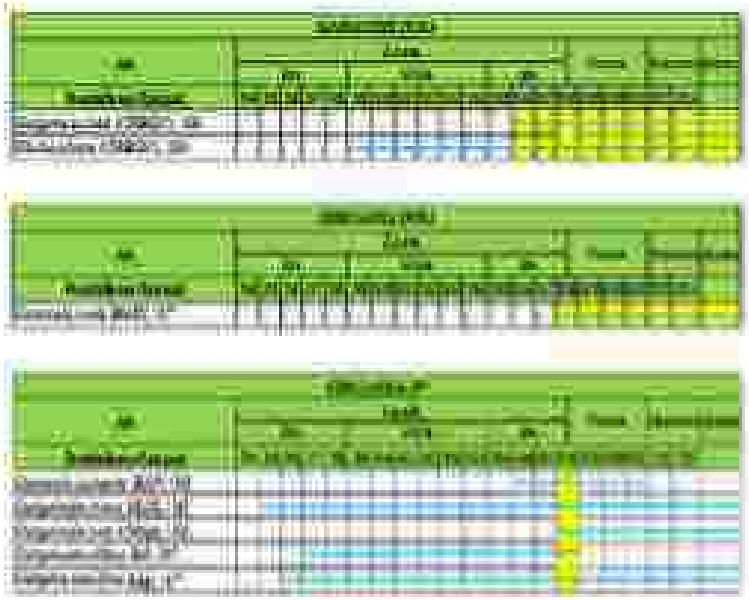
TABLE 3

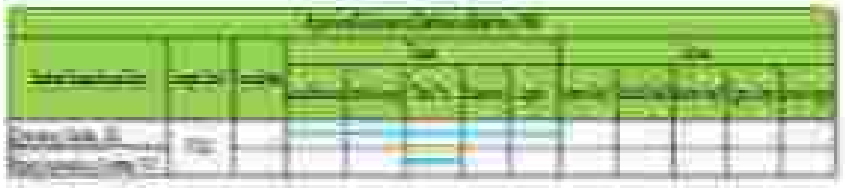
PALYNOMORPH TYPE/SAMPLE

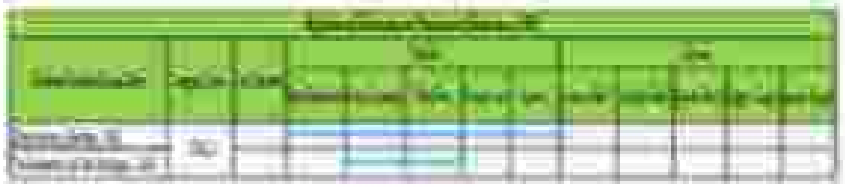
ENVIRONMENT	PALYNOMORPH TYPE	[illegible]											
		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
		No	[illegible]	No	[illegible]	No	[illegible]	No	[illegible]	No	[illegible]	No	[illegible]
[illegible]	[illegible]									[illegible]	[illegible]		
[illegible]	[illegible]												
	[illegible]			[illegible]	[illegible]								
	[illegible]	[illegible]	[illegible]										
	[illegible]			[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]												
	[illegible]			[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]												
	[illegible]			[illegible]	[illegible]								
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]								
	[illegible]												
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]			[illegible]	[illegible]								
	[illegible]			[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]			[illegible]	[illegible]								
	[illegible]			[illegible]	[illegible]								
	[illegible]					[illegible]	[illegible]			[illegible]	[illegible]		
[illegible]	[illegible]			[illegible]	[illegible]							[illegible]	[illegible]
	[illegible]									[illegible]	[illegible]		
[illegible]	[illegible]			[illegible]	[illegible]							[illegible]	[illegible]
	[illegible]			[illegible]	[illegible]							[illegible]	[illegible]
	[illegible]												
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 2

DETERMINATION OF AGE AND DEPOSITIONAL ENVIRONMENT BASED ON FORAMINIFEROUS







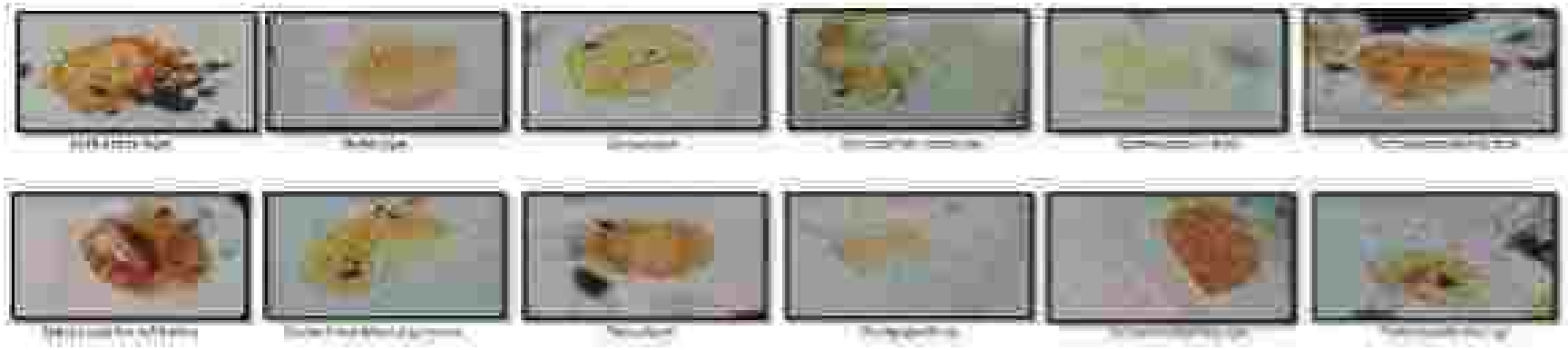


Figure 1 - Polymorph Type

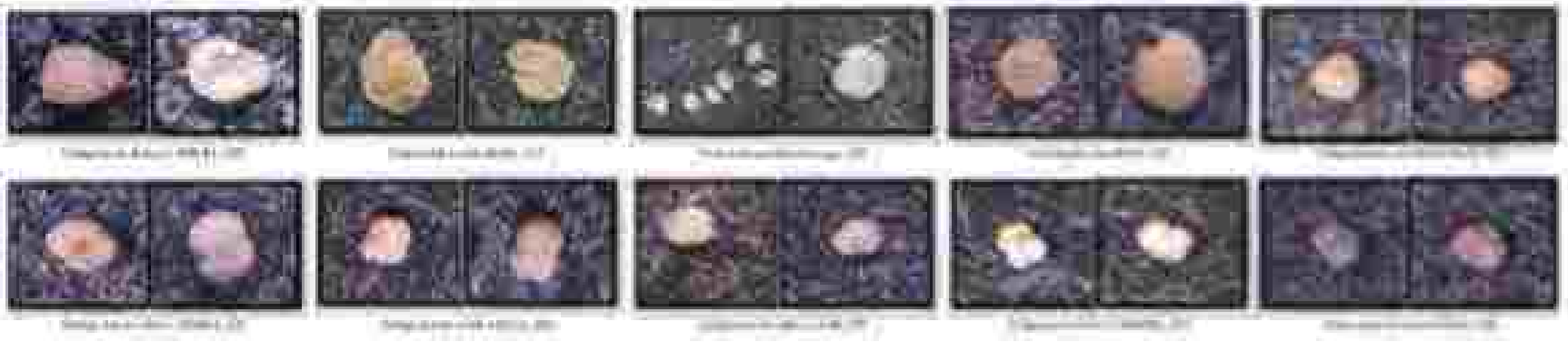


Figure 2 - Foraminiferida Fossils

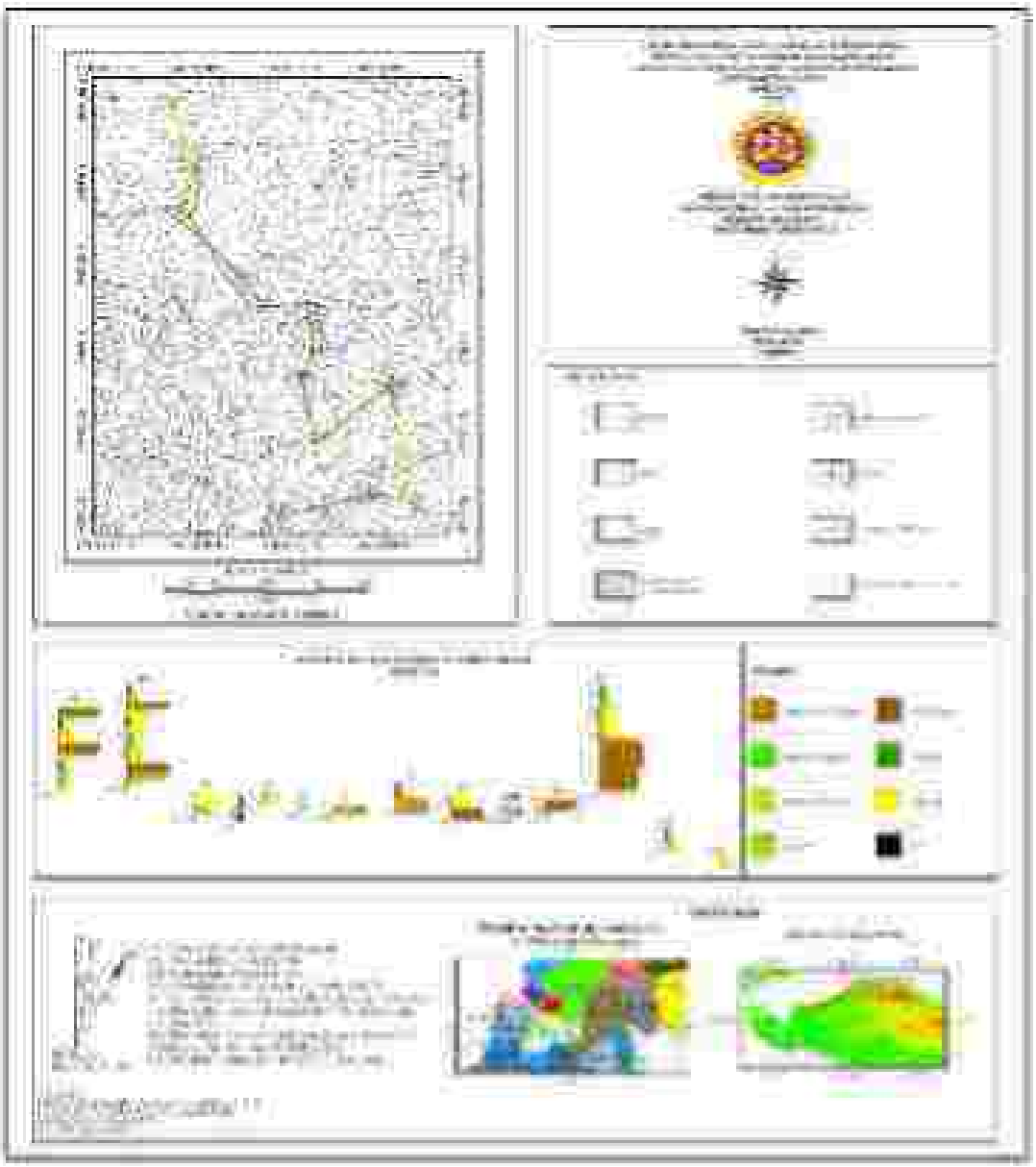


Figure 3 - Track and Waypoint Map

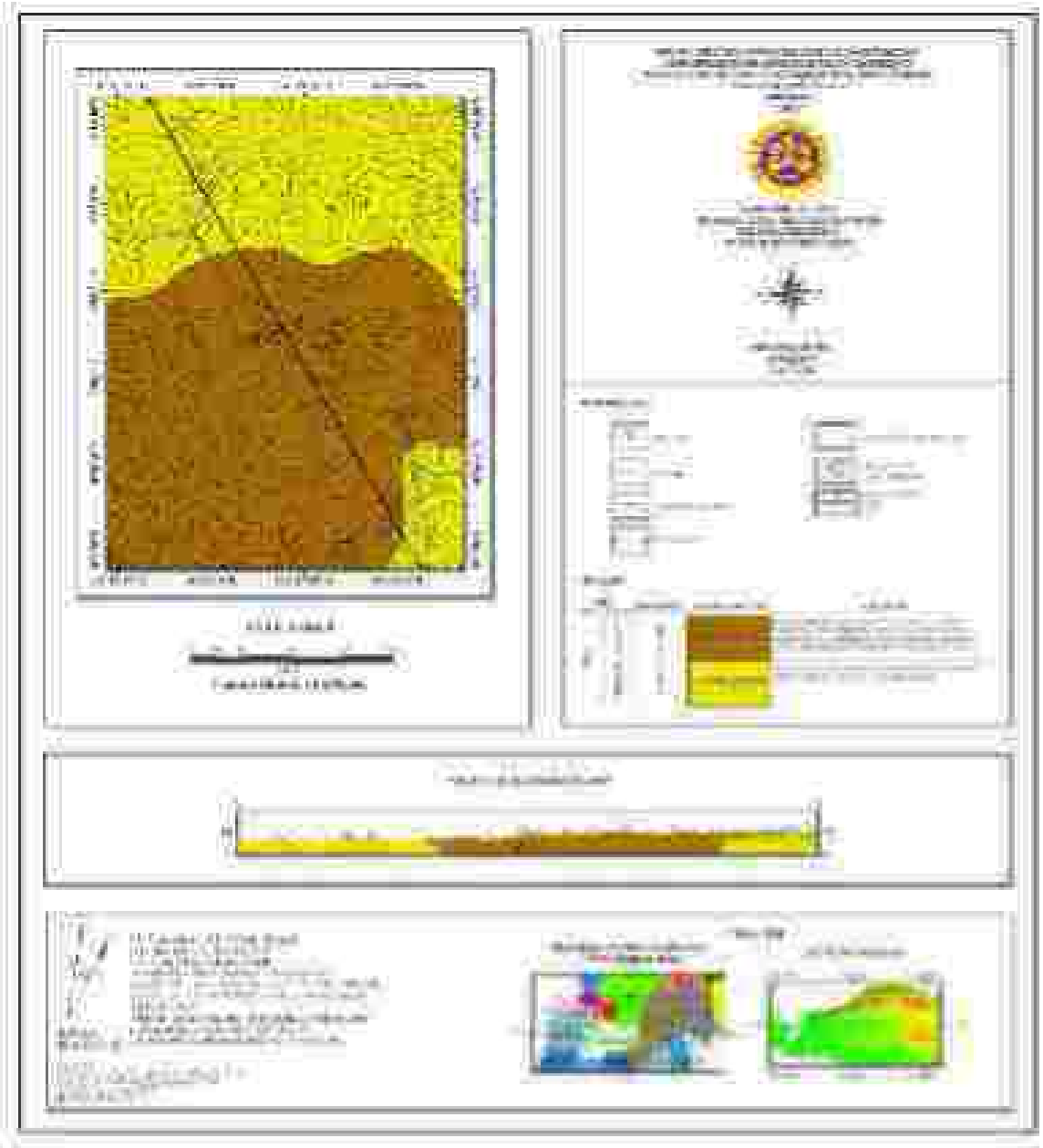


Figure 4 - Geological Map

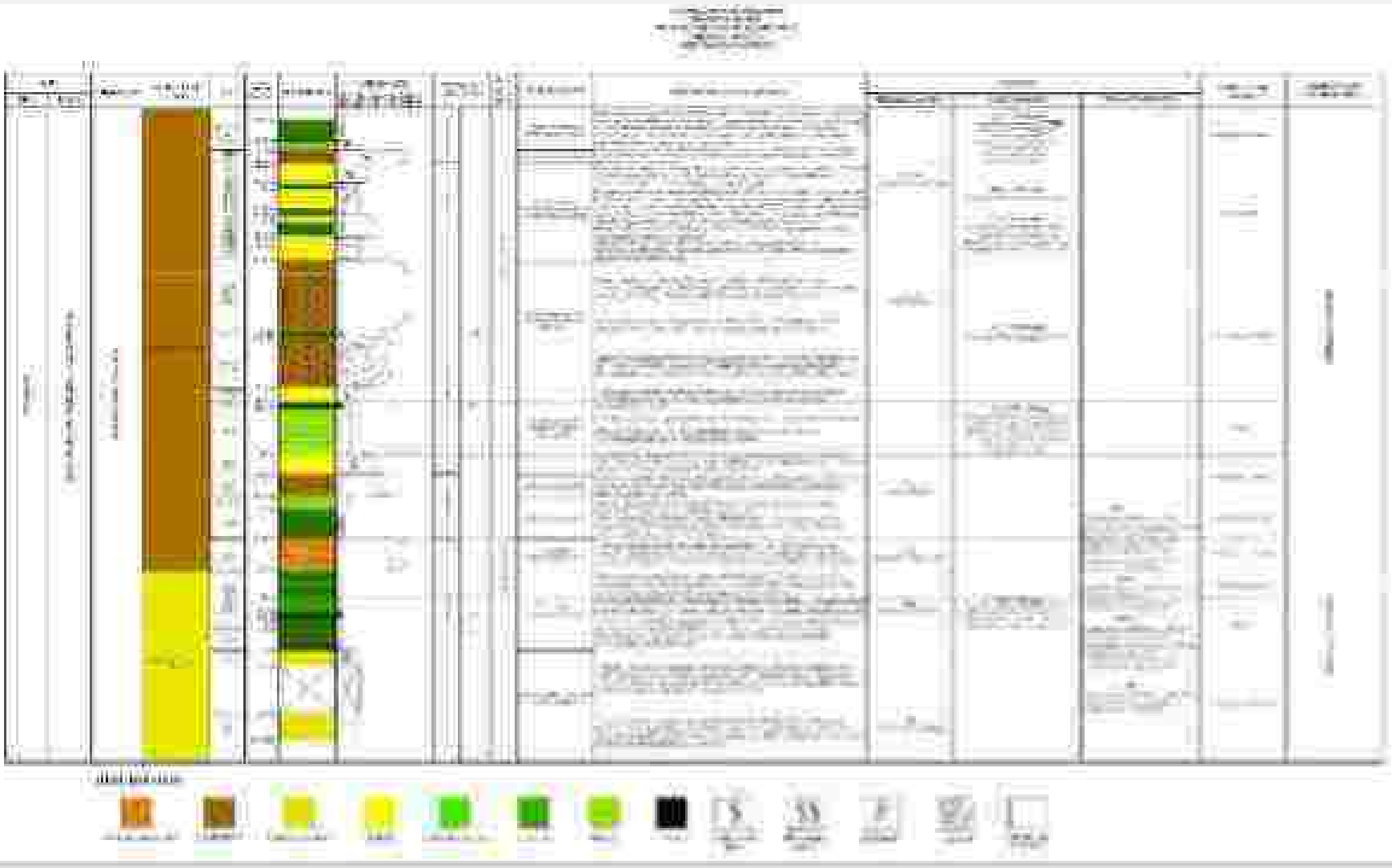


Figure 4 - Composite Stratigraphy

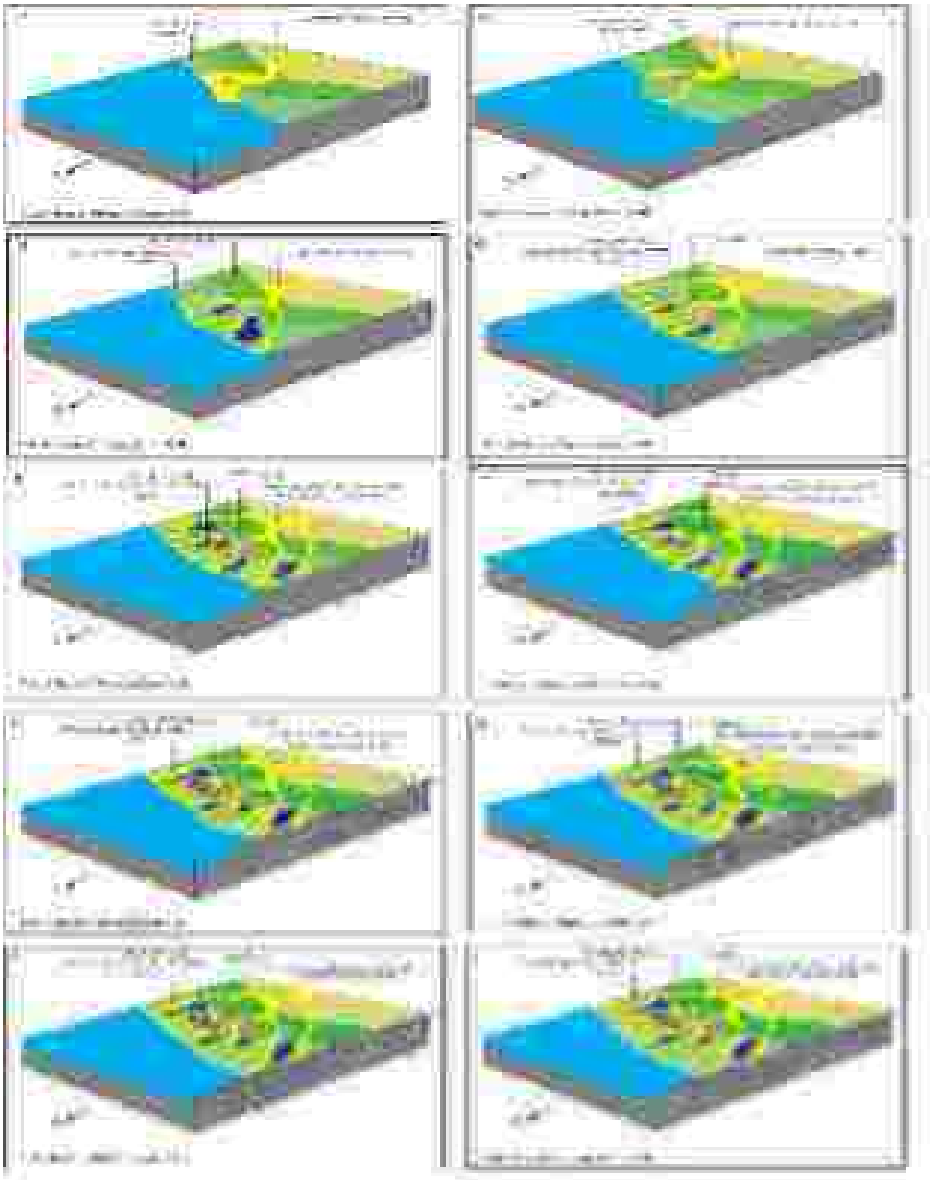


Figure 4 - Schematic Depositional Environment Diagram.