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The Environmental Construction of the Bojongmanik Formation in the Rangkasbitung Basin

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The Bojongmanik Formation is the typical formation in the Rangkasbitung Basin. This study aims to know the evolution of the depositional environment in the Rangkasbitung sub-basin, along the Middle Miocene. It continues previous research on the Bojongmanik Formation. The method is field observation and mapping an area of 7 x 8km in the Gajrug area. The development of the Rangkasbitung Basin environment begins at the age of Middle Miocene N9 - N11, at a depth of 10m to 180m, deposited in the form of claystone and sandstone intercalation. The elevation process which causes the basin to be elevated to a depth of 20m – 80m, is the coastline moving further north at the age of N13 - N14. This movement deposited sandstone unit rocks of claystone and limestone intercalation. The process of sedimentation that occurs is Regression.

Key words: *Environmental Construction, Bojongmanik Formation, the Rangkasbitung Basin.*

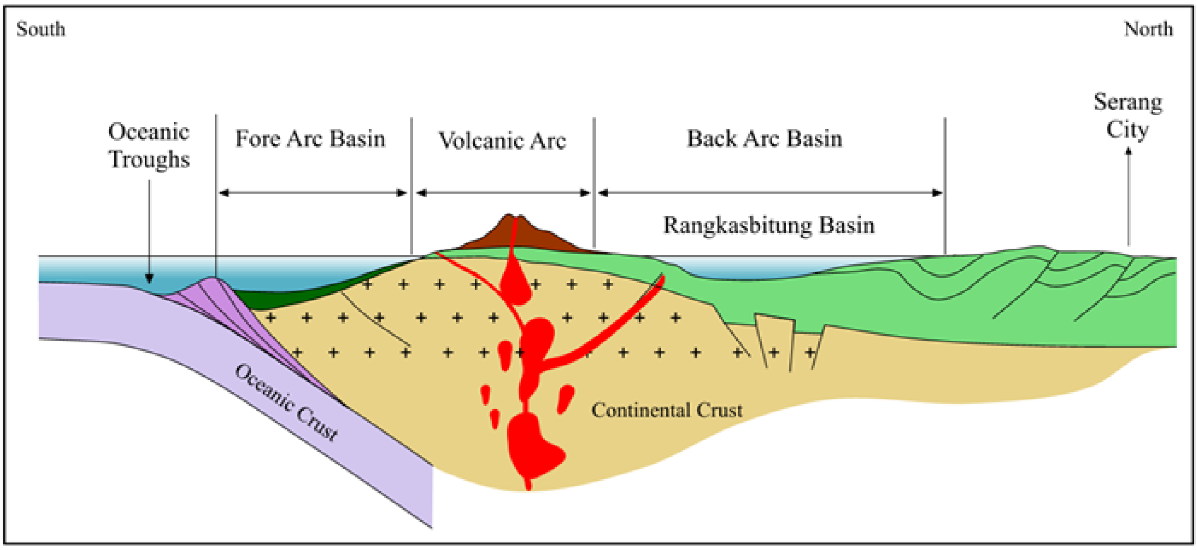
Introduction

The Bojongmanik Formation is a typical rock formation in the Rangkasbitung Basin (Martodjojo, 1984). It is encountered in the Banten Block Mandala sedimentation, characterised by mixing volcanic material with clastic sedimentary material. Sedimentary rock succession (Pambudi et al., 2017) is generally dominated by layered limestone with tuff sandstones that develop well in the lower – middle layer. It indicates that the dynamic of basin sedimentation which formed during that period was influenced by volcanic activity.The existence of the Bojongmanik Formation can be found along the Rangkasbitung Basin

(Asikin, 1986). Many researchers claim that the Bojongmanik Formation dates from the Middle Miocene.

Judging from a tectonic cross-section, the Rangkasbitung basin is a sedimentary basin located in the Rear Arc, extending West-East from Bojongmanik District in Banten Province, to Leuwiliang District in West Java Province (Asikin,1986).

Figure 1: Position of the Rangkasbitung Basin to the tectonic cross section of West Java Province (Asikin Modification, 1986)

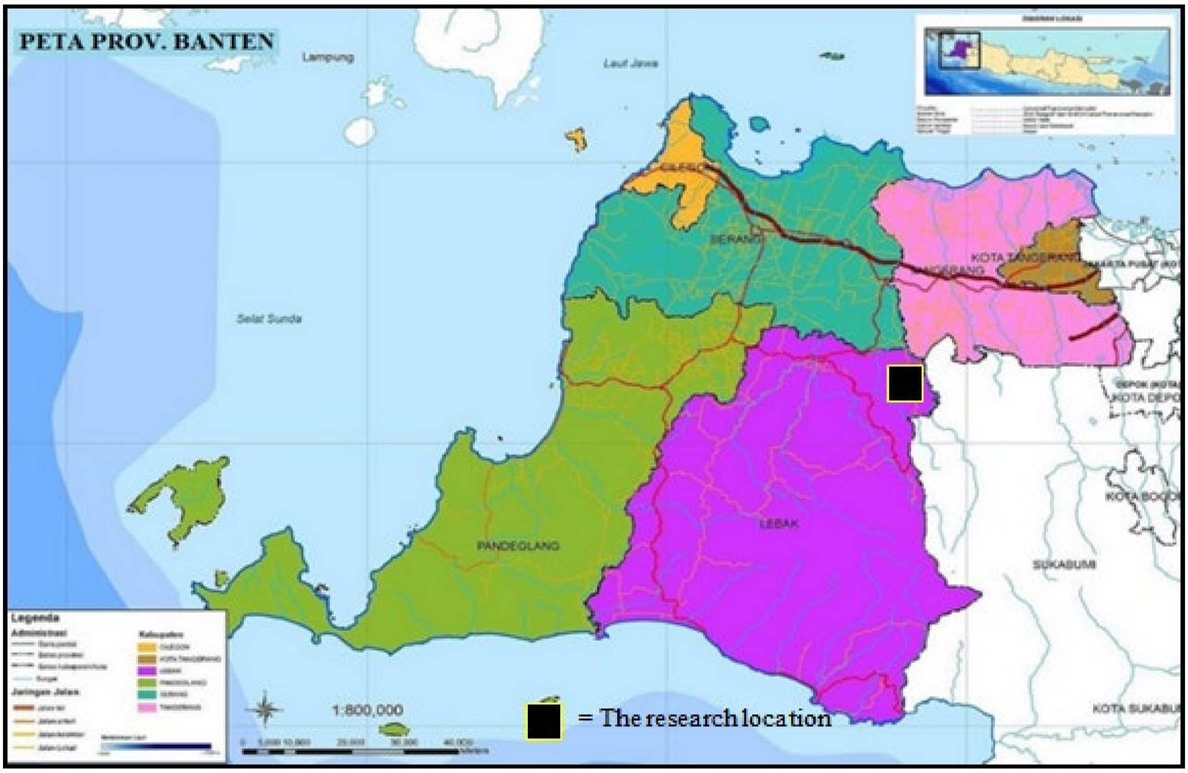


Some opine that the Bojongmanik Formation was deposited in the transition to the initial Neritic environment, while other researchers state that the Bojongmanik Formation was deposited in the middle to deep Neritic environment (Syaeful, 2017). This is a very interesting study, the causes of differences of opinion about the depositional environment. Is this due to the evolution of the depositional environment in the Rangkasbitung sub-basin along the Middle Miocene?

The initial hypothesis to address these differences is: The Rangkasbitung sub-basin on the Middle Miocene to the Late Miocene experiences removal due to being influenced by Intra-Miocene orogenesis in Western Java. This changes the basin, from Neritic to initial Neritic. Therefore, throughout the occurrence of intra-Miocene orogenesis, an evolution of depositional environment occurred (Delinom, 2010).

To study the above, a geological mapping activity was carried out in the Gajrug area of Lebak Regency, Banten Province. The mapping is located at coordinates 106^0 21 '40.0 "BT - 106^0 25' 28.6" East and 6^0 35 '12.4 "LS - 6^0 30' 52.6" LS, with an area of 7km x 8km, or around $56km^2$. It is hoped that these findings will reveal: Development of basin changes along the Middle Miocene, which led to the evolution of the depositional environment in the Rangkasbitung sub-basin (Delinom and Robert, 2017).

Figure 2. The research location



Research Methodology

This research maps the surface geology along the observation path. Geological structure data was recorded, specifically the distribution and type of existing lithology, and taking samples for determining the age and depositional environment of existing rock units.

Taking rock samples was done by "purposive sampling". In the laboratory the samples were prepared using a solution of hydrogen peroxide to separate fossil foramnifers from rocks. After the fossil was separated from the rock bonds, drying and sieving occurred using a Sieve Shaker. Fossils separated from the rock were then identified by a microscope, to determine their content and type (Sujatmiko, 1992). Based on the fossil plankton and benthos content found, the age of the rock and its depositional environmental conditions can be seen (Syahrulyati, 1987).

Results and Discussion

This geological mapping activity is more focused on the study of biostratigraphy as a determinant of past depositional environmental conditions. Therefore, the discussion will focus more on the role of plankton and benthic fossils, in determining the evolution of the depositional environment. Lithostratigraphic analysis is more focused on obtaining rock age sequences from old to young, as follows:

- Claystone unit intercalation Tuffaceous Sandstone and Sandy Limestone (Bojongmanik Formation) of Middle Miocene age (N11-N13), deposited in edge Neritic to middle Neritic (10–180 m).
- Sandstone Unit Intercalation Tuffaceous Sandstone and Tuffaceous Conglomerates (Bojongmanik Formation) of middle Miocene age (N13-N14), deposited in a transitional to middle Neritic environment (3-80m)
- Andesite intrusion, younger than N14.
- Tuff and Breccia Tuff Unit, aged Pleistocene (N20).
- Alluvial deposits, of Holocene age.

Outcrops of the Bojongmanik Formation are exposed in the Cinanggung, Cikaniki and Hambaro Rivers, in the Leuwiliang District, Bogor, West Java. The Miocene Bojongmanik Formation is a part of the Bogor Zone which is mostly covered by volcanic deposits, such as the Genteng Formation (Ali Munir, et al., 2016). An explanation of the characteristics of each lithology in each mapped rock unit follows.

Claystone Unit and Sandstone Intercalation Unit Claystone and Limestone

Based on the planktonic and benthonic foraminifera content (Bojongmanik Formation) of Middle Miocene (N11-N13), it was deposited in a shallow marine environment, namely littoral, edge Neritic to middle Neritic (10-180m). It spread in the middle to the south of the study area. Sedimentary structures were found in the form of parallel laminate, parallel bedding, and massif.

Outcrops can be found in the Ciberang River, Cimanggu River, Cibaliung River, Cimangeunteung River and Cisampaleun River. This unit occupies ± 61% of the area of the study area, ± 912m thickness. That is based on geological cross-sectional measurements, on claystone being partially a tuff, on sandstone intercalation, some lignite thin lens intercalation, as well as on carbonate sandstone nodules, massive to the point of showing parallel lamination, and macrofossils found in the form of *Bioturbation*. The remainder of the *Pelechipoda* shell and the *Chondrite feeding* type *Bioturbation* trace, are a sedimentary structure: coating parallel ± 10 cm to ± 1.4m, as intercalation on Claystone. The main constitutions of limestone forming in this unit are: *Algae* Framework and detachment fragments of clastic form of quartz and plagioclase, basic mass: clay, relationship between items: floating. In intra-particle porosity, the partially intact algae skeleton is partially broken and filled with sparits. The name of the incision: Limestone Packston (Kusumah et al., 2018). Most karsts were formed millions of years ago by calcium-secreting marine organisms (eg, corals and brachiopods) before tectonic movements lifted them above sea level (Satyanti, et al., 2010).

Figure 3. Macro fossil bioturbation trace type of *chondrite feeding* trail on sandy limestone, in the Cisampaleun river.

Planktonic foraminifera is marked by the first appearance of *Grobolotaria bolli* on N11 and the last appearance of *Hastigerina phraesiphonifera* on N13. then the age of this rock unit is N11-N13, namely in the Middle Miocene Period.

The presence of benthonic foraminifera index fossils *Amphistegina sp,* the central rock unit deposited in the littoral environment, Neritic edge to outer Neritic (10m to 60m depth), is characterised by the presence of benthonic foraminifera index fossils *Rotalia becardii*. Lower rock units were deposited in the middle Neritic environment to the outer Neritic (depth of 20m to 150m), characterised by the presence of benthonic foraminifera *Cibicides sp.* Stratigraphic position: This rock unit with units below it is unknown, because older units are not exposed in the area study. The relationship between stratigraphy and the units above is in conformity. Based on the results of the analysis of planktonic foraminifera fossils, the age between these two rock units is continuous. This rock unit can be compared to the Upper Bojongmanik Formation (Syaeful, et al., 2017). Most karsts were formed millions of years ago by calcium-secreting marine organisms (eg, corals and brachiopods) before tectonic movements lifted them above sea level.

Figure 4. Micro fossils *Hastigerina phraesiphonifera* marked this rock unit.

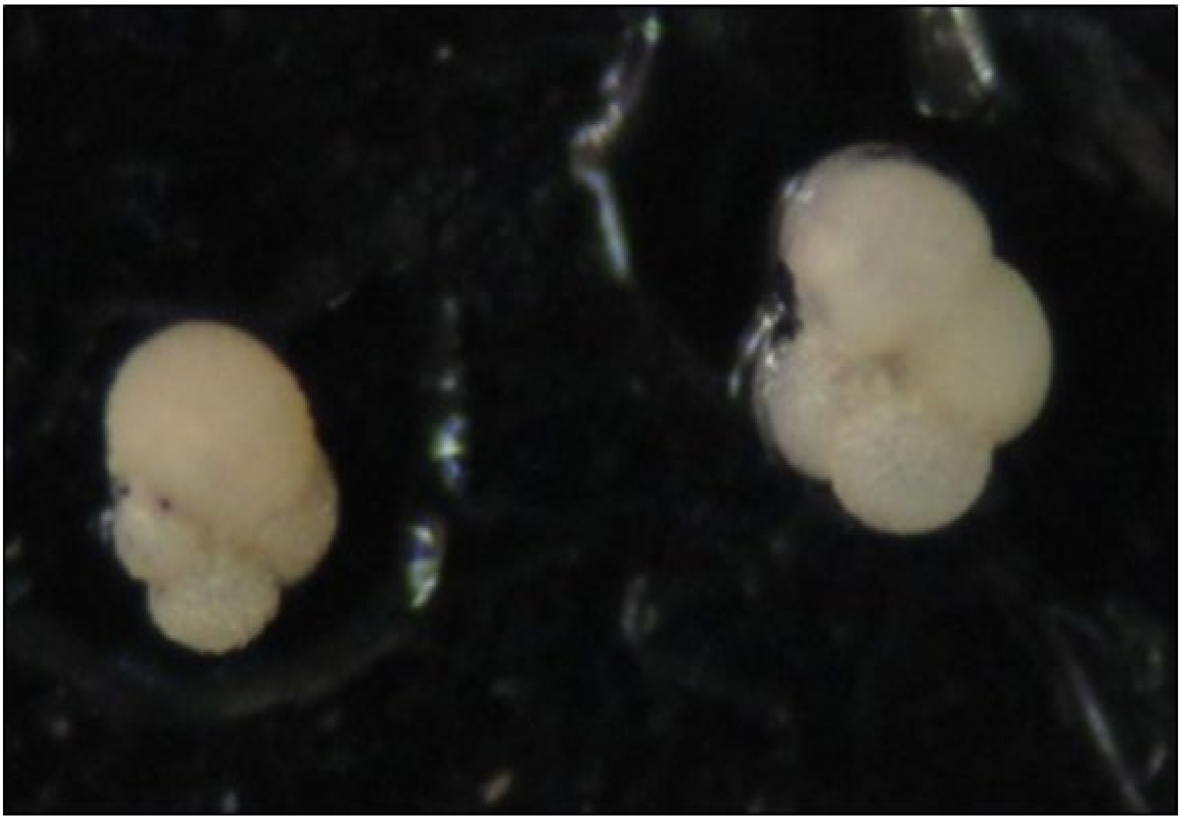


Figure 5. Outcrop Claystone intercalation of sandstone in the Cigebas River which shows the mechanism of the sedimentation process.

Sandstone Unit Intercalation Tuffaceous Sandstone Tuffaceous Conglomerates

This unit is of middle Miocene age (N13-N14), deposited in a transitional environment to the middle Neritic (3-80m). Lithological characteristics mark grey to dark grey, grain size ± 1/8mm to ± 2mm, angled responsibility to round, open packaging, poorly sorted, good porosity, compact to be squeezed, carbonaceous, main components: lithic, quartz, feldspar, base mass: clay, carbonate cement. massive until showing parallel lamination, and coating parallel to 5cm to 80cm. Microscopic description of the results shows that the tuff sandstone is: Chiefly Volcanic wacke (Gilbert, 1953).

Tuffan sandstone derives from megascopic outcrop conditions - weathered material and bedding that are easily measured, fresh colours medium gray to bright yellow, weathered colours of dark gray grain size: fine sand (± 1/8mm) to medium sand (± 1 / 4mm), angular responsibility, disaggregated, covered, non-carbonated, poor porosity, grain components: Feldspar and quartz, Base mass: tuff, cement: silica, fresh to moderate weathering, compact, massive until parallel layered laminates.

Figure 6. Outcrops sandstone with a parallel laminated sedimentary structure in the Cigebas River

Tuffan conglomerates, megascopic characteristics of fresh outcrop conditions - weathered, fresh colors of medium gray to bright yellow, weathered colors of dark gray, bright gray, Ø ± 1 / 8mm to ± 3cm, rounded up to rounding, poorly sorted, open packing, good porosity, fragments: lithic, matrix: lithic, feldspar and quartz, base mass: tuff, cement: silica, a little mineral: iron oxide.

Planktonic foraminifera content is characterised by the appearance of *Grobolotaria menardi* and *Hastigerina siphonifera* on N13 and last appearance of *Globigerinoides subquadratus* on N14, so that the age of this unit is N13 -N14. Based on its benthonic foraminifera content, the emergence of *Amphistegina* and *Quincuiloqulina sp* was deposited in the environment of edge-to-outer Neritic (2m to 80m deep), at the same time as the Parigi Formation, Bojonglopang Formation, and Limestone member of Bojongmanik (Kusumah et al., 2018).

Andesite Rock Units

These units are scattered in the southern, central and south-eastern parts of the study area. They occupy the Gebas mountains, Ponggo mountains, Serendet mountains and parts of the Cikarae Lebak village; ± 2.52% of the study area. The geological map is coloured red, based on the distribution of outcrop data on the surface and reconstruction of the Geological Map and geological cross section reconstruction. The intrusion diameter in the Gebas Mountain is ± 1.2km. The intrusion diameter in Ponggo mountain is ± 200m. The intrusion diameter in Serendet Mountain ± 200m and in Cikarae Village where the intrusion dimension is elongated flat, ± 500m long and ± 100m wide.

Based on observations and records in the field, the characteristics of andesite rock lithology of the study area can be divided into two. Andesite with porphyritic texture is found in Mount Gebas, while Andesite with fine texture is found in Ponggo Mountain, Serendet Mountain and in Cikarae Lebak Village.

Tuff and Breccia Tuff Unit

This unit is spread in the south and south-east of the study area. Outcrops can be found in the Cikaak upstream river, Cimanggu upstream river and upstream Cilangke river. These rock units do not have any measurable coating. Occupying an area of ± 22.13% of the area of the study area, the geological map is coloured light brown. It has a thickness of ± 265m based on the results of geological cross-section measurements.

Age is determined by the stratigraphic position in the field, which is deposited unconformably above the rock units below. The age of this unit is Plistocene (N20) in medial to proximal volcanic terrestrial environments. This unit is spread in the south and south-east of the study area. Outcrops can be found in the Cikaak upstream river, Cimanggu upstream and upstream Cilangke river. These rock units do not have any measurable coating. Occupying ± 22.13% of the study area, the geological map is light brown. It has a thickness of ± 265m based on the results of geological cross-section measurements.

Figure 7. Tuff outcrops on the wall of the Cimangeunteung river magnification of 10 X rock tuff, showing graded beds, the process of sedimentation that occurs due to the large size factor of rock grains.

Breccia tuff megascopic, fresh color of bright grey rocky, weathered colour of dark grey brown, grain size of coarse ash (± 1 / 4mm) to lump (± 10cm), angled to angular responsibility, Fragments: Litik, matrix: Litik, Feldspar, base mass: Tuff, poorly sorted, open-packed, good porosity, non-carbonated, compact, fresh to moderate weathered, massive. From the results of petrographic analysis of the basic mass samples of the breccia tuff, thin incision analysis results are: Tuff litik (Dunham,1962) . Planktonic and Benthonic Foraminifera not found, Determination of age this rock unit refers to previous researchers , unit age of this rock is N 21 to N22.

Tuff: megascopic, fresh color of bright yellowish gray rock, weathered color of dark brownish gray, fine grain size (± 1 / 16mm) to moderate ash (± 1 / 2mm), well disposed, non-carbonated, feldspar fragments, matrix : feldspar, the basic mass of the glass. closed container, poor porosity, compact, weathered until fresh. Planktonic and Benthonic Foraminifera not found, Determination of age This rock unit refers to previous researchers , (Isnaniawardhani et al., 2018) , the age of this rock unit is N21 to N22. The results of petrographic analysis of thin section are: Glass Tuff (Pettijohn, 1956). Determination of the depositional environment, refers to the "Pyroclastic Vulcaniclastic Facies" model.

Stratigraphic position: Tuff and bruff tuff units with units below are not aligned. They can be known by finding the contact angular unconformity between tuff and claystone, on the walls of the Cimangengteung River, Keusal village. The stratigraphic relationship with the unit above it, the unit, specifically the Alluvial Deposits unit, is in the form of erosion contact. The tuff and tuff breccia rock units in the study area have the same lithological characteristics as the Endut Volcano Deposition (Isnaniawardhani. et al., 2018). Thus, the authors declare this unit the Endut village *Volcano Deposition*.

Alluvial Sediments Unit

It is the youngest unit deposited unconformably with the rock beneath, aged Holocene with erosive field contact limits, and spread along the main river east of the study area, the Ciberang River, and part of the Cimanggu River. This alluvial unit occupies the Alluvial Plain Geomorphological Unit. The thickness of this unit, from 0.2m to 2m in the study area, is the result of previous rock fragments and has not been compacted. The Alluvial Deposition Unit is deposited with contact in the form of erosion fields with rock units underneath.

Figure 8. Alluvial deposits at the Ciberang River observation site

Tectonic Activity

In the late Miocene, starting in the range N14 - N 15, tectonic forces worked to suppress the research area with the N 350^0 E direction, from south to north. This caused the research area to be folded up to form a syncline and anticline, and broken in the form of a horizontal fault. It was followed by the formation being muscularly crushed, then formed into a horizontal fault. The events above were followed by magmatic activity, and intermediate composition of magma through the weak fields due to fracture and burly structures. In addition magma also penetrated weak fields between rock layers, forms shallow intrusions of andesite rocks. The findings of this study (Batu et al., 2012) showed that tectonic processes produced an intensive erosion activity through the Bojongmanik Formation. In that case, the Bojong Formation overlies both older Bojongmanik Formations.

Analysis

The presence of planktonic and benthonic foraminifera fossils was analysis. It showed that the unit of Sandstone Tuffan and Sandstone Limestone Intercalations (Bojongmanik Formation) in Middle Miocene age (N11-N13) (Postuma, 1971), was deposited in the shallow marine environment, ie edge to middle Neritic (10-180m). The Bojongmanik Formation, consists of interbedded of sandstone and clay stone, with intercalated limestone (Delinom, 2011).

The presence of planktonic and benthic foraminifera fossils on the Tuffan Sandstone Intercalation Unit and the Tuffan Conglomerate (Bojongmanik Formation) was also analysed. It shows that this unit is of middle Miocene age (N13-N14), deposited in the transitional environment to the middle tufan sandstone (3-80m).

Further, the presence of planktonic and benthic foraminifera fossils on the Tuffan Sandstone Intercalation Unit and the Tuffan Conglomerate (Bojongmanik Formation) was analysed, too. It shows that this unit is of middle Miocene age (N13-N14), deposited in the transitional environment to the middle Tuffan sandstone (3-80m). As to the findings of this study see Sujatmiko and Santosa, (1992).

The time span of N13 - N14 falls for consideration. At the age of N13 the deepest ocean reaches a depth of ± 180m. Whereas, at the age of N14, the depth of the sea becomes ± 80m. This means a decrease in sea level during the span of N13 - N14 (Esmeray-Senlet et al, 2015), to ± 100m.

This large decrease in sea level can, in theory, be triggered by a regression process. Specifically, it is the supply of sediment from the land which is abundant enough to go to the open sea. However, it is not offset by a decrease in the basin. This results in the rate of decline in the bottom of the basin being slower than the sediment supply, a regression that causes the coastline to advance towards the open sea. Thus, the edges of the ocean basin turn into land. This continuous supply of sediment also deposits sediment in the oceans, making them shallow.

Thus, the causes of the depositional environment differences in the Bojongmanik Formation can be answered. The Bojongmanik Formation was deposited in the conditions of the middle-to-deep Neritic depositional environment. That is because sampling was taken when the Rangkasbitung basin condition had not undergone a regression process. The Bojongmanik

Formation was deposited during the transition of the depositional environment to the initial Neritic, because the Rangkasbitung Basin has undergone a regression (Isaack et al., 2016).

Thus it can be obtained that in the period N11 to N14 there has been an evolution of the depositional environment (Postuma, 1971). This resulted in the Rangkasbitung basin undergoing regression. The coastline to the shallow sea turns into a terrestrial environment, while the middle part of the basin changes into a transitional to early Neritic environment.

Figure 9. During the period N11 - N13 the Tuffan Sandstone and Sandstone Limestone intercalation Unit (Bojongmanik Formation) was deposited in the edge Neritic environment to the middle Neritic (10-180m).

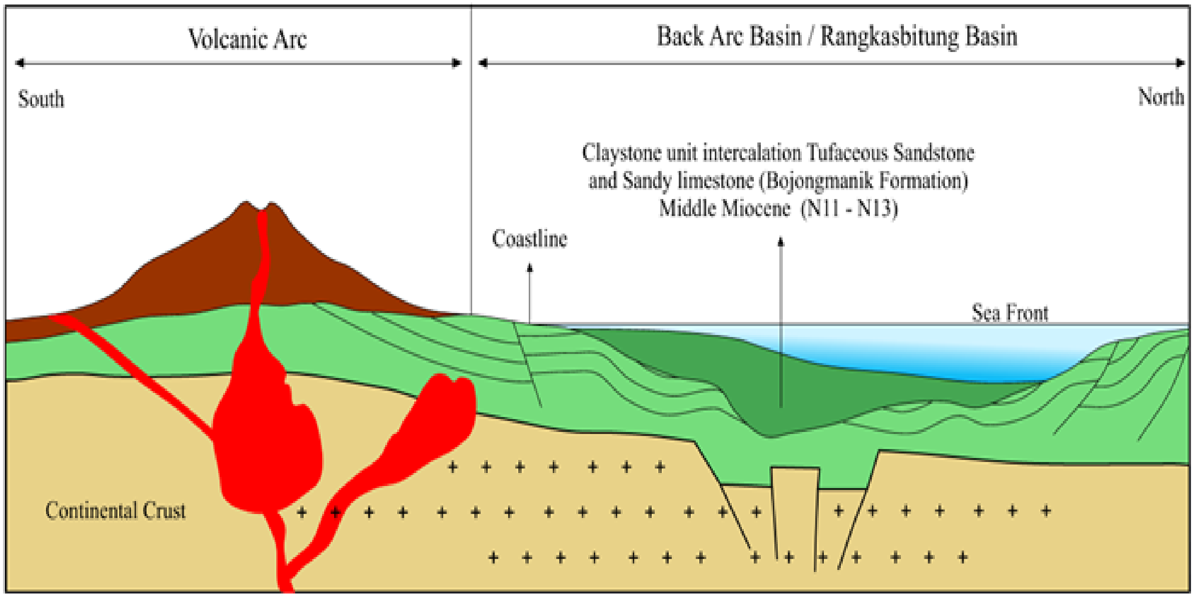


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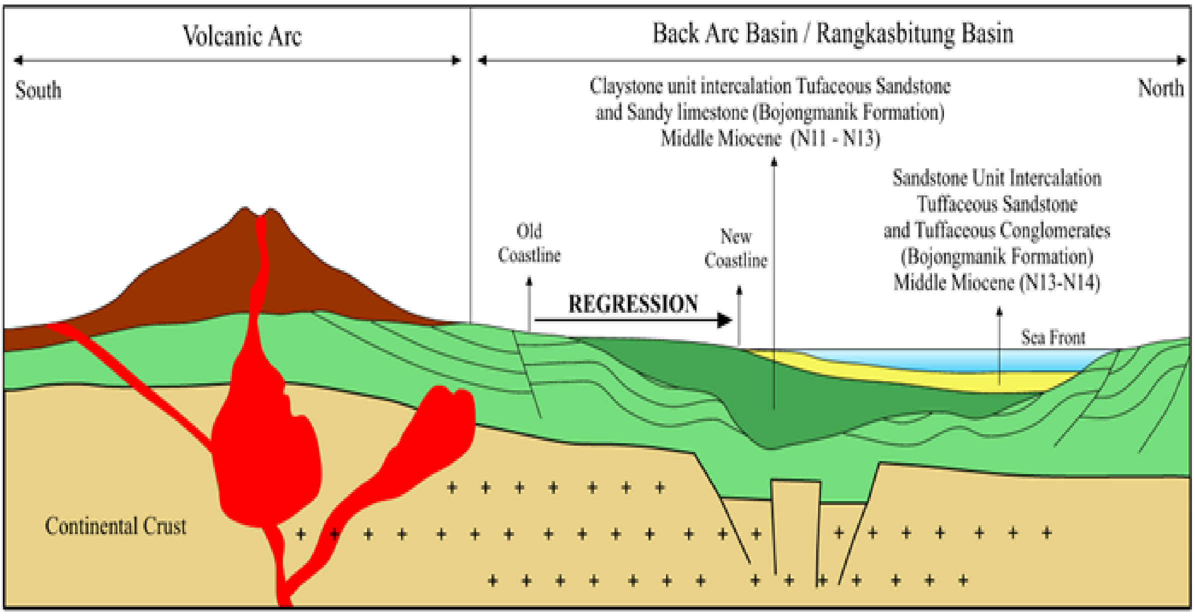
Figure 10. In the period N13 - N14 a regression process occurs. The coastline advances towards the high seas, followed by the deposition of the Tuffan Sandstone Intercalation Unit and the Tuffan Conglomerate (Bojongmanik Formation), in the transition environment to the middle Neritic (3-80m).



Conclusions and Discussion

Old stratigraphy in the study area is sourced from sediment deposits in the southern part of the Banten region. This sediment material enters into a narrow basin called the Rangkasbitung Basin. Sedimentation in the Basin begins with the deposition of Tuffan Sandstone and Tomban Sandstone Intercalation aged between N11 - N13 (Middle Miocene), with depths between 10-180 m.

Furthermore, in the age phase between N13-N14, a Regression occurs. The coastline moves towards the north of the basin. As a result the southern part of the basin which was once the ocean turned into land. The shape of the basin is advancing northward, with the coastline bounding in the south from the Tufan Sandstone Intercalation Unit and Tufan Conglomerates aged N13 - N14.

Therefore, it can be concluded that there has been an evolution of the depositional environment during the period N11 to N14. The Neritic Edge depositional environment changed to a Land depositional environment, then the Middle Neritic depositional environment changed to the Neritic Edge depositional environment. The evolution of this depositional environment occurred because of the Regression during the N13-N14 age range (Asikin, 1986).

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