

The geologic potentials of Riau Islands Province and its development design

Emi Sukiyah¹⁾; Vijaya Isnaniawardhani¹⁾; Adjat Sudradjat¹⁾; Fery Erawan²⁾

¹⁾ Faculty of Engineering Geology, Padjadjaran University

²⁾ Task Force Unit, Ministry of Public Works and Settlement, Riau Islands Province

Correspondence e-mail: emi.sukiyah@unpad.ac.id

Abstract.

Geologically Riau Islands is located in the topography of the old stadium erosion. The morphology is characterized by smooth hills with convex slopes and alluvial plain consisting of the erosion products. The morphology exhibits the remnants of peneplain that submerged at ca 13,000 BP now forming Sunda Shelf with the average depth of 120 meters. The irregular coast's line of almost all the islands in Riau Islands characterized the submerged old morphologic stadium. The lithology consists of granites and metasediments. Granites contain various types of economic minerals. The weathered granites produce bauxite, kaolin and quartz sands. The metasediments are generally soft resulting in the formation of valleys suitable for agriculture and settlements due to the availability of surface and subsurface water. Irregular coastal line provide the bays for harbors. The geological potentials to be developed therefore consists of the provision of stable plain and resistance to landslide and earthquake, the bays suitable for various marine industries, granites for building materials, and base metals. The submarine hydrocarbon basins produce oil and gas. Geologically Riau Islands is very unique because it represents the remnants of the peneplain of Jurassic and Cretaceous age of about 63 to 181 years old now becoming the Sunda shelf which is the largest in the world. This region is very good when developed as an industrial area, trade, and marine tourism

Keywords: Riau Islands, geologic potentials, granites, submerge, marine tourism.

INTRODUCTION

The Riau Islands Province is located in the most outer Northern territory of Indonesia. It is bounded by Vietnam, Cambodia and Singapore in the North and the West and West Kalimantan, Bangka Belitung and Proper Riau Provinces in the South and East (Figure 1). The following facts and figures outline the social and geographical condition of the province (Anonymous, 2015): 1) The province consists of 1,350 large and small to tiny islands, 30% of them unnamed; 2) The territory covers the area about 251,810.71 sq km, in which 96% of them are sea waters; 3) The number of population exceeds 1,973 million in 2015; 4) The economic bases are fishery, services and mining.

The interesting facts concern with the telecommunication that composes of 13 TV stations, 42 broadcasting stations, 13 newspaper, 17 portals, 35 popular magazines and four weekly tabloids. The province harbors also three universities, namely Raja Ali Haji Maritime University, Batam International University and Batam University.

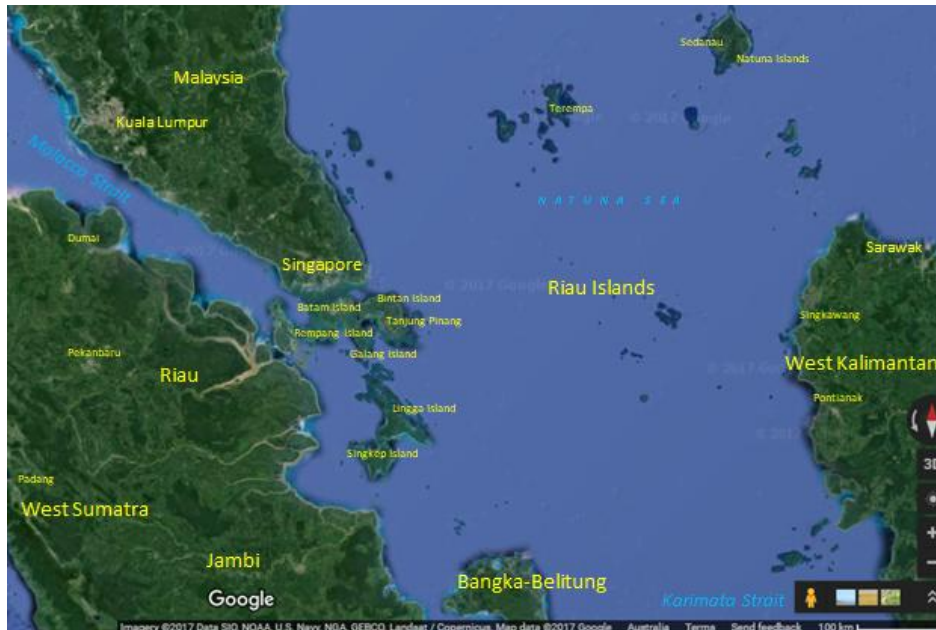


Figure 1. Location of the investigated area (Anonymous, 2017)

This paper will concentrate the discourse on the geologic potentials consisting of minerals, hydrocarbon, building materials, fresh water and the landscape. The availability of stable lands suitable for industrial sites, tourism and modern settlement draws a special attention taking into account the large number of population and business activities in Singapore that needs more space.

METHODS

This research uses various methods in data acquisition. Literature studies from previous publications are complemented by search results data through the website. Primary data is obtained through field survey activities conducted in 2015 to 2017. Field surveys cover areas of Bintan Island, Batam Island, Rempang Island, and Galang Island (Sudradjat et al, 2015; Sukiyah and Sudradjat, 2016; Sudradjat et al, 2017).

The data obtained were analyzed using descriptive statistical approach done in the studio. Visualize the results of analysis in the form of images and maps The scheme of the research method is shown in Figure 2.

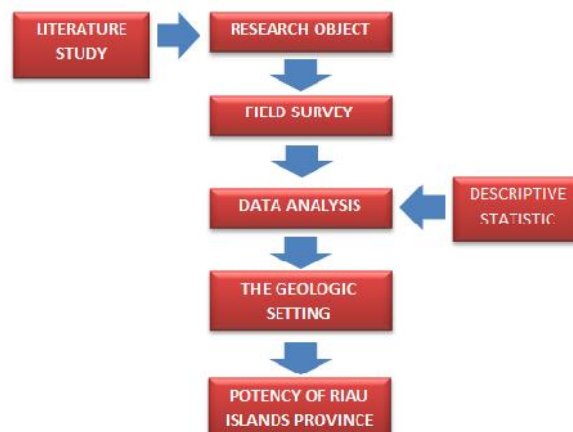


Figure 2. Scheme of research method

RESULT AND DISCUSS

Geologic setting

Riau Islands Province is one of eight provinces in Indonesia whose territory consists of islands. The Province is located in the stable mass of Eurasian continental earth's crust. Based on the results of literature study, the earthquake activities take place beyond Sumatra Island at a distance more than 1000 kilometers. The area therefore locates in a non-seismic zone in the vast Sunda shelf (Rovicky, 2015; Figure 3). It is part of a lead line sourced from granite rocks. Some of the rocks on the island have undergone a process of weathering and erosion. The exogenous process is intensive and extensive so it appears as a monadnock when viewed from the aspect of Sunda shelf (Molengraaf & Weber, 1921).

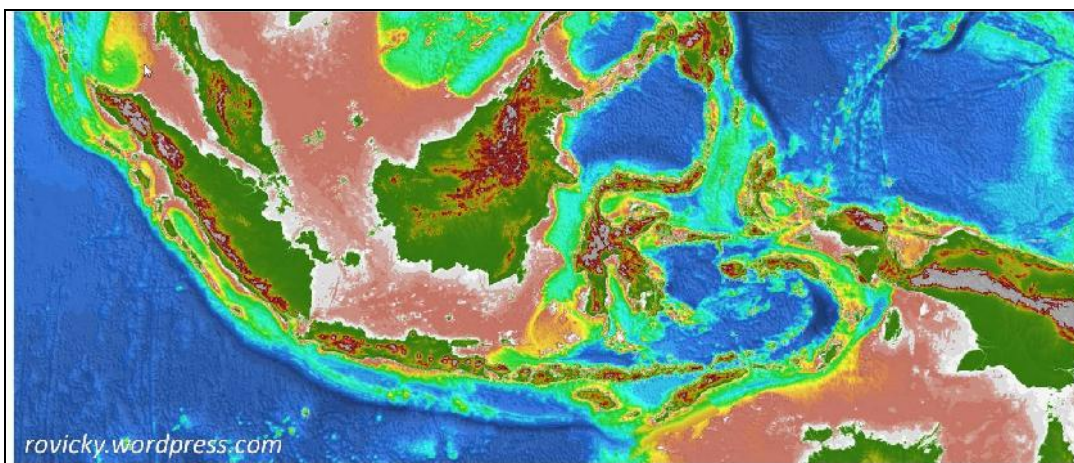


Figure 3. Sunda Shelf covering the western part of Indonesian waters is the location of the investigated area (Rovicky, 2015)

The rocks composing the islands of the Province consist of old magmatic belts and the metamorphosed clastic sediments of Mesozoic age ranging from 63 to 181 million years old. Approaching to the North the rock becomes older of Permian age or about 280 years old. The weathering therefore has intensively taken place, forming the peneplain with undulated hills indicated by gentle convex slope of about 7 to 20% with the elevation 50-100 meters belonged to inner low land according to van Zuidam's classification (van Zuidam and van Zuidam, 1985).

Rock types in the Riau Islands are generally composed by acidic rocks, including Triassic granite and Plio-Pleistocene epiclastic sedimentary rocks (Kusnama et al, 1994). The metamorphosed clastic sediments form the metasediments predominantly covers most of the islands (Figure 4). In places magmatic rocks intruded those rocks along curving magmatic belts extended from Malaysian Peninsula to West Kalimantan (Figure 5). The belt faces to Southwest manifesting the ancient subduction zone in this direction (Katili, 1980). The repetitive magmatic activities took place resulting in two magmatic belts, known as SI and SS types respectively originated from igneous and sedimentary rocks.



Figure 4. Inclined metasediments exposure in Batam Island (Sudradjat et al, 2015)

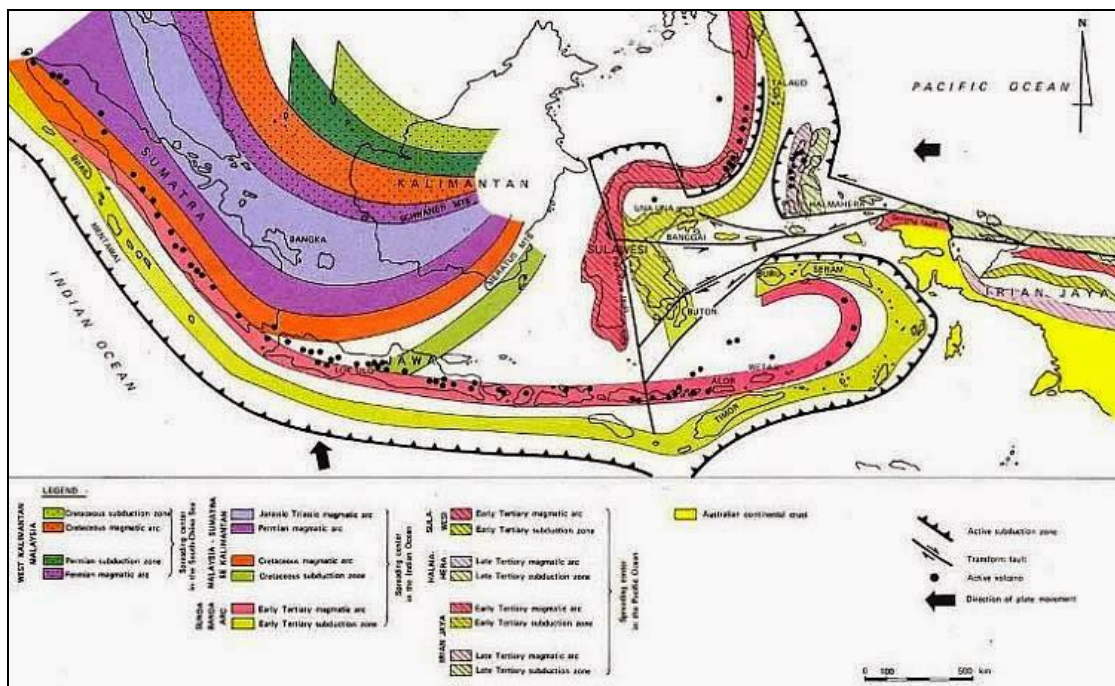


Figure 5. The configuration of geologic setting in Western part of Indonesia, where Riau Islands Province is located (Katili, 1985)

The age determination using Potassium-Argon method shows the figures of 155 ± 6 to 167 ± 6 million years old or Middle Jurassic age in Singkep Island. The rocks in Anambas show the age of 86 ± 2 million years old, whereas in Natuna 73 ± 2 million

years old or Cretaceous (Katili, 1980). This means that to the North the age becomes younger.

The younger terrestrial deposits of Quaternary age unconformable overlay the Mesozoic rocks indicating the absence of Tertiary sediments. This evidence exhibits the continental position of the area during the Late Mesozoic to Tertiary age. The region did not experience the recent tectonic movements of the post-Tertiary age; it thus locates in a stable earth's crust. The deformation took place during Mesozoic epoch resulted in the predominantly NE-SW foliation of the metasediments. In places the relics of sediments exhibit the steep or vertical angle. The metasediments consist of schist and quartzite. The latter own a relatively resistant property against exogenous process, resulted in elongated ridges.

Geologic potentials

The geological potential of the Riau islands is very diverse. They include minerals, hydrocarbons, morphology, and unique rock phenomena due to the erosion process. The following discussion reveals each potential in more detail.

1. Minerals

The formation of granitic rocks in the metasediments yielded the base metals of tin (Sn) and rare earth elements (REE). The weathered rocks produced quartz and zircon (Zr) and tin placer deposit. The intensive weathering resulted in the enrichment of Aluminum (Al) in bauxite deposit and the formation of clay or kaolin (Figure 6). The environmental problems in mining occur due to the removal of the top soil and left the land barren.



Figure 6. Kaolin with hematite cap exposed in Batam Island (Sukiyah and Sudradjat, 2016)

2. *Hydrocarbon*

The continental crust provides sag basin which potential for the formation of hydrocarbon. Such an environment generates gas with high CO₂ content which needs an engineering process to produce hydrocarbon commodity. The process will reduce the CO₂ content to avoid the impact to the global warming.

3. *Building materials*

Granites and the intermediate intrusions of late magmatic activities attain high physical properties suitable for building materials. However the granitic rocks mostly are weathered. The intermediate to basaltic intrusions are usually fresh and good for building materials. Sea sands are mined for filling materials, mostly for reclamation. The intermediate to basaltic rocks are suitable for the final domestic waste disposals taking into account the topography and hydrogeology. The size and skewness of the rock fractions hold an important role (Erawan, 2015).

4. *Fresh water*

The alluvial deposits covering the valleys consist of sand layers that provide aquifer containing ground water sufficient for domestic and industrial uses. The fractured granites might also yield fresh water. An endless source of fresh water is found on Panyengat Island. Since long time ago, this island has become a transit point for ships passing through the Strait of Malacca. Now, the place becomes a religious tourism destination because there is a memorial park of Raja Alihaji. He was a poet who created Gurindam XII (Figure 7b).

5. *Suitable morphology for contructions and sanitary treatment*

The morphology of the islands in Riau Islands Province forms an undulated topography as the result of long denudation in Tertiary to Quaternary Times or more than 63 million years. The process produced the peneplain of old geomorphologic stadium characterized by vast and flat lands. The topography provides the ideal location for large buildings, highway and the industrial sites. The stable crust due to the a-seismic zone is very conducive for the construction of high rise buildings.

The uprise of the sea level in the Quaternary age related to the increase temperature after the ice age at about 13,000 years ago produced the crenulated coastal line that provides suitable bays for marine industries. In the future these geologic potentials might produce the commodity of fresh water.

The morphological aspects combined with hydrologic and geotechnical assessment determined the requirement for the site of sludge water treatment (Rusdi, 2016). The black and grey waters yielded from the toilet become a serious problem due to the increasing number of the population.

6. *Beautiful landscapes*

The crenulated coastal lines provide embayment and beautiful landscape. The tourism industry enjoyed the embayment for the shallow and friendly seawater (Figure 8). In some places the buildings stand above sea water. The quarzitic white sands spread over the beaches. In addition to the Natuna islands, beach panoramas in East and North Bintan also become a haven for foreign tourists (Figure 7a).

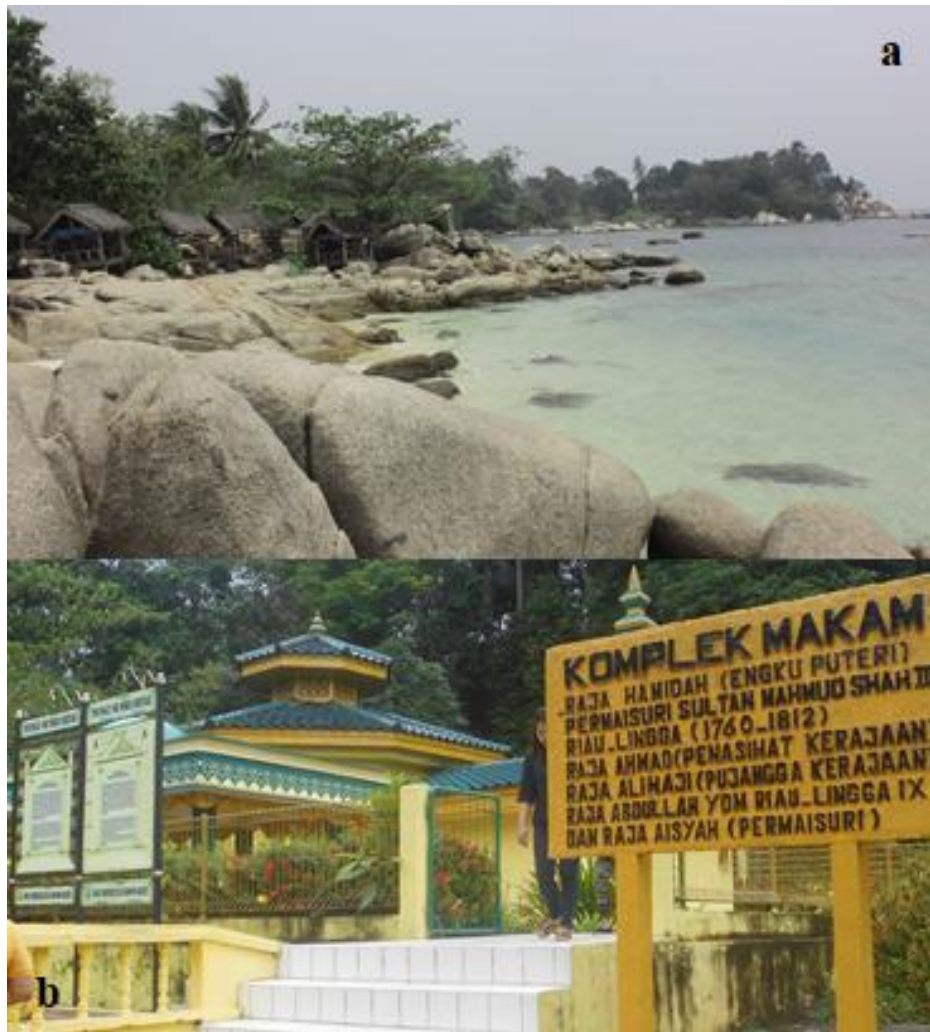


Figure 7. Granite rocks beach of East Bintan Island (a) and Raja Alihaji memorial park on Panyengat Island (b)

7. Unique stone sculptures

Because the erosion has taken place for more than 63 million years, the batholiths exposed to the surface. The giant size of stone emerged from the deep of the earth and subsequently polished by the erosion creating unique stone sculptures (Figure 8). The unique does not only concern with the shape and the extra-ordinary size of the stone, but it also represents the remnant of the Mesozoic plain which is more than 63 million years old and rarely found in Indonesia. The submerged peneplain of Sunda shelf is by size the largest in the world. Many geographers consider the shelf is equivalent to the imaginative lost continent of Atlantis philosophically taught by Plato.



Figure 8. The beautiful landscape of Natuna Island, the exotic embayment is enjoyed by the tourism industry, and the unique shape of quartzitic metasediments in Natuna Island (Anonymous, 2015)

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The geologic potentials of Riau Islands Province consist of minerals, hydrocarbon, fresh water, the provision of suitable lands for buildings, and the beautiful and unique landscape. The availability of the geological potential is not evenly distributed. Therefore, the utilization can be a priority for each region where the potential is present.

The geological processes produce rare submerged peneplain of Mesozoic age considered to be the largest in the world. The vast peneplain located in a stable earth's crust of non-seismic zone is suitable for high rise buildings and industrial sites. Some areas can be utilized as industrial estates, both mining materials processing and various industries that utilize these materials. Strategic location on the world trade routes, facilitate in the market aspect.

The embayment produced by submerged peneplain is conducive both for marine and tourism industries. The mix between the shopping area of modern products and marine tourism will be something distinctive and can be a flagship that can compete with other regions, especially Singapore.

Recommendations

Inventarization of mineral wealth both in land and sea is recommended. The utilization of the material can be done based on its priority. Meanwhile, the management of the beauty and unique landscape is suggested to be proposed for the national and international geopark under the UNESCO network.

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