Study of Granitoid Distribution at Toboali Waters, Bangka Belitung Province: Seismic data interpretation approach

Studi Penyebaran Granitoid di Perairan Toboali, Provinsi Bangka Belitung: Berdasarkan penafsiran data seismik

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ABSTRACT: Bangka Island is one of the islands in Indonesia which is traversed by Southeast Asia granitoid belt. This belt stretches from Burma (Myanmar) to Bangka Belitung. This granitoid has potential as a source rock of mineral that carrying tin and rare earth element. At present, mapping of granitoid rocks to the waters area is rarely published, so acoustic basement mapping is necessary to do in order to determine the distribution of granitoids in Toboali waters. The research method used is a single channel seismic with an energy source of 300 joules. The sound source uses a single plate boomer, so it has a high enough resolution but the penetration is not deep enough. Acoustic basement in Toboali waters varies in depth from 15 - 75 ms or getting deeper south. When viewed from the continuity of the acoustic basement, it is estimated that the granitoid is 7 km from the nearest coastline.

Key words: single channel seismic, seismic interprtation, granitoid distribution, Toboali Waters, Bangka Belitung Province

ABSTRAK: *Pulau Bangka merupakan salah satu pulau di Indonesia yang dilalui oleh jalur granitoid Asia Tenggara. Jalur ini membentang dari Burma (Myanmar) hingga Bangka Belitung. Granitoid ini memiliki potensi sebagai batuan sumber pembawa mineral timah dan unsur tanah jarang. Pada saat ini pemetaan batuan granitoid pada daerah perairan jarang dipublikasikan, sehingga pemetaan batuan dasar akustik perlu dilakukan dalam rangka mengetahui sebaran granitoid di Perairan Toboali. Metode penelitian yang digunakan yaitu seismik single channel dengan sumber energi yang dikeluarkan sebesar 300 joule. Sumber suaranya menggunakan boomer single plate, sehingga memiliki resolusi yang cukup tinggi akan tetapi penetrasinya tidak cukup dalam. Batuan dasar akustik di Perairan Toboali memiliki kedalaman bervariasi mulai dari 15 – 75 ms atau semakin ke selatan semakin dalam. Jika dilihat dari kemenerusan batuan dasar akustiknya diperkirakan granitoid tersebut berada 7 km dari garis pantai terdekat.*

Kata kunci: *Seismik single channel, interpretasi seismik, distribusi granitoid, Perairan Toboali, Provinsi Bangka Belitung*

INTRODUCTION

The Southeast Asian granitoid belt is a granitoid line that stretches 3000 km from Burma, Myanmar to Bangka and Belitung Islands which are rich in tin. Bangka Island is one of the islands from north to south which is traversed by Southeast Asia granitoid belt in the form of continuous plutonic intrusion from land to the surrounding waters (Aryanto, 2014). The continuity of this granitoid needs to be known in the sea, because in mining industry the exploration for deposits containing placer minerals is not only focused on the place of mineral accumulation (valley hunting), but also necessary to find the source rock (source rock hunting).

Currently, the distribution of granitoid in the South Bangka waters cannot be further investigated due to the lack of drill data in the ocean, therefore using an

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acoustic basement interpretation approach on seismic data is expected to be able to see the distribution of acoustic basement which has a characteristic reflector pattern that resembles granite. Hopefully, it can provide a geological understanding for distribution of granitoids and knowing about the boundaries area that have potential to contain placer minerals as carriers of tin or rare earth elements.

then mixed with the mantle that touches the crust (Winter, 2001). According to Widana (2013) based on its geochemical characteristics, granite rocks in the western and southern parts of Bangka Island are S type granites which show strongly evolved with a Th / U ratio> 8, while granite rocks on the North and Central Bangka Island are I type granites which shows a Th / U <8.

Figure 1. Study area map (Aryanto *et al.*, 2015)

Administratively, the study area is in the Toboali waters which is part of the South Bangka Regency area, Bangka Belitung Province. Geographically, it is included in the UTM Zone 48 S with coordinates 9650000 mN - 9672500 mN and 662000 mE - 700000 mE (Figure 1).

Granitoid of Bangka Island

Bangka Island granite is composed of I type and S type granites. Genetically, I type granite is a granite that formed due to non-orogenic processes where the process occurs due to the seafloor spreading. Meanwhile, granite S type is a product of the collision zone which is the final phase rather than orogenic and is formed as a result of the continental crust partial melting that enters to the lower part (metasediment)

Mangga and Djamal (1994) stated that the granite rocks in the northern part of Bangka Island are Late Triassic - Early Jurassic Granite which is named Klabat Granite (TJkg) because most of these types of granite rocks are found in Klabat Bay. These granite rocks are biotite granite, gray in color, porphyritic texture with medium-coarse-sized crystal grains, phenocrystalline crystals up to 4 cm in length, and some granites show a foliation structure. This granite intruding the older rock formations, that called Pemali Formation (Permian) which is a rock formation dominated by metamorphism rocks, and the Tanjunggenting Formation (Early Triassic) which is a rock formation that dominated by sedimentary rocks. At the top of this Klabat Granite, Holocene alluvium (Qa) is deposited.

Margono *et al.* (1995) stated that the granite rocks in the southern part of Bangka Island to Lepar Island (Small Island to the east of Bangka Island) are still Klabat Granite which is the same as the northern part of Bangka Island Late Triassic - Early Jura. This granite intruding the older rock formations, that called Permian Pemali Formation (CPp) which is composed of metamorphism rocks and the Early Triassic Tanjunggenting Formation (Trt) which is composed of sedimentary rocks. At the top of this Klabat Granite, Pleistocene Ranggam Formation (TQr), Holocene swampy sediment (Qs), Holocene quartz sand (Qak), and Holocene Alluvium (Qa) were deposited. But in the southern part of Bangka, the same diabase are not found like the northern part of Bangka. The results of these studies are summarized in the stratigraphic column of the study area (Figure 2).

Aryanto (2015) research in South Bangka Waters shows granite rocks are widely spread from the mainland to the coast (Figure 3). Most of the beaches in the South Bangka region are composed of rocky beaches with granite rocks. Some of these granite rocks were formed as in situ rocks, another one was boulders only. These rocks are still Klabat Granite rocks that stretch from north to south of Bangka Island. Hypotetically these granite rocks are also spread into the sea.

METHODS

To determine the depth of the acoustic basement in Toboali waters we have used the single-channel seismic method as the basic data. There are 12 selected seismic lines that showed chaotic reflector-free reflector pattern, and hyperbolic shape. In order to produce a good seismic resolution, this seismic system used a single plate boomer as a sound source with a shot interval of 0.5 seconds. Moreover, in order to get sufficient penetration to limit the granitoid, the energy source that we used up to 300 joules.

The sound waves penetrate the rock layers below the seafloor and then were reflected back according to the rock velocities. The different velocities of this rock properties then received by hydrophones series on streamers that are towed behind the ship. The results were digitally recorded using Sonarwiz software and printed using the Graphic Recorder EPC 3200.

The results of the acquisition are processed using a bandpass filter to reduce interference (noise) in the recording, then interpret the seismic recording as seen from the unconformities relationship between the layering sediment (Vail, 1977 in Veeken, 2007) and reflector configuration (Mitchum, 1977 in Veeken, 2007). The contour of this interpretation is then made to determine the depth (in milliseconds) and the distribution pattern in Toboali waters.

RESULT

There are 17 seismic data that have been acquired, but the seismic lines that used in this study are 12 lines which have a north-south, northwest-southeast, and west-east direction with a total length of 50.2 km (Figure 4). Because only these 12 seismic lines show a granitoid reflector pattern.

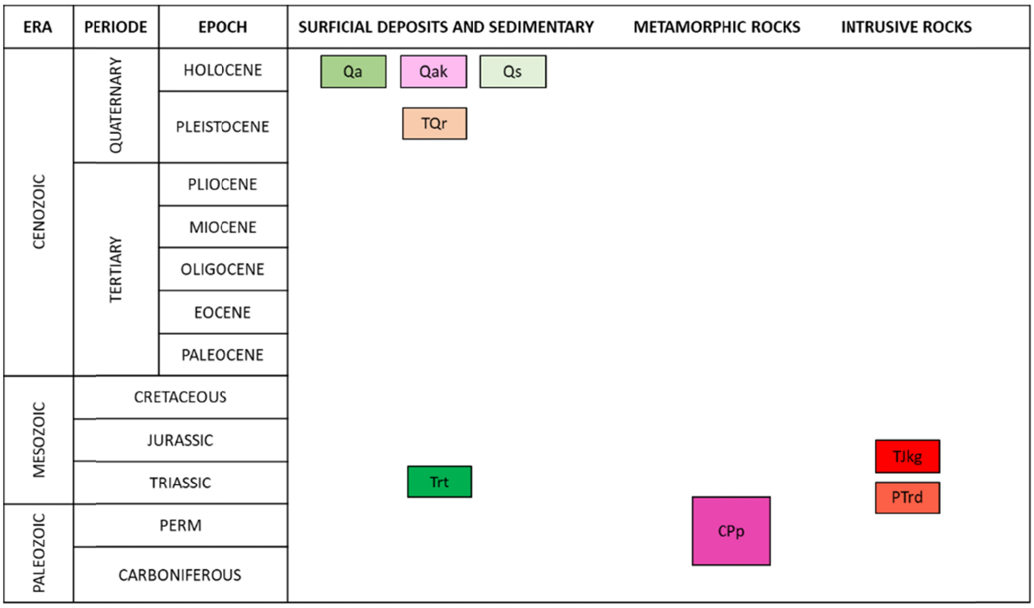

Figure 2. Bangka Islnd Stratigraphic Clumn (Margono *et al.*, 1995 and Mangga *et al.*, 1994)

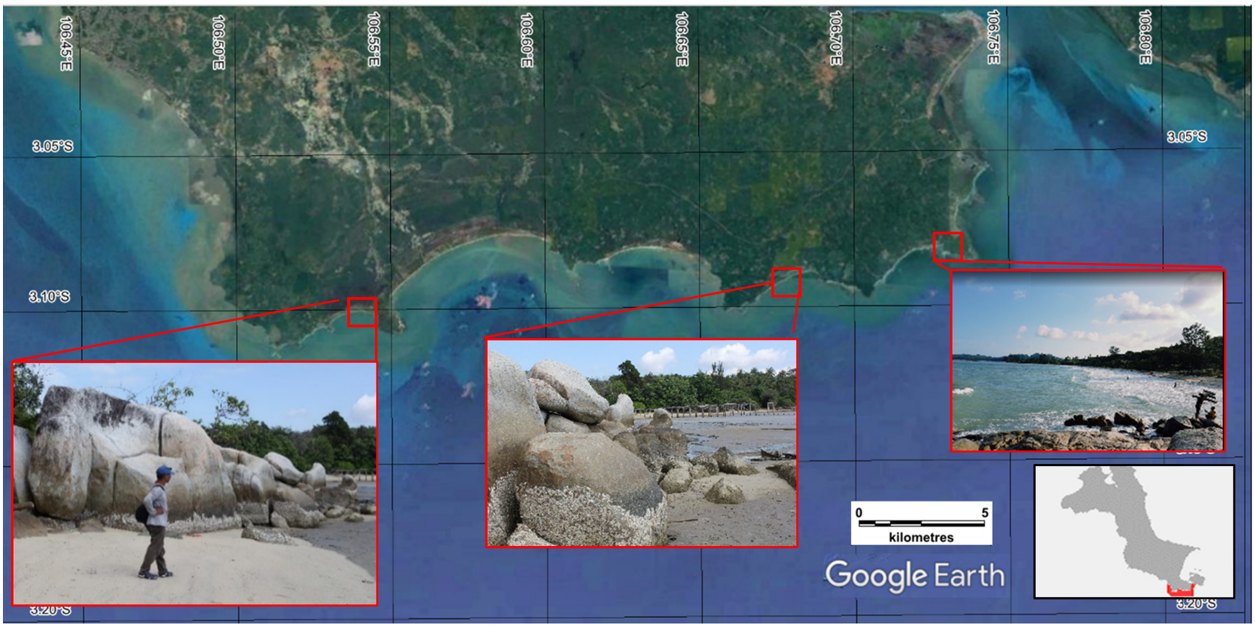

Figure 3. Rocky beach composed of granite rocks (Aryanto, 2015 combine with Google Earth

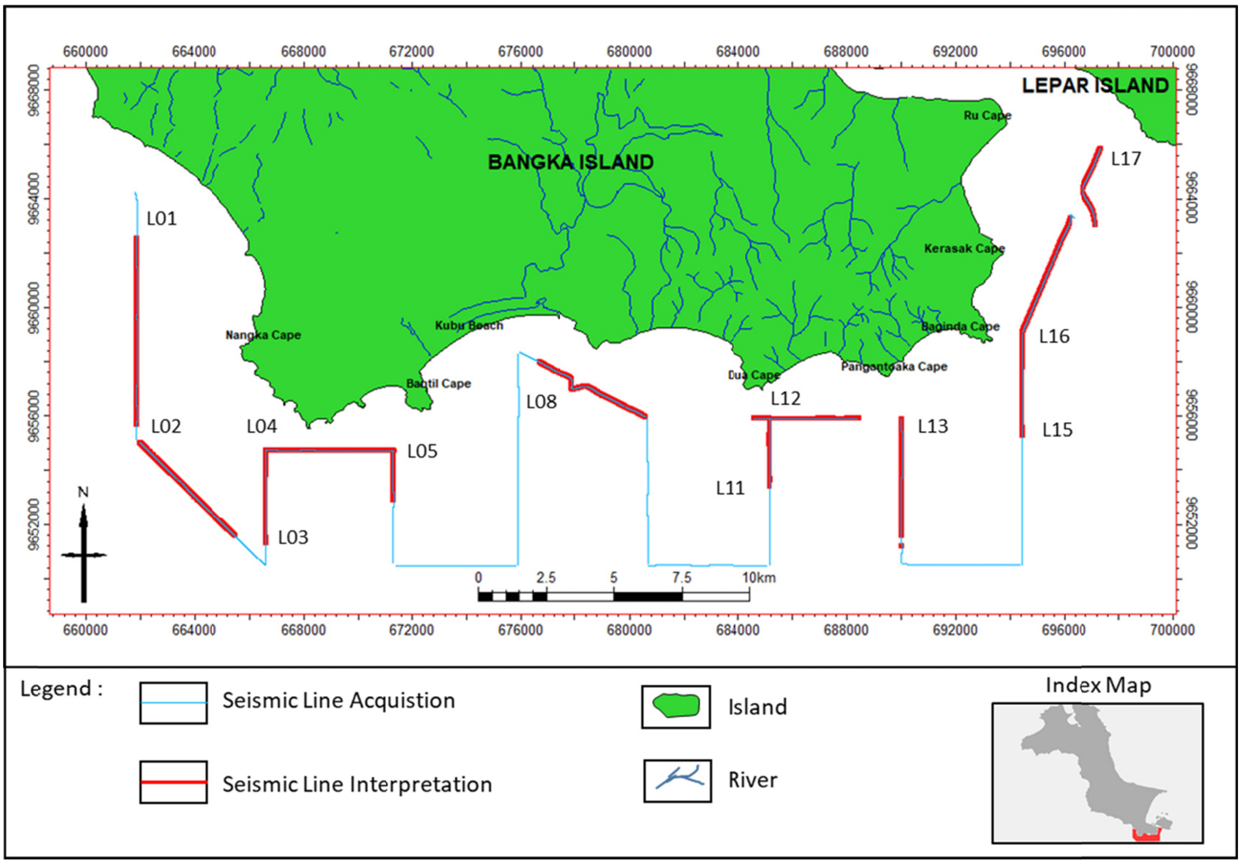

Figure 4. Seismic Lines Map

The quaternary sediment was deposited on the acoustic basement which is thought to be an older granitoid rock characterized by erosional truncation. These granitoid rocks in the Toboali waters are generally shown with a chaotic reflector-free reflector pattern, but on several seismic sections, it shows a subparallel-chaotic reflector pattern. The interpretation of seismic data is focused on the chaotic reflector pattern - free reflector. The distribution of granitoid in Toboali waters generally has a depth of 15 - 75 ms with an increasingly shallow presence, this is in accordance with previous studies which states that the sedimentation pattern is thinning towards the mainland (Zulfikar and Aryanto, 2016).

L01 seismic section (Figure 5) is on the west side of Toboali waters. This line has a direction from north to south, it shows an acoustic basement that is deep enough from the seafloor. This acoustic basement is 20 milliseconds from the seafloor with a depth ranging from 28-70 milliseconds. The reflector looks hyperbolic and has a morphological shape with a fairly steep slope. The reflector configuration that looks chaotic - free reflector with weak energy and separated by erosional truncation. Above this acoustic basement, there are 2 seismic facies units with a total thickness ranging from 15 - 55 milliseconds.

L04 seismic section (Figure 6) is on the west side of Toboali waters. This line has a direction from west to east, it shows an acoustic basement that is shallow towards the seafloor. This acoustic basement is 0-5 milliseconds from the seafloor with a depth ranging from 20-30 milliseconds. The reflector looks hyperbolic and has a morphological shape with a fairly steep slope. The reflector configuration that looks chaotic - free reflector with weak energy and separated by erosional truncation. Above this acoustic basement, there are 2 seismic facies units with a total thickness ranging from 7 - 20 milliseconds. This granite is a continuation of the headland in the north of these seismic lines. Because the granite is closer to the surface, so the quaternary sediments deposited on it are relatively thin.

The L08 seismic section (Figure 7) is on the middle side of Toboali waters. This line has a direction from northwest to southeast, it shows an acoustic basement that is quite shallow from the seafloor. The depth of this acoustic basement ranges from 15 - 60 milliseconds with a reflector that tends to look hyperbolic with a morphological shape sticking out towards the surface with a fairly steep slope. The reflector configuration that looks chaotic - free reflector with weak energy and separated by erosional truncation. Above this acoustic basement, there are 2 seismic facies units with a total thickness ranging from 2 - 40 milliseconds. This granite is a continuation of the headland in the north of these seismic lines. Because the granite is closer to the surface, so the quaternary sediments deposited on it are relatively thin.

The L11 seismic section (Figure 8) is on the east side of Toboali Waters. This line has a direction from northwest to southeast, it shows an acoustic basement that is quite deep from the seafloor. The depth of this acoustic basement ranges from 40 - 75 milliseconds with a reflector that tends to look hyperbolic with a morphological shape sticking out towards the surface with a fairly steep slope. The reflector configuration that looks chaotic - free reflector with weak energy and separated by erosional truncation. Above this acoustic basement, there are 2 seismic facies units with a total thickness ranging from 10 - 45 milliseconds. This granite is a continuation of the Dua Cape in the north of these seismic lines. Because the granite is deeper from the surface, so the sediment deposited on it is quite thick.

DISCUSSION

Distribution of Granitoid in Riau Islands - Bangka Belitung

Cobbing (2005) suggests that the granite stretching from the Riau Islands to Bangka Belitung consists of 2 different granite province. Where Granite in the Riau Islands is included in the eastern granite province, while Bangka-Belitung granite is included in the main granite province. Granite in the Riau Islands has quite different characteristics, even though both are intrusive rocks, the scale of the intrusive rocks is relatively different. For example, granitoid in northern Batam waters show intrusive granite which acts as a basement at the same time. However, this granite distribution pattern is only localized (Usman, 2007). While the granite on Bangka and Belitung Islands is granite in batholith size, apart from being seen in the distribution of granite outcrops on the surface, this can also be illustrated in the gravity anomaly analysis which shows a high anomaly on a fairly large scale on the northern part of Bangka Island (Simamora, 2007). This granite continues to the southern part of Bangka Island.

Distribution of Granitoid in South Bangka Water

The subsurface mapping of an acoustic basement from the interpretation of 3 selected seismic lines shows that the depth of the acoustic basement is quite varied, ranging from a depth of 15 - 75 ms. These acoustic basements generally have a chaotic pattern and are free reflectors with high acoustic impedance. Reflector patterns like this indicate that the rock is granitoid, but the more chaotic reflector pattern toward the sea shows a steep morphology, the more difficult it is to find. This acoustic basement has valleys filled with sediments of

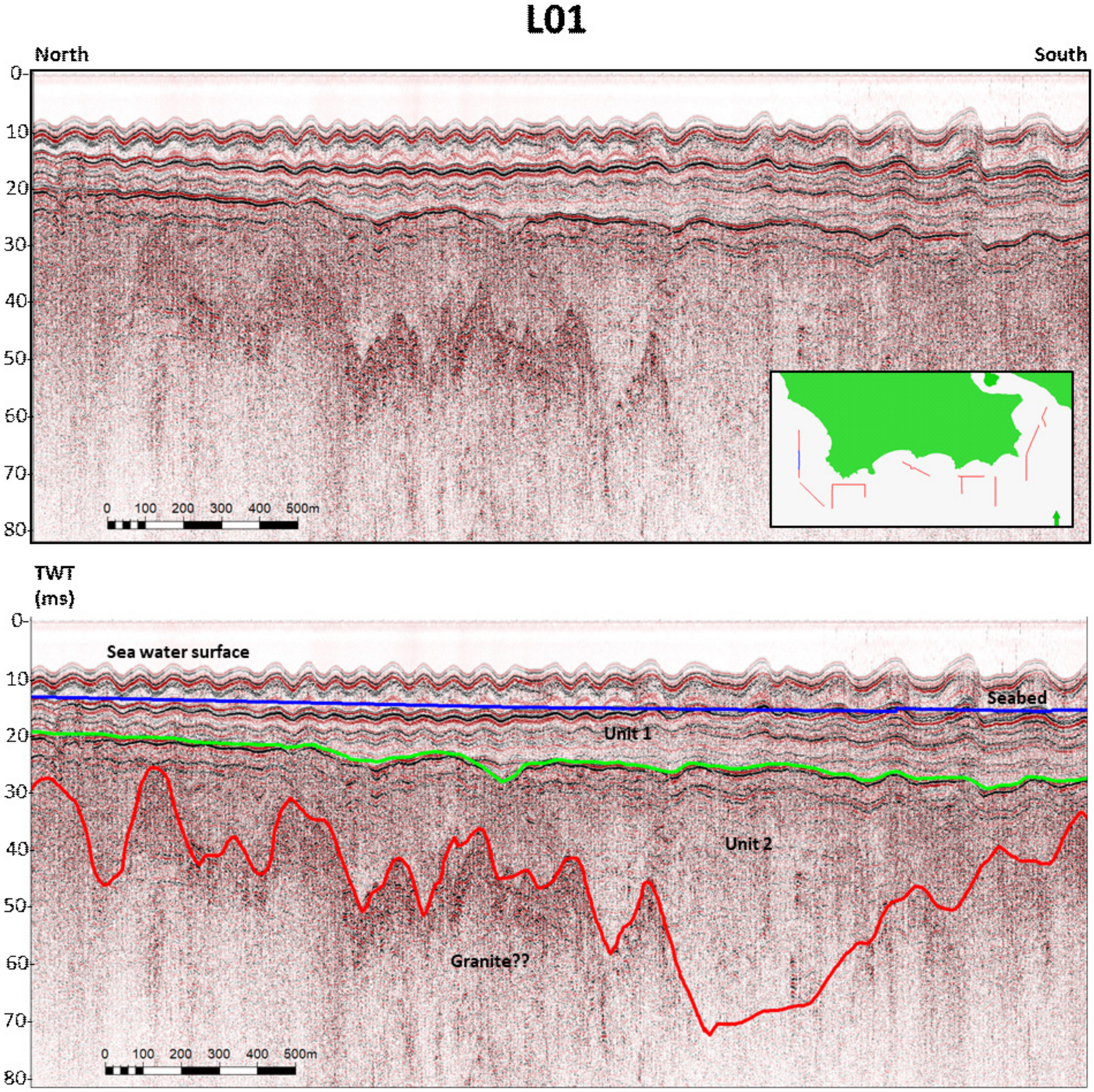

Figure 5. L01 Seismic Lines Interpretation

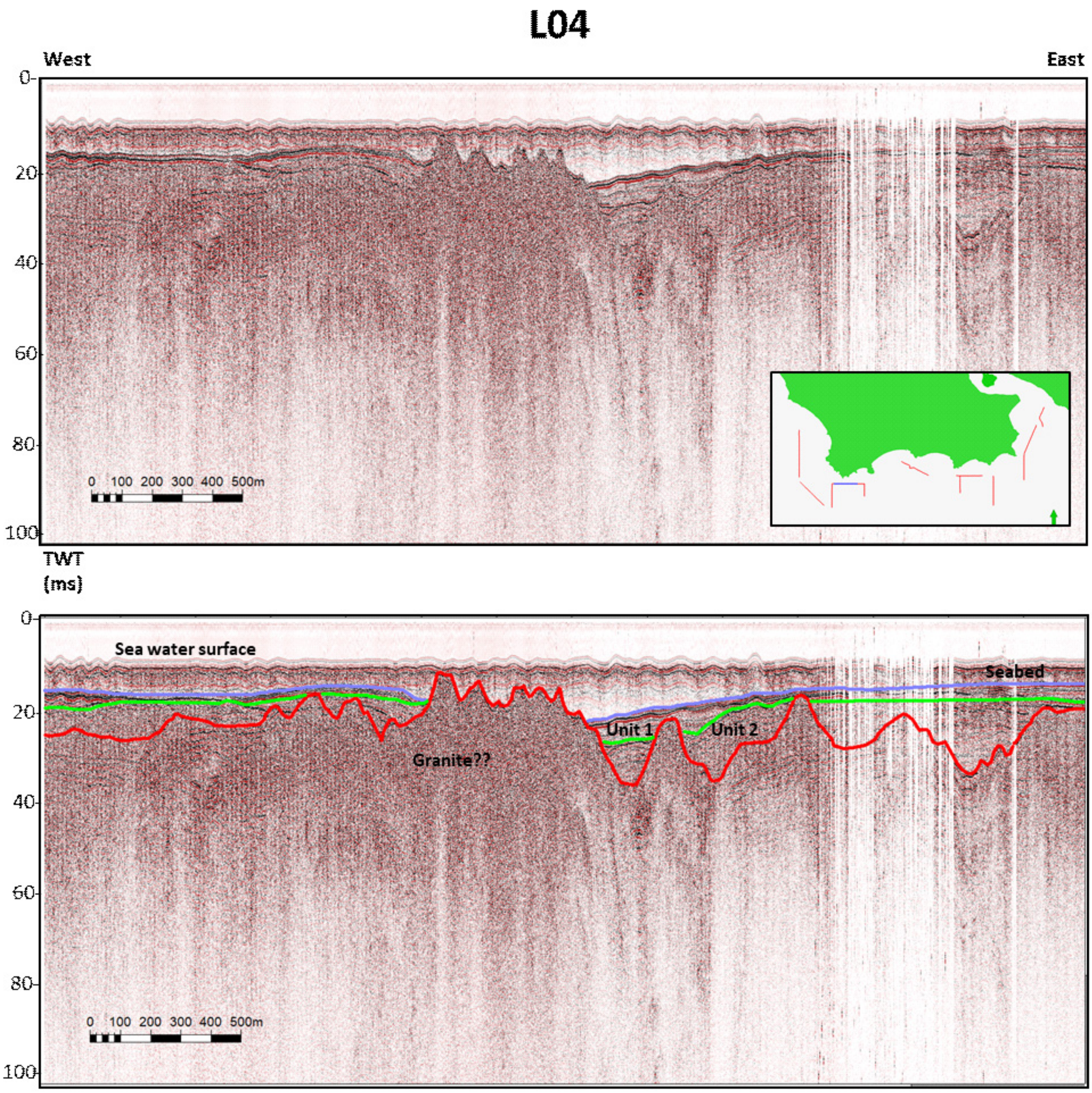

Figure 6. L04 Seismic Lines Interpretation

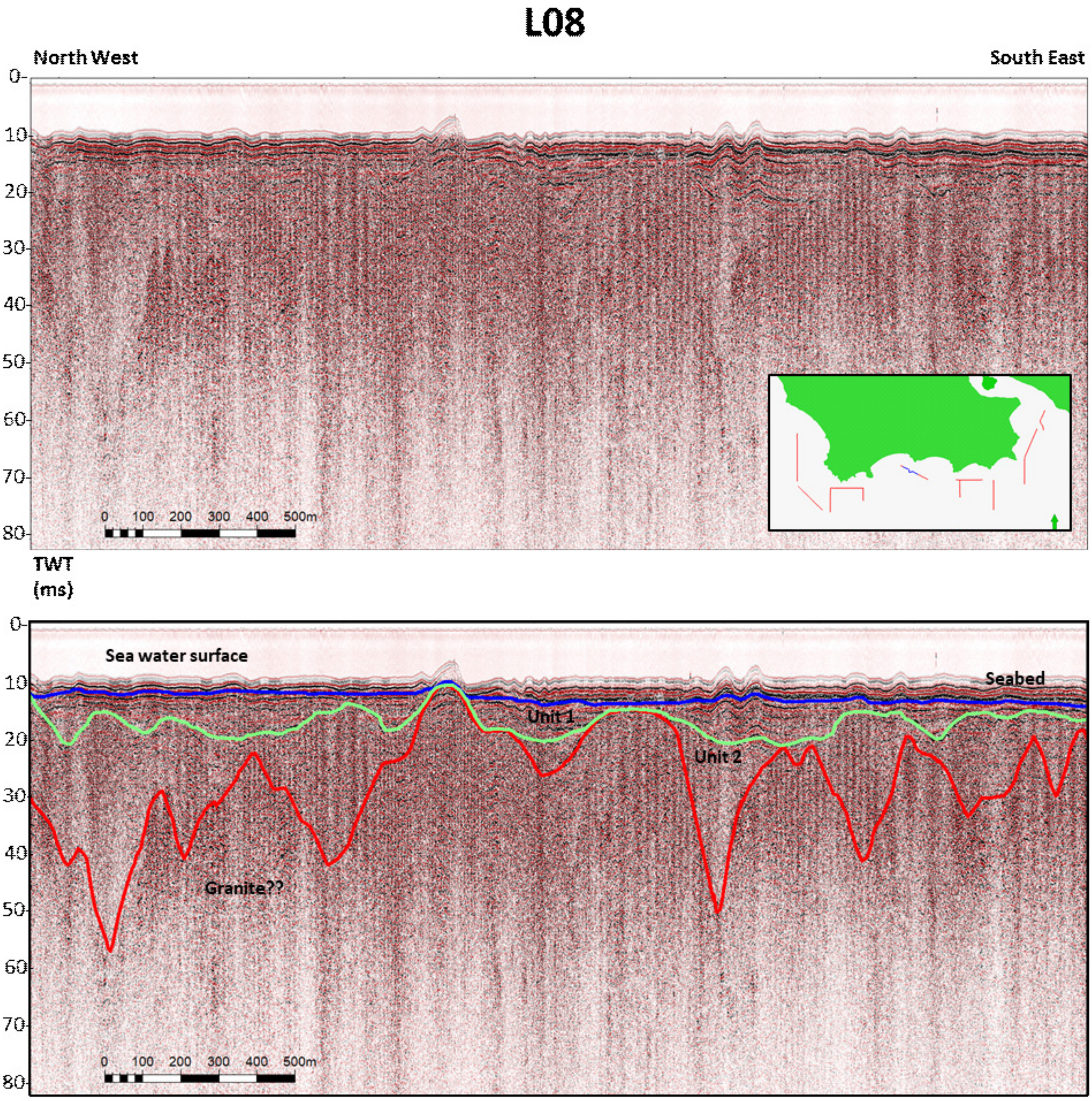

Figure 7. L08 Seismic Lines Interpretation

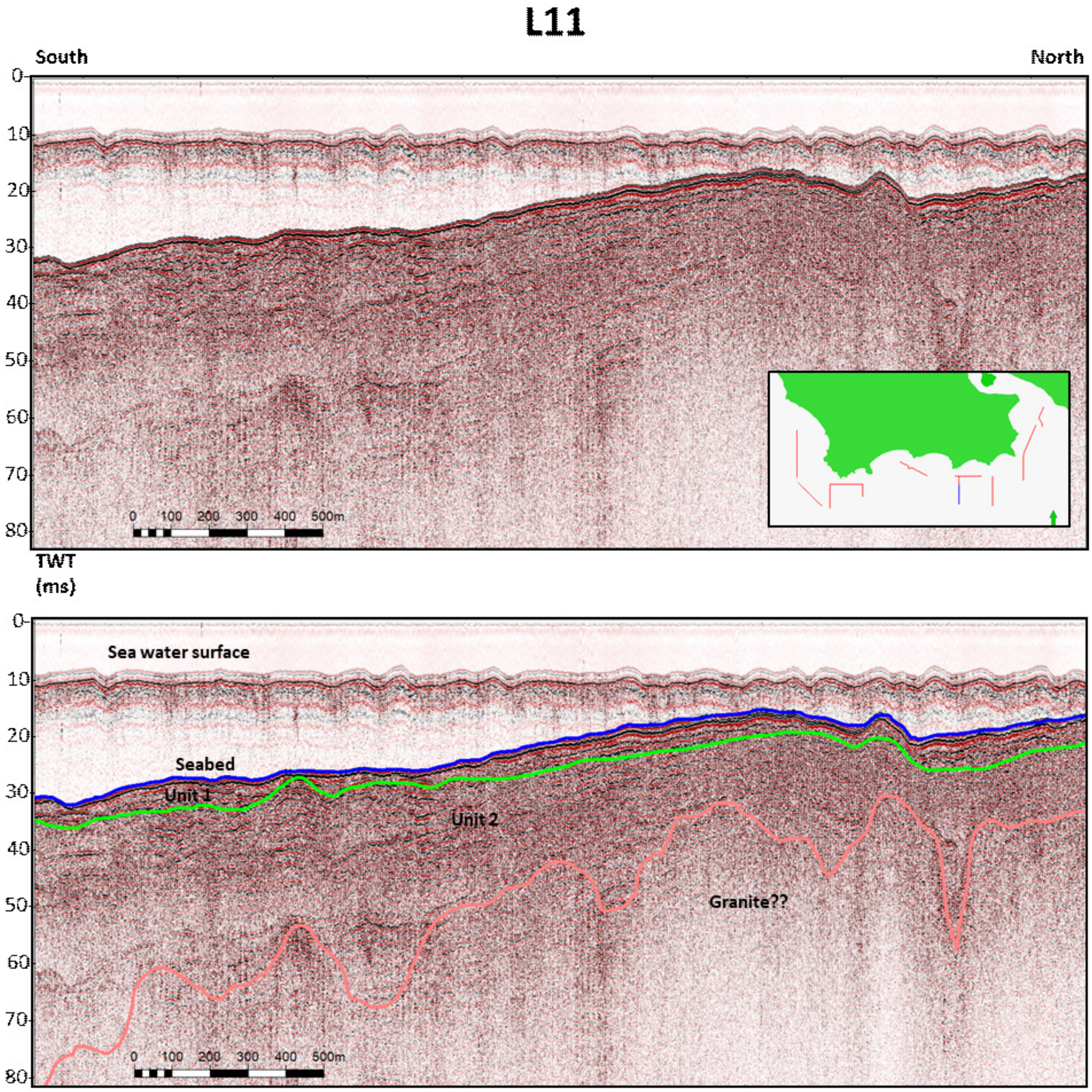

Figure 8. L11 Seismic Lines Interpretation

the quaternary age. The sediments of this quarter are composed of 2 deposition units.

The acoustic basement which has granitoid-like characteristics is located from the west of the Toboali waters to the east of the Toboali waters (Figure 9). In some places, it shows an intrution granite to the surface of the sea. This is indicated by the presence of closure. These closure describe a fairly steep morphological formation of the intrusion. The distribution of granitoids in South Bangka waters is still a continuation of the batholith body on the land. As the land from Kerasak Cape, Baginda Cape, Pangantoaka Cape, Dua Cape, and Nangka Cape indicates the presence of Klabat Granite.

In water areas > 7 km from the coastline, the reflector pattern that resembles granite is going deeper. Cobbing (2005) also states that the granitoid belt from the south of Bangka Island turns towards Belitung, but Cobbing only limits the granite path to the land side. The marine seismic acquisition result shows that the granitoid is still spread into the water (Figure 10).

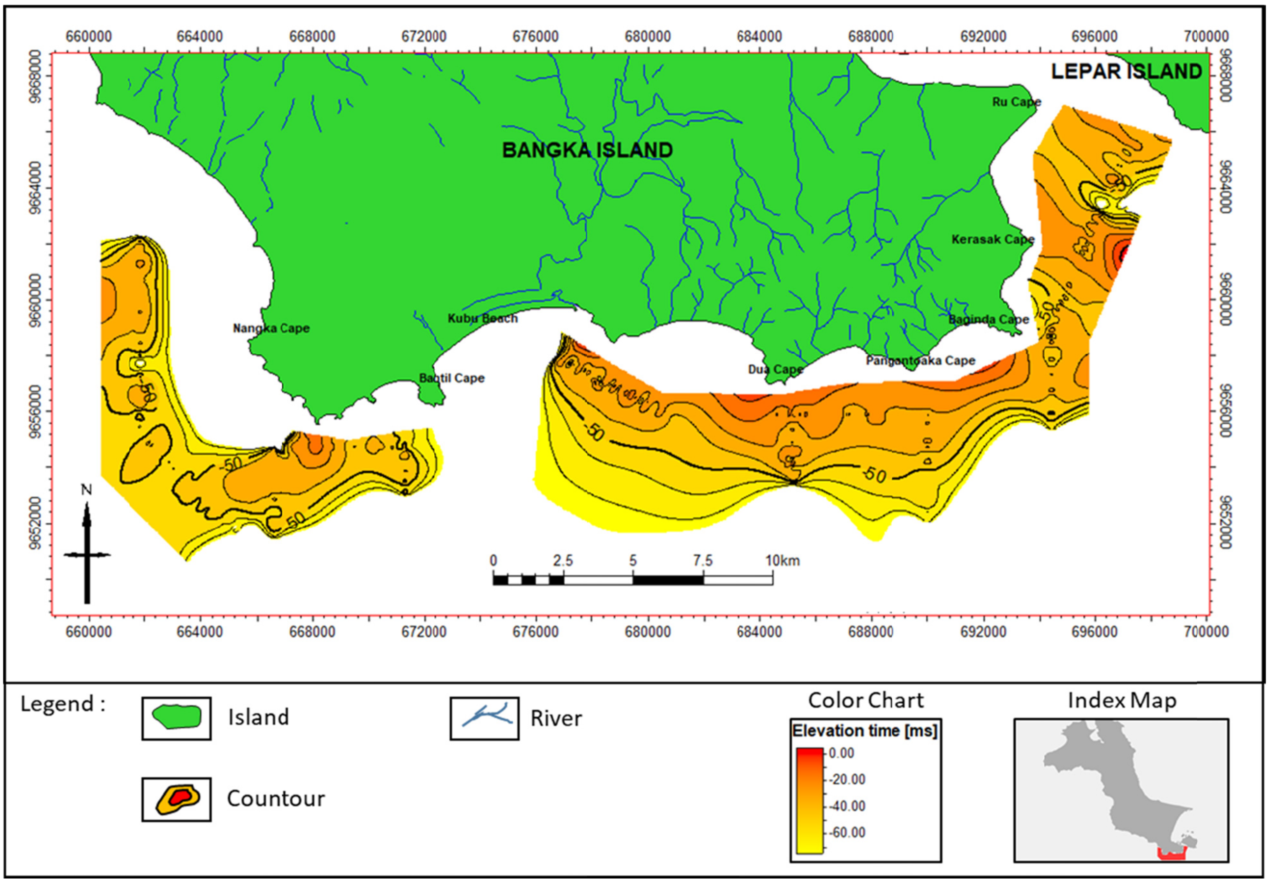

Figure 9. Acoustic Basement Map (ms)

CONCLUSION

Based on acoustic basement seismic interpretation in Toboali waters, it shows that distribution of granitoid rocks that getting deeper southward because it is away from the main granitoid belt. Thus, if want to explore economical minerals (both heavy minerals and ree-carrying minerals) in the waters of Toboali, the area of interest must not exceed 7 km from the nearest coastline.

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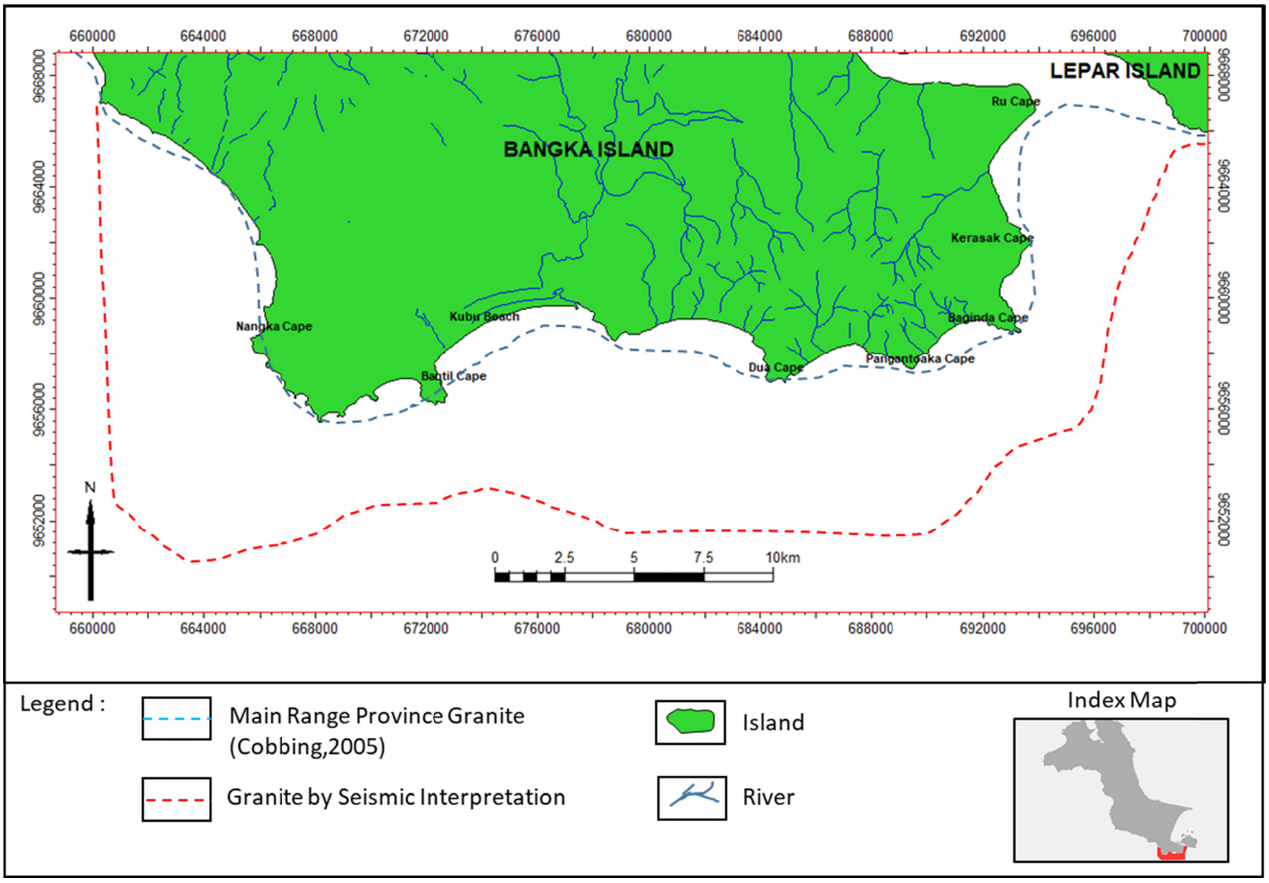

Figure 10. Granitoid Distribution of South Bangka – Lepar Island (modified after Cobbing, 2005)

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