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Subduction Zone in Java Island Using Primary Wave Tomography from Jacobian Relocation Method Based on *ak135* Velocity Model

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Abstract. The subduction zone occurs in Java Island analyzed based on data of tectonic earthquake. Earthquake data used is P wave velocity accessed from the ISC website from 1900-2013 years located along the Java Island. ISC is an organization that provides a variety of data tectonic earthquakes around the world, but the data used is the data before relocation. Relocation needs to reposition the hypocenter, so it can result a new position based on geological model. The relocation is using Jacobian's matrix and *AK135* velocity model of P wave in each depth. The tomography process using FMTOMO software from result of new hypocenter represent the subsurface condition at a depth of 0-700 km. The result of hypocenter relocation is shifted horizontally to the southeast while vertically relatively shallow. The results obtained from the tomographic analysis of north-south section show the response of the velocity wave where high value shown in blue color as subduction zone and low value shown red color under volcanic as the partial melting. Tomographic 3D visualization displayed by Voxler software shows the different subduction in Java Island. Result of 3D analysis indicate that the subduction in West Java until Central Java relatively sloping than subduction in East Java.

INTRODUCTION

Earthquakes are caused by tectonic fault process because folding crust, forming mountains and movements in subsurface for example in Java. Tectonic earthquake data used in the research is accessed on International Seismological Center (ISC) sites. Incorporated Research Institutions for Seismology (IRIS, 2013) explains that seismologists can use tomography to infer the geological structures such as subduction of tectonic plates or partial melting while volcanologist use tomography to determine the size of the magma chamber beneath volcanoes. In this research, the process do in 2 stages that are relocation and tomography. The relocation is needed to reposition the hypocenter which assumes that the Earth is heterogeneous using Jacobian matrix method and *ak135* velocity model then the results, new hypocenters, are used for tomography process. Basically, the principle of tomography utilize arrival time to describe the condition of the subsurface based on the concepts of physics and mathematical calculations. The processing of tomography use FMTOMO software with *ak135* velocity model. Seismic tomogram describe the P wave velocity [1]. The quantity plotted is the deviation of the P wave velocity to the one-dimensional of the velocity.

SETTING TECTONIC OF JAVA ISLAND

Setting tectonic in Java Island and Sumatra is not so difference. It can be observed in the interaction between the Indian-Australian Plate, the Eurasian Plate, and the Sunda Arc. Java Island located in the southeast of Sundaland. The movement of the Eurasian Plate move to the Southeast since the Oligocene [2]. Indian-Australia Plate in south move to north since the Mesozoic and subduction Sumatra and Java arc [3]. The Control of the tectonic in Java is collision activity between two Eurasian continental Plates (granitic composition) and the Indian Ocean-Australian Plate (basaltic composition). According to [4], the activities of the collision in the past

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resulted a subduction of ancient (ophiolit belt) and as well as controlling the order of tectonics in West Java while [5] order tectonic Java Island is influenced by several variables, such as the interaction of convergent characterized by symptoms subduction among the Indian-Australian Plate that move relative to northern and continental crustal plates move relative to the south where one of the products is magmatic arc in Java.

RESEARCH METHOD

Hiposenter Relocation

Relocation aims to repositioning the quake at coordinates x, y and depth z by subsurface velocity model. It is necessary to seismic data owned ISC [6]. Relocation process is done using Matlab R2008b based on Jacobian matrix and *ak135* velocity model. Grid used is at the x coordinate is 20 km, the y coordinate is 10 km, while the z is variation from 5, 10 to 20 km adjusted with increasing depth, the greater the depth value (z).

Tomography Method

This research uses a FMTOMO software. [7] assume that under the earth's surface is lateral heterogeneity which do not affect the relative wave arrival time in tomographic inversion. The concept of FMTOMO apply Huygens Law and Fermat Principle so from two basic principles of seismic software is able to describe the plate boundary (Moho), crust, upper mantle. Performed checkboard manufacture and test the resolution test to determine the input parameter corresponding to the location of research before the tomography (Figure 3a).

RESULT AND DISCUSSION

Relocation of Hiposenter

The result of relocation make the position shift horizontally towards the southeast with x is 20 km and y is 10 km and becomes shallower in depth of 1, 5, 10 to 15 km (Figure 1). The results of the hypocenter distribution can identify the shape of subduction zone based hypocenter distribution which is the central location of the earthquake tectonic activity resulting from subduction. The results of the hypocenter distribution can also describe the angle subduction zone under the island of Java in the range of 15^{o} beneath in West Java to 35^{o} beneath in East Java.

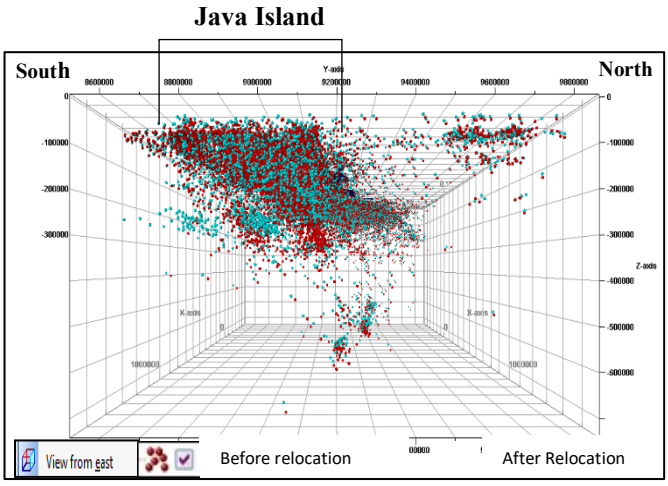

FIGURE 1. Hypocenter distribution after and before relocation.

Delay Time of Tomography

Horizontal Section

The results of tomography are controlled by checkboard and resolution test (Figure 2a and 2b) where the black line on the picture is a good resolution boundary, so from the test, the limit can be interpreted to a depth of 120

km. Tomography results were analyzed by the spread of blue and red. Distribution of the colors on the map horizontally (figure 2c) at a depth of 10 km looks dark because the waves that pass a shallow depth is very much, so in the grid that have been made during the process of tomography missed by a lot of waves in the grid. The increasing depth of the wave that passes through a medium will also be reduced. Results of tomography appear in relative velocity value (Vp) showed a response of velocity of the medium traversed by perturbation unit (km / s). Velocity response is also shown by the spread of blue and red. The blue color of the horizontal cross section observed from the color scale indicates the response to the relative Vp accelerating +0.5 km / s identified as compact medium while the red color observed also on the color scale indicates the response to Vp relative that experienced a reduction in the relative speed - 0.5 km / s were identified as a not compact medium.

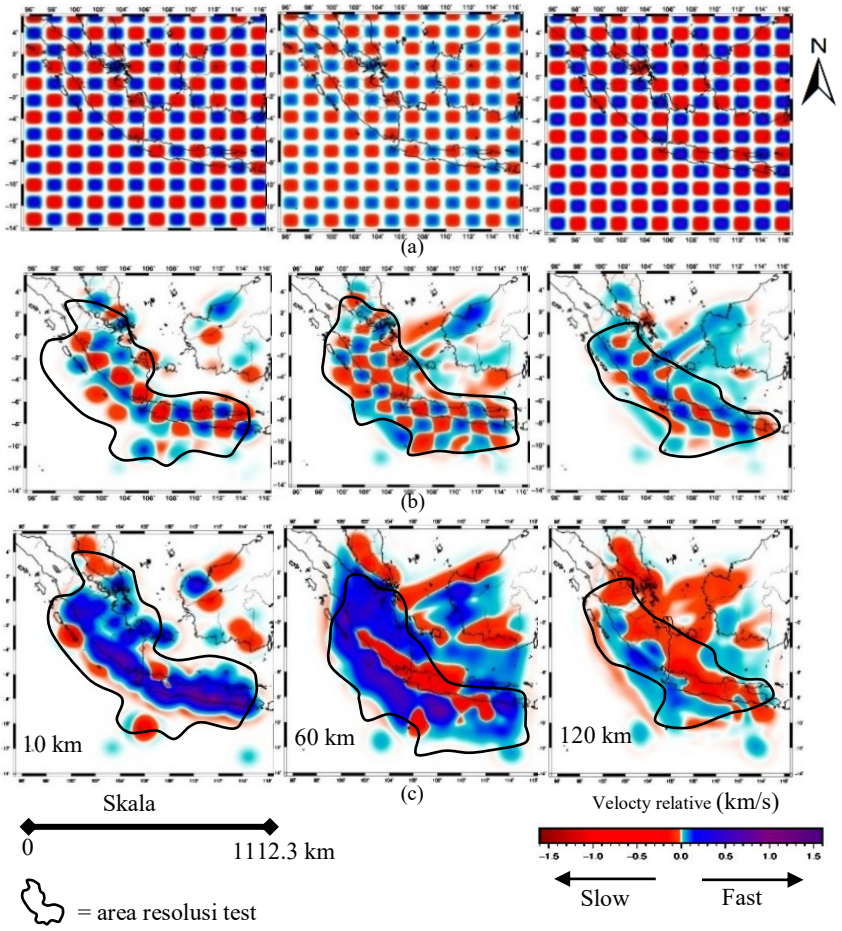

FIGURE 2. (a) Checkboard, (b) Resolusi Test (c) Result of tomography in horizontal section.

Vertical Section

Vertical section (Figure 3) shows the shape of subduction beneath Java Island. The blue color that looks down is a subduction of Indian-Australian Plate beneath Java Island that is included in the Eurasian continent. Vertical section describe subduction zones of Sundaland, South Sumatra, and Bali. It also shows a continuity of the subduction zone beneath the island of Java as well as differences in the subduction zone of West Java to East Java. Section A-A' to H-H' shows the continuity of the subduction zone in South Sumatra to Bali. When observed from South Sumatra to Bali, there are differences the slab subduction eastward increasingly visible subduction. Figure 4 is result of distribution the hiposenter after relocation, overlay with the result of tomography vertical section, that (Figure 4) shows about distribution of the earthquake was in the southern island of Java, which is the result of reflection from the movement of the Indian plate with the Eurasian Australian widespread in the east. Distribution of earthquake data reflects the subduction of the Indian-Australia plate under the Eurasian plate. Indian-Australia plate is located in the south moving north since the Mesozoic and subduction under Sumatra island arc system and Java [3].

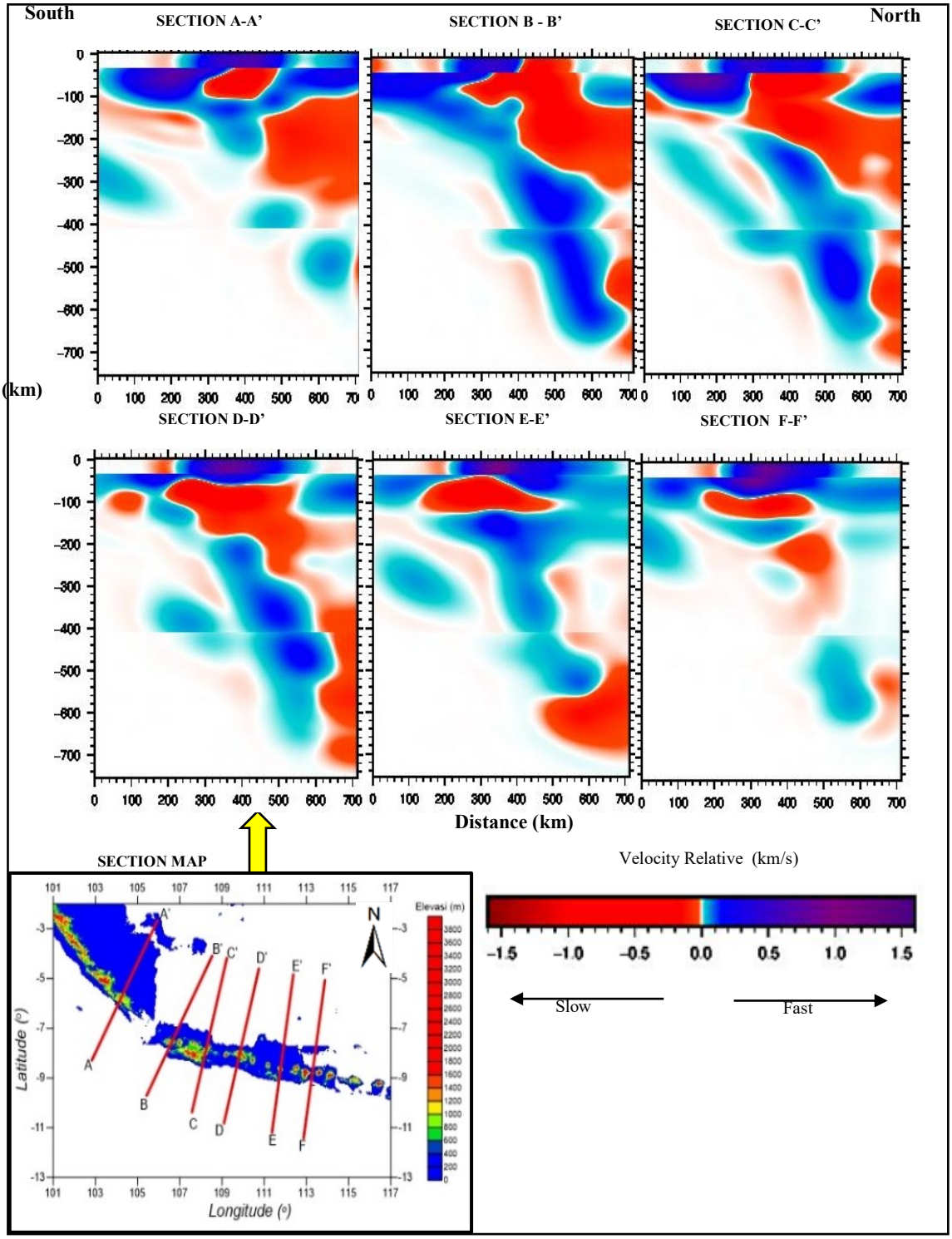

FIGURE 3. Result of tomography in vertical section to describe of slab subduction.

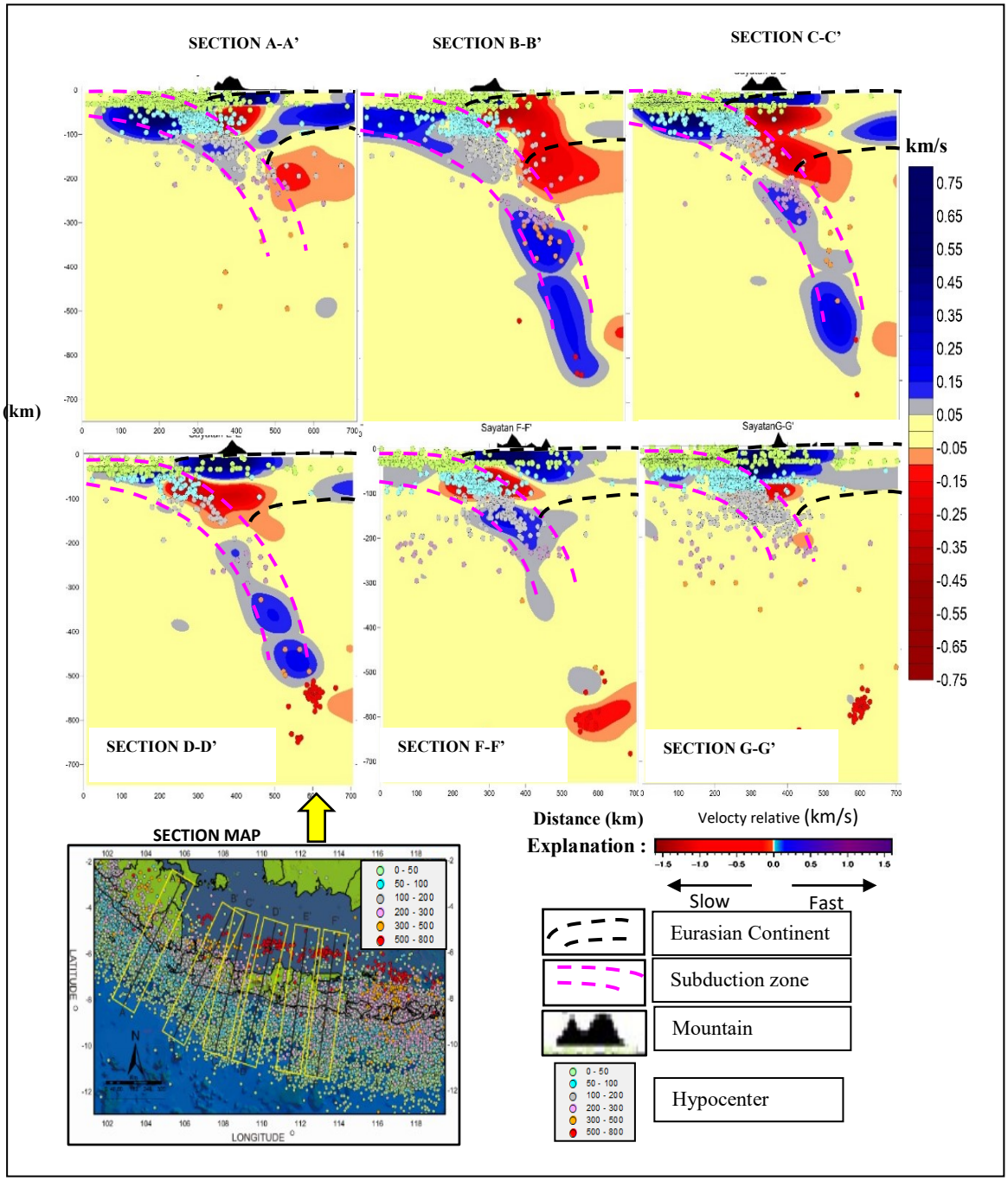

FIGURE 4. Dsitribution of hiposenter overlay with resulth of tomography vertical section.

CONCLUSIONS

Based on the results of relocation and tomography method can be concluded that:

1. The result of the relocation get the position horizontally shift to the east with x coordinate is 20 km, y coordinate is 10 km, and becomes shallower in depth from 5 to 15 km.
2. The results of the relative perturbation tomography produces not compact distribution in red with perturbation value about -0.5 km / s while the compact medium in blue with perturbation value about +0.5 km / s indicating subduction zone beneath in Java Island.
3. Difference of angle subduction from West Java to East Java is about 20° which is greater than in the West-Central Java.

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