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3D TOMOGRAPIC ANALYSIS OF EARTHQUAKE IN SUMATRA USING *LOCAL EARTHQUAKE TOMOGRAPHY*

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Abstract

Tectonic earthquakes need more detailed study because it has big influence of damage. Seismic method that has been used by several researchers to show the subsurface structure of the earth, tried to be applied in the area of Sumatra. Seismic tomography is a method of 3D local model development on a subsurface structure using seismic wave. Data processing steps on seismic tomography consist of the earthquake hypocenter determination using 1D model hypo71 software (Single Event Determination). 3D velocity distribution that consists of location of 3D model determining using ray tracing algorithms, grid parameterization and inversion using LSQR method (Least Square) and then it will be processed by using a 3D tomography inversion Local Earthquake Tomography Lotos-12. The result show that in upper crust have Vp= 6.625 km/s and Vs= 4.064 km/s, in lower crust have Vp=7.230 km/s and Vs is 4.269 km/s, in upper mantle have Vp= 7.935 km/s and Vs=4.679 km/s. In the vertical plane, minimum Vp/Vs ratio obtainable in depth 0 km until 55 km while high Vp/Vs ratio obtainable in depth 55 km until 110 km. 3D tomography have anomaly variation of Vp and Vs in north Sumatra, south Sumatra and west Sumatra that have negative anomaly and there is triplication effect with deviation for P wave and S wave in Mentawai and Nias Island.

INTRODUCTION

Three tectonic plates; Indo-Australia plate, Pasific plate and Eurasia continent plate will formed earthquake trace and volcanism trace that have major impact on spread distribution of earthquake in Indonesia[1]. Tectonic earthquakes need more detailed study because it has big influence of damage. Seismic method that has been used by several researchers to show the subsurface structure of the earth, tried to be applied in the area of Sumatra. Seismic tomography is a method of 3D local model development on a subsurface structure using seismic wave [2]. Segmentation research microplate Sumatra that has been done by several researchers previously shown that the possibility of a more detailed division of tectonic segments which further contribute to the distribution of seismic areas [3]. In the science of seismology, seismic methods are usually used to get a picture of the earth's surface form seismic waves. Seismic tomography consists of two modeling process, that is forward (forward modeling) and inverse (inverse modeling). In this study the authors used inverse modeling to obtain the velocity distribution in subsurface of rock structures. Objects in this study are earthquakes in Sumatra that has been recorded by the earthquake monitoring stations, further processing using tomography inversion Local Earthquake Tomography (LET) Lotos-12 was created and developed by Koulakov (2009) with a consideration of inversion produce in Vp-Vp/Vs, a data structure more simple and have detailed explanations then it can have correlation with existing geological data.

METHODS

1.1 Chemicals

Chemicals in this study is openssl-0.9.8k_win64 for clicking encript earthquake catalog data from WebDC, JrdseedVer0.10.1 to transform seismic data format from *seed format into *SAC format, seisgram2k60 to pick P-wave arrival times and S-wave arrival time, Hypo71 to relocate earthquake hypocenter which 3 types of input files are needed. They are .INP file, .PRT file and .PUN file. .INP file which contains the station data includes the name of the station, the location of the station and earth velocity model for the island of Sumatra, .PRT files which is the output file and .PUN files which is punched files. Arcviewgis to describe the position of before and after relocation. Lotos-12 for inversion tomography. Lotos-12 to tomography analysis.

1.2 Procedures

Processing data methods are earthquake hypocenter determination using hypo71 software (Single Event Determination), 3D velocity distribution that consists of location of 3D model determining using ray tracing algorithms, grid parameterization and inversion using LSQR method. Objects in this study are 71 earthquakes that happened in Sumatra Island, which has been recorded by 35 earthquakes monitoring stations with magnitude 4.7 SR, and then it will be processed by using a tomographic inversion Local Earthquake Tomography LOTOS-12 that has been developed by Koulakov.

RESULTS AND DISCUSSION

There is anomaly variation of Vp and Vs around north of Sumatra, south of Sumatra and west of Sumatra that tend have negative anomaly with maximum velocity deviation and have good resolution for P-wave and S-wave. This negative anomaly located in Mentawai and Nias Islands. It caused by there is some faults type in that region, such as Andaman fault, Batee fault, and Mentawai fault. Vp in upper crust about 6.525 km/s and Vs about 4.064 km/s, Vp in lower crust about 7.230 km/s and Vs about 4.269 km/s. Vp in upper mantle 7.935 km/s and Vs about 4.679 km/s. The minimum ratio of Vp/Vs is 1.695 and maximum ratio of Vp/Vs is 1.899. High Vp/Vs associated with cracks in rocks containing fluid and high levels of water saturation. Absolute velocity anomaly P-wave and S- wave on the vertical incision showed that the characters in the propagation of P-wave and S- wave there is little difference where the P-wave character is able to spread in all mediums while character S-waves are not able to spread the fluid medium. However in general the resulting cross section shows the similarity structure of rocks beneath Sumatra , this can be seen in the resulting image. In the case of this study, Sumatra is estimated that there are several layers of upper crust at a depth of about 0 km to 25 km , the bottom crust at a depth of about 25 km to 45 km and upper mantle at depths of more than 45 km (in this study the maximum depth is 130 km). If seen in the figure, most of the earthquake accumulated in the southern part of Sumatra because there are subduction zone, where the Australian plate and the Eurasian plate subducting Australian plate subducting toward the Sunda plate. Some earthquake had accumulated in the northern part of Sumatra because there are subduction of India towards the Eurasian plate, the Australian plate subducting plate toward the Sunda plate.

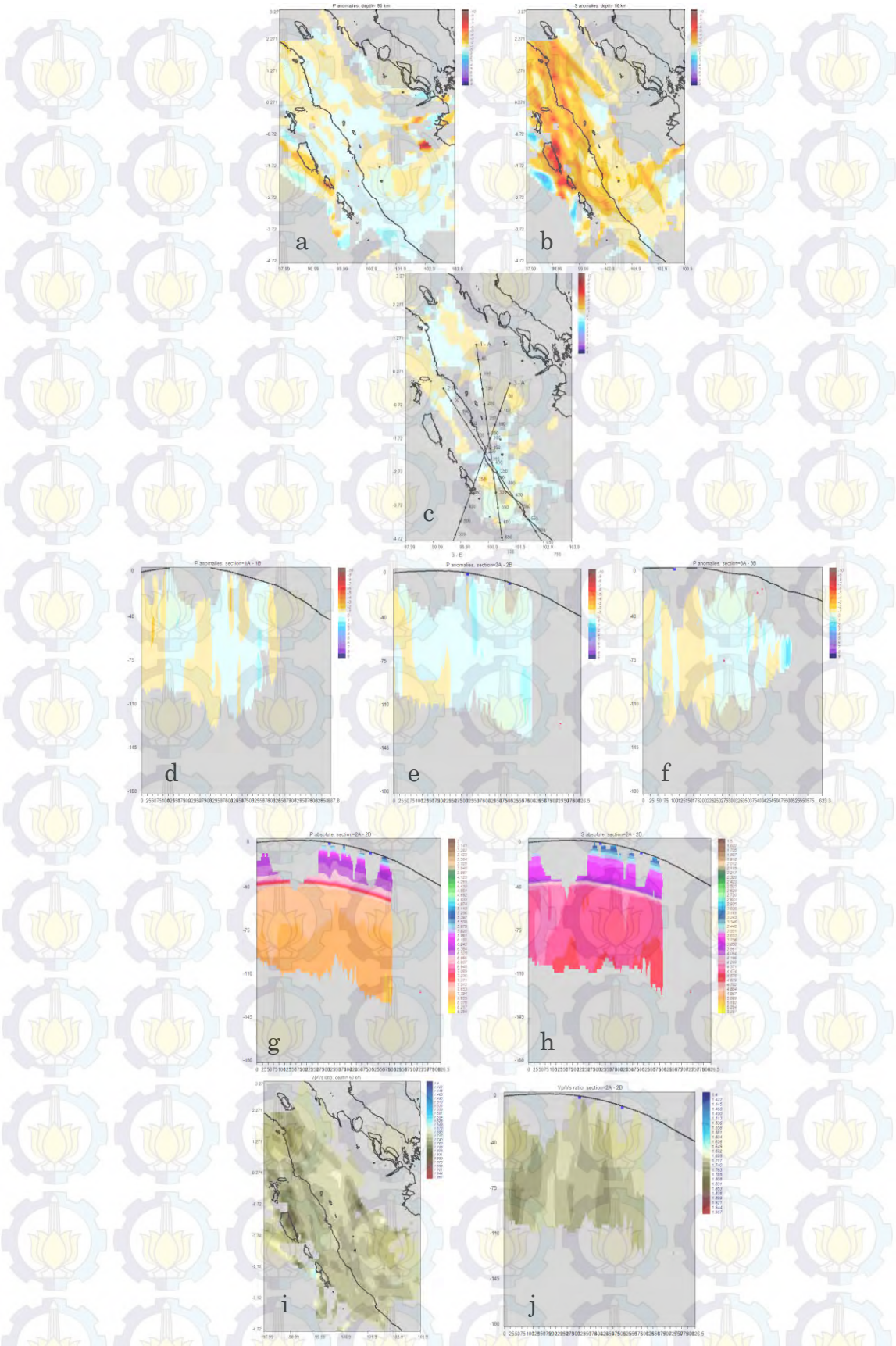

Figure 1. a, b is distribution anomaly P and S in horizontal, c is cross section, d, e, f is distribution anomaly P and S in vertical, g, h is P and S absolute velocity, i is Vp/Vs ratio in horizontal, j is Vp/Vs ratio in vertical

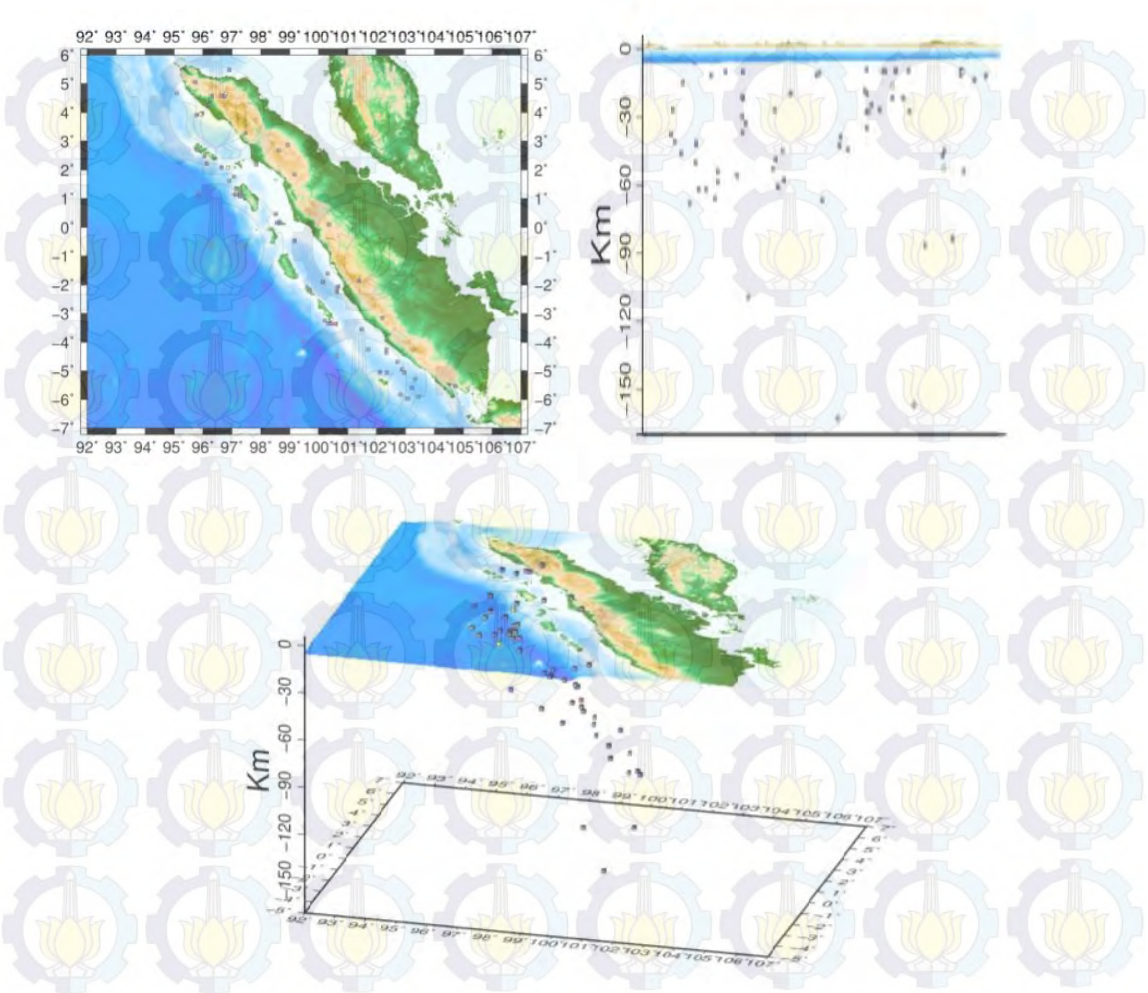

Figure 2. 3D relocation hypocenter of Sumatra

4. CONCLUSIONS

Amount of event earthquakes after inversion and parameterization is 50 events with a number of picking as much as 621 P-wave and S- wave picking, Vp in upper crust about 6.525 km/s and Vs about 4.064 km/s, Vp in lower crust about 7.230 km/s and Vs about 4.269 km/s. Vp in upper mantle 7.935 km/s and Vs about 4.679 km/s. The minimum ratio of Vp/Vs is 1.695 and maximum ratio of Vp/Vs is 1.899. In 3D image obtained by the variation of Vp and Vs anomalies around the northern part of Sumatra, South Sumatra and West Sumatra, which have a negative anomaly with a maximum speed deviation for P-wave and S-wave contained in the Mentawai and Nias Islands, because in that area there are several types of faults such as Andaman fault, Batee fault and Mentawai Batee.

REFERENCES

1. Hidayat, N. Dan Santoso, E., W. *Jurnal Alami*, vol 2 No 3. hal. 50-52. Gempa Bumi dan Mekanismenya. (1997).
2. Lay, T., Wallace, C.T. *Global Modern Seismology*. Vol. 58, Academic Press, California. (1995).
3. Diament, M., Harjono, H., Karta, K., Deplus, C., Dahrin, D., ZenJr. M.T., Gerrard, M., Lassal, O., and Malod, J. *Geology 20*, p. 259-262. Mentawai Fault Zone off Sumatra: A New Key to the Geodynamics of Western Indonesia (1992).