Journal of Physics: Conference Series

PAPER • OPEN ACCESS

Western Java Ambient Noise Tomography: A Preliminary Result

To cite this article: Shindy Rosalia *et al* 2019 *J. Phys.: Conf. Ser.* **1204** 012099

IOP Conf. Series: Journal of Physics: Conf. Series **1204** (2019) 012099 doi:10.1088/1742-6596/1204/1/012099

Western Java Ambient Noise Tomography: A Preliminary Result

Shindy Rosalia[1], Sri Widiyantoro[2], Tedi Yudistira[2], Phil Cummins[3], Andri Dian Nugraha[2]

[1]Graduate Program of Geophysical Engineering, Faculty of Mining and Petroleum Engineering, Institute of Technology Bandung
[2]Global Geophysics Research Group, Faculty of Mining and Petroleum Engineering, Institut Teknologi Bandung
[3]Research School of Earth Sciences, Australian National University, Canberra, Australia

E-mail: shindy.rosalia31@gmail.com

Abstract. Western Java, Indonesia, has at least three important active faults: the Cimandiri, Lembang, and Baribis Faults, which pose a great danger for the cities near them. It is crucial to have a better understanding of shallow crustal structure to delineate active faults and deep basins in order to support seismic hazard and disaster mitigation efforts in Indonesia. In this study, we perform ambient seismic noise tomography which can give better resolution of the shallow structure beneath western Java. We have deployed a seismometer network in the western to central Java region through a research collaboration program between the Bandung Institute of Technology (ITB) and the Australian National University (ANU). We deployed 70 seismometer stations from June to January 2017 to acquire ambient seismic noise data. As the first stage of the data processing, we will focus on conducting single data preparation and cross-correlation to retrieve an estimate of Green's functions between station pairs. We also use the frequency-time analysis technique to obtain dispersion curves to measure the interstation group velocity. The group velocity is use as an input in tomography inversion. Our preliminary results show low velocity anomalies associated with sedimentary basins and a high velocity anomaly associated with the southern mountains.

1. Introduction

Western Java, part of the Sunda arc, is an active tectonic region with high seismicity [1,2]. The tectonic activity produces 3 active faults: Cimandiri, Lembang, and Baribis faults which are located near densely populated areas. These densely populated areas are mostly located in a basin that will be affected if a big earthquake occurs due to amplification effects. Hence, it is crucial to have a better understanding of shallow crustal structure in order to support seismic hazard and disaster mitigation efforts in Indonesia.

In this study, we applied ambient noise tomography (ANT) methods to image crustal velocity structure beneath Western Java. Some of the previous studies using the same methods have successfully imaged structure beneath New Zealand [3], the northwestern U.S [4], SE Tibet [5], Australia [6], Central Java [7], and East Java [8]. In this paper, we will focus on southern part of West Java.

2. Data and Method

We installed 27 portable seismometers in 3 areas of Western part of Java (Figure 1) for about 2 to 8 weeks. We used broadband trillium compact seismometers, Australian National University (ANU) data recorders, and synchronized the time with GPS. We first deployed the instruments in the Banten area and moved it to the southern and northern parts of West Java. In total, we have deployed 70 stations in Western Java.

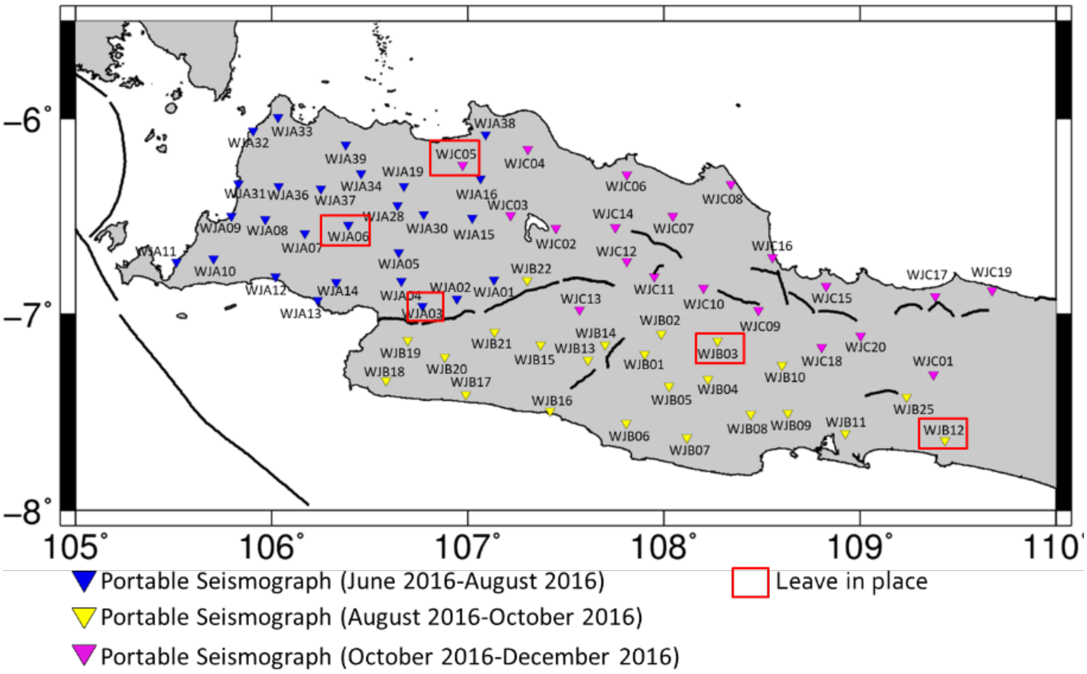

Figure 1. Map showing portable stations (inverted triangles) deployed in the study area. The colour in inverted triangles shows deployment period. Blue shows seismometers deployment in Banten, yellow shows seismometers deployment in southern parts of West Java, and magenta shows seismometers deployment in northern parts of West Java.

We followed the ANT processing method by Bensen et al. [9] and used the vertical component to obtain Rayleigh wave Green's function. We converted the miniseed files from each station to SAC format and then did the data preparation for each station, including mean and trend removal, band pass filtering, time domain normalization, and spectral whitening to reduce the earthquake signal recorded by the instruments. After the single-station data preparation, we calculated the cross-correlation for daily data time series and stacked the results to obtain Rayleigh wave Green's functions between pairs of stations. Green's functions extracted from interstation pairs gives information about the surface wave travel time and dispersion between the stations. The cross-correlation process for stations in the south of Java produced 250 empirical Green's functions (Figure 2. a.), however, we selected 152 of these interstation cross-correlation to use for inversion because some of the other cross-correlations have unclear Rayleigh wave Green's functions.

To obtain group velocity information from the cross-correlation results, we applied frequency time analysist using a multi-filter technique (MFT) [10] and produce dispersion curves in the period range 3-18 s. (Figure 2. b.). We picked the dispersion curve as an input for tomography processing. We calculated forward modelling using straight ray paths and applied standard linearized least-square inversion to obtain group velocity maps [11].

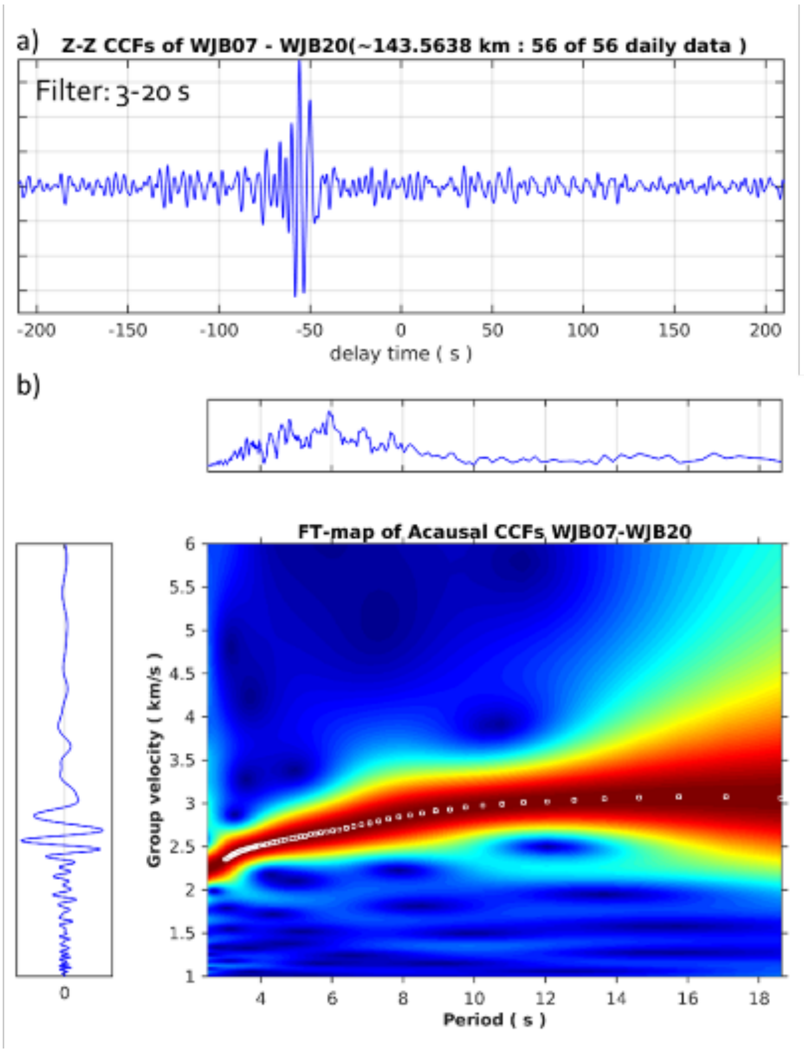

Figure 2. (a) Cross-correlation result from 6 weeks waveform data of a pair of station, WJB07 and WJB02 in south of West Java shows clear Rayleigh estimation Green's Function in acausal part. (b) Dispersion curve from corresponding station pair above. The dispersion curve is used to obtain the group velocity that shown by the red color.

3. Result and Discussion

Preliminary results for southern West Java are group velocity maps in the period range 3-6.5 s (Figure 3). These results give a first approximation of the underlying structure in Western Java. Red colour indicates negative group velocity anomaly while blue indicates positive group velocity anomaly. The negative group velocity anomaly means the inversion result is lower than the background velocity, usually associated with sedimentary deposit and vice versa. We used grid size of 5.5 x 18 km and straight raypath as the forward modelling and perform standard linearized least-square inversion. The tomographic result shows a low group velocity anomaly in the middle part of study area (number 1 in figure 3, period 3 s) associated with sedimentary basin in Bandung area. On the other hand, the high group velocity anomaly (number 2 in figure 3, period 3 s) in southern West Java indicate more compact rocks associated with the Southern Mountains of West Java. The low group velocity anomaly in the south-east denoted by number 3 in Figure 3 (period 3 s) is associated with the Kroya sub-basin [12].

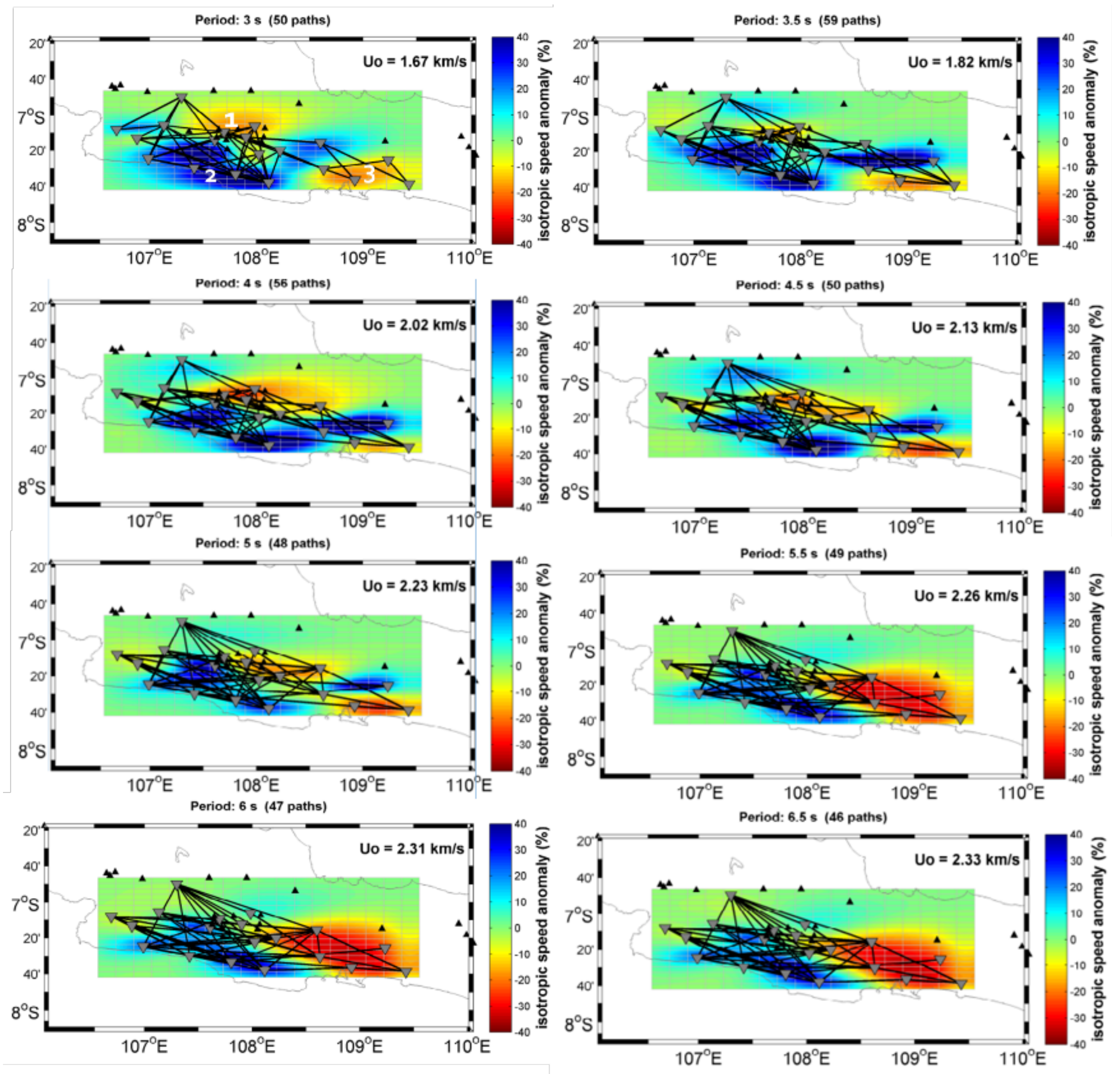

Figure 3. Group velocity maps from period 3 to 6.5 s in south of West Java. Red indicates low group velocity anomaly and blue indicates high group velocity anomaly. U_0 is background velocity in each period.

4. Conclusions

We have acquired data for a seismic ambient noise study in the western part of Java and processed the waveform data to produce group velocity maps in south of West Java. In this study, three geological features are imaged: the Kroya sub-basin in the south-east part of the study area, associated with low group velocity anomaly, sedimentary basin in Bandung area also associated with low group velocity anomaly; and the Southern Mountains of West Java, associated with high group velocity anomaly. For future work, we will conduct tomography inversion for all Western Java and do the depth inversion to obtain precise images of subsurface structure.

Acknowledgments
We are grateful to the Australian National University for allowing their instruments to be used in this study, and to the Australian Dept. Foreign Affairs Australian Aid for partial support of the fielwork; and the Meteorology, Climatology, and Geophysics Agency of Indonesia (BMKG) for the support in the acquisition process. We are also grateful to the PMDSU scholarship granted to SR from the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia; and also the Ministry of Public Works and Housing for partially funding this study. Maps figures were prepared using the GMT Software [13]

References
[1] Supendi P and Nugraha A D 2016 Preliminary result of earthquake hypocenter determination using hypoellipse around western Java region *AIP Conference Proceedings* vol 1730
[2] Rosalia S, Widiyantoro S, Dian Nugraha A, Ash Shiddiqi H, Supendi P and Wandono 2017 Hypocenter Determination Using a Non-Linear Method for Events in West Java, Indonesia: A Preliminary Result *IOP Conference Series: Earth and Environmental Science* vol 62
[3] Lin F-C, Ritzwoller M H, Townend J, Bannister S and Savage M K 2007 Ambient noise Rayleigh wave tomography of New Zealand *Geophys. J. Int.* **170** 649–66
[4] Gao H, Humphreys E D, Yao H and van der Hilst R D 2011 Crust and lithosphere structure of the northwestern U.S. with ambient noise tomography: Terrane accretion and Cascade arc development *Earth Planet. Sci. Lett.* **304** 202–11
[5] Zheng D, Saygin E, Cummins P, Ge Z, Min Z, Cipta A and Yang R 2017 Transdimensional Bayesian seismic ambient noise tomography across SE Tibet *J. Asian Earth Sci.* **134** 86–93
[6] Saygin E and Kennett B L N 2010 Ambient seismic noise tomography of Australian continent *Tectonophysics* **481** 116–25
[7] Zulfakriza Z, Saygin E, Cummins P R, Widiyantoro S, Nugraha A D, Lühr B-G and Bodin T 2014 Upper crustal structure of central Java, Indonesia, from transdimensional seismic ambient noise tomography *Geophys. J. Int.* **197** 630–5
[8] Martha A A, Cummins P, Saygin E, Widiyantoro S and Masturyono 2017 Imaging of upper crustal structure beneath East Java–Bali, Indonesia with ambient noise tomography *Geosci. Lett.* **4**
[9] Bensen G D, Ritzwoller M H, Barmin M P, Levshin A L, Lin F, Moschetti M P, Shapiro N M and Yang Y 2007 Processing seismic ambient noise data to obtain reliable broad-band surface wave dispersion measurements *Geophys. J. Int.* **169**
[10] Dziewonski a, Bloch S and Landisman M 1969 A technique for the analysis of transient seismic signals *Bull. Seismol. Soc. Am.* **59** 427–44
[11] Yudistira T, Trampert J and Paulssen H 2015 The Crustal Structure Beneath the Netherlands Inferred from Ambient Seismic Noise *Dissertation*
[12] Sribudiyani, Muchsin N, Ryacudu R, Kunto T, Astono P, Prasetya I, Sapiie B, Asikin S, Harsolumakso A H and Yulianto I 2003 The Collision of the East Java Microplate and Its Implication for Hydrocarbon Occurrences in the East Java Basin *29th Annual Convention Proceedings (Volume 1)*
[13] Wessel P and Smith W H F 1998 New, improved version of generic mapping tools released *Eos, Trans. Am. Geophys. Union* **79** 579–579