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Determination of Subsurface Velocity Structure and Precise Hypocenters Relocation by using Double-Difference Technique: Case Study of Central Java - Indonesia

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High resolution subsurface seismic velocity structure image beneath onshore and offshore of Central Java by using Double Difference Tomography method (TomoDD) is presented. This study is conducted in order to understand the mechanism effect of the subduction process to the surface seismicity and volcanic activity in Central Java. The data set was collected by a temporary seismic network called MERapi AMphibious EXperiment (MERAMEX), which was deployed for 150 days in May – August 2004. The network consists of 134 seismographic stations (106 short-period stations; 14 broadband stations; 8 ocean bottom hydrophones; 6 ocean bottom seismometers), which were installed onshore and offshore of Central Java. 210 events were selected for this research.

Tomo-DD is a simultaneous method to obtain a three-dimensional seismic velocity structure, and at the same time more precise earthquake hypocenter could also be determined. Although only absolute arrival times are used as input data, but this method could produce both more accurate hypocenter locations and seismic velocity structure near the source region. These products are the benefit of TomoDD application, in which standard tomography process could not facilitate them. During TomoDD calculation, cross-correlation of P- and S-wave differential travel-time measurements could also be conducted, if it is necessary. In this study, we used the only absolute travel-time measurement data.

From the preliminary results, the joint inversion of the event locations and seismic velocity structure considerably improves the resolution of the subsurface image. The final locations of the sources after the inversion show a narrow region of the double seismic zone which correlated with the subducting slab. The dip angle of the slab increases gradually from almost horizontal beneath offshore to 65o-80o beneath the northern part of Central Java. The seismic gap at depths of 140 km – 185 km is also imaged clearly. It is showed that the subduction plays an important role in causing the volcanism in this study area. The strong negative velocity anomalies under the Merapi Complex Volcano are interpreted as the upward migration of fluids rejected from the slab because of the phase transition. These fluids may have caused decreasing viscosity, and possibly, partial melting. The partially molten materials are soft and less rigid, thus the velocity decreases.

The next steps of our research are to try several cases with different inversion parameters in order to obtain the most reliable result and to test the reliability of the result. Checkerboard test and the other reliability tests will be conducted.