INTRODUCTION

High seismicity in the Molucca Collision Zone (MCZ) is a result of complex tectonic setting in and around this region. The Molucca Sea Plate (MSP) collides with the Halmahera arc in the east and with the Sangihe arc in the west and slab of MSP forms a reversed V-shape dipping beneath the Halmahera and Sangihe arcs. The shallow part of MCZ is highly deformed crust and most of large earthquakes occurred in this area.

In this study we aim to provide a catalog of relocated hypocenters and interpret their relation to the tectonic process. Furthermore, we investigate the spatiotemporal variation of b-value from relocated BMKG earthquakes and also the International Seismological Centre (ISC) catalog to obtain information regarding tectonic process and its relation to large earthquakes in this area.

DATA AND METHODS

Teleseismic Double-Difference Relocation

We relocated nearly 10,000 earthquakes in the Molucca Sea and surrounding regions by applying teleseismic double-difference relocation method (SD relocation) by Peacock et al. (2010). We performed relocation inversion utilizing local, regional and teleseismic arrival time data from BMKG data catalog for the period 2009-2015. The 3D regional seismic velocity model has been taken from Widiyantoro and van der Hilst (1997) to calculate seismic travel time.

Frequency Magnitude Distribution (FMD)

Statistical analysis between the distribution of earthquakes’ magnitudes with their total number is represented by Gutenberg-Richter law (1934).

\[
\log N = a - bM
\]

Where N is number of events with a magnitude ≥ M while a and b are constants. Constant b or b-value is an important tool for determining the stress state of a region. In this study, we utilized ZMAP code (Wiemer, 2001) to analyze the spatiotemporal distribution of b-value in the Molucca sea region. For this analysis, we used DD relocated hypocenters and ISC catalog (1990 to 2015).

RESULTS

Our results show that travel-time RMS residuals were reduced 42% compared to BMKG catalog. Cross-sections of DD relocated seismicity on this region clearly show two opposing Wadati-Benioff zone that represents geometry of subduction slabs beneath this region.

CONCLUSIONS

We have successfully relocated BMKG earthquakes which refined tectonic structures and Wadati-Benioff zone in the MCZ area. FMD analysis using relocated events and ISC catalog shows a distinctive low b-value anomaly in the central part of MCZ where an earthquake with Mw 7.2 occurred in November 2014. Depth-profile of b-value reveals a low anomaly at shallow depths between 15 and 50 km, which agrees well with the depth of several large earthquakes in this region. There are also significant low b-value anomalies in the southern part of MCZ related to the northern Seiring Fault and the Sangihe Thrust.

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