

Local Earthquake Tomography used for investigating the structure of the Tarutung Geothermal site in North Sumatra, Indonesia

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Abstract

The Tarutung region in North Sumatra, Indonesia, is a seismically active zone located at the active Sumatra fault. Along this fault pull-apart basins and grabens together with volcanic activity of the recent magmatic arc are found. It is also the region future geothermal exploitation. In order to understand the tectonic setting of the Tarutung region system a temporary local seismic network was deployed for a time period of 10 months since May 2011. The initial hypocentre parameters were calculated by using HYPO71, and we found 2,586 local earthquakes recorded by at least 8 stations. We relocated 809 events (gap angle less than 180) and determined the 1D V_p and V_p/V_s models by using the program code VELEST. These models were used as starting models for the SIMUL2000 3D tomographic inversion of the travel times. Additionally, fault plane solutions were calculated for the events containing at least 10 polarity picks by using FPFIT. 229 of these events which were recorded by at least 10 stations and which had a signal to noise ratio greater than 3 were used for an attenuation tomography. The path-averaged attenuation values (tp^*) were calculated from the spectral decay; these were later inverted for the 3D attenuation structure (Q_p) by using SIMUL2000.

The distribution of the local earthquakes is in accordance with the geometry of the Sumatran fault. A steeply dipping fault is found along the Sarulla basin as indicated by almost vertical seismicity distribution. Along the Tarutung basin, the seismicity pattern and the focal mechanism suggest the presence of the negative flower structure. Low V_p along Tarutung and Sarulla correlates with the shape of the basins. High V_p/V_s anomalies correspond to low Q_p anomalies. High V_p/V_s and high attenuation in Tarutung can be related to pathway of fluids originating from below the main fault. High attenuation (low Q_p) is found underneath the Dolok Martimbang volcano, however this region could be characterized by high V_p/V_s .

Keywords: seismicity distribution, focal mechanism, velocity structure, attenuation, geothermal exploration