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Seismic imaging of the geothermal area in Tarutung (Sumatra, Indonesia): Comparison of local earthquake and ambient noise tomography

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A joint German-Indonesian research initiative is conducted to support the geothermal energy development in Indonesia, where one important aspect is exploration technology. An almost unexplored region located in northern Sumatra (Indonesia) was chosen to develop and demonstrate an integrated exploration strategy which includes structural geology, active seismics, passive seismology, and magnetotelluric investigations. The geothermal potential at this site is mainly determined by the Sumatran fault system and its interplay with young volcanism associated with subduction zone processes. Within the passive seismology study, a temporary network of 42 stations was installed around the city of Tarutung running over a period of 10 month from May 2011 until February 2012. The Sumatran fault was covered at the center of the network, and stations were distributed within a radius of 20 km with spacings of about 5 km on average. The collected data allow for the 3D imaging of seismic velocities and intrinsic attenuation, high resolution relocalisation of seismicity, determination of fault plane solutions, and analysis of ambient noise generated surface waves. The general objective is to integrate the final results with other geoscientific data and interpretations and to develop a conceptual model for the geothermal system of the target region.
In the presentation we will focuss on a comparison of local earthquake tomography and ambient noise surface wave inversion. We applied HYPO71 to locate events and found 2,586 events within the network and relocate 809 events having gap angle less than 180 degrees by using VELEST and determined the 1D Vp and Vp/Vs models forming the starting models of the subsequent 3D inversion. SIMUL2000 code was used to invert for Vp and Vp/Vs as well as the intrinsic attenuation for P waves (Qp). For the ambient noise tomography we cross-correlated the daily vertical component recordings for all available station pairs in the 40 station array. Surface wave travel times were picked and inverted using the Fast Marching Surface-wave Tomography (FMST) method. The Vp structure images the geometry of the basins while high Vp/Vs and low Qp are associated with hot fluid pathway originated below the Sumatran fault. We examine the comparison of the results of the Vp/Vs and Qp with the ambient noise tomography to investigate the potential for combining both approach to study geothermal systems.