Geophysical Research Abstracts
Vol. 15, EGU2013-5548-1, 2013
EGU General Assembly 2013

Comparison of high-resolution P- and SH-wave reflection seismic data in alluvial and pyroclastic deposits in Indonesia

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Seismic reflection is one of the stable methods to investigate subsurface conditions. However, there are still many unresolved issues, especially for areas with specific and complex geological environments. Here, each location has an own characteristic due to material compounds and the geological structure.
We acquired high-resolution, P-and SH-wave seismic reflection profiles at two different locations in Indonesia. The first location was in Semarang (Central Java) and the second one was in Tiris (East Java). The first region is located on an alluvial plain with thick alluvial deposits of more than 100 m estimated thickness, and the second location was located on pyroclastic deposit material. The seismic measurements for both locations were carried out using a 48-channel recording system (14-Hz P-wave, 10-Hz SH-wave geophones) with geophone intervals of 5 m (P-waves) and 1 m (SH-waves), respectively. The seismic source for the P-wave was a ca. 4 kg sledge hammer which generated a seismic signal by by hitting on an aluminum plate of 30x30 cm, whereas the SH-wave source was a mini-vibrator ELVIS (Electrodynamic Vibrator System), version 3. Thirteen seismic profiles at Semarang and eighth profiles at Tiris were acquired.
The results of seismic data in Semarang show fair to good seismic records for both P-and SH-waves. The raw data contain high signal-to-noise-ratio. Many clear reflectors can be detected. The P-wave data shows reflectors down to 250 ms two-way time while the SH-wave records show seismic events up to 600 ms two-way time. This result is in strong contrast to the seismic data result from the Tiris region. The P-wave data show very low signal to noise ratio, there is no reflection signal visible, only the surface waves and the ambient noise from the surrounding area are visible. The SH-waves give a fair to good result which enables reflector detection down to 300 ms two-way time.
The results from the two seismic campaigns show that SH-wave reflection seismic seems to be the suitable method, which could be applied in Indonesia mainly in both alluvial and pyroclastic regions. In contrast, P-wave energy in the pyroclastic area is strongly attenuated and scattered within the uppermost layer. This prevented that the P-wave seismic signal reaches deeper reflectors, and therefore seismic P-wave records contain only noise from surface waves and ambient noise from the surrounding area, without any reflection signal.