

Continuous observation of seismic wave velocity and apparent velocity using a precise seismic array and ACROSS seismic source

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We report the results of continuous monitoring, via a seismometer array, of the travel time of seismic waves generated by an ACROSS artificial seismic source. The seismometer array was deployed in a surface vault located at 2.4 km from the source. Using semblance analysis, we identified direct P- and S-waves and refracted P- and S-waves that traveled along a velocity boundary between granite basement and overlying sedimentary rocks. We analyzed temporal variation in differential travel time and apparent velocity of these phases for one month, and found significant temporal variation in the differential travel time. Most of the variation can be attributed to weather patterns such as atmospheric temperature and precipitation.

We detected a daily variation in the velocity of the refracted P- and S-waves with maximum amplitude of 0.5 ms. This particular variation shows a strong correlation with changes in atmospheric temperature. Part of this fluctuation can be attributed to variation on the foundation where the vibration source is attached. Most of the fluctuation was affected around the surrounding ground of the ACROSS source because the fluctuation was attributed to variation on a borehole record 50 m away from the source. The fluctuation was also limited in a narrow frequency band of 18 to 20 Hz. A possible cause of the fluctuation is the dynamic interaction between the ACROSS source and the surrounding ground. Saeki (2000) suggested that inelastic effect of the surrounding ground affects the phase angle between the motion of the surrounding ground and the motion of the ACROSS source. He also suggests from a result of numerical calculation that this dynamic interaction can be affected by the thickness of the surface layer, its shear wave velocity and the frequency of signals.

The variations in the travel time of the direct S-waves with the amplitude of about 1.0 ms, correspond to the rainfall patterns. Part of this variation can be attributed to variation on the foundation, and the variation was also limited in a frequency band of 15 to 20 Hz. No variation, however, was observed for the direct P-wave.

Analyzing the temporal variation in differential travel time and apparent velocity for these phases without using the signal of 15 to 20 Hz, the variation resulted in very low correlation to the atmospheric temperature and rainfall. It shows that more accurate observation can be achieved for waves traveling a long path or a deep part by removing effects near a source region using ACROSS signal analysis.