Reduction of the near-surface effect on the ACROSS signal recorded by receivers at far-field.

Hiromi Misu[1], ryoya ikuta[2], Kazuo Mino[3], Hiroshi Ogasawara[4], Koshun Yamaoka[5]

[1] Physics Sci,Ritsumeikan Univ, [2] Earth and Planetary Sci. Nagoya Univ., [3] Fac. Sci. Engr., Ritsumeikan Univ., [4] Fac.Sci. Engr., Ritsumeikan Univ., [5] RC. Seis. & Volc., Nagoya University

Introduction

The ACROSS (Accurately Controlled Routine Operated Signal System) is invented for monitoring the temporal variation of wave propagation within the earth. The system consists of a vibration source and receivers. We made an experiment lasting 15-months from Jan.2000 to Apr.2001 at an experiment site near the Nojima fault, which ruptured in the 1995 Kobe earthquake (M7.2). In this site the ACROSS vibrator is deployed at the surface near the fault and two seismometers are installed in the boreholes with 800m, 1700m deep to detect the temporal variation of the seismic velocity after the earthquake. In this experiment we are lucky enough to detect the delay of travel time caused by the shaking of western Tottori earthquake. The delay was about 1ms, and it have never detected by usual experiment. On the other hand, near field variation such as rainfall or atmospheric temperature vary the delay of travel time very much. Five seismometers were placed on the surface and in two boreholes of 10m near the source to measure the vibration of foundation. Using the near-source variation of the signal, we made a correction on the signal of the borehole seismometer as shown below.

Method

In the correction we assumed that the signals of borehole sensors are expressed as a linear combination of those of seismometers near the source in the frequency domain. Under this assumption the transfer function between the source and receivers are calculated by using the least square method. We removed the near field variation from the signal in the borehole seismometer using the method as proposed in Yamaoka et al. (2001). The observation signal suffers both daily variation caused by temperature and long periodical variation caused by rainfall. We have to remove the both effects with a method as simple as possible for practical use. We investigated the method proposed by Yamaoka et al. (2001) for the correction of the 22day-long data. We use 13Hz and 19.1Hz out of the frequency components obtained by this experiment.

Result

The method substantially reduced both daily and long term variation due to near-source effect. For example, in 13Hz, the method reduced the RMS (root mean square) of the phase variation of the borehole seismometer to be one fifth of that before correction. The RMS after correction was about 0.0048 radian, and corresponded to 60 microsecond, indicating the possibility for the detection of the variation less than several microsecond. In the case of 19.1Hz, the method also reduced the variation. The signals of the 10m-deep boreholes are useful for more efficient correction.