

Seismic ACROSS as a potential technology for geophysical exploration and monitoring

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We have started the automated routine transmission of the accurately controlled elastic wave signals by the seismic ACROSS transmitter at Tono mine (Toki-shi, Gifu) from Oct. 2002, and continuous observations have been executed for more than three years, in order to establish a routine technology of the next generation for the structural exploration and active monitoring of the Earth's interiors by seismic waves.

The current specifications of seismic signal being transmitted since Feb.20, 2004 (ongoing for ~two years) are as follows: FM signal with a carrier frequency of 13.01 Hz, modulation period 50s in the frequency range 10.25-19.45Hz and ~2700N in spectrum amplitude. The signal and operational mode of rotary transmitter with the vertical rotation axis are optimized to be most robust against noise for the S wave, in particular, and also for acquiring the accurate tensor transfer function data in frequency domain between the source and receivers located anywhere. The performance of the current ACROSS technology has been evaluated by analyzing the observed signals detected by our local seismic arrays near the transmitter, and also by Hi-net stations located up to ~100 km from the source. The major results are as follows:

1) Transmitting technology was established as demonstrated by the very stable continuous operation for more than three years without any serious failure except some power line breakdown due to some eventual agents such as lightning discharge, for example.

2) Technology of data acquisition and processing has been developed to be a practical level as demonstrated by the result of noise reduction, in which noise level is in inverse proportion to square root of the reciprocal time period of successive stacking as predicted by theory.

3) The combination of the transmitting and receiving technologies has provided the 6-component tensor transfer functions for ~70 Hi-net stations up to ~100 km from the transmitter. This transfer functions carry a large amount of new information never acquired before and indicates the presence of significantly large lateral heterogeneity and polarization anisotropy in the relevant area.

4) Clear arrivals of direct S wave and its later phases are recognized well in all the cases and are correlated well with the P waves and its later phases. This indicates that the active S wave exploration method is now realized for the study of crustal structures in the 100 km scale.

5) One notable finding is the presence of quite an anomalous later arrivals of S wave at the observation stations in the north of Toyohashi-city, where deep low frequency tremors take place.

6) Time variations of the transfer functions are recognized beyond the level of observation error. Whereas we can not locate the place where the temporal variation takes place within the Earth's crust yet, we may state that the monitoring observation of the area around the Tono mine up to 100 km has been started on a routine basis.

In conclusion, the seismic ACROSS technology has been developed as a practical tool of seismic exploration and monitoring the dynamics of the Earth's crust in the scale of 100 km. Application to the geophysical exploration in a smaller scale comes to be feasible through the works presented here.

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