Temporal variation and its correction of radiation characteristic of Acoustic ACROSS source system deployed in Awaji Island.

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We are developing an Accurately Controlled Routinely Operated acoustic Signal System (Acoustic-ACROSS) to observe time evolution of crustal structure. Acoustic-ACROSS source generates elastic signal and received signal has the information of the time evolution in crustal stress field or material movements which took place on the path of the signal. If the emission of the ACROSS signal does not vary, we can attribute the time evolutions in the received signal to the change of propagation properties along the path. But it was suggested that the wave field generated by ACROSS source changes due to some climate condition such as atmospheric temperature and rainfall. So we should correct the effects by some methods.

We conducted a 15 months long-term monitoring experiment from 2000 to 2001 using a couple of ACROSS sources deployed near Nojima fault, Awaji Island. The ACROSS sources were on the surface and the receiver seismometer was deployed at the bottom of an 800 m deep borehole which was 120 m away from the sources. *Yamaoka et al*. 2001 and *Ikuta et al*. 2004 proposed a correction method to reduce the variation in the signal at borehole sensors caused by variation in the source motion by referring to the records of seismometers deployed near the sources as follows.

They deployed 4 three-component seismometers on the foundation of the sources. They assumed that the wave field at the borehole sensor Y(t) is modeled with a linear combination of the signals at the seismometers placed near the sources S(t). The observed vibrations are represented with transfer function G(t) by

$Y(t)=[G_0+DG(t)][S_0+DS(t)]$, (1)

in which G_0 and S_0 denote the time-invariant parts of G(t) and S(t), respectively. They also assumed that the term including temporal variations was small and denoted it as D. Ignoring higher-order fractions, it can be rewritten as

$Y(t)=G_0[S_0+DS(t)]+DG(t)S_0$. (2)

They obtained G_0 by applying least square method to fit Y with S_0+DS(t). The residual of this fitting is $DG(t)S_0$. They can obtain corrected observed record by the borehole sensor Y'(t), which does not include the variation of the sources.

$Y'(t)=G_0S_0+DG(t)S_0$. (3)

However, it was pointed that their method was not effective for a record longer than a few months. The reason was revealed that the G_0 was so different between short-term and long-term records that we could not correct the source effect simultaneously.

We adopted another new method for correction. We separated the records into the short-term and the long-term variations by applying a moving average with an interval of 20 days. Next we corrected both variations individually and then added the results again. In this method, we adopted a new model of observation instead of the model expressed by the equation 1. The records by the sensors located near the source do not represent the whole source function but represent a part of it. The whole source function should be written by $S=[S_k, S_u]$ in which S_k is records observed by sensors and S_u is un-observed wave field around the sources. We can write the observation equation instead of the equation 2 as follows:

$Y(t)=G_{k0}[S_{k0}+DS_k(t)]+DG_k(t) S_{k0}+G_{u0}S_{u0}$. (4)

Removing the time average from the both sides, we can acquire the equation

$DY(t)=G_{k0}DS_k(t)+DG_k(t)S_{k0}$. (5)

We can obtain G_{k0} by applying least square method to fit DY(t) with $DS_k(t)$ and the residual is $DG_k(t)S_{k0}$. This is none other than corrected observed variation by the borehole sensor DY'(t), which does not include the variation of the sources.

We applied this method to the record in the whole period of the 15 months experiment. The variation in the borehole records due to source effect was reduced by this correction twice as good as the traditional method. The detailed change included in the record after correction would be mentioned in the future.