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Penetrate across the mantle, and light up the heart of the Earth

HIGASHIHARA, Hiromichi[1*] ; KUMAZAWA, Mineo[1]

[1]Earthquake Research Institute, Univ. of Tokyo

ACROSS is an active tomography method, in which highly accurate oscillators radiate designed wave. So far, we have studied elastic wave and electromagnetic diffusive wave. The latter is not mentioned here. Underlying physics may differ from one problem to another, but the procedure of operation and data processing is common. Suppose an ACROSS hardware is given, we first define, corresponding to the desirable frequency range of recording, a unit time interval. Next, we define a wave form over this unit interval; this is the unit waveform and the oscillator simply repeats this. Obviously, the waveform of the input electricity into the actuator is not same to that of the actuator's motion; the actuator's physics and the soil-structure interaction intervene. After intensive stacking, we transform the data into the frequency domain. The result is just a spectrum of the <frequency comb>type; it consists of distinct signal channels and noise channels. Thus signal and noise have been intrinsically separated. The <frequency comb>also allow us run many ACROSS sources simultaneously.

The first generation of the elastic wave sources, have a rotary mass. Rotational frequencies are around several ten Hz. They have been used for two decades without serious troubles. Their achievement proved a remarkably high performance of commercially available inverter motors, which use angular position control by means of encoders. However, rotary sources have one weak point, frictional loss. The second generation source that is under feasibility study aims at lower frequency range (less than several Hz), and linear motion of heavy mass is used. Preliminary estimation of the performance of the new model is telling so far that its range covers the heart of the Earth.

In the long run, we will apply the new ACROSS to the whole-globe exploration. But at first, we target the D" layer of the mantle and the inner core. Recently, remarkable experimental data about D" materials as well as tomography evidence of heterogeneity of D" were reported. D" is thus one of the hottest spots within the globe, and ACROSS may get useful data for calibration. Historically, ACROSS efforts first started as an attempt to provide with tools for the earthquake prediction research program. The first generation ACROSS thus focused on the exploration of shallow crust. While some results were obtained, it was also revealed that earthquake prediction will take still a long way to go. But trial of ACROSS to the deep Earth will bear a lot of lessons.

During the course of development of ACROSS, we kept a collaborative basis of science and engineering, avoiding hasty unification of separate disciplinary biases, different ways of thinking and knowledge. Which existing disciplines are effective for analysis of ACROSS data? The global seismology will be a good candidate. It is widely known that the American global seismology, its great progress since 1970s above all, is one of the major successors of the American space engineering, which accomplished the Apollo project in 1960s. Engineering mind, together with technologies, sciences and expertise, span out from NASA and developed a new horizon of global seismology. This antecedent is encouraging the ACROSS enterprise.

Keywords: ACROSS, active monitoring, dlobal seismology, D", ST collaboration