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Relationship between corner frequency and seismic moment for AE from continuous and broadband records (2)

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The seismic moment (Mo) and the corner frequency (fc) are fundamental parameters which characterize the source properties of the earthquake rupture. The scaling relationship that Mo is proportional to cube of fc is satisfied for natural earthquakes larger than about Mw -2. In a fracturing rock sample, a series of elastic waves radiated from micro cracking (Acoustic Emission; AE) enables us to estimate whether this relationship can be extended down to the AE size events.

PZT elements which have often been used as AE sensors in laboratories have narrow frequency ranges, and the waveform records with them can not be used to estimate Mo and fc. To solve this problem, Sellers et al. (2003) recorded AE waveforms with broadband transducers during a uniaxial rock fracture experiment. They indicated that the source parameters of AE satisfied the extrapolated scaling relationship of natural earthquakes. However, they carried out triggered recording which hid some events behind the mask times and/or below the trigger level. Yoshimitsu et al. (2011) estimated Mo and fc of AE in a fracturing rock sample under uniaxial conditions with broadband, continuous recording, and indicated the scaling for natural earthquakes can be extended down to AE size. Both Sellers et al. (2003) and Yoshimitsu et al. (2011) did not make clear that the source parameters of AE satisfy their own cube law. In this study, we carried out the experiment under the same conditions as Yoshimitsu et al. (2011) with advanced measurement, to confirm that their result is independent of the sample. Further, we are interested in whether AE source parameters satisfy their own cube law.

We prepared eight broadband transducers (sensitive range; 100 kHz - 1,000 kHz), two PZT elements, and a cylindrical Westerly granite sample (100 mm in height and 50 mm in diameter). Six strips with 60 degree intervals parallel to the loading axis of the sample were grounded to mount the transducers on. Six broadband transducers and two PZT elements were attached on the side surfaces and the other two were attached inside of metallic pressure tight housings placed at the upper and lower ends of the sample. High sampling recording as 20 MS/s per channel was continued, during uniaxial loading which was continued to be controlled even after the peak strength. We estimated the frequency response of the transducer and removed it from the recorded waveform spectra, and we obtained displacement waveform spectra for S waves to estimate fc. Mo is estimated for the events which have S/N high enough, using path lengths, and low-frequency displacement spectral levels of S wave spectra. The new data of this study is satisfied the same scaling relationship as Yoshimitsu et al. (2011) indicated, and it verified the independency of the result on individual samples.

Keywords: corner frequency, seismic moment, scaling, AE, rock fracture experiment