

## Extraction of characteristics of seismogram envelopes

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The difference of seismogram envelope between borehole and surface are discussed and broadening of seismogram envelope with hypocentral distance is observed.

Seismogram envelope are obtained from vector summation of RMS of band-pass filtered waveform of the three component. Time dependent ratio of seismogram envelope obtained in borehole ( $E_b(t)$ ) to that at surface ( $E_s(t)$ ) is estimated, where Kik-net data of NIED are used. The time dependent ratio,  $E_s(t)/E_b(t)$ , changes at the time of P wave incidence and S wave incidence, but does not change after S wave onset.  $E_s(t)/E_b(t)$  at signal portion (P wave onset or S wave onset) is larger than that at noise portion, which means that S/N ratio in borehole is smaller than that at surface.

Envelope broadening is explained by strong forward scattering, and its mathematical expression was obtained by Sato(1989) for plane wave and by Saito et al.(2002) for spherical wave. In these expression, seismogram envelope is characterized by 1 parameter,  $t_m$ . We analyzed data obtained in northern Tohoku and estimated the hypocentral distance dependence of  $t_m$ , that is  $t_m=0.2*D$  for around 1Hz, and  $t_m=0.1*D$  for around 8Hz, where  $t_m$  is in sec., and  $D$  in hypocentral distance in km. The results suggests that envelopes used for stochastic green function should depend on the frequency of main element.