AV-27

Seismic Attenuation in a Non-Volcanic Earthquake-Swarm Area of Wakayama, Southwest Japan

○Koji Matsunami and Masao Nakamura

Abstract

In order to estimate seismic attenuation characteristics in a non-volcanic earthquake-swarm area of Wakayama, Southwest Japan, Mean-squared (MS) envelopes of S-coda waves were analyzed using records of 130 small events (M = 2 - 3) with a S - P time shorter than 1 s observed by a strong motion array with velocity-type seismometers deployed in the swarm area. An envelope with a common shape, i.e., a common envelope, was produced by averaging the S-coda MS envelopes over all records at all stations for 7 frequency-bands centered at 1, 2, 4, 8, 16, 32 and 48 Hz. The common envelope is characterized by a smooth decay in its early part from about two times the S-wave travel-time to 11 s in lapse time and by two ripple-like amplitude-anomalies in the later parts at lapse-time intervals of 11 to 15 s and 18 to 26 s, particularly at 4-, 8-, and 16-Hz bands. Scattering attenuation (Q_s^{-1}), intrinsic absorption (Q_i^{-1}), and total attenuation ($Q_t^{-1} = Q_s^{-1} + Q_i^{-1}$) were estimated by optimally fitting the compact model for multiple scattered wave energy in time domain by Zeng (1991) to the early part of the common envelopes that were composed of scattered waves sampling the earthquake-swarm region in the upper crust. The Q_t^{-1} decreasing with increasing frequency is characterized by remarkably high values compared with previous results for other regions, suggesting a high seismic attenuation in the fractured swarm region. The Q_s^{-1} can be well approximated by the relation $0.05 f^{-1}$ in the frequency range of $1 < f < 48$ Hz. The Q_i^{-1} has a peak around 4 Hz and decreases for both lower and higher frequencies. The seismic albedo, $B_0 = Q_s^{-1}/Q_t^{-1}$, decreases with increasing frequency; 0.9 to 0.6 at 1 to 2 Hz, 0.5 to 0.4 at 4 to 16 Hz, and 0.4 to 0.3 at 32 to 48 Hz, indicating that scattering is the dominant cause of attenuation for frequencies below 2 Hz while intrinsic absorption is dominant for frequencies above 16 Hz, in the swarm region. Although the coda Q_c^{-1} lies, in general, between the total Q_t^{-1} and intrinsic Q_i^{-1}, these three attenuations very closely approach each other at high frequencies, and the coda Q_c^{-1} is sensitive to changes of the intrinsic Q_i^{-1}, suggesting that the coda Q_c^{-1} is dominated by intrinsic attenuation. Furthermore, the total attenuation Q_t^{-1} was found to be in good agreement with S-wave attenuation Q_d^{-1} estimated by linear inversion using direct S-waves from swarm earthquakes, supporting the basic hypothesis that S-coda is composed mostly of scattered S-waves. The corrections for geometrical spreading of wave front and wave attenuation along propagation path and the NMO (normal moveout) correction to seismograms revealed that reflection phases from Conrad and Moho discontinuities located at depths of about 24 and 37-42 km make the ripple-like amplitude-anomalies at lapse-time intervals of 11 to 15 s and 18 to 25 s in the common envelopes, respectively.

Zeng (1991), BSSA, Vol. 81, No. 3, pp. 1022-1029.