S044-005 Room: C401 Time: May 29 9:48-10:00

Attenuation and dispersion of SH waves due to scattering by 2-D cavities (2)

Jun Kawahara[1], Taichi Ohno[2], Kiyoshi Yomogida[3]

[1] Dept. Environmental Sciences, Ibaraki Univ., [2] Science and Engineering, Ibaraki University, [3] Earth and Planetary Sci., Hokkaido Univ.

In our preceding report (Ohno et al., 2001), we simulated scattering of SH waves by 2-D circular and elliptic cavities embedded in otherwise homogeneous media, using a boundary integral method (Benites et al., 1992). We estimated the attenuation and velocity dispersion due to scattering, by taking averages of amplitudes and travel times of the first peaks in seismograms obtained at observation arrays. The results agree with the prediction by a single scattering theory (Kawahara and Yomogida, 1996) within the ranges of errors, independently of the aspect ratios and the axial directions of cavities. Together with the similar results by Murai et al. (1995) for cavities, this suggests the validity of the theory independent of the types of scatterers.

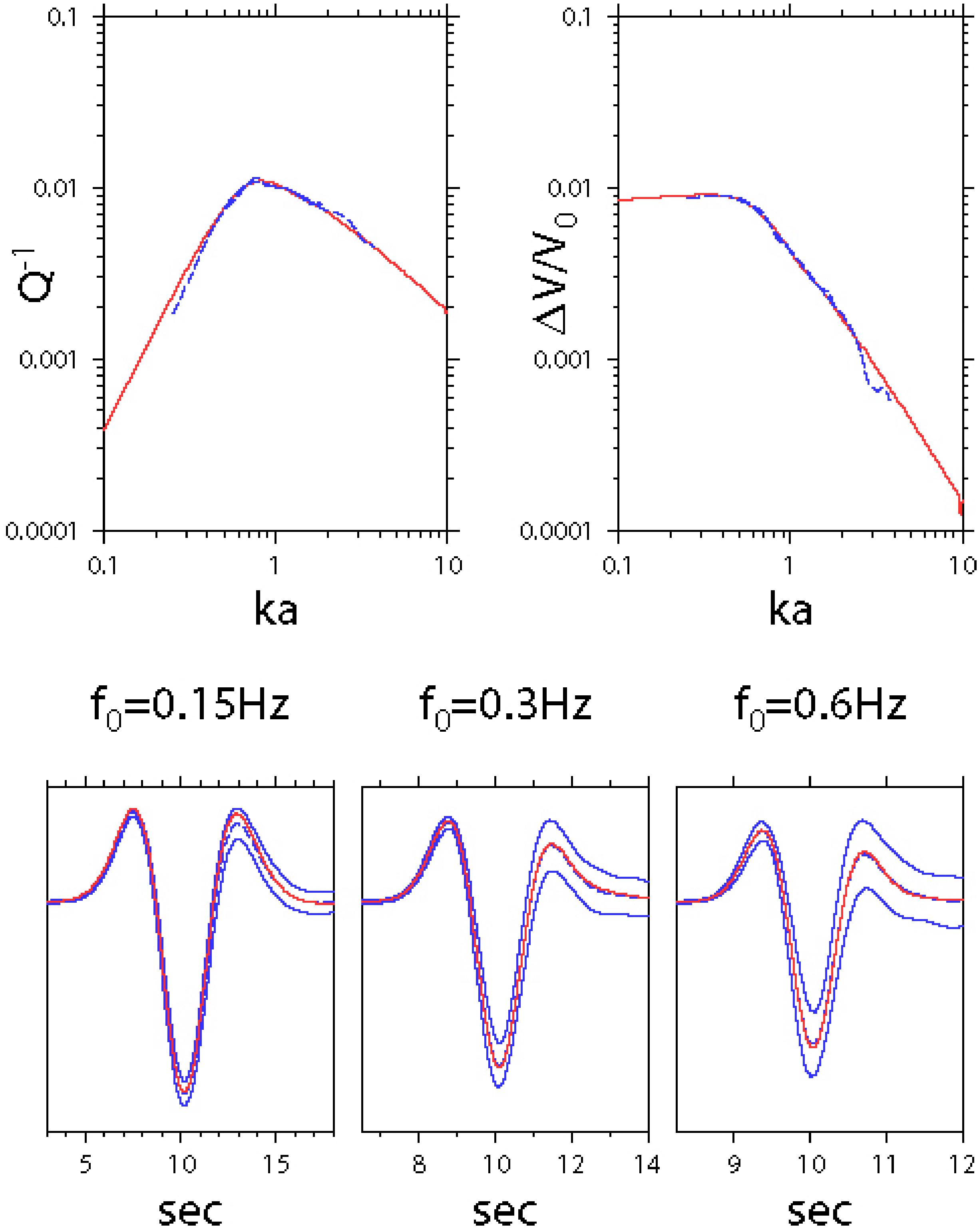
Strictly speaking, however, the attenuation and dispersion measured by the above method do not directly correspond to the theoretical prediction, because the theory really predicts those of ensemble average of observed waves, i.e., mean waves. It is consistent and preferable to compare the attenuation and dispersion of experimentally estimated mean waves with theoretical prediction. In the present report, we re-estimated the scattering attenuation and dispersion due to circular cavities in the following method. First, we made plane SH Ricker wavelets be incident on a side of a rectangular region with cavities, simulated the scattering, and performed array observation at the other side, as in the preceding report. Second, we averaged the seismograms along the array and then among the models of cavity distributions, thus estimating the mean wave traces. Then, the Q and the phase velocities were obtained from the Fourier spectral ratios of the mean waves and the incident (unscattered) Ricker wavelets. Finally, the estimates with frequencies close to the dominant frequencies of the Ricker wavelets within the factor of 2 were adopted as meaningful. This process was repeated for the Ricker wavelets with different dominant frequencies. Some results thus obtained are shown in the top of Figure 1. They are based on the same simulations as in the preceding report, and the experimental estimates again agree well with the theoretical prediction. Though discussing the significance of the agreement requires the estimated errors of the experimental values, they cannot be directly obtained by the present method. Instead, we compared the predicted mean waves with the measured mean waves and their errors (the standard deviations of the seismograms). The bottom of Figure 1 shows the measured and predicted mean wave traces, corresponding to the above graphs. The both traces coincide very well with each other, supporting the agreement between the experiments and the theory.

The single scattering theory is based on the neglect of multiple scattering and hence thought of as valid for sparse distributions of scatterers, but the limit of validity is unclear. We are therefore trying the same experiments as above for denser cavity distributions. The preliminary results suggest that the theory is valid up to considerably dense distribution of scatterers.

References

Benites, Aki and Yomogida, 1992, Pure Appl. Geophys., 138, 353-390.
Kawahara and Yomogida, 1996, Abst. J.E.P.S. Joint Meeting, E22-03.
Murai, Kawahara and Yamashita, 1995, Geophys. J. Int., 122, 925-937.
Ohno, Kawahara and Yomogida, 2001, Abst. J.E.P.S. Joint Meeting, Sr-P002.

Figure 1. Top: 1/Q (left) and decrements of phase velocity normalized by the velocity of the matrix (right) , due to scattering by some distributions of circular cavities. The red solid curves denote theoretical prediction and the blue broken ones experimental estimates. Bottom: The mean waves traces with three different dominant frequencies, corresponding to the above graphs. The red solid curves denote the predicted mean waves. The blue broken curves denote the measured mean waves and the blue solid ones their standard deviations.



0.1
0.01
0.001
0.0001
Q^{-1}
0.1
1
10
ka
$\Delta V/V_0$
f0=0.15Hz
f0=0.3Hz
f0=0.6Hz
5
10
15
sec
8
10
12
14
9
11