Spectral and polarization analysis of scattered waves with the wavelet transform

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Seismic reflection/refraction experiments around the Nagamachi-Rifu fault, northeastern Japan, were conducted as part of a comprehensive joint research project named Modeling of Deep Slip Processes in Seismogenic Inland Faults in order to study the deep structure of the Nagamachi-Rifu fault and its relation with the fault plane of the 1998 M5.0 earthquake. Off-line data system with LS8000 and LS7000 loggers recorded seismic signals from each vibrator or chemical explosion at a sampling rate of 100 Hz, as a dense short-period three-component seismic array.

The polarization of reflected/scattered phases would play an important role in the detection of reflectors/scatterers. We selected seismograms under the following criteria, (1) high signal-to-noise ratio and (2) recorded at stations equipped with a three-component seismometer. We analyzed twelve seismograms from four stations. We could identify clear secondary phases at the lapse time of 4-10 sec in most seismograms. These phases seems to be dominated by waves of a period longer than the initial P phase. Since these waves are apparently localized in both time and frequency, the wavelet transform should be suitable to analyze them. We therefore conducted the wavelet analysis, using the Meyer-Yamada analyzing wavelet. We obtained wavelet coefficients and found that the amplitude of the secondary phases are larger than the initial P phase, particularly with j=7 (1-4 Hz).

The initial P phase shows linearly polarized motions that are consistent with the back azimuth of each hypocenter. On the other hand, the particle motion at 6042 station is about N30E through the entire secondary waves. Small amplitude in the vertical component suggests these waves to be P-S mode-converted waves reflected/scattered. Since their polarization is nearly common among hypocenters, these secondary phases are interpreted not as a shallow origin but as the reflection/scattering by a relatively deep heterogeneities structure.