Imaging fine seismic structures of faults with fault-zone trapped waves

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A fault is a low-velocity zone with widely distributed scatterers compared to the surrounding uniform materials because of the highly damaged rocks in its core. When seismic waves travel through faults, they will reflect on boundaries multiply and be trapped in the fault zones which cause the energy redistribution and generate coda waves with complicated characteristics after the direct P- and S-waves. The coda is named fault-zone trapped waves (FZTWs) (Li et al., 1990). The amplitude and duration characteristics of FZTWs (Li et al., 2016) can be used to constrain the geometric features of the fault and the physical parameters of the scatterers, so the fine structure of the fault can be finally obtained. We observed some FZTWs at several Hi-net stations in Japan, which were generated by low magnitude aftershocks following large earthquakes. Relatively strong FZTWs can be recorded by the seismic stations near or on the fault where the events happened. In this study, we simulate the theoretic envelops of FZTWs with radiative transport theory (Sanborn et al., 2017) for possible velocity models with scatterers described with von Karman distribution (Sato et al., 2012). While the theoretical envelops of FZTWs fit the observed ones well, the fine fault model is determined. The FZTWs from different events before and after the main shock can be used to determine the physical properties of faults and their adjoint area varied in the seismogenic process, then we can deeply understand the fault evolutions before and after earthquakes. The varying properties of faults can provide a new perspective for earthquake preparation and a new reference for earthquake prediction and promotes the development of earthquake prediction.


