Detection of lower limit of fault low velocity zone in depth by S-wave arrival pattern on an array observation across a fault

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Modeling of the fault trapped waves has been revealing the details of the fault zone properties. These modeling illustrate the fault zone structure extending to the seismogenic zone at around 10 km depth as a low velocity zone of seismic waves. Recently, studies based on the numerical simulations found that the trapped waves can be clearly excited by the sources locating not only in the fault low velocity zone but also out of the zone, when the zone has discontinuity in depth (Mamada et al., 2004; Fohrmann et al., in press). Based on these results, fault low velocity zones with discontinuity in along-strike direction and depth direction were inferred by the waveform modeling of trapped waves (Ben-Zion et al., 2003; Mamada et al., 2004). In this study, we propose a method to detect a lower limit of a low velocity zone in depth more precisely, apply the method to observed seismograms recorded at Mozumi-Sukenobu fault, and infer a lower limit of the low velocity zone of the fault.

A seismometer array was installed in the tunnel across the Mozumi-Sukenobu fault. It has 32 stations and the station spacing is about 15 m. We performed 3-D finite-difference simulation of seismic waves with grid interval of 30 m so that the waveforms obtained from the simulation can be compared to those from observation. We assumed the fault low velocity zone sandwiched between two elastic half-spaces with relatively high velocity. Based on the study of Mizuno et al. (2003), we assumed the width of the zone is 300 m and the velocity reduction of the zone is about 10 %. Simulation was performed for two cases: low velocity zone extends to infinity in depth direction and it disappears at a depth of 5 km. We investigated a travel time pattern for initial S-waves in the array when sources were placed 10, 7.5, and 5 km in depth and 0, 0.3, and 0.6 km away from the center of the low velocity zone in previous two cases. Comparing the travel time patterns of observation and those of simulation, travel time pattern of most events can be explained in next two cases: (1) sources locating in the low velocity zone, (2) low velocity zone dissipating in some depth, and sources locating out of the low velocity zone and deeper than the location of the dissipation of the zone. Taking it into account, the hypocenter distribution of the events indicating previous travel time pattern suggests that the lower limit of the zone is shallower than 7 km in depth.