Geophysical Research Abstracts
Vol. 21, EGU2019-12374, 2019
EGU General Assembly 2019

Seismological imaging using S-wave reflection analysis and receiver function analysis about fault zone extending to the lower crust

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The model called "water-weakened lower crust model" has been proposed to explain the mechanism of stress concentration on faults causing inland earthquakes (Iio et al. 2002). According to this model, the viscosity of the deeper part of faults in the lower crust decreases by water, and stress concentrates on faults in the upper crust due to the localized deformation in the deeper part. Although this model has been reported to be qualitatively reasonable, we have not obtained a result indicating that the model is quantitatively reasonable. This is because we do not resolve a heterogeneous structure due to fluid in the deeper part of faults in the lower crust. In order to solve this problem, we try to image the heterogeneous structure in the lower crust in detail.
As a method for imaging the heterogeneous structure in the lower crust, there is an S-wave reflection analysis (Aoki et al. 2016, Katoh et al. 2018). If the heterogeneous structure is related to fluid, seismic waves can be reflected there. Therefore, the heterogeneous structure due to fluid can be determined as a reflector. In this analysis, the resolution is extremely high, 1.5 km in the horizontal direction and 1 km in the vertical direction. Katoh et al. (2018) indicated that the reflector reflects that fluid exists in fractures generated by faulting from the positional relationship between the reflector, DLFs, and a fault zone, and they proposed the reflector was a fluid pathway.
In the S-wave reflection analysis, it is difficult to determine the structure deeper than the reflector, therefore it is not resolved whether the reflector exists as a thin layer of the fluid pathway. For that reason, we estimated the structure beneath the reflector by calculating receiver functions using seismic waves incident on the reflector from below. In order to compare the result of the receiver function analysis with the result of S-wave reflection analysis, we used a same velocity structure in their analysis.
As a result of the S-wave reflection analysis and the receiver function analysis, it is found that the reflector only exists on the north side of the Arima-Takatsuki fault zone (ATFZ), and it is found that reflector is a thin layer with low S-wave velocity.
As the origin of the thin layer with low S-wave velocity, it is possible to consider fluid dehydrated from the Philippine Sea slab subducting beneath southwestern Japan and the ATFZ. In the vicinity of the ATFZ, it is known that fluid that seems to originate in the mantle spring out (Kazahaya et al. 2014). In the lower crust, pores between minerals exist independently (Yoshino et al. 2002), and fractures caused by faulting is thought to be necessary for fluid movement (Yoshino et al. 2002). Furthermore, since the spatial distribution of the reflector is related to the ATFZ, we consider that the reflector in the lower crust indicates that fluid exists in fractures caused by faulting. This result supports the water-weakened lower crust model.