Influence of Mantle Fluids on Inland Large Earthquakes

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A magnitude (Mj) 7.3 crustal earthquake occurred in the western Tottori area, southwest Japan, on 6 October 2000. The inferred fault had a length of 25 km, a width of 10 km, and a dip angle of nearly 90 degree. Clear surface faulting could not be found, probably because the earthquake faulting reached a depth of only 1 km, not reaching the surface. In order to determine 3-D resistivity structure beneath the source region of the 2000 earthquake, magnetotelluric (MT) surveys have been performed on 37 sites. The observed apparent resistivity and phase data were inverted simultaneously using the 3-D inversion code [1]. Inversion result reveals that an anomalous conductive body is clearly visible in the lower crust and the upper mantle beneath the southwest seismic source region. The fault plane, which is determined based on a combination of relocated hypocenters and moment tensor solutions [2], is located near the boundary between resistive and conductive regions. In addition, the $^{3}He/^{4}He$ ratios of groundwater samples collected near the main trace of the probable fault segments are several times higher than the atmospheric value, indicating a significant contribution of mantle helium released from the subcrustal lithosphere [3]. Therefore, an anomalous conductive body in the crust and the upper mantle may be ascribed to mantle fluids derived from the dehydration of the subducting Philippine Sea slab. These results suggest that the generation of the large earthquake is not a pure mechanical process, but is closely related to heterogeneities in the material property and stress field due to the relatively effective transfer of mantle fluids from the upper mantle.

References

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