Relation between plate structure and major aftershocks of the 1923 Kanto earthquake off the Kanto district

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1. Introduction

At the southern Kanto district, central Japan, the 1703 Genroku earthquake (M8.2) and the 1923 Kanto earthquake (M7.9) occurred on the subducting Philippine Sea plate(PHS). Takemura(2003) revealed that numerous major aftershocks occurred after the 1923 Kanto earthquake. Moreover, a large intraslab event(M6.7) occurred inside the PHS at northeastern coast of the Boso Peninsula (Kujukuri coast) on 1987 (Okada and Kasahara, 1990). To understand seismotectonics at the Kanto district, clarification of focal mechanisms of these large events is essential. For this purpose, we expect exploration of the plate structure is contributable. Off the Boso Peninsula, deep seismic reflection survey was carried out and detailed subduction structure of the PHS has been revealed (Kimura, 2005). The obtained profile clearly images the upper boundary of the PHS (UPHS) and heterogeneity of reflection intensity on the UPHS is observed. Reflection intensity is strong at depths smaller 10 km, weak at depths of 10 to 13 km, and moderately strong at depths larger than 13 km. We expect heterogeneity of reflectivity reflects that of physical properties and/or conditions at the plate boundary and have close relation with earthquake occurrence. At this viewpoint, we compared the obtained plate structure with the other geophysical data.

2. Seismogenic area of large events off the Kanto district

After the 1923 Kanto earthquake, 3 major aftershocks with magnitude 7 or greater occurred at the inland area within 1 hour and 2 events occurred at the offshore region next day. A major aftershock off Katsu'ura, the eastern Boso Peninsula, was the largest aftershock(M7.6). For this event, larger ground motion than the mainshock and tsunami with wave height of 1.5 to 1.8 m was observed at Katsu'ura (Ishibashi, 1986).

The weak reflection zone is located in the vicinity of the largest aftershock. Since the uppermost structure of the PHS spreads to at least the offshore region of Katsu'ura smoothly, shearing of plate subduction is likely to occur along the top of this structure south to there. Dense seismic surveys at the inland area revealed that intensity of reflection at the UPHS is weak at an asperity of the 1923 Kanto earthquake (Sato et al., 2005). Considering these results, if distribution of major aftershock is correct, the weak reflection zone off the Boso Peninsula is likely to correspond to an asperity of the largest aftershock. This model is consistent with observations of tsunami and large backslips estimated from the GPS data (Sagiya and Sato, 2005).

The moderately strong reflection zone overlaps with large slip area of the Boso slow slip event estimated from the GPS data (Ozawa et al., 2003). Based on these spatial relations, we expect that stability of the strong, weak, and moderately strong reflection zone would be stable, unstable, and conditioned stable, respectively (Kato et al., 2003).

A major aftershock at the Kujukuri coast(M7.1) is located near repeating earthquakes and aftershock area of the 1987 intraslab event. As a focal mechanism of this event, we can suggest a model that asperities of all repeating earthquakes rupture at the same time or that this event occurred inside the PHS as well as the event on 1987. Strain might be accumulated inside the PHS due to the 1923 Kanto earthquake and aftershocks next day. Major aftershock is likely to occur inside the PHS due to such strain in the case of the latter model. Takeda et al. (2007) discover significant discontinuity in the geometry of the PHS. The major aftershock at the Kujukuri coast is located at northern extent of this discontinuity and relation is implied.

By comparing the plate structure with the other geophysical data, we can obtain new insights to major aftershock sequence of the 1923 Kanto earthquake.