Collision or subduction which is appropreate for present Izu?: an interpretation based on focal mechanisms and seismic tomography

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Introduction

Izu arc having continental structure in Philippine Sea Plate (PH) is converging with Honshu arc. It may result in collision or subduction in suture zone. If the densities are same in both sides, typical collision occurs. We expect compressional stress field perpendicular to boundary or parallel to relative motion. In contrast, subduction of continental structure may occur when slight density difference and/or motion guide at the portion of oceanic structure are essential. We first searched mechanical plate boundary in suture zone based on the focal mechanism distribution. Next, we interpreted the focal mechanisms appeared near the mechanical plate boundary by considering its relation with the plate shape revealed by seismic tomography.

Where is the mechanical plate boundary?

Although Sugimura (1972) proposed the location of surface plate boundary in suture zone, we need knowledge on the mechanical plate boundary to discuss mechanical aspect of the Izu convergence. Here we estimate mechanical plate boundary by examining the extent of the stress provinces in PH. Two explanations exist for the stress field in northernmost PH. One is that the fan shaped smooth stress trajectories are characterized by bending or collision (Nakamura et al., 1984; Ukawa, 1991). Another is that two stress provinces exist in northernmost PH (Nakano et al., 1980; Tsukahara and Ikeda, 1991). Based on the compilation of focal mechanisms of shallow earthquakes (Figure 1), we could not recognize the stress trajectories with smoothed fan shape. Thus, we used an interpretation of two stress provinces. In stress province A (Figure 1), P-axes with N-S direction are dominant. It extend northward (35.5degN) beyond the surface plate boundary. In the region north of this stress province, P axes show almost E-W direction in region C (Figure 1). Another stress province B (Figure1) is characterized by compression in NW-SE direction. Its northern end is also located around 35.5degN and beyond the surface plate boundary. We can estimate the mechanical plate boundary defined as northern end of the stress province in PH as shown in Figure 1 by solid line. In the eastern part, it is weakly constrained, but abrupt seismicity change near Isehara fault suggests it is close to there. Estimated boundary is located far north than surface plate boundary. We draw the mechanical boundary at the north of the region C in Figure1, because we interpret that these focal mechanisms reflect the deformation within PH.

An interpretation of focal mechanism around mechanical boundary

P-axes in Misaka mountains (Reg. C in Figure 1) direct E-W. We cannot explain these observations by collision toward NW-SE. We should recognize these orientations are parallel to the mechanical boundary. In addition, P-axes in stress province A are also parallel to the direction of nearby mechanical boundary. Although we could not distinguish the boundary parallel direction from maximum stress direction within stress province B in western Kanagawa region, we can found boundary parallel P-axes in the most area along mechanical plate boundary. Directions of T-axes of these focal mechanisms show directions perpendicular to mechanical plate boundary. These features are inconsistent with simple collision. According to the seismic tomography, PH plate change its dip angles at the locations of mechanical plate boundaries. Thus cause of the focal mechanisms, which is inconsistent with collision, may be bending of the plate.

Conclusion

We estimated the location of mechanical plate boundary associated with Izu convergence relative to Honshu. Along this mechanical plate boundary, we found specific focal mechanism with boundary parallel P-axes and boundary perpendicular T-axes. This feature is due to plate bending process toward subduction rather than collision. Similar focal mechanisms are found in Indo-Himalaya convergent boundary.

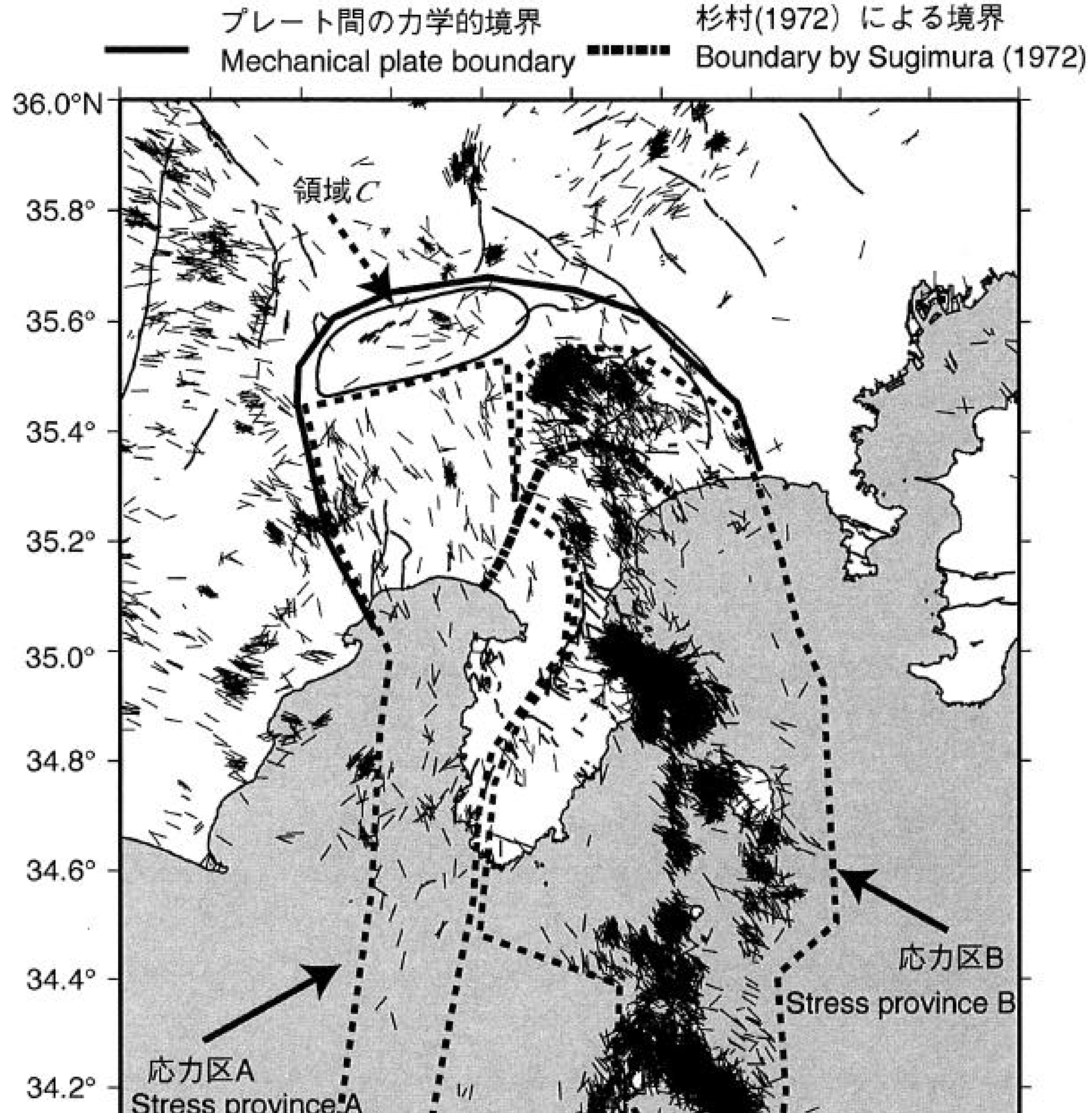

図１　浅い地震（深さ≤20km）のP軸方位分布、データは防災科学技術研究所関東東海観測網による（1979-2002）.

Figure 1 Paxes distribution of shallow earthquakes (depth≤ 20km). Focal mechanisms by NIED Kanto-Tokai network are used(1979-2002).