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Subduction structure of the Izu-Bonin arc and its implications for the seismic activity

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Collision and subduction structure in the Izu collision zone has been revealed by recent seismic experiments of Special Project for Earthquake Disaster Mitigation in Urban Areas, including a wedge-like structure of the Tanzawa block and its delamination from the subducted Philippine Sea plate in the eastern part (Sato et al., 2005; Arai et al., 2009), and multiple collision structure of the Misaka and Tanzawa blocks in the western part (Sato et al., 2006; Arai et al., 2011). However, the physical property of the subducted crust of the Izu-Bonin arc and its relation to seismicity, especially in the lower crustal level, remains to be solved.

In order to reveal the subduction structure of the Izu block in the southern part of the collision zone, we performed seismic tomography analyses incorporating active and passive source seismic data. The analyses were undertaken in two directions along the eastern (2003 Odawara-Kiryu) and western (2005 Odawara-Yamanashi) profiles. Hypocenters and velocity structure were simultaneously determined based on the double-difference method (Zhang and Thurber, 2003).

The obtained P and S wave velocity models showed large lateral velocity variations associated with the collision/subduction processes of the Izu-Bonin arc. The northward dipping low velocity layer along the Kozu-Matsuda Faults was imaged between the Tanzawa and Izu blocks. The middle/lower crust of the Izu block with P wave velocity of 6.5-7.0 km/s is subducted beneath the Tanzawa, within which intensive seismicity occurs. These events form 10-km-thick seismicity zone dipping northward in the depth of 15-30 km. From this distribution, this seismicity must be related to the subduction process of the Izu block. Vp/Vs ratio in this seismogenic zone shows the intermediate value, which agrees well with hornblende gabbro measured in dry condition (Nishimoto et al., 2008). Not only Vp/Vs ratio but also other geophysical evidence such as b value and resistivity structure (Aizawa et al., 2004) suggest low water content and poor dehydration in the subducted Izu-Bonin arc crust. Furthermore, the low water content is also consistent with the seismic evidence obtained from active source data (Arai et al., 2011). Thus, it is concluded that the role of dehydrated fluid is not significant for this activity. We propose two hypotheses for physical causes of the remarkable seismicity beneath the Tanzawa; a fracture zone associated with the progress of the crustal delamination and high crack density in the middle/lower crust of the Izu-Bonin arc. These two factors may contribute to generate microseismicity in the collision zone.

Keywords: Izu collision zone, Seismic wave velocity structure, Physical property, B value, Seismicity, Seismic tomography