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Crustal structure in the northwestern part of the Izu collision zone

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Since the middle Miocene, The Izu-Bonin arc has been colliding with the Honshu arc in central Japan. This collision process is responsible for an extremely complex crustal structure of the Izu collision zone. The Kanto Mountains is located at the northern side of the Izu collision zone, and mainly composed of the Paleozoic to Mesozoic accretionary prisms represented by the Sambagawa metamorphic belt, the Chichibu belt and the Shimanto belt. In the southwestern part of the Kanto Mountains, the Kofu Granitic Complex (KGC) is exposed at the surface, and a basin structure was formed called the Kofu Basin. Although these areas are bordered to the northwesternmost part of the Izu-Bonin arc and expected to provide important geological/geophysical information in understanding the collision process in an early stage, their crustal structures remained to be clarified.

In 1982, Research group for explosion seismology (RGES) carried out a seismic experiment named Miyota-Shikishima profile in the western flank of the Kanto Mountains and the KGC (RGES, 1986). A 60-km-long profile was extended in NS direction just north of 2005 Odawara-Yamanashi profile (Sato et al., 2006), on which refraction/wide-angle reflection data from 5 dynamite shots were recorded at 61 seismic stations. Although these seismic data are useful for understanding crustal structure in the northwestern part of the collision zone, they were not fully interpreted in terms of collision structure between the Honshu arc crust and the IBA crust further south. We reanalyzed these data paying special attention to the following two points. One is to reveal velocity structure of the pre-middle Miocene accretionary prisms (Shimanto belt). The velocity information is helpful for understanding the origin of crustal material beneath the Kofu Basin which was not fully understood due to the lack of geological evidence. The second is to constrain the subsurface distribution of the KGC. The seismic line was located in the western flank of the granitic complex, which may provide useful structural information for the process of the magma intrusion.

The data quality was so good that P wave first arrivals of every shot were observed in the whole profile. In addition, several P wave reflections and S wave first arrivals were recorded. Using these data sets, we constructed P and S wave velocity models by forward modeling using the ray tracing method (Iwasaki, 1988; Cerveny and Psencik, 1983).

The obtained P wave velocity model showed some interesting crustal features. The first one is a layer with P wave velocity of 5.6-6.0 km/s and S wave of 3.4-3.7 km/s situated in the upper 4 km crust, which corresponds to the Shimanto belt. Although the KGC is exposed at the southern part of the profile, a significant velocity variation was not identified in this layer. Among several clear reflectors found at a depth of 4-20 km beneath this profile, the most important is one at the depth of 4 km in the southern part. From amplitude modeling, P wave velocity beneath the reflector is estimated to be 6.15-6.4 km/s, 0.15-0.2 km/s higher than that further north. This reflector continues further south to a top of the high velocity body of the KGC in 2005 Odawara-Yamanashi profile (Arai et al., 2010). In addition, the location of this reflector almost corresponds to the north-south extension of the KGC at the surface. Thus, the reflector at 4 km depth is interpreted to be the top of the high velocity body of the KGC which is imaged as a higher velocity of 6.15-6.4 km/s in a depth range of 4-10 km. For these reasons, we interpreted that the Shimanto belt extends further south beneath the Kofu Basin and the Misaka block. The whole crustal model suggests a tectonic history including intrusion of the KGC into the Shimanto belt and obduction of the Misaka block onto the Shimanto belt. Probably, a large amount of the KGC magma intruded from just beneath the Kofu Basin.

Keywords: Izu collision zone, Seismic wave velocity structure, Refraction/wide-angle reflection analysis, Kofu granitic complex, Misaka Mountains, Shimanto belt