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Seismic wave velocity structure beneath central part of the Itoigawa-Shizuoka Tectonic Line, central Japan

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The 250-km long Itoigawa-Shizuoka Tectonic Line (ISTL), running with NS direction in Central Japan, is a major tectonic boundary between NE and SW Japan. The northern part of the ISTL is defined as the western boundary fault complex of the sedimentary basin formed by the Miocene back-arc spreading of the Sea of Japan. Under a compressive stress regime since the late Neogene, the northern segment of the ISTL has been reactivated as a reverse fault system with a large slip rates (4-9 mm/yr), and is ranked an earthquake fault with the highest risk. Detailed formation process of the southern part of the ISTL, on the other hand, remains unclarified although it is evident that the arc-arc collision between the Honshu arc and Izu-Bonin arc, which is continuing from the Miocene time, plays an important role.
Since 2002, several seismic reflection/refraction surveys were conducted across the ISTL. The most intensive research activity is 'the Integrated Research Project for Active Fault System along Itoigawa-Shizuoka Tectonic Line' funded by MEXT, Japan in 2005-2009, which succeeded in elucidating remarkable structural variation along the ISTL. In the northern part of the ISTL (north of the Suwa Lake), the fault shows a gentle eastward dipping geometry (10-30 degrees) dominated by the thin-skinned tectonics associated with the back-arc spreading and the subsequent tectonic inversion. The southern part, on the other hand, has a westward dip of 15-30 degrees. The most important finding in this region is a high deformation rate of 7-10 mm/y estimated for its southern most part, which provides quite an important constraint for fault extent/size of future earthquake.
In 2007, an intensive reflection/refraction experiments were carried out crossing the Suwa Lake with WNW-ENE direction. This study provides detailed fault structure in this part from intensive refraction/wide-angle reflection analysis. The most important finding of this study is a steeply westward dipping geometry of the Suwa fault complex as main fault. Actually, this fault has a very high angle of 70-80 degrees in the uppermost 3 km, but it becomes gentle with an angle of 4 5 degrees. The very strong wide angle reflection from it appearing in the central part of the profile requires a thin (less than 500 m) low velocity (3-3.5 km/s) layer on the fault plane, probably representing the fracture zone. This low velocity layer is restricted in a depth range of 3-8 km because the observed reflection from the deeper part of the fault plane is less pronounced. Combining the results from this analysis with the reflection image enabled us to carry out more reliable geological interpretation. Actually, this model well corresponds to the reflection events and patterns in the migrated depth section (MDS). West of the fault, the structure is characterized by the basin structure as Suwa basin. East of the fault, on the other hand, the relatively high velocity Sanbagawa belt is situated at a depth of 600m. The steeper part of the fault plane by refraction data well corresponds to the western edge of the reflective part within the Sanbagawa belt. The deeper geometry of the fault, on the other hand, is consistent with westward dipping events within MDS. Earthquakes are concentrated around the fault plane at a depth of 9-11 km, just below the fracture zone.
From this structure, it is clear that the Miocene sedimentary package (Moriya Formation) show a

considerable subsidence just master fault. It indicates that this fault was active at the time of early Miocene. In the shallowest part, the Enrei Formation also shows about 1-km subsidence master fault. It probably occurred after the regional stress filed was changed into compressional regime at time of Pliocene, consistent with the hypothesis of pull-apart basin. Our result also clarified that the segment boundary between the northern and middle parts of the ISTL occurs in a limited region, just northernmost part of the Lake.

Keywords: seismic survey, Itoigawa Shizuoka Tectonic Line, ray tracing method,
travel time tomography, fault, 2007 Suwa-Tatsuno Line