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Structure and behavior of the Itoigawa-Shizuoka Tectonic Line revealed from seismic-reflection and gravity profiling

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The Itoigawa-Shizuoka Tectonic Line (ISTL) in Central Japan is a fault zone with a very high slip rate in Pliocene-Quaternary time. The structure and behavior of the ISTL is highly variable along strike, with a possible boundary of rupture segments around Suwa Lake. In order to reveal the overall structure of ISTL, a three-year research project consisting mainly of seismic-reflection and gravity surveys started in 2002, and was followed by a five-year project from 2005. We report here overall results from the projects during the last seven years. These projects are part of the Pilot Research Project for the Itoigawa-Shizuoka Tectonic Line (2002-2004) and the Integrated Research Project for the Itoigawa-Shizuoka Tectonic Line (2005-2009) sponsored by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan.

Seismic reflection and gravity surveys were carried out along 5 long lines (13-40 km each) and 6 short lines (0.5-5.6 km each) across the ISTL. For long-line surveys, we used an array of 3-4 large vibroseis tracks as a signal source at shot intervals of 12.5-100 meters. For high resolution, short line surveys, we used a large vibroseis track (or a smaller one where inaccessible) as a signal source at shot intervals of 5-10 meters. Receiver intervals were 12.5-50 meters for the long line surveys and 5-12.5 meters for the high-resolution surveys. Gravity measurements were also made along each seismic line and its extensions at intervals from 50-200 m in order to test geologic interpretation of the seismic reflection profile. Our studies so far have revealed along-strike changes in structure, behavior and origin of the ISTL as follows:

The ISTL north of Suwa Lake dips east. Surface geology and available seismic reflection data indicate that the ISTL here (and further north) was originated from a normal fault which borders the western margin of the Northern Fossa Magna Rift Basin of Middle Miocene age. Tectonic landforms indicate that the fault has been reactivated as an oblique-slip (left-slip plus thrust slip) fault since Late Pliocene or Early Quaternary time.

On the other hand, the ISTL around Suwa Lake is a normal fault dipping west. Near Chino south of Suwa, this fault dips also west but the sense of slip becomes almost purely left slip. Deep seismic reflection profiling across the lake, as well as seismic refraction analyses using the same data set, indicates that the west-dipping fault is likely to be the master fault of the ISTL. The middle portion of ISTL from Suwa to Fujimi has no evidence for pre-Pliocene activity, and hence is inferred to have been newly born under the present tectonic regime.

The southern part of the ISTL south of Fujimi dips also west, but a thrust-slip component on it becomes dominant. Near Hakushu and further south, slip on the ISLT has been transferred to the Shimotsuburai-Ichinose Fault (SIF), which is located several kilometers east of the ISTL. Deep seismic reflection and gravity surveys across this portion of the ISTL indicate that the SIF dips

west at a low angle and is likely to merge down-dip into the ISTL. Between these two faults is a Miocene volcanic arc complex (the Koma Group), which was accreted onto the Shimanto Belt to the west. Thus, the SIF was originated from a Miocene subduction zone thrust, and has reactivated as a thrust fault in the present-day tectonic regime.

Significant slip partitioning takes place along the ISTL from Matsumoto to Fujimi, where a strike slip fault exists parallel to, and on the up-thrown side of, a thrust fault. It is revealed from seismic profiling and tectonic landforms that the strike-slip fault merges down-dip onto the thrust fault at a depth as shallow as 0.5-2 km, and therefore oblique slip occurs on the inclined fault plane at further depths. This implies that the ISTL is not fully adapted to the present-day stress field, and that the frictional strength on ISTL is very weak

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