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Tectonic evolution of the Inadani fault zone.

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The Inadani fault zone extends in a north-south direction in Inadani (Ina Valley), which is surrounded by the Akaishi Range on the east and the Kiso Range on the west. The Inadani fault zone consists of two subparallel faults: the boundary fault and the frontal fault, by which the geologic structure and topography of Inadani have been controlled significantly. This study reveals the relationship between subsurface fault structure and surface deformation in Inadani by using seismic reflection profiling, gravity data analyses, and numerical simulation. The results obtained are described below.

First, we analyzed the geologic structure beneath Inadani by using the data of seismic reflection profiling, which was carried out in October 2004 by the crew consisting mainly of students of the University of Tokyo. The seismic reflection profile revealed that (1) the boundary fault dips west at a fairly low angle (about 19 degrree) near the surface and bends down-dip to a higher angle fault at a depth of 92 m (at a distance about 263 m from the surface trace), and that (2) the frontal fault does not cut the basement but is a detachment fault in or at the base of the basin-fill sediments.

Secondly, the subsurface geologic structure interpreted from seismic reflection profile was tested by gravity data. Forward modeling of density structure revealed that (1) the dip angle of boundary fault at depth is lower than that interpreted from the seismic reflection profile, and that (2) the frontal fault does not significantly displace the basement, as has been interpreted from the seismic profile.

Finally, the subsurface geologic structure interpreted from the seismic reflection profile was tested by dislocation models. We calculated the surface deformation due to slip on the fault, and compared the results with observed tectonic landforms. Calculations suggest that (1) the dip angle of boundary fault at shallow depths is lower (about 15 degree) than that interpreted from the seismic profile, and that (2) the bending point is located farther west at a distance about 685 m from the surface trace of the fault. Therefore, it is likely that the boundary fault forms a fault-bend fold near the surface. In addition, the frontal fault becomes flat at a depth of several hundred meters, as has been interpreted from the seismic profile.

Overall analyses described above indicate that the boundary fault dips west at a very low angle near the surface, and bends down-dip to a higher angle fault at a depth of 183 m (685 m west of the surface trace). The amount of net slip on the fault is about 3.7 km and the average slip rate is 4.6 mm/yr. The frontal fault is likely to be a detachment fault in or at be base of Quaternary basin-fill sediments. Its average slip rate is estimated at 0.4 mm/yr; however this value is possibly underestimated due to erosion of fault landforms. The thrust front has probably migrated from the boundary fault to the frontal fault.