

Balanced cross sections of the source area of the 2004 Mid-Niigata Prefecture earthquake

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The 2004 Mid-Niigata Prefecture earthquake occurred in one of anticlines in the Shinetsu fold-belt. The anticline forms the Uonuma and Higashiyama hills trending in the NNE-SSW direction and 80 km long and comprises of middle Miocene to early Pleistocene sediments. The late Pliocene to early Pleistocene Uonuma Group is the youngest marine sediments in the anticline and has been uplifted several hundred meters during the period of the last about 1 million years. The fold geometries in the hill vary along its strike. The northern and southern parts are east vergent anticline accompanying west-dipping reverse faults along the eastern margin of the hill. In contrast, the anticline in the middle part has a west vergent profile bounded by east-dipping reverse faults along the western margin of the hill.

The earthquake occurred in the northern half of the southern part where is characterized by relatively tight folds in the middle part and open folds in the eastern part of the hill. The Muikamachi fault, an active fault bounding the eastern margin of the southern part of the hills, is obscure along the eastern margin of the source area.

Fault geometry under the Uonuma hill in the source area was inferred from folding geometry of the Uonuma Group. The geological map of the quadrangle Ojiya at the scale of 1:50000 provided detailed information of the structure of the Uonuma Group. The present and initial geometries of the base of the Uonuma Group were constructed from the structural and paleoenvironmental data of the geological maps and previous geologic studies, and layer-parallel slip was assumed for the deformation of the hanging wall. The depth of the base of the fault was given to be 15 km based on the depth of the aftershocks of the 2004 earthquake. The fault geometry inferred from the folding shows a large bend between the deeper steep and upper gentle parts. The modeling result strongly suggests that the tight folding in the source area has been formed by the bend. In contrast, it is inferred that there is no bend of the fault to the south of the source area where a simple asymmetric anticline has been growing. The lateral change of fold geometry shows the change of fault geometry under the hill, which presumably restricted the rupture area of the earthquake.