

## Structural features of co-seismic surface ruptures produced by the 2014 Mw 6.2 Nagano earthquake, central Japan

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The 2014 Mw 6.2 (Mj 6.8) Nagano earthquake occurred at 22:08 (Japan Standard Time) on 22 November, 2014 and resulted in extensive damage in the intermontane area of northern Nagano Prefecture, central Japan (Japan Meteorological Agency, 2014). A maximum seismic intensity of 6.0 (on the Japanese seven-point seismic intensity scale) was observed in the area around the epicenter of the earthquake. Our survey group traveled to the epicentral area one day after the earthquake to investigate the mechanism, earthquake surface deformation features, and nature of the seismogenic fault. We undertook one week of fieldwork, during which time we collected primary field data related to the geometry, morphology, and spatial distribution of co-seismic surface displacements. Here, we report the main results of our field investigations. We also discuss the co-seismic rupturing mechanism and the implications of our findings for the seismo-tectonics of the Itoigawa-Shizuoka Tectonic Line (ISTL).

Field investigations reveal that the Mj 6.8 (Mw 6.2) Nagano (Japan) earthquake of 22 November 2014 produced a 9.3-km-long co-seismic surface rupture zone. Slip occurred on the pre-existing active Kamishiro Fault, which is developed along the Itoigawa-Shizuoka Tectonic Line, which defines the boundary between the Eurasian and North American plates. The surface-rupturing earthquake produced dominant thrusting and subordinate strike-slip displacement. Structures that developed during the co-seismic surface rupture include thrust faults, fault scarps, en-echelon tension cracks, folding structures such as mole tracks and flexural folds, and sand-boils. The surface displacements measured in the field range from ~5 cm to 1.5 m in the vertical (typically 0.5-1 m), accompanied by a strike-slip component that reached 0.7 m along NE-trending ruptures. These observations indicate a thrust-dominated displacement along the seismogenic fault. Our results show that (i) the pre-existing Kamishiro Fault, which strikes NNE-SSW, controlled the spatial distribution of co-seismic surface ruptures and displacements; and (ii) the style and magnitude of thrust displacements indicate that the present-day shortening strain on the Eurasian-North American plate boundary in the study area is released mainly by seismic thrust displacements along the active Kamishiro Fault.

Keywords: 2014 Mw 6.2 Nagano earthquake, co-seismic surface rupture, Kamishiro Fault, Itoigawa-Shizuoka Tectonic Line, plate boundary, thrust