Paleoseismology of the Kurozu fault, Nobi active fault system, central Japan: its role in multiple fault rupture

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During the 1891 Nobi earthquake, a well-known example of a multiple-fault rupture, three active left-lateral faults, the Nukumi, Neodani, and Umehara faults, ruptured simultaneously. Previous paleoseismic studies revealed that timing of surface-faulting events on these faults were not always synchronous, suggesting that a multiple-fault rupture as occurred in 1891 is a sort of exception rather than a rule. The Kurozu fault is a ~8-km-long short active left-lateral fault located in between the Nukumi and Neodani faults and is known to have ruptured in 1891 together with these two faults. Although the fault may play a certain role in rupture propagation from the Nukumi fault onto the Neodani fault, very little has been known on its recent fault activity.

At one location, the Kurozu fault cuts across a fluvial terrace surface on the left bank of the Neo-Nishitani River, forming a clear uphill-facing scarp. Our pit excavations into eolian deposits that overlay the terrace surface revealed a horizon of Aira-Tanzawa (AT, ~30 ka) volcanic glass concentration immediately above the terrace gravels. This suggests that the terrace is correlated to a surface downstream that was abandoned 30–40 ka. Our coring and penetration tests on the downthrown side of the fault scarp also suggest that the terrace surface is vertically displaced by ~5.5 m, yielding a vertical slip rate of 0.14–0.18 m/kyr on the Kurozu fault.

We also hand-excavated a trench across the fault scarp, exposing a fault zone that defines a clear boundary between terrace gravels on the upthrown side and peaty and lacustrine dammed-up sediments on the downthrown side. From displacement and deformation of the dammed-up sediments, we were able to identify evidence of only two surface-faulting events after abandonment of the terrace surface at 30–40 ka, including the 1891 Nobi earthquake. This is consistent with a coseismic vertical displacement of ~3 m at the time of the Nobi earthquake, which is about half the ~5.5 m cumulative vertical displacement of the terrace surface.

Our results suggest that a rupture interval of the Kurozu fault is on the order of as long as 10,000 years. This is a good contrast to those of the Nukumi and Neodani faults that are reportedly 2,000–5,000 years. Given that timing of surface-faulting events on these faults were not always synchronous, and also given that the Kurozu fault ruptured in 1891 together with these two faults, we infer that the Kurozu fault plays a critical “relaying” role in rupture propagation across the Nukumi and Neodani faults. Our static coulomb stress modelling also suggests that rupture of the Kurozu fault significantly promotes rupture propagation across these two faults.

Keywords: Nobi earthquake, active fault, trench, slip rate, paleoseismic history

