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Transfer fault earthquake in compressionally reactivated back-arc failed rift: 1948 Fukui earthquake (M7.1), Japan

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Back-arc rift structures in many subduction zones are recognized as mechanically and thermally weak zones that possibly play important roles in strain accommodation at later post-rift stages within the overriding plates. In case of Miocene back-arc failed rift structures in the Sea of Japan in the Eurasian-Pacific subduction system, the mechanical contrasts between the crustal thrust wedges of the pre-rift continental crust and high velocity lower crust have fundamentally controlled the styles of post-rift, Quaternary active deformation (Ishiyama et al. 2016). In this study, we show a possibility that strike-slip M>7 devastating earthquakes in this region have been gregion enerated by reactivation of transfer faults highly oblique to the rift axes. The 1948 Fukui earthquake (M7.1), onshore shallow seismic event with a strike-slip faulting mechanism (Kanamori, 1973), resulted in more than 3,500 causalities and destructive damages on the infrastructures. While geophysical analyses on geodetic measurements based on leveling and triangulation networks clearly show coseismic left-lateral fault slip on a NNW striking vertical fault plane beneath the Fukui plain (Sagiya, 1999), no evidence for coseismic surface rupture has been identified based on both post-earthquake intensive fieldwork and recent reexamination of stereopair interpretations using 1/3,000 aerial photographs taken in 1948 (Togo et al., 2000). To find recognizable fault-related structures that deform Neogene basin fill sediments, we collected new 9.6-km-long high-resolution seismic reflection data across the geodetically estimated fault plane and adjacent subparallel active strike slip faults, using 925 offline recorders and Envirovib truck as a seismic source. A depth-converted section to 1.5 km depth contains discontinuous seismic reflectors correlated to Miocene volcaniclastic deposits and depression of the overlying Plio-Pleistocene sediments above the geodetically determined fault plane. We interpreted these structural features as negative flower structures related to the strike-slip fault activated during the 1948 seismic event. Locations of these strike-slip faults are consistent with Miocene transfer faults that offset syn- and post-rift sediments and underlying crustal wedges, suggesting that reactivation of transfer faults resulted in active strike-slip faulting including the 1948 seismic event. These findings demonstrate that not only rift-related normal faults but also transfer faults have strong structural inheritances and played essential roles on their active reactivation and seismicity during the post-rift stress regime.