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Near-surface structure revealed by ground penetrating radar profiling across an inland active fault ruptured one month after the 2011 Tohoku-oki earthquake, southern Fukushima, NE Japan

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The 2011 Tohoku-oki earthquake (M_w 9.0) ruptured a 500 km-long and 200 km-wide thrust of convergent boundary between the North American and Pacific plates. The earthquake caused crustal stress field changes and triggered widespread seismic activity in the northeast Japan. The southern Fukushima area was struck by many earthquakes. The largest normal faulting (M_w 6.6) in the area ruptured the NW-trending Yunodake fault and the NNW-trending Itozawa fault on 11 April 2011. The coseismic surface ruptures were observed along active and presumed active faults identified previously. To investigate the near-surface structure of the Itozawa fault, we conducted ground penetrating radar (GPR) profiling across the fault, and we carried out two drilling surveys in hanging and foot walls of the fault. The survey line, which length was about 50m, was located nearby a trench site (Toda and Tsutsumi, 2013). The GPR data were collected by common-offset modes using 50, 100, and 200 MHz GPR systems (pulseEKKO PRO made by S&S Inc.), and the station spacing was 0.05 m. Furthermore, we carried out wide-angle measurements, and acquired common mid-point ensembles at the both sides of the surface rupture to estimate the electromagnetic wave velocity used in the data processing. The depth-converted GPR sections after careful data processing show detailed structure above a depth of about 10 m. We interpreted horizons as an event showing coseismic deformation on 11 April 2011, the past seismic event reported by Toda and Tsutsumi (2013), that informing the former event, respectively. The horizons explain accumulation of vertical displacement on the Itozawa fault.

Conclusion

Seismic events on the Itozawa fault

< i > 11 Apr. 2011 **Horizon A**

Vertical displacement (VD): **0.7–0.8 m**

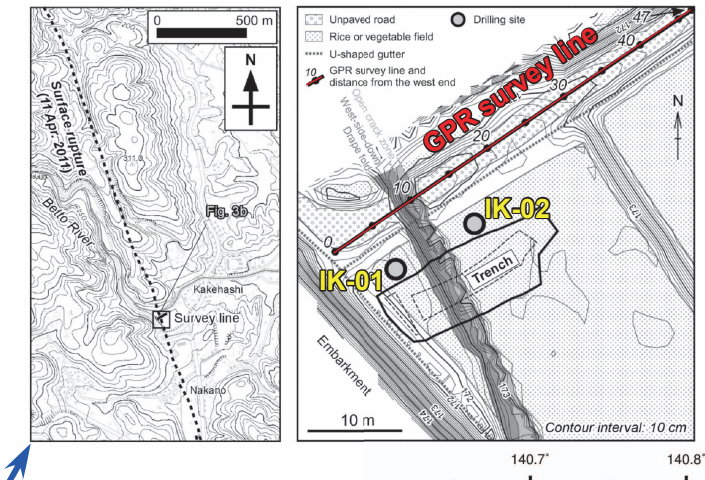
< ii > 12,620-17,410 cal yr B.P. (Toda and Tsutsumi, 2013) **Horizon B**

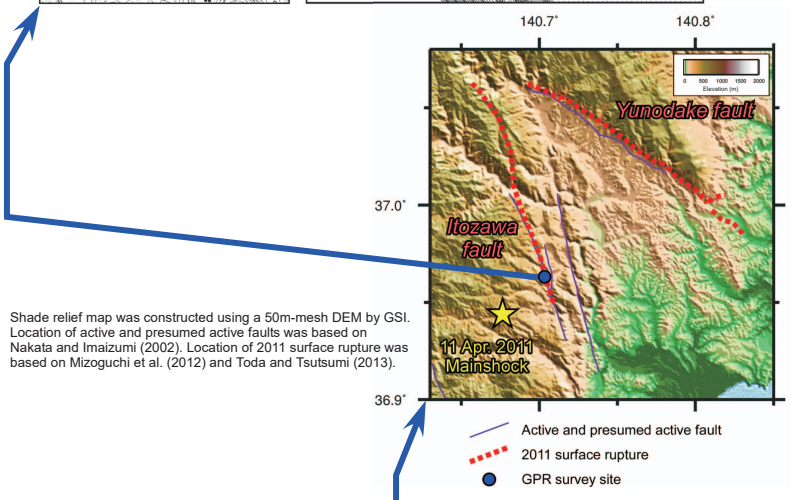
Cumulative VD : **1.0–1.1 m**

< iii > antepenultimate event ? **Horizon C**

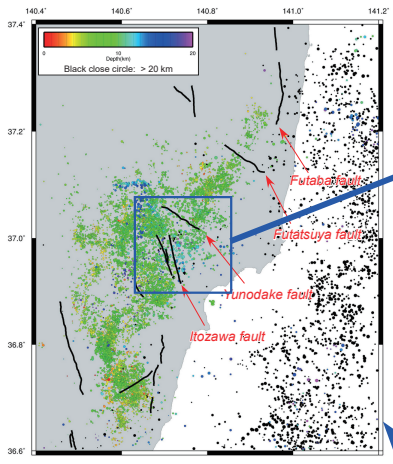
Cumulative VD : **1.5–2.0 m**

1. Study Area

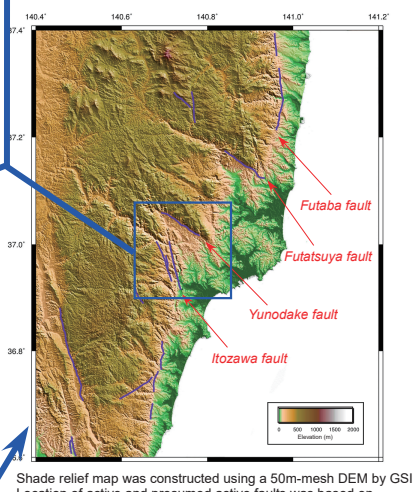




Shade relief map was constructed using a 50m-mesh DEM by GSI. Location of active and presumed active faults was based on Nakata and Imaizumi (2002). Location of 2011 surface rupture was based on Mizoguchi et al. (2012) and Toda and Tsutsumi (2013).



Sesimic activity is based on JMA unified earthquake catalog, 11 Mar. 2011 - 10 Jun. 2011. Location of active and presumed active faults is based on Nakata and Imaizumi (2002).



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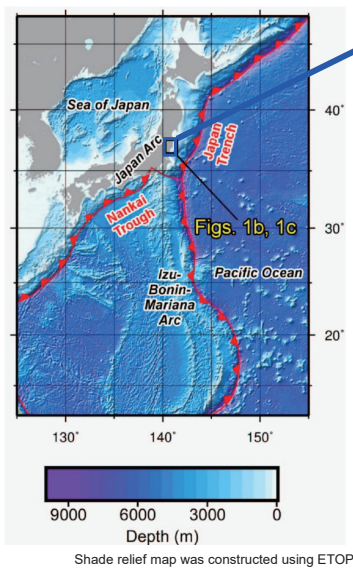
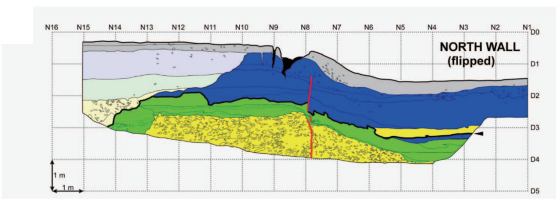
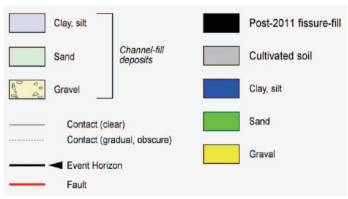


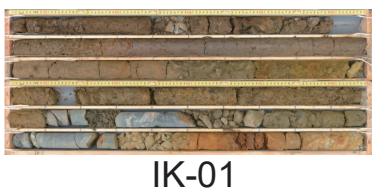
Shade relief map was constructed using ETOPO1.

3.1. Trench (Toda and Tsutsumi, 2013)





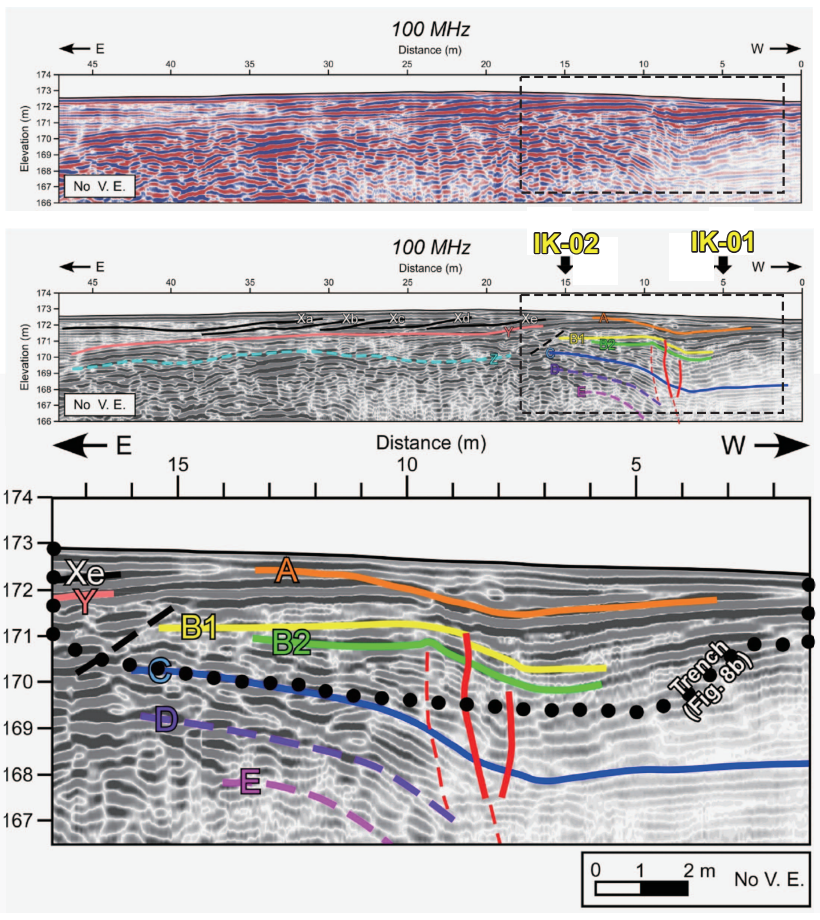
3.2. Drilling



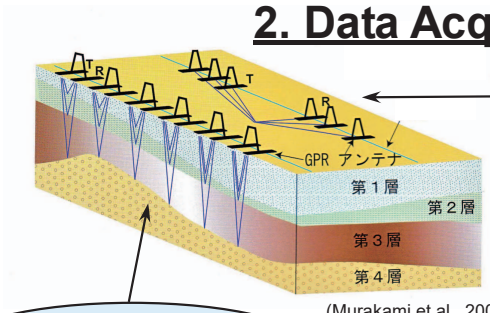
IK-01

IK-02

4. Ground Penetrating Radar

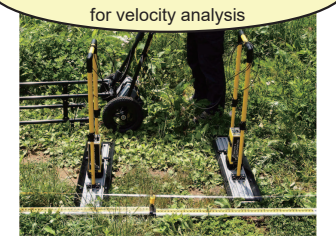


2. Data Acquisition and Processing



(Murakami et al., 2008)

Wide-angle measurement for velocity analysis



Reflection measurement for subsurface cross section

Acquisition parameters for GPR data.

Instruments	pulseEKKO PRO (Sensors & Software Inc.)
Frequency	50 MHz, 100 MHz, 200 MHz
No. of scan points	941 (50 MHz), 941 (100 MHz), 940 (200 MHz)
Scan point interval	0.05 m
No. of scans / 1 scan point	8
No. of samples	2000
Sampling intervals	0.2 ns
Recording length	399.8 ns

Flow chart of processing for GPR data ITK-01