S-wave seismic imaging of active reverse fault-related landform: A case study of the Yoro fault, Gifu Prefecture, central Japan

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We acquired high-resolution seismic reflection data to determine the precise geological structure of the uppermost part of growth strata across the Yoro fault. Time sections reveal that east-vergent asymmetric fold underlies beneath the tectonic landform at Shizu site. For the eastern half of line 1 flat-lying reflectors above 1 s are imaged. On the other hand, sections of the western half of line and the eastern half of line 2 show east-facing fold limb with steep dips and west-facing fold limb with gentle dips.

Introduction

The Yoro fault is an east vergent reverse fault that extends north-south for 30 km along the western margin of the Nobi Plain and the Ise Plain. At Shizu, Nan-no town, Gifu Prefecture, located at the eastern margin of the Yoro Mountains, distinctive fault-associated geomorphic features are expressed as warping on late Holocene alluvial plain (Togo, 2000). Ishiyama et al. (2001, submitted) obtained numerous cores across tectonic landform at this site, using Geoslicer and percussion sampler. Geological cross-section across the uplifted alluvial plain based on closely spacing drilled provides the confirmation that active folding of late Holocene deposits underlies beneath the uplifted floodplain. Near-surface stratigraphic relations, age controls of strata based on radiocarbon dating, and structural analyses on stratal geometry show that recent two historic earthquakes have produced topographic relief across the tectonic landform at this site. Ishiyama et al. (2001, submitted) also reconstructed evolution of tectonic landform on alluvial plain during late Holocene at Shizu-Shobuhara site, indicating that tapering strata deposited the pre-existing fold limb have been progressively rotated due to the following deformational (active folding) events. To understand kinematics for tectonic landform from the point of view of bed-by-bed growth of structures by discrete deformational and depositional events, precise and continuous geologic cross-section is a necessary data.

Seismic Reflection Data Acquisition and Processing

We acquired high-resolution seismic reflection data to determine the precise geological structure of the uppermost part of growth strata beneath the drilling site. S-wave as a source is used so that S-wave reflectors with smaller wavelength could be acquired. Data collection was designated under consideration of obstacles lying across the survey lines. In general, S-wave seismic reflection survey requires straight survey line because of anisotropy of shear wave velocity due to heterogeneity. So we designated multiple survey lines; line 1 started 200 m east of the embankment, progressed westward and through the Tsuya River, whereas acquisition on the line 2 started at the lowest point near the Tsuya River and progressed westward. We minimized lateral gap between two lines so that they overlap each other to obtain integrated geological cross-section throughout fault-related landform developed over the Yoro fault.

A 1-m geophone spacing was used where east-dipping strata are underlying beneath the ground were recognized by the drilling survey, whereas a 2-m source spacing was used where underlying strata are lying flat. Spacing of common depth points (CDPs) on the final profile was composited to be approximately 0.5 m for the western half of line1 and the eastern half of line 2, and 1.0 m for the remained parts of the survey line. 150-channel, G-Daps 4 (© JGI) recording system was used in an on-end configuration with the nearest receiver 1m from the source. Minivib (© IVI) was used as a source with three shots per one channel. Geophones were 40Hz, with one per station. For the entire lines it was possible to plant the geophones directly on the sidewalk or the grass. Data quality was so good for the entire line that several reflectors with different velocities were easily observed on most shot records for 1 s, whereas for the western parts of the line2 reflections are obvious only for 0.5 s.

Interpretation of the Seismic Reflection Data

Time sections reveal that east-vergent asymmetric fold underlies beneath the tectonic landform at Shizu site. For the eastern half of line 1 flat-lying reflectors above 1 s are imaged. On the other hand, sections of the western half of line and the eastern half of line 2 show east-facing fold limb with steep dips and west-facing fold limb with gentle dips.