Seismic imaging of active reverse fault-related landform: a case study of the Kuwana fault, Mie Prefecture, central Japan

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We acquired high-resolution seismic reflection data to determine the precise geological structure of the Kuwana anticline beneath the deformed terrace treads.Time section reveals that east-vergent asymmetric fold underlies beneath the tectonic landform along the Kuwana fault. East of warping on alluvial plain along the Kuwana fault, several reflectors above 1.7 s are lying flat, whereas east-facing fold limb with steep dips and west-facing fold limb with gentle dips are imaged.

Introduction

The Kuwana fault is an east vergent reverse fault that extends northwest-southwest for 20 km along the western margin of the Nobi Plain and the Ise Plain, central Japan. Geomorphic and geologic evidence of late Quaternary-Holocene reverse faulting along the Kuwana fault has been found by previous researchers (Awata and Yoshida, 1991; Ishiyama and Togo, 1999; Ota and Sangawa, 1984; Suzuki et al., 1996). As introduced by Kaizuka (1949), tectonic landforms along the Kuwana fault is characterized by east-facing warping developed on the treads of fluvial terraces with numerous west-facing scarps. These distinctive tectonic landforms develop over the east-facing forelimb of the Kuwana anticline, which is an east-vergent asymmetric anticline of late Pliocene-early Pleistocene strata, with steeply dipping forelimb and gently dipping backlimb. As mapped by Yoshida et al. (1991), anticlinal axis runs along the western edge of the warping treads. Over the backlimb, the treads of fluvial terraces also distribute, but with gentle west dips, i.e., treads dipping upstream. These observations generate a hypothesis that the Kuwana anticline is a growing fold during late Quaternary. One way to test this hypothesis is establishing kinematic model by which evolution of fold geometry of both Neogene strata and late Pleistocene geomorphic features is explained.

Seismic Reflection Data Acquisition and Processing

We acquired high-resolution seismic reflection data to determine the precise geological structure of the Kuwana anticline beneath the deformed terrace treads. Data collection was designated under consideration of logistical constraints along the survey lines. A 15-m geophone spacing was used and spacing of common depth points (CDPs) on the final profile was composited to be approximately 7.5 m. 150-channel, G-Daps 4 (© JGI) recording system was used with the nearest receiver 15 m from the source. Minivib (© IVI) was used as a source with 5-10 shots per one channel. Geophones were 10Hz, with nine 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 the easternmost parts of the line several reflectors were observed above 2 s , whereas for the western parts of the line reflectors are obvious only for 1 s.

Data processing was a routine work. The presence of continuous reflectors on the final stacked sections gave us confidence that the final residual statics solution and velocity model were appropriate. The final profiles were time-migrated and converted to depth sections using a smoothed velocity function.

Interpretation of the Seismic Reflection Data

Time section reveals that east-vergent asymmetric fold underlies beneath the tectonic landform along the Kuwana fault. East of warping on alluvial plain along the Kuwana fault, several reflectors above 1.7 s are lying flat, whereas east-facing fold limb with steep dips and west-facing fold limb with gentle dips are imaged.