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Structure and evolution of active faults with strike-slip in a forearc basin: An example of Enshu fault system in the ea

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1. Introduction

Accretionary prisms and forearc basins are developed in the Nankai Trough, SW Japan. Many active faults are recognized and classified into five fault systems in the eastern Nankai Trough. The most landward Enshu Faults System runs over 200 km along the northern margins of the Tokai and Kumano forearc basins. Swath bathymetry and side-scan sonar surveys indicate a general fault trend of ENE-WSW and dextral displacement of submarine canyons. However, there is no report about the history of the active faults. Fault activities have been recorded in sedimentary sequences, because sedimentation in a forearc basin is very active in this area. Therefore, fault activity histories can be restored by seismic reflection records. Structural investigation of this area is important for earthquake disaster mitigation as well as understanding of oblique subduction tectonics because this area is closed to densely populated cities.

2. Data source

This study is based on data from seismic reflection survey ”Tokai-Kumano Nada” in 2001 and MITI well ’Nankai Trough’ in 1999 conducted by Japan Oil, Gas and Metal National Corporation (JOGMEC) (Fig. 1). 3.5 kHz sub-bottom profiles and chirp sub-bottom profiles obtined during KH-10-3 cruise in 2010 and IZANAGI side-scan sonar images are also used in this study.

3. Results and Discussion

3-1. Seismic stratigraphy

This study picked continuous reflectors and divided the formation into five units. Moreover, these units were correlated with core data from MITI Well ”Nankai Trough” and got to correspond to Ogasa Group, Upper Kakegawa Group, Mid Kakegawa Group, Lower Kakegawa Group and Basement (Saigo/Kurami Group), respectively (Fig. 2).

3-2. Terrace structure and Lineament

IZANAGI side-scan sonar image showed the NEN-SWS trending three lineaments parallel to each other on a seafloor (from north to south, L-1, L-2, L-3). Seismic reflection profiles indicate that faults are developed beneath each lineament. It is thought that displacements of active faults formed basin structures and terrace morphologies on a seafloor.

3-3. Flower structure and Strike-slip fault

Seismic reflection profiles indicate that most reverse faults developed beneath lineaments seem to have strike-slip component judging from existences of flower structures. Riedel shear deformations were observed on the Shima Spur, and horizontal shift was recognized at an axis of Anoriguchi submarine canyon. These observations are consistent with strikes-slip deformation. Moreover, shallow extension of fault planes on seismic reflection profiles and cold seeps observed by submersibles, strongly suggest that most faults are active in this area.

3-4. Restoration of activity in strike-slip fault

An isopach map of each unit was made on the basis of seismic stratigraphy. Seismic profiles in E-W direction show discontinuous reflectors suggesting paleo-submarine canyons (Takano et al., 2010) in Units 3 and 4. Unit 3 exhibits horizontal stepwise displacement of a region with uniform sediment thickness. It seems that dextral strike-slip fault displaced a paleo-submarine canyon. Above Unit 2, there is no deformation structure suggesting strike-slip displacement. In summary, fault activity of the lower units (Units 3 and 4) seems to be higher than that of the upper units (Units 1 and 2).

3-5. Restoration of activity in reverse fault

In general, reverse faulting is accompanied by thick sedimentary sequence in a footwall side. Such structures are well developed in Unit 4, and partly recognized in Unit 3. In addition, reverse faults were active in the formations lower than Unit 4 by vertical displacements in seismic reflection profiles. In contrast, the faults seem to be inactive above Unit 2. Vertical displacements of Units 1 and 3 show large differences from place by place along lineaments. The cause of this deformation pattern is explained by subduction of a basement high.

Keywords: Nankai Trough, Forearc basin, Reverse fault, Strike-slip fault, Seismic reflection survey