

GEOLOGICAL STRUCTURES CONTROLLING SLIP BEHAVIORS IN THE CONVERGENT PLATE MARGIN

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CONVERGENT PLATE MARGIN

(プレート収束境界におけるプレートの滑り挙動を支配する地質構造の解明)

区 分 :

論 文 内 容 の 要 旨

The shear zone (or shallow plate interface) may contain high pore fluid pressure, which can cause tectonic tremors. Minor pore pressure increase at the shear zone can cause fault rupture along the shallow plate interface if the fault zones are critically stressed. Thus, continuous monitoring of the shallow plate interface with high pore pressure is important in plate convergent margins such as the Nankai Trough and Japan Trench. In this study, I evaluate the mechanism of tectonic tremor and the factors that influence its occurrence and fluctuations in the Nankai Trough. First, seismic reflection data is used to map in detail a shear zone associated with the plate boundary fault in the Nankai accretionary prism. The shear zone can be characterized based on chaotic or weak reflection and low seismic velocity anomaly hosted high pore fluid pressure. High pore fluid pressure can be accumulated in the shear zone due to fluid expulsion from the inner wedge – transition zones to the outer wedge in Nankai Trough, southwest Japan.

In Chapter 1, I describe an introductory section about slow slip events at the shallow plate interface. This chapter reviews previous studies regarding geological structures controlling slip behaviors in the convergent plate margin. Furthermore, I describe that the shear zone thickness and slow slip distribution are not straightforwardly related.

In Chapter 2, I describe the geological setting and previous research studies in this region. An episodic style and the migrating activity of slow earthquakes can promote tectonic tremors in the plate subduction zone. Particularly in the Nankai Trough, slow slip events are caused by the subduction between the Philippine Sea Plate and the Japanese Islands plate. The previous study interpreted that these slow slips are caused by the reactivation of strike-slip faults accommodating shear strain in the plate interface. Some studies have proposed that the low-velocity zone or the shear zone near the plate boundary may be the location of slow earthquakes including tectonic tremors. Slow earthquakes are associated with thickness fluctuations of the shear zone hosted by high pore pressure around the plate interface. Such heterogeneous geological structure around this plate interface is also influenced by the collision of accretionary prism with the igneous dome operated as a static backstop around the Cape Shionomisaki.

In Chapter 3, I describe seafloor bathymetric and seismic reflection datasets. A high-resolution

bathymetric map of the study area is used to map fault distribution based on the basis of its elevation and topography with a spatial resolution of ~100 m. The shear zone is accurately defined on the 3D seismic volume. To estimate the shear zone distribution in the extensive area, the shear zones were mapped using several 2D seismic reflection profiles by comparing with the 3D seismic volume.

In Chapter 4, I investigate how shear zone thickness and faulting can influence the tectonic tremor distribution change in spatiotemporal. I proposed three-steps investigation. Step one, I calculated seismic attributes from the 2D and 3D seismic reflection data. Then, step two is mapping fault distribution from seafloor bathymetric and seismic reflection data. After mapping fault distribution, I identified the shear zone based on the seismic facies and physical characteristics. From the last step, a detailed comparison of the mapped shear zone and the distribution of tectonic tremors was obtained. The results demonstrate the tectonic tremors seem to have relationship with the shear zone.

In Chapter 5, I show the results and geological interpretation of this study, which contain interpretation of structures around the shear zone and estimation of the shear zone thickness. I interpret the strike-slip faults around the shear zone based on features and pattern structures from bathymetric, seismic profiles, and coherence attributes. The fault geometry indicates the positive flower structures that tended to occur in the thick part of the shear zone. In addition, high pore fluid pressure in the thick shear zone may weaken faults and thereby trigger slow earthquakes.

In Chapter 6, I discuss about slow earthquakes or tremor distribution controlled by shear zone thickness, relationship between the tremor number and the shear zone, and tectonic structures controlling shear zone distribution. Tectonic tremors line up on the oblique strike-slip faults, which changed and varied the shear zone thickness as well as fluctuation of stress and pore pressure. The thickness of the shear zone and tremor distributions are controlled by the oblique strike-slip faults, which are theorized to have originated as a result of the collision of an accretionary prism with a landward tectonic backstop around the Cape Shionomisaki.

In Chapter 7, I describe the key findings and summaries of this study. The thickness of shear zone and the strike-slip fault influence the spatiotemporal tectonic tremors in Nankai Trough. This study contributes to evaluating the fluctuations of slow earthquakes; The number of tremors is influenced by variations in shear zone thickness and faults. Strike-slip faults that influences upon the variation of shear zone thickness may be elucidated by the collision of accretionary prism with a tectonic backstop. This study will certainly help to evaluate earthquake monitoring and long-term and short-term crustal deformation monitoring associated with slow earthquakes. In addition, this study helps to understand the geological structures controlling slip behaviors in the convergent plate margin.