

Effects of Subducted Seamounts on the Source Process of the 1946 Nankai Earthquake, SW Japan

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Abstract

We hypothesize that the complexity of the source process of the 1946 Nankai earthquake is mainly caused by the subduction of the seamounts. We carried out incremental stress field calculation for a seamount subduction using FEM. The results indicates that we may explain some of the characteristics of the source process considering the stress perturbation caused by the seamount subduction.

Introduction

Great interplate earthquakes occur repeatedly along the Nankai trough, where the Philippine Sea plate is subducting beneath southwest Japan. The last one occurred in 1946 with magnitude 8.0. The source process of this earthquake has been reinvestigated recently using seismic data and analysis of seafloor deformation and shown to be fairly complex (Cummins and Kaneda, 2000[1], Cummins et al., 2000 [2]).

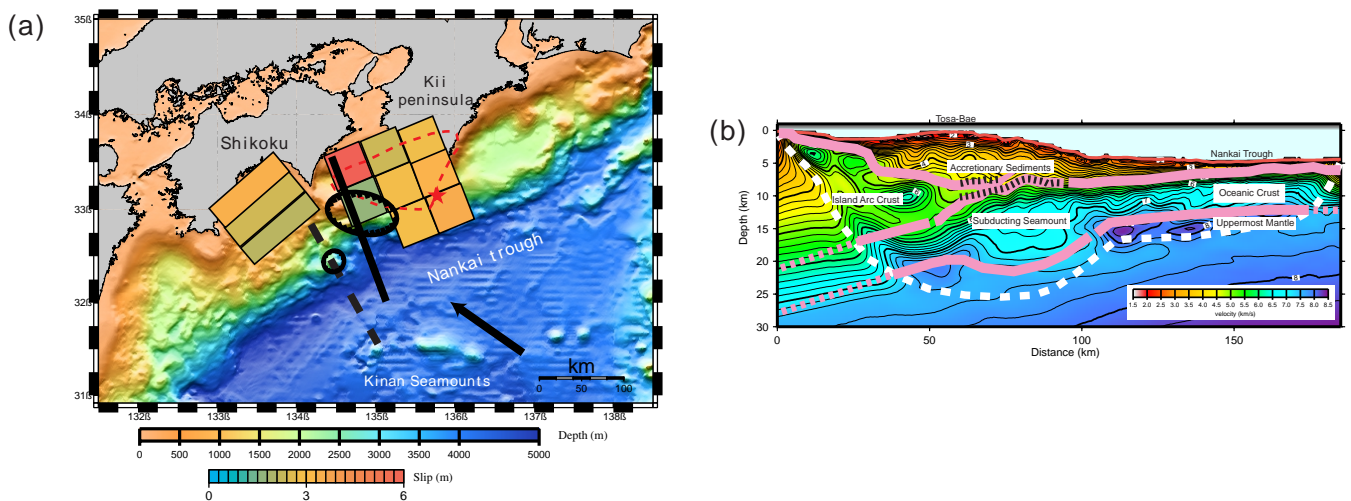


Figure 1: (a) Topography of the western part of the Nankai trough and locations of MCS (dashed line) and OBS (solid line) seismic profiles. Each ellipse on the profile shows the location of the subducted seamount. Slip distribution of the 1946 Nankai earthquake is also shown. The 1-day aftershock area is shown as red dashed line. Red star mark indicates the epicenter. Arrow shows the direction of the plate convergence here. (b) Seismic velocity image along the OBS seismic profile in (a). The region where the result is reliable is above a white broken line.

In the central part of this source region, some subducted seamounts have been imaged in MCS (Park et al., 1999 [3]) and OBS surveys (Kodaira et al., 2000 [4]) as shown in Figure 1.

We hypothesize that the complexity of the source process is mainly caused by the subduction of the seamounts.

The 1946 Nankai earthquake

The characteristics of the source process of the 1946 Nankai earthquake are as follows (Figure 1a, Cummins et al., 2000 [2]): (1) most of the coseismic slip occurred in the east of the subducted seamounts, where most of the 1-day aftershocks occurred (Mogi, 1968[5]). (2) to the west or the northwest of the seamounts, seismic or tsunamigenic slip occurred on a splay fault whose strike is not parallel to the trough axis but perpendicular to the direction of relative plate motion here (Miyazaki and Heki, 2000[6]). (3) additional aseismic but tsunamigenic slip may have occurred to the west of the subducted seamount.

FEM model and results

We calculate the incremental deformation and stress around a seamount associated with subduction using FEM (the method is described in Baba et al., 2000[7]). Figure 2 shows the mesh pattern of our model. The configuration is based on the Muroto seamount (Park et al., 1999[3]). Gravity is applied on the whole system with constant Coulomb friction acting on the plate boundary.

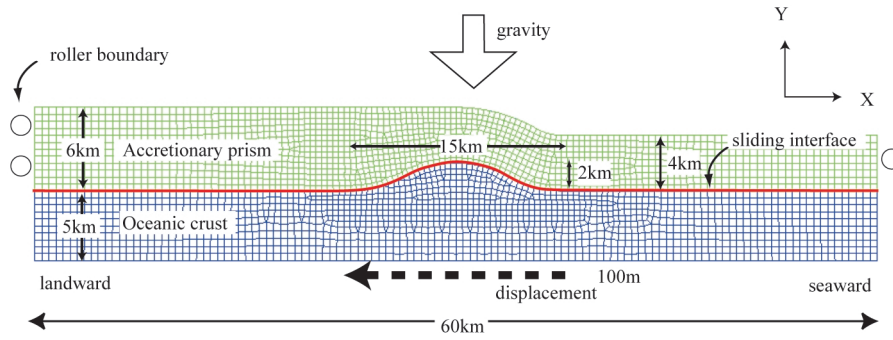


Figure 2: Two-dimensional finite element mesh. The material properties for the accretionary prism and the oceanic crust are given in Table 1. The circle indicates roller boundary condition.

Table 1: Assumed values of material parameters

	Accretionary Prism	Oceanic Crust
Young's modulus [Pa]	0.18×10^{11}	1.05×10^{11}
Poisson's ratio	0.40	0.25
density [kg/m^3]	2.0×10^3	2.8×10^3

The results which may relate to the source process are as follows: (i) the traction acting on the plate boundary increases and decreases on the forward flank and on the backward flank of the seamount, respectively, due to forward displacement of the seamount (Figure 3a). (ii) the incremental compressional stress is maximum in the direction of subduction in the landward portion of the overriding plate (Figure 3b).

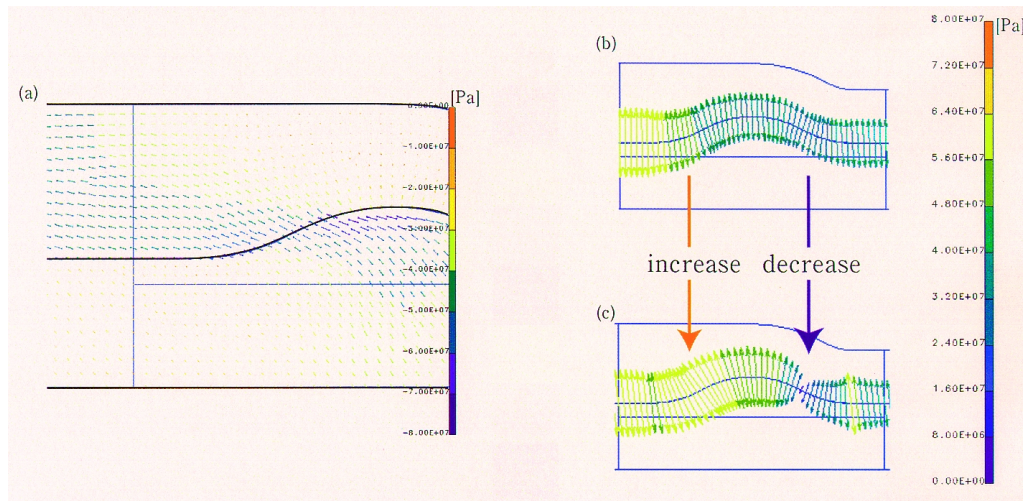


Figure 3: (a) Distribution of the max. principal stress. (b) and (c) are the distribution of the traction on the interface for the case with only gravity and that with both gravity and displacement, respectively.

Conclusions

We consider that the source process characteristics (1) and (2) are related to the calculated stress field (i) and (ii), respectively. The mechanism of (3) is an open question. The result (i) indicates that the plate boundary is strongly coupled and weakly coupled on the forward flank and the backward flank of a subducted seamount, respectively. So the forward flank of the seamount possibly behaves as a barrier. Along the backward flank, little slip may occur because little strain is accumulated there. The stress field (ii) can not be released by slip on the plate boundary, so fracture will occur in the overriding plate to release the accumulated stress. The plausible mechanism of the fracture is consistent with that of the splay fault proposed by Cummins and Kaneda, 2000[1].

References

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