Influence of Plate Subduction and Trench Type Great Earthquakes on Crustal Deformation
− Examination by Crustal Deformation Simulation −

Background

When we build an important institution related to atomic energy such as a nuclear power plant or a high level waste disposal institution, it is desirable that crustal deformation in the neighboring area is stable. Stability of the crustal deformation here means for the crust not to display sedimentation and upheaval by volcano and fault or plate movement. The future of crustal deformation of the Japanese Archipelago is predicted based on the premise that "the present crustal deformation continues in the future unless the present conditions of plate movement change". Future crust structure is predicted by extending inclination from the past to the present to the future if based on this premise. The technique that is needed to grasp inclination of crustal deformation from the past to the present is already well established as an earth science investigation technique. Establishment of quantitative crustal deformation analysis technique based on this investigation technique and the prediction concept mentioned above is desired.

Objectives

To examine the influence that plate subuduction gives to the Japanese Archipelago by numerical value simulation from the point of view of accumulation of stress. Furthermore, to estimate crustal deformation when a trench type great earthquake occurs. And to clarify long-term crustal deformation when this earthquake is repeated.

Principal Results

1. Crustal deformation with regular plate subuduction (Fig.1, Fig.2)

At first we supposed main tectonic line and geological boundary distributed over the Japanese Archipelago to be the area where hardness was low. And, based on this supposition, a crustal structure model was made. We calculated crustal deformation with regular plate subduction for this model by the finite element method. As a result, some areas where stress was concentrated were recognized. These areas are almost equal to the area where meters above the sea level geographically. In other words it is thought that these areas were formed by a structural geology factor with influence of regular plate subduction.

2. Crustal deformation caused in connection with a trench type great earthquake (Fig.3(a))

Crustal deformation caused in connection with a great earthquake which occurs in a plate subuduction area was calculated by finite element method. Consequently, in the calculation when the trench type earthquake of M8 class occurs in offshore Tokachi, offshore Sanriku, offshore Shikoku and Hyuganada, the upheaval region appeared on the earthquake source fault, and the subsidence region spread to the land side. Especially, in offshore Shikoku, the upheaval region spread to the tip part of the Cape Muroto and Kii Peninsula.

3. Crustal deformation when regular plate subuduction and a trench type great earthquake are repeated (Fig. 3(b))

In the calculation when the subduction due to earthquake source fault continued for 100 years, the subsidence region spread in all areas. In offshore Shikoku, the upheaval reaches land by calculation when subduction for 100 years and a trench type great earthquake are repeated. In other areas, although the seabed on earthquake source fault upheaves, the upheaval does not reach to the land.

Future Developments

We want to develop a general idea of the crustal deformation simulation that we examined by this study as an interface to connect new field investigation with existing knowledge to draw up a rational field investigation plan.

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Reference

S. Abe, et.al., 2005, "Influence of plate subduction and trench type great earthquakes on crustal deformation", CRIEPI Report N04036 (in Japanese)

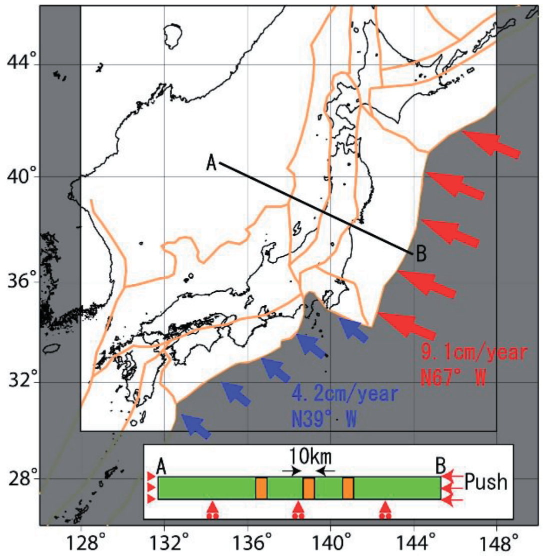

Fig.1 The modeling region that examined crustal deformation with regular plate subduction

Width of an area of the low hardness that simulated major tectonic line and geological boundary is 10km. The forced displacement equivalent to speed of a plate movement was given from the east end of model.

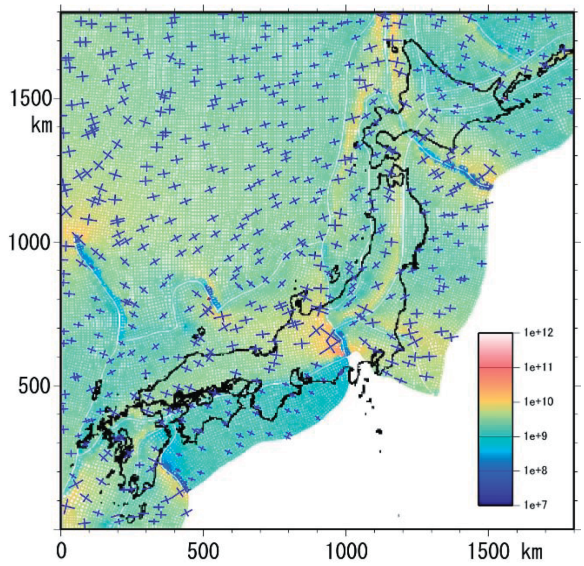

Fig.2 Maximum principal stress distribution around the Japanese Archipelago with regular plate subduction calculated by stress deformation analysis with finite element method

A warm color shows a big value. A vector shows a direction of principal stress. A major axis is a direction of maximum principal stress.

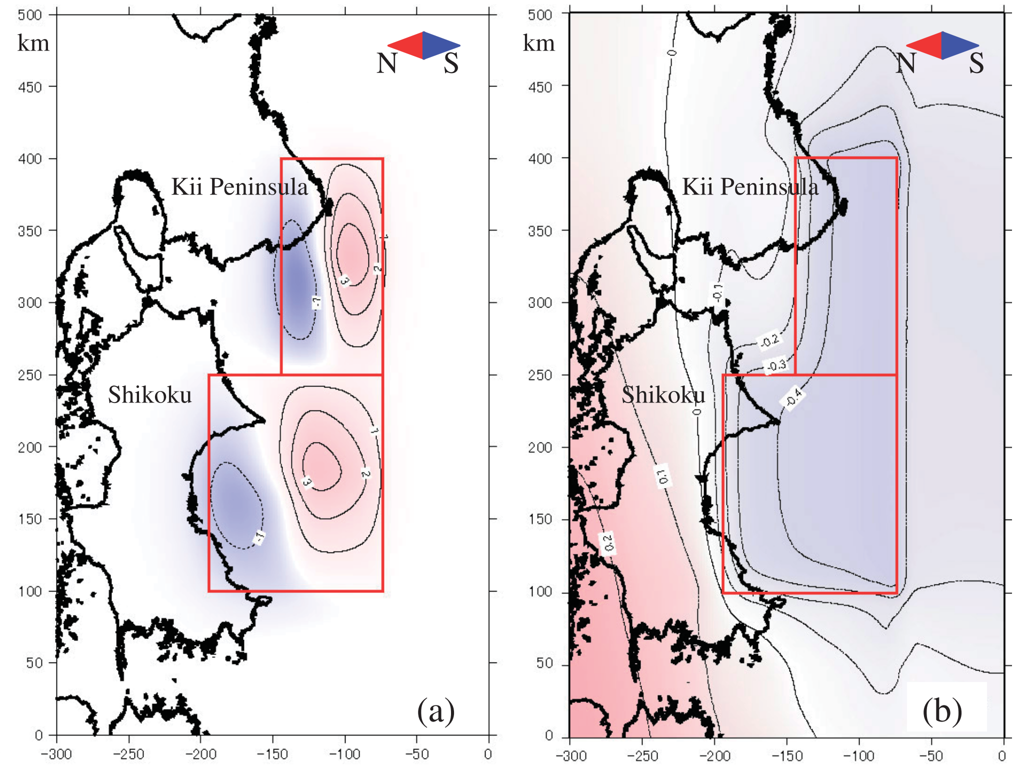

Fig.3 As a result of crustal deformation analysis in offshore Shikoku
(a) An analysis result of crustal deformation with a trench type great earthquake
(b) An analysis result of crustal deformation with plate subduction for 100 years

The position where a fault plane was reflected to the sea bottom is shown in the red frame. A red area shows an upheaval. A blue area shows subsidence.