

New System of Information
about the Tokai Earthquake based on
Pre-slip Models

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JMA's Responsibilities

The background of the slide features a stylized illustration of Mount Fuji, a snow-capped mountain, centered in the upper half. Below it, there are several layers of darker, semi-transparent mountain ranges, creating a sense of depth and a landscape. The overall color palette is light blue and green, with a gradient from light blue at the top to a darker teal at the bottom.

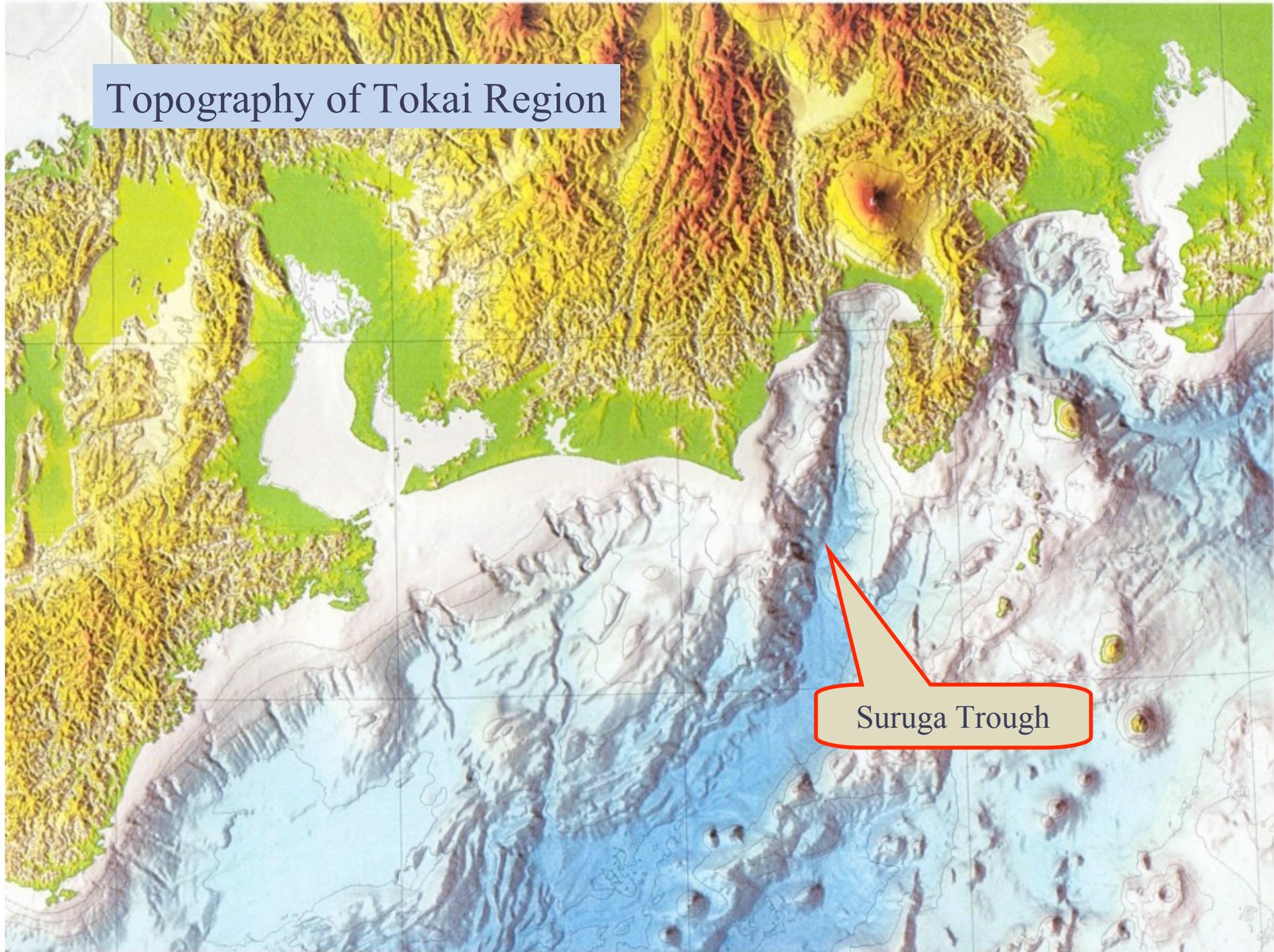
Emergency Operations

- 1 Tsunami Warning
- 2 Seismological Information
- 3 Prediction of Earthquake (Tokai Earthquake)
- 4 Volcanological Information

Research Work

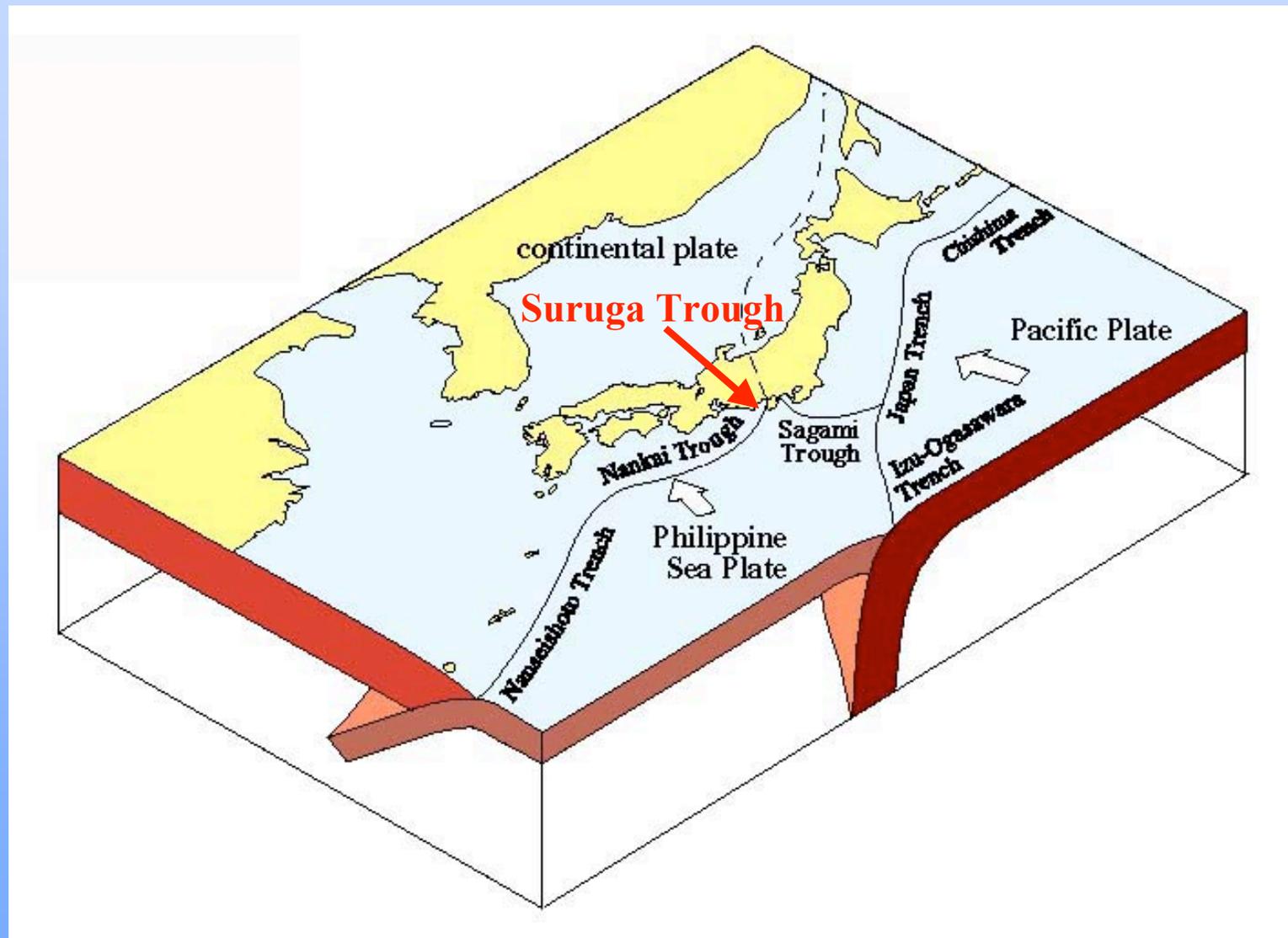
- 5 Seismological and Volcanological Bulletins

Topography of Tokai Region



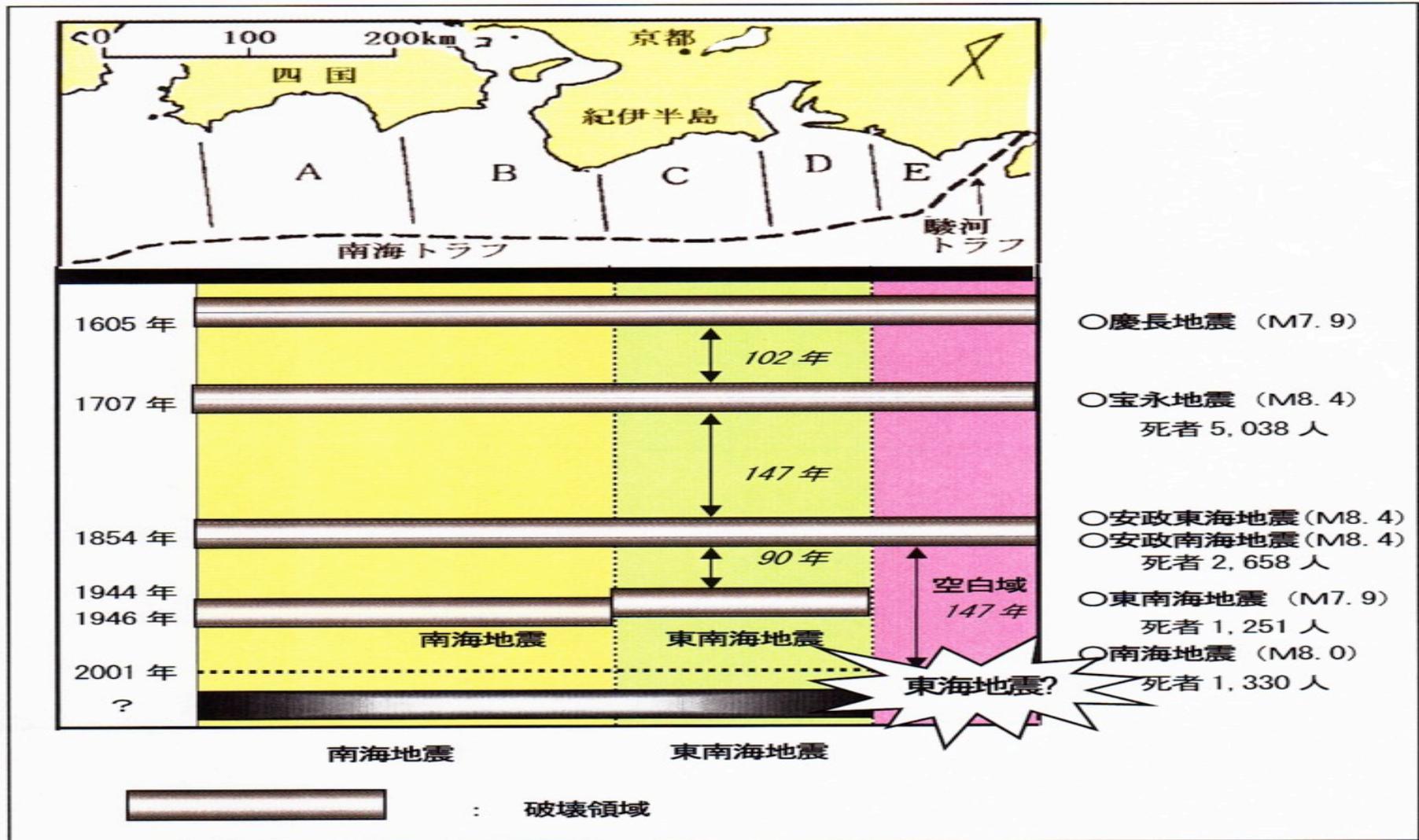
Suruga Trough

Plate Tectonics around Japan



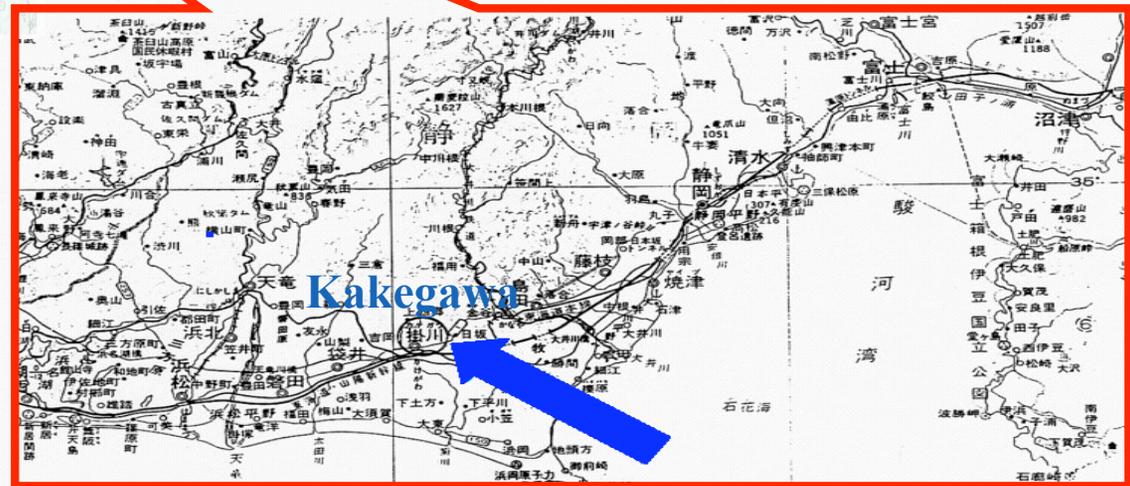
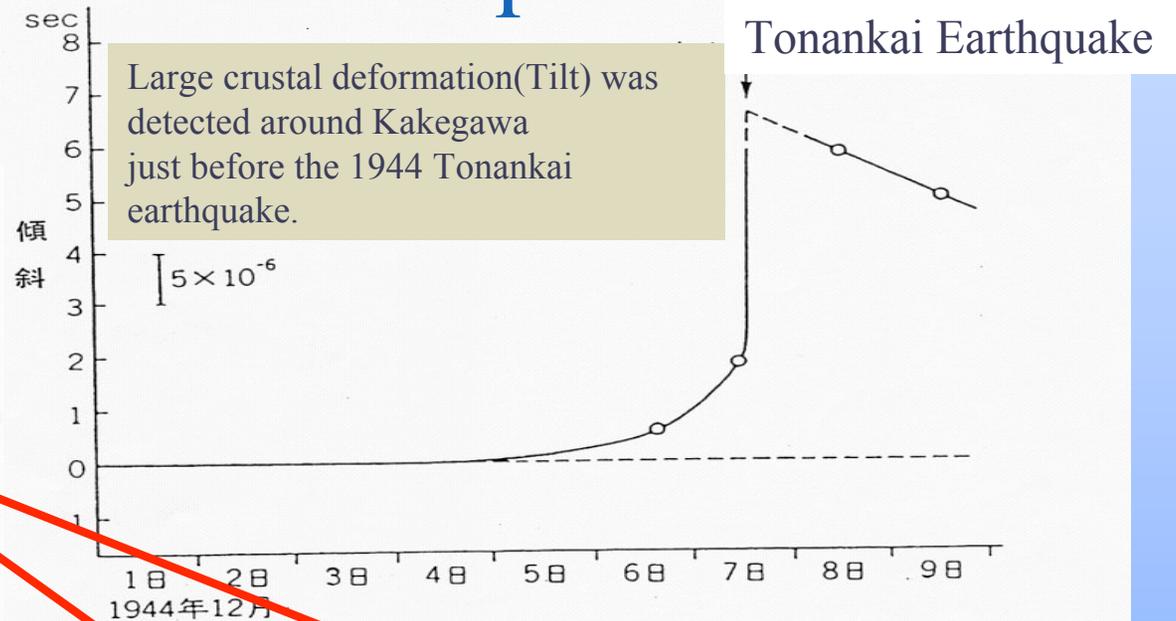
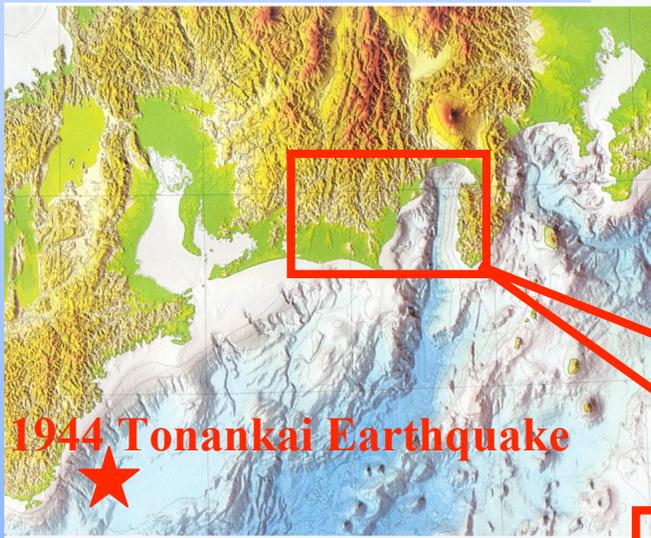
Great earthquakes have occurred in the A-E regions repeatedly with 100-150 years of time interval.

The E region was left unbroken in the last cycle. *i.e.* Tokai Earthquake



(「地震考古学」(中公新書、1992)より作成)

Precursory crustal movement for 1944 Tonankai Earthquake M7.9



Old Information system for the Tokai Earthquake Prediction

Situation

Action of
Public
Organizations

Information Issued by JMA



Establishment
of Headquarters
for Earthquake
Disaster
Prevention

Announcement of convocation of EAC

- The Earthquake Assessment Committee (EAC) convenes and determines whether or not the anomaly is a precursor of the Tokai Earthquake.

Earthquake Prediction Information

- The occurrence of the Tokai Earthquake is expected.

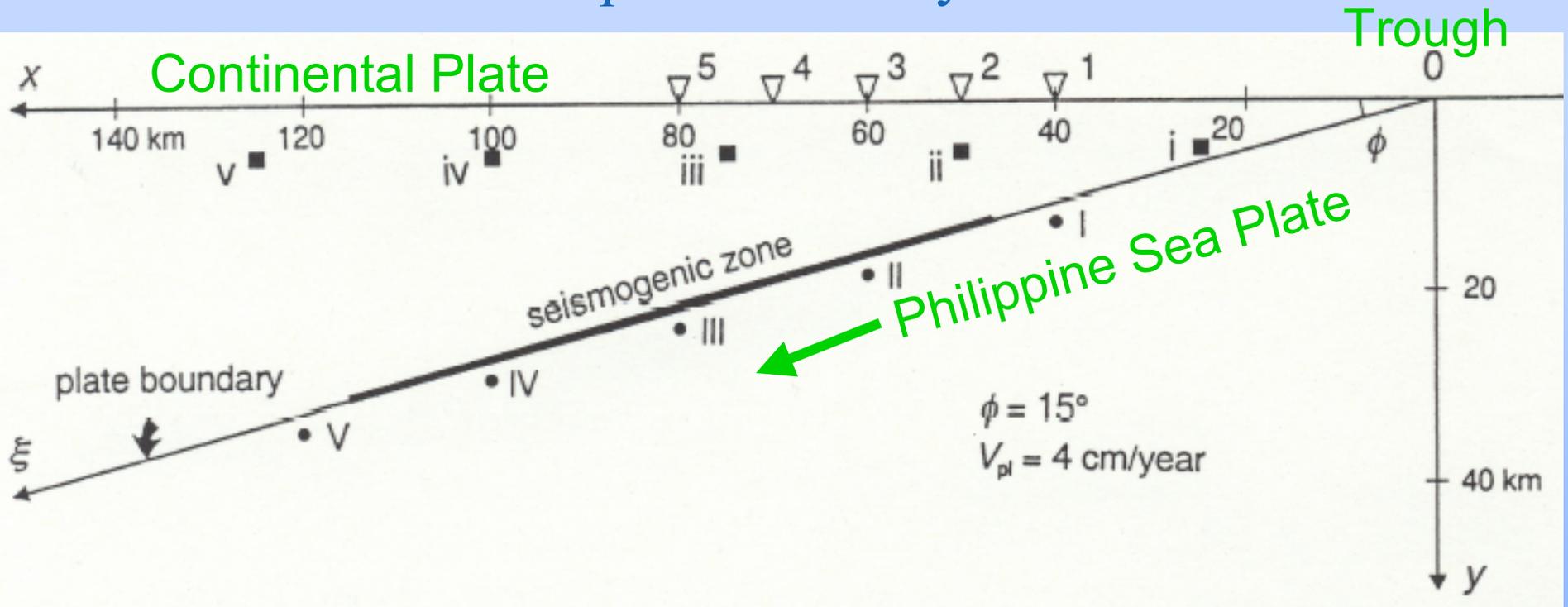
Problems under the Old Information System

- ◆ Appearance of clear precursors was presumed.
- ◆ Risk of false alarms was not fully taken into account.

→ Appropriate classification of seismic risk was needed.

Numerical Simulation

- 2D model for the plate boundary in the Tokai area -



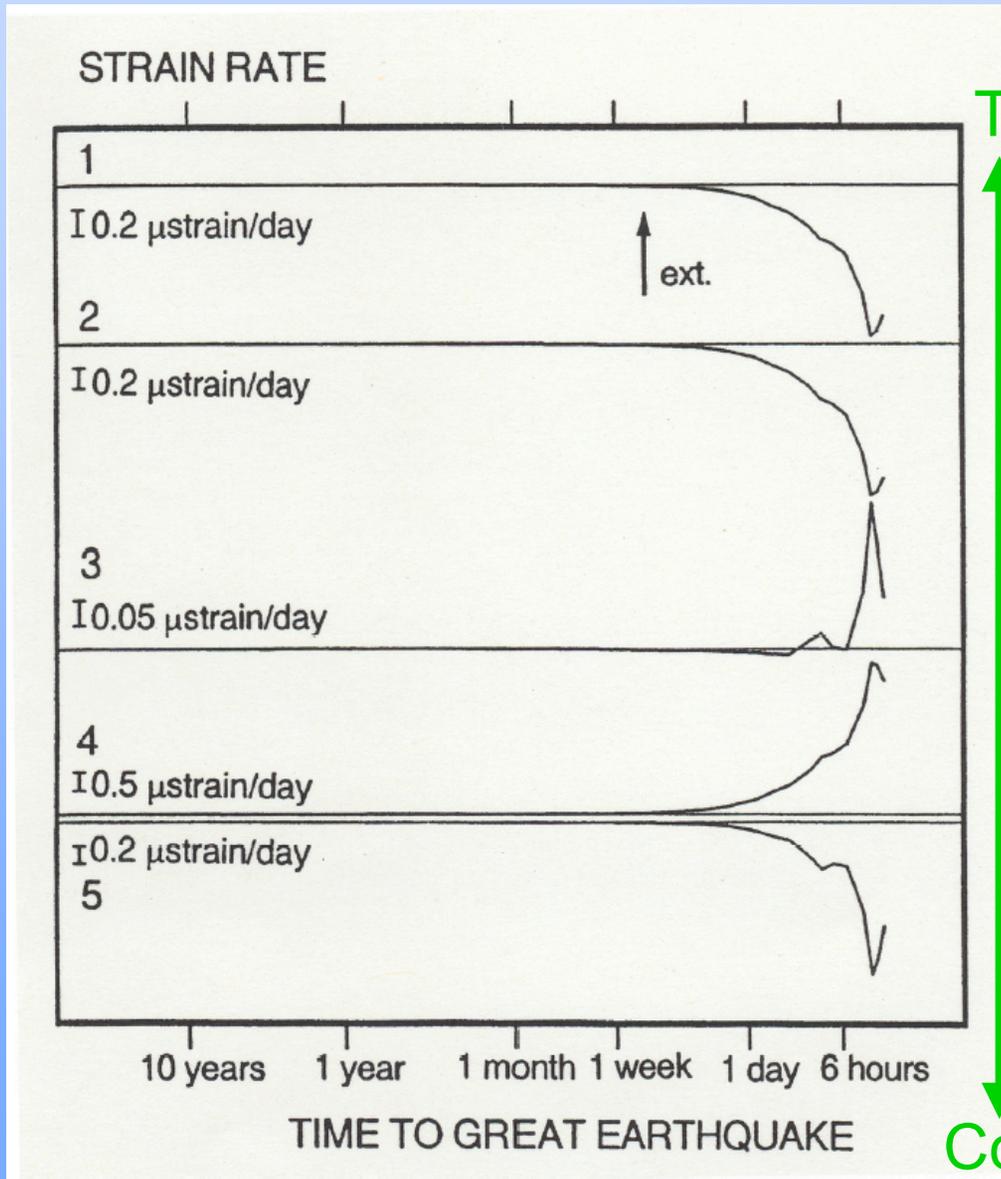
Kato and Hirasawa (1996)

- ◆ Rate- and state-dependent friction law by Ruina (1983)

Important results -> Pre-slip which was observed in lab has been re-created.

Numerical Simulation

- 2D model for the plate boundary in the Tokai area -



- ◆ Strain rate 6 hours before the earthquake is about 0.5 micro strain / day.

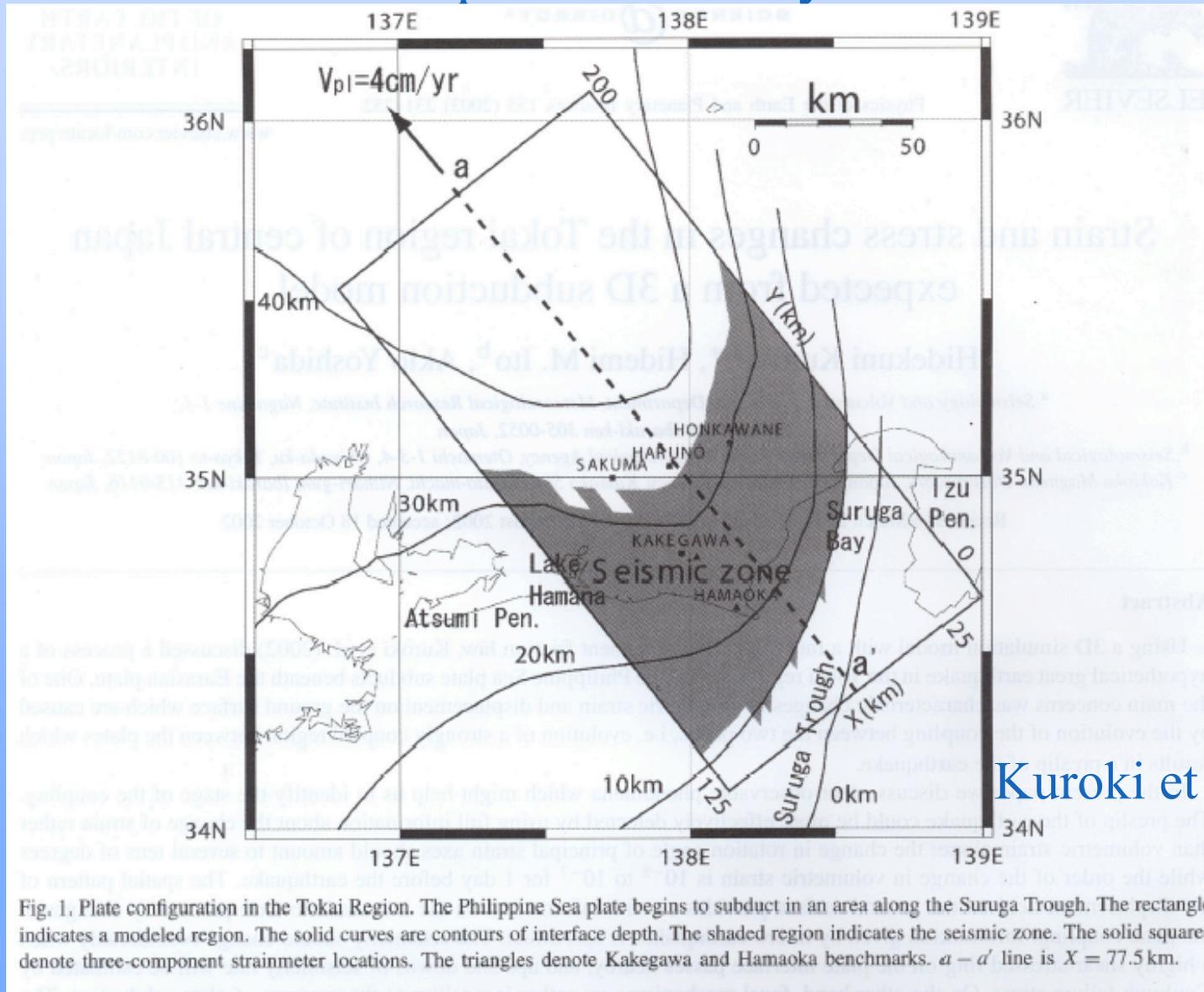
This is big enough to be detected by the network of strainmeters of JMA.

Kato and Hirasawa (1996)

Continental Plate

Numerical Simulation

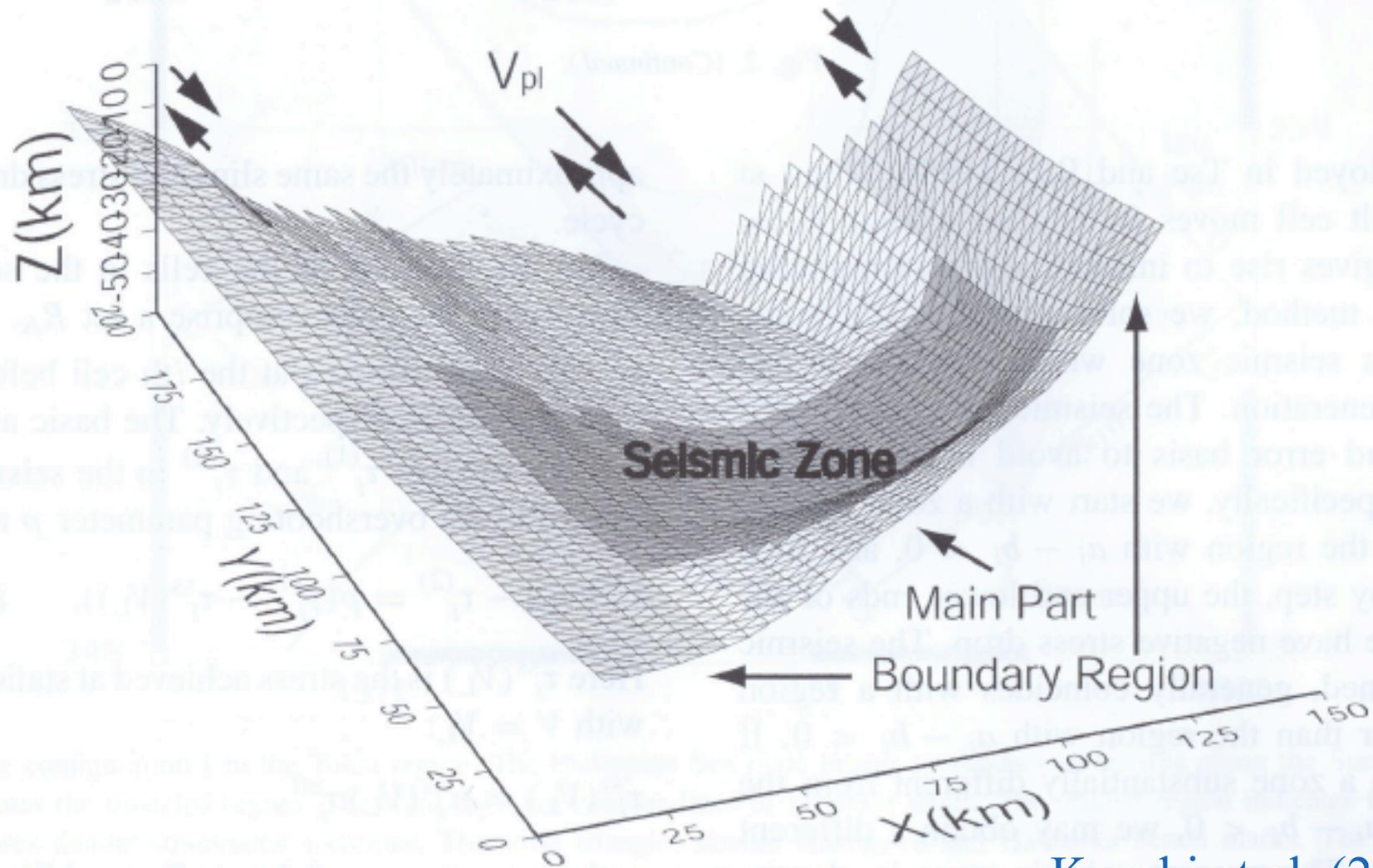
- 3D model for the plate boundary in the Tokai area -



Kuroki et al. (2003)

Numerical Simulation

- 3D model for the plate boundary in the Tokai area -

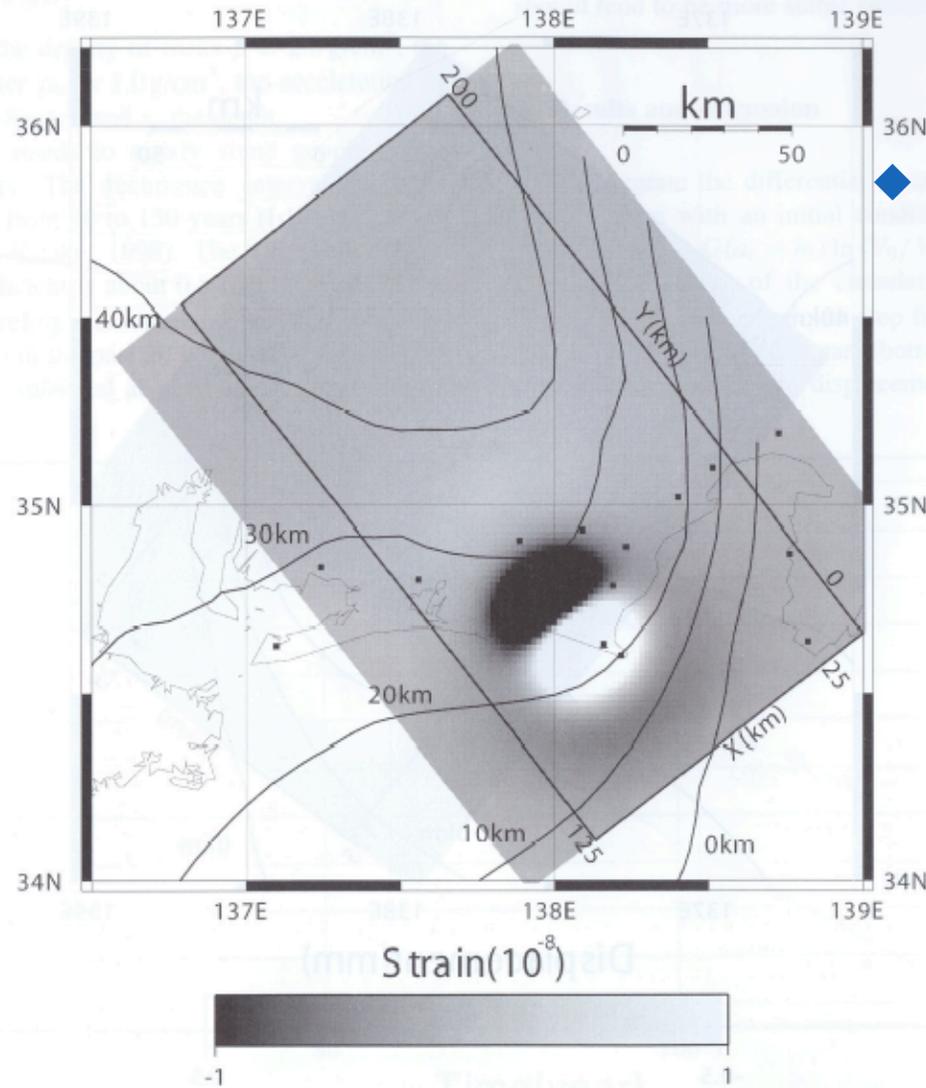


Kuroki et al. (2002)

Fig. 4. Schematic representation of the three-dimensional model. The plate interface is viewed from Suruga Bay.

Numerical Simulation

- 3D model for the plate boundary in the Tokai area -

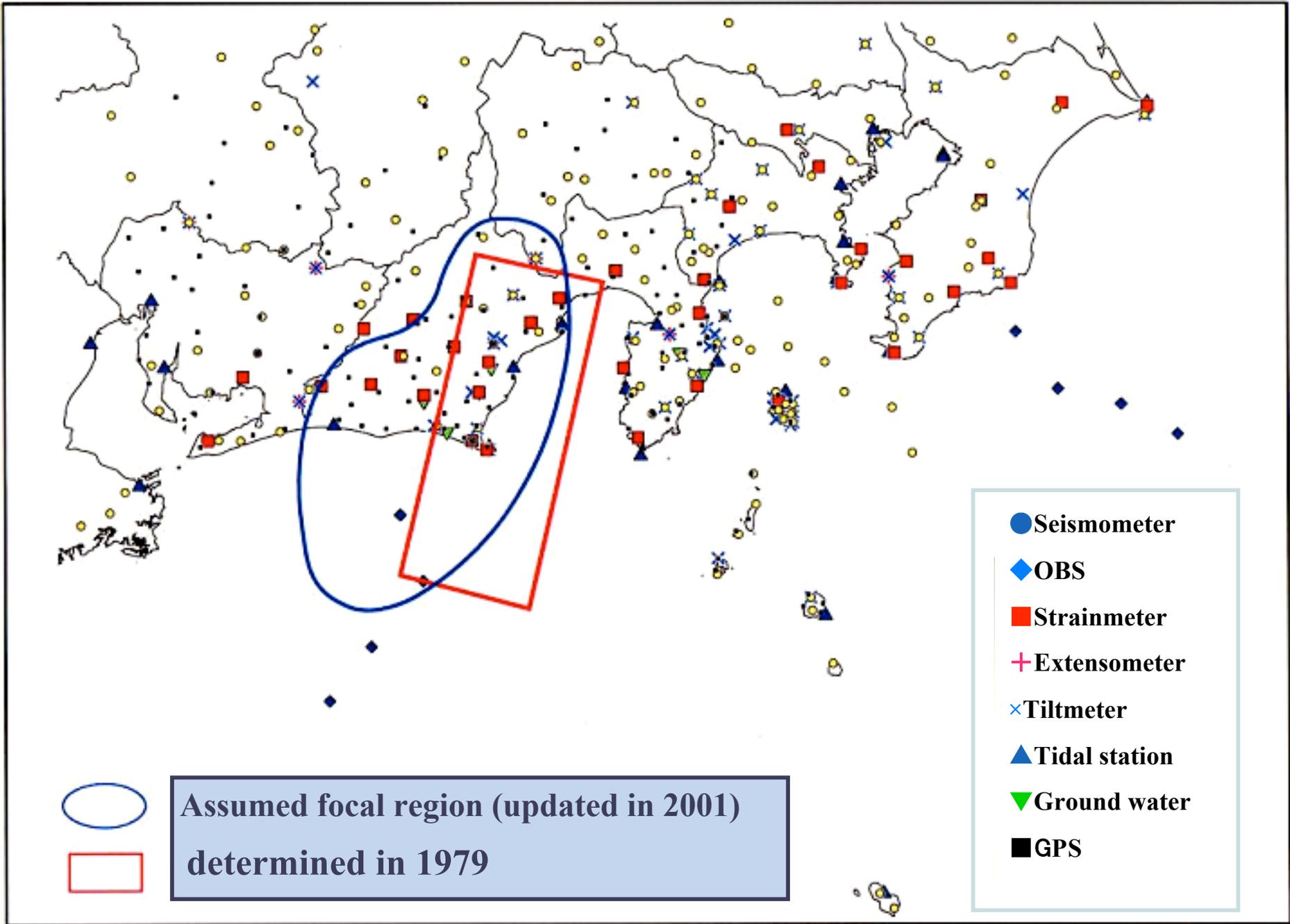


◆ Maximum extension is 8.0×10^{-8} .

Although a pre-slip is still observed, it is much smaller than that in the 2D model.

Kuroki et al. (2002)

Fig. 12. Strain change on the earth's surface for 1 day before the earthquake. The maximum extension is 8.0×10^{-8} ; the maximum compression is -4.7×10^{-8} .

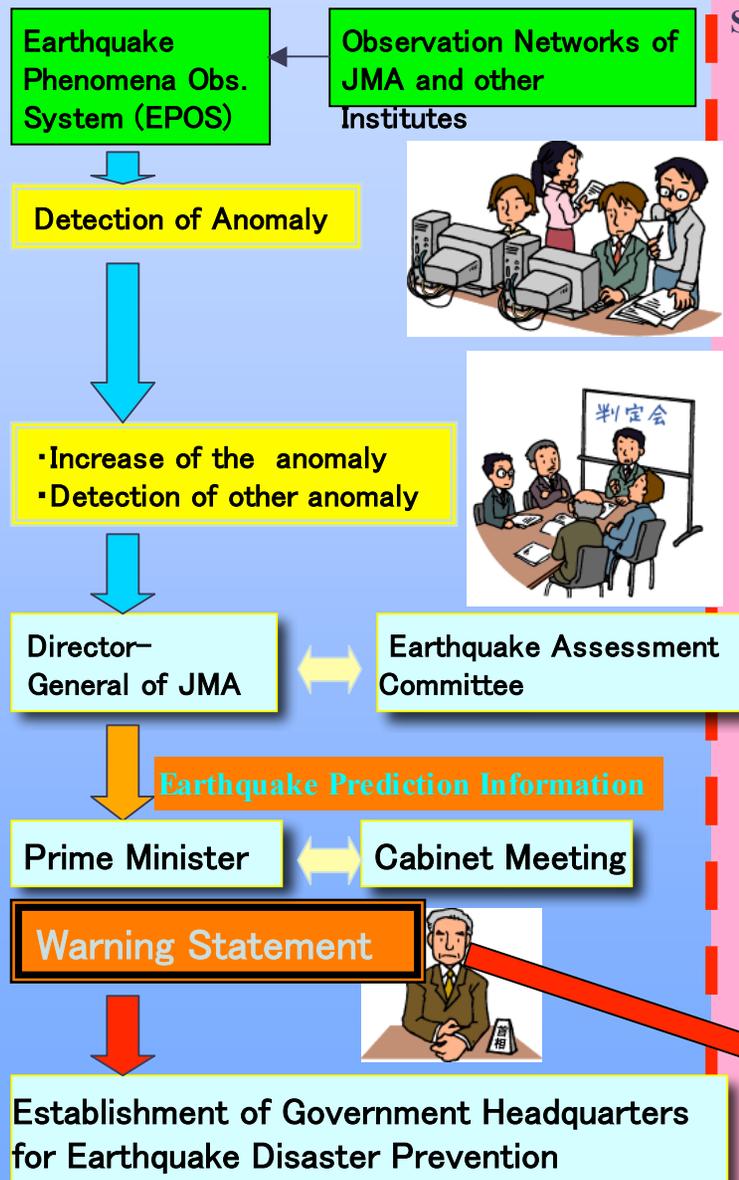


Degree of Crustal Anomalies

Anomalies in strain data are labeled as Level 1, 2 and 3.

- ◆ Level 1: Anomalies appearing once a year on the average.
- ◆ Level 2: $1.5 * \text{Level 1}$.
- ◆ Level 3: $2.0 * \text{Level 1}$.

New System of Information for the Tokai Earthquake Prediction



Situation | Action of Public Organizations



Collection of Information

Preparatory Action

Establishment of Headquarters for Earthquake Disaster Prevention

Information issued by JMA

Anomaly observed at

One station
Tokai Earthquake Report

Two stations
Tokai Earthquake Advisory



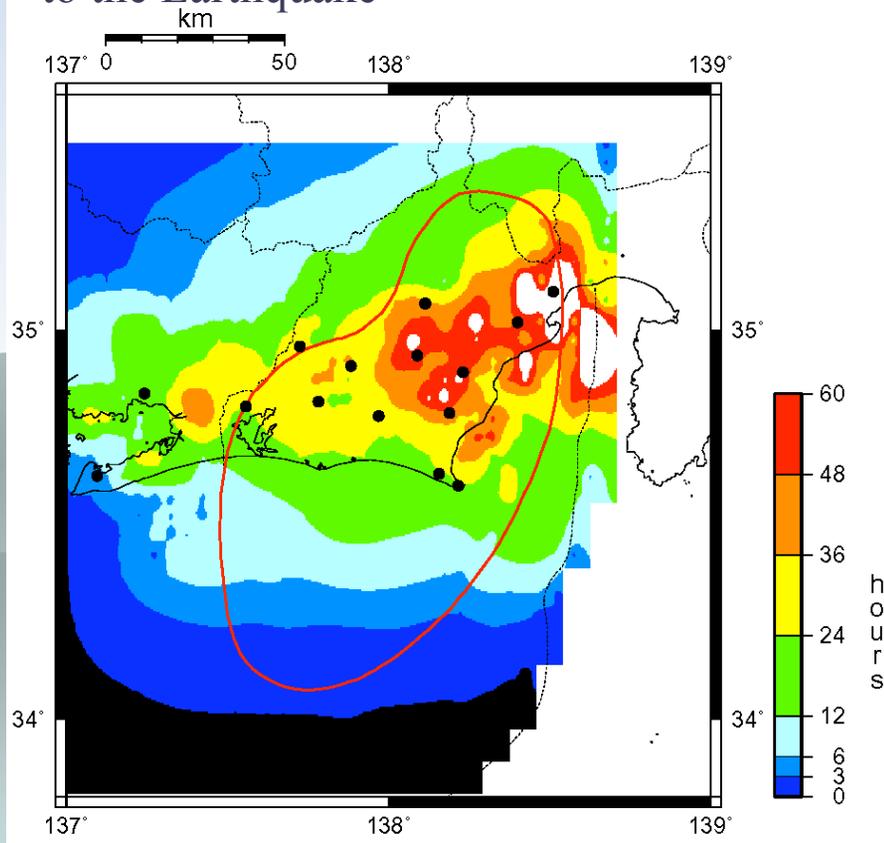
Three stations
Tokai Earthquake Warning

Time to the Tokai Earthquake

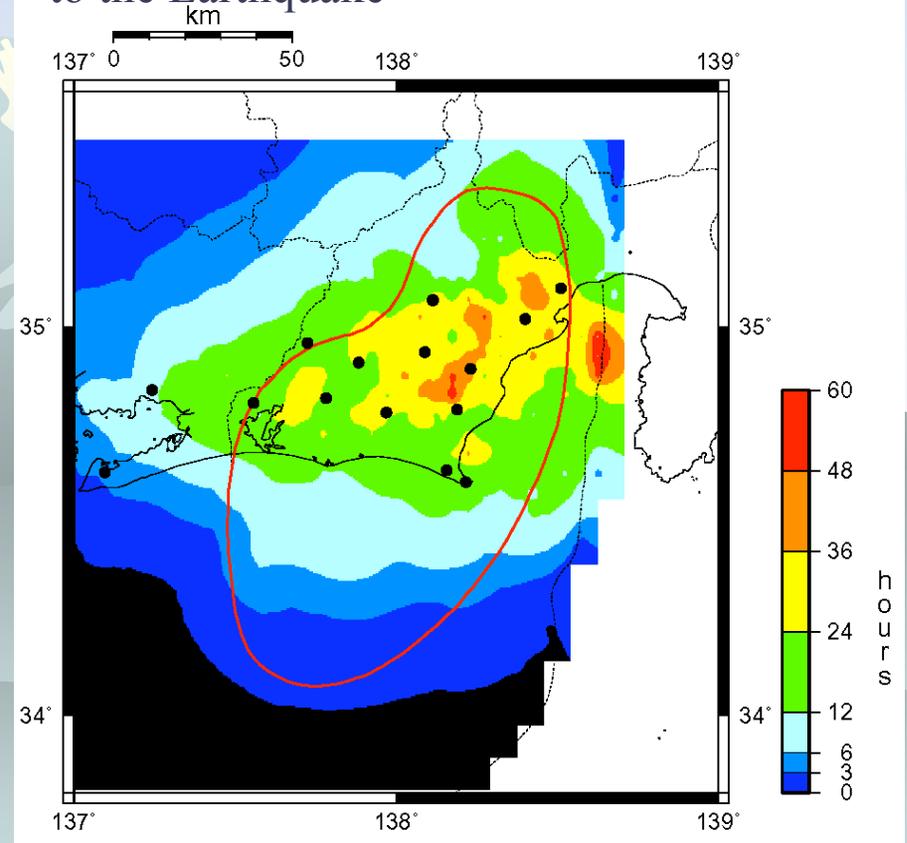
-Pre-slip start point and left time when information is issued-

Pre-slip = M6.5 --- *Tonankai Earthquake*

Left time from Tokai Earthquake Advisory to the Earthquake



Left time from Tokai Earthquake Warning to the Earthquake



*Slope of volumetric strain rate by Kato and Hirasawa (1999) is used in this case.

Time to the Tokai Earthquake

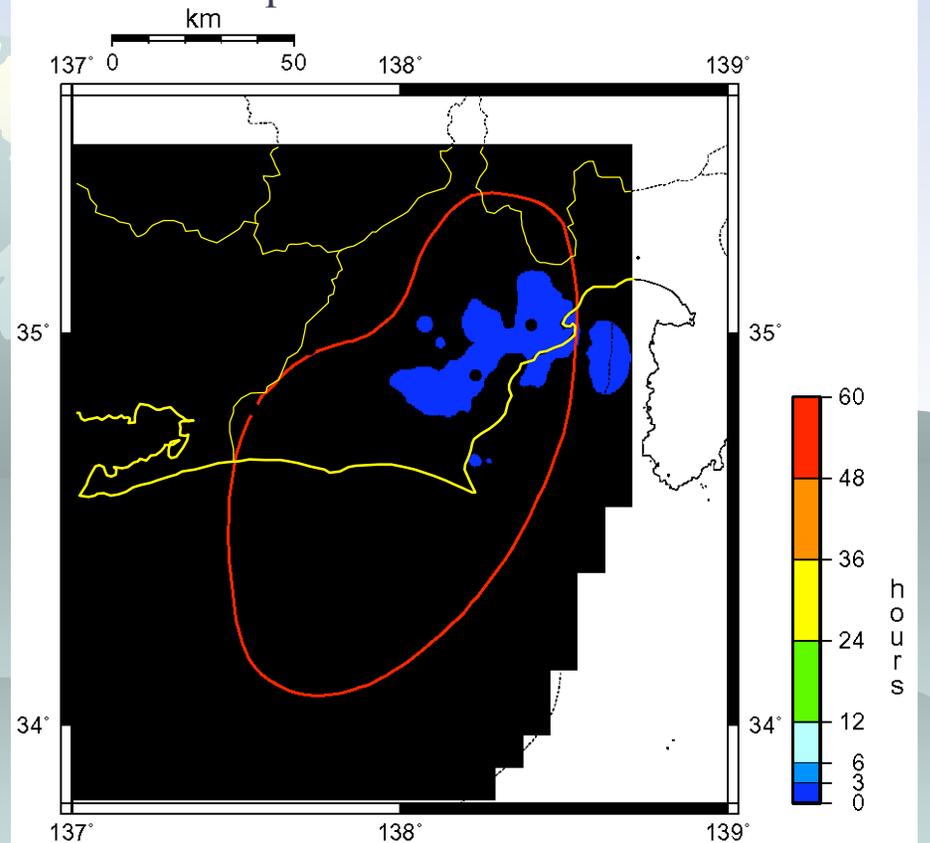
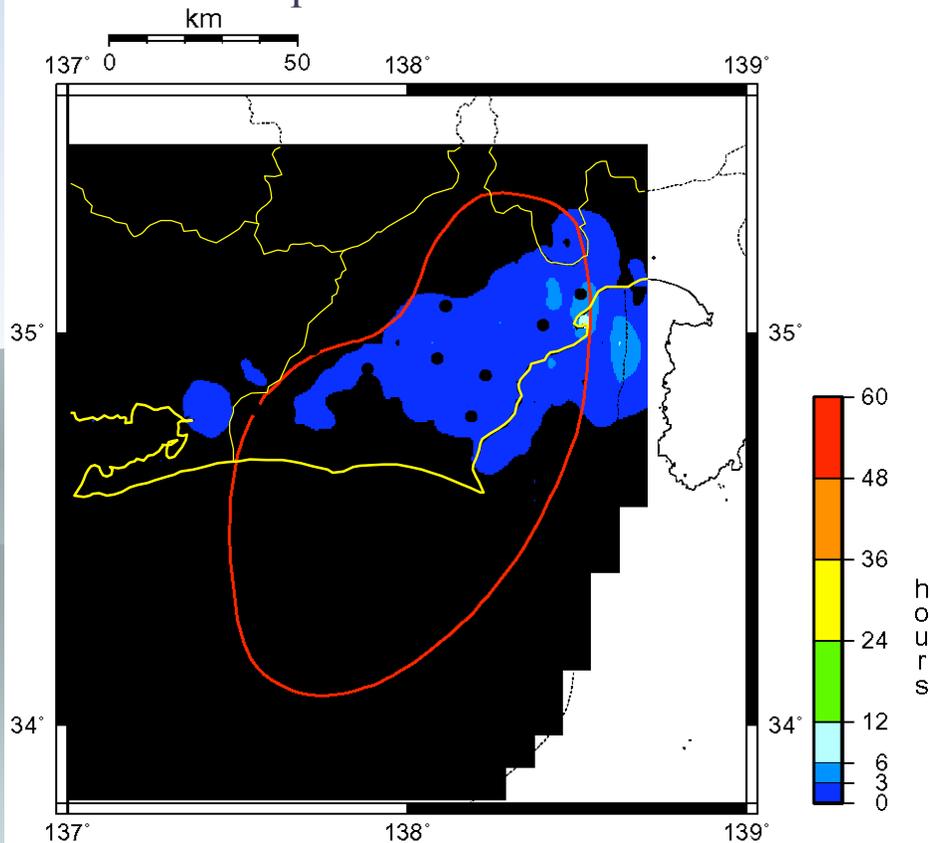
-Pre-slip start point and left time when information is issued-

Pre-slip = M5.5 --- 3D

model

Left time from Tokai Earthquake Advisory to the Earthquake

Left time from Tokai Earthquake Warning to the Earthquake



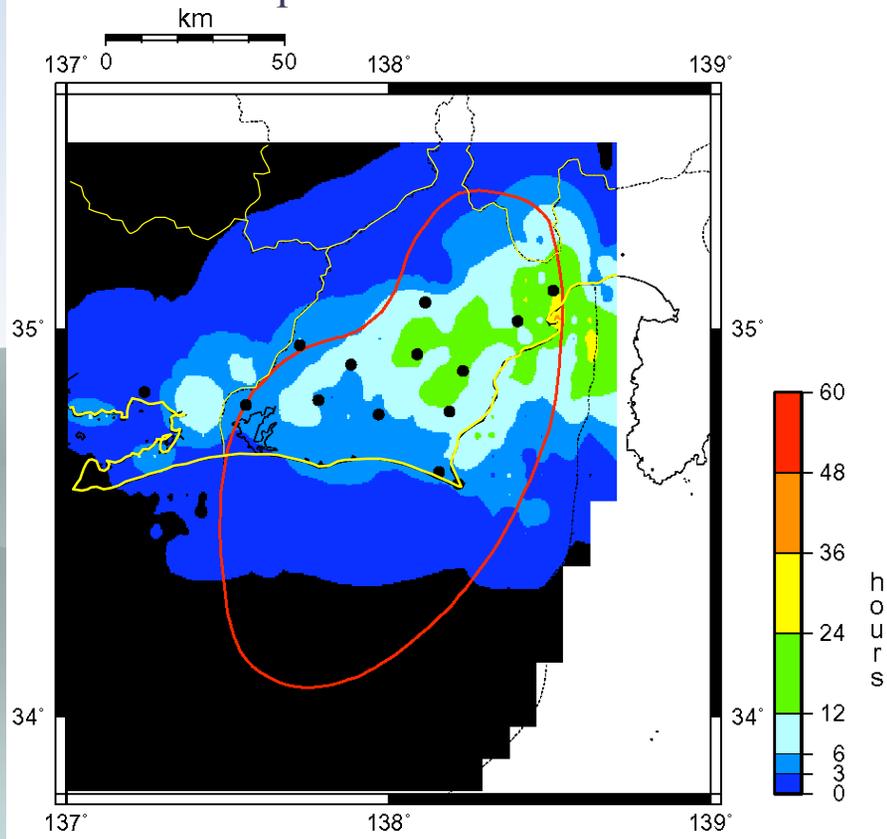
*Slope of volumetric strain rate by Kato and Hirasawa (1999) is used in this case.

Time to the Tokai Earthquake

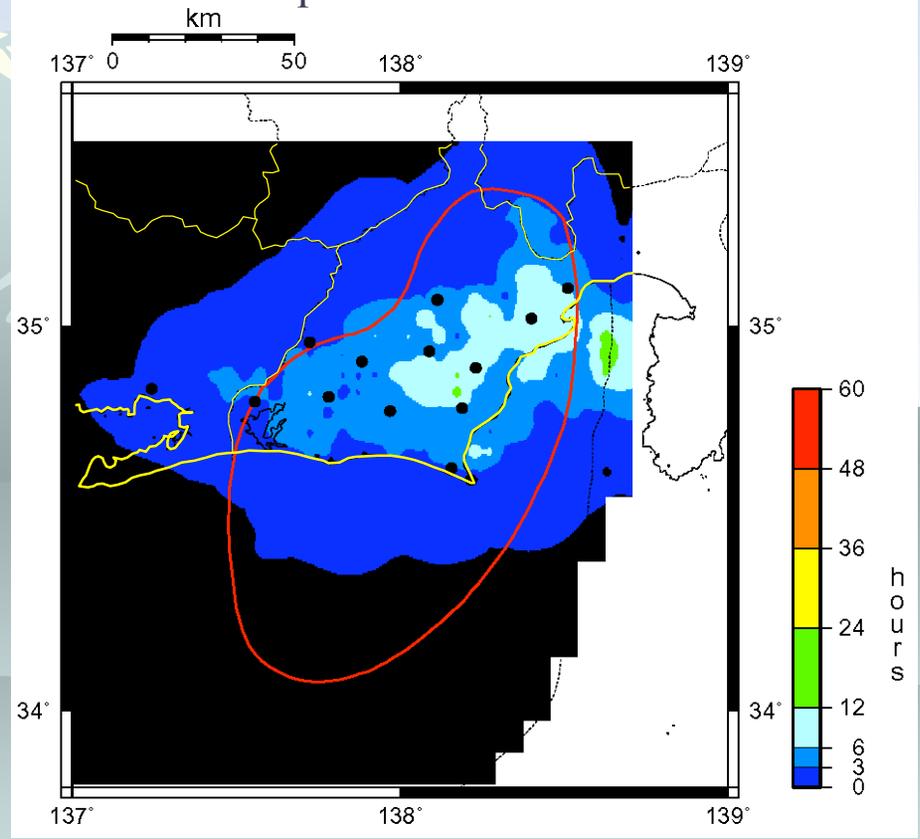
-Pre-slip start point and left time when information is issued-

Pre-slip = M6.0 --- *Probable?*

Left time from Tokai Earthquake Advisory to the Earthquake



Left time from Tokai Earthquake Warning to the Earthquake



*Slope of volumetric strain rate by Kato and Hirasawa (1999) is used in this case.

Earthquake disaster prevention is important as well as efforts to predict earthquakes

Earthquake prediction in the Tokai area

Observation → Catching Pre-slip → Issue of Information

Unexpected

The Tokai Earthquake

We can't issue information if pre-slip progress very fast or pre-slip is too small to detect.

Earthquake Preparedness

Is your house quakeproof?

Secure furniture to a wall.

Stockpile enough food and water.

Participate in local events for disaster prevention.

東海地域における地震予知
 —観測データの変化に応じた地震予知情報等の発表—

観測 → **前兆現象 (前兆すべり) の把握** → **情報発表** → **地震発生**

★前兆すべりが急激に進んだ場合
 ★前兆すべりが小規模であった場合 など、予知に関する情報を発表できない場合があります。

東海地震への備え

東海地震直前予知のための観測技術等は年々進歩していますが、現状では直前予知ができる場合と、できない場合があります。直前予知の可能性に関わらず、いつ地震が発生してもしっかり対応できるよう、日頃から備えておくことが大切です。

- **自宅等の耐震性を確認しましょう。**
 → 耐震診断を行い、自宅の耐震性を確認しましょう。
 → 耐震性に問題があった場合は、耐震改修を行いましょ。 (詳しくは市町村の建築窓口へ。)
- **家具の固定をしましょう。**
 → 阪神・淡路大震災やその後の大きな地震でも多くの人が家具の転倒等でケガをされています。家具は必ず固定しましょう。
 → 壁面に重い家具を置かないなど、家具の配置にも気を配りましょう。
- **食料・飲料水の備蓄をしましょう。**
 → 食料品は7日分程度、飲料水は最低3日分は用意しましょう。
- **地域の防災活動に参加しましょう。**
 → 日頃から地域の防災訓練に参加しましょう。
 → いざというときの避難場所や救出救助活動について家族や地域で話し合いましょ。

Leaflet by JMA, 2003

Summary

- ◆ JMA issues information on the Tokai Earthquake based on crustal anomalies.

the Lowest level: wait-and-see policy

the Advisory level: preparatory action

(disaster prevention organization only)

the Warning level: implementation of countermeasures

- ◆ Time until the occurrence of the Tokai Earthquake is estimated at about 24 hours or less from the issuance of the Advisory.
- ◆ JMA raises awareness and preparedness of the public for the possible worst case of the Tokai Earthquake striking without warning.

Future Direction

- ◆ Improvement of detectability
by using data from tiltmeters (APE system of NIED), water level monitor (AIST), ...
- ◆ Incorporation of “Earthquake Early Warning” into the new information system.