Estimation of groundwater-level anomalies associated with preseismic sliding of the anticipated Tokai earthquake

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Historical Great Earthquakes along the Nankai trough

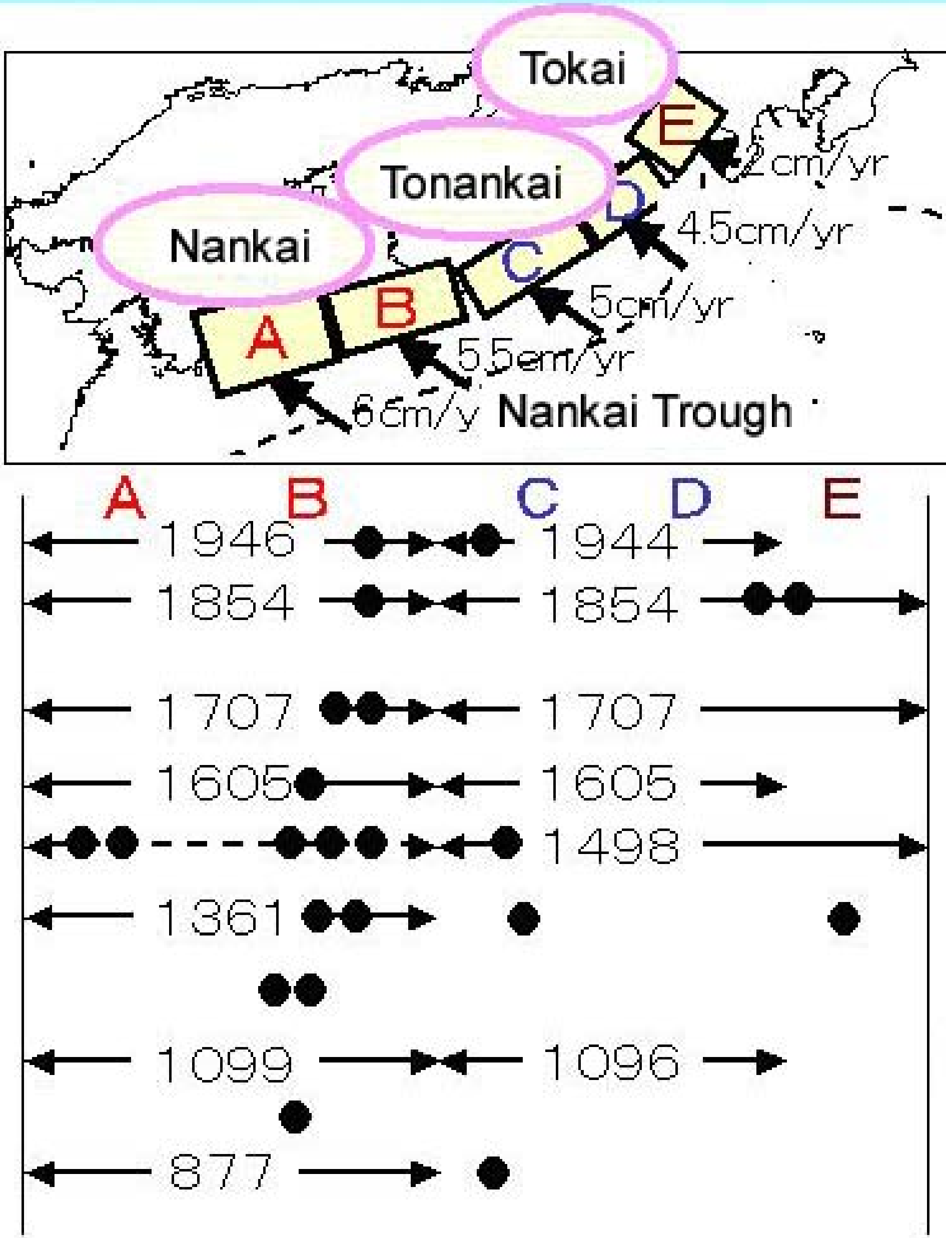


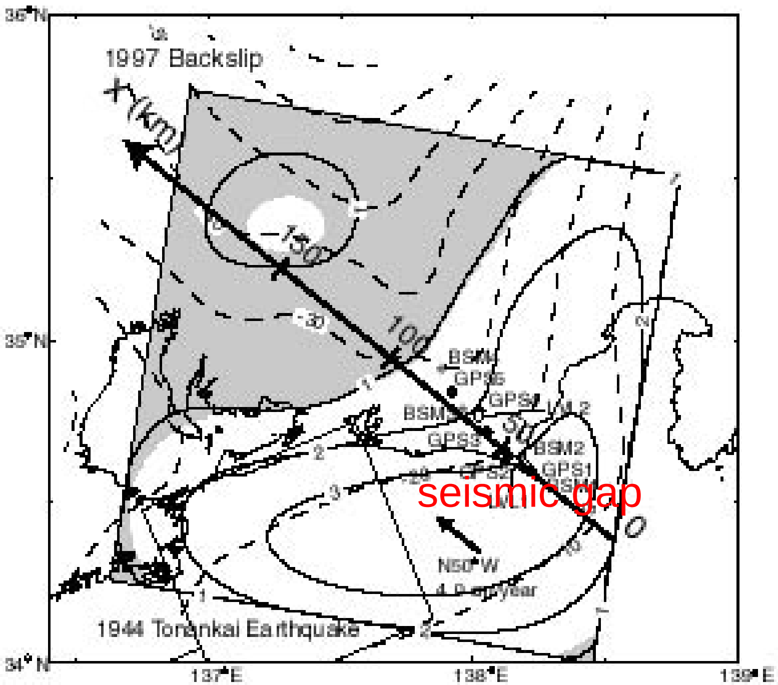
Plate velocity
2 - 6 cm/yr
(Heki and Miyazaki, 2001)

Recurrence interval
90 - 150 years

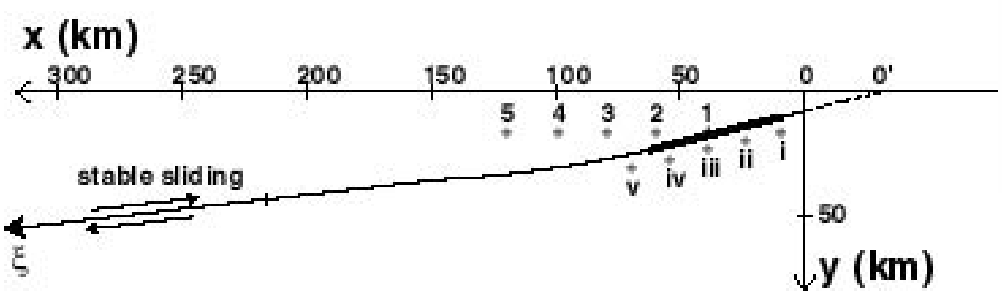
Ishibashi and Satake (1998)
from historical documents
and traces of liquefaction
at archeological sites

Kato (2002)

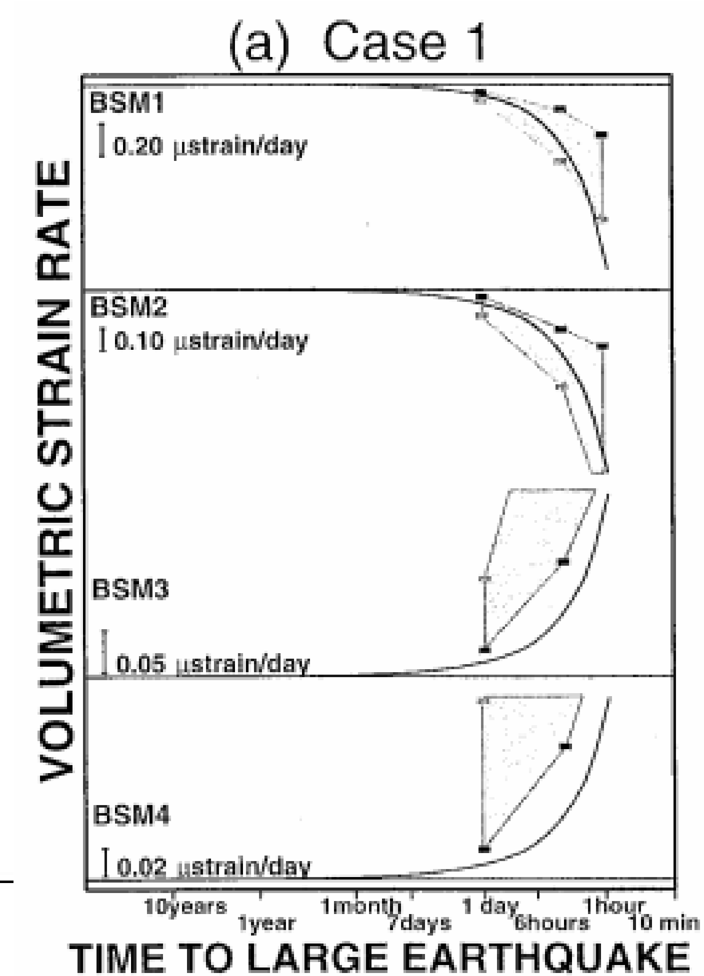
Model for seismic cycle at the Tokai seismic gap



Back slip distribution estimated from GPS data by Sagiya (1999)



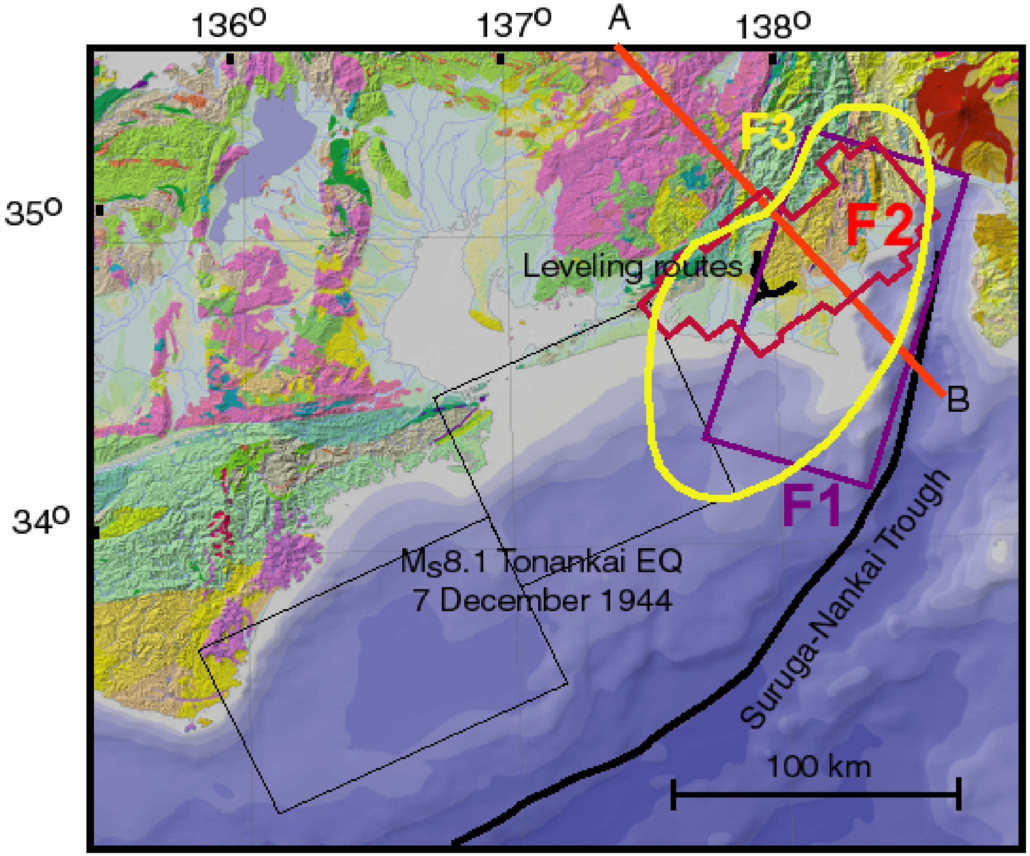
2-D model for the Tokai earthquake
Kato and Hirasawa (1999)



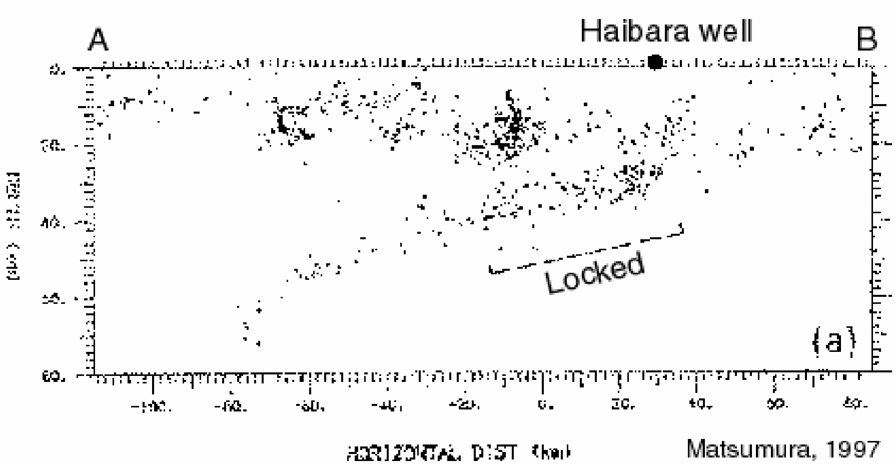
Kato and Hirasawa (1999)

Strain change is accelerated
about one day before the earthquake.

Tokai earthquake



Ishibashi, 1981; Mogi, 1985; Matsumura, 1997; Sagiya, 1998; Central Disaster Prevention Council, 2001; Editorial Group for Computer Graphics, Geology of Japanese Island, 1996



Matsumura, 1997

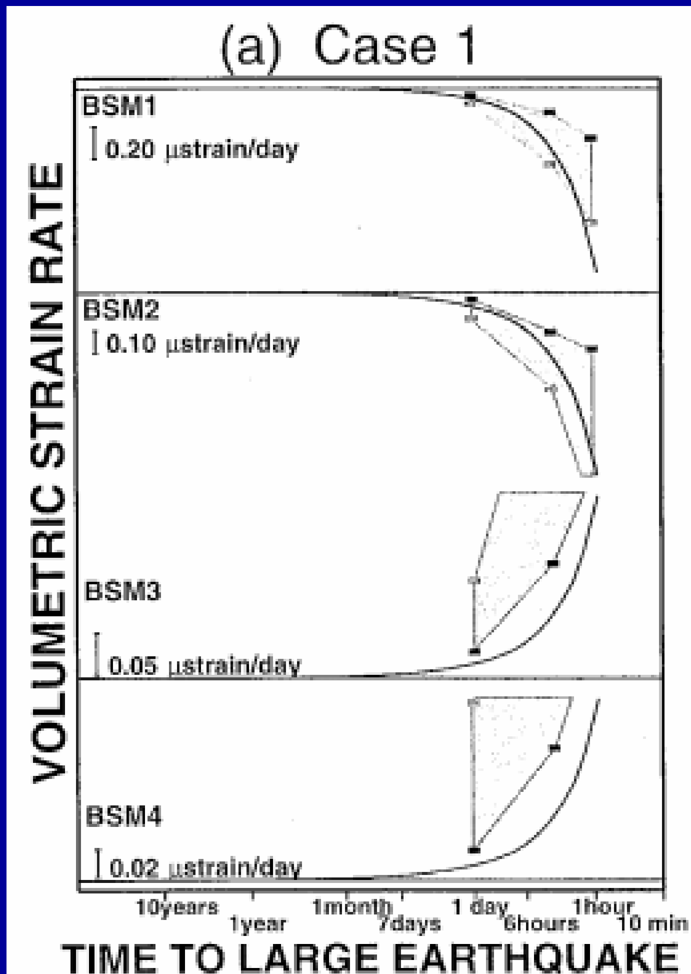
-- F3 is approved as a predicted rupture zone of the anticipated Tokai earthquake by the Central Disaster Prevention Council, Japanese Government.

-- The F3 area is estimated to be locked by using both seismological data and GPS data.

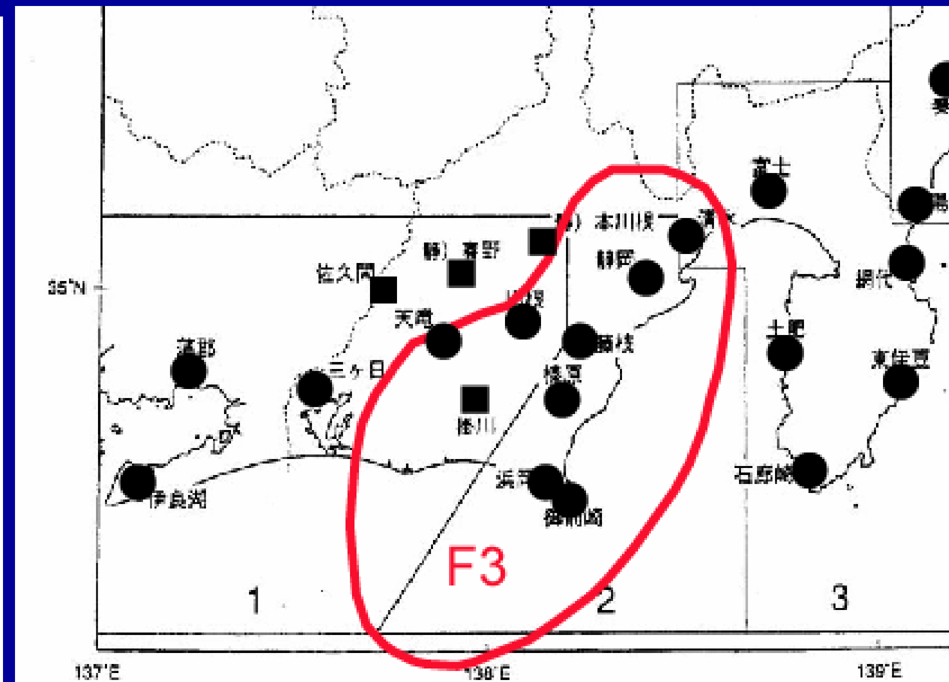
Earthquake Prediction in the Tokai Region

- Japan Meteorological Agency (JMA) is responsible for the prediction of anticipated Tokai earthquake. Director-General of JMA convenes the Earthquake Assessment Committee to predict the Tokai earthquake.
- Groundwater data observed by our institute (AIST) is reported to the Committee once a month, and a part of the data is transferred to JMA by real-time processing.

JMA borehole strainmeter network



Kato and Hirasawa (1999)



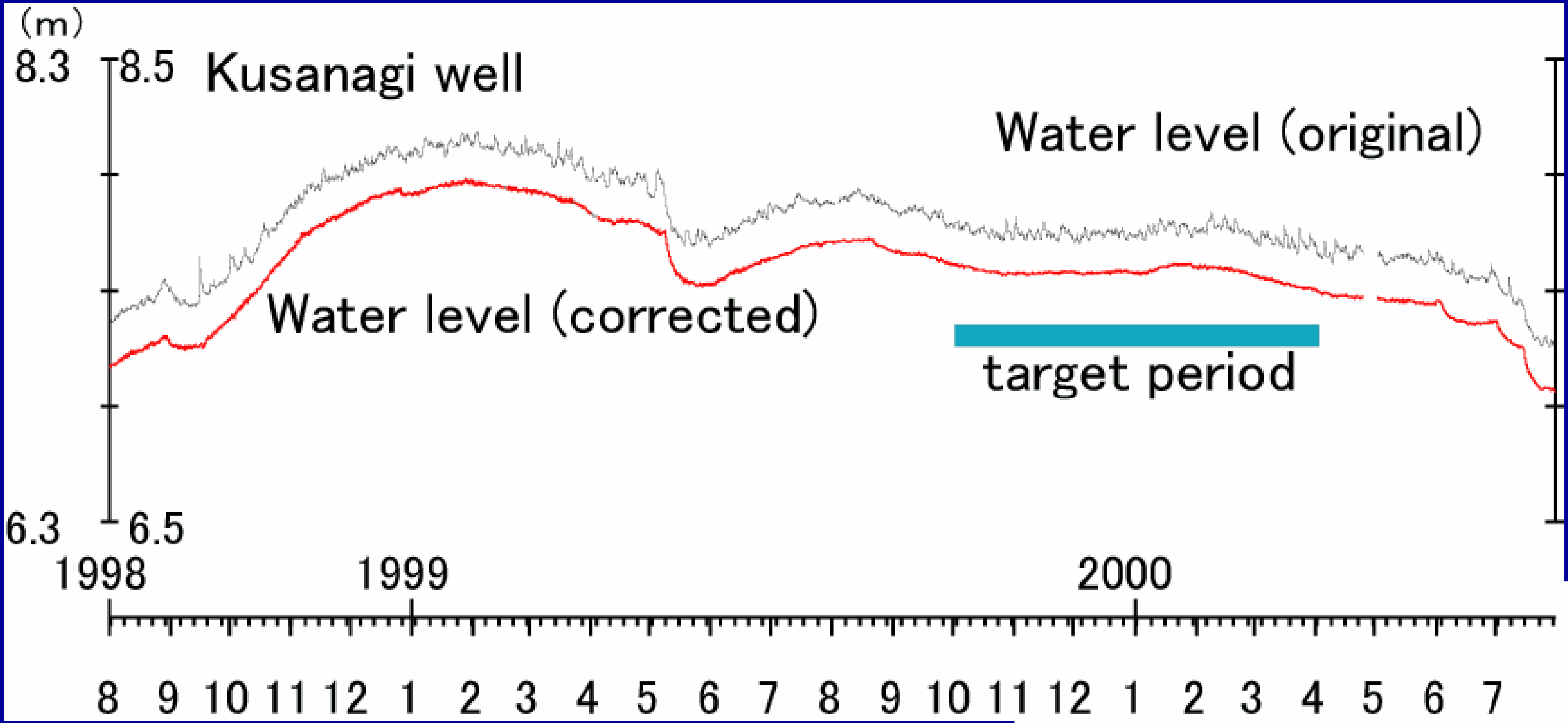
JMA (2001)

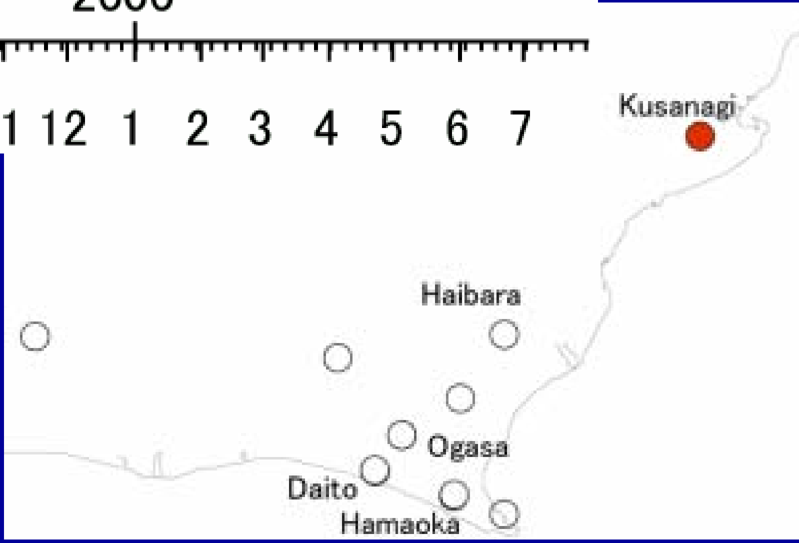
To detect preseismic sliding, JMA installed 17 borehole strainmeters (BSM) in Shizuoka Prefecture.

To detect groundwater-level changes associated with preseismic sliding:

- Kobayashi and Matsumori (1999) defined maximum difference of borehole strainmeter data with 5-minutes, 1-hour, 3-hours and 24-hours lags for each observation sites.
- We investigate max. difference of water level with 1-hour, 3-hours and 24-hours lags. Max. difference of cubic strain is estimated using tidal response of water level.
- We compare the max. difference of cubic strain estimated by water level and simulated strain change associated with preseismic sliding. We find when we can detect water-level changes associated with the preseismic sliding

Target data to detect maximum difference of water level with a lag





-- No water-level changes due to earthquakes

-- No anomalous changes due to rainfall

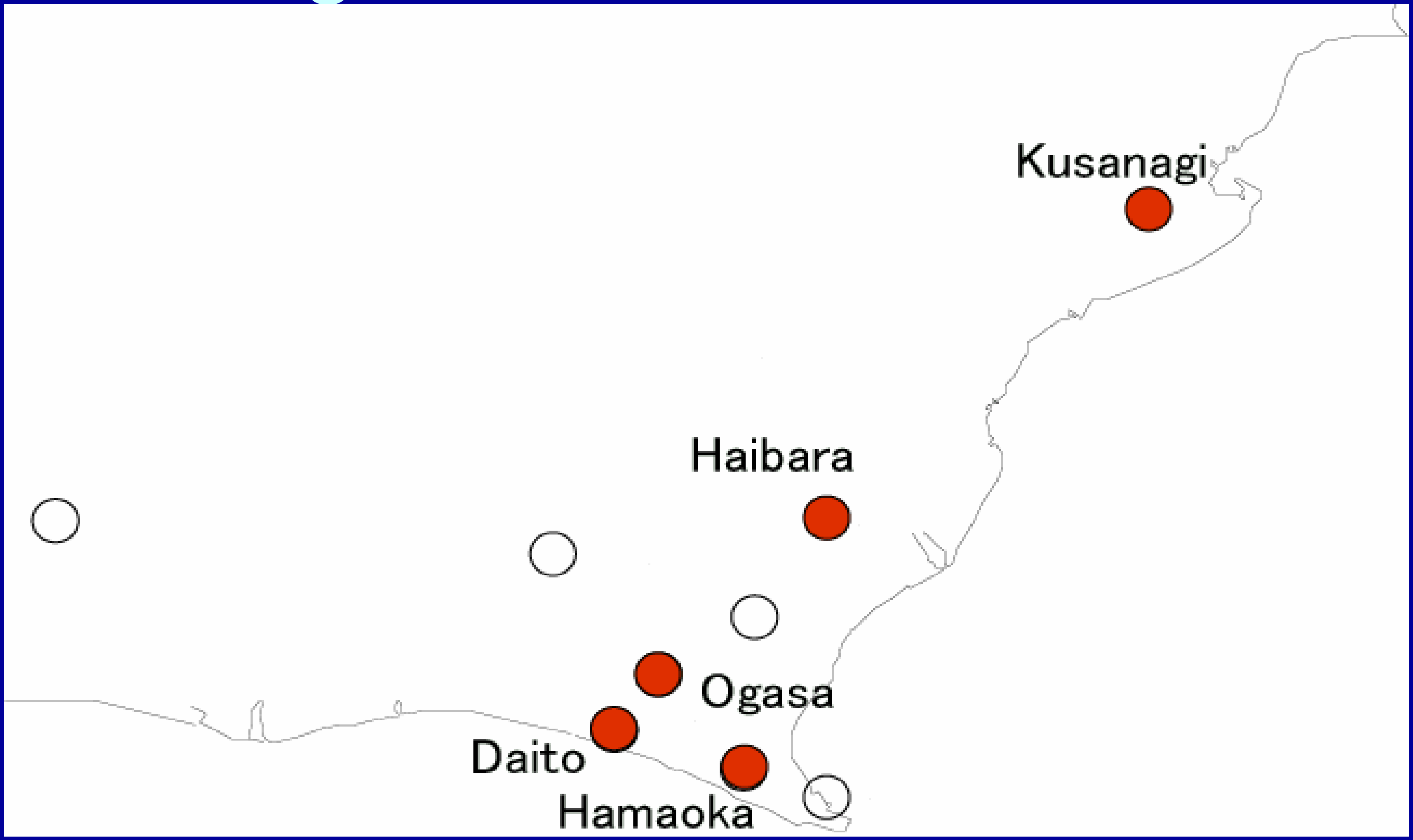
Maximum difference of water level with a lag

difference (mm)	Number
x < −6	0
−6 < x < −4	1
−4 < x < −2	99
−2 < x < 0	2150
0 < x < 2	2013
2 < x < 4	119
4 < x < 6	2
6 < x < 8	1
8 < x	0

Differences of corrected water-level data with a 1-hour lag at Kusanagi well from Oct., 1999 to March, 2000.

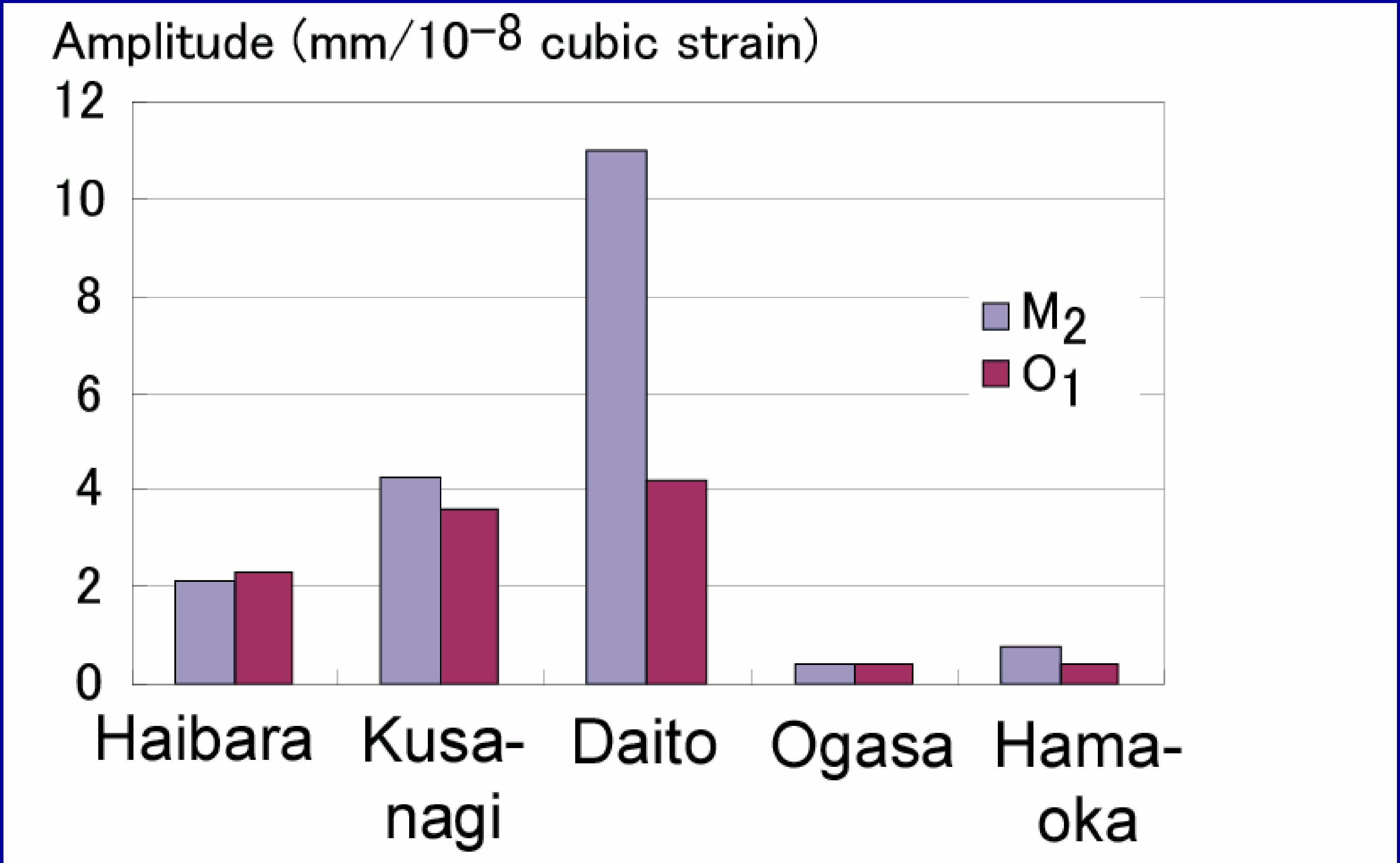
- Take differences of data with 1-hour, 3-hours and 24-hours lags.
- Get absolute maximum value for each difference.
- In this case, 6.0 mm is the maximum difference of data with a 1-hour lag (standard deviation is 1.0 mm).

Target observation sites



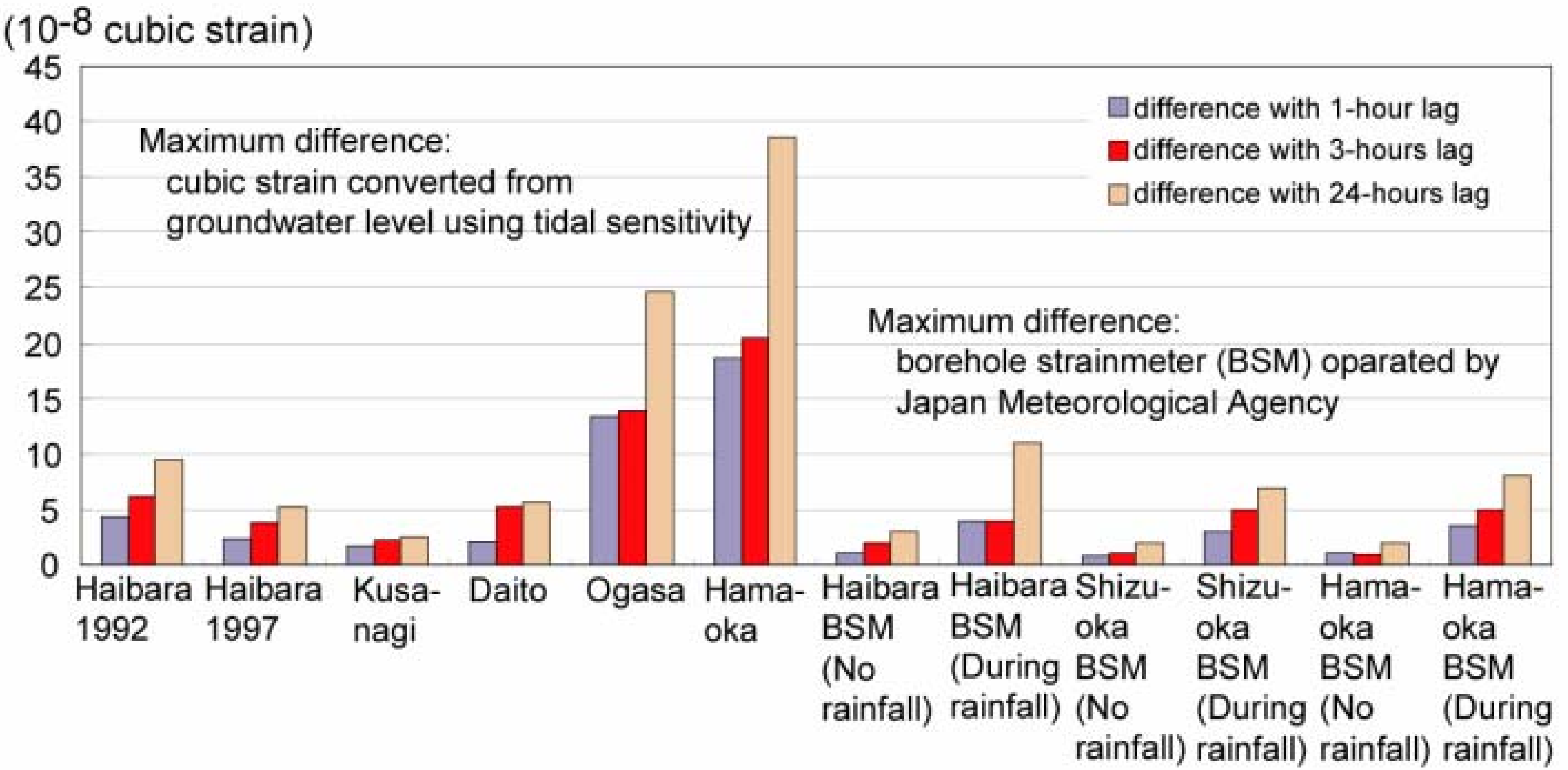
- Sites are selected whether there is an apparent response to earth tide or not.

Tidal responses

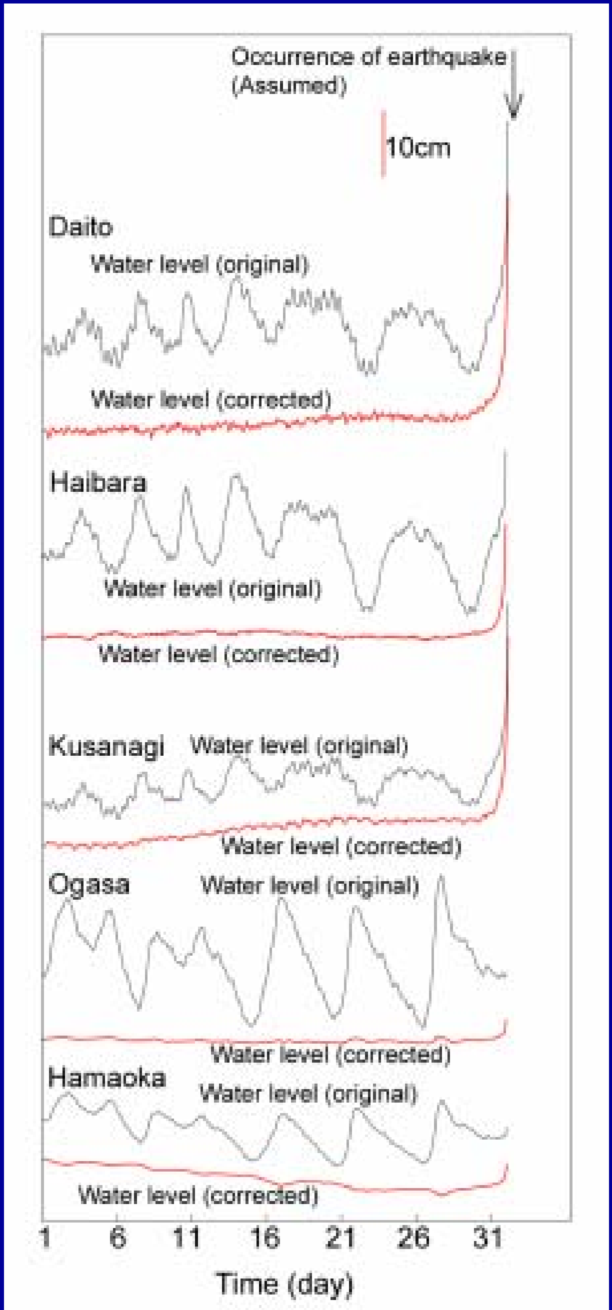


Smaller amplitude is used as a tidal response of the site.

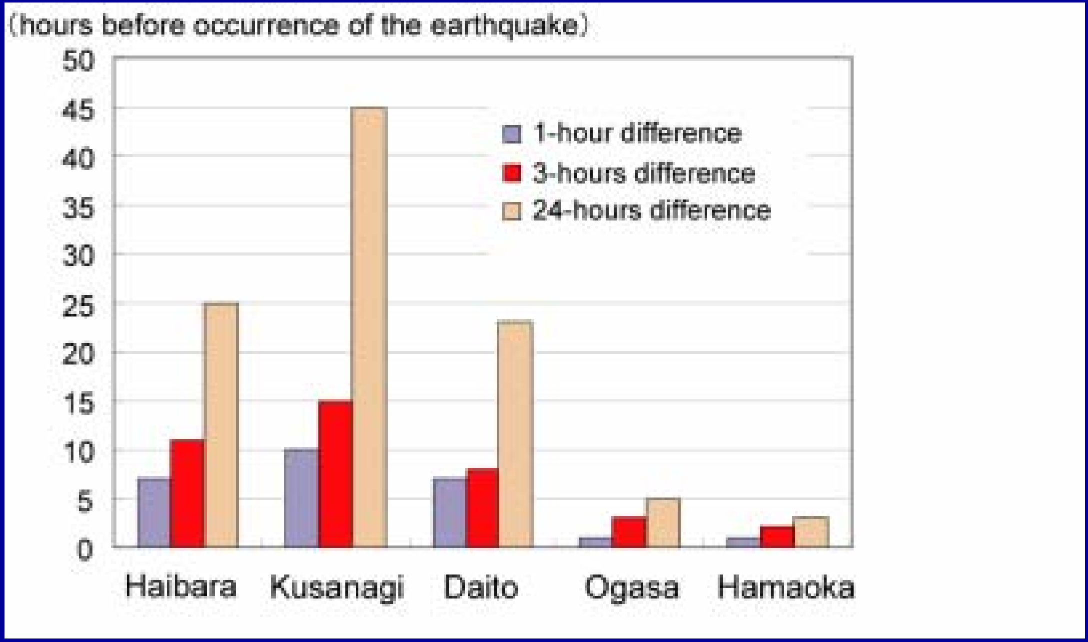
Maximum difference – comparison groundwater levels with borehole strainmeters



Detectability of preseismic sliding using groundwater levels



We assumed a M6 preseismic sliding started three days before the mainshock at 10 km depth just under each well.



We can observe anomalous groundwater level changes associated with the preseismic sliding 1 - 45 hours before the mainshock.

Conclusion

- We investigate maximum differences of water level in six wells with 1-hour, 3-hours and 24-hours lags. Max. difference of cubic strain in each well is estimated using tidal response of water level.
- We compare the max. difference of cubic strain estimated by water level and simulated strain change associated with preseismic sliding prior to the anticipated Tokai earthquake. We find we can observe anomalous groundwater-level changes associated with the preseismic sliding 1 - 45 hours before the mainshock.