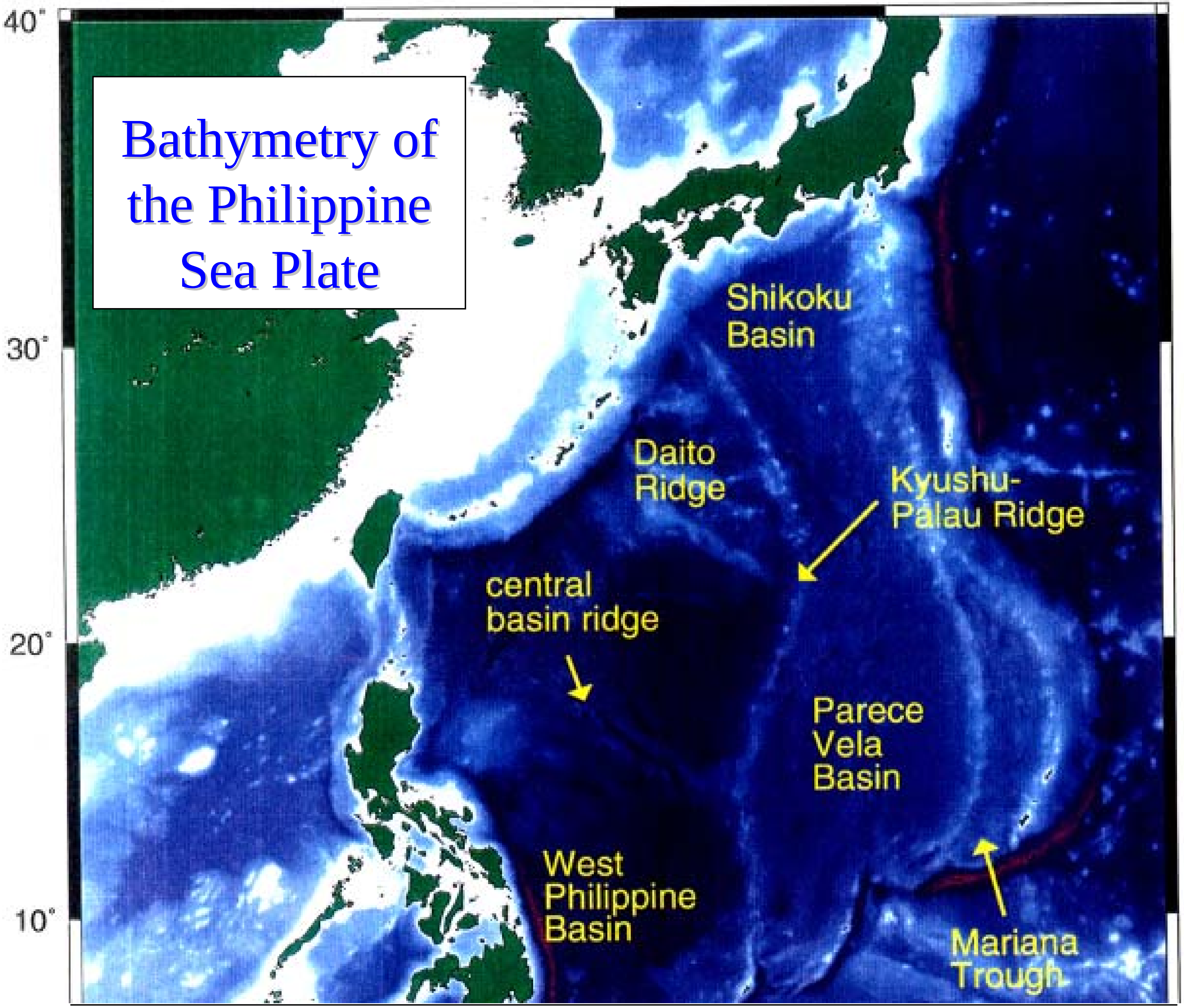
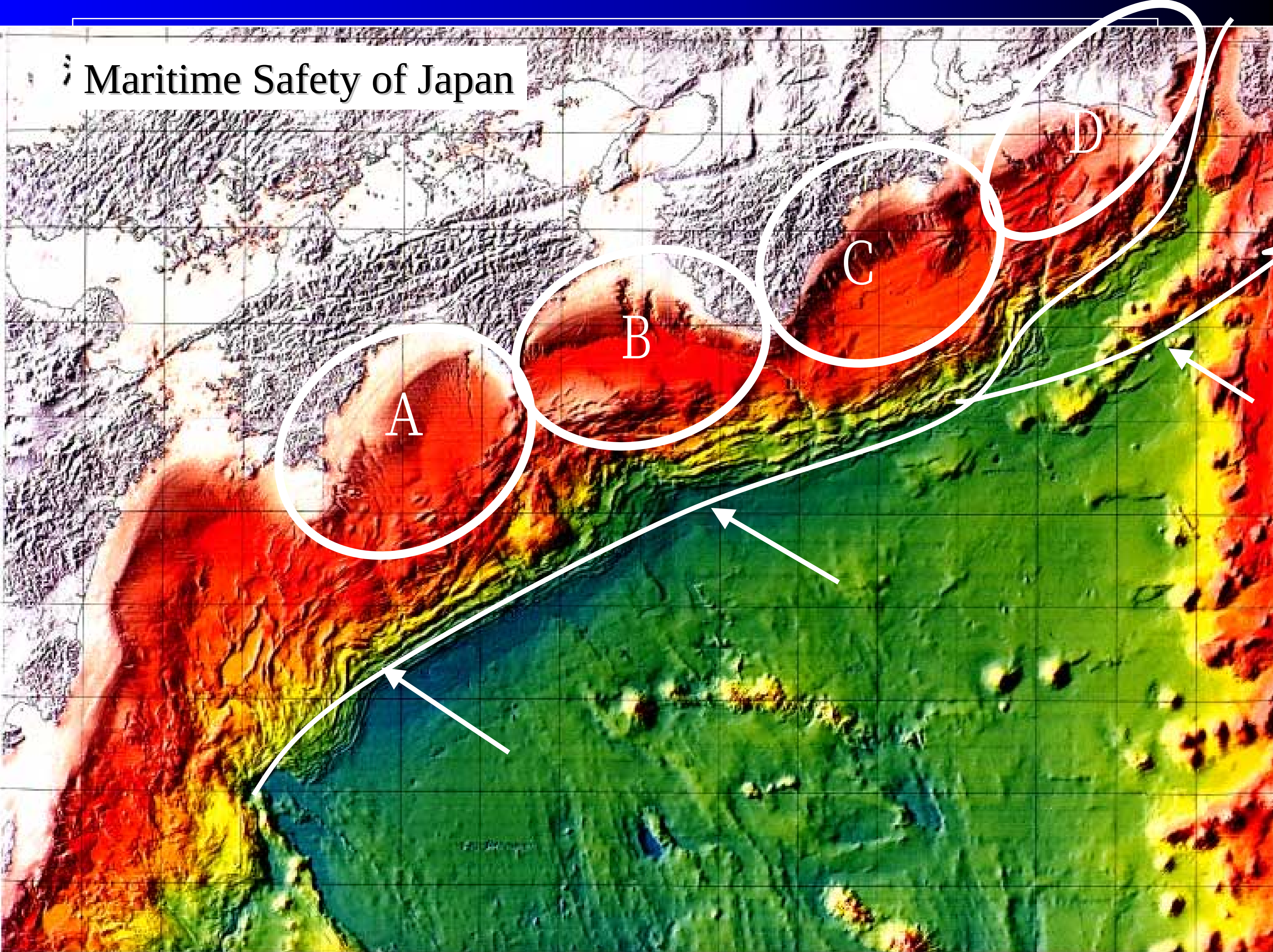
Pre- and Co-seismic Ground-Water Level Changes Associated with the Mw8.0 1946 Nankai Earthquake

- Similarities between Nankai splay faults and the 1999 Chi-chi earthquake fault

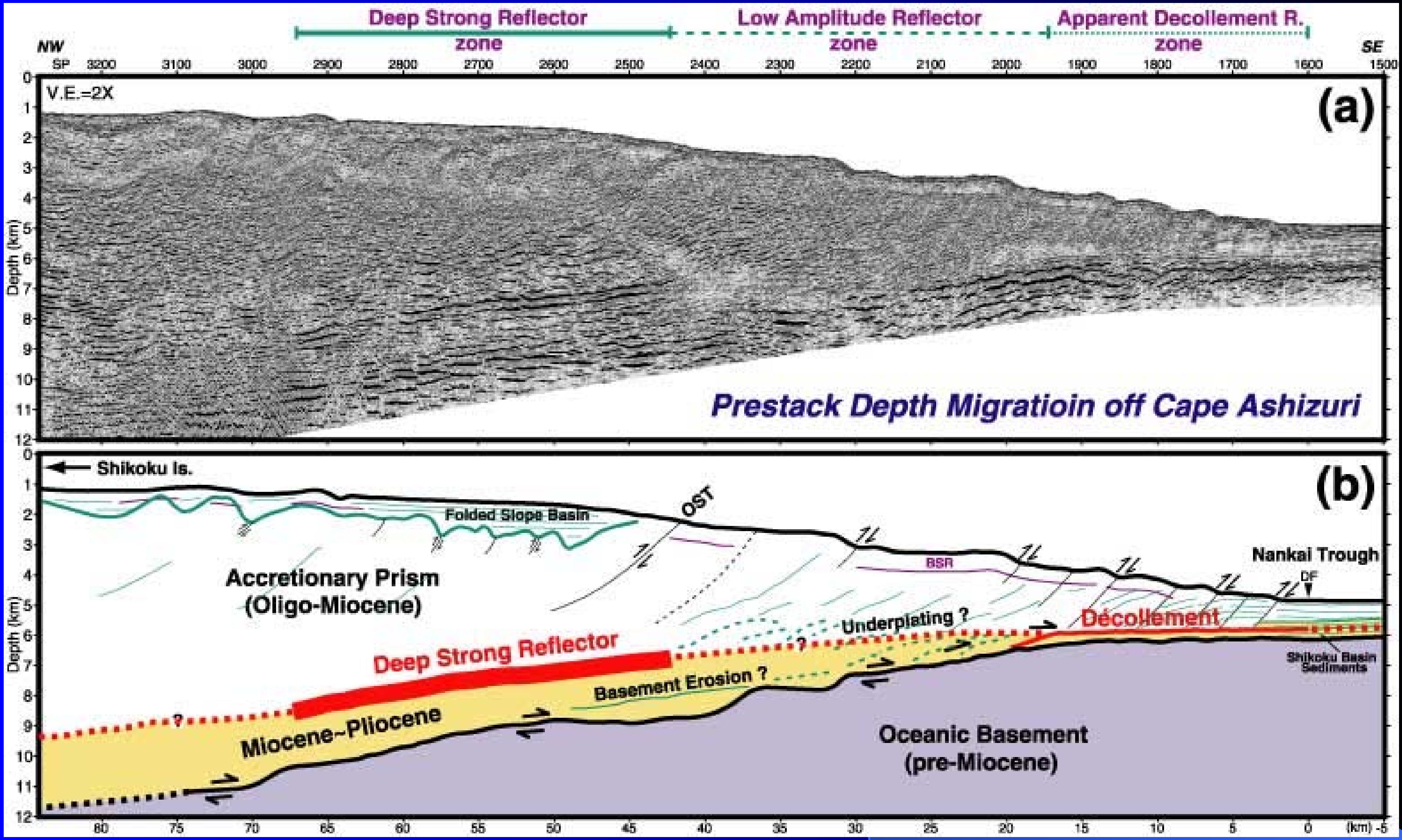
Masataka Ando, Nagoya Univ.

Bathymetry of the Philippine Sea Plate



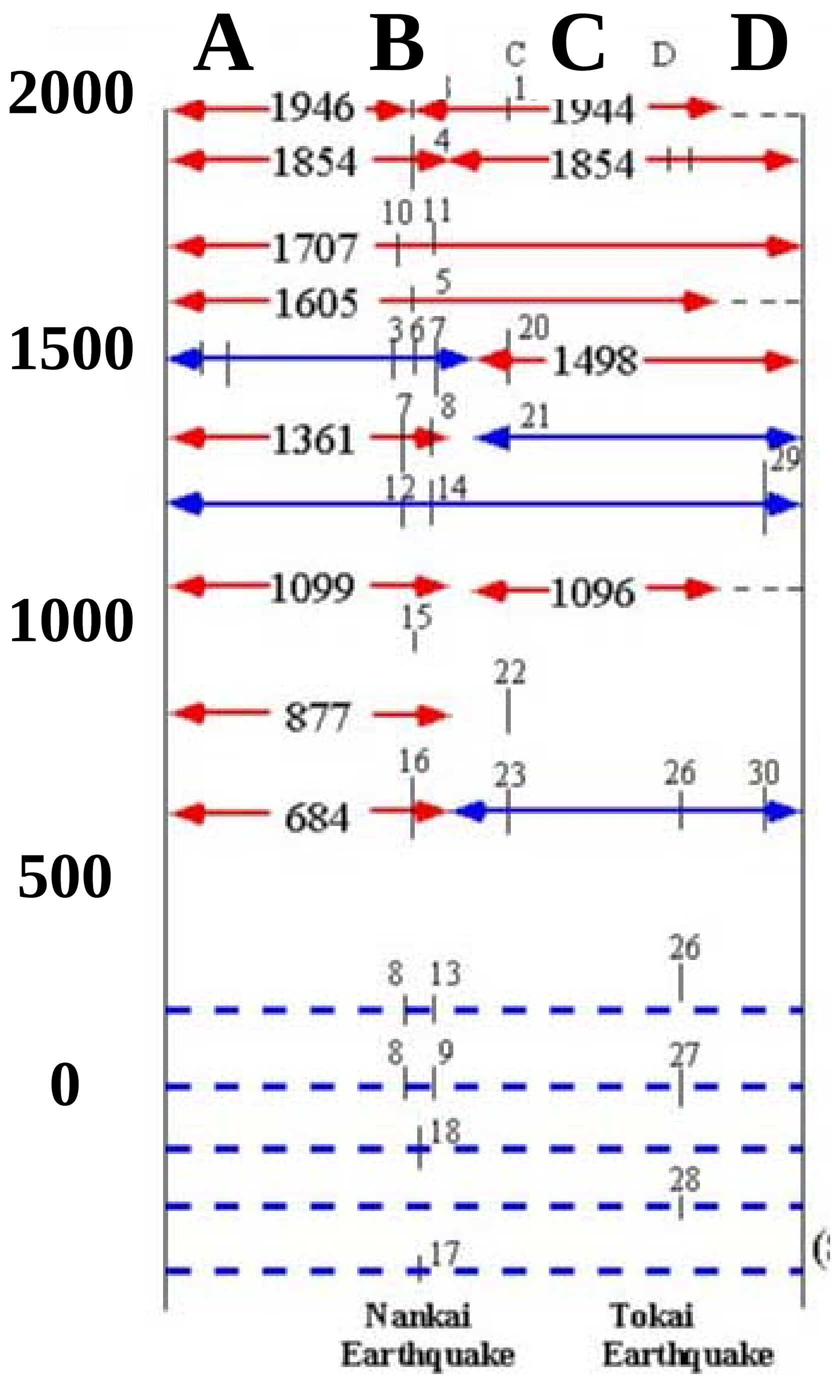

Maritime Safety of Japan
A
B
C
D

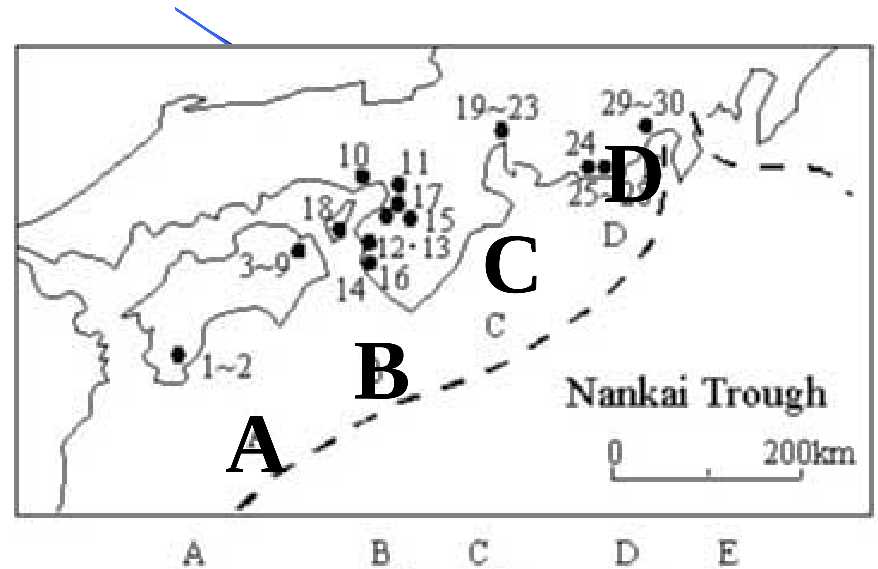
Nankai Trough Accretionary Wedge



J. Park (2001)

Large Earthquakes along the Nankai Trough



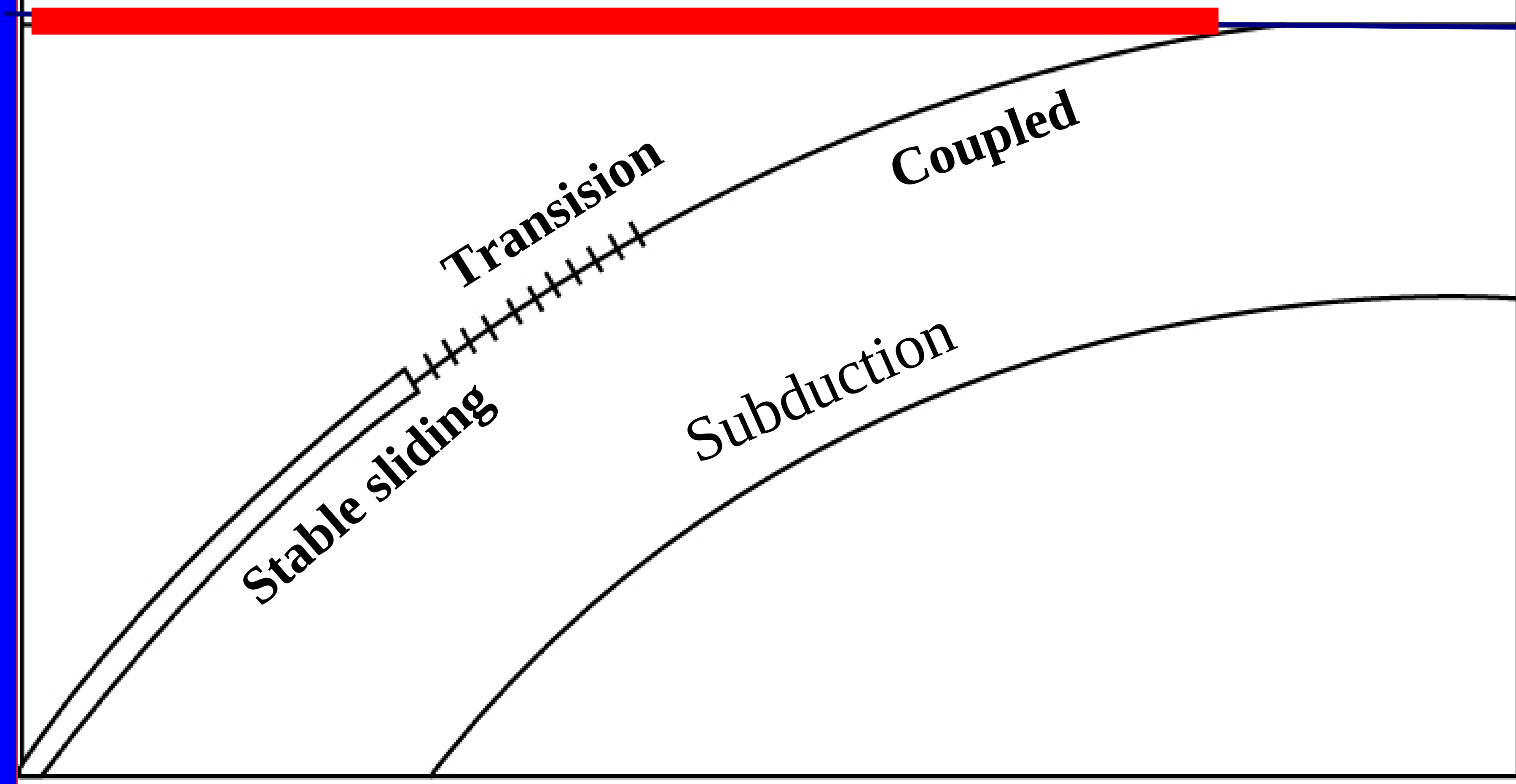


Historical Documents

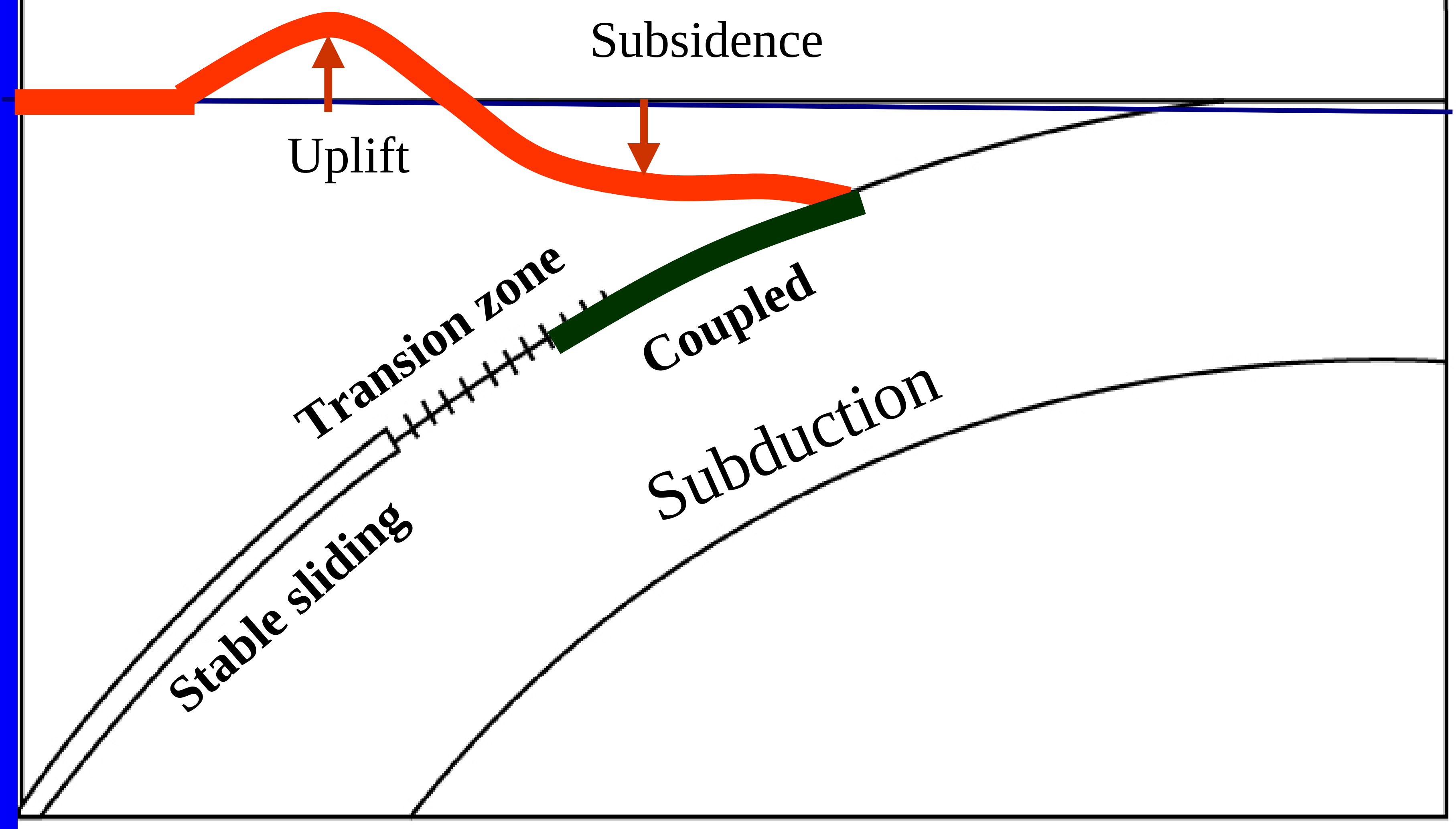
Archeological Data

Modified from Sangawa (1992)

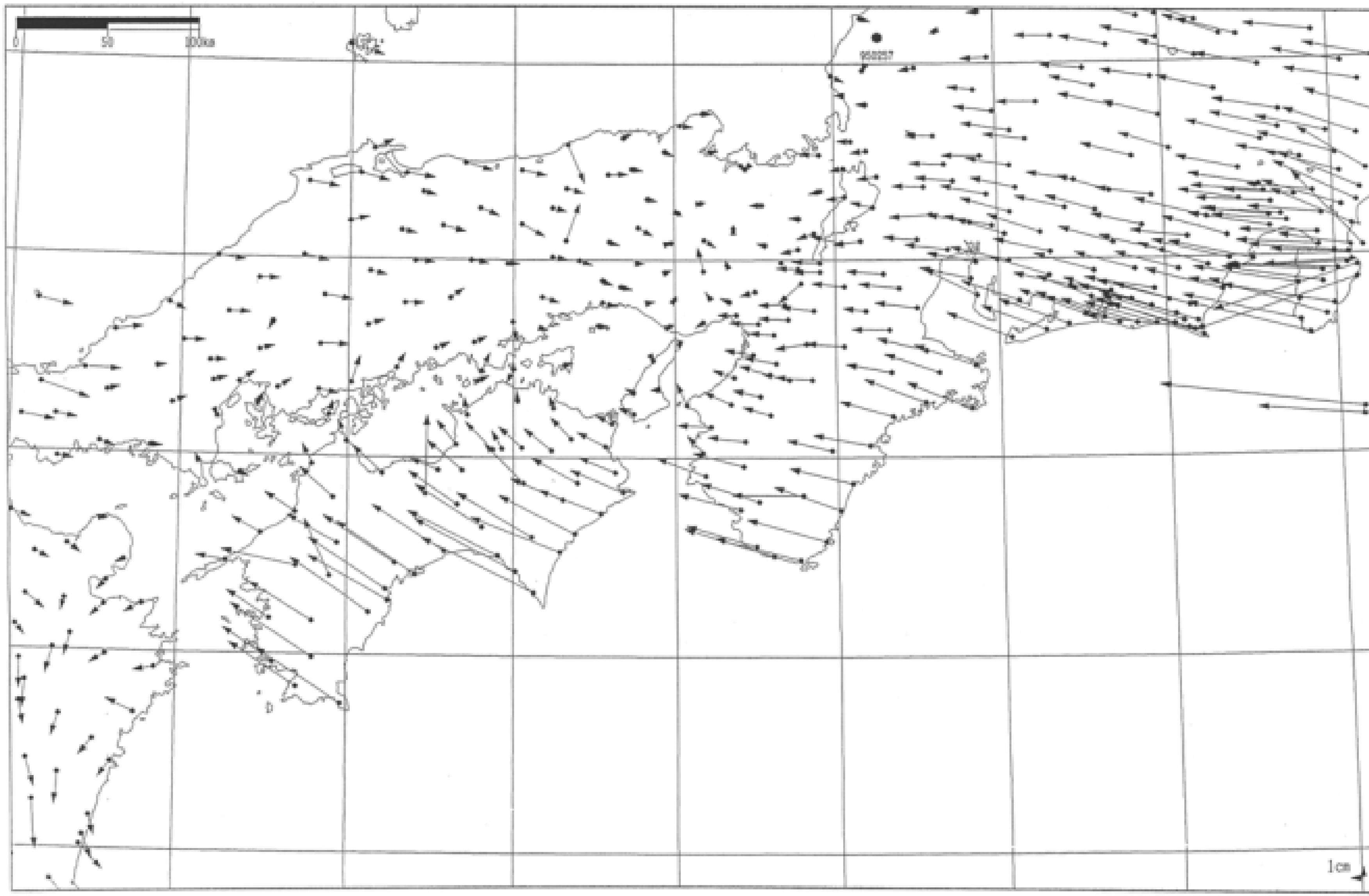
Interseismic Crustal Deformation along the Nankai Trough



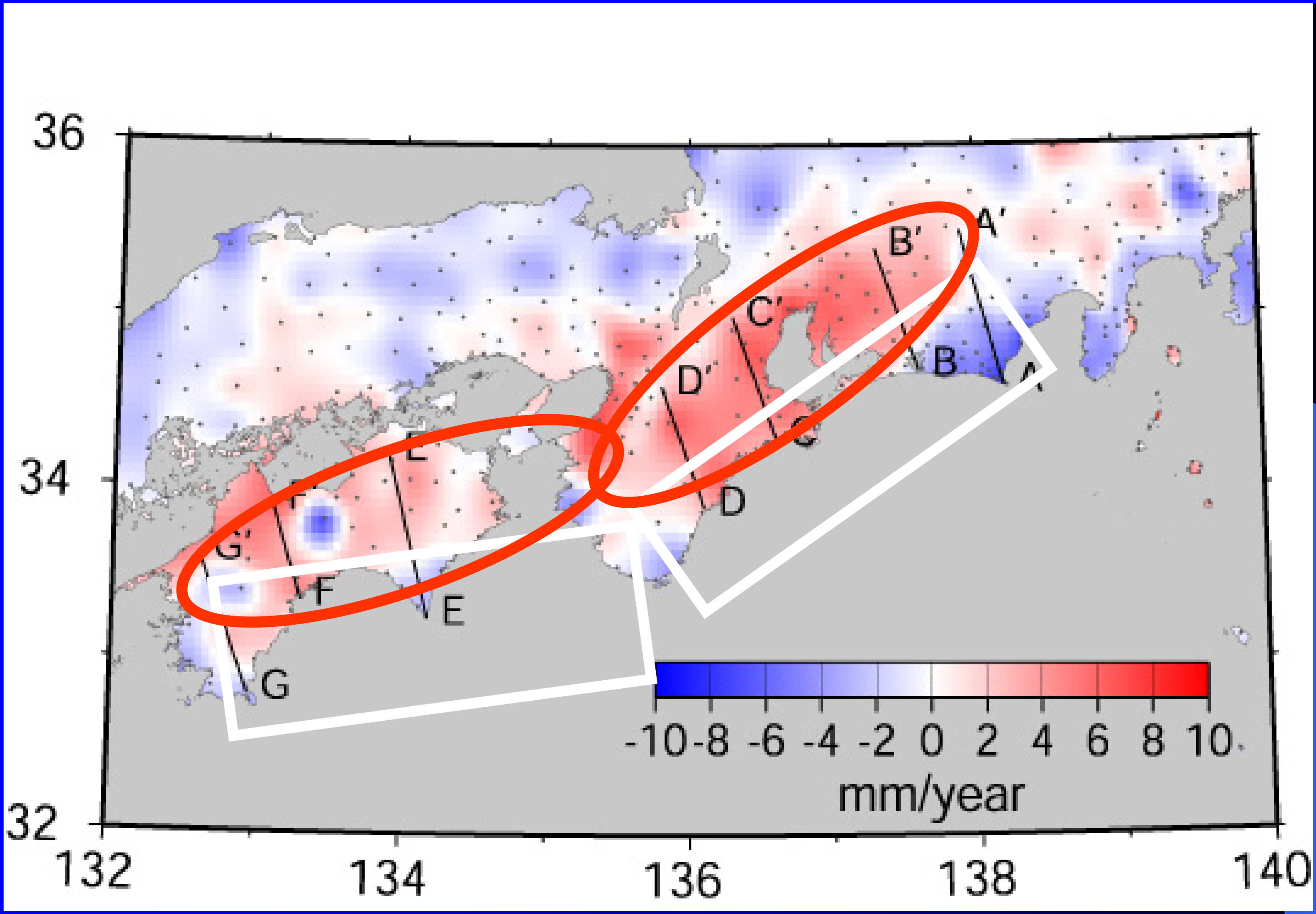
Interseismic displacements



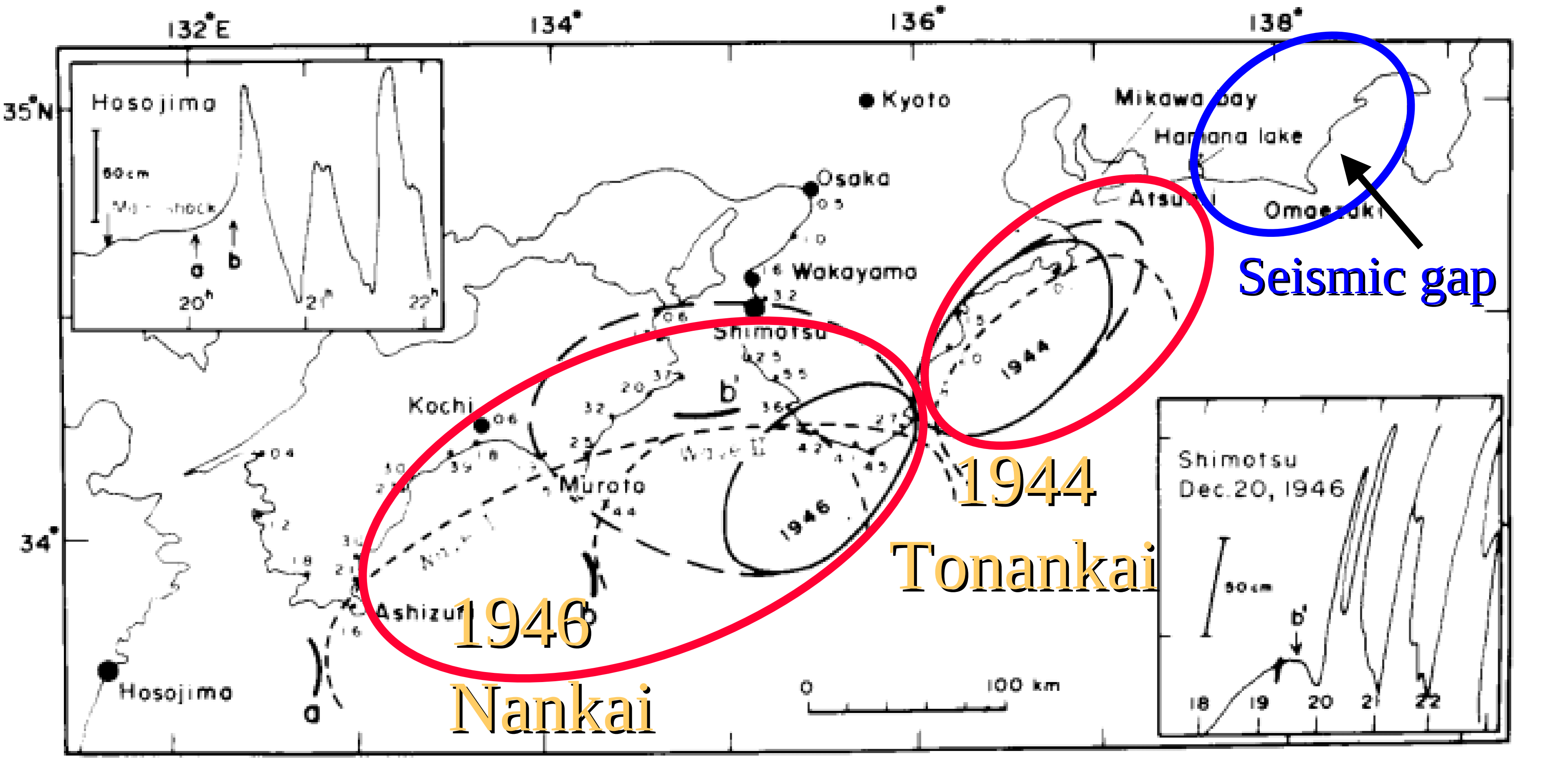
GPS Horizontal Velocities



GPS Vertical Velocities

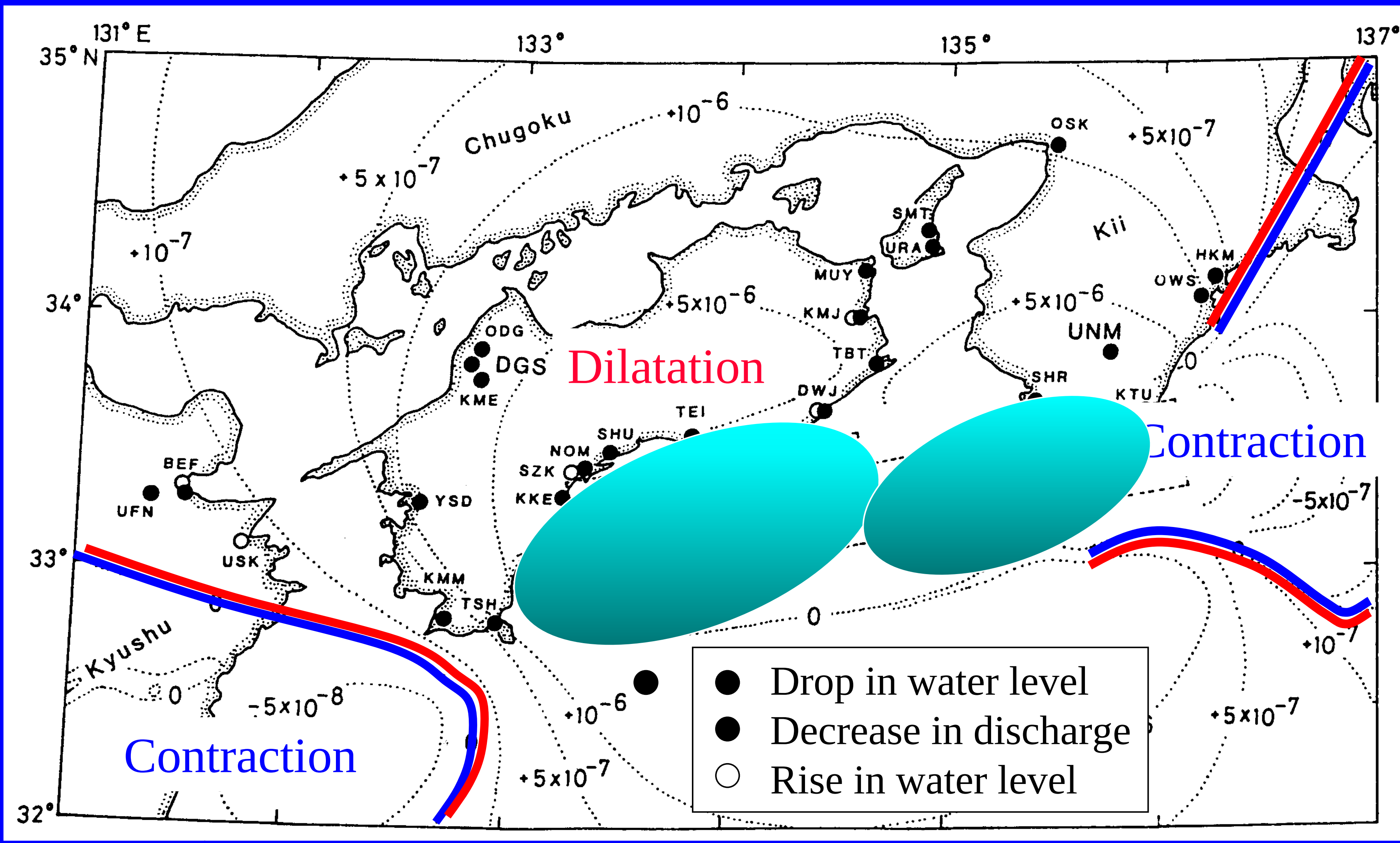


1944 and 1946 Nankai trough great earthquakes



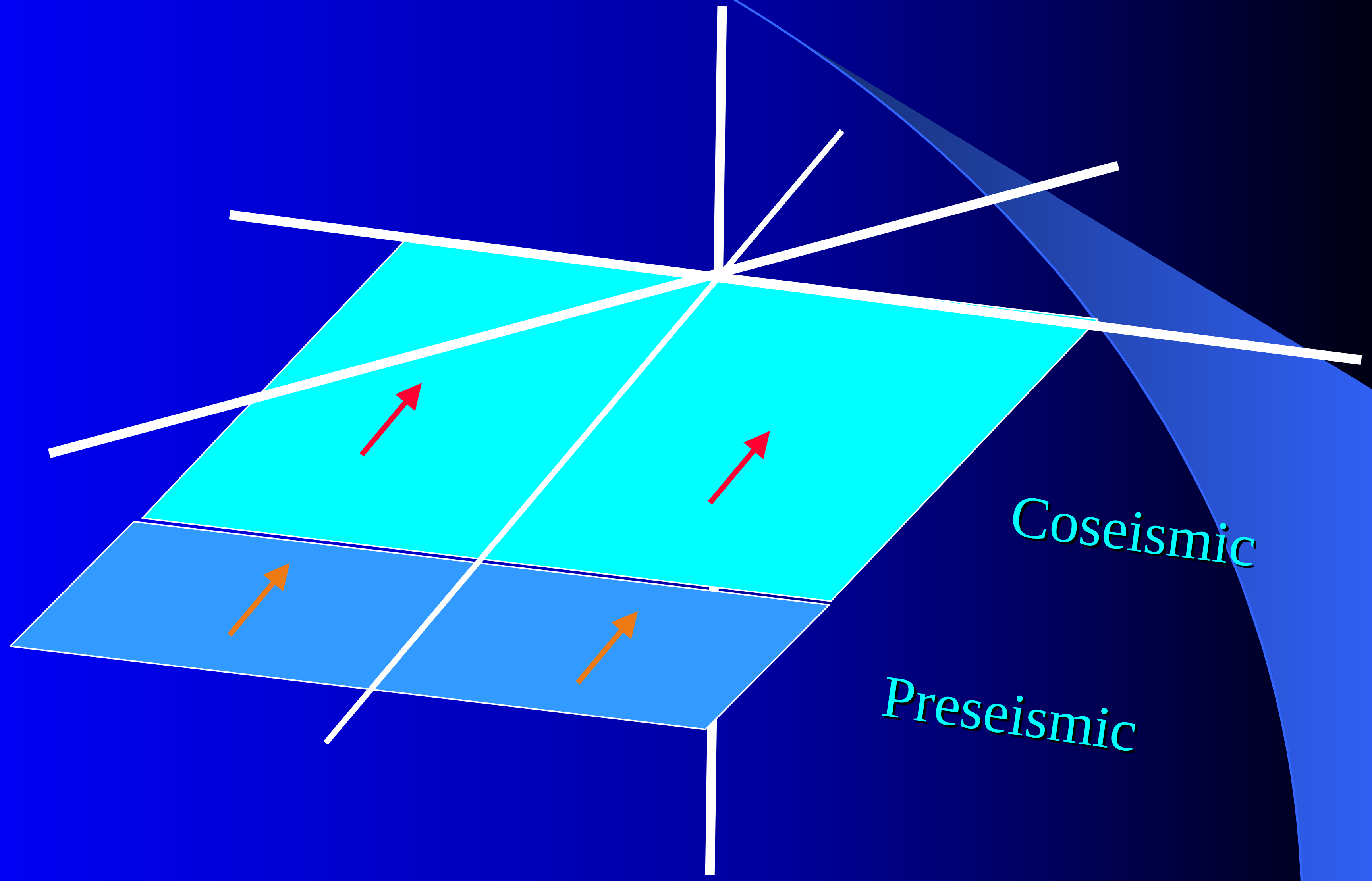
Ando (1975)

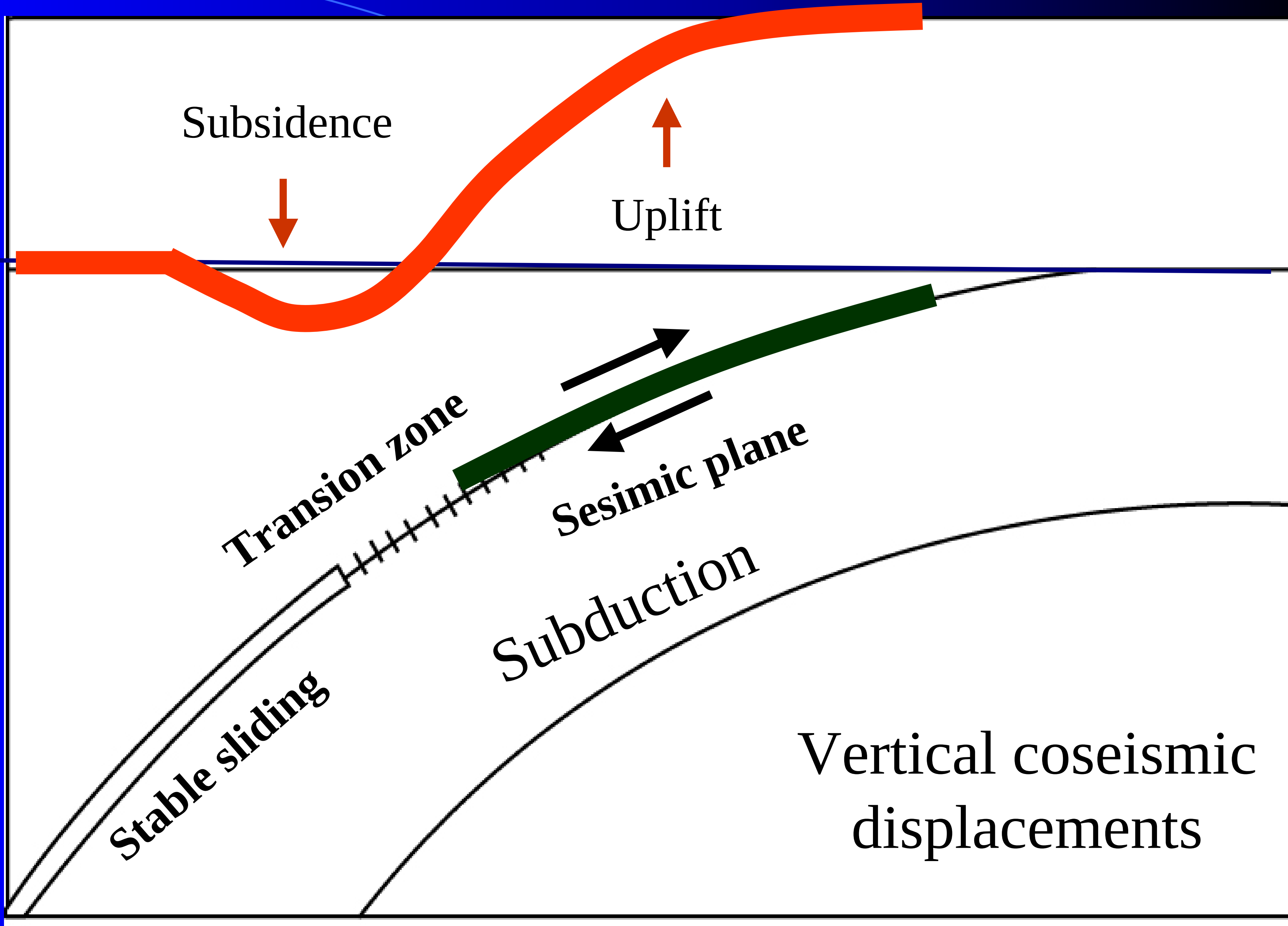
Coseismic Ground-Water Level Changes



Kawabe (1991)

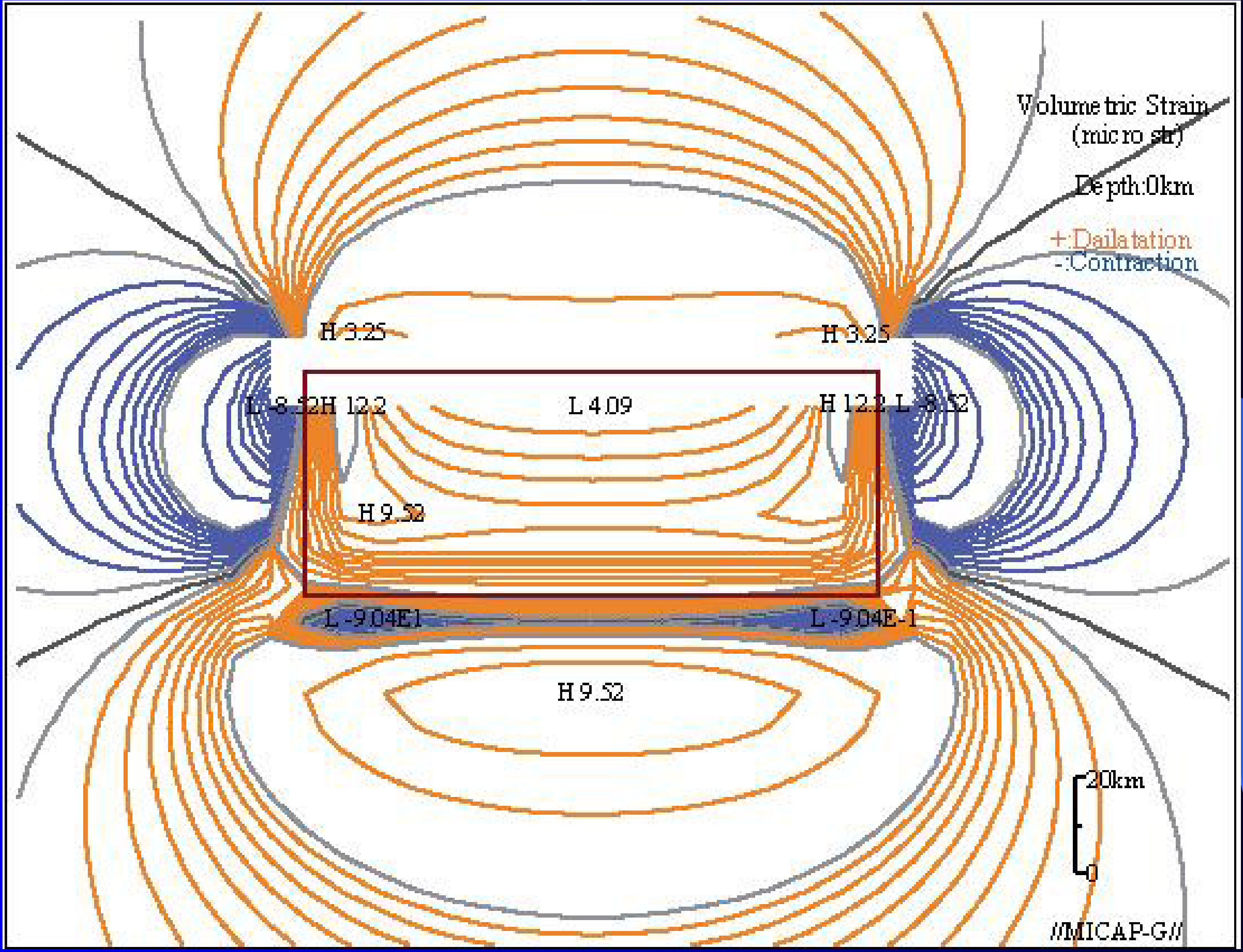
Fault Model of the 1946 Nankai Earthquake



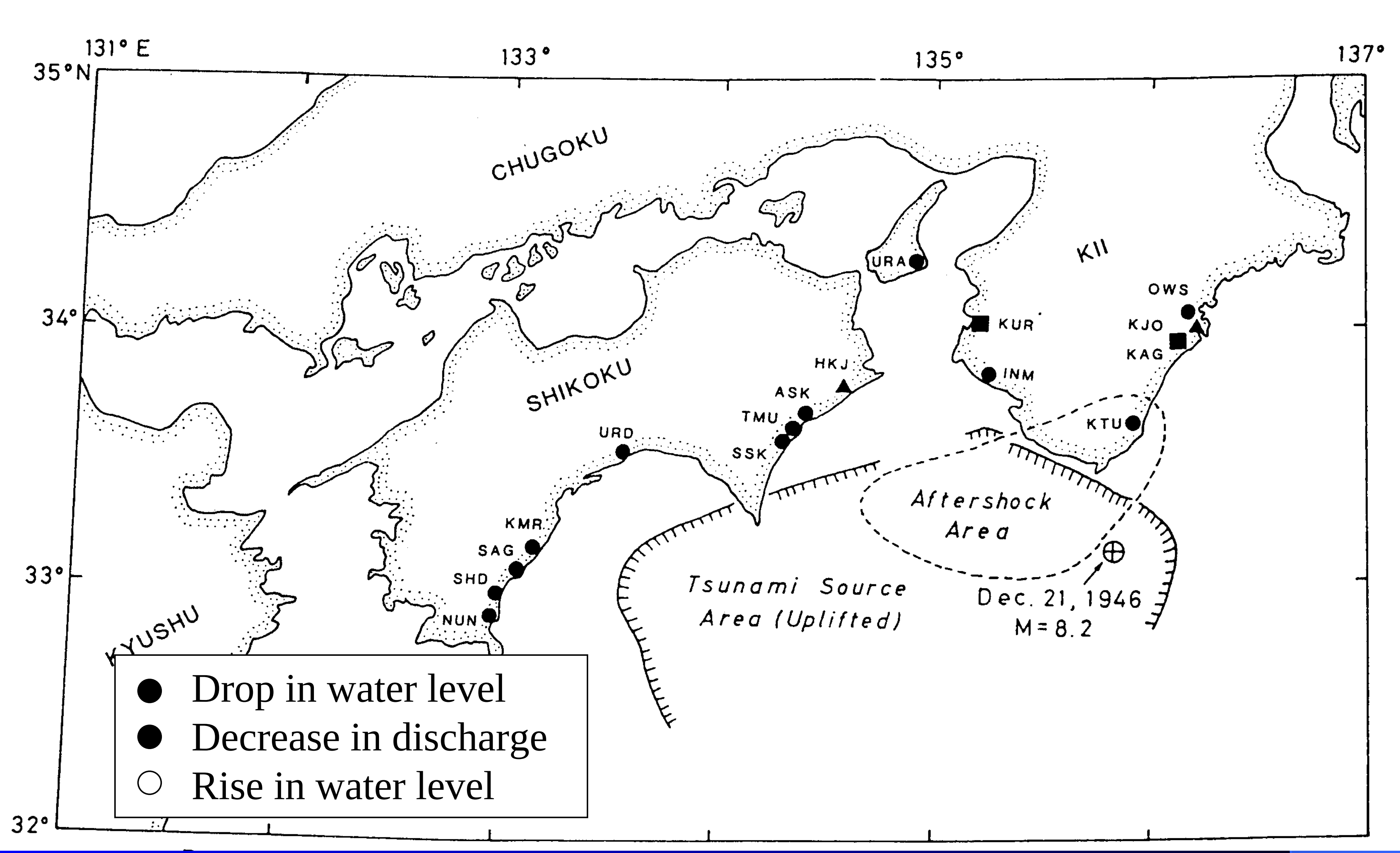


Subsidence
Uplift
Transion zone
Sesimic plane
Subduction
Stable sliding
Vertical coseismic displacements

Coseismic Volume Change

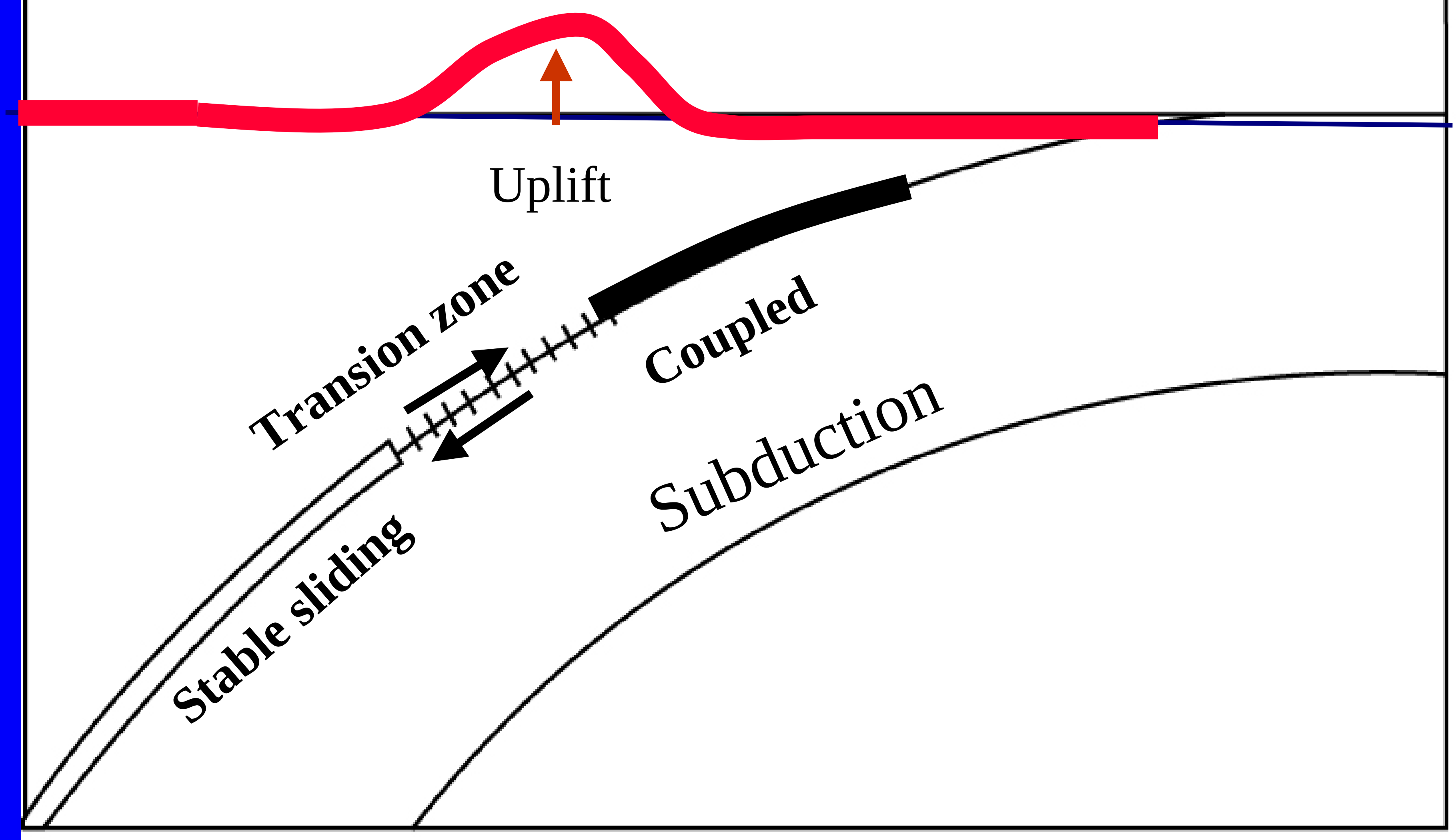


Preseismic Ground-Water Level Changes

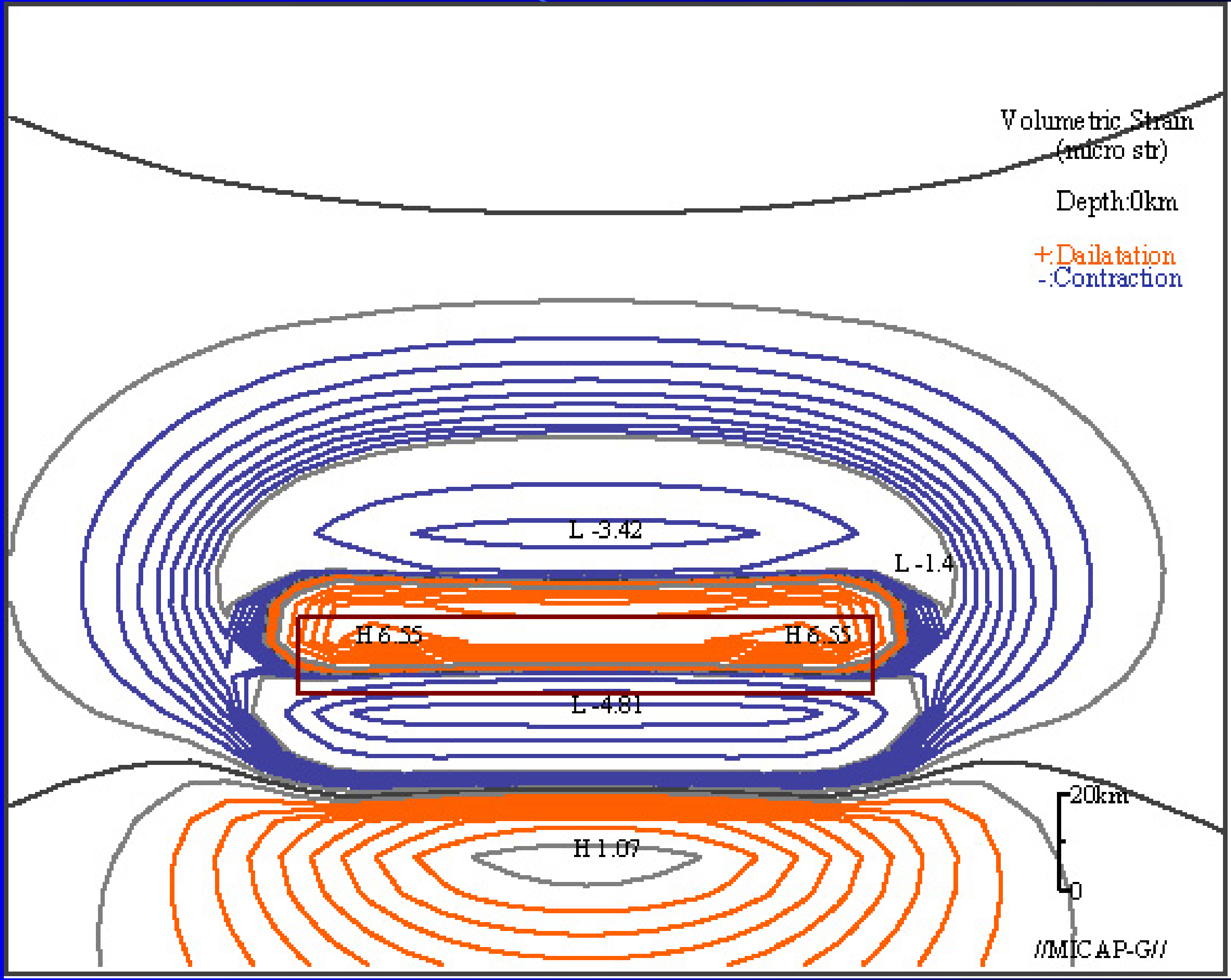


Kawabe (1991)

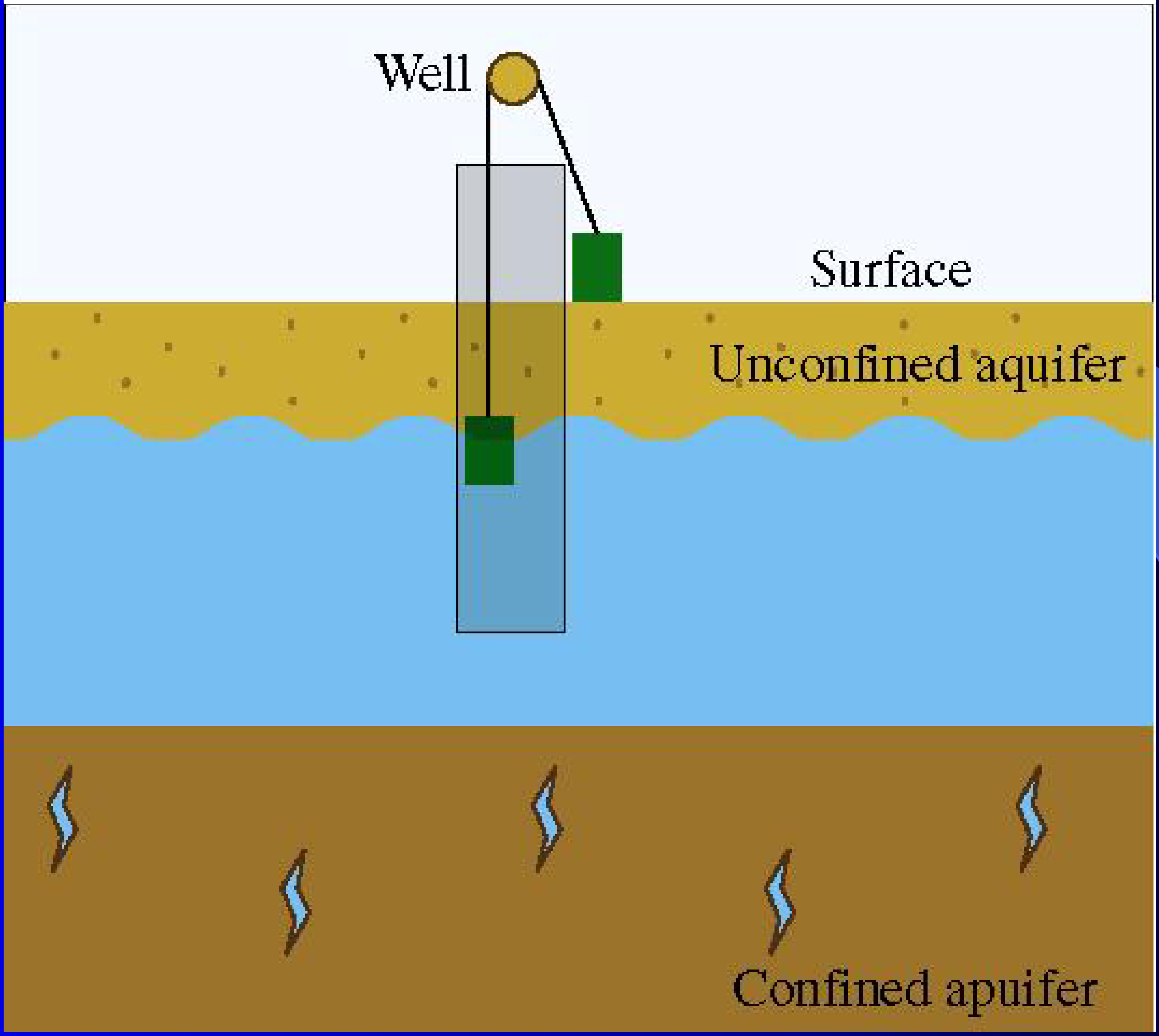
Preseismic displacements



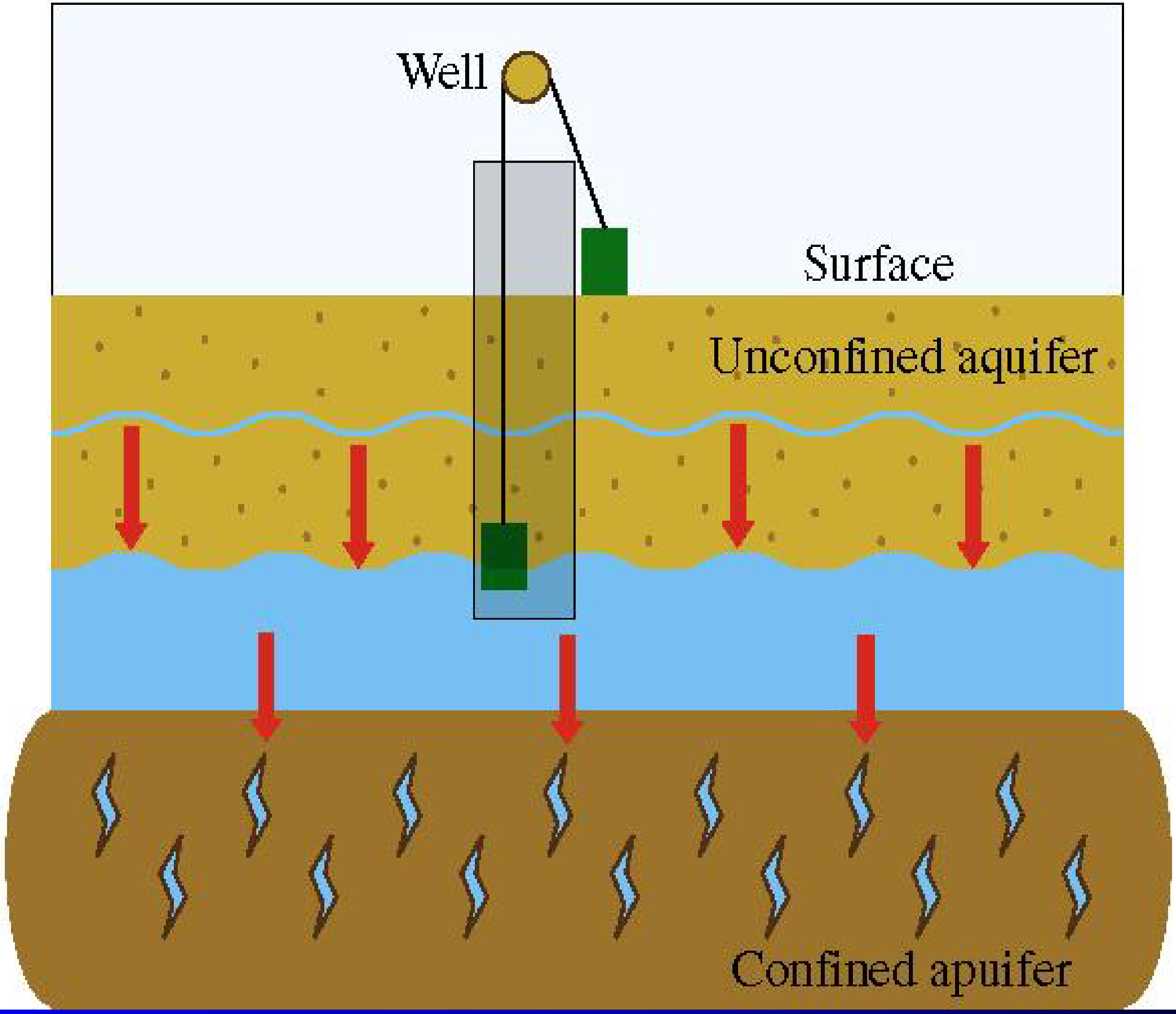
Preseismic Volume Change



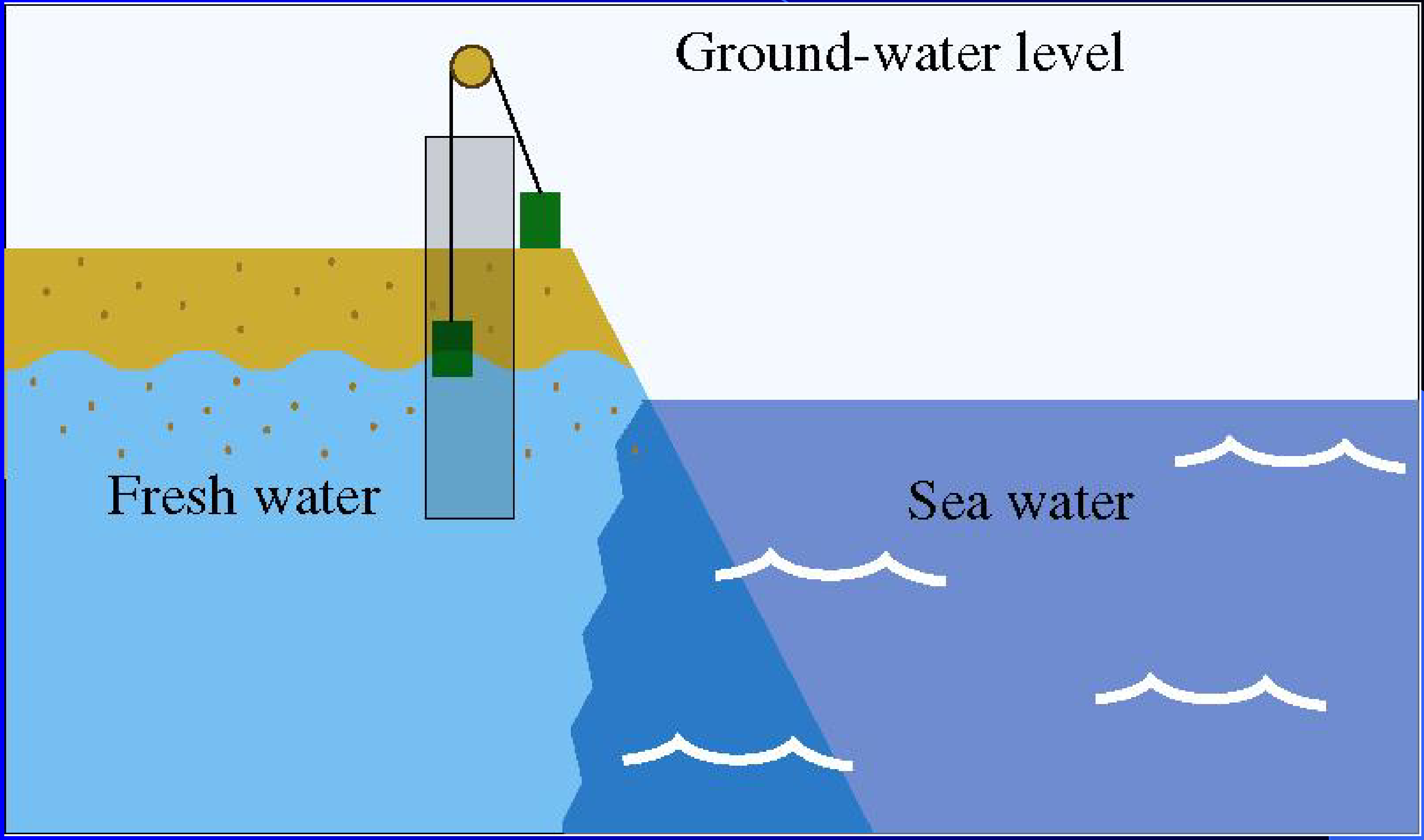
Interseismic Stage



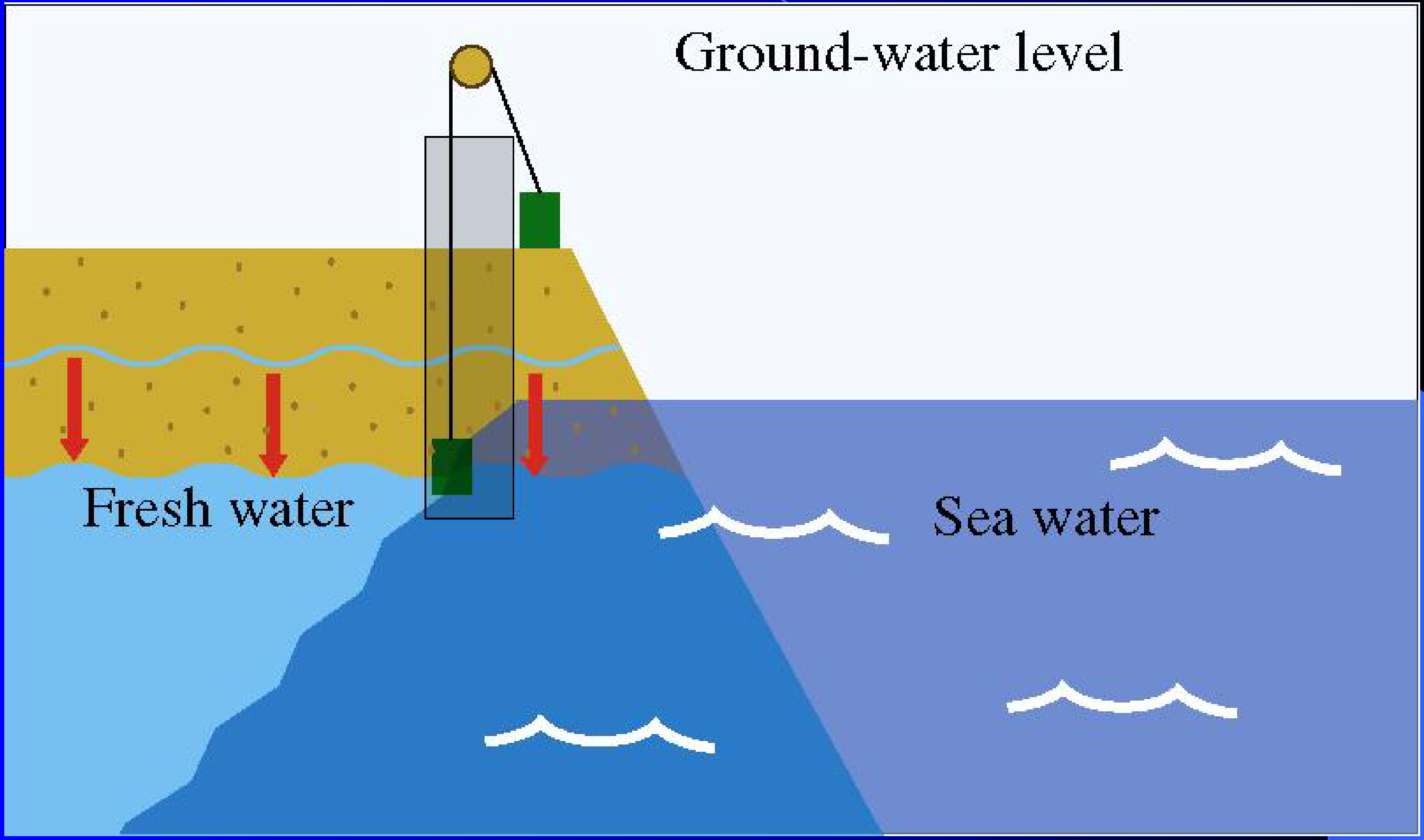
Precursor Stage



Interseismic Stage



Precursor Stage



Conclusions

Precursory ground-water level change occurred 1 week to 1 month prior to the 1946 Nanka earthqukae

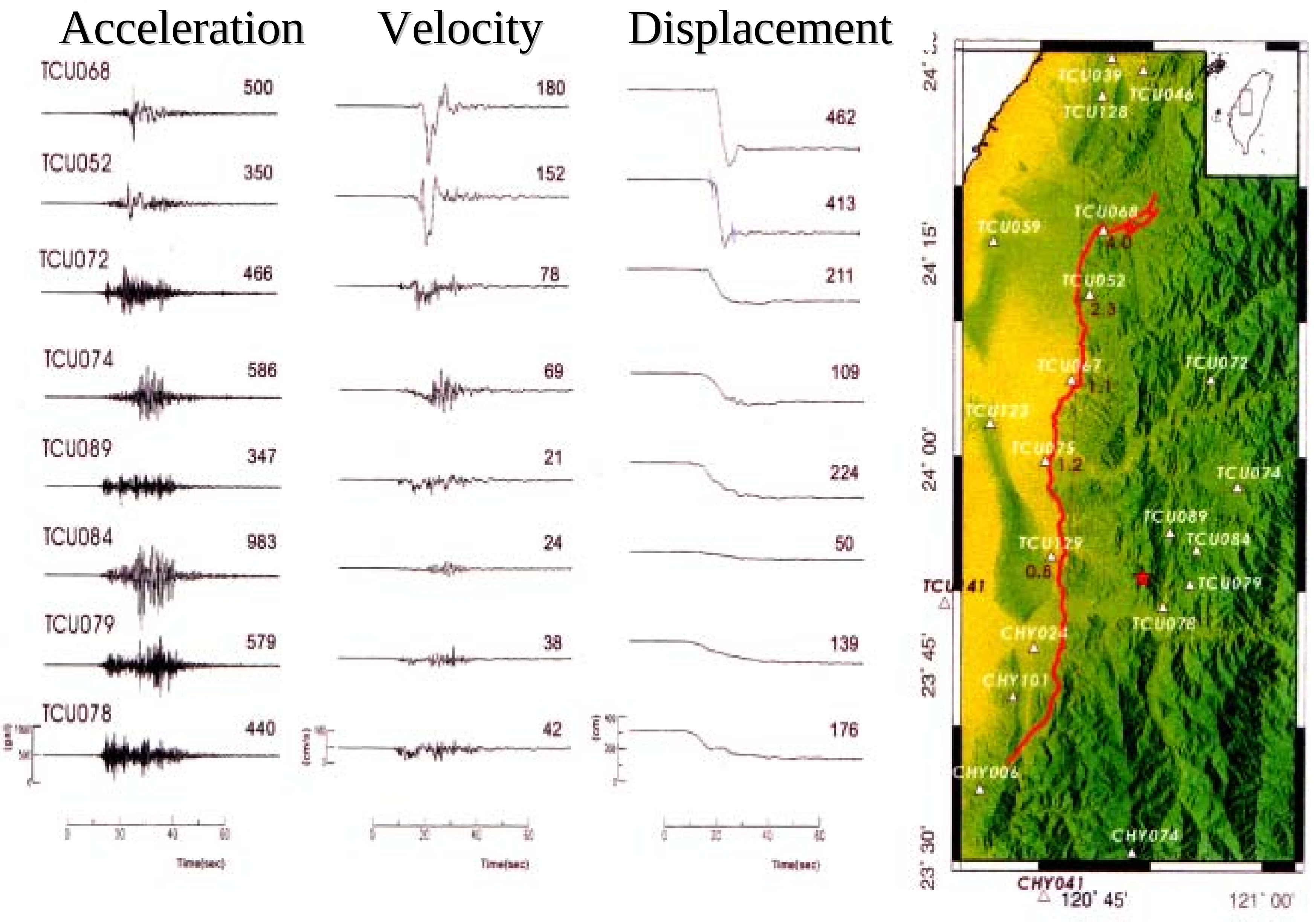
Ground-water level dropped at the Nankai earthquake

Pre-slip possibly occurred around the bottom of the 1946 Nankai earthquake fault

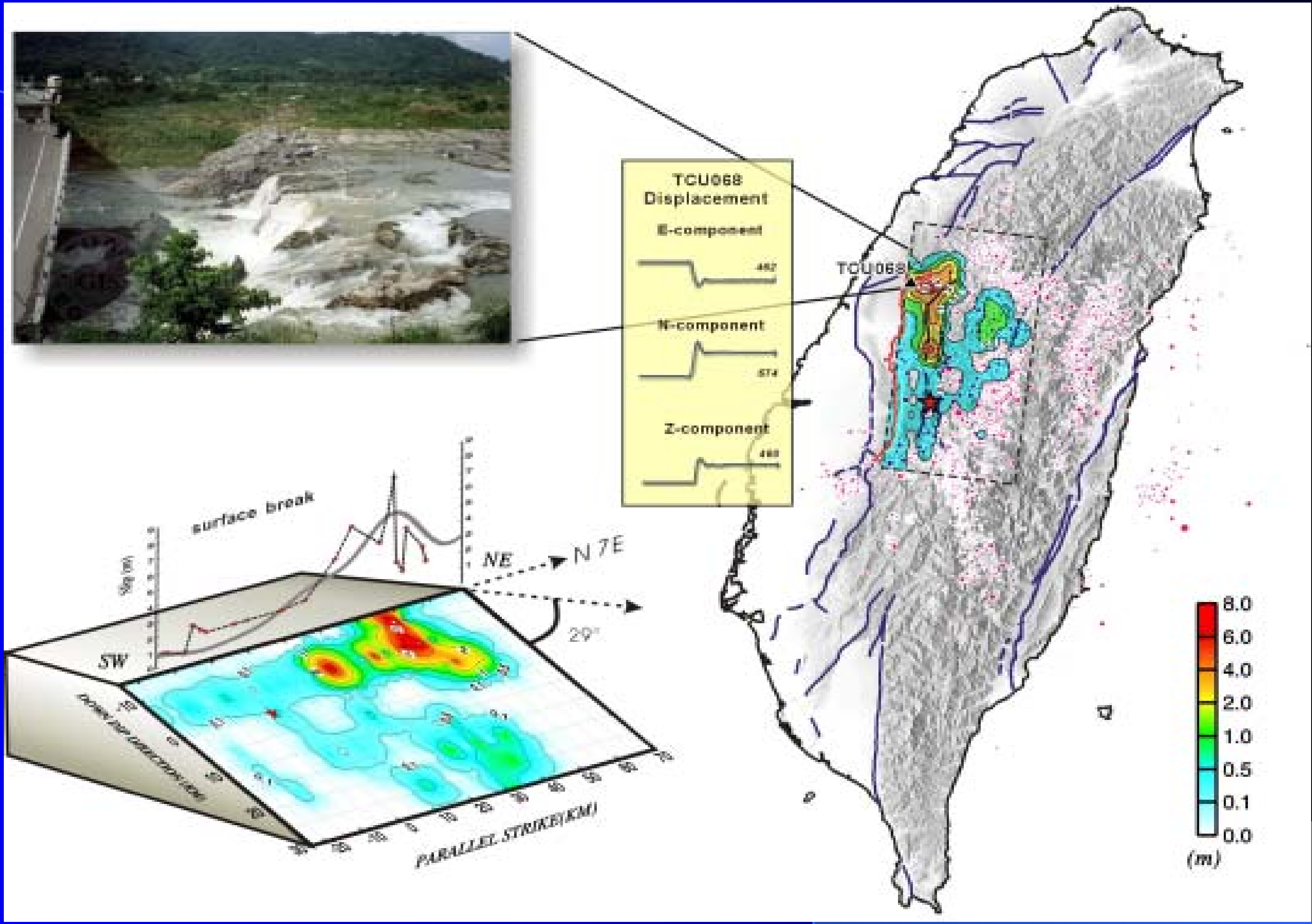
Monitoring of ground-water level and discharge is important to earthquake prediction

1999 Chichi earthquake and the Chelungpu fault drilling program

- Similarities between Nankai splay faults and the 1999 Chi-chi earthquake fault

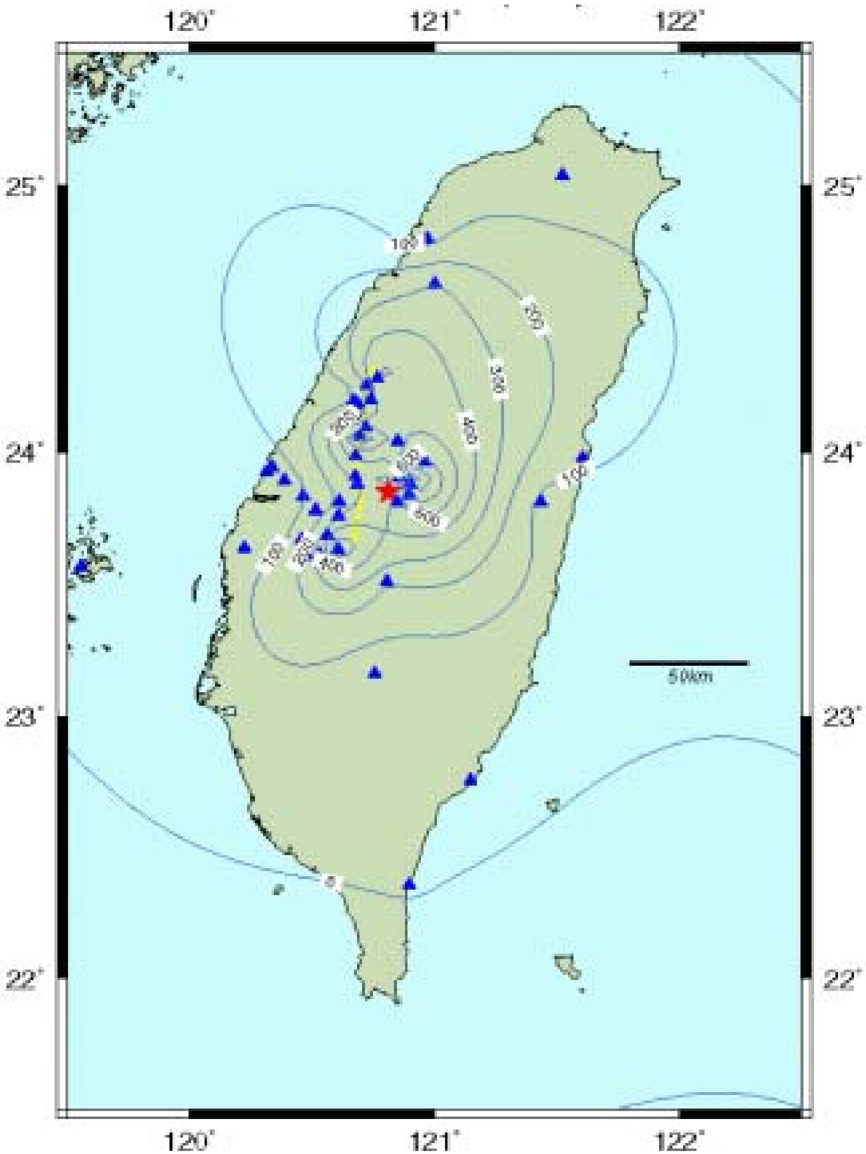

Acceleration
Velocity
Displacement
TCU068
500
180
462
TCU052
350
152
413
TCU072
466
78
211
TCU074
586
69
109
TCU089
347
21
224
TCU084
983
24
50
TCU079
579
38
139
TCU078
440
42
176
Time(sec)
Time(sec)
Time(sec)
TCU039
TCU046
TCU128
TCU068
TCU059
4.0
TCU052
2.3
TCU067
1.1
TCU072
TCU122
TCU075
1.2
TCU074
TCU089
TCU084
TCU129
0.8
TCU079
TCU078
CHY024
CHY101
CHY006
CHY074
CHY041
24° 15'
24° 00'
23° 45'
23° 30'
120° 45'
121° 00'

Fault Slip at the Chichi Earthquake of 1999

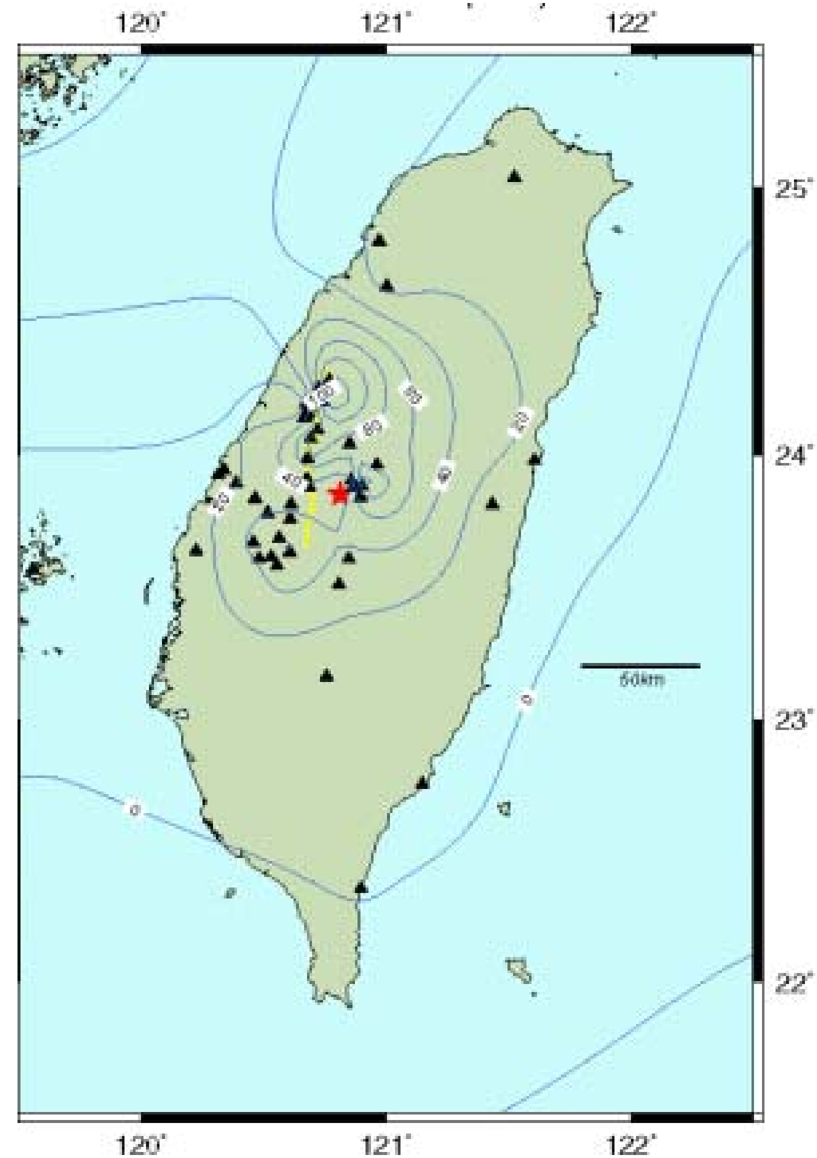


Ma and Mori (2000)

Max Acceleration



Max Velocity

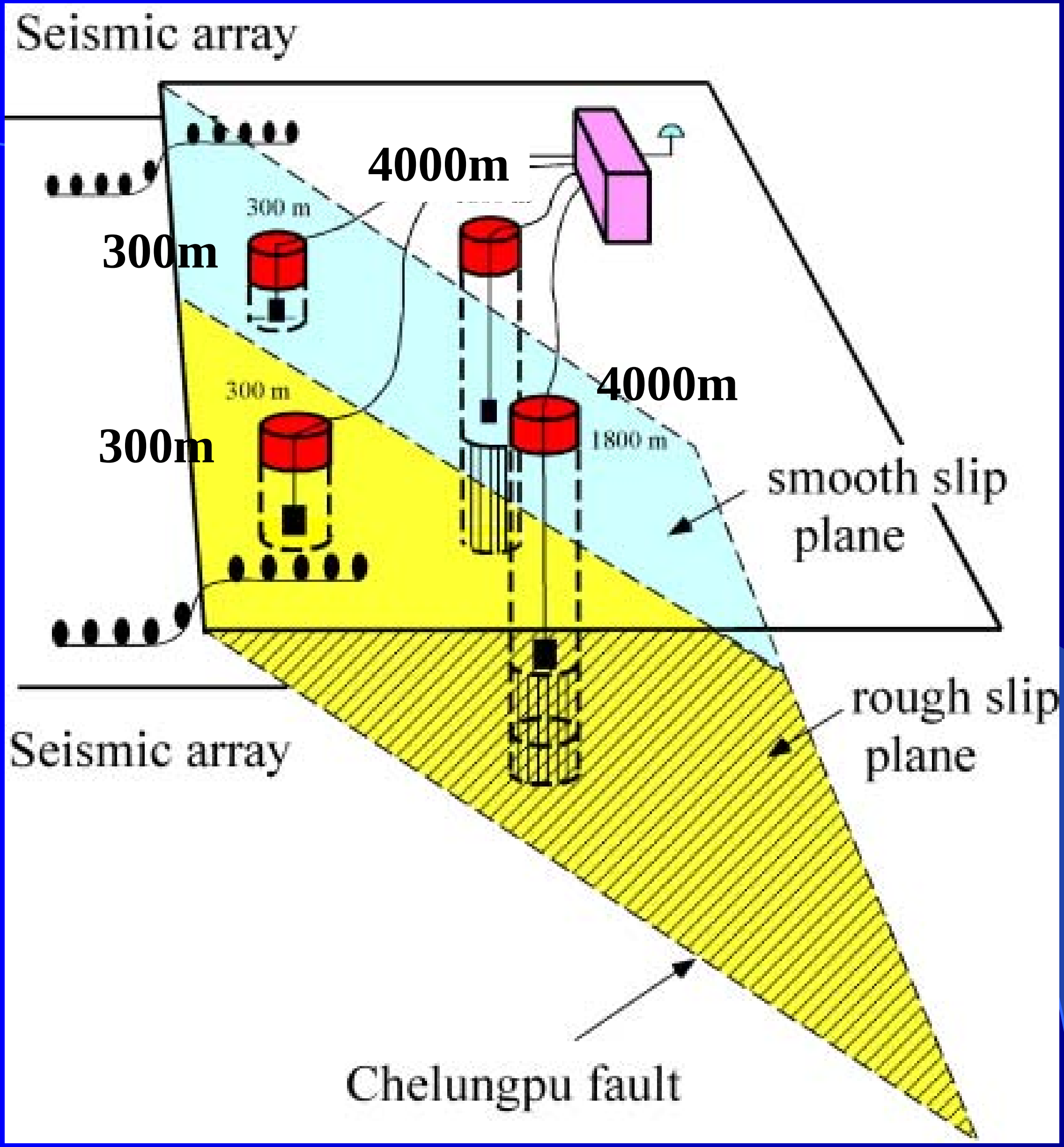


Iwata(1999)

Questions

What fault properties control the amount of slip in a large earthquake?

What fault properties control the level of strong ground shaking?



Planned Shallow and Deep Drilling Holes

North: Smooth
South: Rough

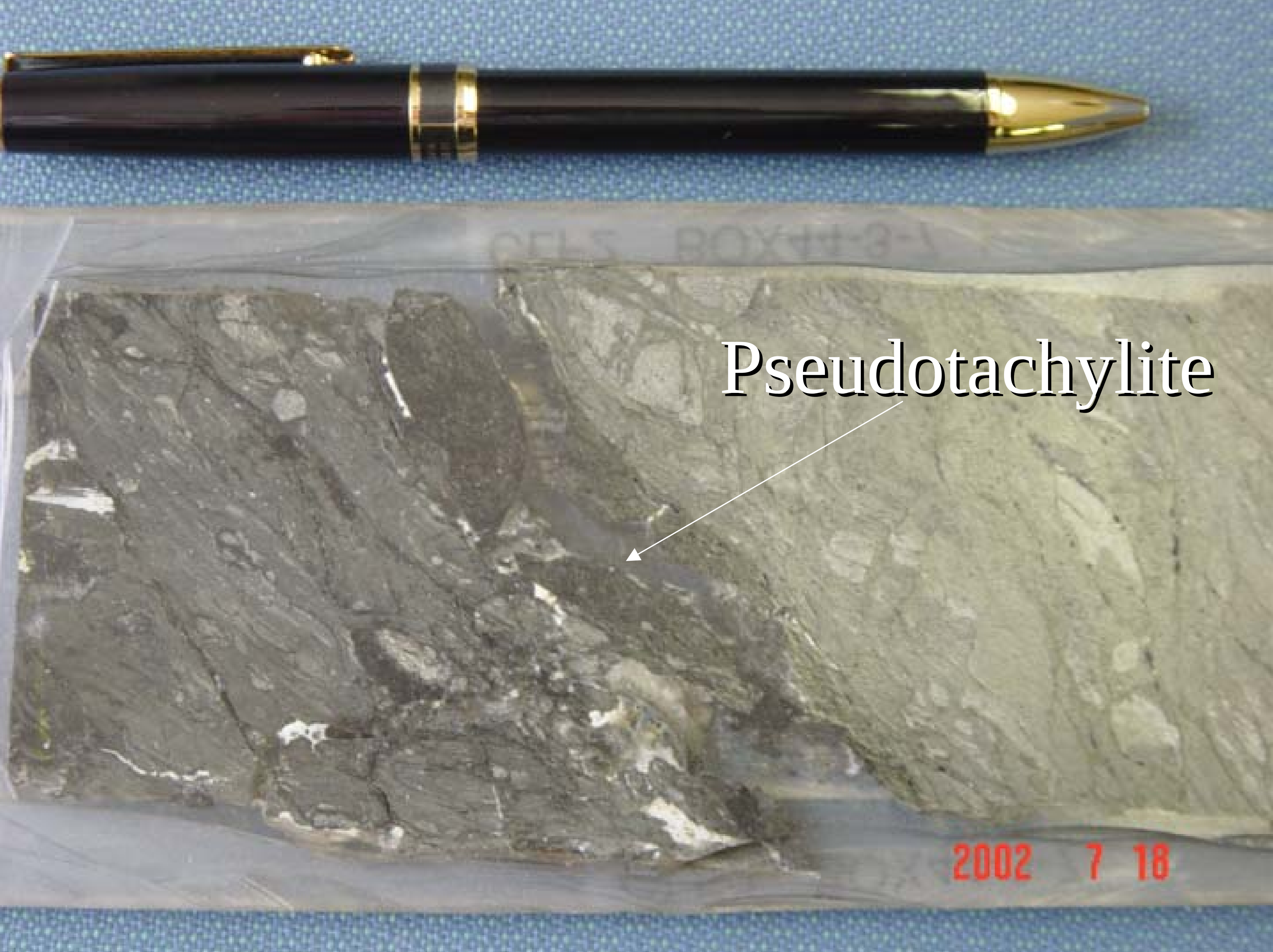
Drilling Sites

South

North


Northern Site
Another possoble fault zone
activated at 1999 earthquake
10cm
Fengyuan Site 327 m depth
Hidemi Tanaka

Southern Site


Pseudotachylite
2002 7 18

Characteristics of faulting behaviors

- ***Northern site***
  - Low T + high pore pressure
  - Consistent with the fast and smoothed slip from seismic data

- ***Southern site***
  - High T + Low pore pressure
  - Consistent with the rough slip from seismic data

Paleoseismological Study along the Chelungpu Fault

No.	Trenching site	Description and Result	References	Remarks
1	Fengyuan	Multiple fault traces in a narrow zone. One event prior to 1999 has been found and can be dated.	Ota et al. in prep.	○
2	Wenshan Farm	Two shallow trenches have been excavated. Multiple fault traces are recognized. The last two events can be determined by radiocarbon ages.	Chen et al., 2001a	○
3	Chienmin Bridge	Two events are found including 1999 Chi-chi earthquake. Penultimate event occurred later than 150 years BP.	Lee et al., 2000	●
4	Peikouchi	Four trenches were excavated. Multiple fault traces are found.. More than four events have been identified.		○
5	Pineapple Field	Two deep trenches with four levels were excavated. Except for the 1999 fault, there are three burial faults. At least four events occurred during the past 1.8ka.	Chen et al., 2001c	●
6	Wufeng	Only 1999 event can be identified in two trenches. Many radiocarbon dates worked out to give age control.	Chen et al., 2001a	●
7	Kuangfu School	Only 1999 event is recorded in this site.	Yuan et al.in prep.	○
8	Fengying Bridge	Two fault traces separates 10m. The western one is 1999 fault. The eastern one is an old fault that moved later than 300 yr BP based on radiocarbon age.	Lee et al., 2001 Chen et al., 2001d	●
9	Tsaotun	One event prior to 1999 may be older than 300-500 yrBP.	Ota et al., 2001	●
10	Chunghsin	Four separated trenches have been done. One of them showed 6 successive colluvial wedges along the major thrust fault. The penultimate event happened younger than 200 yr BP.	Lee et al., 2000 Chen et al., 2001c	●
11	Shijia Field	A 8m deep trench demonstrates that the surface scarp actually is a fold-scarp based on continuous but deformed underlying sedimentary strata. Tilting angle of the paleo-soils increasing downward from top implies that at least three events have been recorded. Radiocarbon ages demonstrate that the last two events occurred in the past 700 years.	Streig et al., 2001	●
12	Mingchien	A trench shows double faults including 1999 rupture and one already buried. Radiocarbon ages illuminate the corresponding event of the old fault is also younger than 200 years.	Chen et al., 2001c	●

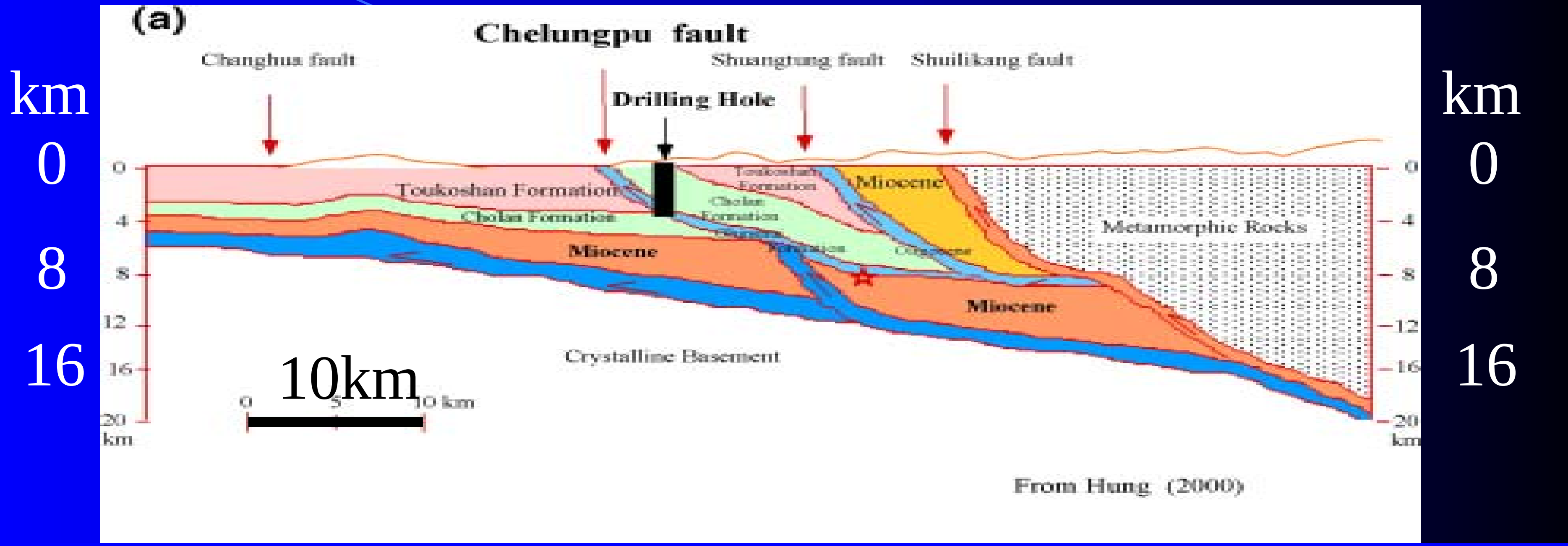
● Study has been already done.
○ Study is still on-going.

Recurrence intervals

1) 2000y
3) <150y
5) 450y
(4 events/1800y)
8) <300y
9) >300-500y
10) <200y
11) 350y
(2 events/700y)
12) <200y

Ota et al. (2002)

Tectonics of Taiwan Island



C.Y. Wang (2000)

Conclusions

- Nankai trough great earthquakes occur with intervals about 100 yrs.
- Earthquakes occur almost simultaneously during a 2-3 year period over the fault area.
- Faulting mode varies from event to event even in the same segment.
- Splay faults play an important role to tectonic processes and earthquake hazards.
- Comparative studies of faults with different properties are necessary to understanding earthquake physics.