Earthquake-related Groundwater Level Changes in a Sensitive Well

Ching-Yi Liu[1], Pei-Ling Wang [1], Yeeping Chia[1], Wan-Yun Ho[1], Yen-Tsu Lin[2], Yen-Chun Kuan[3]

[1]Department of Geosciences, National Taiwan University
[2]Central Geological Survey
[3]Water Resources Agency

Outline

- Pingding sensitive well
- Geological background
- Coseismic water level responses
- Pre-seismic abnormal change
- Discussion
- Conclusions

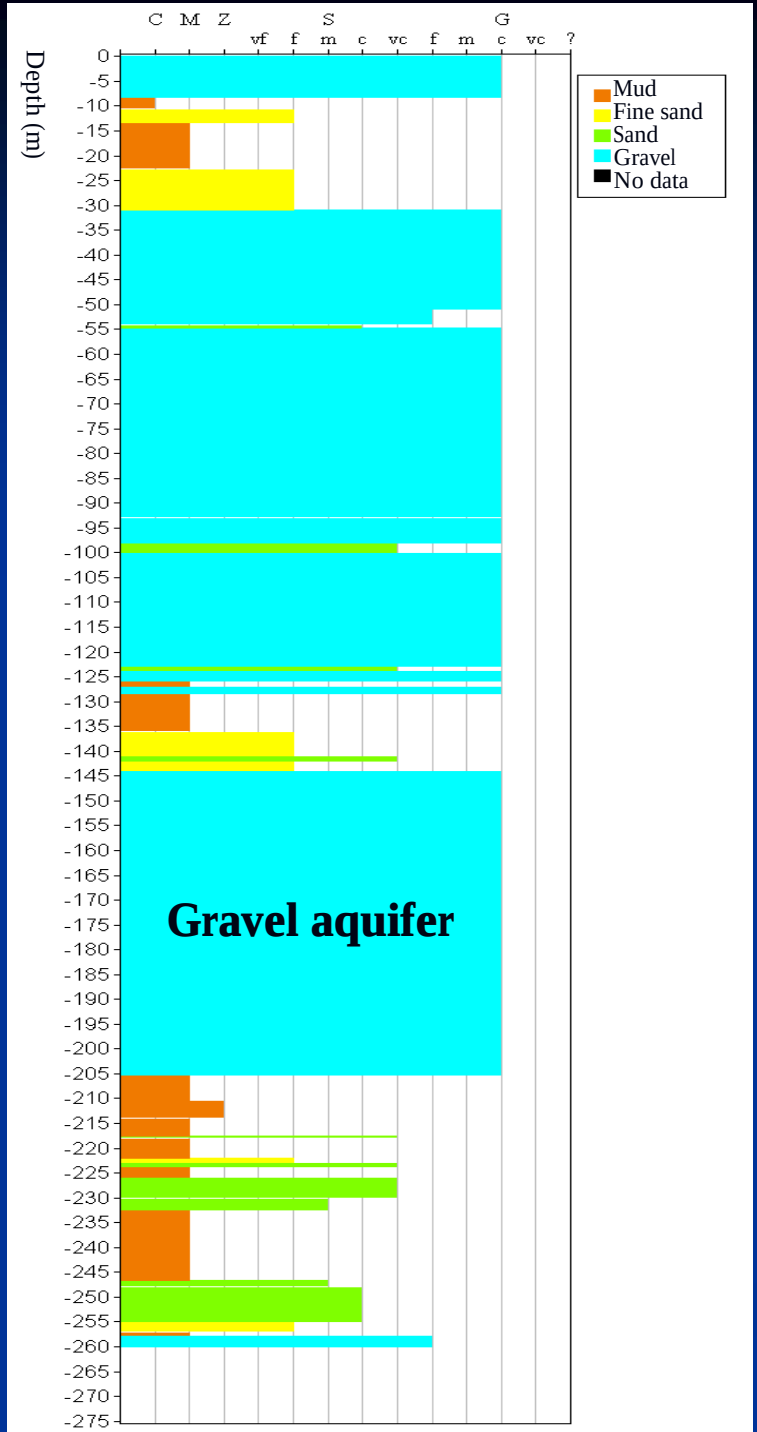

Chang Kang Elementary School

Pingding (PD-1)

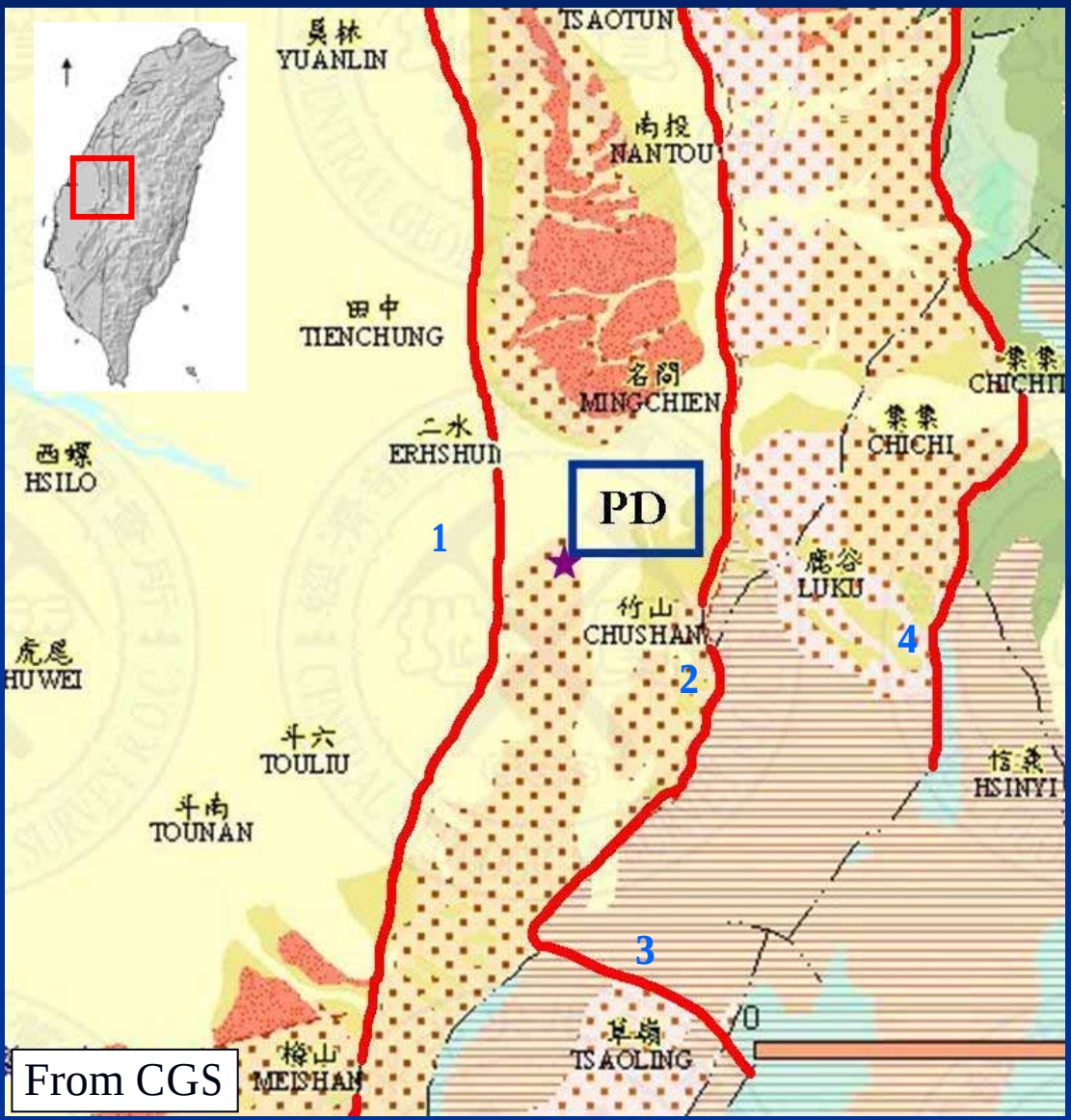
- Elevation: 297 m
- Depth: 260 m

- Diameter: 6 in
- Record interval: 1 hr
- Resolution: 1 cm

- Record starting date: 1997/01/01

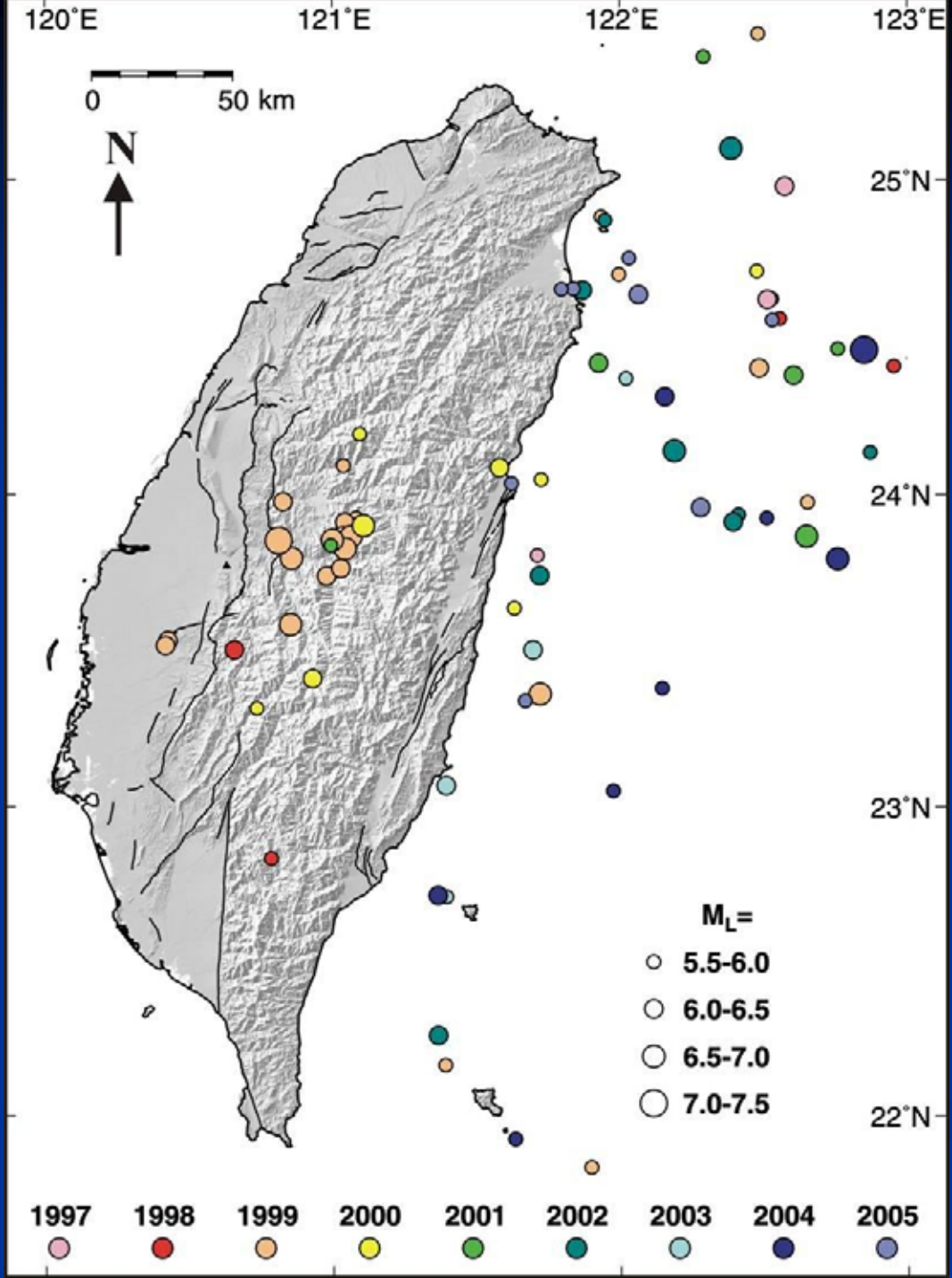

C M Z
S
G
vf f m c vc f m c vc ?
Depth (m)
0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105 -110 -115 -120 -125 -130 -135 -140 -145 -150 -155 -160 -165 -170 -175 -180 -185 -190 -195 -200 -205 -210 -215 -220 -225 -230 -235 -240 -245 -250 -255 -260 -265 -270 -275
Mud
Fine sand
Sand
Gravel
No data
Gravel aquifer

Geological Structuer



- Choshui River Alluvial Fan
- Dou-Liou hill
- Anticline

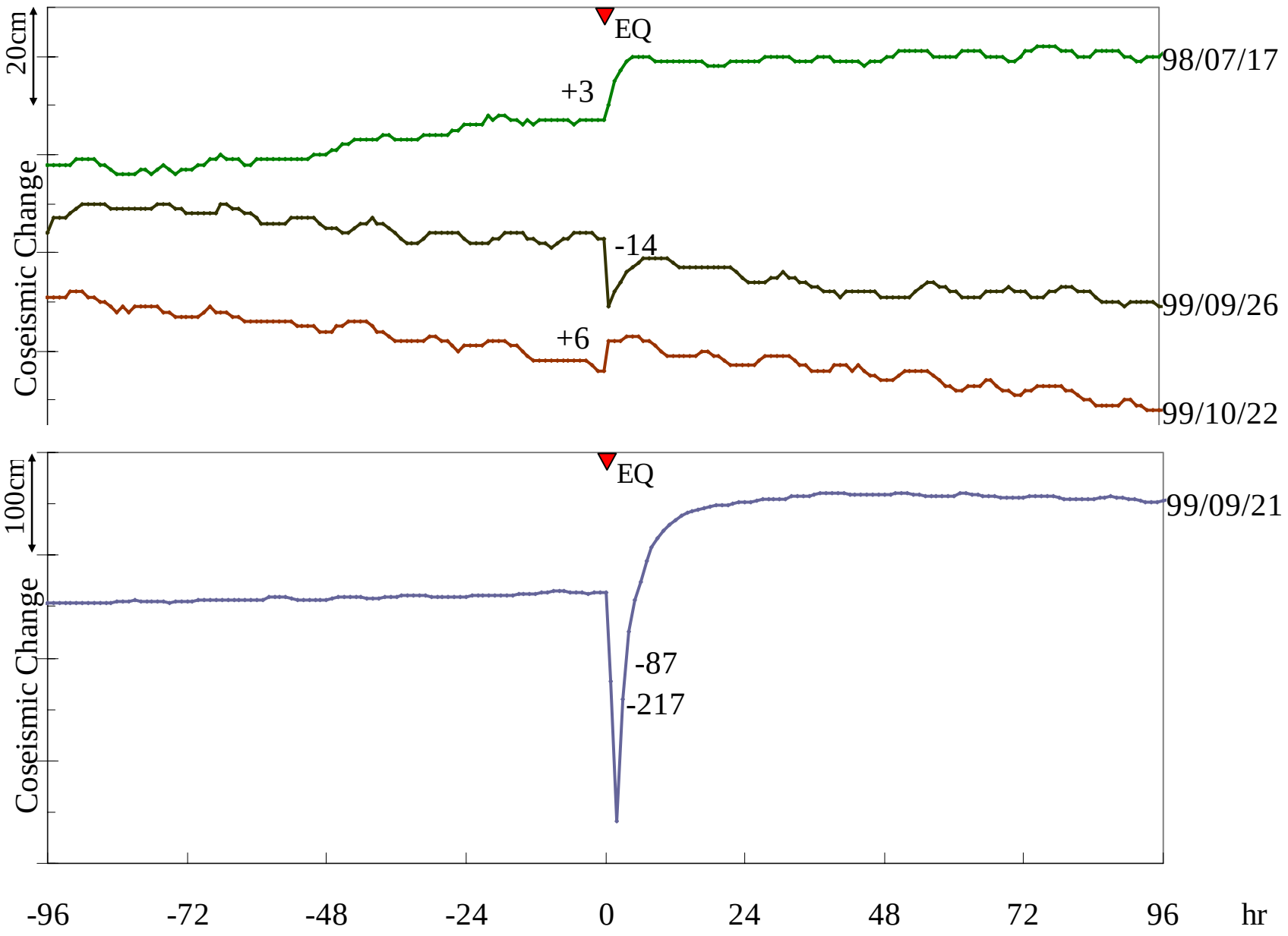
	Fault name	Distance (Km)
1	Changhua Fault	5.4
2	Chelungpu Fault	6.2
3	Gukeng Fault	12.4
4	Damaopu-Shuangtung Fault	15.8



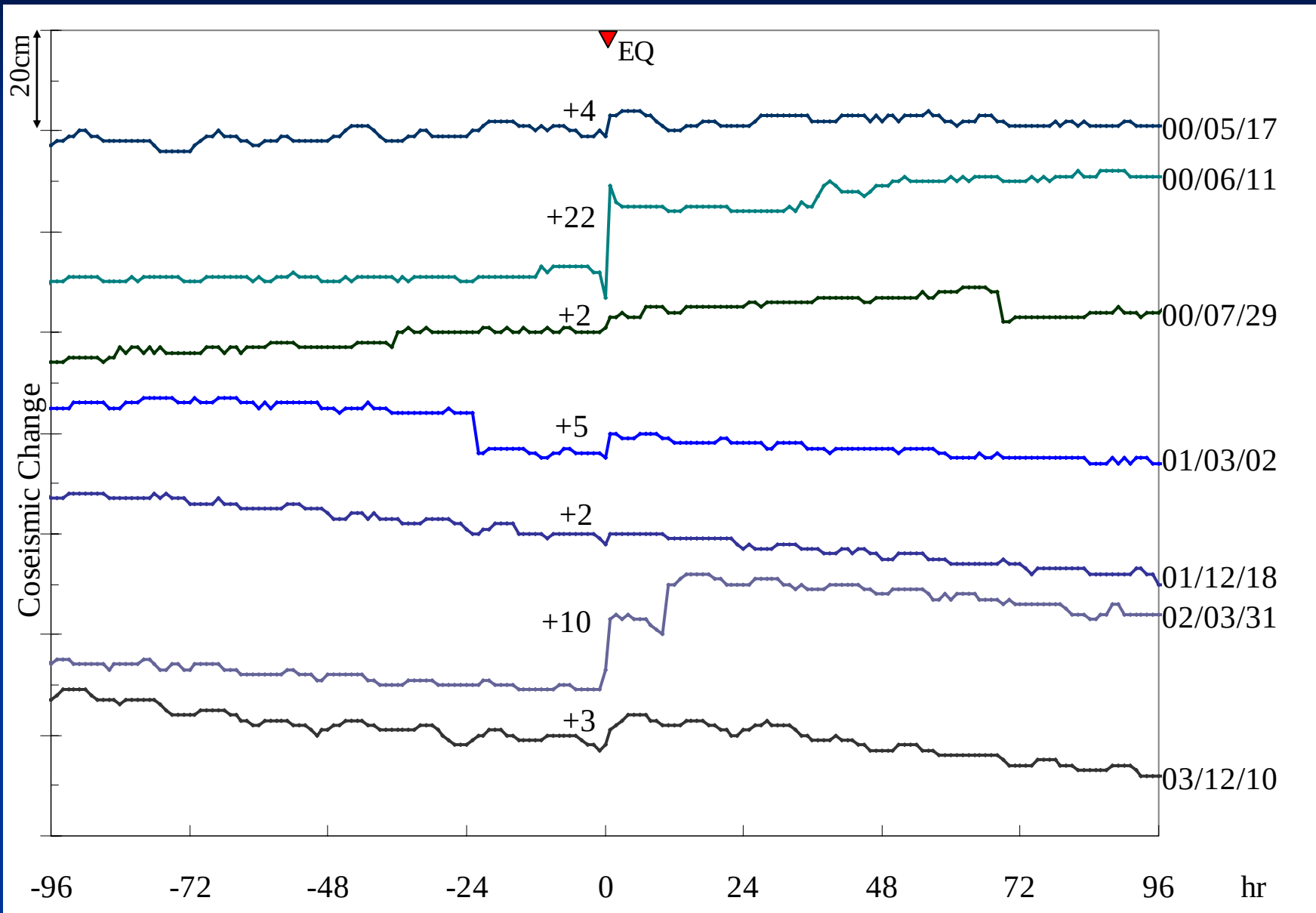
Earthquakes

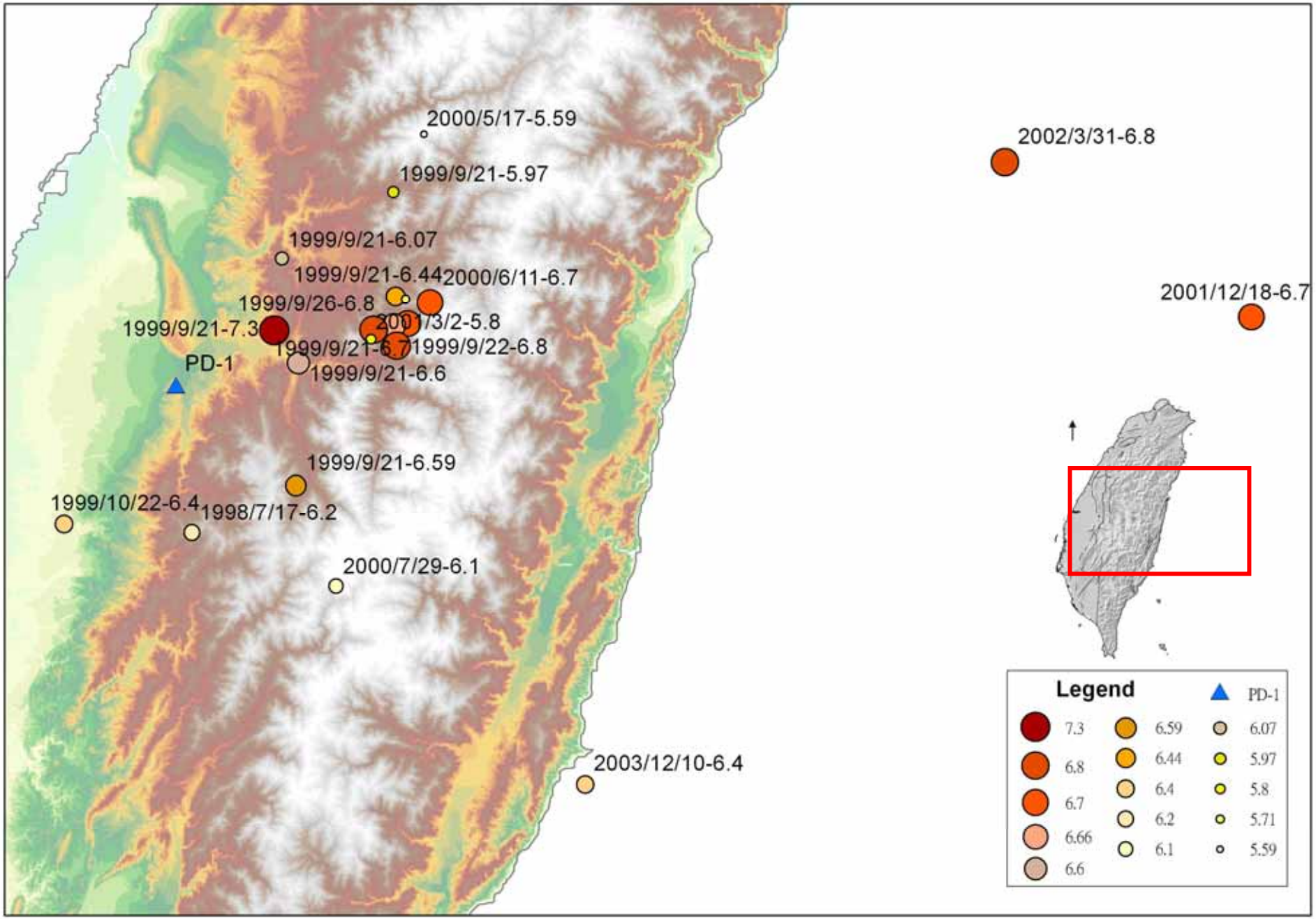
- 1997 to 2005
- $M_L \geq 5.5$
- 78 earthquakes

Coseismic Water Level Responses

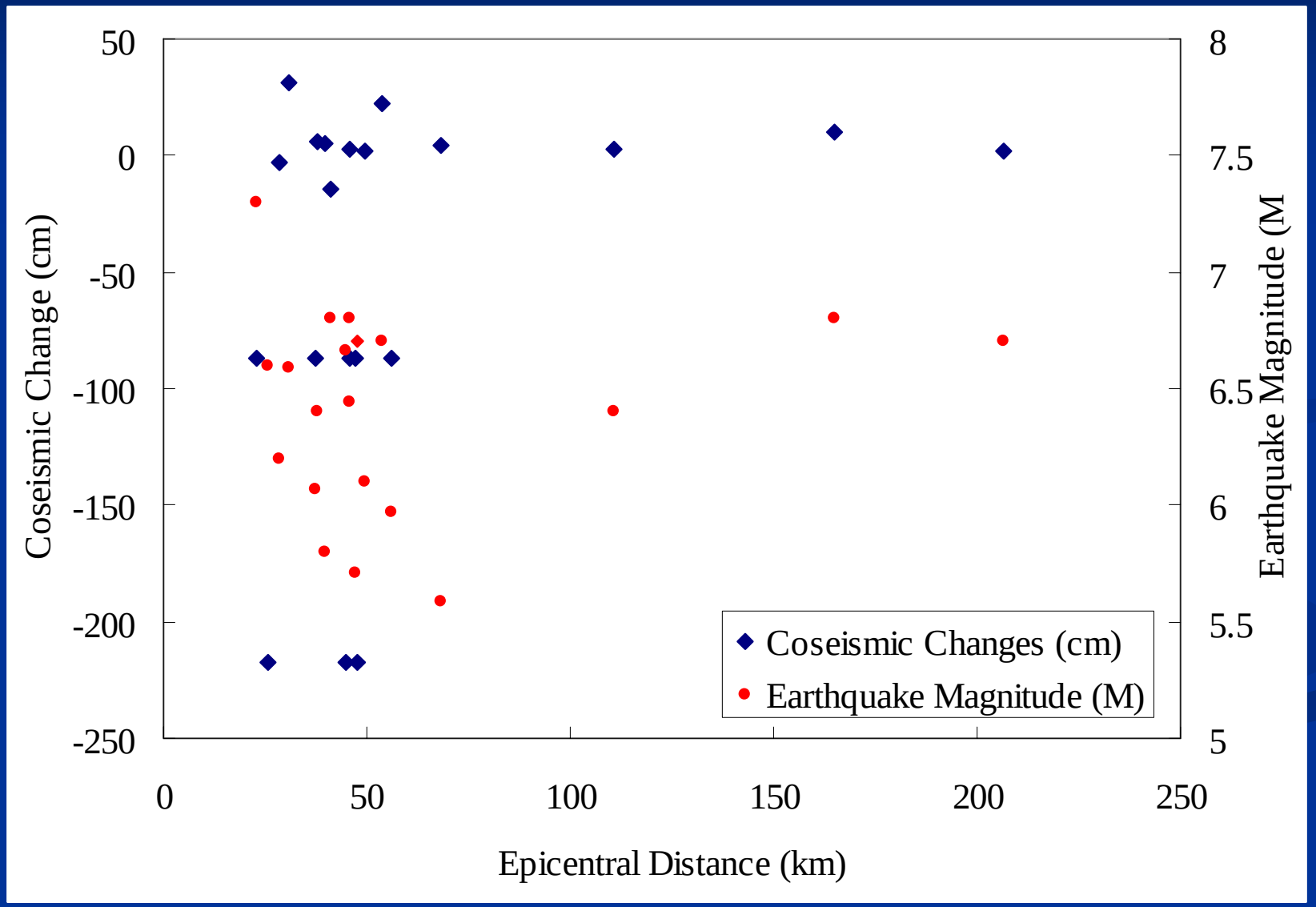


Coseismic Water Level Responses




2000/5/17-5.59
2002/3/31-6.8
1999/9/21-5.97
1999/9/21-6.07
1999/9/21-6.44
2000/6/11-6.7
2001/12/18-6.7
1999/9/26-6.8
1999/9/21-7.3
2001/3/2-5.8
1999/9/21-6.7
1999/9/22-6.8
PD-1
1999/9/21-6.6
1999/9/21-6.59
1999/10/22-6.4
1998/7/17-6.2
2000/7/29-6.1
2003/12/10-6.4
Legend
PD-1
7.3
6.8
6.7
6.66
6.6
6.59
6.44
6.4
6.2
6.1
6.07
5.97
5.8
5.71
5.59

Coseismic Changes & EQ Magnitude vs Epicentral Distance

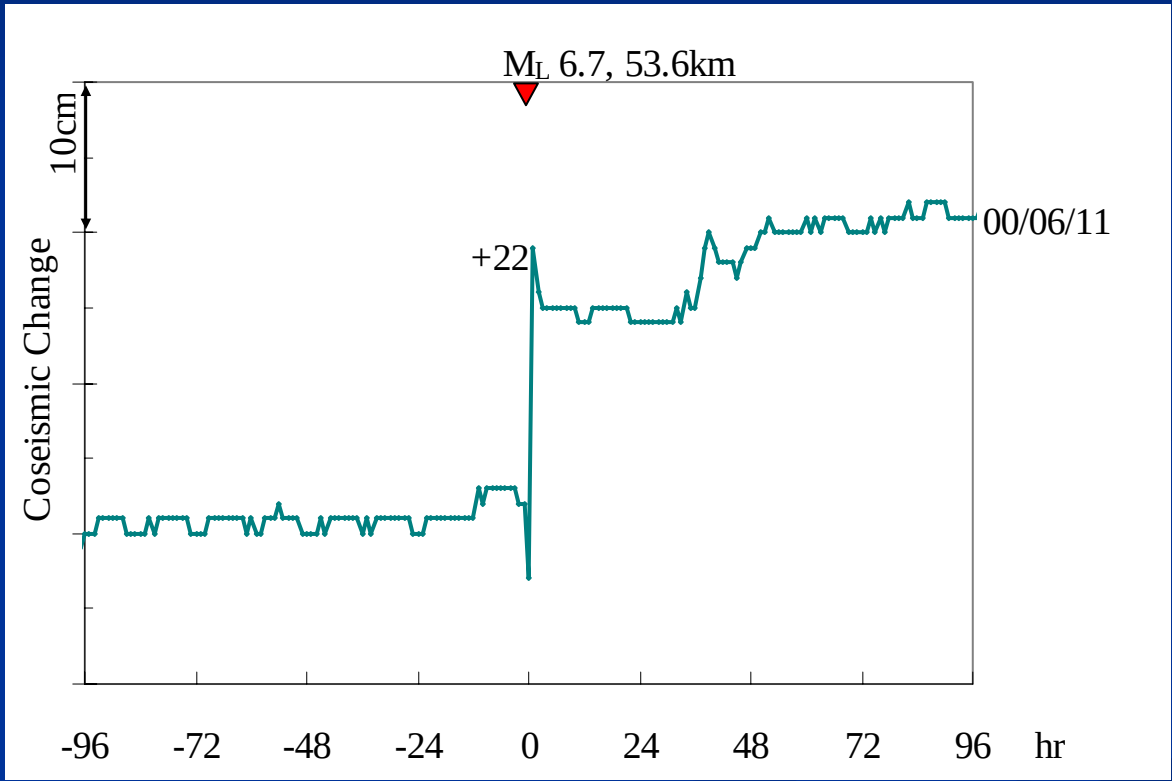


Coseismic Water Level Changes in PD-1

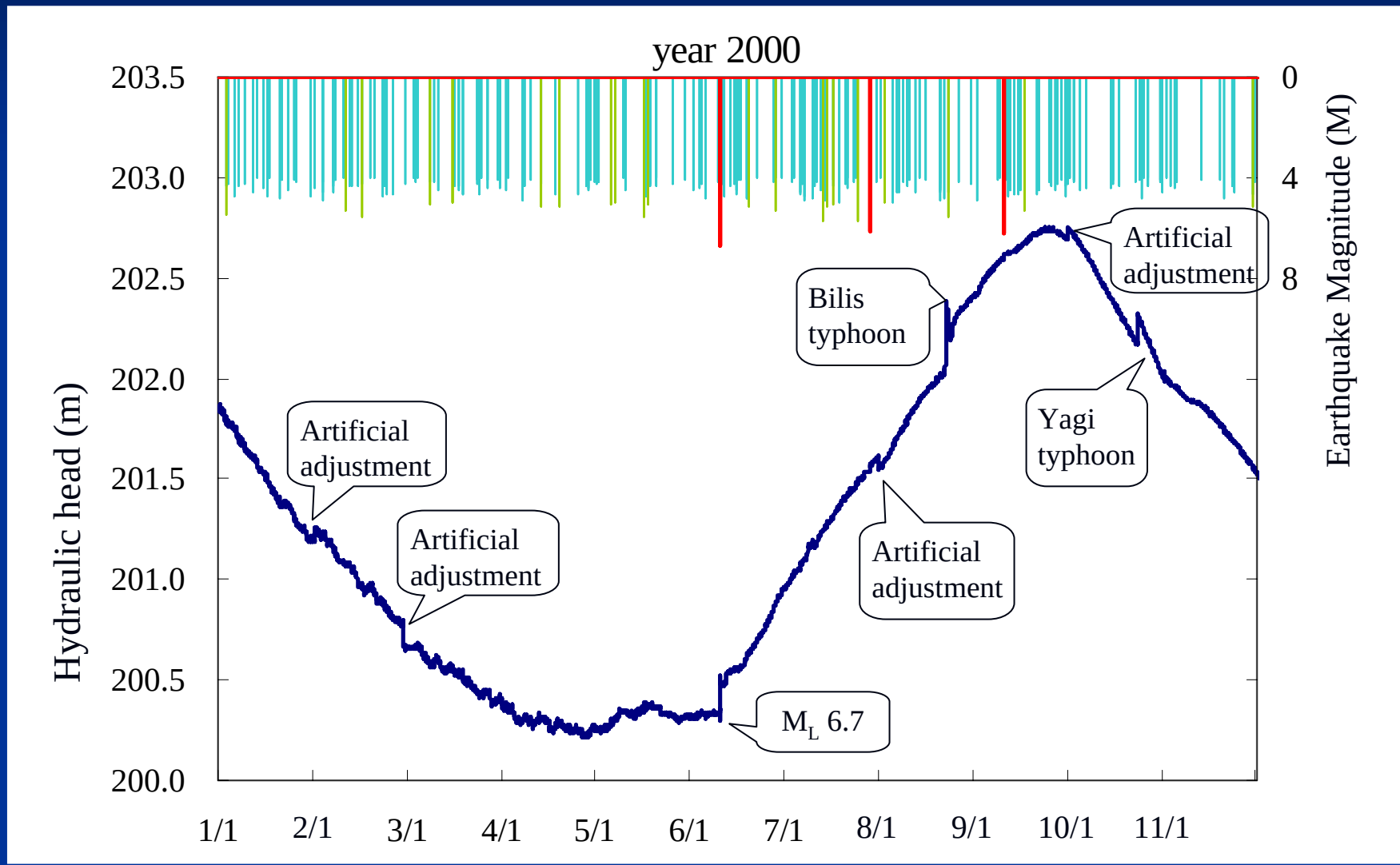
▲ Rise	10
▼ Fall	9
Total	**19**
Starting date	1997/01/01
No. of EQ M $\geq$ 5.5	78
Failure	2
Probability	**0.25**

Pre-seismic Abnormal Change (2000/06/11 M_L6.7 Earthquake)

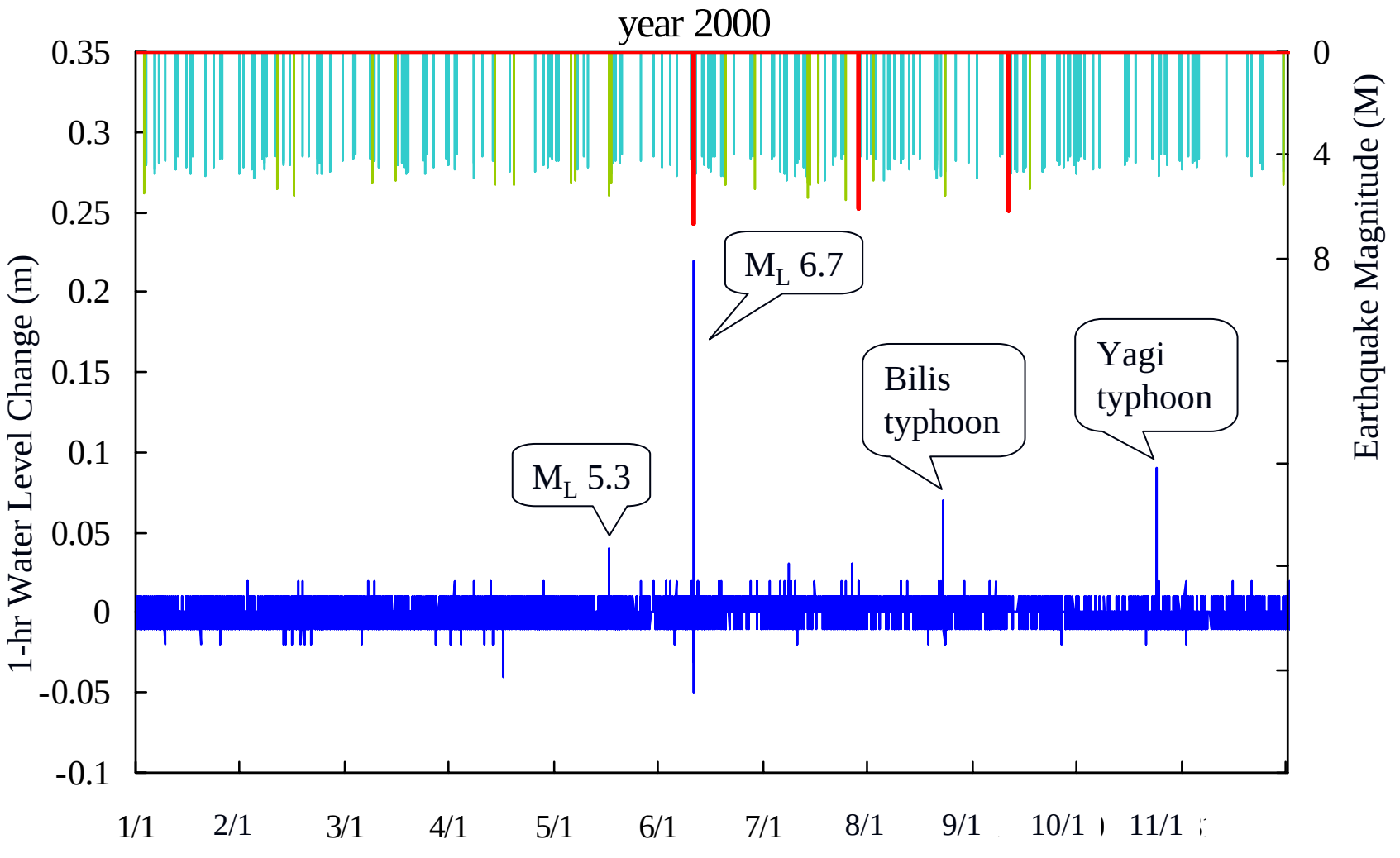
- Coseismic water level change: 22cm rise
- 5 cm fall immediately before coseismic water level rise



Variation of Water Level in 2000



1-hr water level change



Discussion

- Coseismic water level changes
  - Pattern of water level changes
  - Epicentral distance
  - Magnitude
- Pre-seismic abnormal change
  - 2000/06/11 M_L 6.7 Earthquake
  - Approximately 1hr before the earthquake

Conclusions

- The PD-1 well water level is sensitive to earthquakes.
- The process of coseismic change took from less than 1 hr to more than 2 hrs.
- The well water level declined 5 cm immediately before a 22 cm coseismic rise due to the 2000 M_L 6.7 earthquake.
- Located at the fold axis and near several active faults.

Thank you!