Evaluation of coseismic groundwater changes caused by the 2003 Tokachi-oki earthquake

#Naoji Koizumi(1), N. Matsumoto(1),
F. Akita(2), T. Sato(1), and Y. Kitagawa(1)
(1)Geological Survey of Japan, AIST
(2) Geological Survey of Hokkaido

RELATIONSHIP AMONG 3 PRESETATIONS OF Drs.KATO, MATSUMOTO AND ME

ESTABLISHMENT OF HYDROLOGICAL METHOD FOR PREDICTION (Dr.Matsumoto)

APPLICATION TO THE 2003 TOKACHI-OKI EARTHQUAKE (Koizumi)

PORO-ELASTIC THEORY

PHYSICAL BASIS (MODEL) FOR PREDICTION

OF GREAT INTERPLATE EARTHQUAKES (Dr.Kato)

COOPERATION BETWEEN TAIWAN AND JAPAN

ESTABLISHMENT OF HYDROLOGICAL METHOD FOR PREDICTION

APPLICATION AND RESEARCH IN TAIWAN (DPRC, WRA)

PHYSICAL BASIS (MODEL) FOR PREDICTION OF GREAT INTERPLATE EARTHQUAKES

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1. OUTLINE OF THE HYDROLOGICAL CHNAGES RELATED TO THE 2003 TOKACHI-OKI EARTHQUAKE

2. EVALUATION OF THE PRESEISMIC GROUNDWATER CHANGE

3. EVALUATION OF THE COSEISIMIC GROUNDWATER CHANGE

PURPOSE

1. EVALUATION OF THE PORO-ELASTIC MODEL USED IN OUT HYDROLOGICAL METHOD FOR EARTHQUAKE PREDICTION

2. EVALUATION FOR LONG-TERM GROUNDWATER MOVEMENT FOR GEOLOGICAL DISPOSAL OF NUCLEAR WASTE

The Tokachi-oki earthquake in 2003 (M 8.0, 26 September, 2003)

Missing peoples: 2

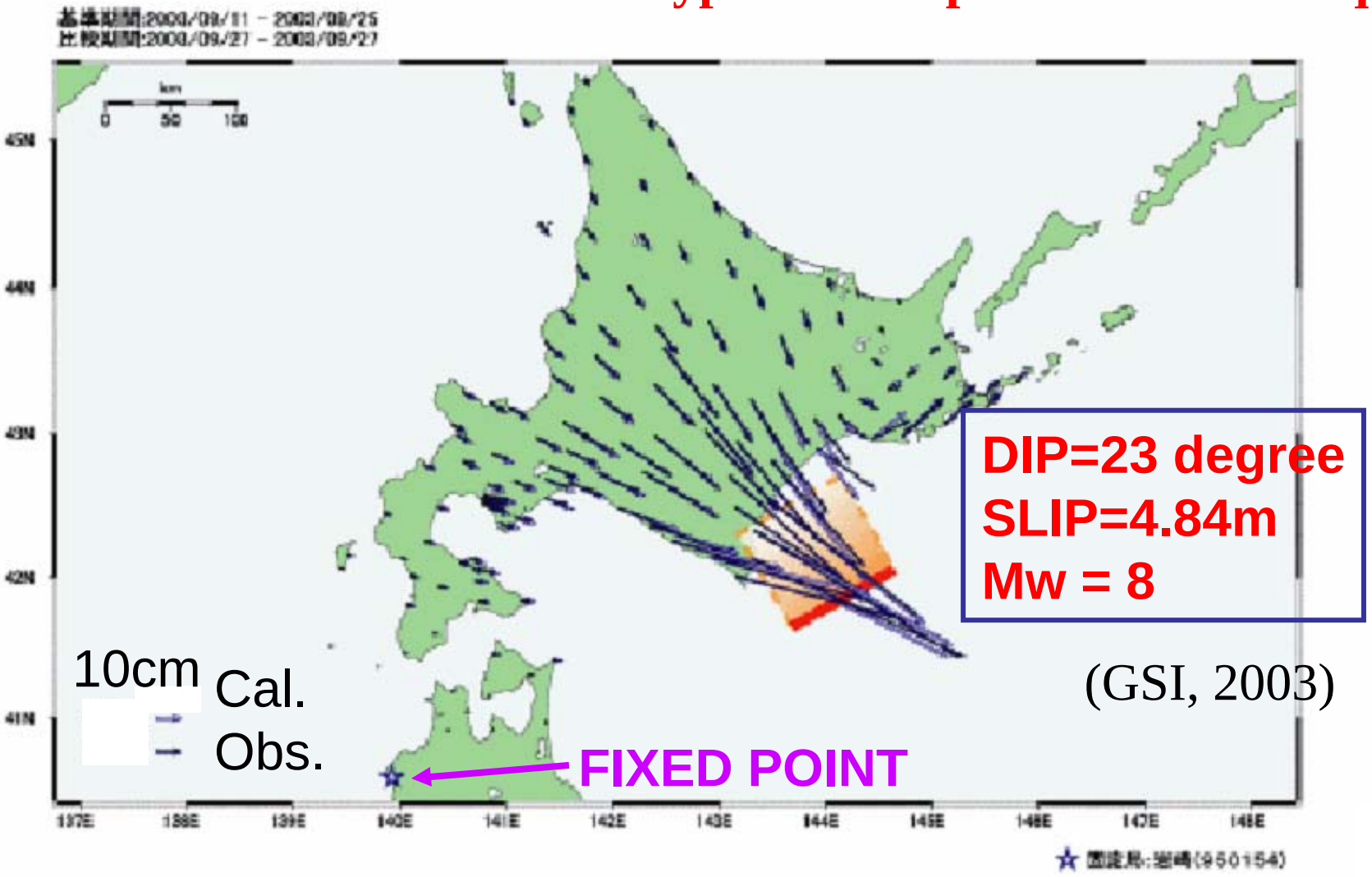
Injured peoples: 847

Damage: 27 billion yen

1) OUTLINE OF THE 2003 TOKACHI-OKI EARTHQUAKE

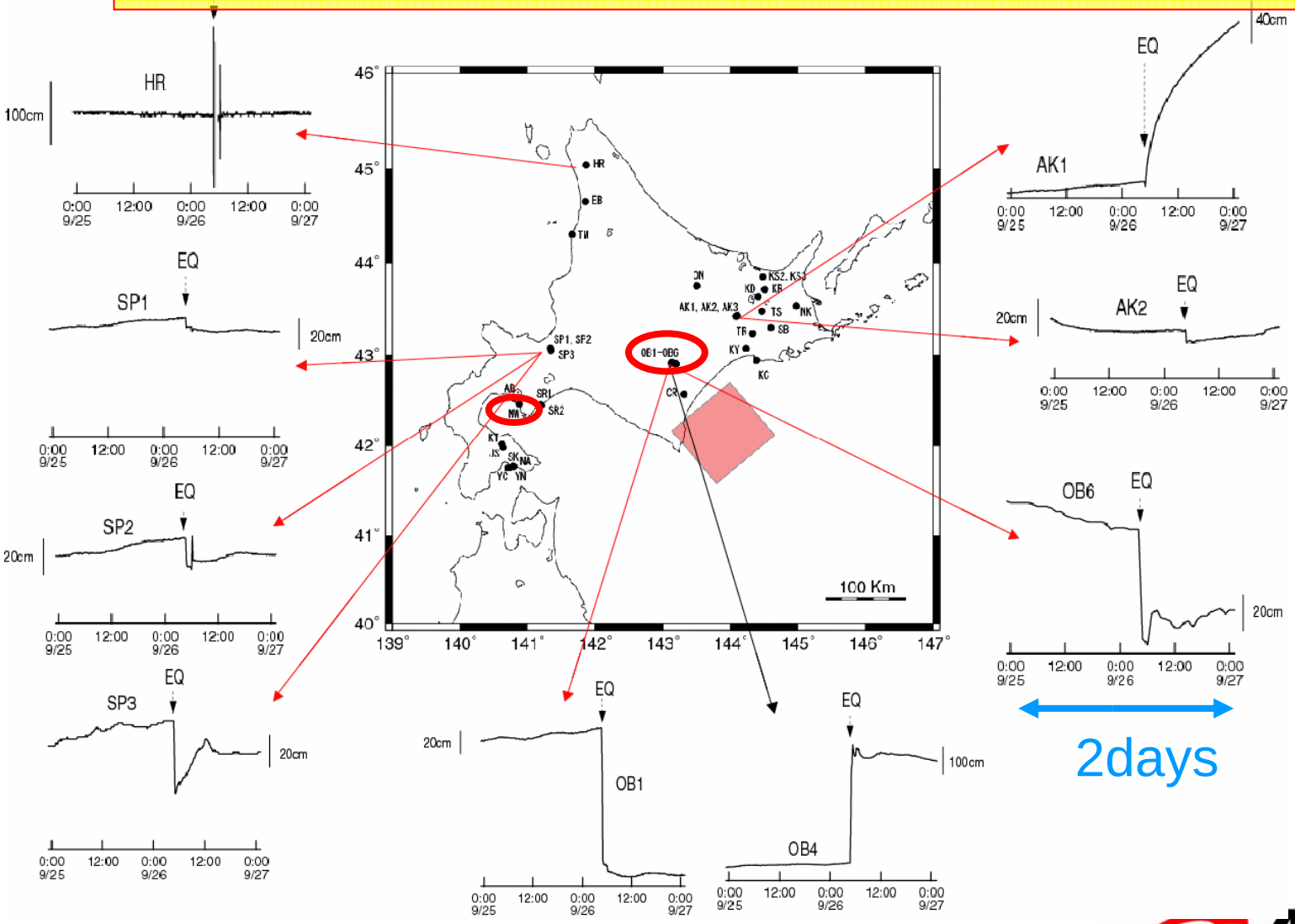
GPS OBSERVATION and THE ESTIMATED FAULT MODEL

Typical inter-plate thrust earthquake



1) OUTLINE OF THE 2003 TOKACHI-OKI EARTHQUAKE

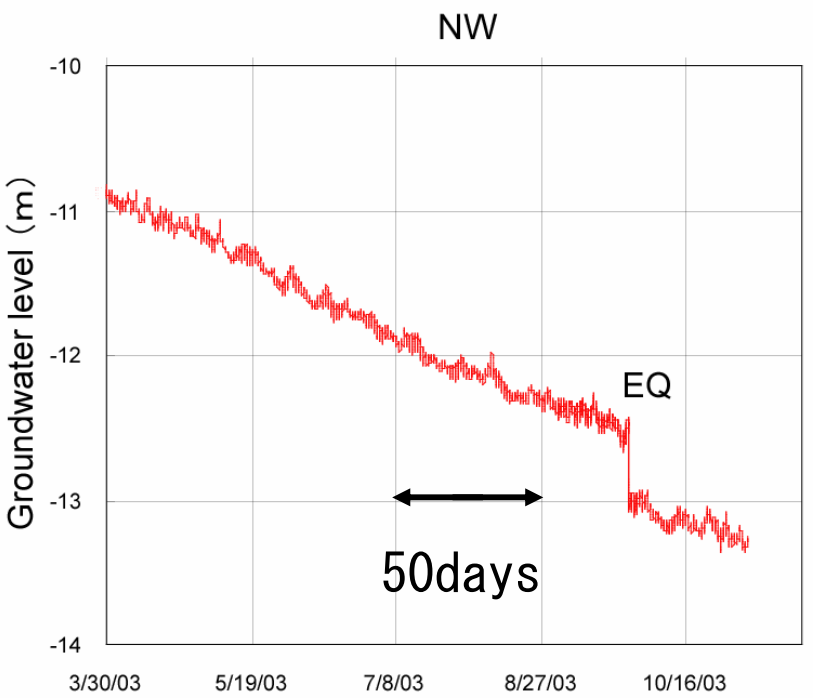
Observed groundwaters in Hokkaido: 32, confined.
Screened depths: 24-1488m, Most of them>100m

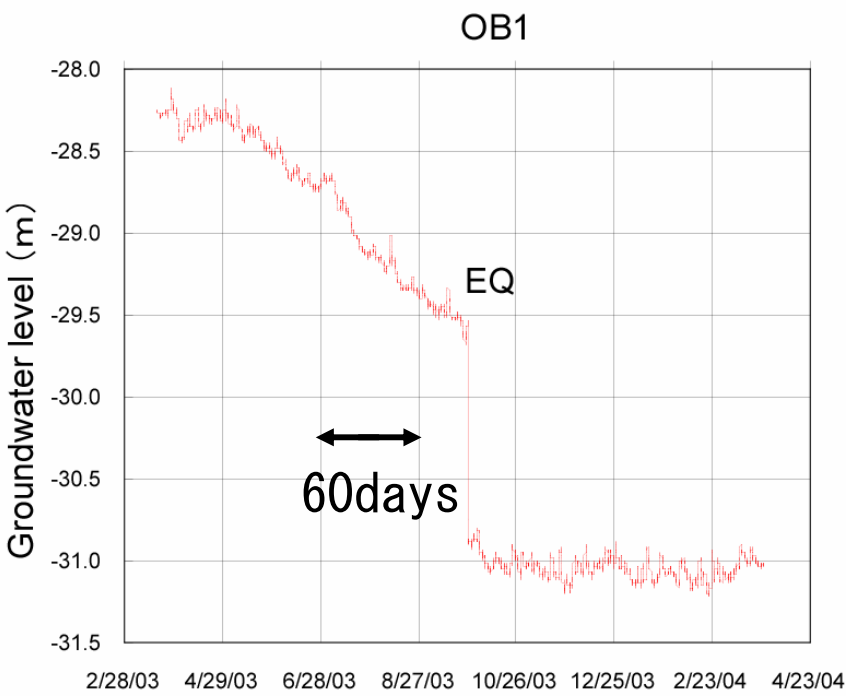


2) PRESEISMIC CHANGE

NO PRESEISMIC CHNAGE

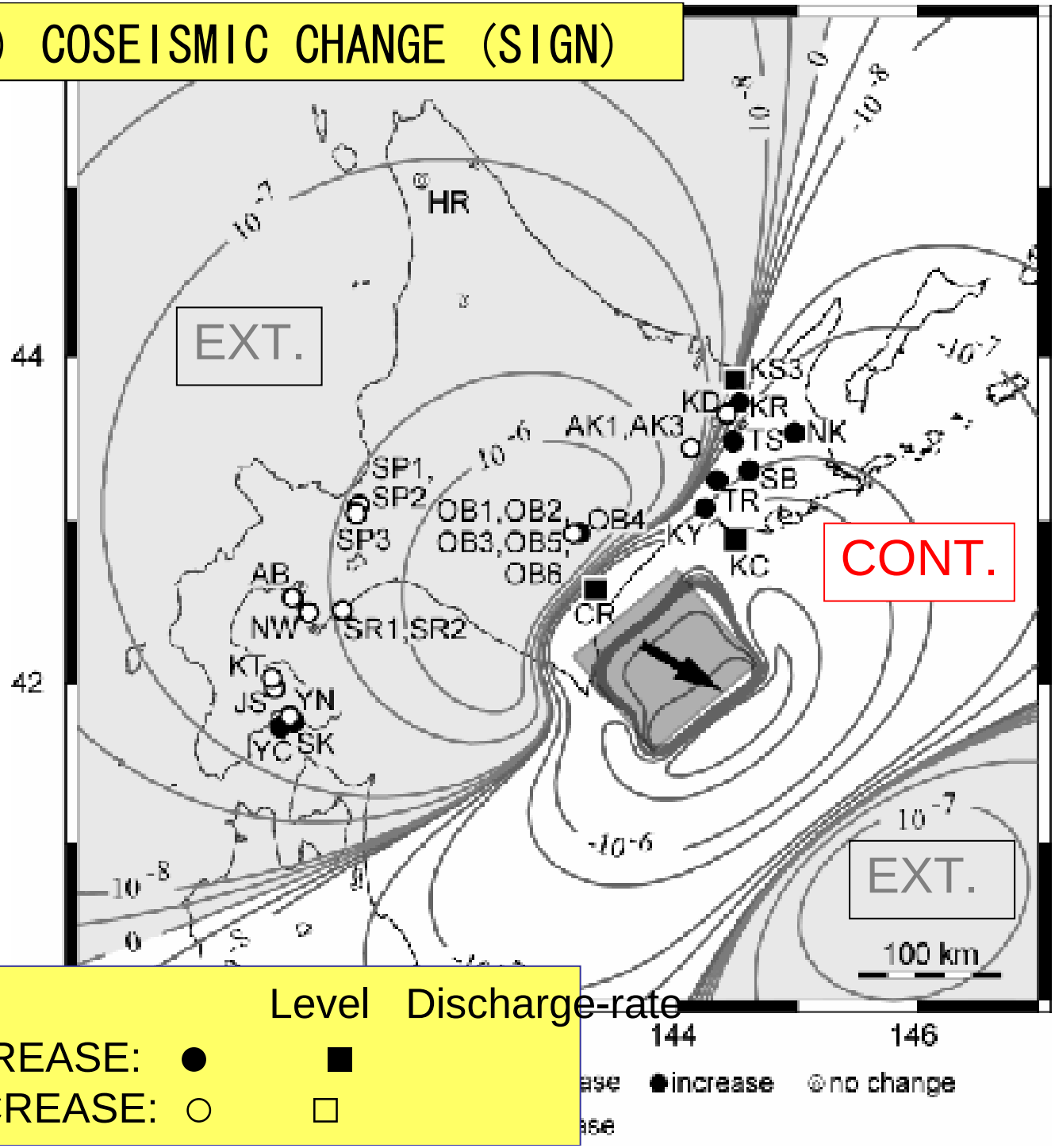
CLEAR COSEISIC CHANGE





EXAMPLES OF THE LONG-TERM GROUNDWATER LEVEL CHANGES

2-1) COSEISMIC CHANGE (SIGN)



Level Discharge-rate

INCREASE: ● ■

DECREASE: ○ □

29 of the 32 coseismic changes can be explained by poro-elastic responses to the coseismic static volumetric strain changes.

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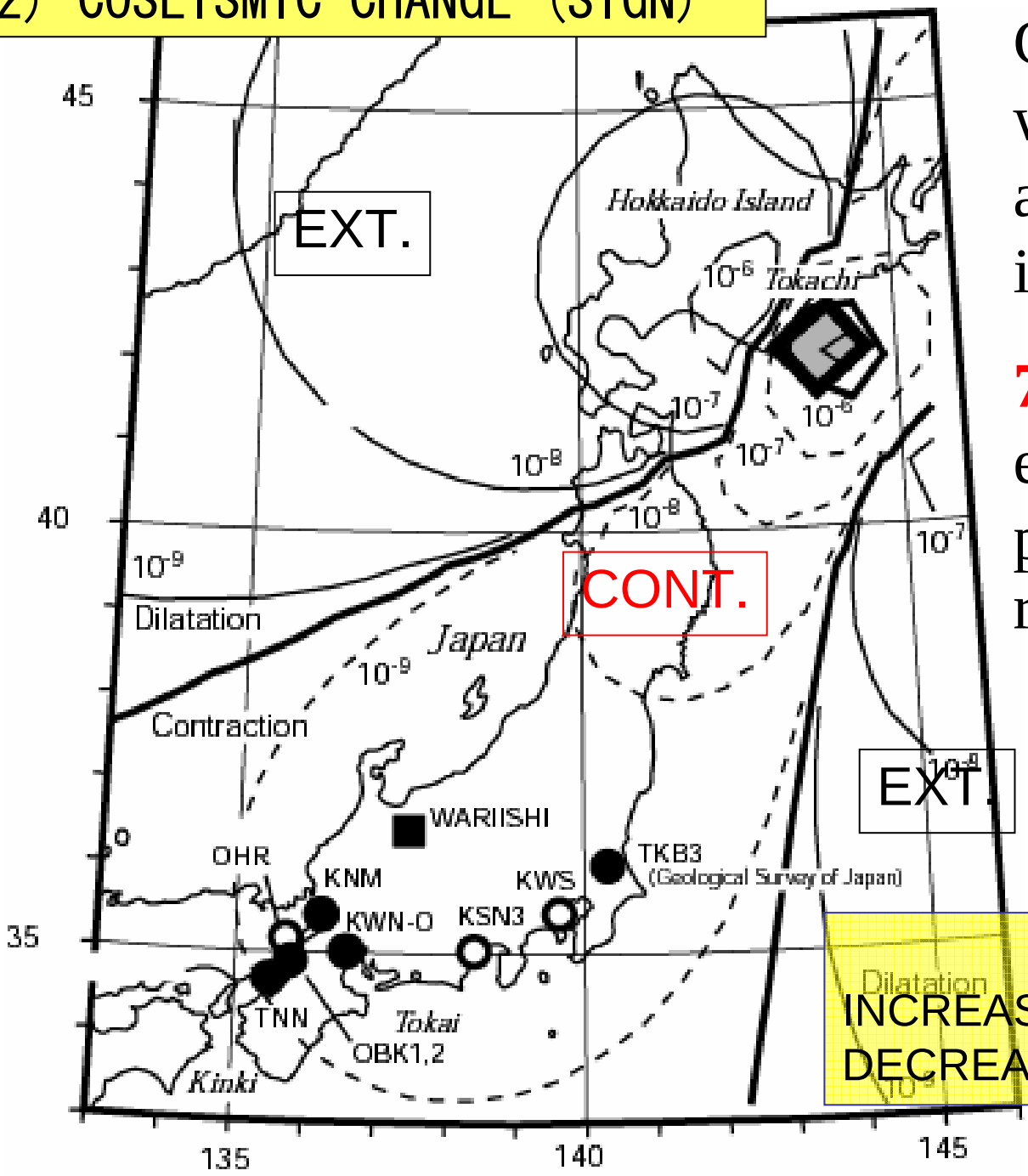
2-2) COSEISMIC CHANGE (SIGN)



Coseismic changes were also detected at **10** of the **42** wells in Honshu.

7 changes can be explained by the poro-elastic responses.

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WHY IS THE COSEISMIC CHANGES IN HOKKAIDO EXPLAINED WELL BY STATIC VOLUMETRIC STRAIN CHANGES?

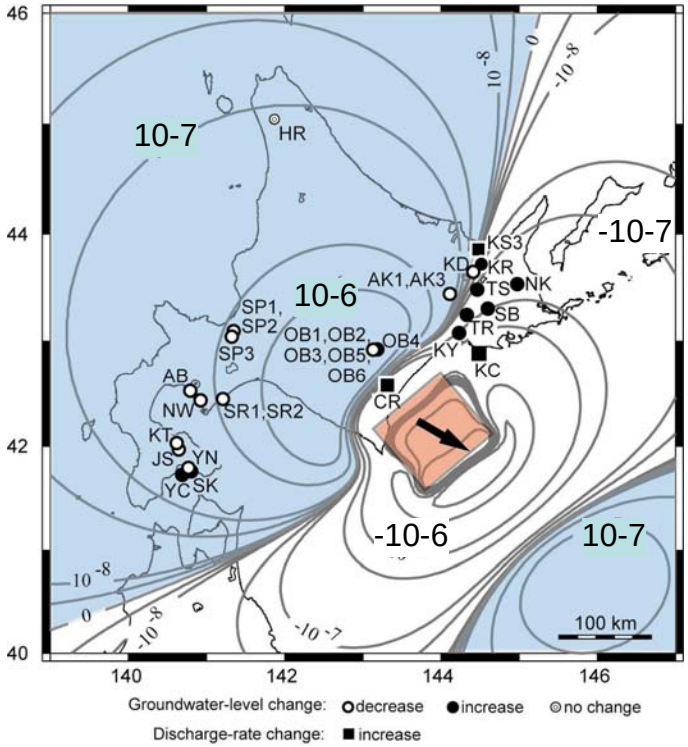
TWO MAIN FACTORS OF HYDROLOGICAL COSEISMIC CHANGES

	STATIC VOLULETRIC STRAIN CHANGE	SEISMIC WAVE(INTENSITY)	
		Liquefaction	Permeability Enhancement
UNCONFINED (SHALLOW) GROUNDWATER	X	○	
CONFINED (DEEP) GROUNDWATER	○	△	
ATTENUATION	LARGER	SMALLER	

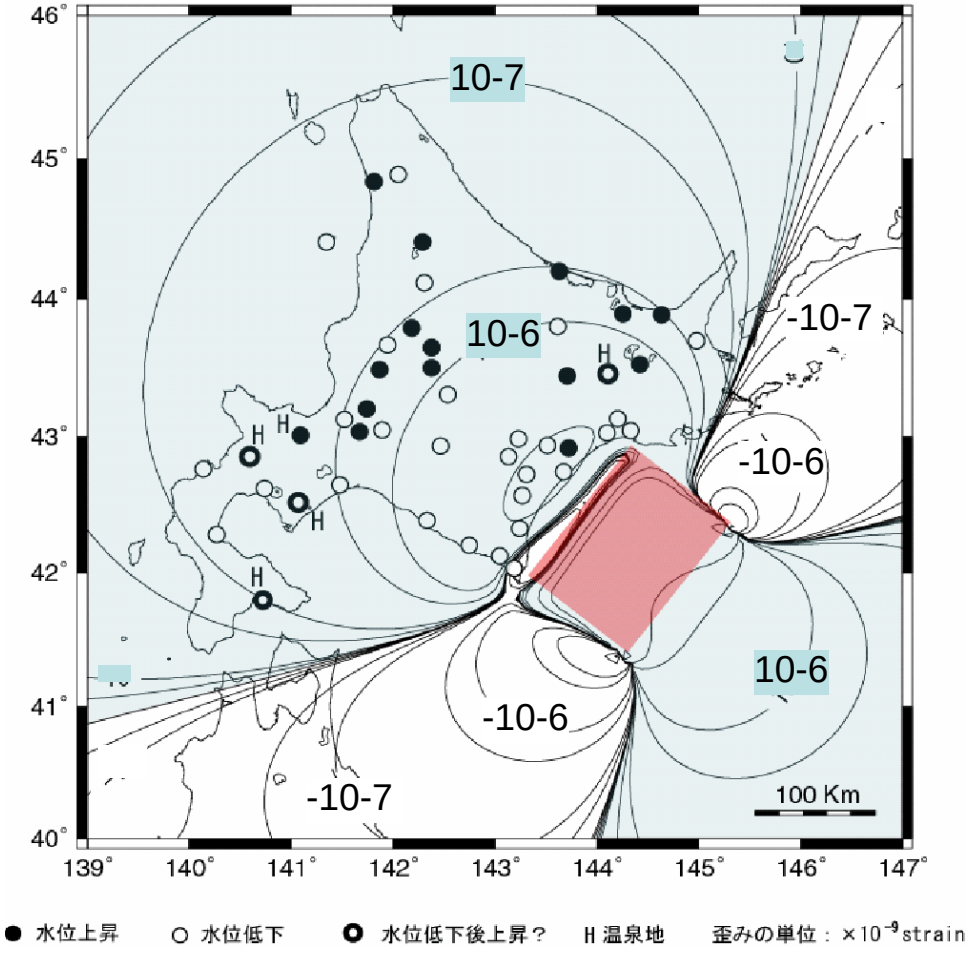
NEAR-FIELD DEEP and CONFINED GROUNDWATER IS SENSITIVE TO COSEISMIC VOLUMETRIC STRAIN CHANGE

2-1) COSEISMIC CHANGE (SIGN)

Comparison of coseismic response to the 1952 Tokachi-oki earthquake with that to the 2003 Tokachi-oki earthquake.



2003 M8.0



1952 M8.2

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2-2) COSEISMIC CHANGE (AMPLITUDE)

FOR CHECKING THE AMPLITUDES IN COSEISMIC CHANGES

OBSERVED **TIDAL** GROUNDWATER LEVEL CHANGE

THEORETICAL **TIDAL** STRAIN CHANGE

STRAIN SENSITIVITY OF THE GROUNDWATER LEVEL

THEORETICAL **COSEISMIC STRAIN CHANGE FROM THE FAULT MODEL**

PREDICTED COSEISMIC GROUNDWATER LEVEL CHANGE BASED ON PORO-ELASTIC THEORY

COMPARISON

OBSERVED COSEISMIC GROUNDWATER LEVEL CHANGE

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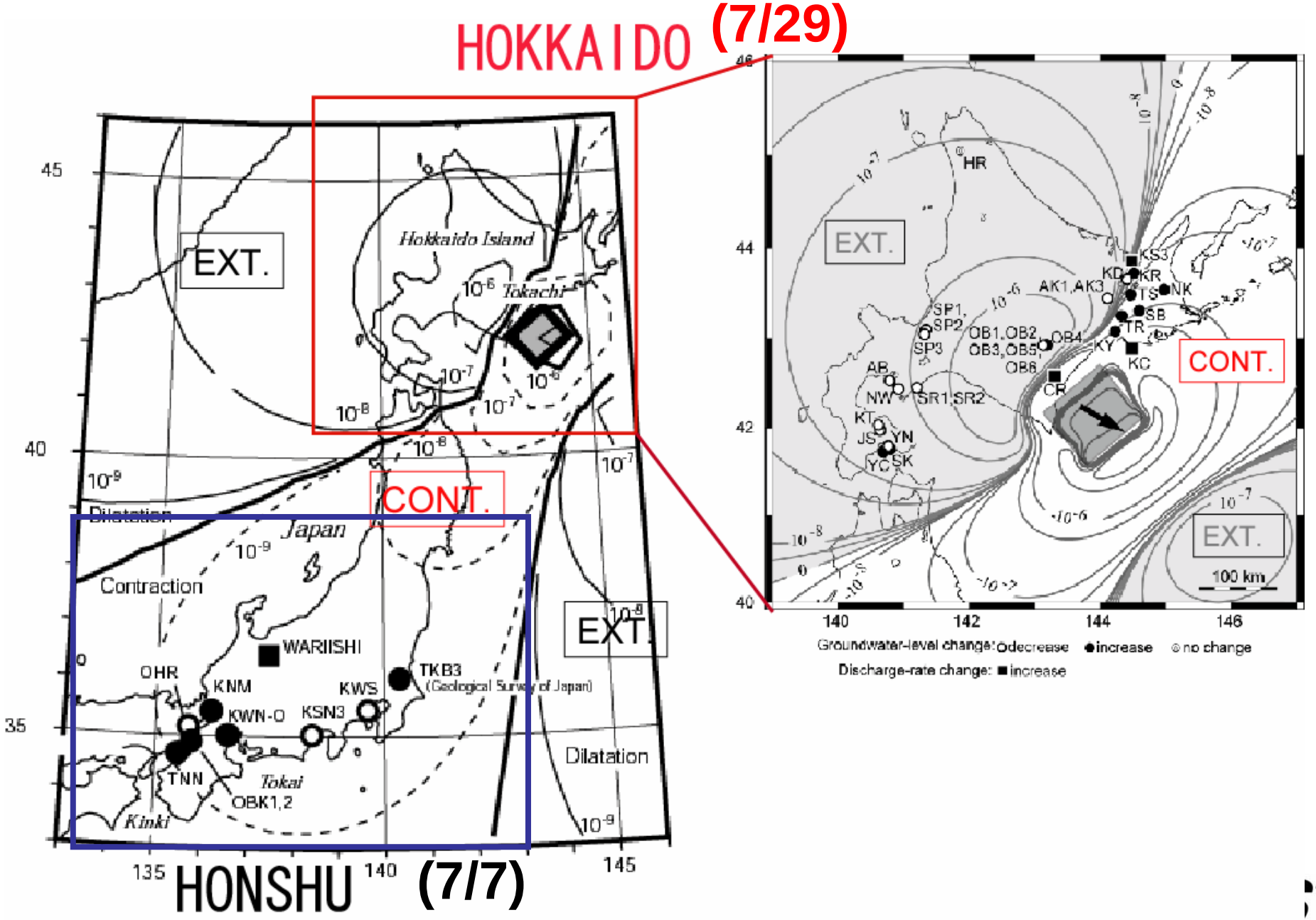
2-2) COSEISMIC CHANGE (AMPLITUDE)



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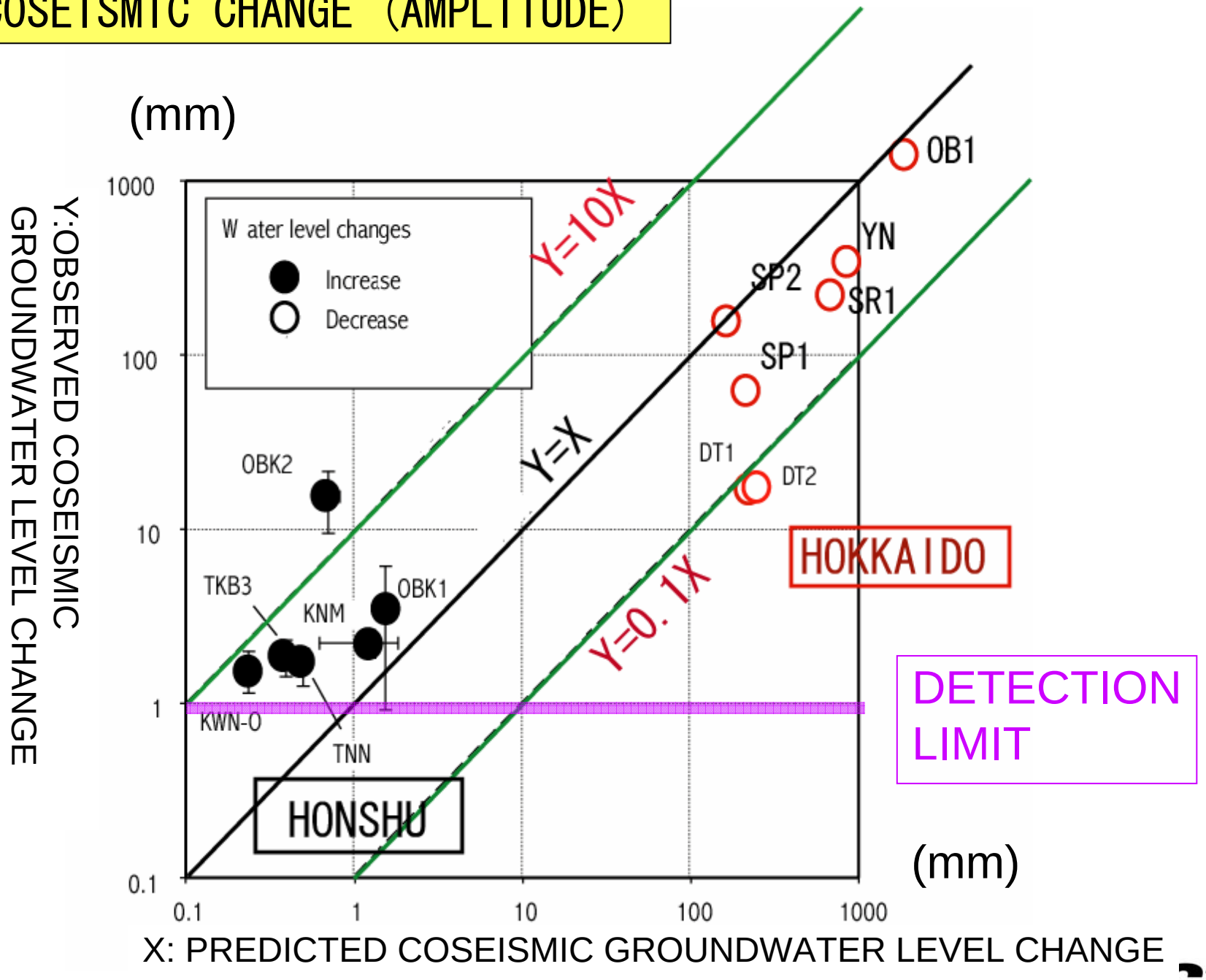

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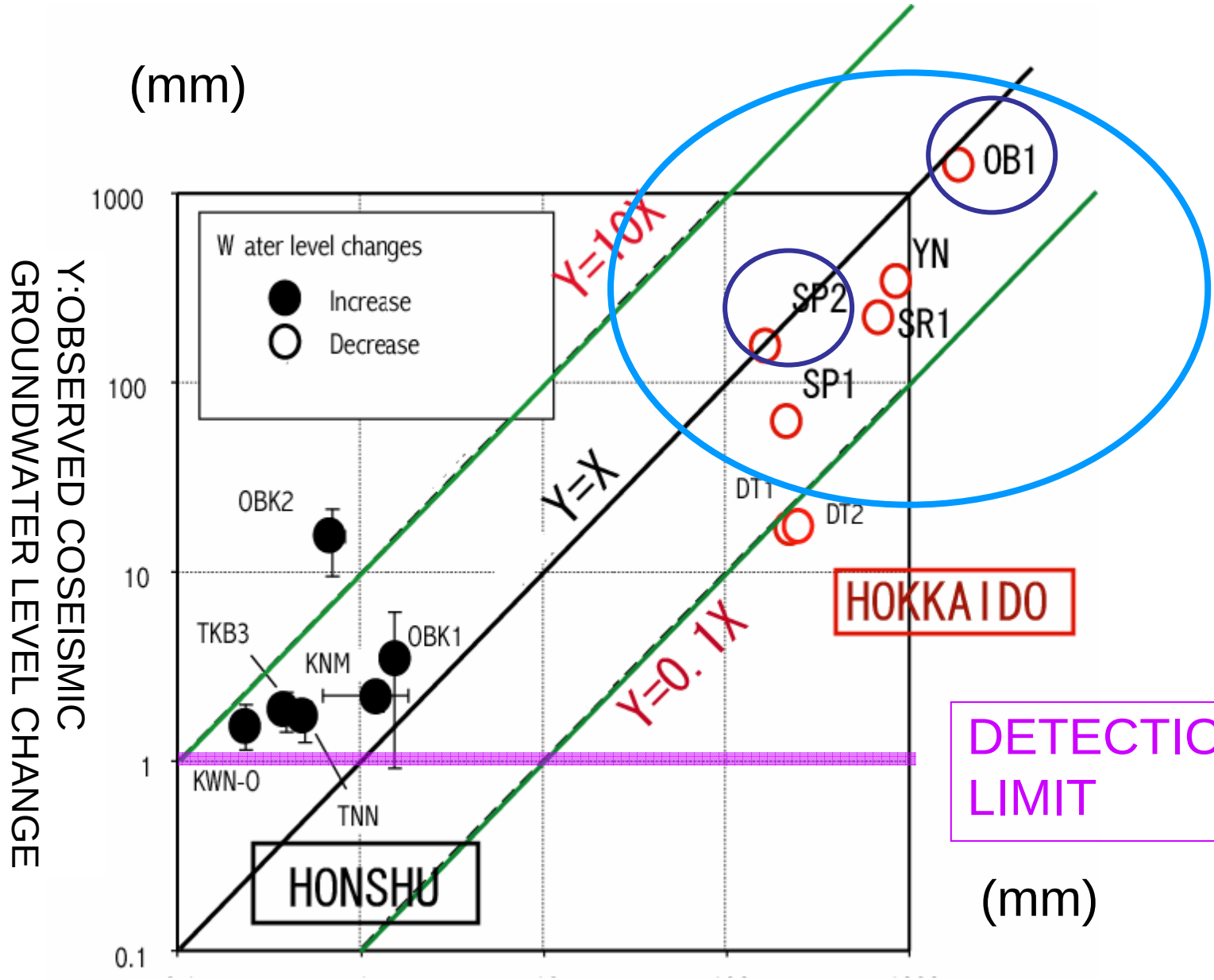
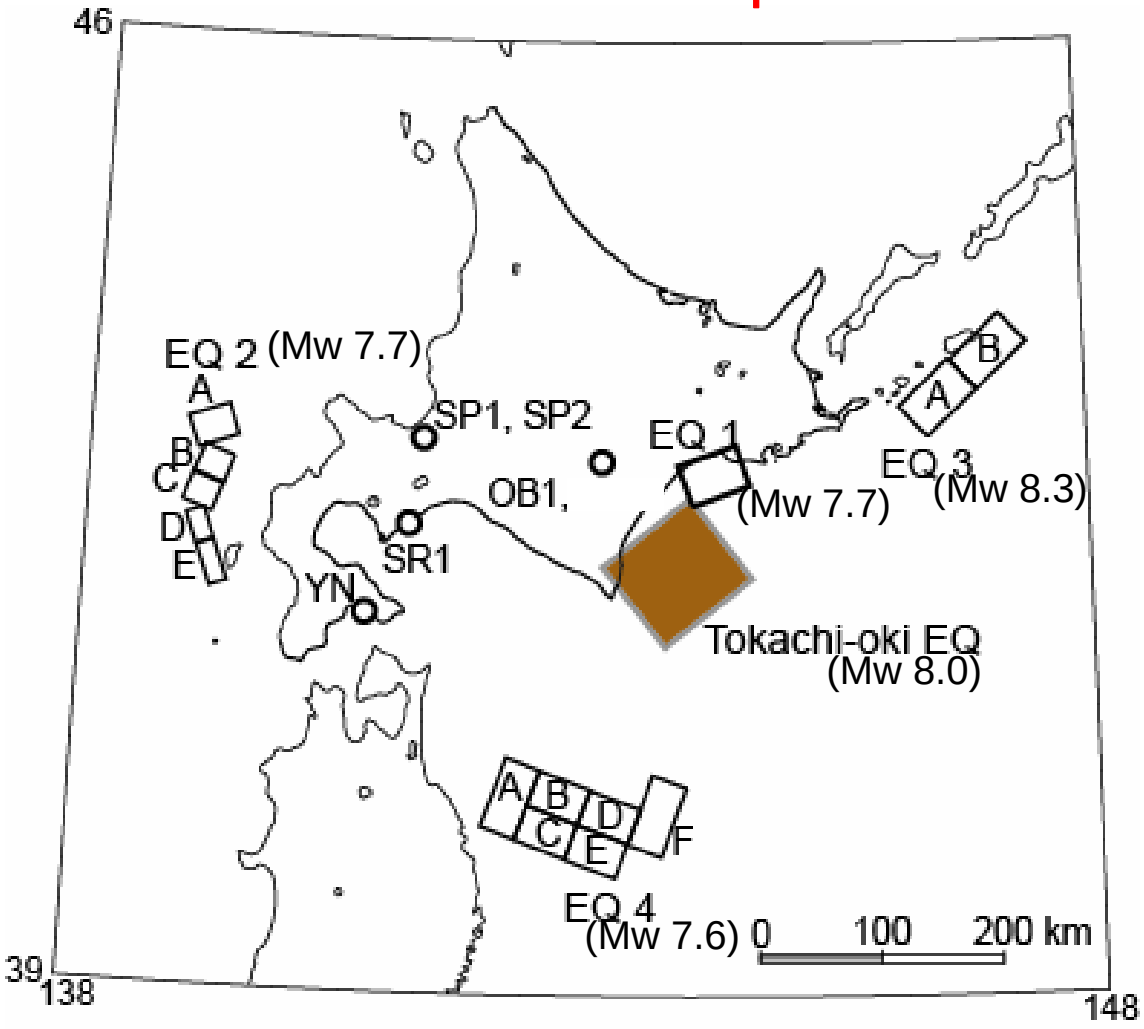


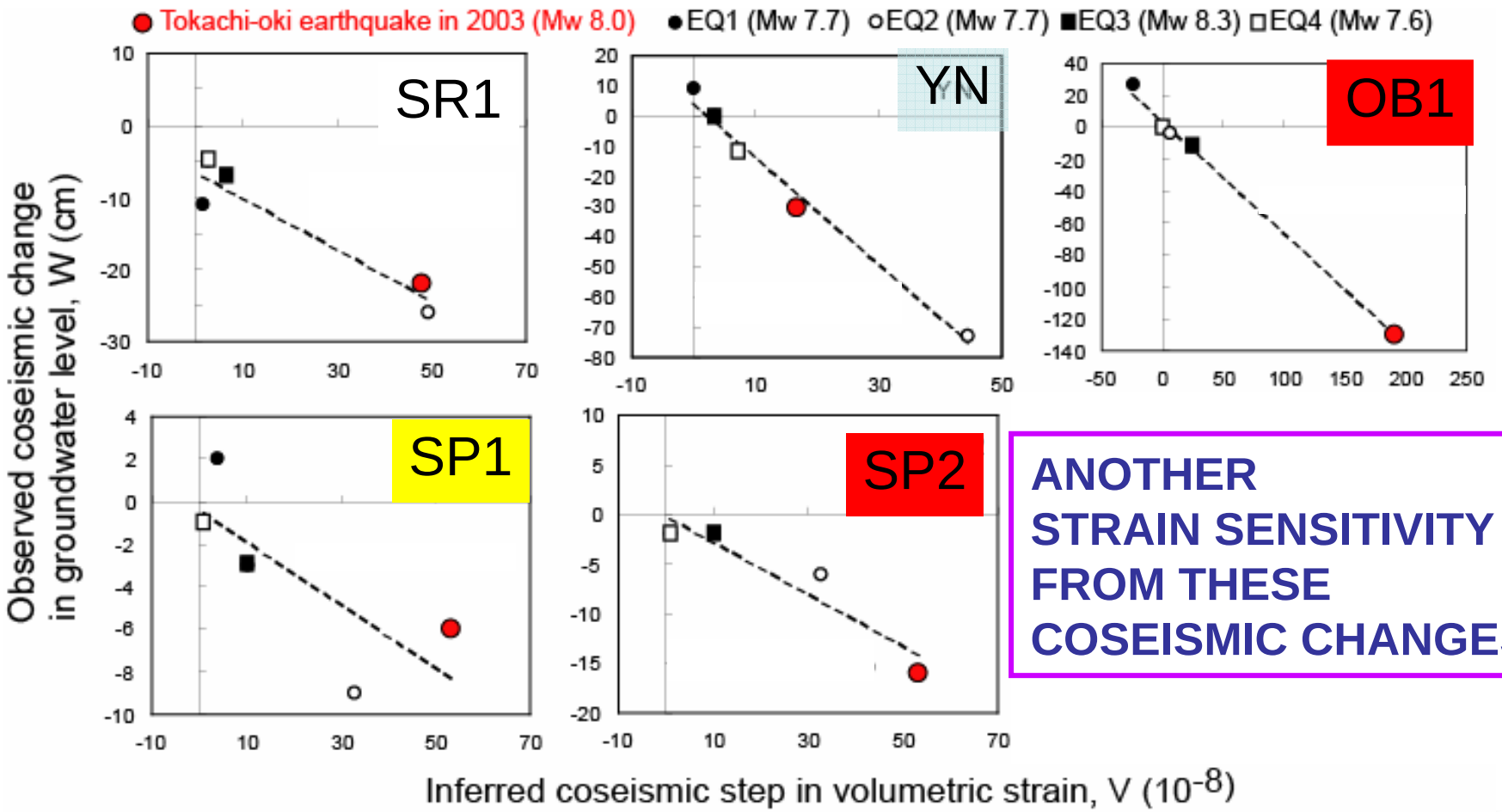
2-2) COSEISMIC CHANGE (AMPLITUDE)

Positions of the Five Wells,
Four Large Earthquakes (Mw > 7.5) in 1993 -1994
and the 2003 Tokachi-oki Earthquake



2-2) COSEISMIC CHANGE (AMPLITUDE)

Coseismic strain steps vs groundwater level changes in the 5 wells after the 5 large earthquakes



ANOTHER STRAIN SENSITIVITY FROM THESE COSEISMIC CHANGES!

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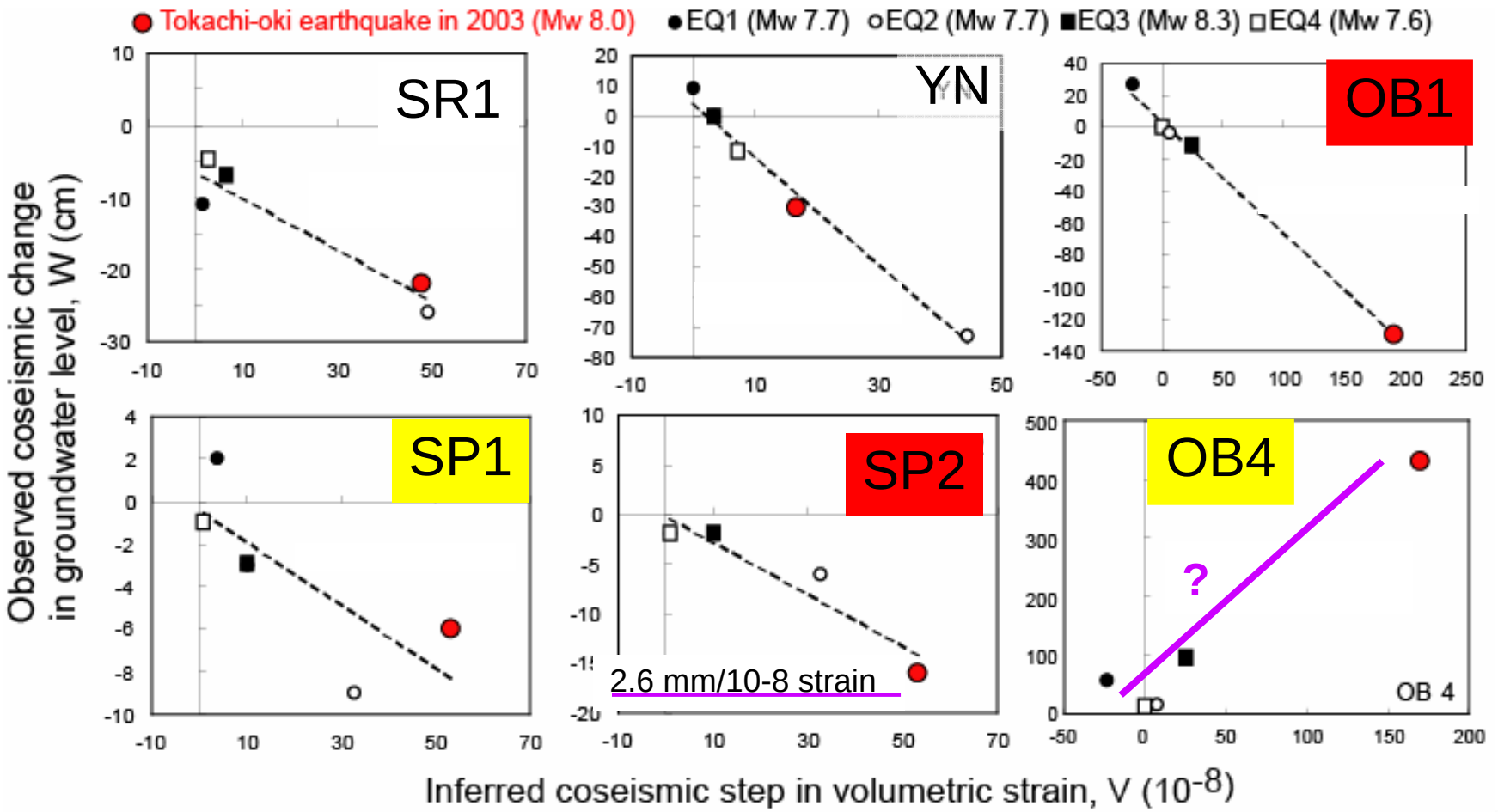
2-2) COSEISMIC CHANGE (AMPLITUDE)

Coseismic strain steps vs groundwater level changes in the 5 wells after the 5 large earthquakes



COMPARISON OF WELL STRUCTURES IN SP1 AND SP2

well name	Screened Depth (m)	gwl change	Strain (10-8)
SP1	288-310 354-376	-6	53.2
SP2	539-594	-16	53.2

2-2) COSEISMIC CHANGE (AMPLITUDE)

COMPARISON OF WELL STRUCTURES IN OB1 AND OB4

well name	Screened Depth (m)	gwl change(cm)	strain (10-8)
OB1	950-1060	-130	191.
OB4	1235-1400	430	170.

SOME POSSIBILITY OF MIXING SHALLOW GROUNDWATERS

CONCLUSION

1. EVALUATION OF THE PRESEISMIC GROUNDWATER CHANGE

NEITHER GROUNDWATER CHANGE NOR CRUSTAL DEFORMATION RELATED TO THE PRESLIP (PRESEISMIC SLIDING)

THERE WAS NO PRESLIP (Mw>=6) IN THE FOCAL REGION OF THE 2003 TOKACHI-OKI EARTHQUAKE.

2. EVALUATION OF THE COSEISIMIC GROUNDWATER CHANGE

2-1 SIGNS OF THE COSEISMIC CHANGES

THER ARE WELL EXPLAINED BY VOLUMETRIC STRAIN CHNAGES AND PORO-ELASTIC THEORY.

IT IS PROBABLY BECAUSE THEY ARE NEAR-FIELD DEEP CONFINED GROUNDWATER RESPONSES TO THE EARTHQUAKE.

2-2 AMPLITUDES OF THE COSEIMIC CHNAGES

SOME WELL-WATERS SHOW SIMPLE PORO-ELASTIC RESPONSES. BUT THE **REASON** OR **CONDITION** FOR IT **IS NOT CLEAR**.

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THANK YOU FOR YOUR INTEREST!!

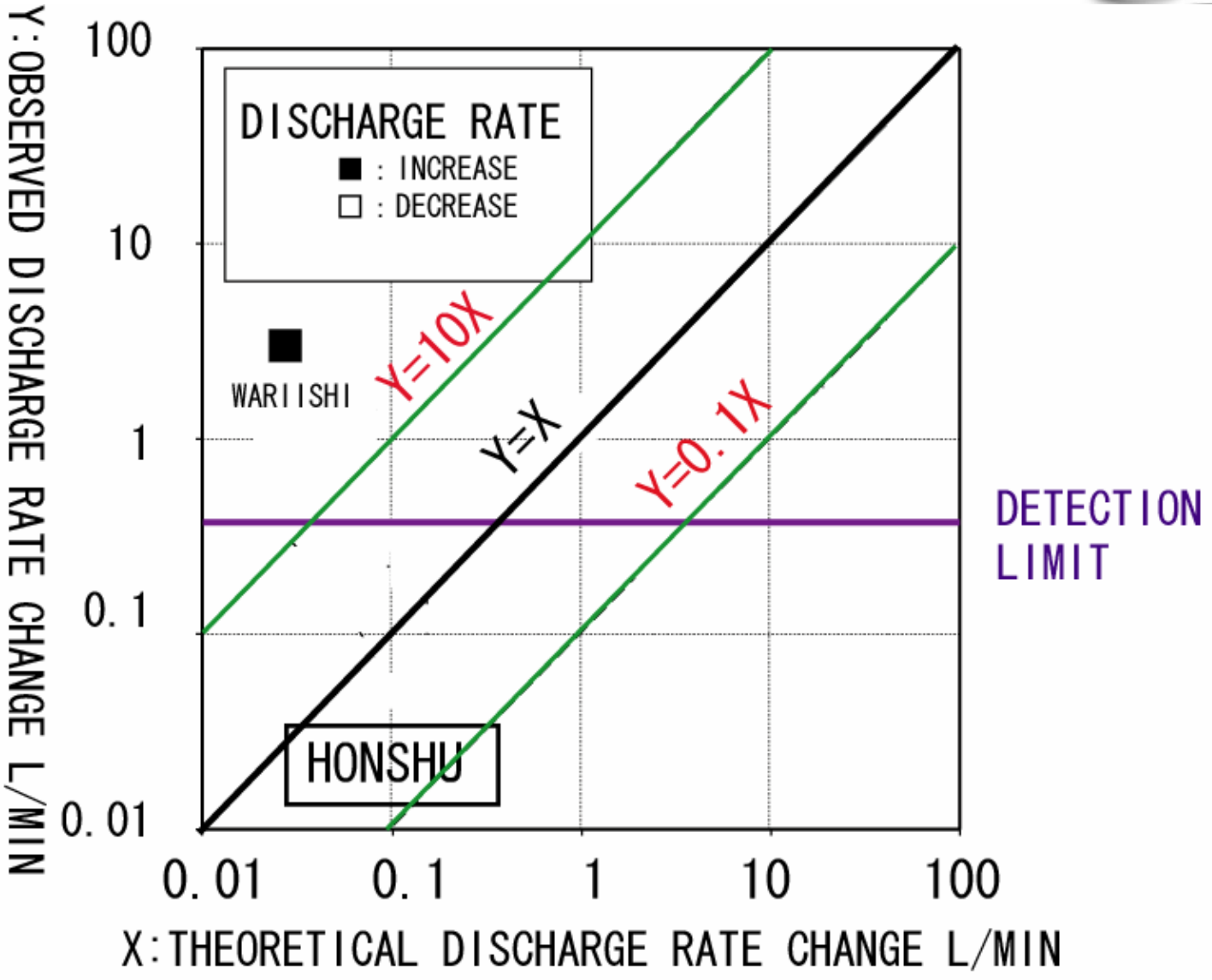
The detailed information

↓

Akita and Matsumoto (2004) and Sato et al.(2004)

The reprints are placed over there.

2-2) COSEISMIC CHANGE (AMPLITUDE)



2-2) COSEISMIC CHANGE (AMPLITUDE)

All observation wells in OB

well name	Screened Depth (m)	gwl change(cm)	strain (10-8)
OB6	165-193	-65	190.3
OB5	560-670	-170	189.8
OB1	950-1060	-130	191.4
OB4	1235-1400	430	170.3
OB3	1258-1478	-100	169.6
OB2	1286-1506	-130	172.4

SOME POSSIBILITY OF MIXING SHALLOW GROUNDWATERS