Groundwater changes related to the 2004 Mid-Niigata Prefecture Earthquake and Niigataken Chuetsu-oki Earthquake in 2007

Similar earthquakes cause similar groundwater changes.

Naoji Koizumi1), Satoshi Itaba1), Tsuyoshi Toyoshima2), Masashi Kaneko3) and Kazuyoshi Sekiya3)

1) Geological Survey of Japan, AIST,
2) Graduate School of Science and Technology Earth Science, Niigata University,
3) Niigata Prefectural Office

INTRODUCTION

THREE MAIN FACTORS FOR EARTHQUAKE-RELATED GROUNDWATER CHANGES.

•FACTORS IN ‘NEAR-FIELD’ AND ‘FAR-FIELD’

RESULTS (2004 EQ AND 2007 EQ)

	SEISMIC INTENSITY	CRUSTAL DEFORMATION	GROUNDWATER CHANGE
NEAR-FIELD	SIMILAR	DIFFERENT	SIMILAR
FAR-FIELD	SIMILAR	SMALL & DIFFERENT	SIMILAR

CONCLUSION

INTRODUCTION

THREE MAIN FACTORS FOR EARTHQUAKE-RELATED GROUNDWATER CHANGES.

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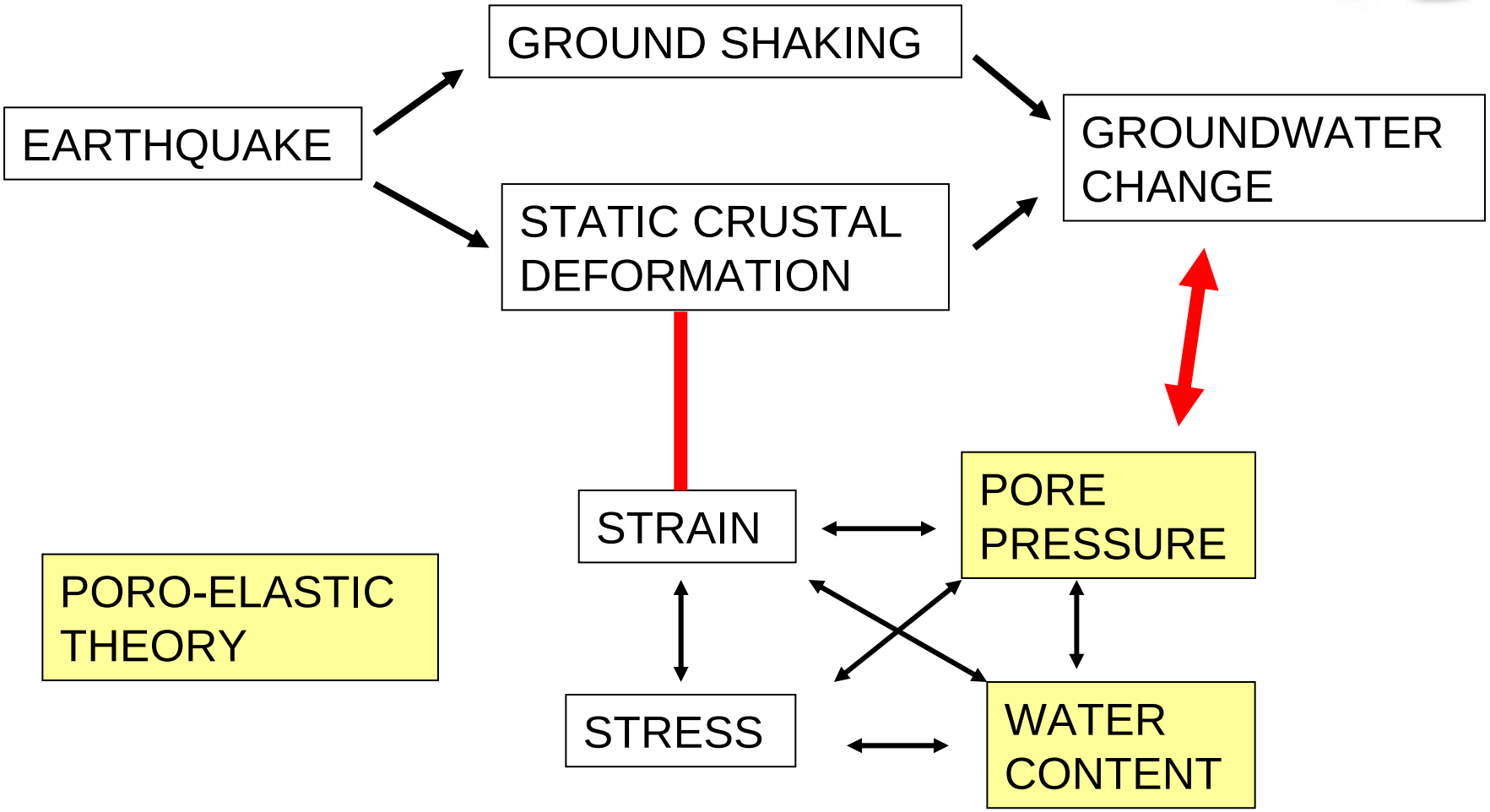
RESULTS

THE 2004 MID-NIIGATA PREFECTURE EARTHQUAKE (2004 EQ) AND NIIGATAKEN CHUETSU-OKI EARTHQUAKE IN 2007 (2007 EQ)

SIMILAR GROUNDSHAKING AND SIMILAR CRUSTAL DEFORMATION IN ‘FAR-FIELD’

SIMILAR GROUNDSHAKING AND DIFFERENT CRUSTAL D


GROUND SHAKING
EARTHQUAKE
GROUNDWATER CHANGE
STATIC CRUSTAL DEFORMATION
STRAIN
PORE PRESSURE
PORO-ELASTIC THEORY
STRESS
WATER CONTENT

EARTHQUAKE → GROUND SHAKING
EARTHQUAKE → STATIC VOLUMETRIC STRAIN CHANGE
EARTHQUAKE → STATIC VERTICAL DISPLACEMENT

GROUND SHAKING → GROUNDWATER CHANGE
STATIC VOLUMETRIC STRAIN CHANGE → GROUNDWATER CHANGE
STATIC VERTICAL DISPLACEMENT → GROUNDWATER CHANGE

GROUND SHAKING $\propto$ $1/R,\ 1/\sqrt{R}$

R: HYPOCENTRAL DISTANCE OR EPICENTRAL DISTANCE

STATIC VOLUMETRIC STRAIN CHANGE $\propto$ $1/R^3$

STATIC VERTICAL DISPLACEMENT $\propto$ $1/R^2$

Factors for earthquake-related groundwater change

"NEAR-FIELD" (Neighborhood of the focal region)

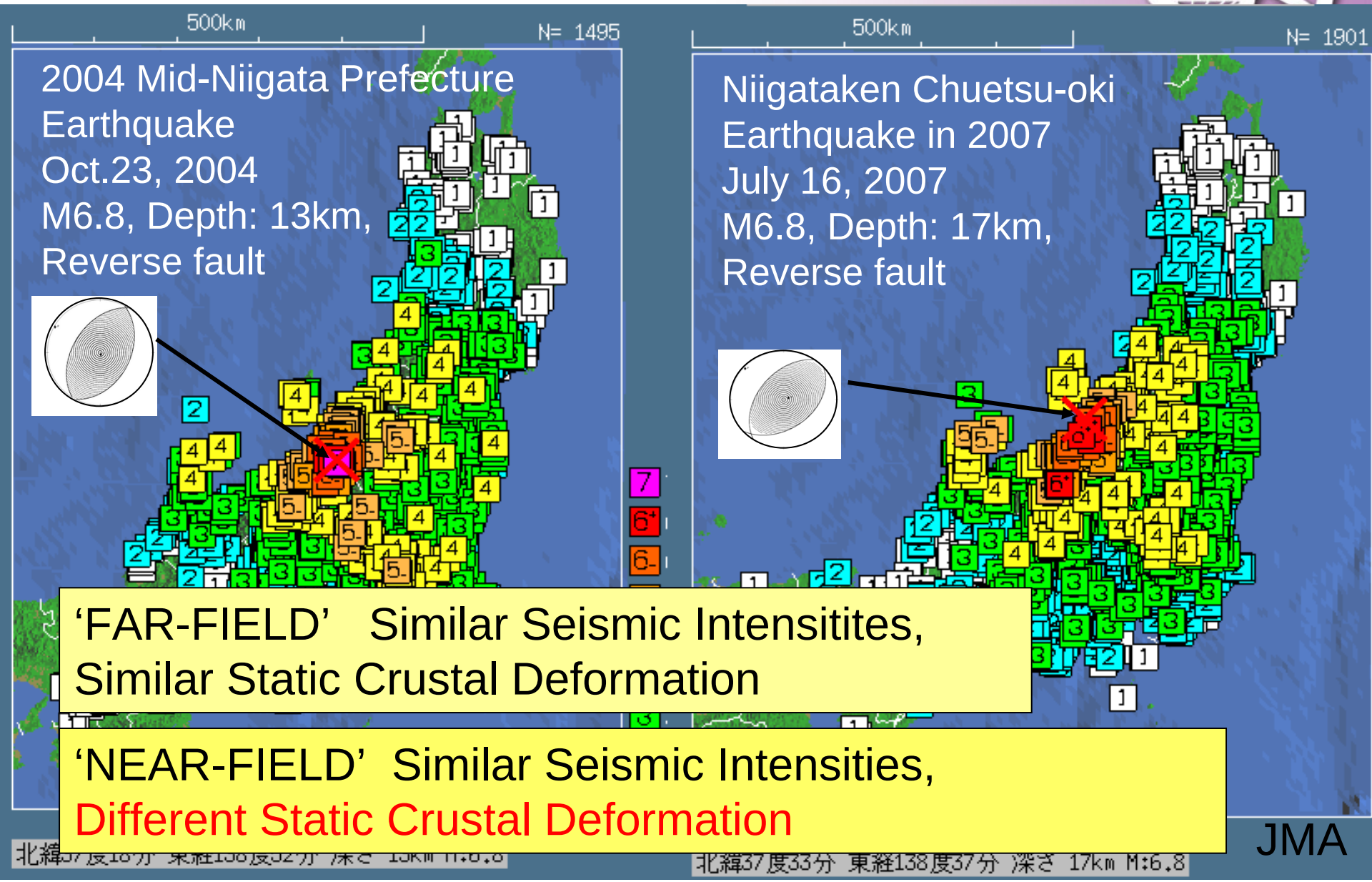
GROUND SHAKING

STATIC VOLUMETRIC STRAIN CHANGE

STATIC VERTICAL DISPLACEMENT

"FAR-FIELD" (Areas far from the focal region)

GROUND SHAKING



‘FAR-FIELD’ Similar Seismic Intensitites,
Similar Static Crustal Deformation

‘NEAR-FIELD’ Similar Seismic Intensities,
Different Static Crustal Deformation

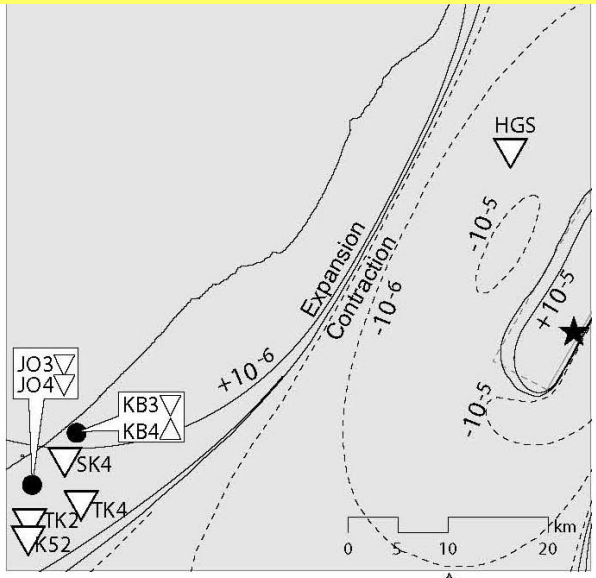
JMA

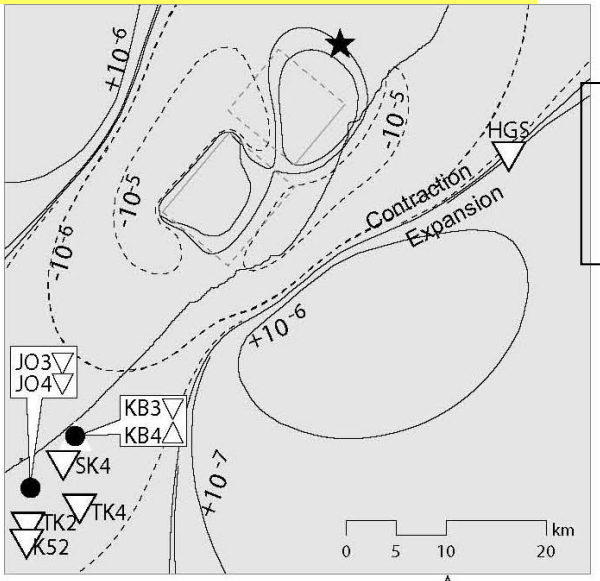
COSEISMIC VOLUMETRIC STRAIN CHANGE AND GROUNDWATET LEVEL(PRESSURE) CHANGE

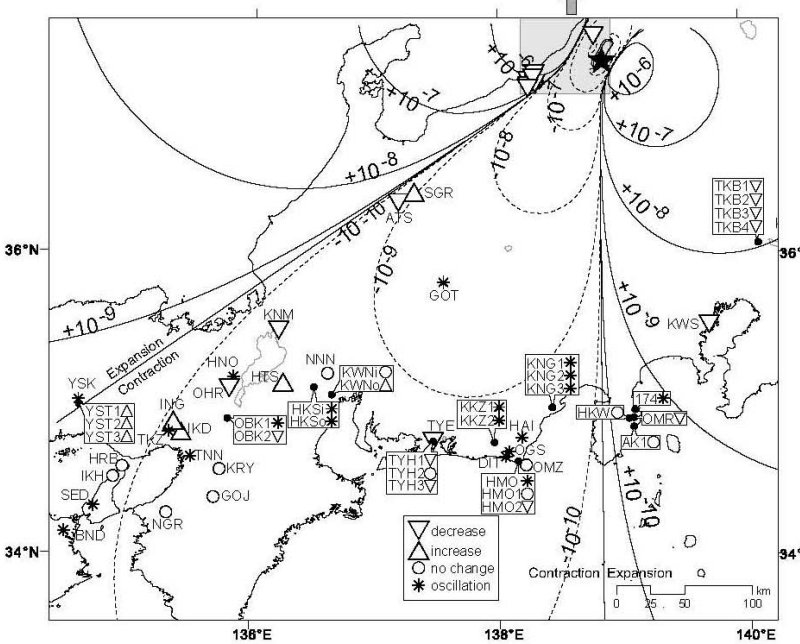
2004 EQ

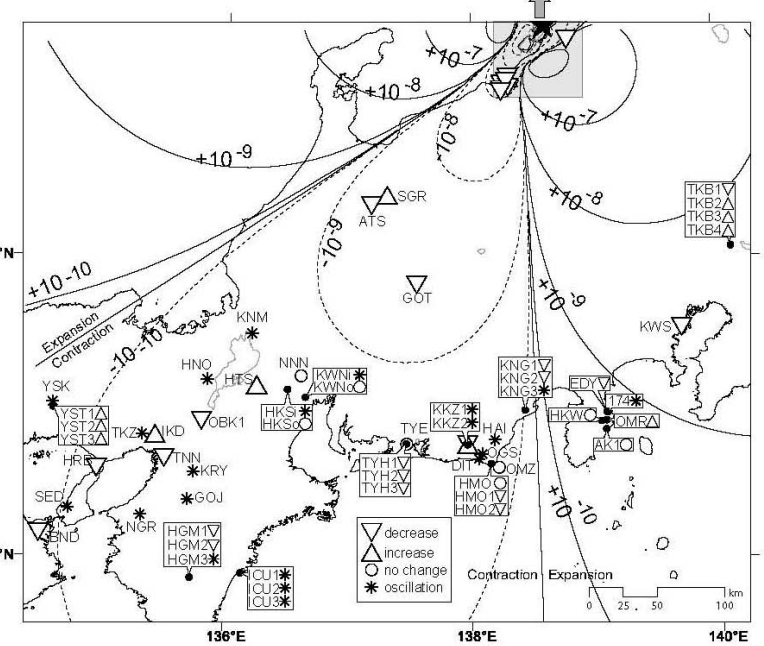
2007 EQ

△INCREASE
▽DECREASE
○NO CHANGE
∗OSCILLATION





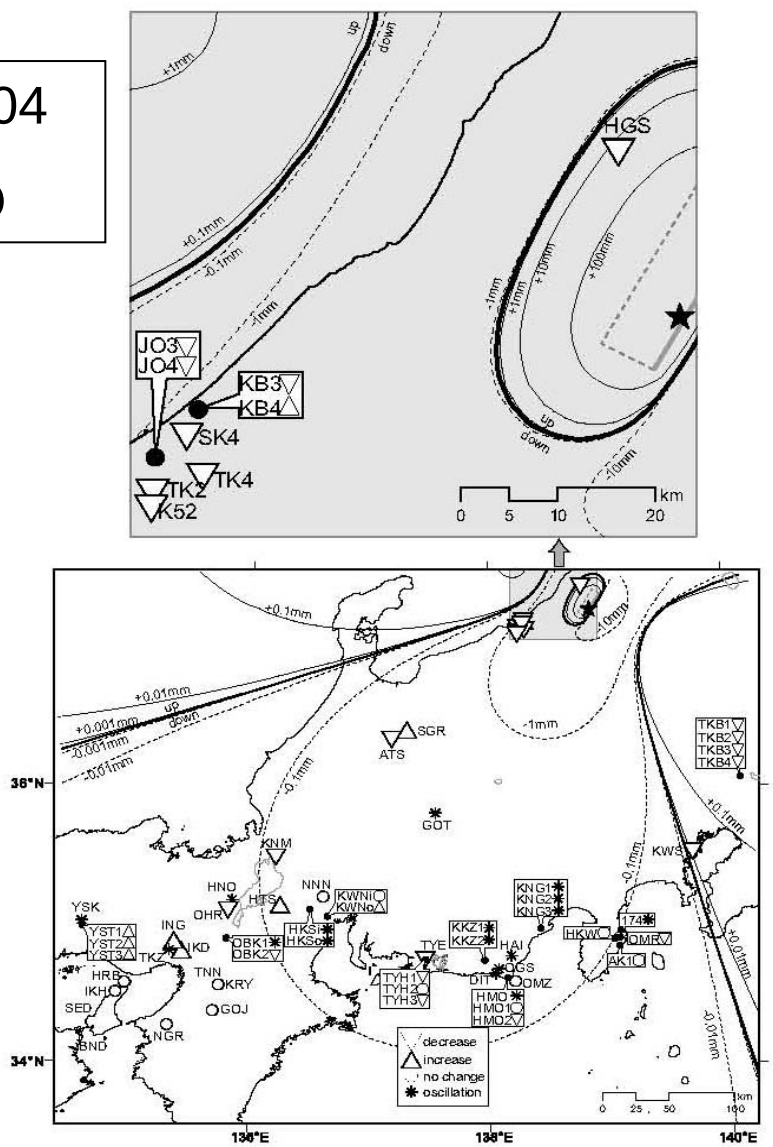




COSEISMIC VERTICAL DISPLACEMENT AND GROUNDWATET LEVEL(PRESSURE) CHANGE

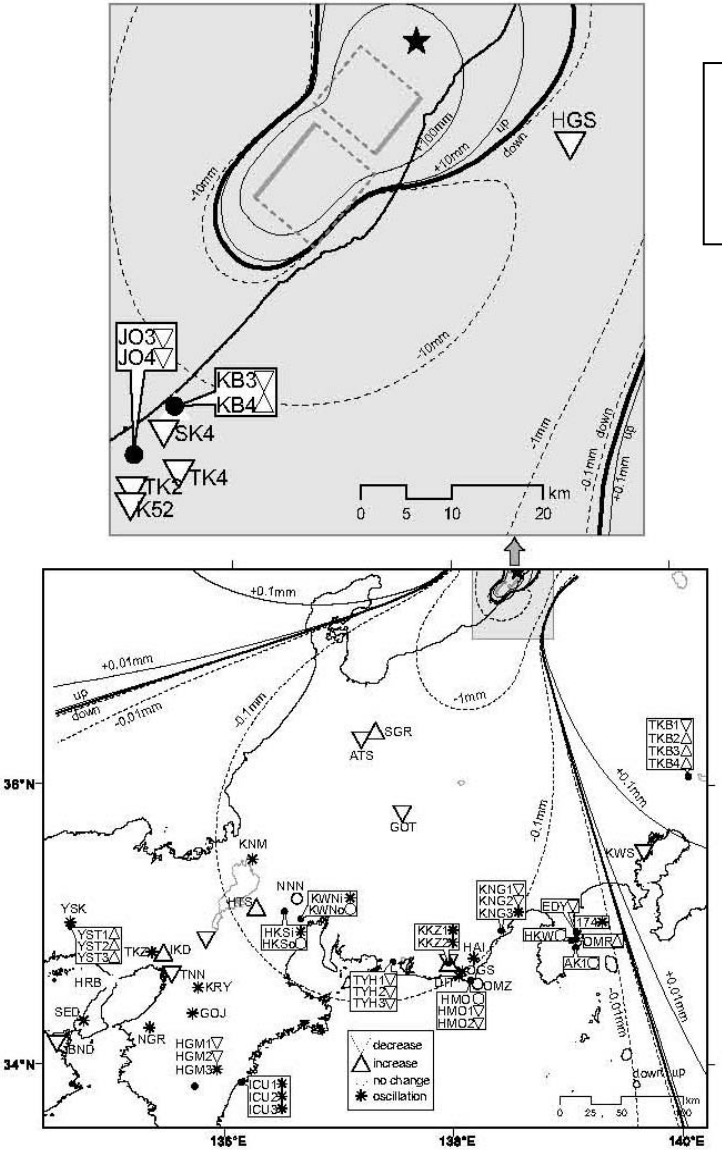
2004

EQ

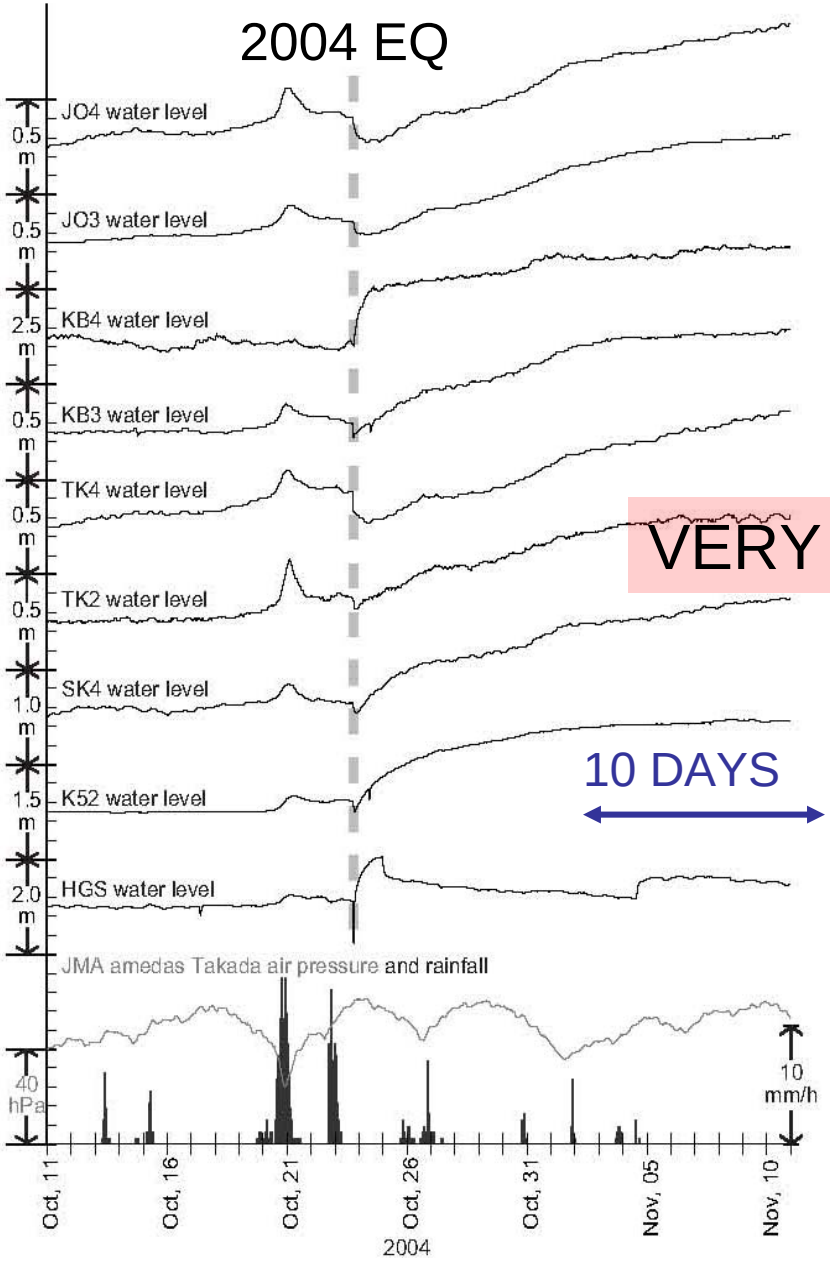


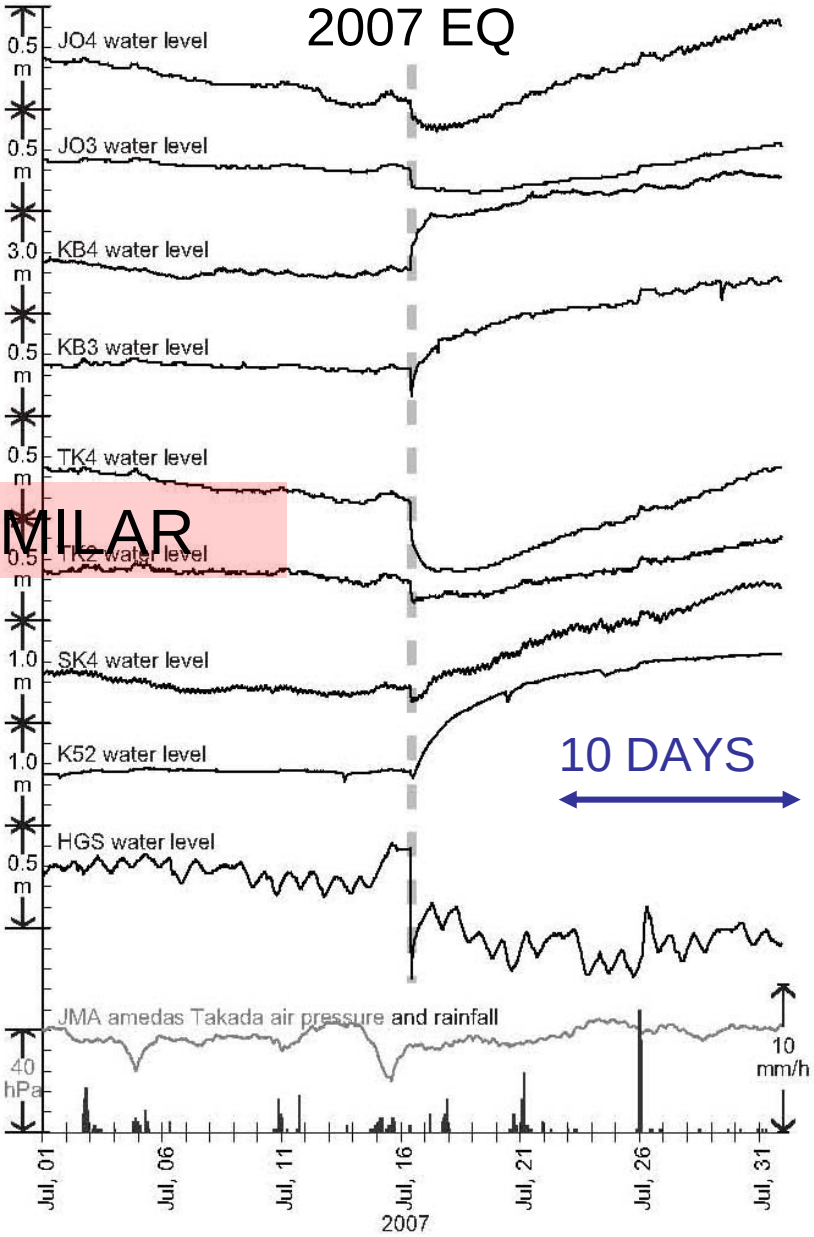
2007

EQ



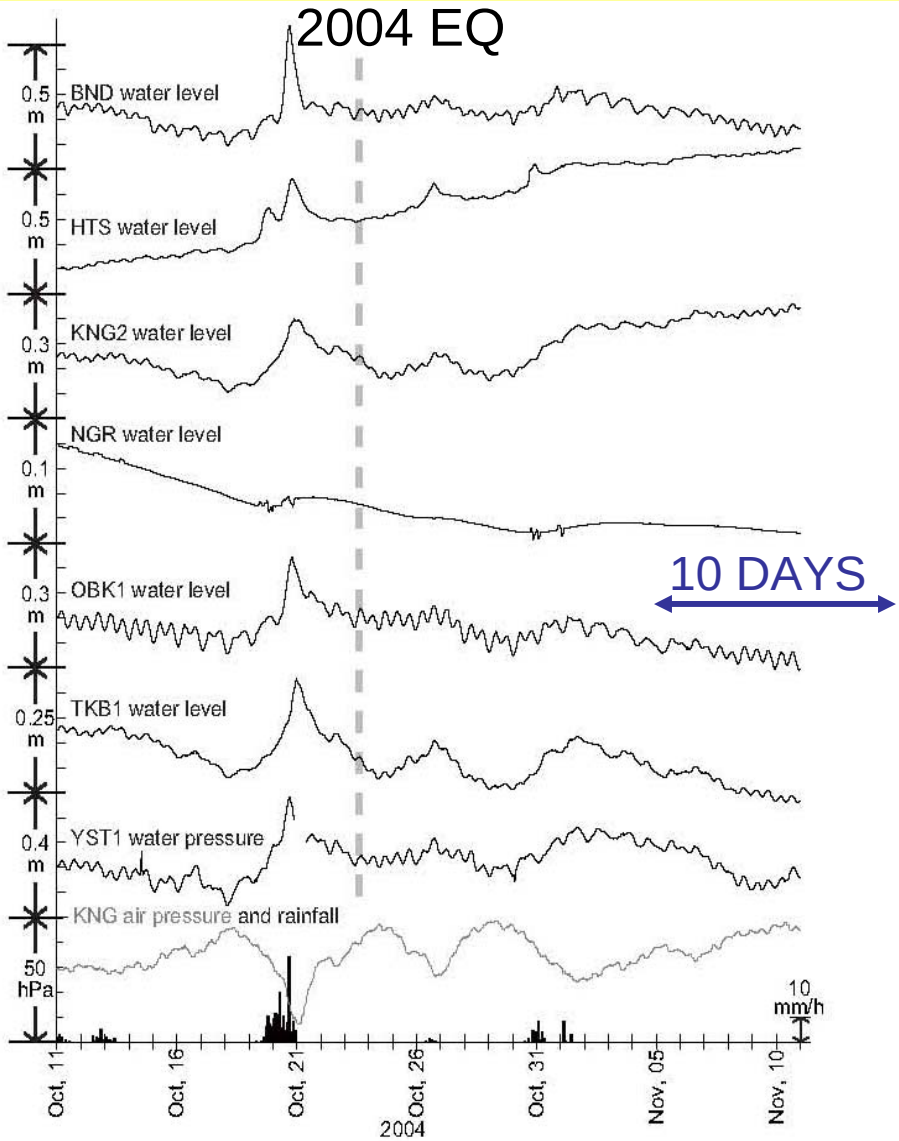
EARTHQUAKE-RELATED GROUNDWATER LEVEL CHANGES IN NIIGATA

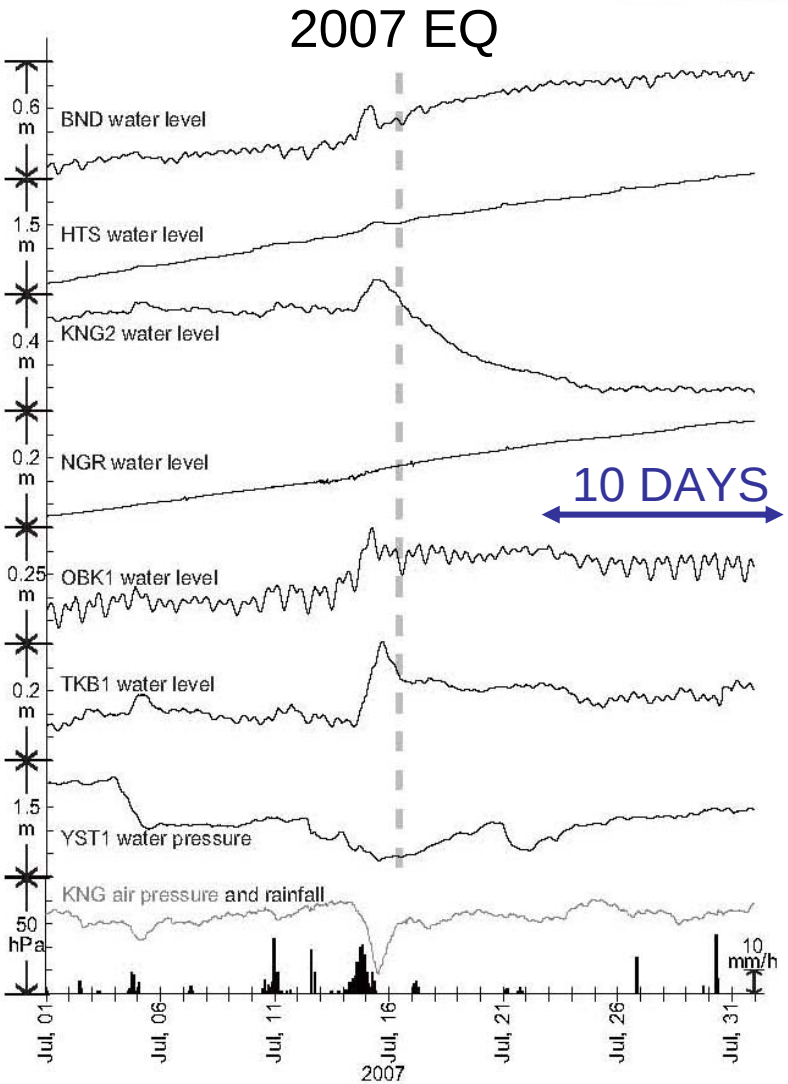




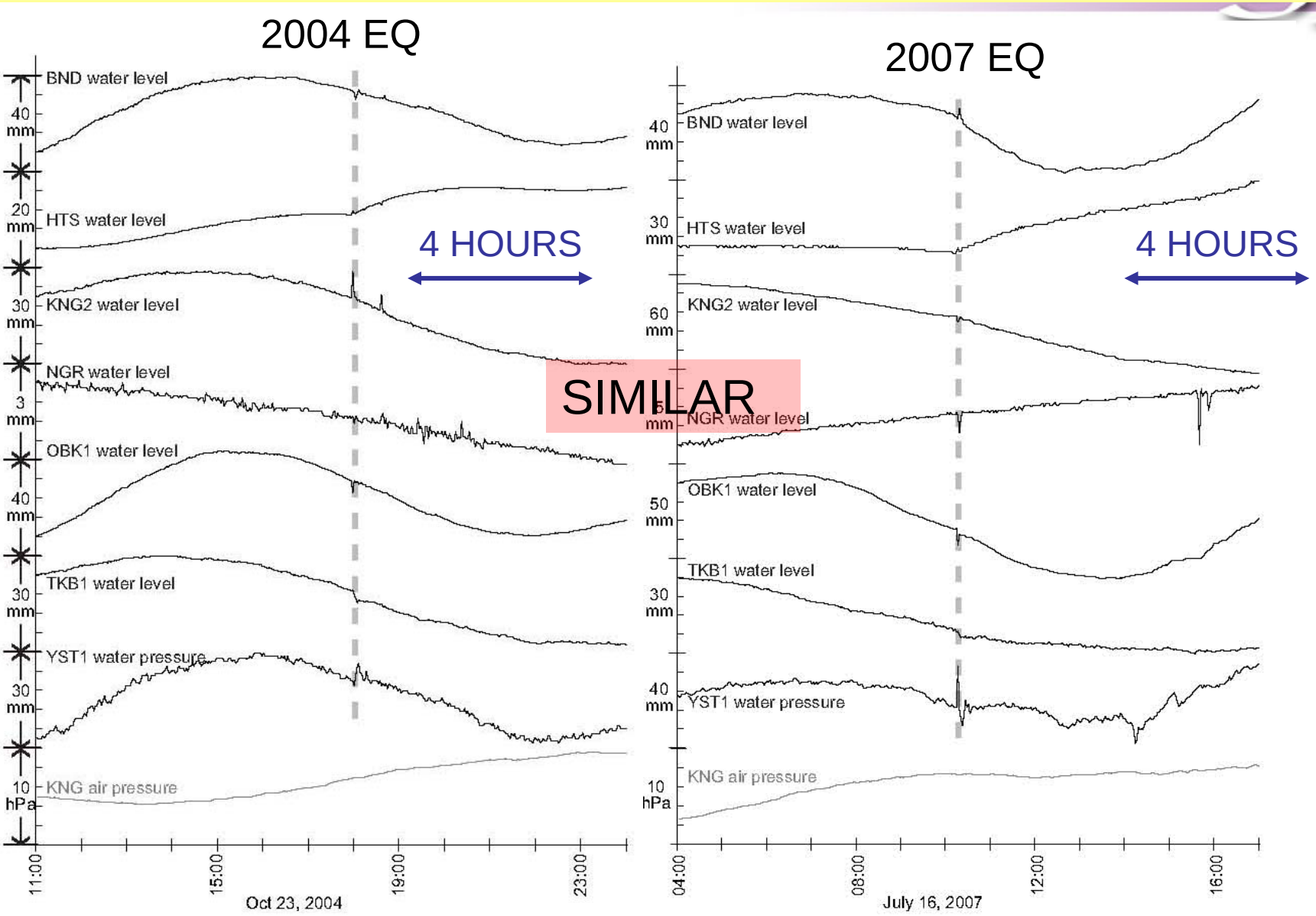
VERY SIMILAR

EARTHQUAKE-RELATED GROUNDWATER LEVEL (PRESSURE) CHANGES IN AND AROUND TOKAI & KINKI REGIONS -1

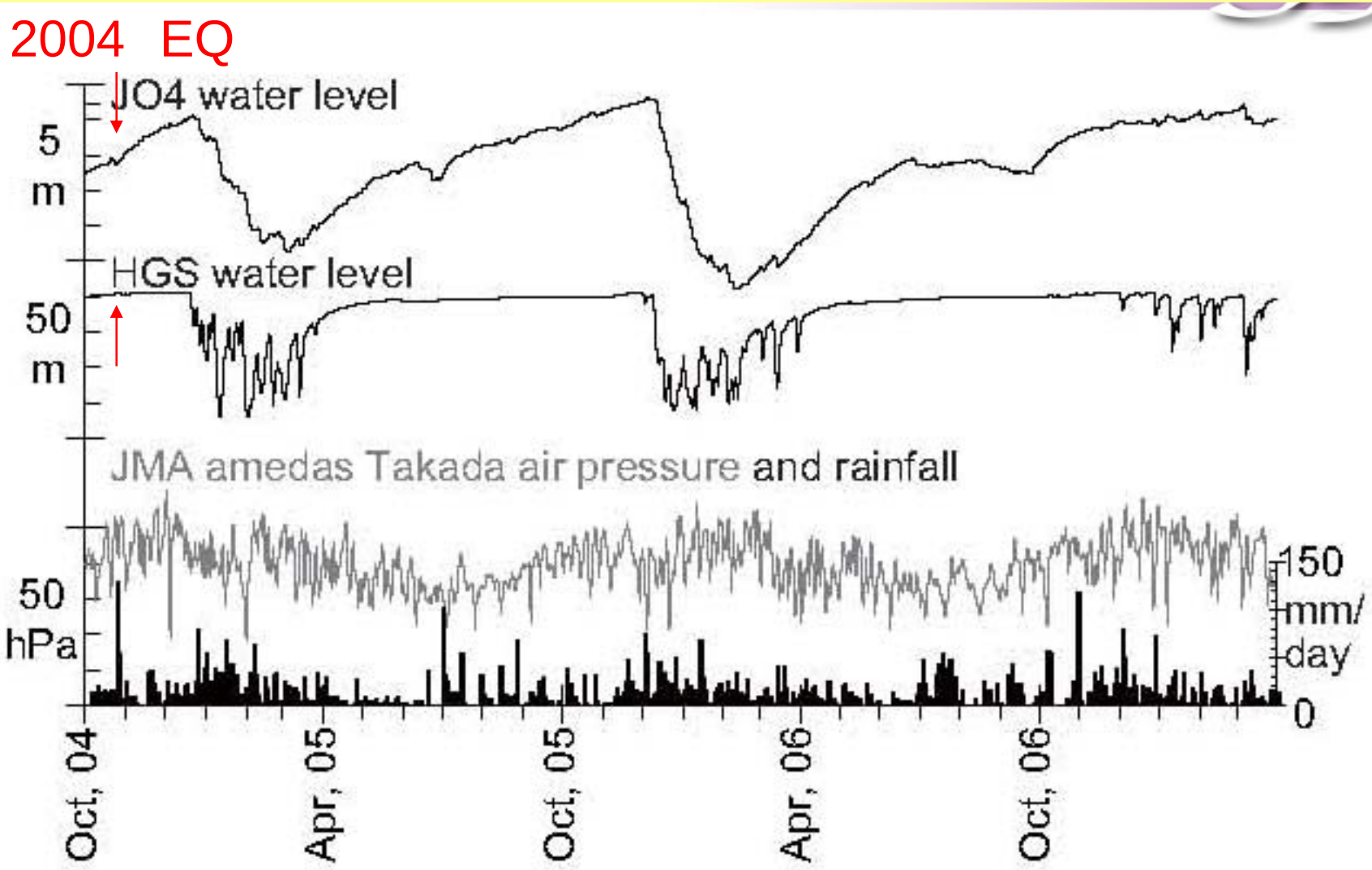




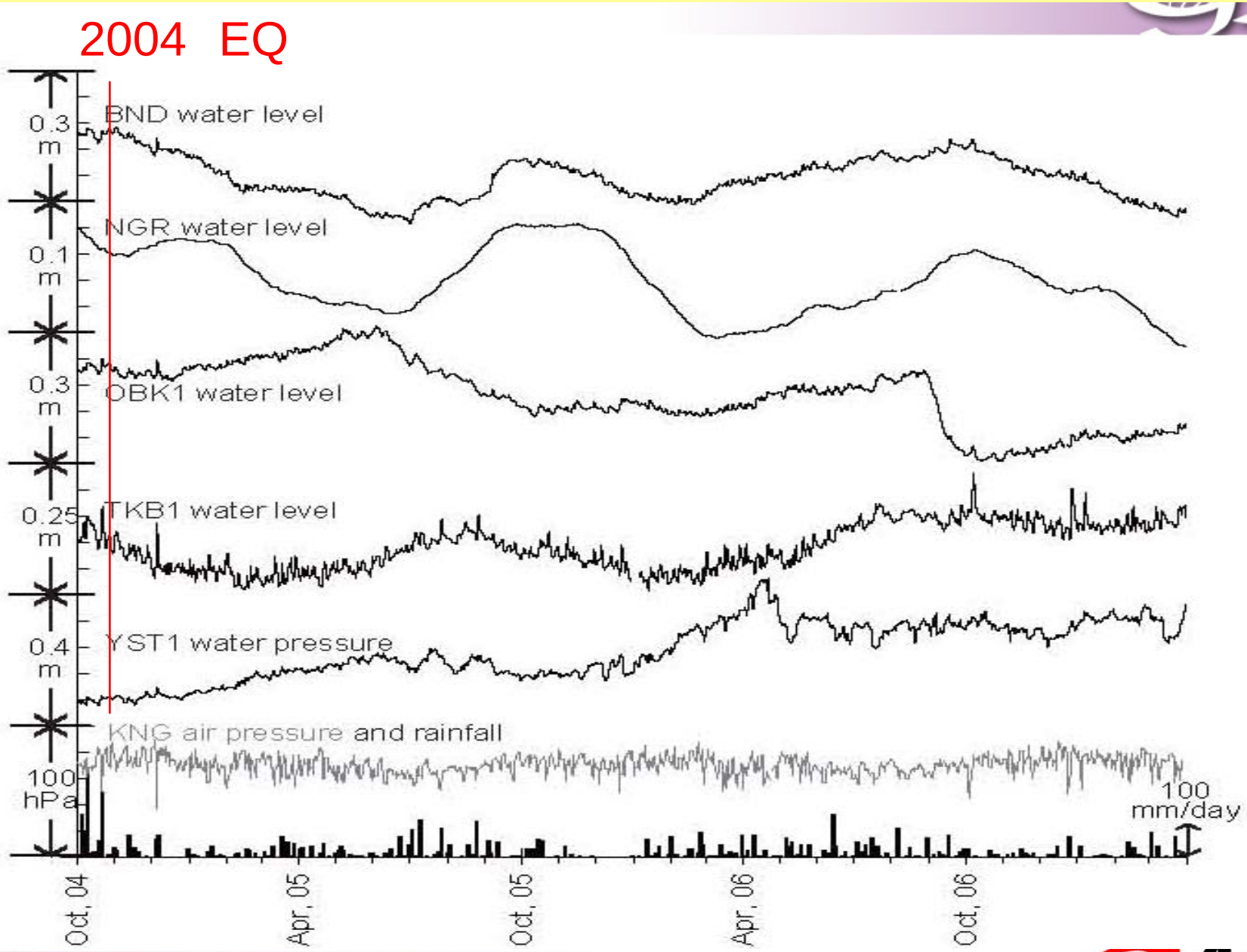
EARTHQUAKE-RELATED GROUNDWATER LEVEL (PRESSURE) CHANGES IN AND AROUND TOKAI & KINKI REGIONS -2



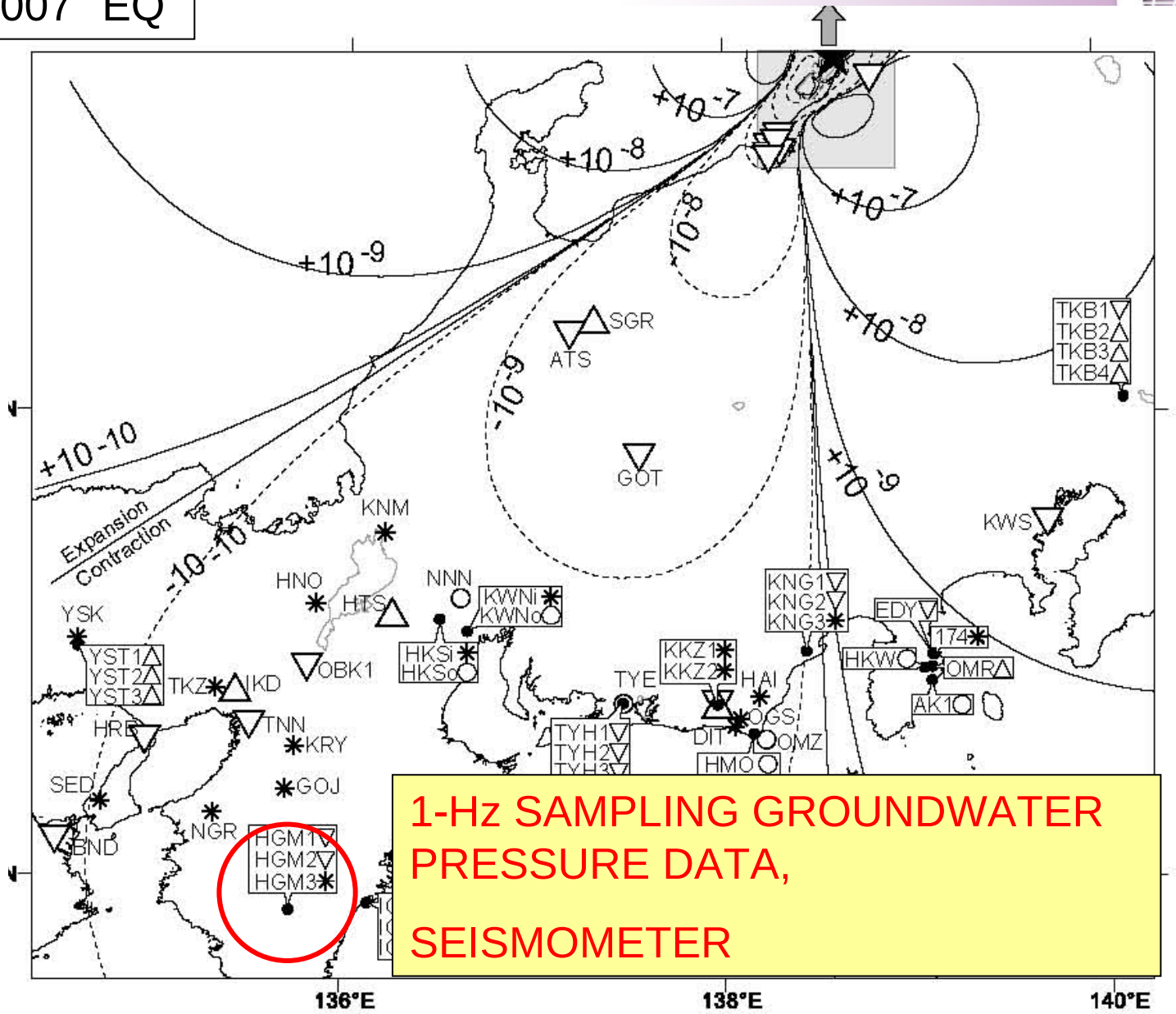
Long-term Groundwater Level Changes (Oct.2004-Mar.2007)



Long-term Groundwater Level Changes (Oct.2004-Mar.2007)

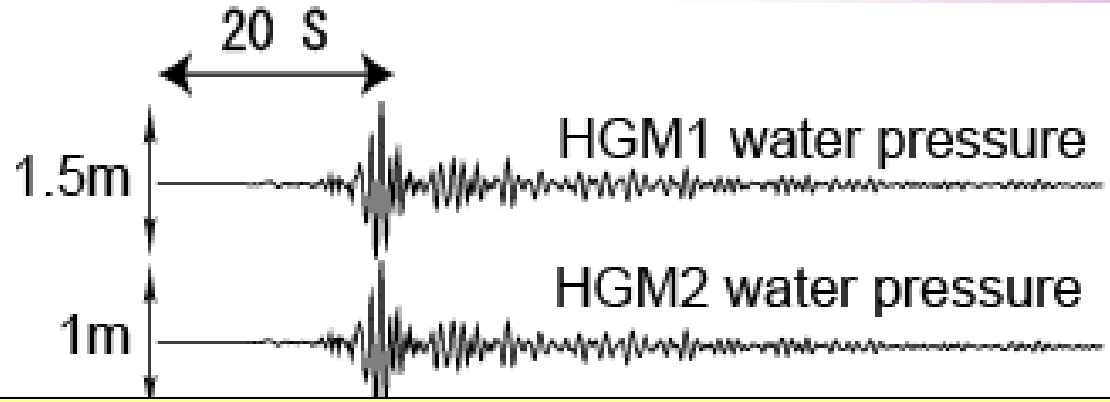


2007 EQ

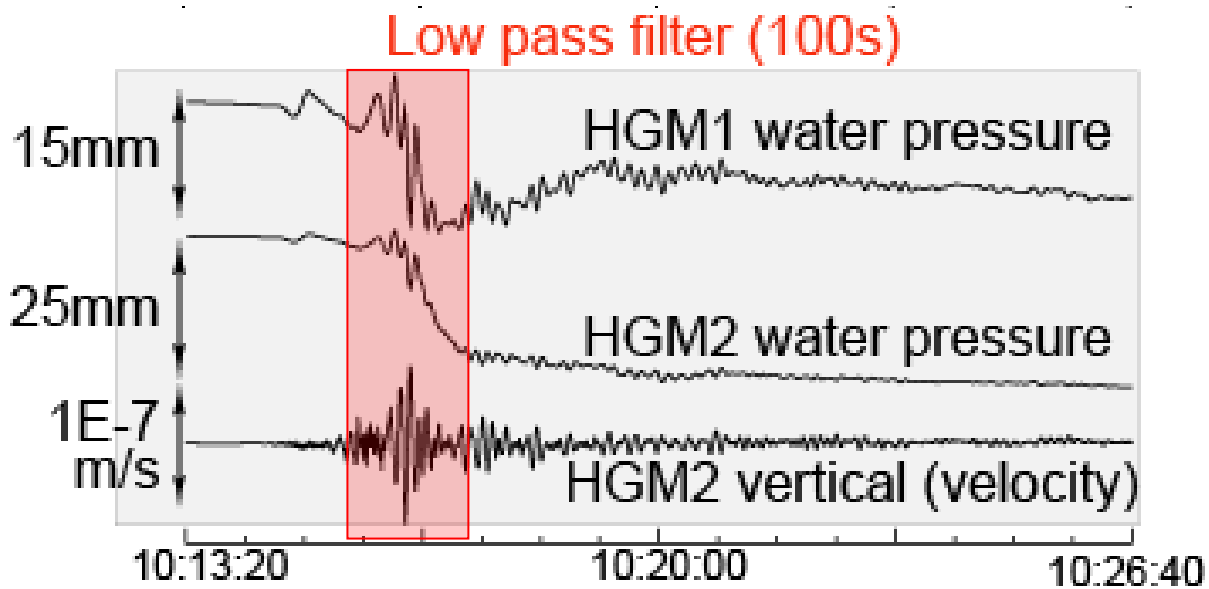


1-Hz SAMPLING GROUNDWATER PRESSURE DATA,

SEISMOMETER



Fracture Cleaning by the Surface Wave?
(Brodsky,2003)



RESULTS

・We have investigated the groundwater changes in Niigata Prefecture and in and around the Kinki and Tokai districts related to the 2004 Niigata-Chuetsu and 2007 Chuetsu-oki earthquakes.

・ Near-field: Niigata Prefecture
  Far-field : Kinki and Tokai districts

・ The static crustal deformations for the two earthquakes were different in Niigata Prefecture, but similar in and around the Kinki and Tokai districts.

・ The distributions of the seismic intensities were similar for both earthquakes.

CONCLUSION

・There was no remarkable precursory change in groundwater level or pressure.

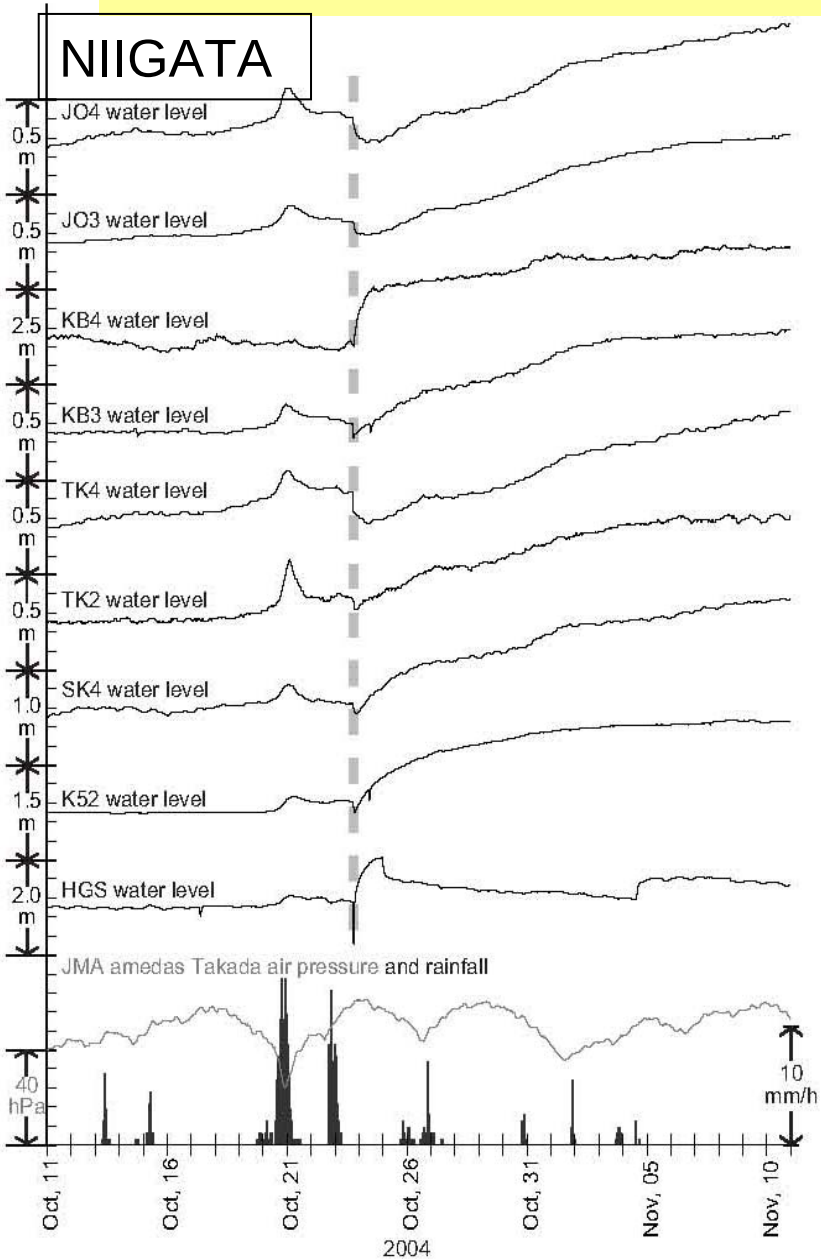
・There were many coseismic and/or postseismic groundwater level or pressure changes and these were almost similar for the two earthquakes.

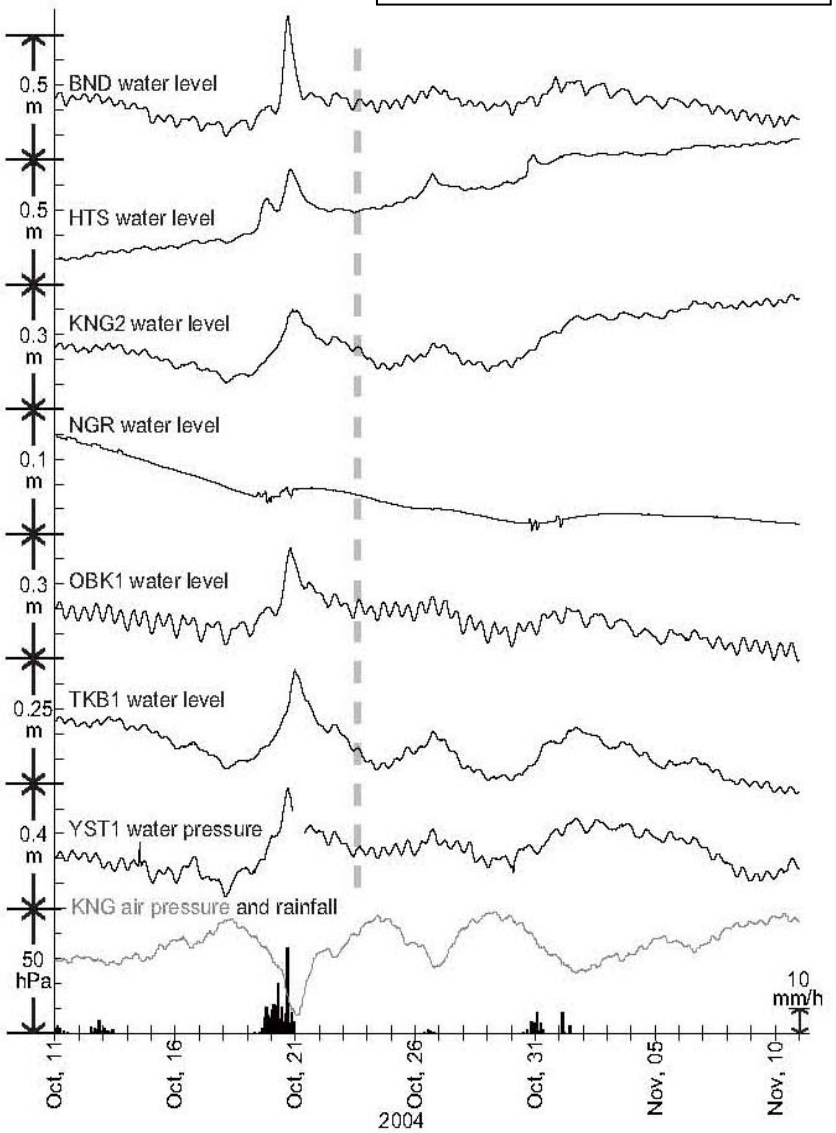
・Those changes were considered to be caused not by static crustal deformation but by ground shaking.

・They were much smaller than the usual annual changes.

・At a certain station, the step-like change in the groundwater pressure started at the arrival time of the surface wave of the 2007 Chuetsu-oki earthquake.

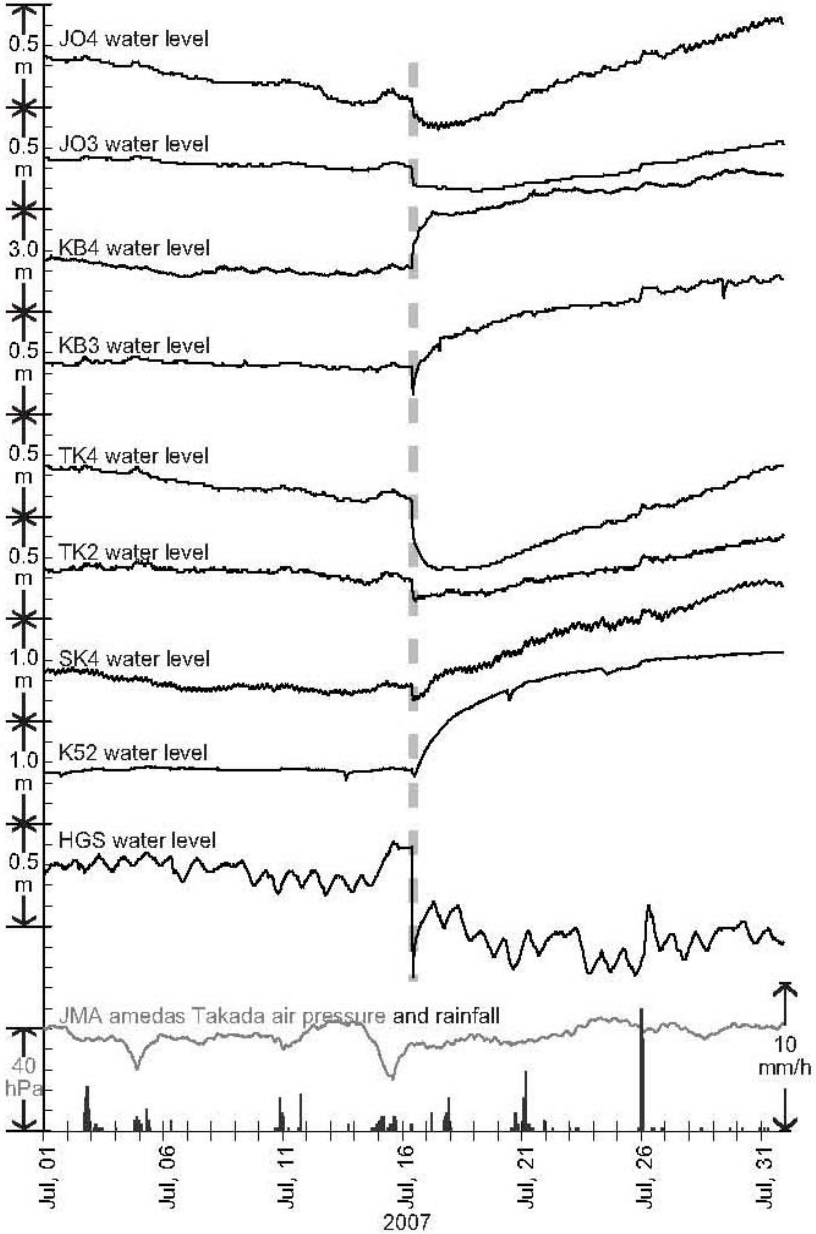
GROUNDWATER LEVEL CHANGES RELATED TO THE 2004 EARTHQUAKE



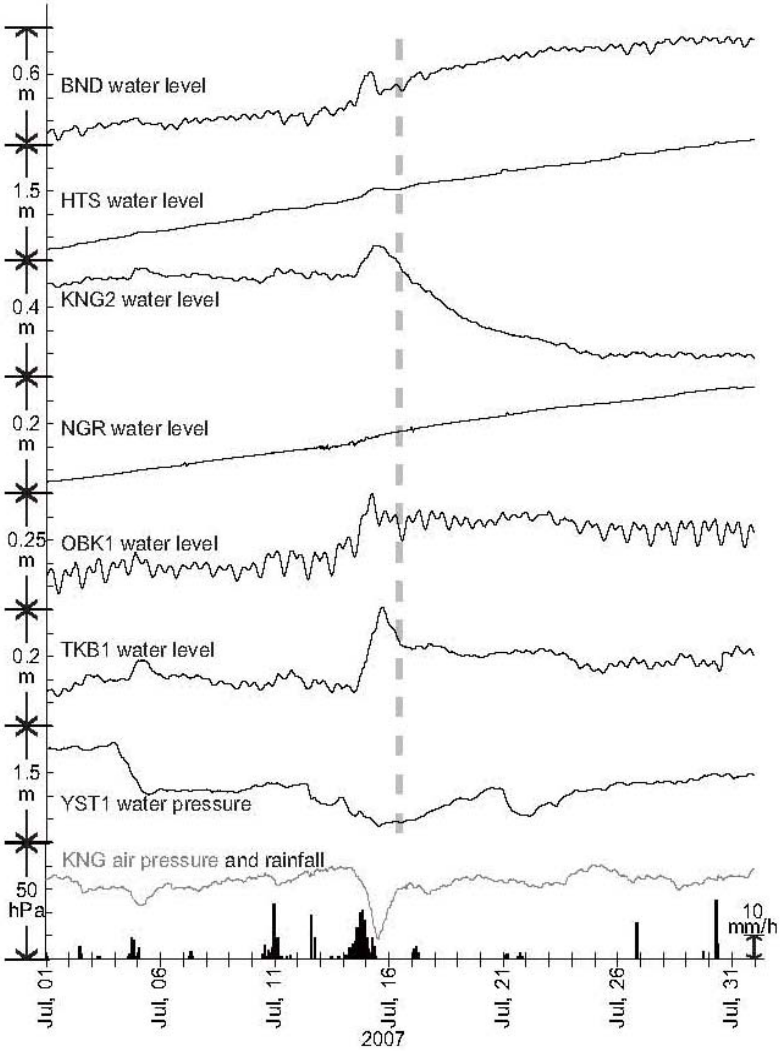


GROUNDWATER LEVEL CHANGES RELATED TO THE 2007 EARTHQUAKE

NIIGATA



TOKAI & KINKI



2004 Mid-Niigata Prefecture Earthquake
Oct.23, 2004
M6.8, Depth: 13km, Reverse fault
Max S.I.(JMA): 7
Deaths: 68,
Damage: 3 trillion yen

Niigataken Chuetsu-oki Earthquake in 2007
July 16, 2007
M6.8, Depth: 17km, Reverse fault
Max S.I.(JMA): 6 upper
Deaths: 15,
Damage: 1.5 trillion yen)