Possible Mechanism of Radon Concentration Anomalies Relating to 1977 and 2011 Big Earthquakes.

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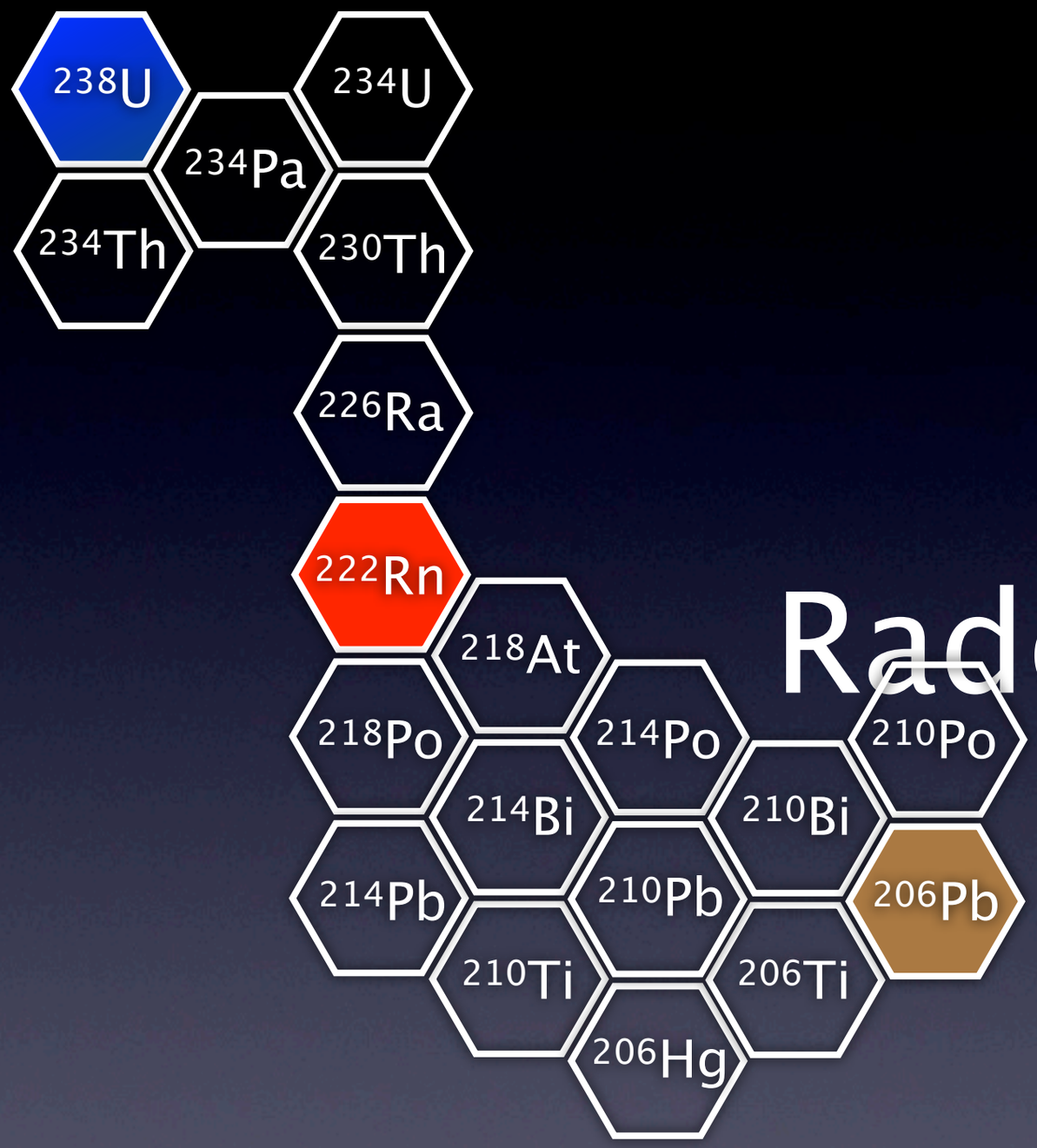
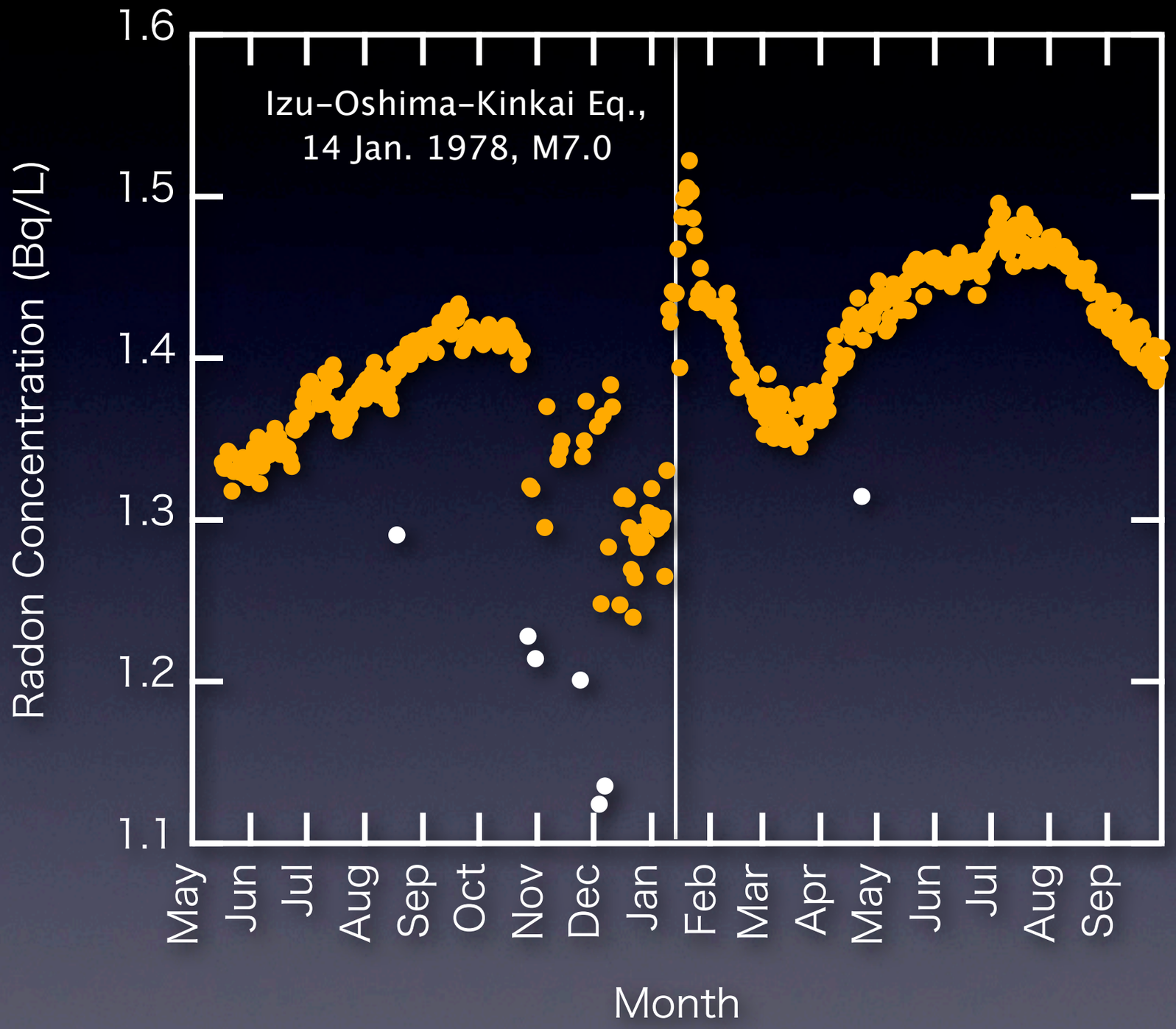
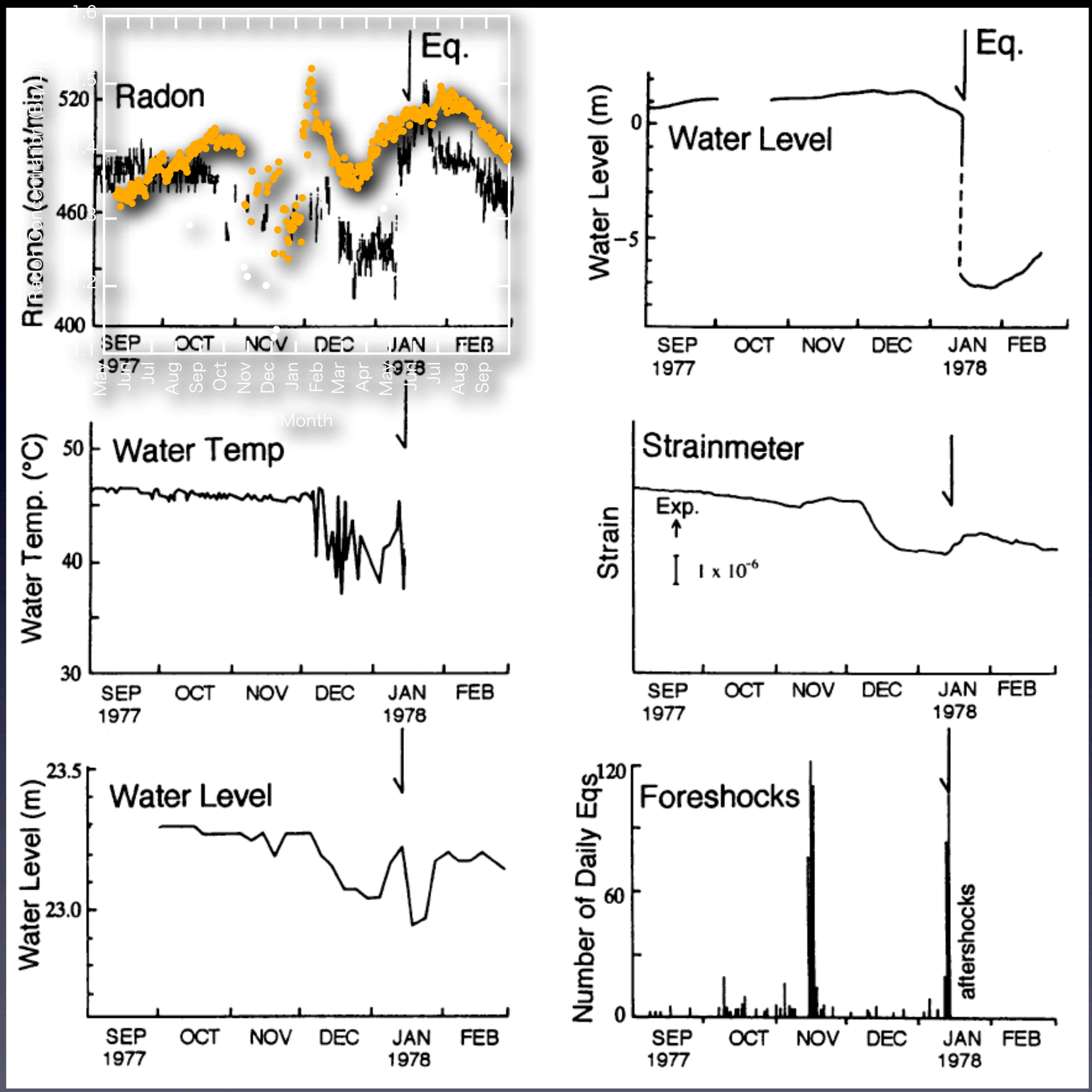


Radon

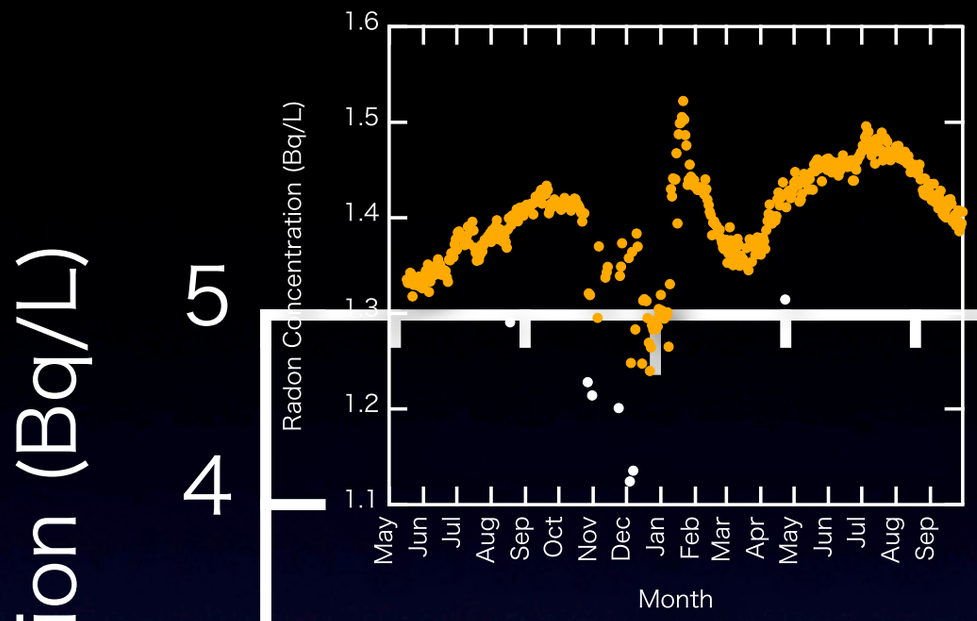
- Gas
- Inert
- Radioactive

Nakaizu Obs


Izu-Oshima-Kinkai Eq.,
14 Jan. 1978, M7.0
Radon Concentration (Bq/L)
1.6
1.5
1.4
1.3
1.2
1.1
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month


Eq.
Radon
Rn conc. (count/min)
520
460
400
SEP 1977
OCT
NOV
DEC
JAN 1978
FEB
Month
Water Level (m)
0
−5
Water Level
Water Temp. (°C)
50
40
30
Water Temp
Strainmeter
Strain
Exp.
1 x 10⁻⁶
23.5
23.0
Water Level
Number of Daily Eqs
120
60
0
Foreshocks
aftershocks

Wakita (1996)

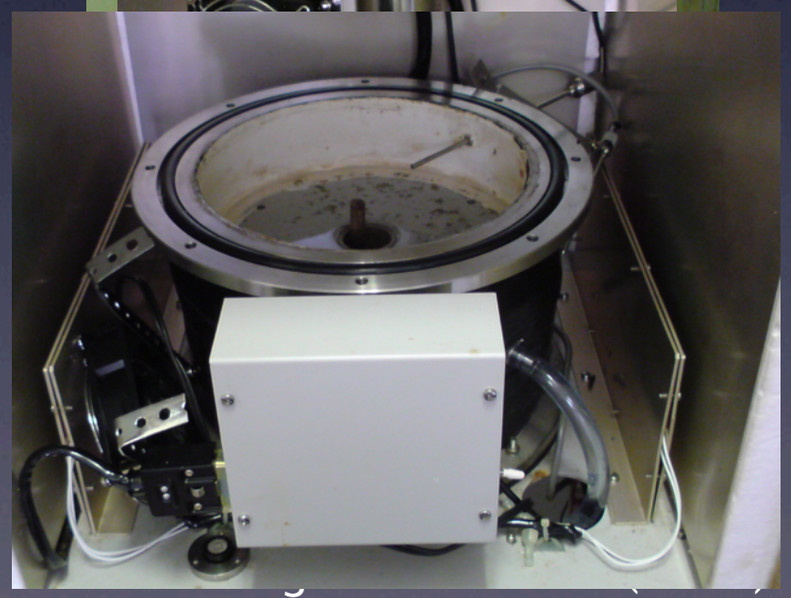


Radon Concentration (Bq/L)

0
1
2
3
4
5

1980
1985
1990

Rep



Problems

- Sporadic
- Unexplained

Possible Mechanism

$$C_{\mathrm{Ra}} SE = C_w V_w + C_a \left(V - V_w\right)$$

- ❖ Radium Concentration
- ❖ Surface Area
- ❖ Release Rate

- ❖ Rn Conc. in Water
- ❖ Water Volume

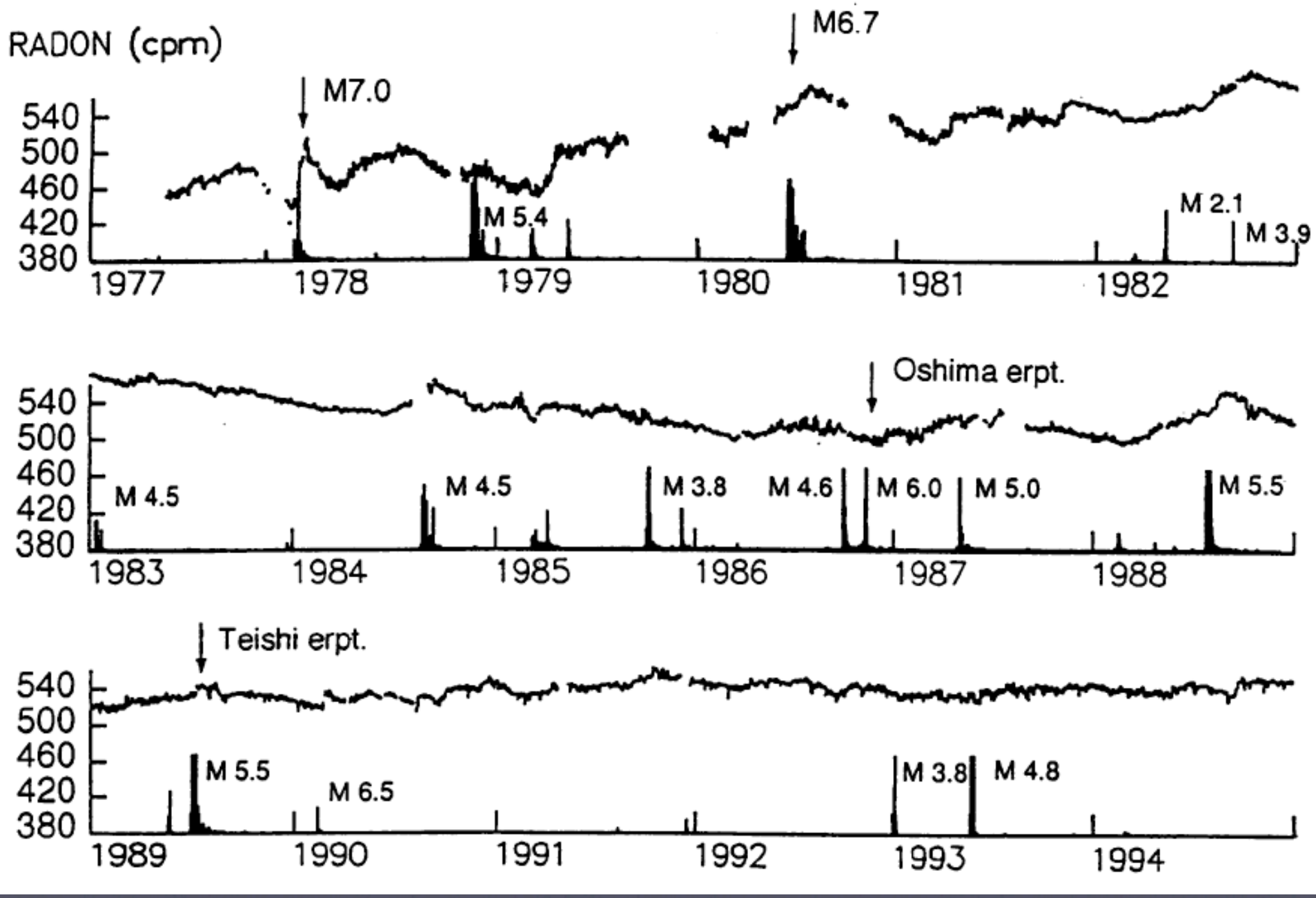
- ❖ Rn Conc. in Gas
- ❖ Gas Volume

$$C_w = C_{\mathrm{Ra}} E \frac{S}{V} \left[\frac{1 - r_{\mathrm{sw}}}{K_d} + r_{\mathrm{sw}} \right]^{-1}$$

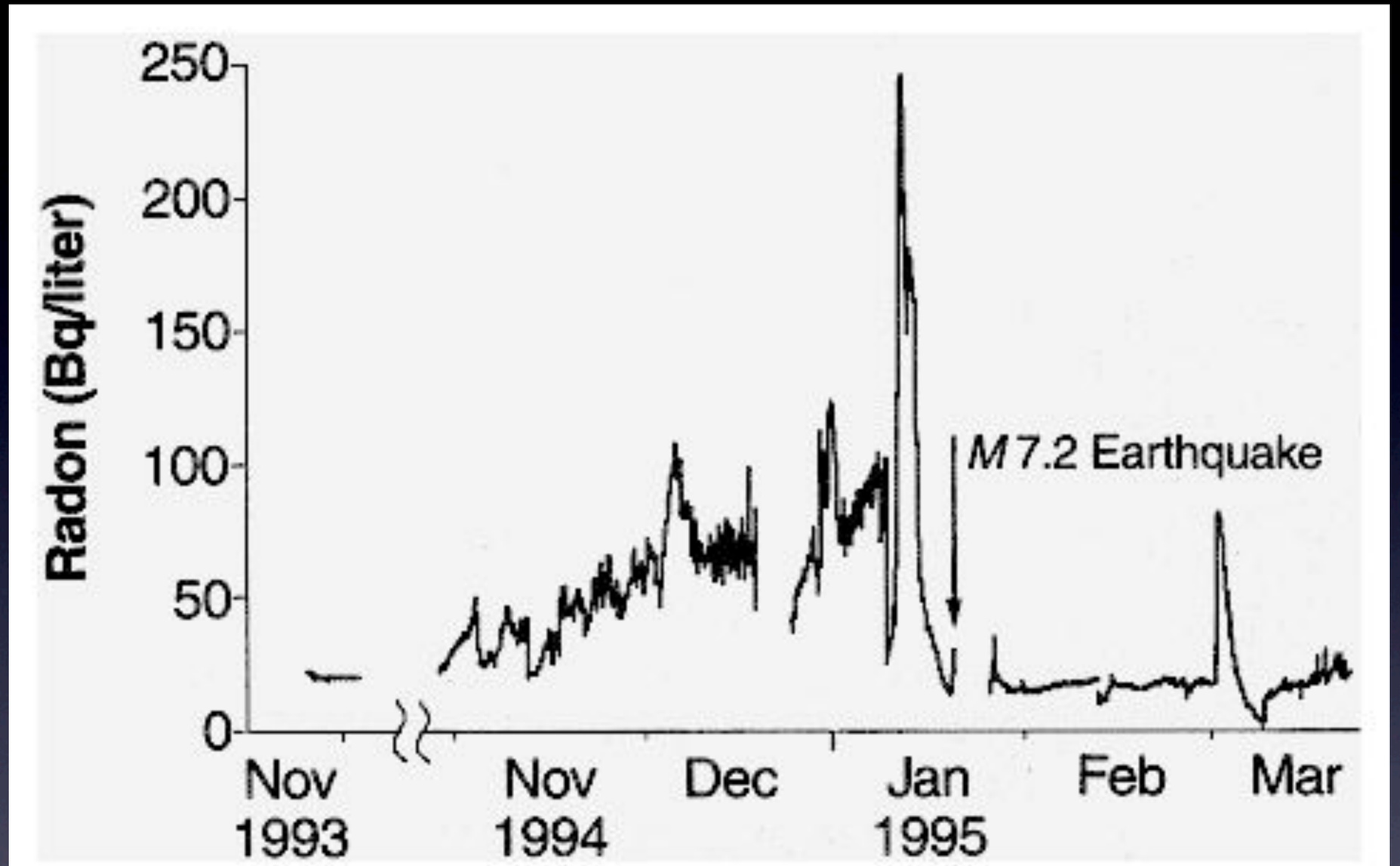
$$r_{\mathrm{sw}} = \frac{V_w}{V} \qquad K_d = \frac{C_w}{C_a} = 0.105 + 0.403 \exp(-0.0502 T)$$

Killiari (2008)

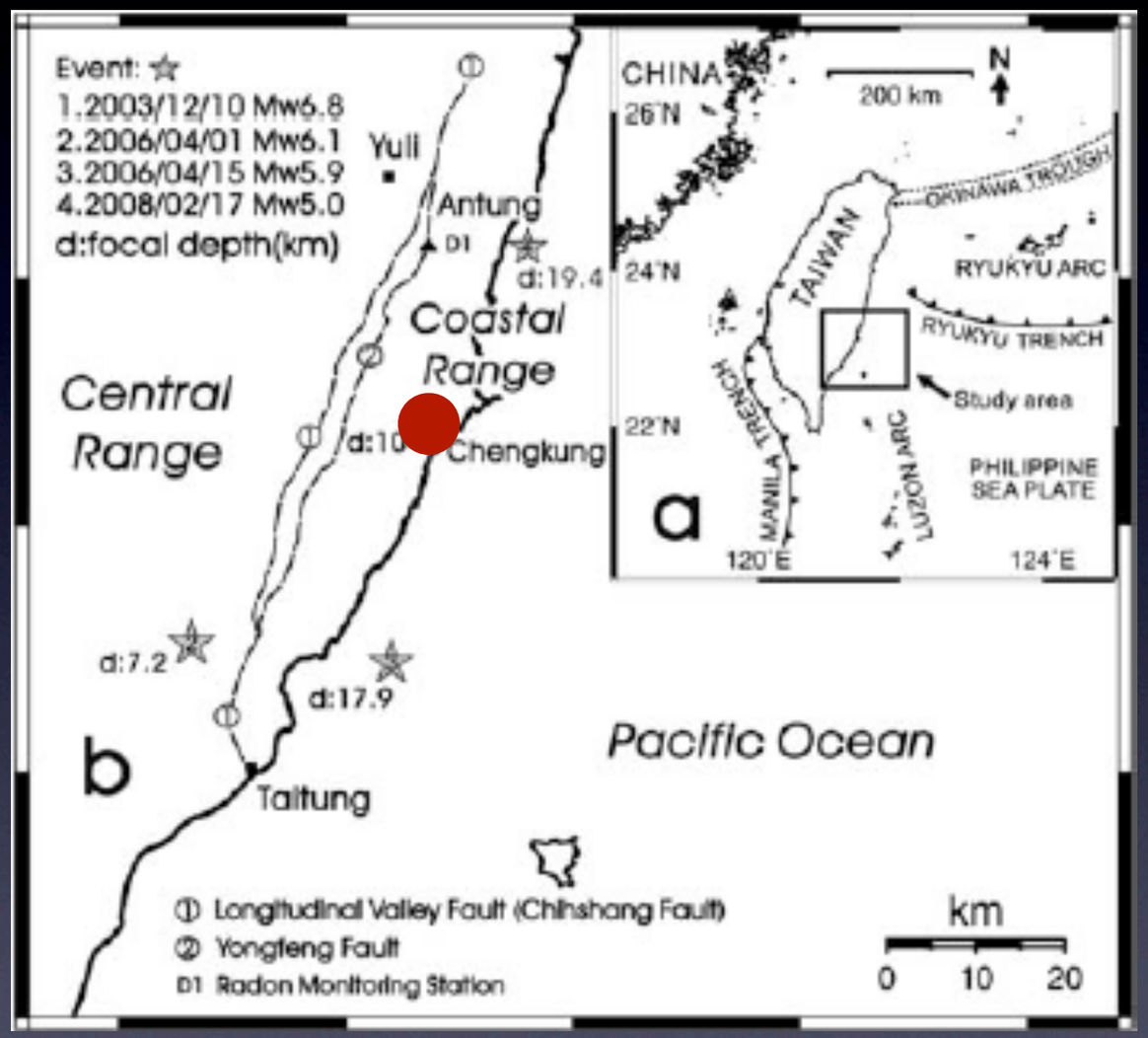
- Radon concentration started to increase before 3.5 months.
- The increase from 1.6 Bq/L to 3.8 Bq/L is likely to a pre-seismic anomaly.
- The concentration reached to a background level now.
- A ratio of surface area to a fracture volume in an aquifer is dominant in a possible mechanism of radon concentration change.


RADON (cpm)
M7.0
M6.7
540
500
460
420
380
M 5.4
M 2.1
M 3.9
1977
1978
1979
1980
1981
1982
Oshima erpt.
M 4.5
M 4.5
M 3.8
M 4.6
M 6.0
M 5.0
M 5.5
1983
1984
1985
1986
1987
1988
Teishi erpt.
M 5.5
M 6.5
M 3.8
M 4.8
1989
1990
1991
1992
1993
1994

Wakita (2010)

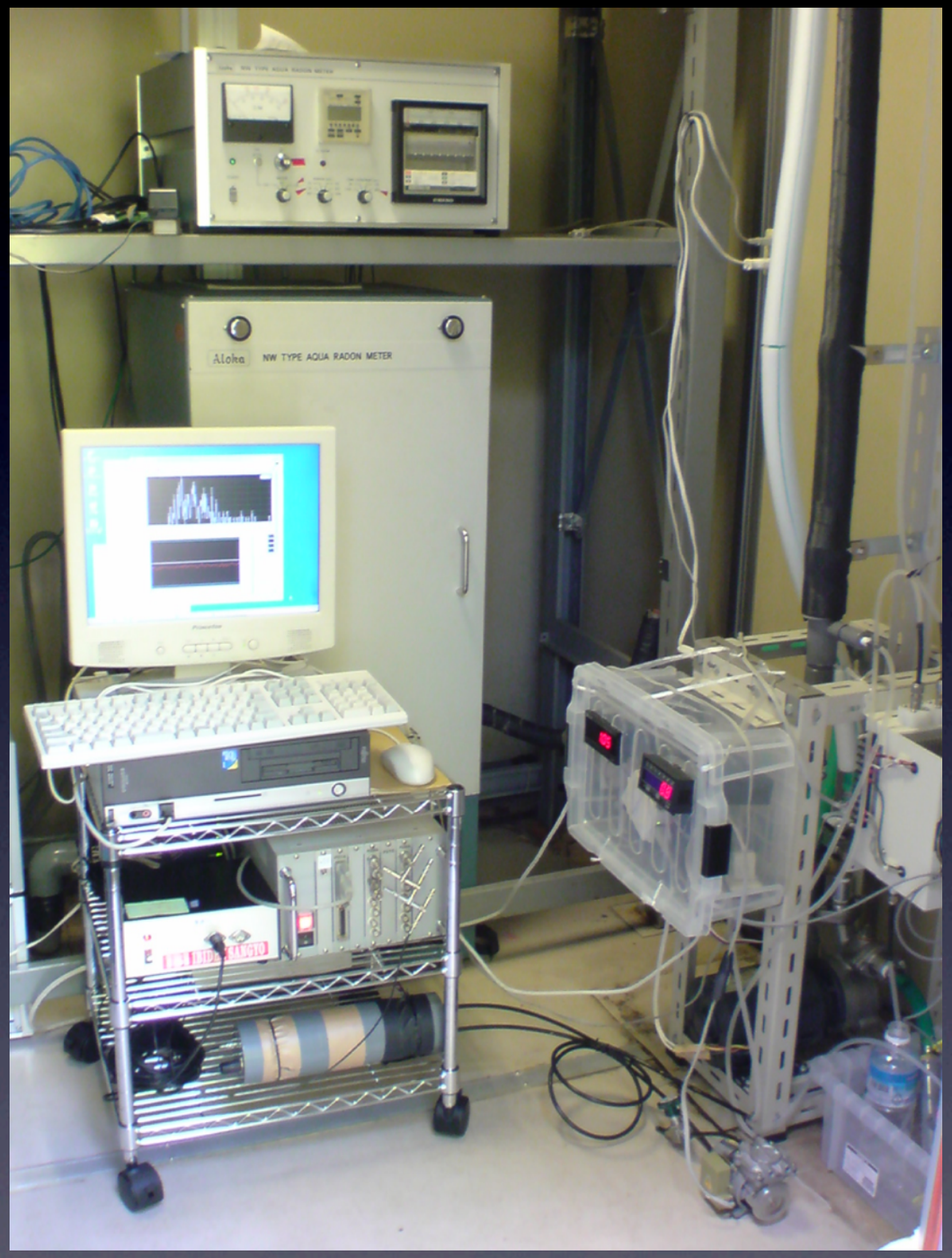


Igarashi, et. al. (1995)



Chengkung Earthquake

Kuo, et. al.(2010)


Aloka
NW TYPE AQUA RADON METER

$$C_{w,0} = C_a \left(\frac{V_a}{V_w} + \frac{1}{K_d} \right)$$

$$\frac{1}{K_d} = 0.403 \exp\left(-0.0502T\right)$$