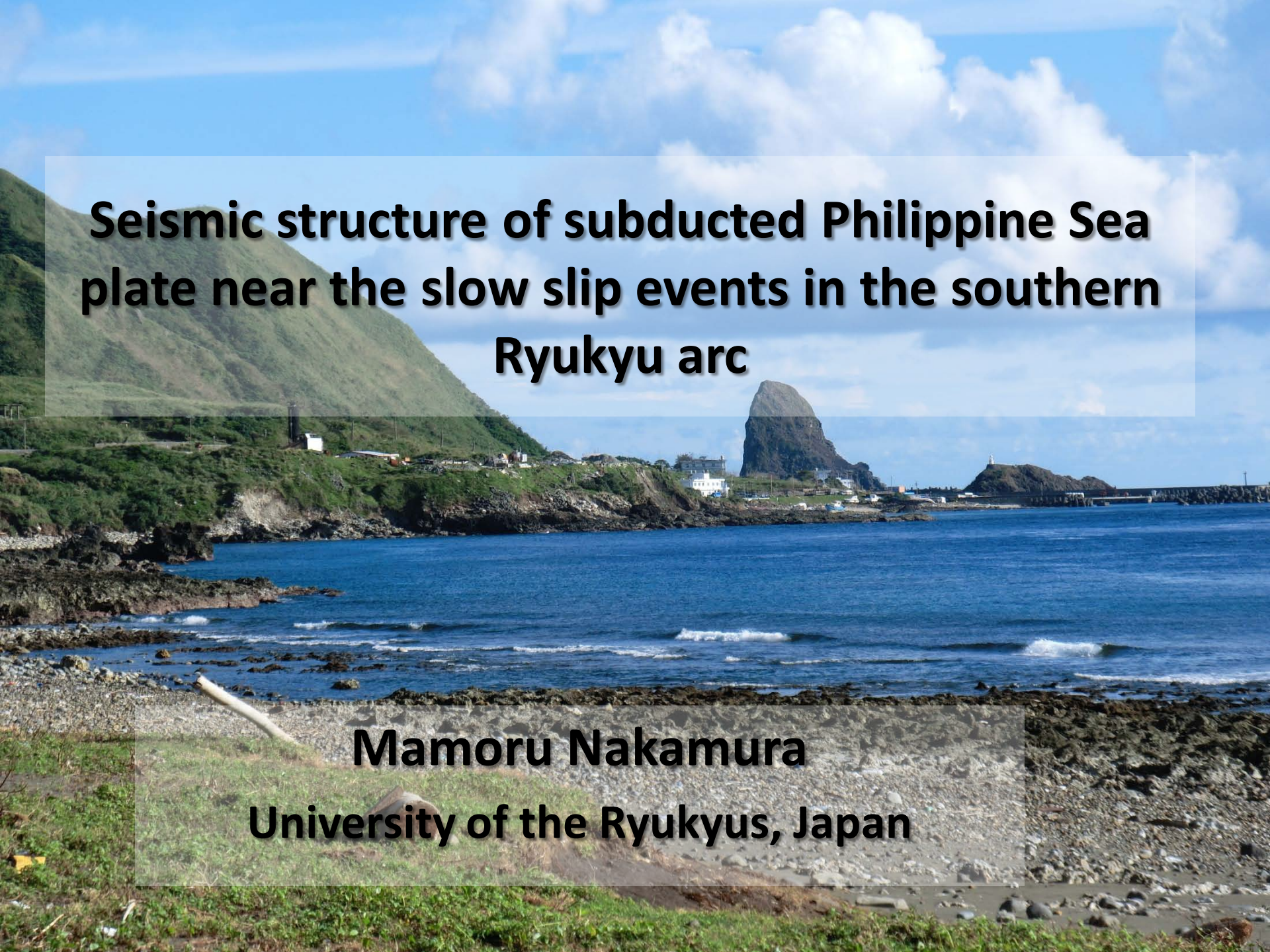
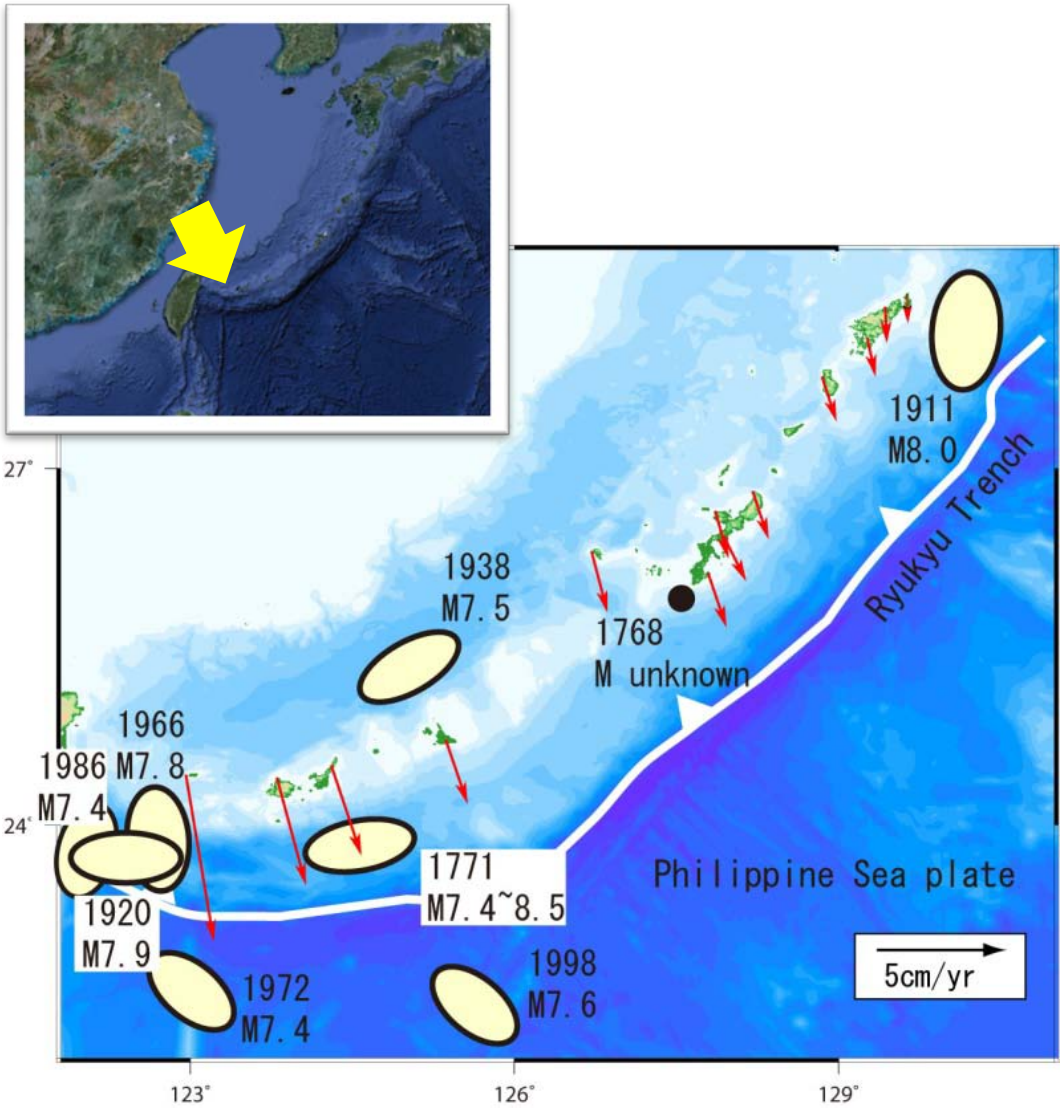


# Seismic structure of subducted Philippine Sea plate near the slow slip events in the southern Ryukyu arc


Mamoru Nakamura

University of the Ryukyus, Japan

# GPS horizontal displacements and historical earthquakes in the Ryukyu Trench

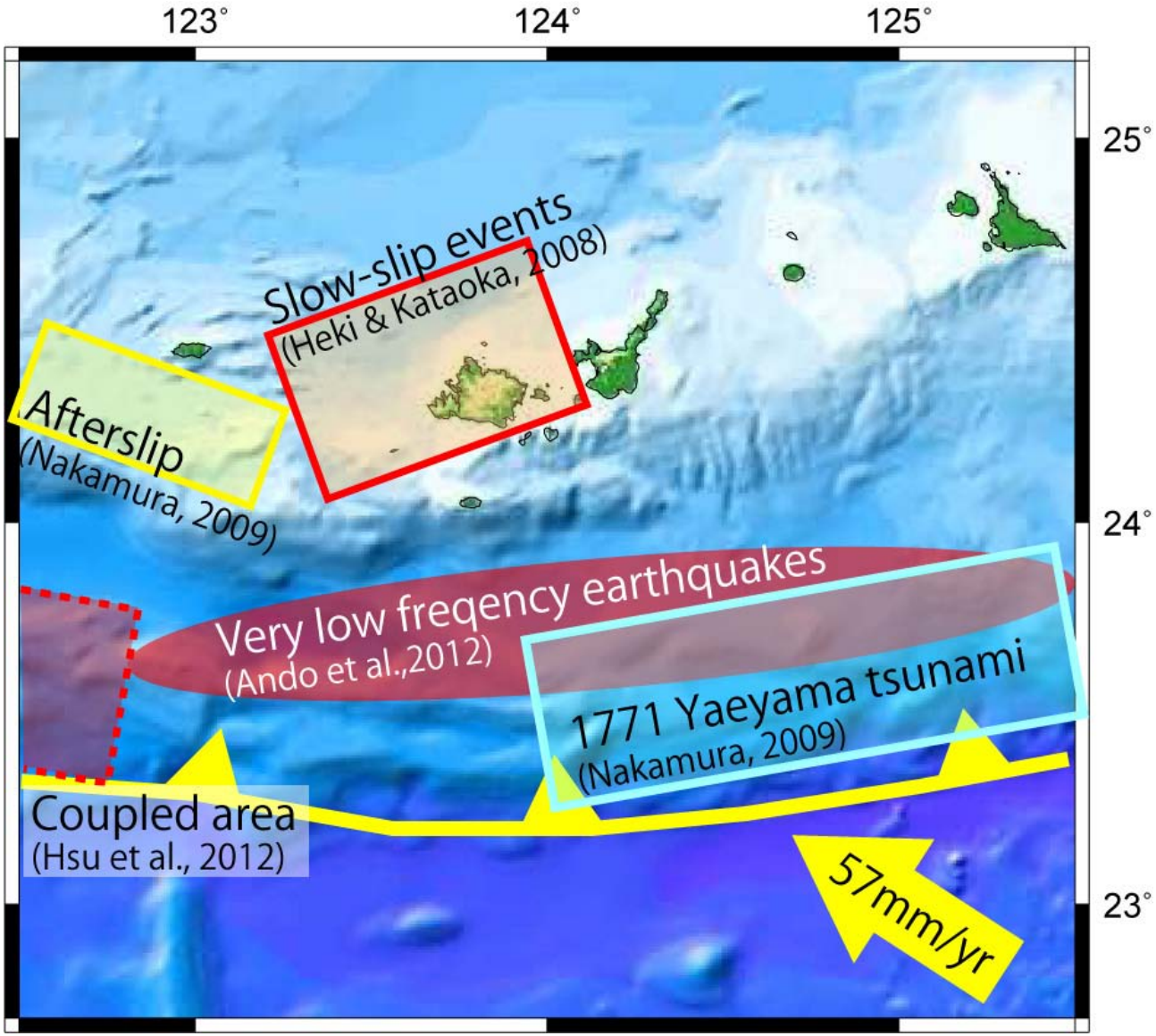



Historical earthquakes:
M<8.0

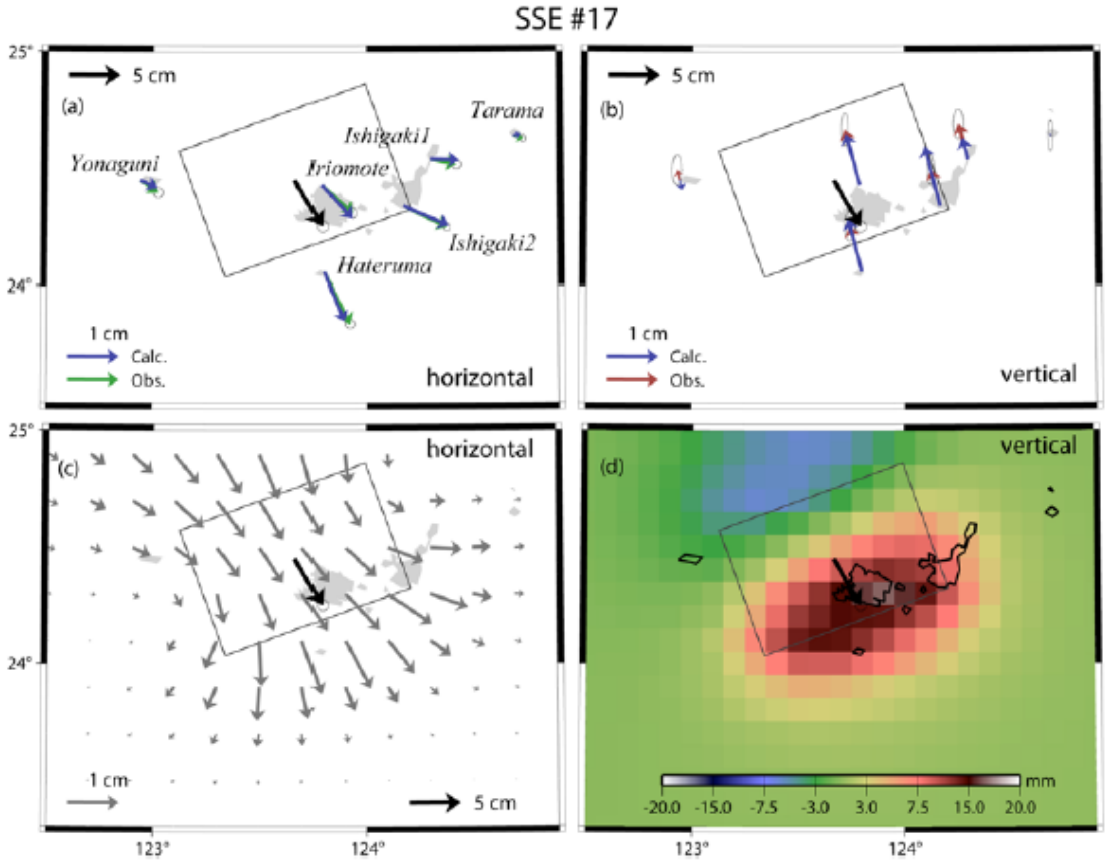
Inter plate coupling is weak?

Historical mega-tsunami (tsunami boulders)

# Interplate coupling in the south Ryukyu Trench



# Repeating slow slip events (Heki and Kataoka, 2008)

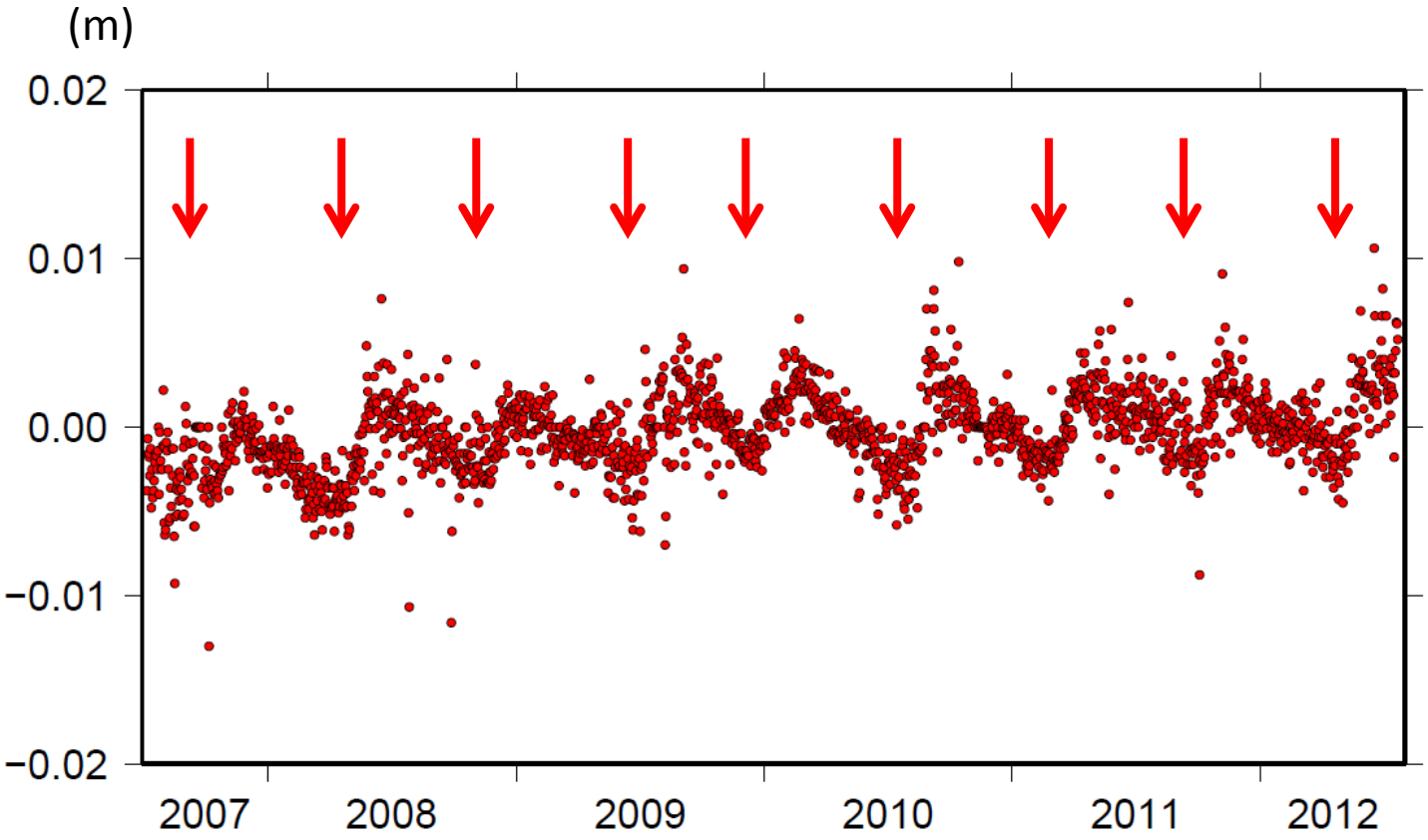


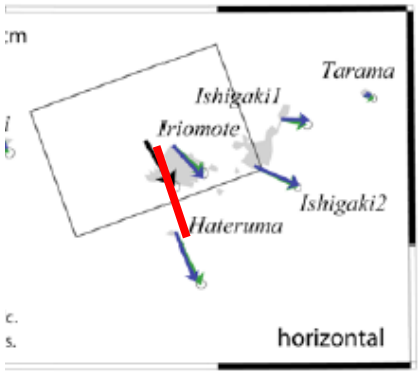

Repeating binaurally

Mw~6.6

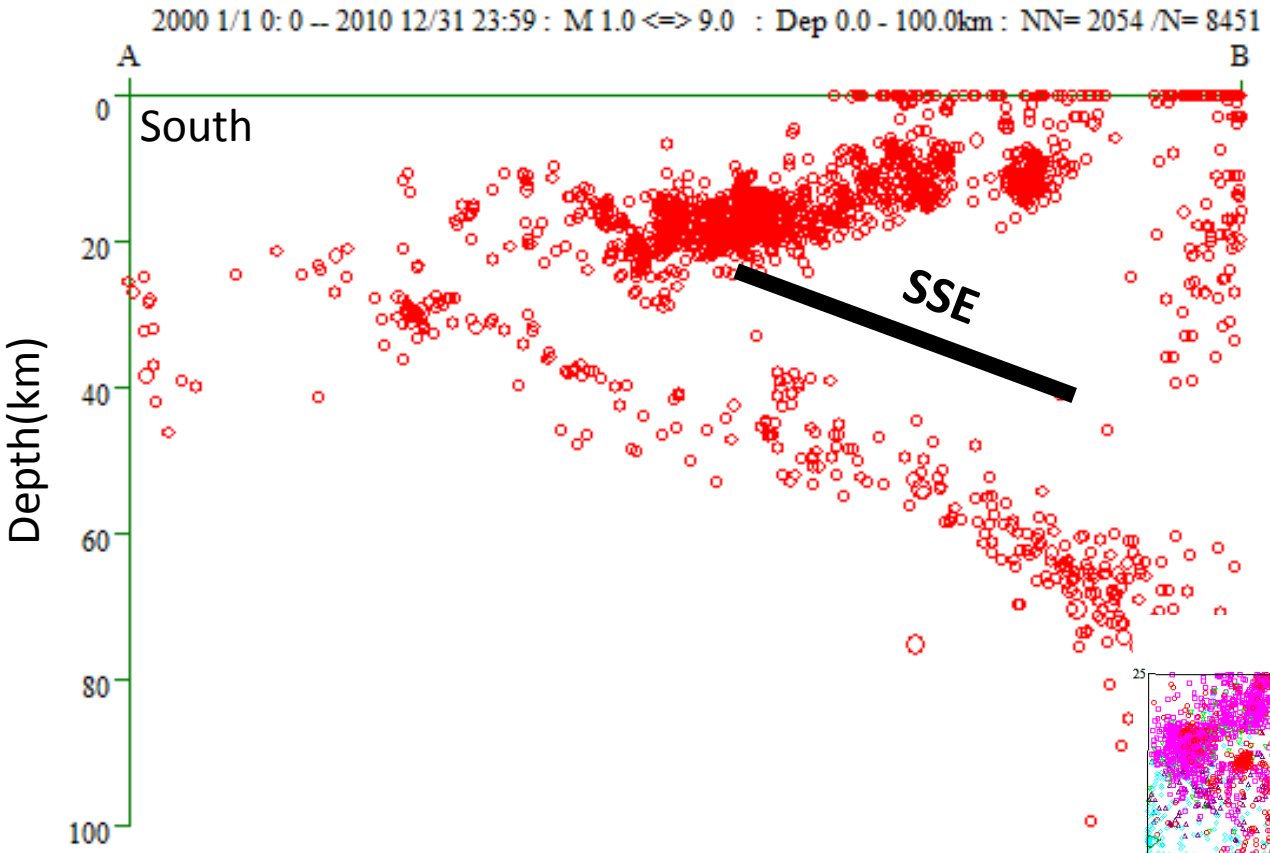
# Repeating slow slip events

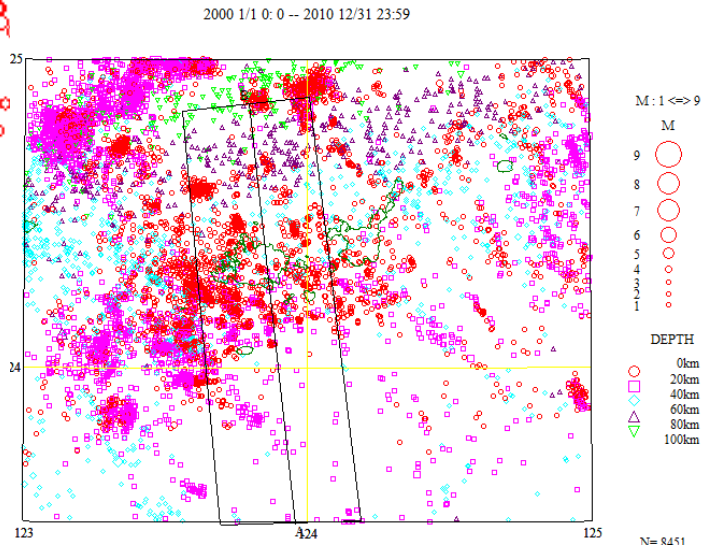
baseline length change between Hateruma and Iriomote



# Different depth of the SSE fault and hypocenters of slab earthquakes



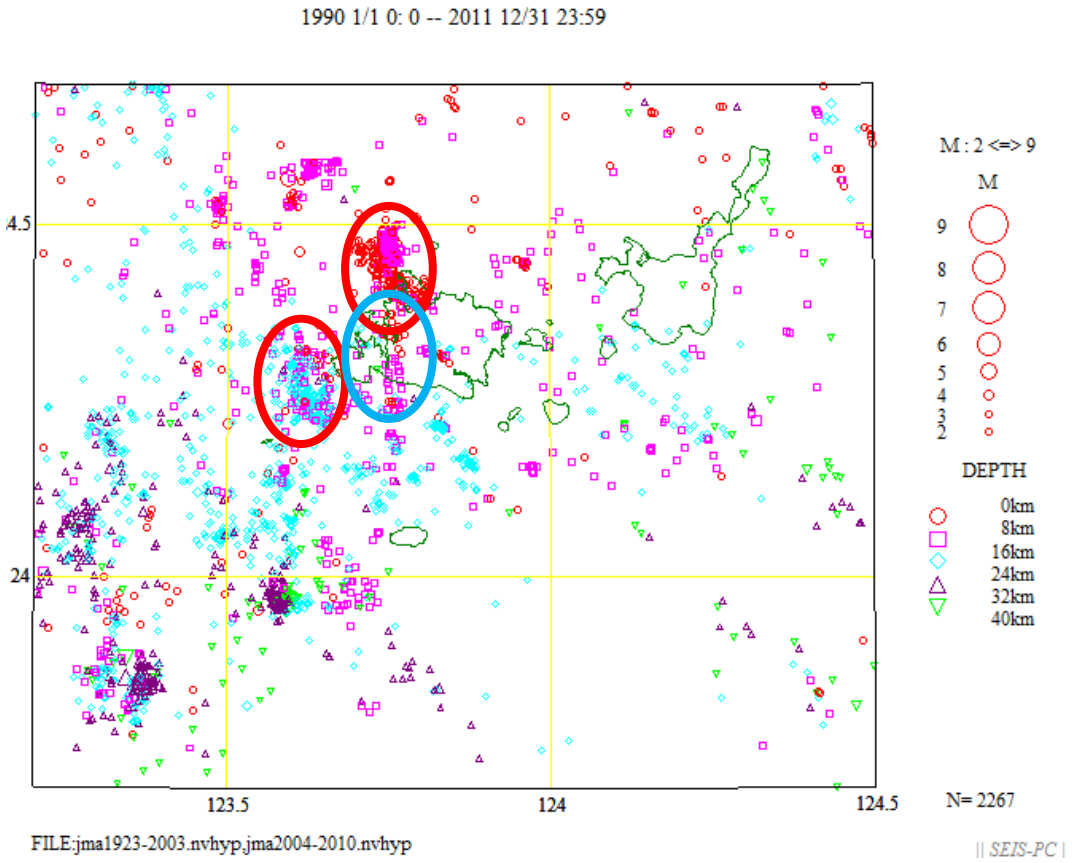



# Active crustal seismicity
# Iriomote earthquakes swarm

Iriomote earthquake swarm

March 1991
(M>2.0 : 49 events)
September 1992
(M>2.0 249 events)

Cause of the Iriomote swarm
-> fluid intrusion
(Shimizu, 1993)



## 1. 3D velocity structure

- **hypocenter distribution**
- **temperature condition**
- **fluid in the slab**

  SSEs and earthquake swarm

## 2. Detection of seismic discontinuity

- **depth of subducted plate**

1. **3D tomography**

   dVp, Vp/Vs structure

   hypocenters distribution

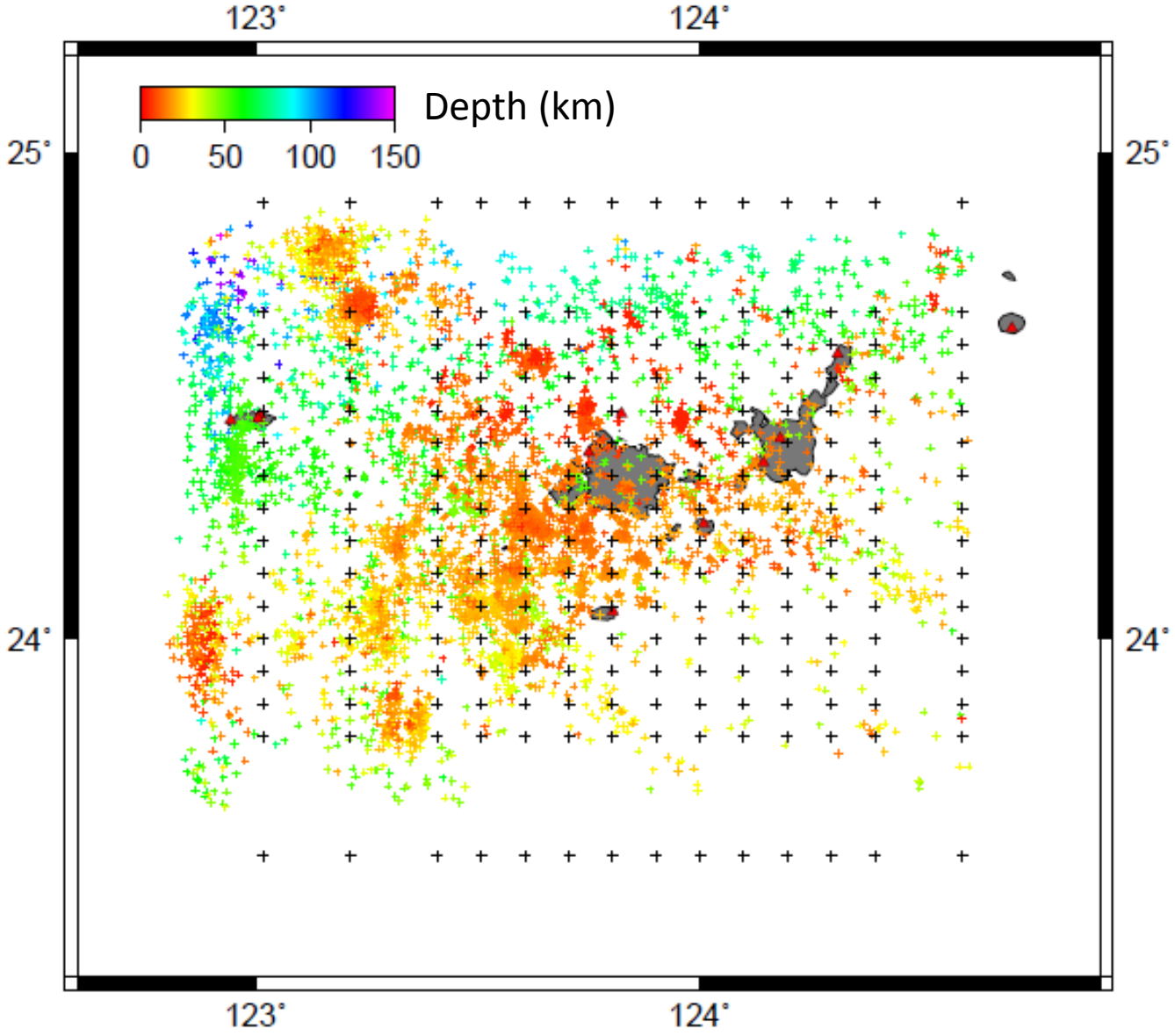
2. **receiver function**

   velocity discontinuity

# Tomography analysis

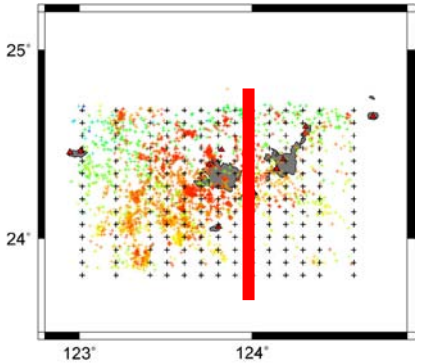
- Simul2000 (Thurber and Eberhart-Phillips, 1999)
- 14 stations of Japan Meteorological Agency and 2 stations of FNET (NIED)
  - P phase 47,476
  - S phase 44,917
- Period: January 2001 to July 2012
- Initial velocity model : JMA2001
- Reduction of Rms
  - P phase: 0.237 s -> 0.173 s
  - S phase: 0.379 s -> 0.286 s

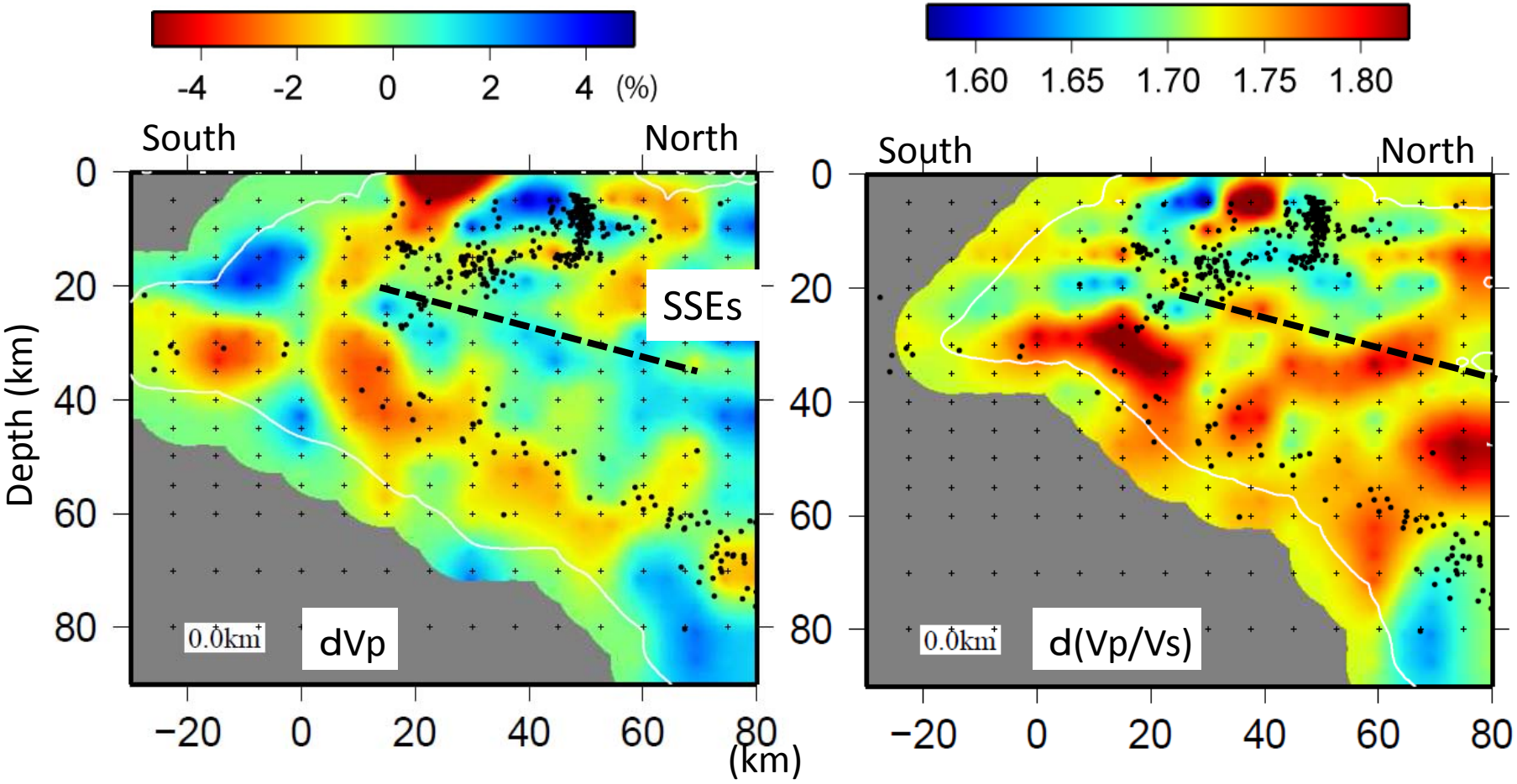
# Distribution of stations and hypocenters



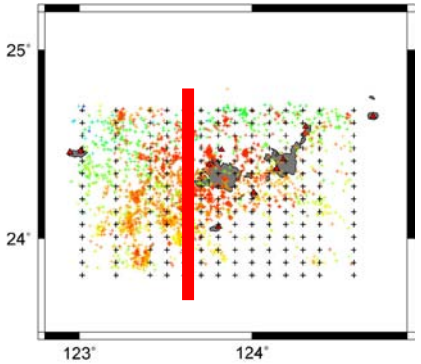
# results

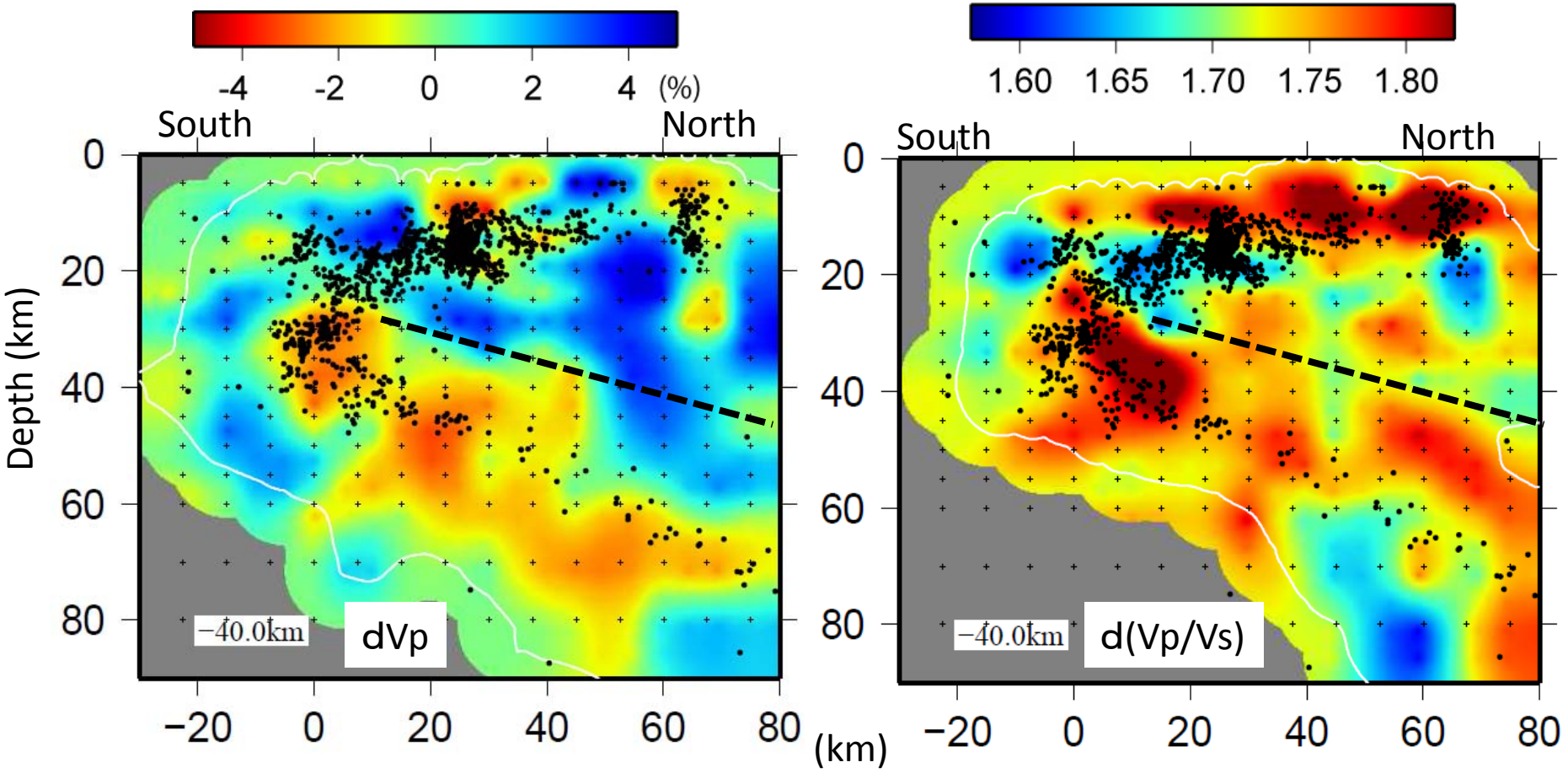
high Vp/Vs and Low Vp zone in the seismic zone



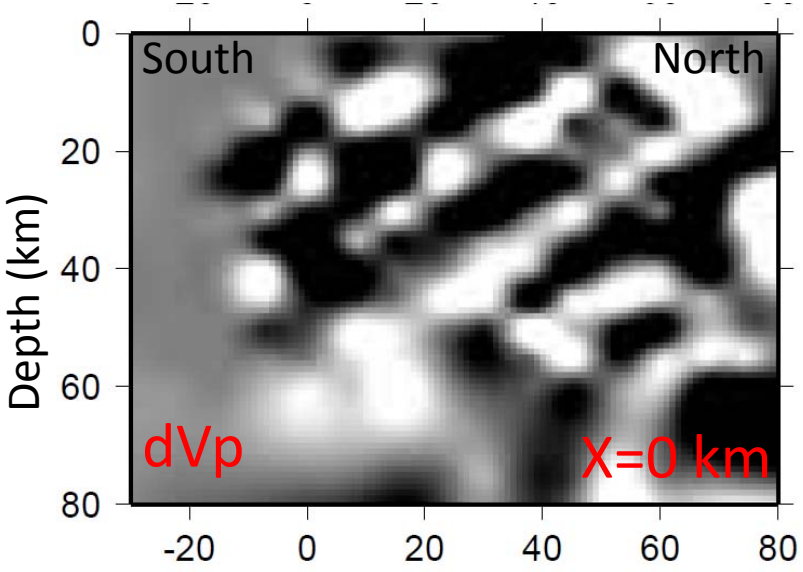



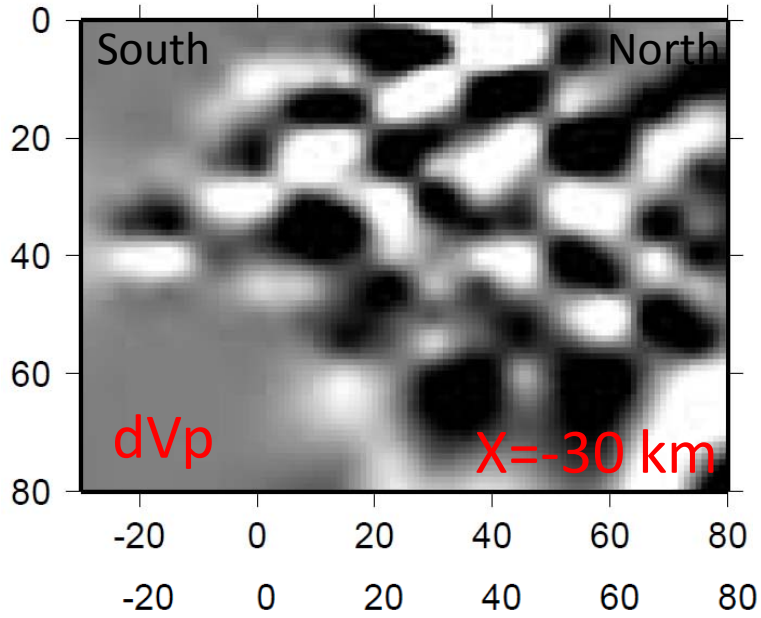
# results

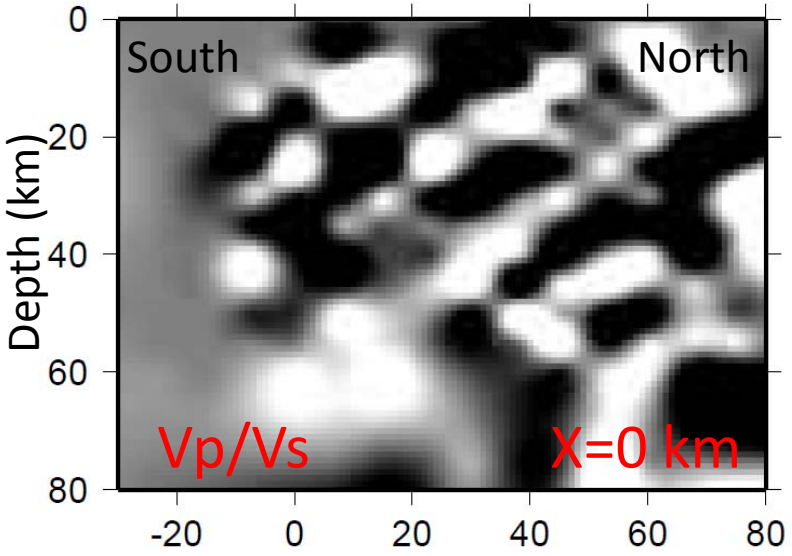

25°
24°
123°
124°

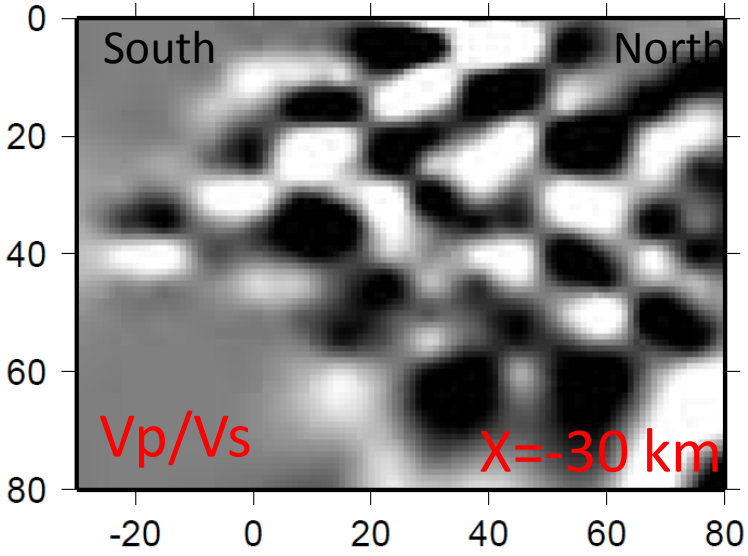

-4
-2
0
2
4
(%)
South
North
Depth (km)
0
20
40
60
80
−40.0km
dVp
−20
0
20
40
60
80
(km)
1.60
1.65
1.70
1.75
1.80
South
North
0
20
40
60
80
−40.0km
d(Vp/Vs)
−20
0
20
40
60
80

# Checkerboard resolution test



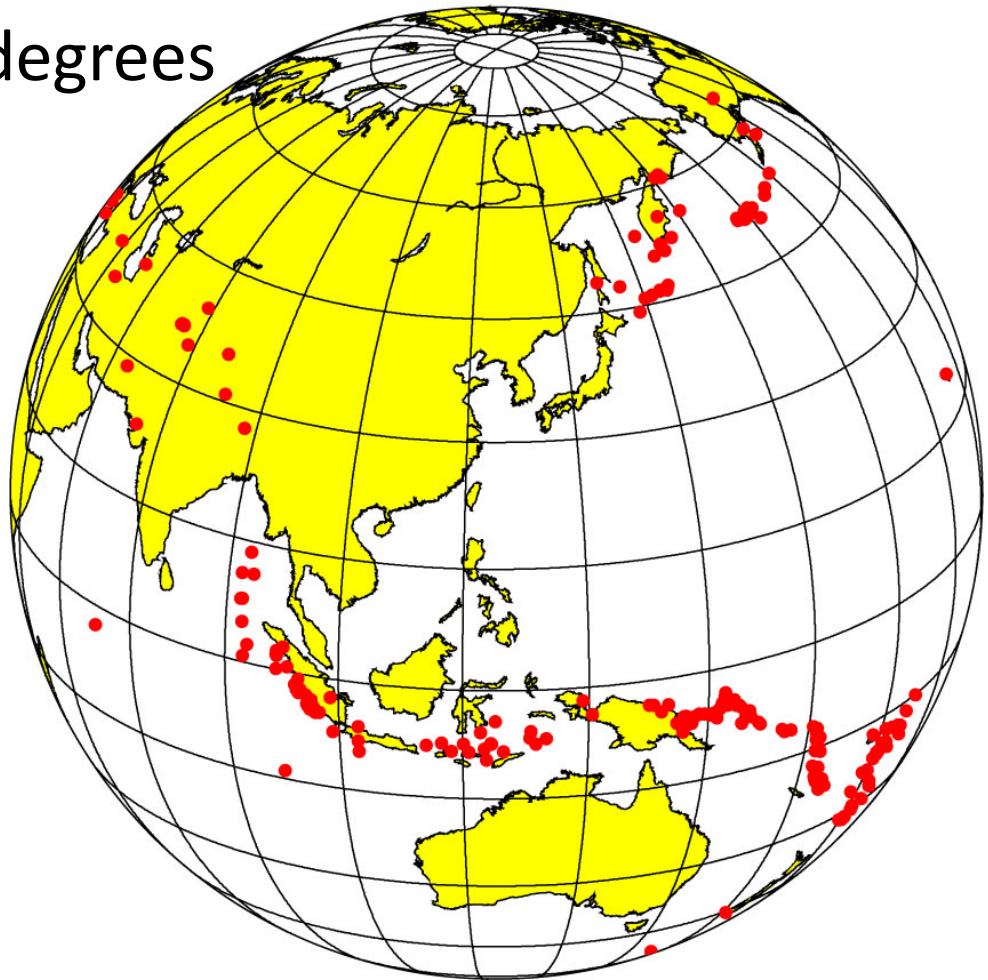
# Receiver function analysis

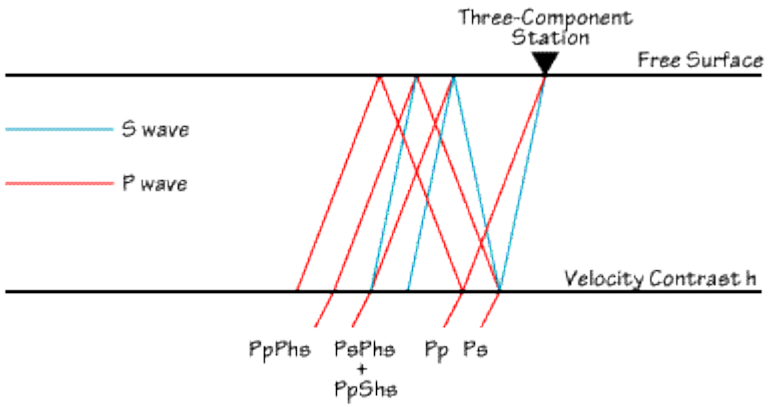
220 telseismic events

M>6.0

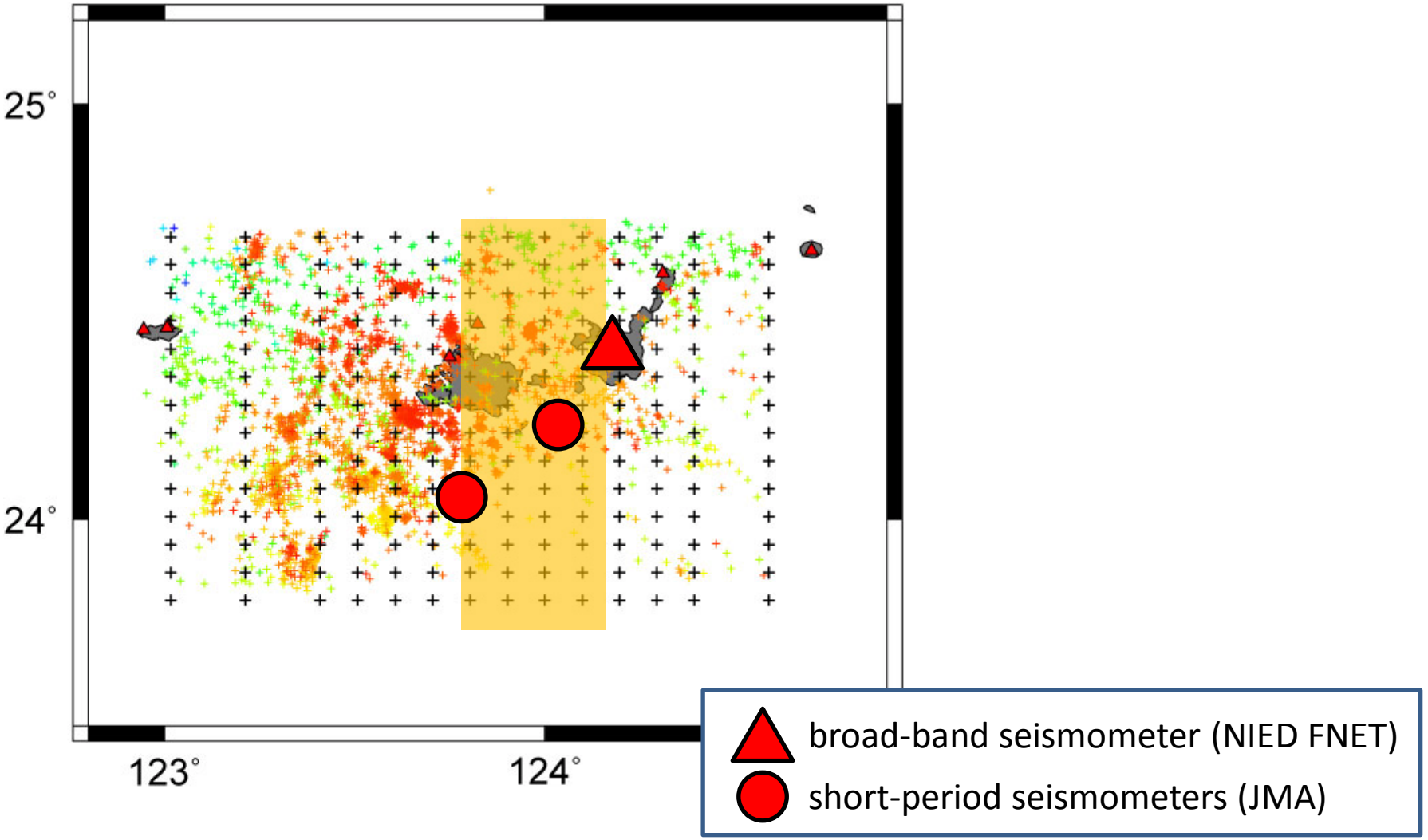
Epicentral distance 30~90 degrees

Jan. 2000 to May 2012





# Receiver function analysis



# procedure

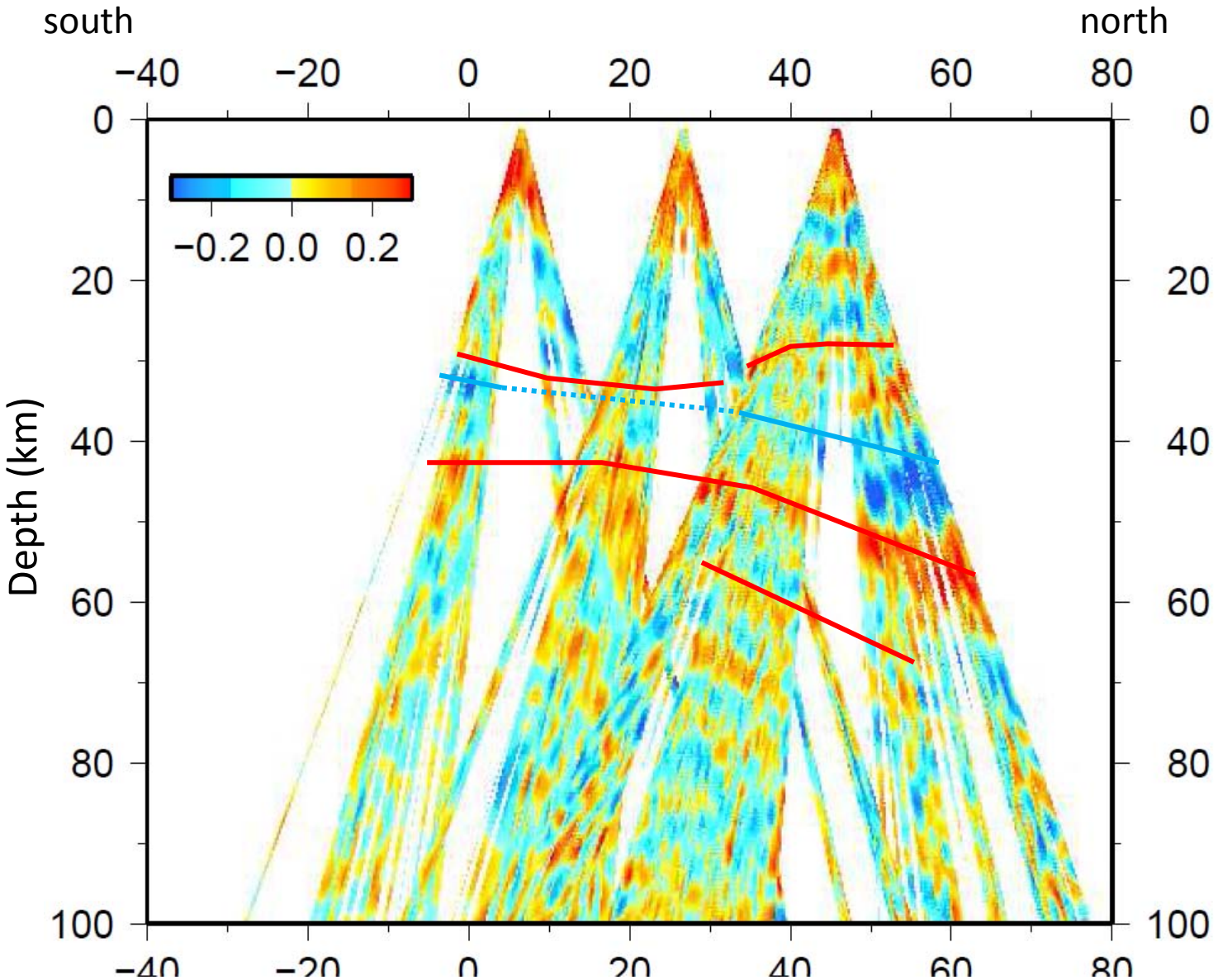
Employ the waveform (vertical and radial components)
5s before and 90 s after the P arrival.

Remove seismometer response

Deconvolution
0.01 water level method (Langston, 1979)
3 Hz low-pass Gaussian filter

Convert time to depth (JMA2001 model)

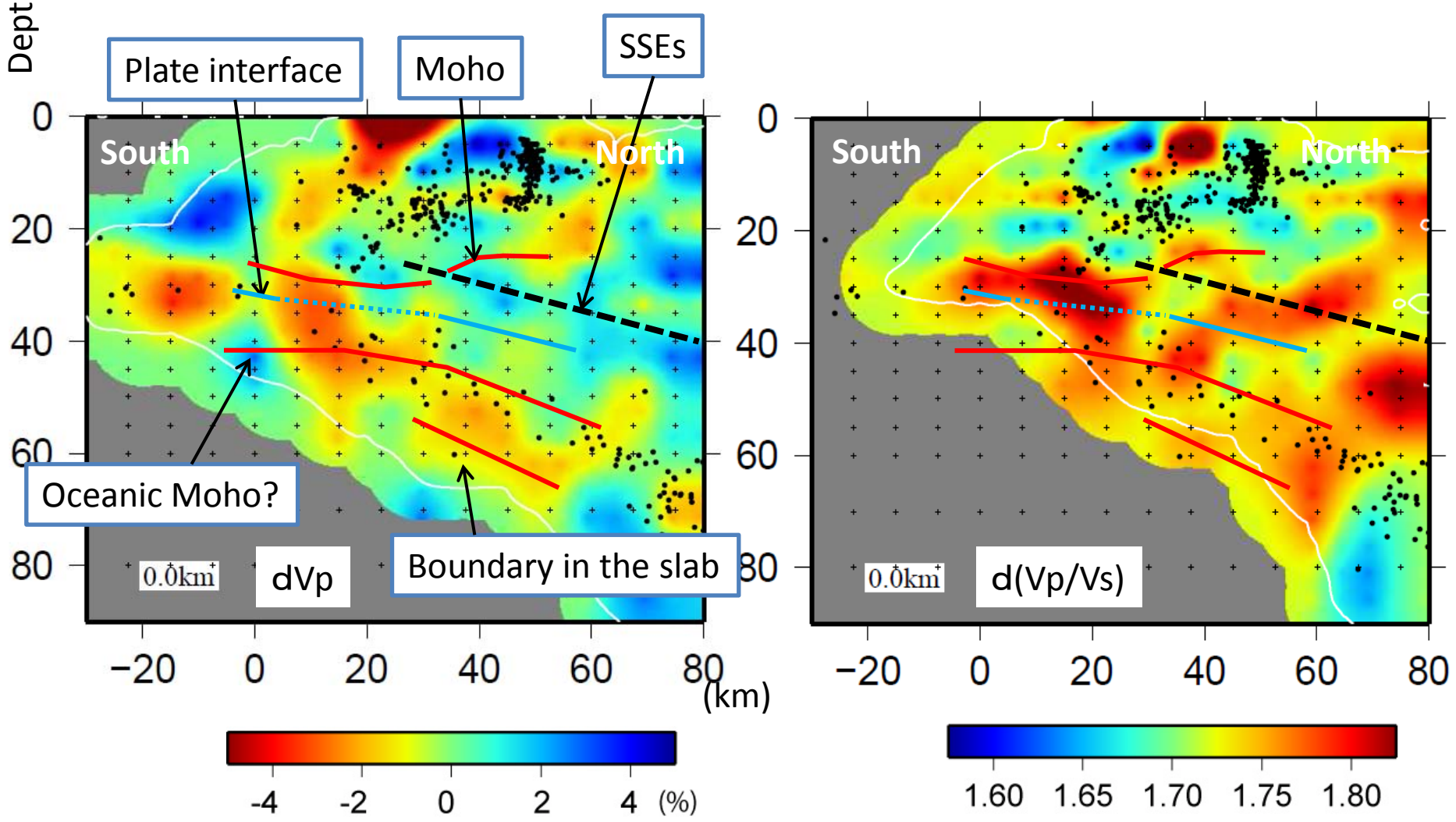
# receiver function



# Result 1. Dip of Slab

Depth <35 km: 6°

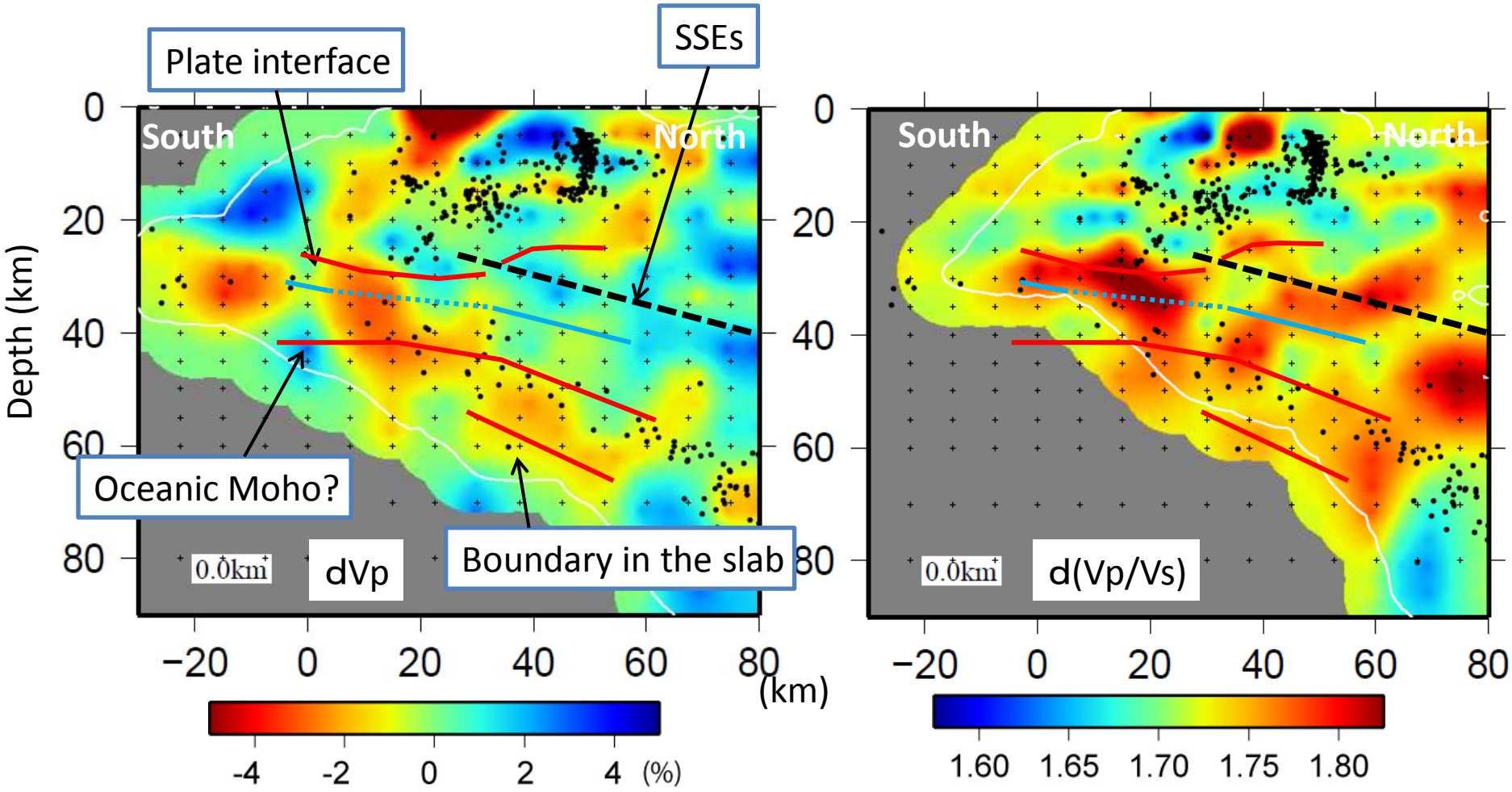
Depth >35 km: 14°



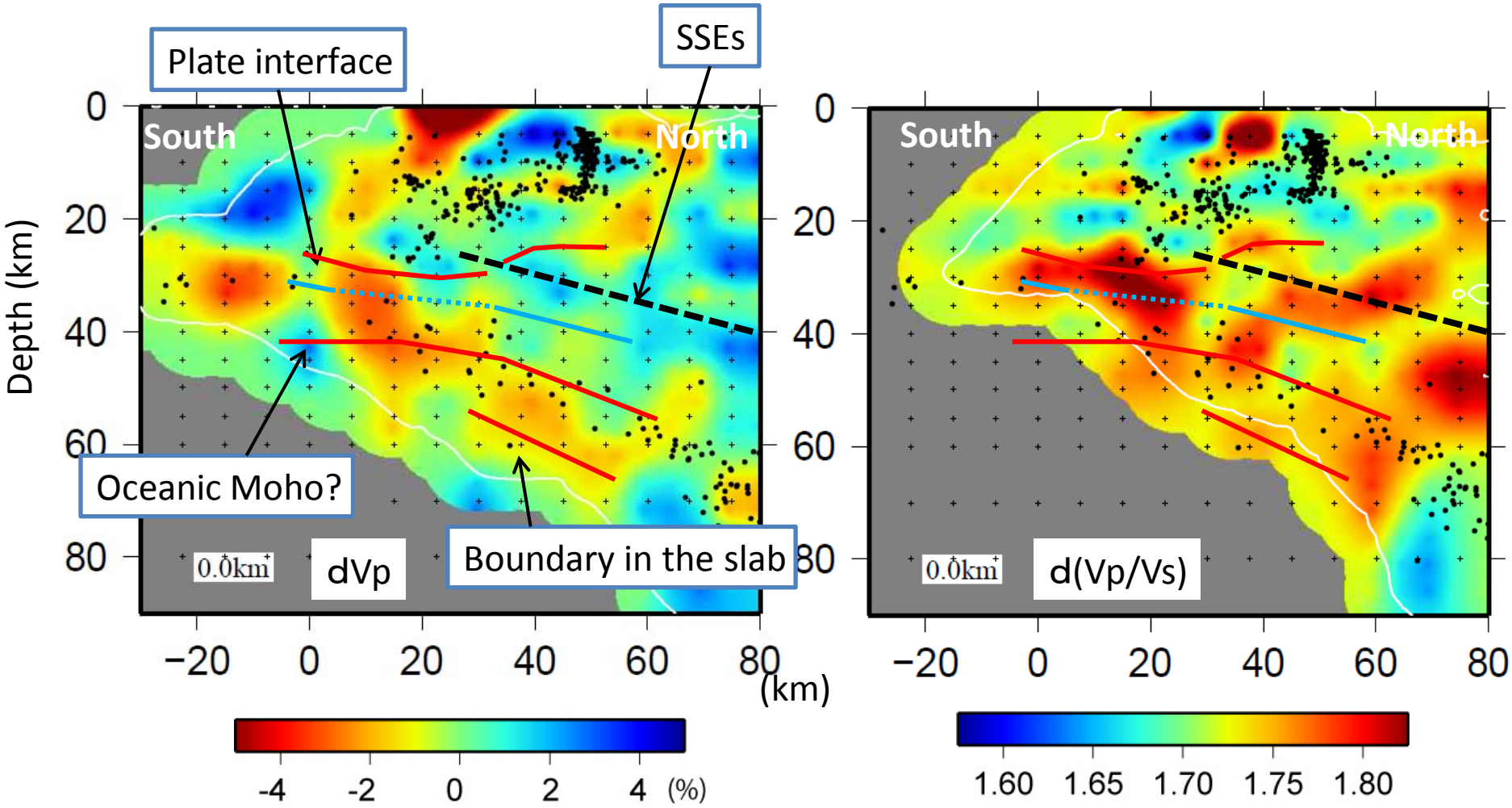
Result 2. Intraslab seismicity

Depth <35 km: in the oceanic crust

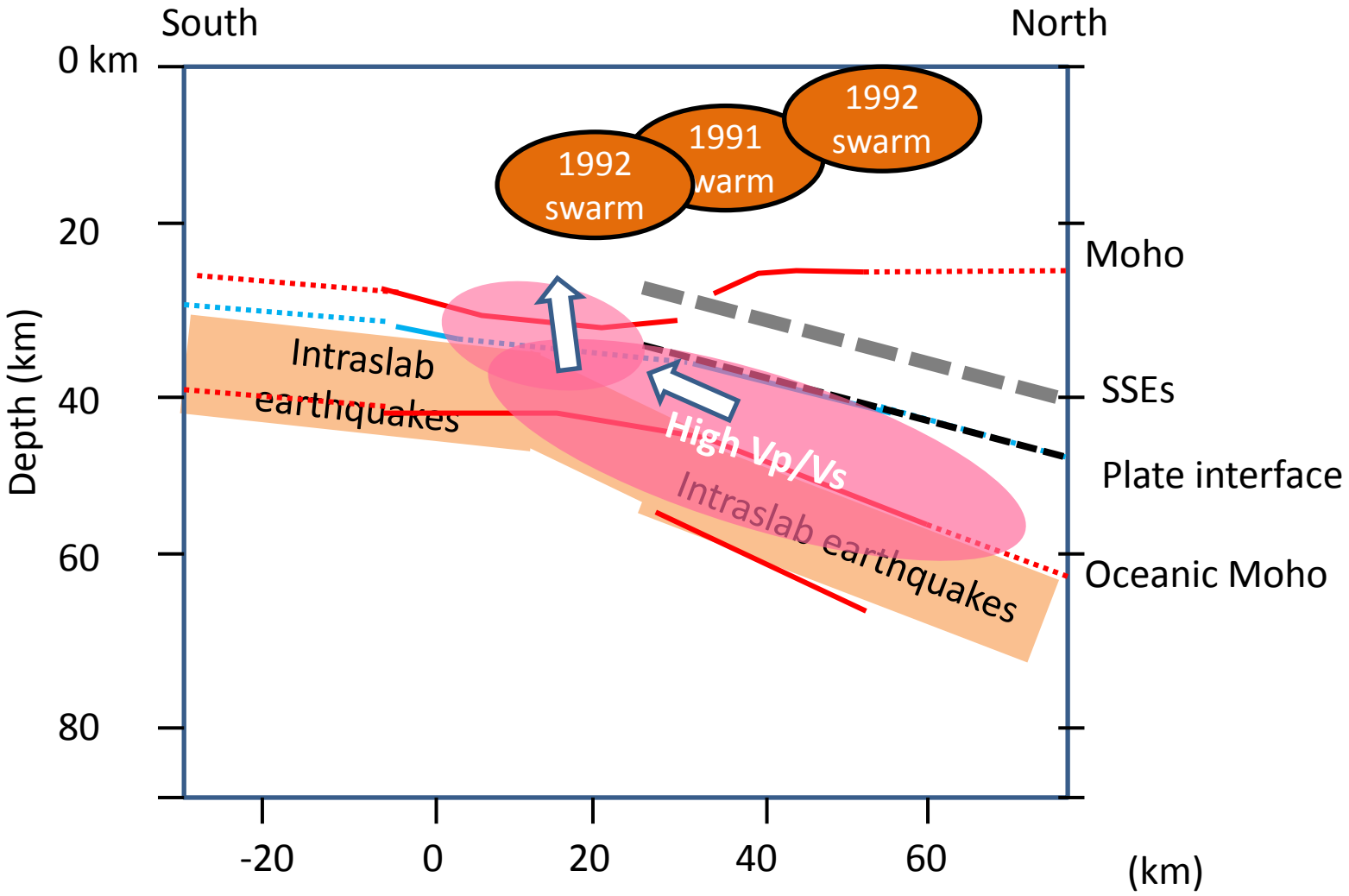
Depth >35 km: beneath the oceanic Moho



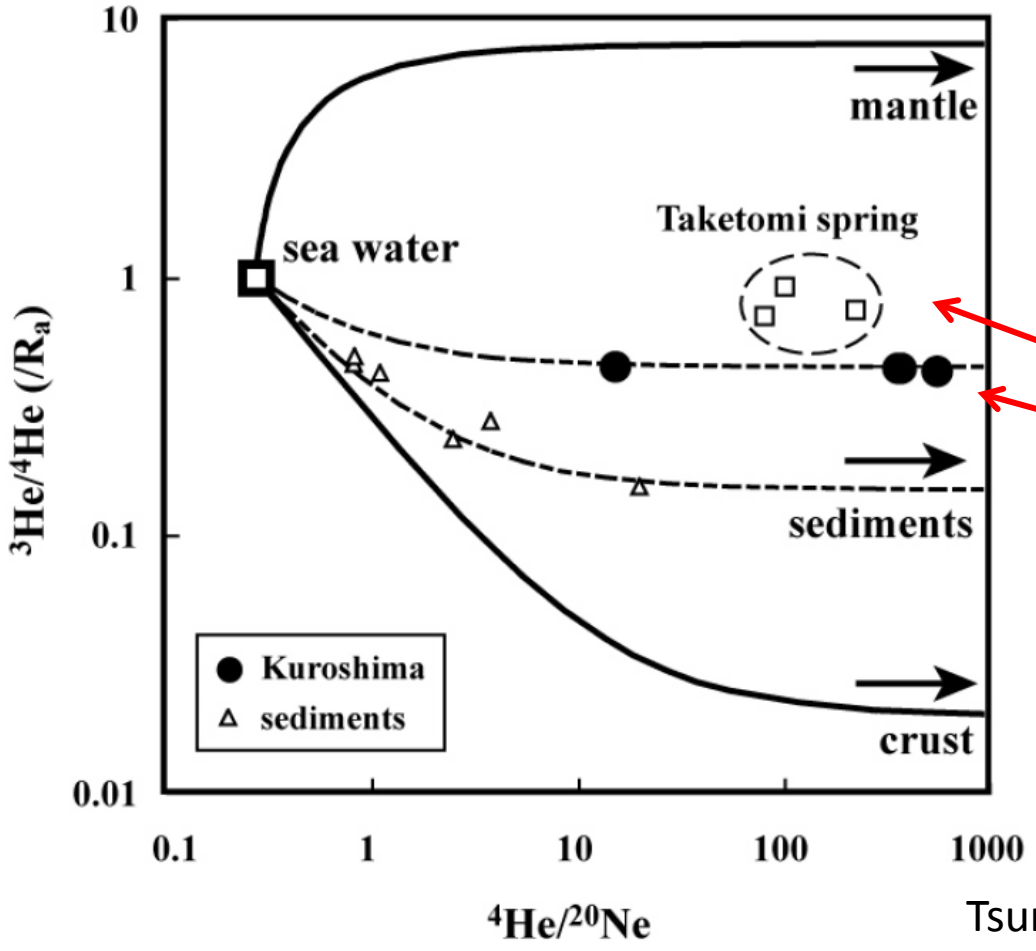
# Result 3. Depth of the Fault of SSEs
# -> <u>similar to the plate interface (within 5 km)</u>



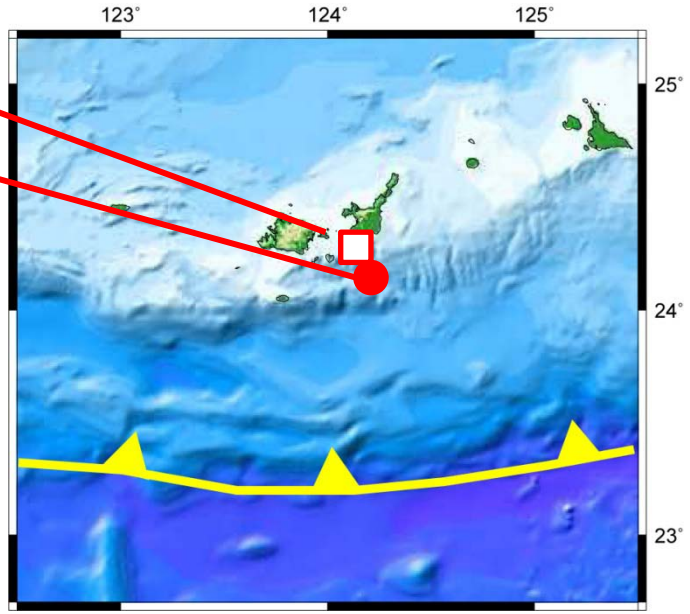
# Schematic illustration of the SSEs area



# *Helium isotopic compositions*




Contribution of mantle helium in the bubble of Taketomi spring and Kuroshima knoll

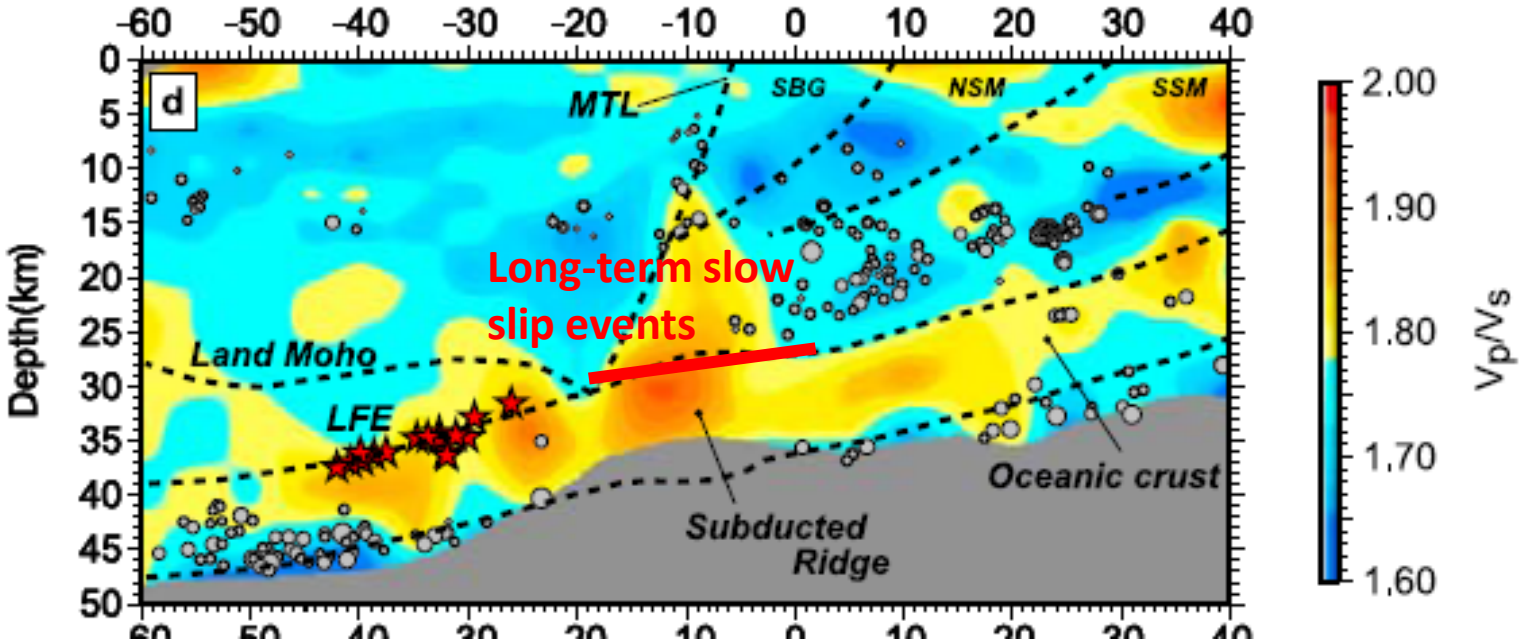



Tsunogai et al., 2010
(Taketomi spring: Ohmori et al., 1993)

# High Vp/Vs beneath the slow slip area in the Tokai region

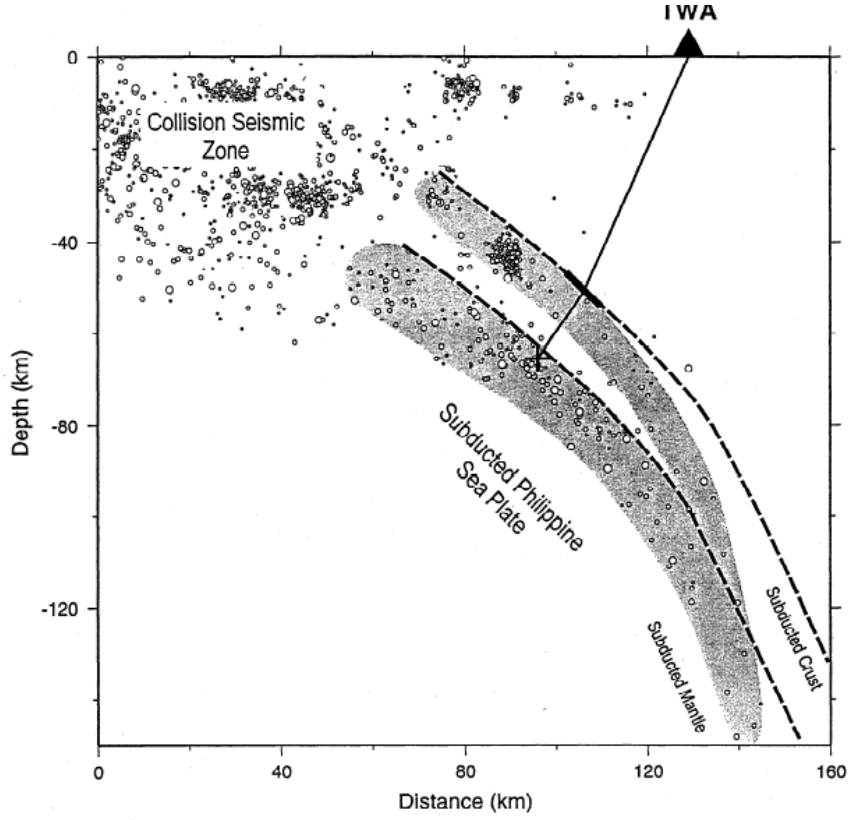
Over-pressured fluid

-> reduce the dehydration and cease the intraslab seismicity

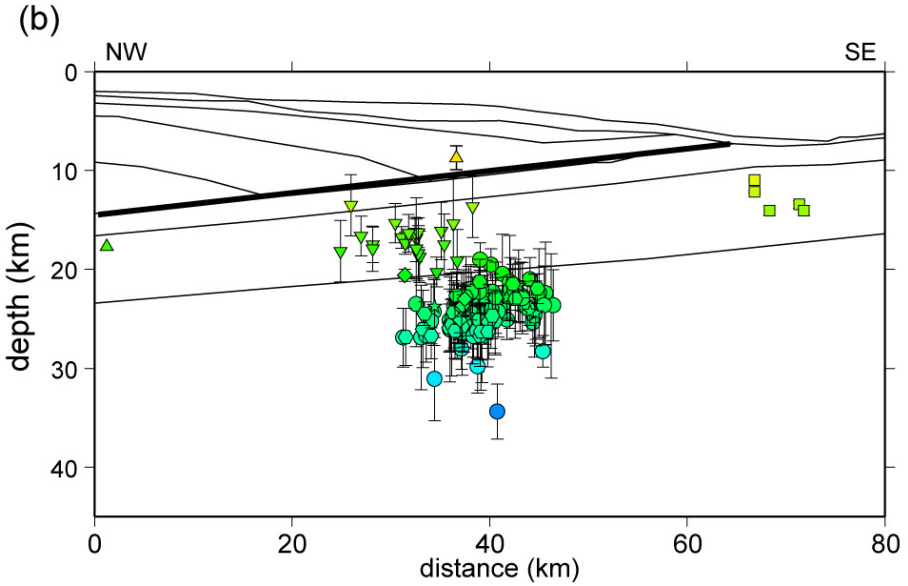



Vp/Vs velocity structure and seismicity in the Tokai region, southwestern Japan (Kato et al., 2010)

# Intraslab seismic zone along the Ryukyu Trench

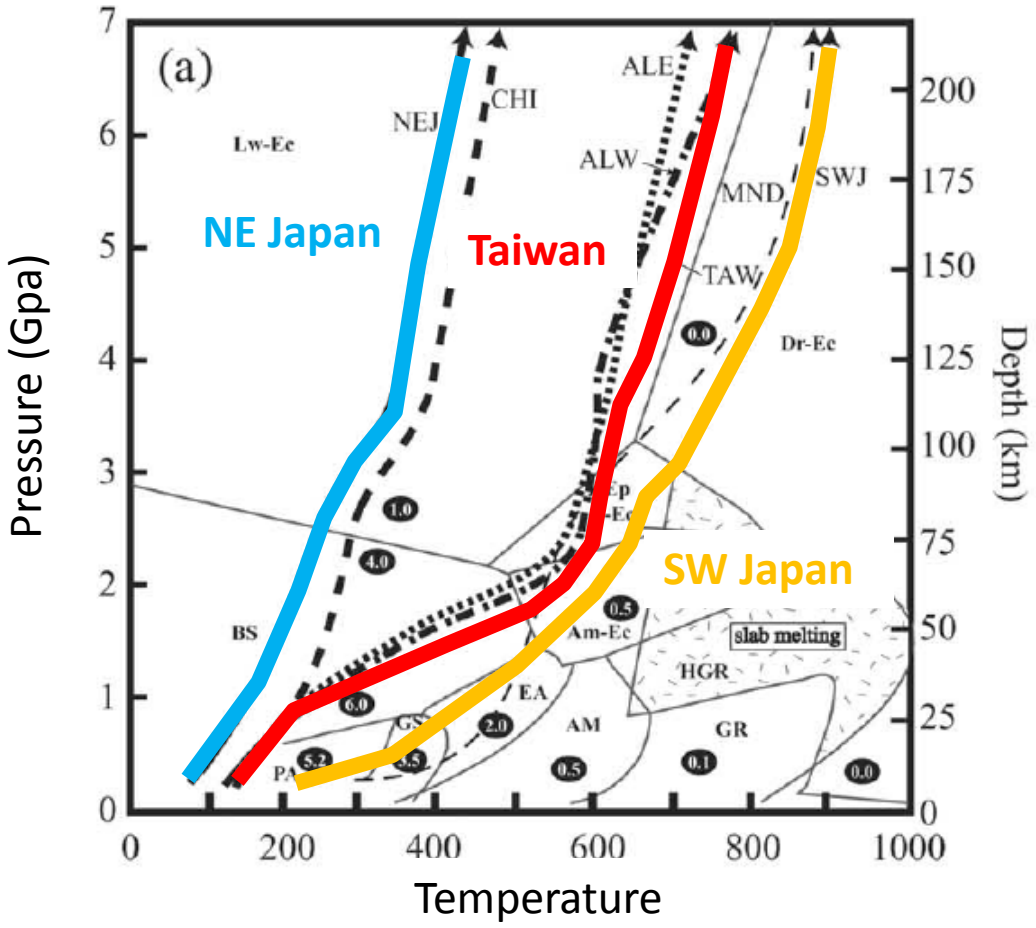



**Northeast Taiwan** (Kao & Rau, 1999)




**Central Ryukyu** (Nakamura, 2011)

# Temperature structure in the Taiwan-south Ryukyu area
## -> similar to the SW Japan




（Yamazaki & Seno, 2003）

# Conclusions

- **Low Vp and high Vp/Vs region at the subducted oceanic crust at the SSE region in the Ryukyu trench, which are similar to those in the SW Japan region.**
- **Intraslab earthquakes occur about 20 km apart from plate interface, which is caused by young plate age**
- **High Vp/Vs zone connects to the earthquake swarm area, and Moho crosses to plate interface. Fluid triggers the earthquake swarm?**


Thank you!