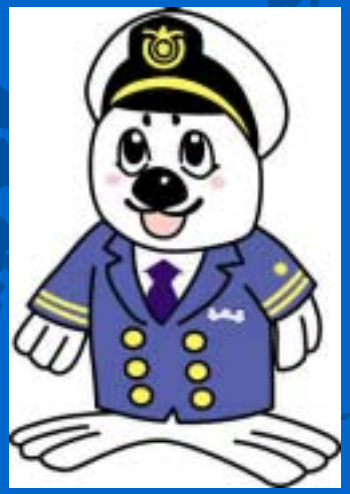
Toward Detecting Crustal Movement in the Undersea Plate Boundary Region around Japan



Hydrographic and Oceanographic Department, Japan Coast Guard

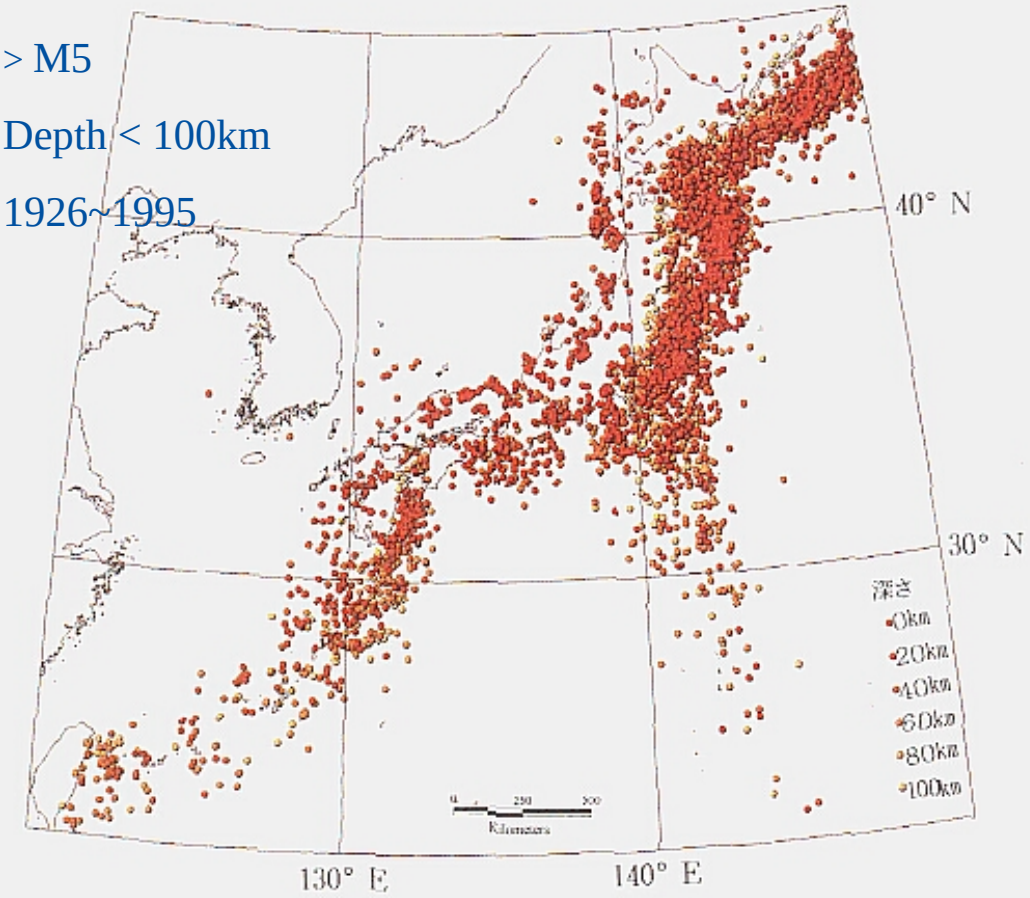
(Presentation by Masayuki Fujita)

Distribution of Epicenters around Japan

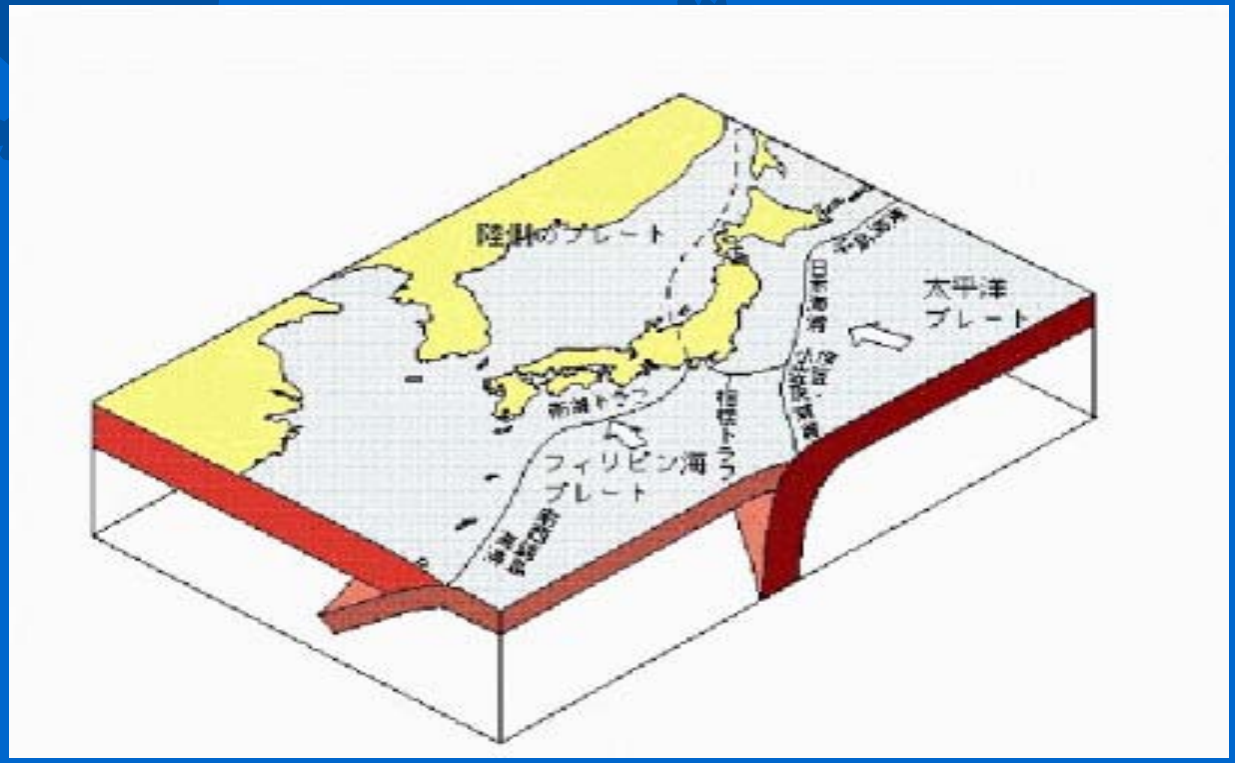
> M5

Depth < 100km

1926~1995

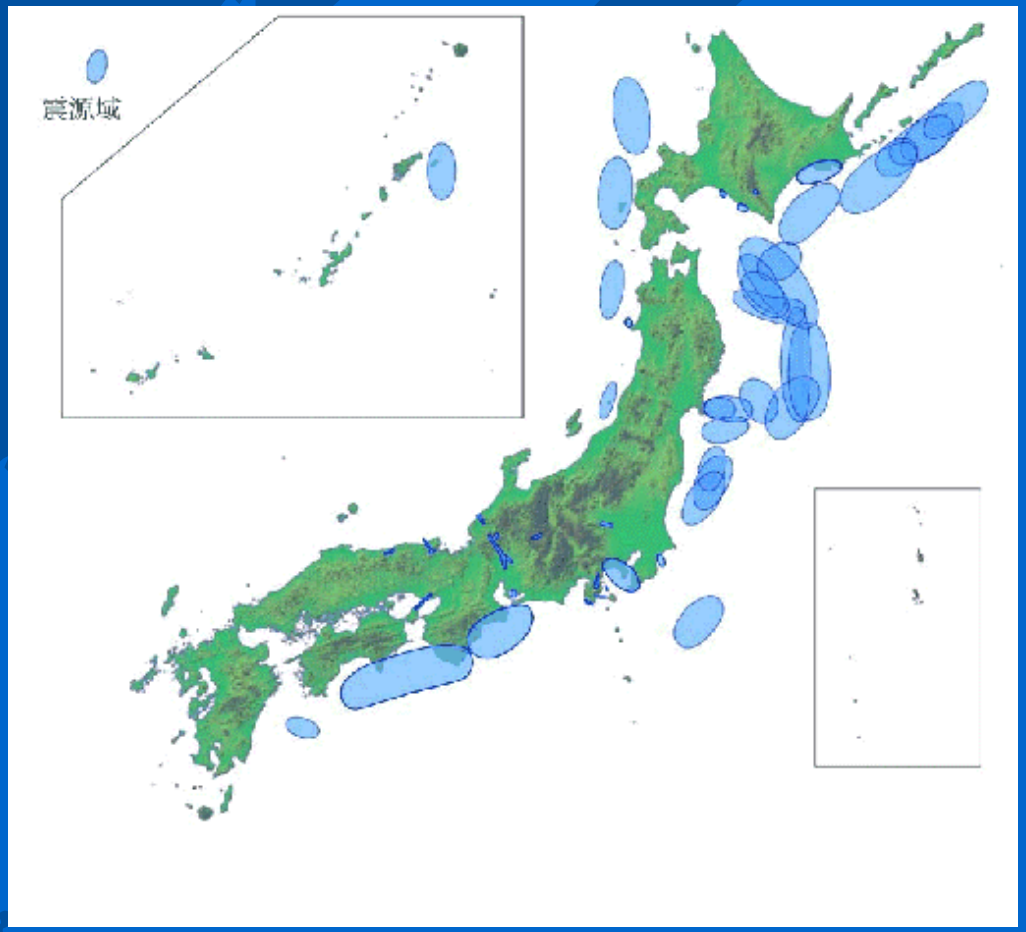


Plates Configuration around Japan



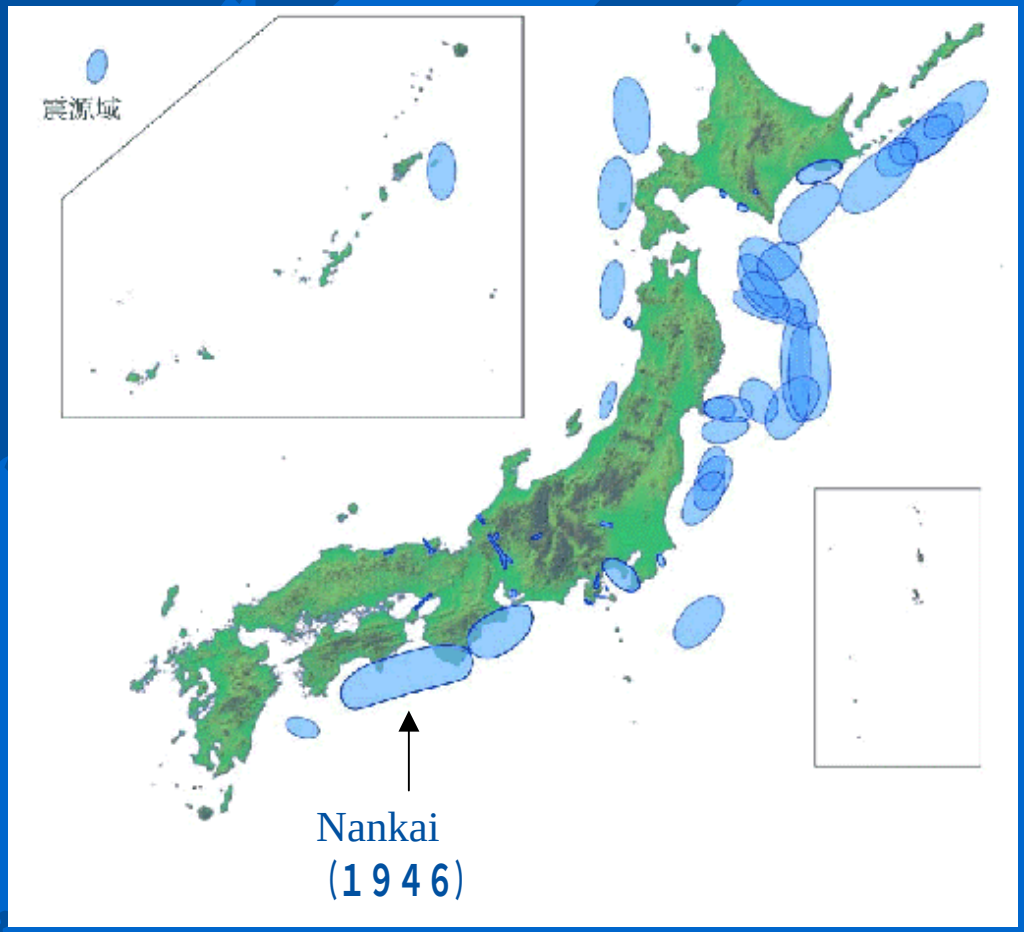
Multiple plates are adjacent to each other.

Fracture Zone of Large Earthquakes



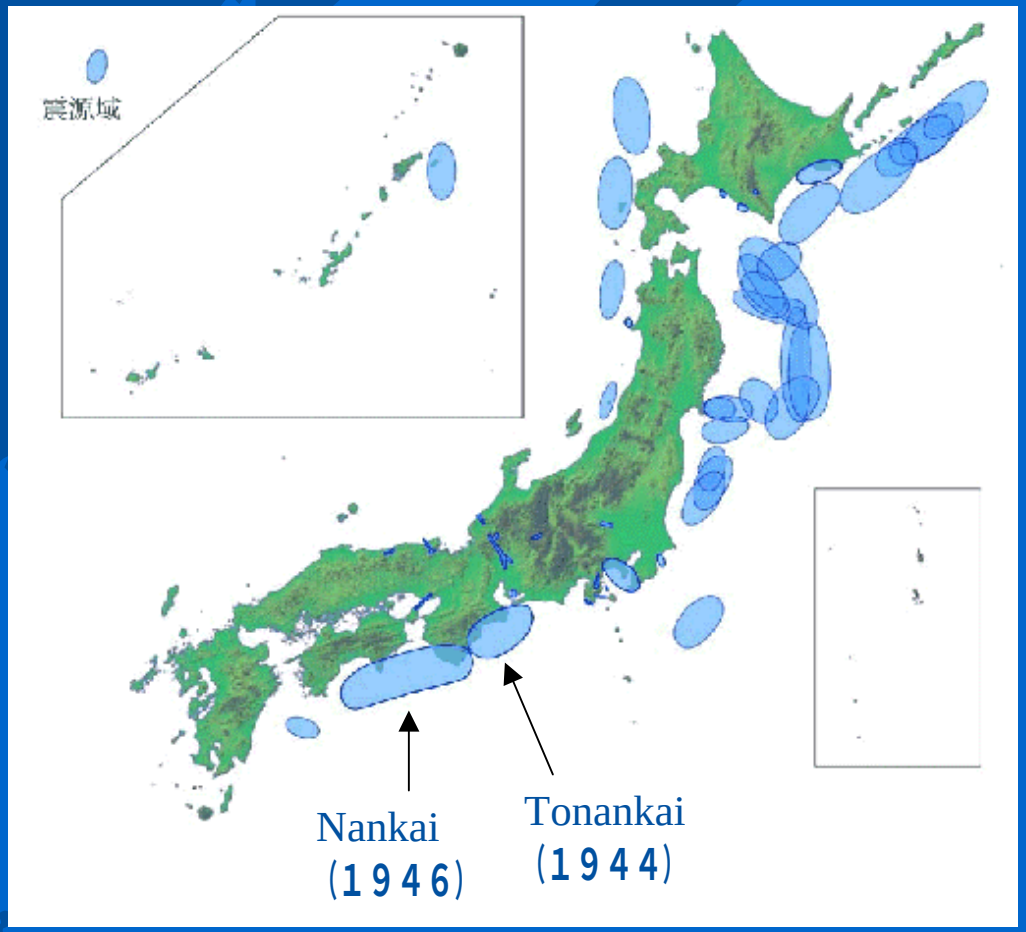
(1885 – 1995: Depth < 100km)

Fracture Zone of Large Earthquakes



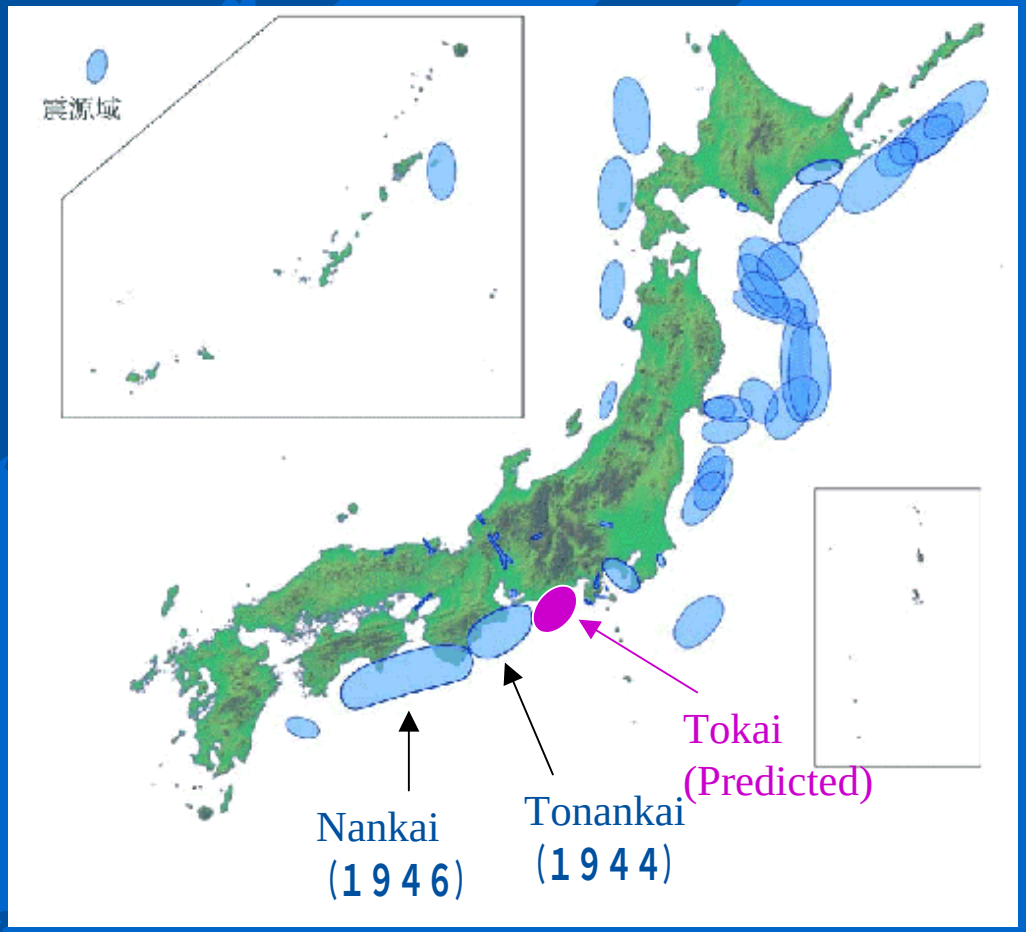
(1885 – 1995: Depth < 100km)

Fracture Zone of Large Earthquakes



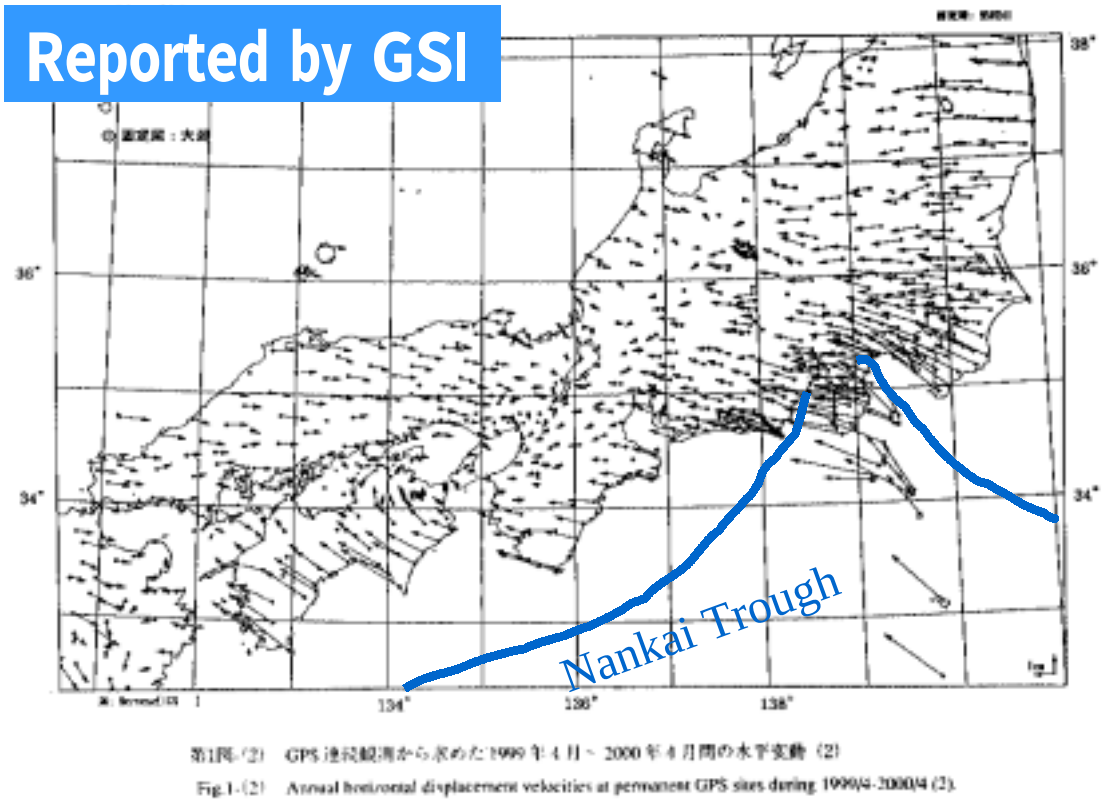
(1885 – 1995: Depth < 100km)

Fracture Zone of Large Earthquakes



(1885 – 1995: Depth < 100km)

Crustal Movement on Land

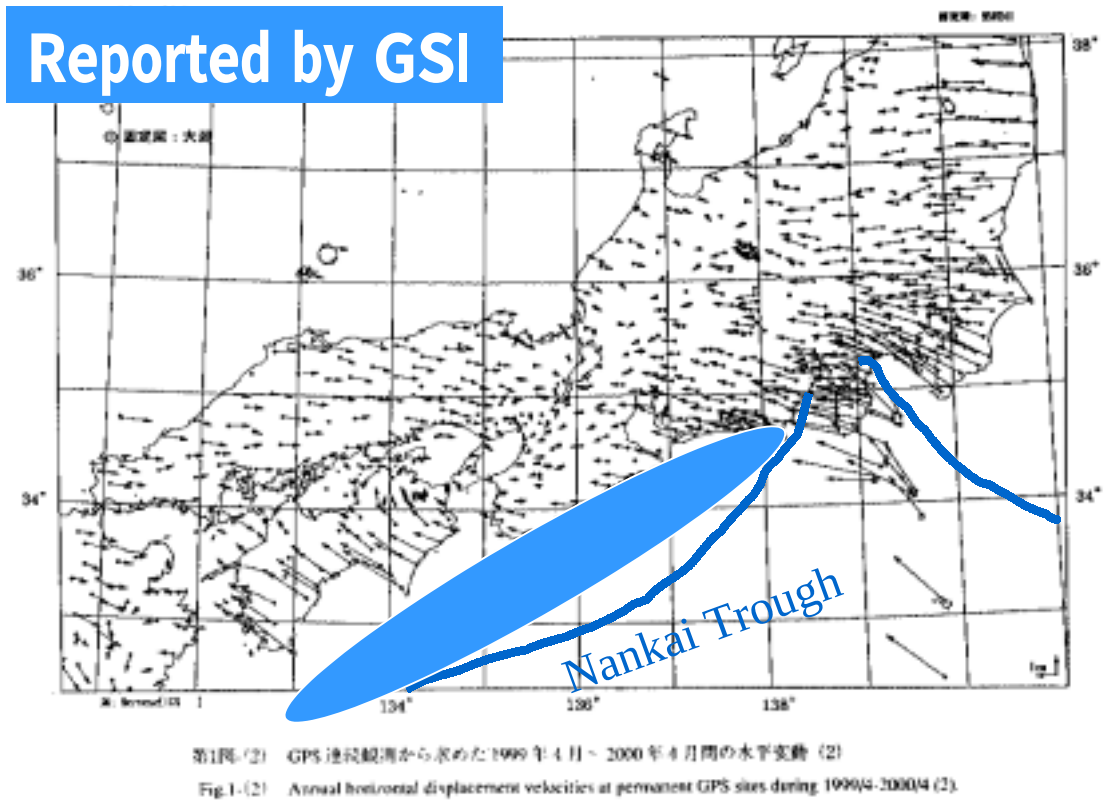


第1図-(2) GPS連続観測から求めた1999年4月～2000年4月間の水平変動 (2)

Fig.1-(2) Annual horizontal displacement velocities at permanent GPS sites during 1999/4-2000/4 (2).

(From Report of the coordinating Committee for Earthquake Prediction)

Crustal Movement on Land



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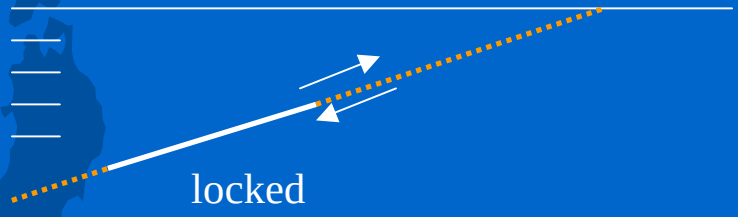
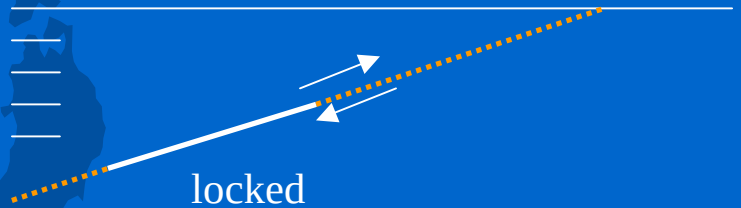
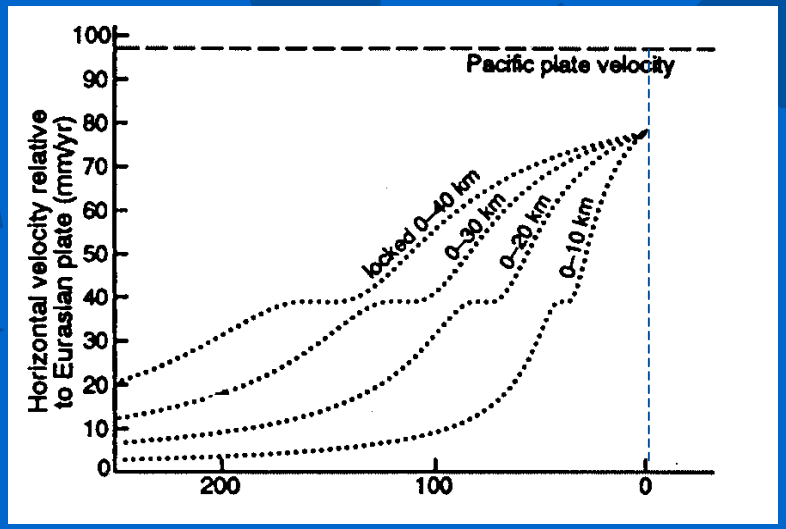
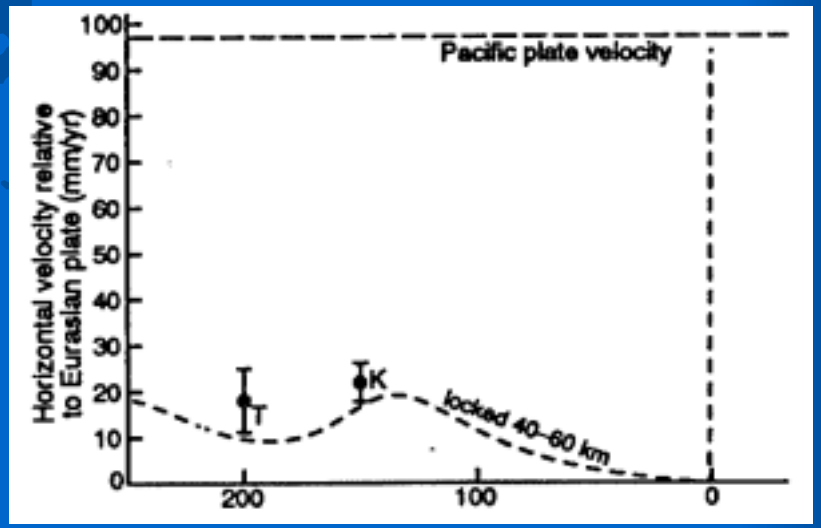
Theoretical Movement
by Simple Dislocation Model



Theoretical Movement
by Simple Dislocation Model







Modified from Argus and Lyzenga (1993)

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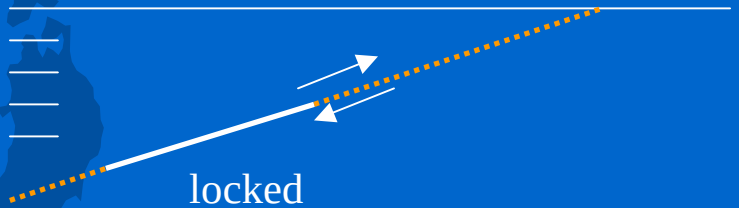

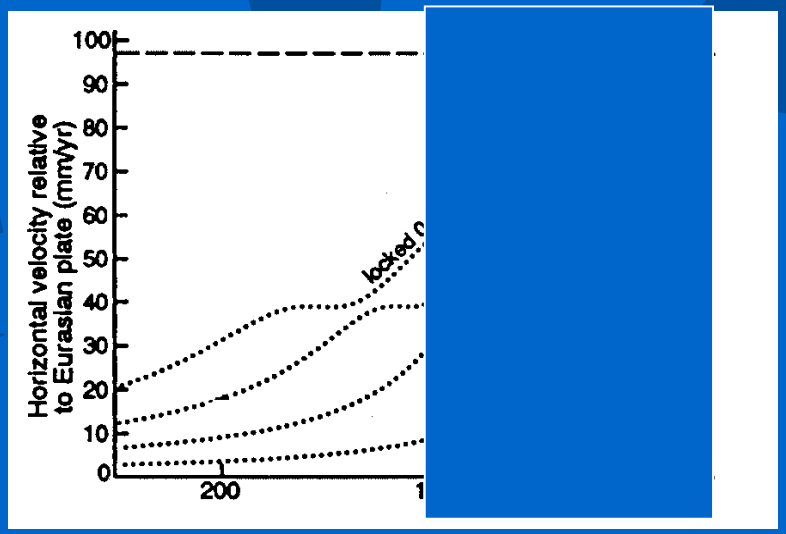

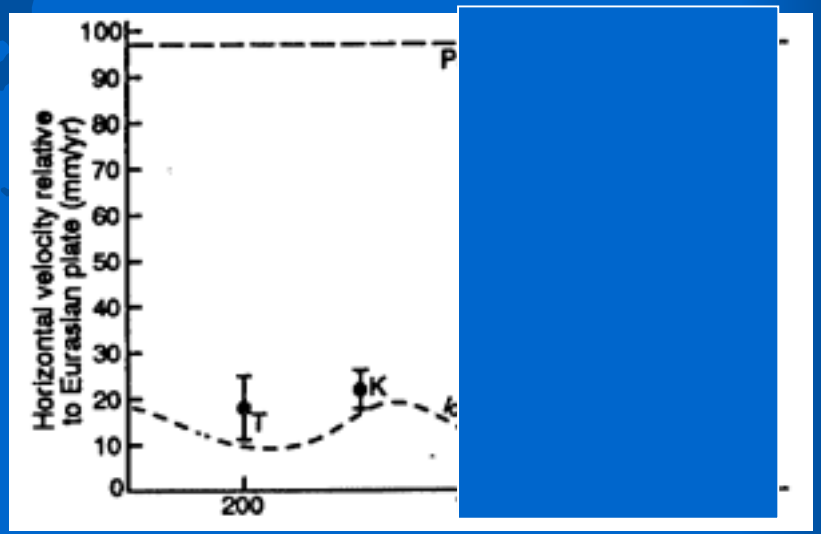

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Theoretical Movement
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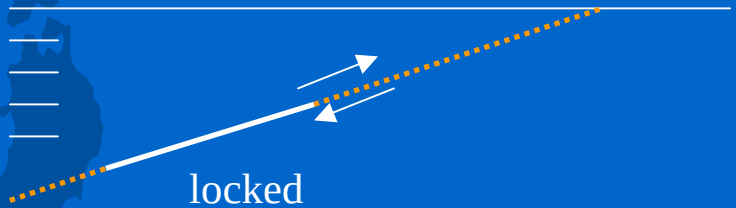

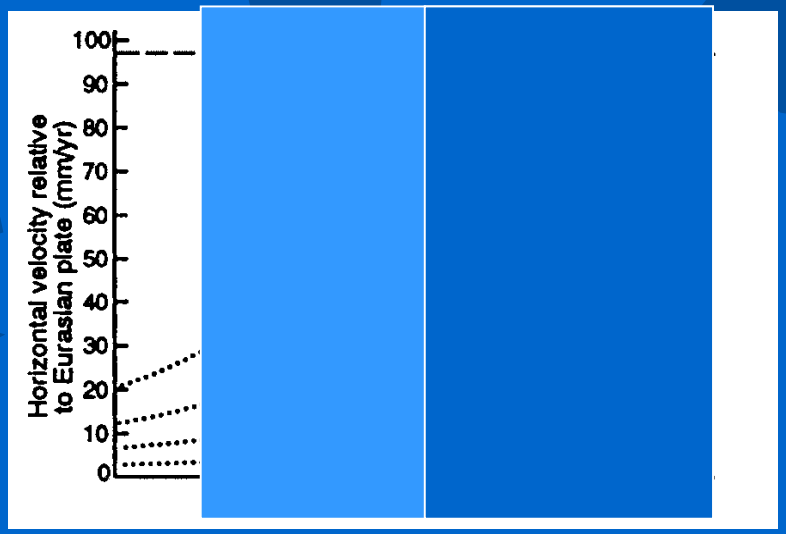

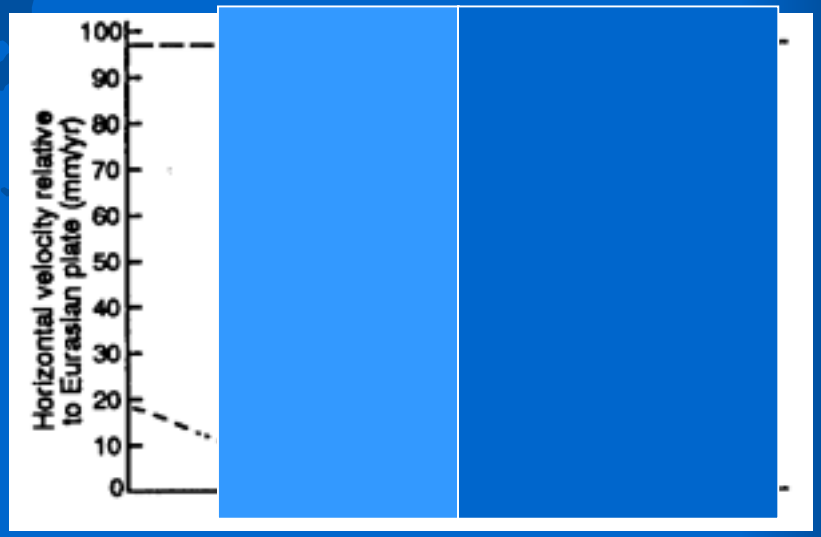

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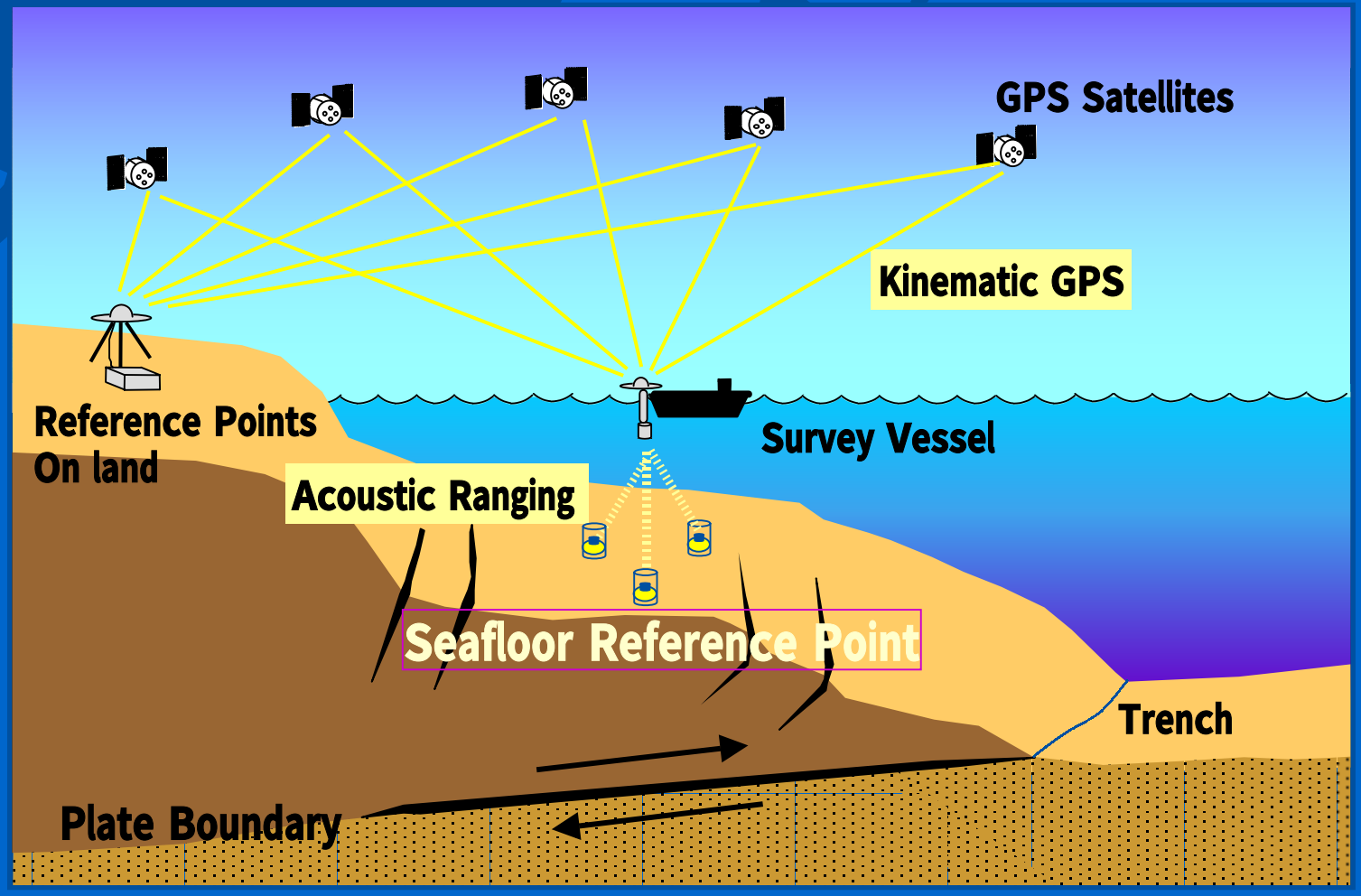
Seafloor Geodetic Measurement



Collaboration between

Japan Coast Guard and The University of Tokyo

Combination of two positioning techniques

Combination of two positioning techniques

- Kinematic GPS

  To determine the position of GPS antenna from the reference points on land

Combination of two positioning techniques

- Kinematic GPS

  To determine the position of GPS antenna from the reference points on land

- Acoustic Ranging

  To measure the travel time between the transducer and the seafloor transponder

Combination of two positioning techniques

- Kinematic GPS

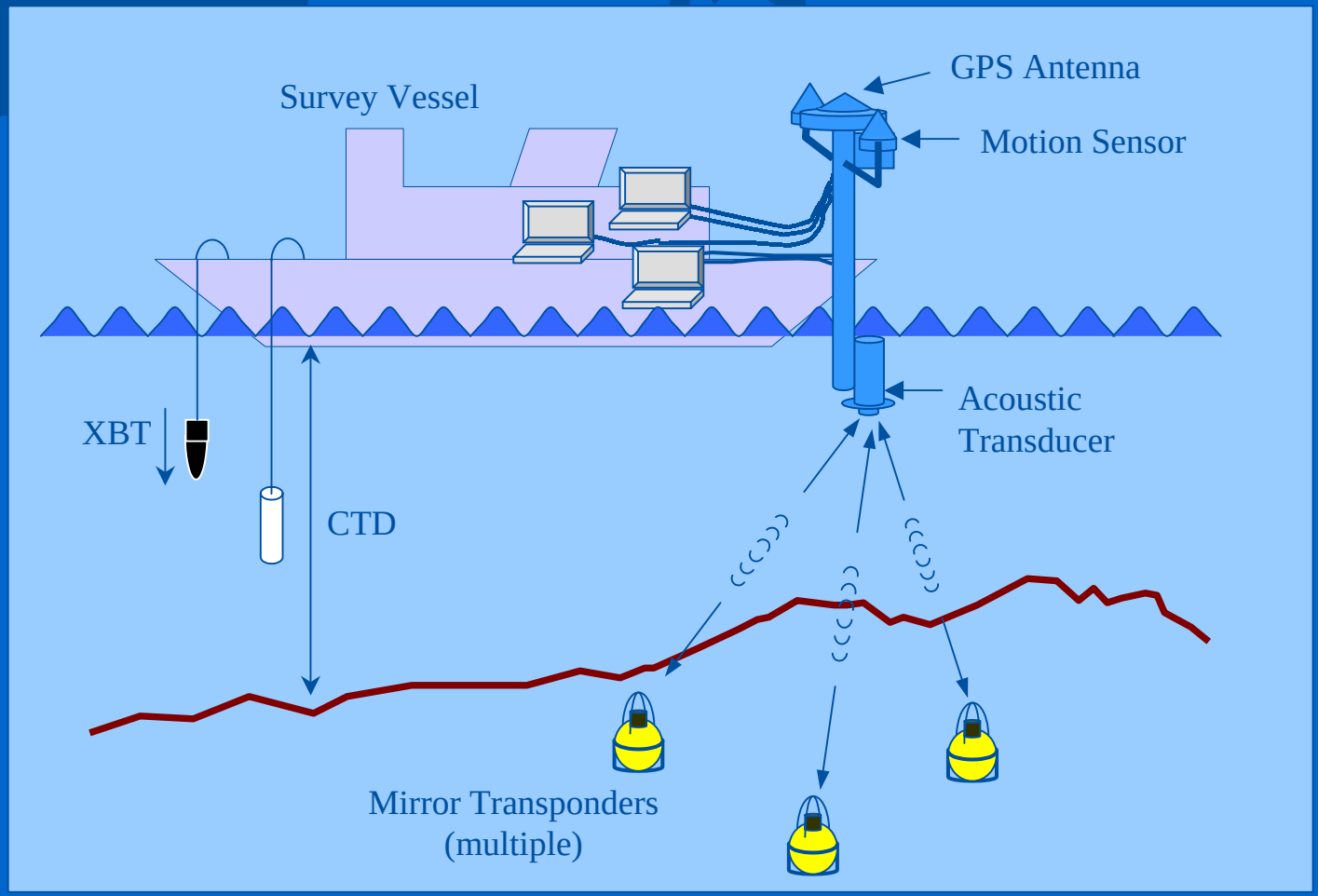
  To determine the position of GPS antenna from the reference points on land

- Acoustic Ranging

  To measure the travel time between the transducer and the seafloor transponder

→ toward cm level

Observation System

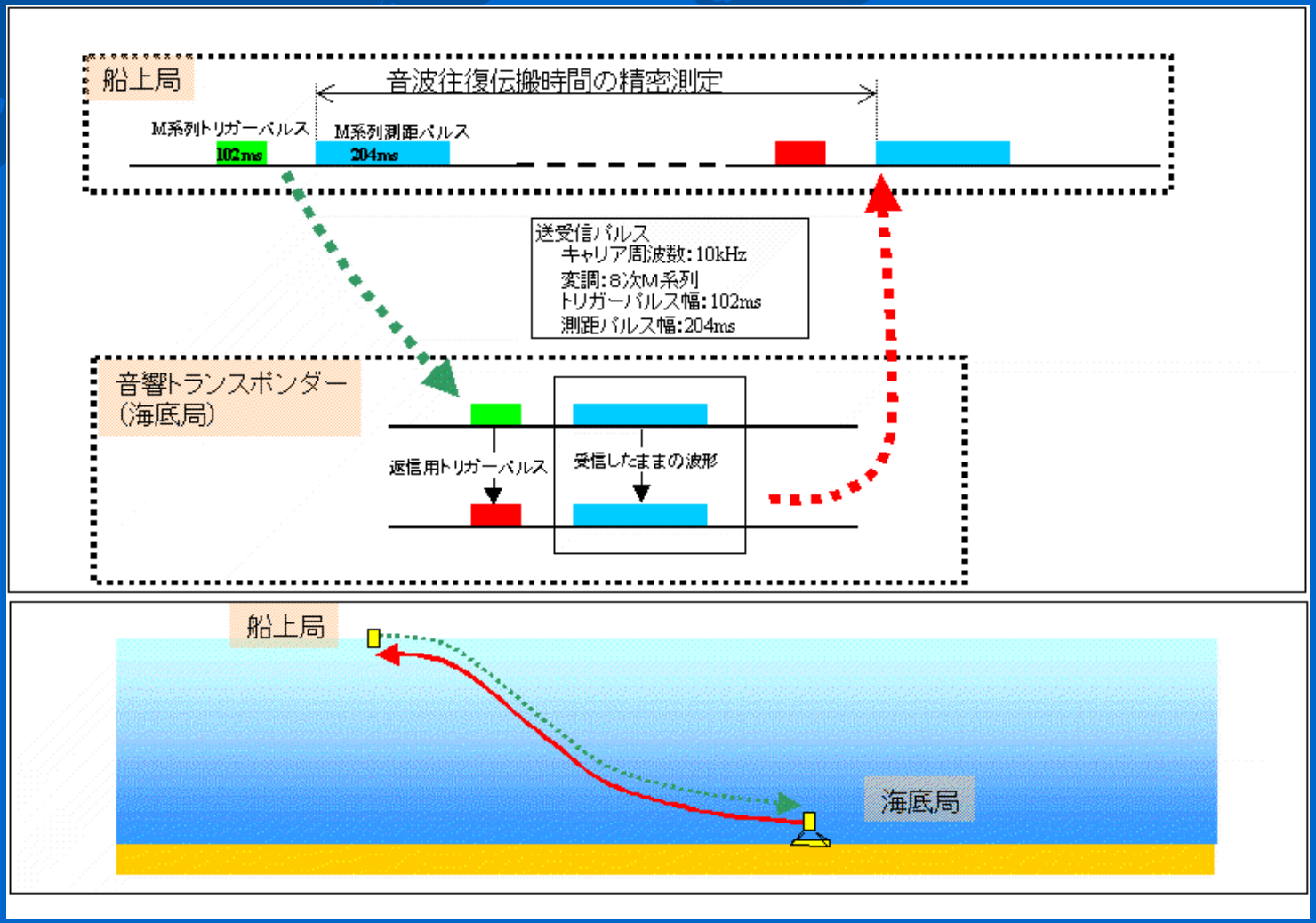


Installation of Transponder onto the Seafloor

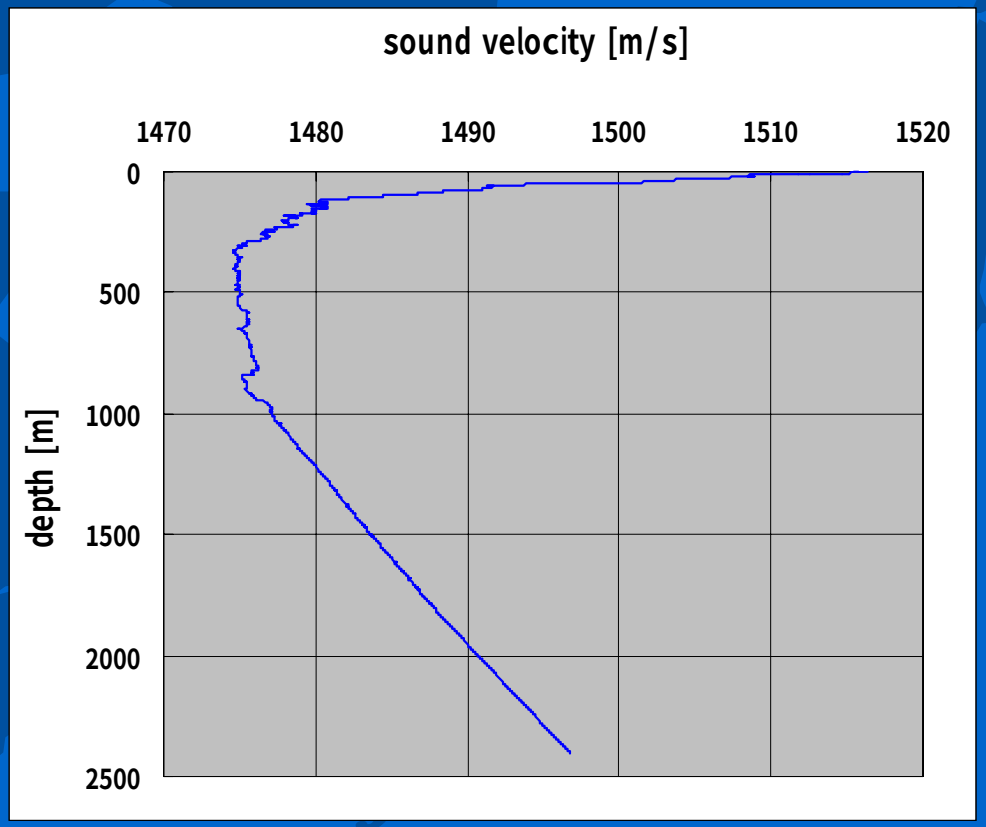
Transponder to be on the Seafloor

Equipment on the Vessel

Acoustic Signal Measurement

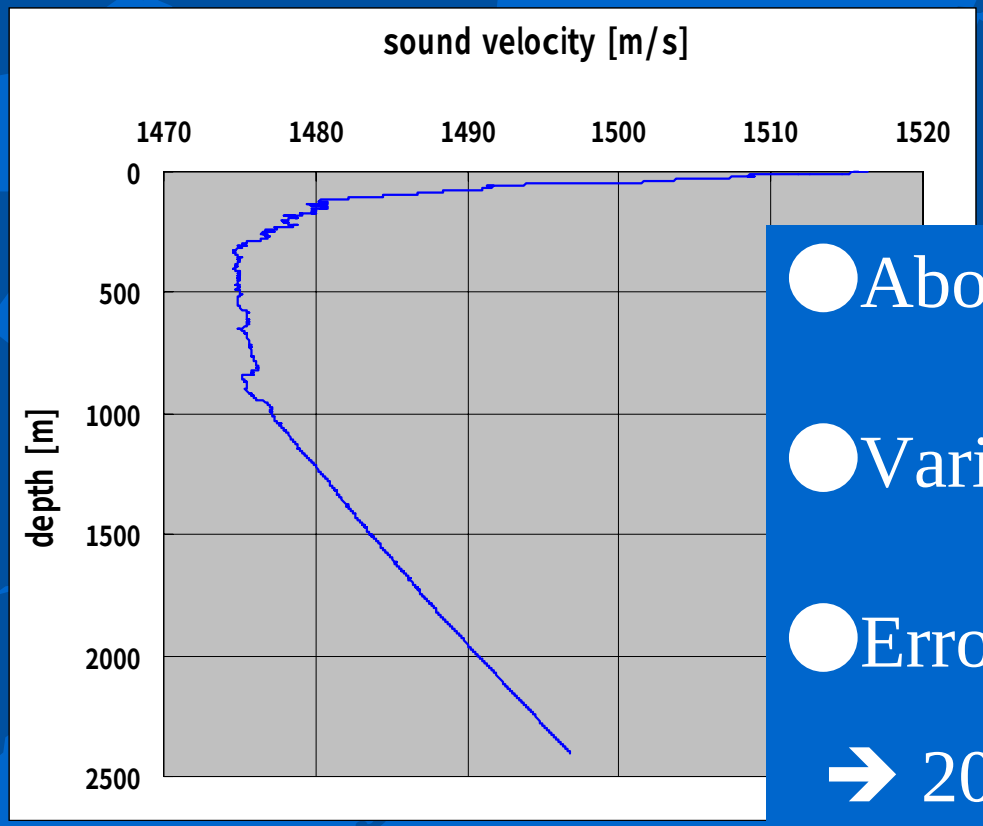


Acoustic Velocity Structure in the Seawater



(from the CTD data)

Acoustic Velocity Structure in the Seawater



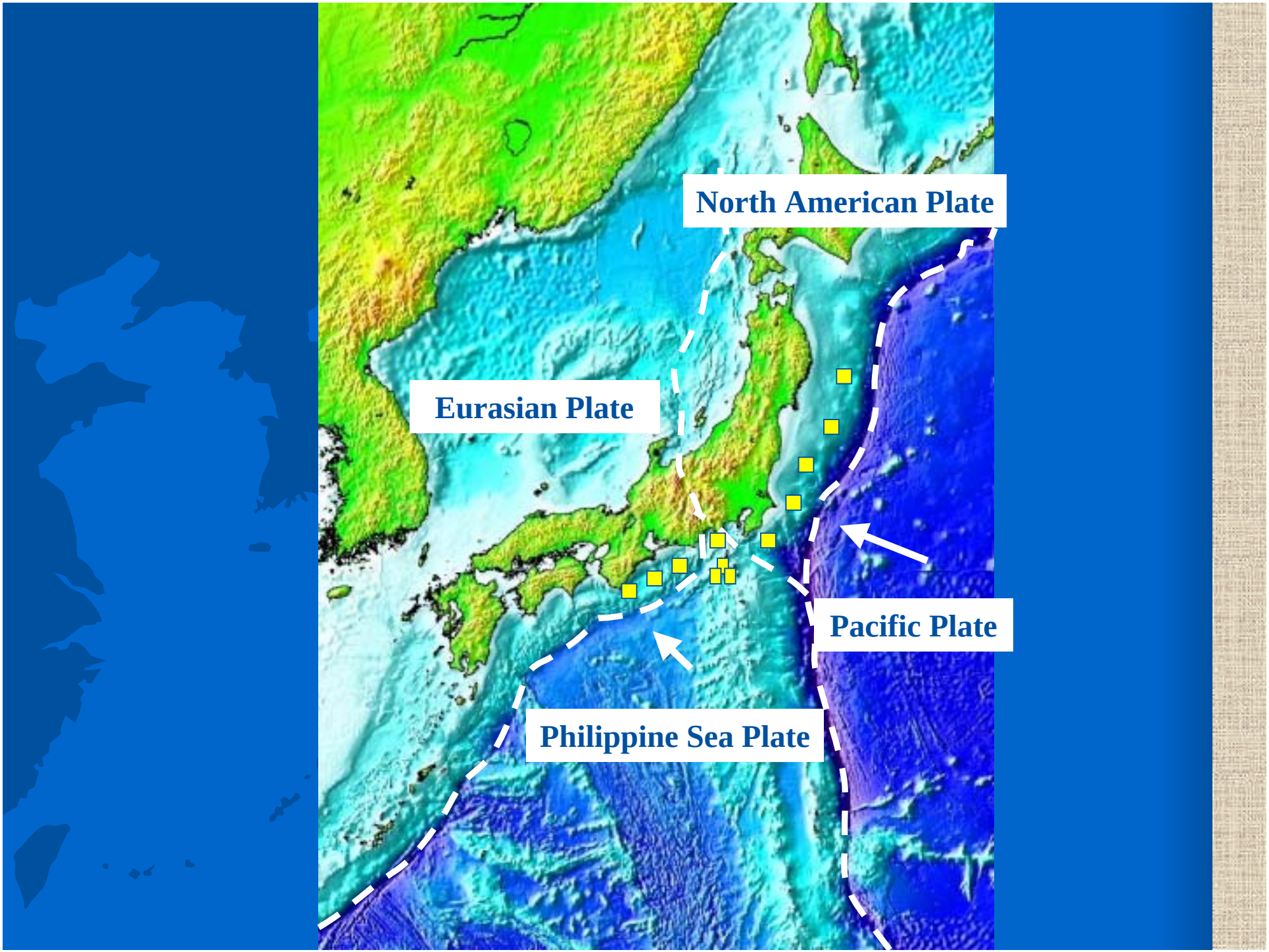
(from the CTD data)

- About 1.5km/s
- Variation due to time and space
- Error by 0.01% (15cm/s)

➔ 20cm range error at the depth of 2000m

Distribution of Seafloor Reference Points

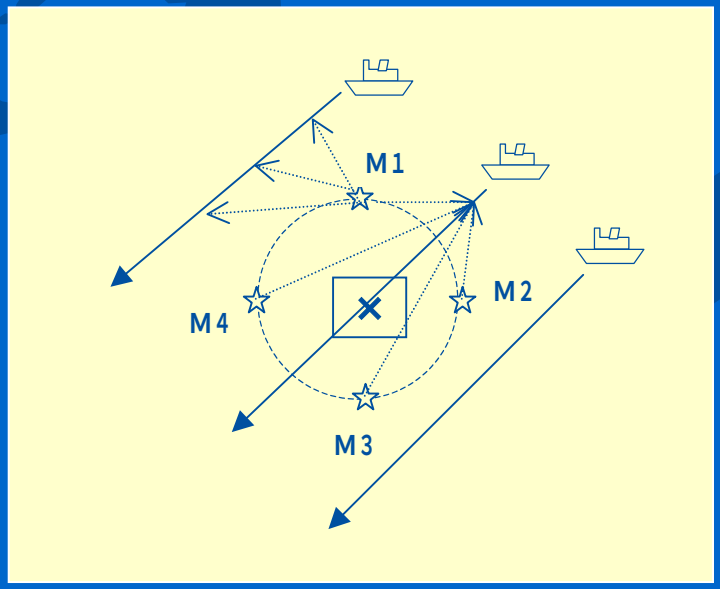
- Landward slope of the Major trench
- About 100km interval
- The depth of about 400 - 2400m


North American Plate
Eurasian Plate
Pacific Plate
Philippine Sea Plate

Survey Vessel

Observation Line

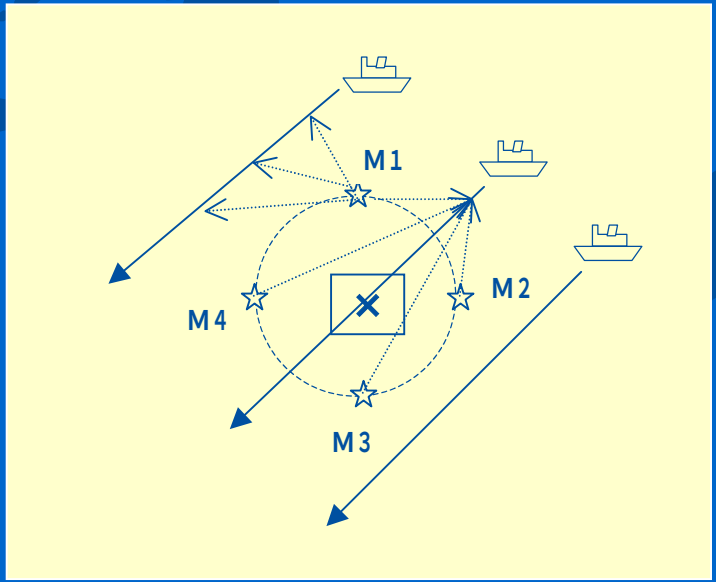
Plan



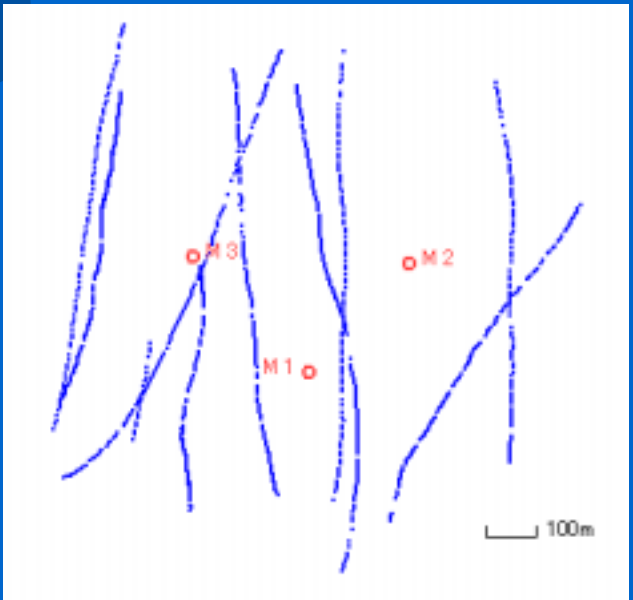
To evade noises from the vessel,
an observation is carried out by drifting.

Observation Line

Plan



Example



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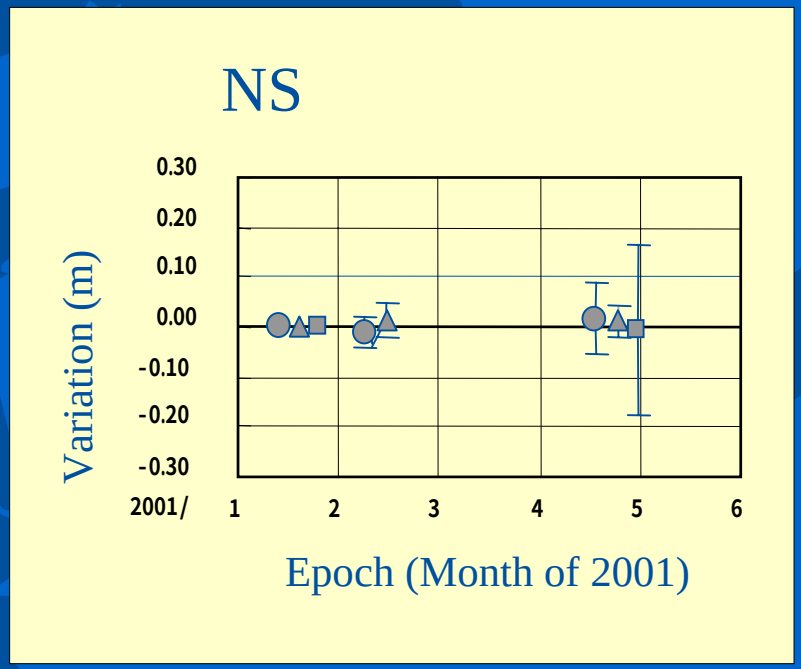
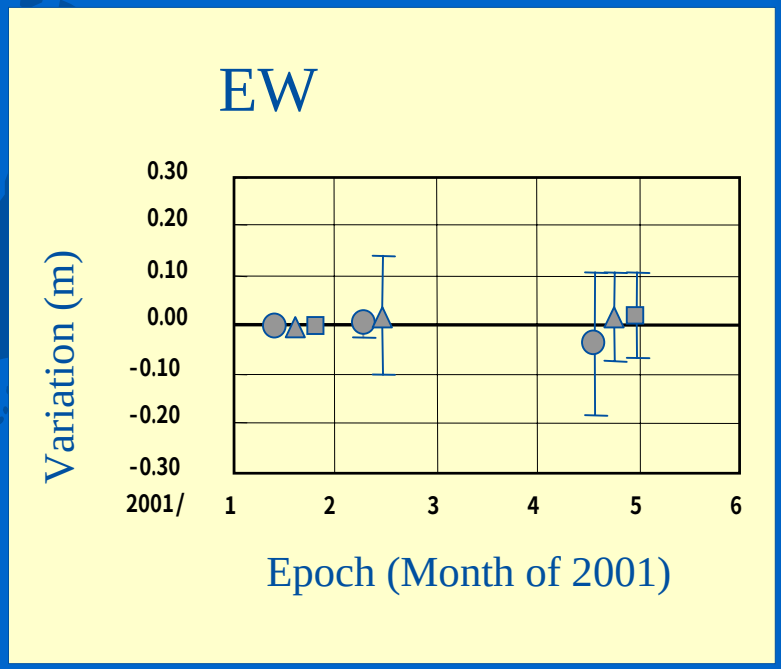
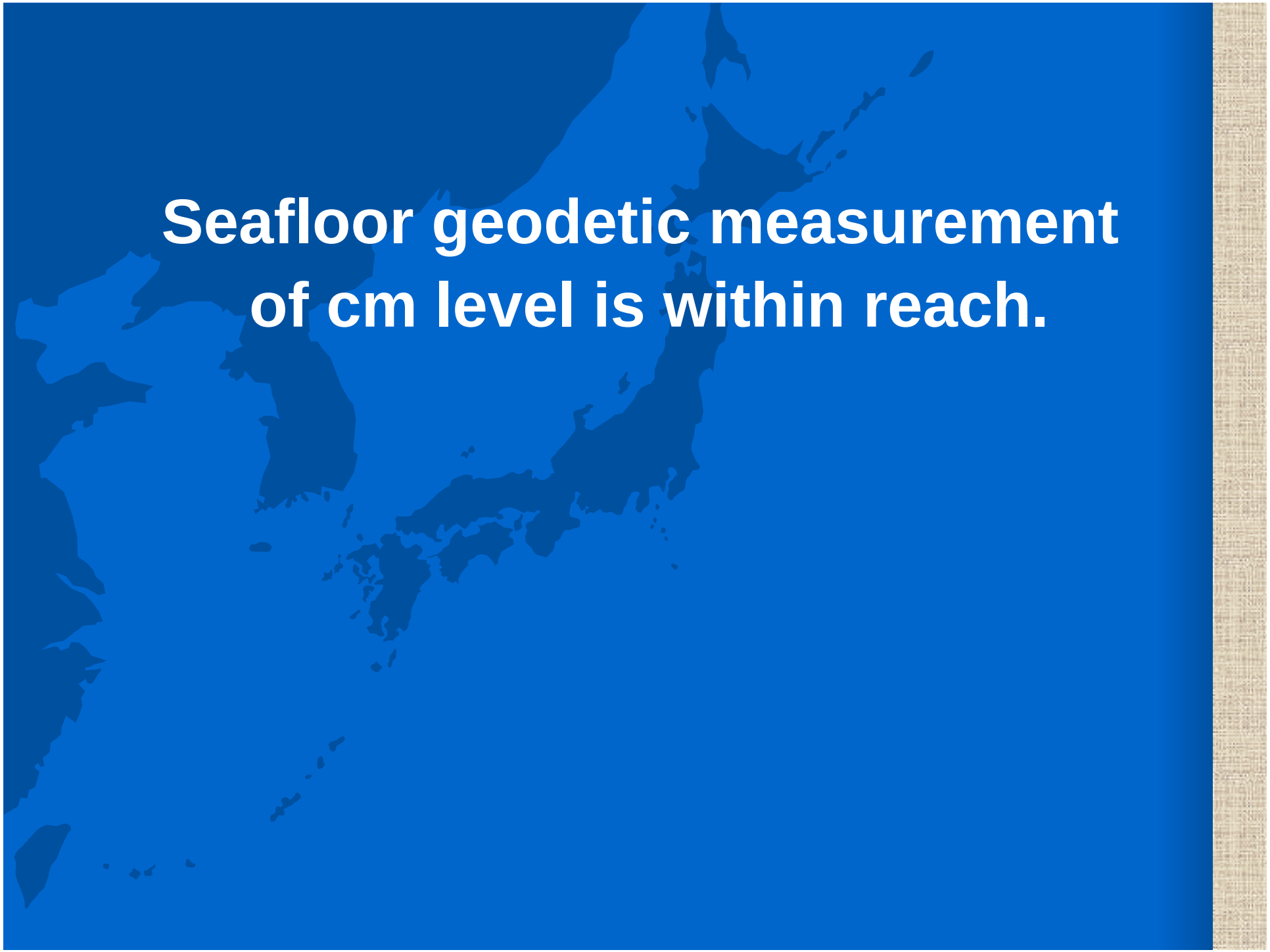
Result of Positioning





●:Miyake A ▲:Miyake B ■:Miyake C

(Near Miyake Is. with depths of about 400 m)


Seafloor geodetic measurement
of cm level is within reach.

Seafloor geodetic measurement of cm level is within reach.

But

Seafloor geodetic measurement of cm level is within reach.

But

Stability problems exist.

Key Problem

Key Problem

- Stability on Long range kinematic GPS

Key Problem

- **Stability on Long range kinematic GPS**

cm level for the baseline < 10km

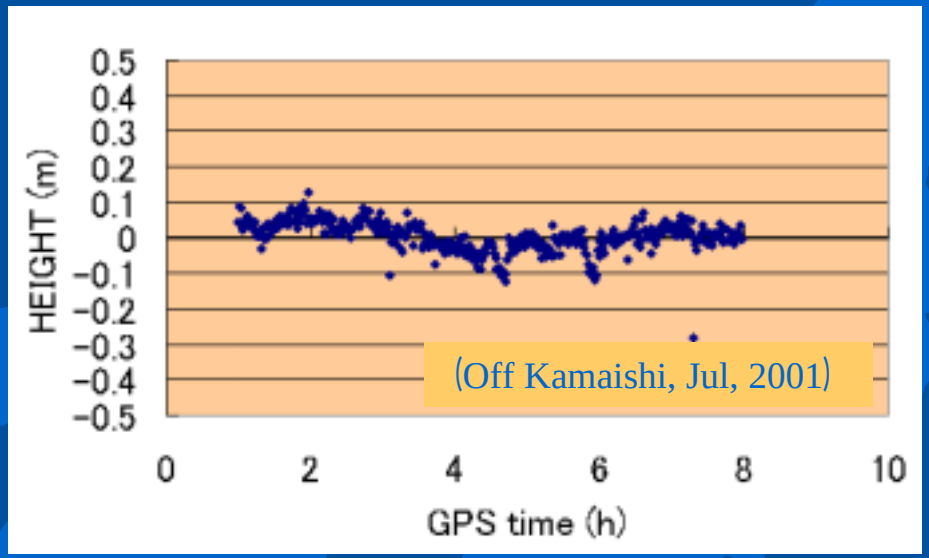
Key Problem

- **Stability on Long range kinematic GPS**

cm level for the baseline < 10km

> 100 km

The methodology has been developed, but still unstable.



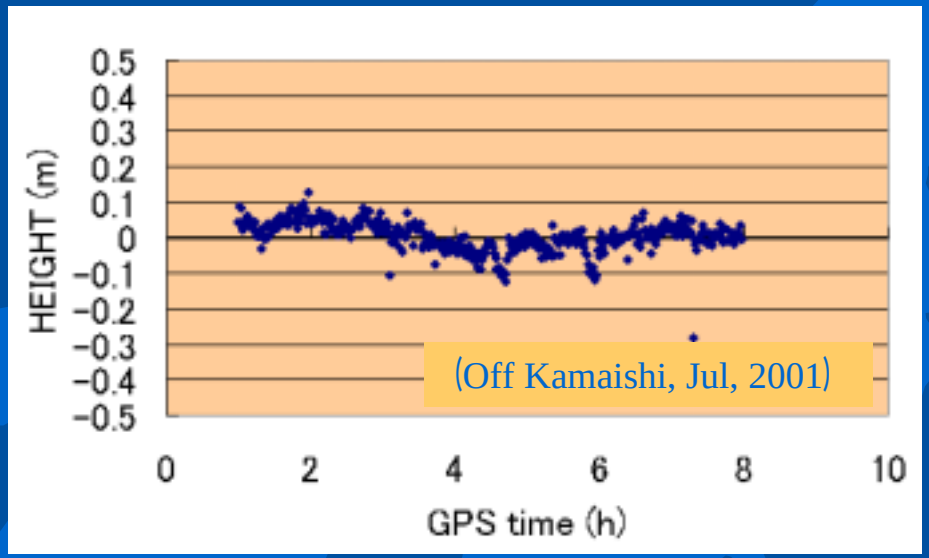
Stability on KGPS

Temporal variation in Height Determination

after

- **Tide correction**
  - **by Nao.99Jb**
- **Geoidal Height correction**
  - **by Fukuda (1990)**

Good Example



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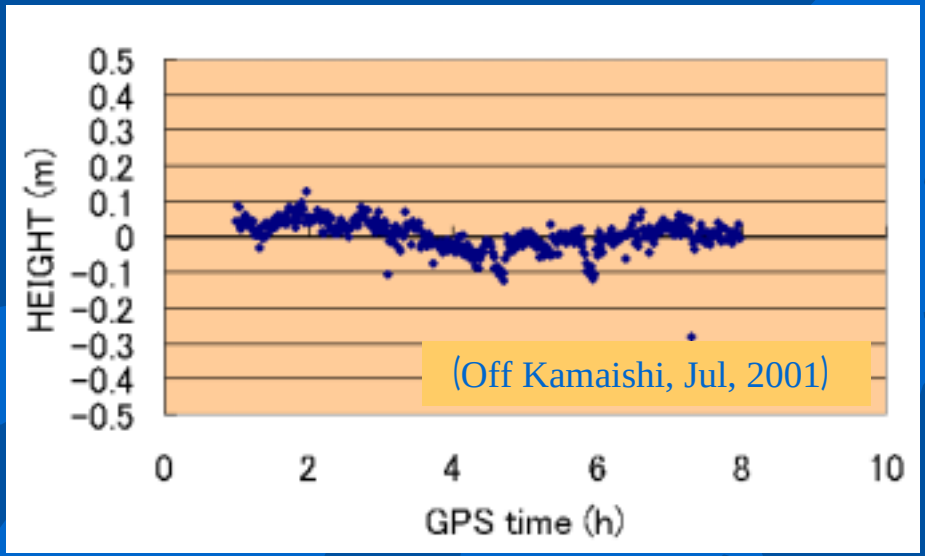
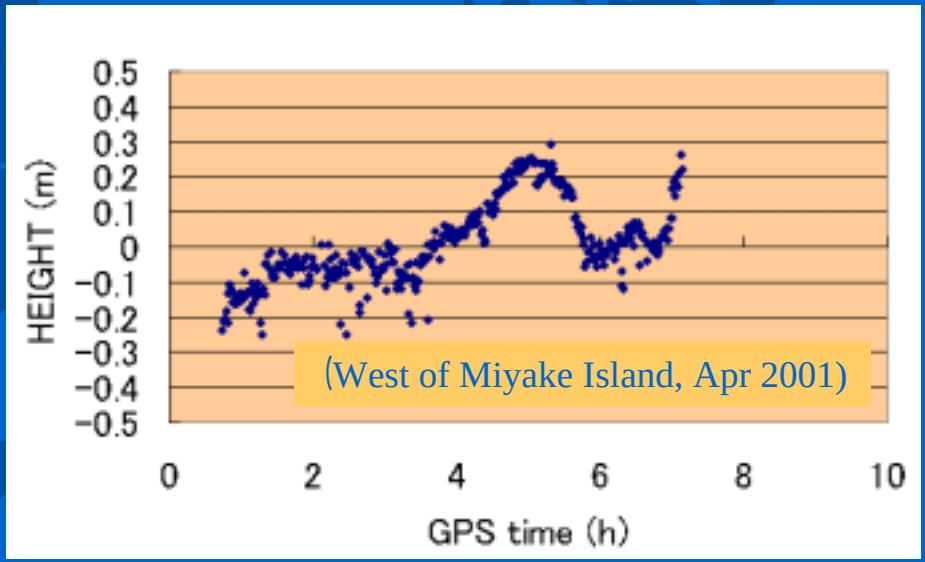


Bad Example



Stability on KGPS

Temporal variation in Height Determination

after

- **Tide correction**
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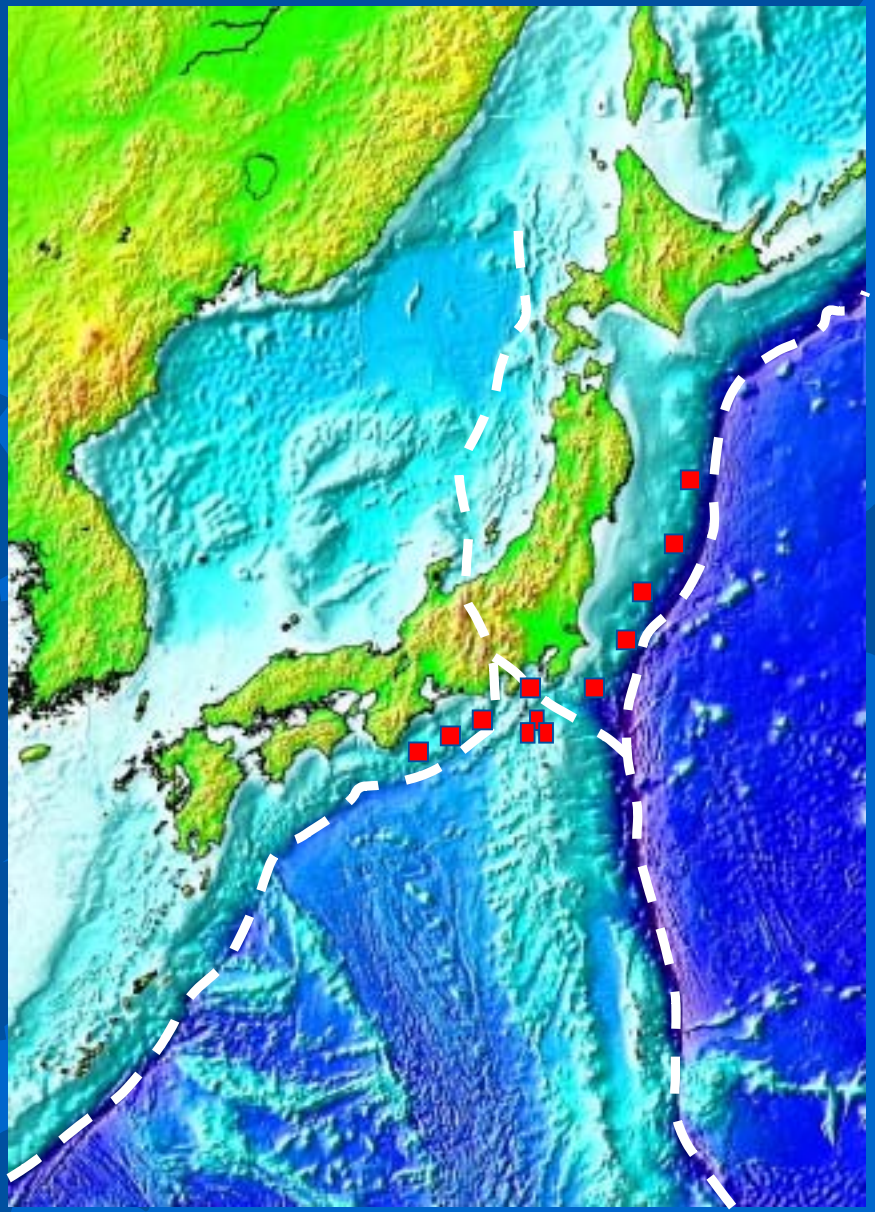
Other Problems

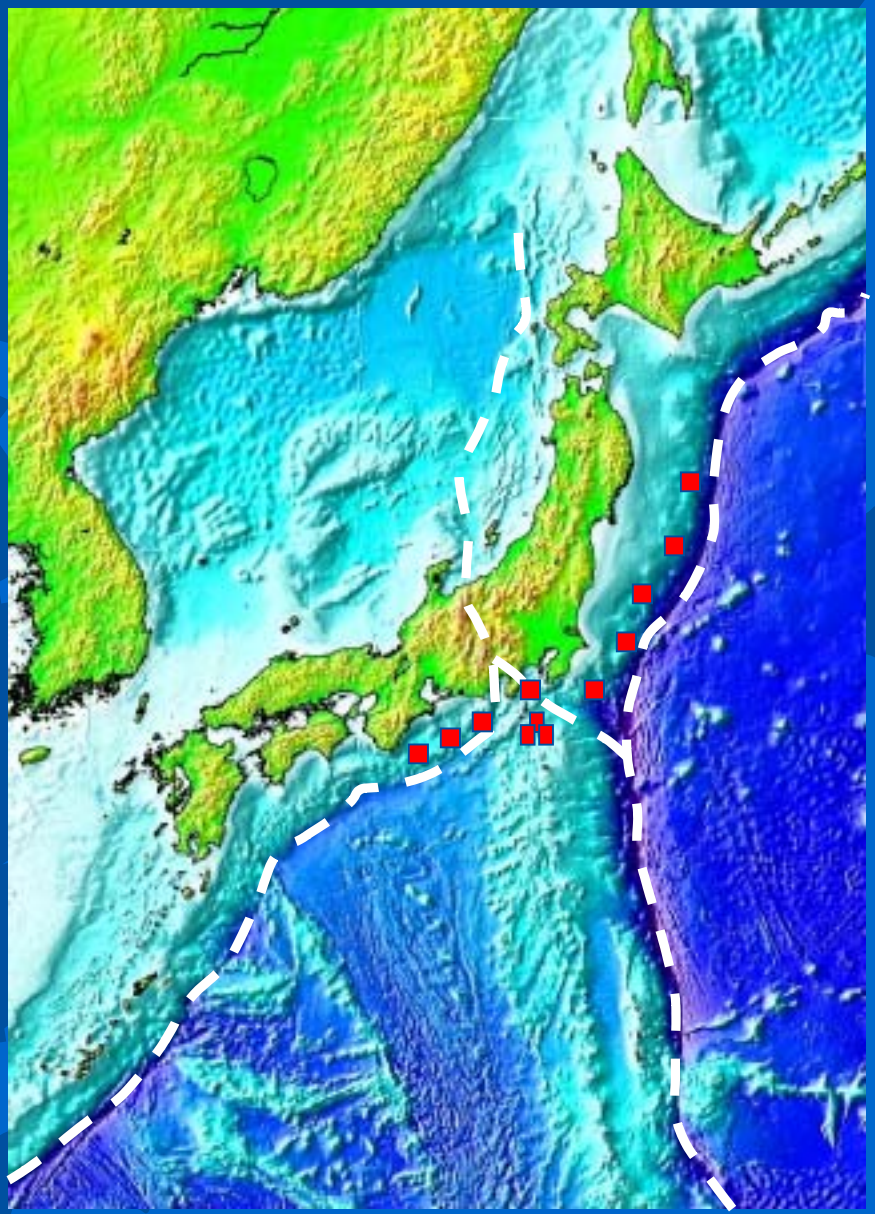
- Error in the acoustic velocity structure
  - Limitation in the observation
    - ➔ Correction method
- Deformation (bending) of the observation pole
  - ➔ Improvement on the material and structure

Other Problems (2)

- Stormy weather
  - Uncontrollable observation plan
  - Degraded quality of the data
- Drifting observation
  - Uncontrollable configuration of lines
  - Case of no flow

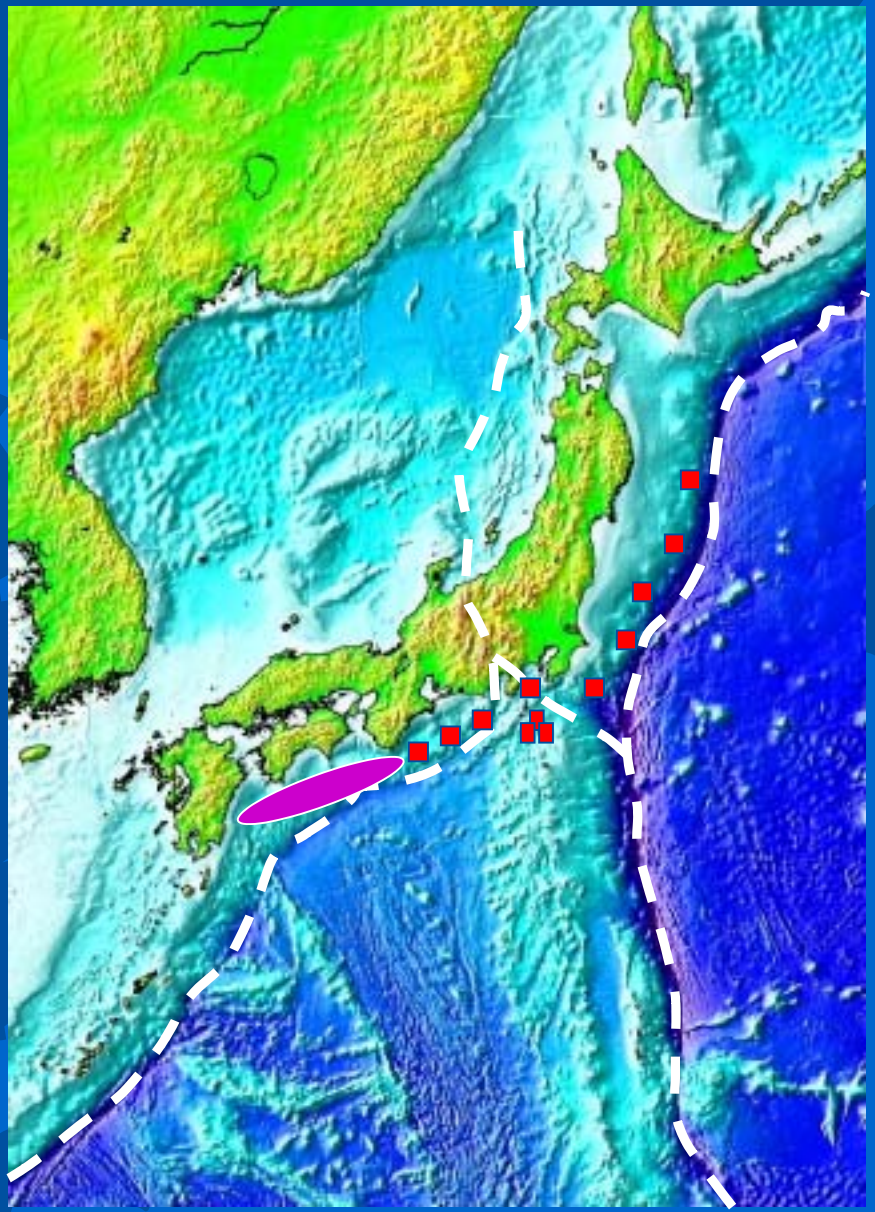


Future



Future

- Denser network



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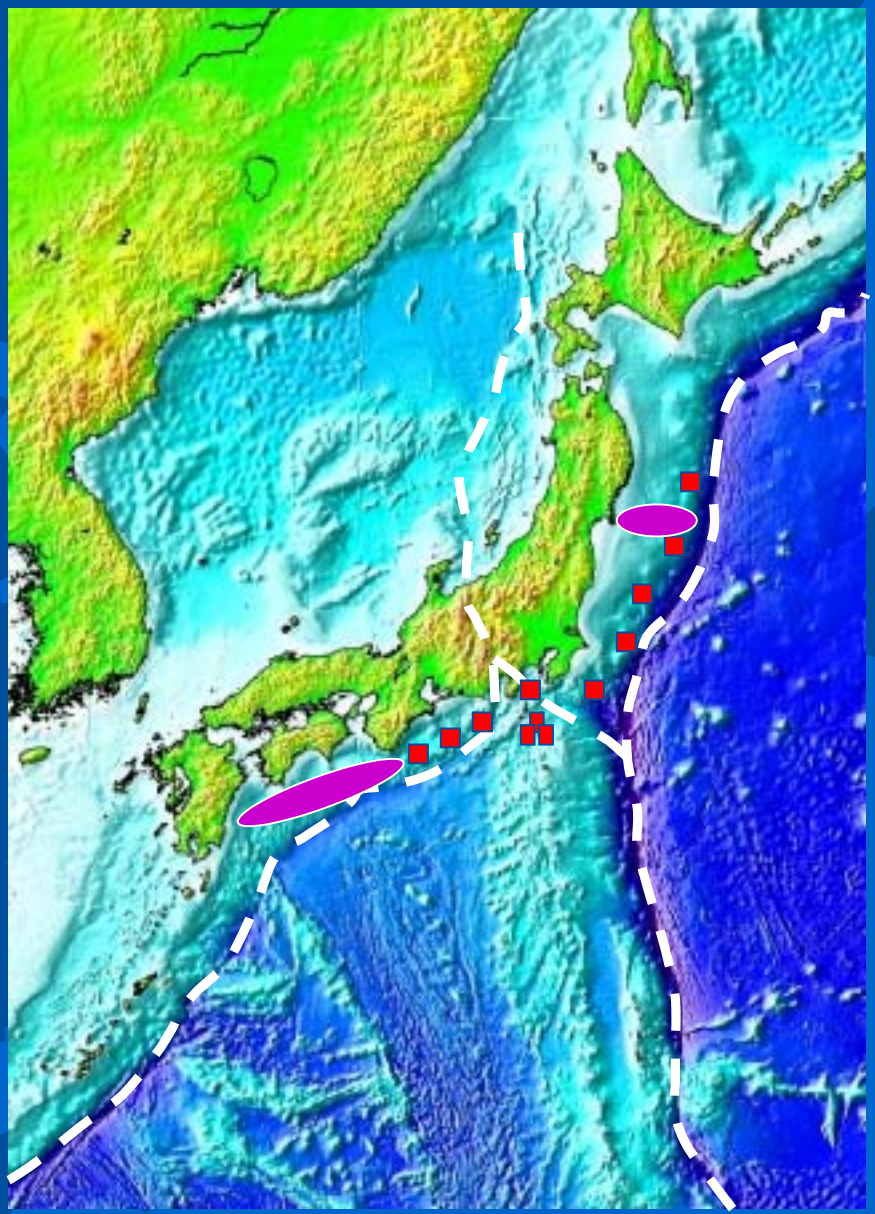

Future

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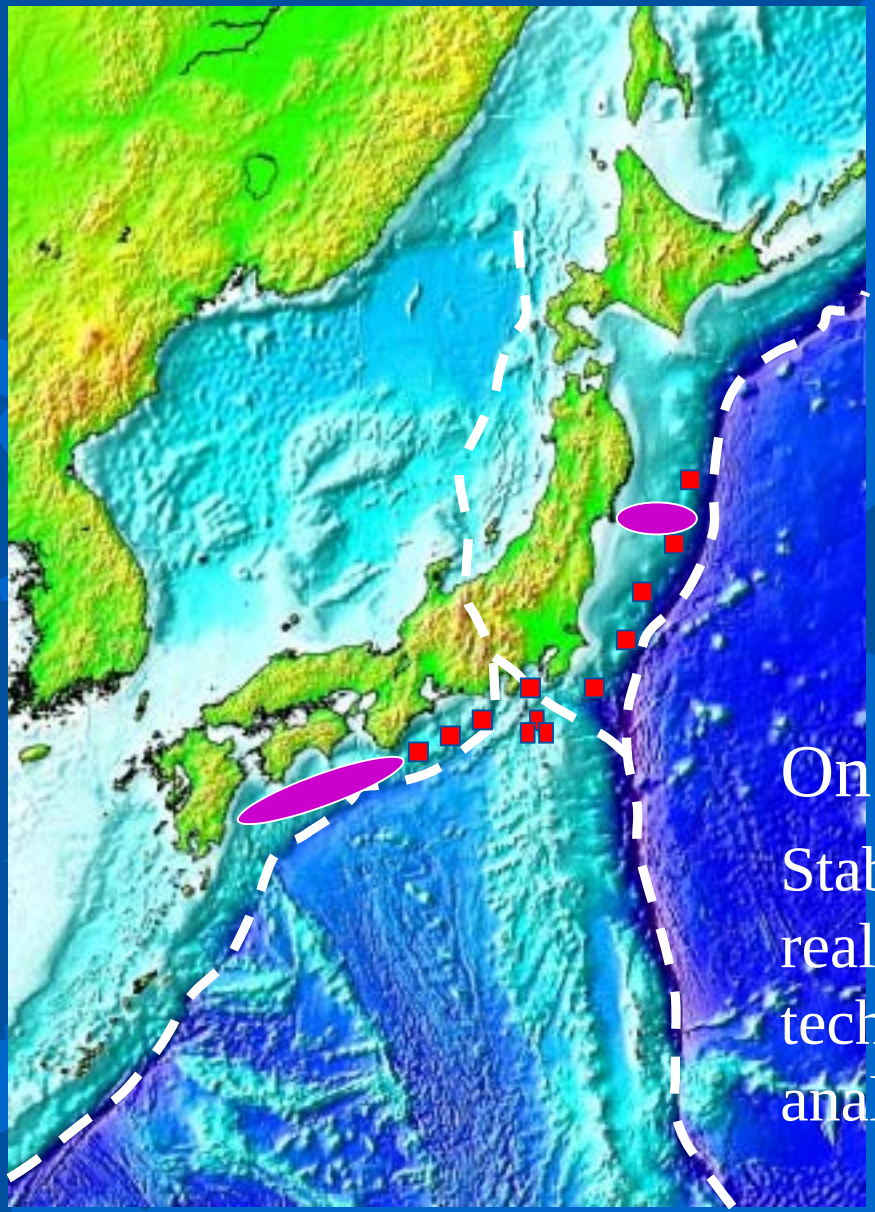

Future

- **Denser network**

On condition that

Stable positioning of cm level will be realized due to the improvement of technology in observation and analysis

End of Presentation