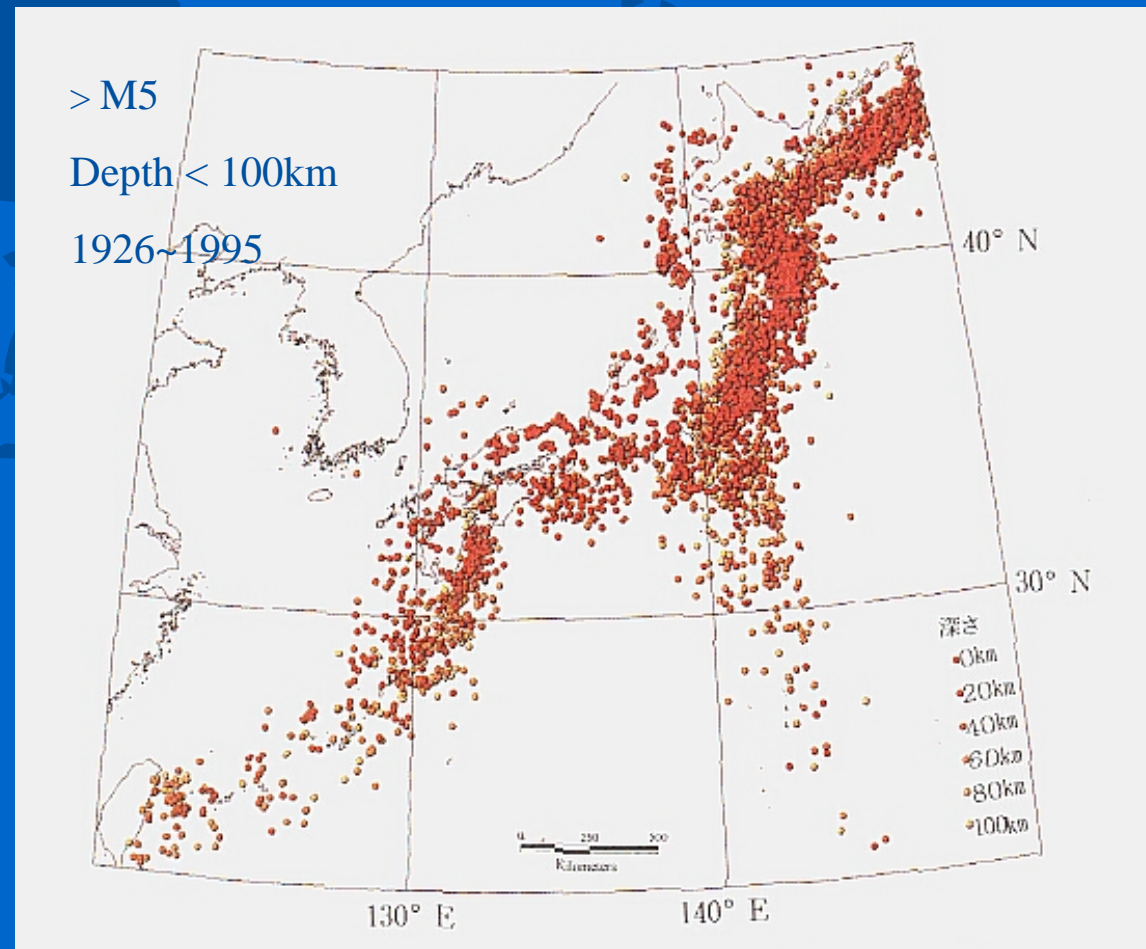


Toward Detecting Crustal Movement in the Undersea Plate Boundary Region around Japan

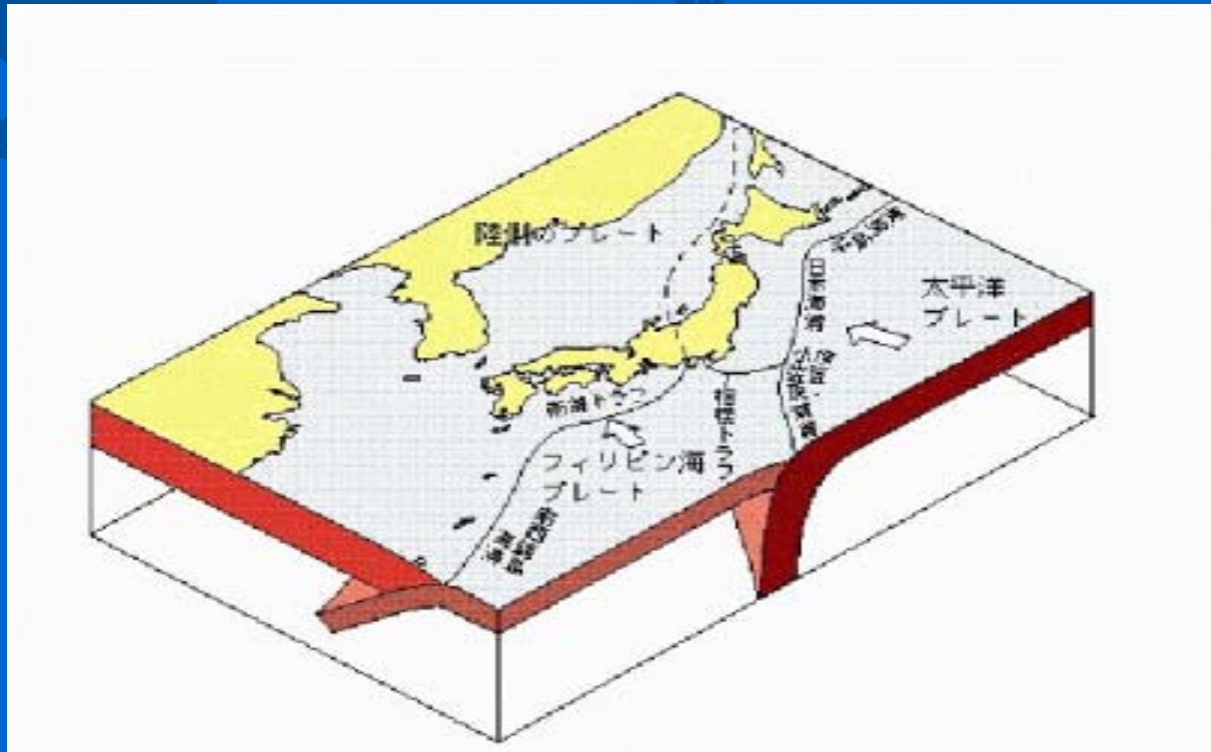


**Hydrographic and Oceanographic
Department, Japan Coast Guard
(Presentation by Masayuki Fujita)**

Distribution of Epicenters around Japan

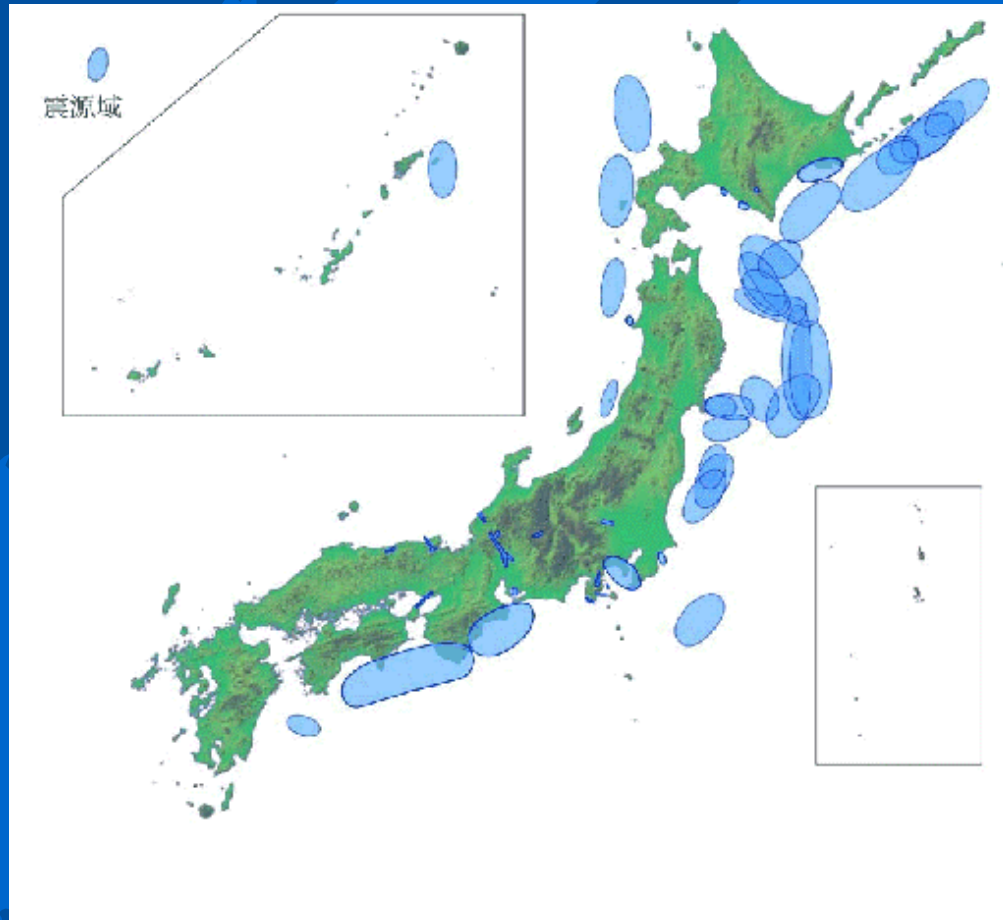


Plates Configuration around Japan



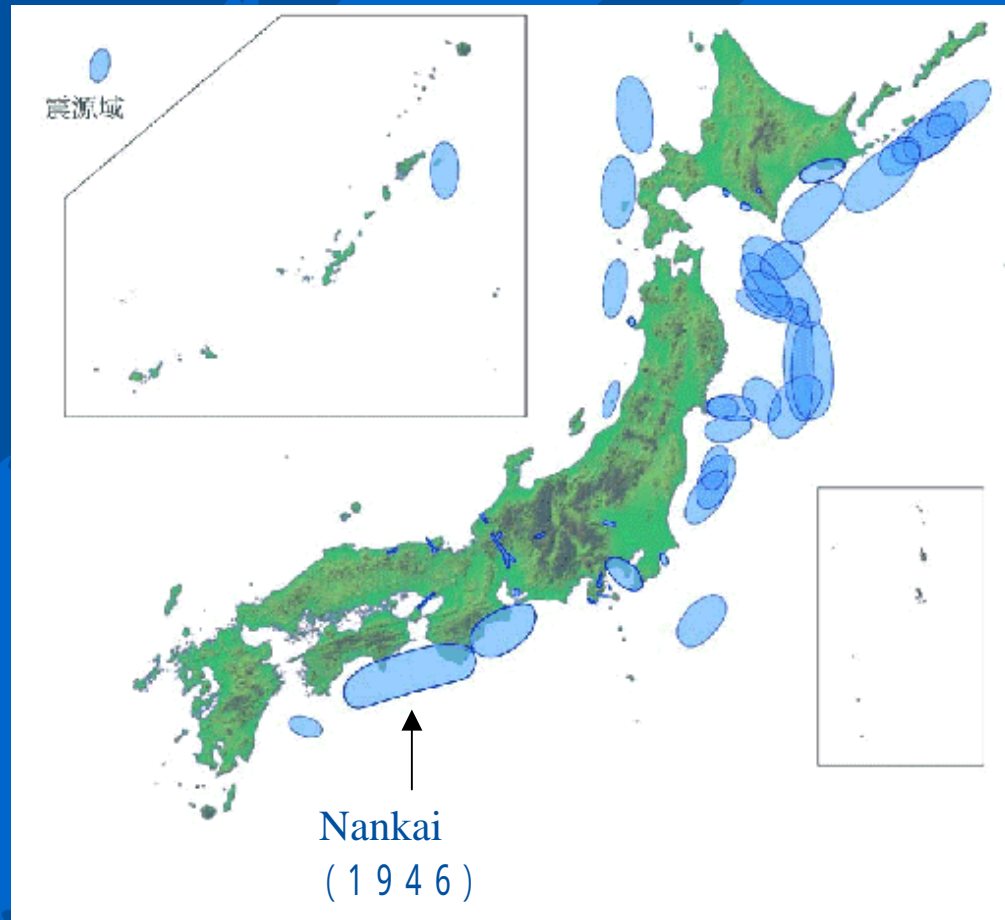
Multiple plates are adjacent to each other.

Fracture Zone of Large Earthquakes



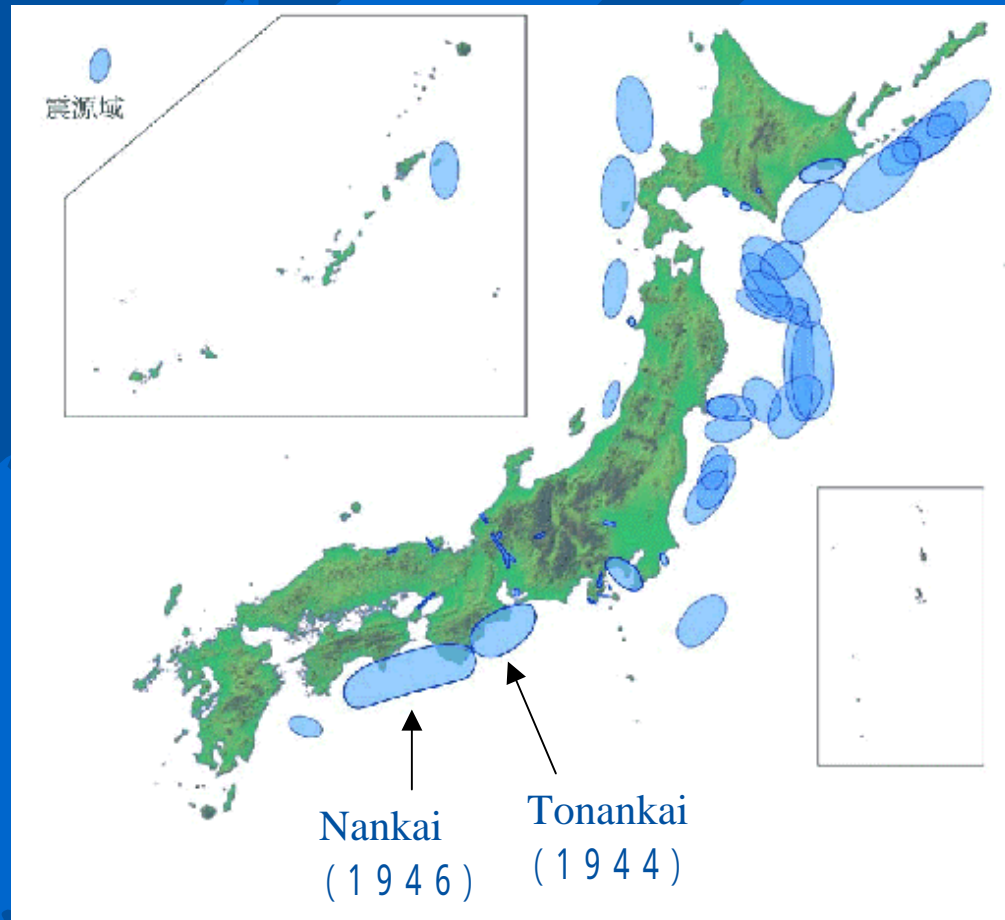
(1885 – 1995: Depth < 100km)

Fracture Zone of Large Earthquakes



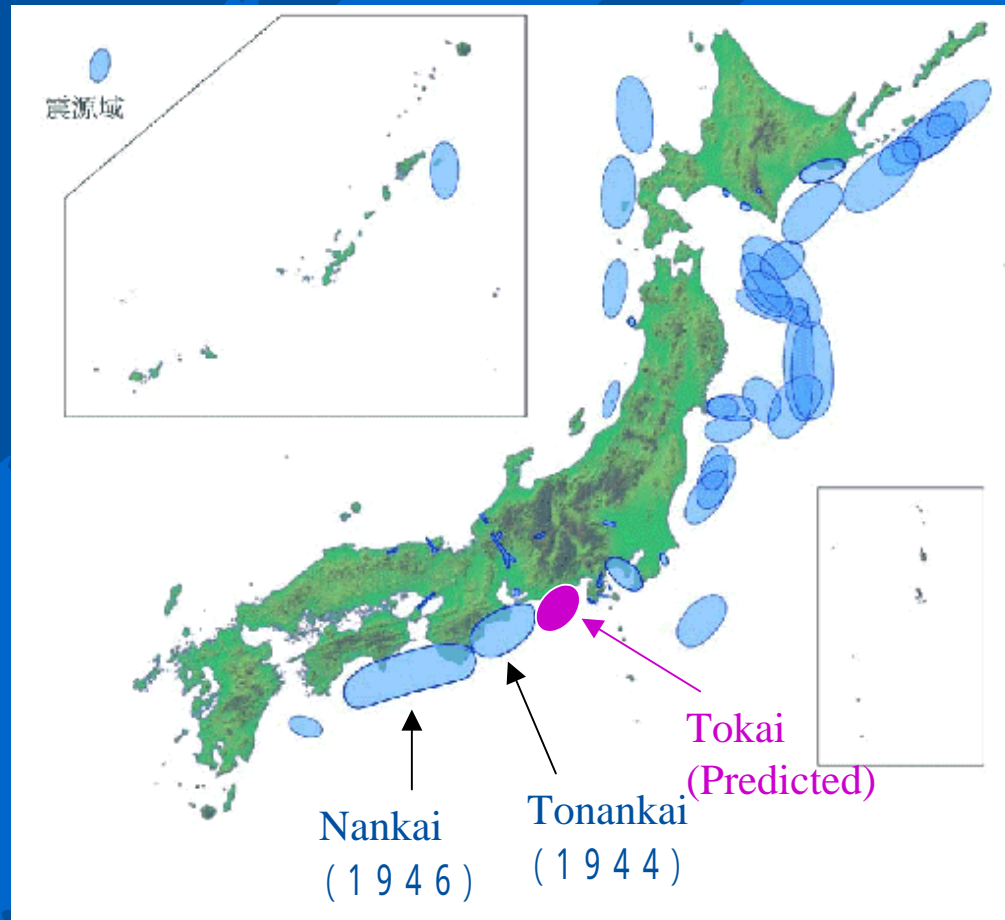
(1885 – 1995: Depth < 100km)

Fracture Zone of Large Earthquakes



(1885 – 1995: Depth < 100km)

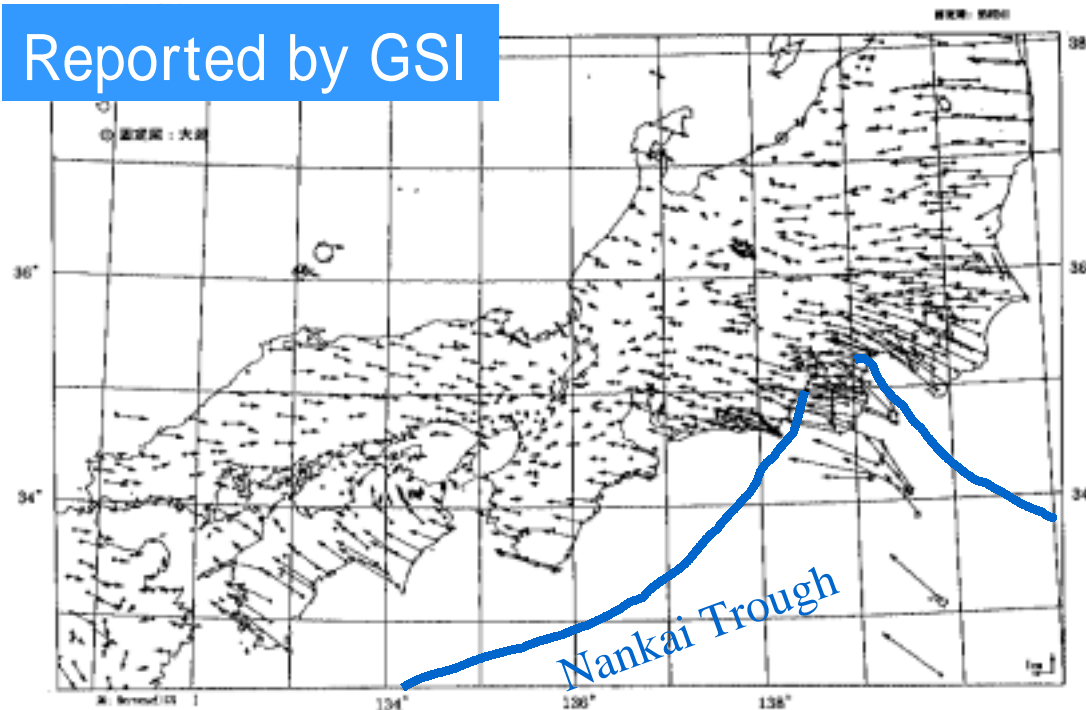
Fracture Zone of Large Earthquakes



(1885 – 1995: Depth < 100km)

Crustal Movement on Land

Reported by GSI



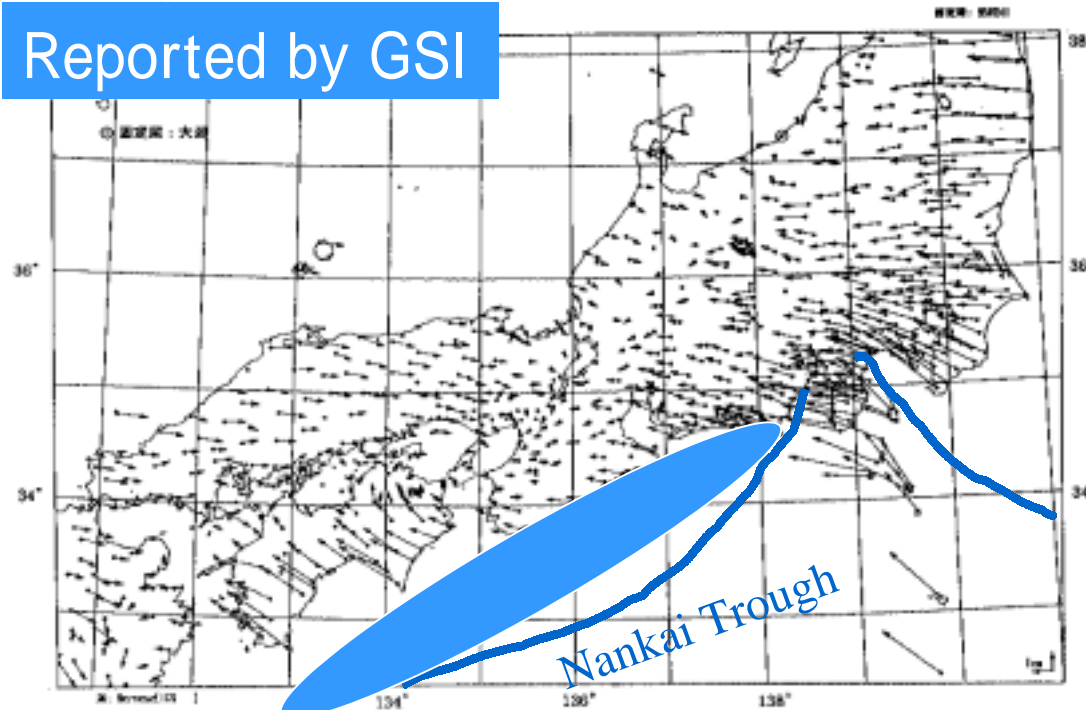
第1図-(2) GPS連続観測から求めた1999年4月～2000年4月間の水平変動(2)

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

Reported by GSI



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)

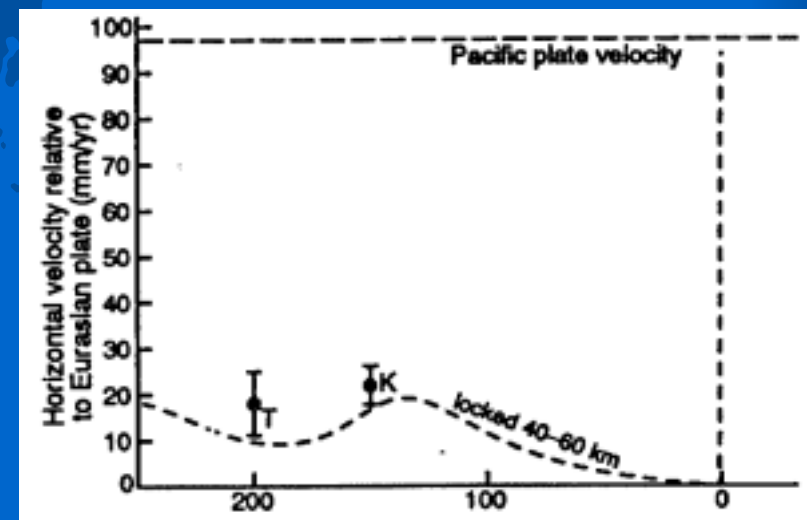
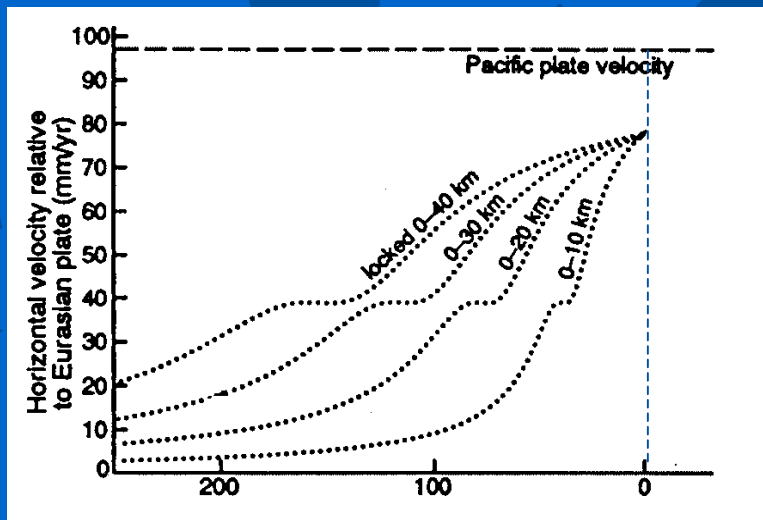
Fig.1-(2) Annual horizontal displacement velocities at permanent GPS sites during 1999/4-2000/4 (2).

(From Report of the coordinating Committee for Earthquake Prediction)

Theoretical Movement by Simple Dislocation Model

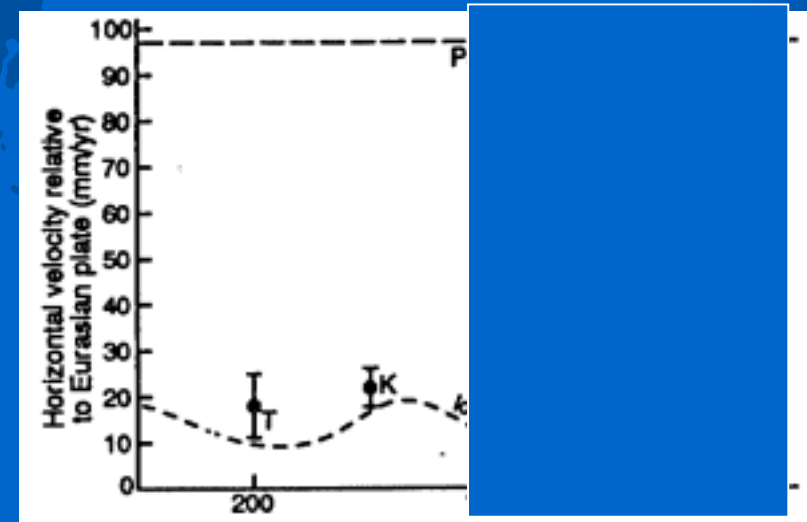
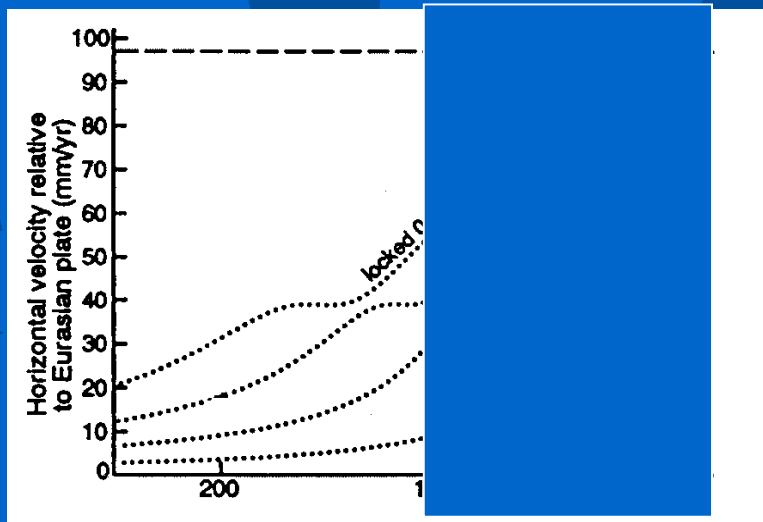


Theoretical Movement by Simple Dislocation Model



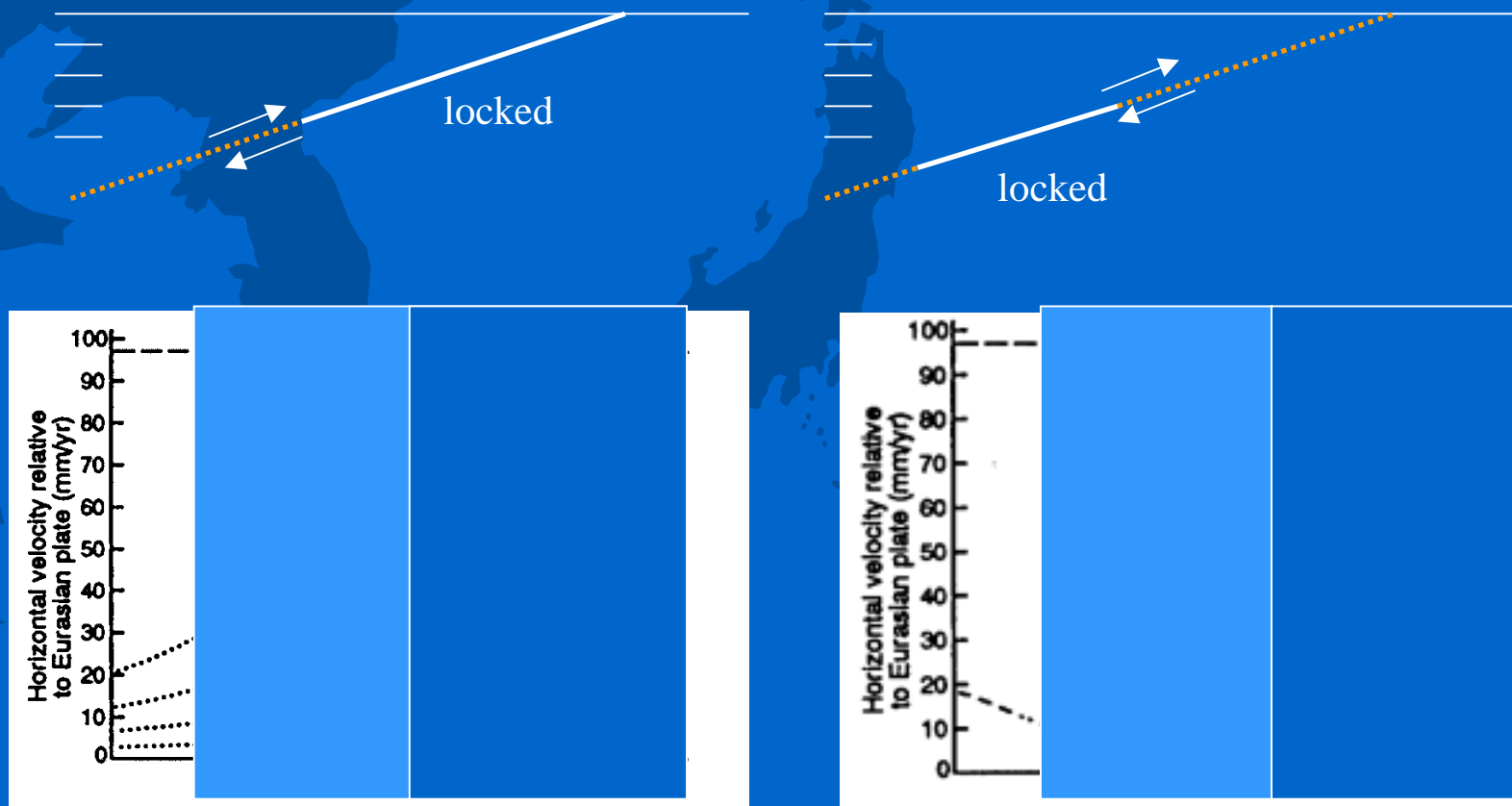
Modified from Argus and Lyzenga (1993)

Theoretical Movement by Simple Dislocation Model



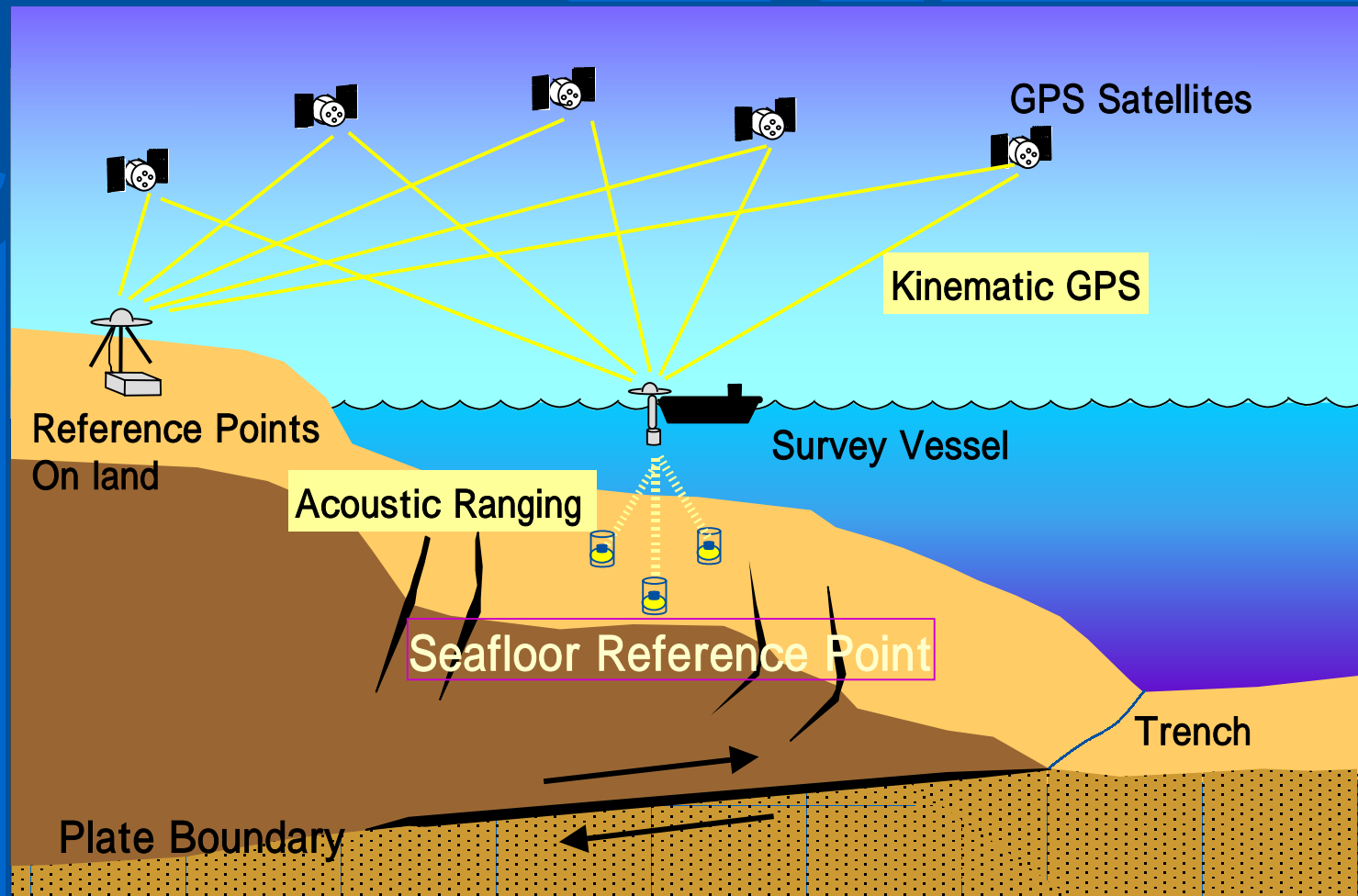
Modified from Argus and Lyzenga (1993)

Theoretical Movement by Simple Dislocation Model



Modified from Argus and Lyzenga (1993)

Seafloor Geodetic Measurement



Collaboration between
Japan Coast Guard and The University of Tokyo

Combination of two positioning techniques



The background of the slide is a dark blue map of Japan, showing the four main islands: Hokkaido, Honshu, Shikoku, and Kyushu. The map is oriented with North at the top.

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

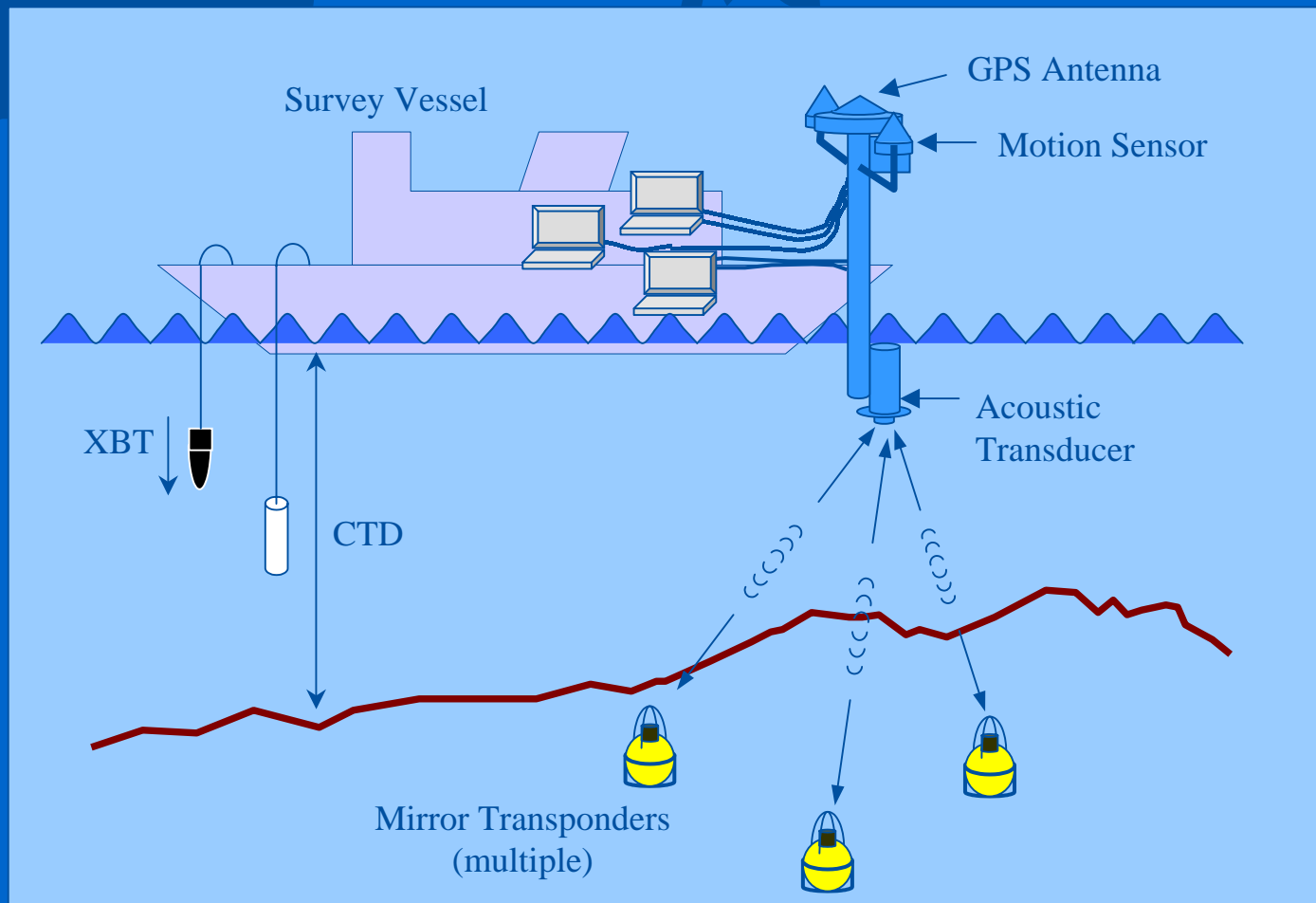
To determine the position of GPS antenna from the reference points on land

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



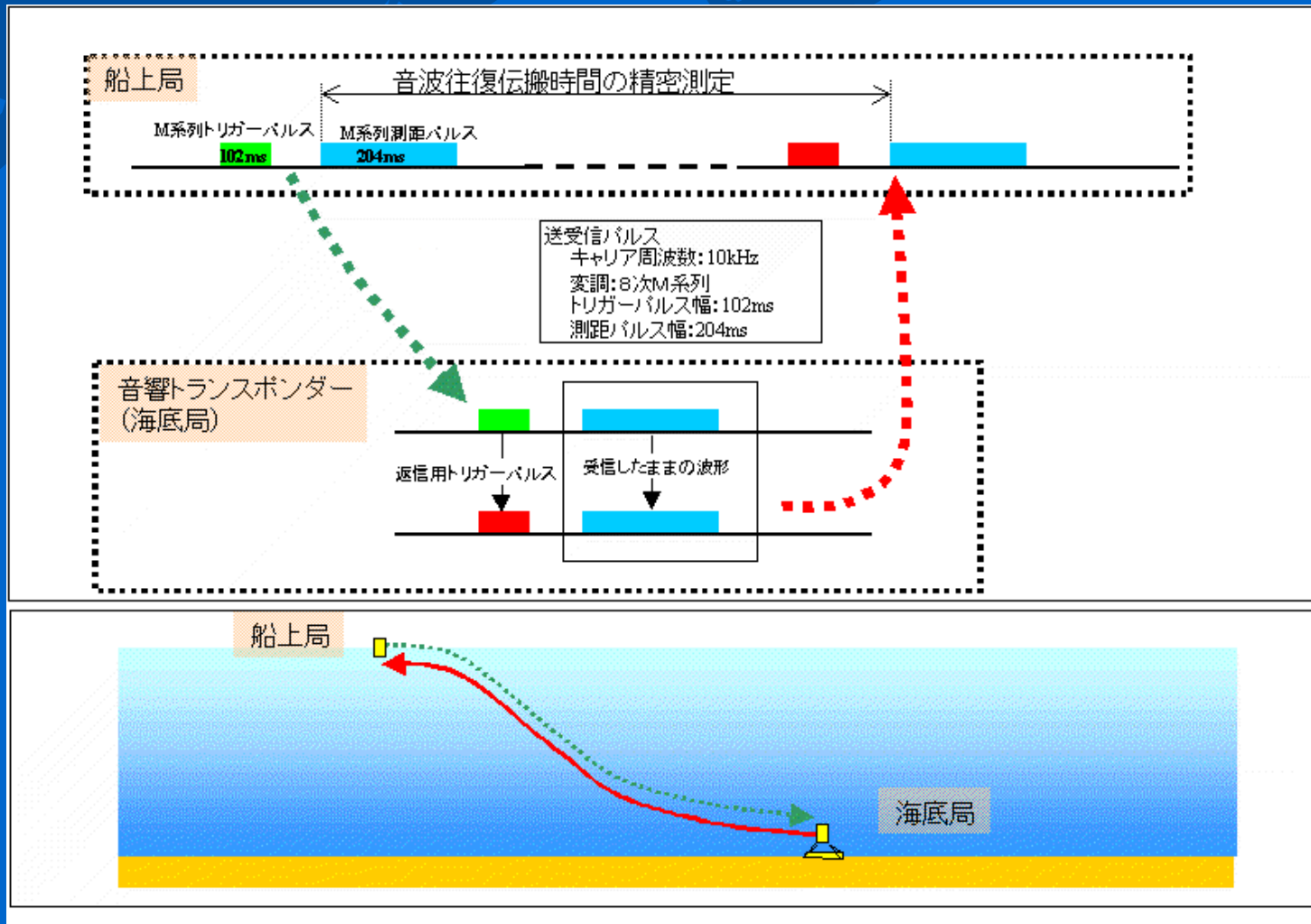
GPS antenna

Motion Sensor
Transducer

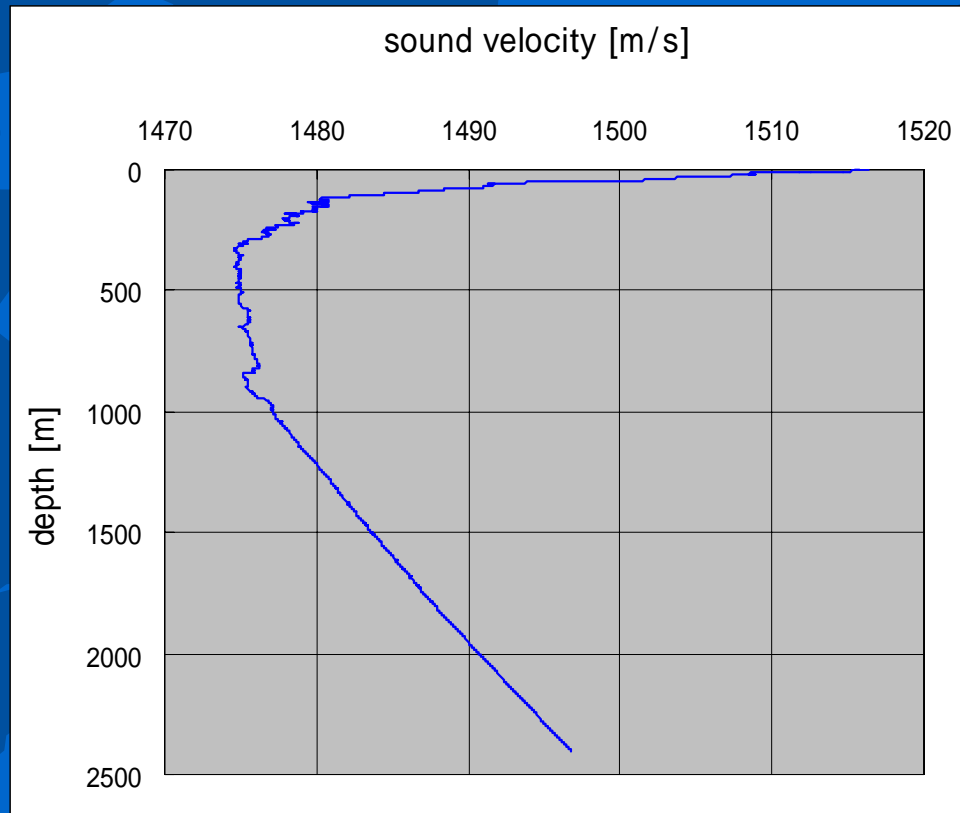


Pole (about 8m)

Acoustic Signal Measurement

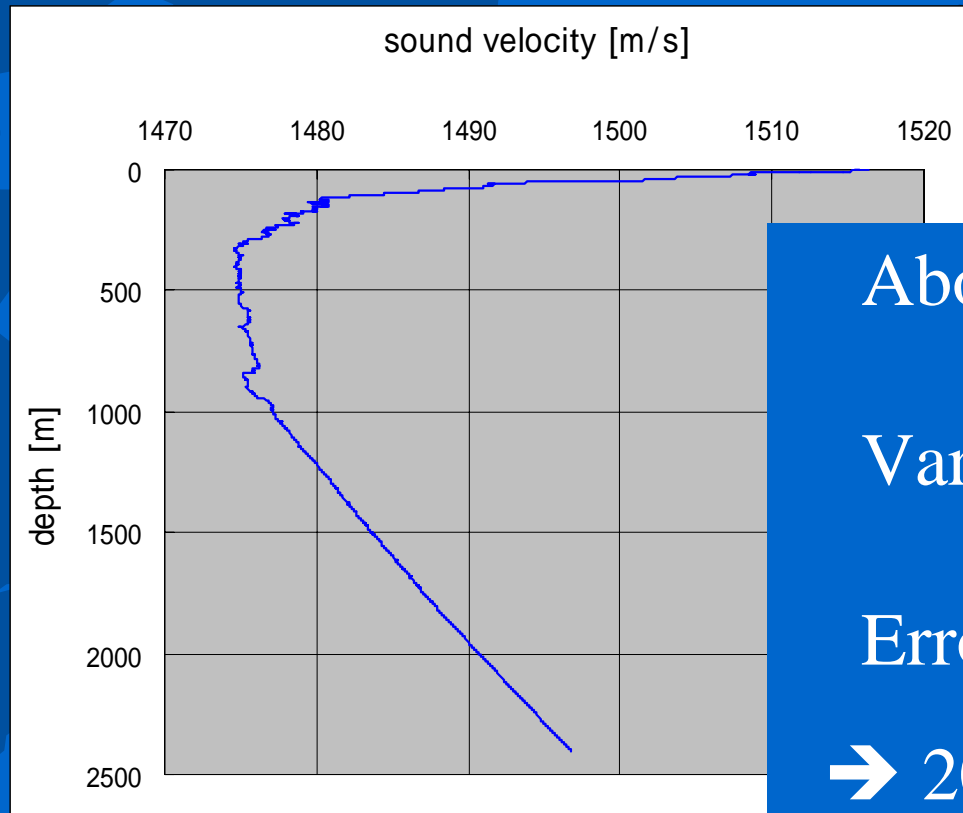


Acoustic Velocity Structure in the Seawater



(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

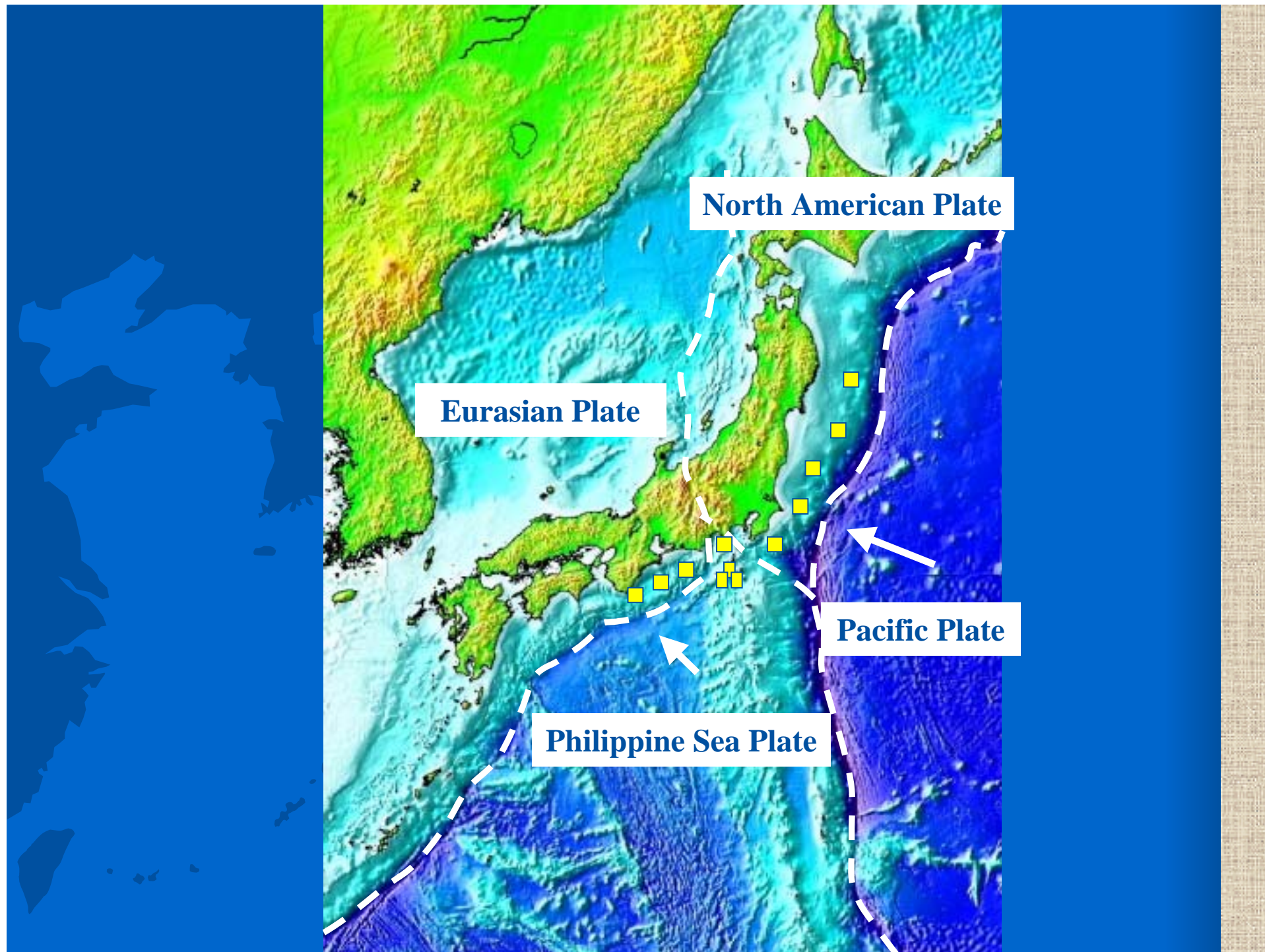


Distribution of Seafloor Reference Points

Landward slope of the Major trench

About 100km interval

The depth of about 400 - 2400m



Kaiyo



Survey Vessel

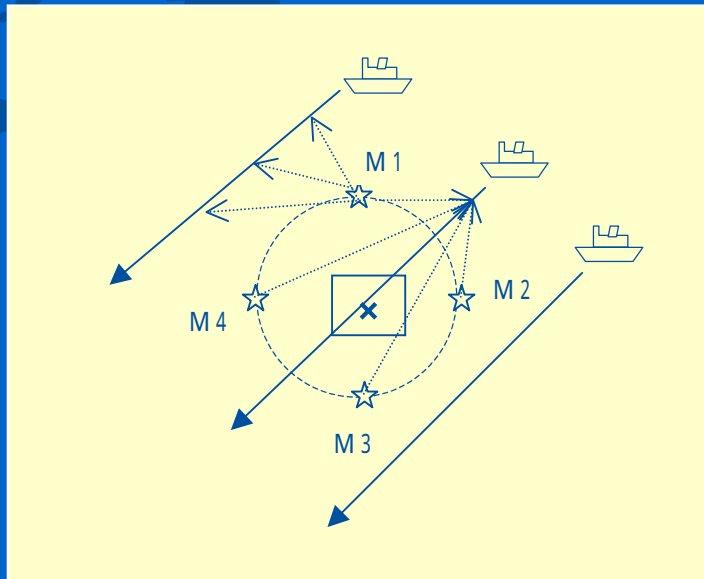


Meiyo



Observation Line

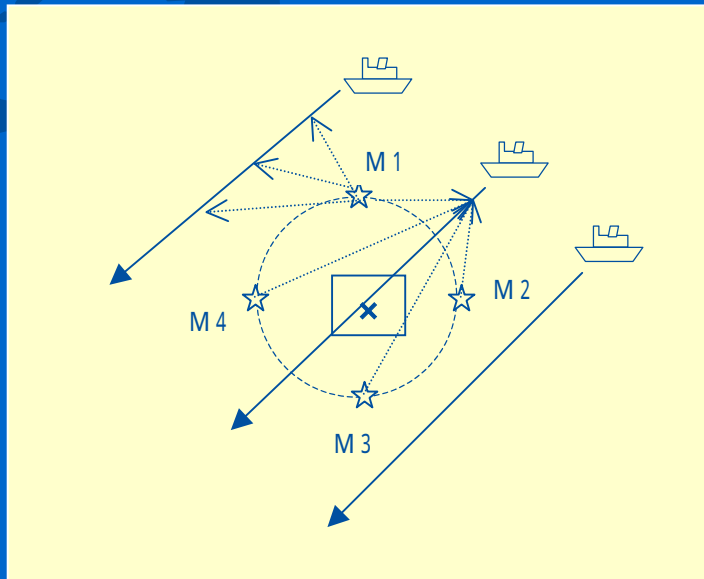
Plan



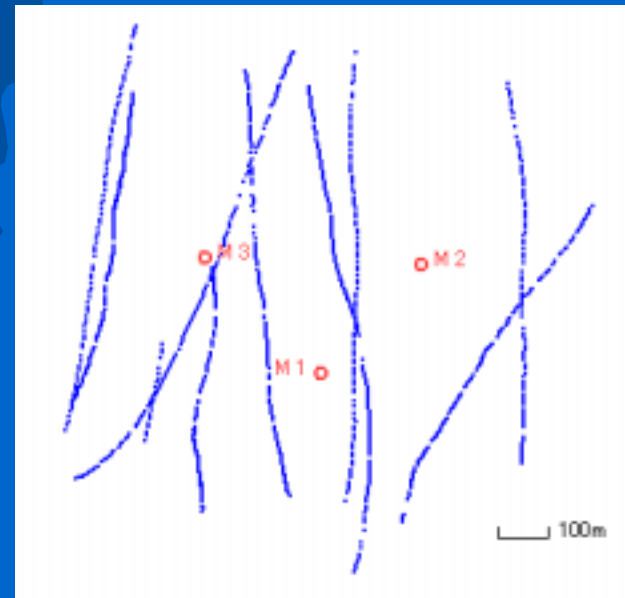
To evade noises from the vessel,
an observation is carried out by **drifting**.

Observation Line

Plan

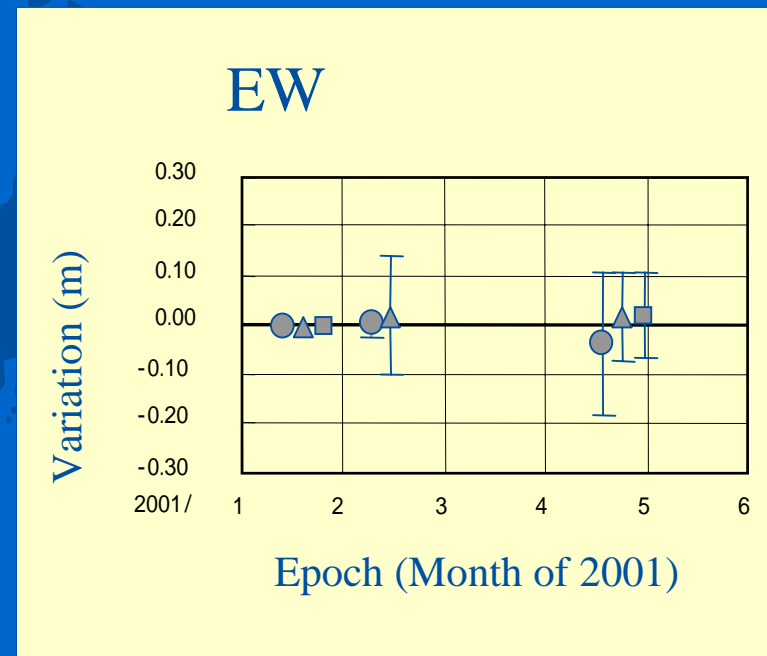
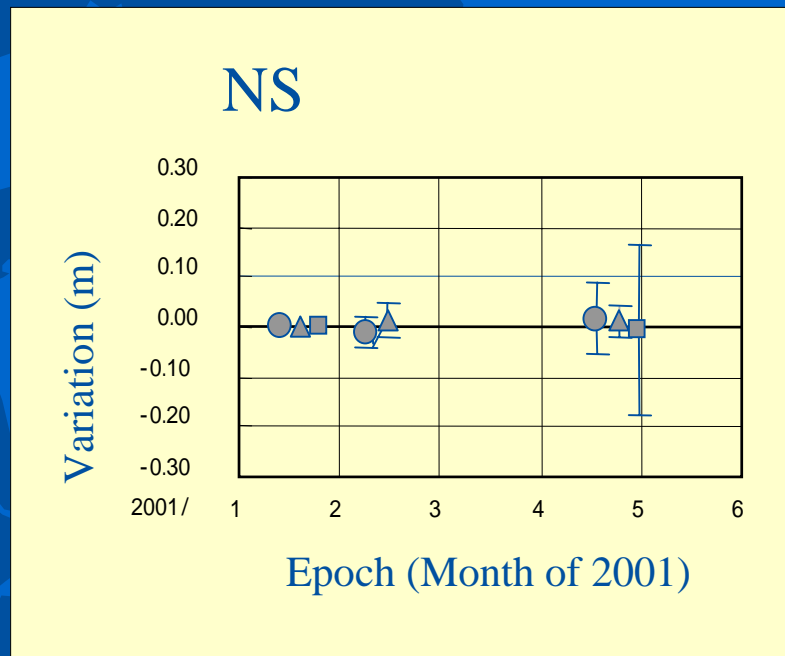


Example



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

Result of Positioning



● :Miyake A ▲ :Miyake B ■ :Miyake C

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

A map of the Pacific Ocean region, showing the coastlines of North America, South America, and the islands of the Pacific. Japan is highlighted in a bright red color, standing out against the blue background of the ocean and the light green landmasses. The text is centered over the map.

**Seafloor geodetic measurement
of cm level is within reach.**

A map of East Asia, including Japan, Korea, and Taiwan, is shown in a lighter blue color against a darker blue background. The map is positioned on the left side of the slide.

**Seafloor geodetic measurement
of cm level is within reach.**

But

The background of the slide is a dark blue map showing the outlines of East Asia, including Japan, Korea, and the Philippines, and the surrounding Pacific Ocean. The text is overlaid on this map.

Seafloor geodetic measurement
of cm level is within reach.

But

**Stability problems
exist.**

A stylized map of East Asia, including Japan, Korea, and Taiwan, is shown in a light blue color against a dark blue background. The map is positioned on the left side of the slide, with the text 'Key Problem' overlaid on it.

Key Problem

Key Problem

- Stability on Long range kinematic GPS

Key Problem

- **Stability on Long range kinematic GPS**

cm level for the baseline $< 10\text{km}$

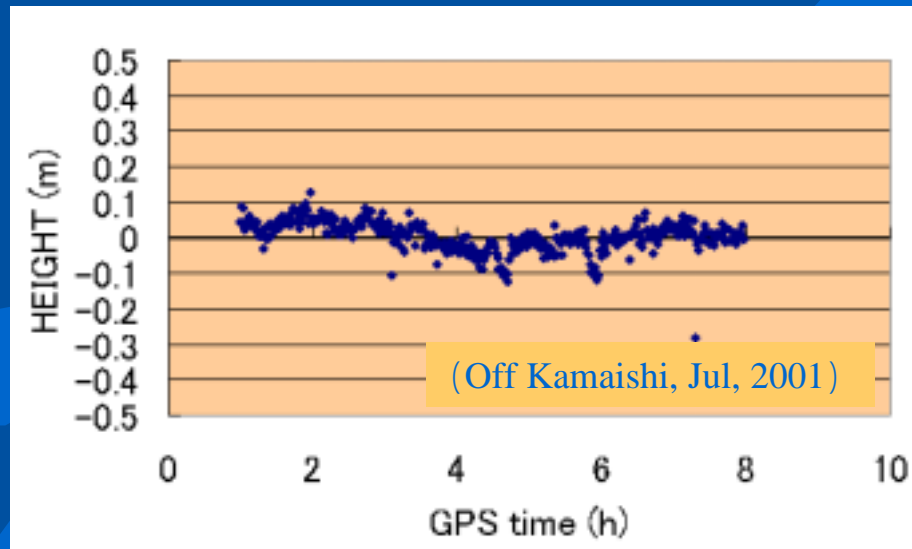
Key Problem

- Stability on Long range kinematic GPS

cm level for the baseline $< 10\text{km}$

$> 100\text{ km}$

The methodology has been developed,
but still unstable.

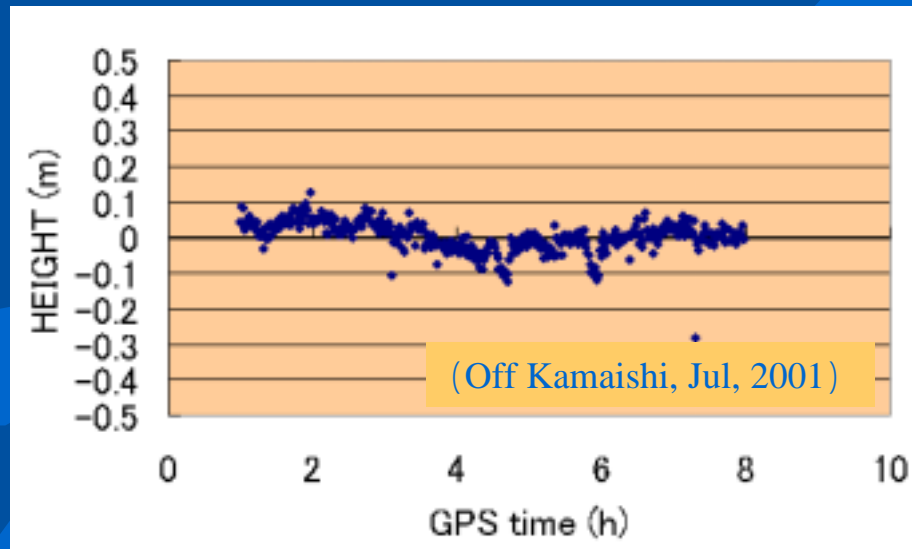


Stability on KGPS

Temporal variation in
Height Determination
after

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

Good Example

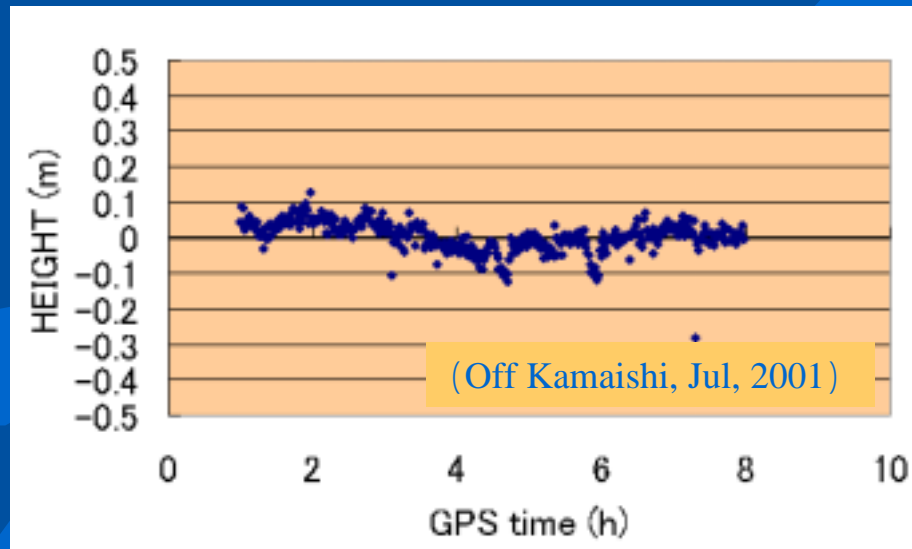


Stability on KGPS

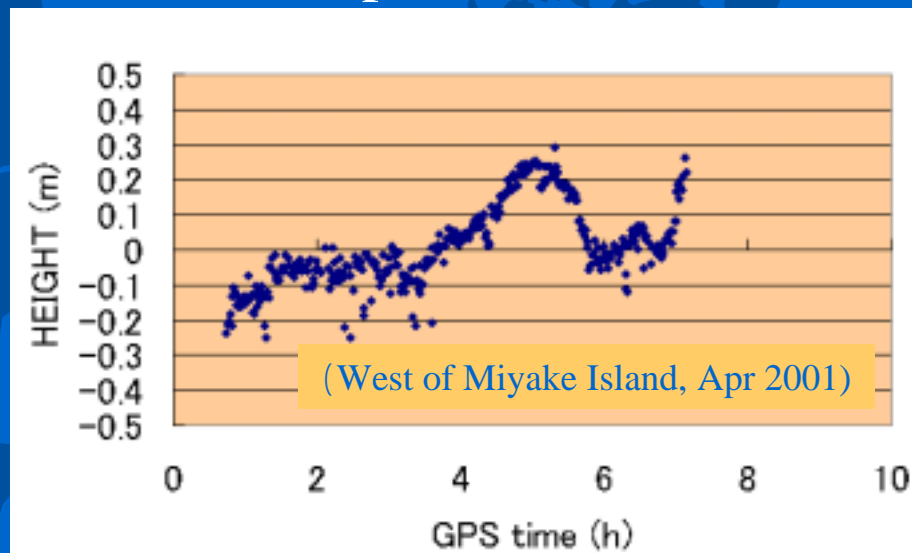
Temporal variation in
Height Determination
after

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

Good Example



Bad Example



Stability on KGPS

Temporal variation in
Height Determination

after

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

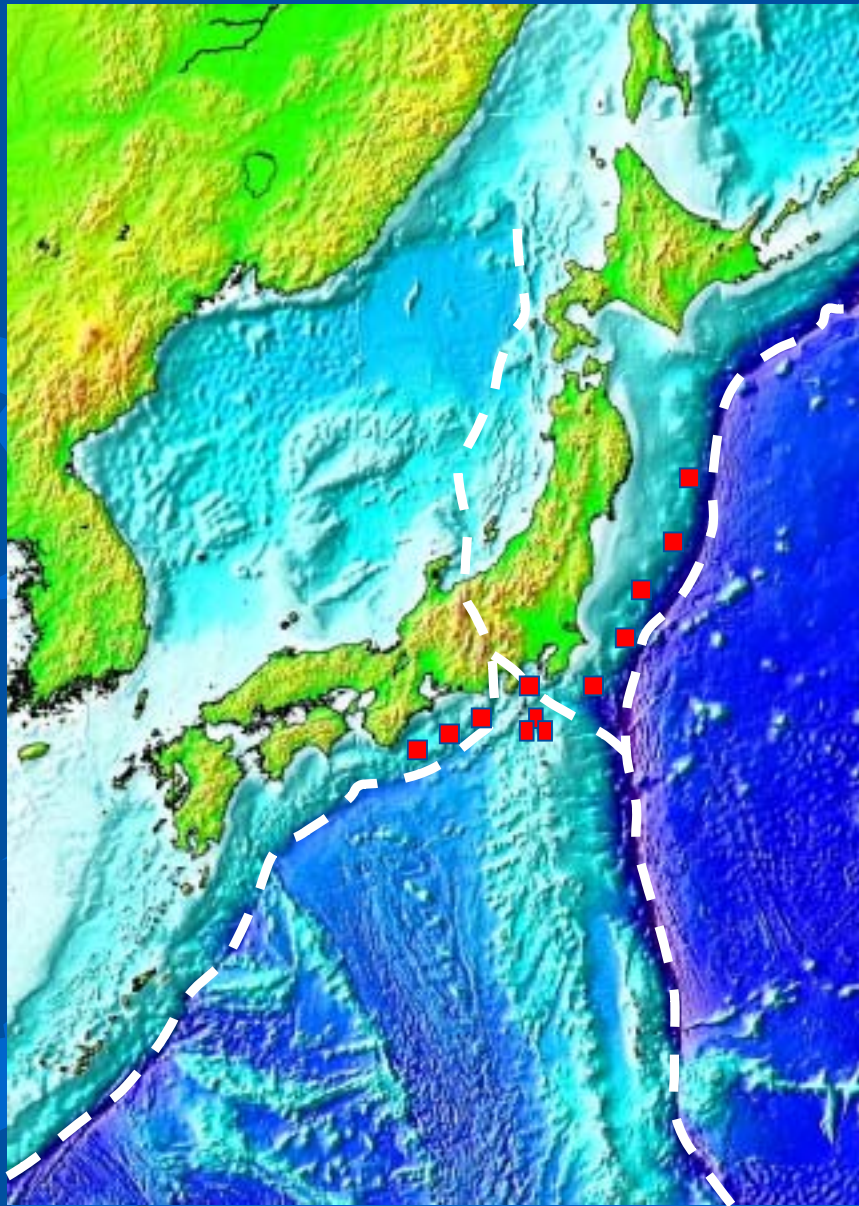
Other Problems

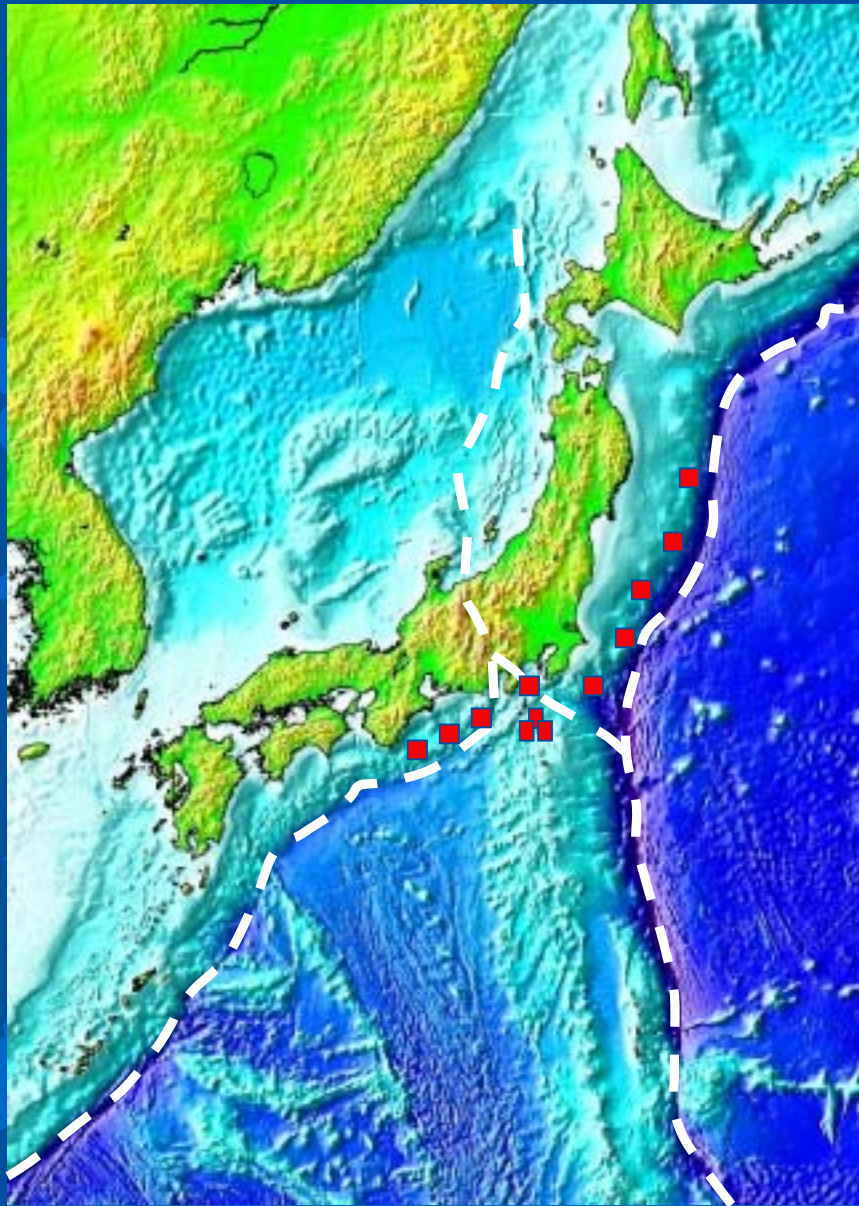
- Error in the acoustic velocity structure
 - Limitation in the observation
 - Correction method
- Deformation (bending) of the observation pole
 - Improvement on the material and structure

Other Problems (2)

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

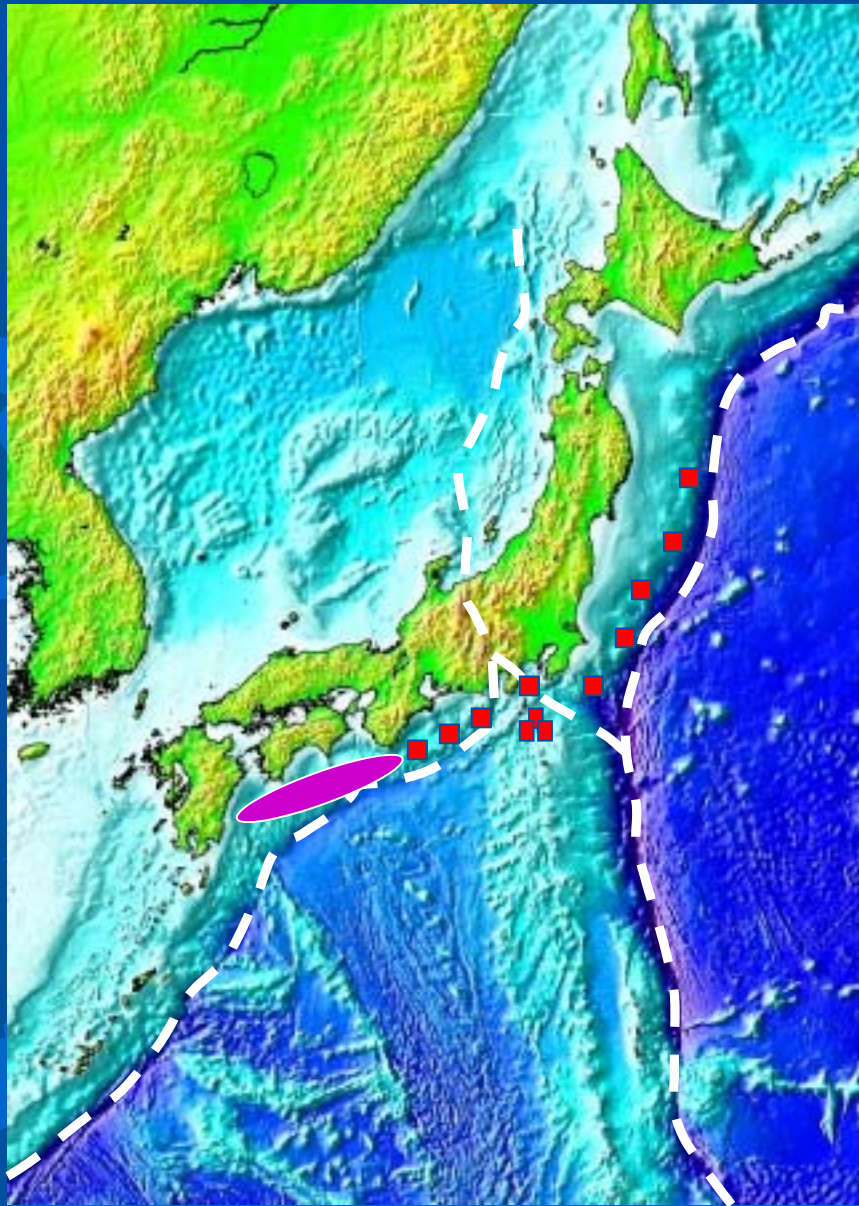
Future





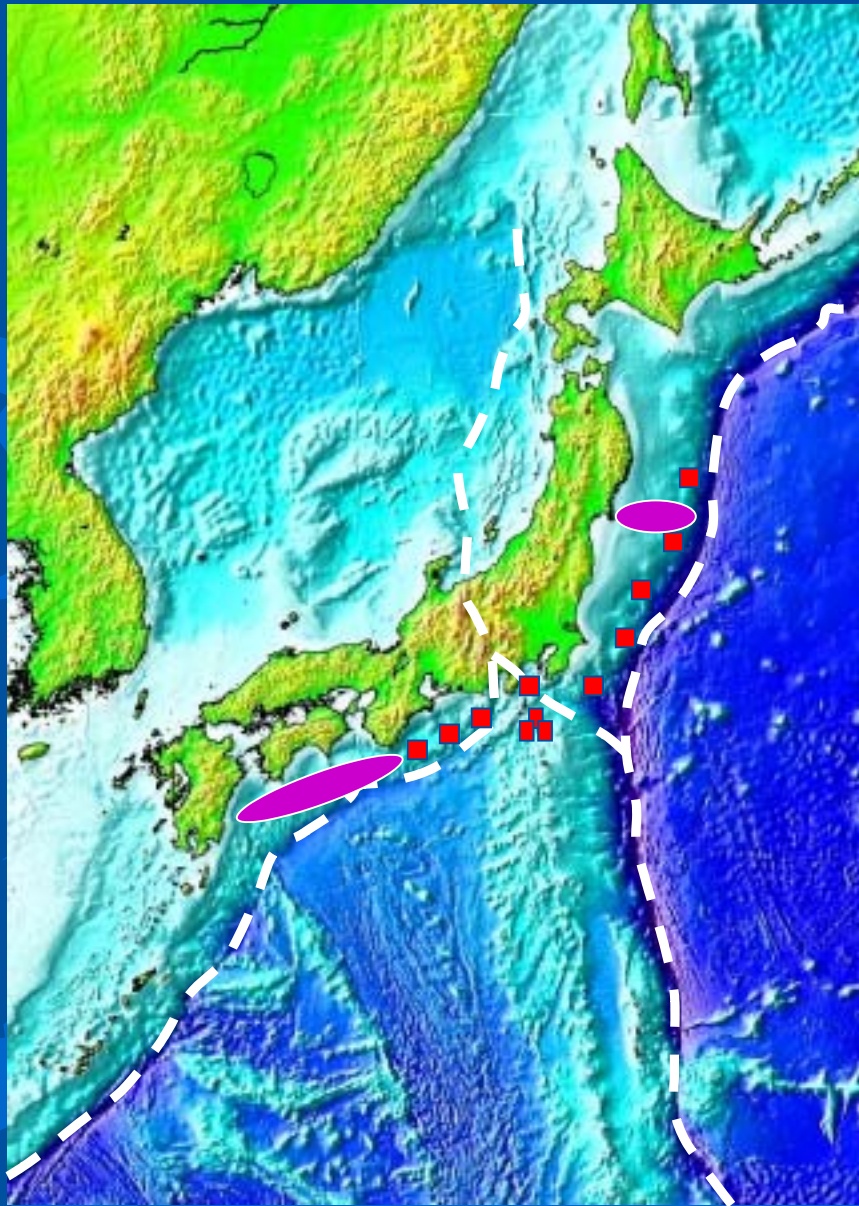
Future

- Denser network



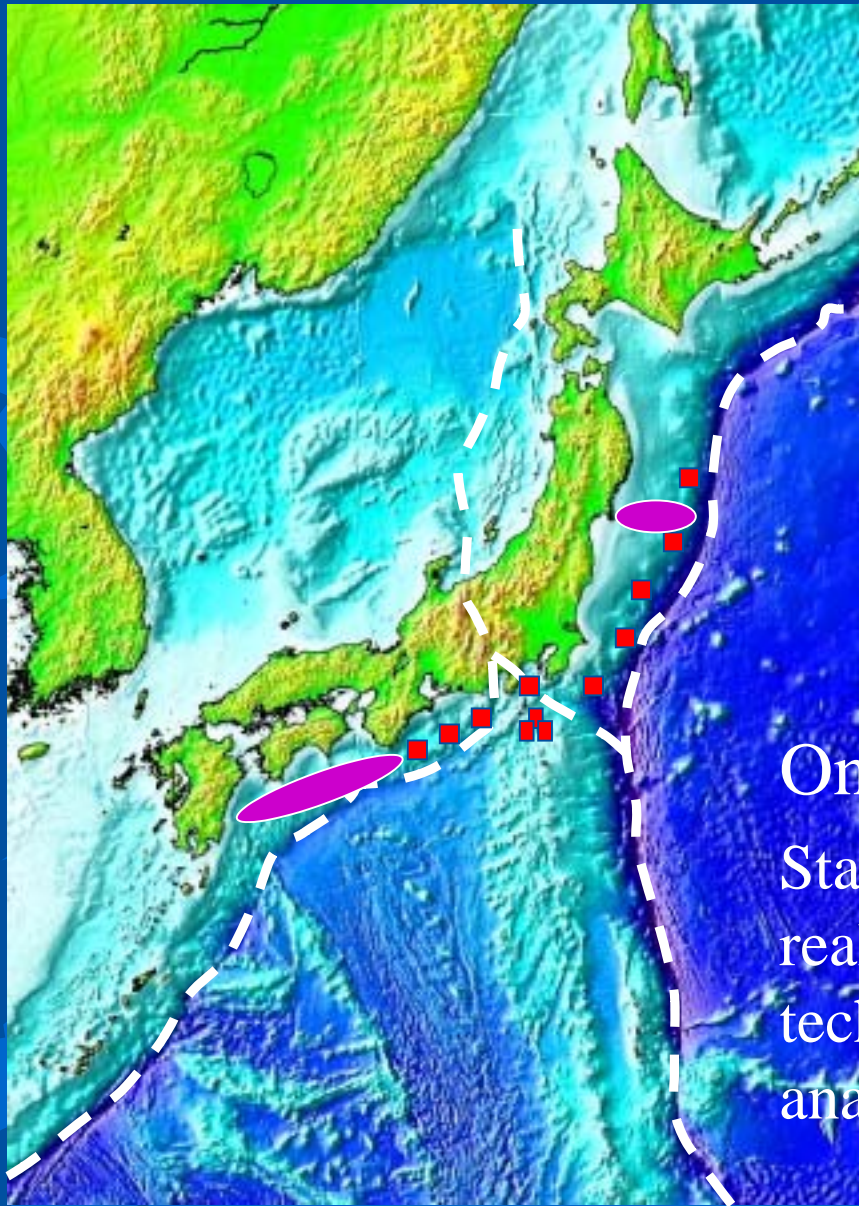
Future

- Denser network



Future

- Denser network



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

