

# Importance of the geological investigations for paleoseismology in areas with short history



**Takashi AZUMA**  
**Active Fault Research Center**  
**Geological Survey of Japan/AIST**

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## **1) Methods for the earthquake study**

*Why geological study needs?*

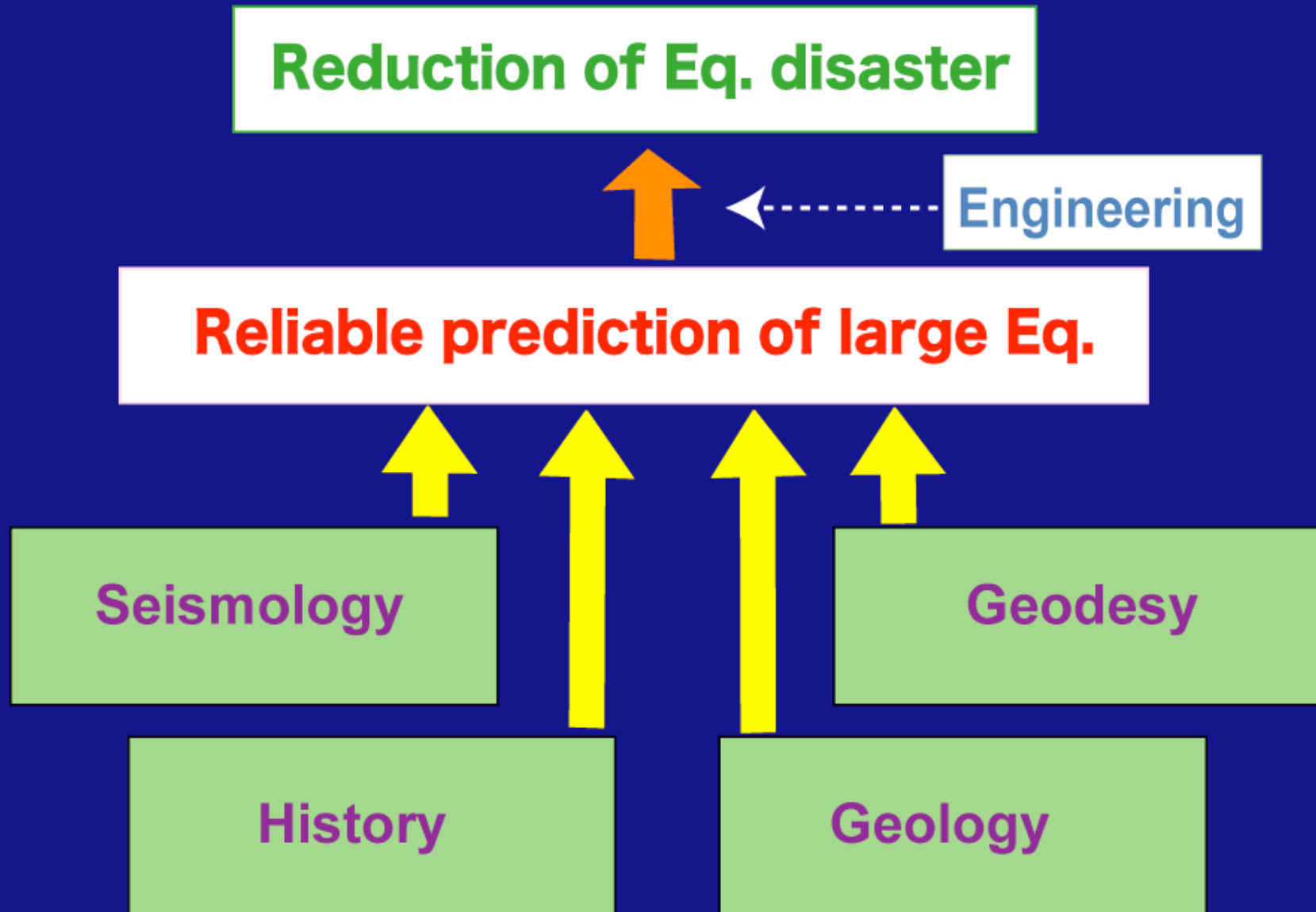
## **2) Geological investigation in Hokkaido**

*Trench excavation on active faults*

*Tsunami deposits*

## **3) Conclusion**

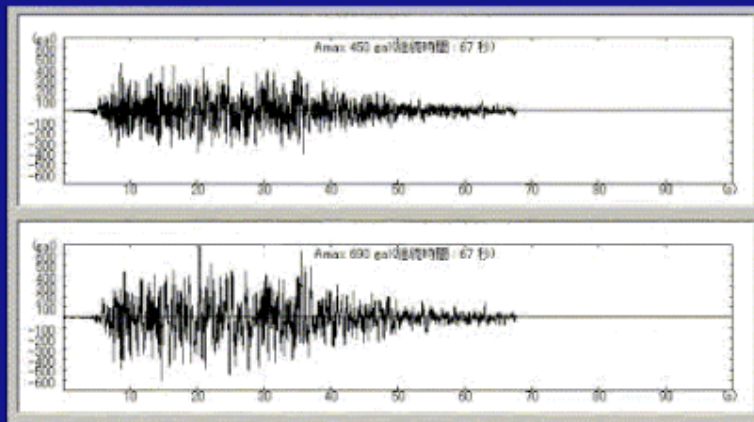
# Goal and approach



# Seismology

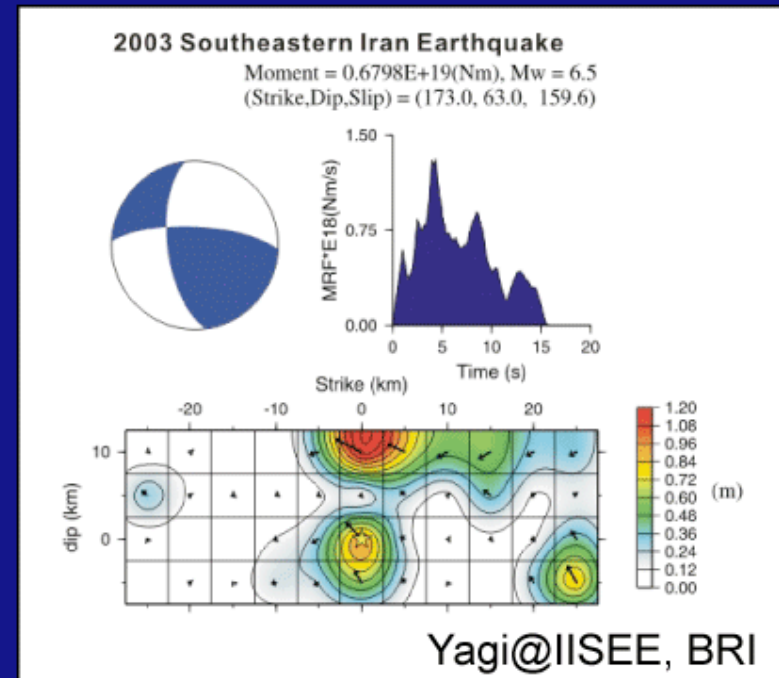
## Network of wave form data

- > quick analysis of source information (*location, mechanism*)



## Telemetry system

- > real-time seismology

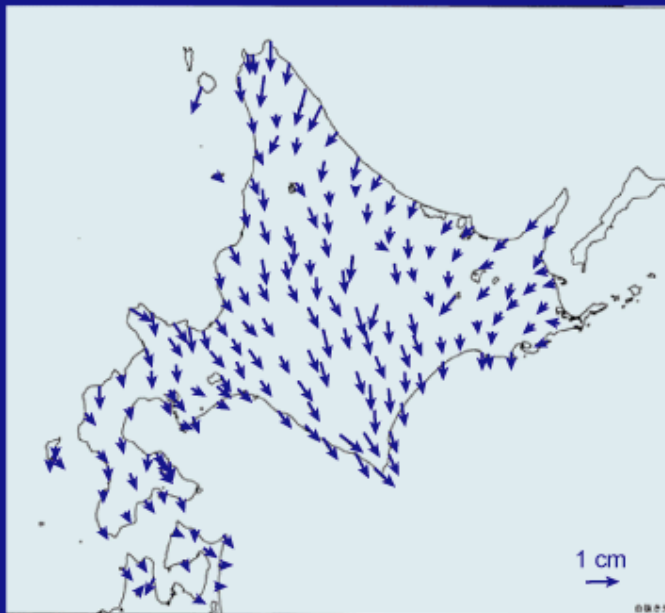


# Geodesy

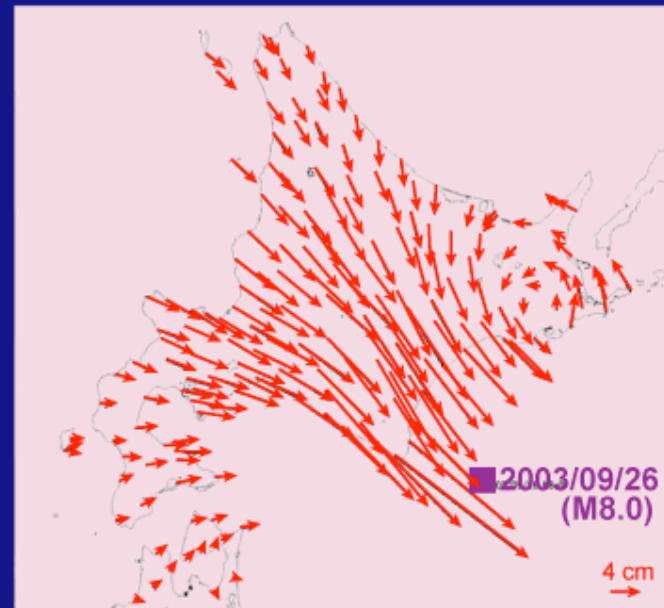
## GPS

- > precise data on crustal movements  
(strain accumulation, coseismic displacement)

### Hokkaido



2004/7-2004/8



Afterslip of  
2003 Tokachi-oki Eq.(ca.1 year)

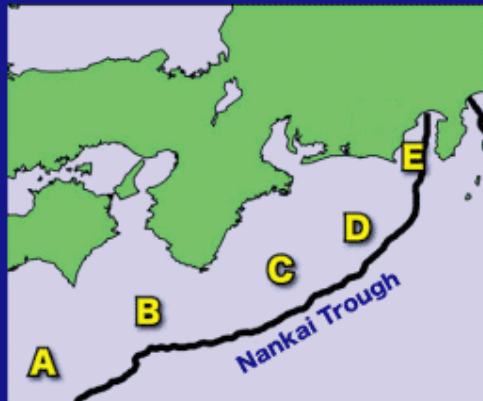
(GSI web-site)



# History



## Old documents > earthquake catalogue



	A	B	C	D	E
102 yrs		1605 Keicho			
147 yrs		1707 Hoei			
94-96 yrs		1854 Ansei	1854 Ansei		
		1946 Nankai	1944 Tonankai		
		20XX ?			



# Geology

## Active faults on land

> Trench, drilling, Seismic profiling

*Deformation*

*Timing of fault event*



## Off-shore faults and earthquakes from subduction zone

> Survey on the coast

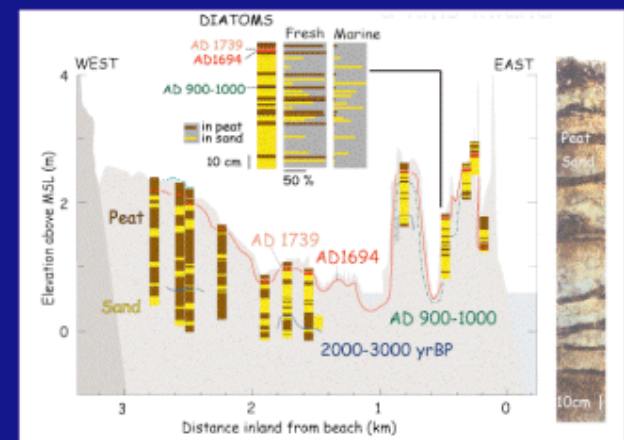
*marine terraces (uplift)*

*Drawn deposits (subsidence)*

*Tsunami deposits*

> Off-shore survey

*Turbidites*



# Time window of each method

**Seismology:** **second ~ minutes**  
*(since ca. 100 yrs before)*

**Geodesy:** **days ~ years**  
*(since ca. 100 yrs before)*  
*(GPS: since ca. 20 yrs before)*

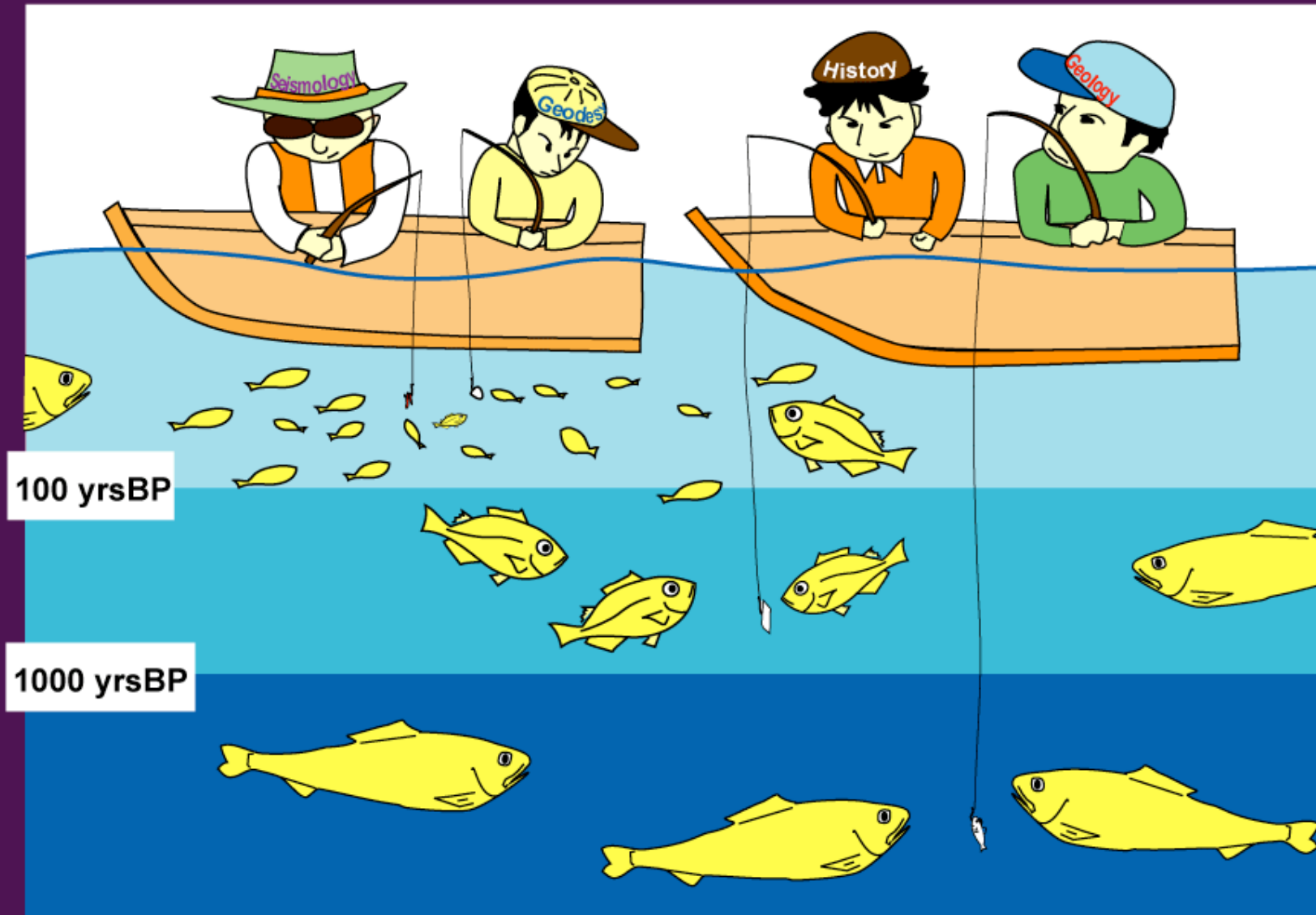
**History:** **hours ~ days**  
*(since ca. 1,000 yrs before)*

**Geology:** **years ~  $>10^3$  yrs**  
*(depend on dating technique)*

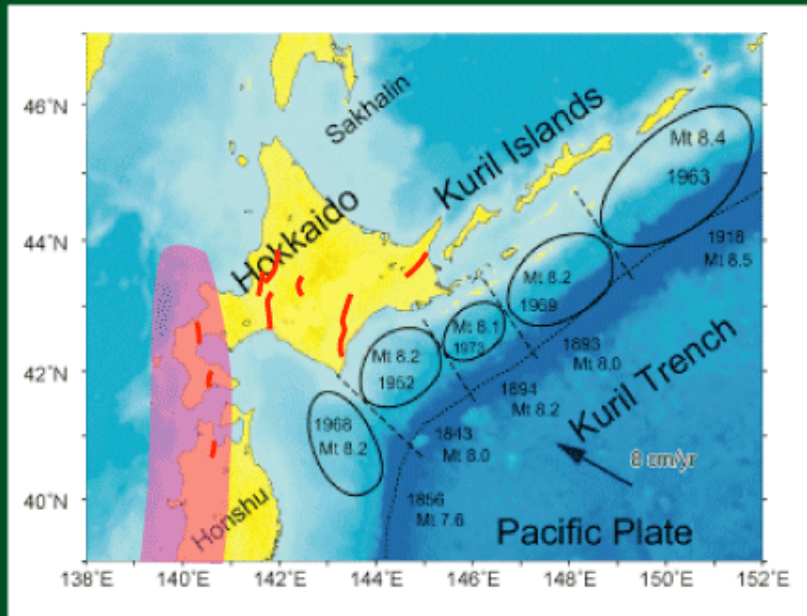
**Frequency of large eq. :  $10^2 \sim 10^4$  yrs**



# Difference of time range for the target



# Hokkaido



## Active faults

*Northernmost part of  
fold and thrust belt  
(western part)*

## Kuril subduction zone

*Series of large Eq. (19-20c)  
Tsunami deposits*

## Native people (Ainu)

*Oral culture*

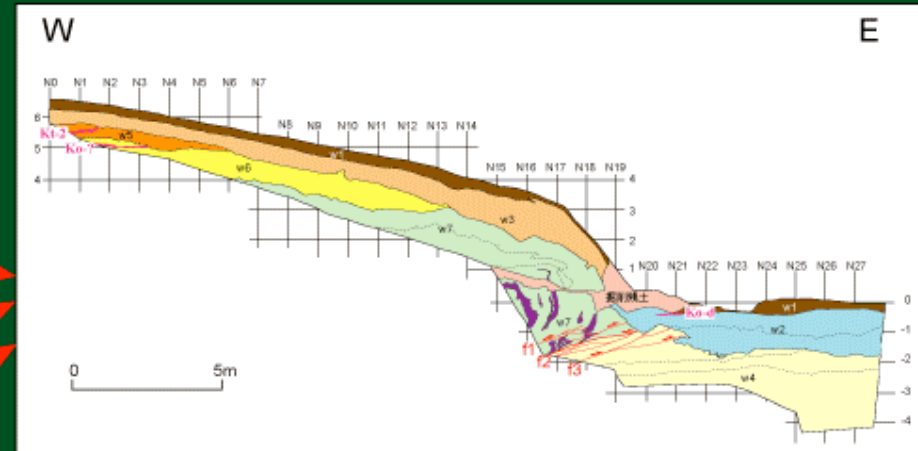
*No detailed documents  
before 19c*



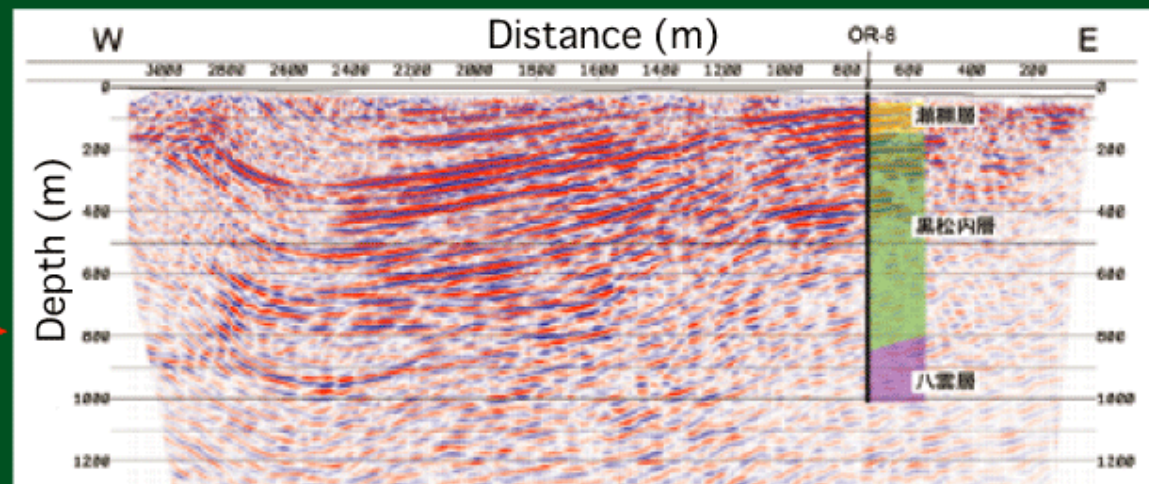
@Ainu Museum

# Study on active faults

## Trench excavation

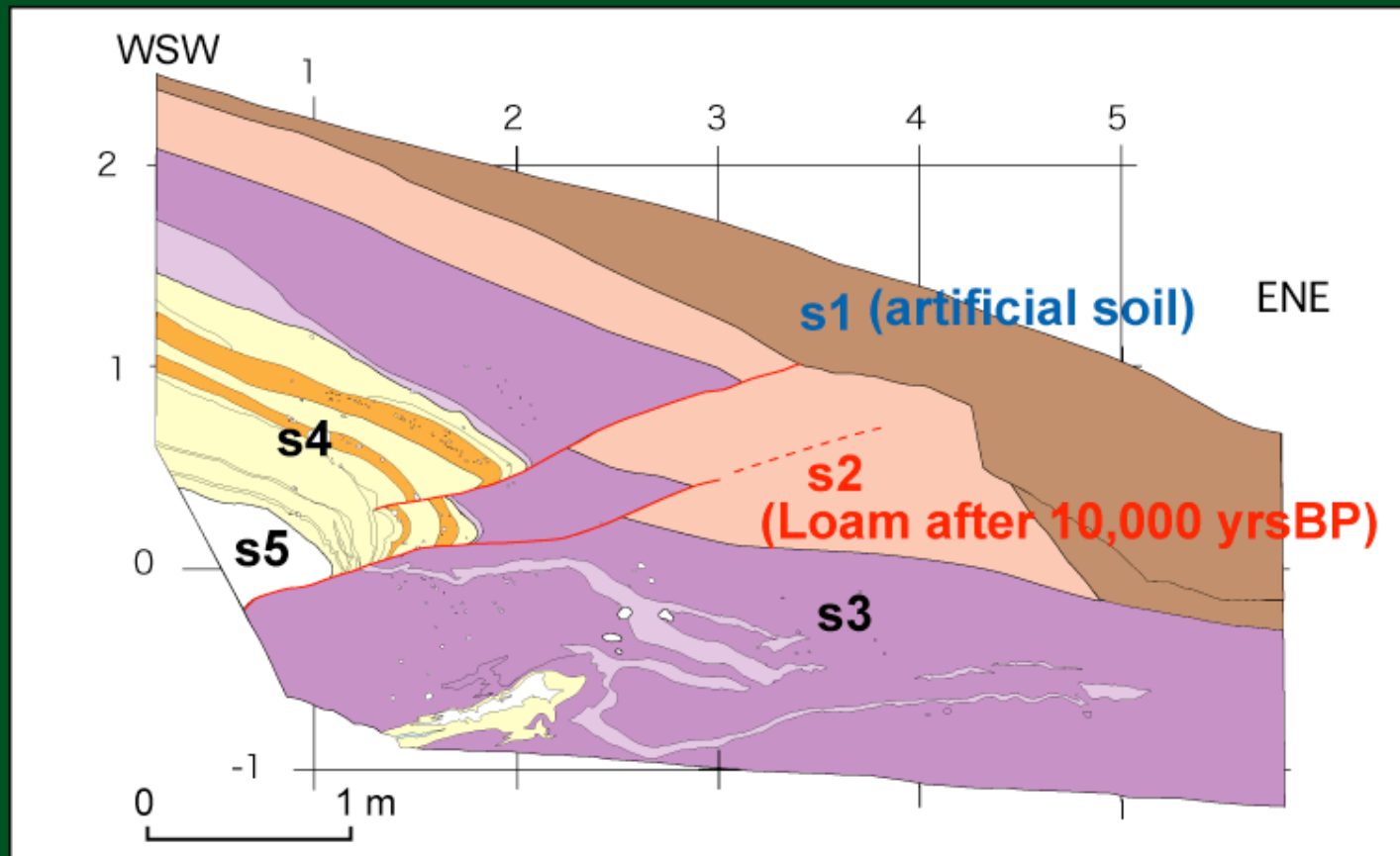


## Seismic profiling



# Trench excavation: 1

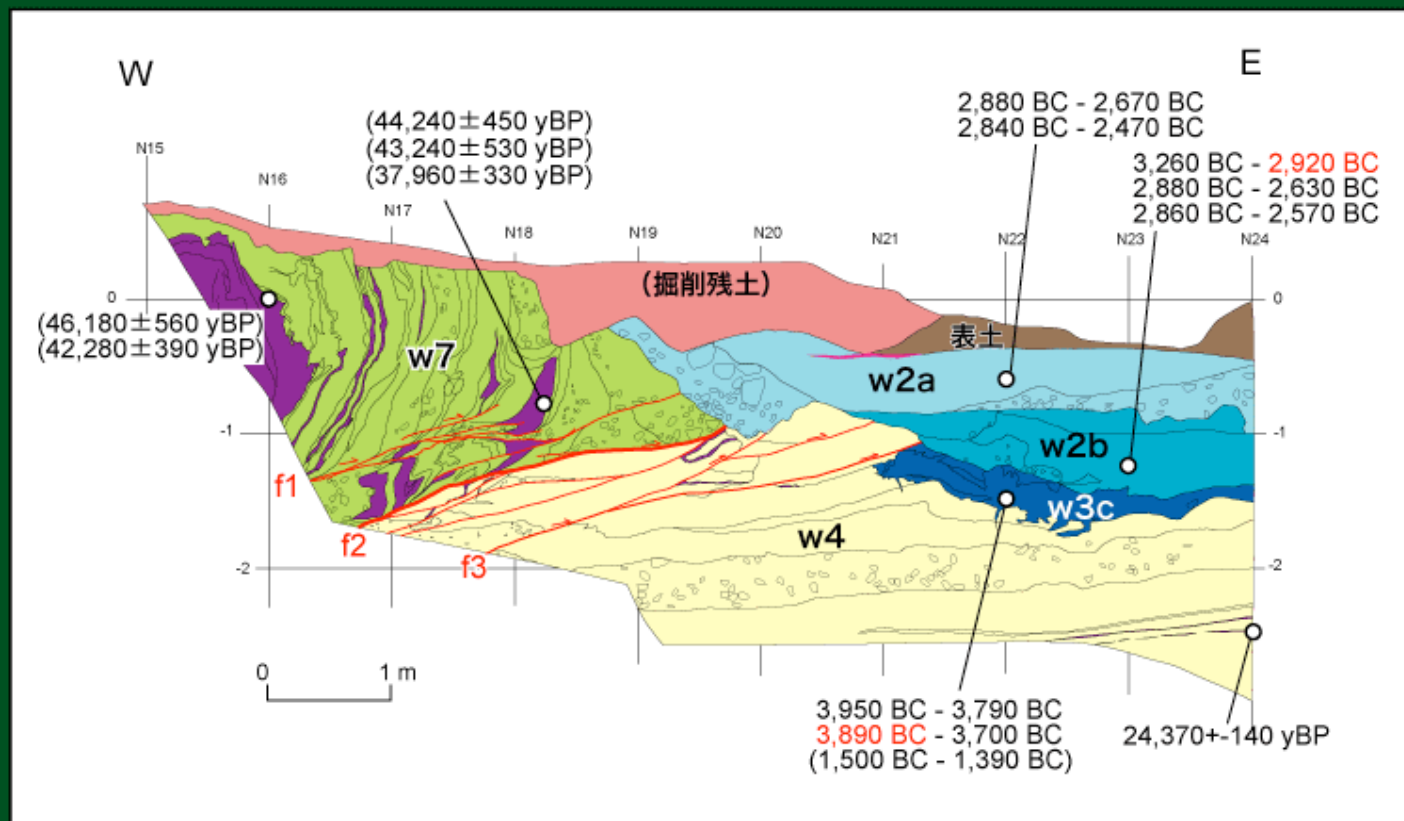
## *Shirozumi site*



***Timing of fault event : after 10,000 yrsBP***

# Trench excavation

## Warabitai site

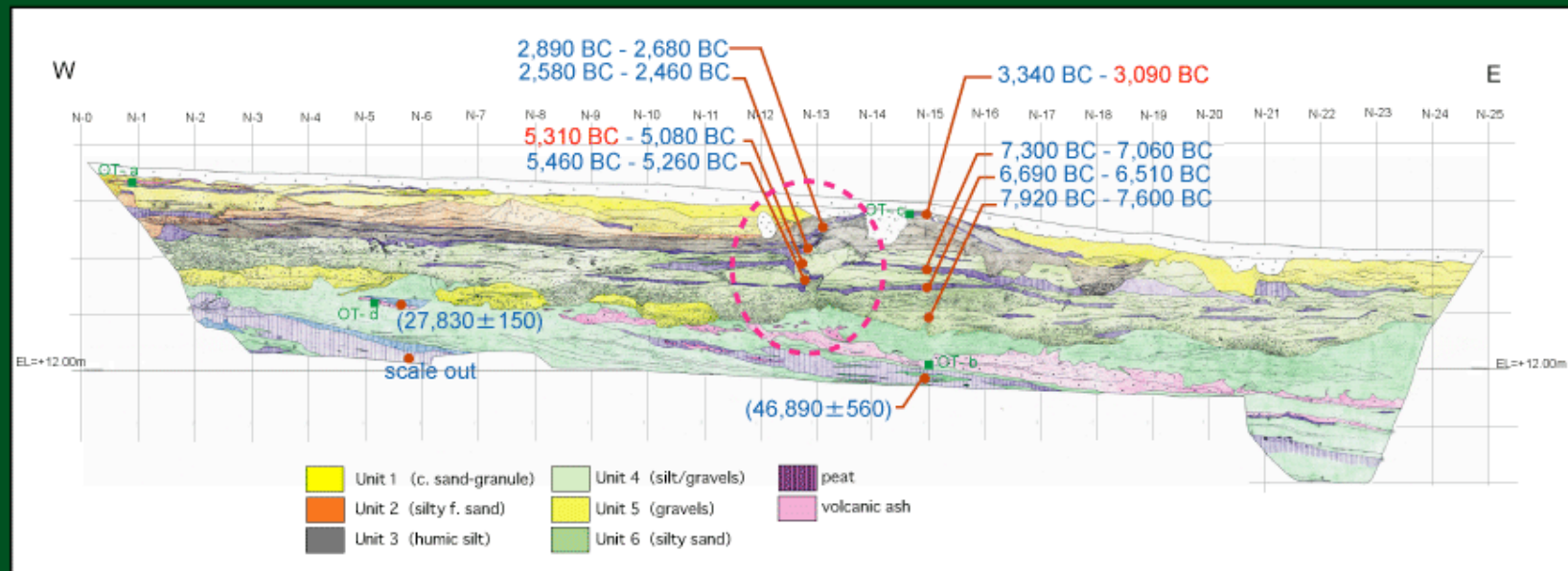


**Timing of fault event : 3,890 BC - 2,920 BC**



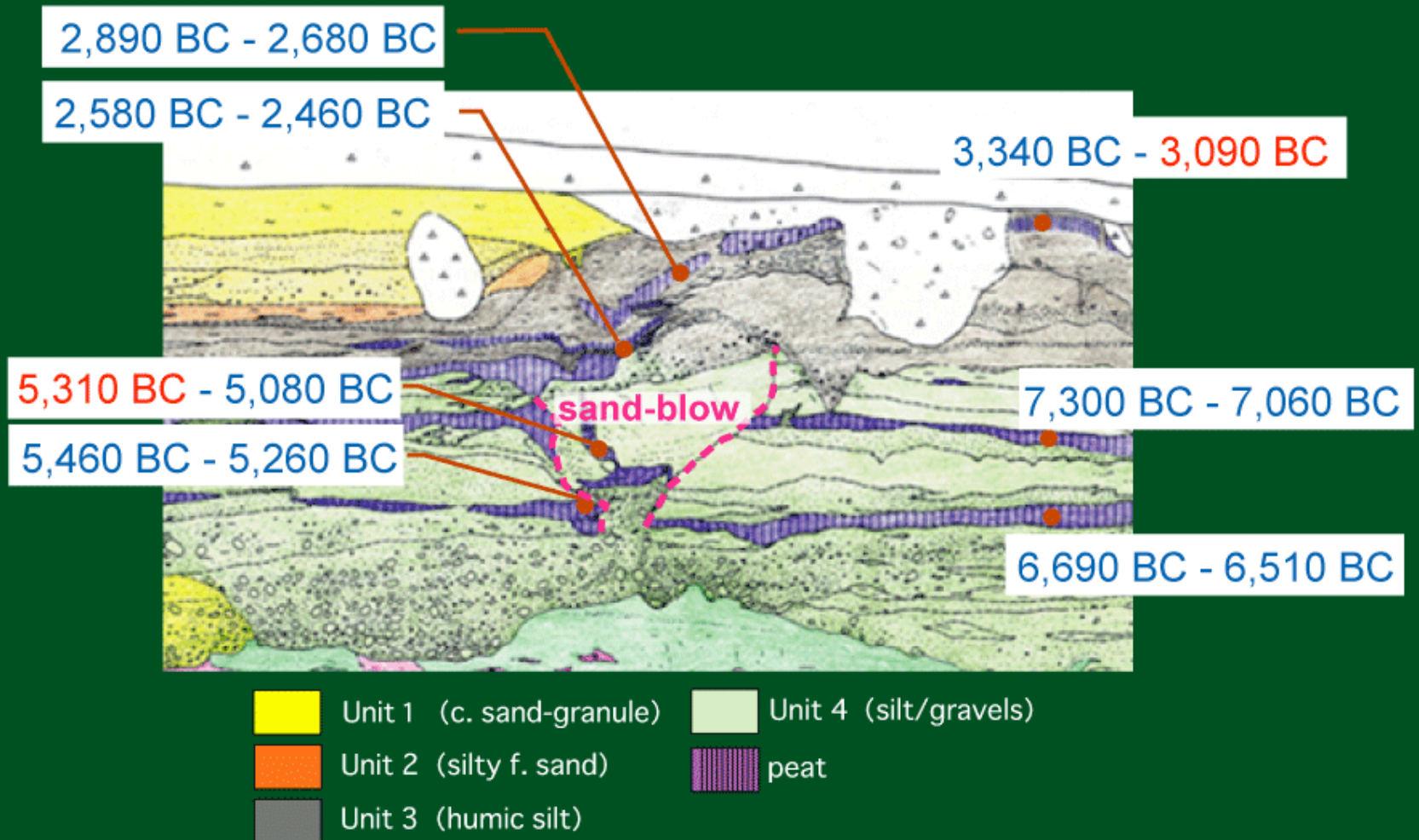
# Trench excavation

## *Oshamanbe site*



***Fault event is not recognized  
But we found a fossil liquefaction  
> occurrence of strong ground motion***

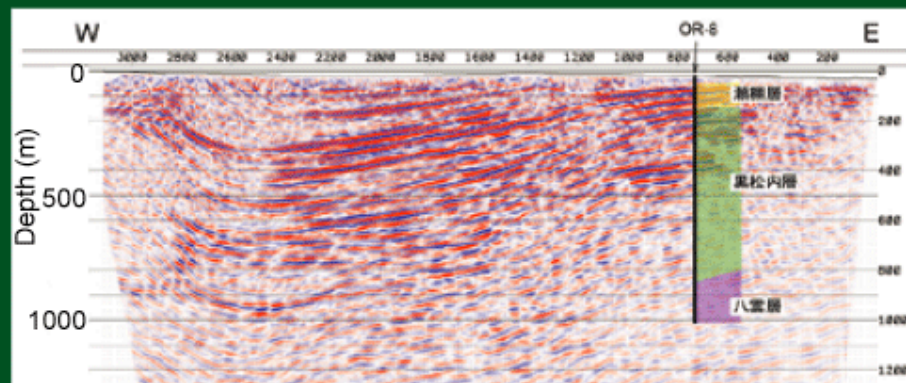
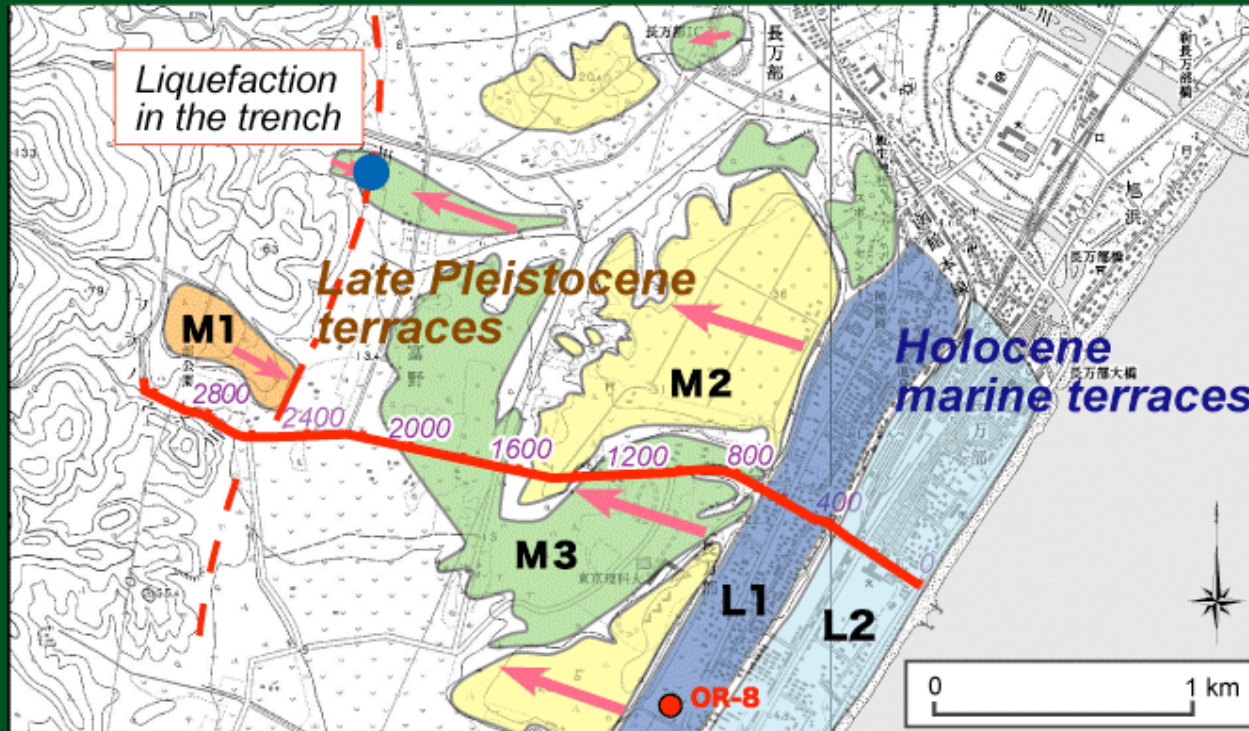
# Liquefaction



***Timing of liquefaction : 5,310 BC - 3,090 BC***

# Marine terraces

## Oshamanbe coast



**L2 terrace emerged after the post-glacial transgression (ca. 7000 yBP)**



# The last event on the Kuromatsunai-teichi fault zone



faulting event  
after 10,000 yBP

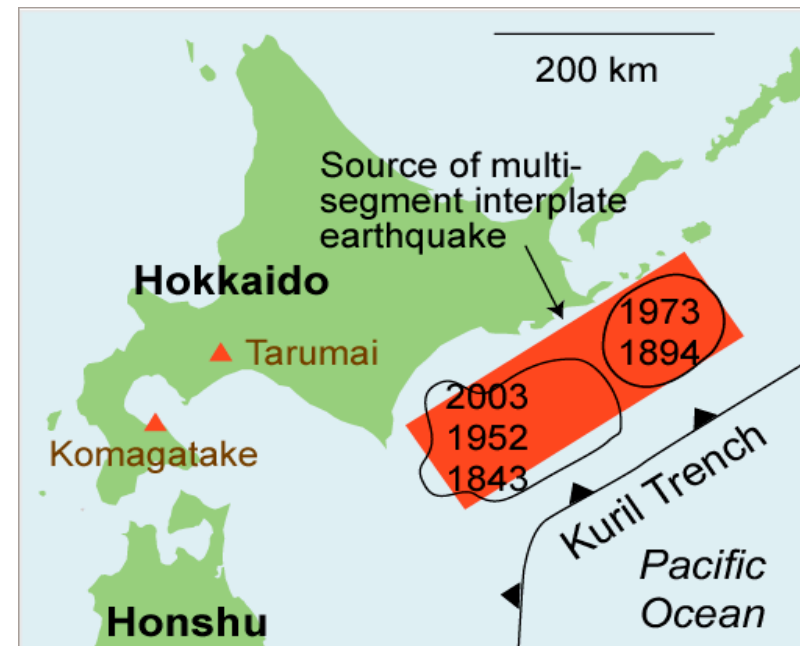
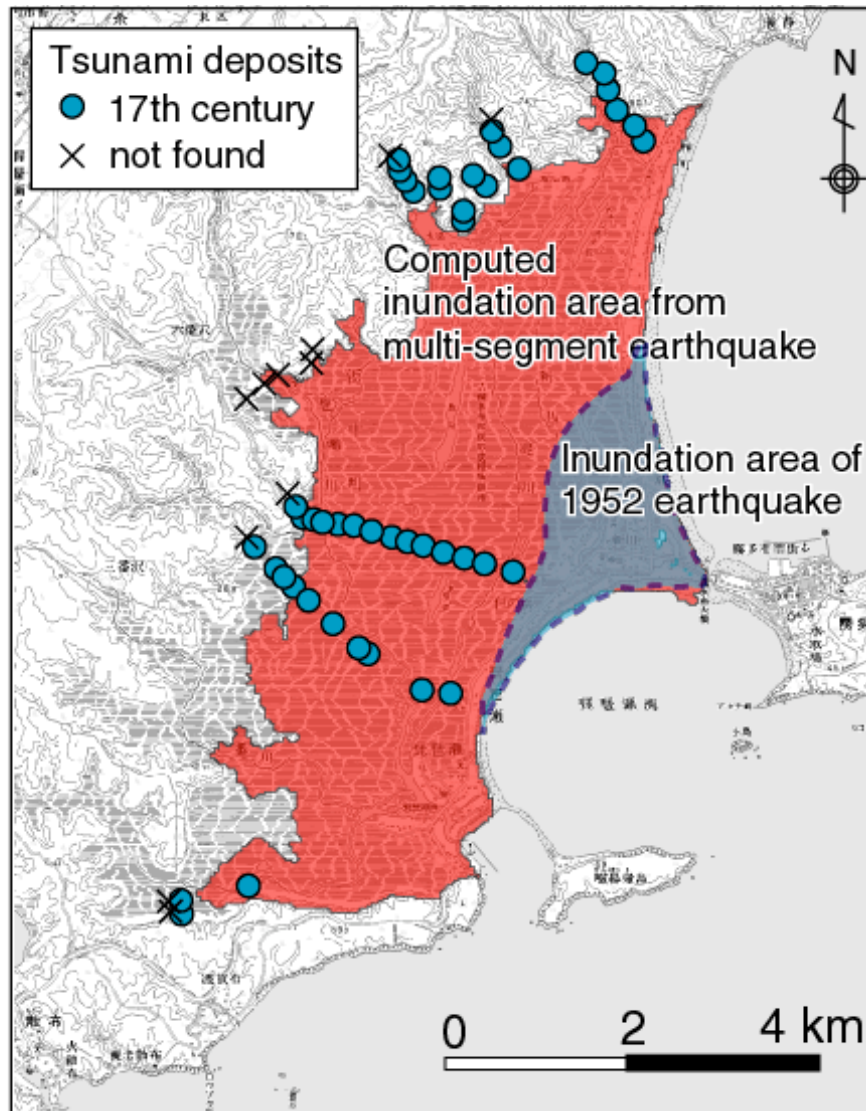
faulting event  
ca. 5000-6000 yBP

Liquefaction  
ca. 5000-7300 yBP

Coastal uplift  
after 7000 yBP

the last earthquake might  
occur around 6000 yBP

# Tsunami deposits from multi-segment earthquake along Kuril trench

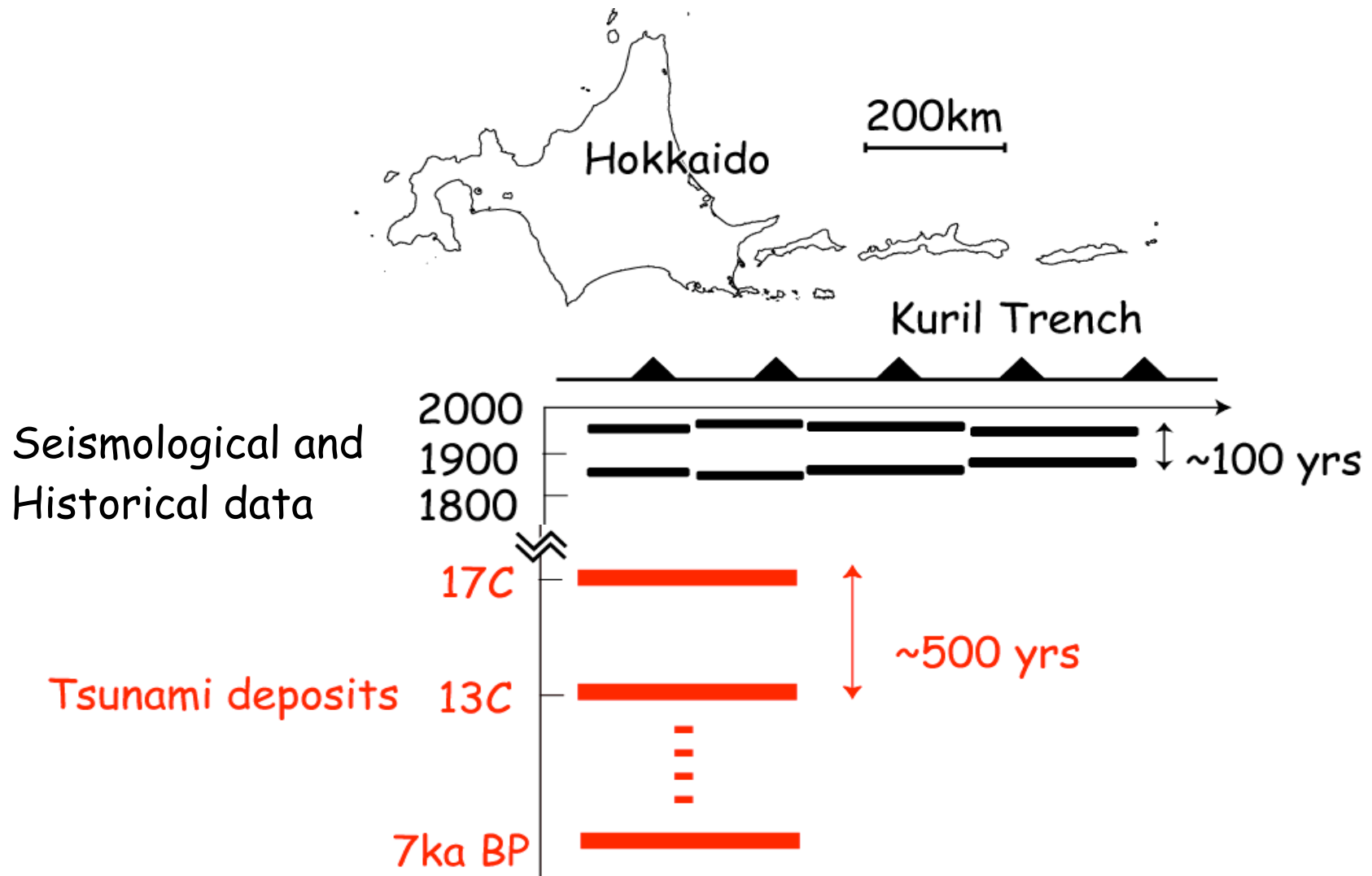


Unusually large tsunamis  
every ~ 500 years  
the last event 17<sup>th</sup> century

Nanayama et al.  
(2003, Nature)



# Characteristic earthquakes in Kuril subduction zone



*Why geological method needs  
for the earthquake prediction?*

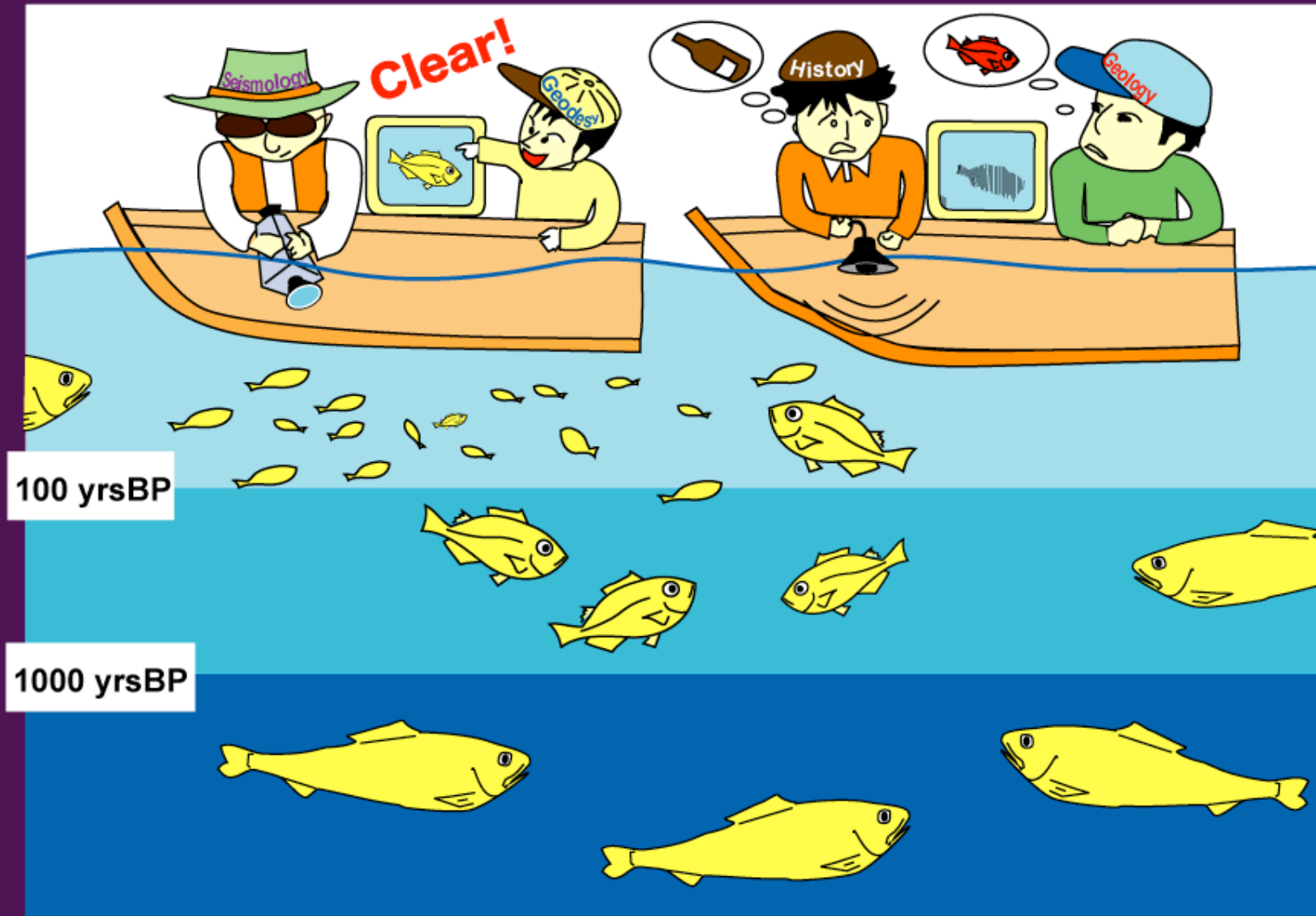
- 1) There are large earthquakes that have recurrence intervals much longer than our history.  
ex. earthquake from (intraplate) active fault**
- 2) There is possibility of unusual large earthquakes  
ex. multi-segment earthquake**
- 3) Earthquakes of 1) and 2) is likely to bring serious damages on human life.**

# **Problems**

**The results of geological investigations include many uncertainties.**

- 1) time range of geological units**
- 2) lack of geological units**
- 3) variation of geologic phenomena**
- 4) accuracy of dating technique**
- 5) contaminations of dating materials**

# Uncertainty of data



Fine



# Tsunami deposits traced kms inland

