Identification of Gigantic Tsunami from the Kuril and Japan Trench based on Tsunami Sediments

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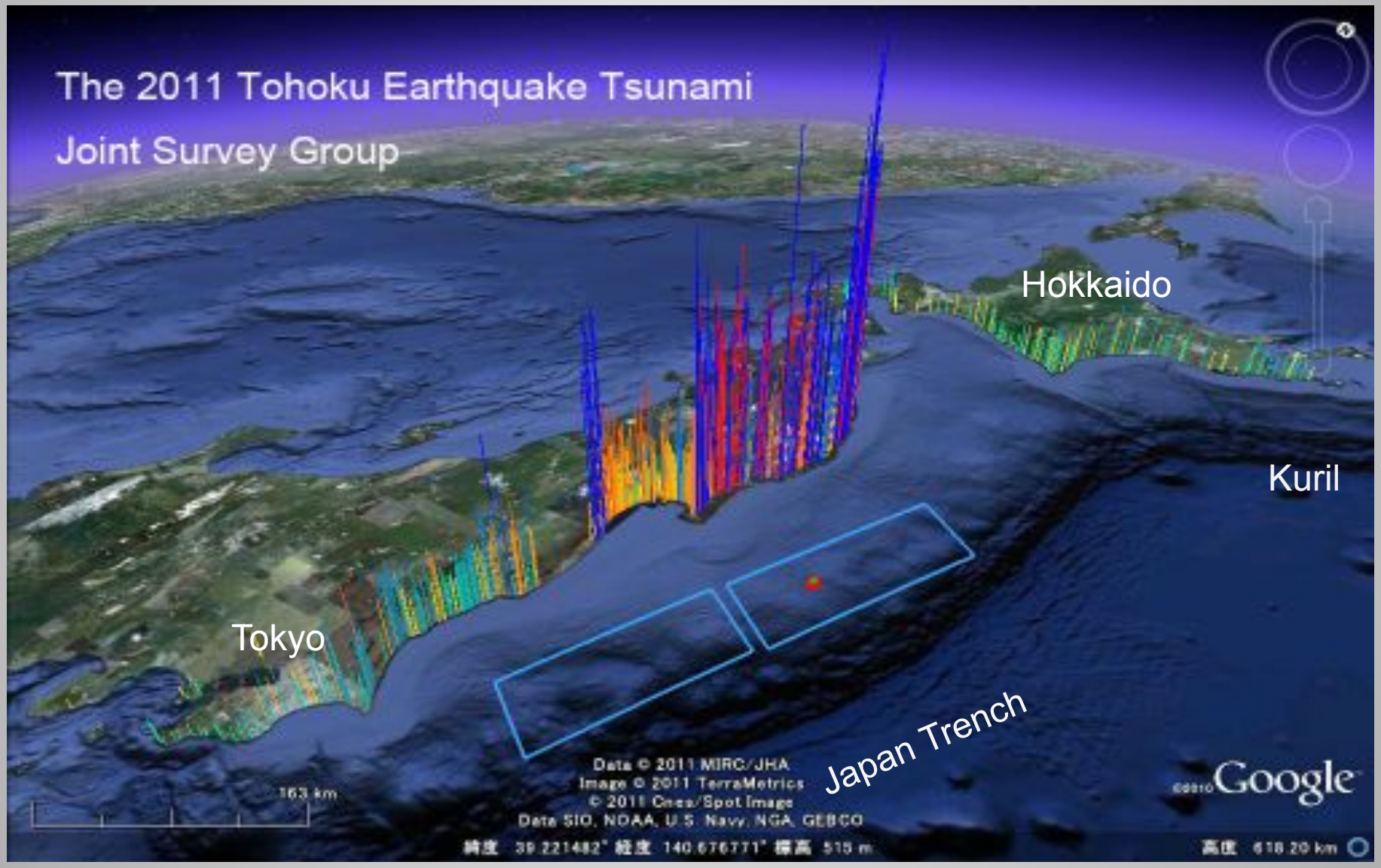
2011Tohoku Earthquake Tsunami inundation and run-up



Topics

Referring to 2011 Tohoku Tsunami,

1. Identification of gigantic Tsunami
   since last 3000~4000 years from Tohoku to Hokkaido Pacific coast, stressing the geomorphological examination
2. Idea on Tsunami Source Areas and Recurrence Interval or “Super Cycles”

on the basis of Tsunami sediments by my own survey

Conclusive illustration

Tsunami Sediments

Tsunami Sources
(possible 4 Sources
for Gigantic Tsunami)

Recurrences
= Super Cycles

(Kyodonews)

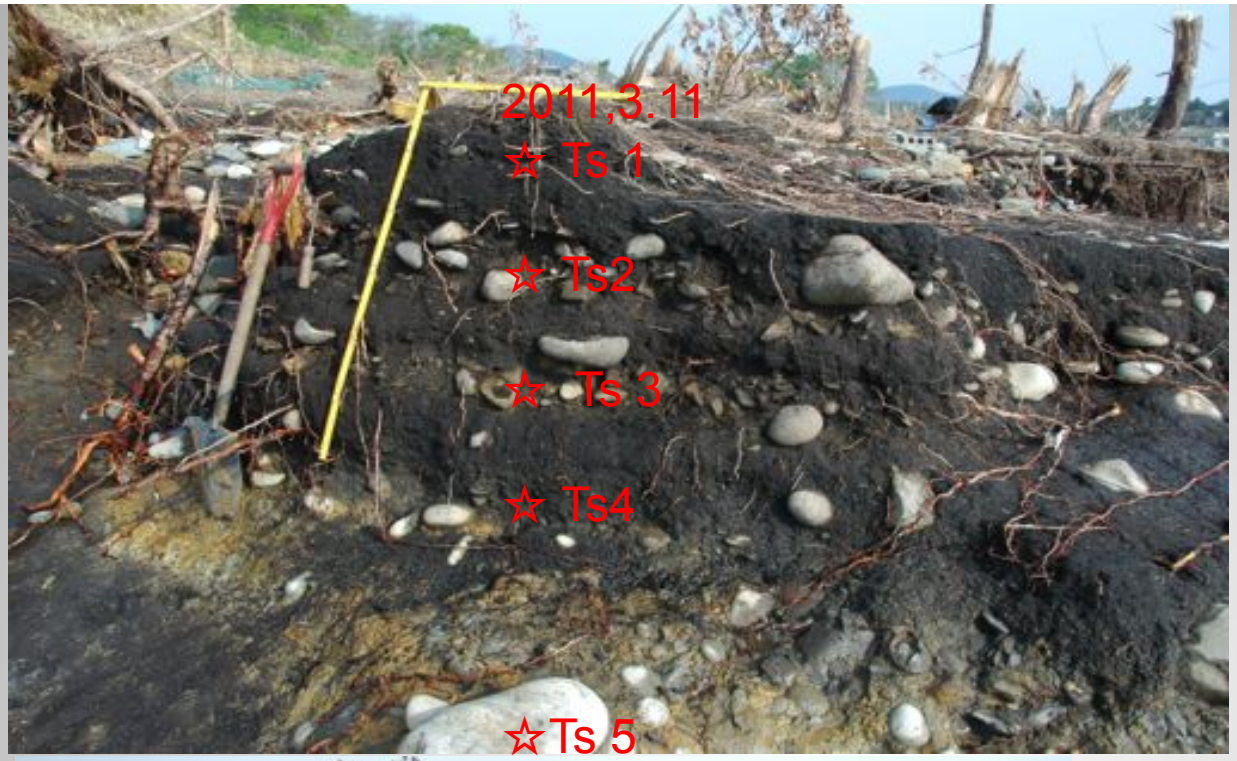
Principle of field survey:

As Tsunami reaches higher position, it's sediments should be remained on the higher geomorphology facing to coast.

Using geomorphology, gigantic tsunami sediments layers could be identified.

Tsunami sediments on the lowestTerrace, intervened in th Soil and tephral

Coastal terrace and steep sea cliff in Hokkaido

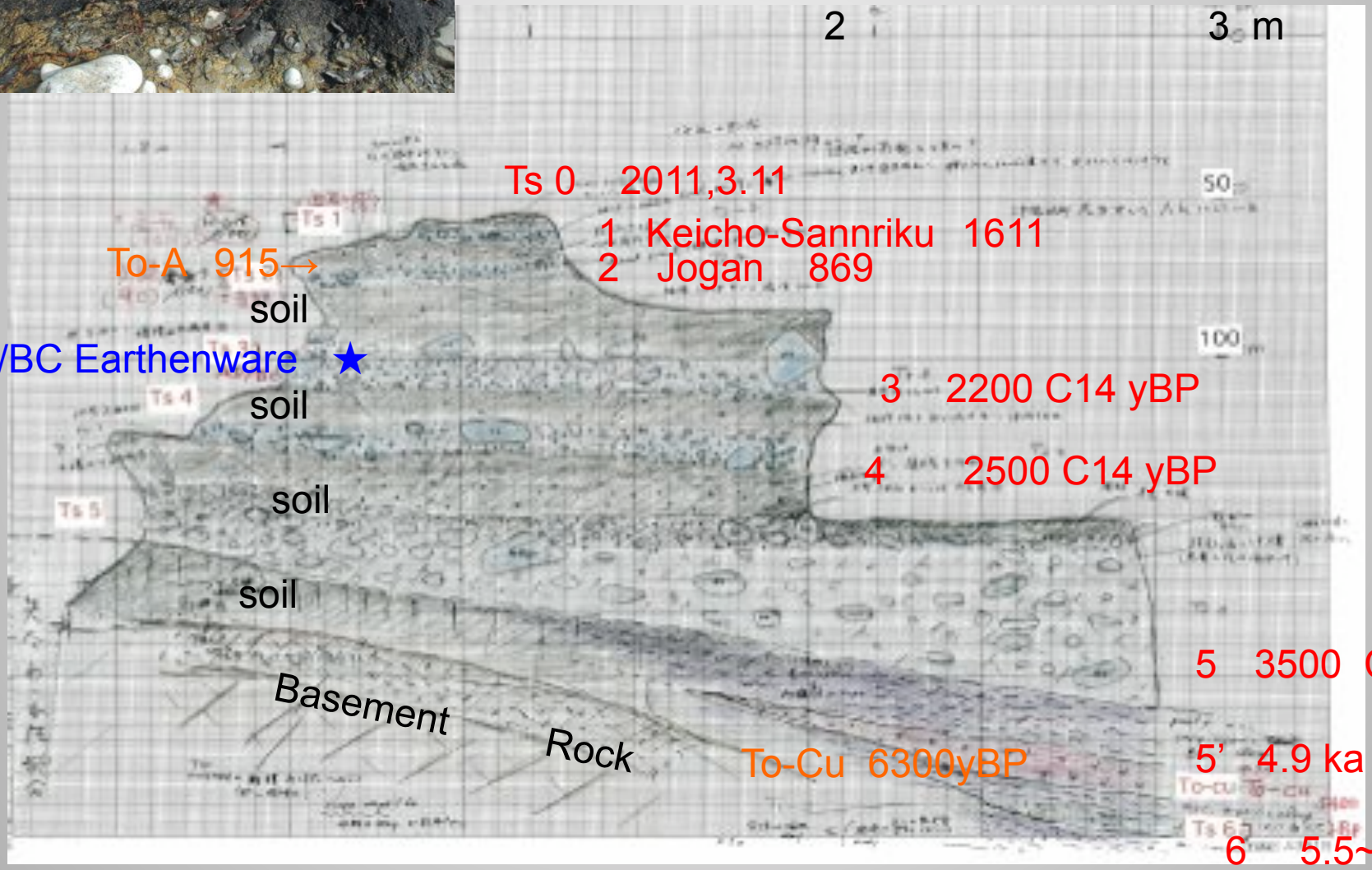


Outcropping Tsunami sediments layer at Kesen-numa (A) Tohoku

2011,5.20

2011,4.23

Field description at Kesen-numa (Site A)



Chronology and Recurrence at Kesen-numa

Key	Tsunami Sediments	Recurrence
	2011,3.11	
	Ts1 (Keicho 1611)	2011/ Ts1: 400 ys
To-a tephra → (AD915)	Ts2 (Jogan869)	2011/Ts2: >1100 Ts3/Ts2 : >1000
Archaeological remain →	TS3 2200 yBP	
	Ts4 2400~2500 ?	Ts4/Ts3: 3~400? Ts4 : Keicho Type？
	Ts5 3500 yBP	Ts5/Ts3: 1500
	Ts5’ 4900 yBP	Ts5/5’: 1400
To-Cu tephra→ (6400 yBP)	Ts6 >6500	Ts6/Ts5’: >1500

only gigantic Tsunami = Super Cycle

2011 Tsunami: since 1100 years –Jogan,869-

different Tsunami sources : 2011.3.11, 869 Jogan

1611Keicho-sanriku

2011

Soil

1896 Meiji

Ts1 1611Keicho

C-14

Soil

C

Ts2 869 Jogan

C

Soil

Debris flow dep.

C

Soil

C

Ts3 3~4C?

Ts? AD/BC?

Soil

C

Ts5 2.4ka

C

soil

Ts6 2.8~3.0 ka

Ts7: 3.5ka ,

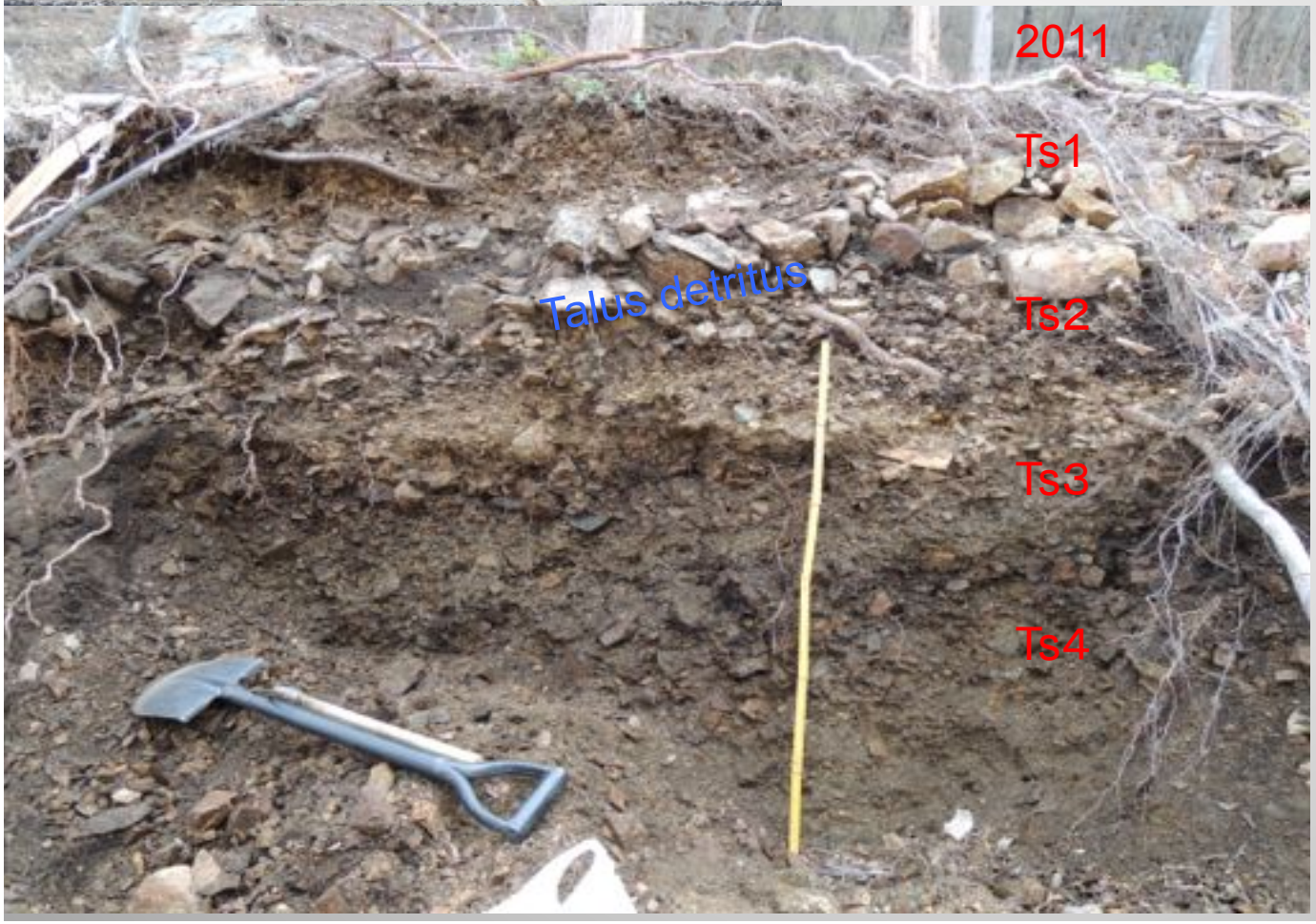
Ts8 ?

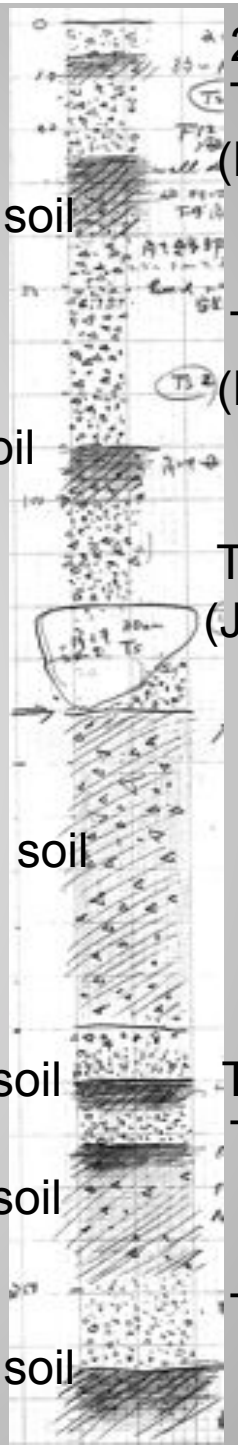
110 km North

MIYAKO/Taro

Tsunami Sediments layers In the talus slope deposits, divided by soil

MIYAKO/Taro

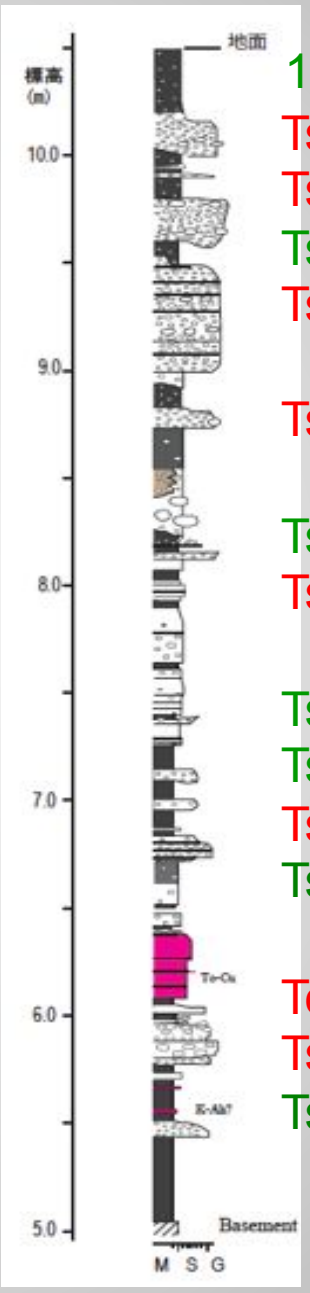




Field description at Noda, Iwate (D) 145km

Sea Cliff, 9msl
Outcropping Tsunami sed. and soil layers

Recurrence: 500+- years



1896Meiji
Ts 1 1611 Keicho
Ts2 869 Jogan
Ts3 3/4 C.
Ts4 AD/BC

Ts5 2.5ka

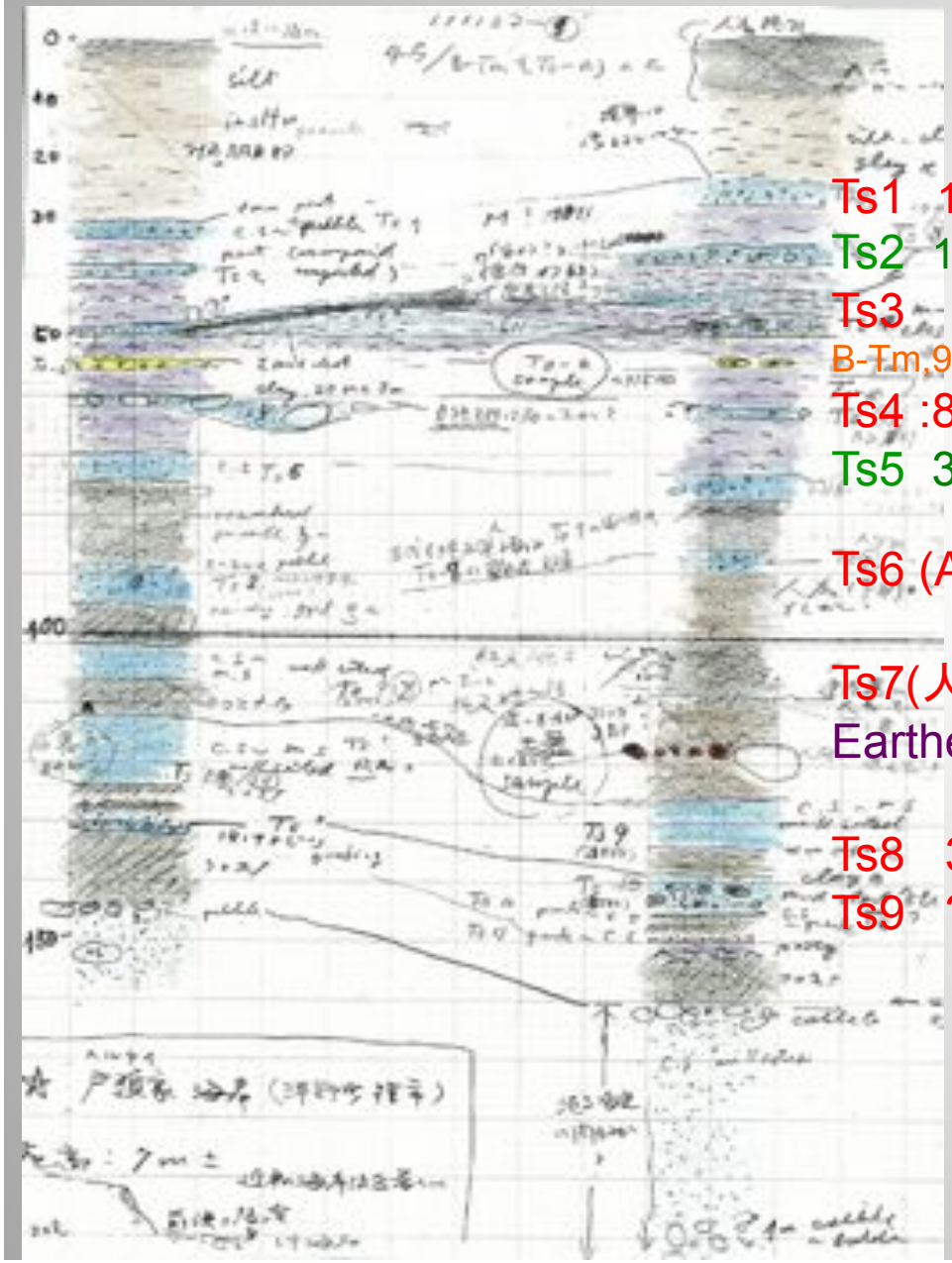
Ts6 3.0ka
Ts7 3.5ka

Ts8 4.0ka
Ts9 4.5ka
Ts10 4.9 ka?
Ts11 5.9

To-Cu 6300 yBP
Ts12 6.4ka
Ts13

Field Note at Hirono, Iwate/Aomori (E) (185km north)

Outcropping Tsunami sediments layer on a sea cliff



Ts1 1611Keicho
Ts2 12/13C
Ts3 ?
B-Tm,947AD
Ts4 :869 Jogan
Ts5 3/4C?

Ts6 (AD/BC ?)

Ts7(人為攪乱）? 2.5 ka ?
Earthen ware: 3000 yBP

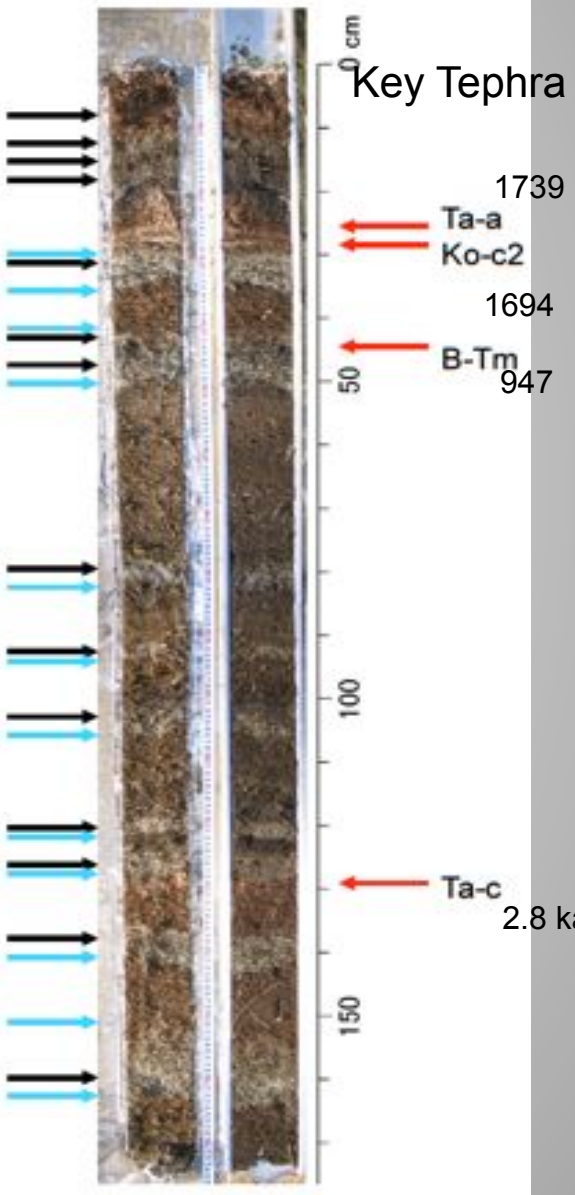
Ts8 3.0ka? 3.2ka? 3.5 ka?
Ts9 ?

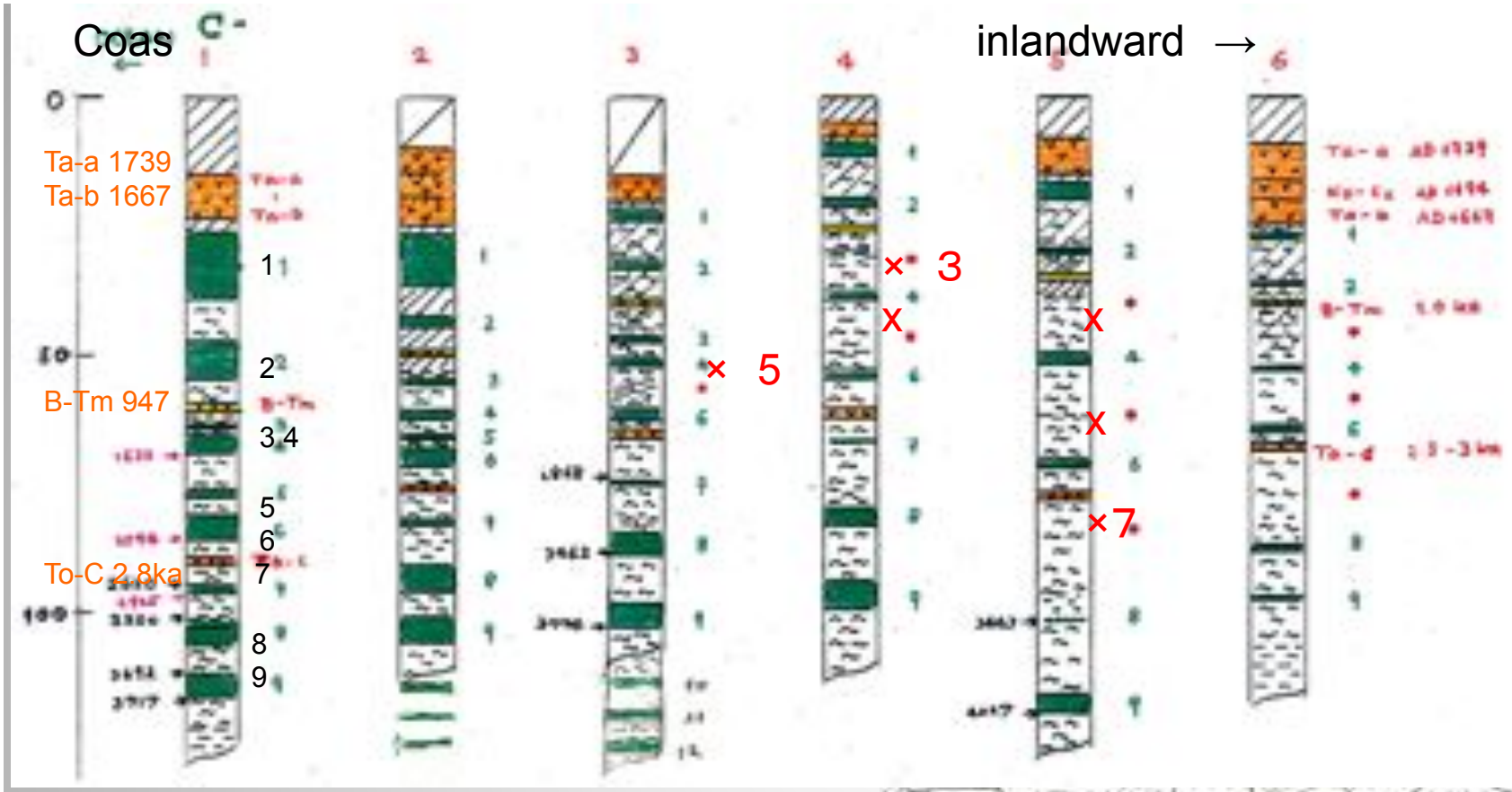
Interval::
>300 ~500 years variable

Outcropping Tsunami sediments layer at Nemuro, eastern tip of Hokkaido 600km NE

18 Tsunami sediments layers during 6400 years

Geo-slicing record





Tsunami Sediments layer sice last 4000 years in the Peat land, Tokachi (J) Hokkaido.

Ta-b tephra

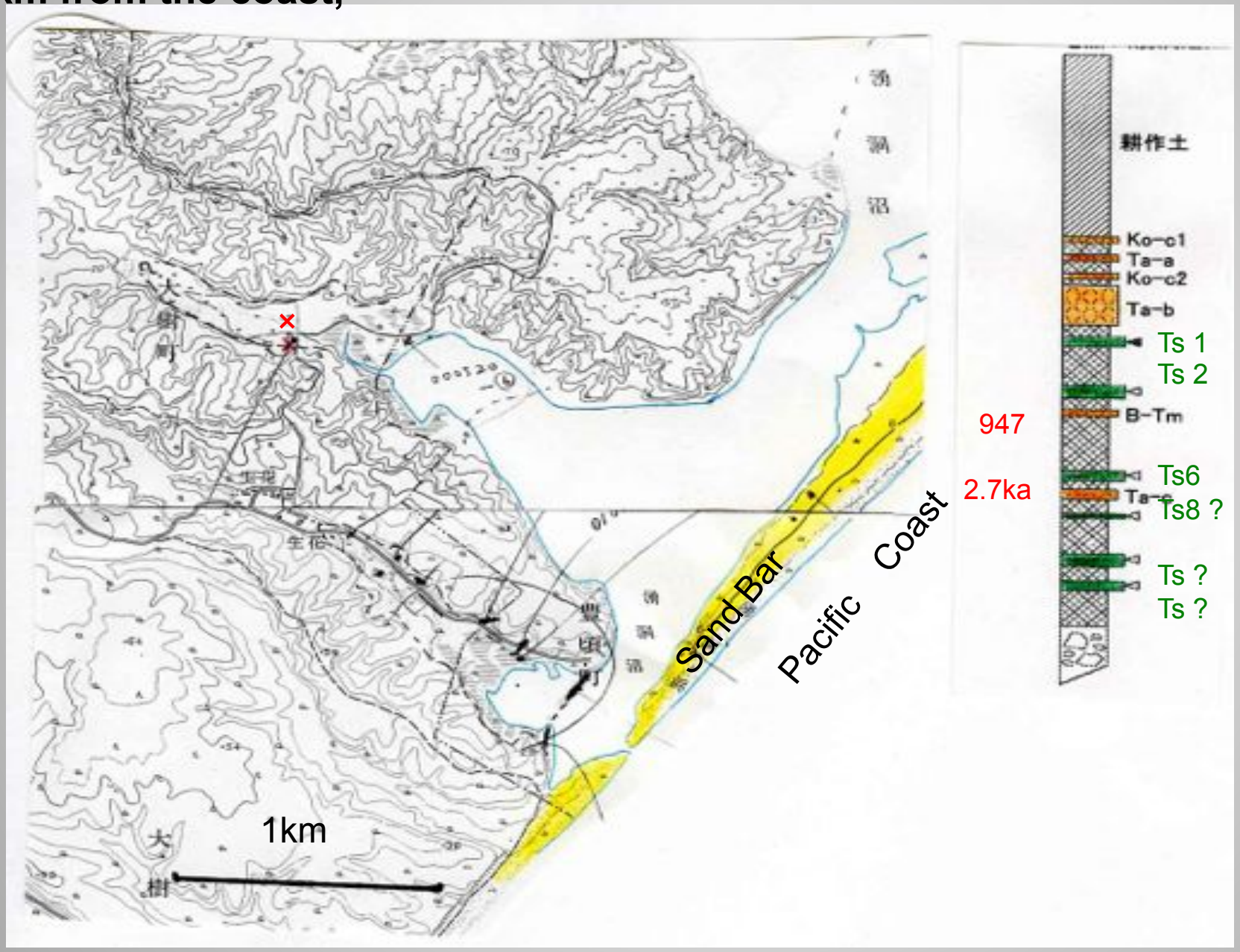
1: 17C.Ts =1611Keicho？

B-Tm tephra

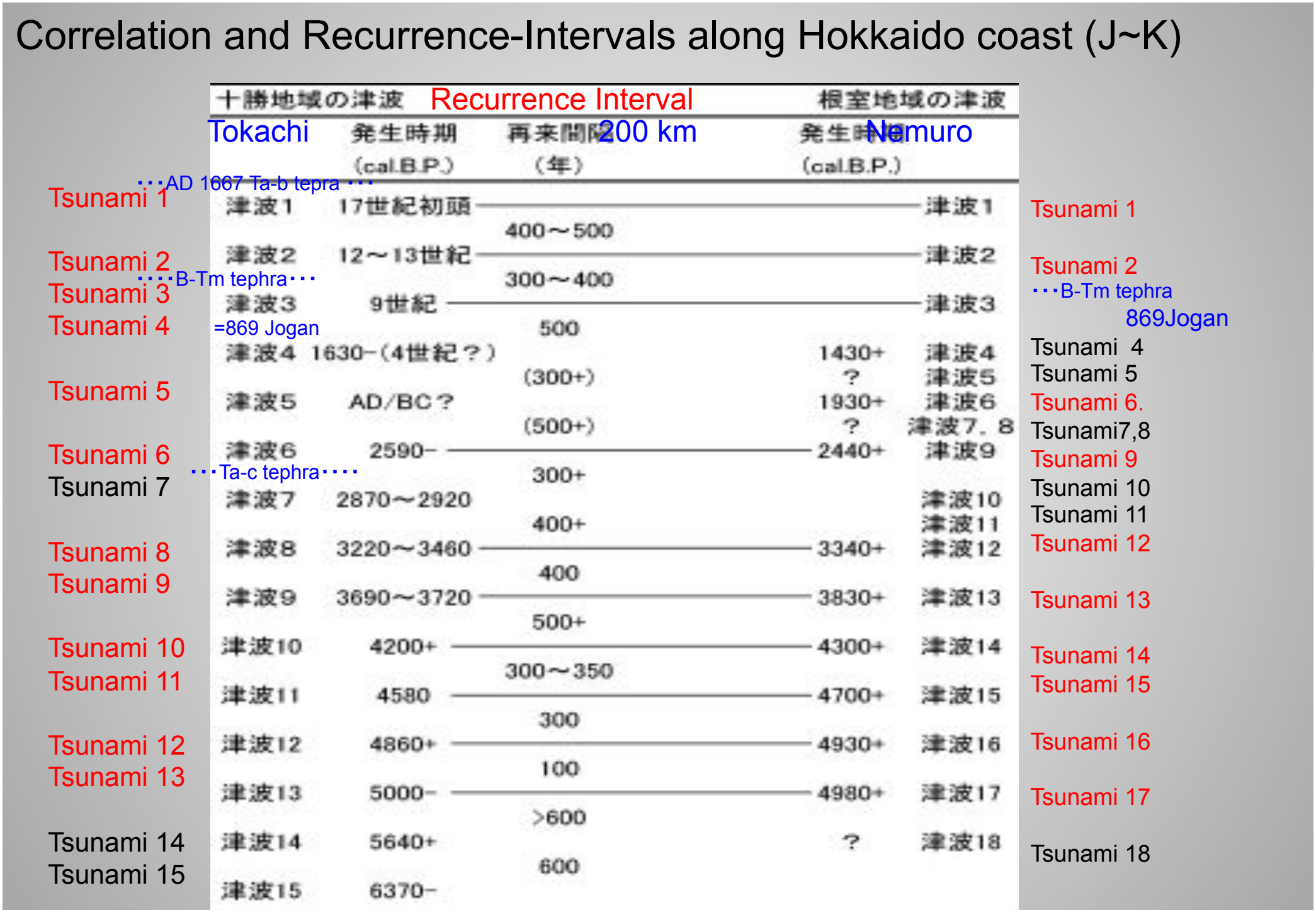
3: 869 Jogan

Tsunami Sediments layers on alluvial cone in the small valley of the hill (J)

2km from the coast,



Correlation and Recurrence-Intervals along Hokkaido coast (J~K)



Hokkaido Pacific coast : unusual gigantic TSUNAMI since last ca. 6500 years

- Identification of Tsunami sediments on the coastal terrace

  6 Tsunami sediments layers since last 2.5 ~3.0 ka.,

- Another older 9 Tsunami sediments layers :

  2.9, 3.3, 3.7~3.8, ,4.2 , 4.6 , 4.9, 5.0, 5.6 and 6.3 ka calBP.

- Recurrence interval

  400~600 years : “500 years Interval Earthquake”

Evaluation of Tsunami sediments far into the Inland Bay (H)

1640 Volacno Collapse Ts

↓

17C Ts

↑12/13C (C14:1000~1148 AD)

Ts AD /BC ? (c-14: 76 AD~)

Ts BC 3~4C C-14

Ts 3200 ? Ta-c

Ts 3500 ?

Tsunami Sediments far in the Inland Bay

- 1640 Volcano collapse Tsunami
- Ts1 17C Ts (1611 Keicho ?)
- Ts2 12/13C

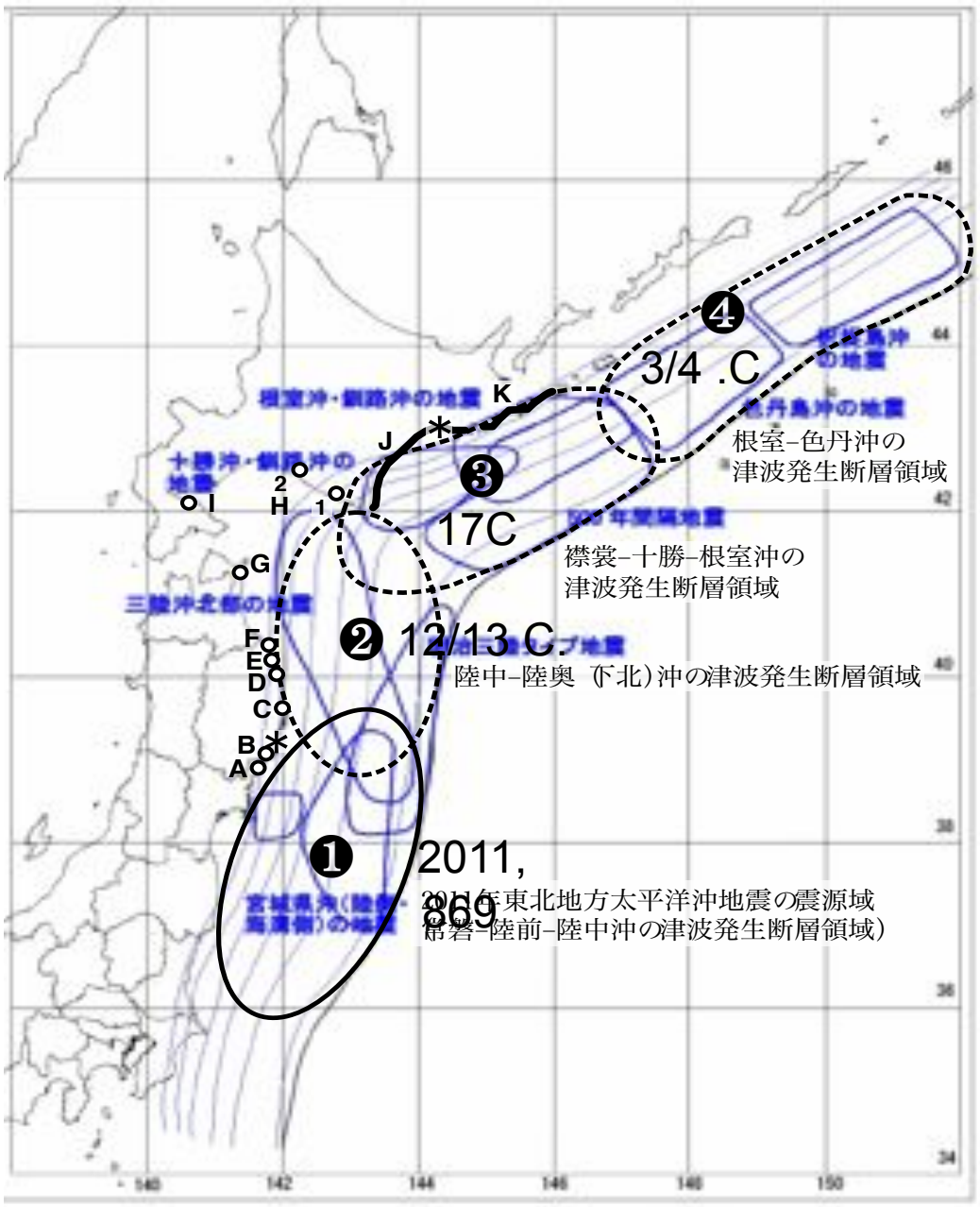
  xxx 869 Jogan (Ts 3 in NE Hokkaido)

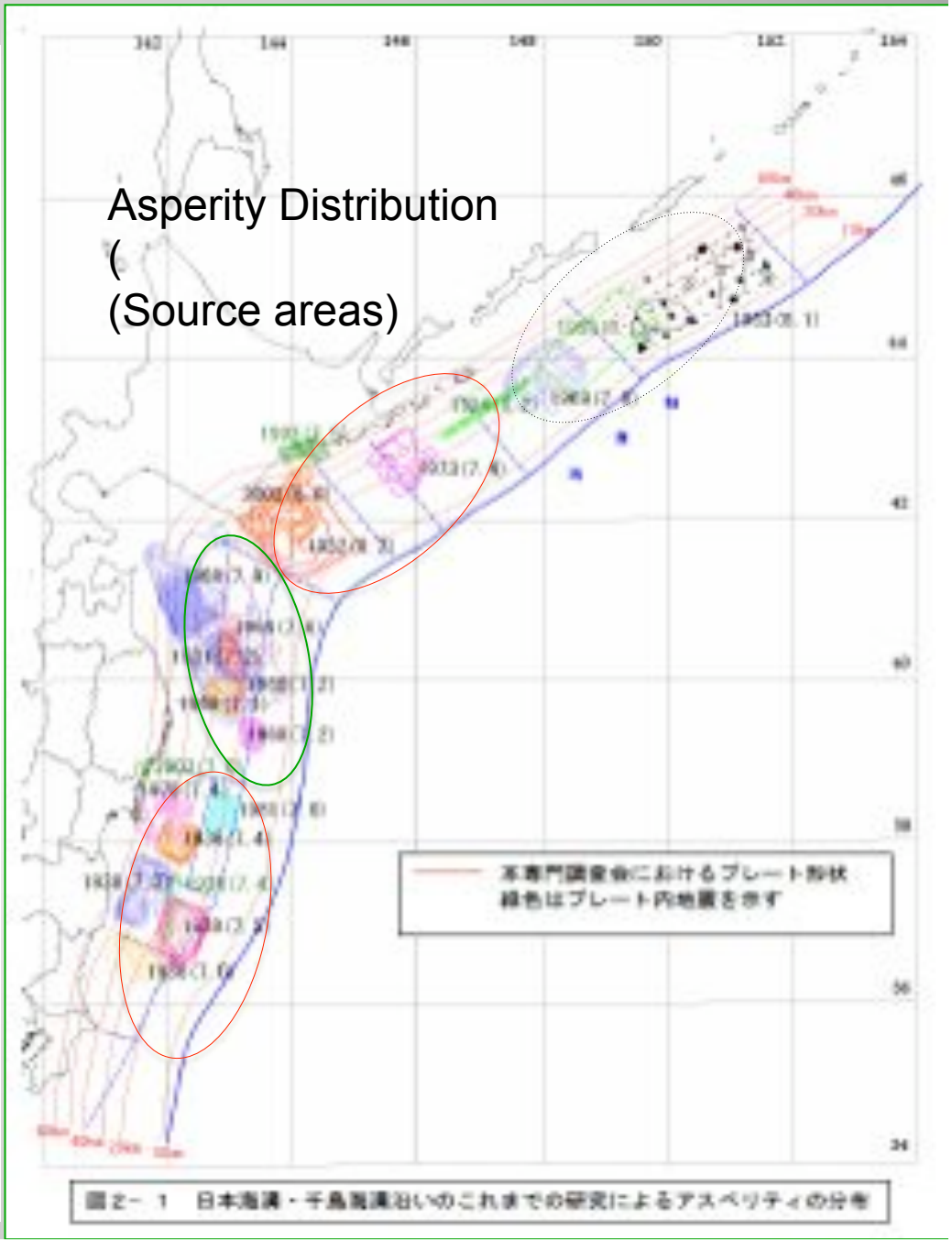
  xxx 3/4C. (Ts4)
- Ts5 AD /BC ? (Ts 5)
- Ts6 BC 3～4C.

  xxx 2700 Ts (Ts7)

  Ts 8 3200 (Largest in the bay)
- Ts9 3500 ?

4 gigantic tsunami sources along the Japan and Kuril Trench





Conclusive Remarks

Geomorphological view (topography, inter-tunami soil or geomorphological process）is the key to examine the gigantic tsunami

4 Tunami Source Areas (propagated each other, one another)

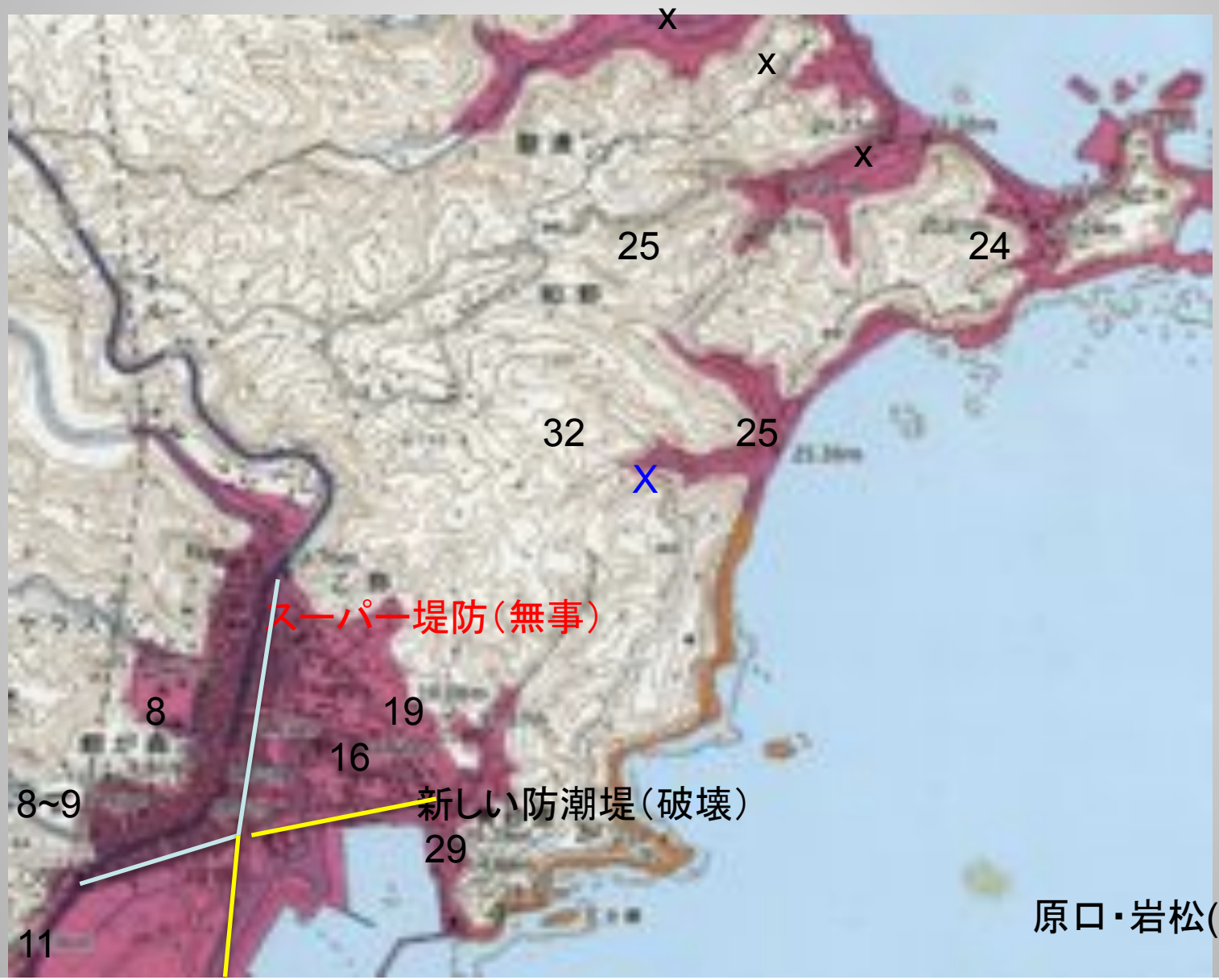
Ca 1000 years Recurrence Intervals （SuperCycles) indivisually

(Kyodo)

Thank you

arigatou gozaimashita

宮古市田老町周辺の地形，スーパー堤防と津波挙動



原口・岩松(2011)に加筆

気仙沼露頭の地形的位置:超巨大津波のみ記録する理想的な地形，土壌形成環境

平成13年現地調査　1:2.5万

大正2年測図　1:5万

三陸～道南

常磐・陸前・陸中

常磐・陸前・陸中

？

常磐・陸前・陸中

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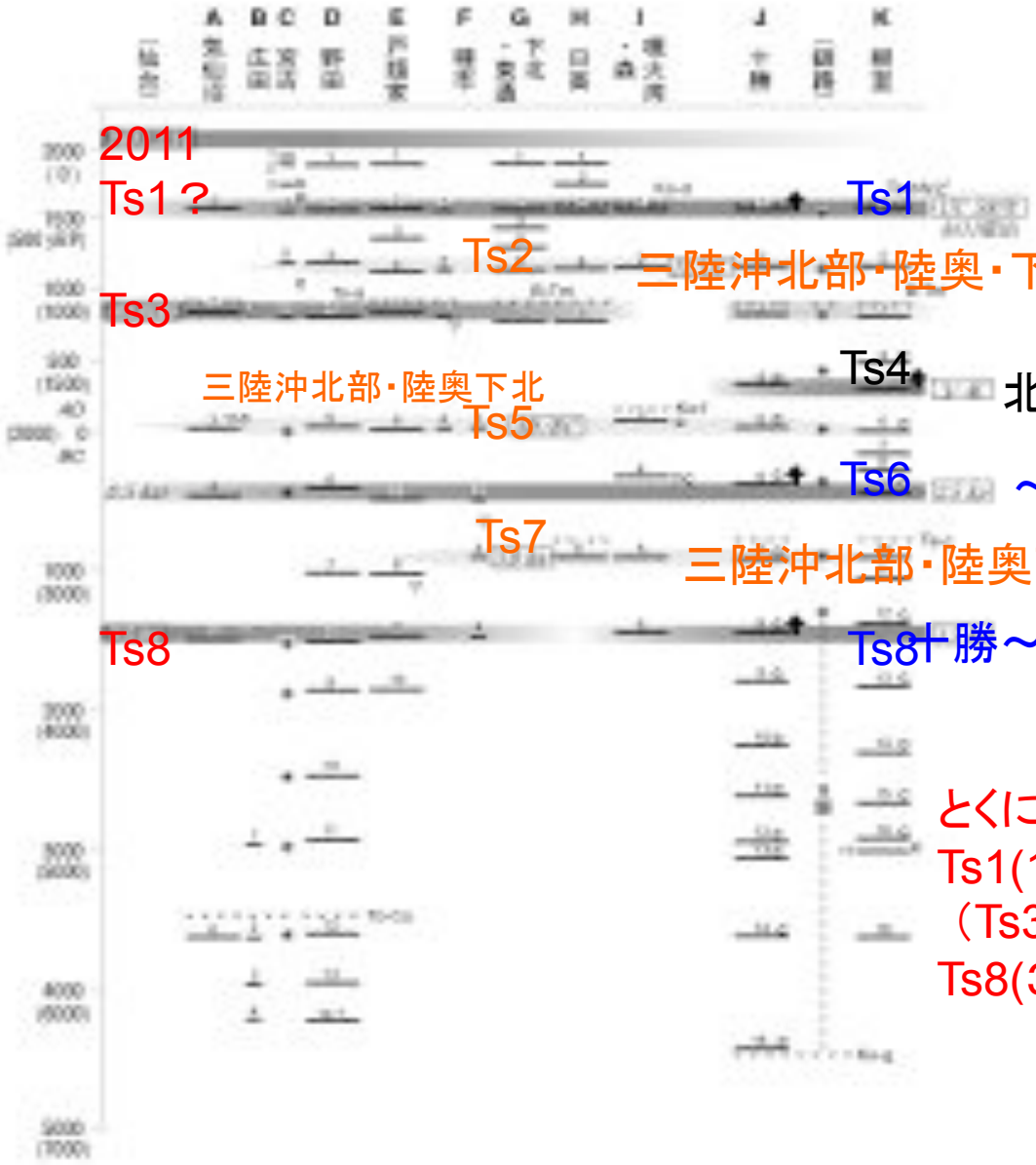


とくに超巨大津波：
Ts1(17世紀初頭）
（Ts3（869 貞観）
Ts8(3200＋前ころ）

宮古田老，真崎

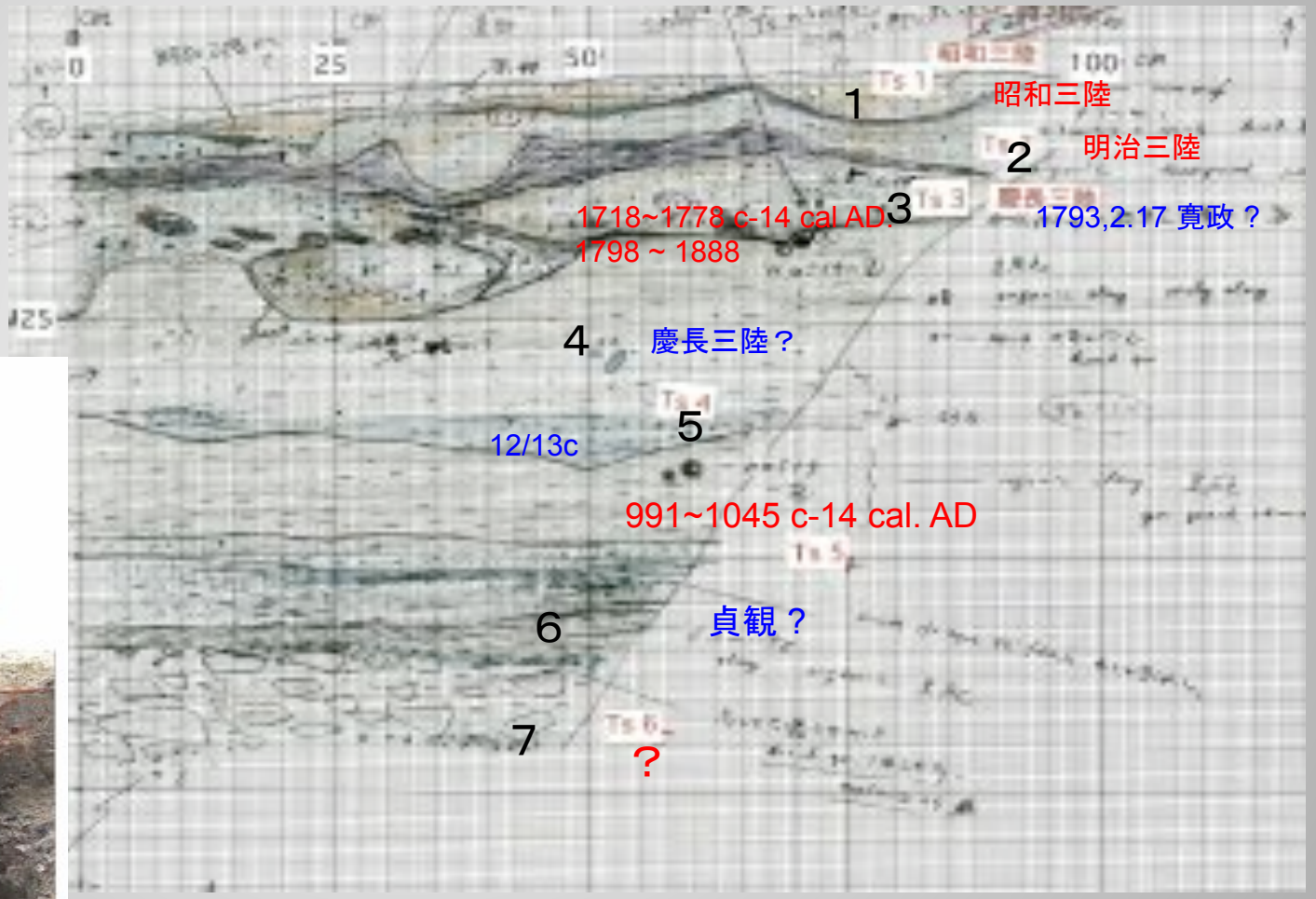
急勾配渓流性V字小谷
17 msl　地点

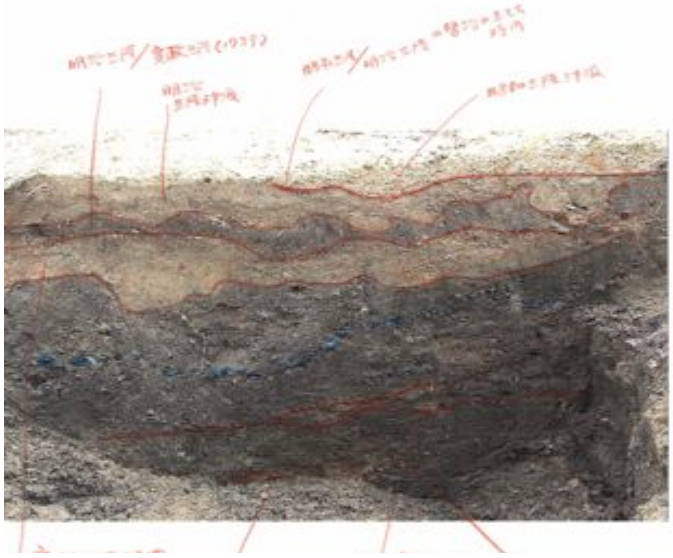
3.11 津波遡上高：>32m

3.11 破損木

田老真崎海岸，急勾配小谷底の古津波堆積物

（埋もれていた明治三陸後生育/昭和三陸津波破損樹幹・根
3.11津波で再露出）





宮古田老の古津波堆積物

異常津波遡上を記録する急勾配V字小谷底の古津波履歴

TS 0: 2011, 3.11 津波

TS1: 1933, 昭和三陸津波

TS2: 1896, 明治三陸津波

TS3: 1793, 寛政三陸津波 （初の認識）

Ts4 : 1611, 慶長三陸津波

Ts5:▪▪12/13C頃？: 下北, 噴火湾、十勝にある

Ts6: 869, 貞観津波 あるらしい

TS7: AD/BC？もっと新しい？

以下にまだ続く

津波挙動（遡上, 浸水高）への局地的な地形の効果

Regional~ Local scale（リアス湾）から

Site-Specific（小規模河谷）への観点

Tsunami sedimenys layers on the Sea cliff 15 m sl.

Ts1, 2 ,4 or6?: