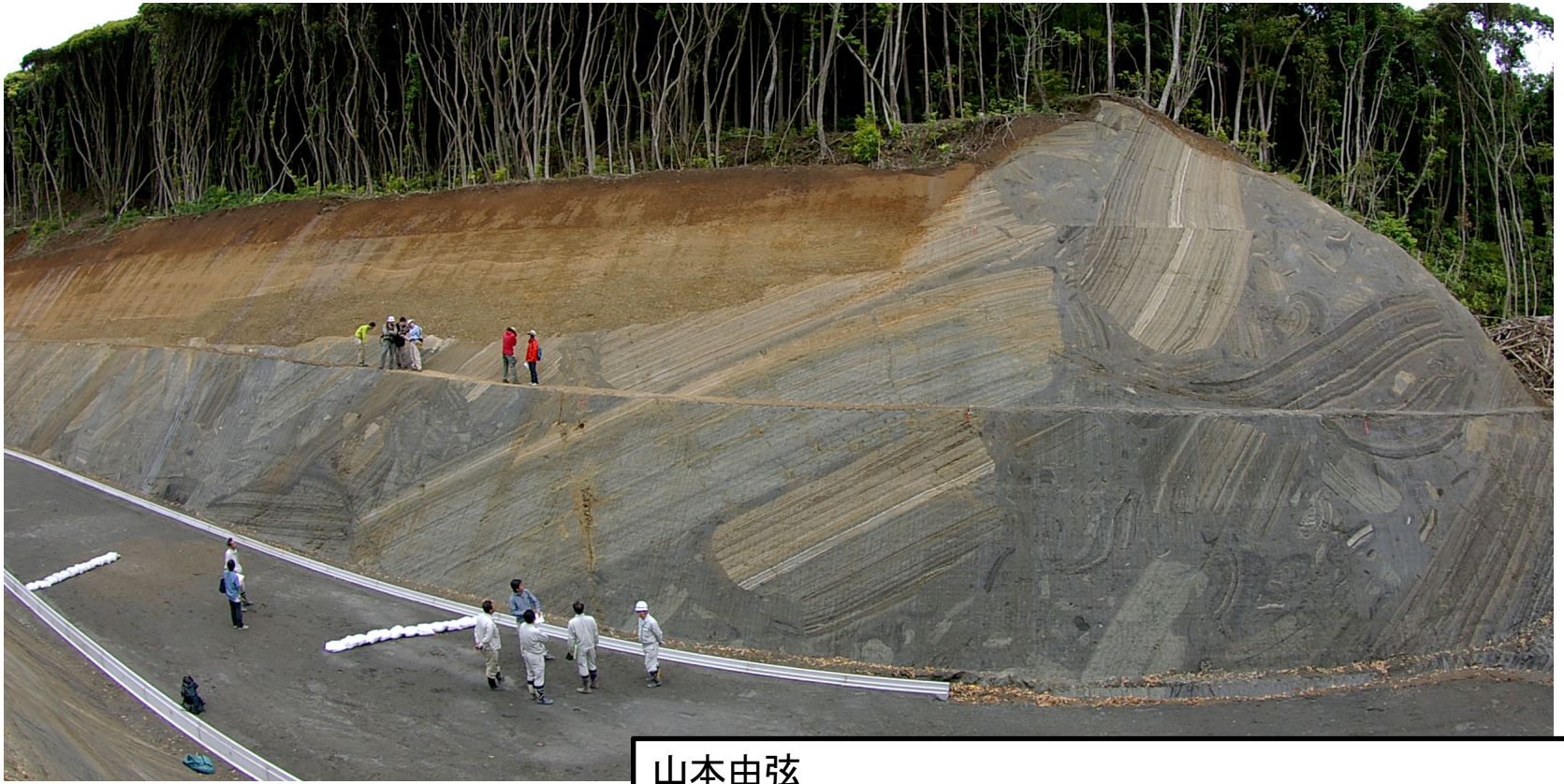
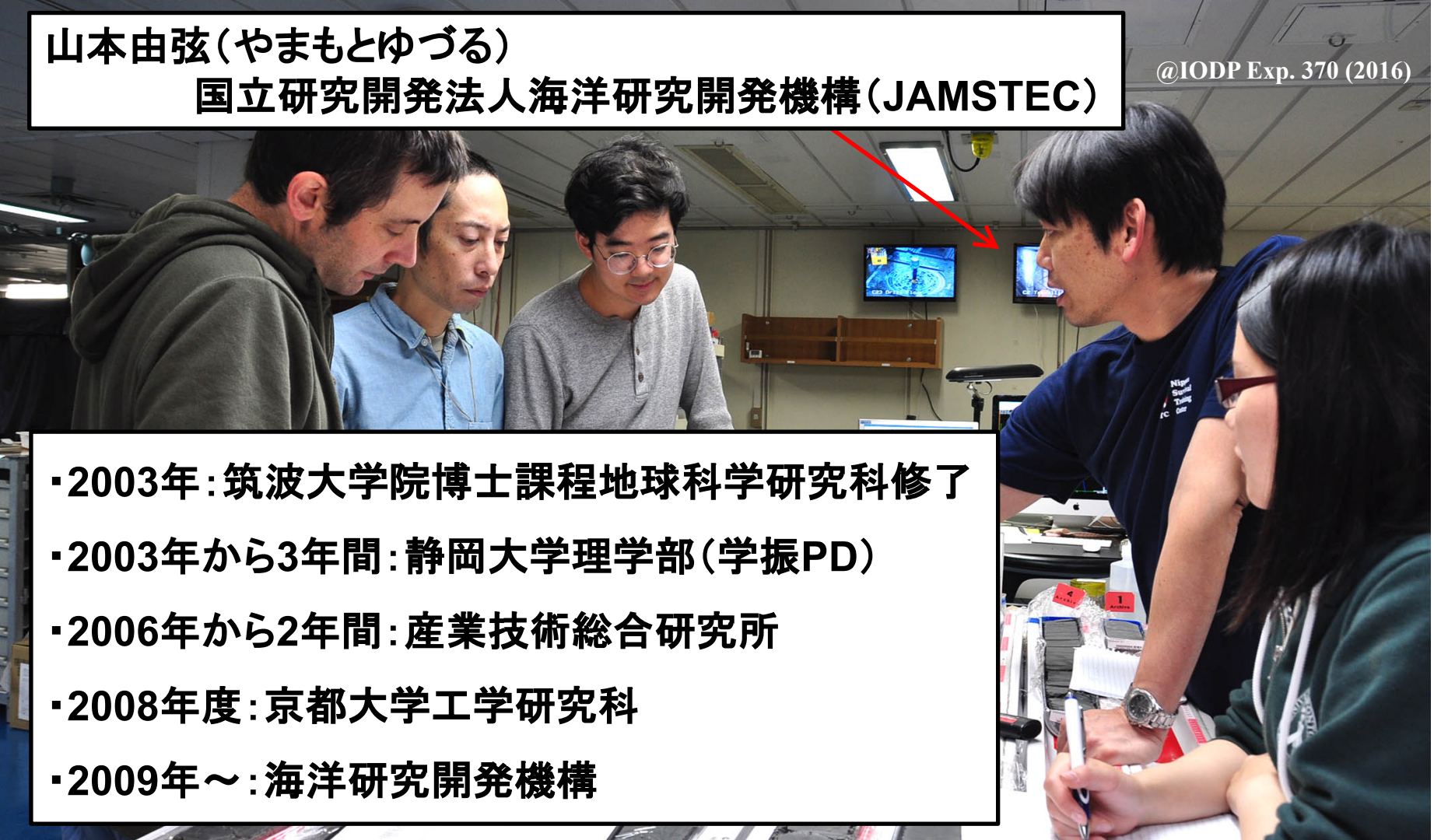
液状化による海底地すべりの内部構造と間欠すべりの特徴



山本由弦
国立研究開発法人海洋研究開発機構（JAMSTEC）

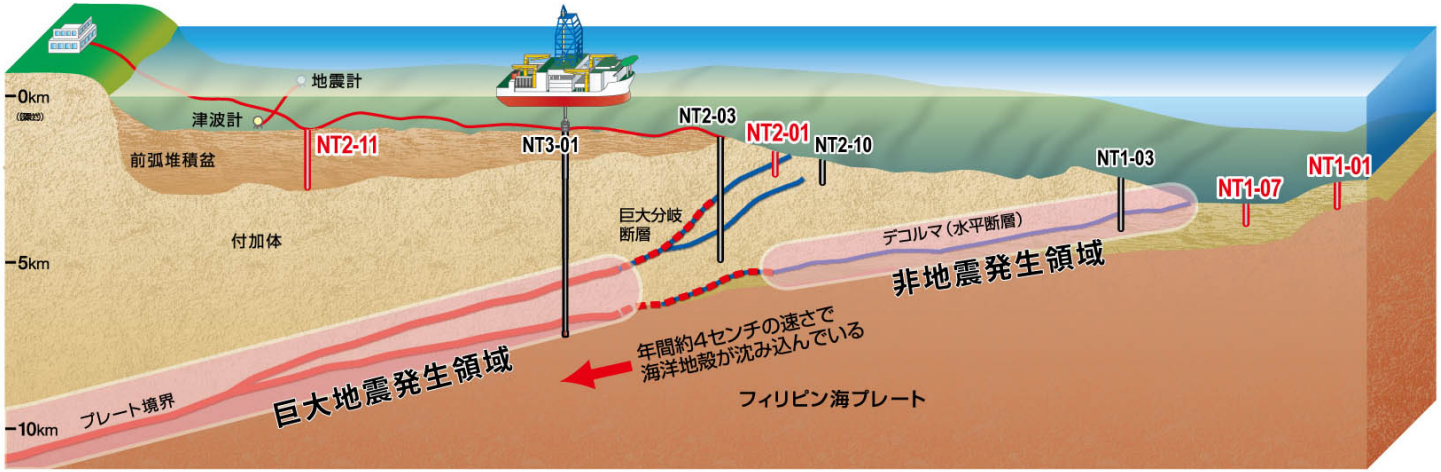
山本由弦（やまもとゆづる）
国立研究開発法人海洋研究開発機構（JAMSTEC）



@IODP Exp. 370 (2016)

- 2003年：筑波大学院博士課程地球科学研究科修了
- 2003年から3年間：静岡大学理学部（学振PD）
- 2006年から2年間：産業技術総合研究所
- 2008年度：京都大学工学研究科
- 2009年～：海洋研究開発機構

主要ターゲット：沈み込み帯浅部～深部（地震発生領域）の追跡

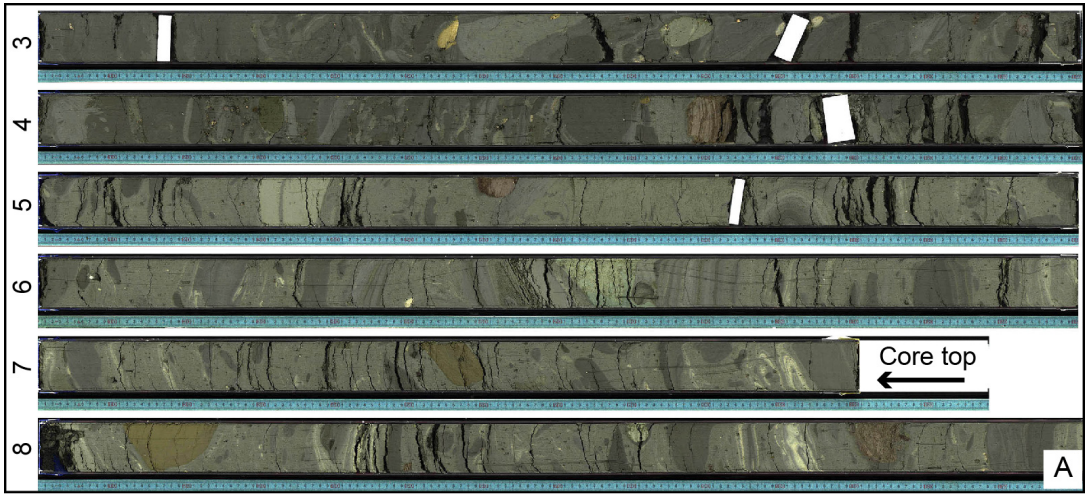


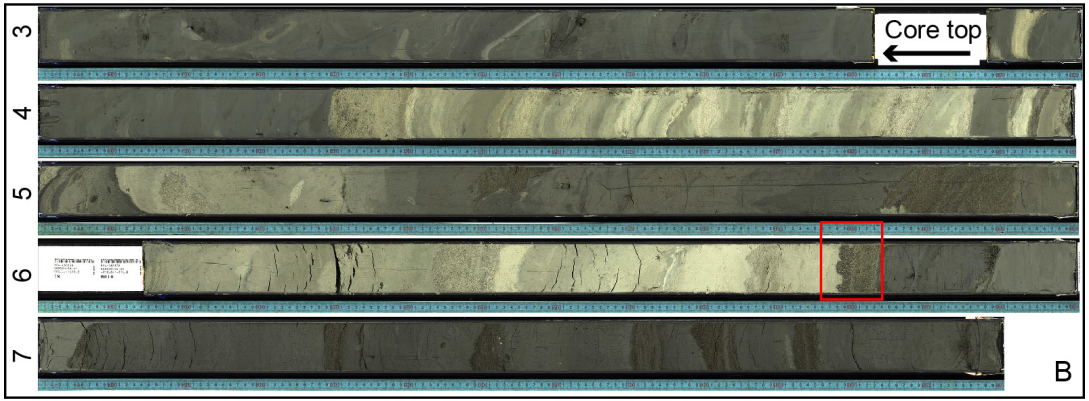
NanTroSEIZE発案当初の掘削計画　http://www.j-desc.org/about-iodp/

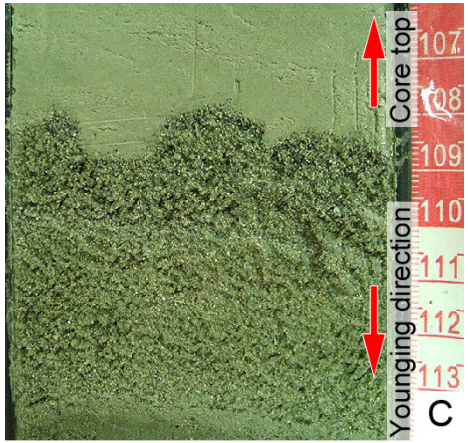
・沈み込んだ堆積物が、どのように堆積物→軟岩→地震発生物質と進化するのか？

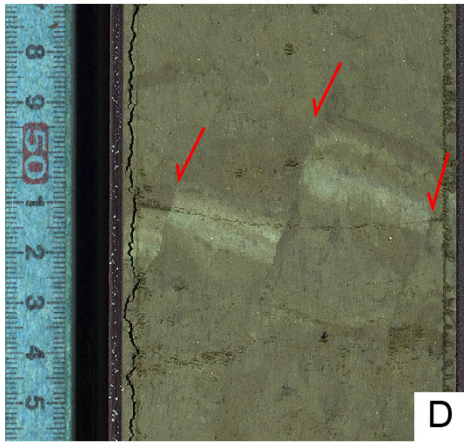
・地震破壊が深部から浅部へと伝播する：浅部物質はどのような挙動を示すのか？

沈み込み帯には無数の海底地すべりが





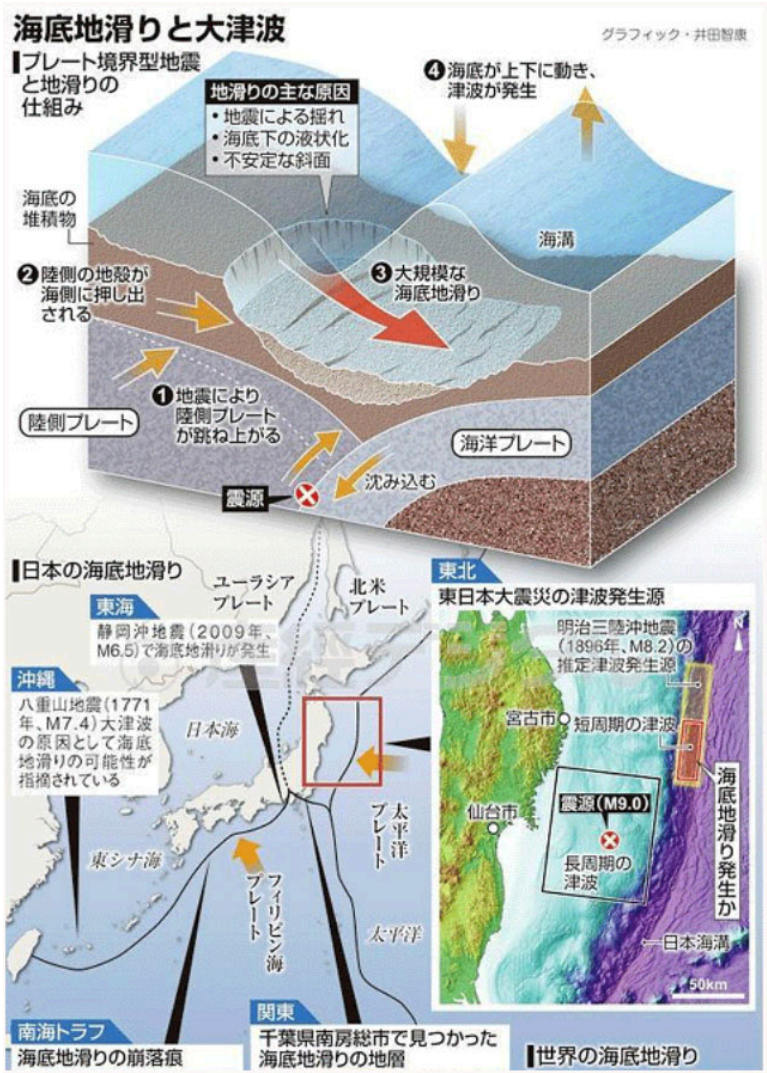




Yamamoto et al. (in press)

Impact of submarine sliding

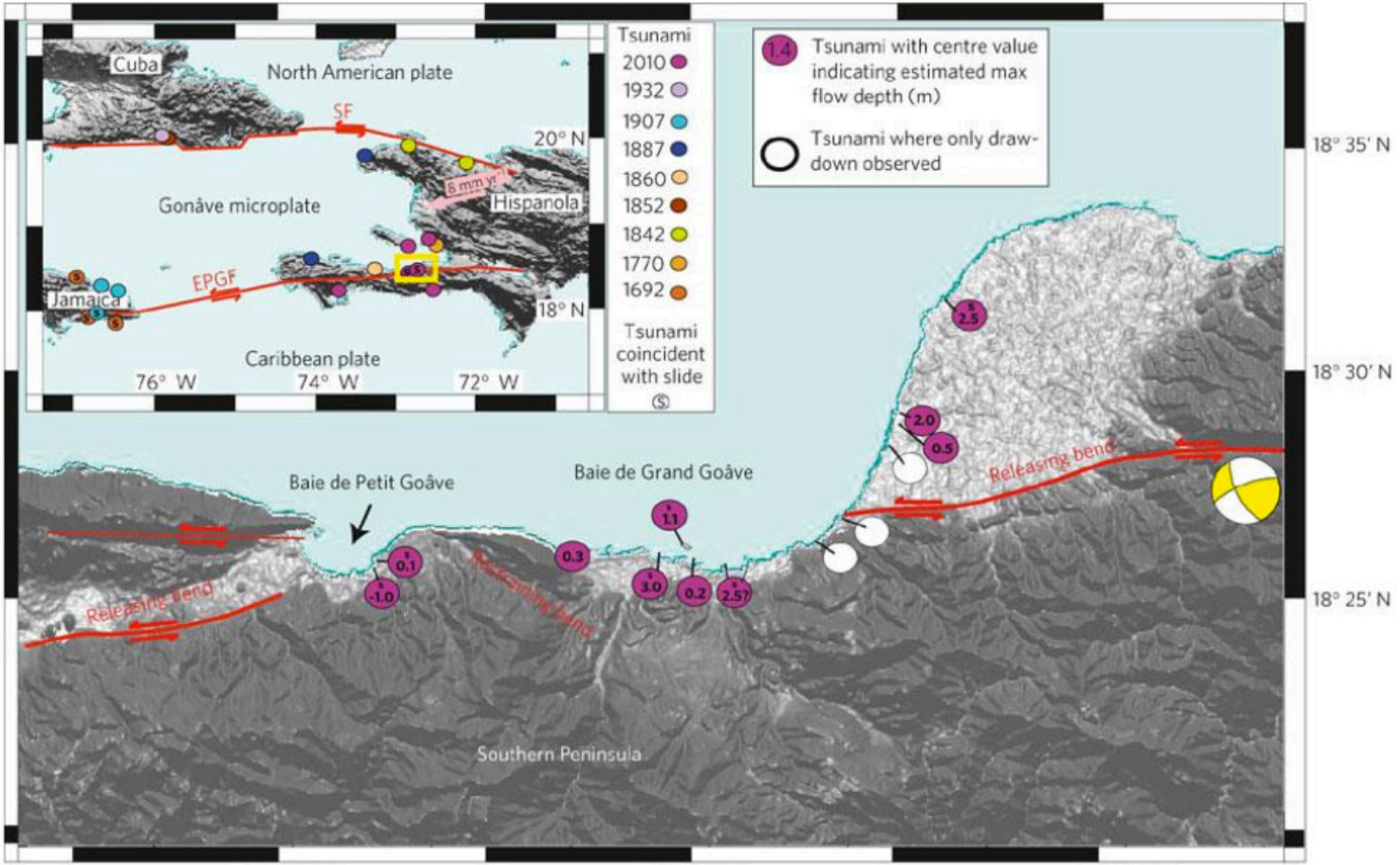
- Destruction of subaqueous infrastructures
- Covering subaqueous resources
- Tsunami



産経ニュース／2013.11.25 - 09:00

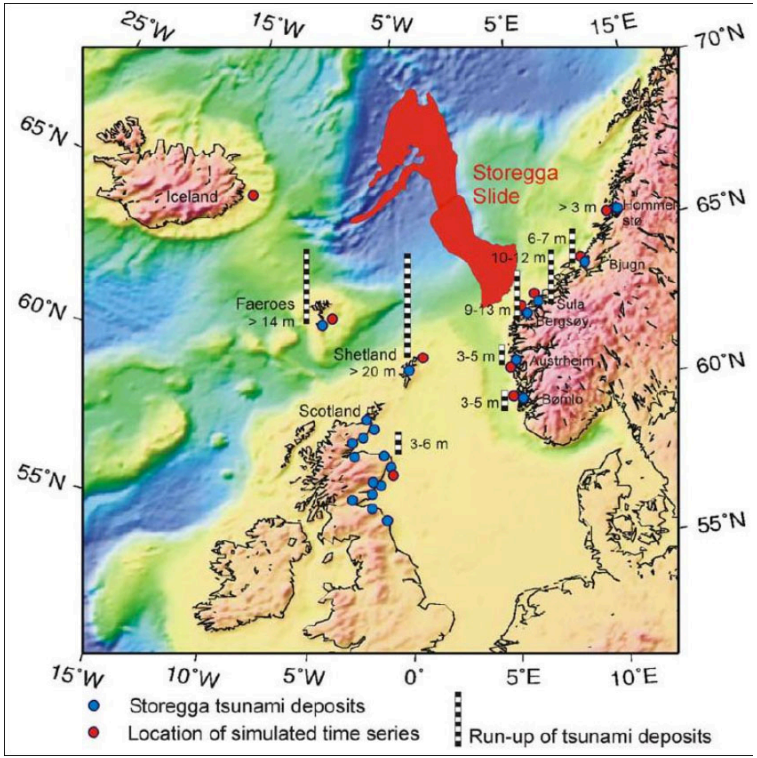
2010 Tahiti-Tsunami

2010. Jan. 12, Mw = 7.0



Hornbach et al. (2010)

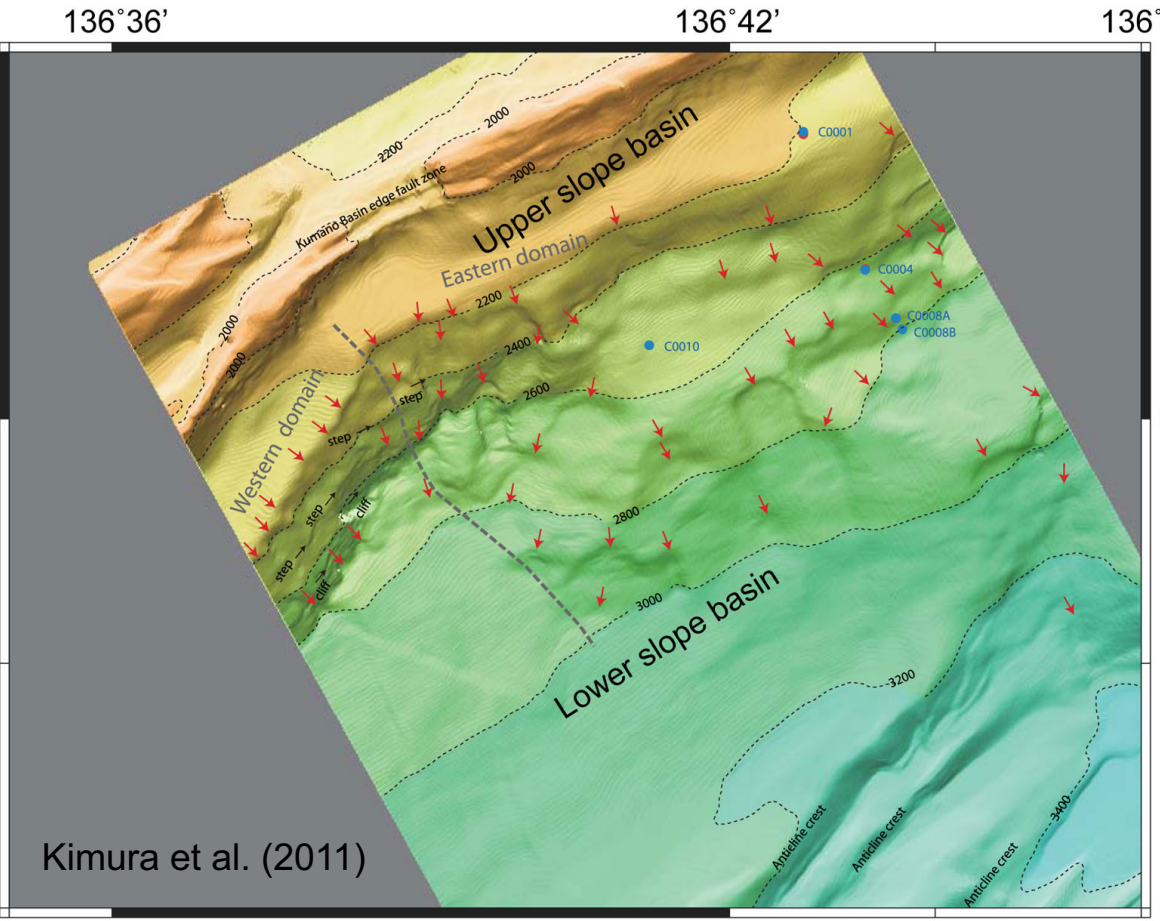
1979. Oct. 16, Nice, France
Tsunami generated by submarine landslide
related to airport construction



Bondevik et al., (2005)

~8,000 yrs. ago:
Storegga slide (3,500 km^3 in total),
western off Norway

Questions for submarine sliding



MTDs or slide scarps:
independent?
close relations?

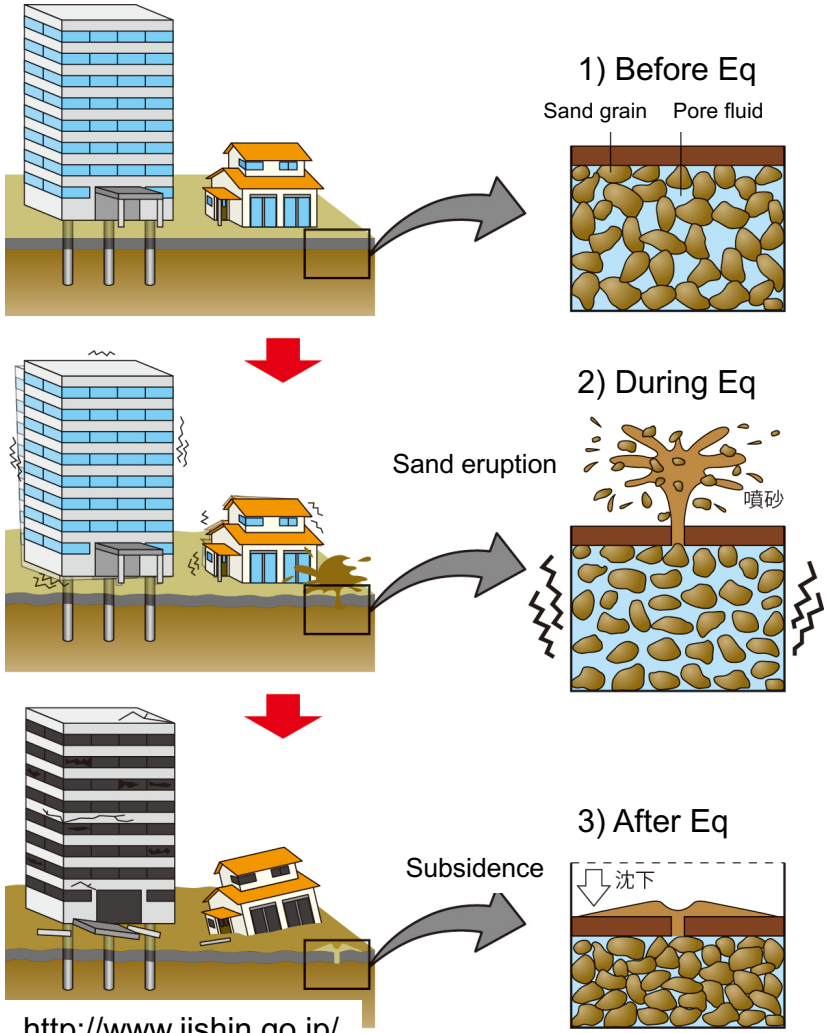
What is the frequency of submarine slides?

How are slides and earthquakes related?

Liquefaction

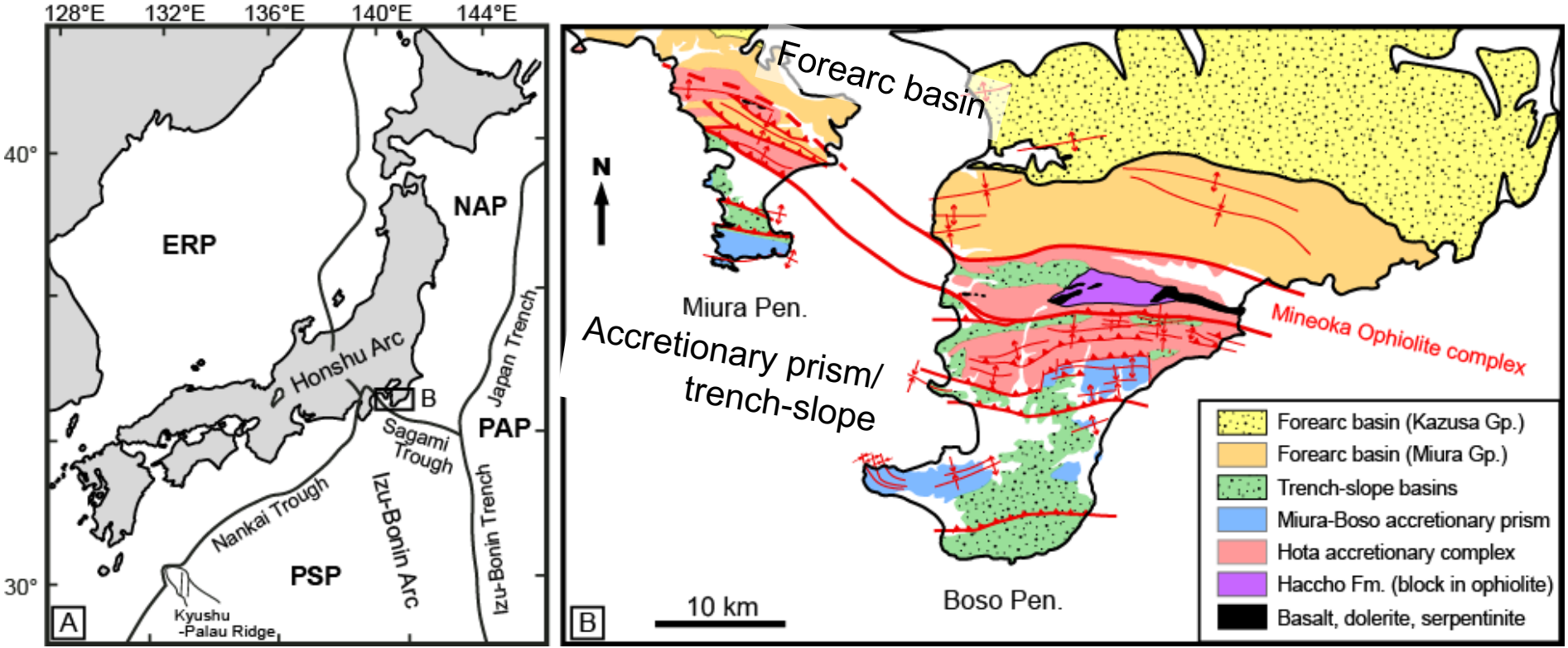
Collapse sand-grains network
Excess fluid pressure
Loss of shear strength

2011 Tohoku Eq: Urayasu (Tokyo-Bayside)

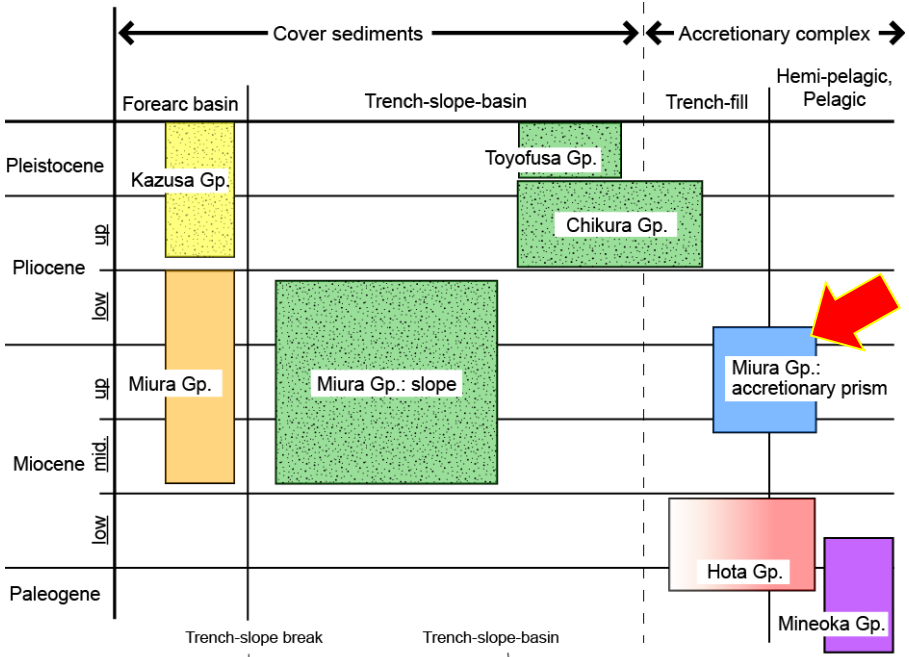


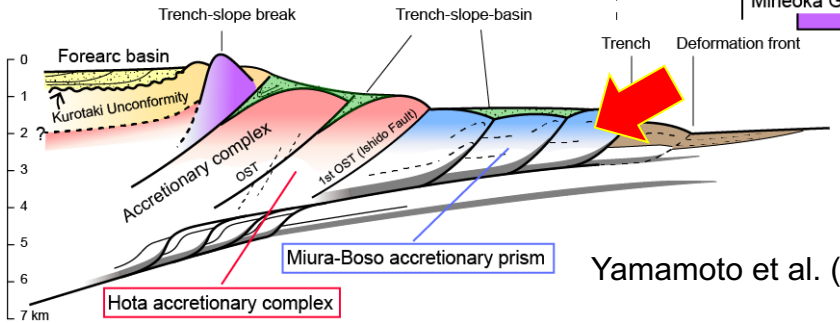
http://www.jishin.go.jp/

Setting

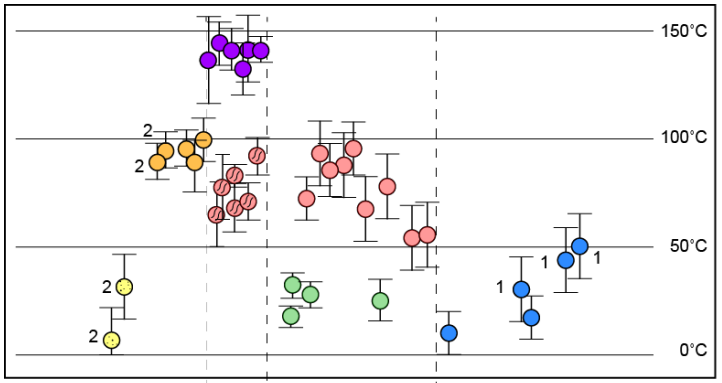

128°E
132°E
136°E
140°E
144°E
40°
30°
ERP
NAP
PAP
PSP
Honshu Arc
Japan Trench
Sagami Trough
Nankai Trough
Izu-Bonin Arc
Izu-Bonin Trench
Kyushu -Palau Ridge
A
B
N
Forearc basin
Miura Pen.
Accretionary prism/ trench-slope
Mineoka Ophiolite complex
Boso Pen.
10 km
Forearc basin (Kazusa Gp.)
Forearc basin (Miura Gp.)
Trench-slope basins
Miura-Boso accretionary prism
Hota accretionary complex
Hacchо Fm. (block in ophiolite)
Basalt, dolerite, serpentinite

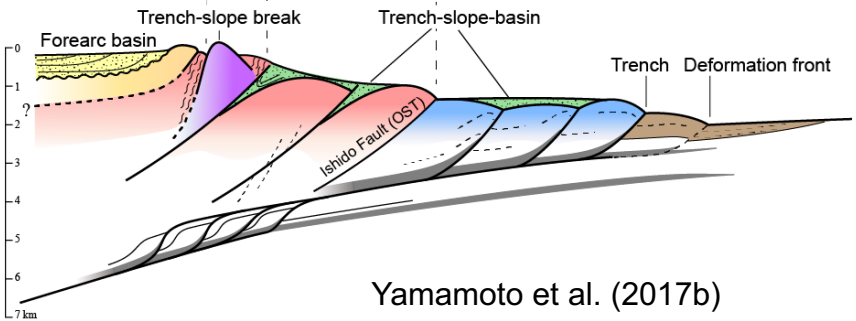
Young subduction margin on the Miura/Boso Peninsulas, central Japan





Yamamoto et al. (2017a)





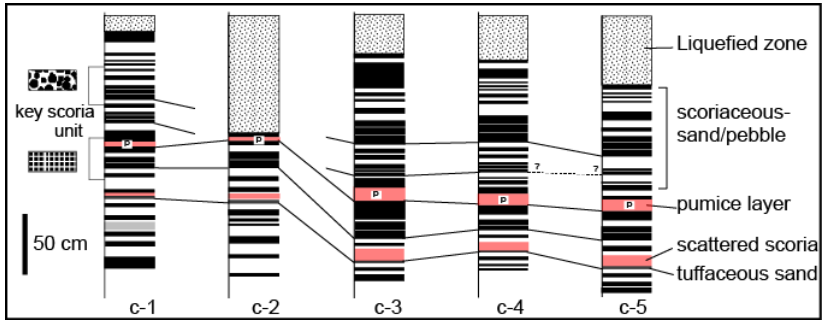
Yamamoto et al. (2017b)

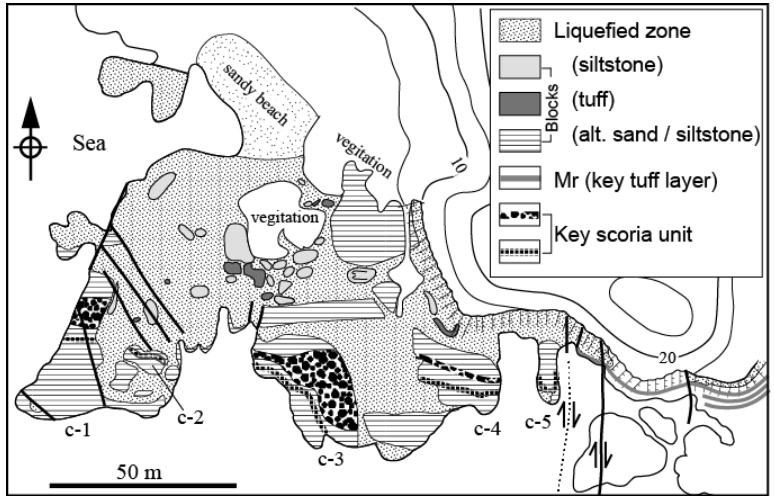
Yamamoto et al. (2009)

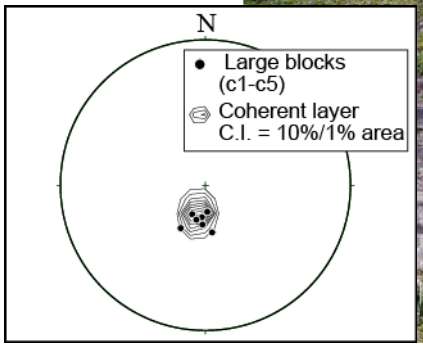
Note:
black colored part: sand/pebble
Lighter colored part: mud

Block-in-matrix (most cases)
Matrices composed of sand/pebble
Matrices lost the original sedimentary structures
Sand intrusions into blocks/coherent layers

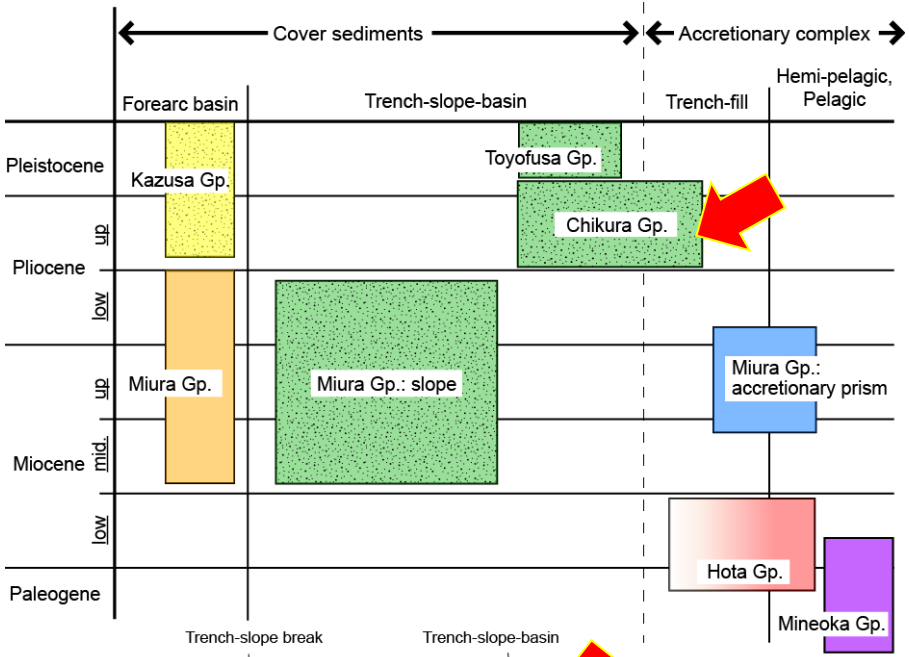
Yamamoto et al. (2009)

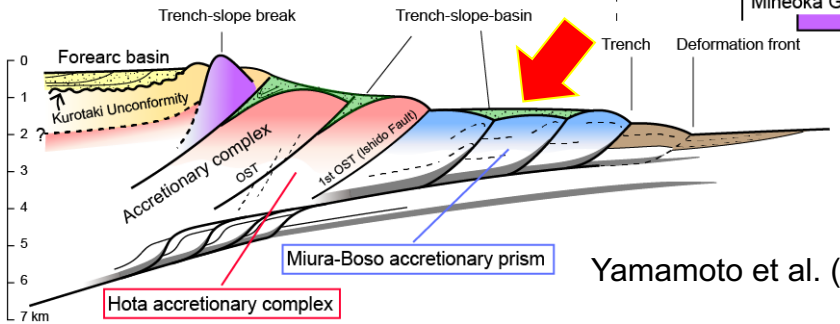




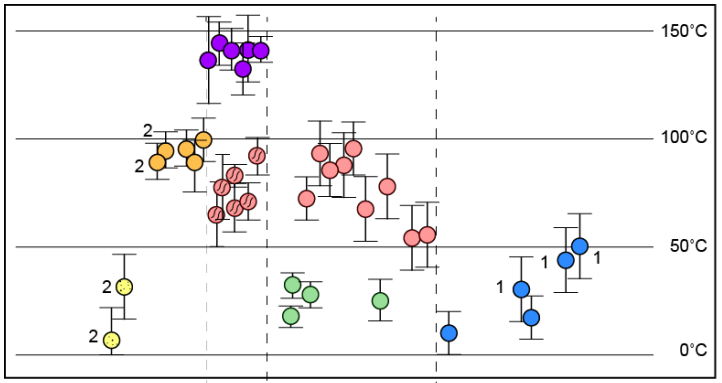


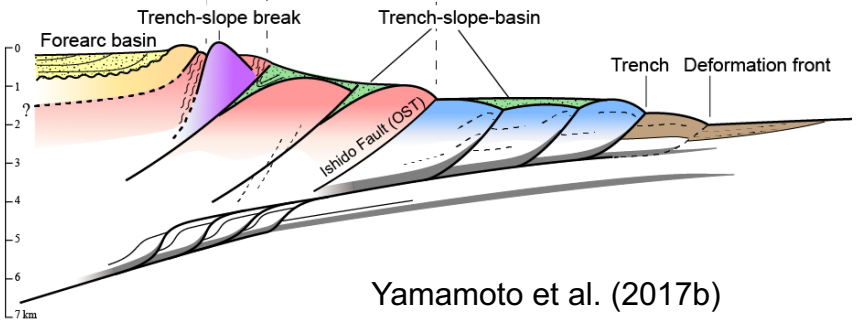
Young subduction margin on the Miura/Boso Peninsulas, central Japan



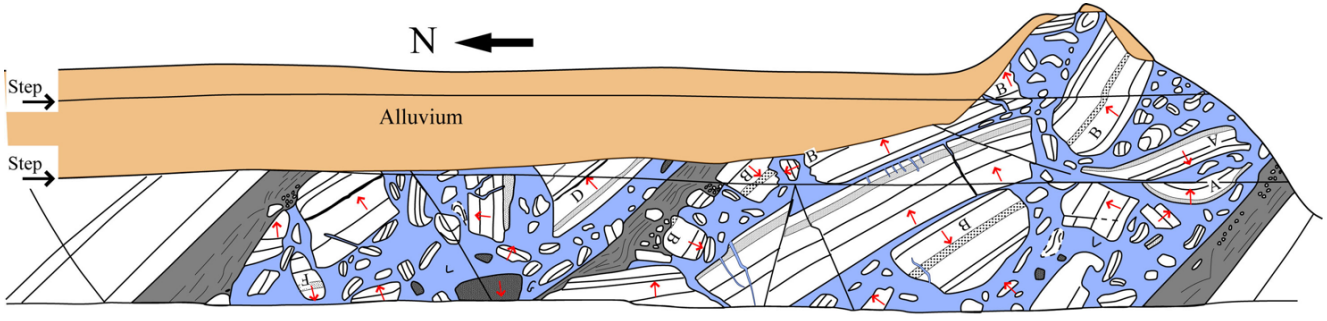


Yamamoto et al. (2017a)





Yamamoto et al. (2017b)



Yamamoto et al. (2007)

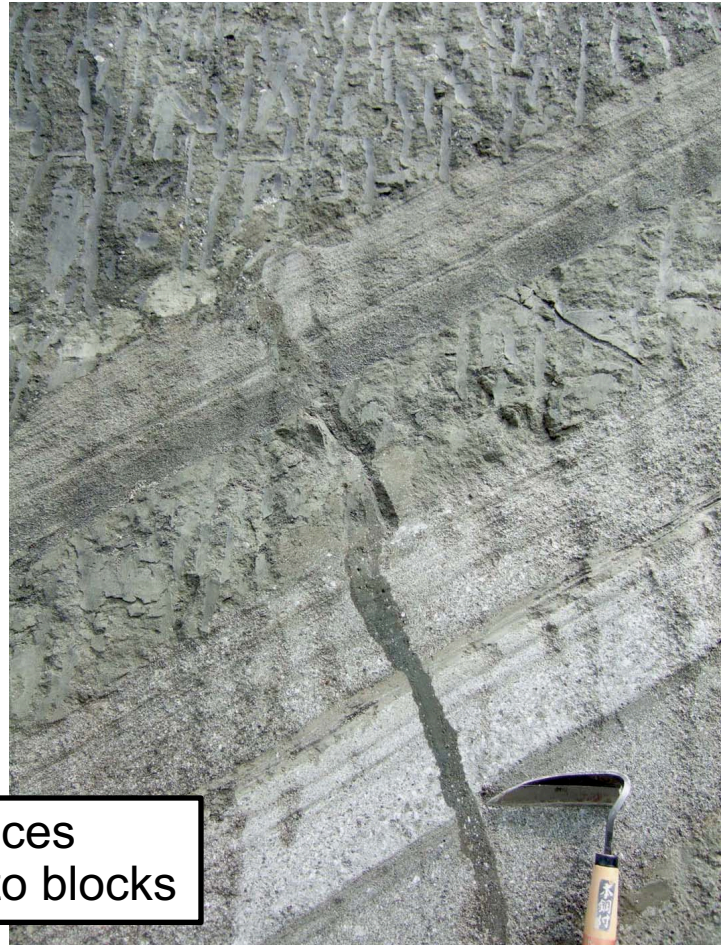
ブロックと基質

Blocks:
Alt. sand and siltstone (-15 m),
siltstone, rarely sandstone

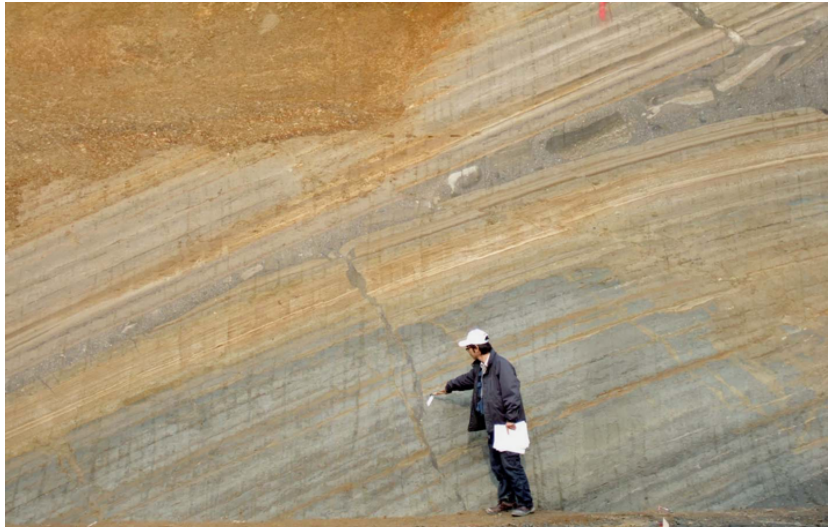
Roundness: subangular- subrounded

Matrix:
Med.-coarse volcaniclastic sand
and the grater sized grains
Homogeneous
No foliation nor grain orientation

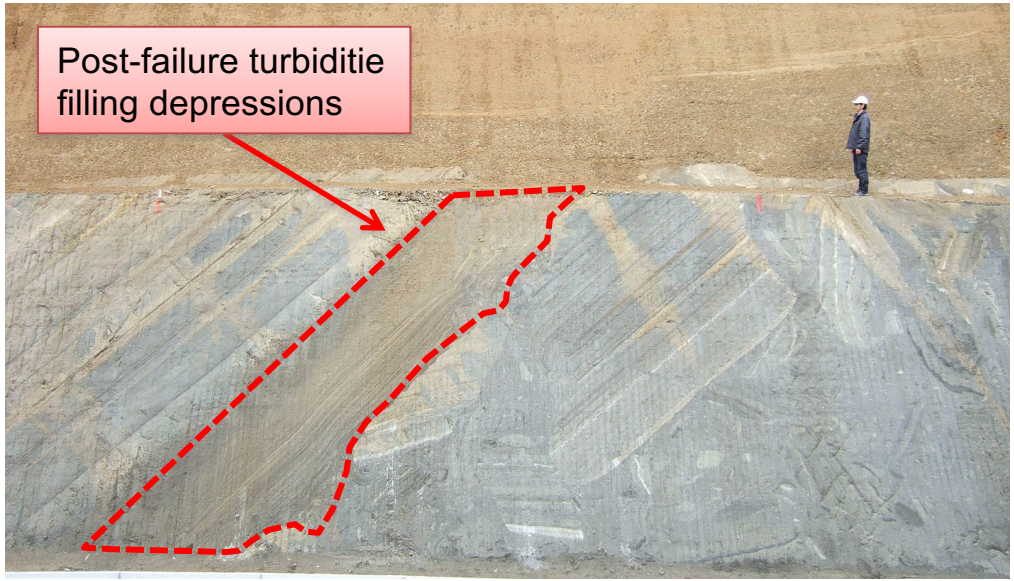
基質（砂）の貫入

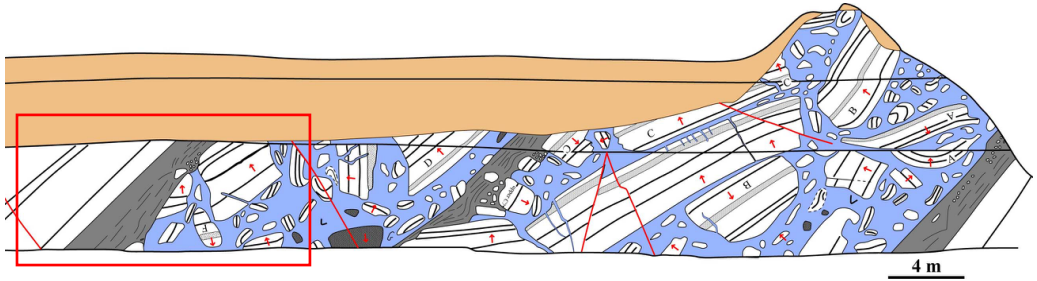


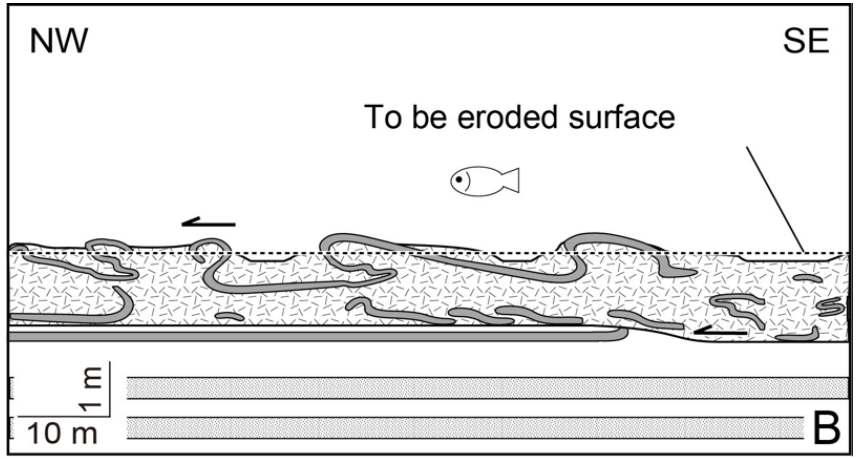
Sandy matrices
injected into blocks

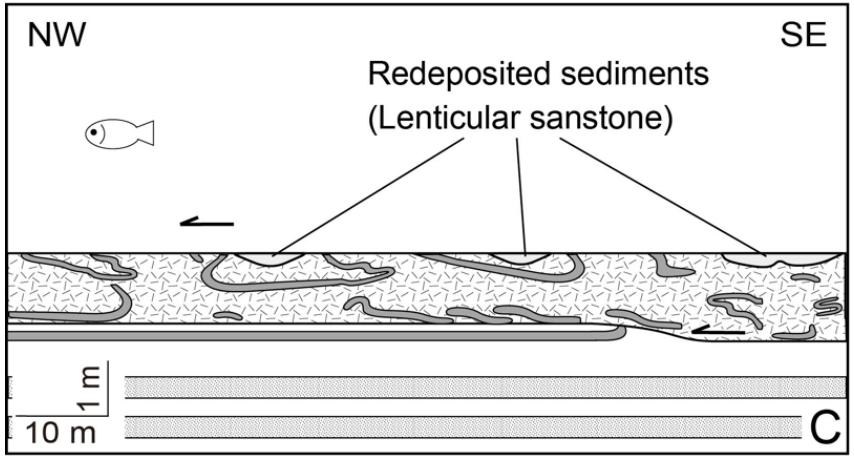


海底「表層」地すべりのマーカー









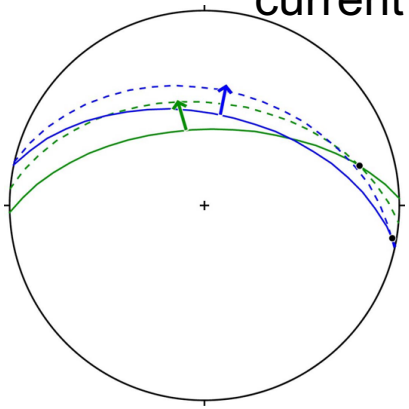
Yamamoto et al. (2009)

⇩ MTD表面を覆うレンズ状砂岩

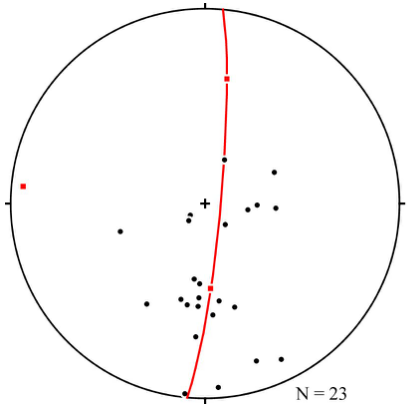
房総半島の前弧海盆の例

ブロックの回転

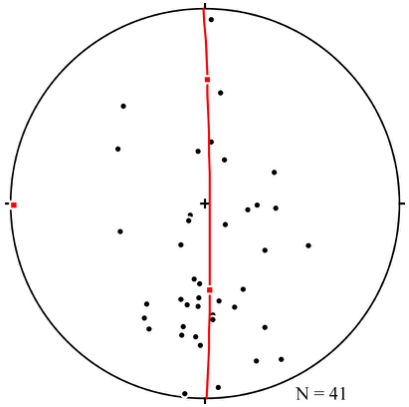
Paleo-turbidite current



Large blocks (>2 m)

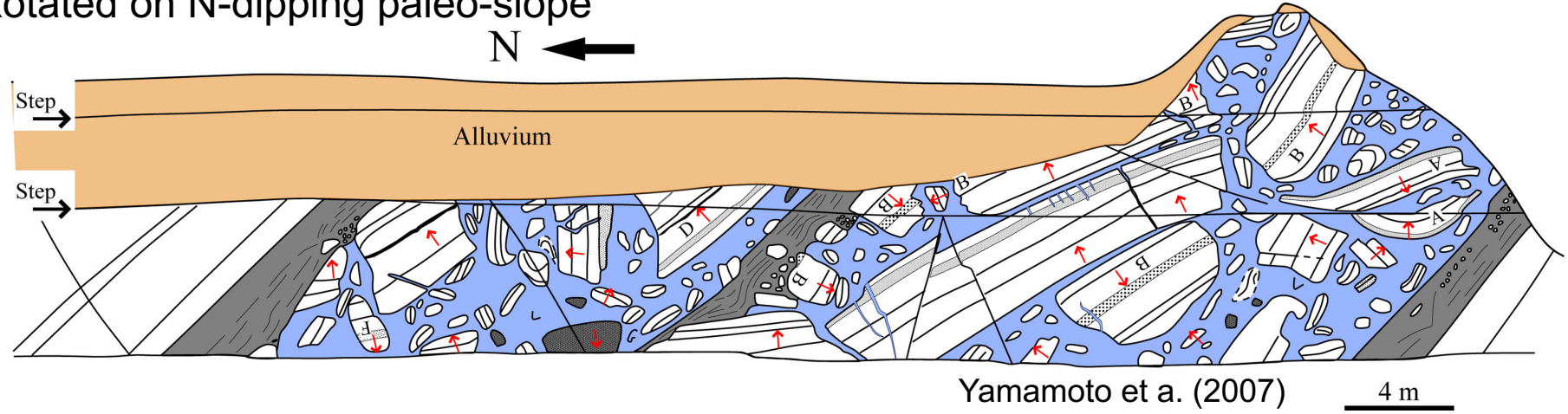


All blocks



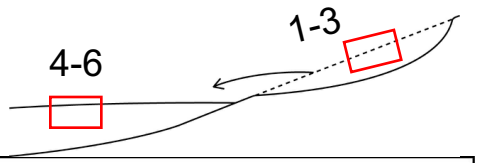
Yamamoto and Kawakami (2014)

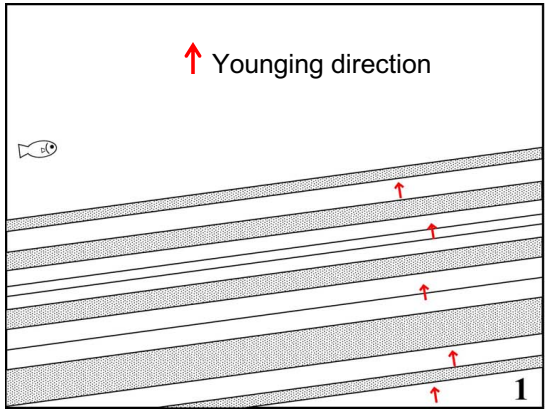
Rotated on N-dipping paleo-slope



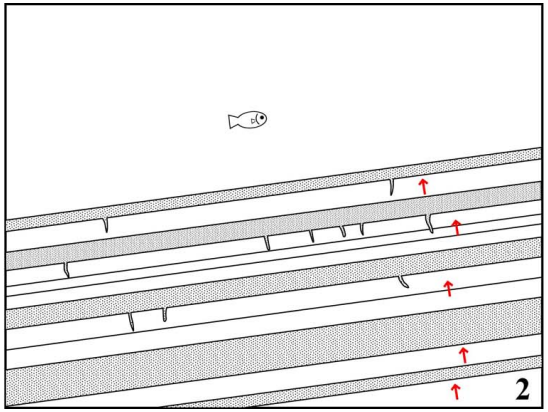
Yamamoto et a. (2007)

液状化/地すべりプロセス

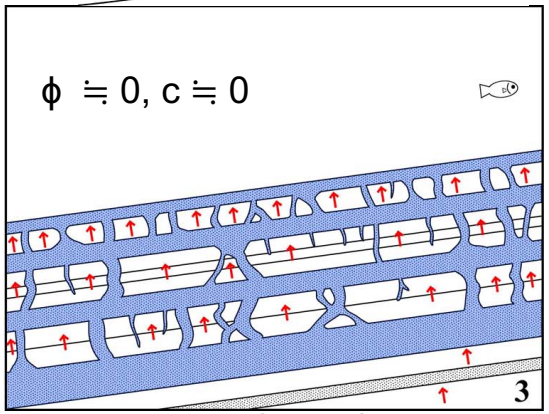




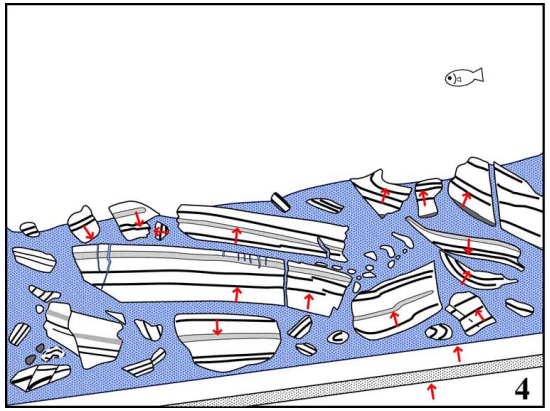
1. Soon after sedimentation



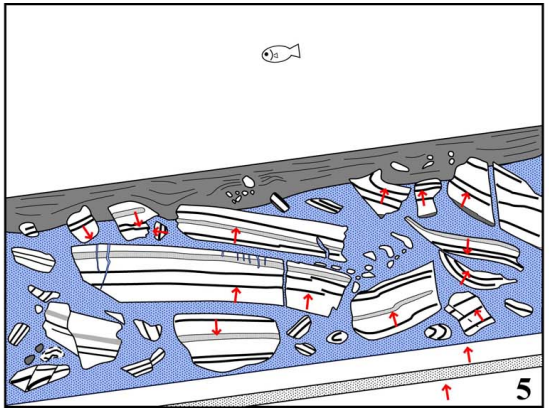
2. Liquefaction &small injection



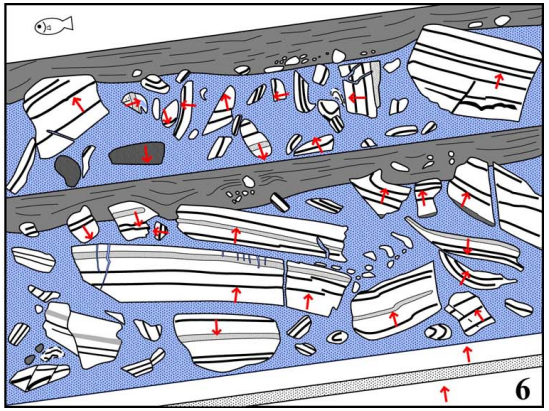
3. Intrusion of liquefied sand



4. Sliding (to the North)



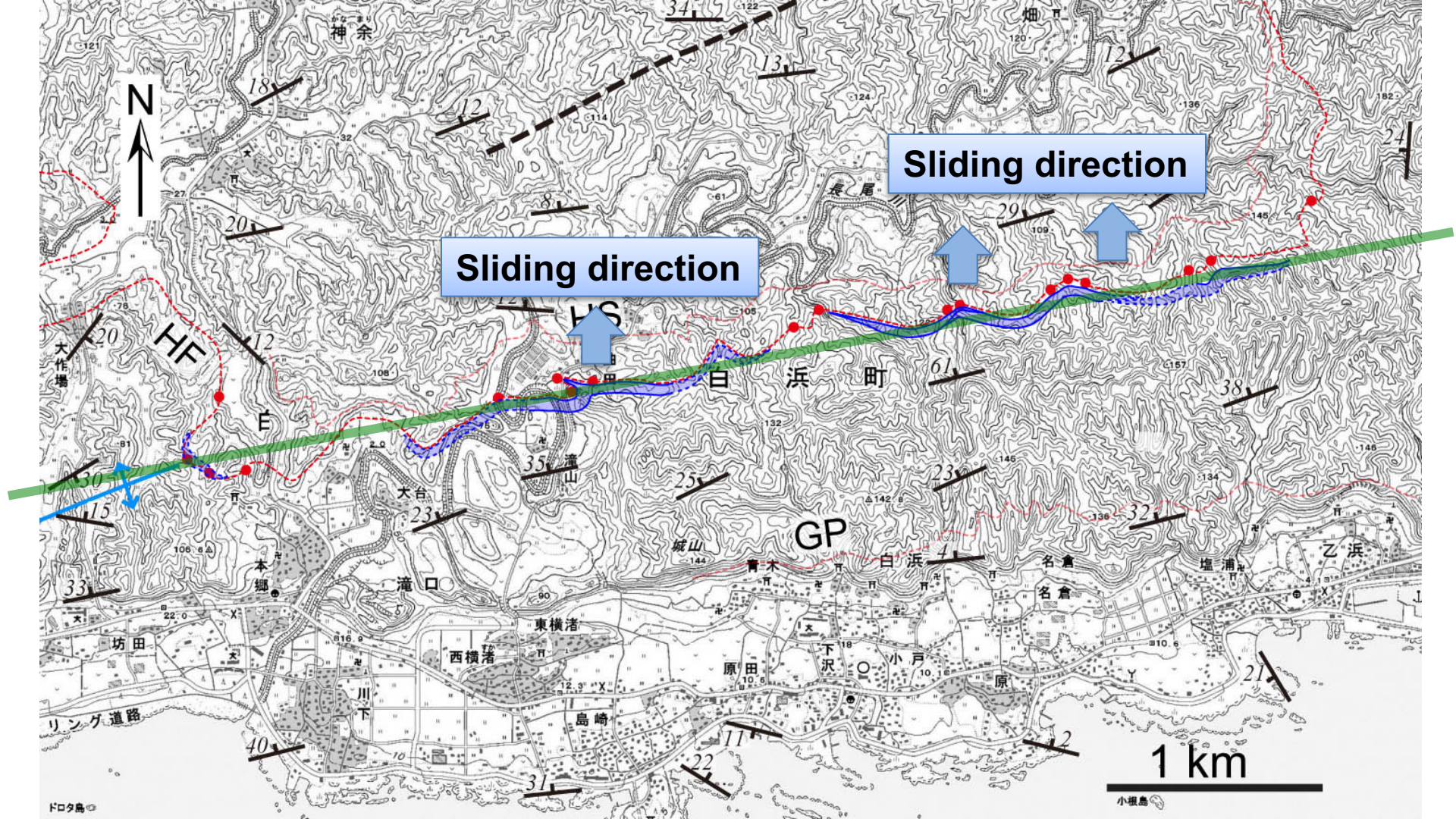
5. Turbiditie layer caped MTD

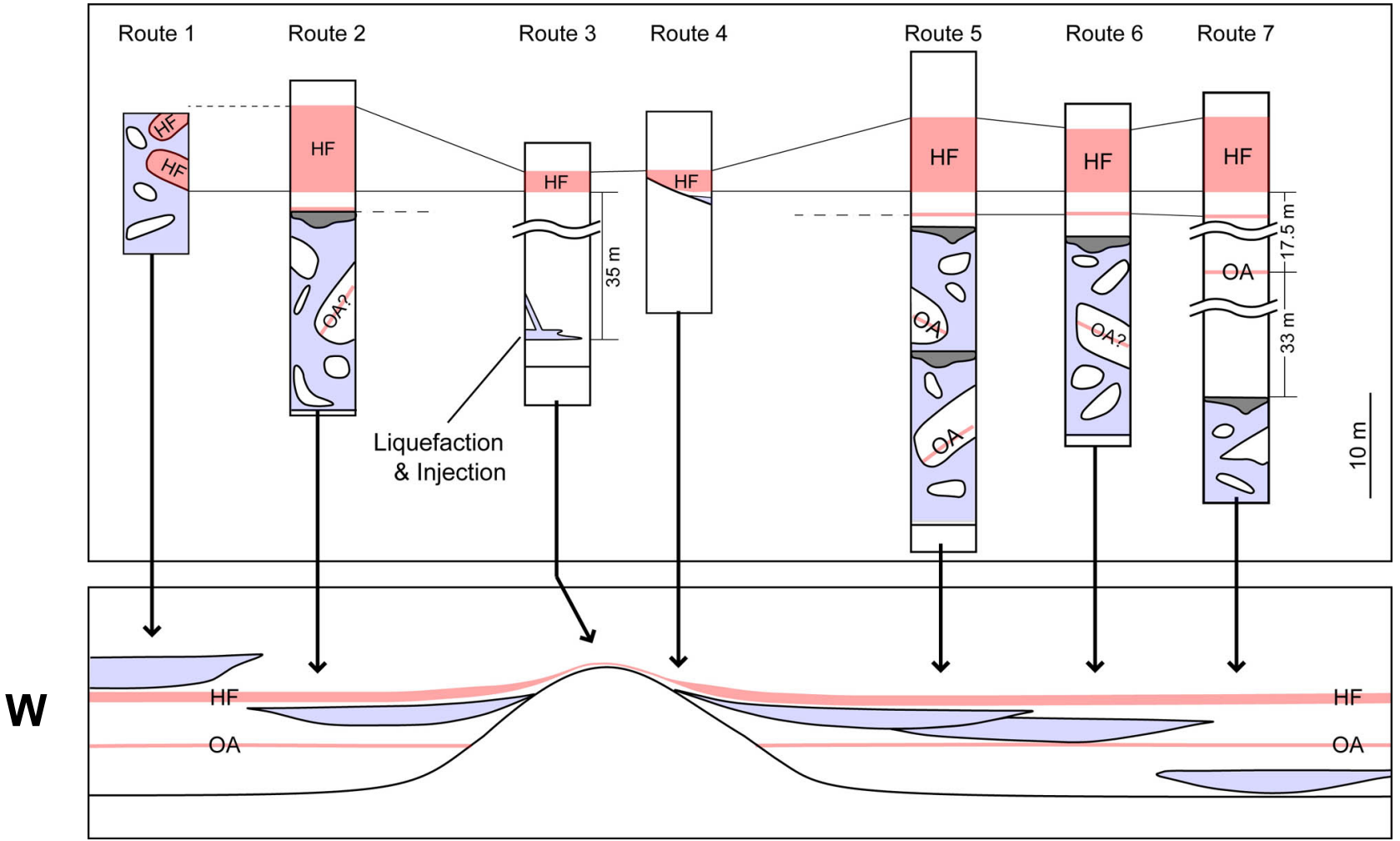


6. Second MTD

Yamamoto et al. (2007)

側方変化の追跡

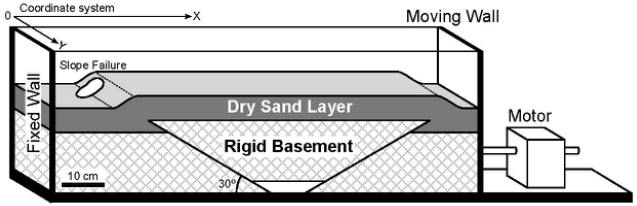

Sliding direction
Sliding direction
N
HF
HS
GP
白浜町
1 km

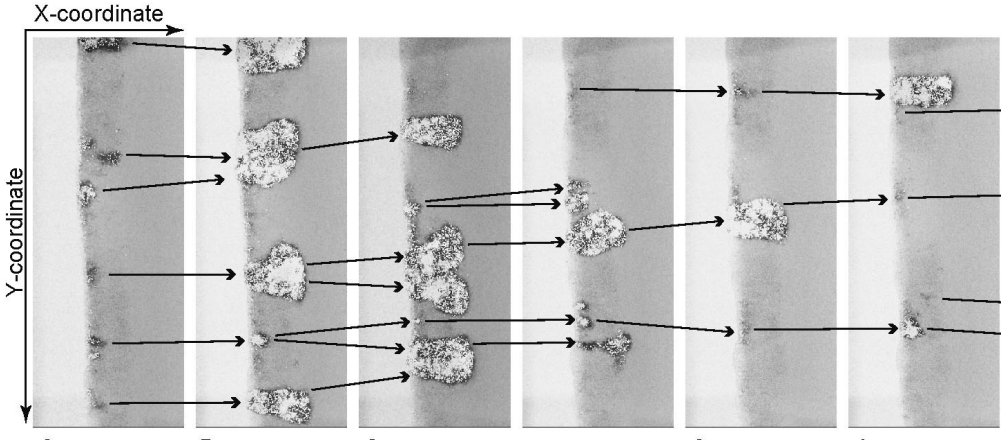


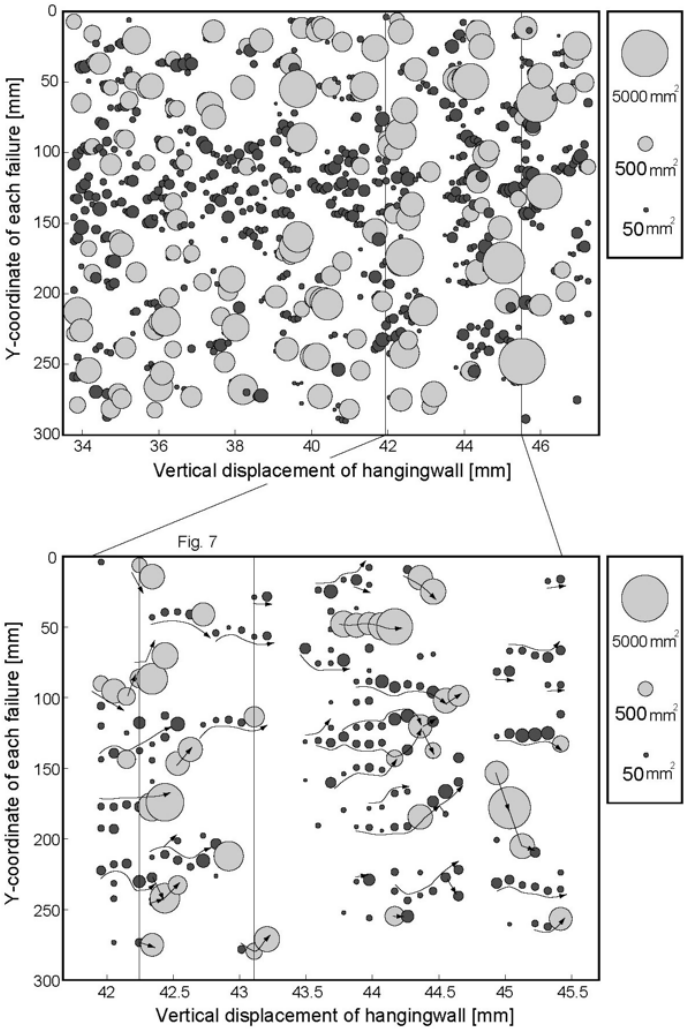
Route 1: Kawakami and Shishikura (2006)

地すべりの側方移動：砂箱実験

（Yamada et al., 2010）





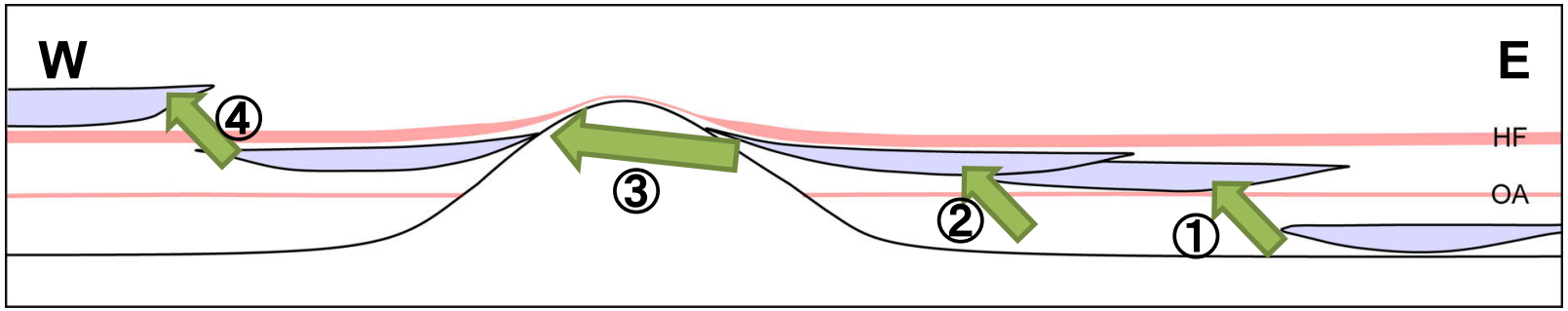


斜面崩壊は，既存崩壊の縁で発生
斜面崩壊の位置は、結果的に側方に移動

Total thickness of Hata Fm. (upper Chikura Gp.): about 500 m
(Saito, 1992; Kawakami and Shishikura, 2006)

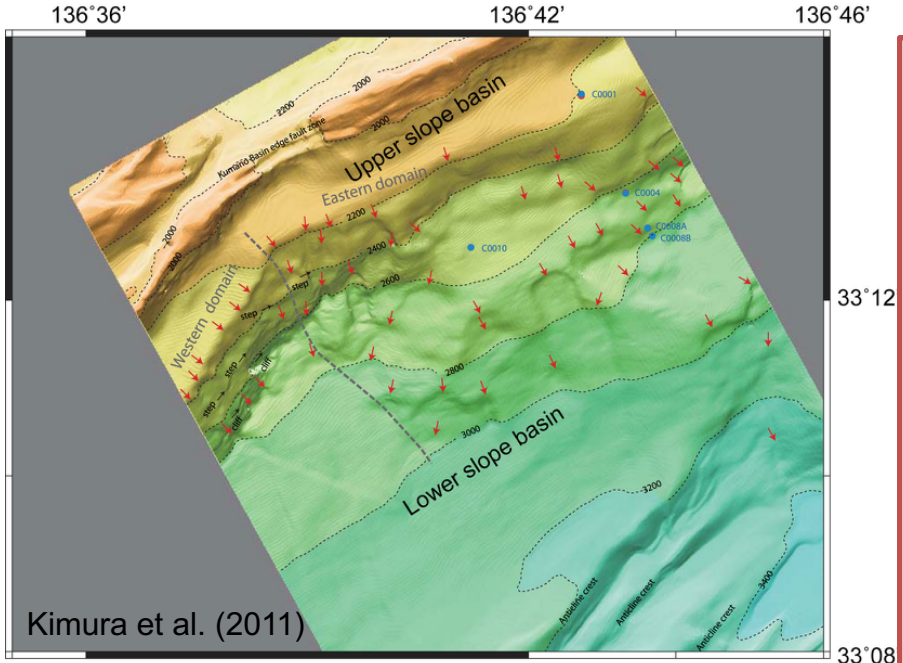
Age: 1.95-0.85 Ma (Kawakami and Shishikura, 2006)

Mean sedimentation rate: 2,200 yr/m



① about 100,000yr
② 1,720 yr
③ 2,640 yr
④ at least 5,900 yr

まとめ



What is the frequency of submarine slides?
How are slides and earthquakes related?

MTDs or slide scarps: independent?
close relations?

地震による砂層の液状化は、海底地すべりの一般的かつ重要なトリガーとなる

液状化すべりの内部構造は、粗粒な砂、礫からなる基質と、その貫入構造で特徴づけられる。

ブロックの配列は、実はランダムではない。

千倉層群における海底地すべりは、約200万年前に地震動によって形成された。

少なくとも５つの完結的な海底地すべりが発生し、西ほど若くなる傾向

海底地すべりの再来周期は、数千年～十万年

地すべりの側方移動は、砂箱実験でも再現