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Submarine slides and marine geohazards: the previous study results and current problems

海底地滑最近問題紹介

Kiichiro Kawamura

（Yamaguchi University）

kiichiro@yamaguchi-u.ac.jp

Contents内容

1) **Importance of submarine landslides**
重要性

2) **Major submarine landslides at a convergent margin**
主要日本海底地滑

3) **Recent surveys in the Japan trench**
最近日本海溝調査

1) **Importance of submarine landslide** 重要性

-> Tsunami excitation

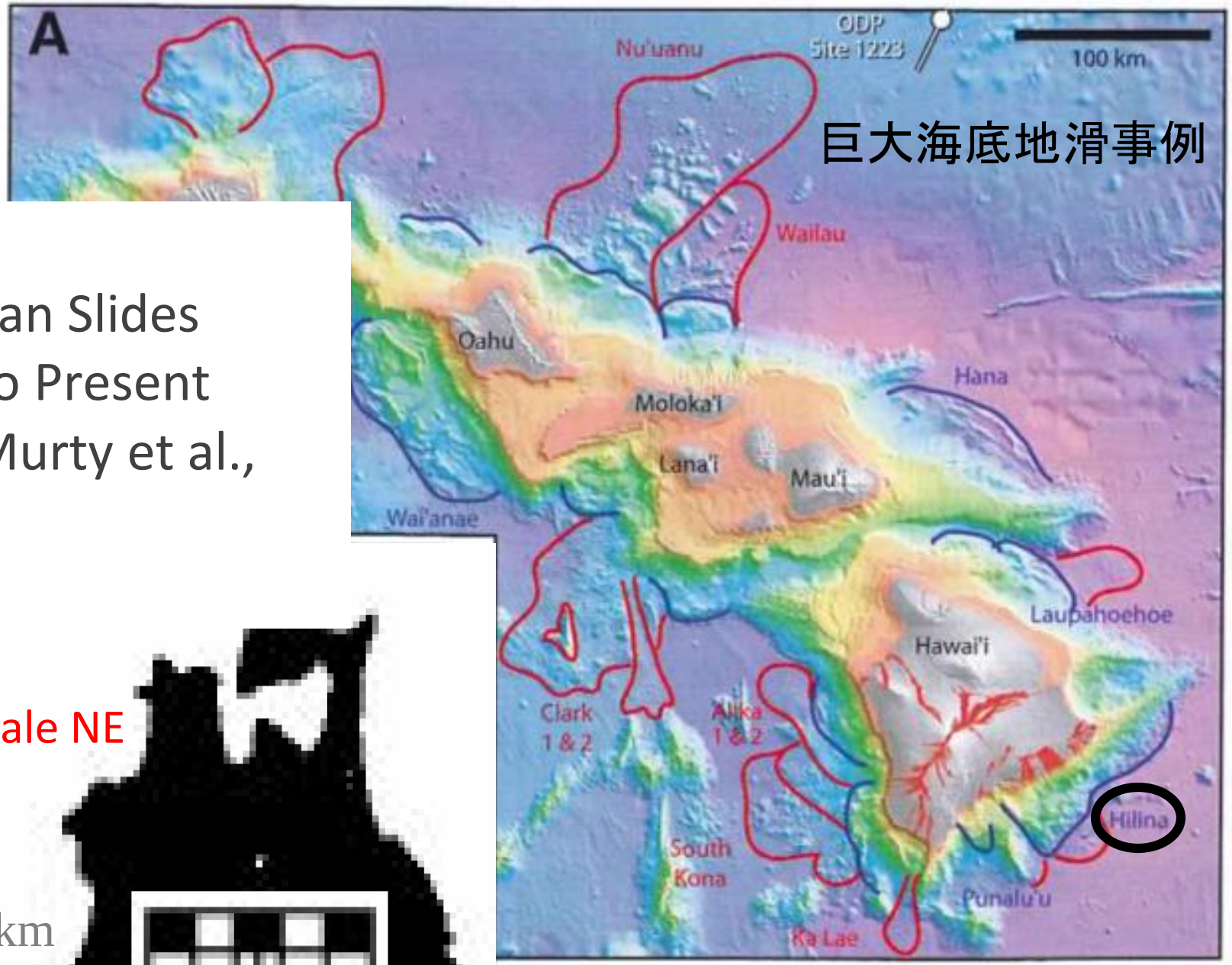
津波

-> Submarine cable cut

海底電覧切断

巨大海底地滑事例

Hawaiian Slides
2 Ma to Present
（McMurty et al., 2004）



Same scale NE Japan

Morgan et al., 2007

If this slides..

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Tsunami 30 m high might be attacked to the US coasts. But this prediction is based on one big slide. If the slide is not one big slide, but many small slides, the tsunami heights should be small.

巨大地滑・津波

Ward, 2002, Nature

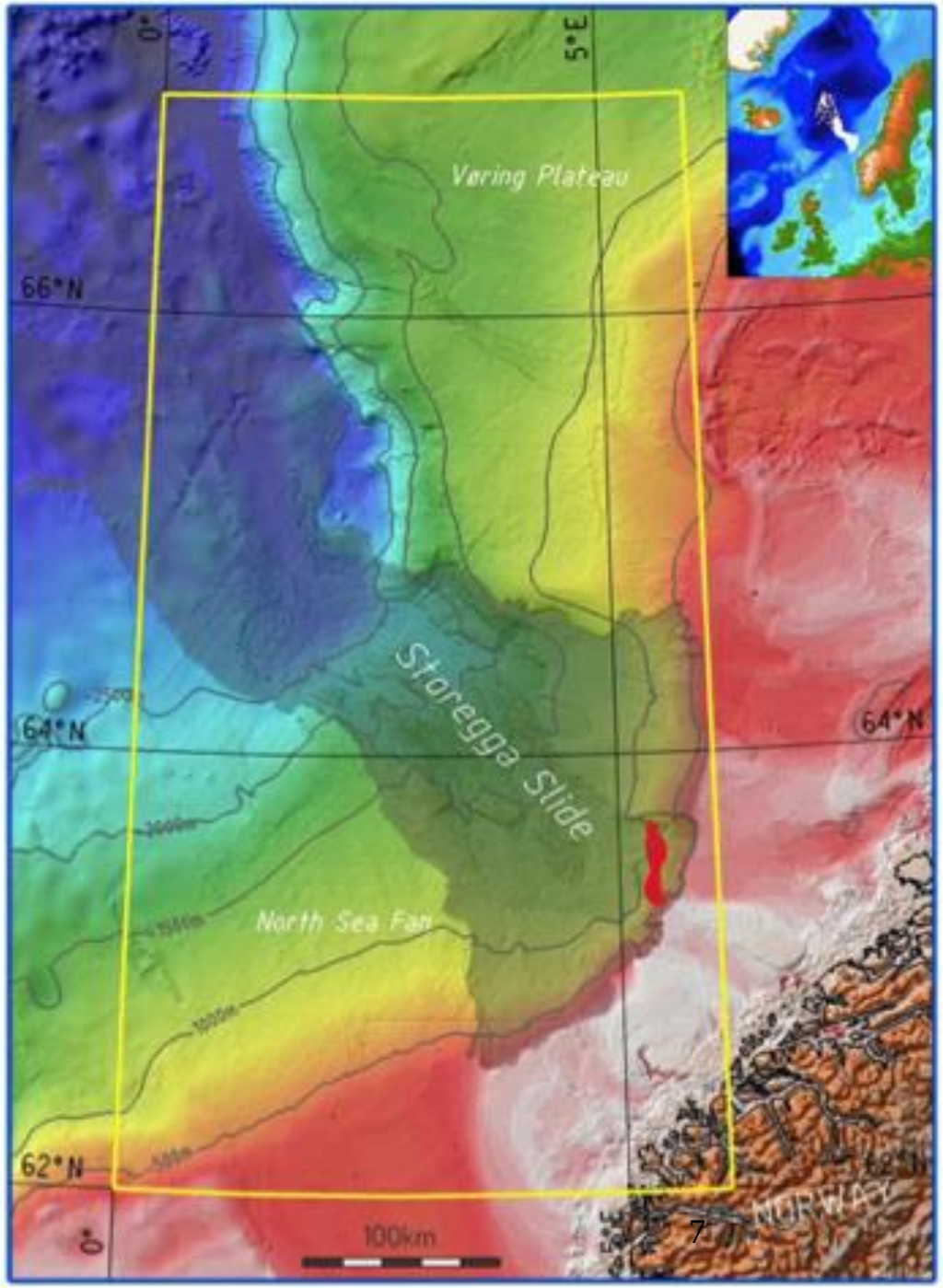
Submarine landslide at Norwegian-Greenland Sea; Storegga Slide

Width：~300 km
Runout：~800 km
Age：8000-5000 years ago
（Canals et al., 2004）

100 km

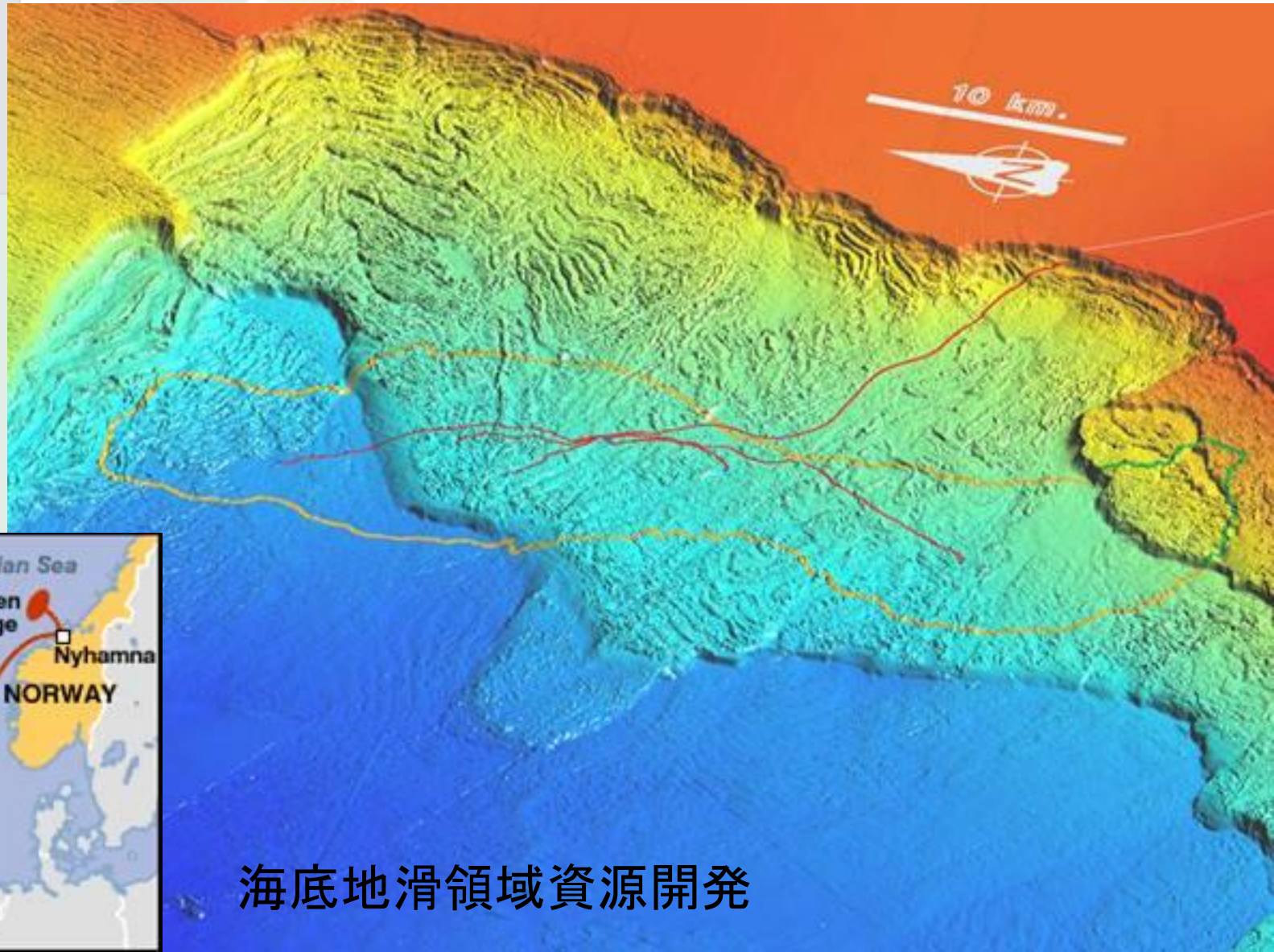
巨大海底地滑事例

Same scale NE Japan



Solheim et al. (2005)

They exploited a large gas field on this submarine slide that is the largest slide during Quaternary.



海底地滑領域資源開発

1) **Importance of submarine landslide** 重要性

-> Tsunami excitation

津波

-> Submarine cable cut

海底電覧切断

Taiwan台湾事例

YAM If the cables were cut, economic, politic works suddenly stopped.

2006.12/26, At least, 6 cables were cut by this event.

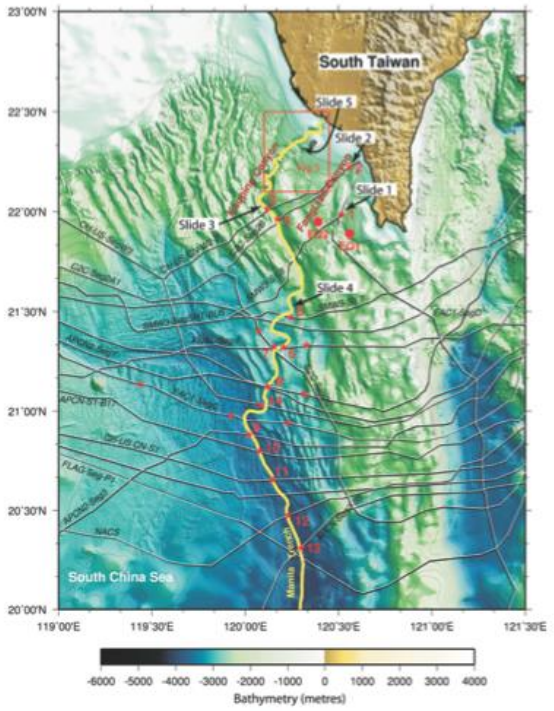


Fig. 1. Location of submarine telecommunication cables and cable breaks offshore SW Taiwan. EQ1 and EQ2 are the two major Pingtung earthquakes of magnitude 7.0. The yellow continuous line underlines the channel of the Kaoping canyon and Manila trench. Red stars correspond to the locations of cable breaks. Numbered stars are used in Fig. 3. Five submarine landslides are identified. Cable break times and locations are given in Table 1.

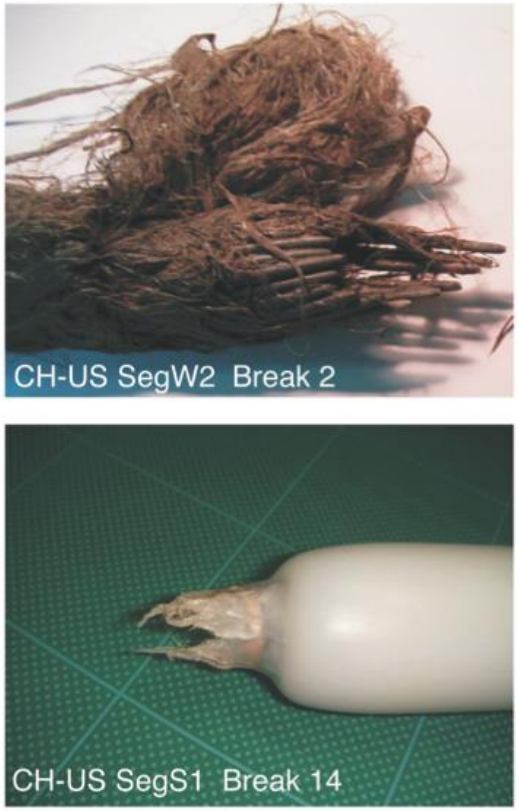


Fig. 2. Broken cables recovered during cable repair operations. Upper piture: break of an armoured type cable recovered during break 2 repair (located in Fig. 1). Lower picture: break of a lightweight type cable recovered during break 14 repair (located in Fig. 1).

Hsu et al.（2008; TAO）

AFP（2007; http://www.afpbb.com/articles/-/2165775?pid=

The trigger mechanisms 誘引

- Earthquake / Tectonics 地震
- Methane Hydrate / Climate Change
- Salt/Mud layers / Salt tectonics 岩塩
- Volcanic activity / Volcanism 火山
- …..

Submarine slide distribution in North Atlantic

Heads of the submarine slides are mostly 1000 – 1300 m water depth.

–> This might imply that the submarine slide formation could be closely related to methane hydrate distribution.

Lee (2009; Mar. Geol.)

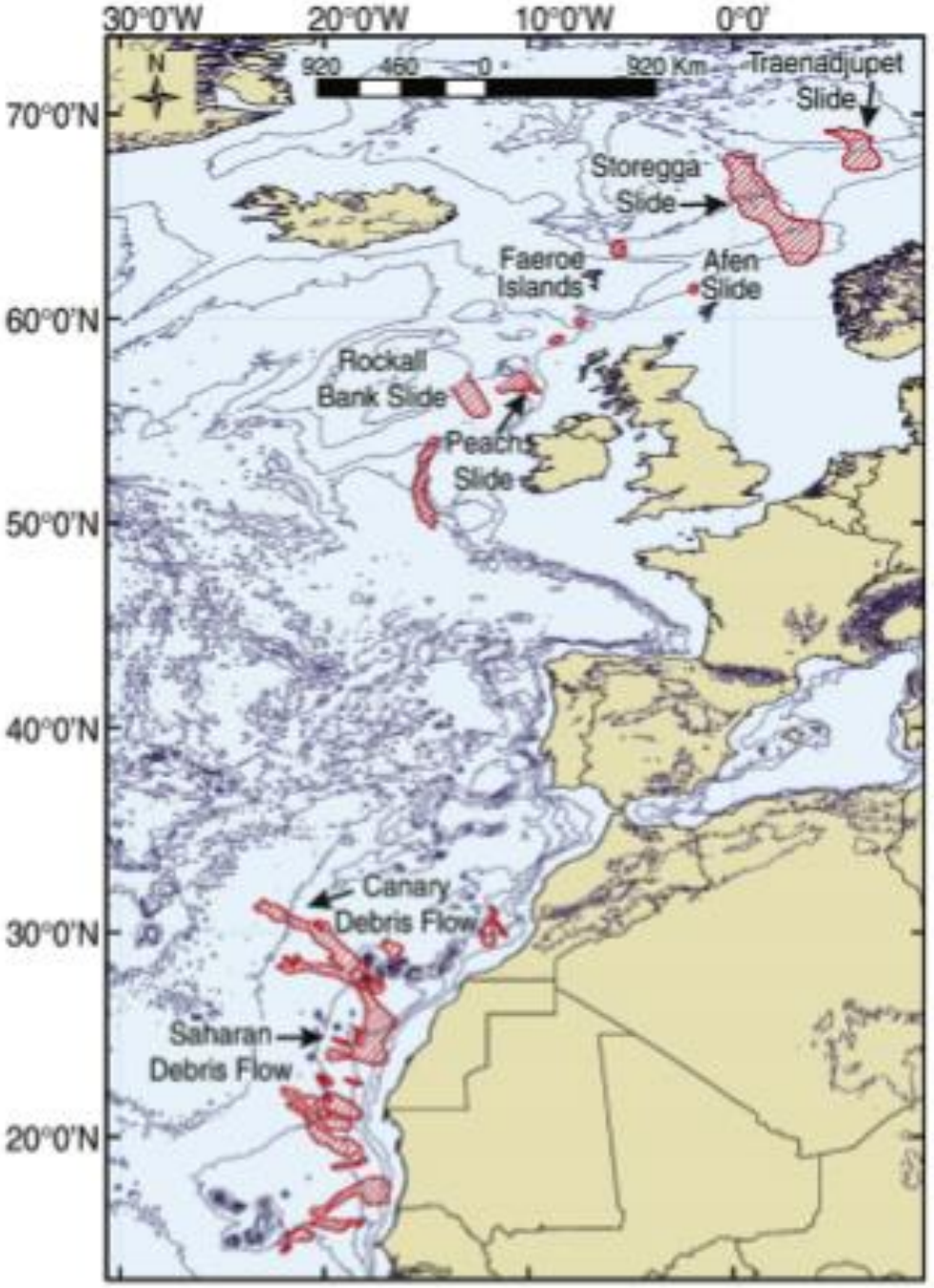


Fig. 4. Locations of submarine landslides discussed in the text off Europe and North Africa.

Methane Hydrate / Climate Change
気候変動

- Glacier period -> Sea level decrease -> Water pressure decrease -> Methane hydrate dissociation -> Slip zone at the methane hydrate -> Submarine slide
- In this case, submarine slides occur to induce methane gas ejection, which is a greenhouse gas. The glacier period may end by such a process? Clathrate gun hypothesis.
- Interglacier period -> Water Temp. of Bottom current increases (5°C?) -> Methane hydrate dissociation

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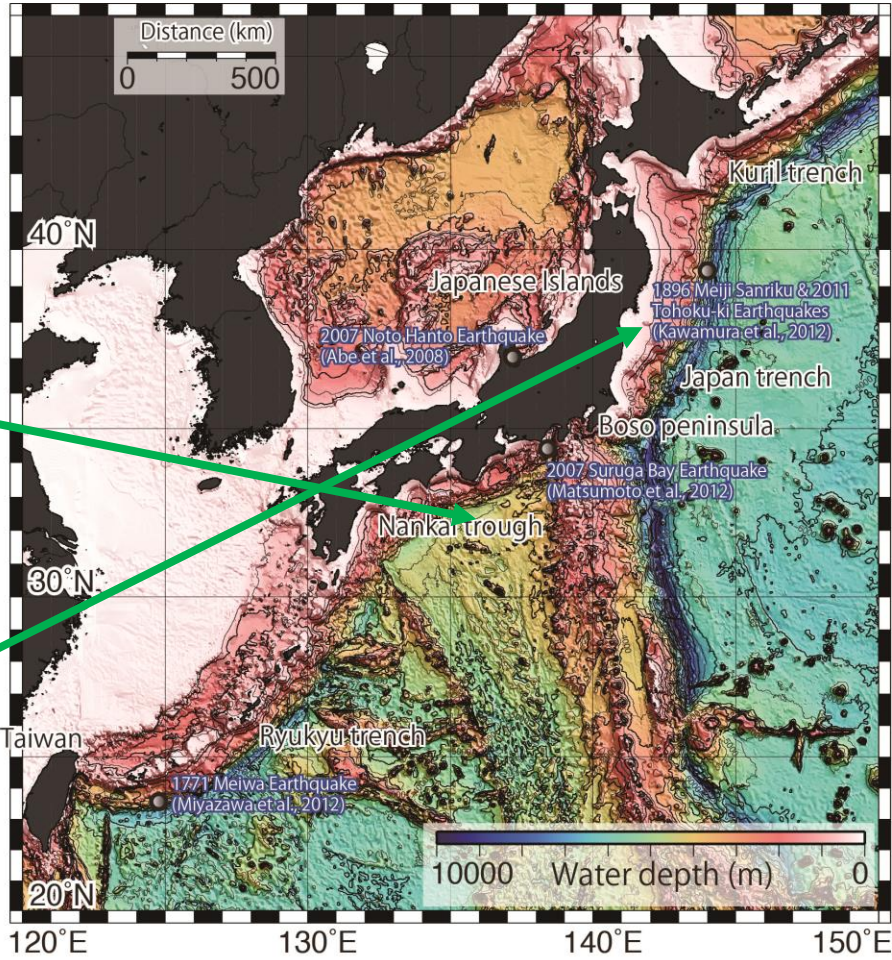
2) Major submarine landslide at a convergent margin
主要日本海底地滑

a) Nankai Trough
南海海溝

a) Japan Trench
日本海溝



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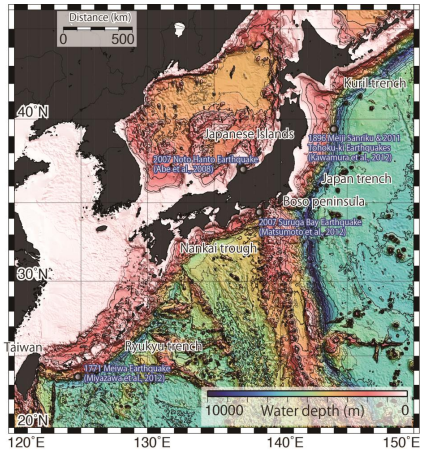
a) Nankai Trough 南海



Frontal thrust 前縁断層

-> translational slide 並進滑

-> debris flow 水中土石流

Trench slope 海溝斜面

-> sediment slide 堆積物滑 **-> turbidity current** 乱泥流

“Accretion” and Translational slide

付加作用･並進滑

Sandbox experiment 砂箱実験

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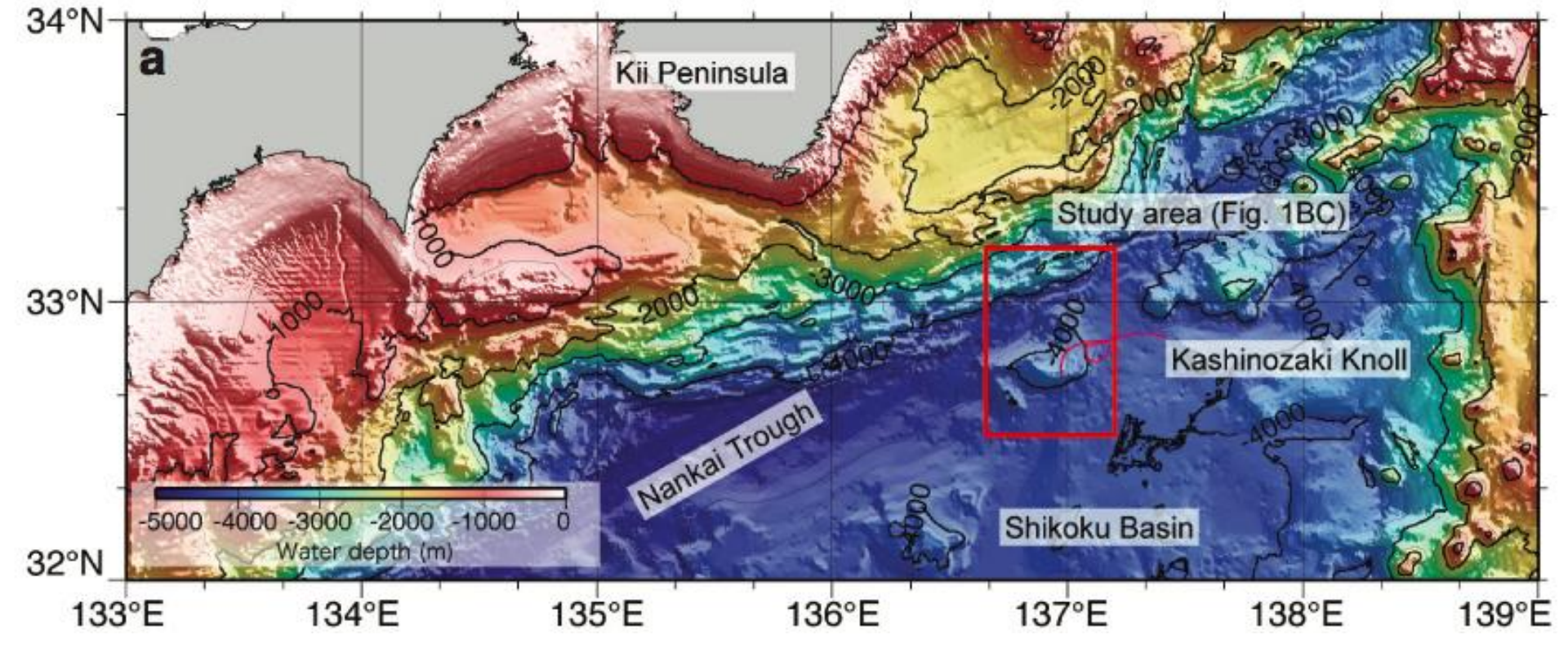
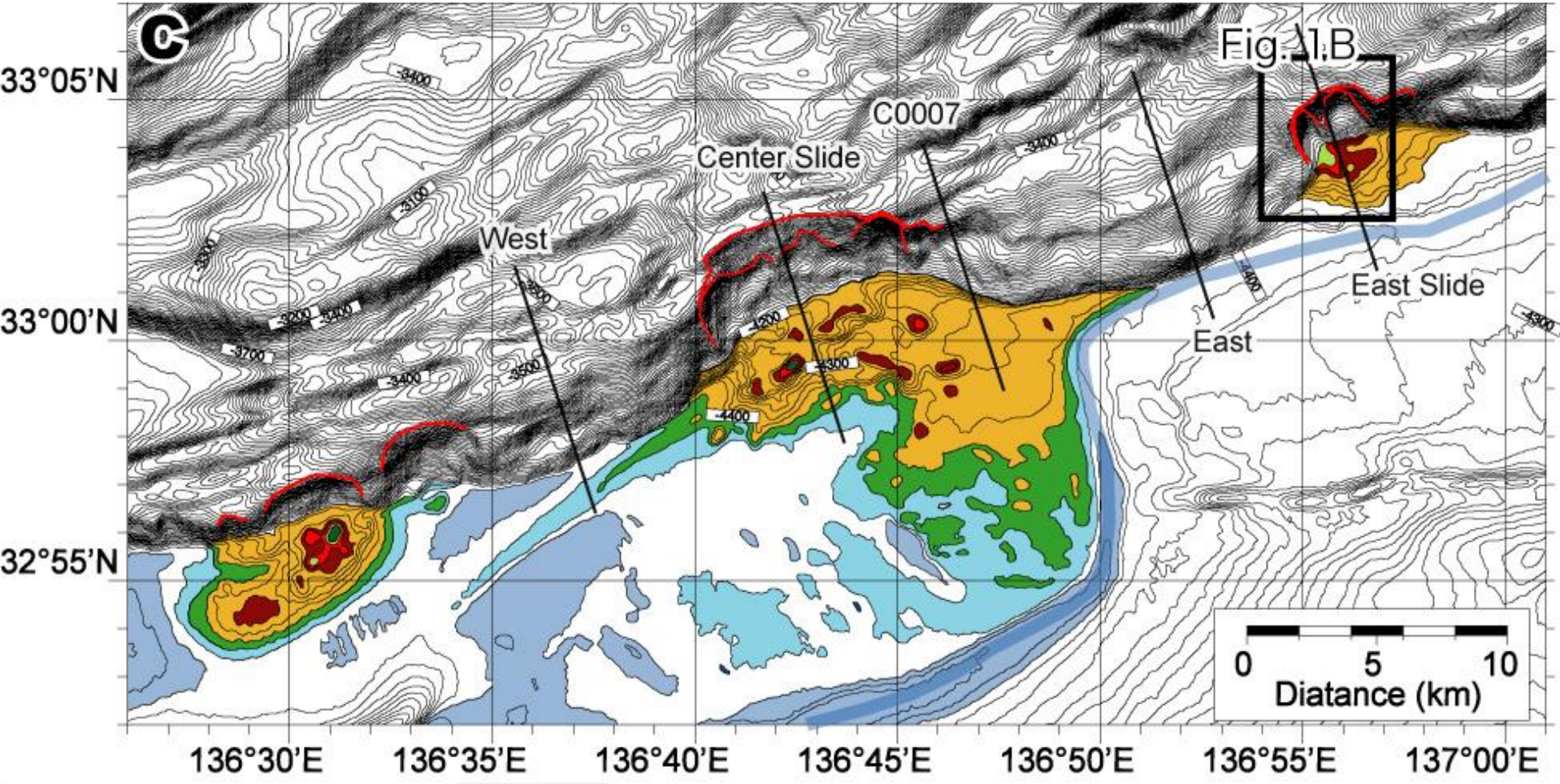
By Yasuhiro Yamada Laboratory in Kyoto University



Nankai trough 南海



Slope in the frontal thrust are collapsed progressively. This can be observed as a debris flow type including many blocks.
前縁断層斜面連続的崩壊. 崩壊発達土石流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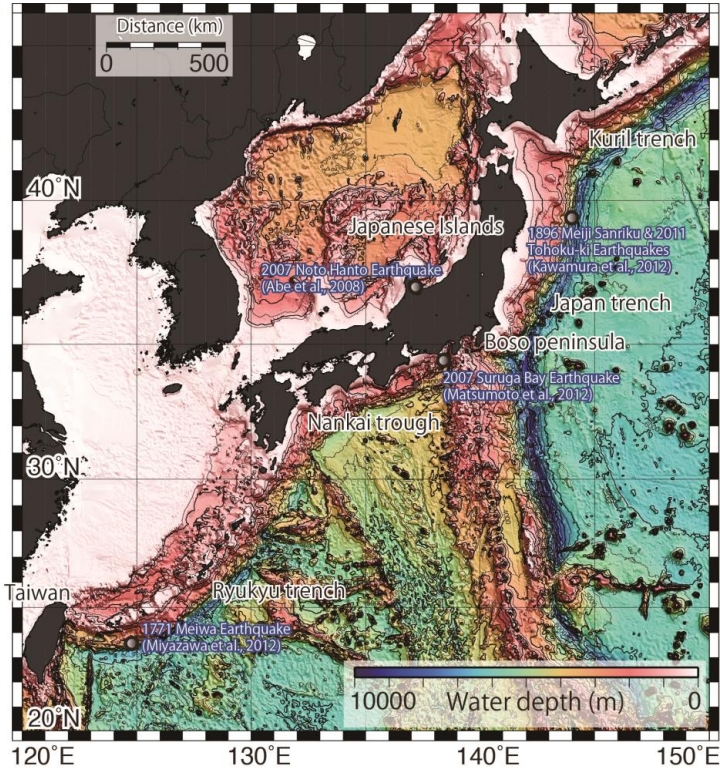
254

b) Japan Trench
日本海溝



Frontal thrust　前縁断層

-> rotational slide　回転滑

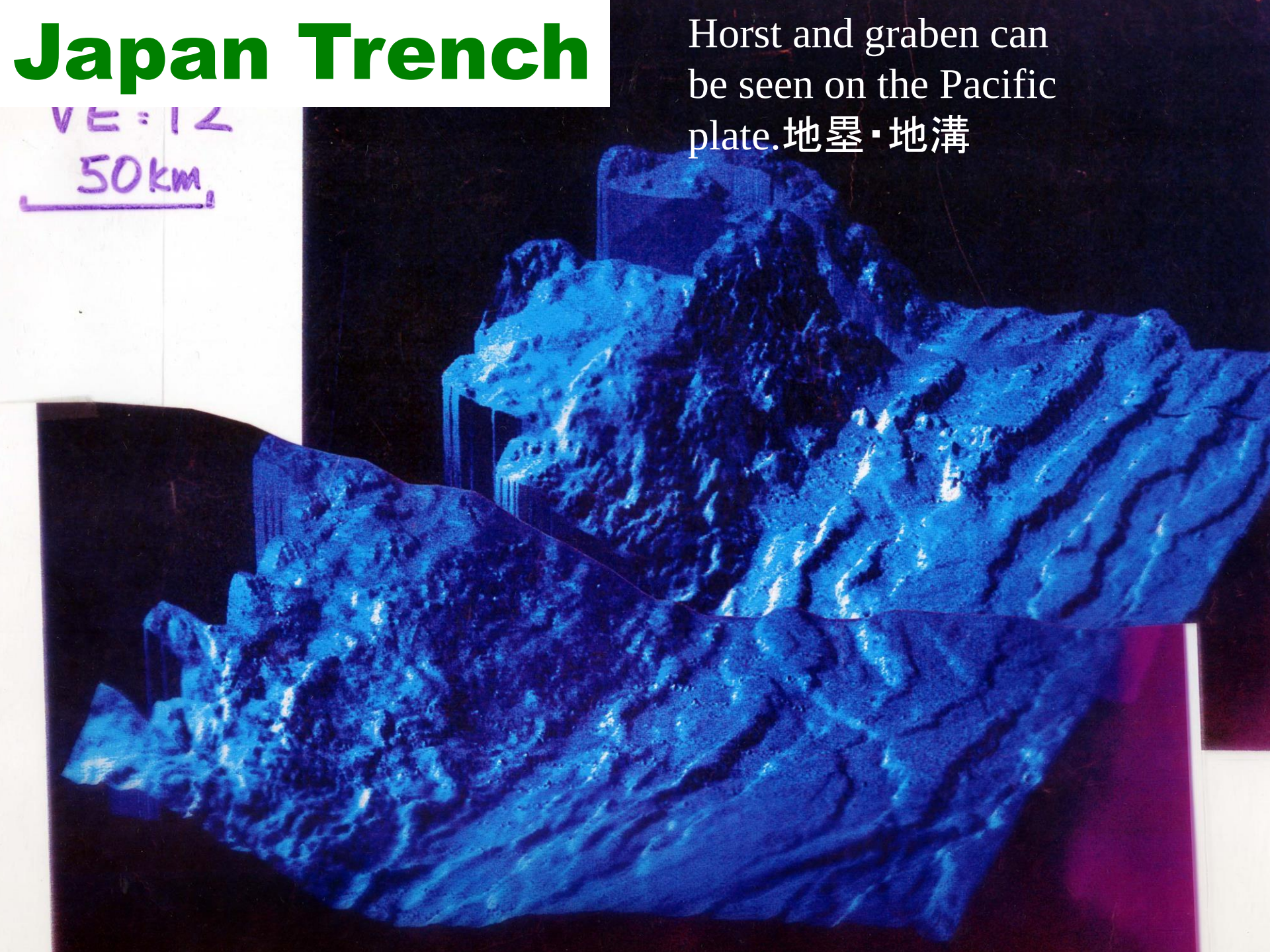
Trench slope　海溝斜面

-> rotational slide　回転滑

“Tectonic erosion” and rotational slide

構造侵食･回転滑

Japan Trench



Horst and graben can be seen on the Pacific plate.地塁・地溝

Japan Trench

The graben is subducted beneath the accretionary wedge, and a submarine slide occur to fill the graben. This is tectonic erosion.

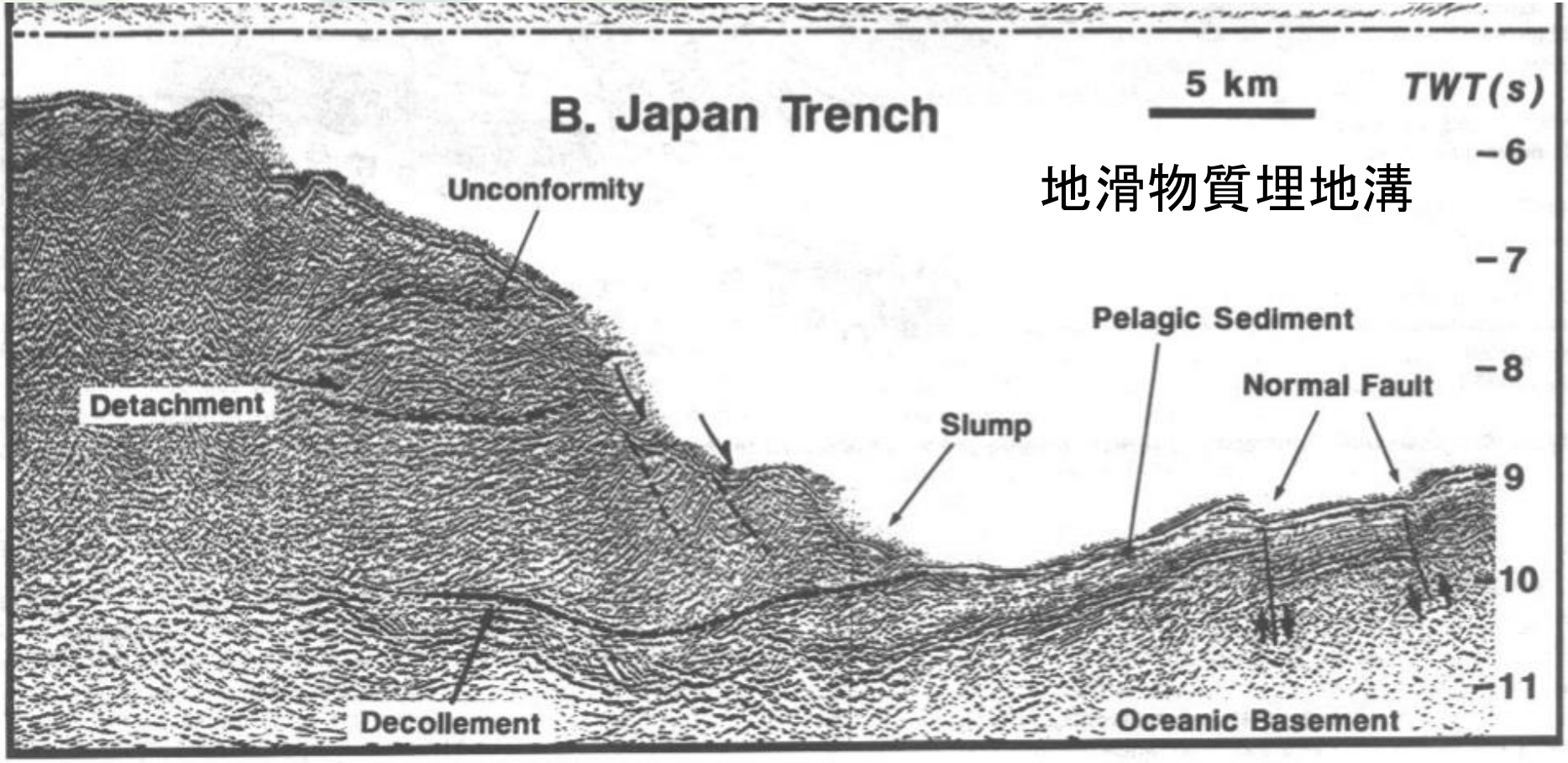


Figure 4.—Seismic-reflection profiles from the Nankai Trough (A) and the Japan Trench (B) (taken from Taira and others, 1990). Abbreviations: TWT(s), two-way traveltime, in seconds; BSR, bottom simulating reflector (gas hydrate phase transition).

Taira and Ogawa (1992, Episode)

Subduction erosion in the Japan trench（Kobayashi, 1990）
構造侵食機構

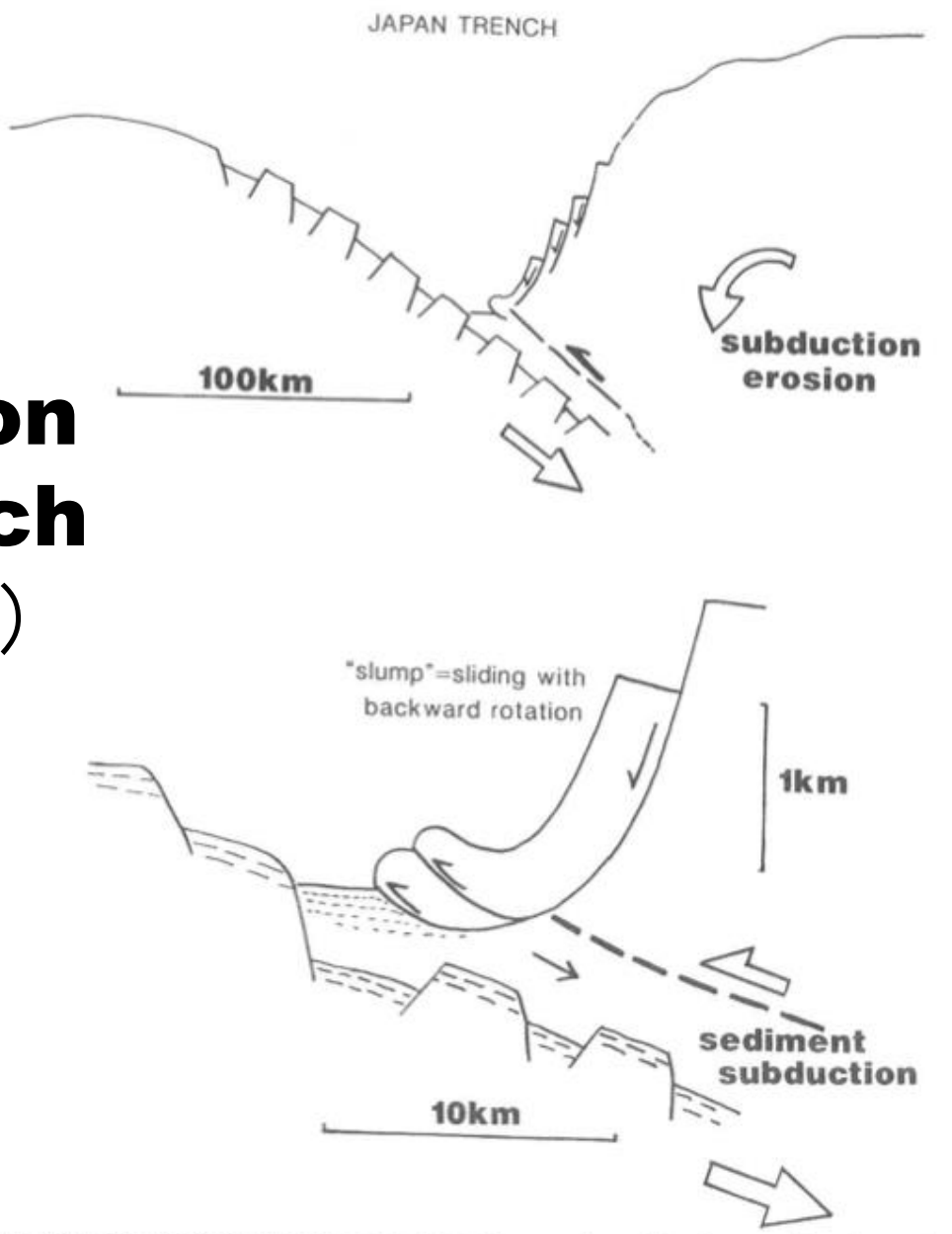
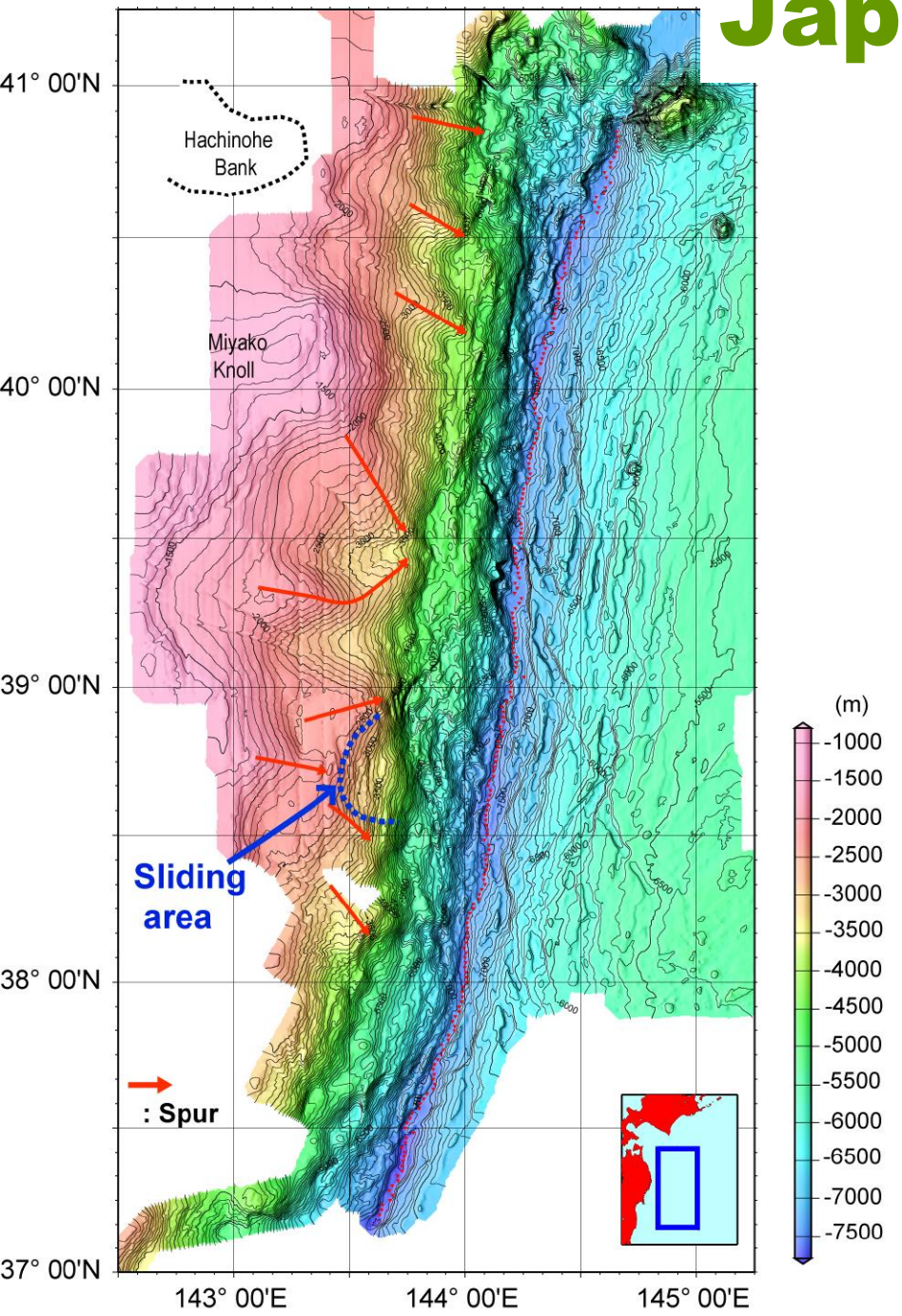
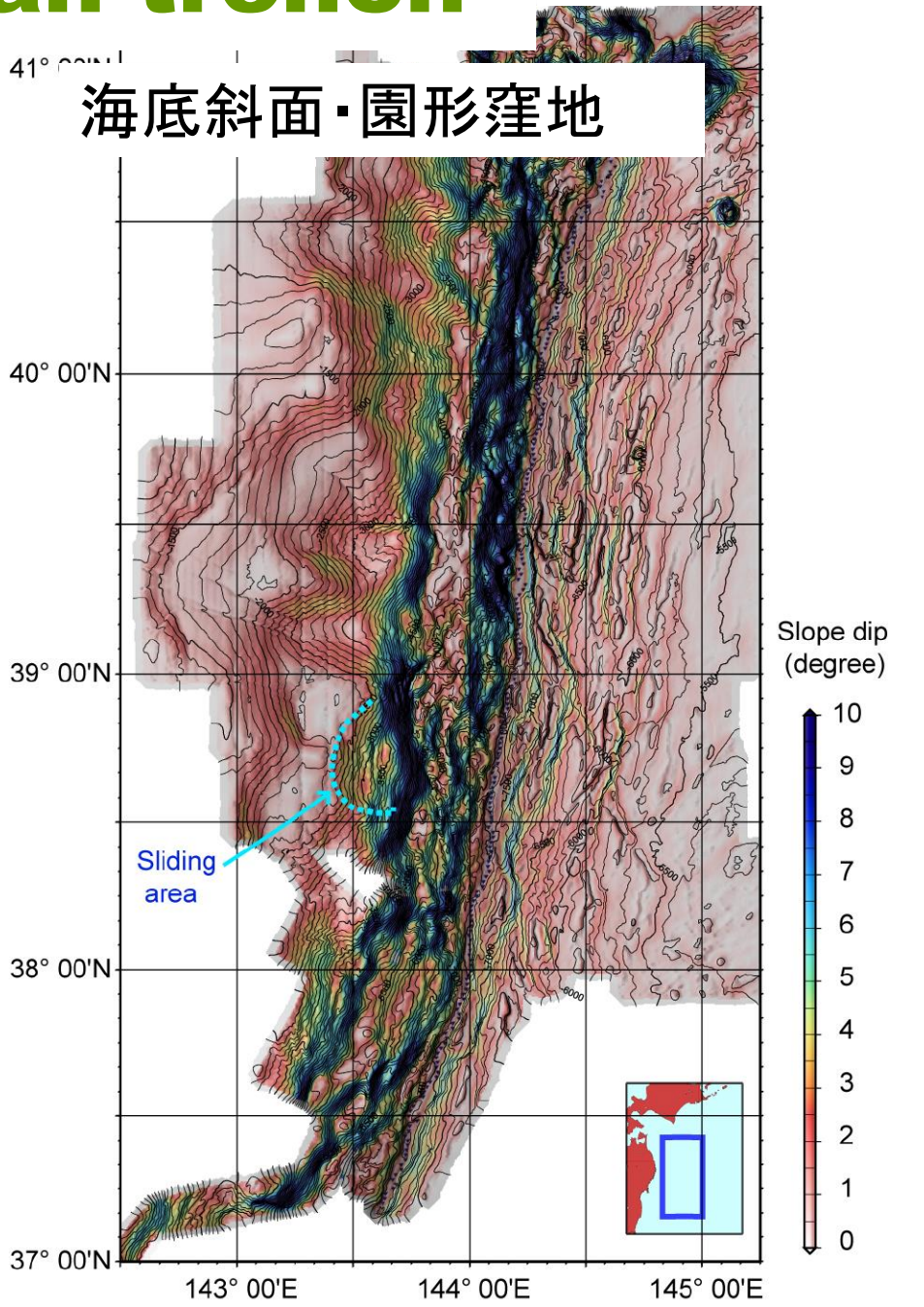


Fig. 4-8. Schematic illustration showing a large scale subduction erosion (tectonic erosion) ocurring in the trench landward slope. Its detailed diagram shows sediments subduction of the trench deposits and slumped mass in below. Bold dashed line denotes plausible subduction plate boundary between the overlying North American plate and underlying Pacific plate.

Japan trench

Sasaki (2003)





Japan trench

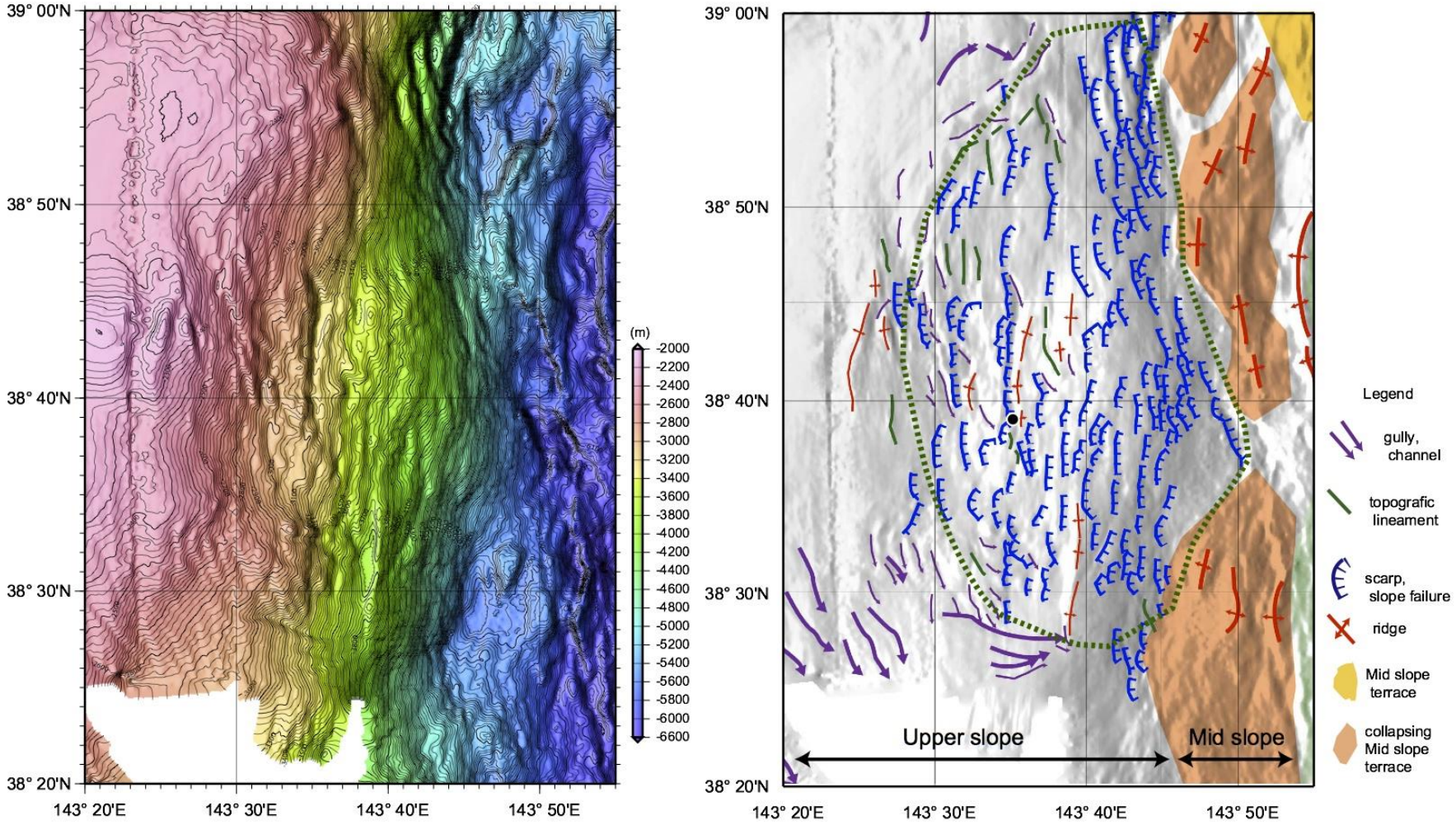


Figure 19. Close up view of the upper slope topografic features, box D in the figure 15 and it's structural map. Bathymetric contour interval is 20 meters. Green thick dotted line show the sliding basin between spurs. Note that scarps and slope failures, channels are developing in the basin at the lower most part of the Upper slope. Small black circle in the right side map showing the research diving point of "KAIKO" dive 245.

窪地事例･活動的海底地滑地形　　Sasaki (2003)

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地震事前

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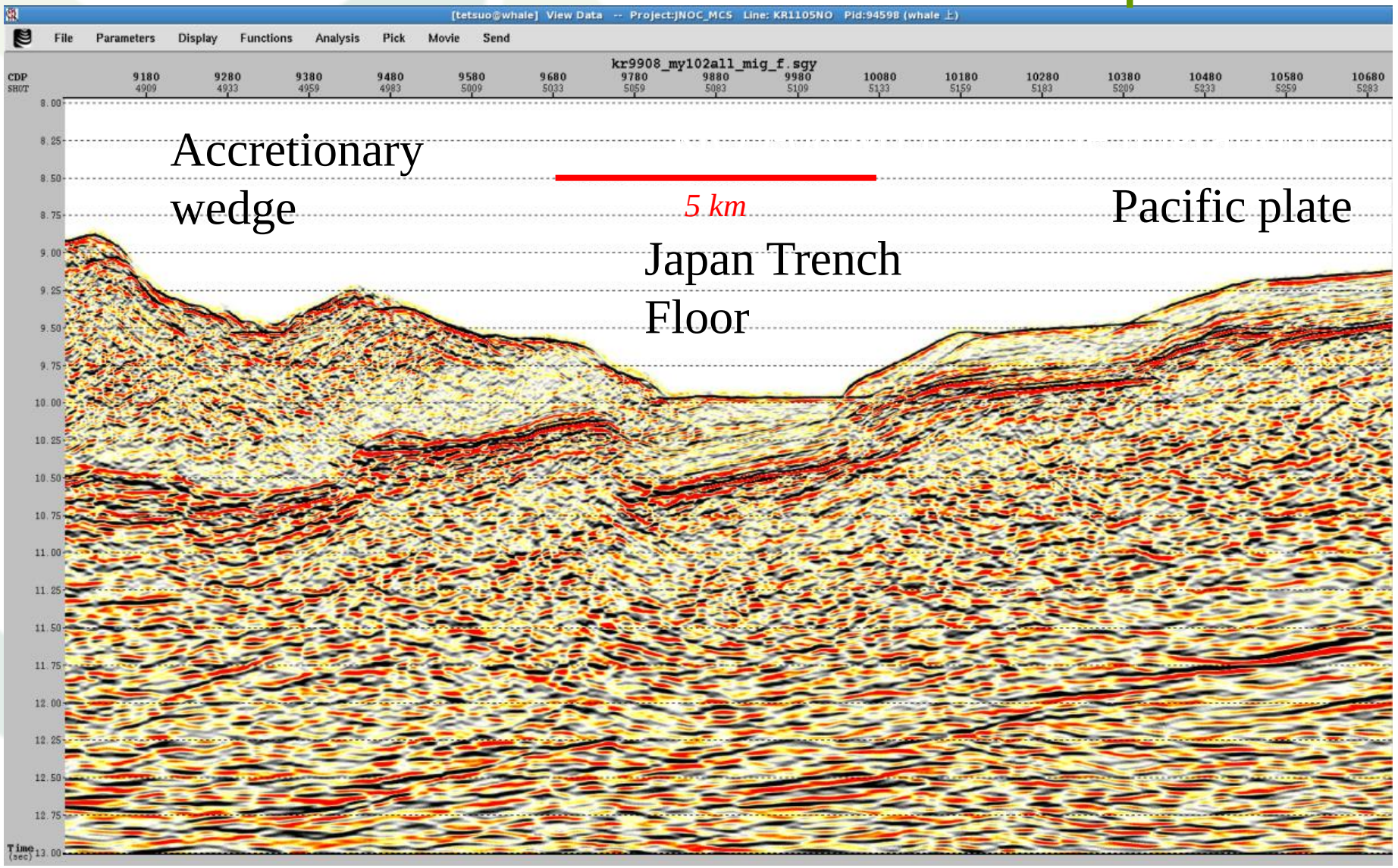
Kodaira et al., 2012, Nature Geoscience

Before the 2011 Tohoku Earthquake



地震事後

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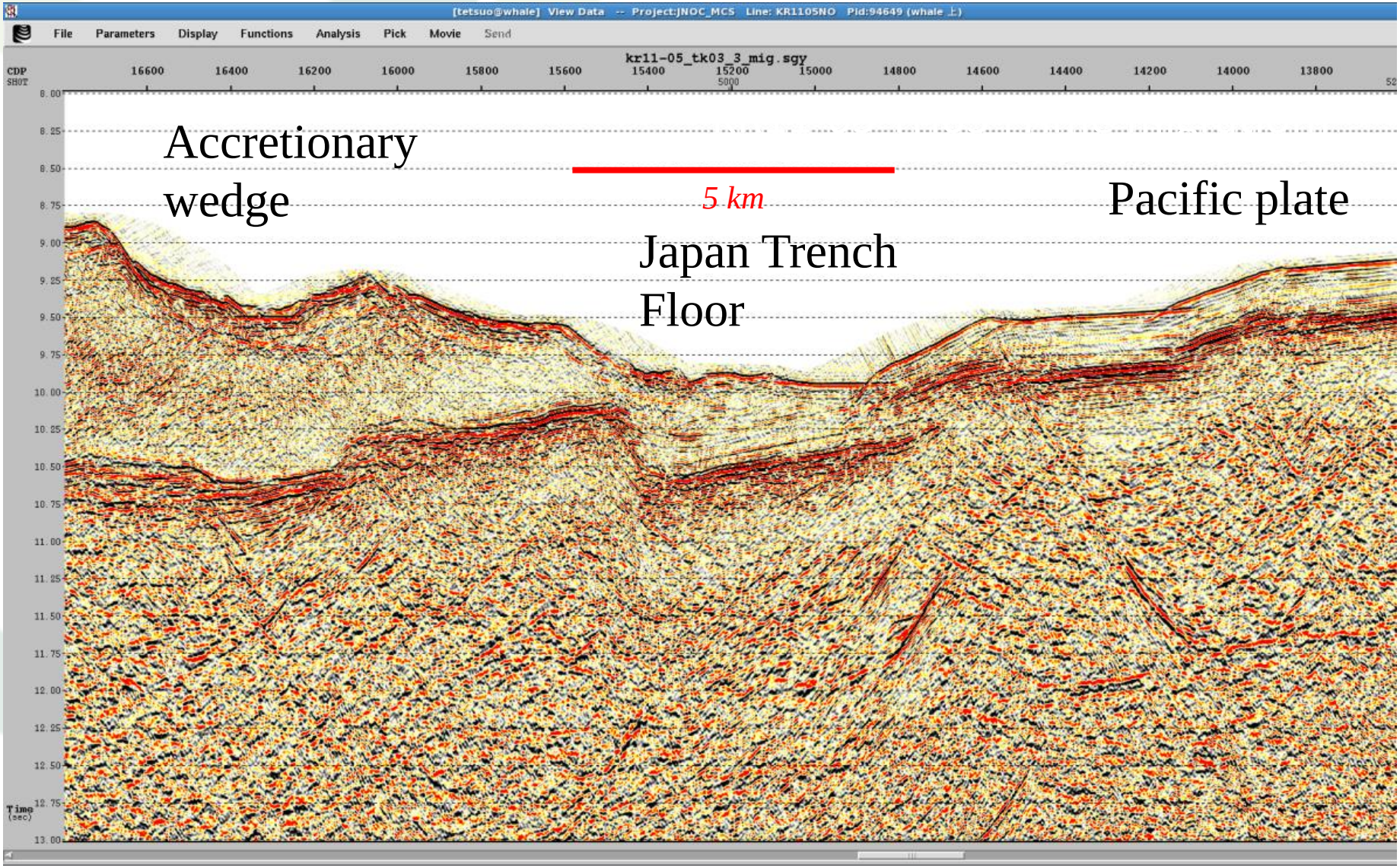
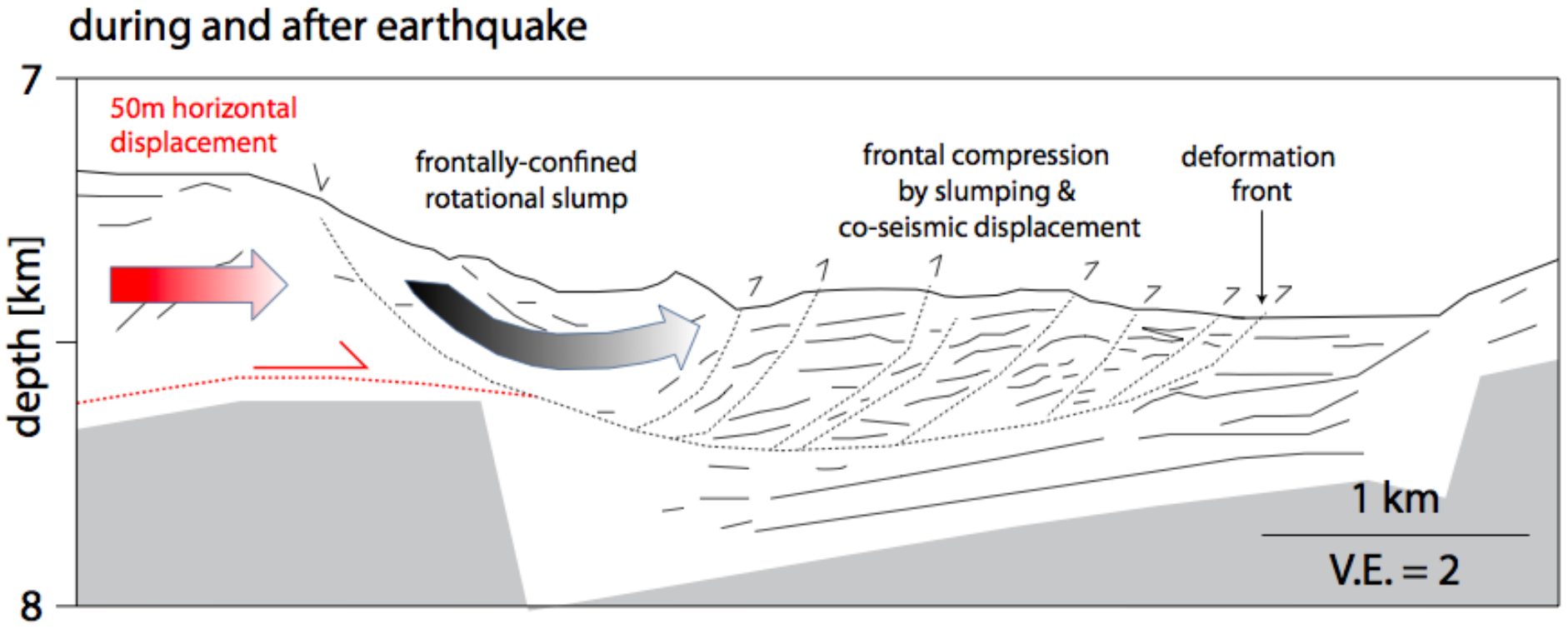
Kodaira et al., 2012, Nature Geoscience

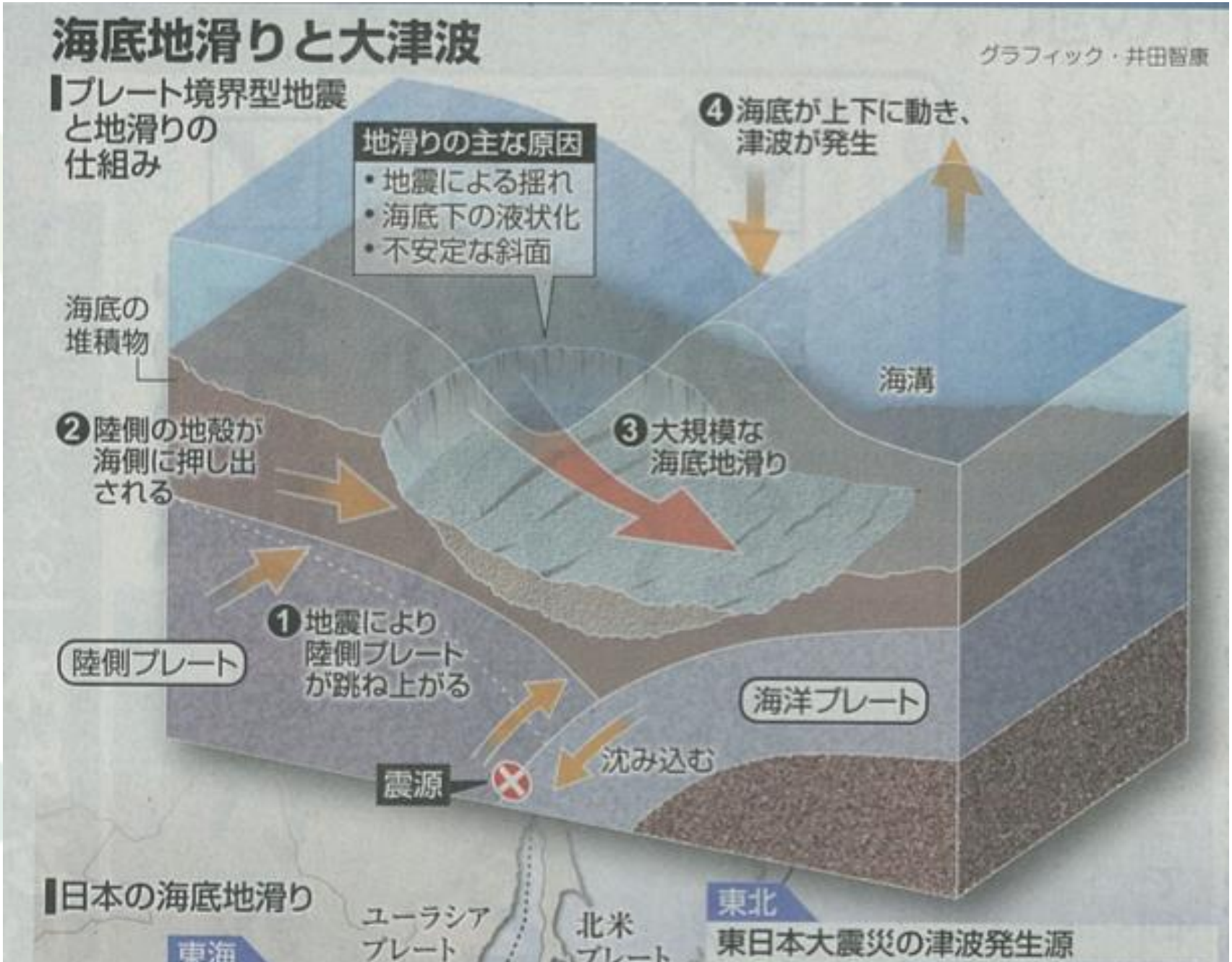
After the 2011 Tohoku Earthquake



At the toe of the wedge around the trench floor



Strasser et al. (2013) Geology


海底地滑りと大津波
グラフィック・井田智康
プレート境界型地震と地滑りの仕組み
地滑りの主な原因
・地震による揺れ
・海底下の液状化
・不安定な斜面
❹海底が上下に動き、津波が発生
海底の堆積物
海溝
❷陸側の地殻が海側に押し出される
❸大規模な海底地滑り
❶地震により陸側プレートが跳ね上がる
陸側プレート
海洋プレート
沈み込む
震源
日本の海底地滑り
ユーラシアプレート
北米プレート
東北
東日本大震災の津波発生源
東海

Summary

- Submarine landslides are serious threat to human society.
- We could observe submarine landslides around Japan. They might be related to earthquakes and tsunamis, but it is not well known.

Recent surveys around the Japan trench

related to 2011 Tohoku-Oki earthquake

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