Submarine Geohazard Risks and Investigation/Research Activities in Taiwan

Char-Shine Liu

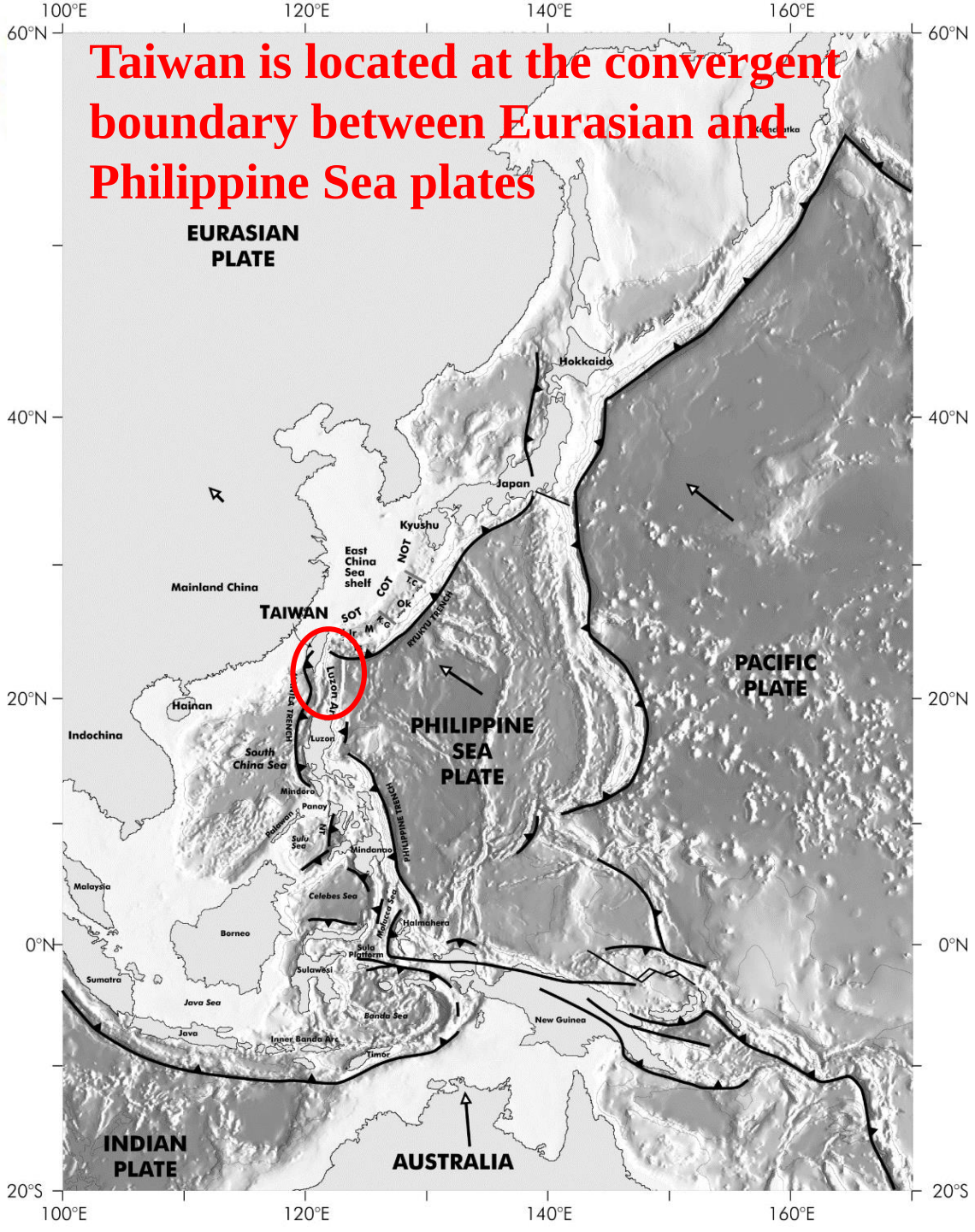
National Taiwan University

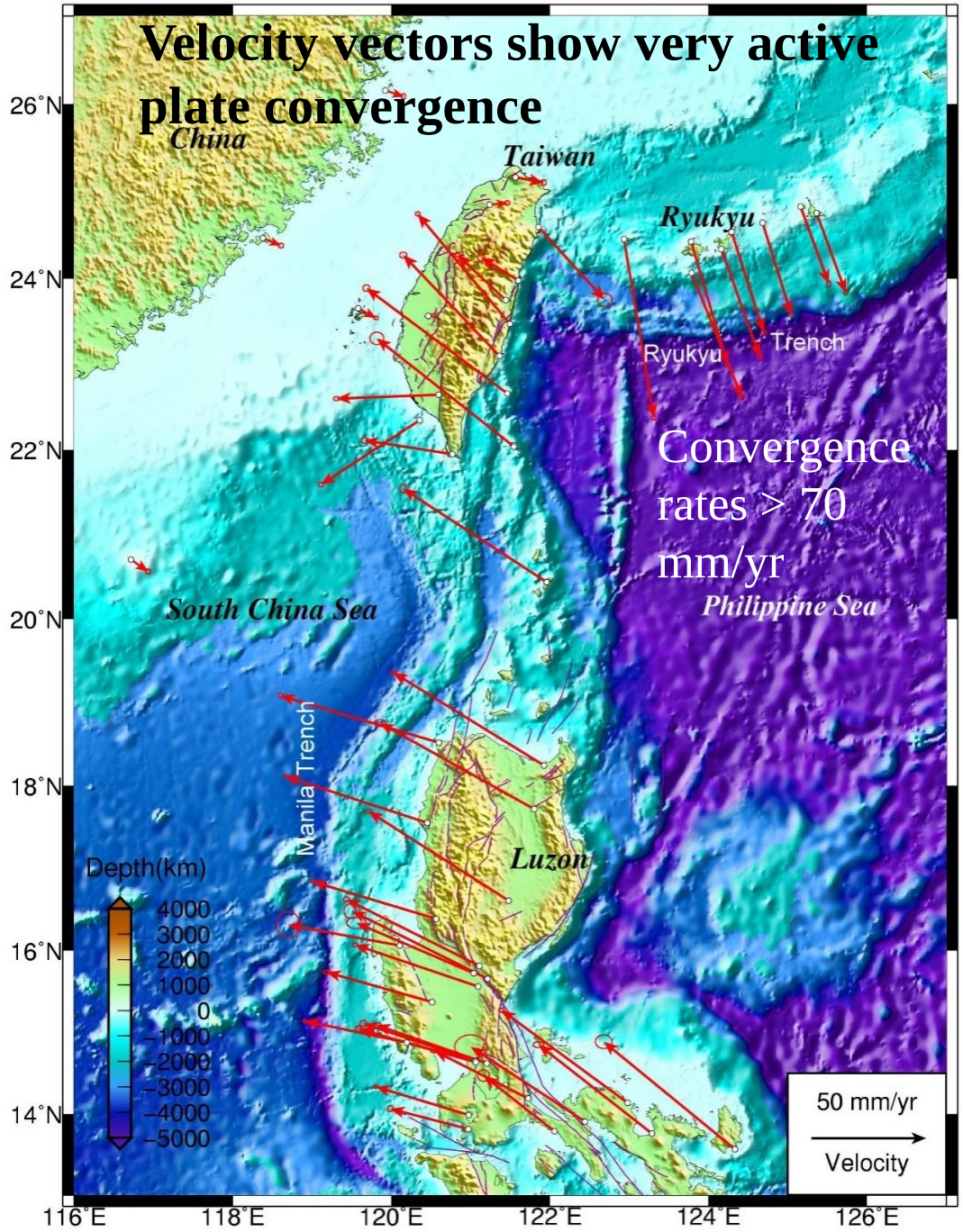
- Tectonic/Geological Settings of Taiwan and Related Natural Submarine Geohazards

- Geohazard risks and investigation/mitigation for offshore engineering works

IUGS-TGSG 1st EC Meeting. 2023.05.02.

Taiwan is located at the convergent boundary between Eurasian and Philippine Sea plates



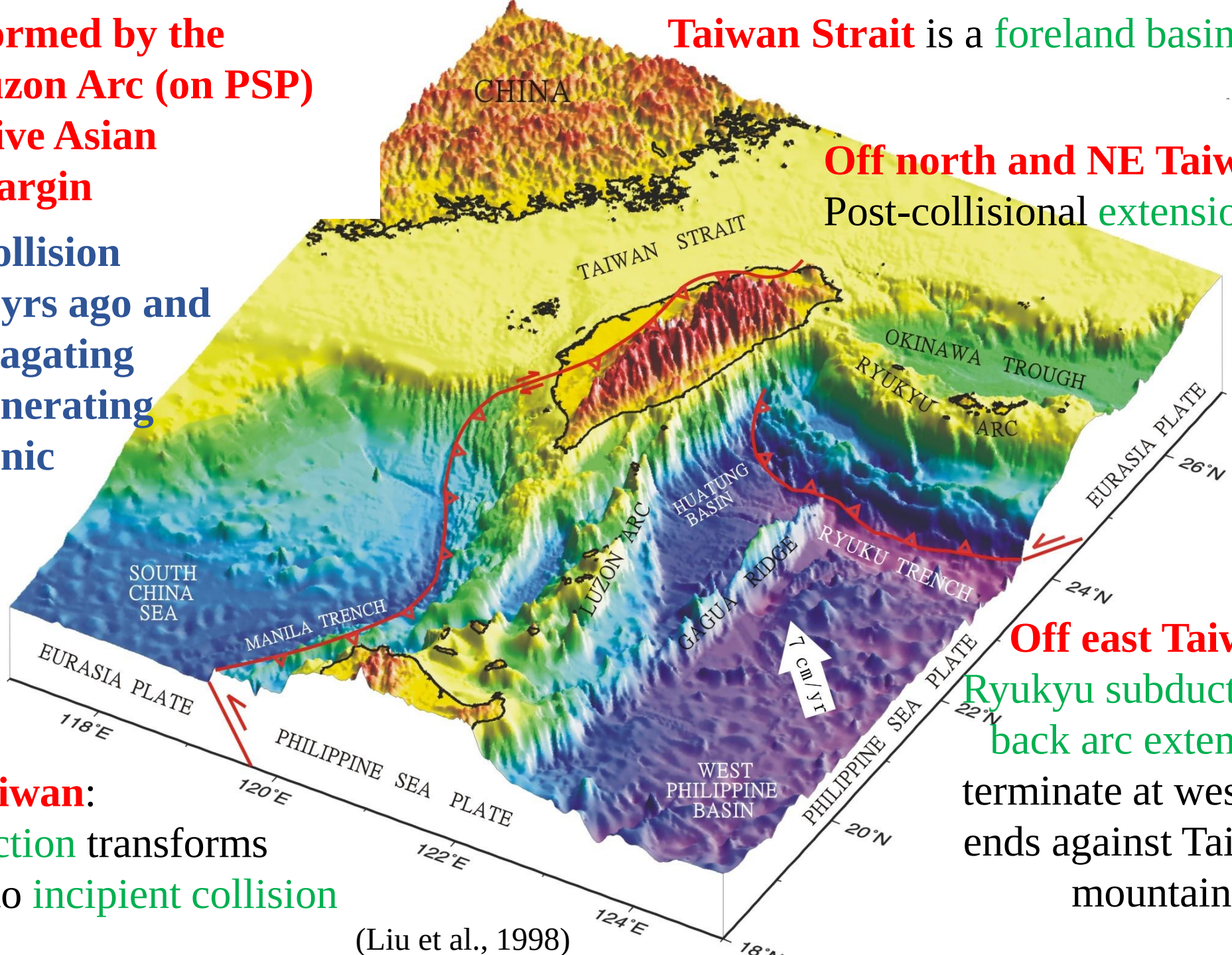


Taiwan was formed by the collision of Luzon Arc (on PSP) with the passive Asian continental margin

The oblique collision initiated ~5 Myrs ago and has been propagating southward, generating different tectonic settings.

Taiwan Strait is a foreland basin

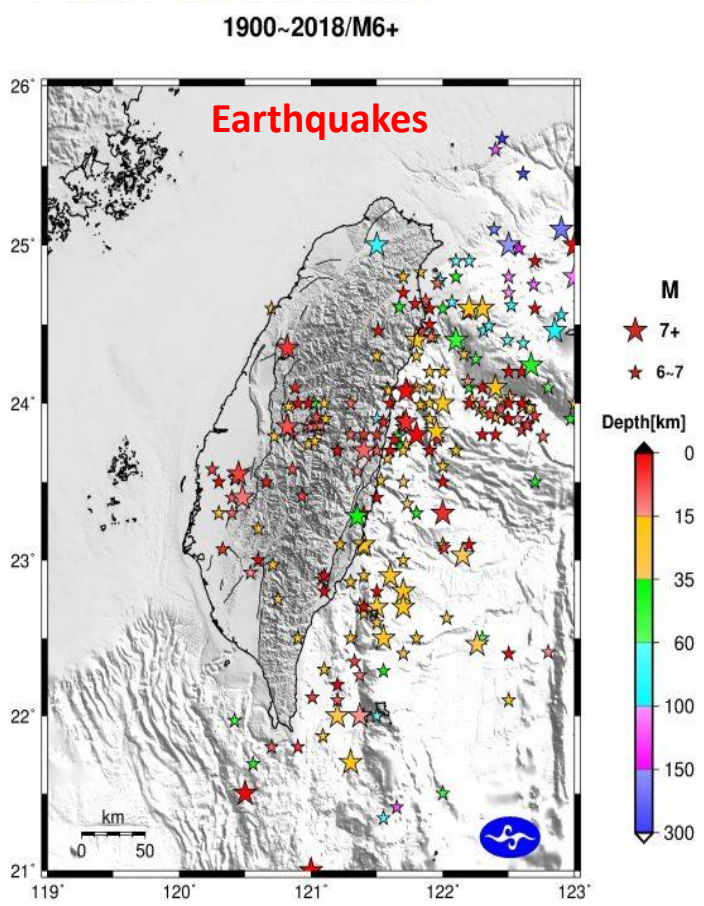
Off north and NE Taiwan: Post-collisional extension

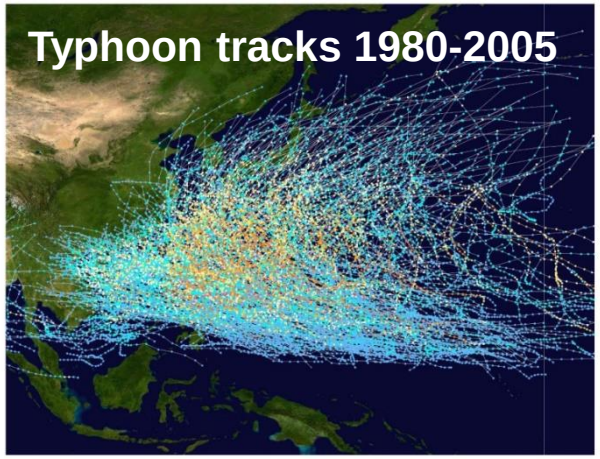


(Liu et al., 1998)

Off east Taiwan: Ryukyu subduction-back arc extension terminate at western ends against Taiwan mountain belt

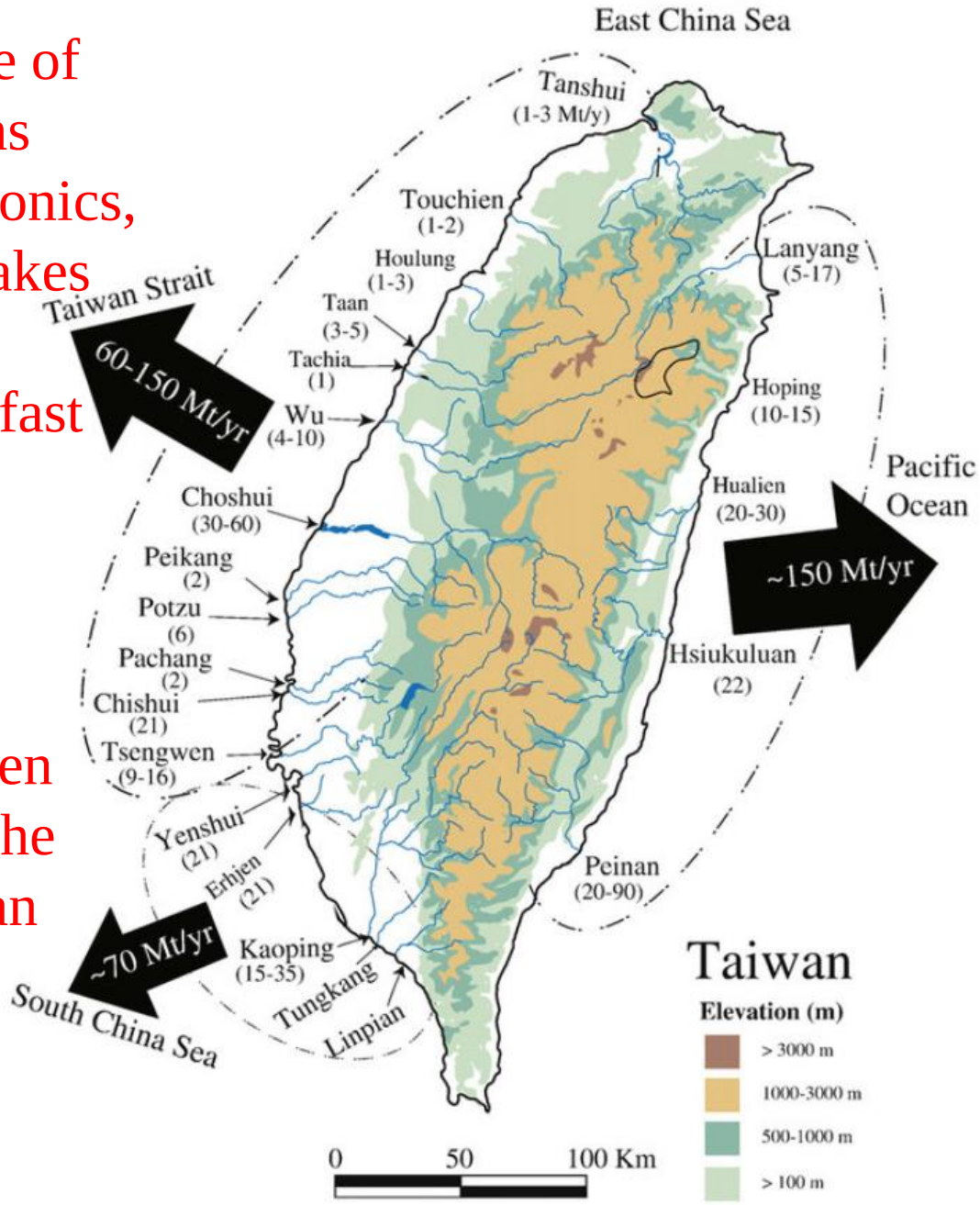
Off south Taiwan: Luzon subduction transforms northward into incipient collision





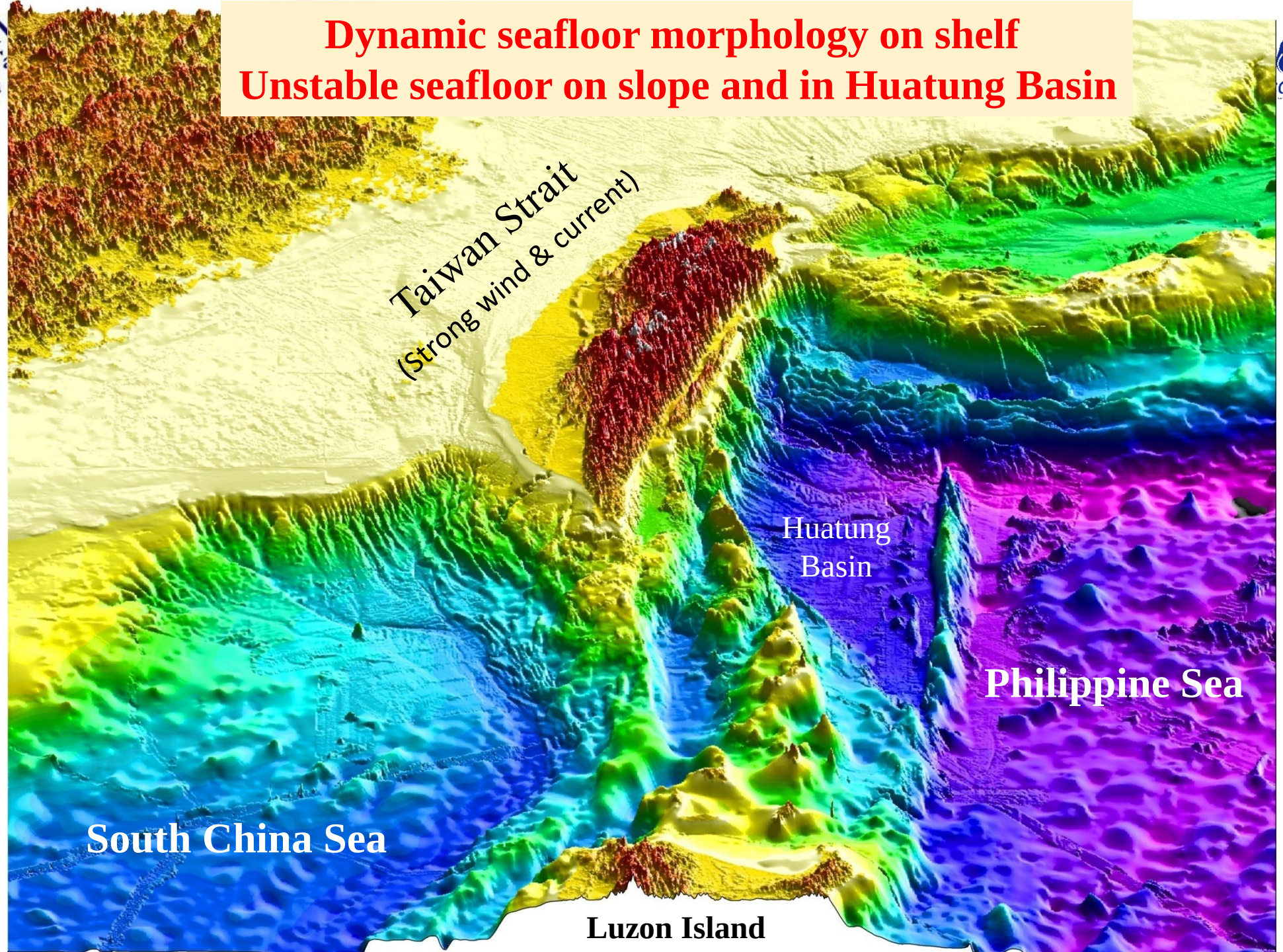
Fast uplifting rate of Taiwan mountains due to active tectonics, frequent earthquakes and typhoons all contribute to the fast erosion on land Taiwan.

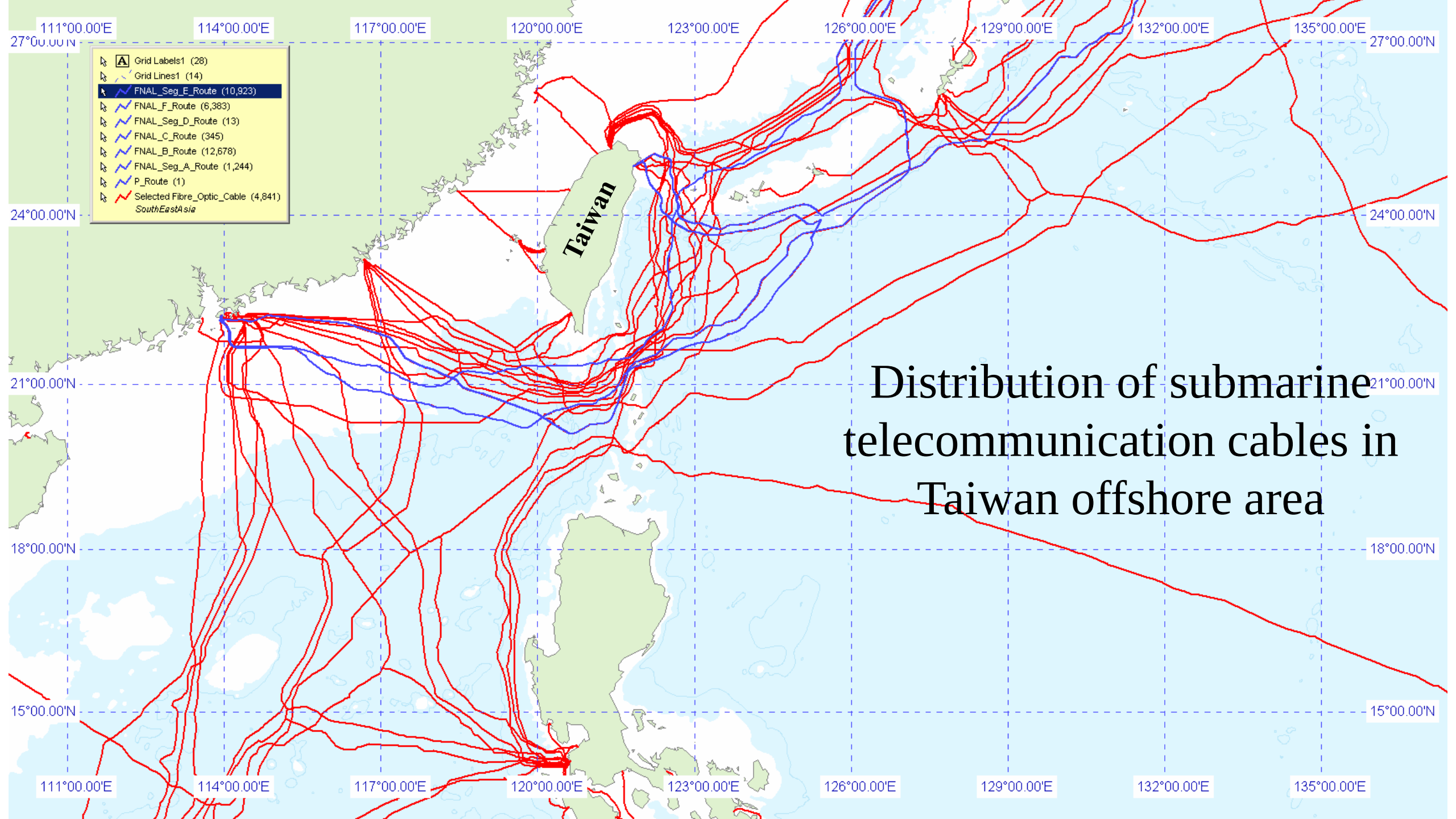
Huge amount of sediments has been transported into the sea around Taiwan (Milliman et al., 2002)

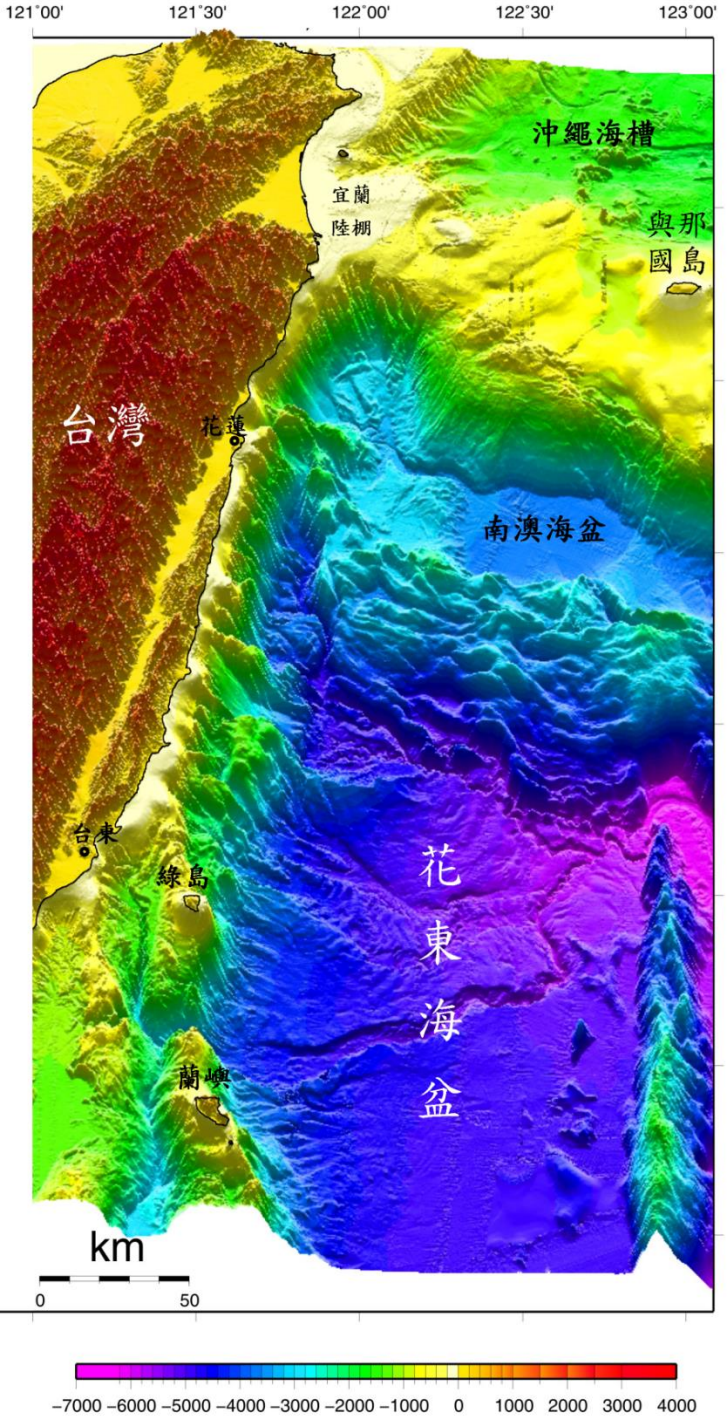


（Milliman et al., 2002）

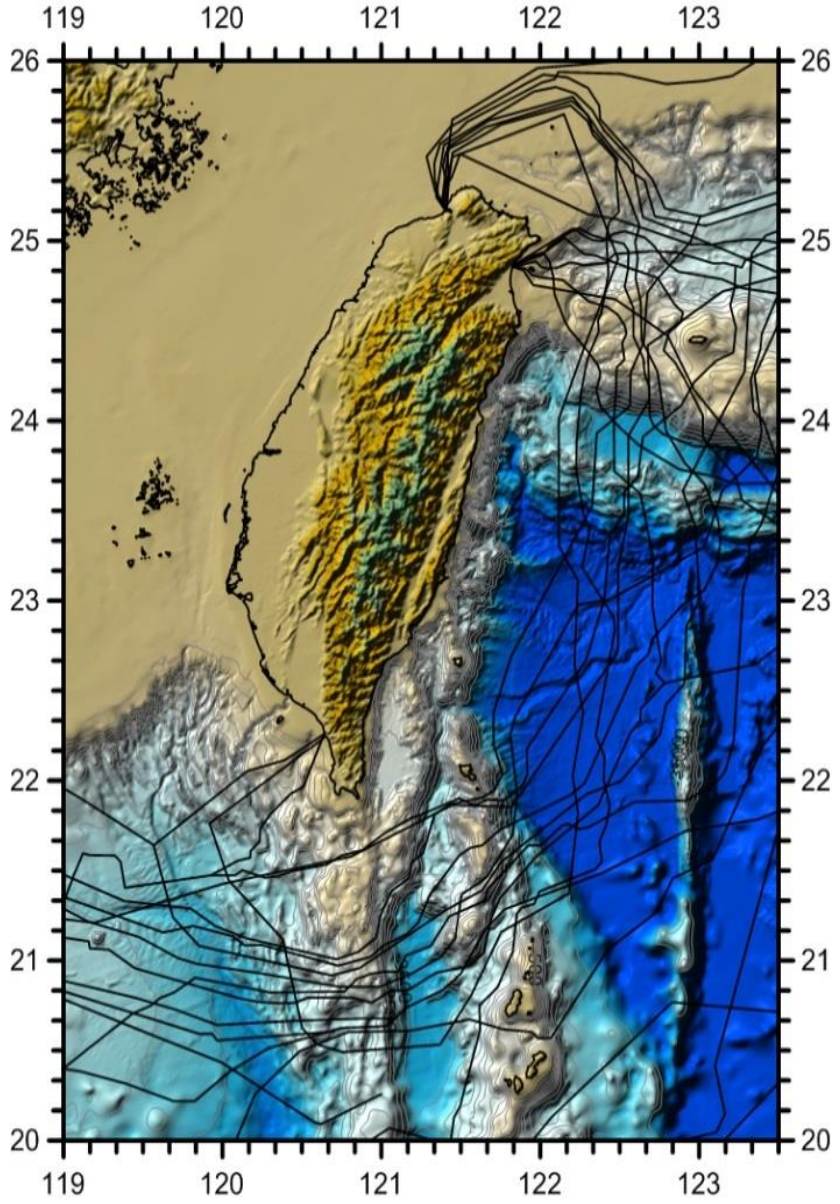
Dynamic seafloor morphology on shelf
Unstable seafloor on slope and in Huatung Basin



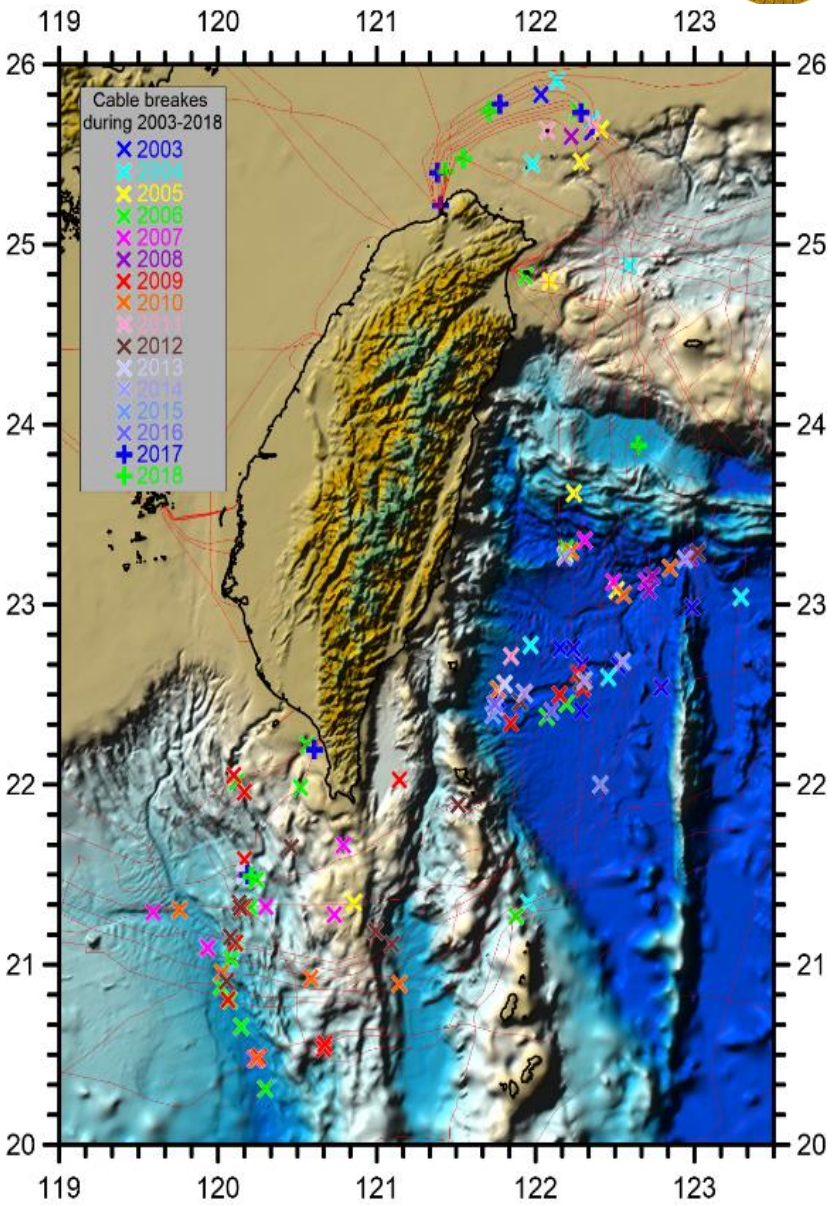

Grid Labels1 (28)
Grid Lines1 (14)
FNAL_Seg_E_Route (10,923)
FNAL_F_Route (6,383)
FNAL_Seg_D_Route (13)
FNAL_C_Route (345)
FNAL_B_Route (12,678)
FNAL_Seg_A_Route (1,244)
P_Route (1)
Selected Fibre_Optic_Cable (4,841)
SouthEastAsia
Taiwan
111°00.00'E
114°00.00'E
117°00.00'E
120°00.00'E
123°00.00'E
126°00.00'E
129°00.00'E
132°00.00'E
135°00.00'E
27°00.00'N
24°00.00'N
21°00.00'N
18°00.00'N
15°00.00'N
Distribution of submarine telecommunication cables in Taiwan offshore area



Distribution of submarine cables

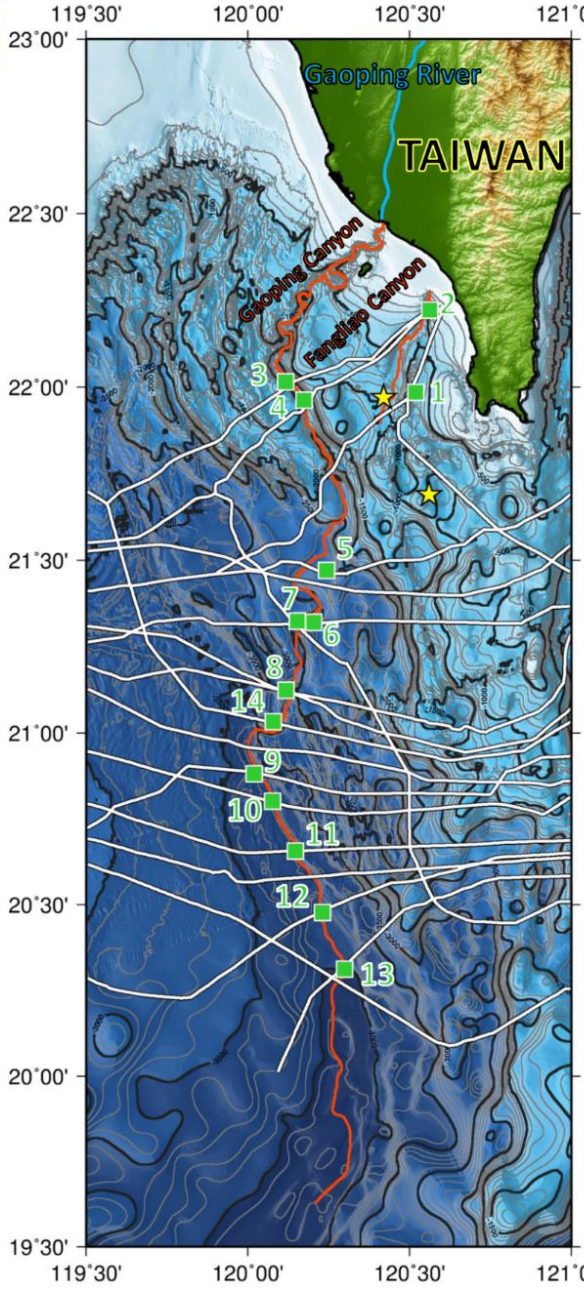


2003－2018 cable broken locations



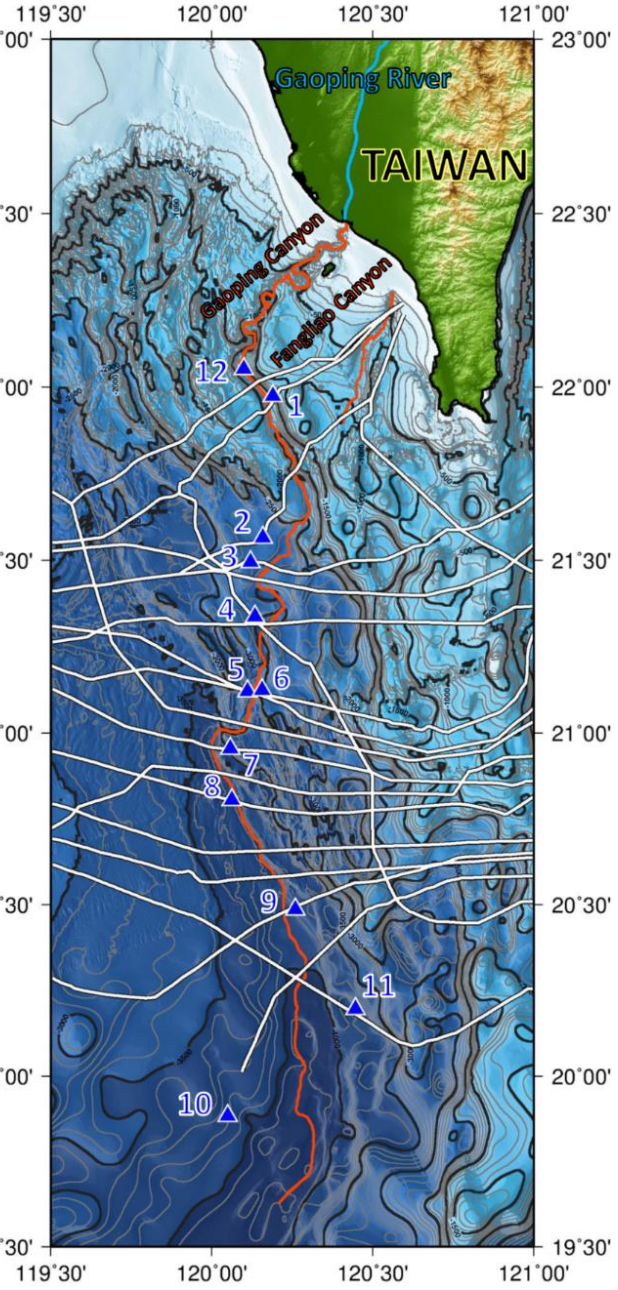
(Provided by Don Su, 2020)

2006 Pingtung Earthquake



(Hsu et al., 2008)

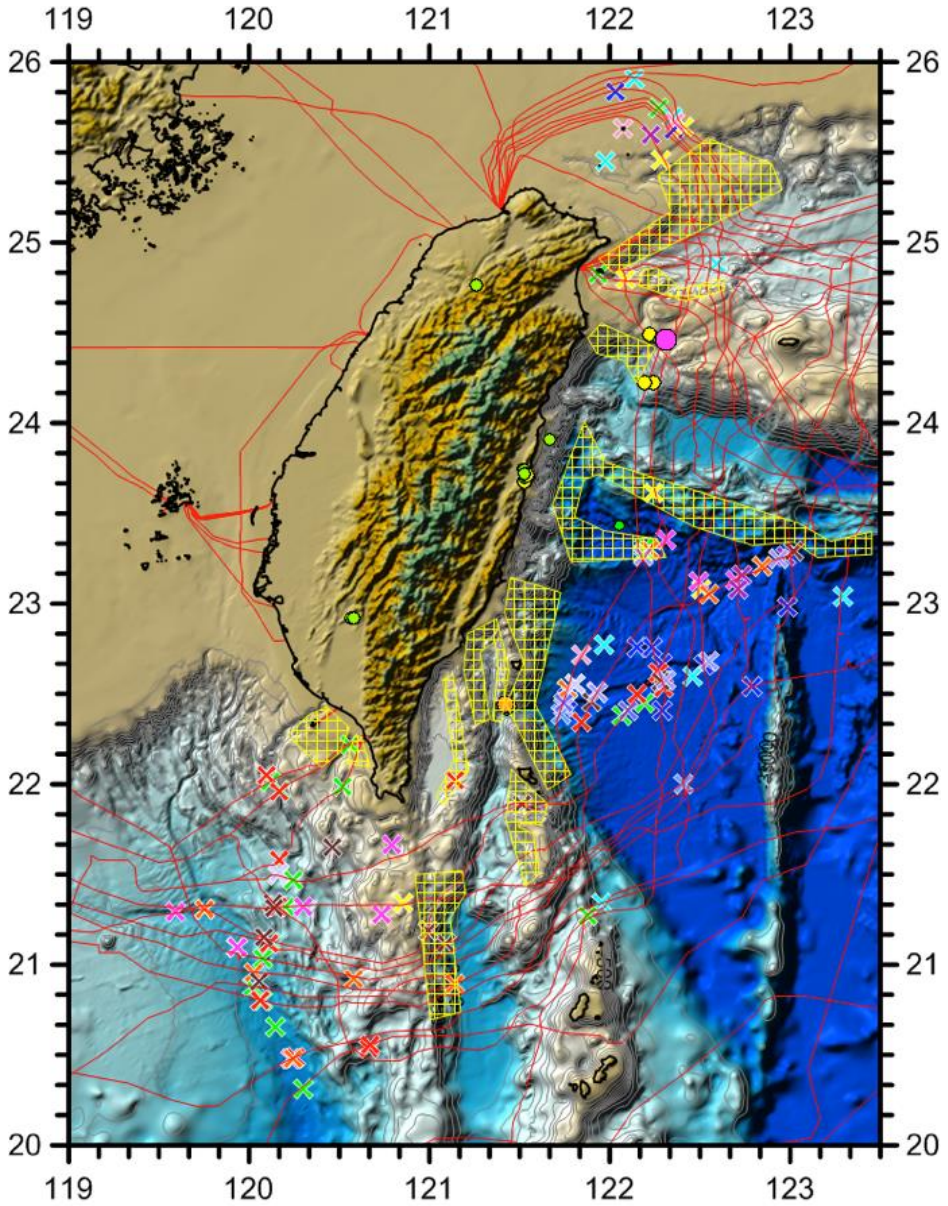
2009 Typhoon Morakot



(Carter et al., 2012)

High risk of cable breakage zones

(yellow mesh zones)



(Provided by Don Su, 2020)

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MG&G Investigations for OWF in Taiwan Strait

OWF seismic surveys in central TS
Energy Bureau, MOEA 2017-2018

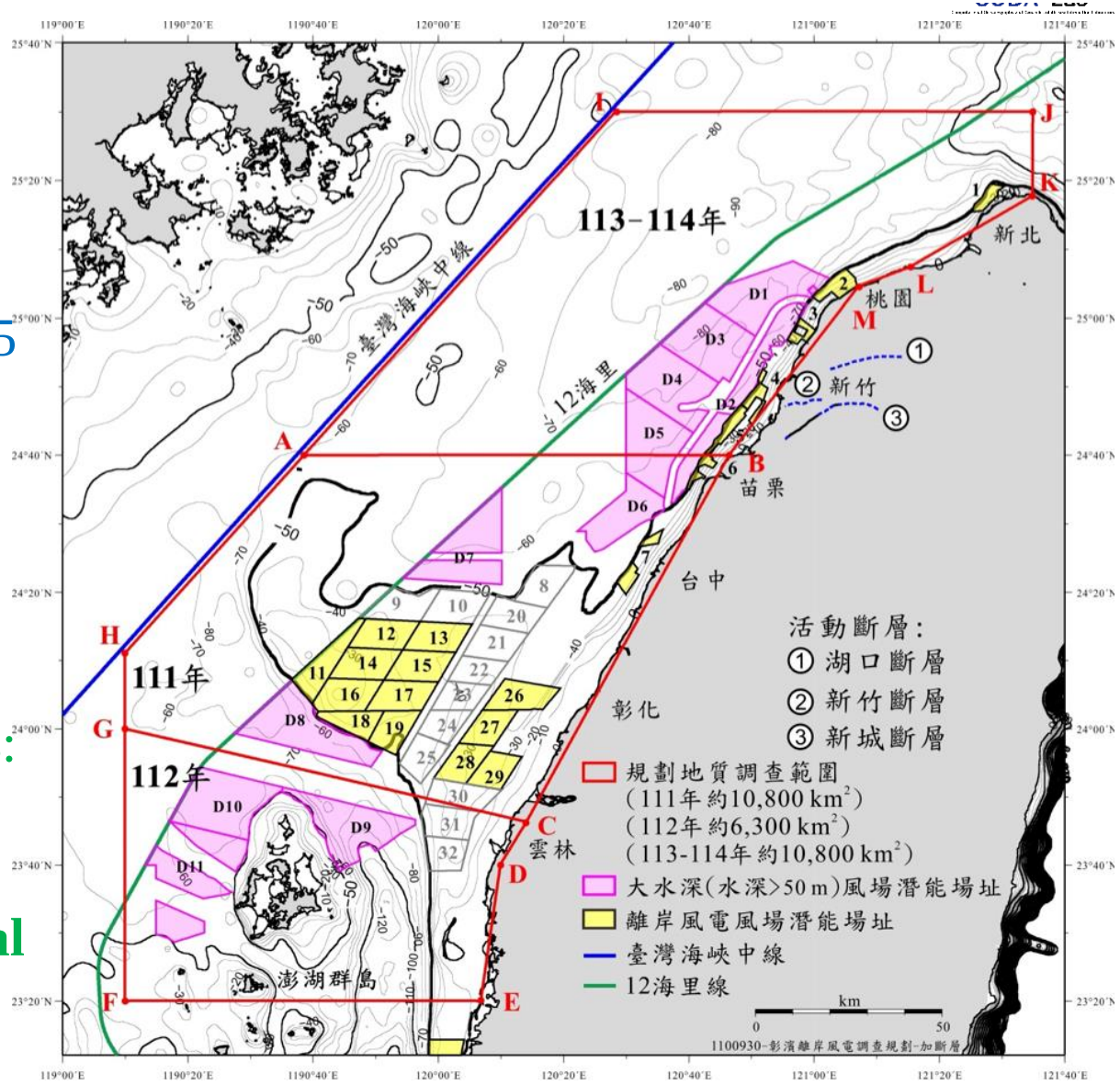
MG&G surveys for all potential OWF in TS
Central Geological Survey, MOEA 2022-2025

Factors contributing to potential geohazard risks in Taiwan Strait

@ Large variation of metocean conditions:
Large seafloor morphologic variations.

@ Fast and dynamic sedimentary processes:
Fast deposition, strong submarine erosion, fluid activities, liquefaction, etc.

@ Faults, igneous rocks and other geological features.

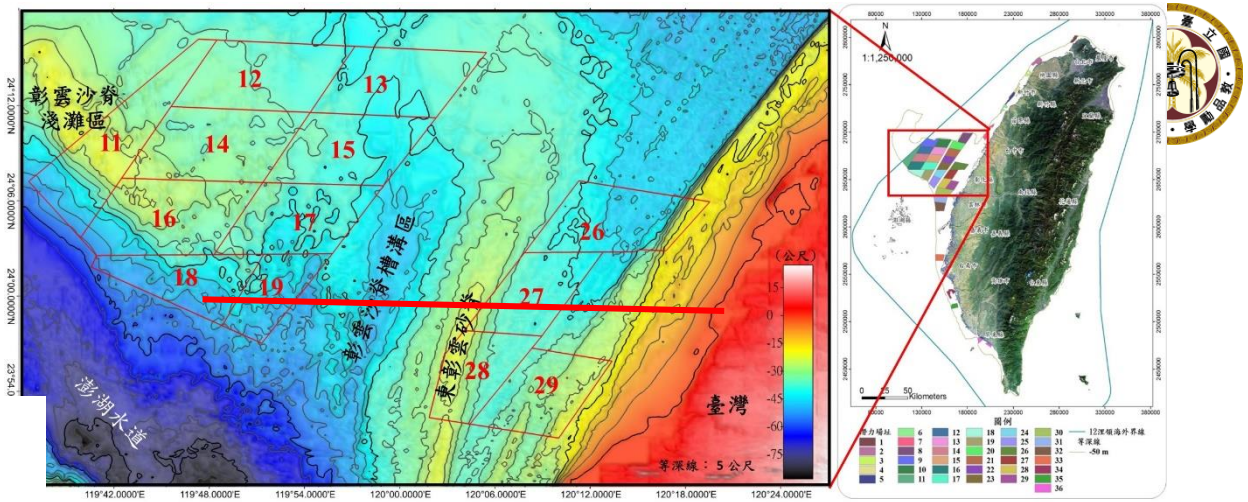


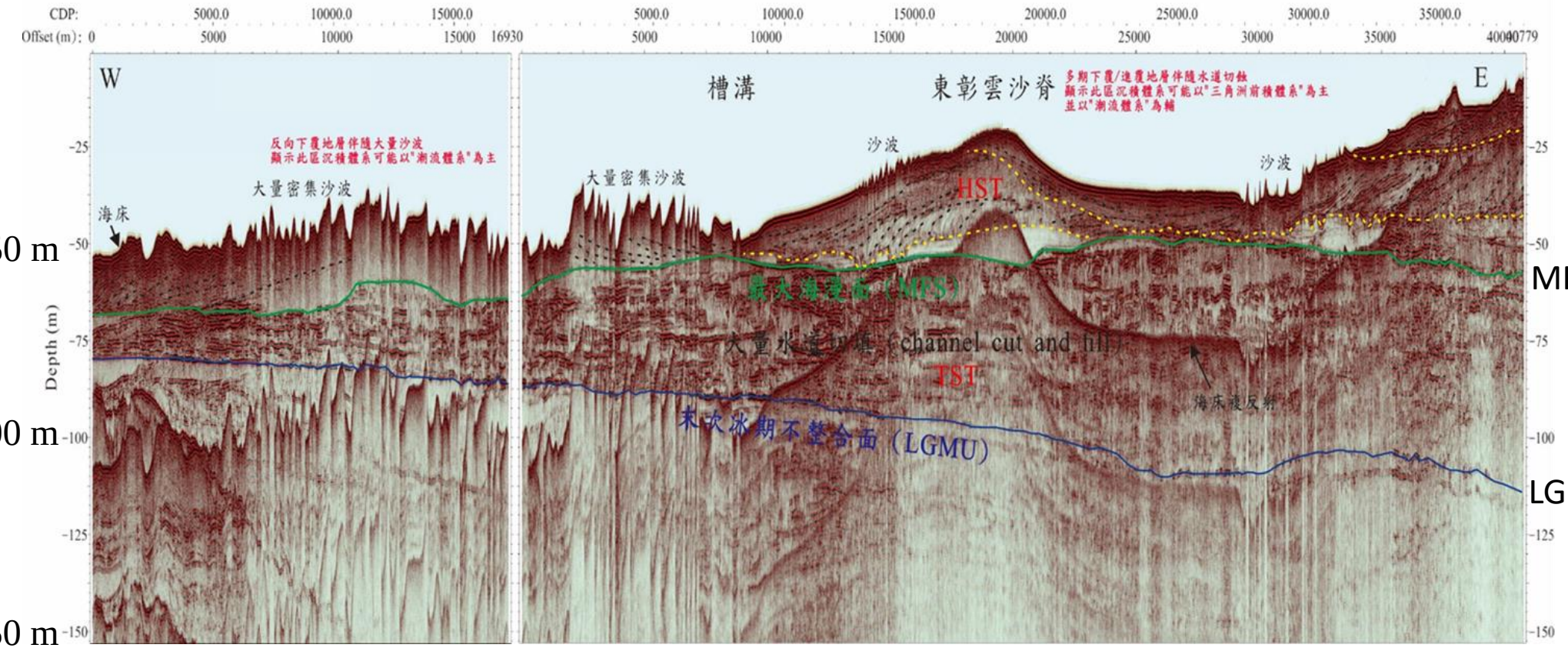
(CGS, 2021)

Seismic image of the OWF in TS

Complex sand waves, sand ridges, channel cuts and fills, and fan delta deposits near shore are observed.

MFS: Maximum flooding surface
LGMU: Last glacial maximum unconformity





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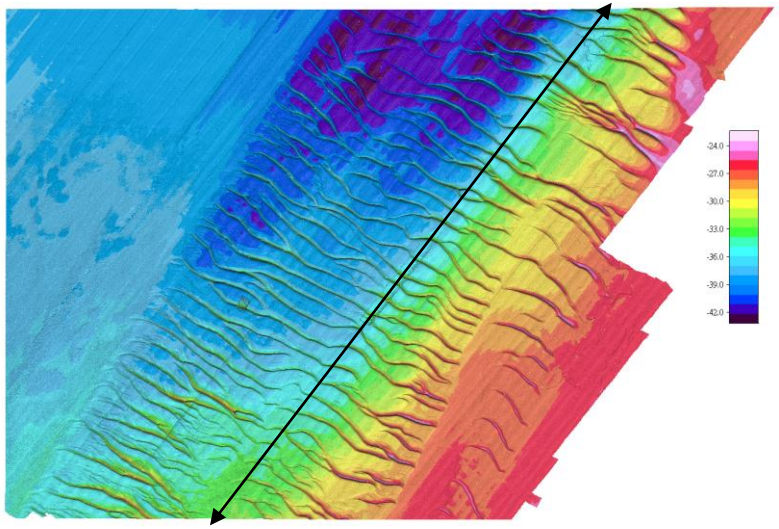
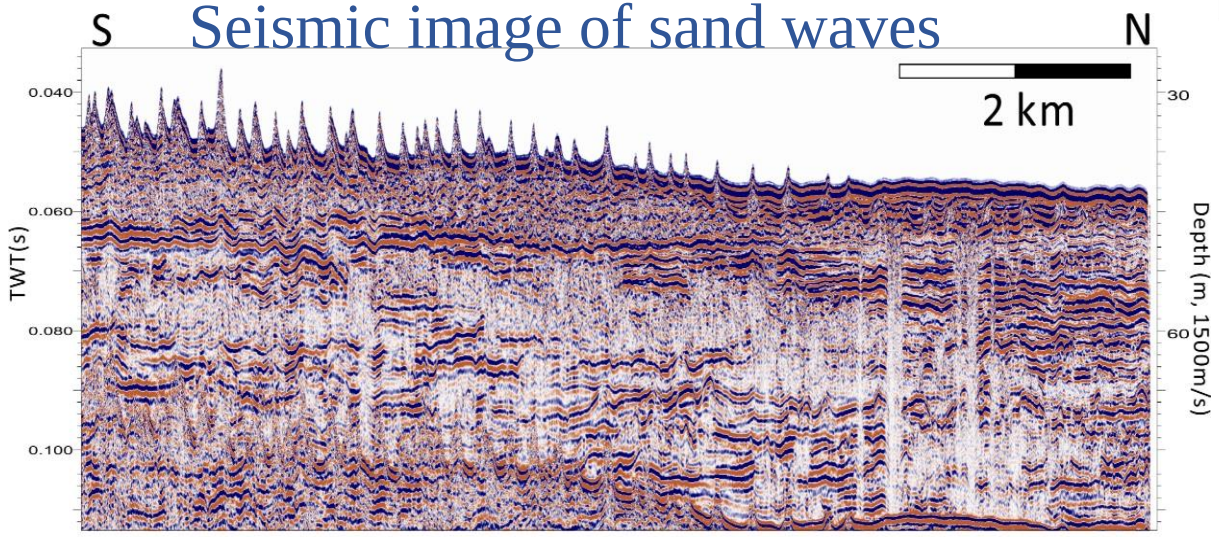
Taiwan Strait Sand Waves

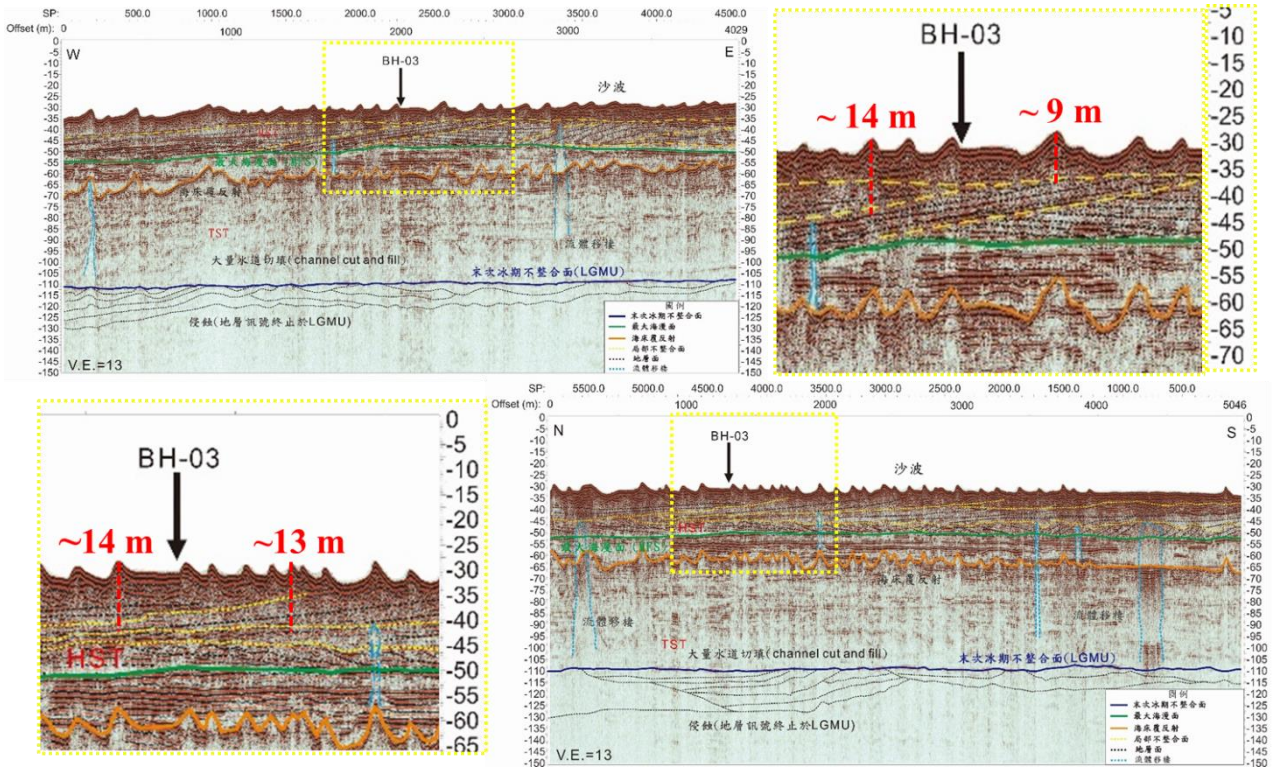


Seismic image of sand waves



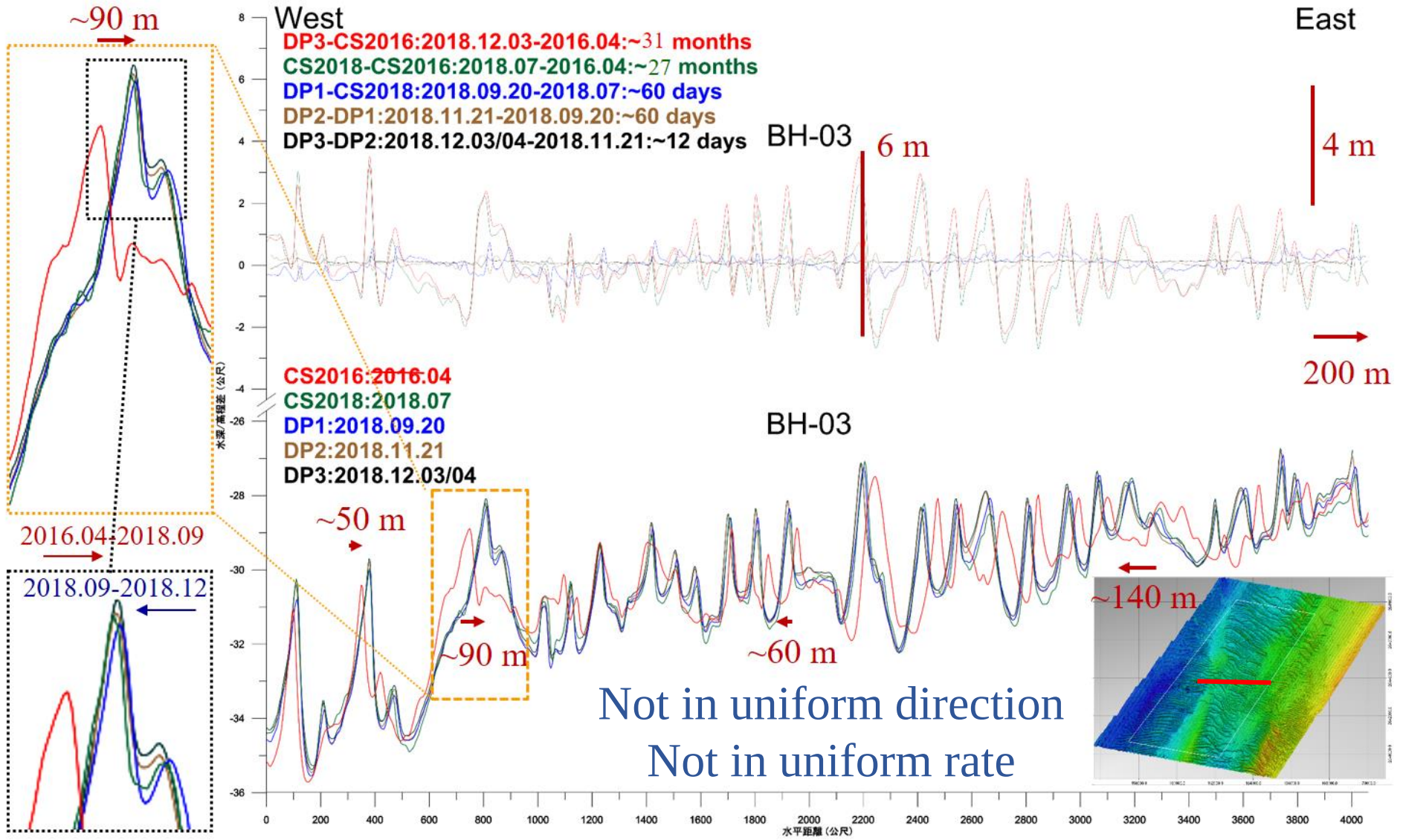
Fluid activities observed in substrata

Sand Wave Structures Analysis



Base of mobile sand layer could lie >10 m below seafloor

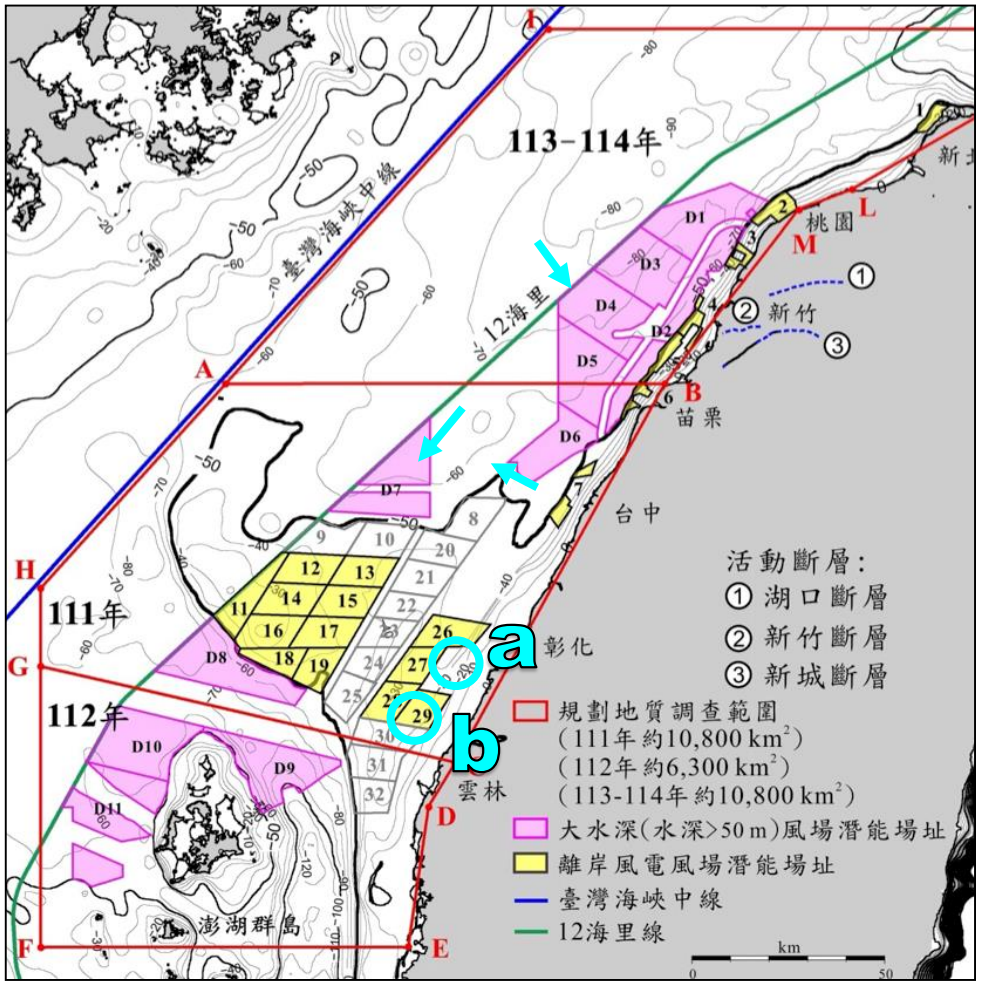
Dynamic Sand Wave Movements

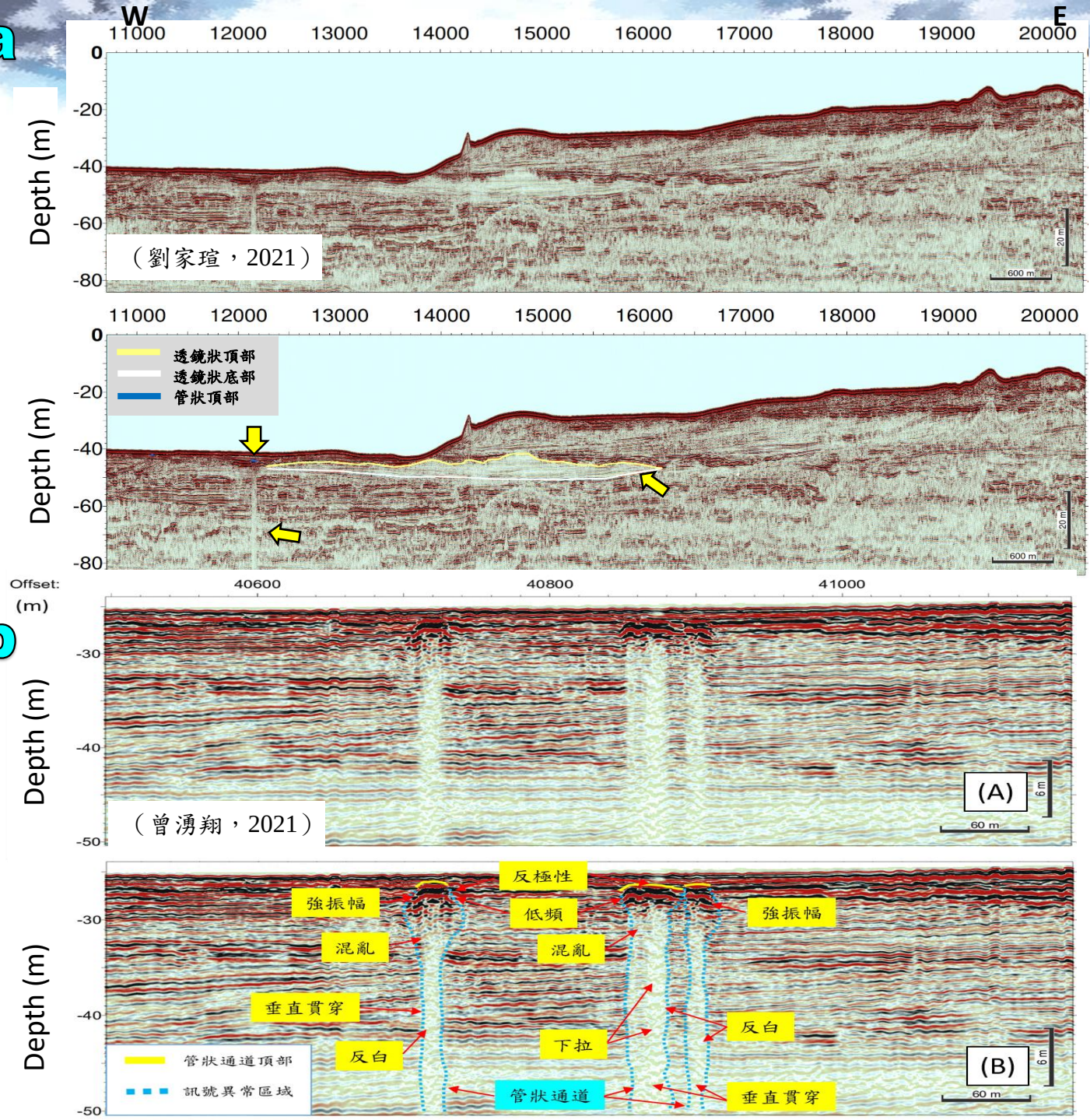


（廖音瑄，2020）

Fluid features

- Seismic chimmy, pockmark, lenticular white zone, etc. are observered in Taiwan Strait



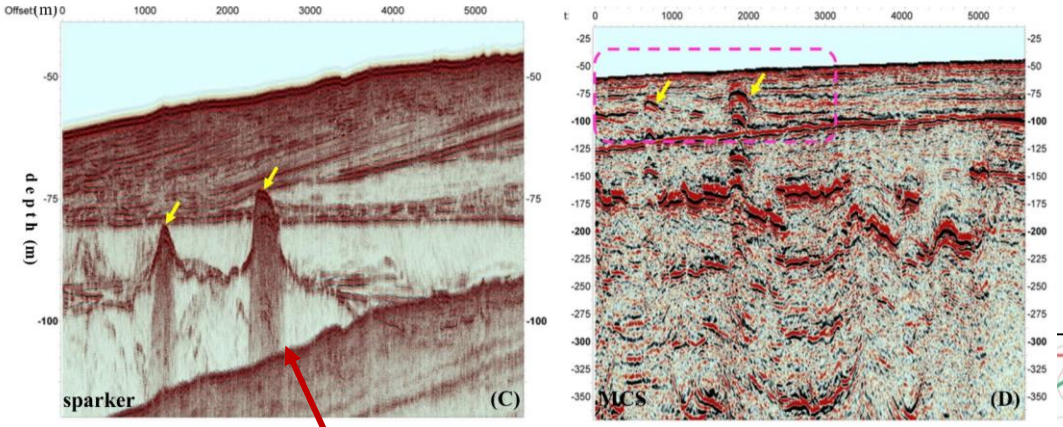


Potential Geohazard for OWF WTG Installation

(Shallow hard layer)

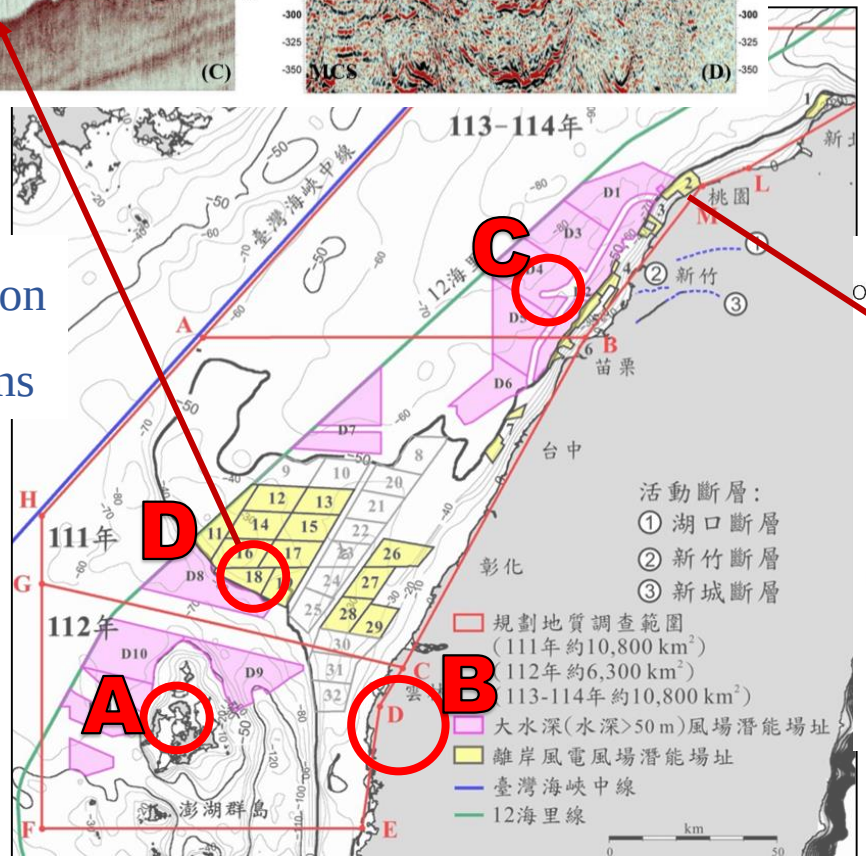
50-80 m below seafloor

Strong reflections



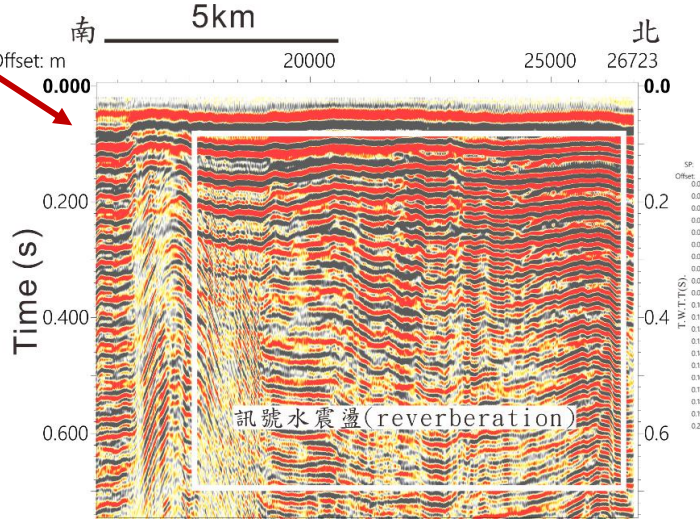
謝欣崧等，2018

Basalt intrusion and extrusions

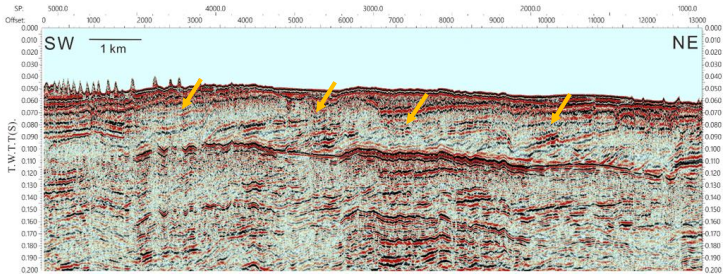


Miocene Basalt Distribution

位置	深度	參考文獻
A	0至320 公尺	(黃立勝、劉秀邦，1967)
B	1142至1422公尺	(原振維，1981)
C	海床下> 2500至2800公尺	(Lin A. et al., 2021)



Conglomerate layers below seafloor

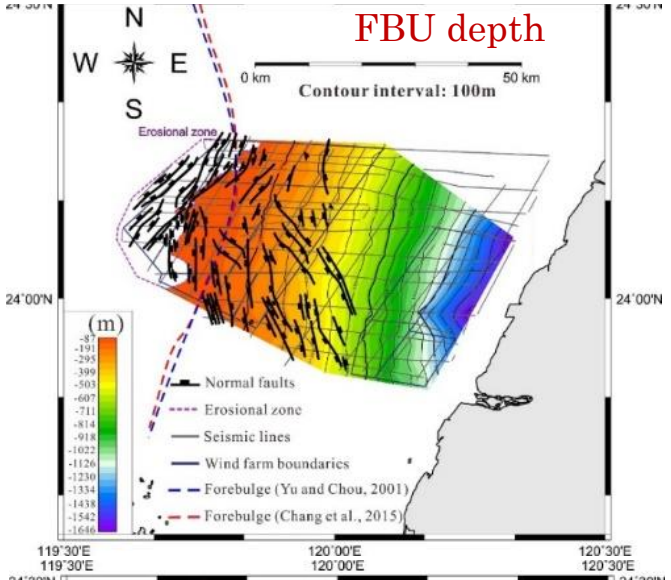


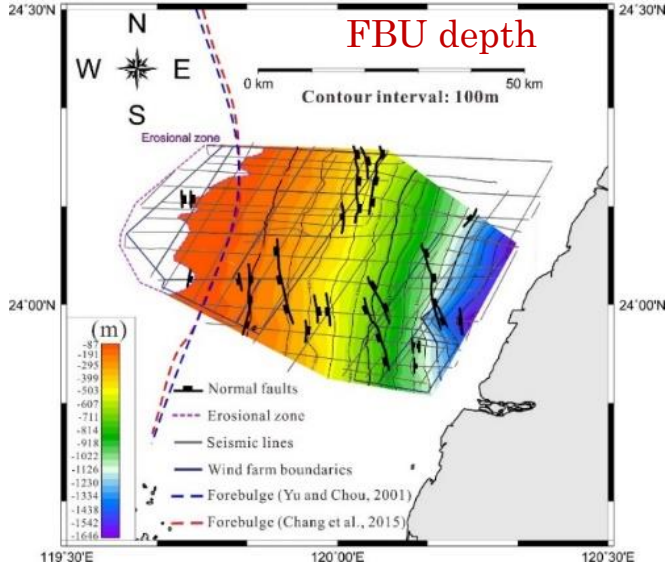
許鶴瀚等，2020

Fault Distribution Related to Major Stratigraphic Boundaries

Major boundaries	Age Depths
Maximum Flooding Surface **(MFS)**	5-6 Ka (0~84 m)
Last Glacial Maximum Unconformity **(LGMU)**	14-20 Ka (84~127 m)
Toukoshan/Cholan formation boundary **(To / Ch)**	0.9-1.25 Ma (143~864 m)
Foreland Basal Unconformity **(FBU)**	6-7 Ma (87~1646 m)

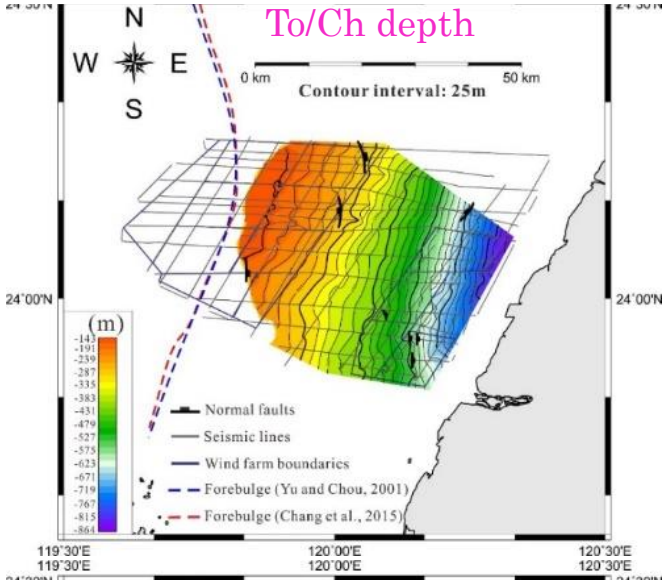
Faults developed below FBU

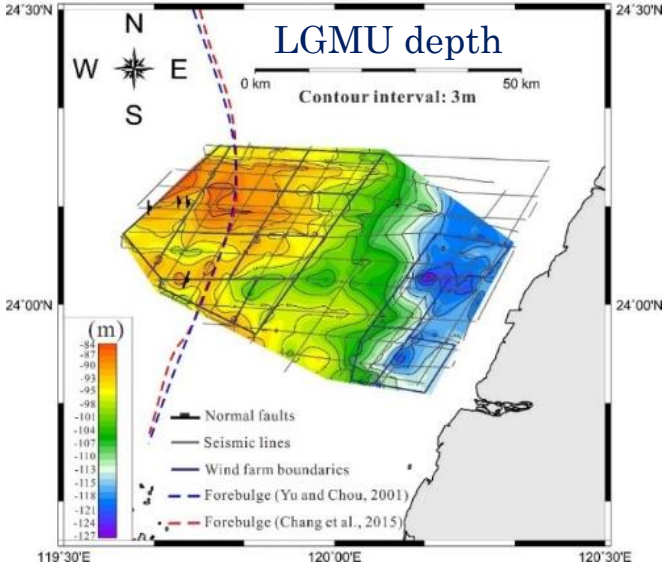




Faults cut through FBU

Faults cut through To/Ch





Faults cut through LGMU

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Geohazard information need to be considered in marine special planning and management