臺灣西南沈積物散佈系統及其從源到匯之意義

Sediment dispersal system of SW Taiwan in terms of source-to-sink

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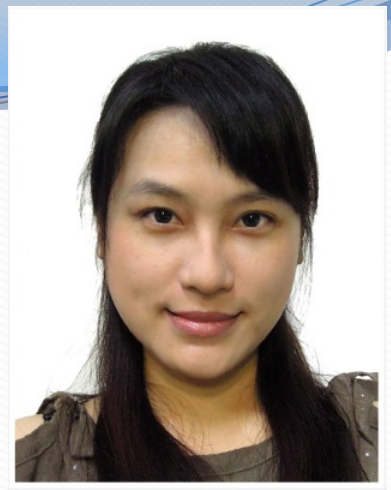
AIST

SUSTAINABLE DELTAS 2015

2015.02.26 NCU

Field

Marine Geology & Geophysics, Marine Sedimentology, Seismic Stratigraphy, Sedimentary Basin Analysis, Dynamic Geomorphology, Magnetobiostratigraphy.



Academic Background

2014 – present Postdoc, Geological Survey of Japan, AIST.

2012 – 2014 Postdoc, Institute of Oceanography, NTU.

2007 – 2012 PhD, Institute of Oceanography, NTU.

Sediment dispersal system along the Taiwan-Luzon convergent margin in the perspective of Source-to-sink

2005 – 2007 RA, Institute of Earth Sciences, Academia Sinica.

2003 – 2005 Master, Institute of Oceanography, NSYSU.

Benthic foraminifera Assemblages of Gutingkeng Formation at Shoushan, Kaohsiung

2000 – 2003 Bachelor, Earth Science Department, NCKU.

Awards

2011 Youth Excellent Article Award, Basin Dynamics and Oil and gas reservoirs Conference, China University of Geosciences, Wuhan, China.

2010 An Outstanding College Youth of 2010, National Taiwan University.

Publications

1. Hsiung, Kan-Hsi*, Chih-Chieh Su, Ho-Shing Yu, Jih-Hsin Chang (2015) Morphology, seismic characteristics and development of the sediment dispersal system along the Taiwan-Luzon convergent margin. Marine Geophysical Research (online). (SCI)

2. Hsiung, Kan-Hsi, Ho-Shing Yu, Cheng-Shing Chiang* (2014) Seismic characteristics, morphology and formation of the ponded Fangliao Fan off southwestern Taiwan, northern South China Sea. Geo-Marine Letters, 34, 59-74. (SCI)

3. Hsiung, Kan-Hsi*, Ho-Shing Yu (2013) Sediment dispersal system in the Taiwan–South China Sea collision zone along a convergent margin: A comparison with the Papua New Guinea collision zone of the western Solomon Sea. Journal of Asian Earth Sciences, 62, 295-307. (SCI)

4. Horng, Chorng-Shern*, Chih-An Huh, Kuo-Hang Chen, Chun-Hung Lin, Kai-Shuan Shea, Kan-Hsi Hsiung, (2012) Pyrrhotite as a tracer for denudation of the Taiwan orogen. Geochemistry, Geophysics, Geosystems, 13, 8, Q08Z47. (SCI)

5. Hsiung, Kan-Hsi*, Ho-Shing Yu (2011) Morpho-sedimentary evidence for a canyon-channel-trench interconnection along the Taiwan-Luzon plate margin, South China Sea. Geo-Marine Letters, 31, 215-226. (SCI)

6. Horng, Chorng-Shern*, Chih-An Huh, Kuo-Hang Chen, Pin-Ru Huang, Kan-Hsi Hsiung, Hui-Ling Lin (2009) Air pollution history elucidated from anthropogenic spherules and their magnetic signatures in marine sediments offshore of southwestern Taiwan. Journal of Marine Systems, 76, 468-478. (SCI)

7. Hsiung, Kan-Hsi*, Ho-Shing Yu, Ming Su (2015) Sedimentation in remnant ocean basin off southwest Taiwan with implication for closing northeastern South China Sea. Journal of the Geological Society, (accepted). (SCI)

8. Ming Su, **Kan-Hsi Hsiung***, Cuimei Zhang, Xinong Xie, Ho-Shing Yu, Zhenfeng Wang (2014) The linkage between longitudinal sediment routing systems and basin types in the northern South China Sea in perspective of source-to-sink. Journal of Asian Earth Sciences (under review). (SCI)

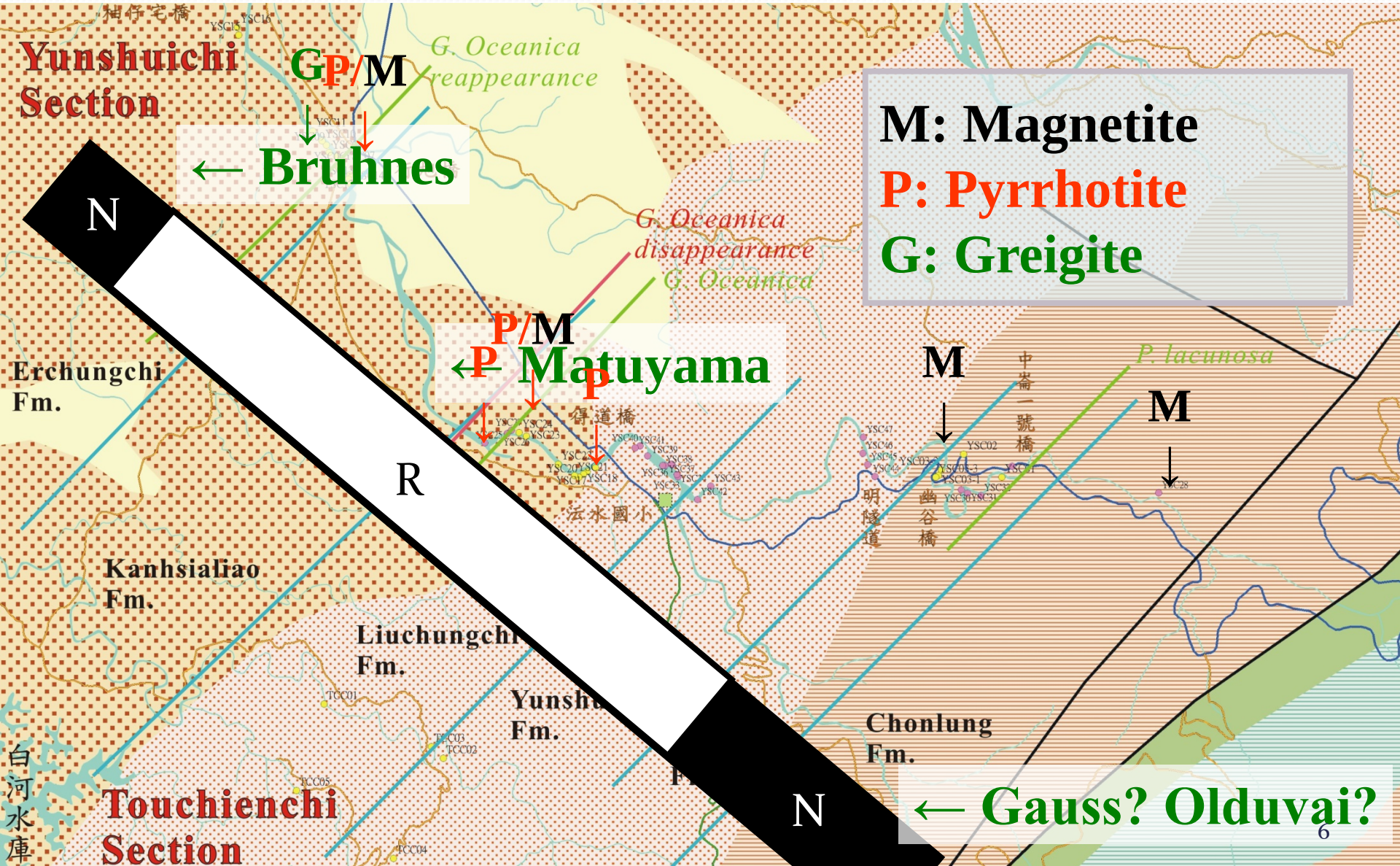
1. 熊衍昕、齋藤文紀 (2014)《地質學》一詞從晚清至今的演變。地質，第33卷第3期，中華民國103年9月出版。
2. 熊衍昕、俞何興 (2012) 以從源到匯之觀點探討臺灣西南外海沈積物散佈系統及傳輸之意義。鑛冶，第56卷第4期，中華民國101年12月出版。

文章發表：英文7篇，中文2篇，審稿中1篇

Land-Sea Link: SW and off SW Taiwan

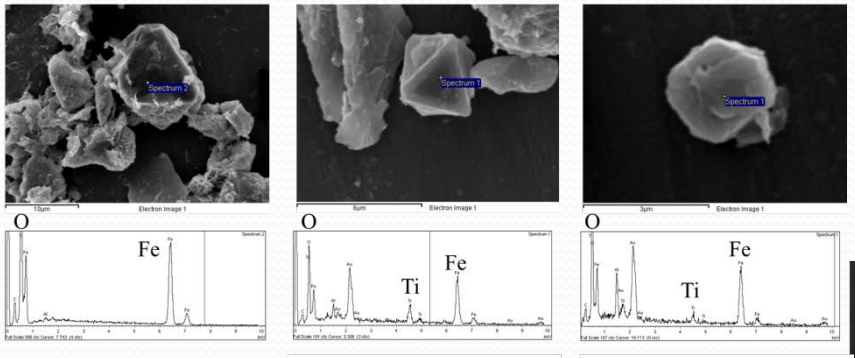
- Yunshuichi section
- MD 178 cruise

Magnetobiostratigraphy SW Taiwan



Magnetobiostratigraphy SW Taiwan

Magnetic minerals (SEM/EDS)

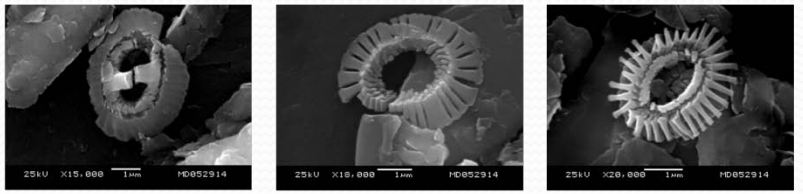


1665cm (MIS 1)
Magnetite (Fe_3O_4)

2040cm (Transition)
Titanomagnetite

2265cm (MIS 2)
Magnetite (Fe_3O_4)

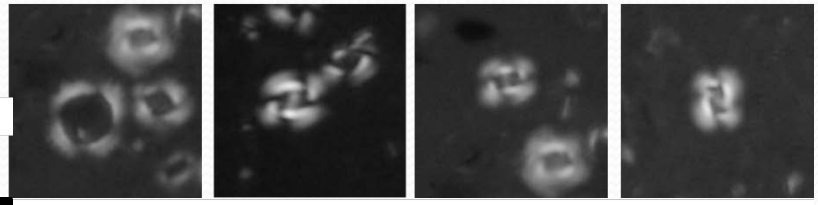
Nannofossils (SEM/POM)

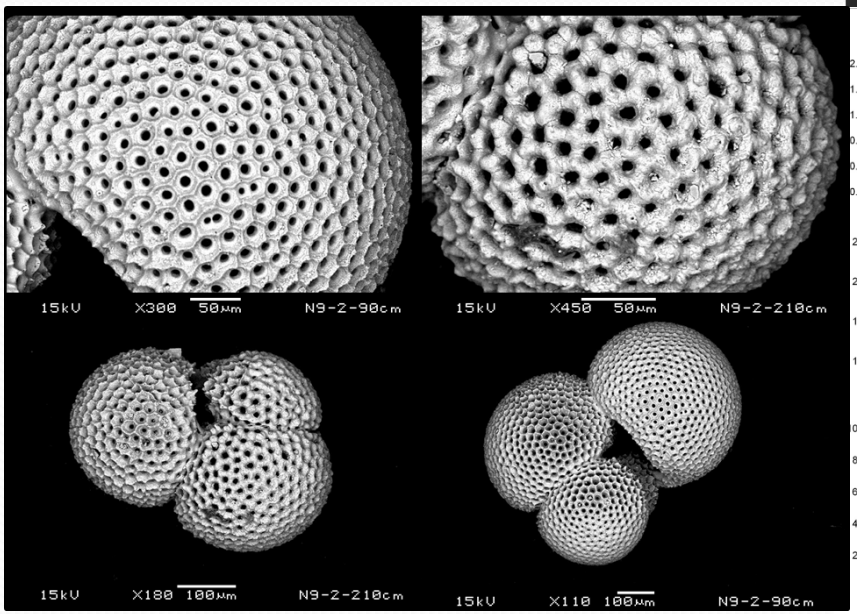


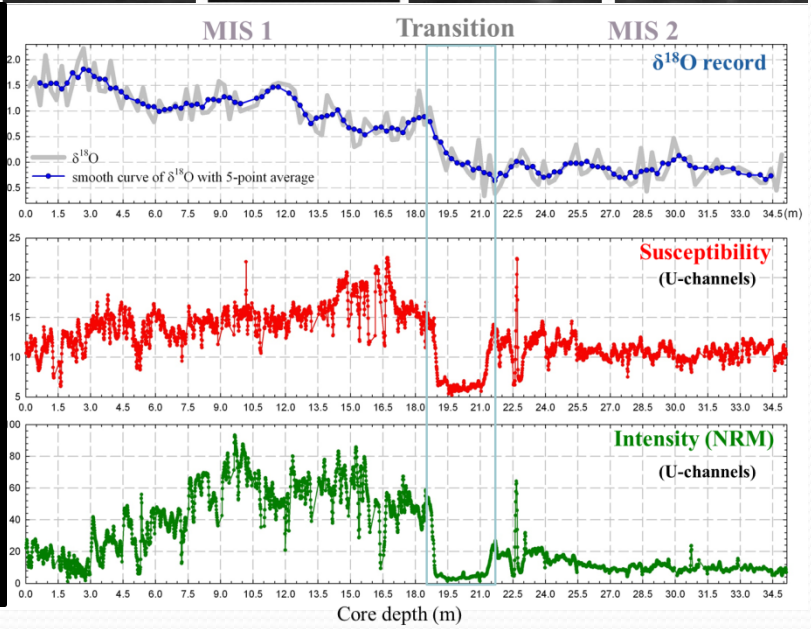
Gephyrocapsa oceanica

Pseudoemiliania lacunosa
LAD: 428 ka

Emiliania huxleyi
Acame zone: 81 ka



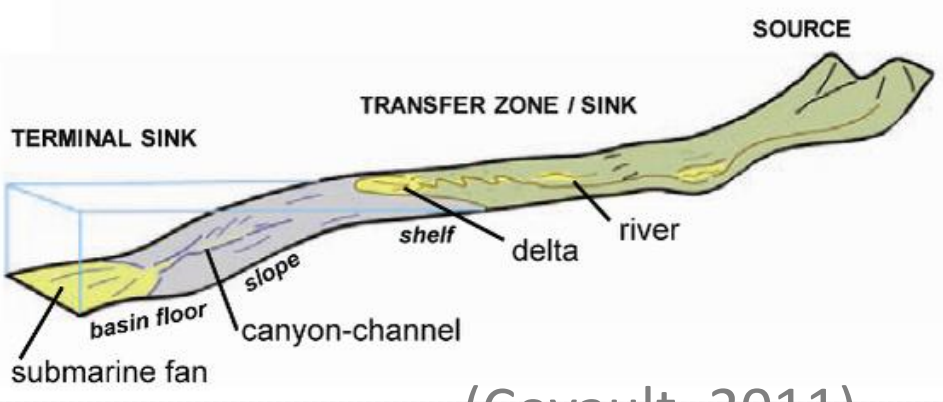




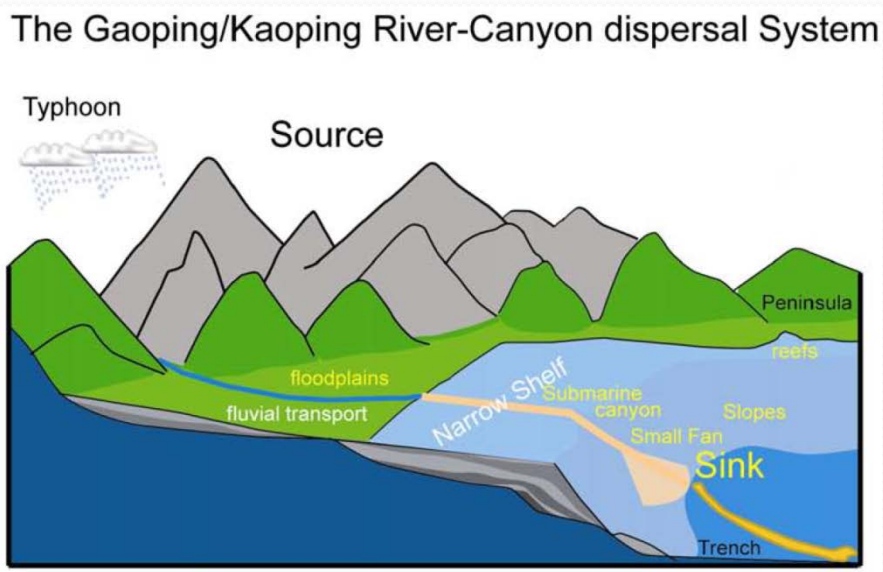
Outline

- ☺ ***Progressive changes in morphotectonics***
  (longitudinal sediment dispersal route)
- ☺ ***Comparison to the Huon Gulf east of PNG***
  (canyon drainage systems)
- ☺ ***Development of the dispersal system***
  (regional source-to-sink study)
- ☺ ***Submarine fan and river-delta studies***
  (off southwest Taiwan)
- ☺ ***Summary***

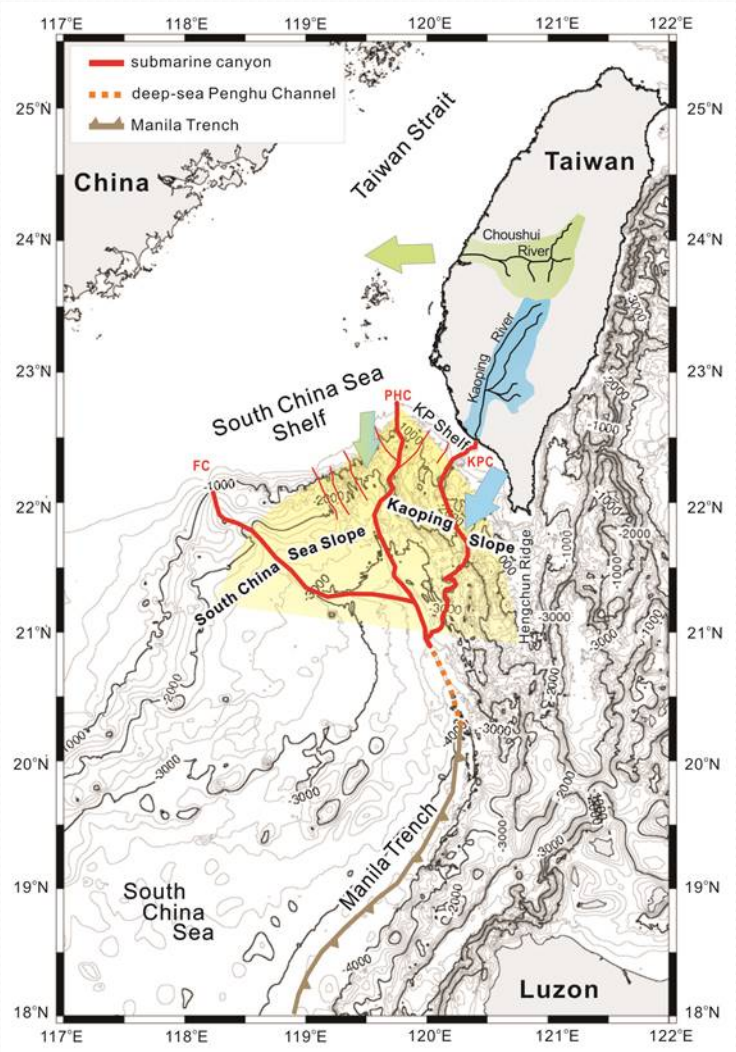
Importance: Regional source-to-sink studies



(Covault, 2011)



(Yu et al., 2009)

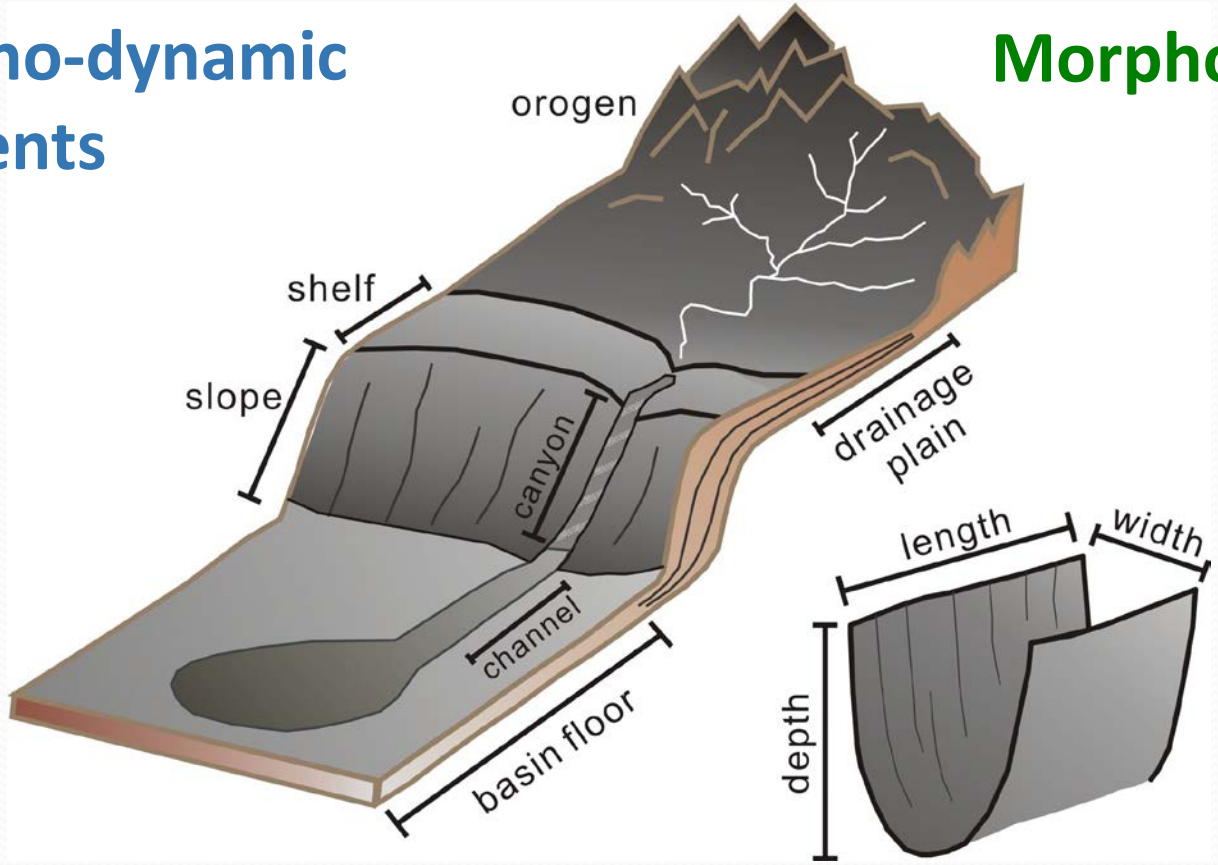


(Hsiung et al., 2015)

Source-to-sink studies

Morpho-dynamic segments

Morpho-sedimentary features



mountains, plains, shelf, slope, and basin floor

submarine canyons and deep-sea channels

(modified from Sømme et al., 2009)

海底峽谷與深海水道
- 沈積物的海底溜滑梯

http://pansci.tw/archives/73102

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- ☺ *Development of the dispersal system (regional source-to-sink study)*
- ☺ *Comparison to the Huon Gulf east of PNG (canyon drainage systems)*
- ☺ *Progressive changes in morphotectonics (longitudinal sediment dispersal route)*
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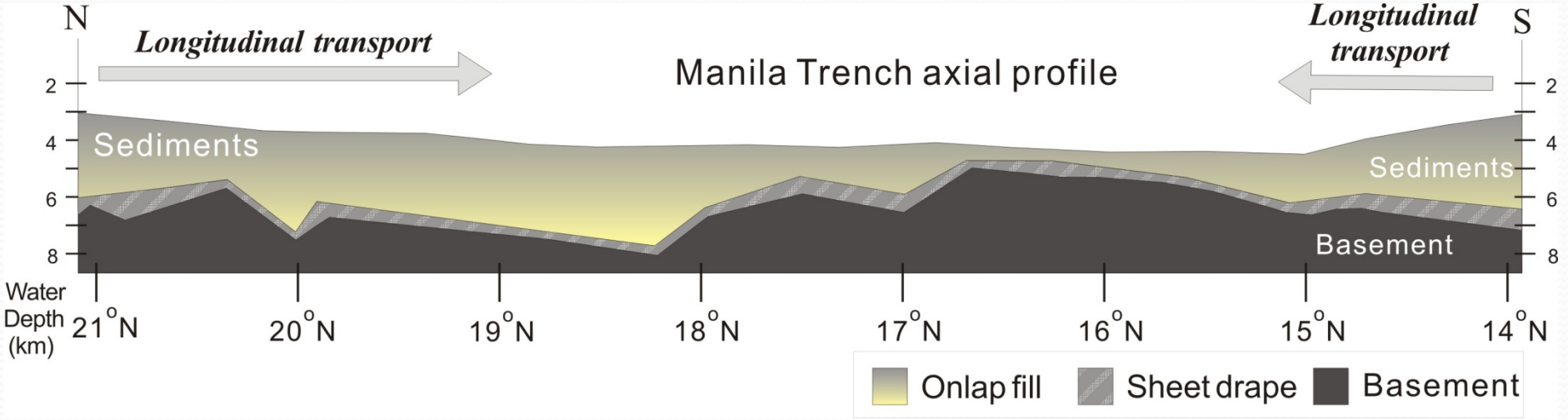
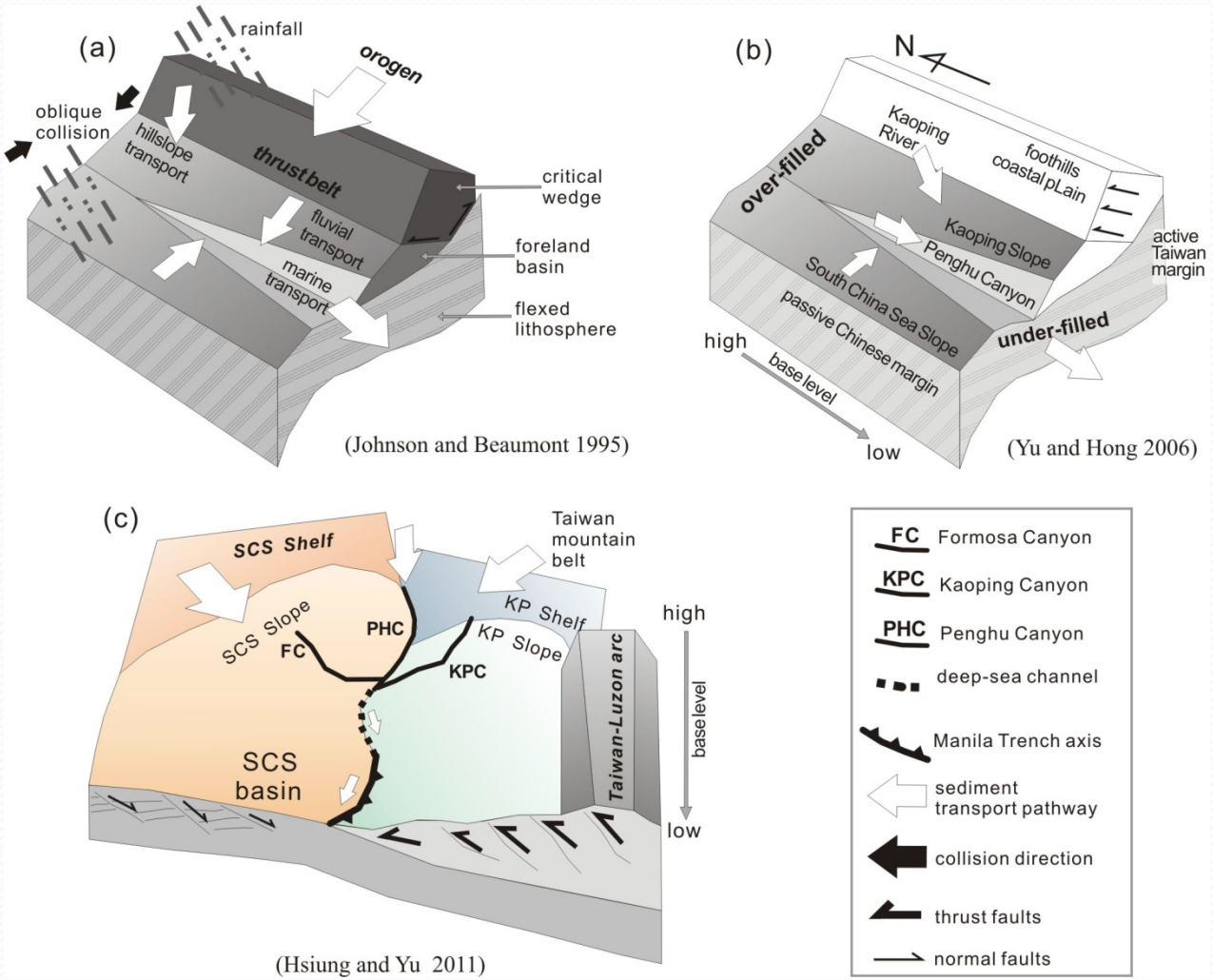
Longitudinal sediment transport



(modified from Lewis and Hayes, 1984)

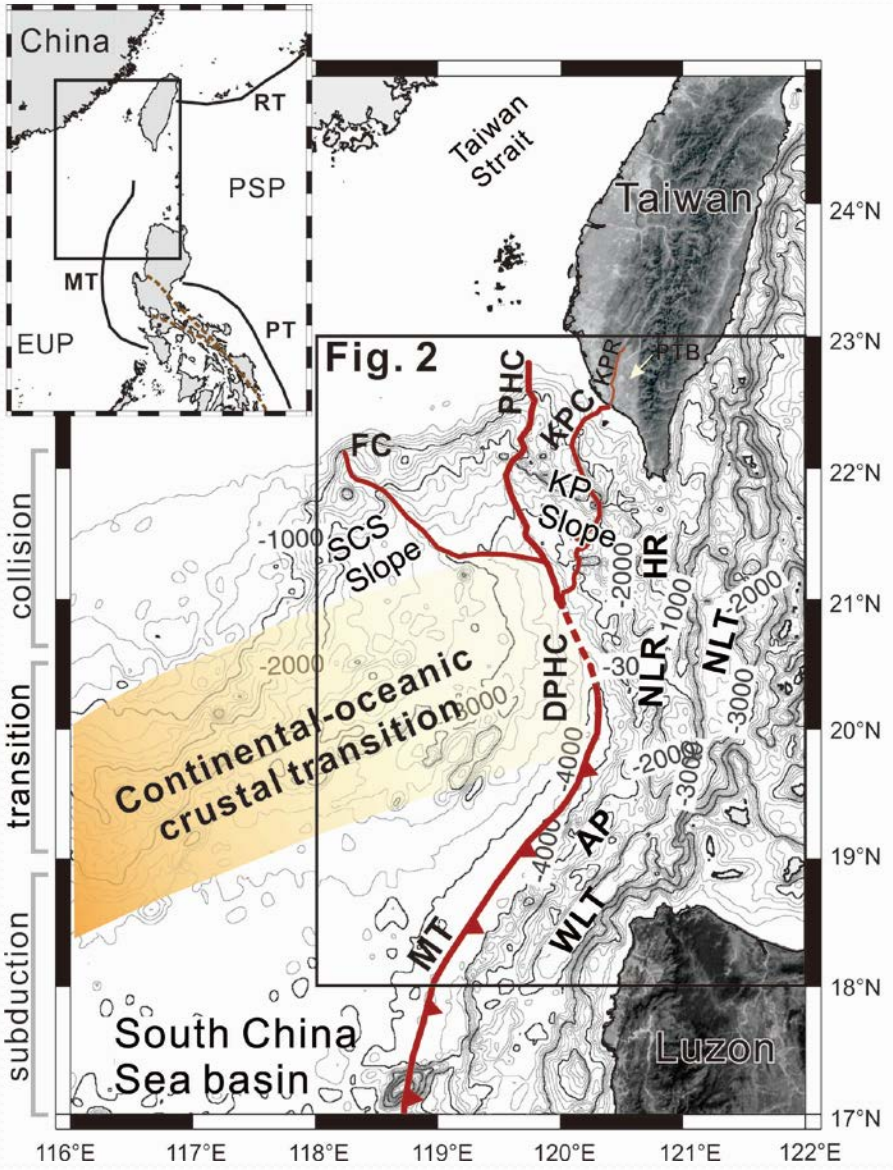
1. **Lewis and Hayes (1984)** : Sediments deposited in the northern Manila Trench are derived from Taiwan orogen.
2. **Suppe (1988)** : Sediments derived from Taiwan orogen will be delivered and deposited in the northern Manila Trench.
3. **Covey (1986)** : Sediments from Western Taiwan Foreland Basin will be over-spilled to the South China Sea.

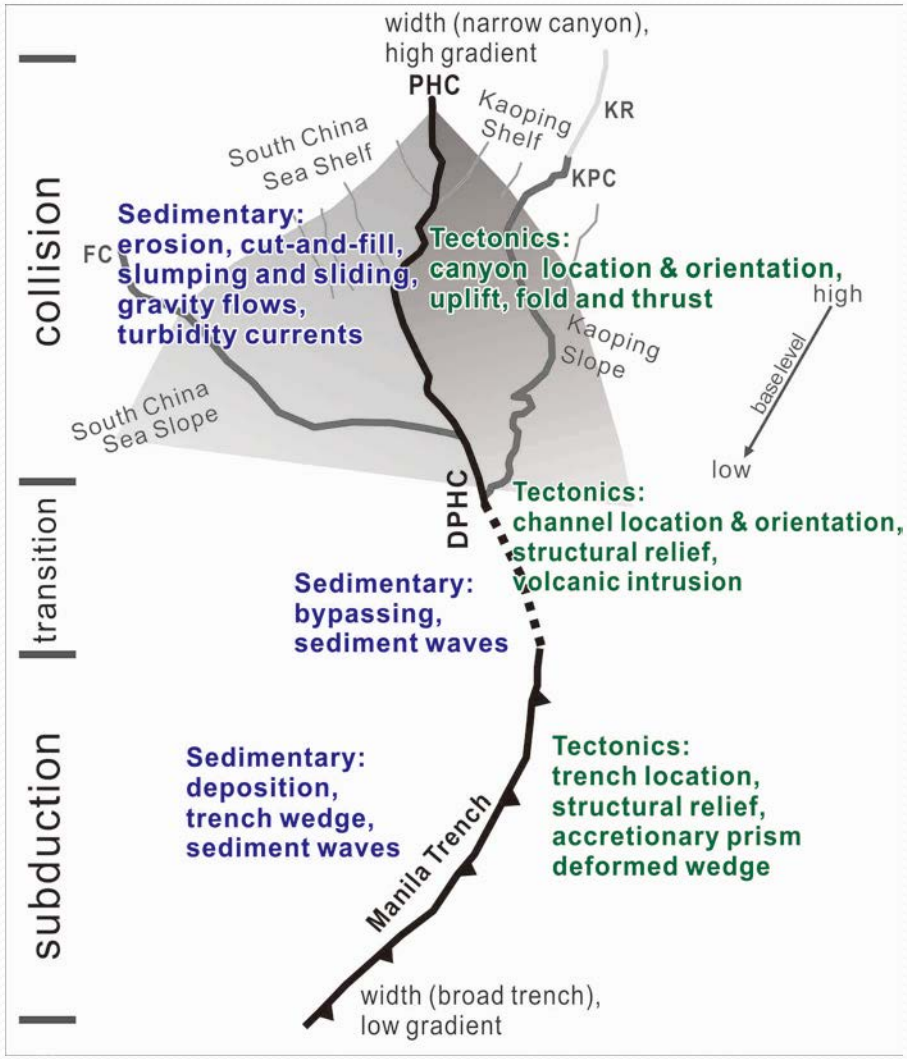
The kinematic foreland model



(Hsiung and Yu, 2011)

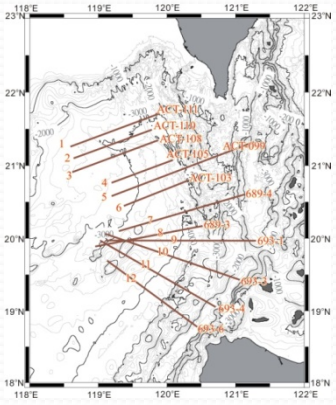
Longitudinal sediment dispersal route





(Hsiung et al., 2015)

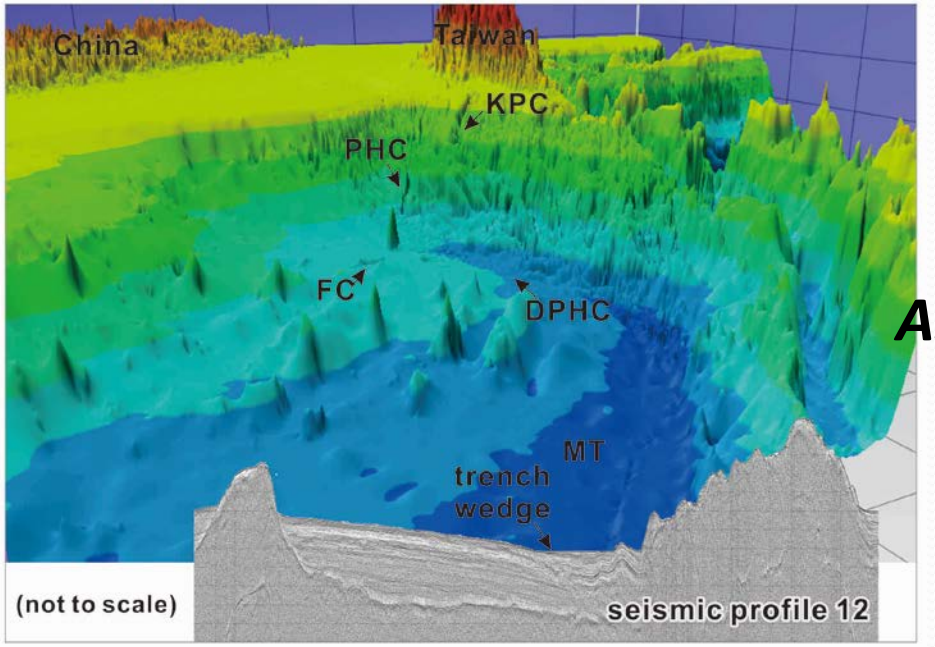
Progressive changes in sedimentary features

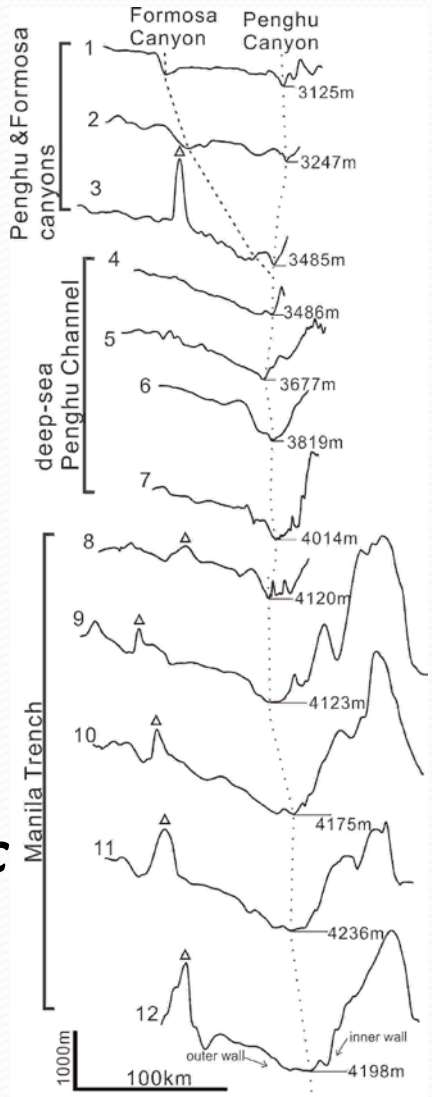


V-shaped

U-shaped

Asymmetric





Shallow

Deep

(Hsiung et al., 2015)

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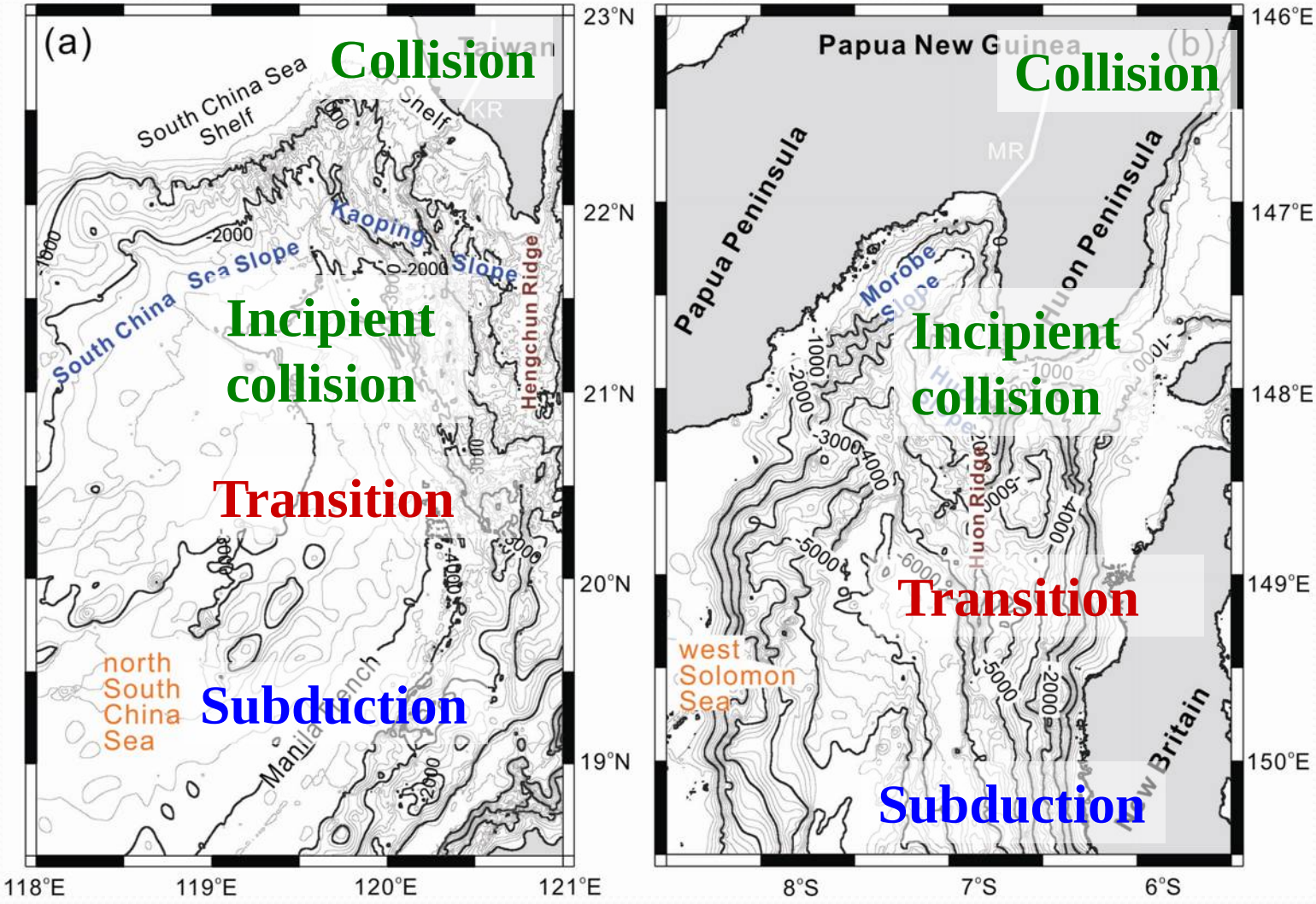
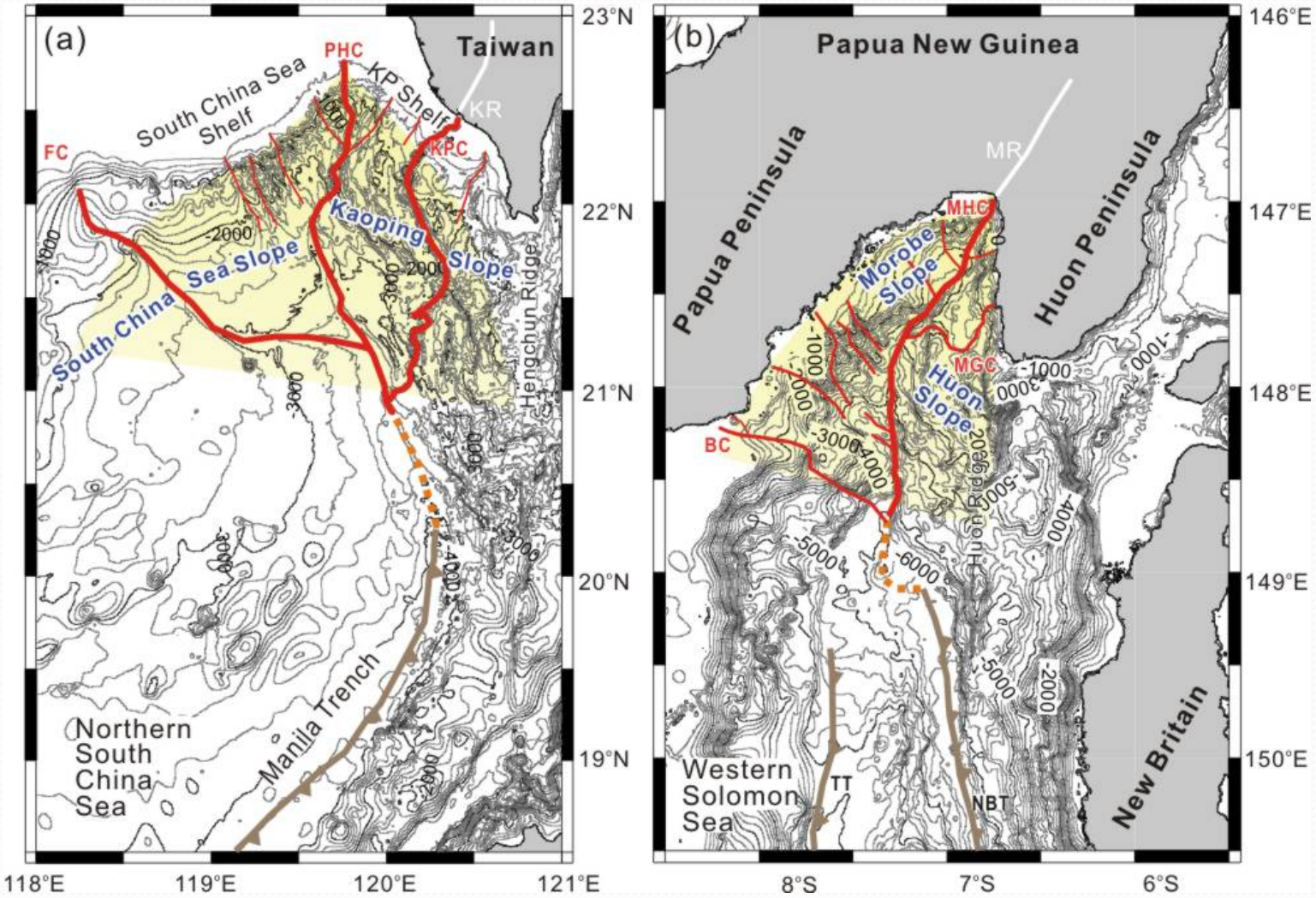
Comparison to the Huon Gulf east of PNG



TW-SCS ***PNG-Solomon Sea***

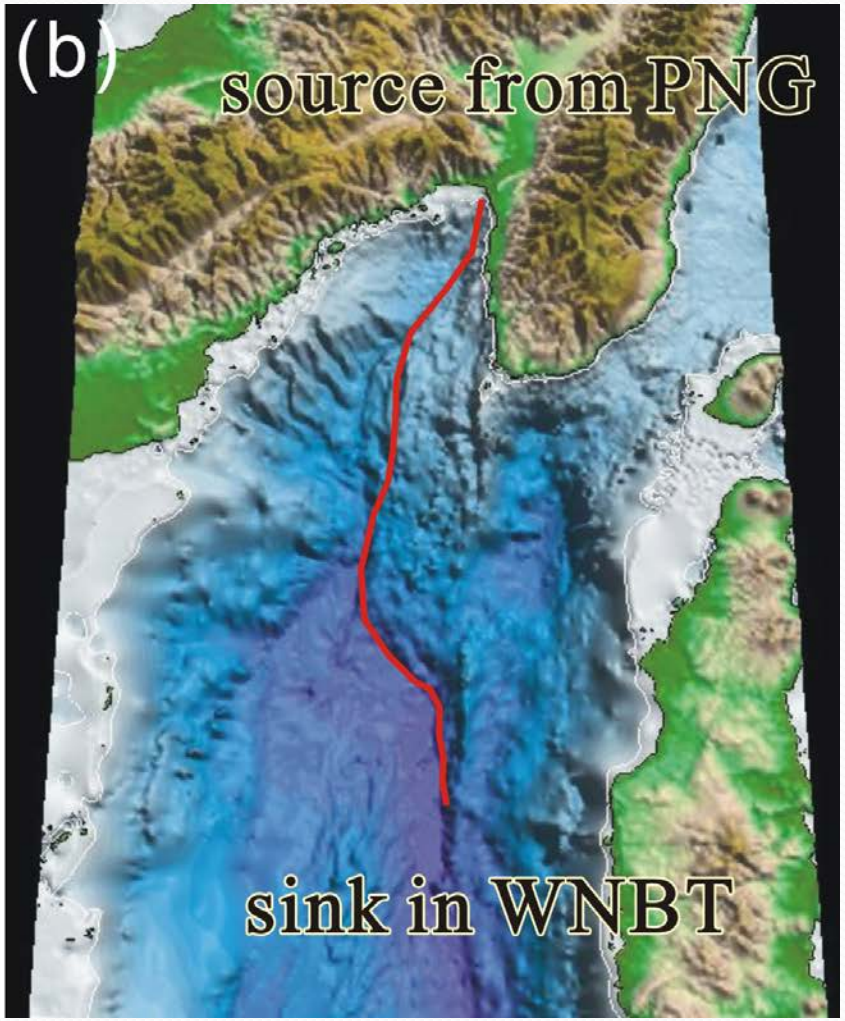
(modified from Galewsky and Silver, 1997; Whitmore et al., 1999)

Comparison: Tilting collisional marine basins

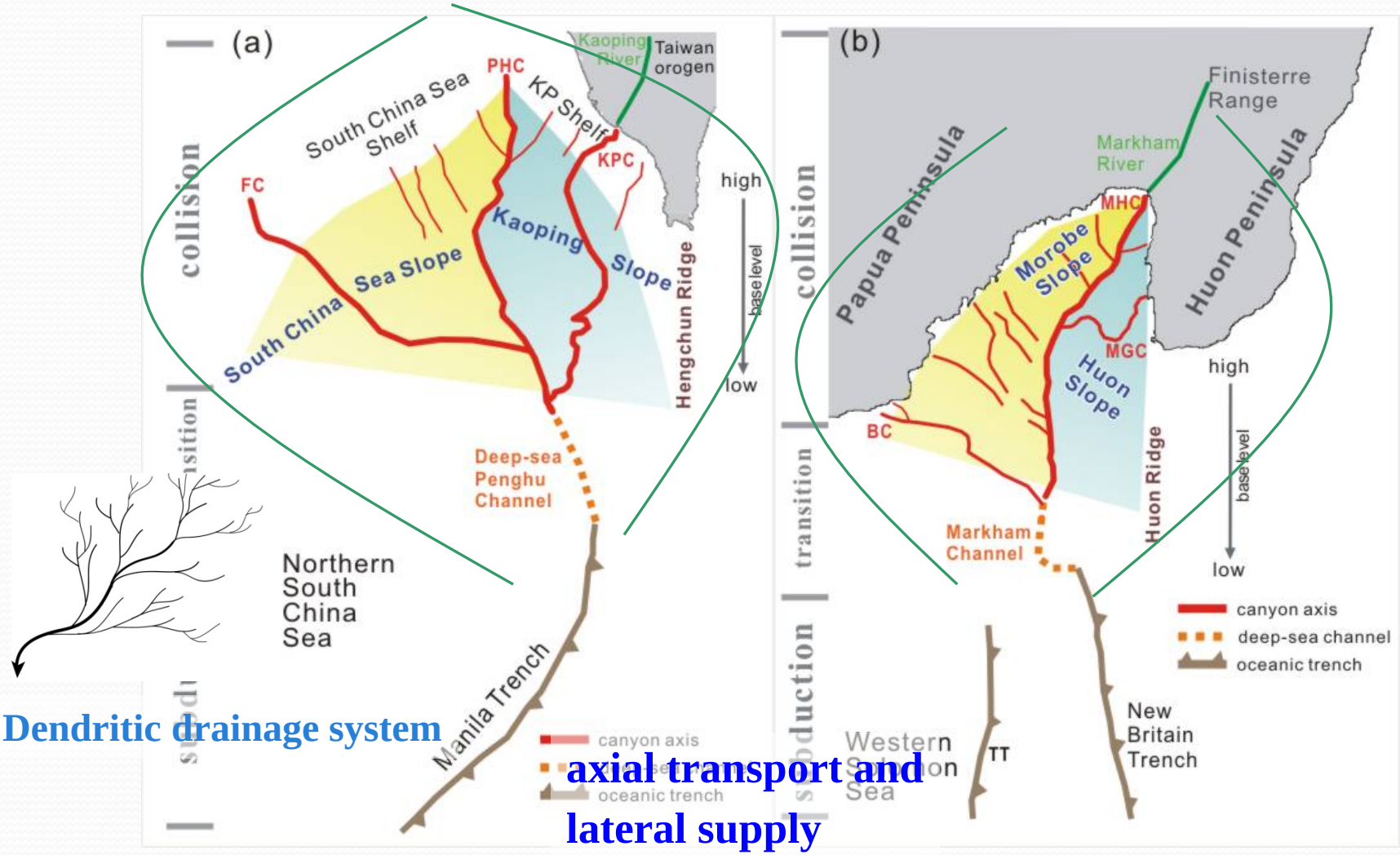


(Hsiung and Yu, 2013)

Source to sink axial routes



Morpho-sedimentary features: Canyon drainage system

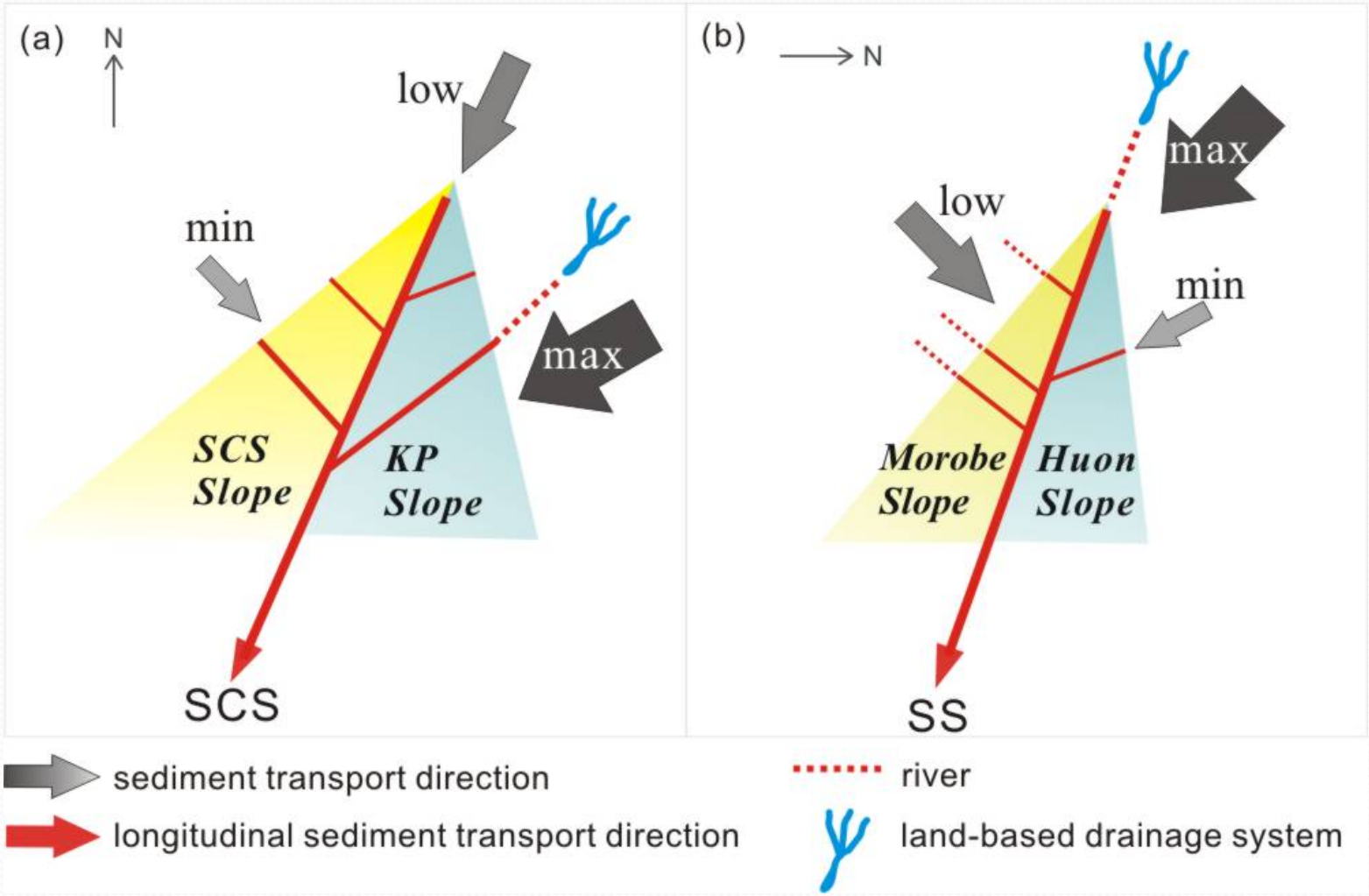


Dendritic drainage system

axial transport and lateral supply

(modified from Whitmore et al. 1999)

Model of canyon drainage systems



(Hsiung and Yu, 2013)

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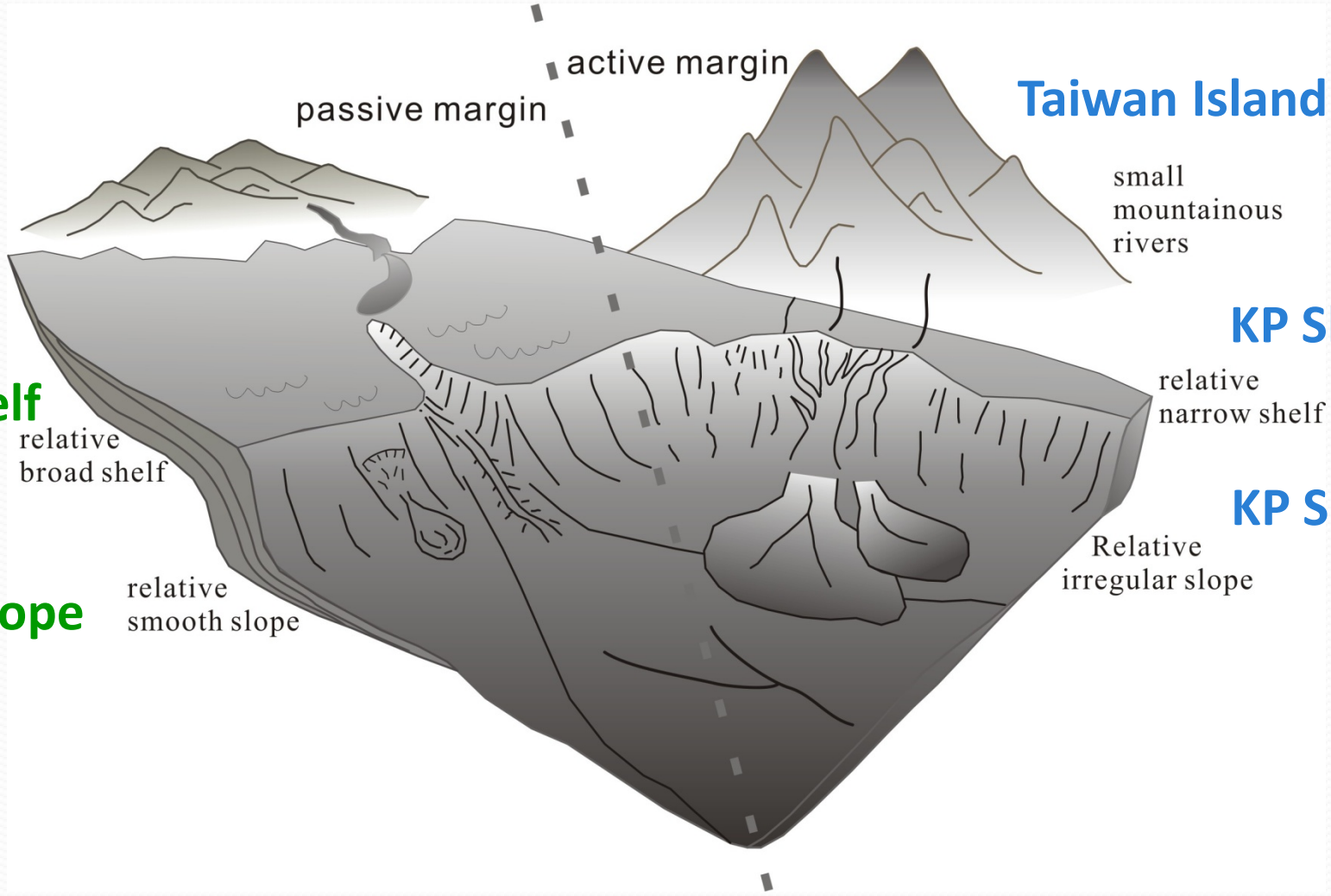
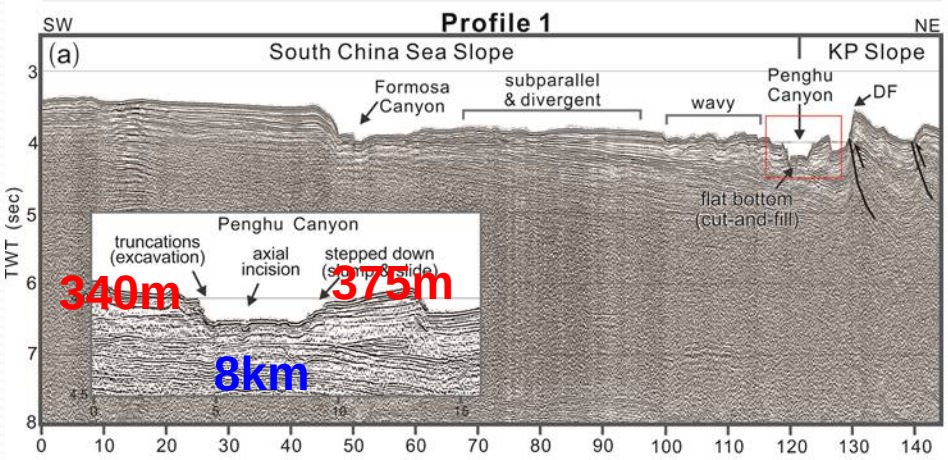
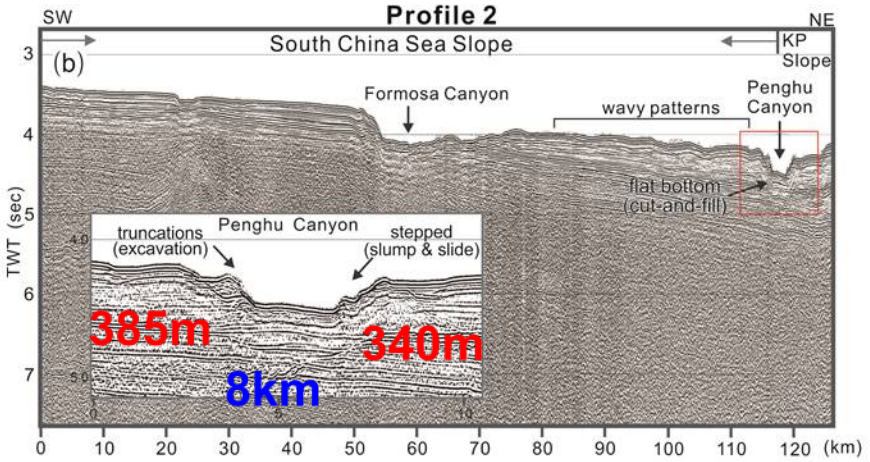
Comparison of passive/active margins

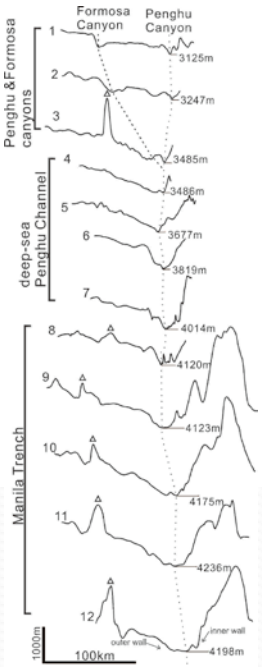


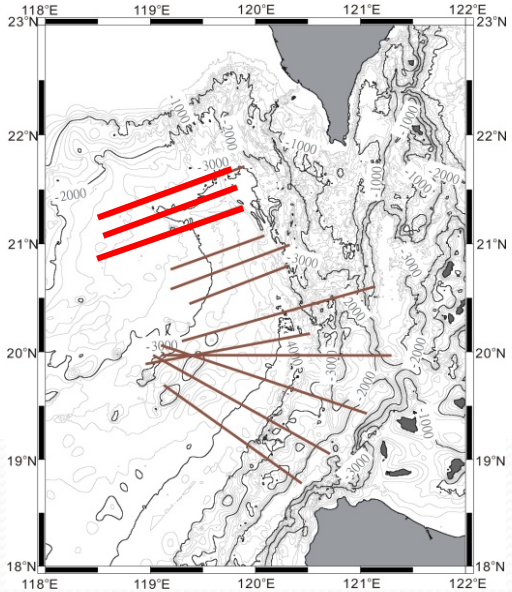
(modified from Sømme et al., 2009)

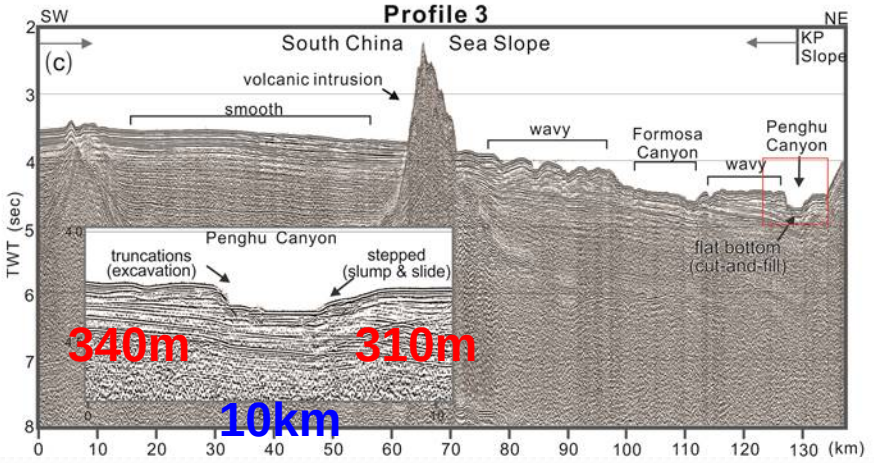
Seismic reflection profiles 1 - 3





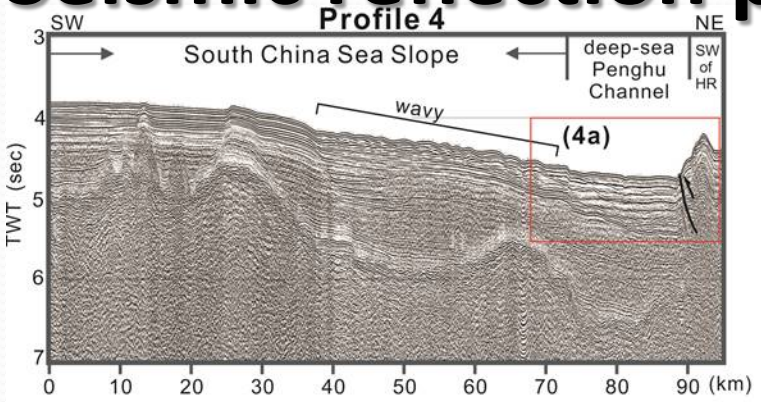


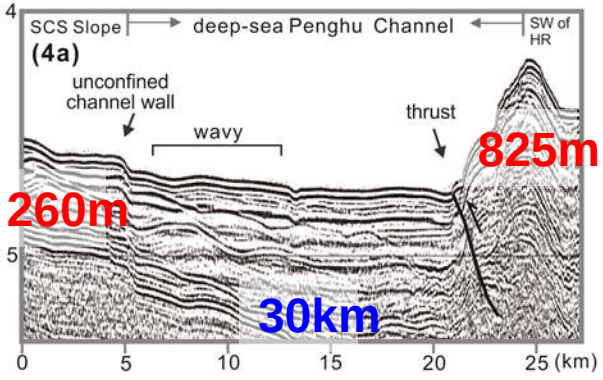


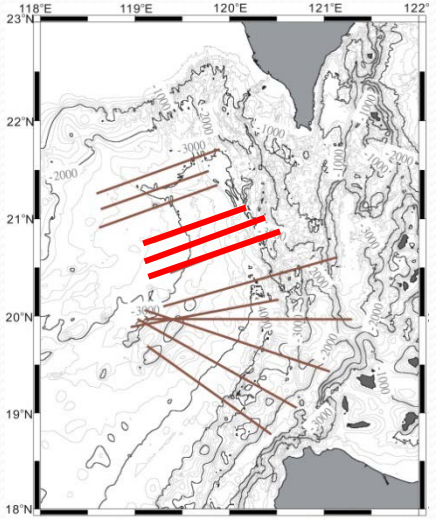


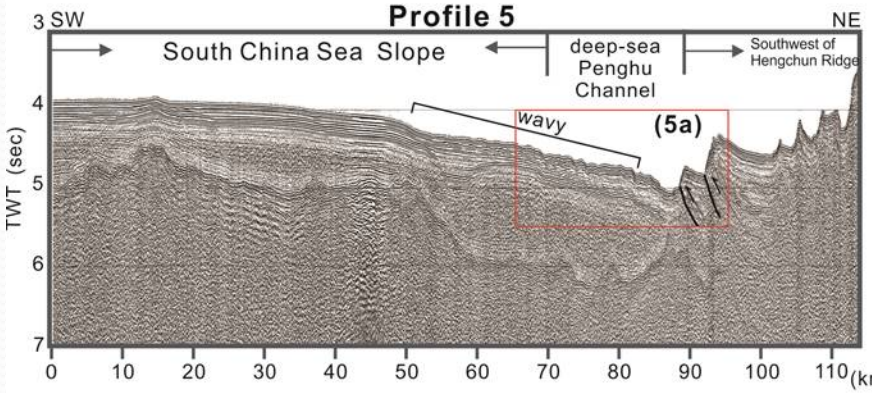
(Hsiung and Yu, 2015)

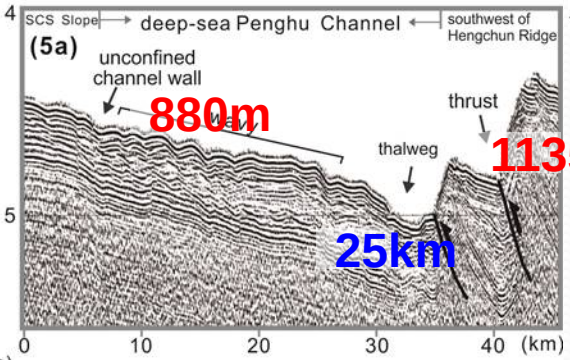
Seismic reflection profiles 4 - 6

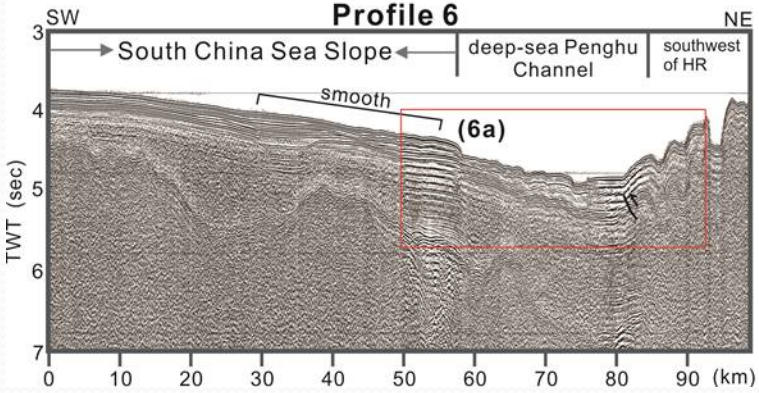


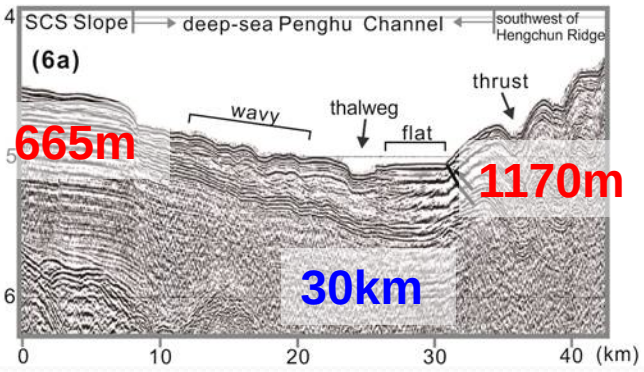




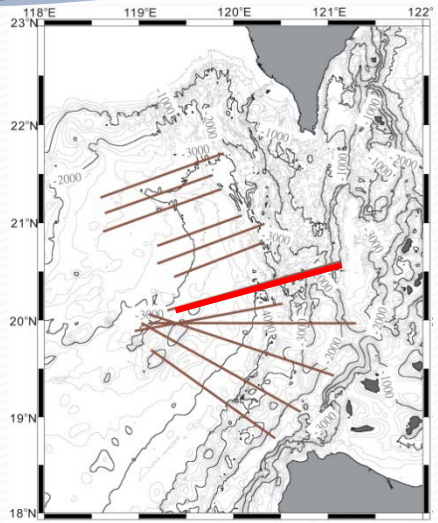


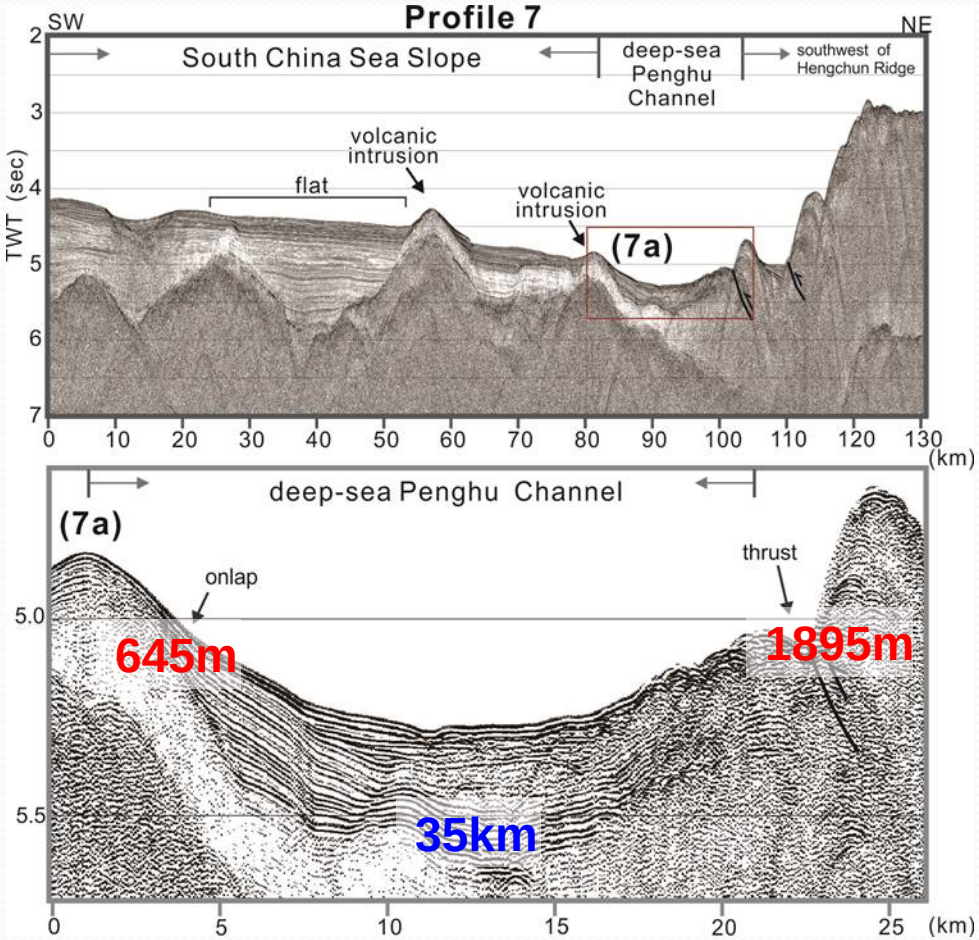




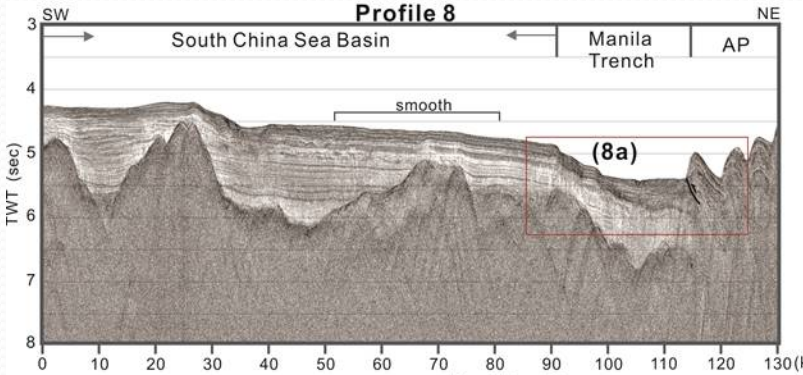


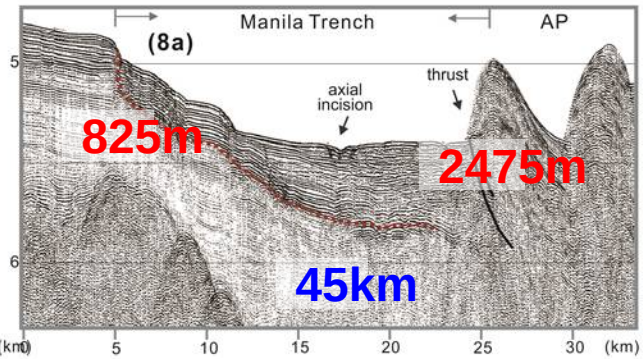
Seismic reflection profile 7

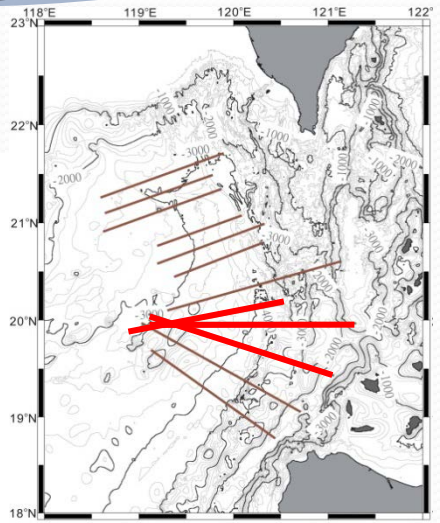


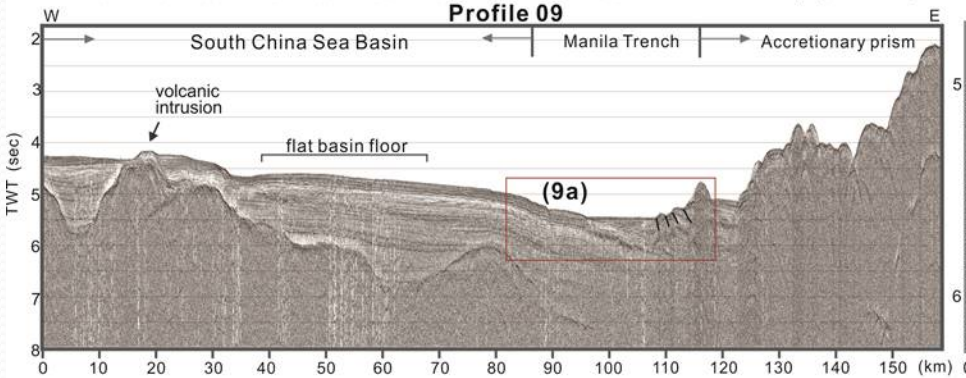


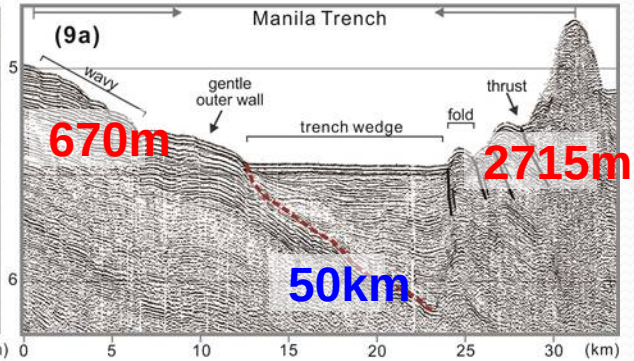
Seismic reflection profiles 8 - 10

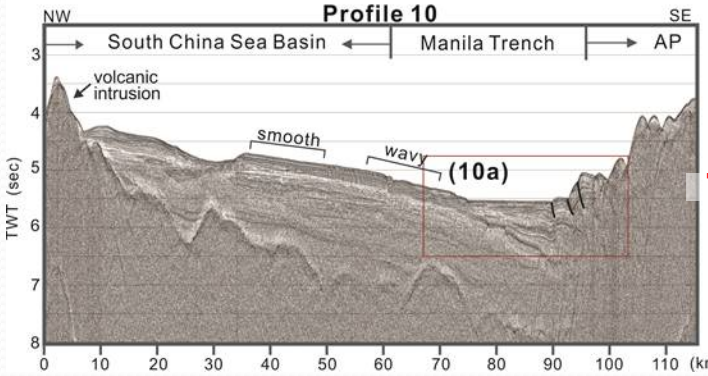


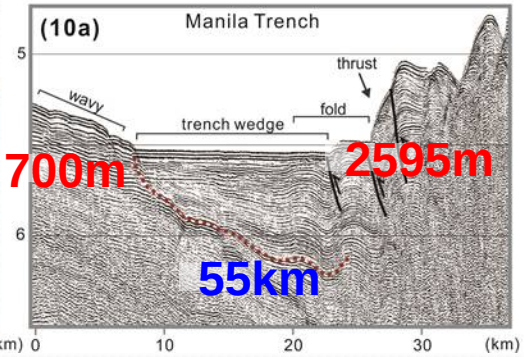




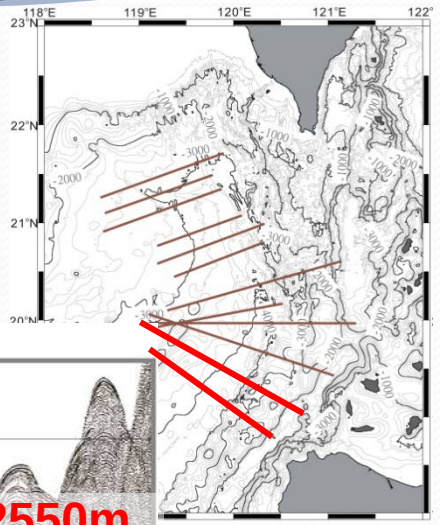


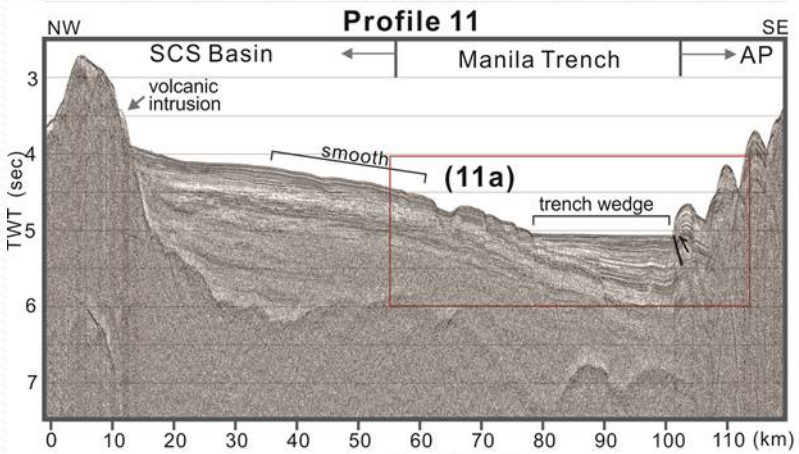


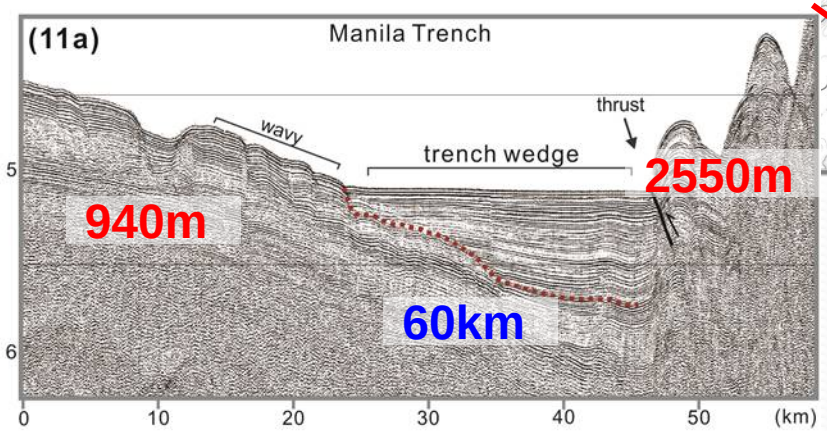


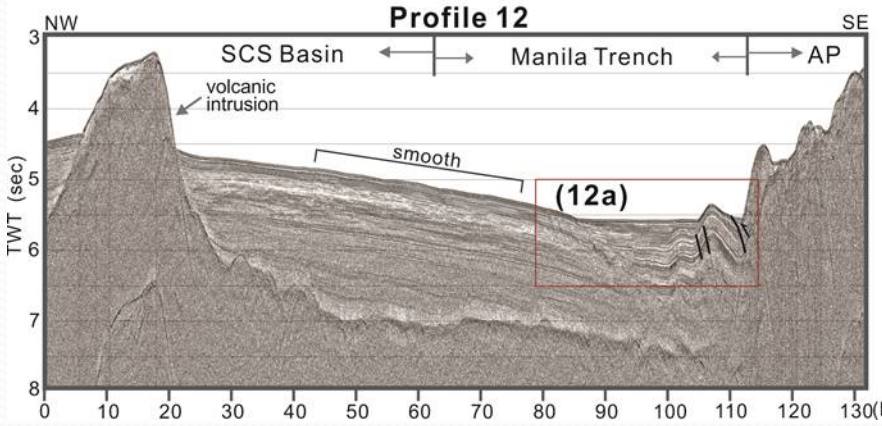


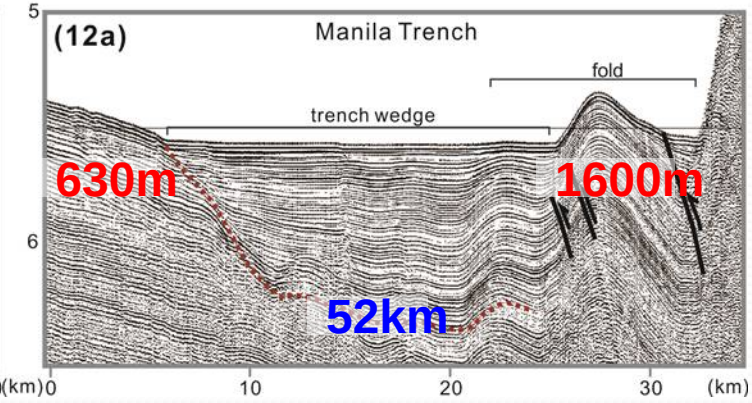
Seismic reflection profiles 11 - 12



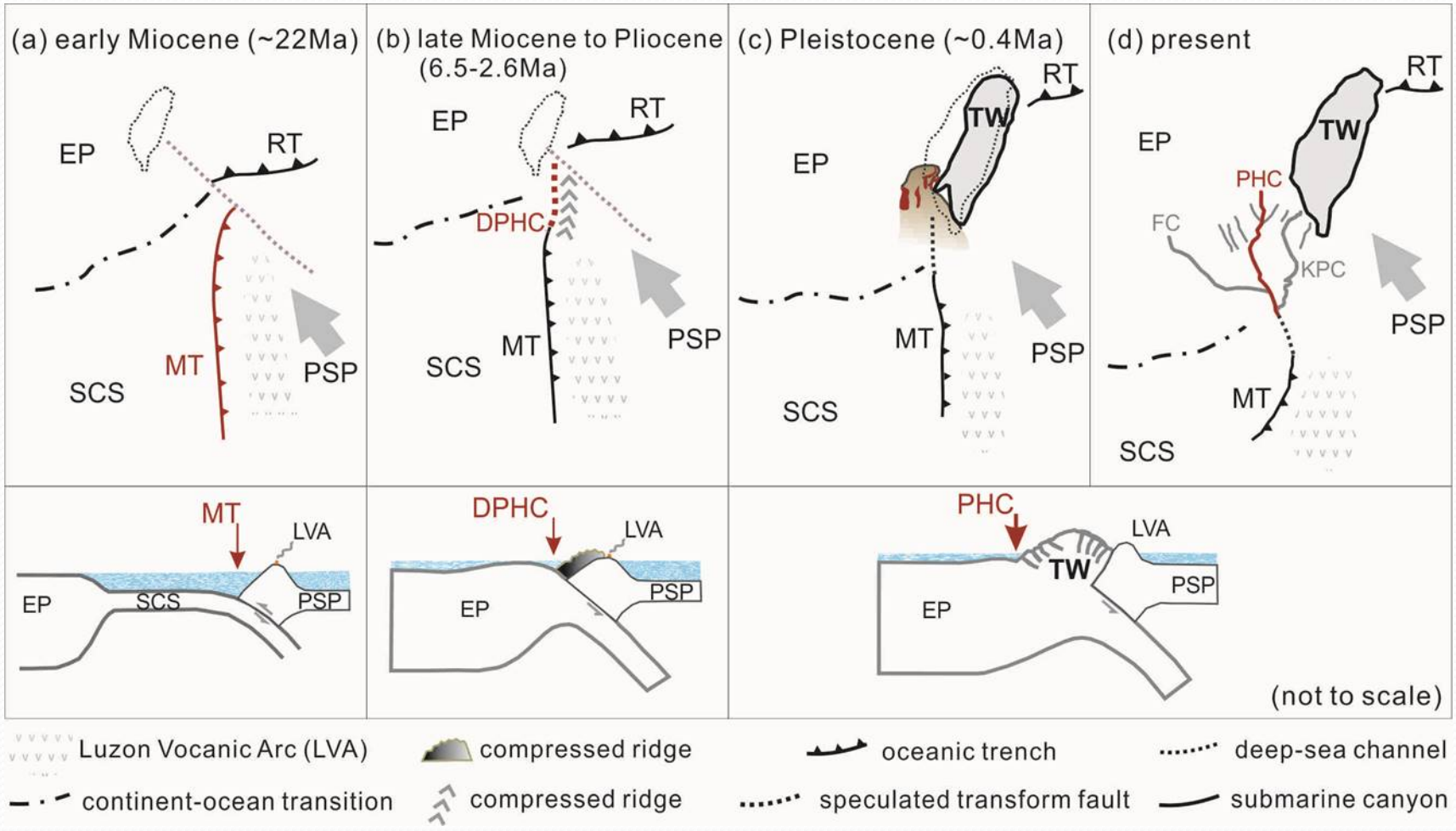






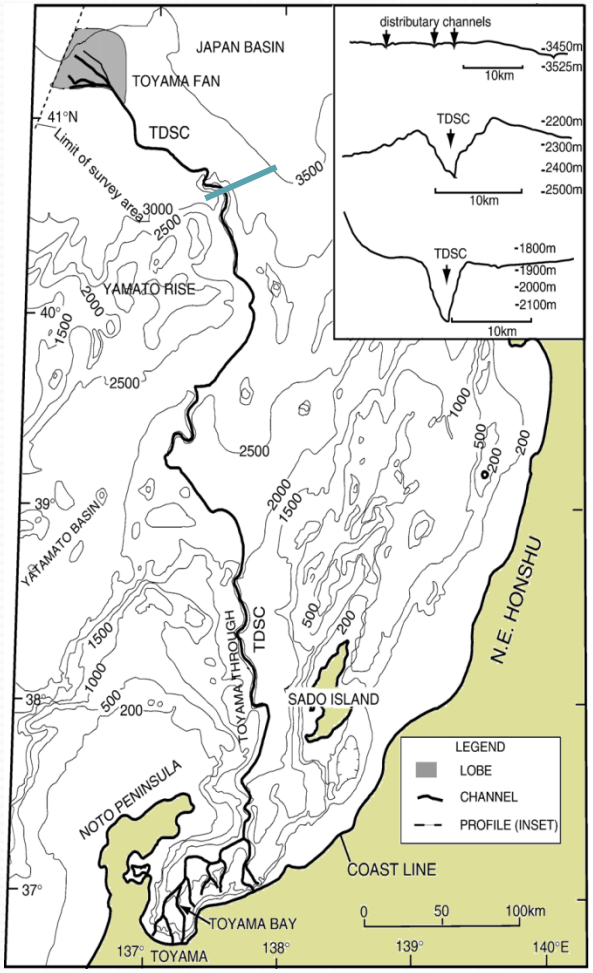


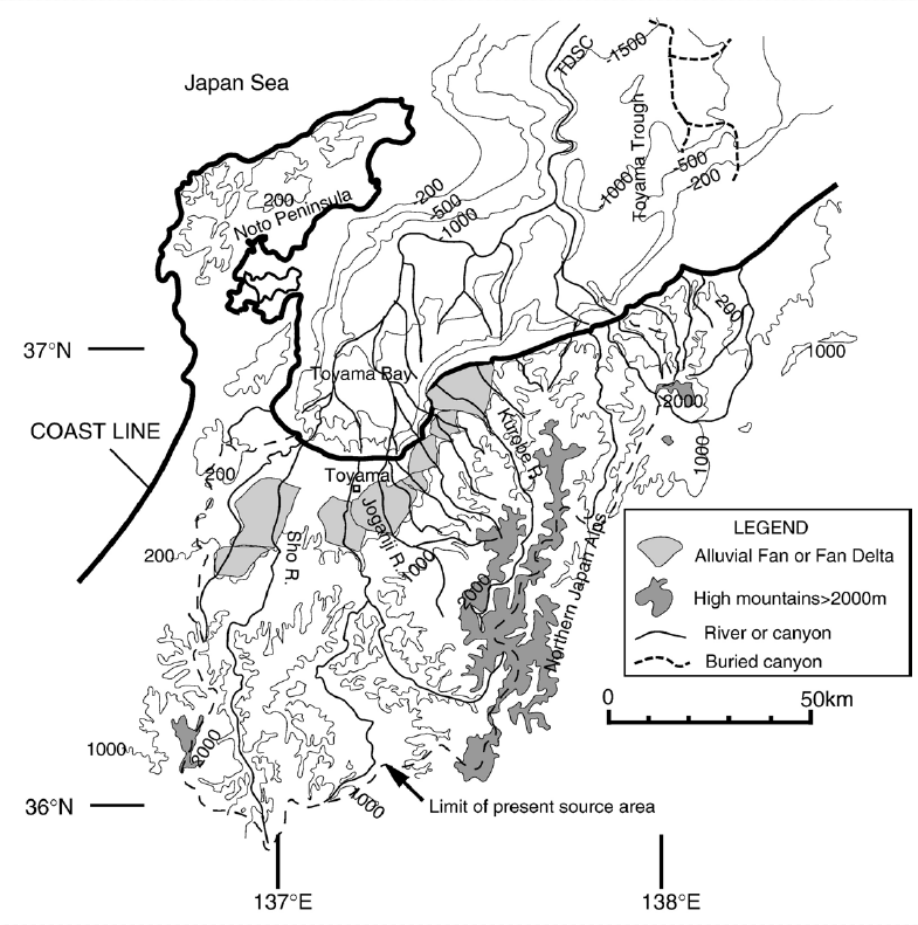
Development of sediment dispersal system



(Hsiung and Yu, 2015)

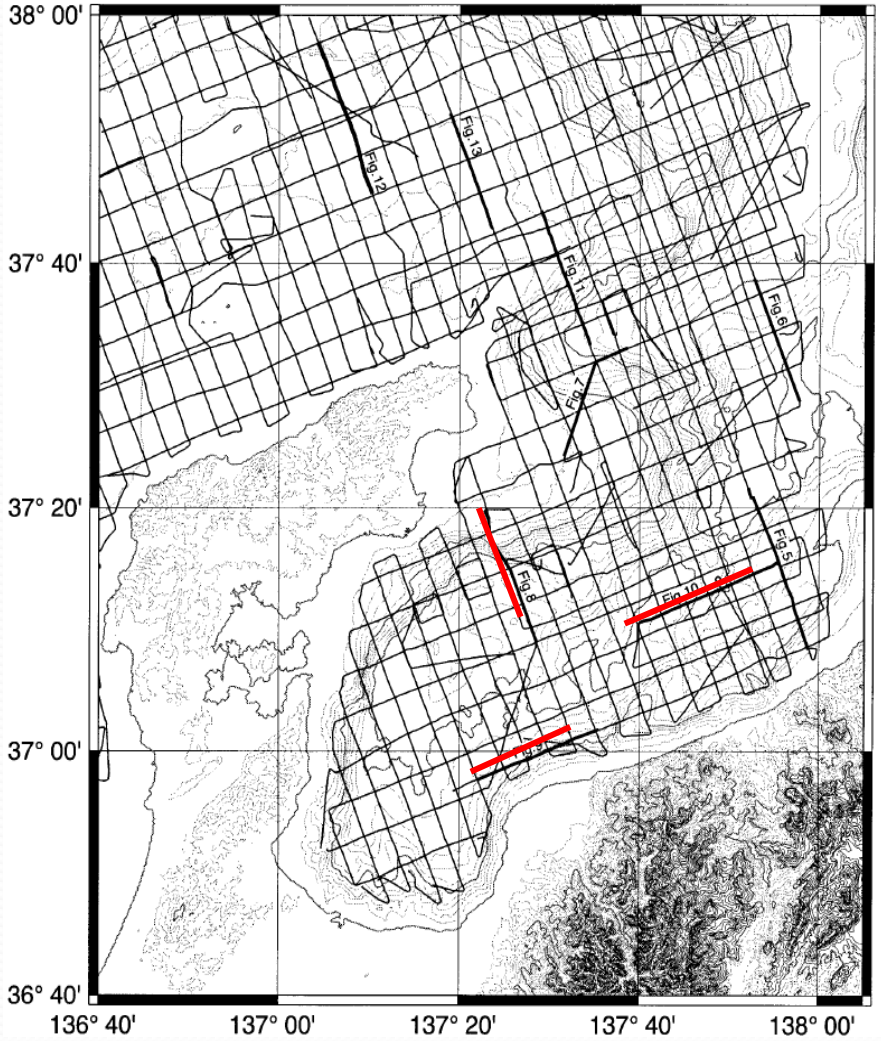
Toyama sediment dispersal system

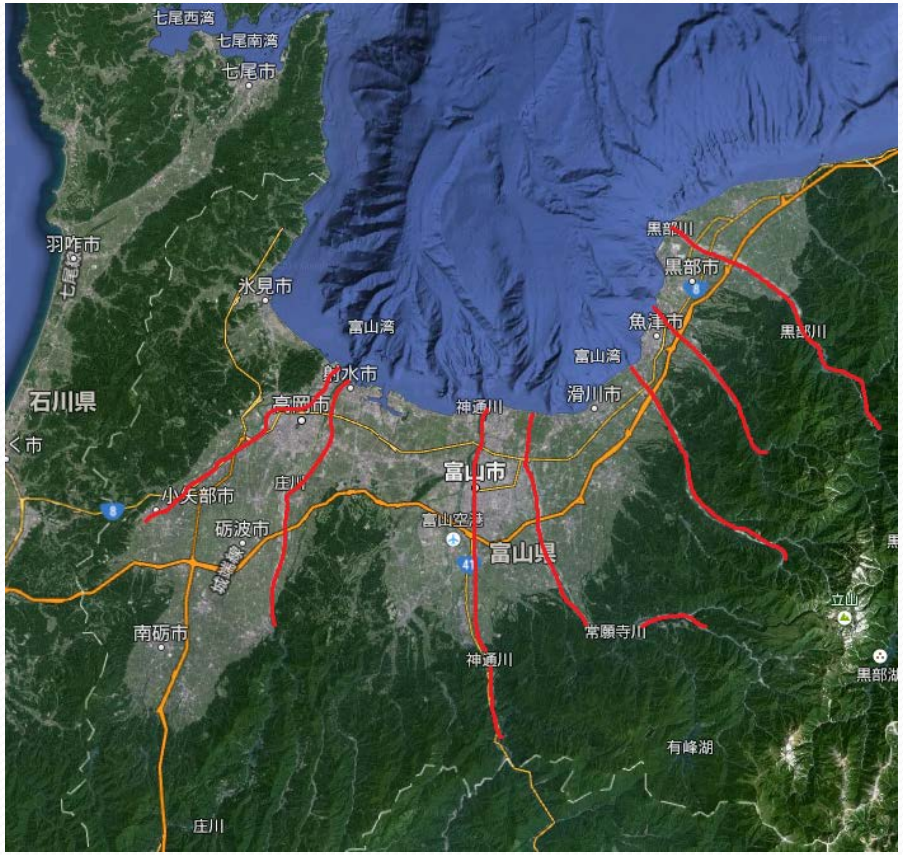




(Nakajima and Itaki, 2007)

Toyama sediment dispersal system

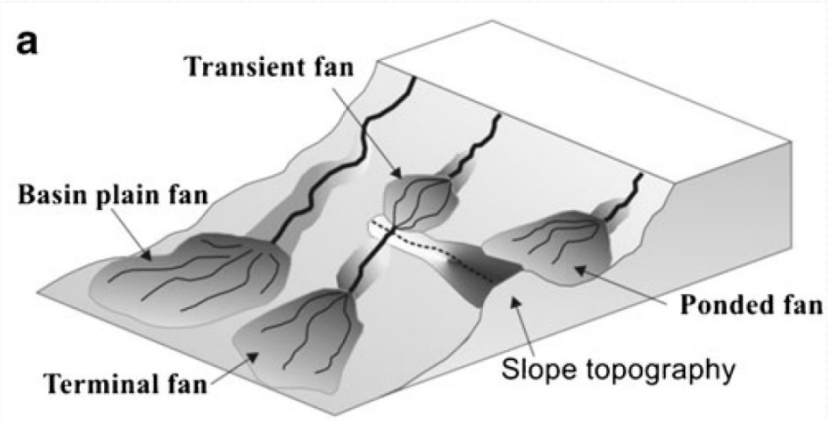


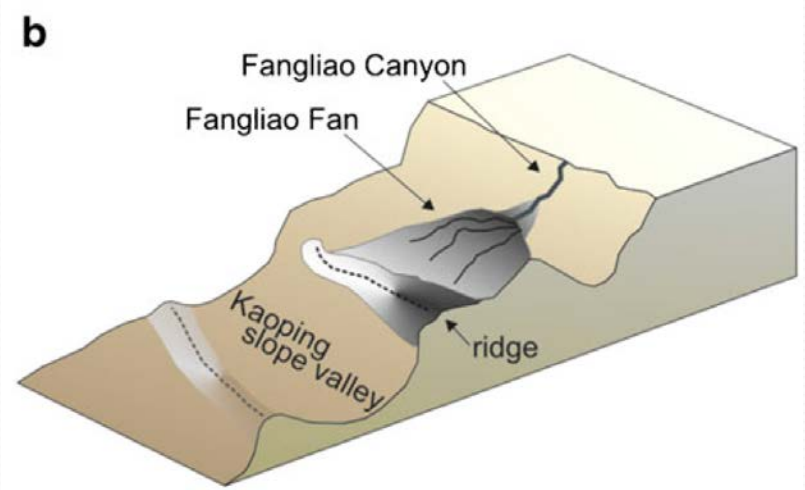


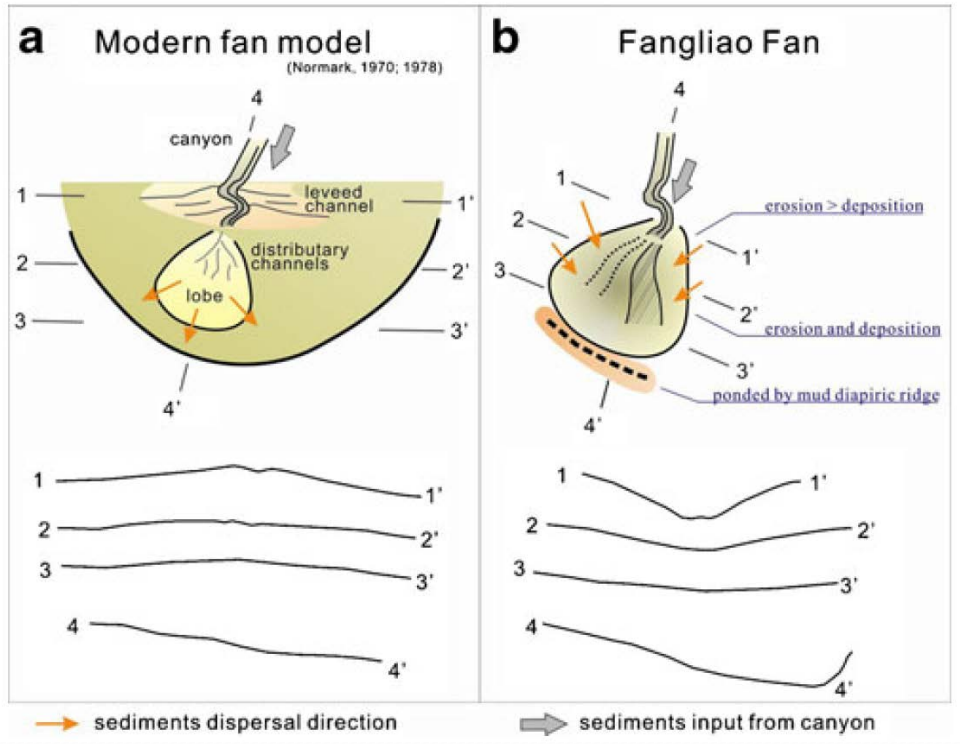
Outline

- ☺ *Development of the dispersal system (regional source-to-sink study)*
- ☺ *Comparison to the Huon Gulf east of PNG (canyon drainage systems)*
- ☺ *Progressive changes in morphotectonics (longitudinal sediment dispersal route)*
- ☺ ***Submarine fan and river-delta studies (off southwest Taiwan)***
- ☺ *Summary*

Fangliao Submarine Fan



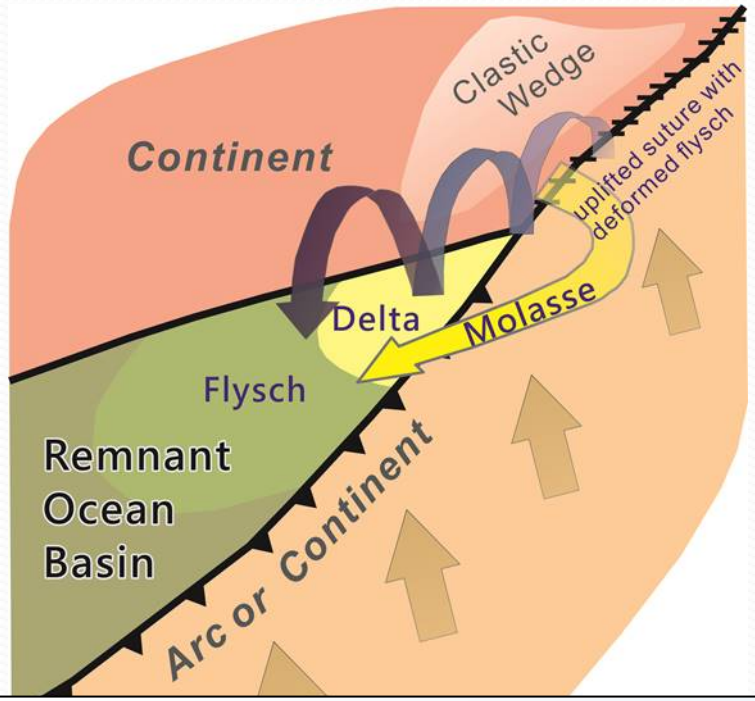




Fangliao Fan on Kaoping Slope (active margin) off SW Taiwan

(Hsiung et al., 2014)

Remnant Ocean Basin

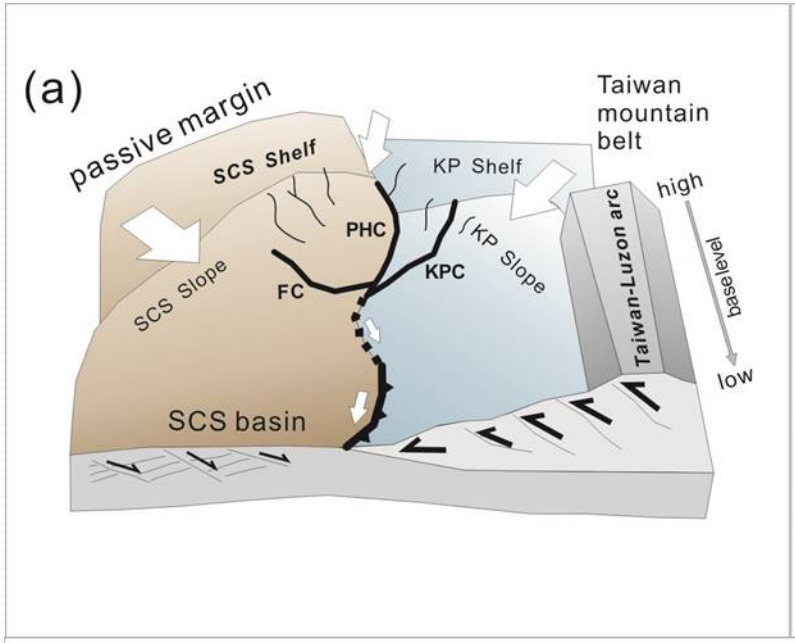


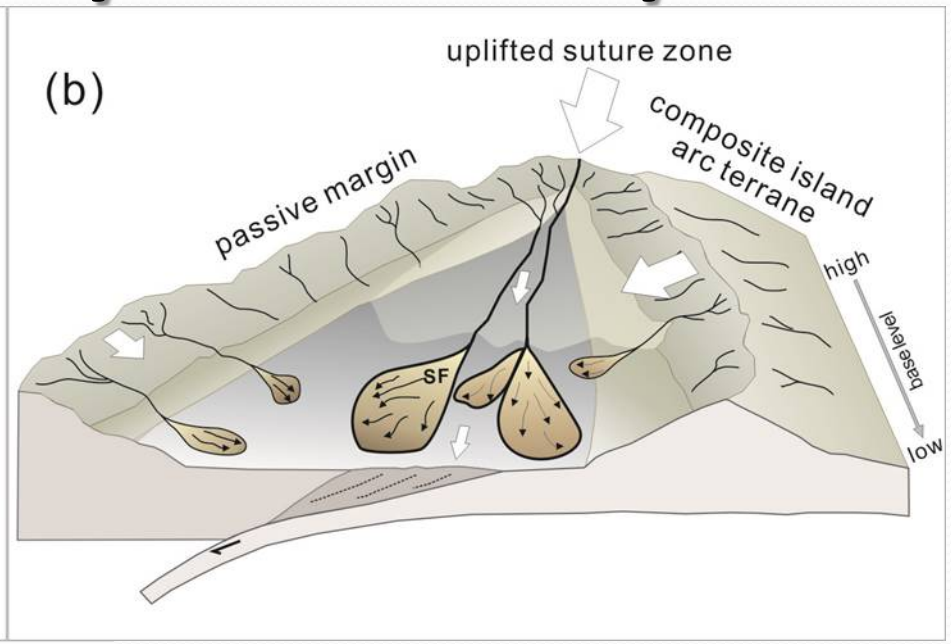
MODERN	ANCIENT
Continent - Continent	
Bengal-Indus	Ouachita-Marathon (C-P)
Mediteranean Sea	Southern Uplands, Scotland (S-D)
Gulf of Oman	Acadian Orogeny (S-D)
	Songpan-Ganzi (T-J)
Intraoceanic Arc - Continent	
	Lachian Foldbelt (O-S)
NW Australia-Java	Alps-Carpathians (T)
Sea of Japan	Apennines (T)
Huon Gulf	Persian Gulf (K-T)
NE South China Sea	Junggaro-Balkhash (D-P)
	Taconic Orogeny (O)
	Antler Orogeny (D-M)
	NE Caribbean (T)
oceanic-Continent Arc - Arc	
	Nevadan Orogeny (J)
Intraoceanic Arc - Arc	
olucca Sea	

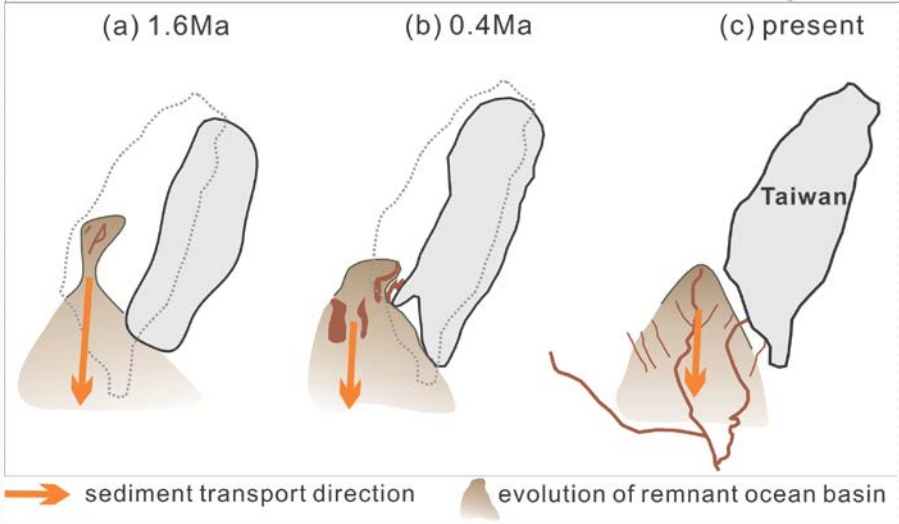
- ***Foreland basin?***
- ***Collisional marine basin?***
- ***Remnant Ocean Basin?***

al., 1975; Ingersoll, 1988)

Submarine fan and canyon-channel systems





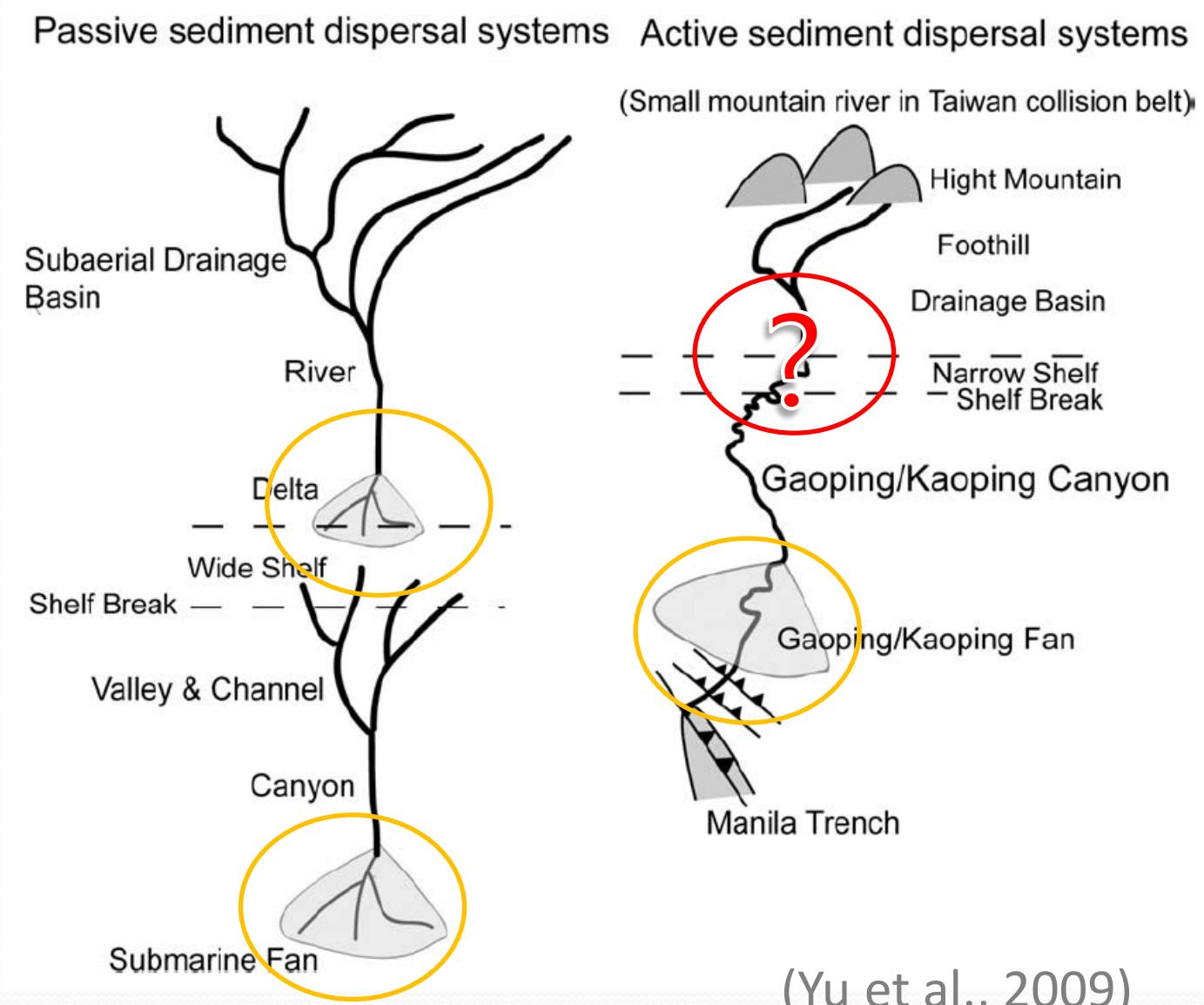


Axial canyon-channel system
Axial fan system

Paleo canyon-channel systems offshore SW Taiwan

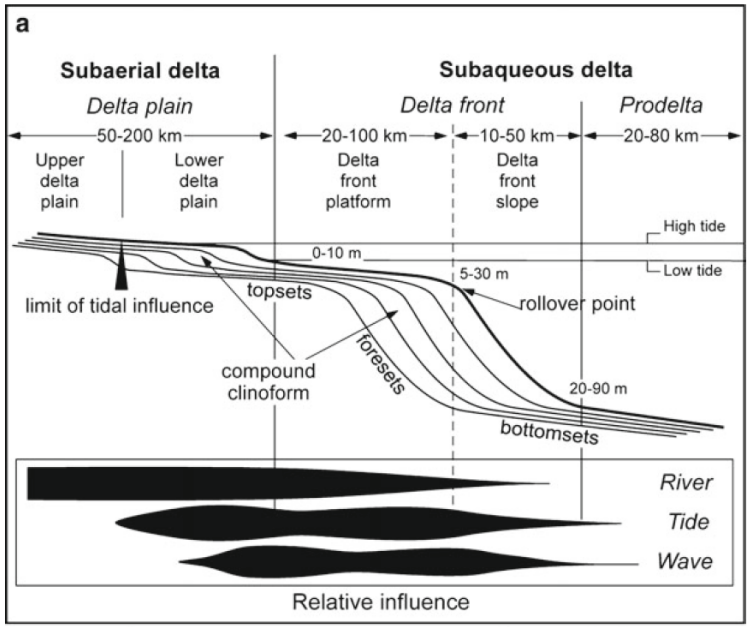
(Hsiung et al., 2015)

Source-to-sink routes



(Yu et al., 2009)

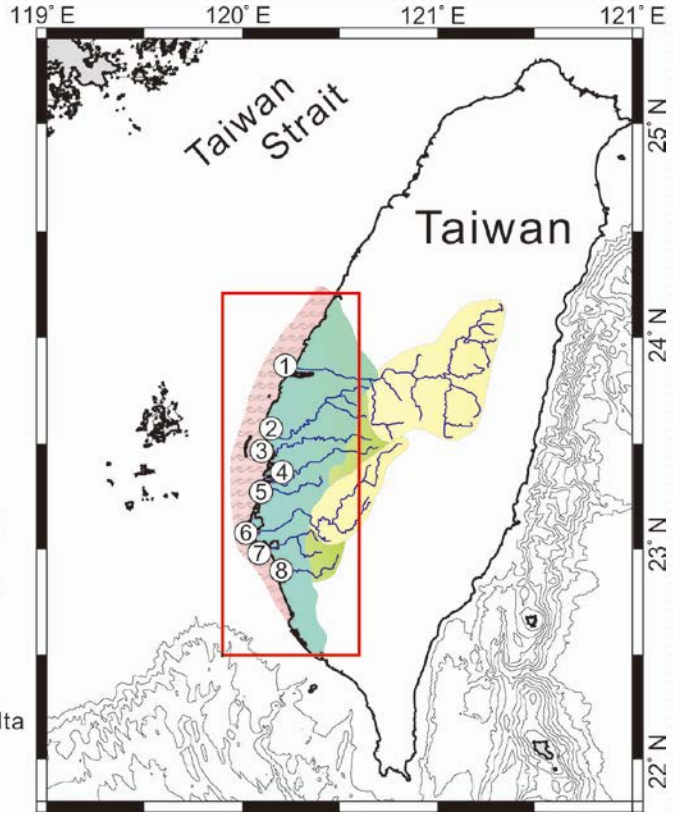
Southwest Taiwan Delta

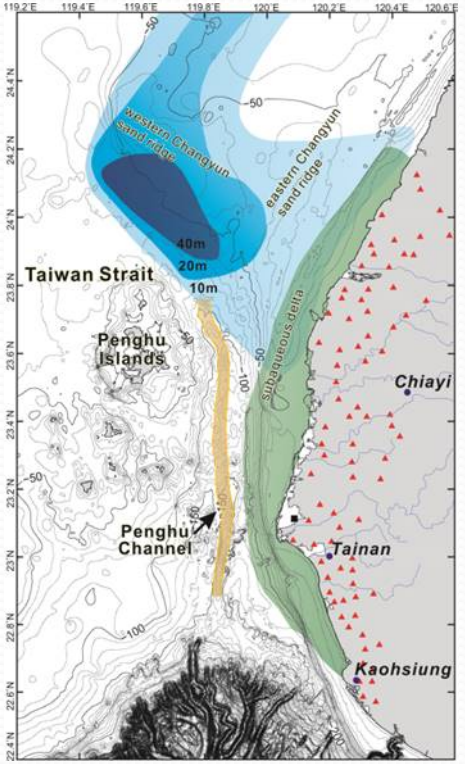


(Goodbred and Saito, 2012)

- ***To determine the subaerial and subaqueous delta***

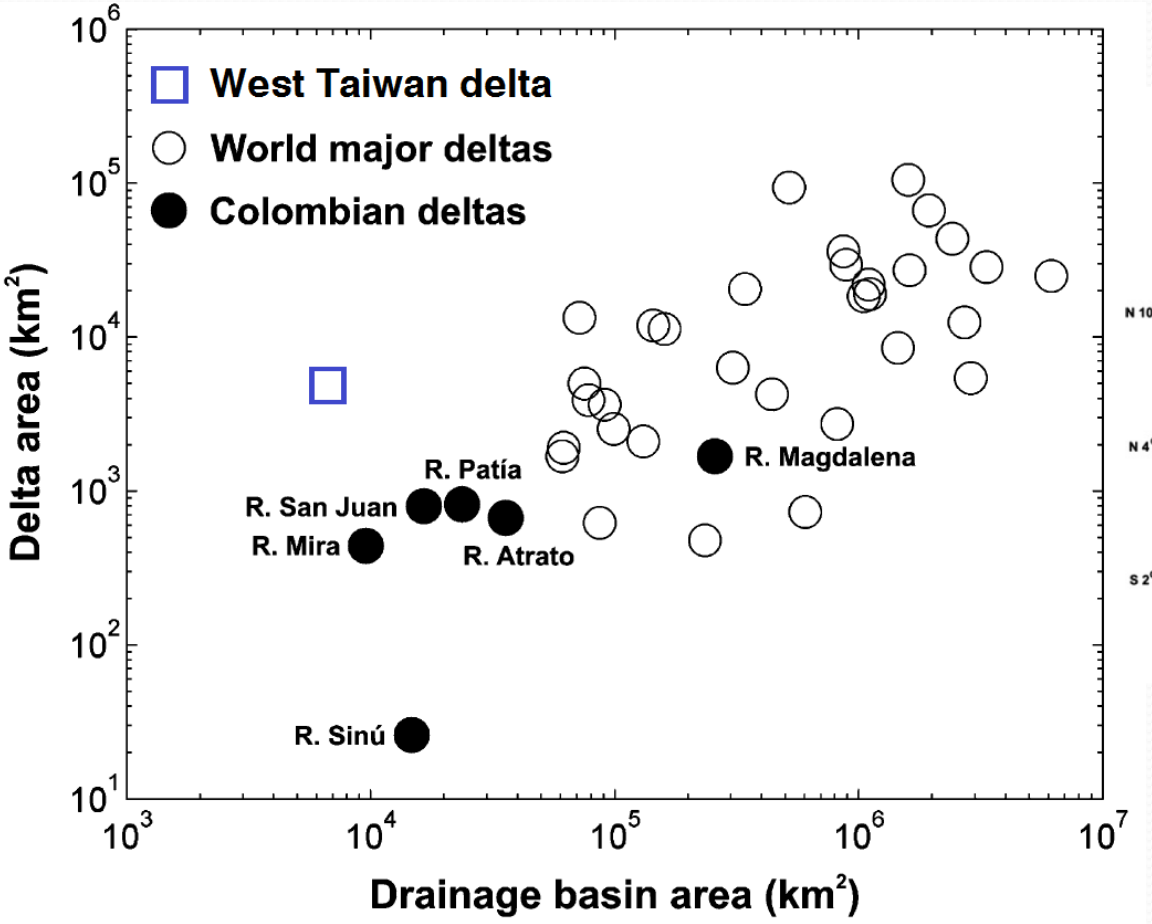
Small Mountainous River delta

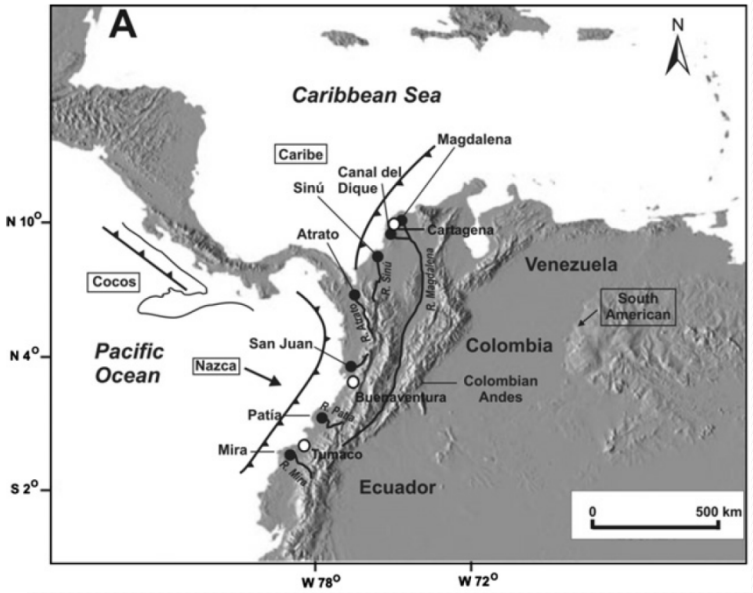




(Hsiung and Saito, 2014 AGU)

Small mountainous river deltas size





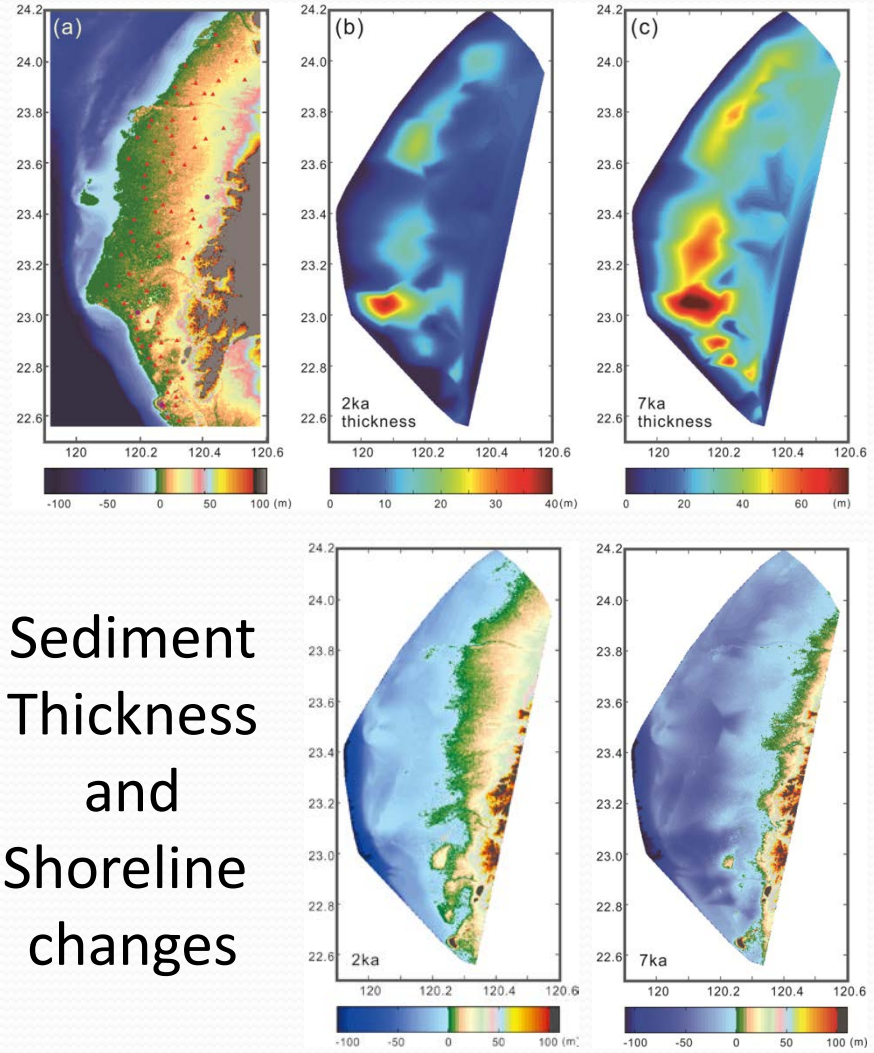
(Restrepo and Lopez, 2008)

(Modified from Syvitski, 2005; Restrepo and Lopez, 2008)

Southwest Taiwan Delta

Table 6.2.1 Pre-dam sediment discharge from land to the ocean in Southeast Asia

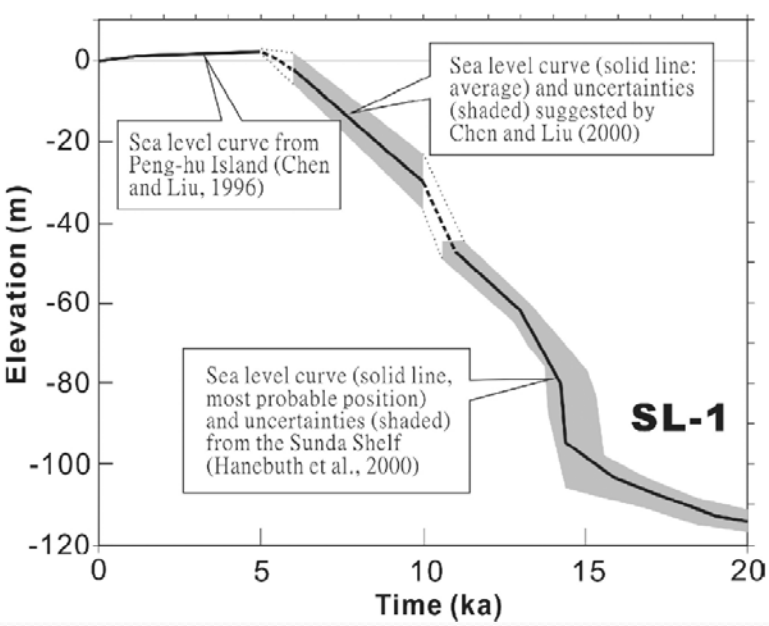
Location	Water Discharge	Sediment Discharge	
	km^3/year	Million t/year	Source
Island			
Taiwan		500	Milliman (1991)
Sumatra		780	Milliman et al. (1999)
Java		330	Milliman et al. (1999)
Borneo		910	Milliman et al. (1999)
Celebes		350	Milliman et al. (1999)
Timor Leste		100	Milliman et al. (1999)
New Guinea		1700	Milliman (1995)
River			
Zhujiang (Pearl River)	300–363	69	Milliman et al. (1995)
Song Hong (Red River)	120–137	116–130	Milliman et al. (1995), Thanh et al. (2004)
Mekong River	470–520	98–160	Milliman et al. (1995), Thanh et al. (2004)
Chao Phraya River	30	11	Milliman et al. (1995)
Mae Klong River	13	8	Milliman et al. (1995)
Sittoung (Sittang) River	34	10	Aye (2000)
Thanlwin (Salween) River	50–360	~100–690	Meade (1996), Aye (2000)
Ayeyarwady (Irrawaddy) River	430–450	260	Milliman et al. (1995), Aye (2000)
Total		~6,000	



Sediment Thickness and Shoreline changes

(Hsiung and Saito, 2014 AGU)

Southwest Taiwan Delta since 7 ka



West Taiwan region

(Hsieh et al., 2000)

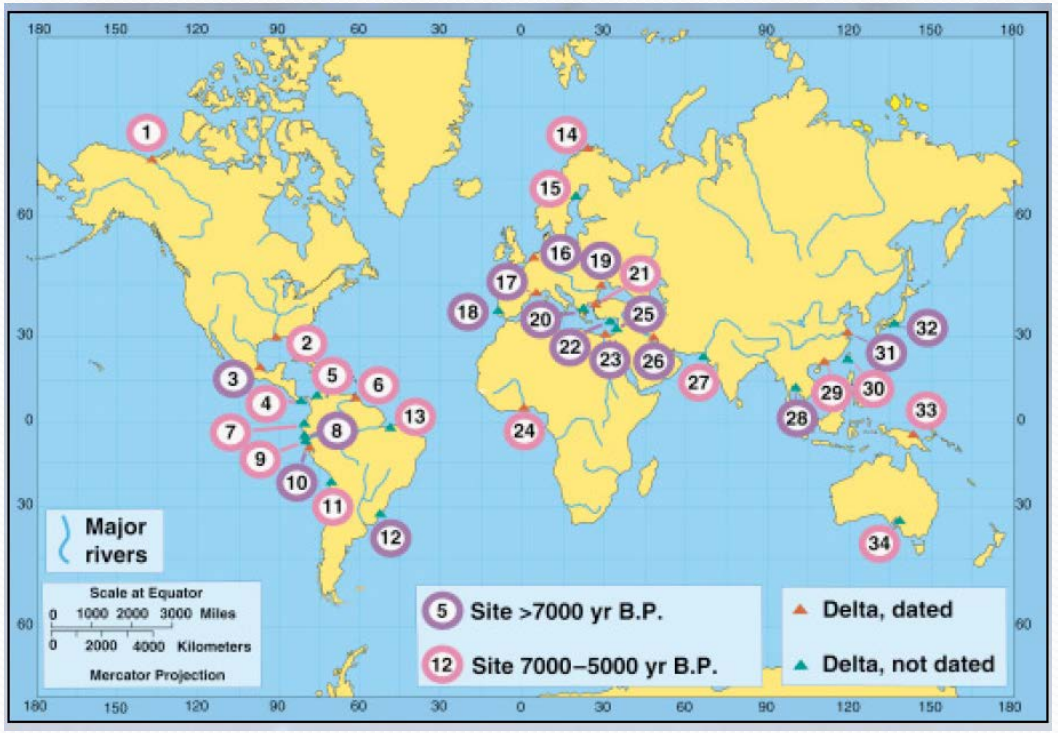
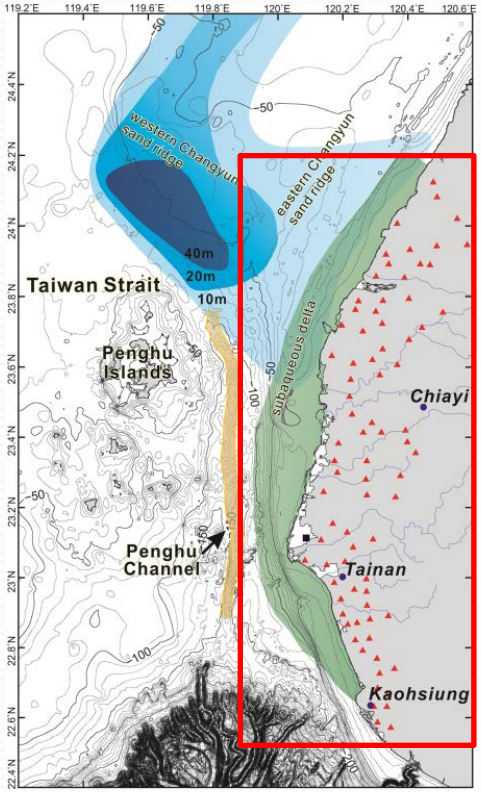
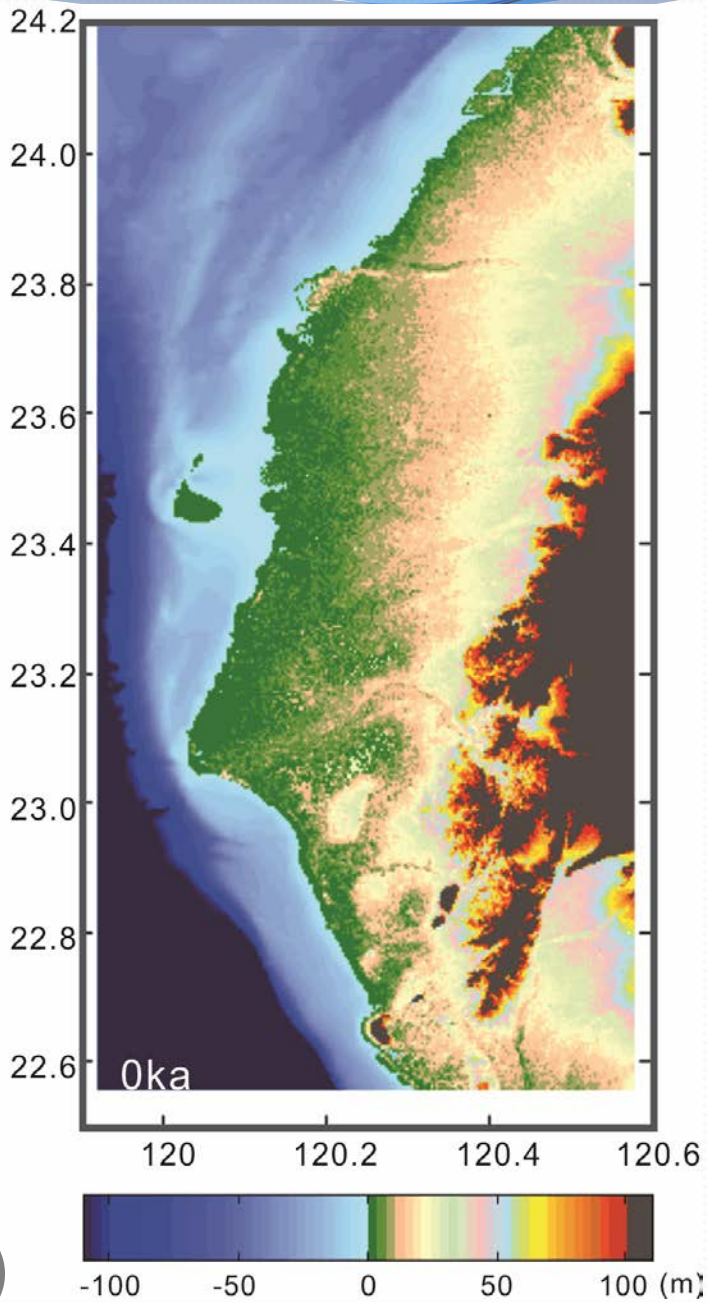


Figure 1. Documented archaeological sites, dated from >7000 to ~5000 yr B.P., on and adjacent to 34 delta sequences compiled in this preliminary survey (Table 1). Sixteen of the 34 delta sequences have been dated (Table 1). Of note are eight sites >7000 yr B.P. (purple circle) positioned on deltas that are dated to >7000 yr B.P. (red triangle), indicating early occupation of these depocenters.

(Stanley and Warne, 1997)

Southwest Taiwan Delta





- ***From modern to 7 ka***

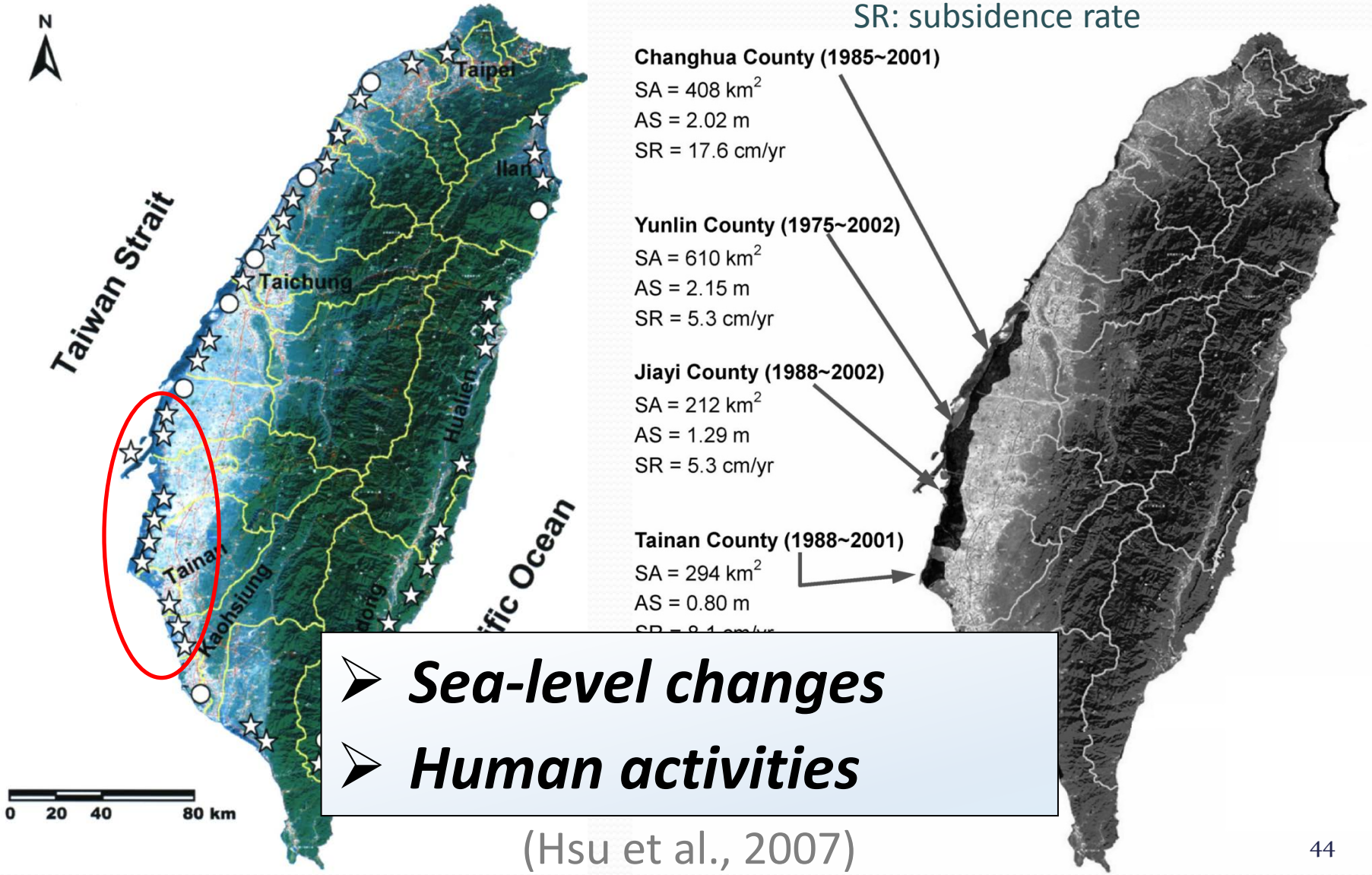
(Hsiung and Saito, 2014 AGU)

Tidal flats southwest Korea (2014.8.)

- 韓國地調所 (KIGAM)

Modern SW Taiwan Delta

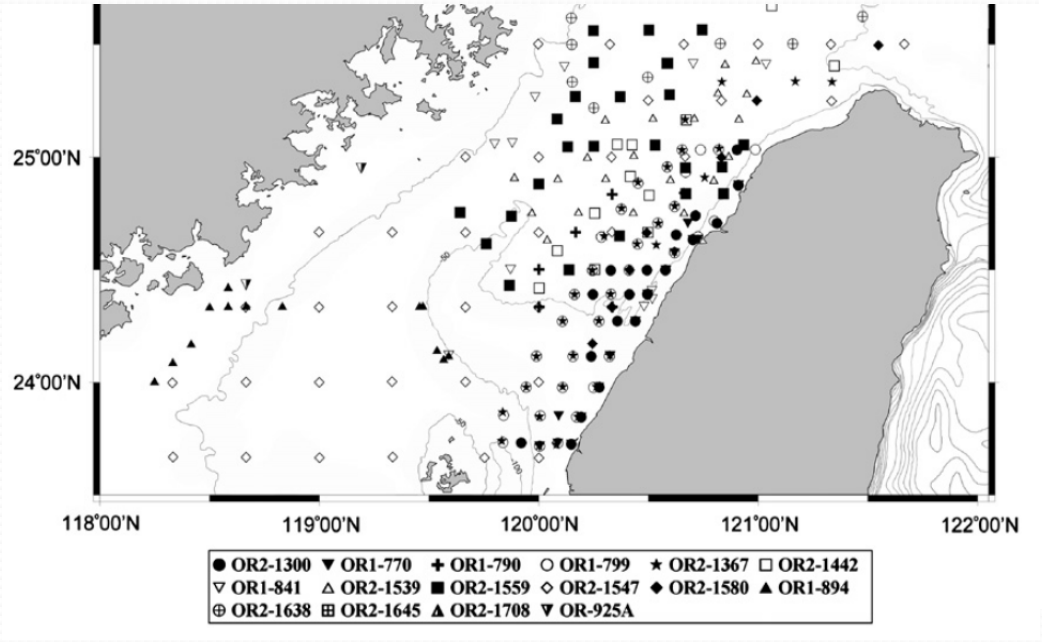
SA: subsidence area recently;
AS: accumulated subsidence depth;
SR: subsidence rate



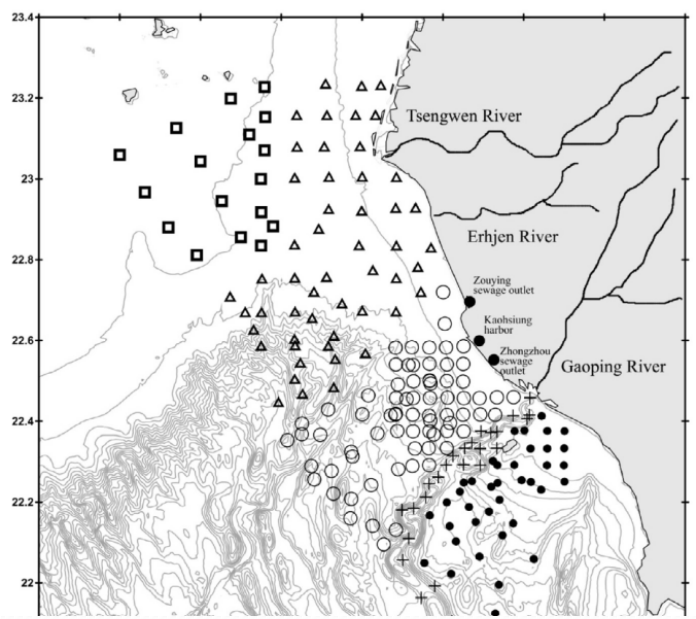
- ***Sea-level changes***
- ***Human activities***

(Hsu et al., 2007)

Modern offshore SW Taiwan



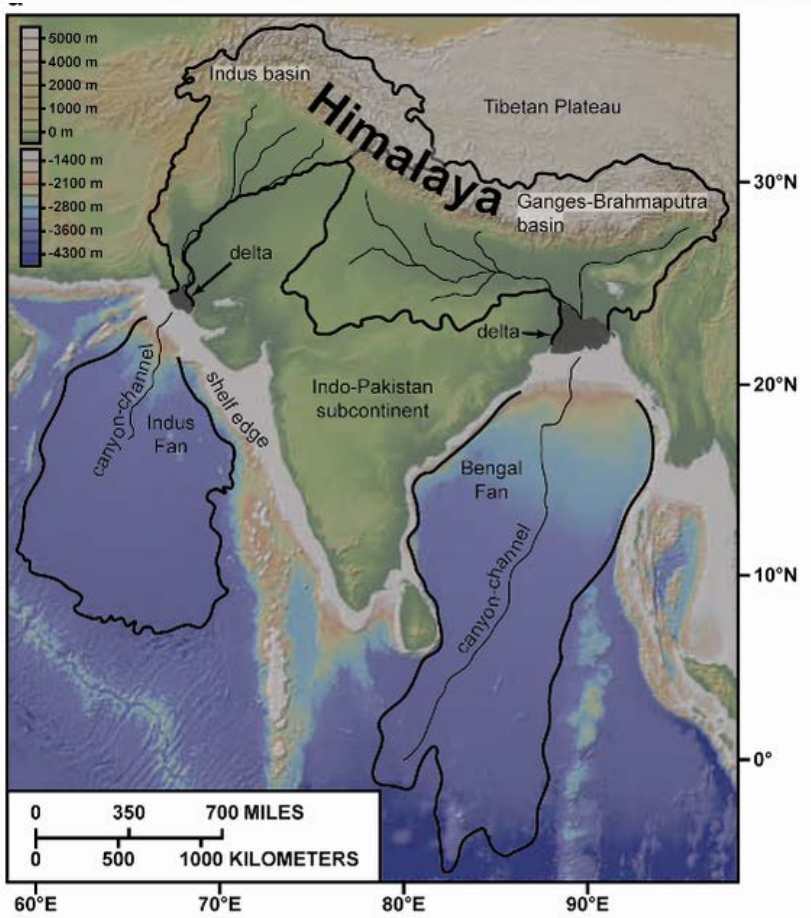
(Huh et al., 2011)

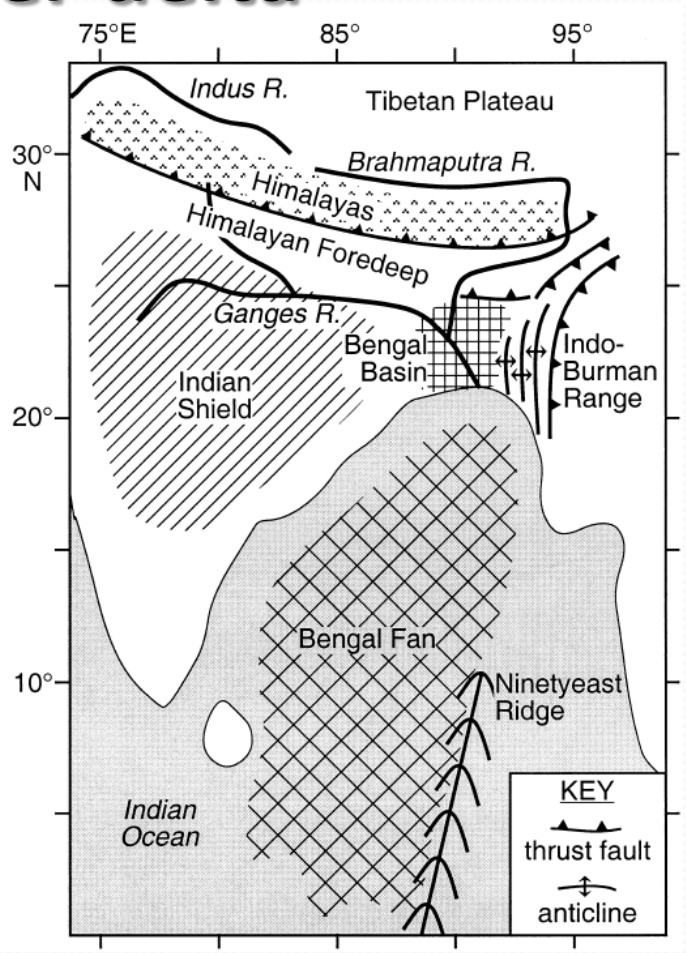


(Hsu et al., 2014)

- ***Sediment accumulation rate: 0.1 – 2 cm/yr (<100 yr) from short-lived isotopes.***

Ganges-Brahmaputra river delta





- **G-B delta area: ~100,000 km^2**
- **Bengal fan area: ~3,000,000 km^2**

(Goodbred and Kuehl, 2000)

Ganges-Brahmaputra river delta

TABLE 2. SEDIMENT BUDGETS FOR THE GANGES-BRAHMAPUTRA RIVER DELTA

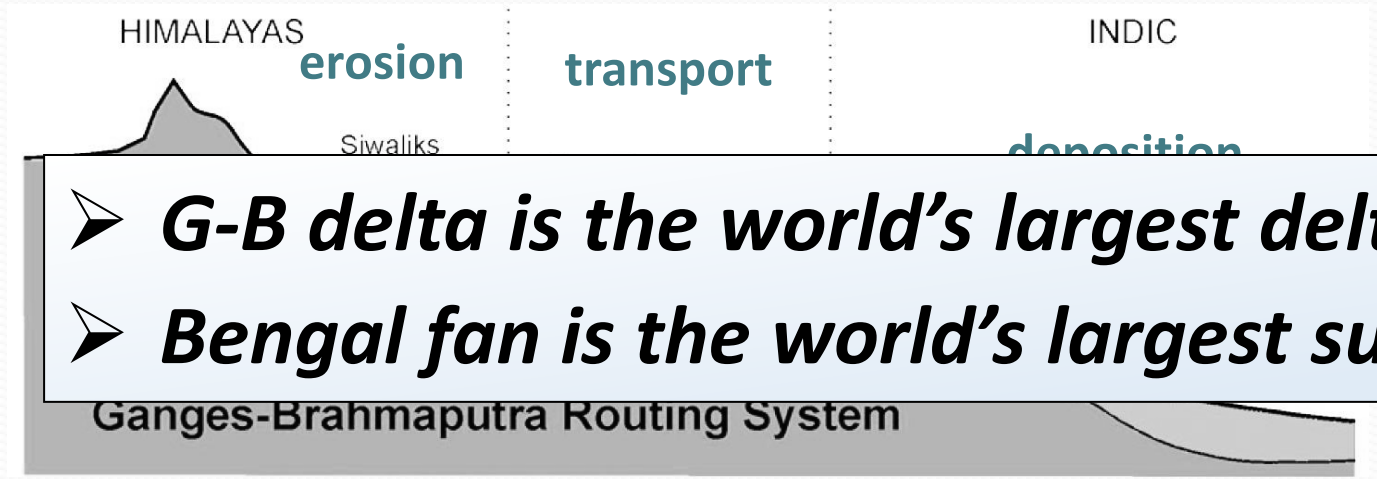
	Flood plain/ delta plain	Subaqueous delta	Canyon/fan
Holocene*	32 (this study)	42 (Kuehl et al., 1997)	26?
Modern	30 (Goodbred and Kuehl, 1998)	21, topset (Allison, 1998)	29?

discharge.

*Calculated since 7 ka.

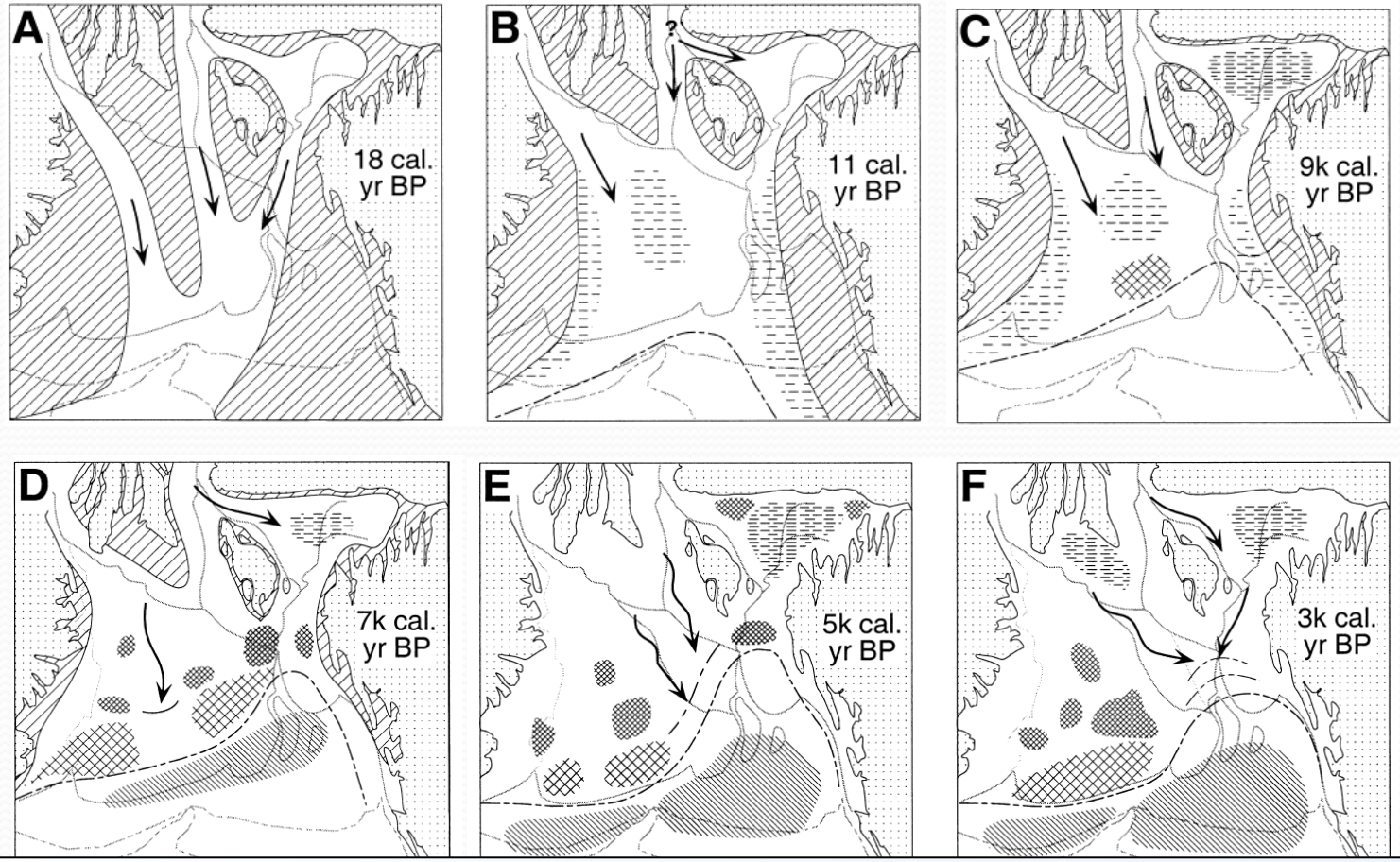
- ***Sediment budgets evaluation (%)***

(Goodbred and Kuehl, 1999)



- ***G-B delta is the world's largest delta***
- ***Bengal fan is the world's largest submarine fan***

Ganges-Brahmaputra river delta



➢ ***Reconstruction of the environment changes***

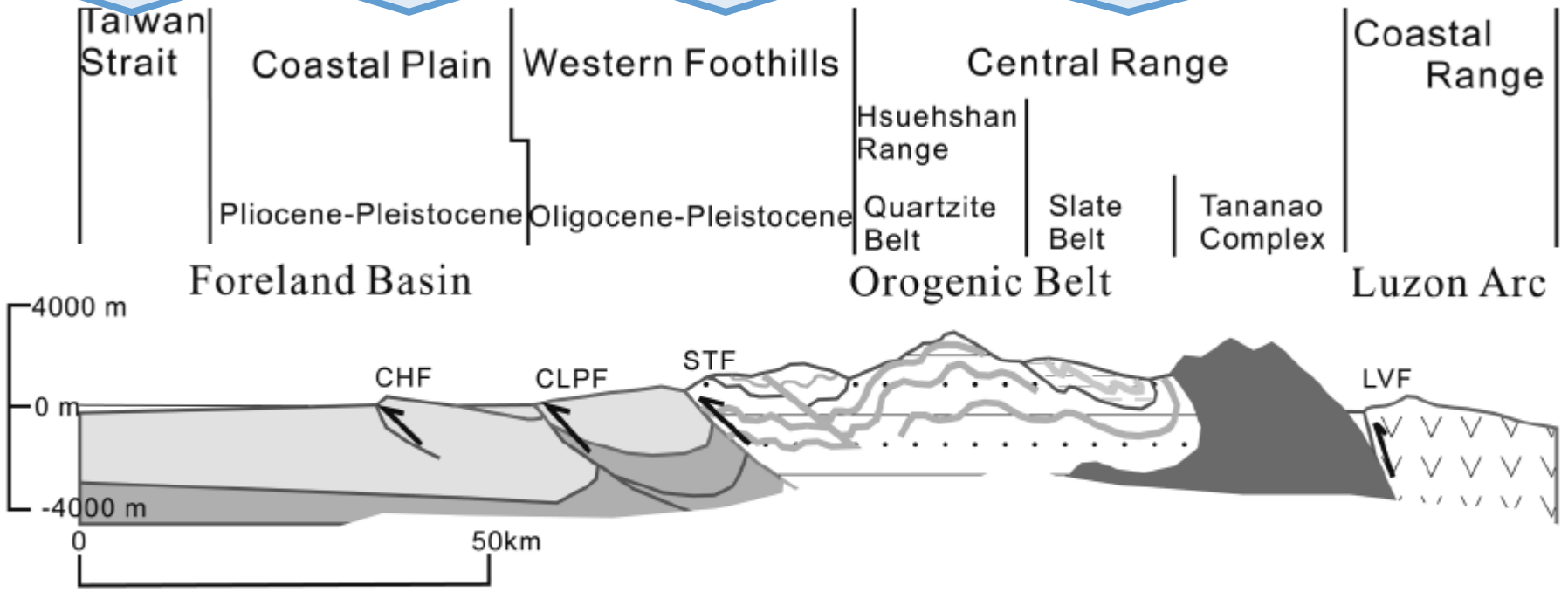
(Goodbred and Kuehl, 2000)

Outline

- ☺ *Development of the dispersal system (regional source-to-sink study)*
- ☺ *Comparison to the Huon Gulf east of PNG (canyon drainage systems)*
- ☺ *Progressive changes in morphotectonics (longitudinal sediment dispersal route)*
- ☺ *Submarine fan and river-delta studies (off southwest Taiwan)*
- ☺ ***Summary***

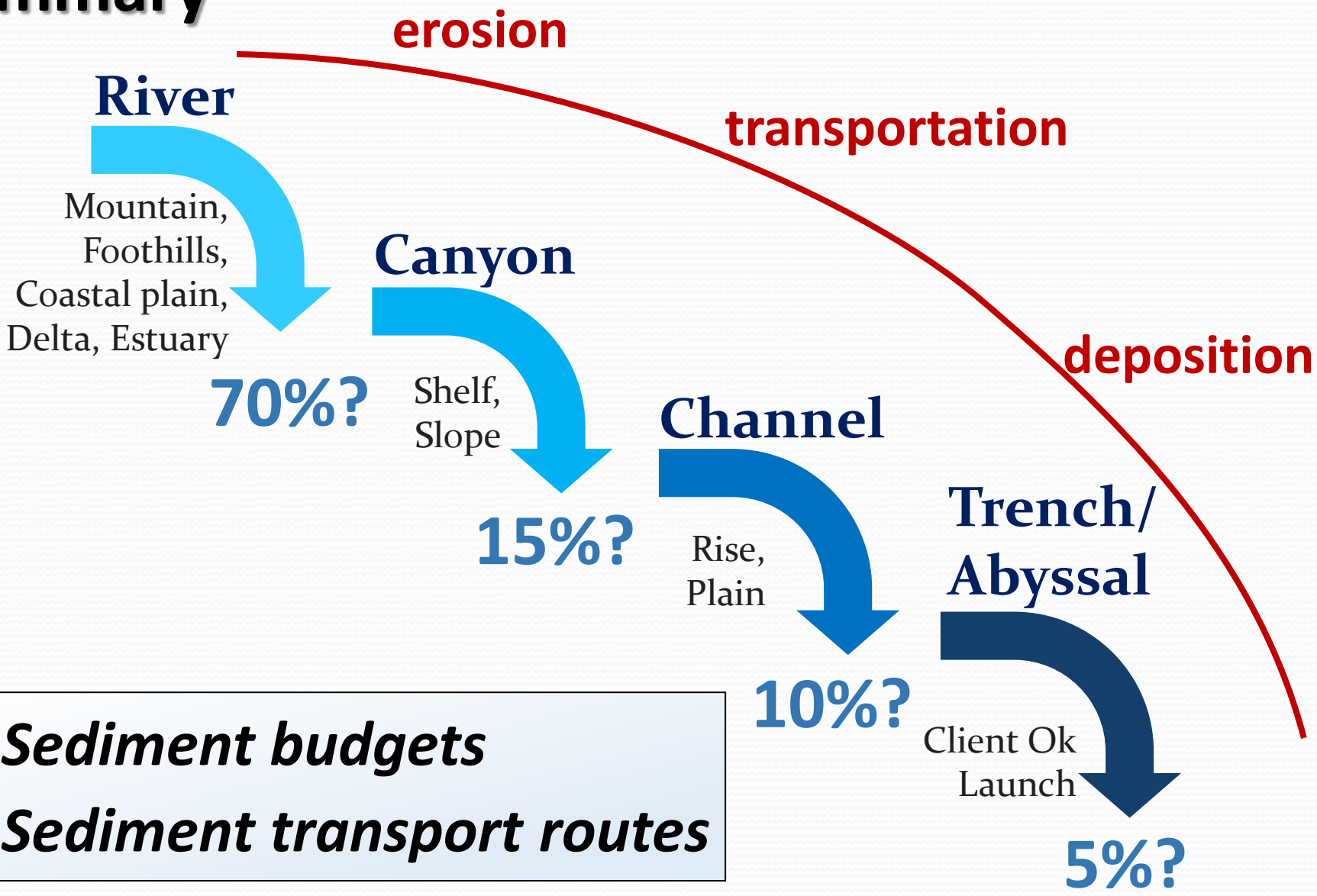
Multi geological time scale

modern | **ka** | **1~3 Ma** | **~Miocene**



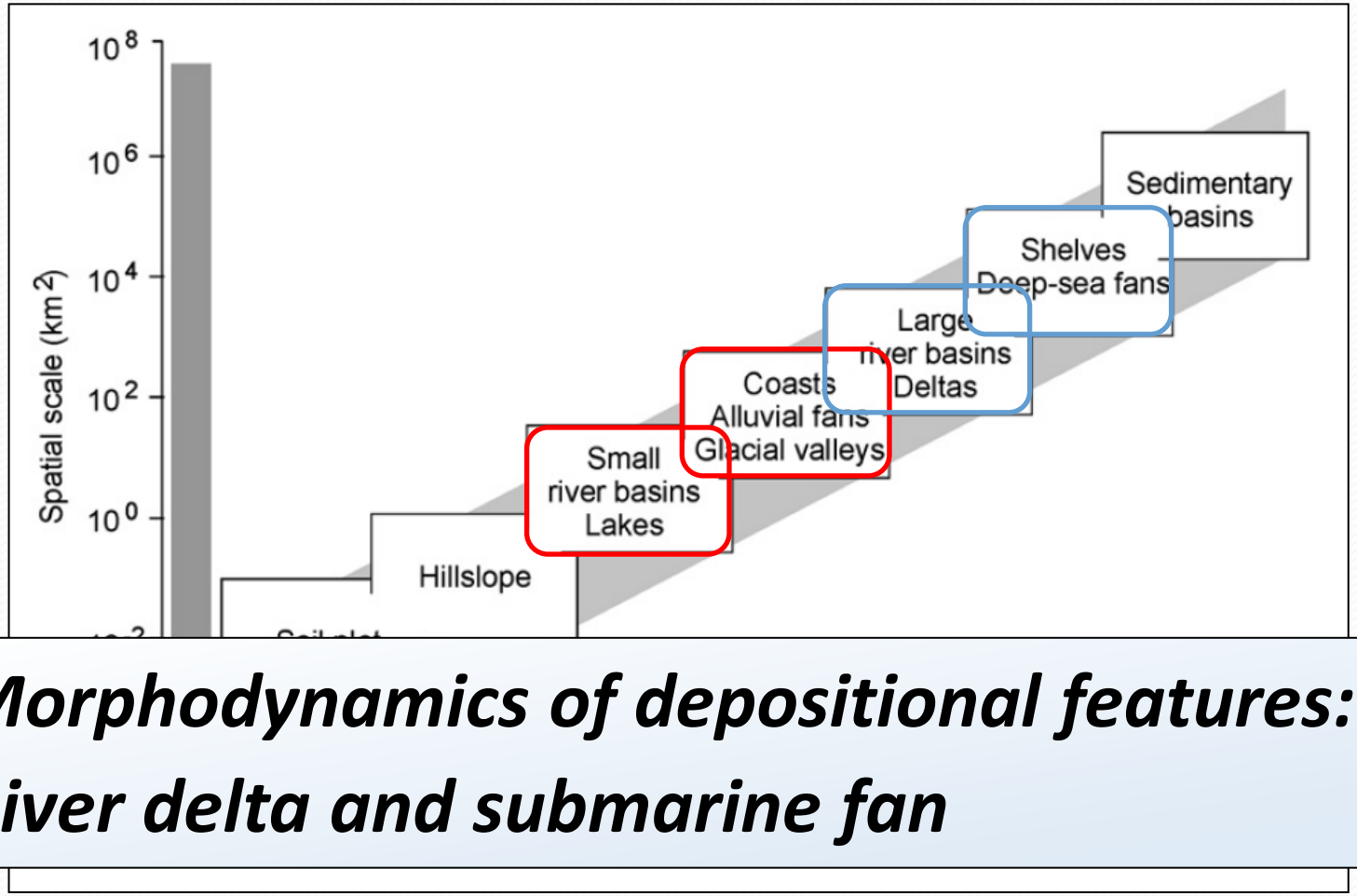
➢ ***Linkage of multi-spatial and temporal scales***

Summary



- ***Sediment budgets***
- ***Sediment transport routes***

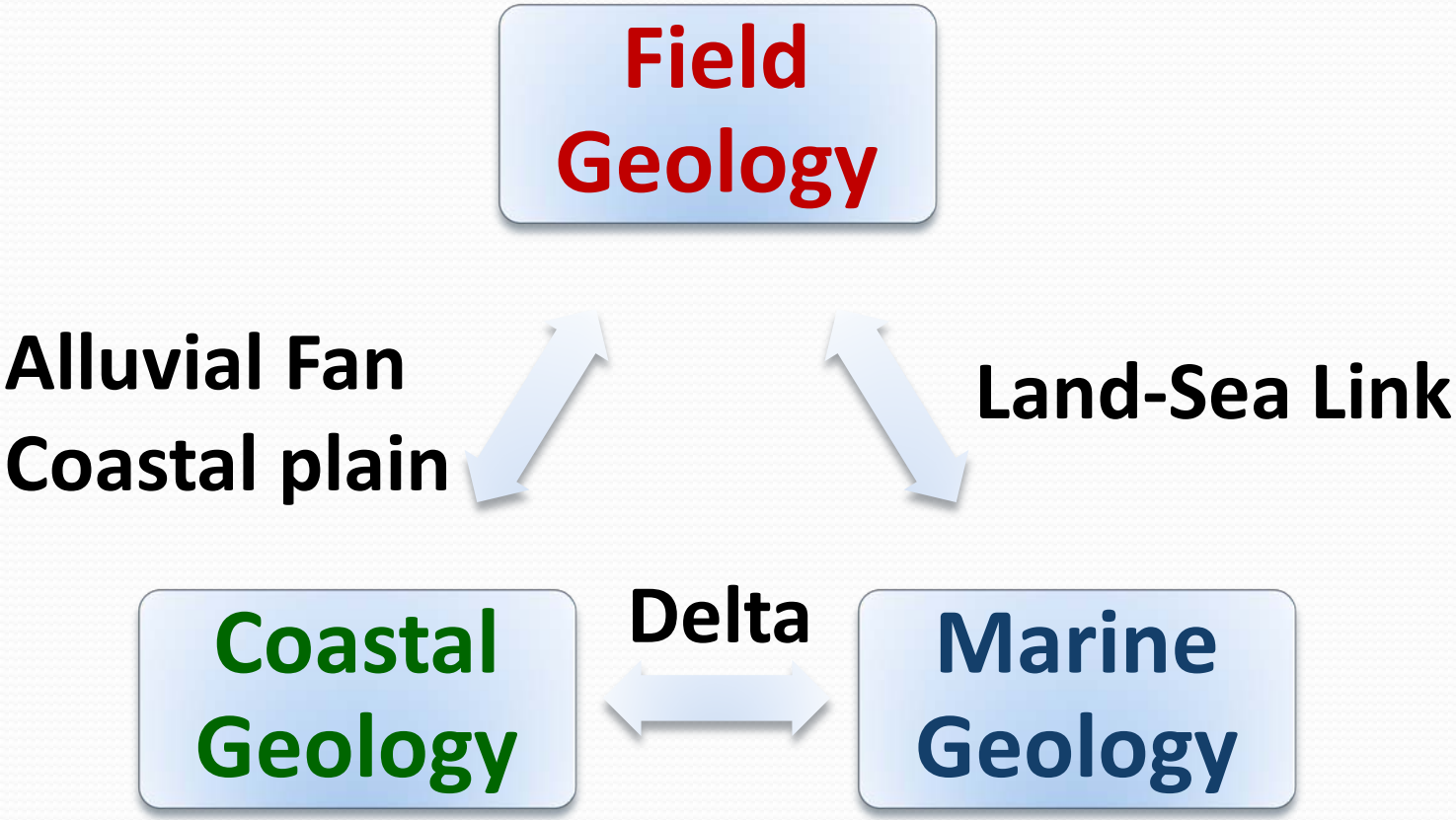
Linkage



- ***Morphodynamics of depositional features: River delta and submarine fan***

Arrangement of different sedimentary systems in terms of spatial and temporal scales. (Hinderer, 2012)

Summary



- ***To better understand the regional S2S studies***

Thank you