

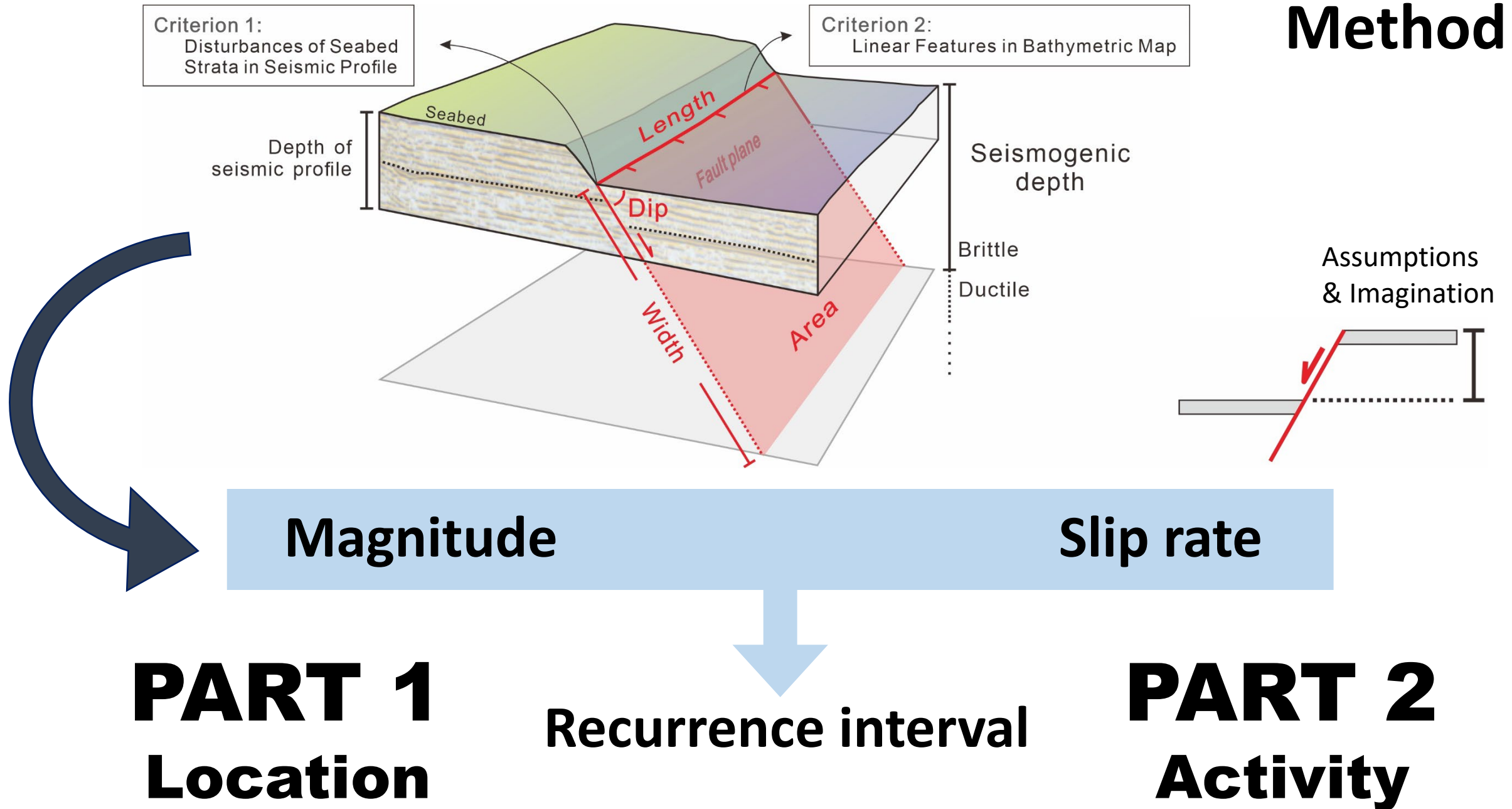
The Offshore Seismogenic Structure Database in Northeast Taiwan

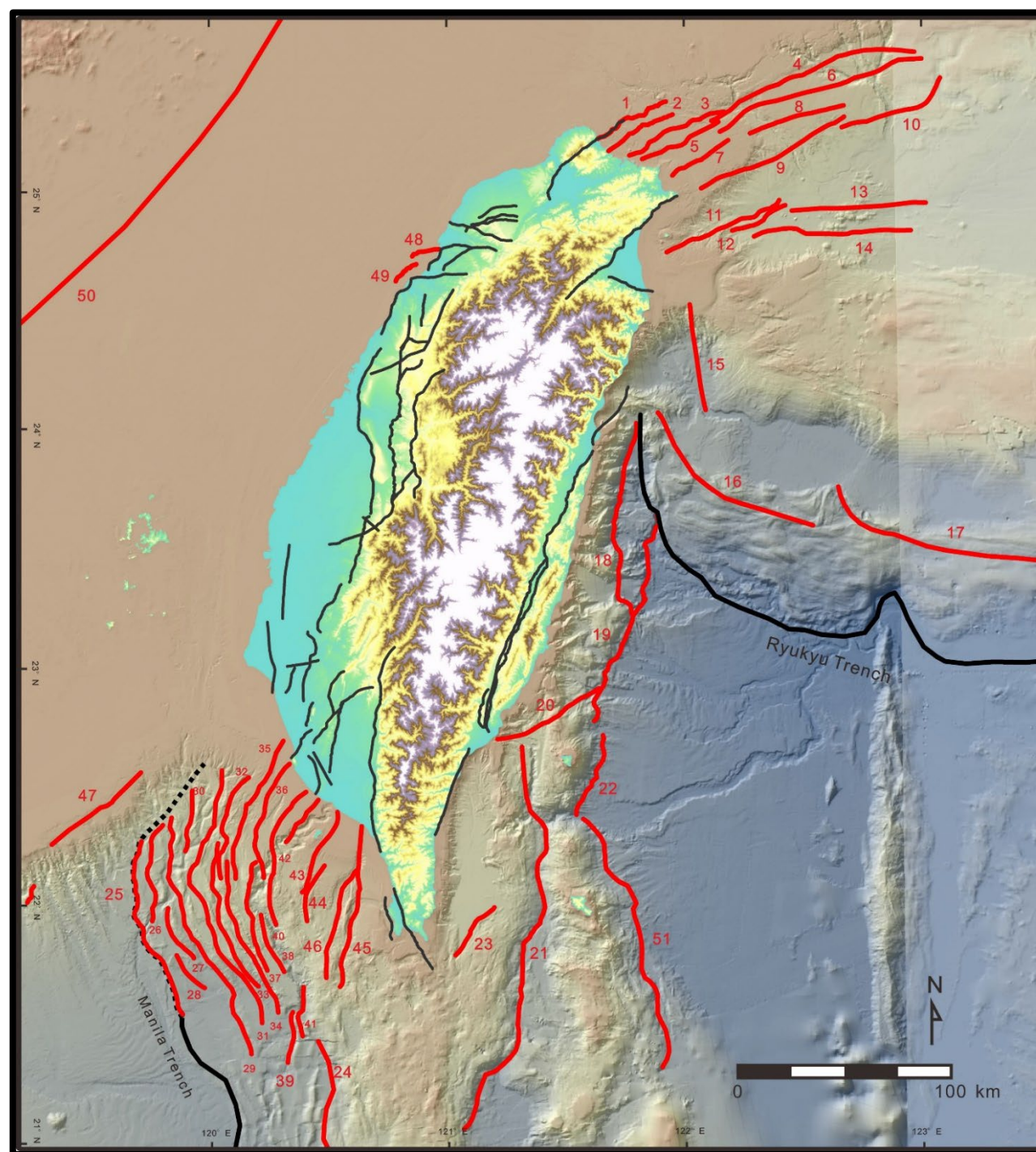
Cheng-Hung CHEN 陳承鴻, J. Bruce H. Shyu
Department of Geosciences, National Taiwan University

2024.01.30

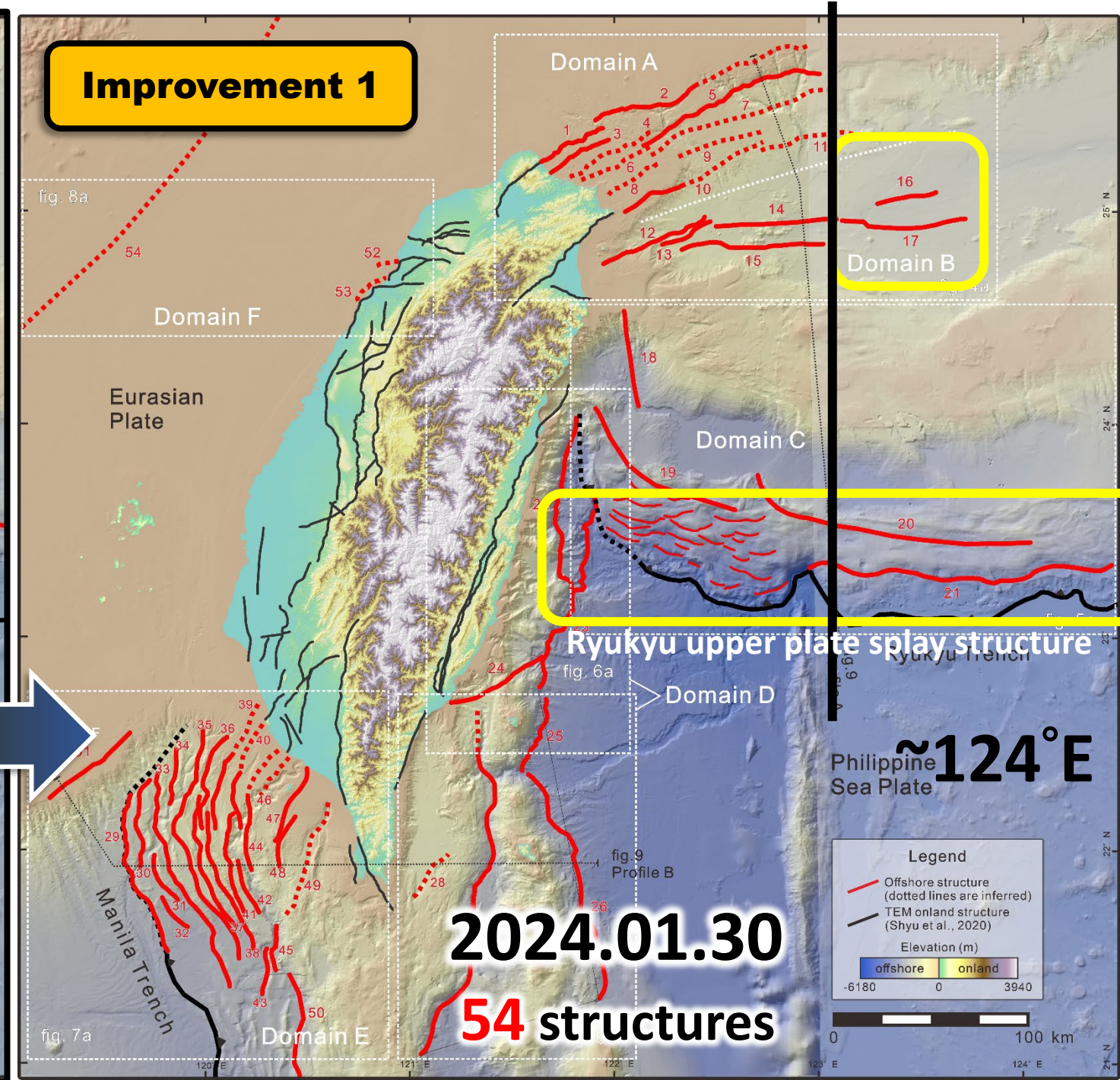
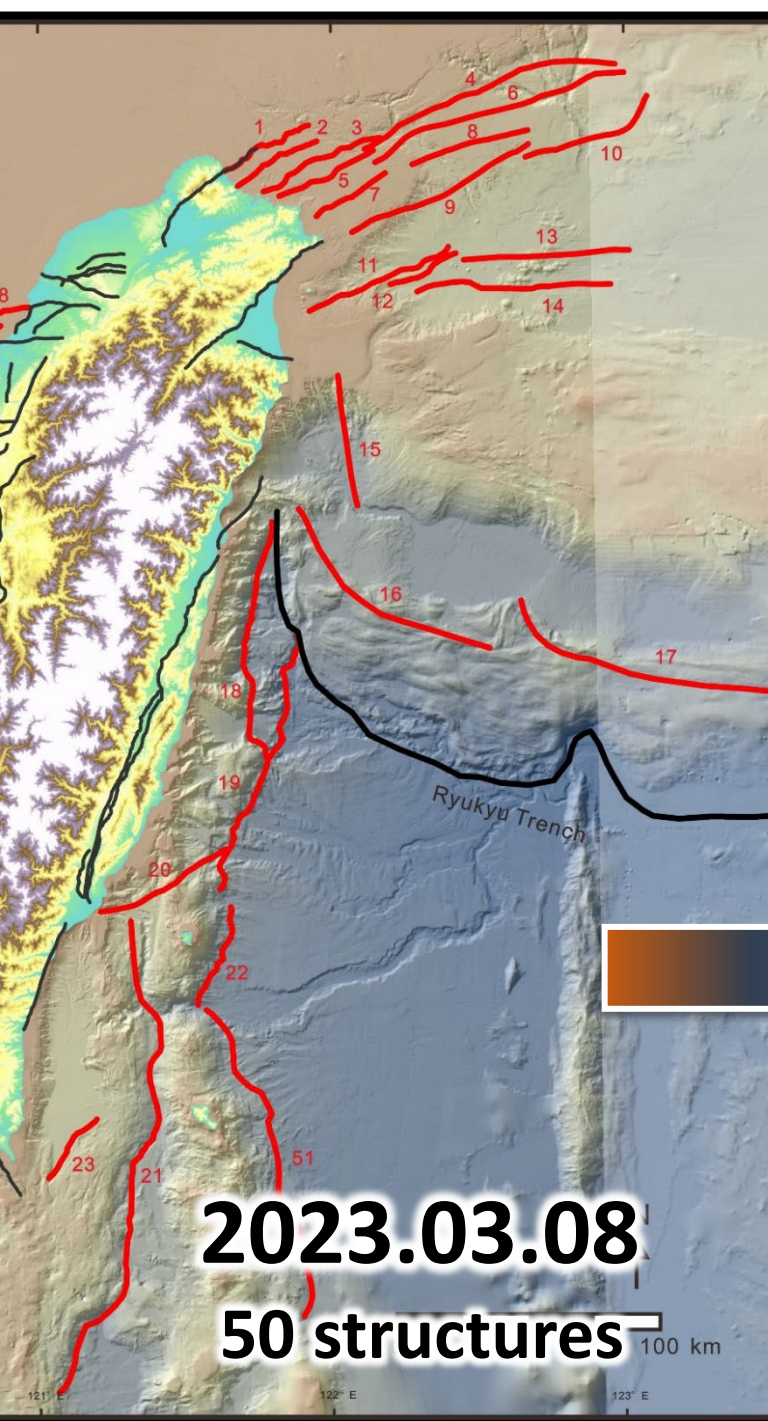


Method



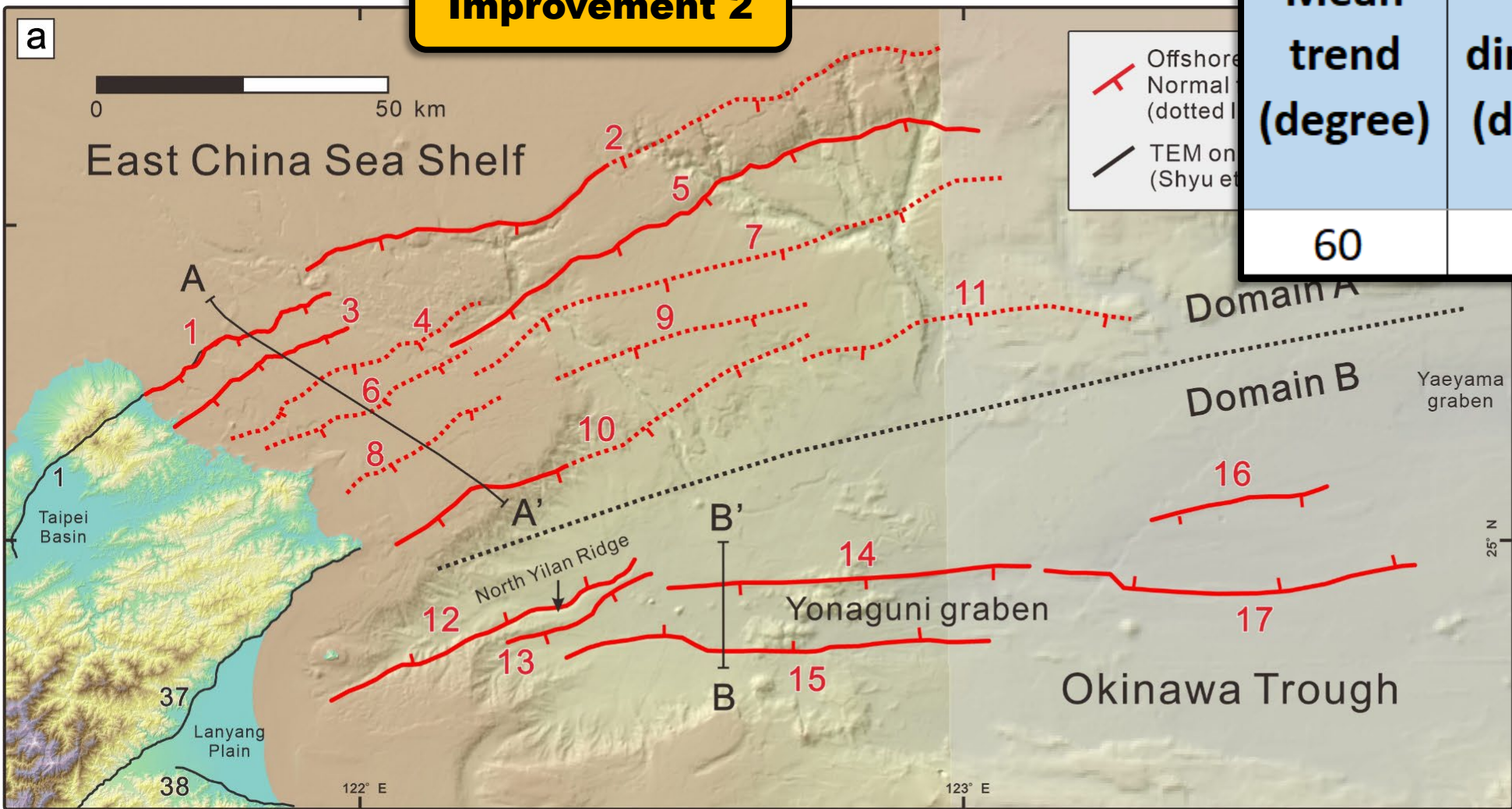


2023.03.08
50 structures



Seismotectonic Domain	
A. Northern Taiwan	
01	Outer Chinshan Structure 1 (ST-I)
02	Outer Chinshan Structure 2 (ST-III)
03	Outer Kanchiao Structure (ST-II)
04	Outer Chilung Structure 1
05	Outer Chilung Structure 2
06	Outer Shenaokeng Structure 1
07	Outer Shenaokeng Structure 2
08	Outer Aoti Structure 1
09	Outer Aoti Structure 2
10	Outer Lishan Structure 1
11	Outer Lishan Structure 2
B. Southern Okinawa Trough	
12	North Yilan Ridge Structure A
13	North Yilan Ridge Structure B
14	North Yonaguni Rift Structure
15	South Yonaguni Rift Structure
16	East Yonaguna Rift Structure A
17	East Yonaguna Rift Structure B
C. Ryukyu Subduction Zone	
18	Suao Fault Zone
19	West Yaeyama Fault Zone
20	Yaeyama Fault Zone
21	Ryukyu Upper Plate Splay Structure
D. Eastern Taiwan	
22	Takangkou High Thrust
23	Chimei Canyon Thrust
24	East Taitung Structure
25	East Lutao Structure
26	East Lanyu Structure
27	East Huatung Ridge Structure
28	East Southern Longitudinal Trough Structure
E. Southwest Taiwan	
29	SW Offshore Structure A
30	SW Offshore Structure B-1
31	SW Offshore Structure B-2
32	SW Offshore Structure B-3
33	SW Offshore Structure C
34	SW Offshore Structure D
35	SW Offshore Structure E
36	SW Offshore Structure F-1
37	SW Offshore Structure F-2
38	SW Offshore Structure F-3
39	SW Offshore Structure G
40	SW Offshore Structure H-1
41	SW Offshore Structure H-2
42	SW Offshore Structure H-3
43	SW Offshore Structure H-4
44	SW Offshore Structure I
45	SW Offshore Structure J
46	SW Offshore Structure K
47	SW Offshore Structure L
48	SW Offshore Structure M
49	Fangliao Canyon Structure Zone
50	Manila Upper Plate Splay Structure
F. Western Taiwan	
51	Tainan Basin Structure
52	Outer Hsinchu Structure
53	Toufen Structure
54	Benhai Fault

Improvement 2



Mean trend (degree)	Dip direction (degree)	Upthrown side
60	150	N

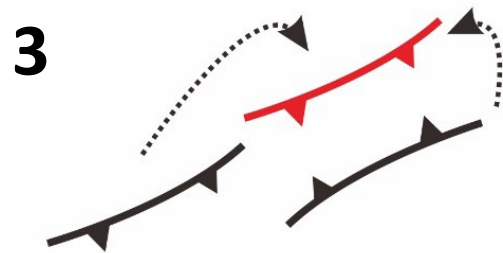
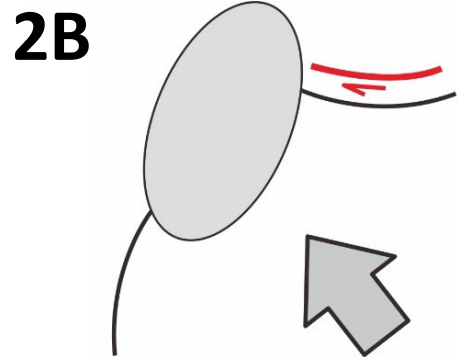
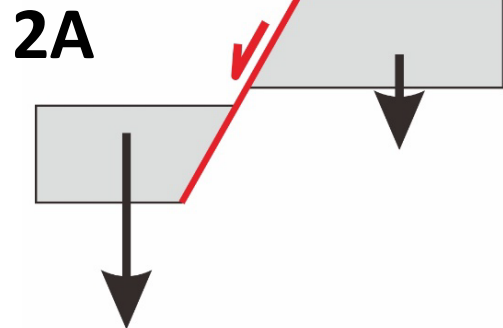
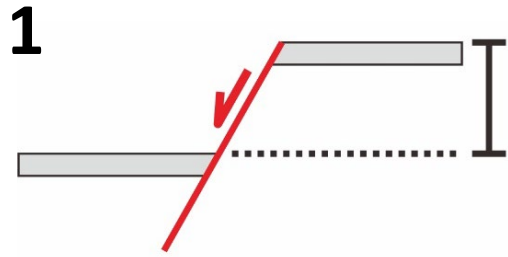
- 07 Outer Shennakeng Structure 2
08 Outer Aoti Structure 1
09 Outer Aoti Structure 2
10 Outer Lishan Structure 1
11 Outer Lishan Structure 2

- B. Southern Okinawa Trough**
12 North Yilan Ridge Structure A
13 North Yilan Ridge Structure B
14 North Yonaguni Rift Structure
15 South Yonaguni Rift Structure
16 East Yonaguna Rift Structure A
17 East Yonaguna Rift Structure B

- TEM Onland Structures**
01 Shanchiao Fault
37 Northern Ilan Structure
38 Southern Ilan Structure

Improvement 3

Flowchart for Slip Rate Calculation



Method	Domain	Structure no.
1. Offset strata or landform / Formation time	A	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
	B	12, 13, 14, 15
	D	22, 23, 24
	E	29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 48
	F	51
2. Relative motion of the two sides of the structure	2A. Differential uplift or subsidence rates across structure	B 14, 15, 16, 17
		D 25, 26, 27
		E 47
		F 54A, 54B
	2B. Plate motion rates	C 18, 19, 20, 21
		F 54A, 54B
3. Slip rates of adjacent structures	D	28
	E	49, 50
	F	52, 53

Improvement 5

Improvement 4

BN22

NEW ID	Fault name	Long-term Slip rate (mm/yr)			Reliability of rate estimation methods	Recurrence interval (W&C) (yr)			Recurrence interval (W) (yr)			Recurrence interval (Y&M) (yr)			Last event	Data source (Slip rate)	Slip rate estimation method (English)
		min	mean	max		min	mean	max	min	mean	max	min	mean	max			
1	Outer Chinshan Structure 1(ST-I) offshore	0.81	1.37	1.92	B	199	605	2205	711	1356	3099	213	642	2317		原能會, 2016	Reference to the 2016 report by the Atomic Energy Council
1b	Outer Chinshan Structure 1(ST-I) offshore	0.42	0.82	2.45	B	156	1012	4224	557	2268	5937	167	1073	4439		原能會, 2016	Reference to the 2016 report by the Atomic Energy Council
1c	Outer Chinshan Structure 1(ST-I) offshore	1.10	1.66	2.94	C	130	497	1624	464	1115	2282	139	528	1706		原能會, 2016	Reference to the 2016 report by the Atomic Energy Council
1d	Outer Chinshan Structure 1(ST-I)	0.81	1.37	1.92	B					373			1442			原能會, 2016	Reference to the 2016 report by the Atomic Energy Council
1e	Outer Chinshan Structure 1(ST-I) added segment																
1f	Outer Chinshan Structure 1+Shanchiao fault	0.51	1.22	1.92	B		1136			328			3105			原能會, 2016	Reference to the 2016 report by the Atomic Energy Council
1g	Outer Chinshan Structure 1																
2	Outer Chinshan Structure 2																
2b	Outer Chinshan Structure 2																
3	Outer Kanchiao structure																
3b	Outer Kanchiao structure																
4	Outer Chilung Structure																
5	Outer Chilung Structure																
6	Outer Shenaokeng Structure																
7	Outer Shenaokeng Structure																
8	Outer Longdong Structure																
9	Outer Longdong Structure																
10	Outer Aoti Structure 1																
11	Outer Aoti Structure 2																
12	North Yilan Ridge Structure																
12b	North Yilan Ridge Structure																
13	North Yilan Ridge Structure																
13b	North Yilan Ridge Structure																
14	North Yonaguni Rift Structure																
14b	North Yonaguni Rift Structure																
14c	North Yonaguni Rift Structure	0.81	1.37	1.92	B												
15	South Yonaguni Rift Structure																
15b	South Yonaguni Rift Structure	0.42	0.82	2.45	B												
15c	South Yonaguni Rift Structure																
16	East Yonaguni Rift Structure																
17	East Yonaguni Rift Structure																
18	Suao Fault Zone																
18b	Suao Fault Zone	1.10	1.66	2.94	C												
19	West Yaeyama Fault Zone																
19b	West Yaeyama Fault Zone																
19c	West Yaeyama Fault Zone																
19d	West Yaeyama Fault Zone	0.81	1.37	1.92	B												
20	Yaeyama Fault Zone																
20b	Yaeyama Fault Zone																
20c	Yaeyama Fault Zone	5.44	18.29	31.13	B	49	123	605	83	164	643	51	139	729			
20d	Yaeyama Fault Zone	1.81	8.69	15.57	B	98	259	1816	166	344	1930	103	292	2186			
20e	Yaeyama Fault Zone	4.84	16.90	28.95	B	53	133	680	89	177	723	55	150	819			
21	Ryukyu Upper Plate Splay Structure	8.50	22.35	36.20	C	17	96	891	519	1488	6373	21	163	2179			
21b	Ryukyu Upper Plate Splay Structure	6.45	22.12	37.79	C	17	97	1175	497	1504	8400	20	164	2872			
21c	Ryukyu Upper Plate Splay Structure	7.74	26.54	45.35	B	14	81	979	415	1253	7002	17	137	2394			

Slip rate estimation method (English)

楊彭丞, 2017 - Teng, 1996	Using the height of the displaced PRSB and the time when it began to be affected by the mountain collapse
徐泊權, 1999 - Teng, 1996	The height difference of the basement / The start time of the mountain collapse
徐泊權, 1999 - 海槽擴張	The height difference of the basement / The spreading time of the Okinawa Trough
徐泊權, 1999 - Teng, 1996	The height difference of the basement / The start time of the mountain collapse
徐泊權, 1999 - 海槽擴張	The height difference of the basement / The spreading time of the Okinawa Trough
Fang et al., 2020 下沉速率	Using the difference in subsidence rates between the hanging wall and the footwall block
徐泊權, 1999	The height difference of the basement / The start time of the mountain collapse
Profile of Tsai et al., 2021	The amount of offset layers in the cross-section / The spreading time of the Okinawa Trough
Fang et al., 2020 下沉速率	Using the difference in subsidence rates between the hanging wall and the footwall block
徐泊權, 1999	The height difference of the basement / The start time of the mountain collapse
Profile of Tsai et al., 2021	The amount of offset layers in the cross-section / The spreading time of the Okinawa Trough
Fang et al., 2020	Using the difference in subsidence rates between the hanging wall and the footwall block
Fang et al., 2020	Using the difference in subsidence rates between the hanging wall and the footwall block
Chen et al., 2022(min) - 棚坡交界與擴張(max)	GPS horizontal vector difference [min], amount of displacement at the shelf-slope boundary / starting time
Sibuet et al., 1998 - Chen et al., 2022	Subtracting the recent spreading rate of the Okinawa Trough from the rate of southward displacement of the hanging wall
Chen et al., 2022	The relative displacement and geometry between blocks (without considering the coupling ratio)
Chen et al., 2022	The relative displacement and geometry between blocks (coupling ratio 0.2-0.5)
Chen et al., 2022	The relative displacement and geometry between blocks (coupling ratio 0.2-0.5)
Chen et al., 2022	The relative displacement and geometry between blocks (coupling ratio 0.2-0.5)
Chen et al., 2022, Nishimura et al., 2004 - Yamamoto et al., 2016	The relative displacement and geometry between blocks (using different results for the eastern and western blocks)
Dominguez et al., 1998	The relative displacement and geometry between blocks (without considering the coupling ratio)
Chen et al., 2022	The relative displacement and geometry between blocks (using different results for the eastern and western blocks)
Chen et al., 2022	The relative displacement and geometry between blocks (using different results for the eastern and western blocks)
Chen et al., 2022	The relative displacement and geometry between blocks (using different results for the eastern and western blocks)
Chen et al., 2022	Synthesizing plate motion rate, velocity distribution, and coupling ratio of 0.2-0.5
Chen et al., 2022	Synthesizing plate motion rate, velocity distribution, and coupling ratio of 0.2-0.5
Chen et al., 2022	Synthesizing plate motion rate, velocity distribution, and coupling ratio of 0.2-0.5

Northern Taiwan

- 01 Outer Chinshan Structure (ST-I)
- 02 Outer Chinshan Structure 2 (ST-III)
- 03 Outer Kanchiao Structure (ST-II)
- 04 Outer Chilung Structure 1
- 05 Outer Chilung Structure 2
- 06 Outer Shenaokeng Structure 1
- 07 Outer Shenaokeng Structure 2
- 08 Outer Longdong Structure 1
- 09 Outer Longdong Structure 2
- 10 Outer Aoti Structure 1
- 11 Outer Aoti Structure 2

Southern Okinawa Trough

- 12 North Yilan Ridge Structure
- 13 South Yilan Ridge Structure
- 14 North Yonaguni Rift Structure
- 15 South Yonaguni Rift Structure
- 16 East Yonaguna Rift Structure A
- 17 East Yonaguna Rift Structure B

Ryukyu Subduction Zone

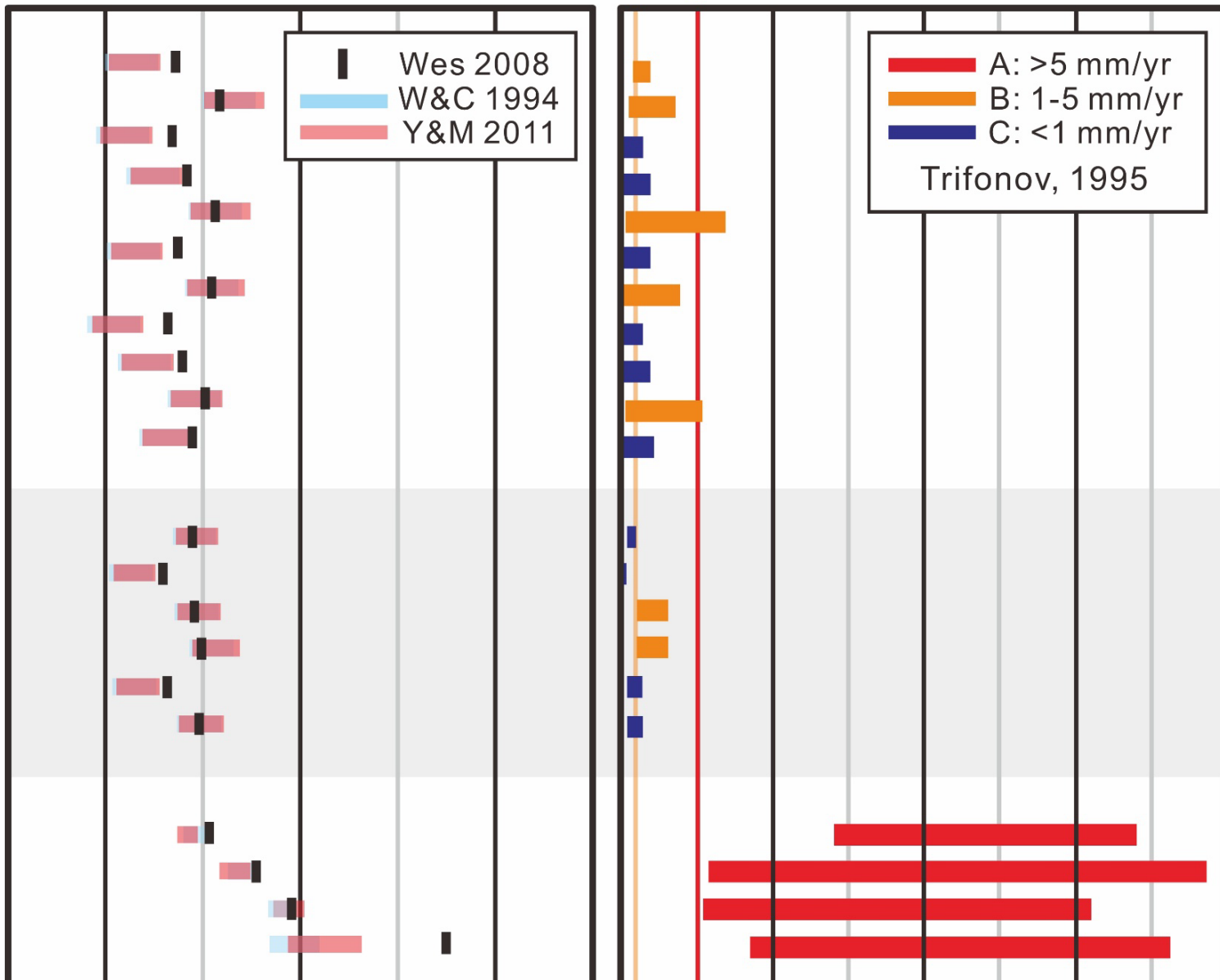
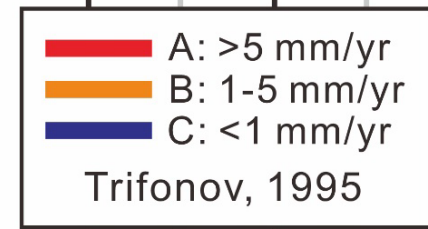
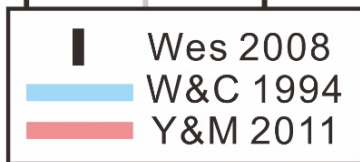
- 18 Suao Fault Zone
- 19 West Yaeyama Fault Zone
- 20 Yaeyama Fault Zone
- 21 Ryukyu Upper Plate Splay Structure

Magnitude (Mw)

6.5 7.5 8.5

Slip rate (mm/yr)

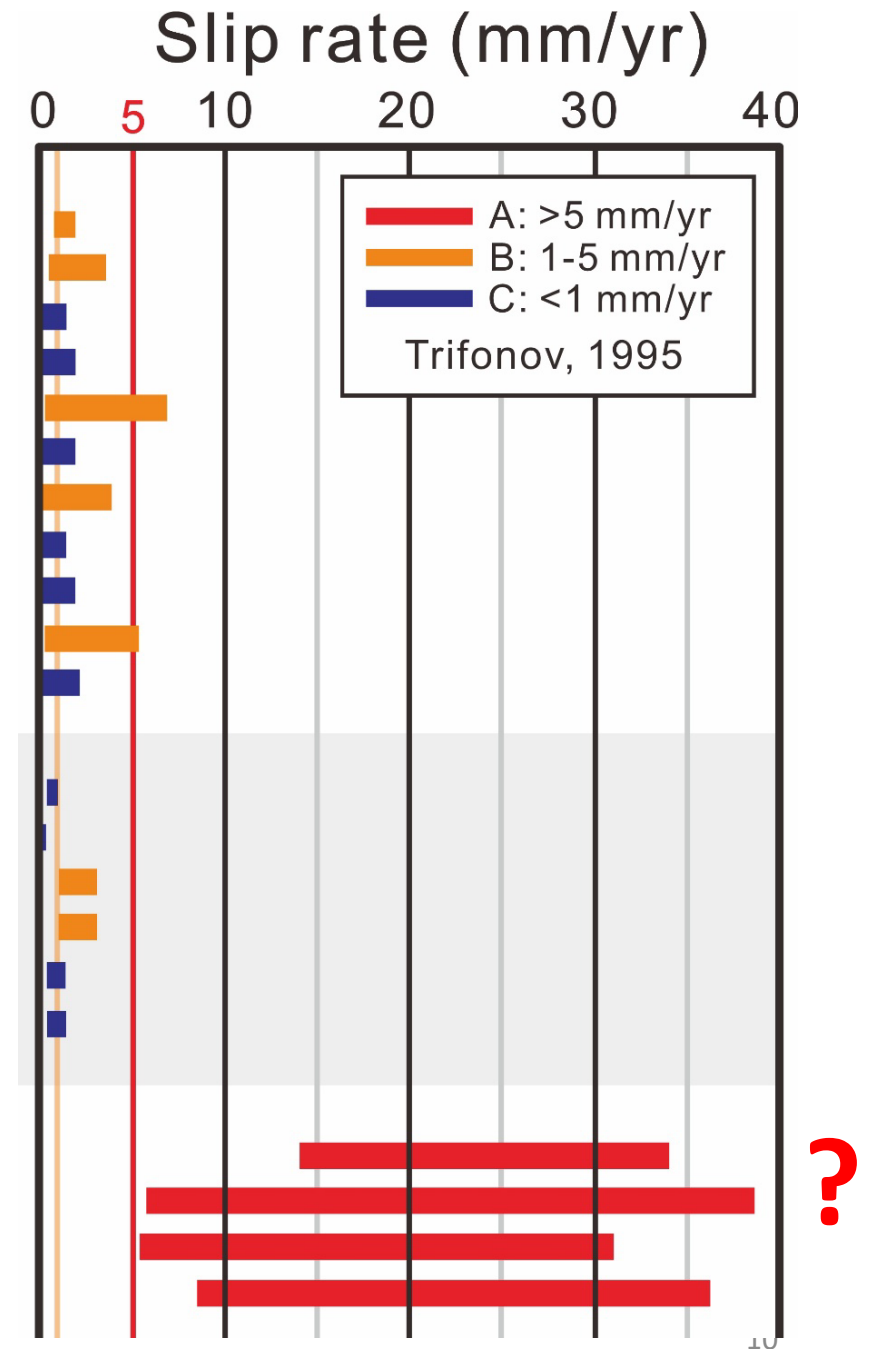
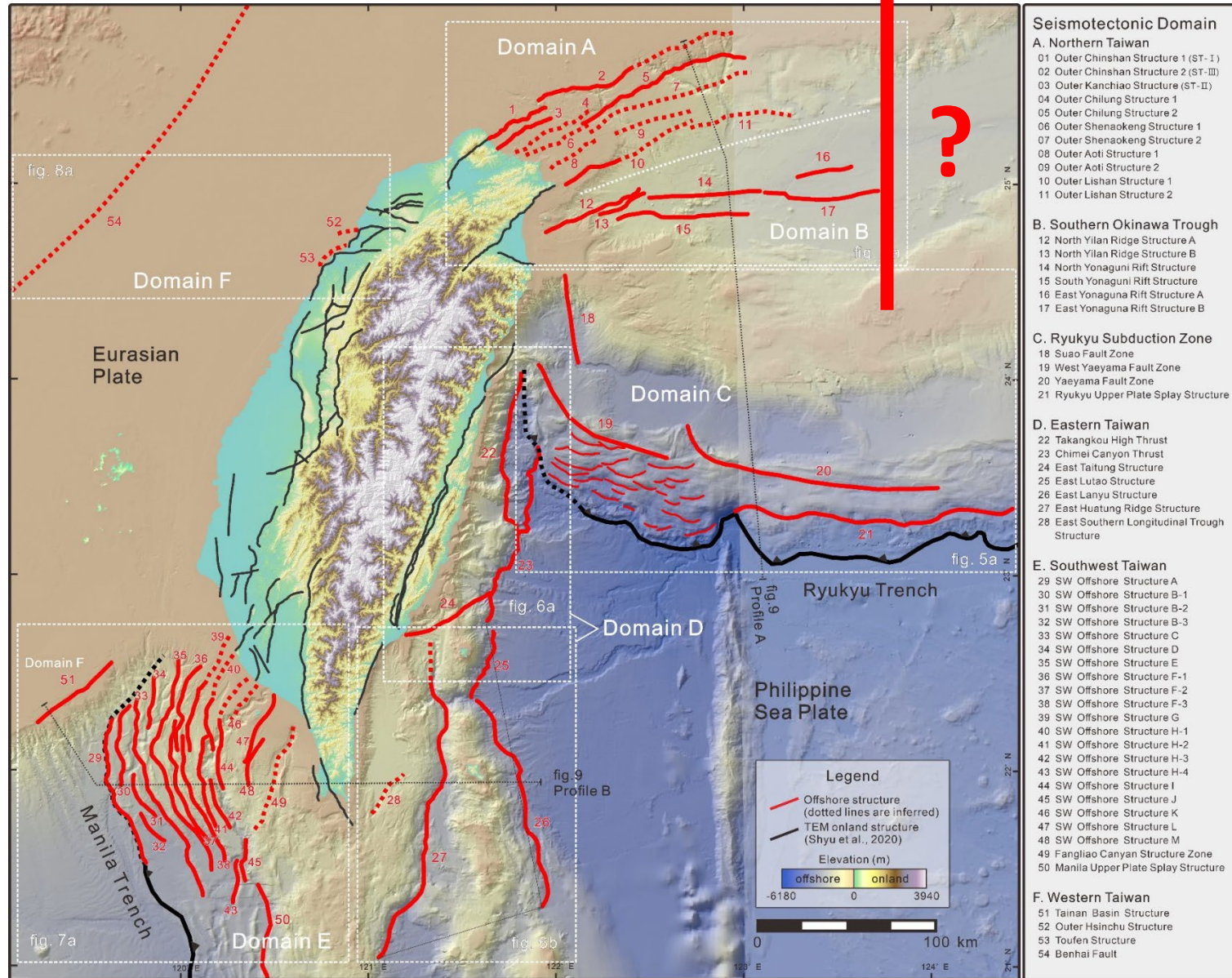
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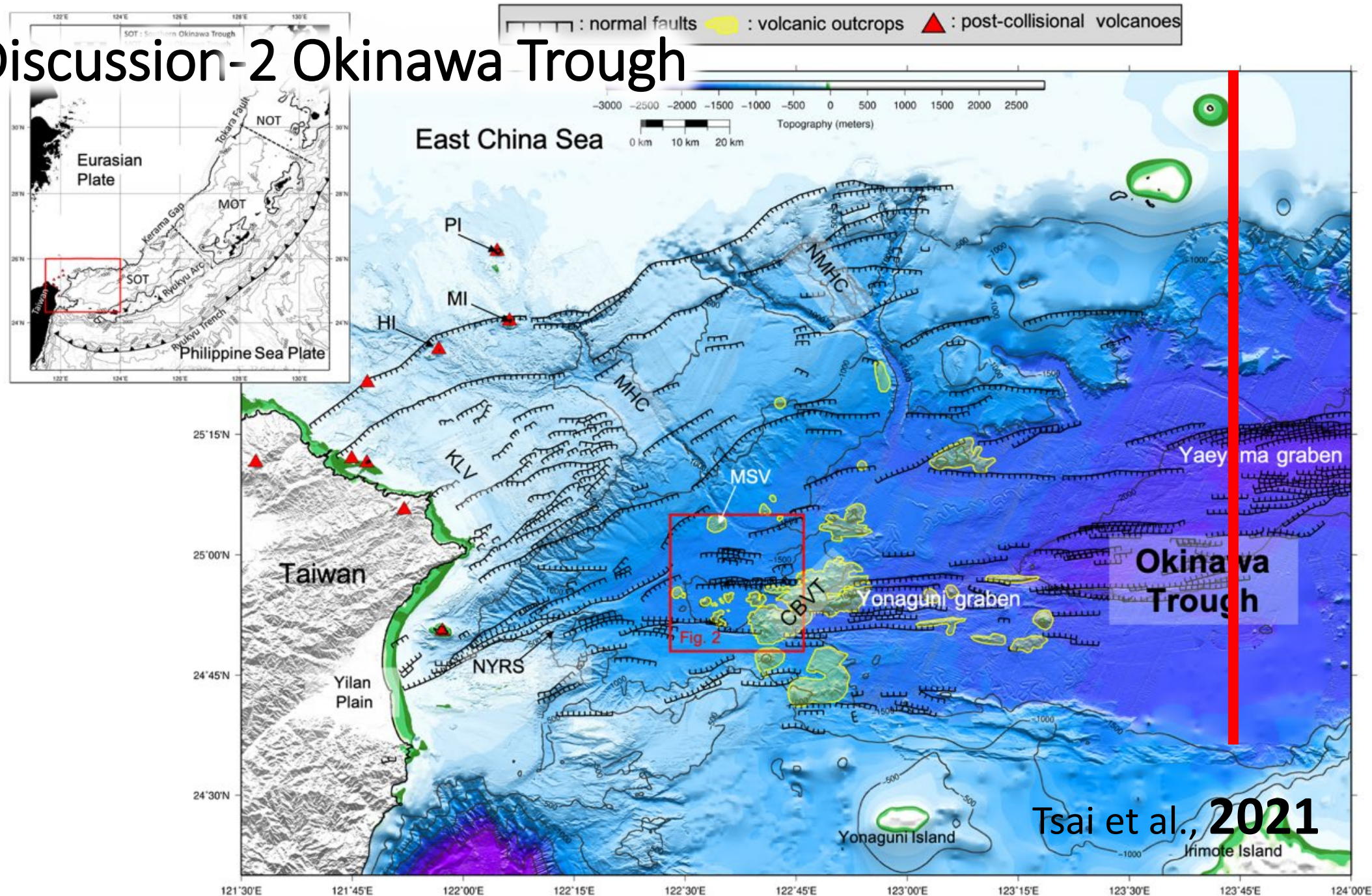
Future work



Future work



Discussion-2 Okinawa Trough



?



Mean trend (degree)	Dip direction (degree)	Upthrown side
60	150	N

230-01 Miyakojima



NW-SE trending northeast dipping normal fault in the Miyako Island

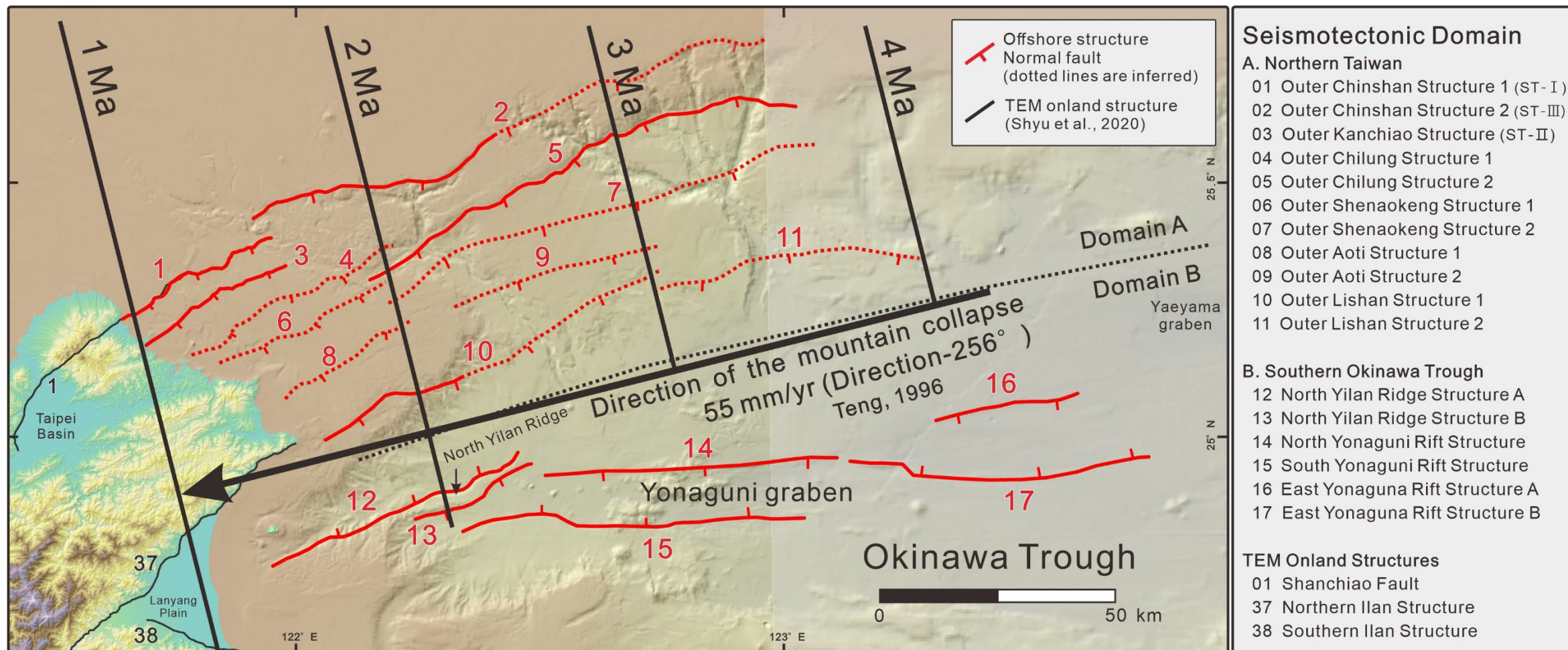
発言中: NIED (host)

trend	330°
dip	60 ° E
length	30 km
sense of faulting	Nor.
upthrown side	W
slip rate	0.3 m/ky
tentative estimate based on a qualitative assessment of its geomorphic expression	
slip per event	3.5 m
calculated based on empirical relationship between segment length and slip per event proposed by Awata (1999)	
recurrence interval	12.0 ky
calculated from the slip rate and the slip per event	
age of the last faulting	
field data	no data
historical record	no data
elapsed time rate	no data
rupture probability in next 30 years	no data
BPT	no data
Poisson	ca. 0.3 %

2023.03.08
PPT from Takashi Azuma

一些討論筆記

- **隱沒帶**
 - 上盤的構造活動速率如何計算？
 - 隱沒帶該如何分配速率？
 - 如何評估速率的合理性？
-
- **沖繩海槽**
 - 多段小構造，如何連接並計算速率？
 - 海槽更東段，未來和日本的計算成果比較

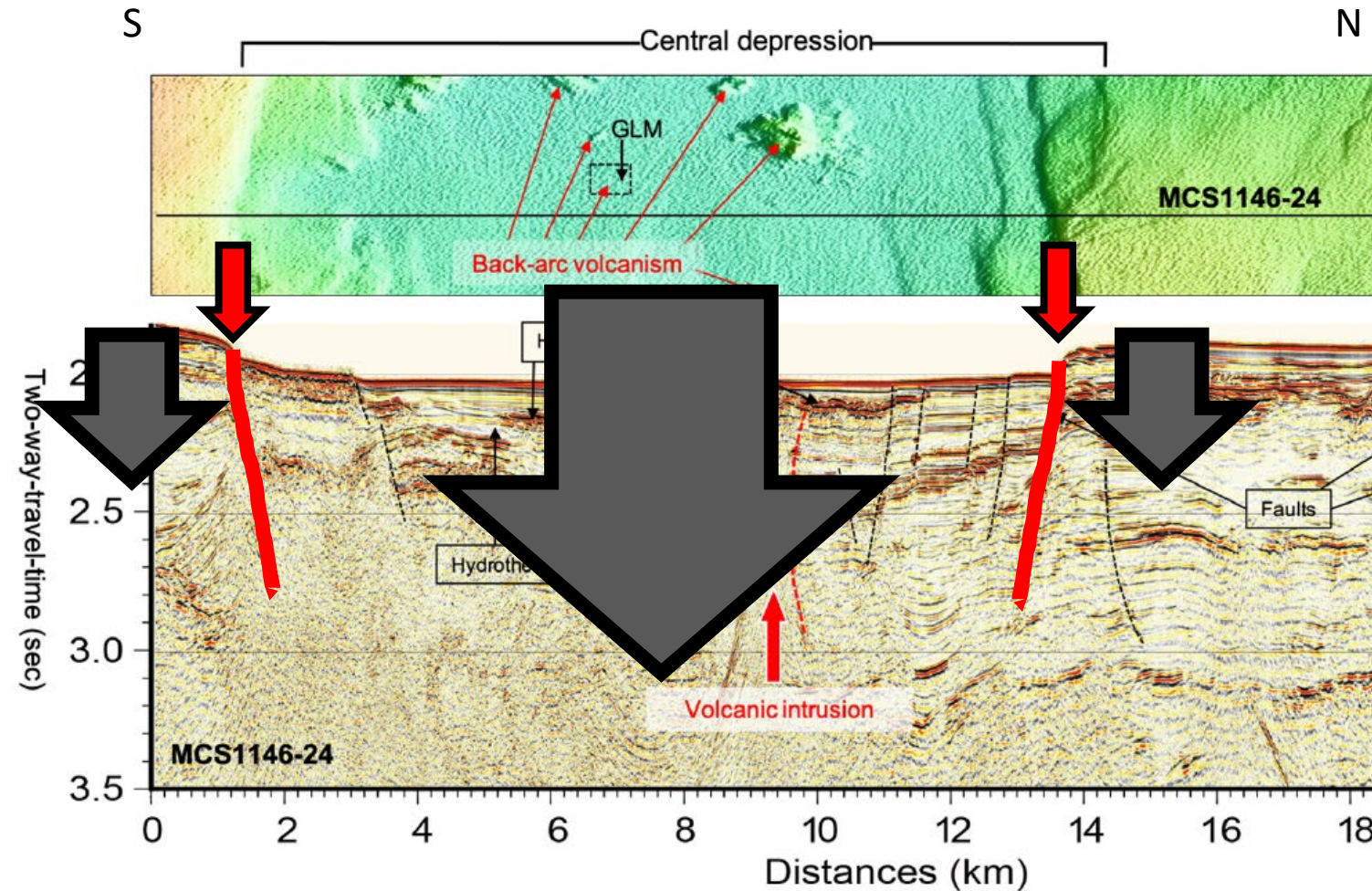


NO.	Structure name	地層受錯移 量，經時深 轉換（m）	時間			滑移速率 （mm/yr）
			年齡下界	年齡上界		
			陸域構造 發育時間 （Ma）	東北端與 1Ma 垮山 邊界距離 （km）	開始垮山時 間（Ma，括 弧內考慮延 遲時間）	
1	Outer Chinshan Structure(ST-Ⅰ)	600-750#a	0.4	33.6	1.61(1.51)	0.82 (0.42- 2.45)
2	Outer Chinshan Structure 2（ST-Ⅲ）	1100-1200#a	0.4	147.0	3.67(3.57)	0.67 (0.33- 3.92)
3	Outer Kanchiao structure(ST-Ⅱ)	225-450#b	0.4	35.3	1.64(1.54)	0.36 (0.16- 1.47)
4	Outer Chilung Structure 1	300-600#b	0.4	58.6	2.07(1.97)	0.39 (0.16- 1.96)
5	Outer Chilung Structure 2	1050-2100#b	0.4	148.2	3.69(3.59)	0.81 (0.31- 6.85)
6	Outer Shenaokeng Structure 1	300-600#b	0.4	54.8	2.00(1.90)	0.40 (0.17- 1.96)
7	Outer Shenaokeng Structure 2	600-1200#b	0.4	150.8	3.74(3.64)	0.46 (0.18- 3.92)
8	Outer Longdong Structure 1	225-450#b	0.4	57.9	2.05(1.95)	0.29 (0.12- 1.47)

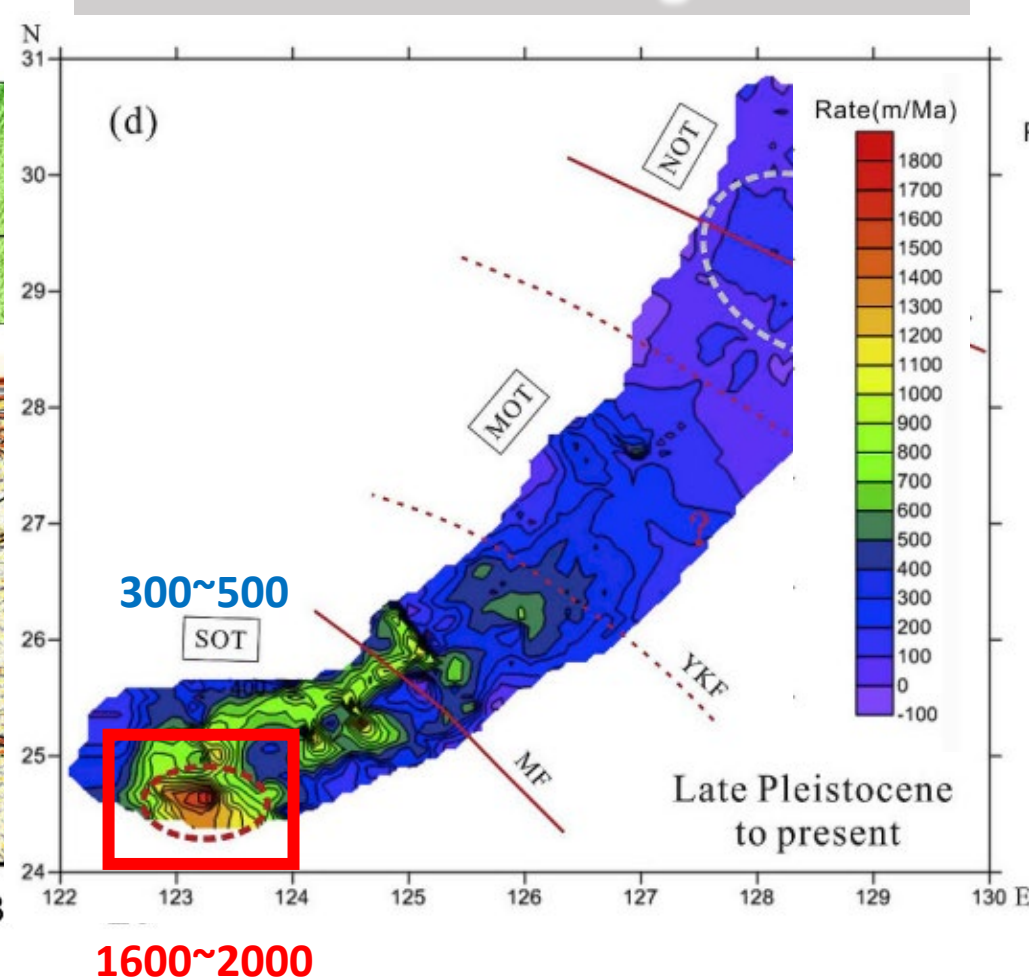
Long-term slip rate -Okinawa Trough

SR: 1.2 – 3.0 mm/yr

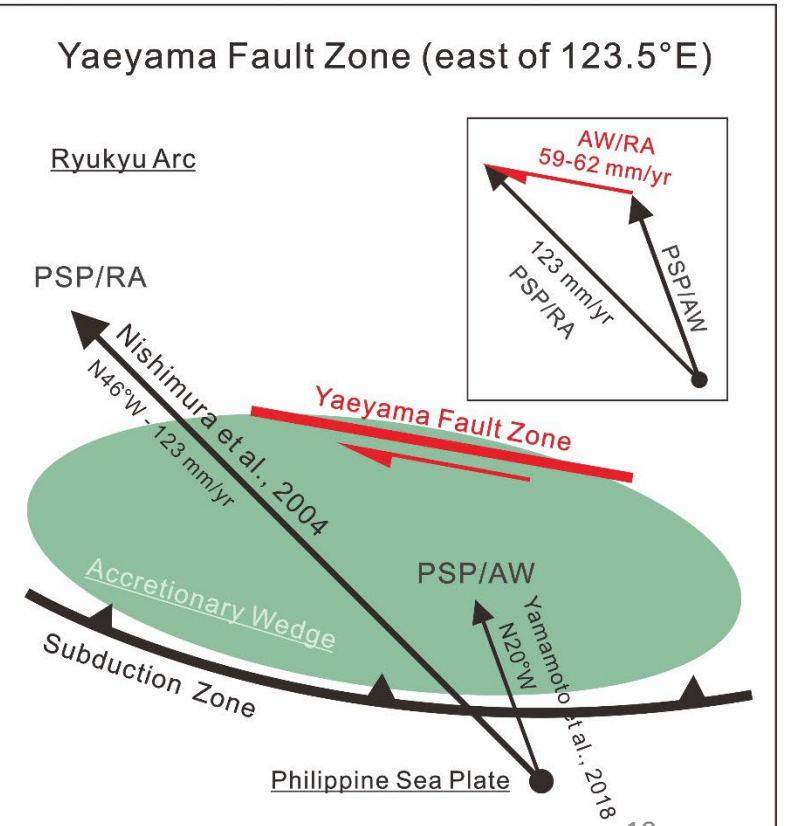
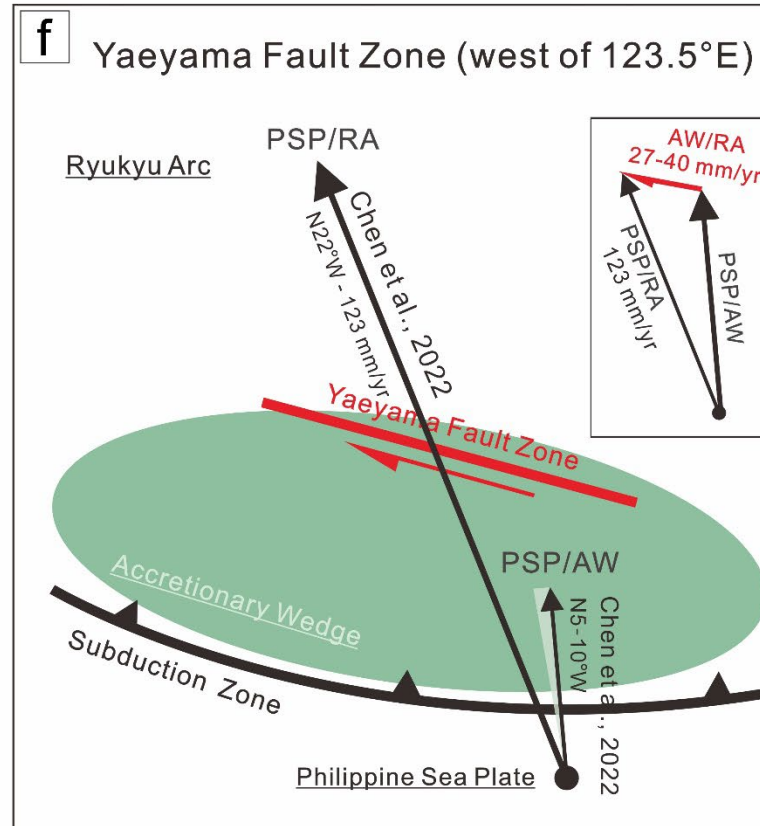
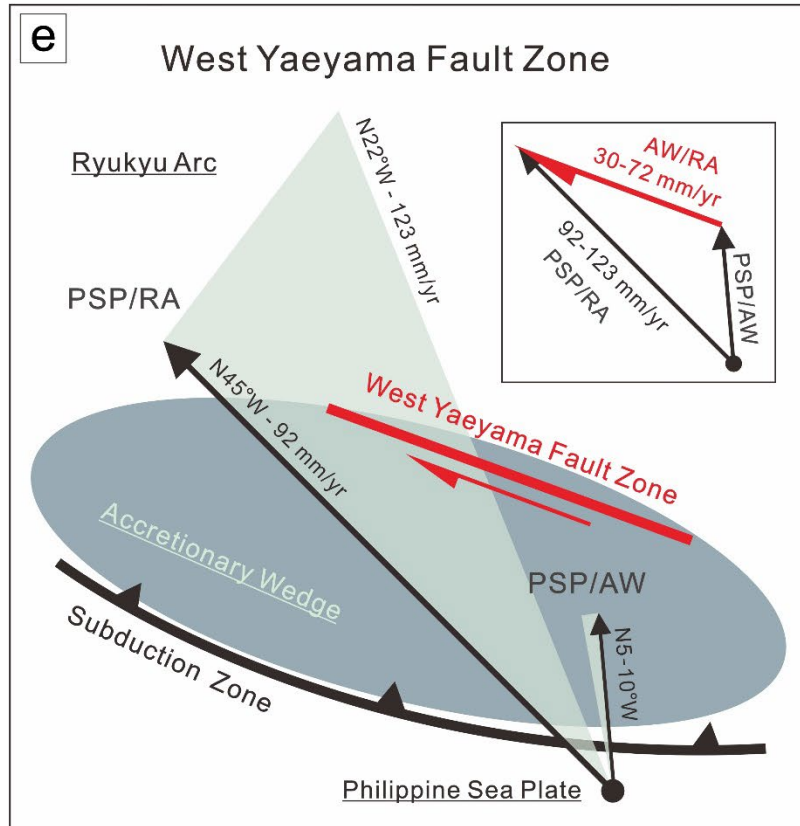
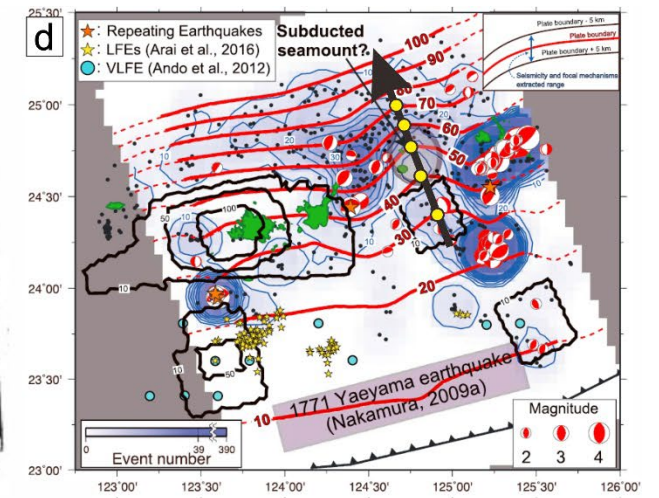
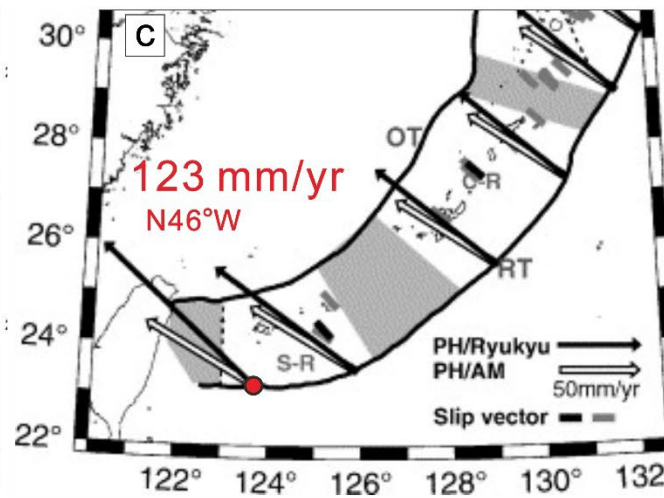
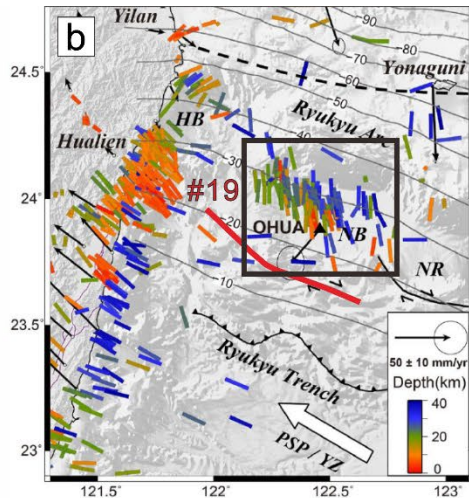
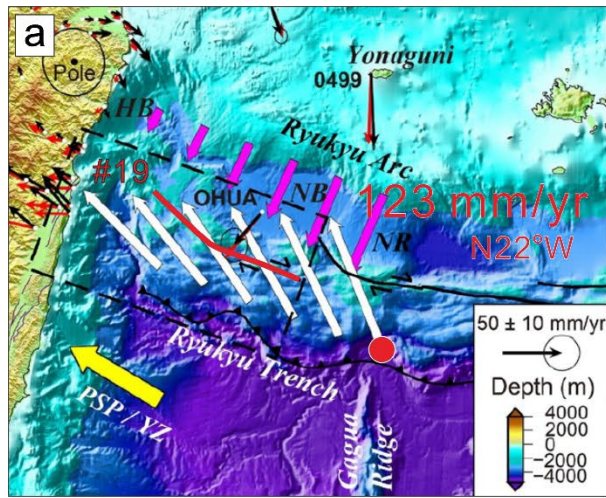
RI: 250 - 2600 yr

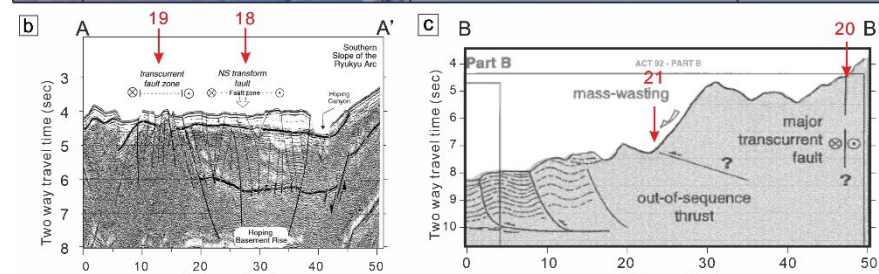
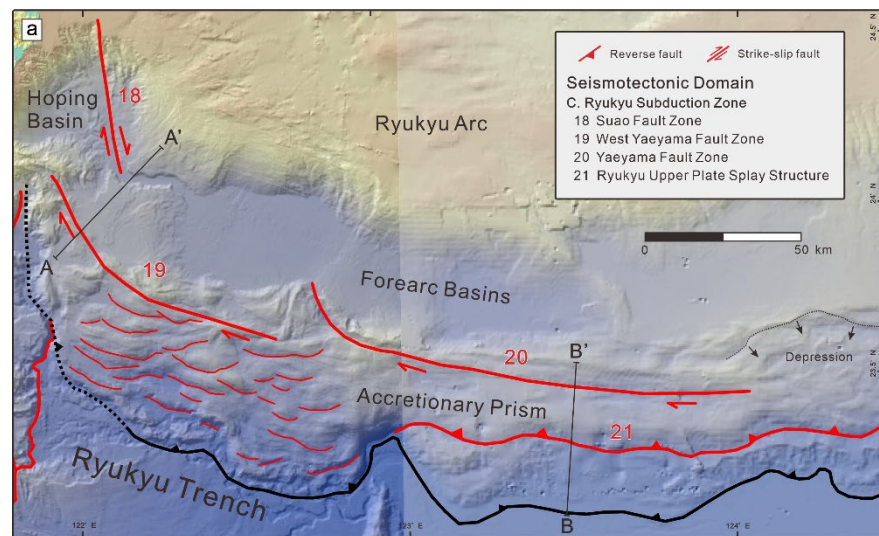
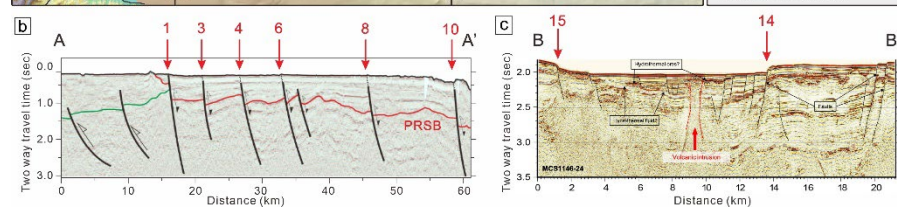
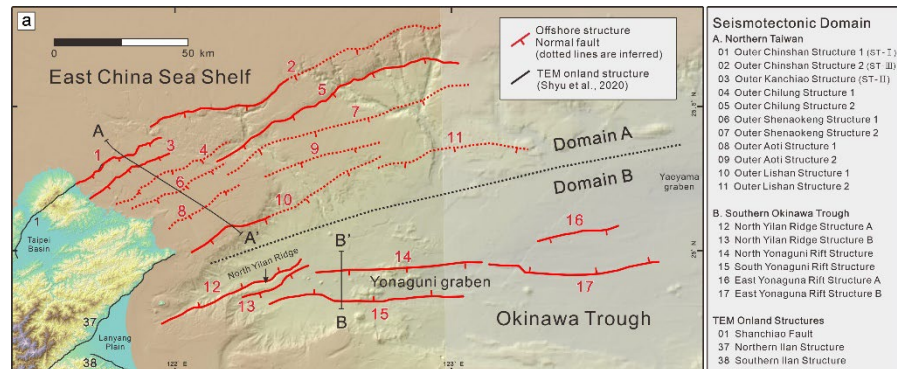
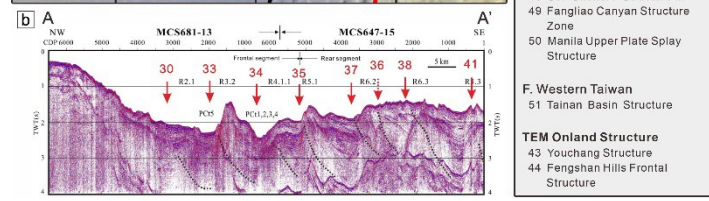
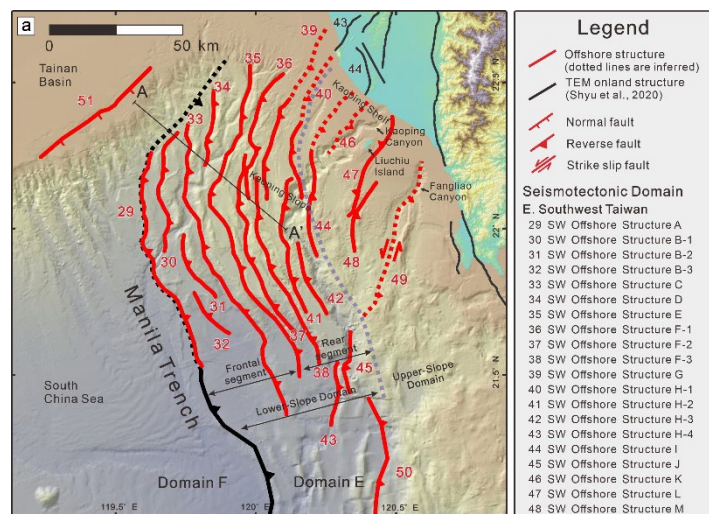
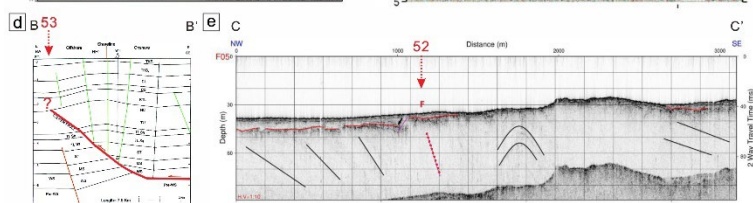
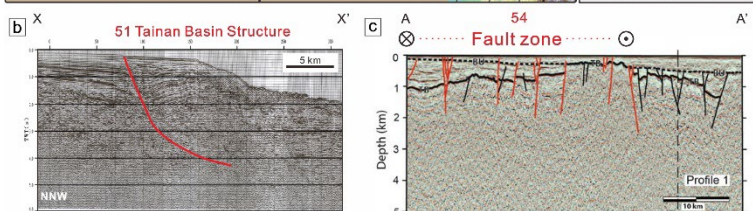
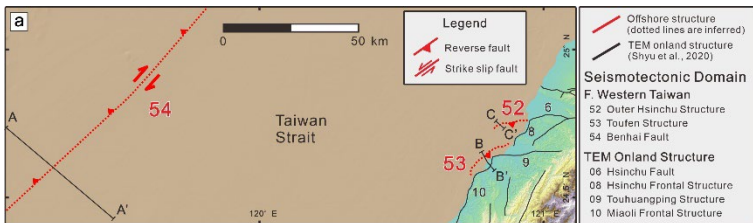


Tsai et al., 2021

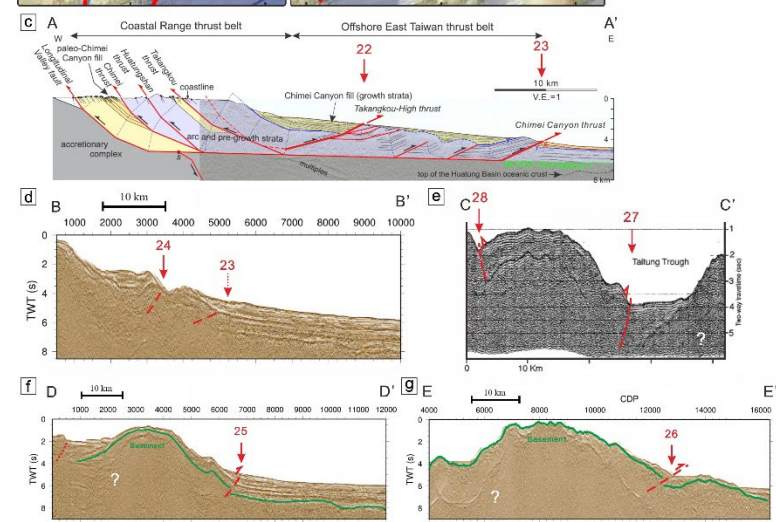
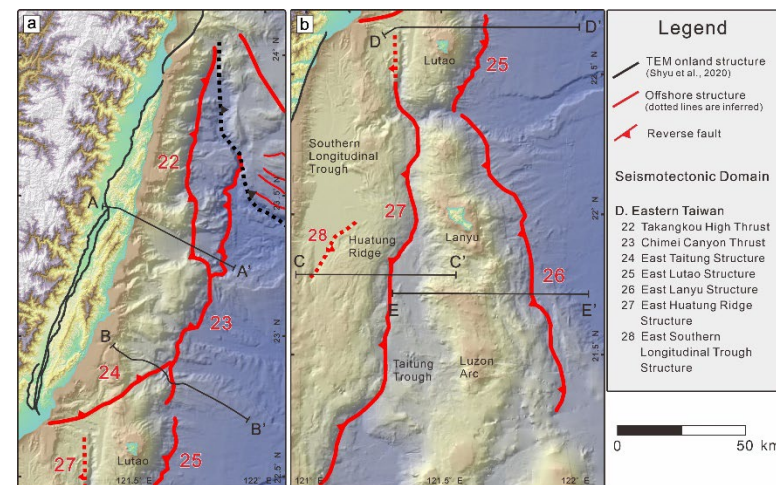


Fang et al., 2020 18

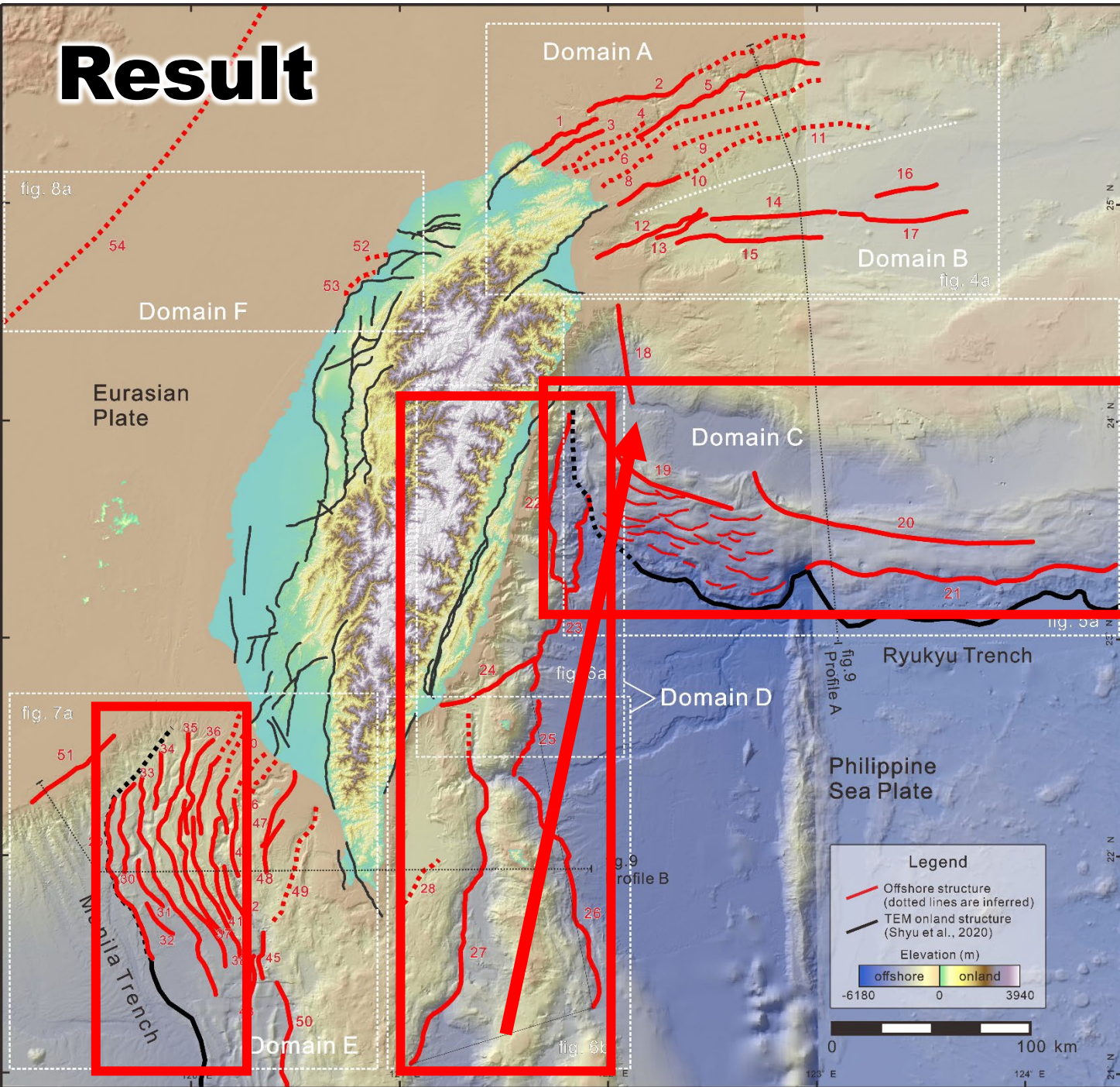




Seismic Profile



Result



Northern Taiwan

- 01 Outer Chinshan Structure (ST-I)
- 02 Outer Chinshan Structure 2 (ST-III)
- 03 Outer Kanchiao Structure (ST-II)
- 04 Outer Chilung Structure 1
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Southern Okinawa Trough

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Ryukyu Subduction Zone

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Eastern Taiwan

- 22 Takangkou High Thrust
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- 26 East Lanyu Structure
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- 28 East Southern Longitudinal Trough Structure

Southwest Taiwan

- 29 SW Offshore Structure A
- 30 SW Offshore Structure B-1
- 31 SW Offshore Structure B-2
- 32 SW Offshore Structure B-3
- 33 SW Offshore Structure C
- 34 SW Offshore Structure D
- 35 SW Offshore Structure E
- 36 SW Offshore Structure F-1
- 37 SW Offshore Structure F-2
- 38 SW Offshore Structure F-3
- 39 SW Offshore Structure G
- 40 SW Offshore Structure H-1
- 41 SW Offshore Structure H-2
- 42 SW Offshore Structure H-3
- 43 SW Offshore Structure H-4
- 44 SW Offshore Structure I
- 45 SW Offshore Structure J
- 46 SW Offshore Structure K
- 47 SW Offshore Structure L
- 48 SW Offshore Structure M
- 49 Fangliao Canyon Structure Zone
- 50 Manila Upper Plate Splay Structure

Western Taiwan

- 51 Tainan Basin Structure
- 52 Outer Hsinchu Structure
- 53 Toufen Structure
- 54a Northern Benhai Fault
- 54b Southern Benhai Fault

