South Primary fault- Hengchun fault and West Hengchun offshore structure (Geometry of Manila subduction zone)

Andrew T.S. Lin
SSC TI Team Member

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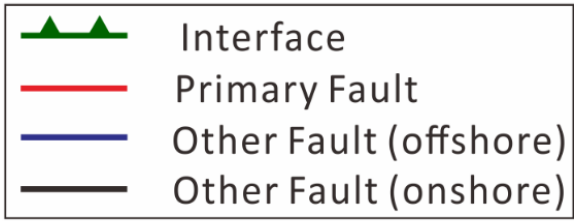
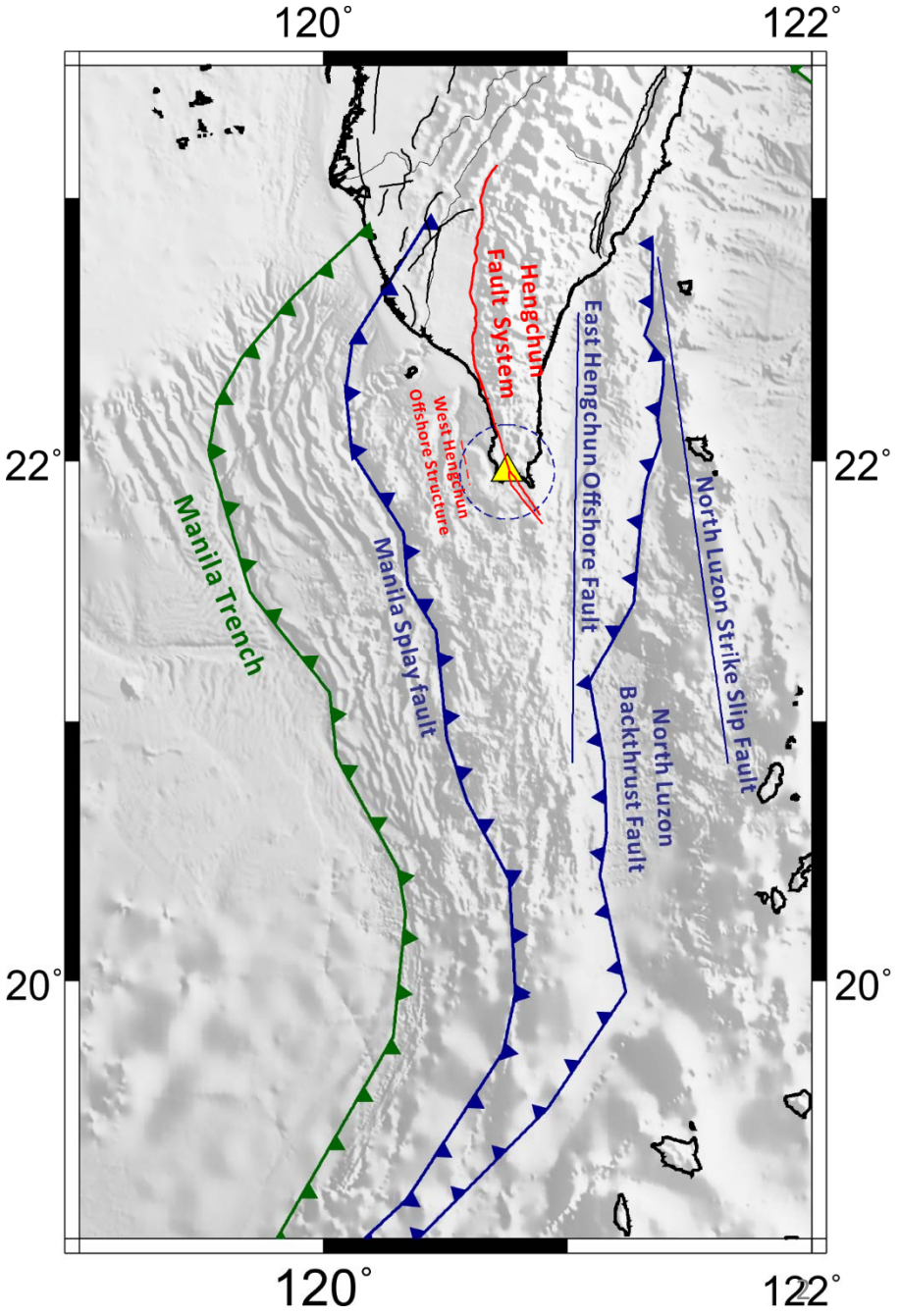
South Primary fault

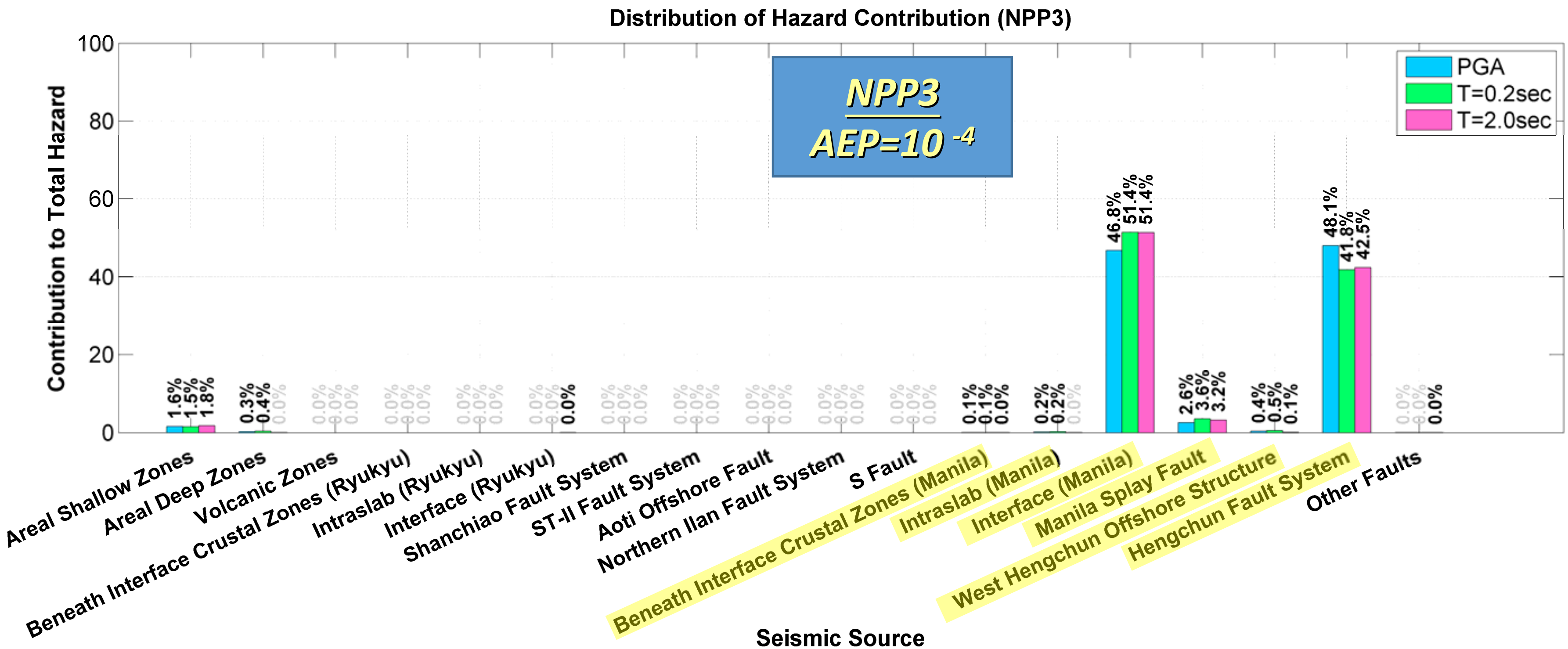
Primary Fault	
1	Hengchun Fault System
2	West Hengchun Offshore Structure
Other Fault (Offshore)	
1	North Luzon Strike Slip Fault
2	North Luzon Backthrust Fault
3	East Hengchun Offshore Fault
4	Manila Splay fault



Geometry of Southern Taiwan Faults are associated with Manila interface.



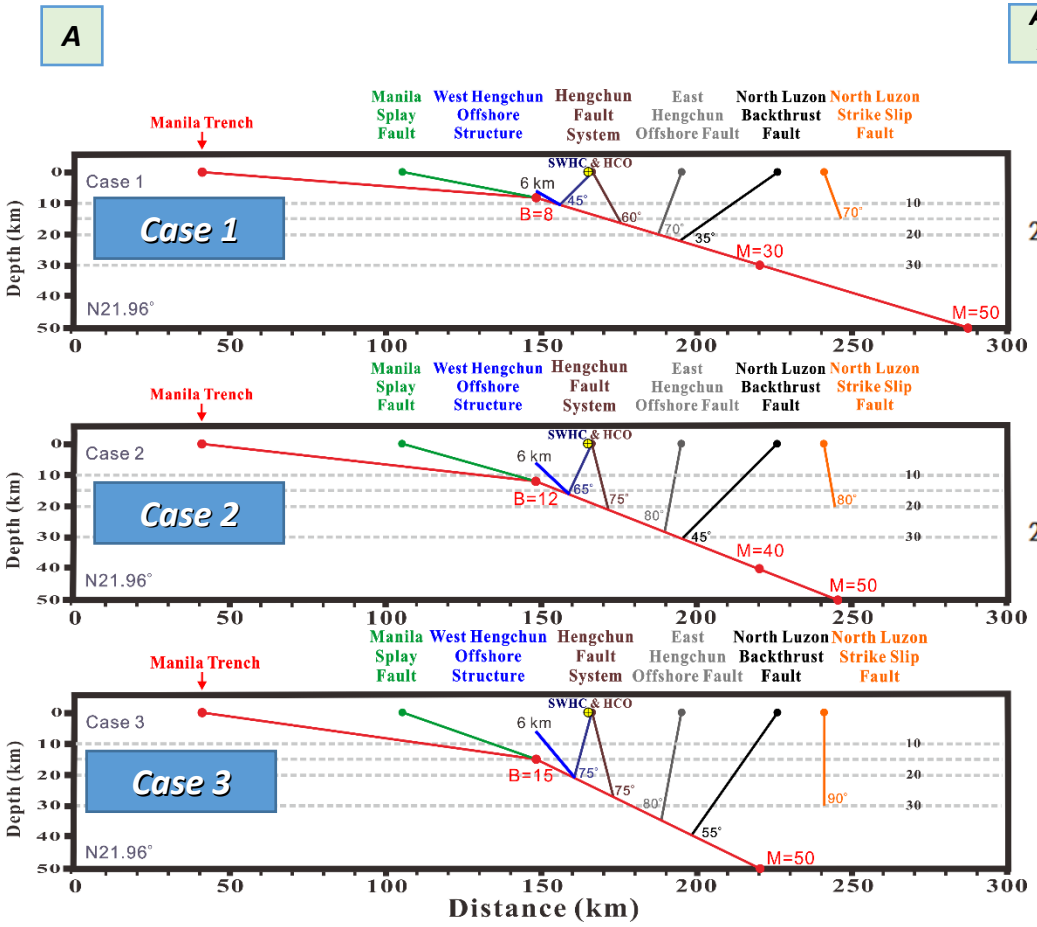
Distribution of Hazard Contribution (NPP3)

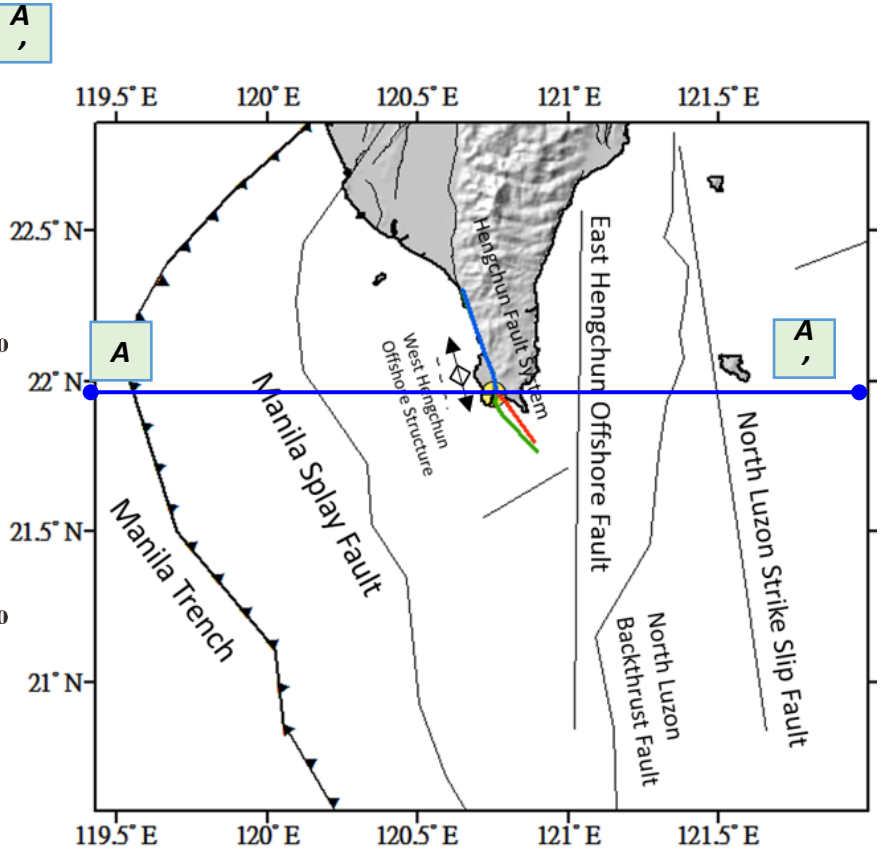


Investigation data of Hengchun Fault Parameters

Investigative Techniques \ Fault Parameters		Segmentation (Length)	Fault Dip	Rupture Depth	Long-term Slip Rate
Structural Geology	Geologic cross-section	●	●	●	●
	Tectonic sequence stratigraphy	●			
	Balanced cross section		●	●	●
	Drilling boreholes	●	●		
Surface Geological Survey	Earthquake surface rupture	●			
	Exploratory trenching		●		●
	Terrace dating				●
Exploration Geophysics	Seismic profile		●	●	
	Resistivity Image Profile	●			
Interpretation of Remote Sensing Image	D-InSAR or PS-InSAR	●			
	Satellite image interpretation	●			
	Aerial photo interpretation	●			
Seismology	Aftershock distribution	●		●	
	Seismicity cross sections		●	●	
	Focal mechanism solution		●		
	Seismic tomography			●	
Geodetic survey	GPS coseismic slip	●			
	GPS block model				●

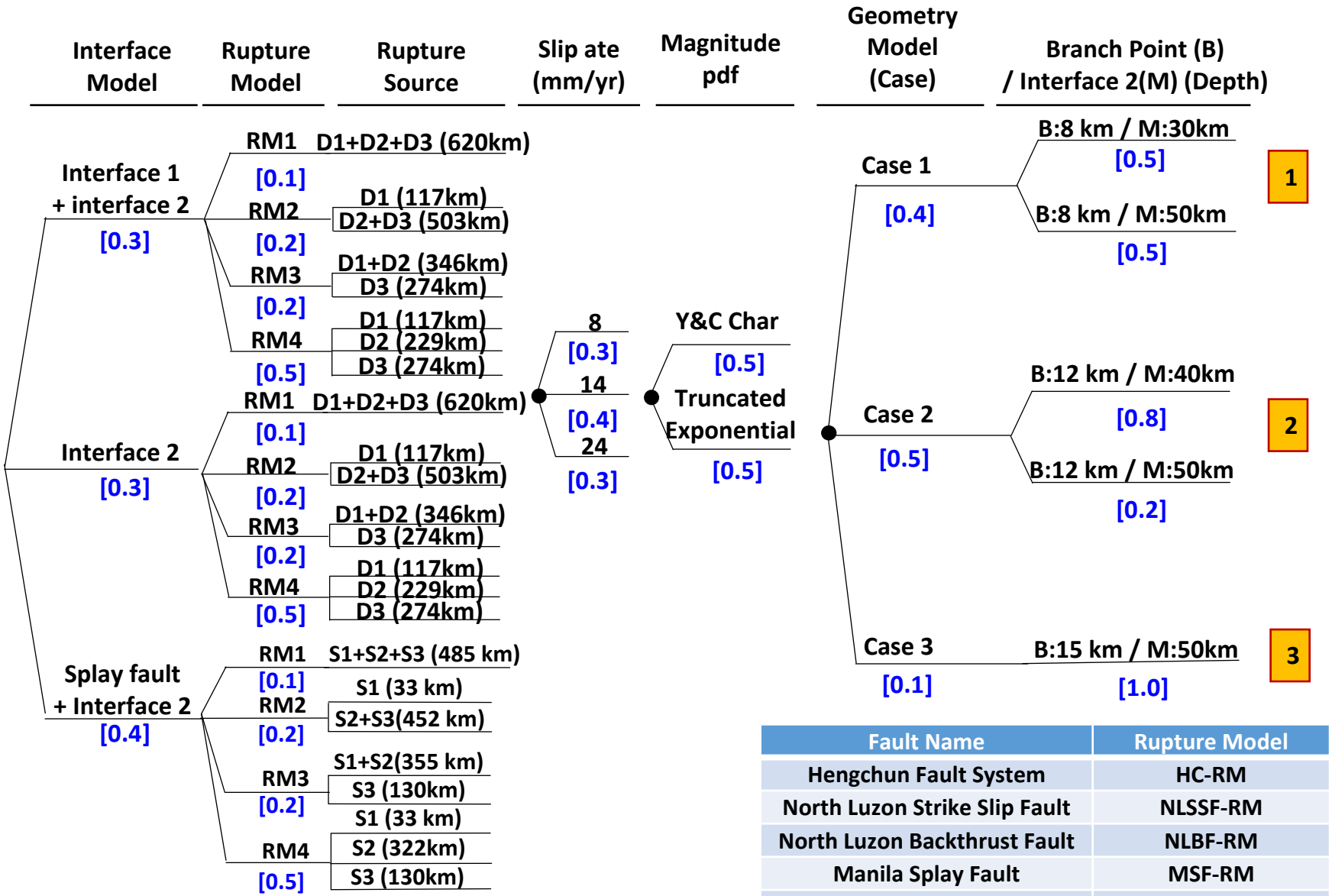
Faults Geometry Modeling in Southern Taiwan





Construction of three Geometry Modeling Cases for the faults system around NPP3 in consideration of the Uncertainties.

Southern primary faults & Manila subduction interface



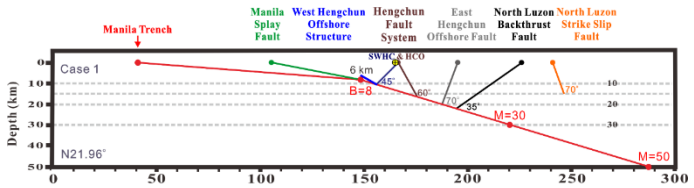
Fault Name	Rupture Model
Hengchun Fault System	HC-RM
North Luzon Strike Slip Fault	NLSSF-RM
North Luzon Backthrust Fault	NLBF-RM
Manila Splay Fault	MSF-RM
East Hengchun Offshore Fault	EHCOF-RM
West Hengchun Offshore Structure	WHCOS-RM

* Note:
- Max Magn. = Char. Magn. + 0.25
- Char. Magn. is calculated from Magnitude Scaling Law: Wells and Coppersmith (1994), Yen and Ma (2011) .

Southern primary faults & Manila subduction interface

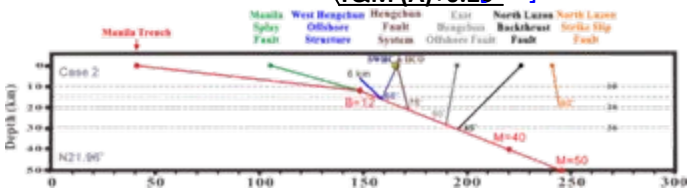
Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate (mm/yr)	Fault Geometry Model: Dip	Fault Geometry Model: Seismogenic Depth	Magnitude Distribution Model: Max. Magn.	Magnitude Distribution Model: Magnitude pdf
Seismogenic [0.4]	RV (90) [0.6]	HC-RM	CC+HC+SWHC (144 km)	[0.4, 1,0.5] [0.2]; [1.6, 4,1.4] [0.6]; [2.4, 6,2.3] [0.2]	60°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
	RV/OB (45) [0.6]		CC+HC+HCO (140 km)					
			CC+HC (117 km)					
			HC+HCO (63 km)					
			HC+SWHC (67 km)					
			SWHC (27 km)	[SWHC, HC, CC]				
			CC (77 km)					
			HC (40 km)					
			HCO (23 km)					
Seismogenic	RV/OB (45)	NLSSF-RM	(216 km)	4* [0.3]; 6 * [0.4]; 8* [0.3]	70°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Seismogenic	RV (90)	NLBF-RM	(593 km)	5* [0.3]; 8* [0.4]; 12*[0.3]	35°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Seismogenic	RV (90)	MSF-RM1 [0.1]	S1+S2+S3 (485 km)	4* [0.3]; 9* [0.4]; 15*[0.3]	11°	(Stop at Manila branch point (8 km))	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
		MSF-RM2 [0.2]	S1 (33 km); S2+S3(452 km)					
		MSF-RM3 [0.2]	S1+S2(355 km); S3 (130km)					
		MSF-RM4 [0.5]	S1 (33 km); S2 (322km); S3 (130km)					
Seismogenic	RV (90)	EHCOF-RM	(190 km)	5 [0.3]; 7 [0.4]; 9 [0.3]	70°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Seismogenic [0.5]	RV (90)	WHCOS-RM	(19 km)	1.2 [0.2]; 1.6 [0.6]; 2.4 [0.2]	30°	(branch fault off interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Non-Seismogenic [0.5]								

* Means constant slip rate



Southern primary faults & Manila subduction interface

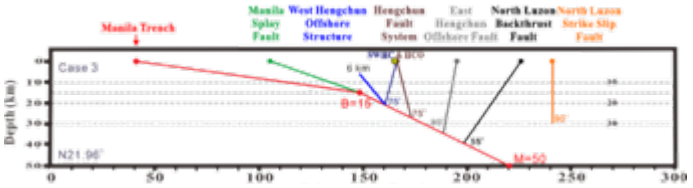
Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate (mm/yr)	Fault Geometry Model: Dip	Fault Geometry Model: Seismogenic Depth	Magnitude Distribution Model: Max. Magn.	Magnitude Distribution Model: Magnitude pdf
Seismogenic [0.5]	RV (90) [0.4]	HC-RM	CC+HC+SWHC (144 km)	[0.4, 1,0.5] [0.2]	75°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
	RV/OB (45) [0.6]		CC+HC+HCO (140 km)	[1.6, 4,1.4] [0.6]			W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
			CC+HC (117 km)	[2.4, 6,2.3] [0.2]			Y&M (A)+0.25 [0.3]	
			HC+HCO (63 km)	[SWHC, HC, CC]				
			HC+SWHC (67 km)					
			SWHC (27 km)					
			CC (77 km)					
			HC (40 km)					
			HCO (23 km)					
Seismogenic	RV/OB (45)	NLSSF-RM	(216 km)	4* [0.3] / 6 * [0.4] / 8* [0.3]	80°	(Stop at Manila interface)	W&C (L)+0.25 [0.4] / W&C (A)+0.25 [0.3] / Y&M (A)+0.25 [0.3]	Y&C Char [0.5] / Truncated Exponential [0.5]
Seismogenic	RV (90)	NLBF-RM	(593 km)	5* [0.3] / 8* [0.4] / 12* [0.3]	45°	(Stop at Manila interface)	W&C (L)+0.25 [0.4] / W&C (A)+0.25 [0.3] / Y&M (A)+0.25 [0.3]	Y&C Char [0.5] / Truncated Exponential [0.5]
Seismogenic	RV (90)	MSF-RM1 [0.1]	S1+S2+S3 (485 km)	4* [0.3] / 9* [0.4] / 15* [0.3]	15°	(Stop at Manila branch point (12 km))	W&C (L)+0.25 [0.4] / W&C (A)+0.25 [0.3] / Y&M (A)+0.25 [0.3]	Y&C Char [0.5] / Truncated Exponential [0.5]
		MSF-RM2 [0.2]	S1 (33 km)					
			S2+S3(452 km)					
		MSF-RM3 [0.2]	S1+S2(355 km)					
			S3 (130km)					
		MSF-RM4 [0.5]	S1 (33 km)					
			S2 (322km)					
			S3 (130km)					
Seismogenic	SS (0)	EHCOF-RM	(190 km)	5 [0.3] / 7 [0.4] / 9 [0.3]	80°	(Stop at Manila interface)	W&C (L)+0.25 [0.4] / W&C (A)+0.25 [0.3] / Y&M (A)+0.25 [0.3]	Y&C Char [0.5] / Truncated Exponential [0.5]
Seismogenic [0.5]	RV (90)	WHCOS-RM	(19 km)	1.2 [0.2] / 1.6 [0.6] / 2.4 [0.2]	40°	(branch fault off interface)	W&C (L)+0.25 [0.4] / W&C (A)+0.25 [0.3] / Y&M (A)+0.25 [0.3]	Y&C Char [0.5] / Truncated Exponential [0.5]
Non-Seismogenic [0.5]								



* Means constant slip rate

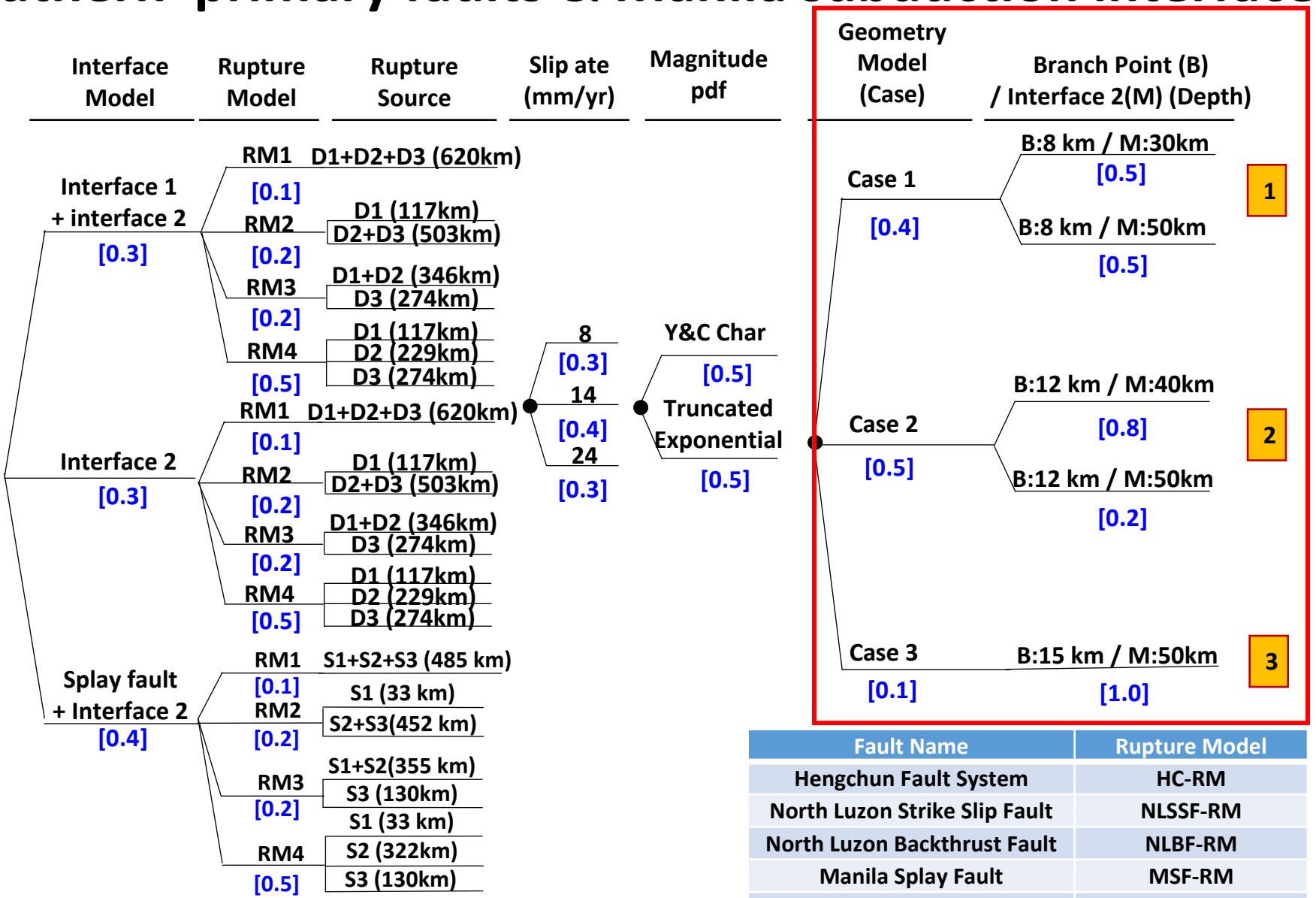
Southern primary faults & Manila subduction interface

Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate (mm/yr)	Fault Geometry Model: Dip	Fault Geometry Model: Seismogenic Depth	Magnitude Distribution Model: Max. Magn.	Magnitude Distribution Model: Magnitude pdf
Seismogenic [0.4]	RV (90) [0.4]	HC-RM	CC+HC+SWHC (144 km)	[0.4, 1,0.5] [0.2] [1.6, 4,1.4] [0.6] [2.4, 6,2.3] [0.2]	75°	(Stop at Manila interface)	W&C (L)+0.25 [0.4] W&C (A)+0.25 [0.3] Y&M (A)+0.25 [0.3]	Y&C Char [0.5] Truncated Exponential [0.5]
	RV/OB (45) [0.6]		CC+HC+HCO (140 km)					
			CC+HC (117 km)					
			HC+HCO (63 km)	[SWHC, HC, CC]				
			HC+SWHC (67 km)					
			SWHC (27 km)					
			CC (77 km)					
			HC (40 km)					
			HCO (23 km)					
Seismogenic	RV/OB (45)	NLSSF-RM	(216 km)	4* [0.3] 6 * [0.4] 8* [0.3]	90°	(Stop at Manila interface)	W&C (L)+0.25 [0.4] W&C (A)+0.25 [0.3] Y&M (A)+0.25 [0.3]	Y&C Char [0.5] Truncated Exponential [0.5]
Seismogenic	RV (90)	NLBF-RM	(593 km)	5* [0.3] 8* [0.4] 12* [0.3]	55°	(Stop at Manila interface)	W&C (L)+0.25 [0.4] W&C (A)+0.25 [0.3] Y&M (A)+0.25 [0.3]	Y&C Char [0.5] Truncated Exponential [0.5]
Seismogenic	RV (90)	MSF-RM1 [0.1]	S1+S2+S3 (485 km)	4* [0.3] 9* [0.4] 15* [0.3]	18°	(Stop at Manila branch point (15 km))	W&C (L)+0.25 [0.4] W&C (A)+0.25 [0.3] Y&M (A)+0.25 [0.3]	Y&C Char [0.5] Truncated Exponential [0.5]
		MSF-RM2 [0.2]	S1 (33 km) S2+S3(452 km)					
		MSF-RM3 [0.2]	S1+S2(355 km) S3 (130km)					
		MSF-RM4 [0.5]	S1 (33 km) S2 (322km) S3 (130km)					
Seismogenic	SS (0)	EHCOF-RM	(190 km)	5 [0.3] 7 [0.4] 9 [0.3]	80°	(Stop at Manila interface)	W&C (L)+0.25 [0.4] W&C (A)+0.25 [0.3] Y&M (A)+0.25 [0.3]	Y&C Char [0.5] Truncated Exponential [0.5]
Seismogenic [0.5]	RV (90)	WHCOS-RM	(19 km)	1.2 [0.2] 1.6 [0.6] 2.4 [0.2]	50°	(branch fault off interface)	W&C (L)+0.25 [0.4] W&C (A)+0.25 [0.3] Y&M (A)+0.25 [0.3]	Y&C Char [0.5] Truncated Exponential [0.5]
Non-Seismogenic [0.5]								



* Means constant slip rate

Southern primary faults & Manila subduction interface



Fault Name	Rupture Model
Hengchun Fault System	HC-RM
North Luzon Strike Slip Fault	NLSSF-RM
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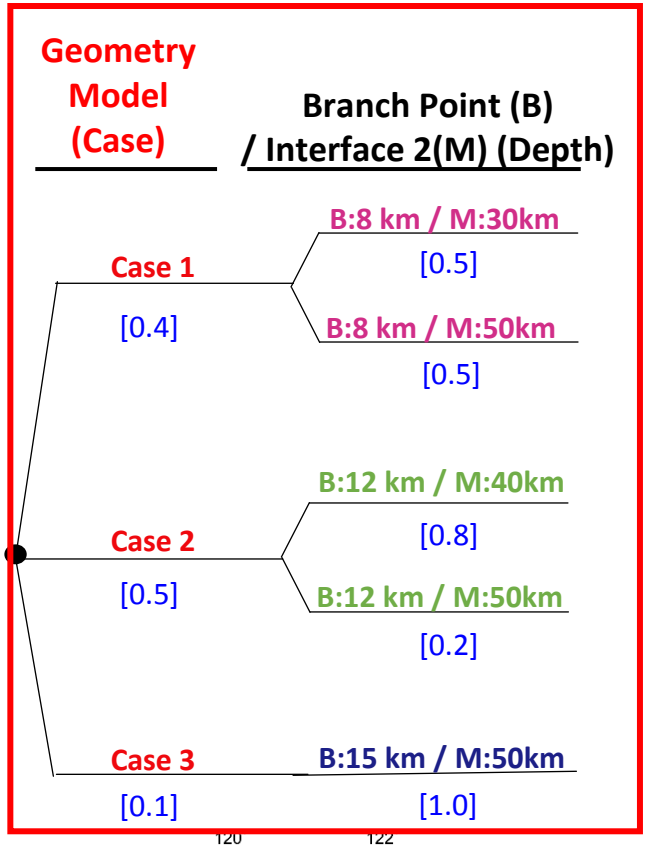
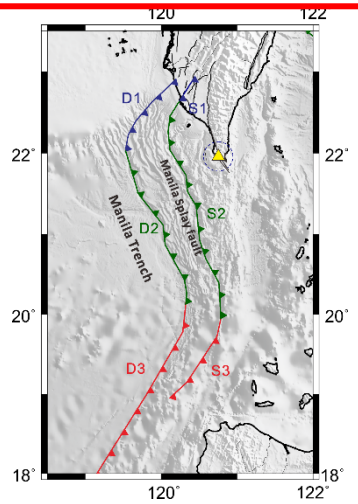
East Hengchun Offshore Fault	EHCOF-RM
West Hengchun Offshore Structure	WHCOS-RM

* Note:
•Max Magn. = Char. Magn. + 0.25
•Char. Magn. is calculated from Magnitude Scaling Law: Wells and Coppersmith (1994), Yen and Ma (2011) .

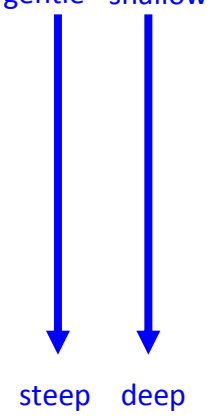
Manila subduction interface – Geometry Model

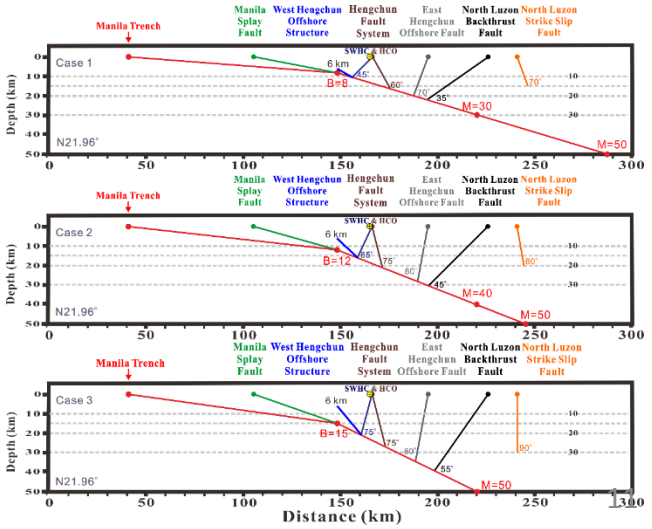




Geometry Model

- We assumed that the dips of all faults are varied by interface geometry.
- Marine geophysical researches show the interface dipping from shallow to steep. However, marine reflection seismic research shows some faults have low angle thrust features in shallow part, such as North Luzon back thrust fault (Reed et al., 1992). Case 2 is the closest model to the surface of interface which is determined from seismicity.
- Thus, the weighting of Case 2 was given as [0.5] with high confident. The Case 3 with steep fault dips is given lowest weight [0.1] and Case 1 with shallow fault dipping is given higher weight [0.4].

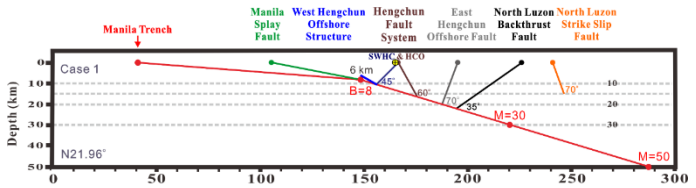




Southern primary faults & Manila subduction interface

Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate (mm/yr)	Fault Geometry Model: Dip	Fault Geometry Model: Seismogenic Depth	Magnitude Distribution Model: Max. Magn.	Magnitude Distribution Model: Magnitude pdf
Seismogenic [0.4]	RV (90) [0.4]	HC-RM	CC+HC+SWHC (144 km)	[0.4, 1,0.5] [0.2]	60°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
			CC+HC+HCO (140 km)	[1.6, 4,1.4] [0.6]			W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
			CC+HC (117 km)	[2.4, 6,2.3] [0.2]			Y&M (A)+0.25 [0.3]	
			HC+HCO (63 km)					
			HC+SWHC (67 km)	[SWHC, HC, CC]				
			SWHC (27 km)					
			CC (77 km)					
			HC (40 km)					
			HCO (23 km)					
	RV/OB (45) [0.6]							

Hengchun Fault System

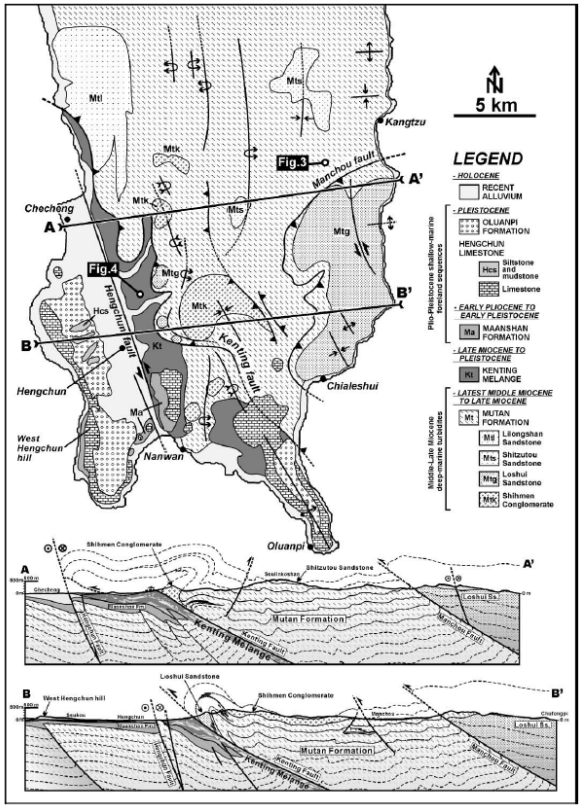


Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate (mm/yr)	Fault Geometry Model: Dip	Fault Geometry Model: Seismogenic Depth	Magnitude Distribution Model: Max. Magn.	Magnitude Distribution Model: Magnitude pdf
Seismogenic	RV/OB (45)	NLSSF-RM	(216 km)	4* [0.3]	70°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
				6 * [0.4]			W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
				8* [0.3]			Y&M (A)+0.25 [0.3]	
Seismogenic	RV (90)	NLBF-RM	(593 km)	5* [0.3]	35°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
				8* [0.4]			W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
				12* [0.3]			Y&M (A)+0.25 [0.3]	
Seismogenic	RV (90)	MSF-RM1 [0.1]	S1+S2+S3 (485 km)	4* [0.3]	11°	(Stop at Manila branch point (8 km))	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
		MSF-RM2 [0.2]	S1 (33 km) S2+S3(452 km)	9* [0.4]			W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
		MSF-RM3 [0.2]	S1+S2(355 km) S3 (130km)	15* [0.3]			Y&M (A)+0.25 [0.3]	
		MSF-RM4 [0.5]	S1 (33 km) S2 (322km) S3 (130km)	* Means constant slip rate				
Seismogenic	RV (90)	EHCOF-RM	(190 km)	5 [0.3]	70°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
				7 [0.4]			W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
				9 [0.3]			Y&M (A)+0.25 [0.3]	
Seismogenic [0.5]	RV (90)	WHCOS-RM	(19 km)	1.2 [0.2]	30°	(branch fault off interface)	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
				1.6 [0.6]			W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
				2.4 [0.2]			Y&M (A)+0.25 [0.3]	
Non-Seismogenic [0.5]								

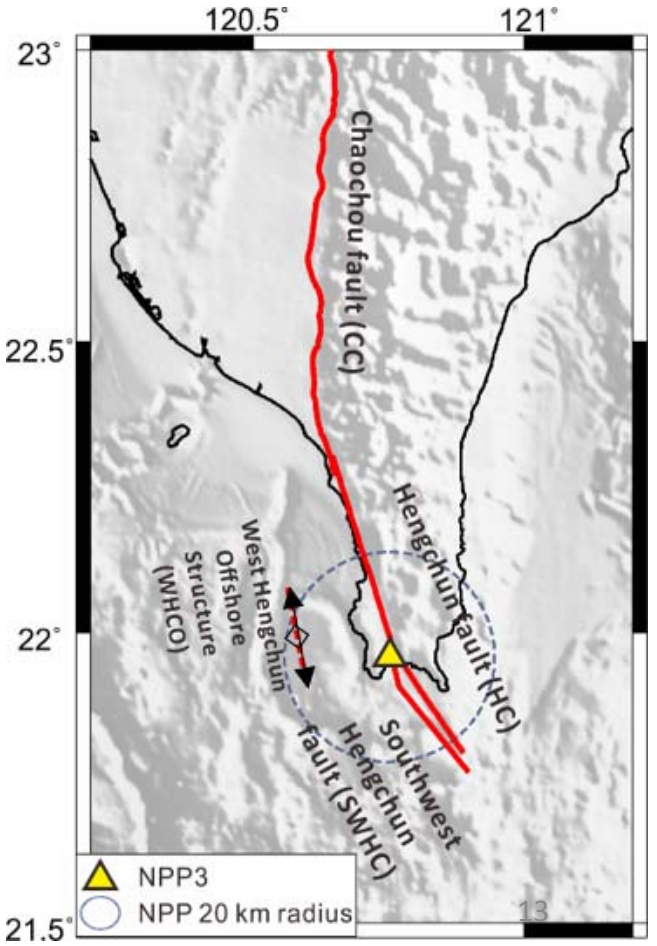
Hengchun Fault System - Style of Faulting

Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate mm/yr [SWHC, HC, CC]	Fault Geometry Model: Dip	Fault Geometry Model: Seismogenic Depth
Seismogenic	RV (90) [0.4]	HC-RM	CC+HC+SWHC (144 km)	[0.4, 1,0.5] [0.2]		
			CC+HC+HCO (140 km)	[1.6, 4,1.4] [0.6]	60°	(Stop at Manila interface)
			CC+HC (117 km)	[2.4, 6,2.3] [0.2]		
	RV/OB (45) [0.6]		HC+HCO (63 km)			
			HC+SWHC (67 km)			
			SWHC (27 km)			
			CC (77 km)			
			HC (40 km)			
			HCO (23 km)			

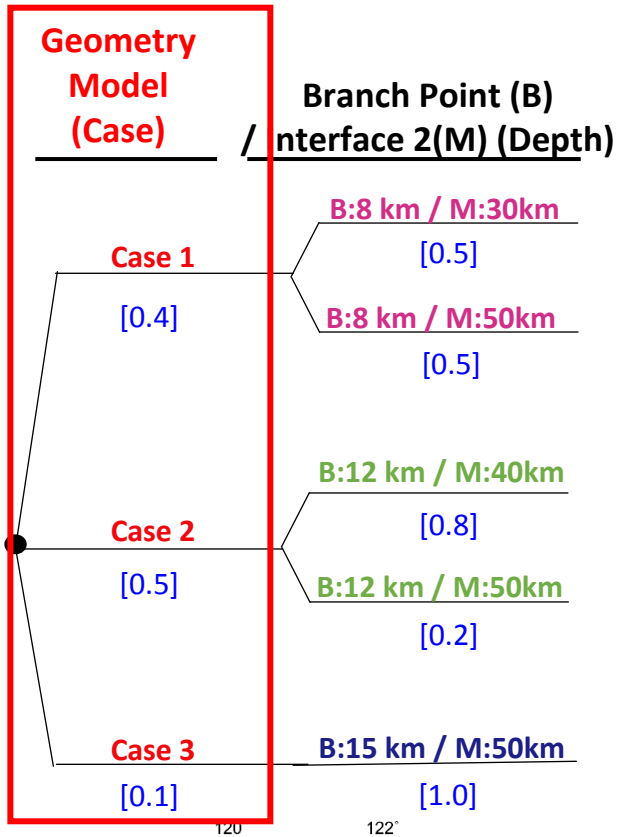
Hengchun fault with oblique component

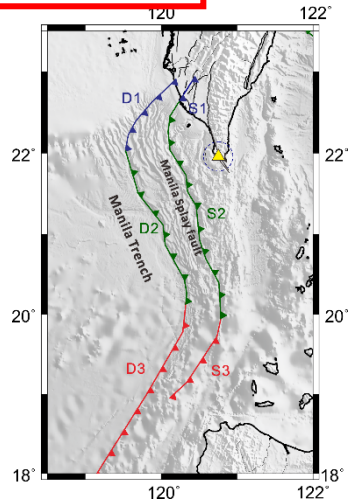


(Chang et al., 2003)



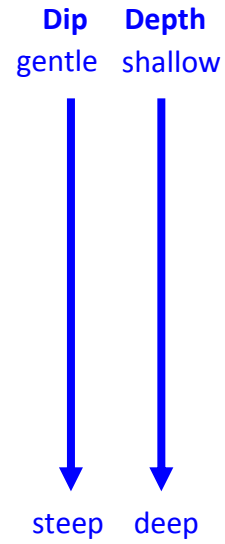
Manila subduction interface – Geometry Model

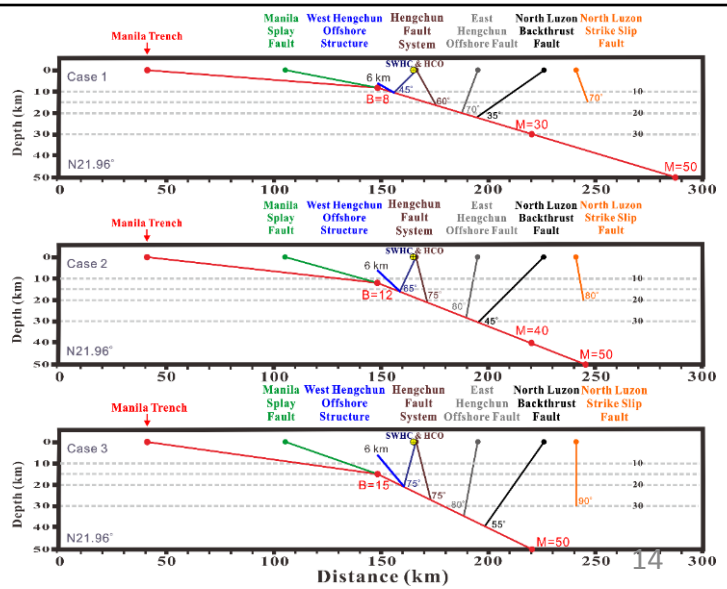




Geometry Model

- We assumed that the dips of all faults are varied by interface geometry.
- Marine geophysical researches show the interface dipping from shallow to steep. However, marine reflection seismic research shows some faults have low angle thrust features in shallow part, such as North Luzon back thrust fault (Reed et al., 1992). Case 2 is the closest model to the surface of interface which is determined from seismicity.
- Thus, the weighting of Case 2 was given as [0.5] with high confident. The Case 3 with steep fault dips is given lowest weight [0.1] and Case 1 with shallow fault dipping is given higher weight [0.4].

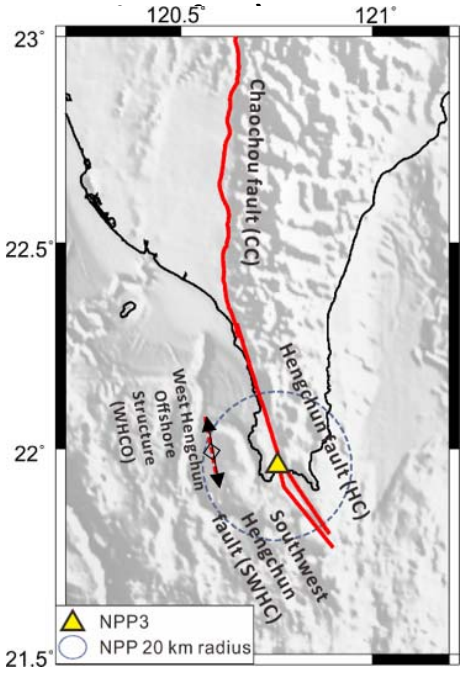




Hengchun Fault System – Geometry Model

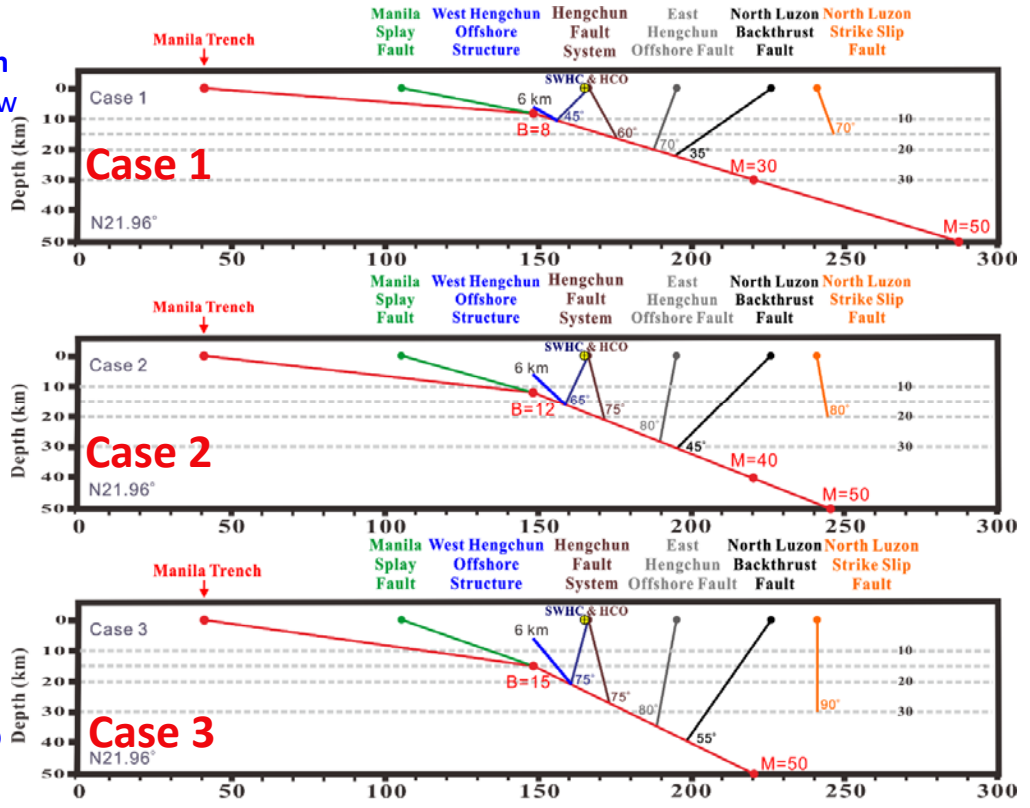
Fault Geometry Model

	Dip	Seismogenic Depth
Case 1 [0.4]	60° (Stop at Manila interface)	
Case 2 [0.5]	75° (Stop at Manila interface)	
Case 3 [0.1]	75° (Stop at Manila	



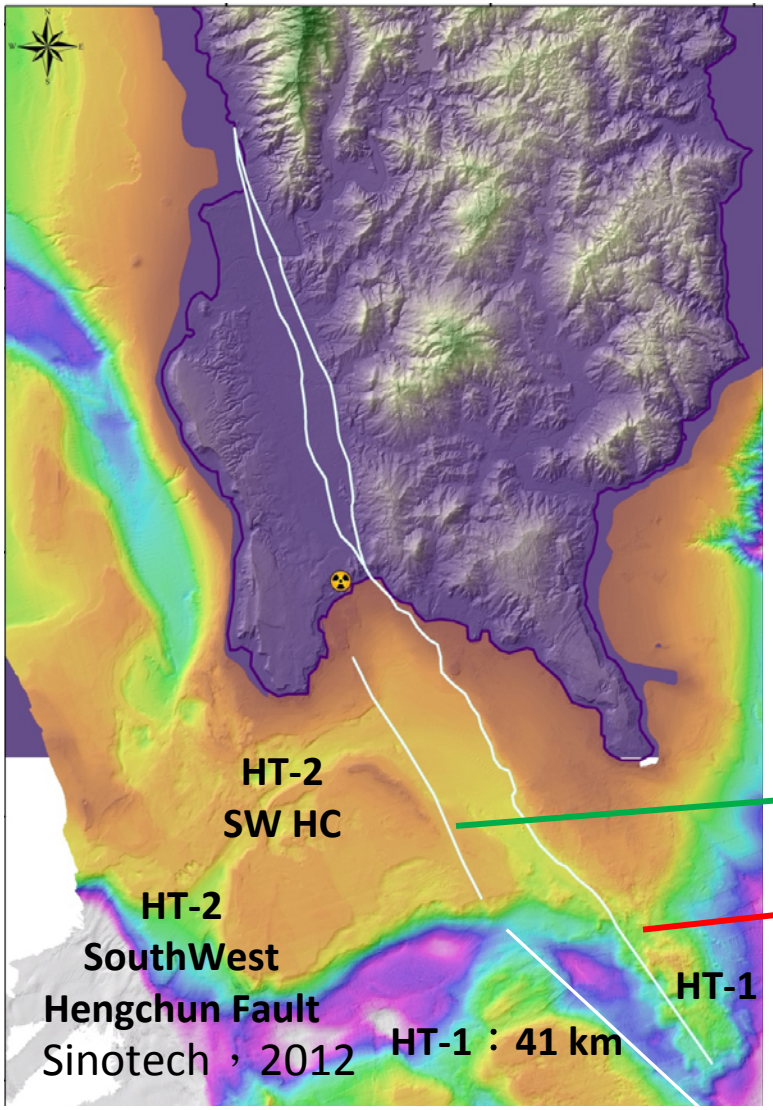
Geometry Model

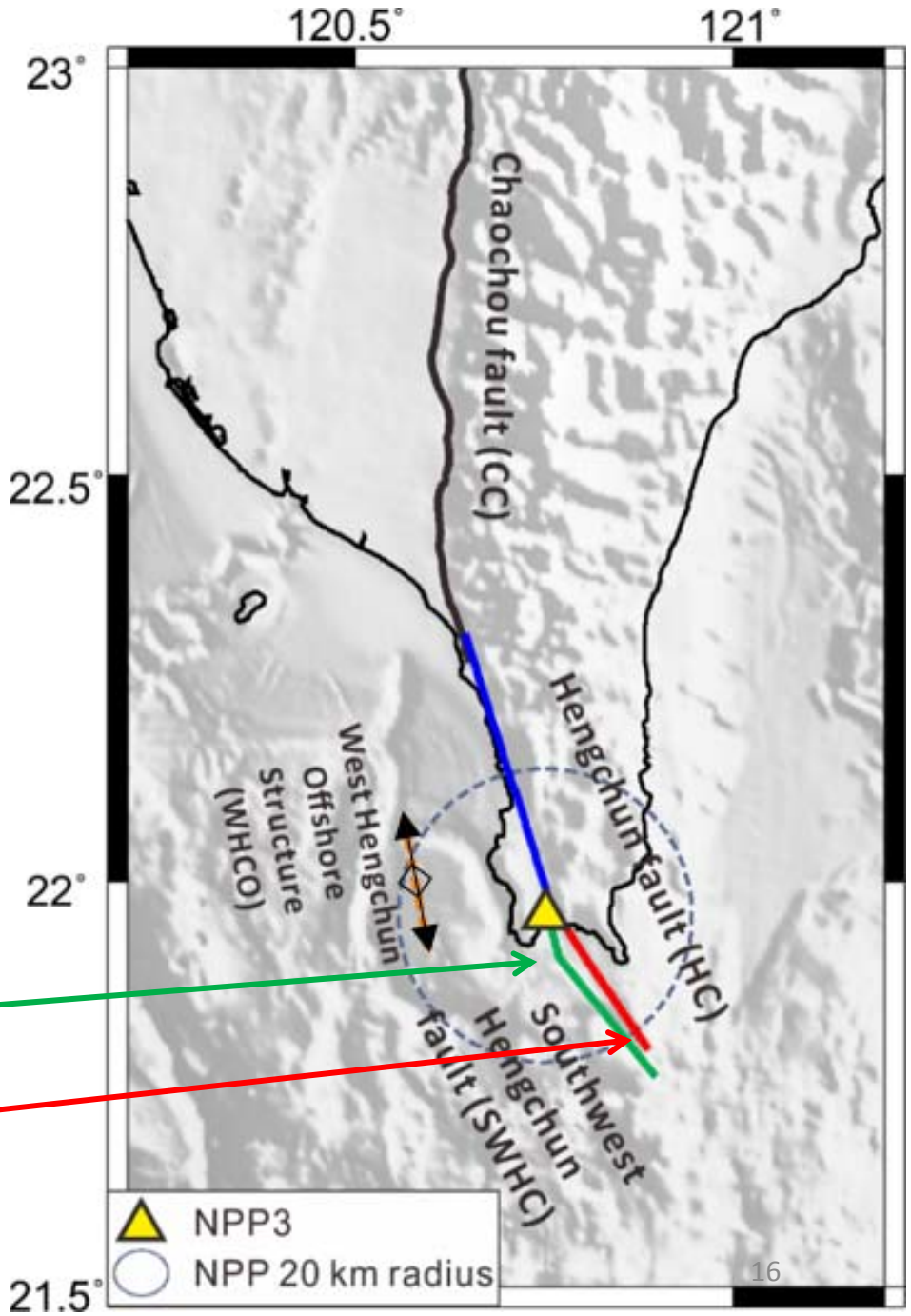
Dip gentle shallow steep
Depth shallow deep



	TEM(2016)	CGS	LCI, Sinotech (2015)	NCU	TI
Depth (km)	13-17	14-18	15-35	20	Stop at Manila interface
Dip (°)	70-80	45-70	45-75	50E	60、75、75
Vertical rate (mm/yr)	5.74-6.62	1.5-6.5	Oblique: 2-10 Reverse: 1-7	1-3	1/4/6

Fault trace from reflection seismic data

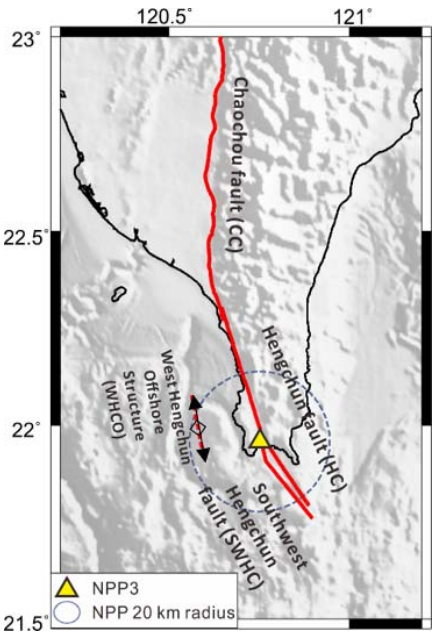


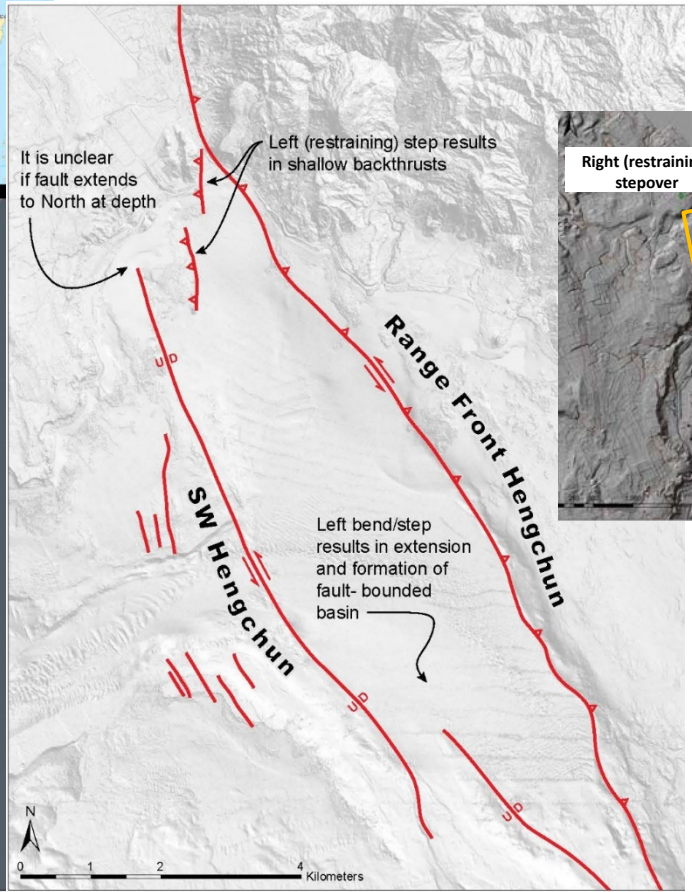


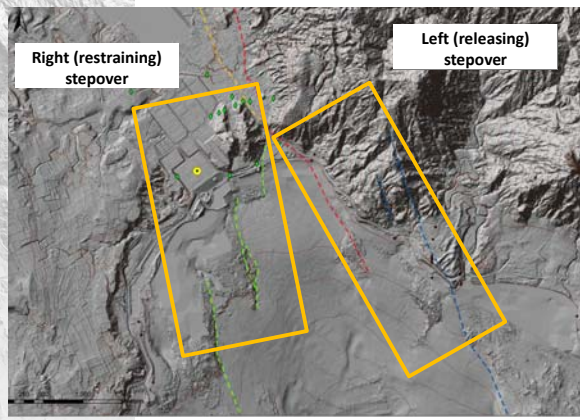
Hengchun Fault System

- Rupture Model
  Rupture Source

Rupture Model	Rupture Source (Length)
HC-RM	CC+HC+SWHC (144 km)
	CC+HC+HCO (140 km)
	CC+HC (117 km)
	HC+HCO (63 km)
	HC+SWHC (67 km)
	SWHC (27 km)
	CC (77 km)
	HC (40 km)
	HCO (23 km)







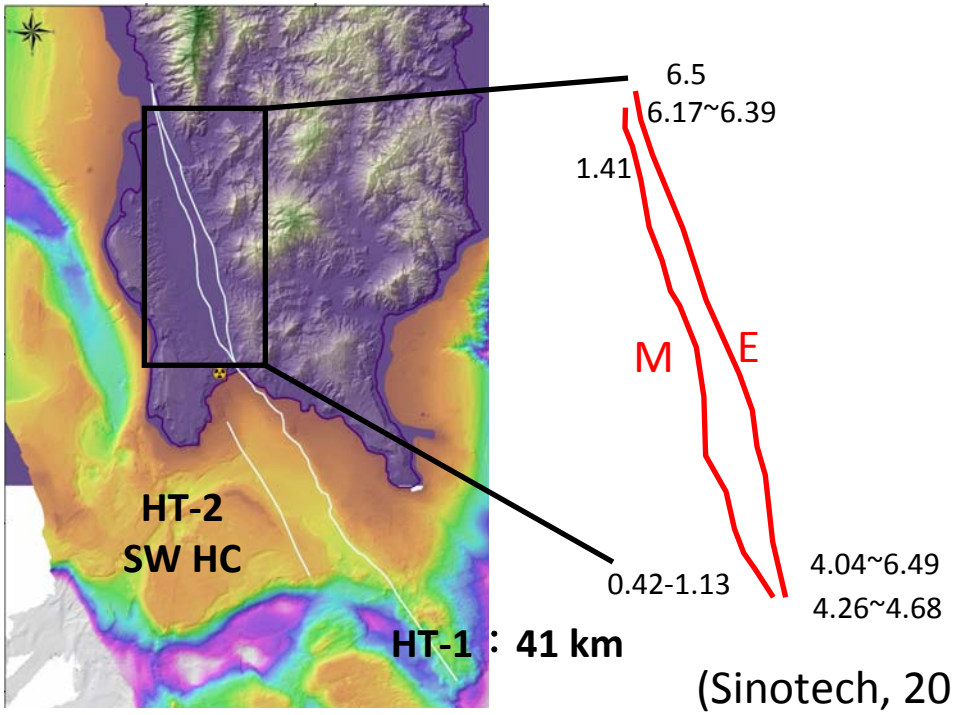
1 Chaochou fault (CC)
2 Hengchun fault (HC)
3 Hengchun offshore fault (HCO)
4 Southwest Hengchun fault (SWHC)

(From Lettis LCI, 2015)

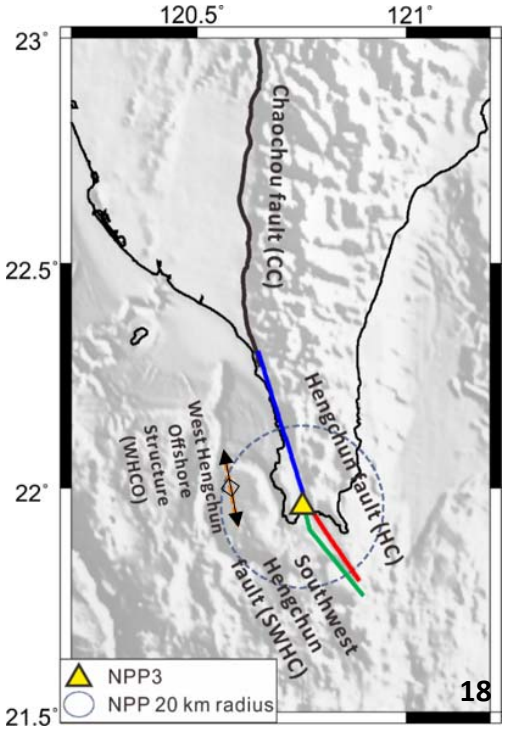
Slip rate data of Hengchun Fault

Reference	Method	Vertical rate(mm/yr)	Slip rate(mm/yr) (Thrust fault assumed)
Chen and Liu , 1993	Marine terrace	6.0	6.5 (Dip 70)
		3.8~6.1	4.04~6.49(Dip 70)
Chen et al，2006	Coral reefs C14 dating and Drilling	5.9± 0.1	6.17~6.39 (Dip 70)
Chen et al，2010	Coral reefs dating and Drilling	4.0~4.4	4.26~4.68 (Dip 70)
Sinotech，2012	Drilling	1	1.41 (Dip 45)
	Drilling	0.3-0.8	0.42~1.13 (Dip 45)

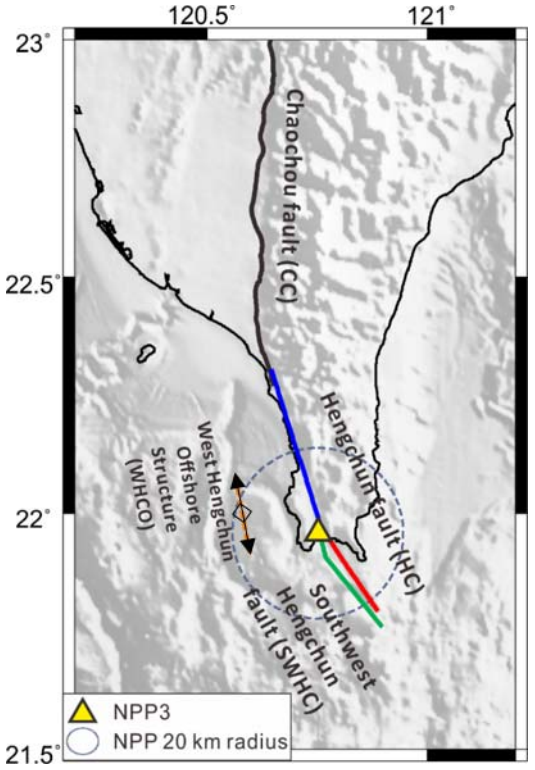
(Hu et al., 2015)



(Sinotech, 2012)



Hengchun Fault System – Slip Rate



Vertical Rate mm/yr

[SWHC, HC, CC]

[0.4, 1, 0.5] [0.2]

[1.6, 4, 1.4] [0.6]

[2.4, 6, 2.3][0.2]

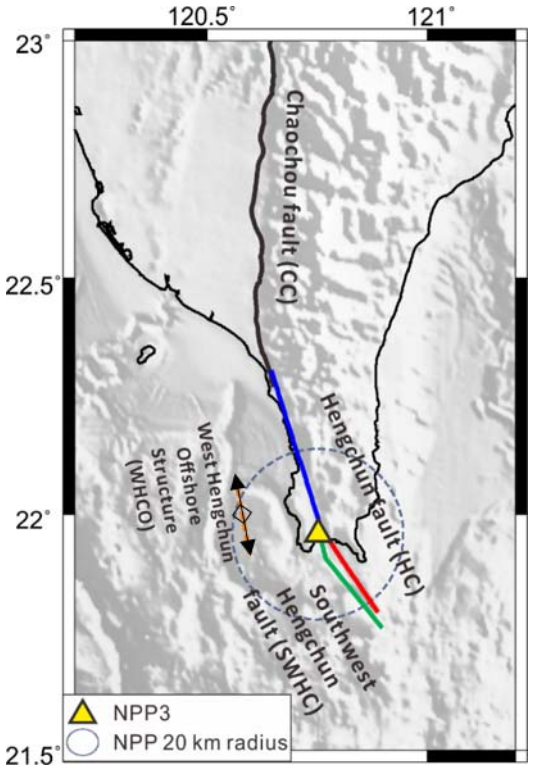
Single source (lager vertical rate)

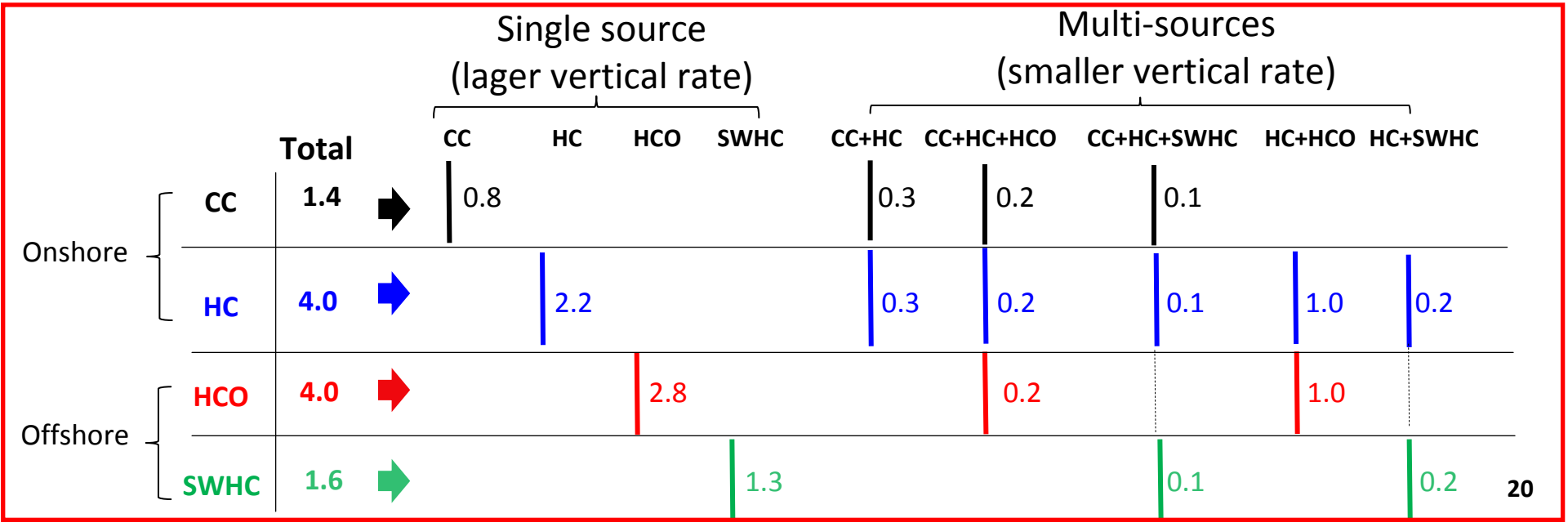
Multi-sources (smaller vertical rate)

		Total	CC	HC	HCO	SWHC	CC+HC	CC+HC+HCO	CC+HC+SWHC	HC+HCO	HC+SWHC
Onshore	CC	1.4	0.8				0.3	0.2	0.1		
	HC	4.0		2.2			0.3	0.2	0.1	1.0	0.2
Offshore	HCO	4.0			2.8			0.2		1.0	
	SWHC	1.6				1.3			0.1		0.2

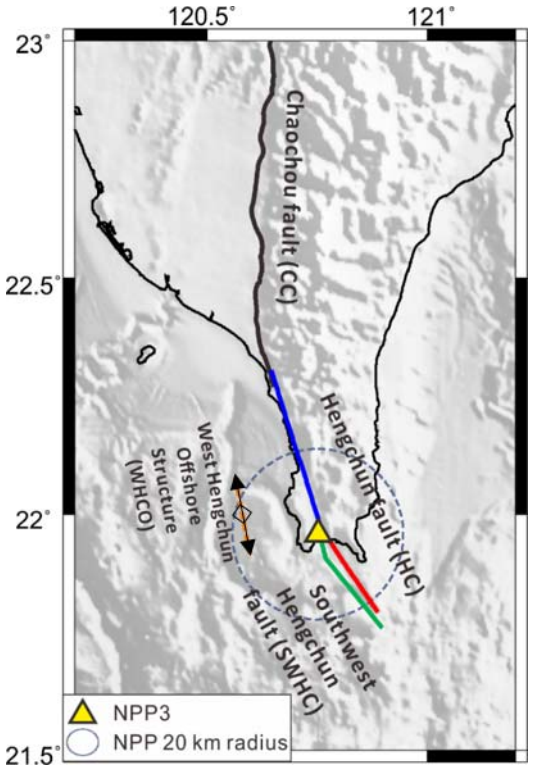
Hengchun Fault System – Slip Rate

- **Slip rate data of each fault segments.**
- **TI judgment**
  - Large magnitude is directly proportional to fault length which follows the scaling law.
  - Fault with longer/smaller length has longer/smaller returned period, smaller/larger (long term) slip rate.
  - Possibility of linked fault. (offset < 5km)
- **Slip rate allocation rule**
  - Slip rate of Individual fault segments > whole fault zone
  - Slip rate of high possibility of fault segment linkage > low possibility of fault segment linkage
  - Slip rate of fault segment with smaller length > with longer length





Hengchun Fault System – Slip Rate



Vertical Rate mm/yr

[SWHC, HC, CC]

[0.4, 1, 0.5] [0.2]

[1.6, 4, 1.4] [0.6]

[2.4, 6, 2.3] [0.2]

Rupture Source	Chaochou fault		Hengchun fault		Hengchun offshore fault		Southwest Hengchun Fault	
	Rate(mm/yr)	% of total	Rate(mm/yr)	% of total	Rate(mm/yr)	% of total	Rate(mm/yr)	% of total
CC	0.8	57.14%						
HC			2.2	55.00%				
HCO					2.8	70.00%		
SWHC							1.3	81.25%
CC+HC	0.3	21.43%	0.3	7.50%				
HC+HCO			1	25.00%	1	25.00%		
HC+SWHC			0.2	5.00%			0.2	12.50%
CC+HC+HCO	0.2	14.29%	0.2	5.00%	0.2	5.00%		
CC+HC+SWHC	0.1	7.14%	0.1	2.50%			0.1	6.25%
Totals	1.4	100%	4	100%	4	100%	1.6	100%

Hengchun Fault System - Max. Magn.

Rupture Source	Style of Faulting	Length (km)	Dip (°)	Depth (km	Area (km^2)	W&C (L)+0.25	W&C (A)+0.25	Y&M (A)+0.25
				D1	A1	Mw	Mw	Mw
CC	90 (RV)	77	60	Stop at Manila docellment	978	7.55	7.27-7.46	7.08-7.26
			75		1201			
			75		1576			
HC		40	60		644	7.21	7.11-7.28	6.93-7.09
			75		793			
			75		1000			
HCO		23	60		426	6.90	6.95-7.12	6.78-6.94
			75		552			
			75		663			
SWHC		27	45		399	7.00	6.92-7.10	6.76-6.92
			65		515			
			75		628			
CC+HC		117	60		1622	7.77	7.47-7.65	7.27-7.43
			75		1994			
			75		2576			
HC+HCO		63	60		1071	7.44	7.31-7.48	7.12-7.28
			75		1345			
			75		1663			
HC+SWHC		67	60		1190	7.48	7.35-7.51	7.15-7.30
			75		1438			
			75		1796			
CC+HC+HCO		140	60		2049	7.87	7.56-7.74	7.35-7.52
			75		2546			
			75		3239			
CC+HC+SWHC		144	60		2168	**7.88**	7.58-7.76	7.37-7.53
			75		2639			
			75		3372			

Hengchun Fault System - Max. Magn.

Rupture Source	Style of Faulting	Length (km)	Dip (°)	Depth (km	Area (km^2)	W&C (L)+0.25	W&C (A)+0.25	Y&M (A)+0.25
				D1	A1	Mw	Mw	Mw
CC	45(RV/OB)	77	60	Stop at Manila docellment	978	7.55	7.27-7.46	7.08-7.26
			75		1201			
			75		1576			
HC		40	60		644	7.21	7.11-7.28	6.93-7.09
			75		793			
			75		1000			
HCO		23	60		426	6.90	6.95-7.12	6.78-6.94
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			75		663			
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			75		3239			
CC+HC+SWHC		144	60		2168	**7.88**	7.58-7.76	7.37-7.53
			75		2639			
			75		3372			

West Hengchun Offshore Structure

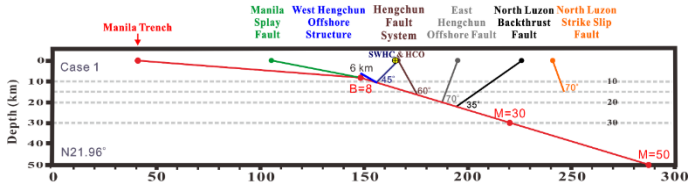
Investigation data of West Hengchun offshore Structrue Fault Parameters

Investigative Techniques \ Fault Parameters		Segmentation (Length)	Fault Dip	Rupture Depth	Long-term Slip Rate
Structural Geology	Geologic cross-section	●	●	●	●
	Tectonic sequence stratigraphy	●			
	Balanced cross section		●	●	●
	Drilling boreholes	●	●		
Surface Geological Survey	Earthquake surface rupture	●			
	Exploratory trenching		●		●
	Terrace dating				●
Exploration Geophysics	Seismic profile		●	●	
	Resistivity Image Profile	●			
Interpretation of Remote Sensing Image	D-InSAR or PS-InSAR	●			
	Satellite image interpretation	●			
	Aerial photo interpretation	●			
Seismology	Aftershock distribution	●		●	
	Seismicity cross sections		●	●	
	Focal mechanism solution		●		
	Seismic tomography			●	
Geodetic survey	GPS coseismic slip	●			
	GPS block model				●

Southern primary faults & Manila subduction interface

Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate (mm/yr)	Fault Geometry Model: Dip	Fault Geometry Model: Seismogenic Depth	Magnitude Distribution Model: Max. Magn.	Magnitude Distribution Model: Magnitude pdf
Seismogenic [0.4]	RV (90) [0.6]	HC-RM	CC+HC+SWHC (144 km)	[0.4, 1,0.5] [0.2]; [1.6, 4,1.4] [0.6]; [2.4, 6,2.3] [0.2]	60°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
	RV/OB (45) [0.6]		CC+HC+HCO (140 km)					
			CC+HC (117 km)					
			HC+HCO (63 km)					
			HC+SWHC (70 km)					
			SWHC (27 km)	[SWHC, HC, CC]				
			CC (77 km)					
			HC (40 km)					
			HCO (23 km)					
Seismogenic	RV/OB (45)	NLSSF-RM	(216 km)	4* [0.3]; 6 * [0.4]; 8* [0.3]	70°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Seismogenic	RV (90)	NLBF-RM	(593 km)	5* [0.3]; 8* [0.4]; 12*[0.3]	35°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Seismogenic	RV (90)	MSF-RM1 [0.1]	S1+S2+S3 (484 km)	4* [0.3]; 9* [0.4]; 15*[0.3]	11°	(Stop at Manila branch point (8 km))	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
		MSF-RM2 [0.2]	S1 (33 km); S2+S3(452 km)					
		MSF-RM3 [0.2]	S1+S2(354 km); S3 (130km)					
		MSF-RM4 [0.5]	S1 (33 km); S2 (322km); S3 (130km)					
Seismogenic	RV (90)	EHCOF-RM	(190 km)	5 [0.3]; 7 [0.4]; 9 [0.3]	70°	(Stop at Manila interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Seismogenic [0.5]	RV (90)	WHCOS-RM	(19 km)	1.2 [0.2]; 1.6 [0.6]; 2.4 [0.2]	30°	(branch fault off interface)	W&C (L)+0.25 [0.4]; W&C (A)+0.25 [0.3]; Y&M (A)+0.25 [0.3]	Y&C Char [0.5]; Truncated Exponential [0.5]
Non-Seismogenic [0.5]								

* Means constant slip rate

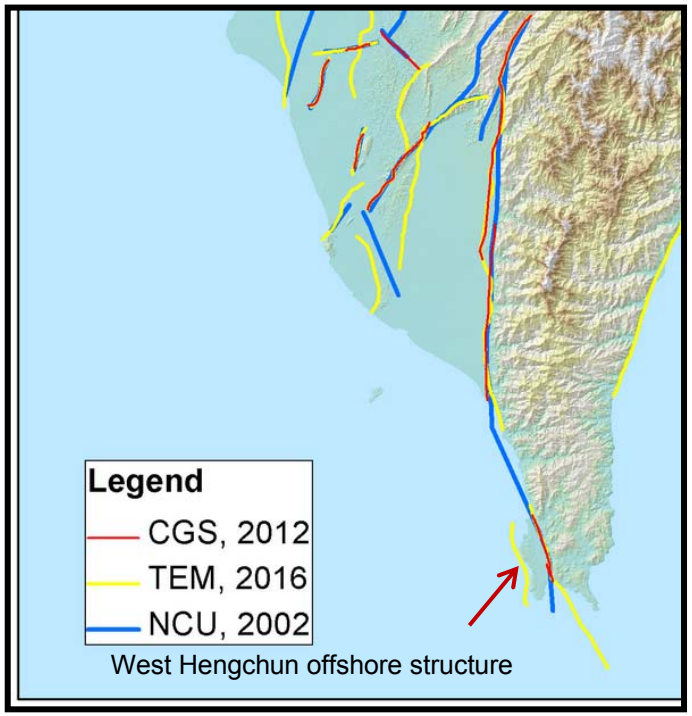


West Hengchun Offshore Structure

West Hengchun Offshore Structure- Seismogenic Probablility

Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate mm/yr	Magnitude Distribution Model Max. Magn.	Magnitude pdf
Seismogenic [0.5]	RV (90)	WHCOS-RM	(19 km)	1.2 [0.2]	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
				1.6 [0.6]	W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
				2.4 [0.2]	Y&M (A)+0.25 [0.3]	
Non-Seismogenic [0.5]						

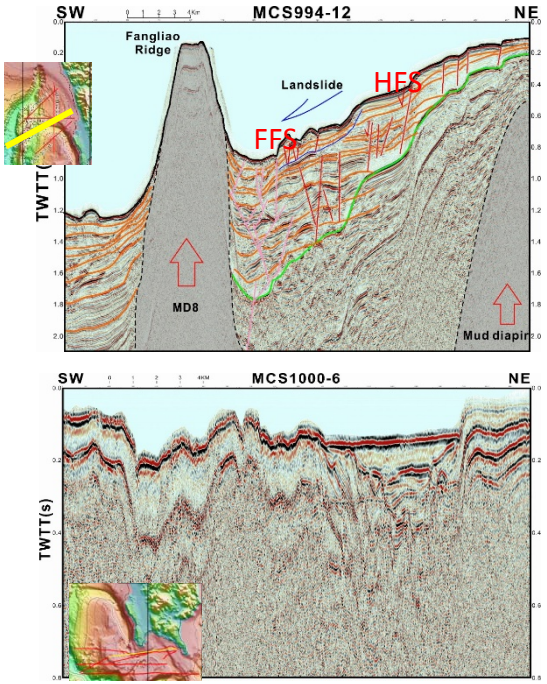
Seismogenic [0.5]



(TEM, 2016)

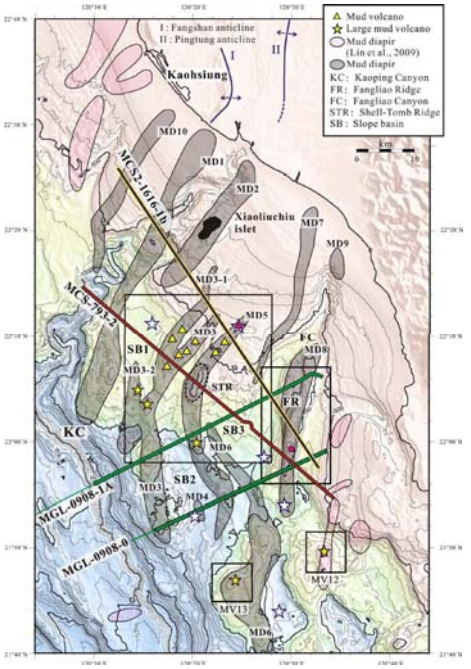
Non-Seismogenic [0.5]

There is no obvious thrust fault on reflection seismic profiles.



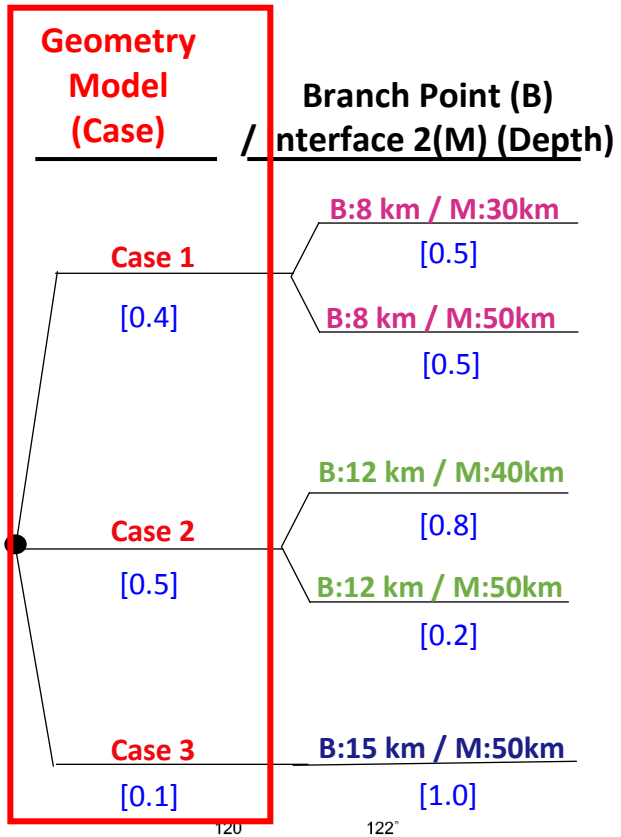
From C.S. Liu in TI-Team Meeting as mini workshop.

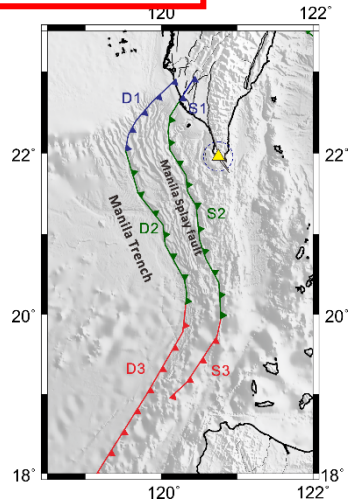
Mud Diapir of the southern of Taiwan



(S. C. Chen, 2013)

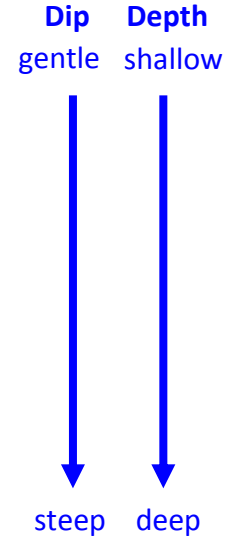
Manila subduction interface – Geometry Model

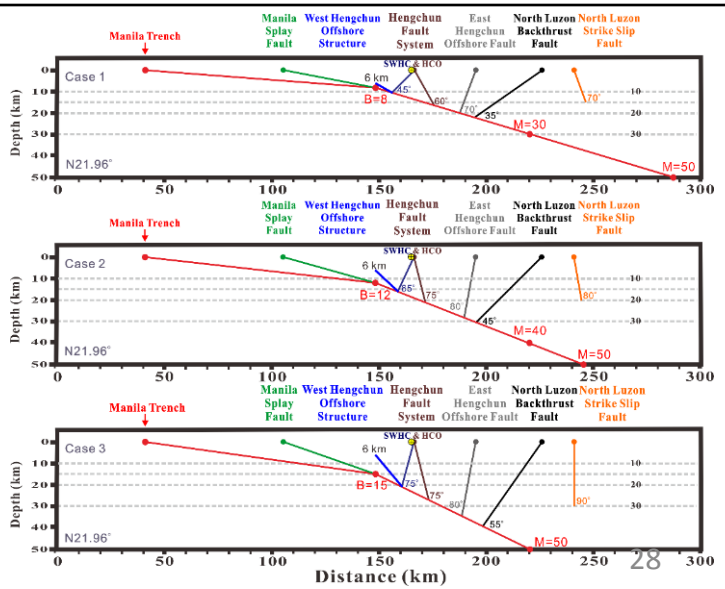




Geometry Model

- We assumed that the dips of all faults are varied by interface geometry.
- Marine geophysical researches show the interface dipping from shallow to steep. However, marine reflection seismic research shows some faults have low angle thrust features in shallow part, such as North Luzon back thrust fault (Reed et al., 1992). Case 2 is the closest model to the surface of interface which is determined from seismicity.
- Thus, the weighting of Case 2 was given as [0.5] with high confident. The Case 3 with steep fault dips is given lowest weight [0.1] and Case 1 with shallow fault dipping is given higher weight [0.4].

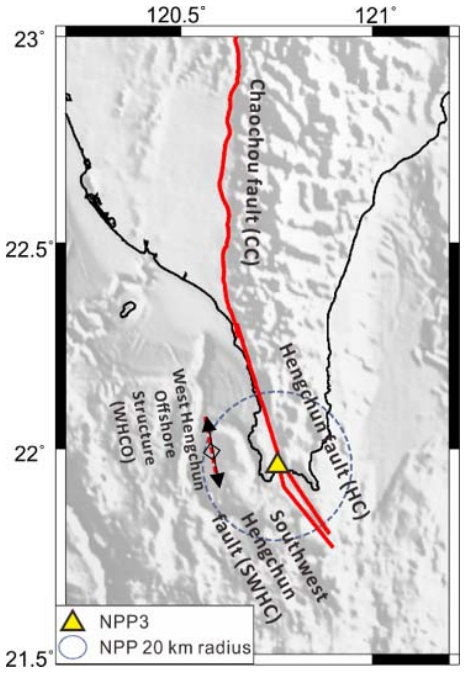




West Hengchun Offshore Structure – Geometry Model

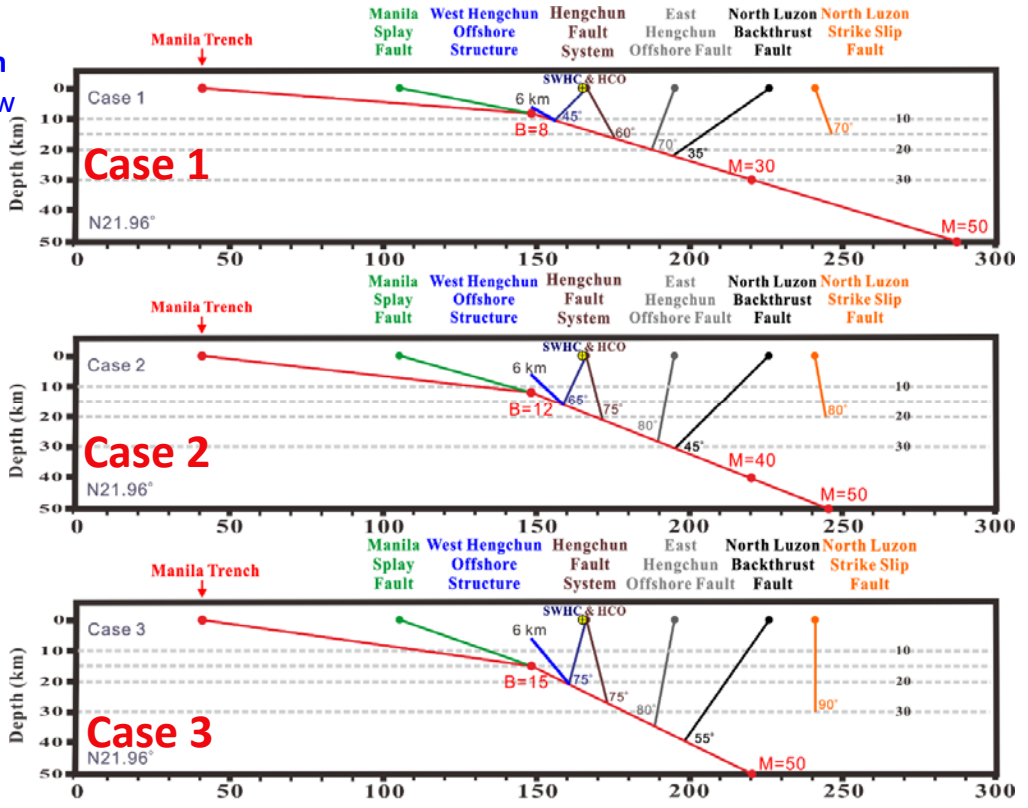
Fault Geometry Model

	Dip	Seismogenic Depth
Case 1 [0.4]	30° (branch fault off interface)	
Case 2 [0.5]	40° (branch fault off interface)	
Case 3 [0.1]	50° (branch fault off interface)	



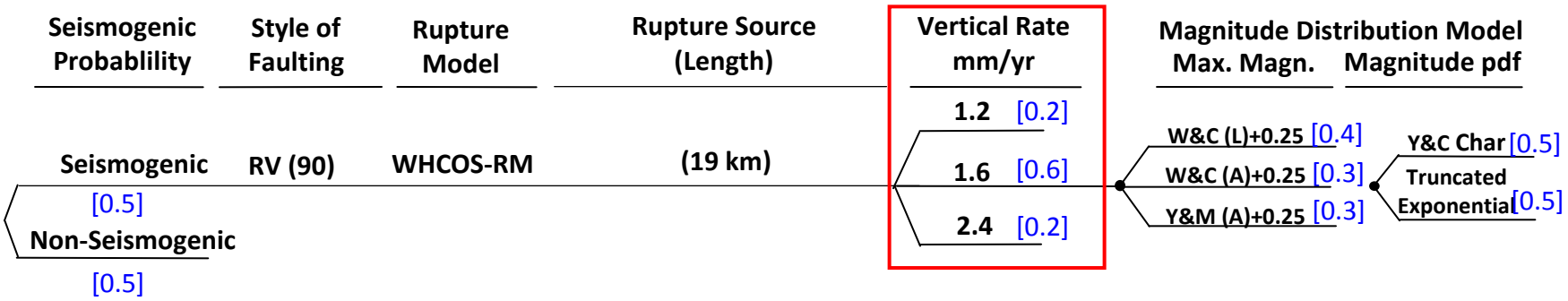
Geometry Model

Dip gentle → steep; Depth shallow → deep

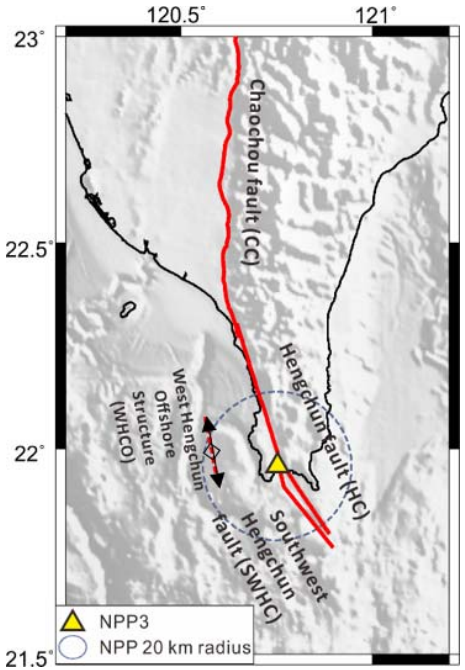


	TEM (2016)	TI
Depth (km)	12-16	6 km Down to South West Hengchun Fault (SWHC)
Dip (°)	0 to 6.5~7.5 km: 60° 6.5~7.5 to 9~11 km: 45° 9~11 to 11.8~15.8 km: 30°	Case 1: branch fault off interface 30° Case 2: branch fault off interface 40° Case 3: branch fault off interface 50°
Vertical rate (mm/yr)	1.2/1.61/2.38	1.2/1.61/2.38

West Hengchun Offshore Structure - Slip Rate



- The middle branch is derived from measurement and the weighting is given to [0.2] [0.6] [0.2].



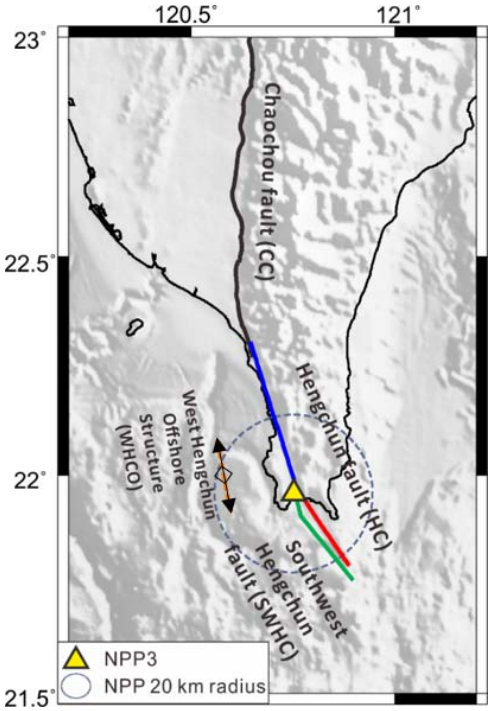
	TEM (2016)	TI
Depth (km)	12-16	6 km Down to South West Hengchun Fault (SWHC)
Dip (°)	0 to 6.5~7.5 km: 60° 6.5~7.5 to 9~11 km: 45° 9~11 to 11.8~15.8 km: 30°	Case 1: branch fault off interface 30° Case 2: branch fault off interface 40° Case 3: branch fault off interface 50°
Vertical rate (mm/yr)	1.2/1.61/2.38	1.2/1.61/2.38

West Hengchun Offshore Structure - Max. Magn.

Seismogenic Probablility	Style of Faulting	Rupture Model	Rupture Source (Length)	Vertical Rate mm/yr	Magnitude Distribution Model Max. Magn.	Magnitude pdf
Seismogenic [0.5]	RV (90)	WHCOS-RM	(19 km)	1.2 [0.2]	W&C (L)+0.25 [0.4]	Y&C Char [0.5]
				1.6 [0.6]	W&C (A)+0.25 [0.3]	Truncated Exponential [0.5]
				2.4 [0.2]	Y&M (A)+0.25 [0.3]	
Non-Seismogenic [0.5]						

Fault Geometry Model

	Dip	Seismogenic Depth
Case 1 [0.4]	30° (branch fault off interface)	
Case 2 [0.5]	40° (branch fault off interface)	
Case 3 [0.1]	50° (branch fault off interface)	



West Hengchun Offshore Structure	Style of Faulting	Length (km)	Dip (°)	Depth (km)	Area (km2)	W&C (L)+0.25	W&C (A)+0.25	Y&M (A)+0.25
				D1	A1	M1	M1	M1
L1	90 (RV)	19	30	Case 1 (down to SWHC)	535	6.82	7.04	6.87
			40	Case 2 (down to SWHC)	526		7.03	6.86
			50	Case 3 (down to SWHC)	617		**7.09**	6.92

Thank you

Node: Slip Rate

Cumulative geologic slip rate across the entire southern region

WS# 2	Manila Trench (mm/yr)	%	Manila Splay Fault (mm/yr)	%	Other Faults (%)	Total slip rate (mm/yr)
Case 1	8	16-25	4	10-13	62	31.60
	10		6		70	54.18
	12		8		73	74.77
Case 2	8	17-25	4	11-13	62	31.74
	10		6		69	52.21
	12		8		72	71.63
Case 3	8	19-28	4	13-14	58	28.50
	10		6		66	46.80
	12		8		69	63.70

WS# 3	Manila Trench (mm/yr)	%	Manila Splay Fault (mm/yr)	%	Other Faults (%)	Total slip rate (mm/yr)
Case 1	8	23-25	4	12-16	63	32.30
	14		9		63	62.10
	24		15		59	95.20
Case 2	8	24-27	4	13-17	61	30.80
	14		9		60	57.90
	24		15		56	88.70
Case 3	8	25-28	4	13-18	60	30.10
	14		9		59	55.90
	24		15		55	85.80

WM# 3	Manila Trench (mm/yr)	%	Manila Splay Fault (mm/yr)	%	Other Faults (%)	Total slip rate (mm/yr)
Case 1	8	22-25	4	12-15	63	32.30
	14		9		63	62.10
	20		15		62	91.20
Case 2	8	24-26	4	13-18	61	30.80
	14		9		60	57.90
	20		15		59	84.70
Case 3	8	24-27	4	13-18	60	30.10
	14		9		59	55.90
	20		15		57	81.80

Other Faults include West Hengchun Offshore Structure, Hengchun Fault, East Hengchun Offshore Fault, North Luzon Backthrust Fault, North Luzon Strike Slip Fault, Soutwest Hengchun Fault.

WS# 2

WM# 3

WS# 3

- The slip rate of Manila trench accounts for 20-30 percent of the slip rate of southern region of Taiwan.
- Consider the plate convergence rate (86/mm/yr) Modify the slip rate of manila trench and splay fault.
- Modify the slip rate of manila trench.

Manila Trench Slip Rate (mm/yr)			
	Max.	Medium	Min.
WS#2	12	10	8
WM#3	20	14	8
WS#3	24	14	8

Node: Slip Rate

Cumulative geologic slip rate across the entire southern region

WS# 2	Manila Trench (mm/yr)	%	Manila Splay Fault (mm/yr)	%	Other Faults (%)	Total slip rate (mm/yr)
Case 1	8	25.3	4	12.7	62.0	31.60
	10	18.5	6	11.1	70.5	54.18
	12	16.0	8	10.7	73.3	74.77
Case 2	8	25.2	4	12.6	62.2	31.74
	10	19.2	6	11.5	69.4	52.21
	12	16.8	8	11.2	72.1	71.63
Case 3	8	28.1	4	14.0	57.9	28.50
	10	21.4	6	12.8	65.8	46.80
	12	18.8	8	12.6	68.6	63.70

WM# 3	Manila Trench (mm/yr)	%	Manila Splay Fault (mm/yr)	%	Other Faults (%)	Total slip rate (mm/yr)
Case 1	8	24.8	4	12.4	62.8	32.30
	14	22.5	9	14.5	63.0	62.10
	20	21.9	15	16.4	61.6	91.20
Case 2	8	26.0	4	13.0	61.0	30.80
	14	24.2	9	15.5	60.3	57.90
	20	23.6	15	17.7	58.7	84.70
Case 3	8	26.6	4	13.3	60.1	30.10
	14	25.0	9	16.1	58.9	55.90
	20	24.4	15	18.3	57.2	81.80

WS# 3	Manila Trench (mm/yr)	%	Manila Splay Fault (mm/yr)	%	Other Faults (%)	Total slip rate (mm/yr)
Case 1	8	24.8	4	12.4	62.8	32.30
	14	22.5	9	14.5	63.0	62.10
	24	25.2	15	15.8	59.0	95.20
Case 2	8	26.0	4	13.0	61.0	30.80
	14	24.2	9	15.5	60.3	57.90
	24	27.1	15	16.9	56.0	88.70
Case 3	8	26.6	4	13.3	60.1	30.10
	14	25.0	9	16.1	58.9	55.90
	24	28.0	15	17.5	54.5	85.80

Other Faults include West Hengchun Offshore Structure, Hengchun Fault, East Hengchun Offshore Fault, North Luzon Backthrust Fault, North Luzon Strike Slip Fault, Soutwest Hengchun Fault.

WS# 2

Consider the plate convergence rate (86/mm/yr) Modify the slip rate of manila trench and splay fault.

WM# 3

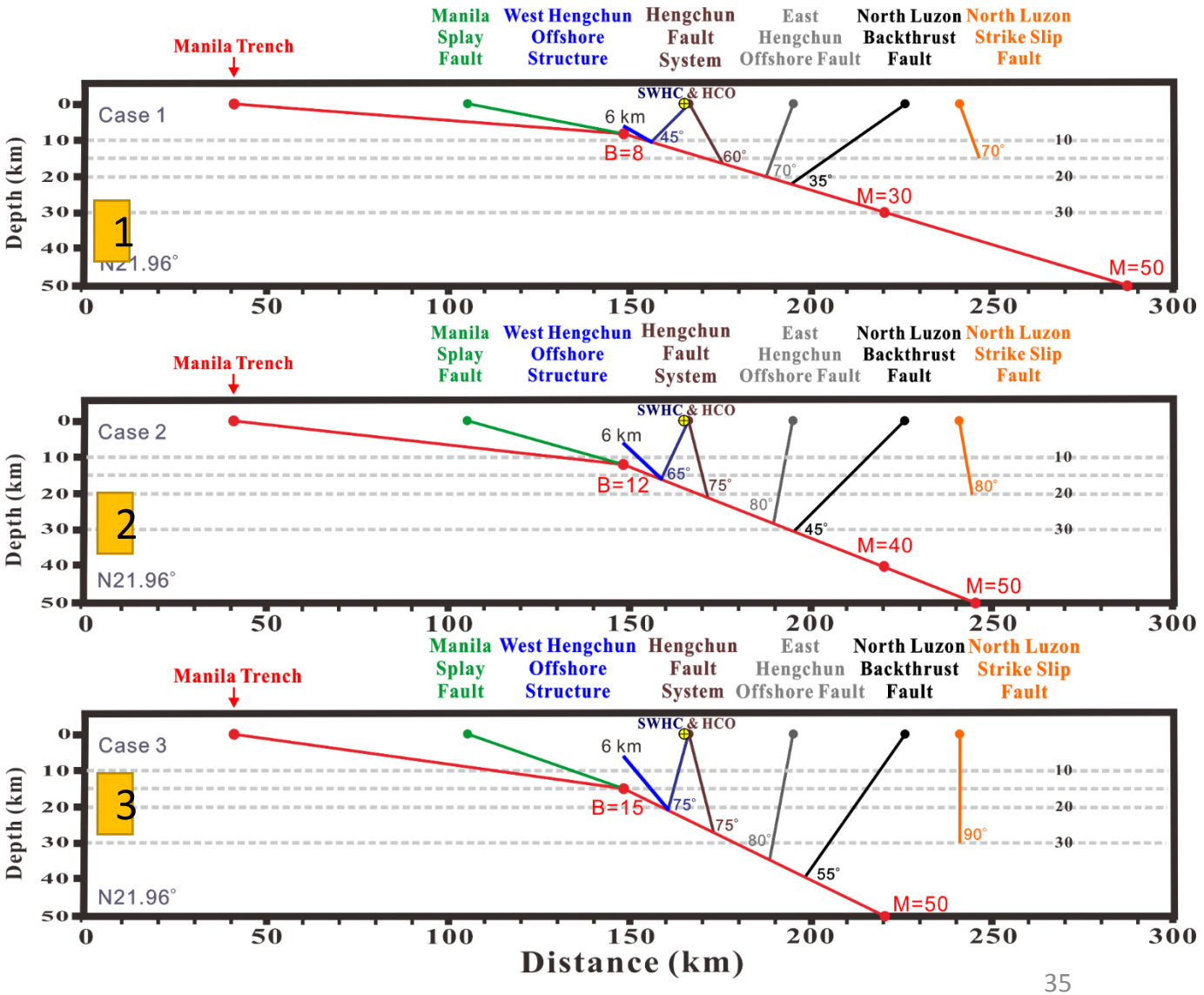
Modify the slip rate of manila trench

WS# 3

Manila Trench Slip Rate (mm/yr)			
	Max.	Medium	Min.
WS#2	12	10	8
WM#3	20	14	8
WS#3	24	14	8

Geometry of Southern Taiwan Faults is associated with Manila interface

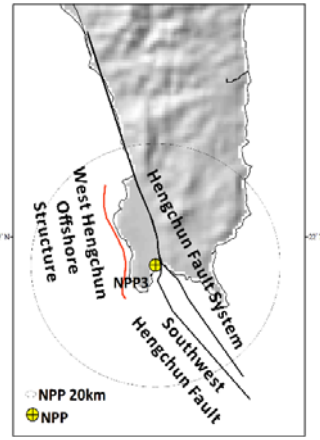
Geometry Model (Case)	Branch Point (B) / Interface 2(M) (Depth)
Case 1 [0.4]	B:8 km / M:30km [0.5]
	B:8 km / M:50km [0.5]
Case 2 [0.5]	B:12 km / M:40km [0.8]
	B:12 km / M:50km [0.2]
Case 3 [0.1]	B:15 km / M:50km [1.0]



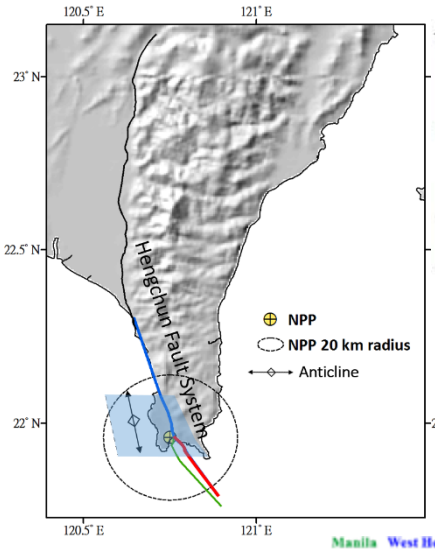
Fault geometry -West Hengchun Offshore Structure

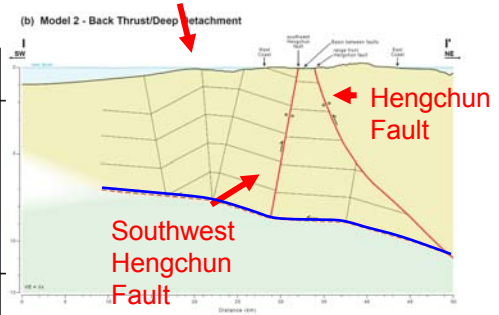
West Hengchun Offshore structure is interpreted a fault bend fold anticline.

TEM 2016
WS #2

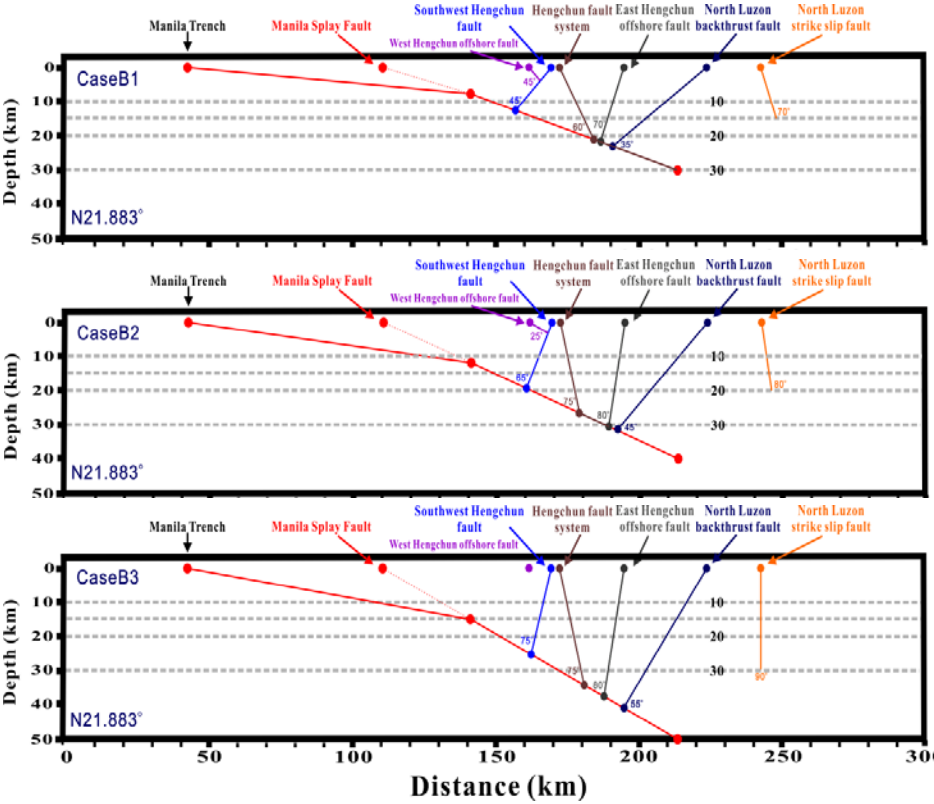


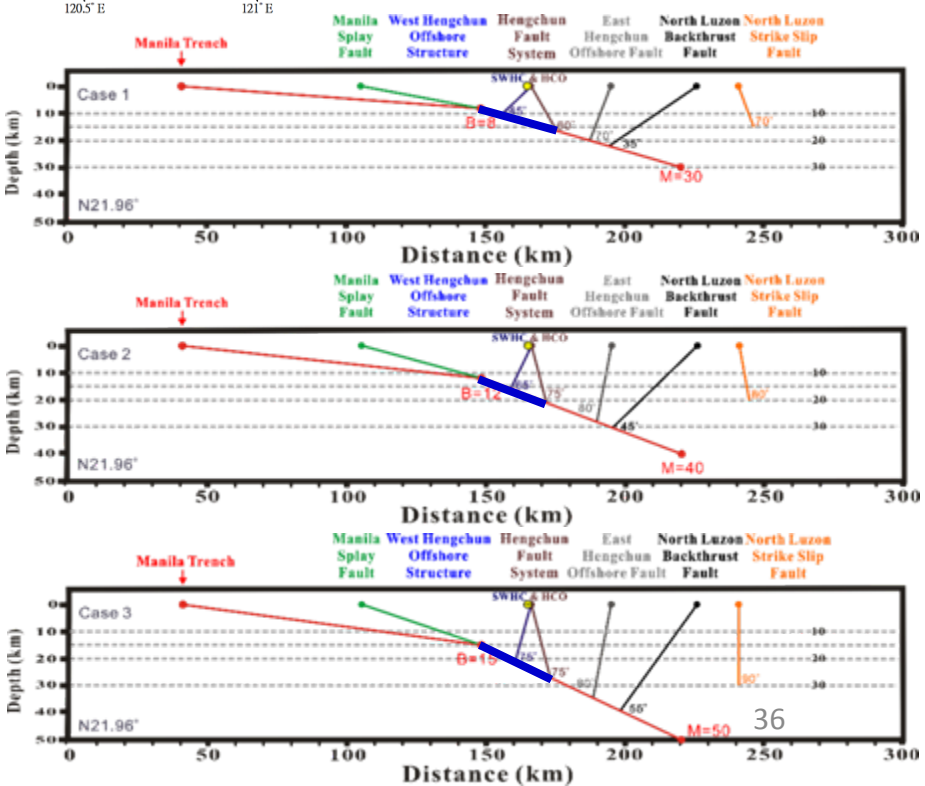
WM #3





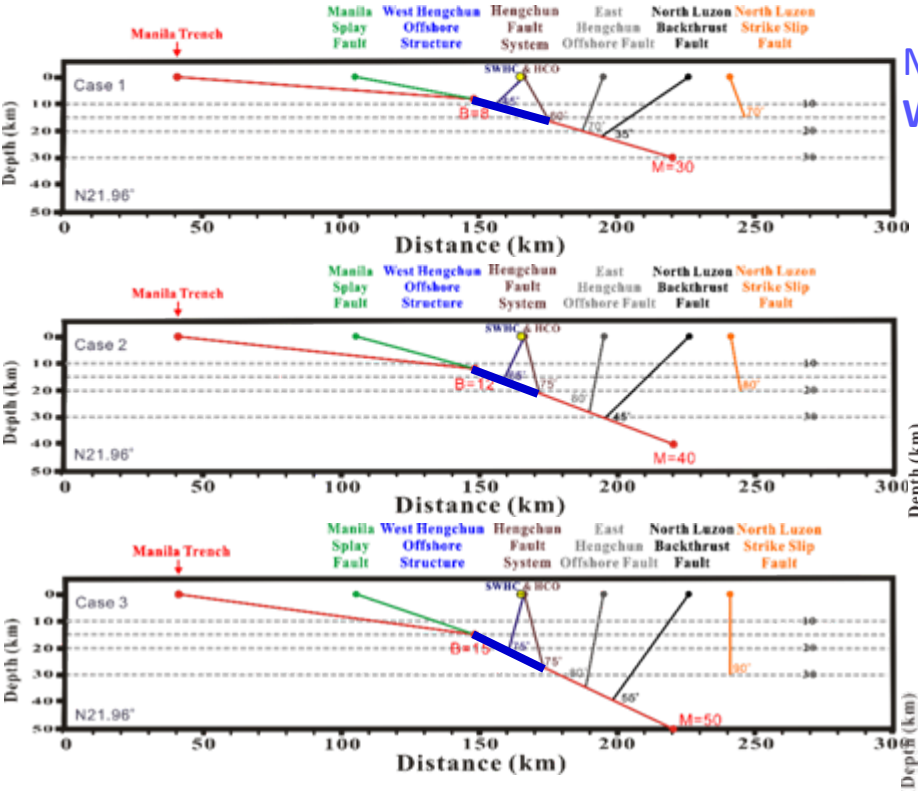
From Lettis LCI, 2015





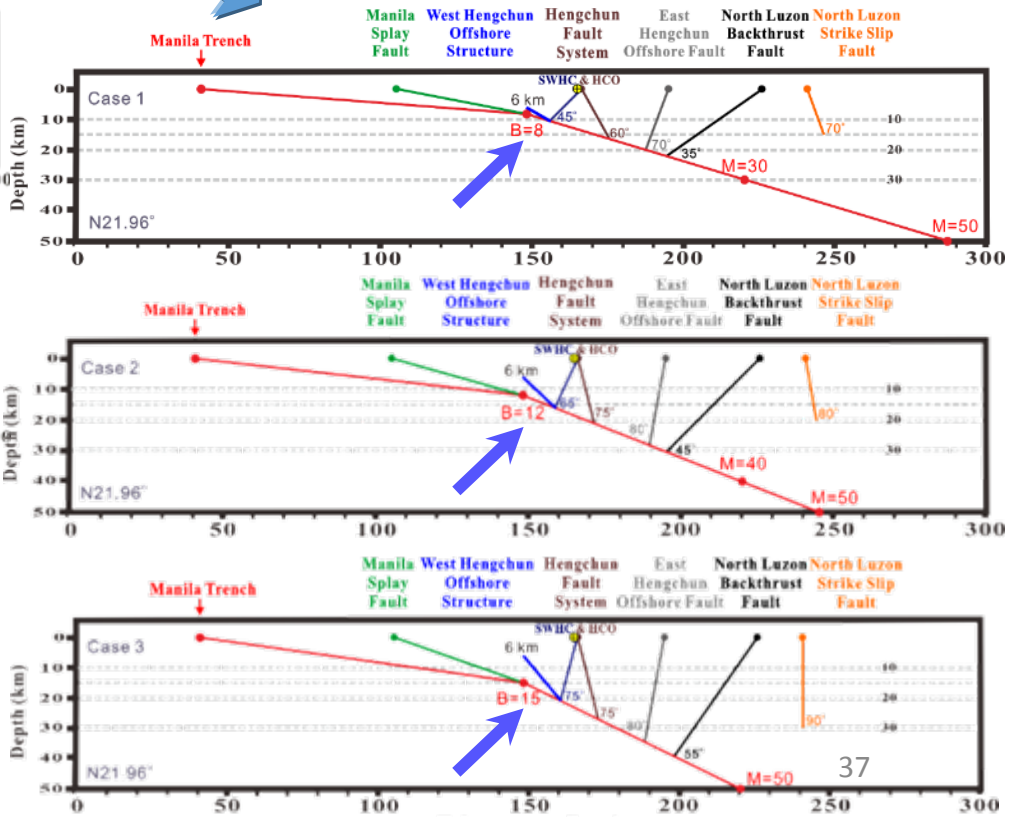
Fault geometry -West Hengchun Offshore Structure

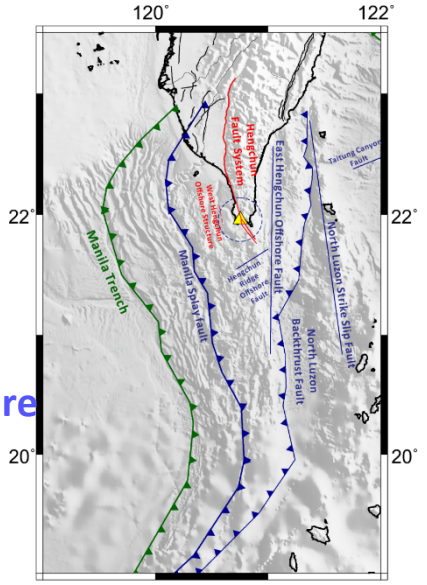
WM #3

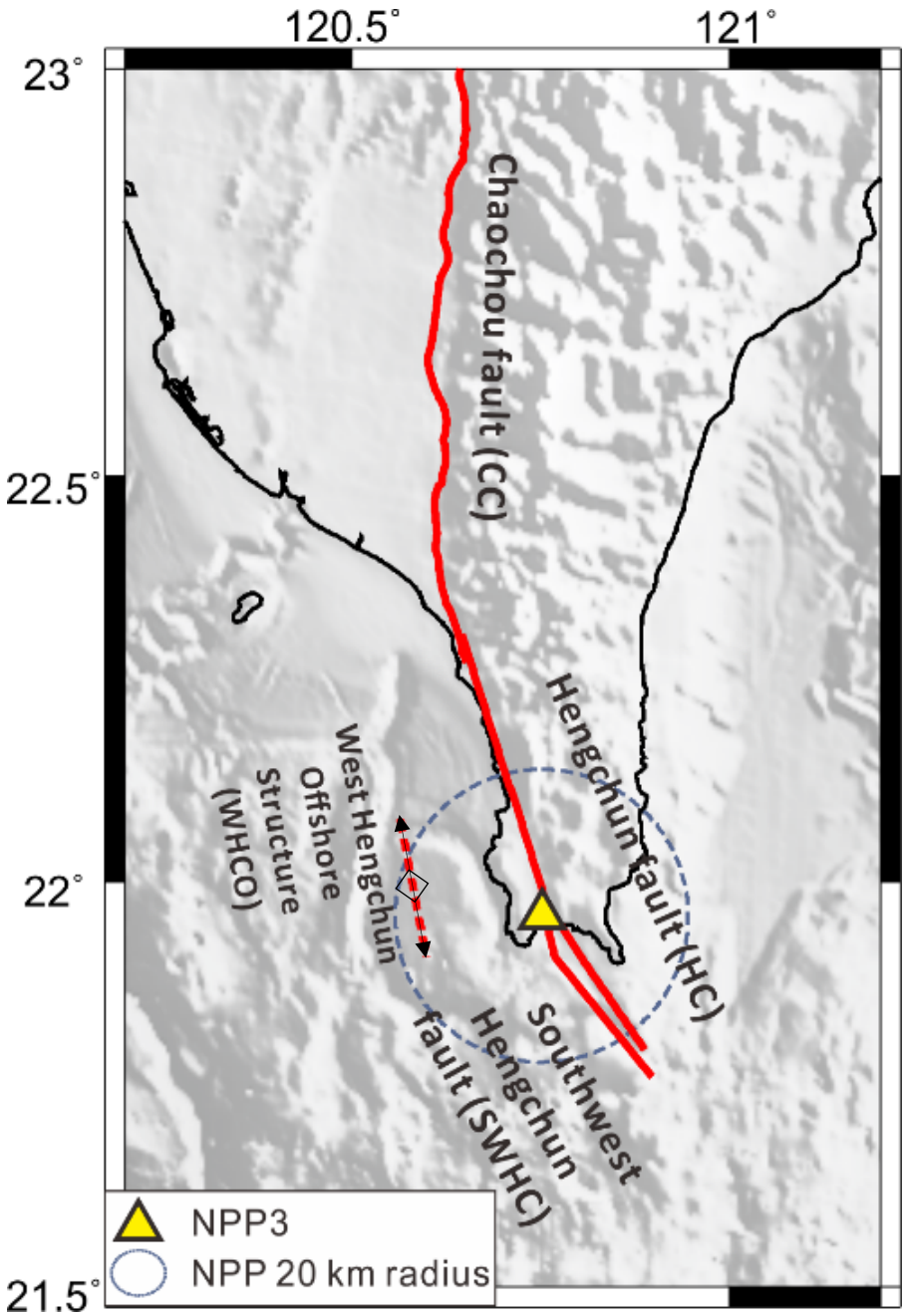


Modify the geometry of
West Hengchun Offshore Structure

WS #3






120.5°
121°
23°
22.5°
22°
21.5°
Chaochou fault (CC)
Hengchun fault (HC)
West Hengchun Offshore Structure (WHCO)
Southwest Hengchun fault (SWHC)
NPP3
NPP 20 km radius