

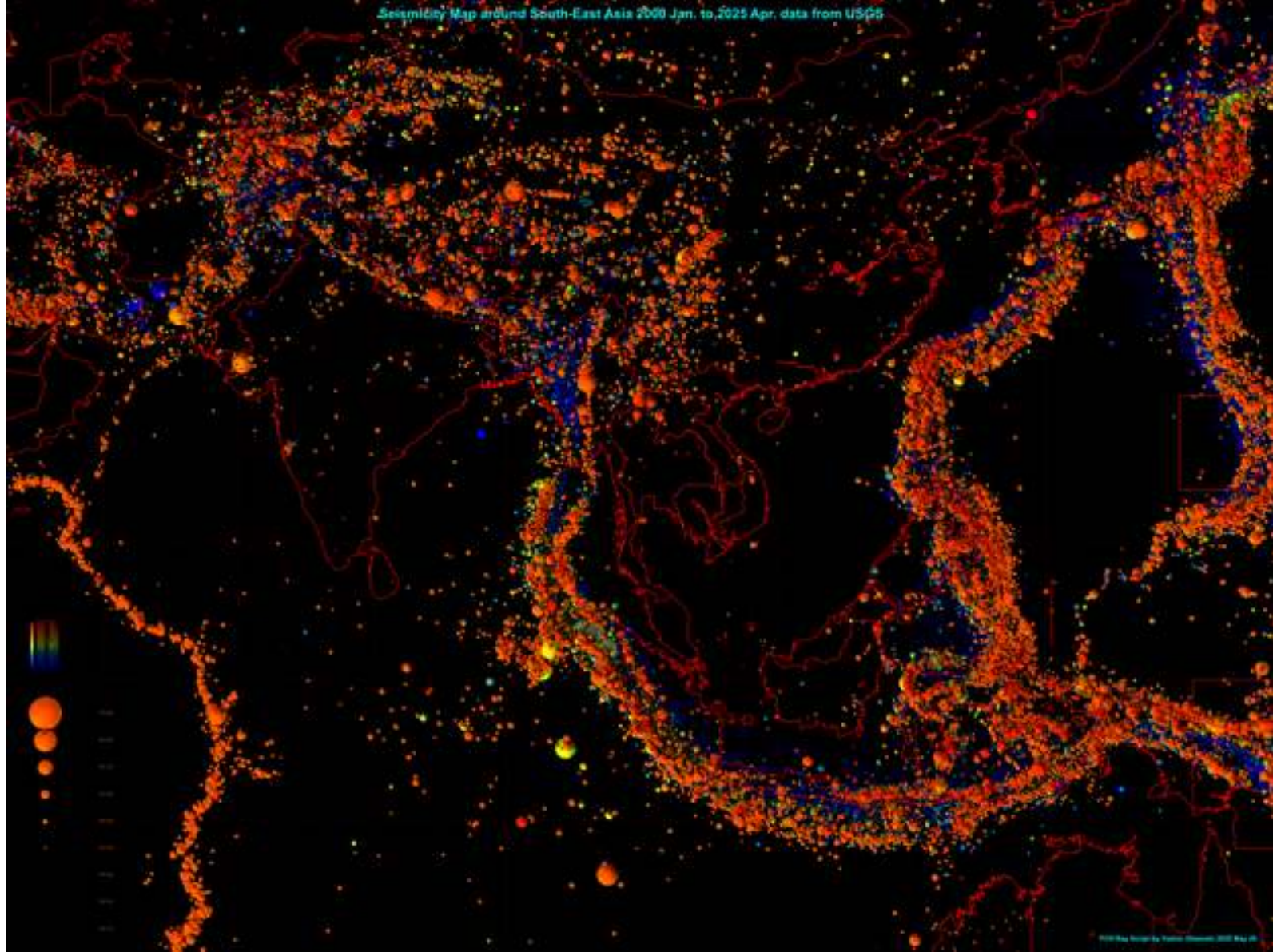
Hands-on Earthquake Education in a Low-Seismicity Country: Science High Schools in Thailand Following the 2025 Myanmar Earthquake

Yoshio Okamoto
(Retired geoscience teacher)

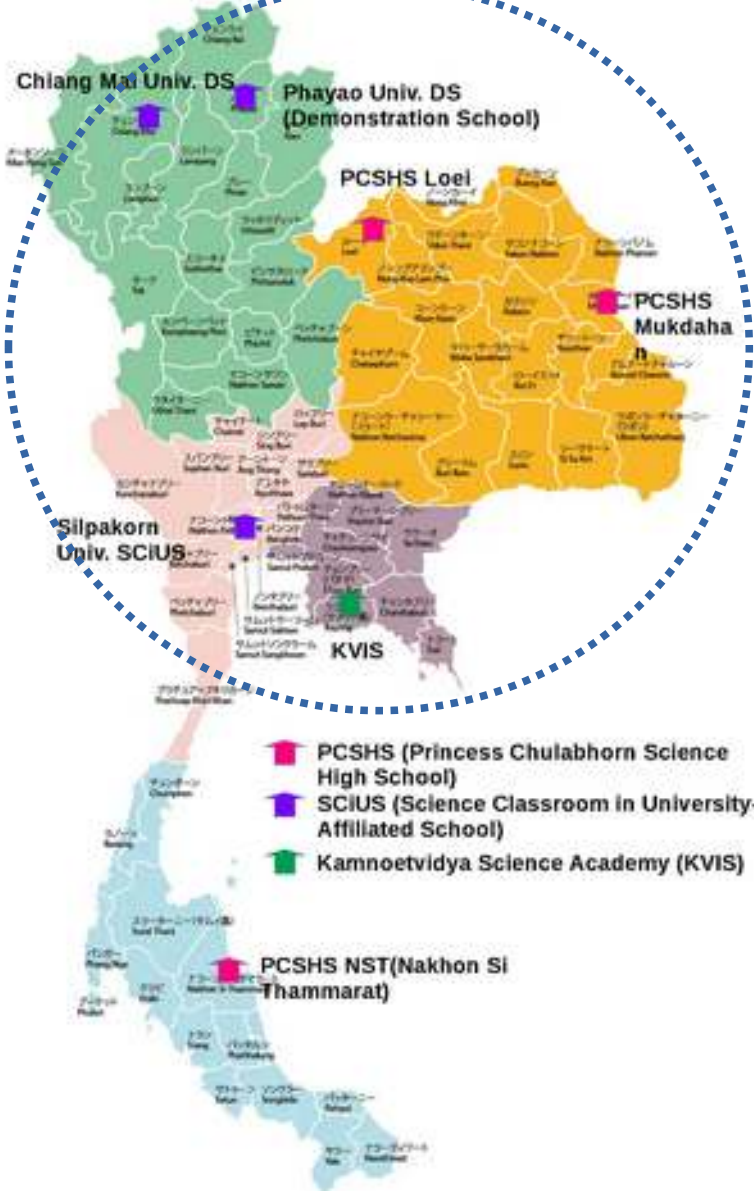
<http://www.yossi-okamoto.net/>
yossi.okamoto@gmail.com

At JpGU2026

Seismicity Map around South-East Asia 2000 Jan. to 2025 Apr. data from USGS



Since retiring from teaching at high schools and universities in Japan, I have occasionally given **guest lectures at Science High Schools and Universities in Thailand.**



At Phayao Univ. DS: The students who felt The 2025 Myanmar Eq. are raising their hand.

Outline of my Special Lecture at Thailand Science High-schools

- 90min+90min = 180 min lecture for 30 to 50 students for 10th grade (each four science highschools: Phayao Univ.DS, Silpakorn Univ. DS, PCSHS Loei, 2025 Dec. to 2026 Jan.)

- Teaching language: English

- The lecture consists of three parts

Part 1: Why Bangkok experienced strong shaking despite its distance from the epicenter (1000km apart from)?

Part 2: A student exercise of locating the epicenter using S-P times.

Part 3: A review focused on seismic hazards in Northern Thailand, primarily from a paleo-seismological perspective.

Part 1: Why Bangkok experienced strong shaking despite its far distance from the epicenter?

(1) **Amplification within the soft Bangkok Basin**

(2) Relatively **low energy loss** along the propagation path
(scattering and wave dispersion)

(3) Characteristics of the **earthquake source**.

- **Students learned that ground motion can largely be explained by linear wave theory**
- **While rupture processes and building collapse involve nonlinear behavior, making precise earthquake prediction very difficult.**

My hand-made seismograph at Thailand Science high-school



PCSHS Mukdahan, Thailand 2025

A seismometer recording showing seismic waves on a grid background. The waves are multi-colored (purple, blue, green, yellow) and show a distinct arrival pattern. A hand is visible in the foreground, pointing towards the recording.

A biology teacher Baramade Simphom heard the news at first, then rushing into this Seismometer room, and he and students watched these waves with no shaking. So he took this video!

The waves just arrived at
PCSHS Mukdahan
on 28 Mar. 2025



10min video recorded by
Dr.Chachawal (Phayao Univ.)



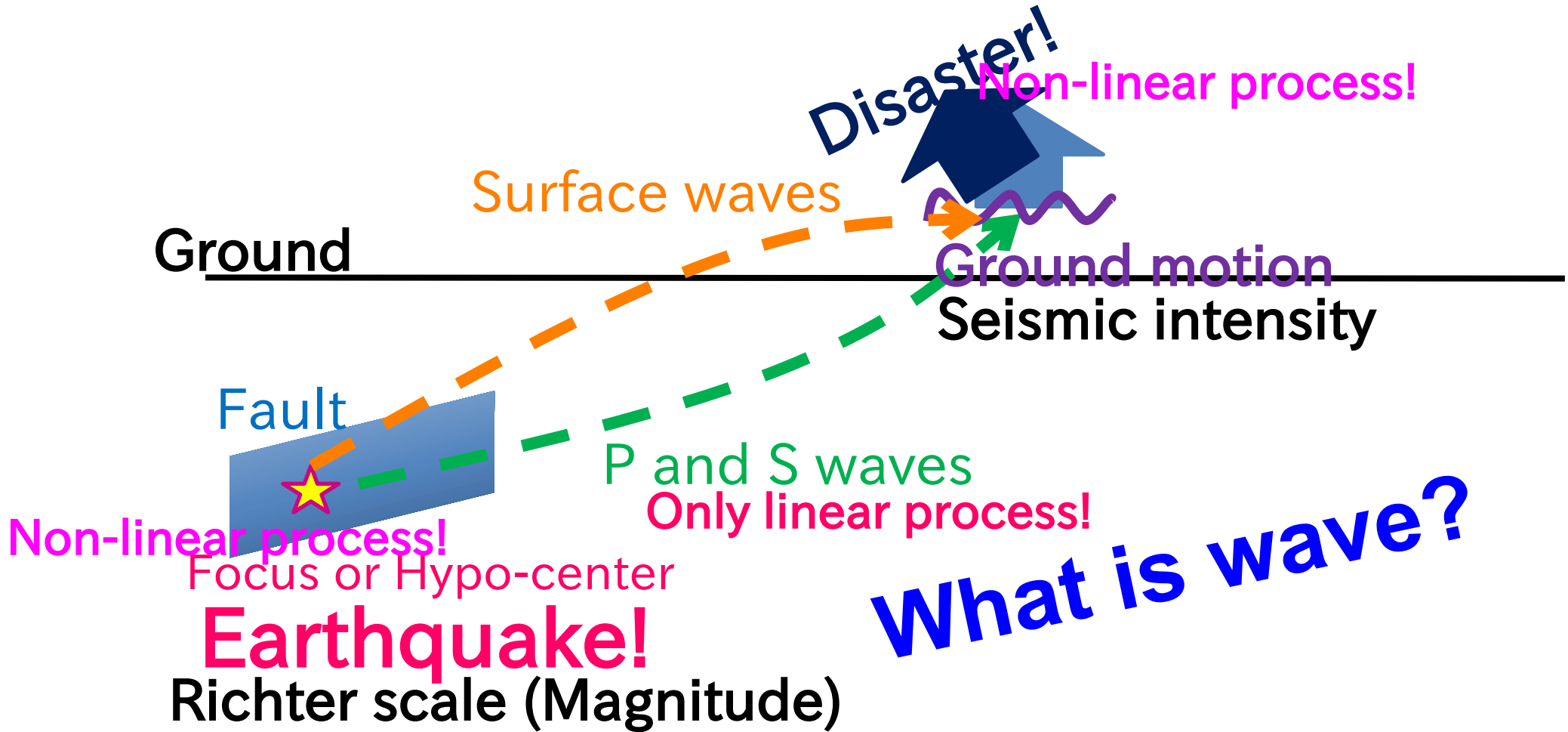
www.youtube.com/shorts/fXUPI8_BPz



[WukpxZE3PA](https://www.youtube.com/shorts/WukpxZE3PA)

https://www.youtube.com/shorts/fXUPI8_BPz

Earthquake: cause and result



Why **Strong Shaking** Was Observed in **Bangkok**, Thailand (Approx. 1,000 km from the Epicenter)?

1. **Site-Specific**

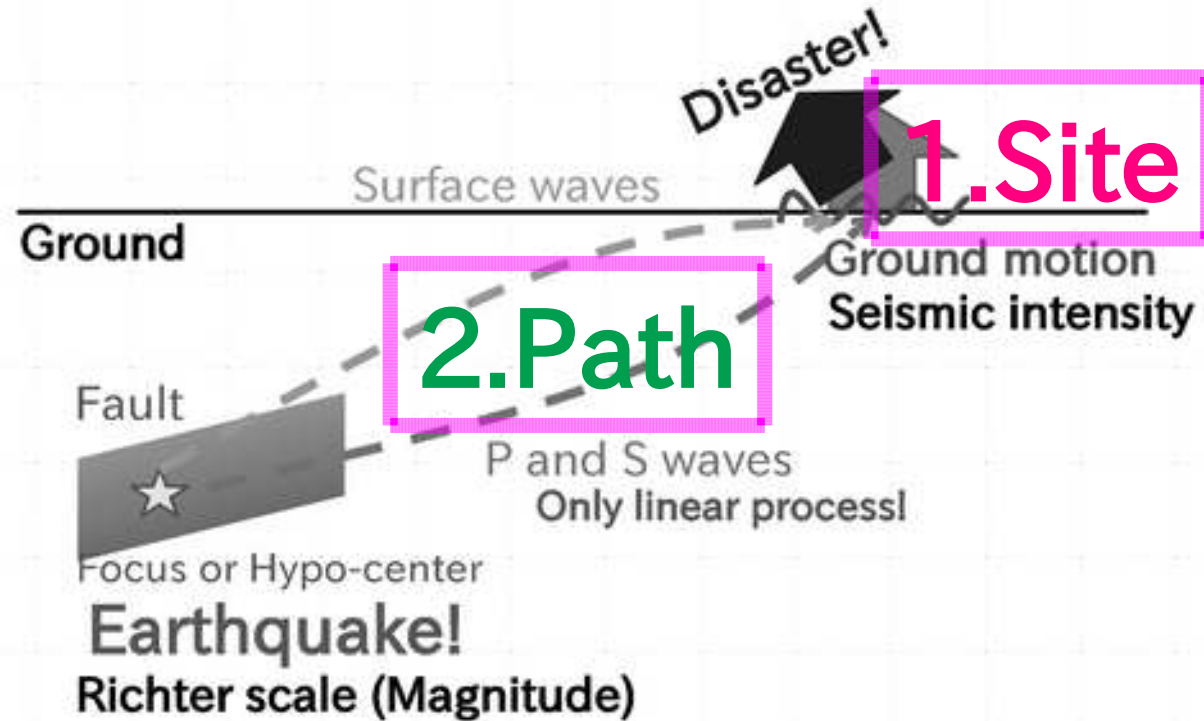
Amplification: The Bangkok Basin Effect

2. **Path: Low**

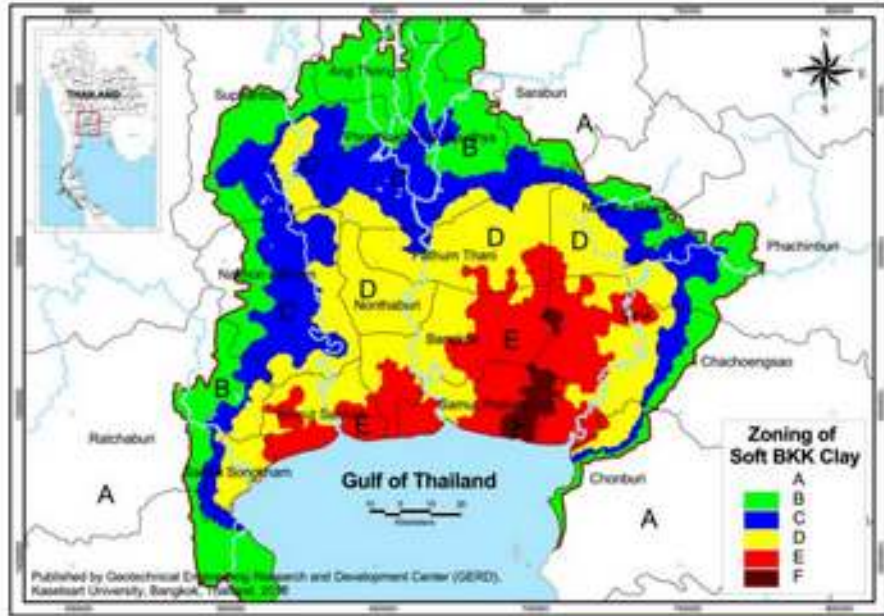
Attenuation Rate (Long-Distance Wave Propagation)

3. **Source**

Characteristics: Directivity and Supershear Rupture



3.Source



soft clay > 18 m.
 $W_n > 100\%$
 $LL > 100\%$
 $PI > 60\%$
 $\gamma_t < 1.45 \text{ t/m}^3$

soft clay 14-18 m.
 $W_n 80-100\%$
 $LL 80-100\%$
 $PI 50-60\%$
 $\gamma_t 1.45-1.55 \text{ t/m}^3$

soft clay 10-14 m.
 $W_n 60-80\%$
 $LL 60-80\%$
 $PI 30-50\%$
 $\gamma_t 1.55-1.65 \text{ t/m}^3$

soft clay 0-3 m.
 $W_n 0-20\%$
 $LL 0-20\%$
 $PI 5-10\%$
 $\gamma_t 1.85-2.15 \text{ t/m}^3$ **A**

soft clay 3-6 m.
 $W_n 20-40\%$
 $LL 20-40\%$
 $PI 10-20\%$
 $\gamma_t 1.75-1.85 \text{ t/m}^3$ **B**

soft clay 6-10 m.
 $W_n 40-60\%$
 $LL 40-60\%$
 $PI 20-30\%$
 $\gamma_t 1.65-1.75 \text{ t/m}^3$

Fig.15 Zoning of Soft Bangkok Clay

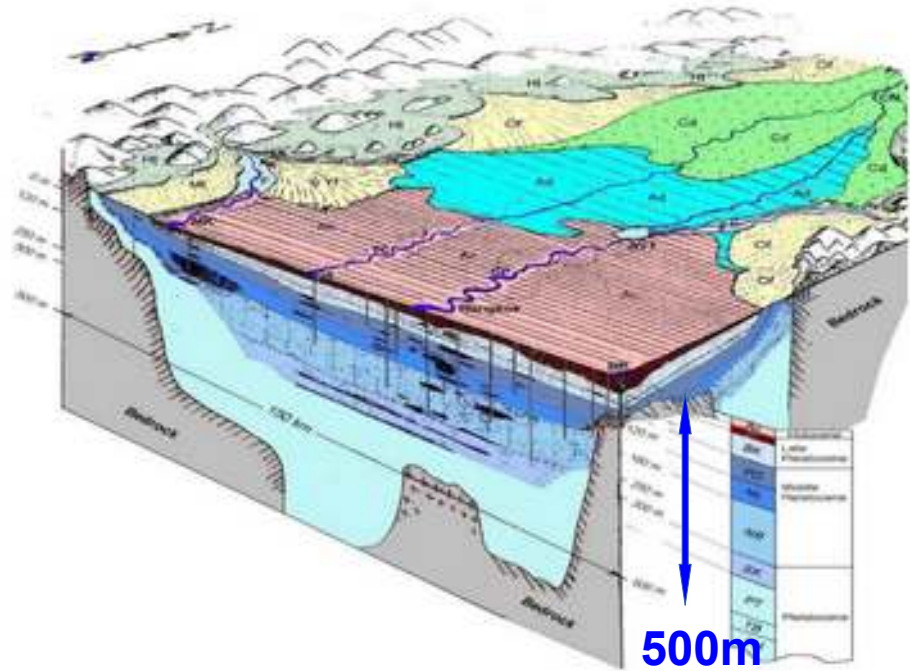


Fig.7 Schematic cross-section of lower Chao Phraya Basin (JICA, 1999)

Warakorn Mairaing and Cherdpun Amonkul
 (2010)

Teraphan Ornthammarath et. al.
 2025

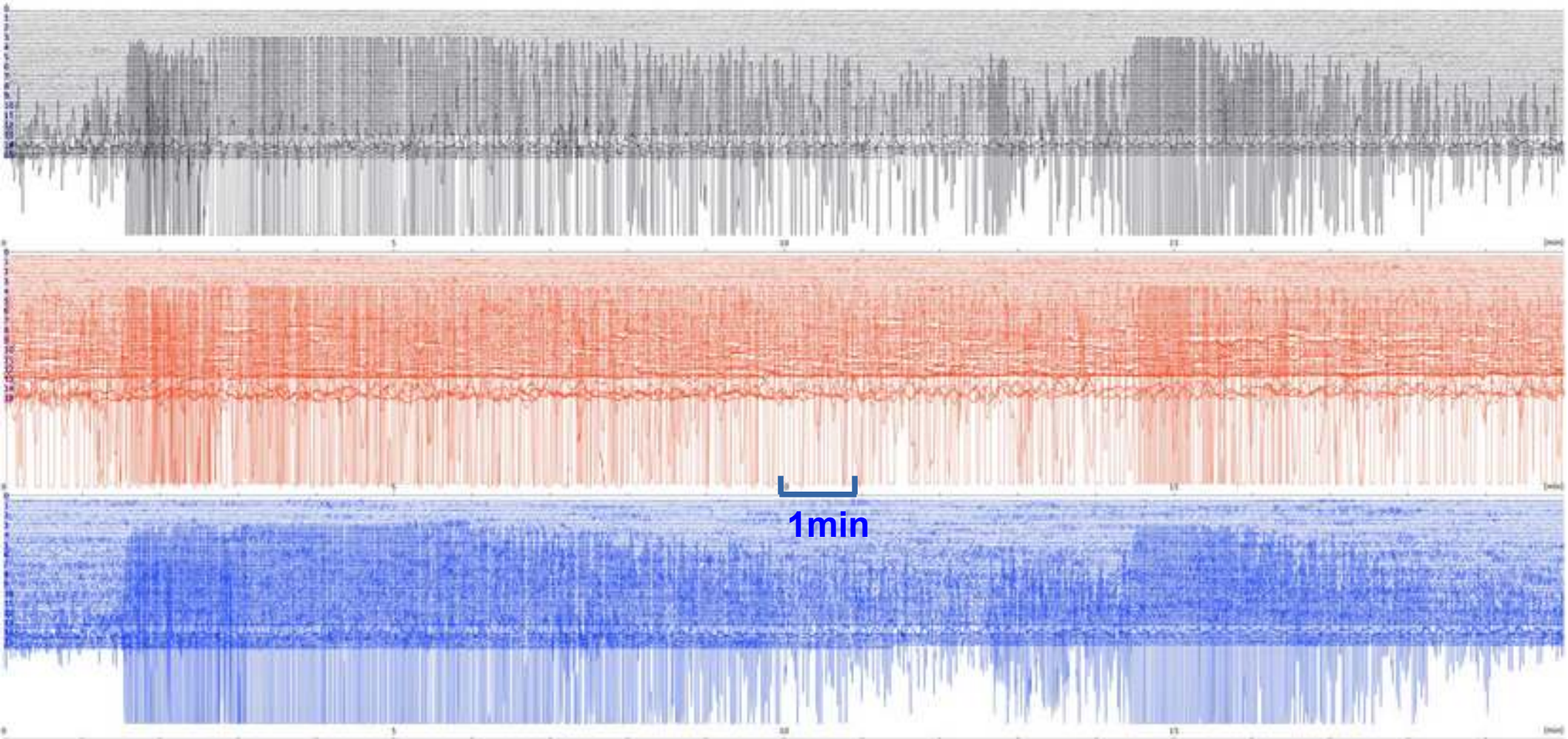
https://www.gerd.eng.ku.ac.th/Paper/Paper_Other/Mairaing/%28EIT-Japan%29Soft%20Bangkok%20Clay%20Zoning.pdf



Our seismographs in Thailand
Prof. Ohm and our seismographs at Silpakorn Univ.
Physics Labo.

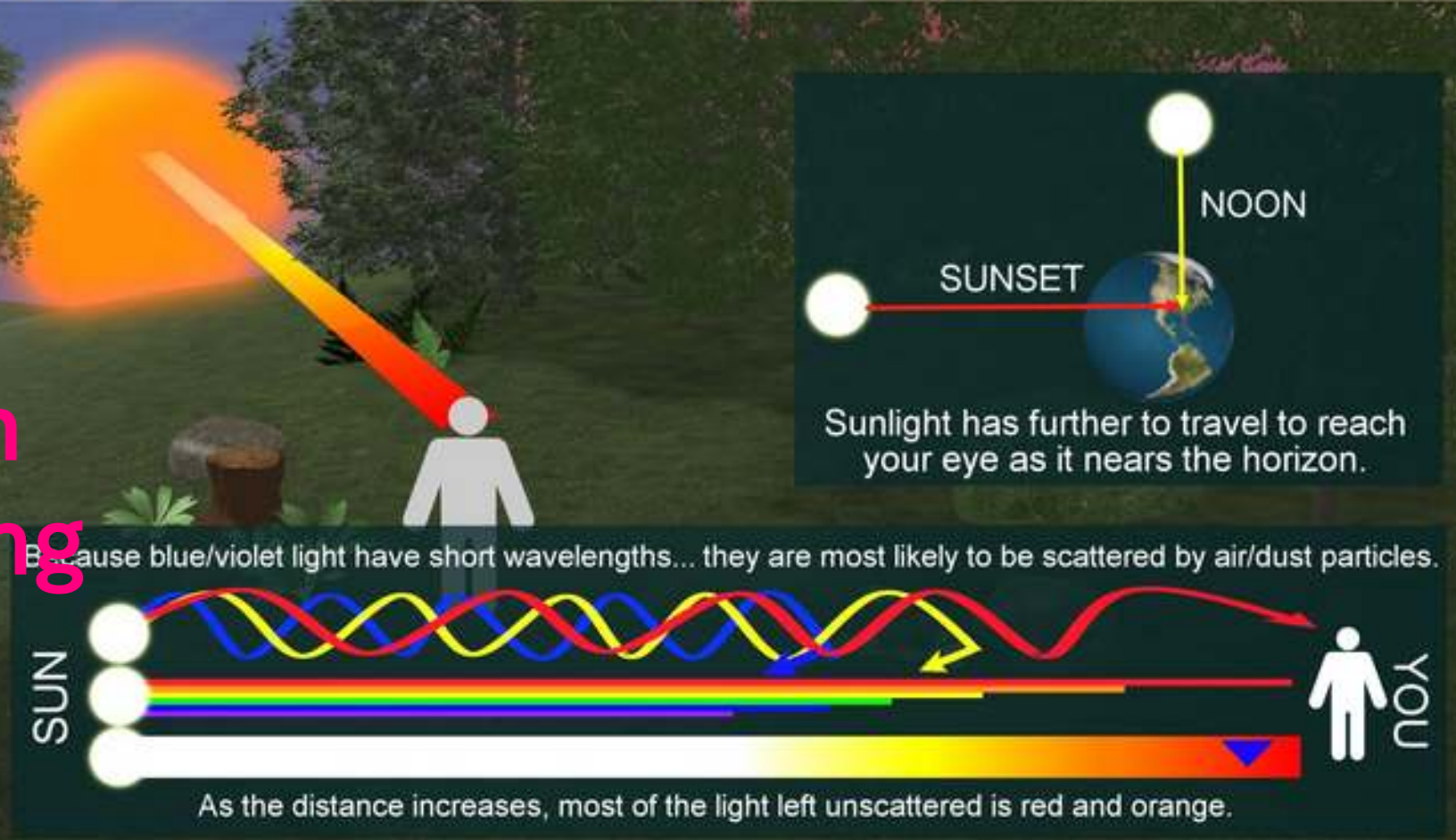
One day record at Silpakorn Univ. Nakhon Pathom Thailand

SI_33h_32Hz1/romi/wegulf/Chattap/2021_Sep/ML_2021/01128



WHY ARE SUNSETS REDDISH?

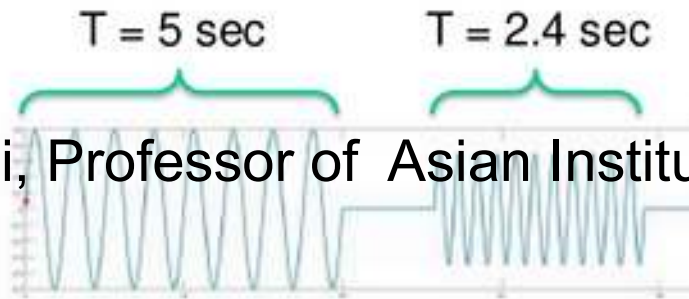
Rayleigh
scattering



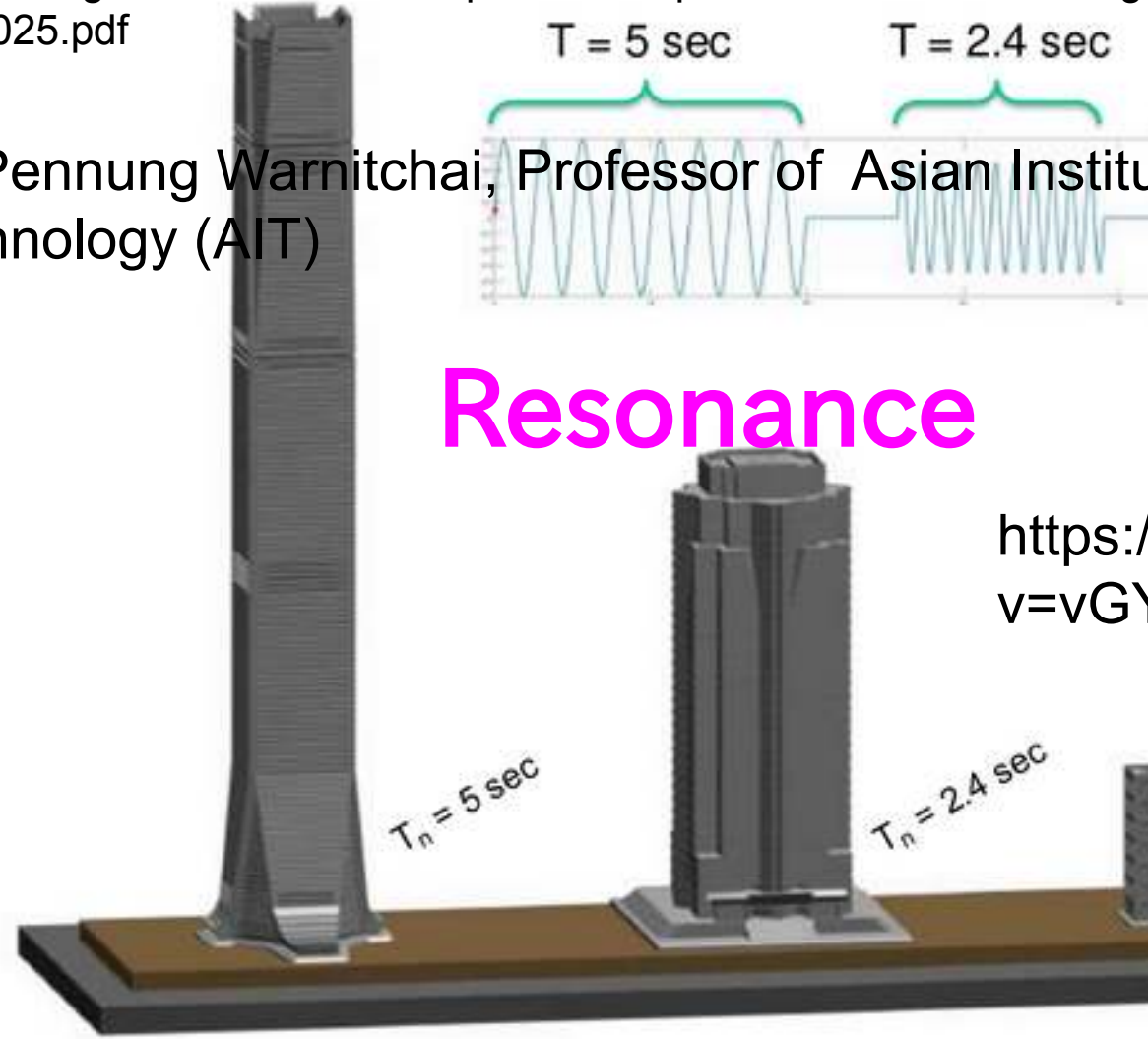
Resonance Effect

<https://peeringforum.bknix.co.th/wp-content/uploads/2025/05/1.0-Bangkok-22May2025.pdf>

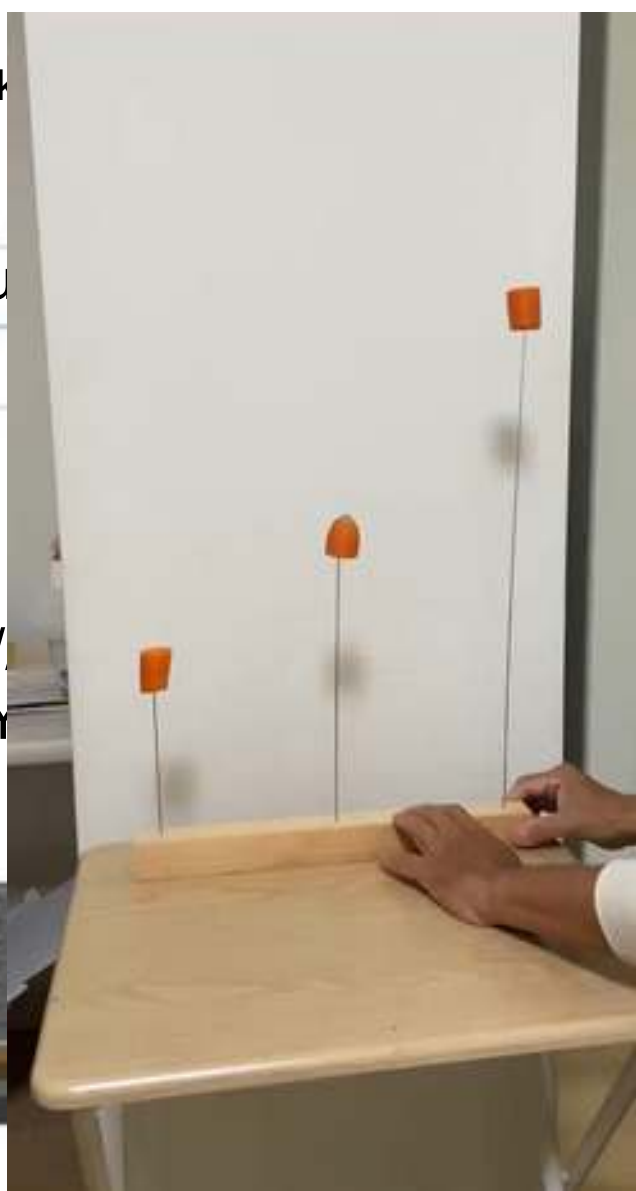
By Pennung Warnitchai, Professor of Asian Institute of Technology (AIT)



Resonance

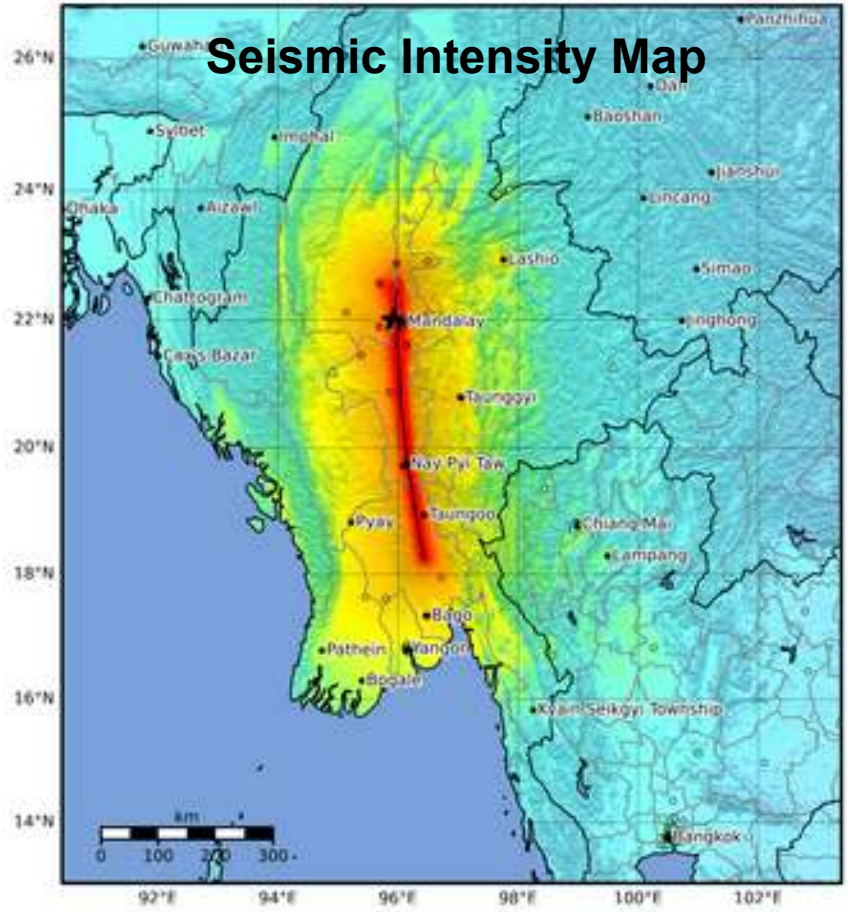


<https://v=vGY>



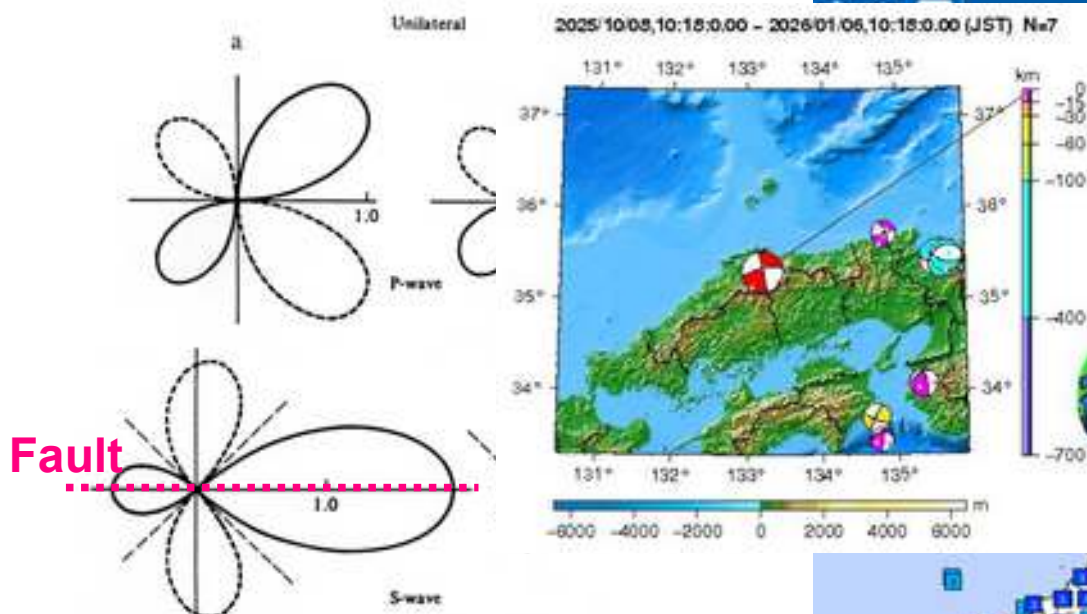
n?

From USGS Web Site



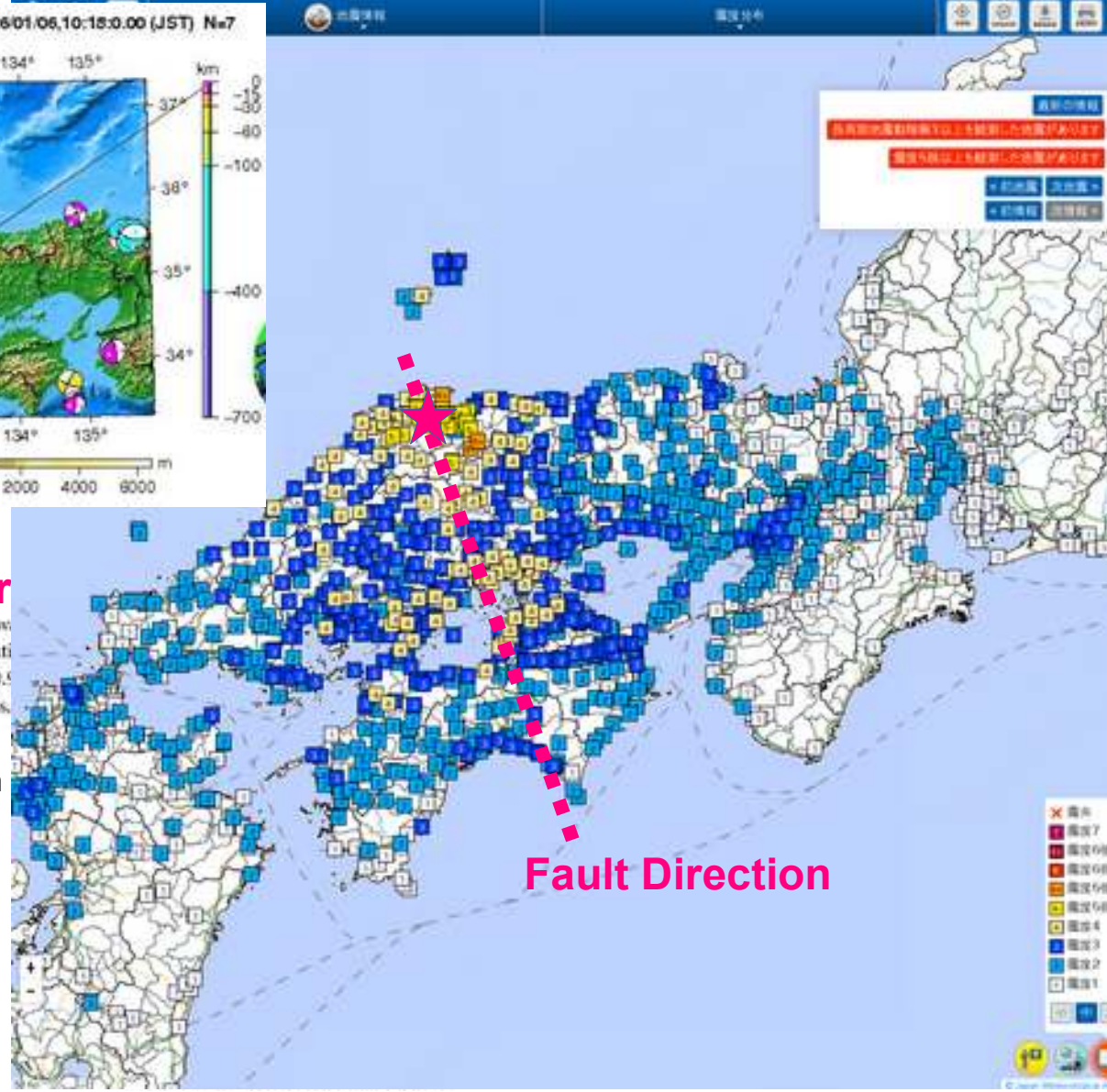
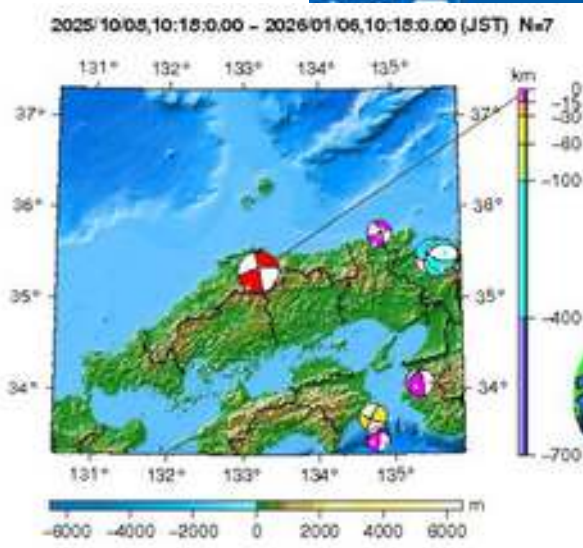
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.046	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X

Scale based on Worden et al. (2012) Version 21: Processed 2025-04-16T05:13:29Z
 Δ Seismic Instrument ○ Reported Intensity ★ Epicenter □ Rupture



Fault

S-wave radiation pattern

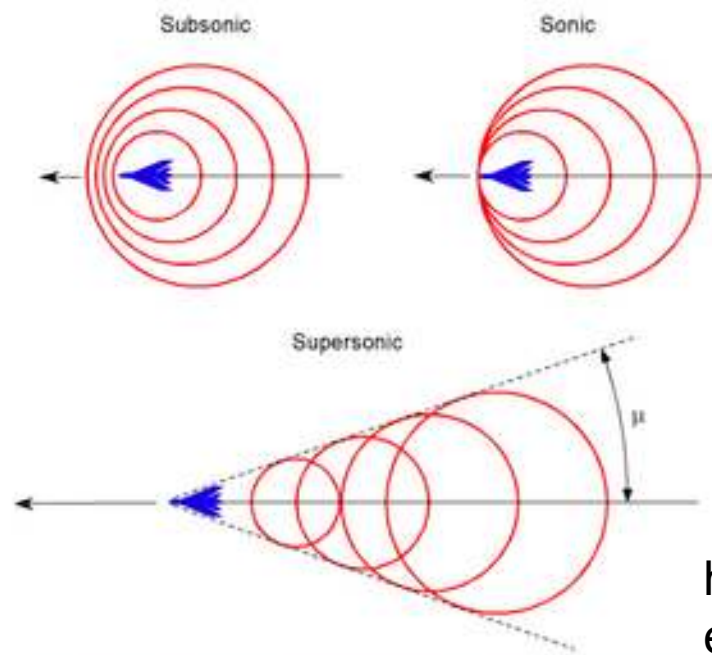


Fault Direction

FIGURE 5.4 Radiation pattern showing the variability of compressional and horizontal shear-wave motion from a fault rupture propagating from left to right. The diagrams on the left are for a rupture propagation velocity of 1.0 times the shear-wave velocity and those on the right are for a rupture propagation velocity of 0.5 times the shear-wave velocity. (From Lay, T. and Wallace, T.C. 1995. *Modern Global Seismology*, Academic Press, permission.)

From
Campbell_Engineering_models_of_strong_ground_motion

Directivity



<https://hiroike.hida-ch.com/e1077578.html>

As an airplane approaches the speed of sound, pressure waves merge ahead of it, and at supersonic speeds, a Mach cone forms at the nose.

Supersonic Shock Wave

<https://eaglepubs.erau.edu/introductiontoaerospaceflightvehicles/chapter/supersonic-flight-vehicles/>

Supershear Rupture

https://www.youtube.com/shorts/Wk9QVPk_IpQ

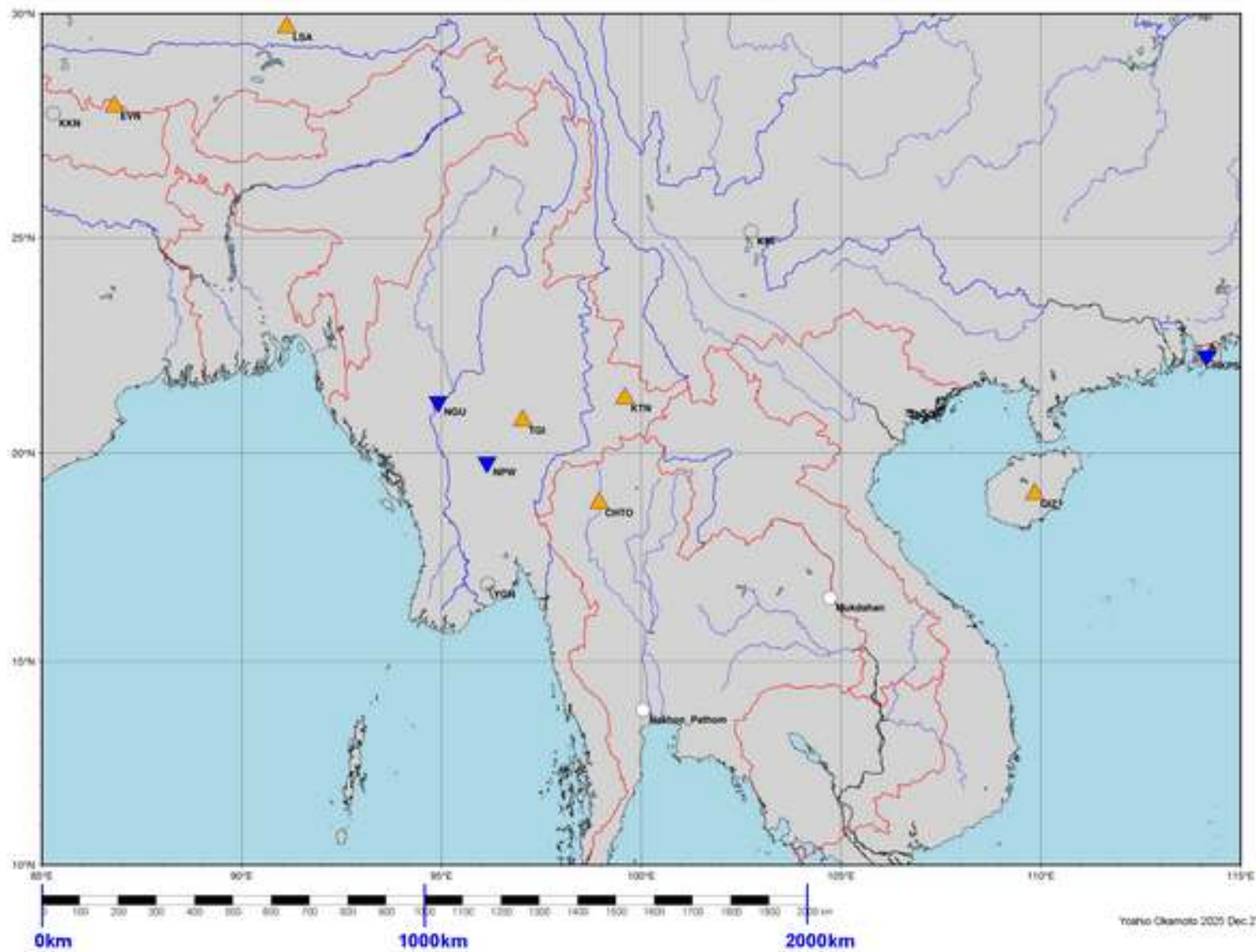


Phayao Univ.DS

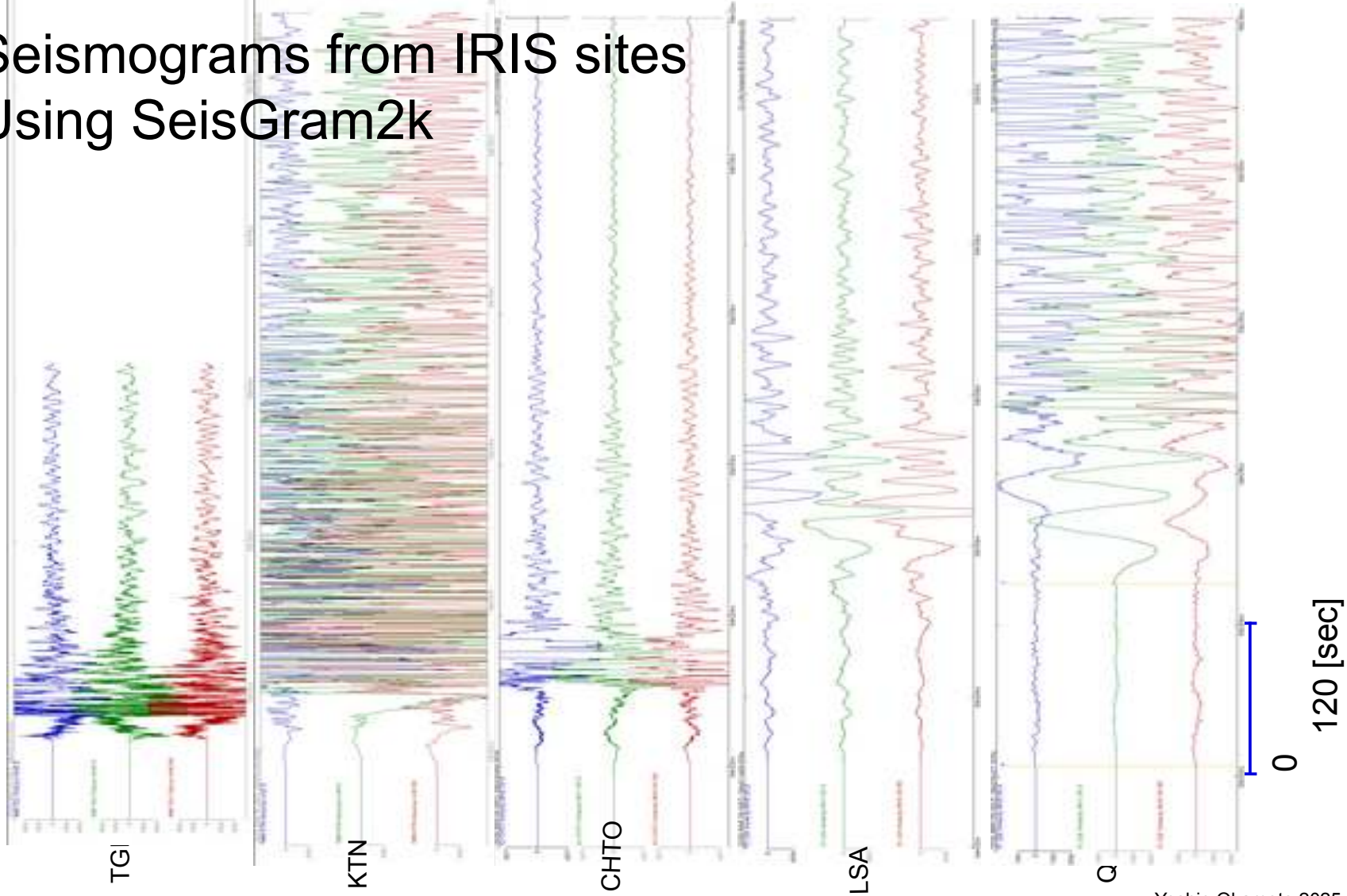
Part 2

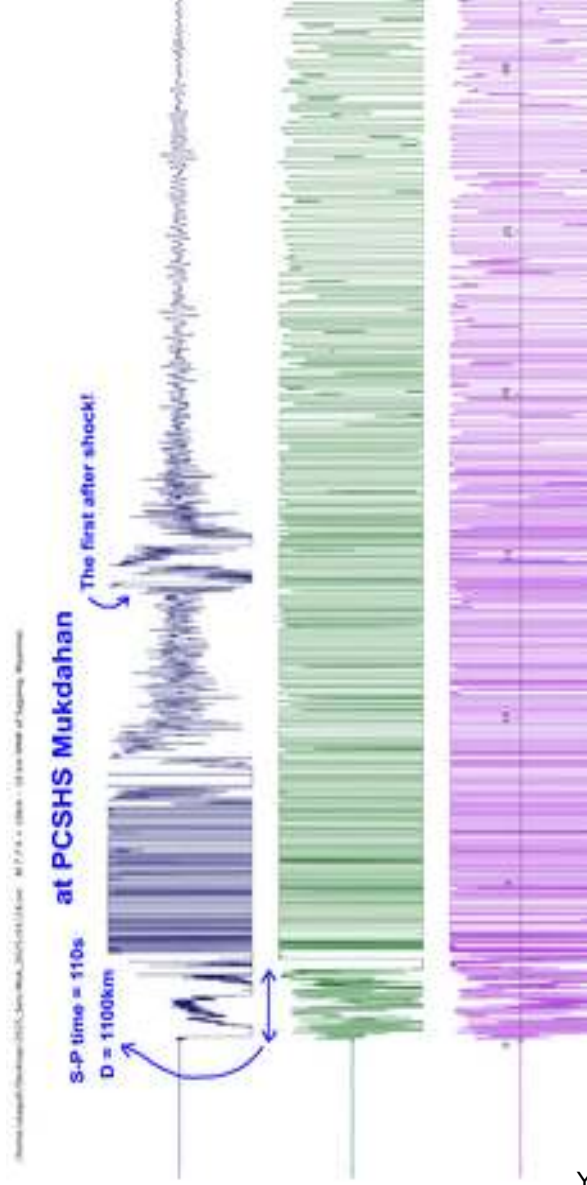
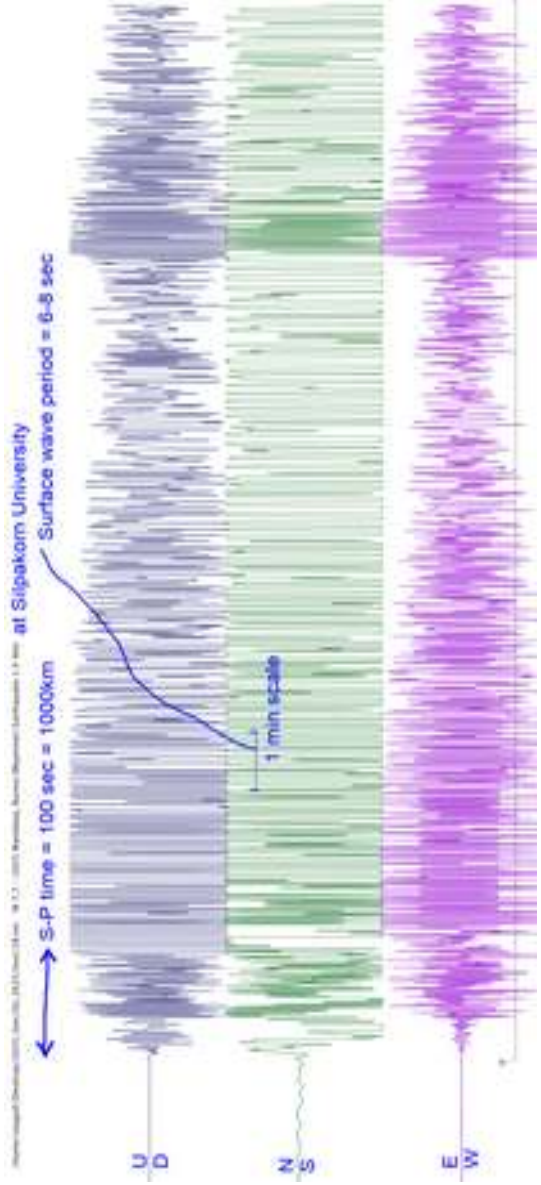
Epicenter-finding

SE Asia Seismic Stations Mapv3



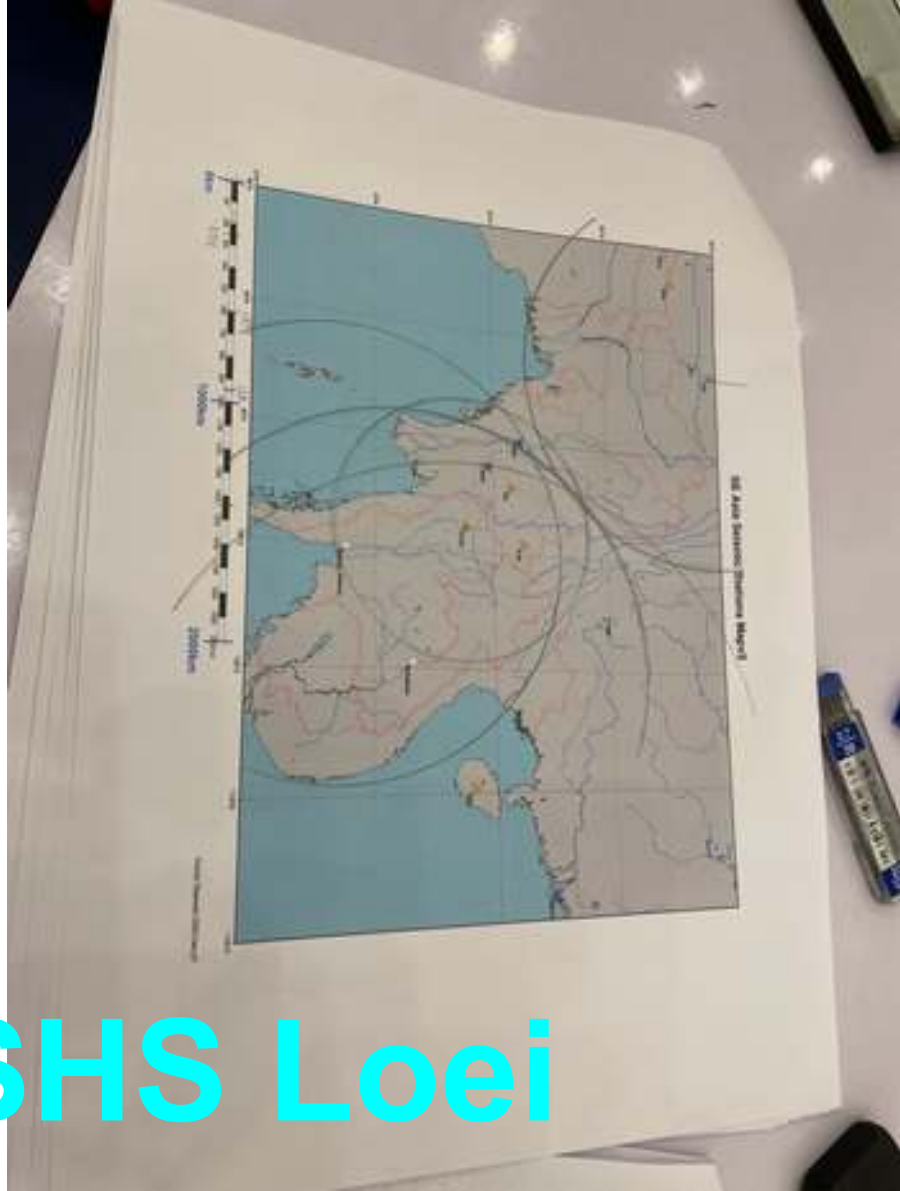
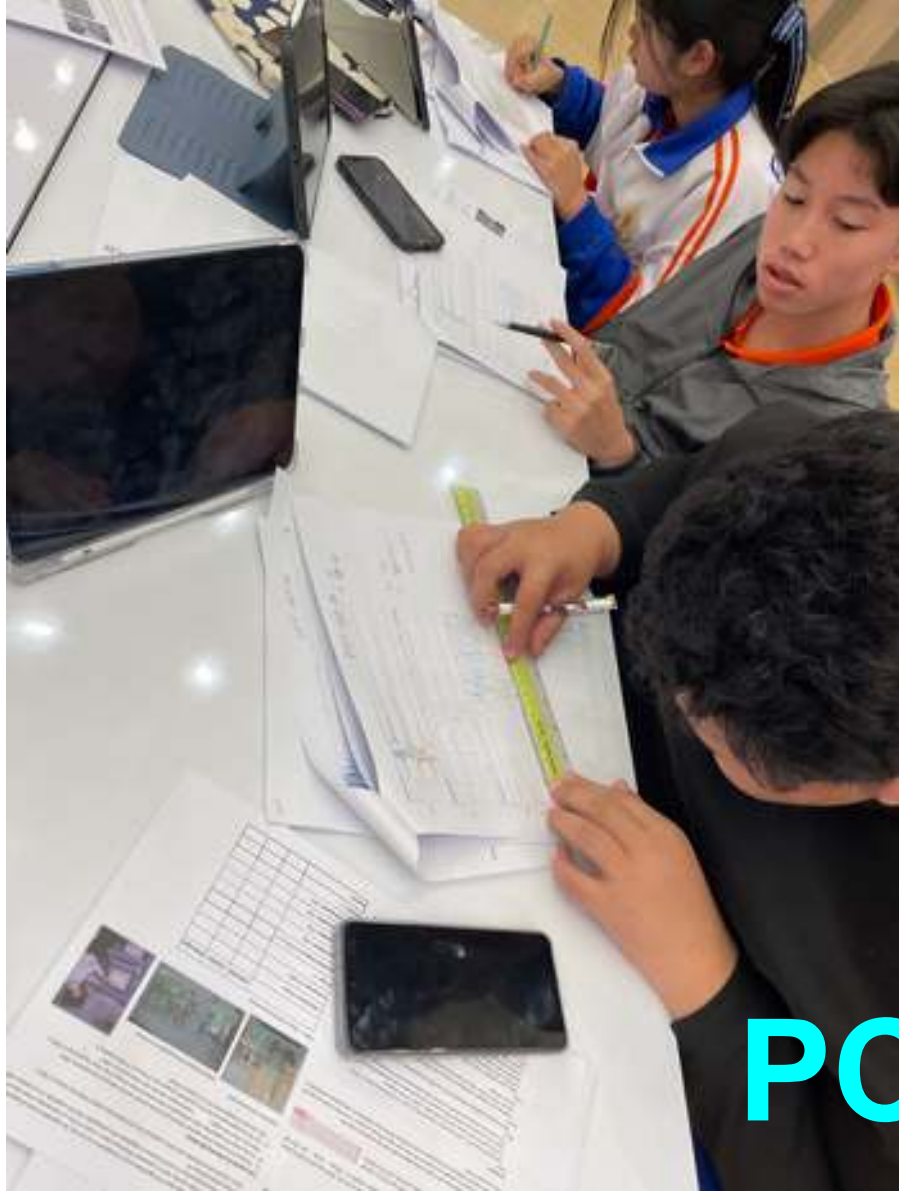
Seismograms from IRIS sites Using SeisGram2k





OBS	S-P Time[s]	Omori K[km/s]	Distance[km]
TGI			
KTN			
CHTO			
LSA			
QIZ	144	10	
Silpakorn Univ	100	10	
PCSHS Muk	110	10	

**My handmade seismographs
At PCSHS Mukdahan and
Silpakorn University**



PCSHS Loei

Part 3

Earthquakes around Northern Thailand

Past – Present - Future

Paleoseismology;

How to know historical earthquakes?

- Old documents and records
- Archaeological study about remaining ruins
- Traces of Fault Activity Left in the Terrain
→ Remote sensing etc.
- Trench or road-cut survey and Optically Stimulated Luminescence (OSL) dating.
- Etc.

The key to the future is the past!

Table 1. Historical and instrumental earthquakes reported in Chiang Saen since 624 B.C. with observed damage. Approximated distance to Chiang Saen from instrumental earthquakes has been determined from rupture area of past studies.

no.	date	maximum estimated distance (km)	description
Historical earthquakes:			
1	624 B.C.	VI [9]	earthquakes, thunder, mountains trembled violently, people's hair stood on end, no damage is mentioned
2	623 B.C.	VI [9]	earthquakes, thunder, mountains trembled, heavy rain, no damage is mentioned
3	594 B.C.	VI [9]	earthquakes, thunder, mountains trembled, no damage is mentioned
4	589 B.C.	VI [9]	earthquakes, thunder, mountains trembled more intensely than during the first three earthquakes, no damage is mentioned
5	460	XII [9]	In the evening, the Earth trembled violently and loudly once; in the middle of the night, it shook once more; late that night, the tremor hit again; the whole town submerged and became a big lake; the king and all of his subjects died except one old widow
6	534	VIII [9]	four pagodas were toppled, thunder
7	1775	VIII [9]	earthquakes occurred; the finials of four jeds broke off and fell down in four districts and were destroyed; the Earth trembled throughout that month before Christmas day
Instrumental earthquakes:			
8	16 May 2007 (distance, 75 km)	IV [10]	in the Chiang Saen district, bricks and cement were dislodged from the Chedi Luang Pagoda. A spire on the top of Wat Phra That Jenkhai Pagoda and the spire of the top of Wat Phra That Jenkhai Pagoda were damaged; the spire of the top of Wat Phra That Jenkhai Pagoda was damaged
9	24 Mar 2011 (distance, 46 km)	VI [1,3]	a spire on the top of Chedi Luang fell down causing additional damage to the nearby stone structure
10	5 May 2014 (distance, 79 km)	IV [2,10]	cracks developed at the top of Chedi Luang

Only religious ancient documents of questionable reliability remain.!

Table 3. Recorded ground motion from Mw 6.1, 5 May 2014 Mae Lao earthquake with their National Earthquake Hazards Reduction Program (NEHRP) site class. (Online version in colour.)

station	NEHRP site class	R _{jb} (km)	distance to Chiang Saen (km)	ground motion		
				PGA (g)	PGV (cm s ⁻¹)	DS-DHS (s)
MEAU	D	38	29	0.04	2.5	79.5

Table 4. Summary of observed damage to ancient monuments from 2011 Tarlay earthquake.

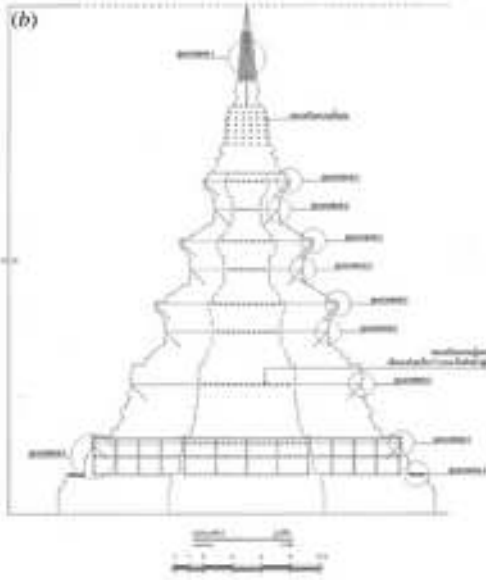
	Chedi Luang	Chedi Prasak	Pu Khao Temple	Chedi Prasak Khum
damage state	moderate	partial	moderate	moderate
structural type	stupa	stupa	arch and masonry solid core load bearing system	stupa
construction period	fourteenth century	fourteenth century	fourteenth century	seventeenth century
height (m)	35	21	4	8
ground floor solid core (m)	9	11	4	2.5
height/solid core width ratio	3.88 (35/9)	1.9 (21/11)	1 (4/4)	3.2 (8/2.5)
				8
				1



Table 7. List of different earthquake scenarios from five major active faults near Chiang Saen considered in this study.

no.	fault name	Rrup (km)	Mw (rupture-length, km)		
			scenario 1	scenario 2	scenario 3
1	Mae Chan	5	6.8 (29 km)	7.5 (150 km)	7.8 (230 km)
2	Mae Ing	41	7.1 (62 km)	7.5 (142 km)	—
3	Phayao	43	6.8 (29 km)	7.2 (65 km)	—
4	Nam Ma	46	6.8 (30 km)	7.5 (134 km)	7.8 (207 km)
5	Meng Xing	67	7.1 (51 km)	7.3 (81 km)	7.8 (237 km)

Seismic damage to ancient monuments in Chiang Saen (Northern Thailand), Ornthammarath, T. 2019



gments
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But this is limited after 14th century!

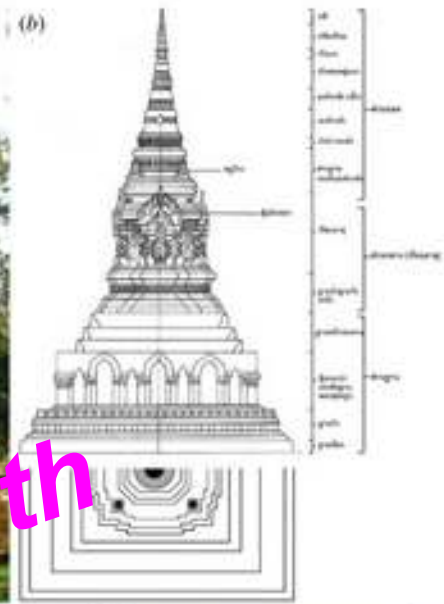
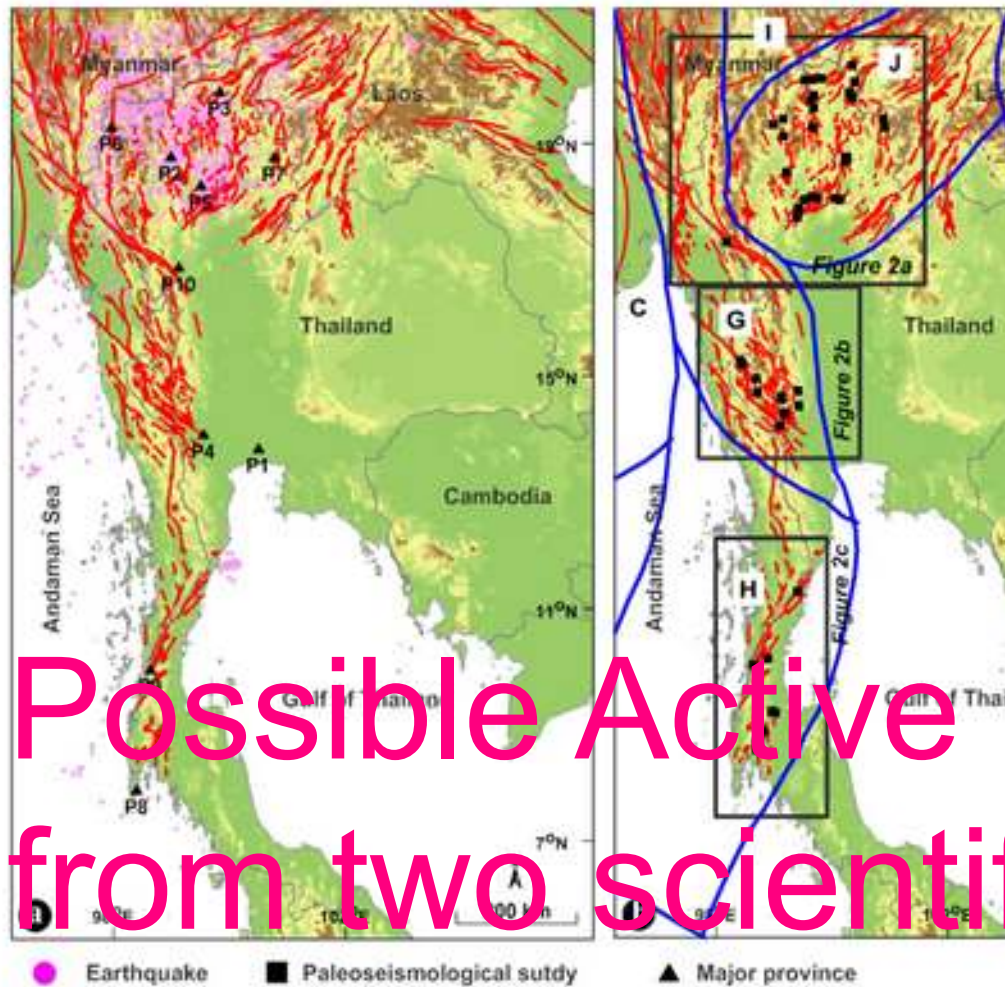


Figure 5. (a) Chedi Pasak before 2011 earthquake. (b) The schematic plot of Chedi Pasak in different layers. (c) Observed wide cracks at the lower top part. (d) Tilt could be clearly seen at the top spire following the 2011 earthquake in Myanmar located at 50 km to Chiang Saen. (Online version in colour.)

Figure 4. (a) The early photograph of Chedi Luang in 1957 (DOFA, 1979). (b) The schematic cross-section of Chedi Luang with reinstalled top spire in 2012. (c) The collapse of the 7-m spire due to the Mw 6.8 Tarlay earthquake in 2011. Its size is comparable to a person next to the toppled spire. A steel pipe could be clearly seen. (Online version in colour.)

Two scientific methods.

- 1) Traces of Fault Activity Left in the Terrain
→ Remote sensing etc.
- 2) Trench or road-cut survey and Optically Stimulated Luminescence (**OSL**) dating.



Possible Active Faults from two scientific surveys

Pailoplee and Charusiri *Earth, Planets and Space* (2016) 68:98

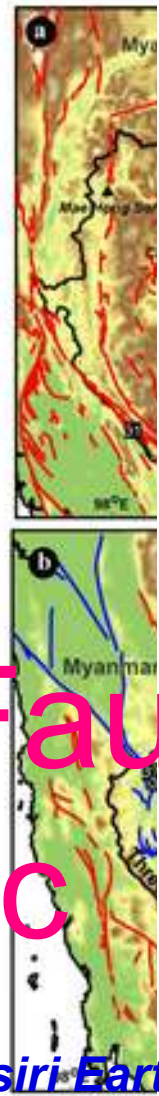


Fig. 2 Maps of different parts of these maps is illustrated in Thailand

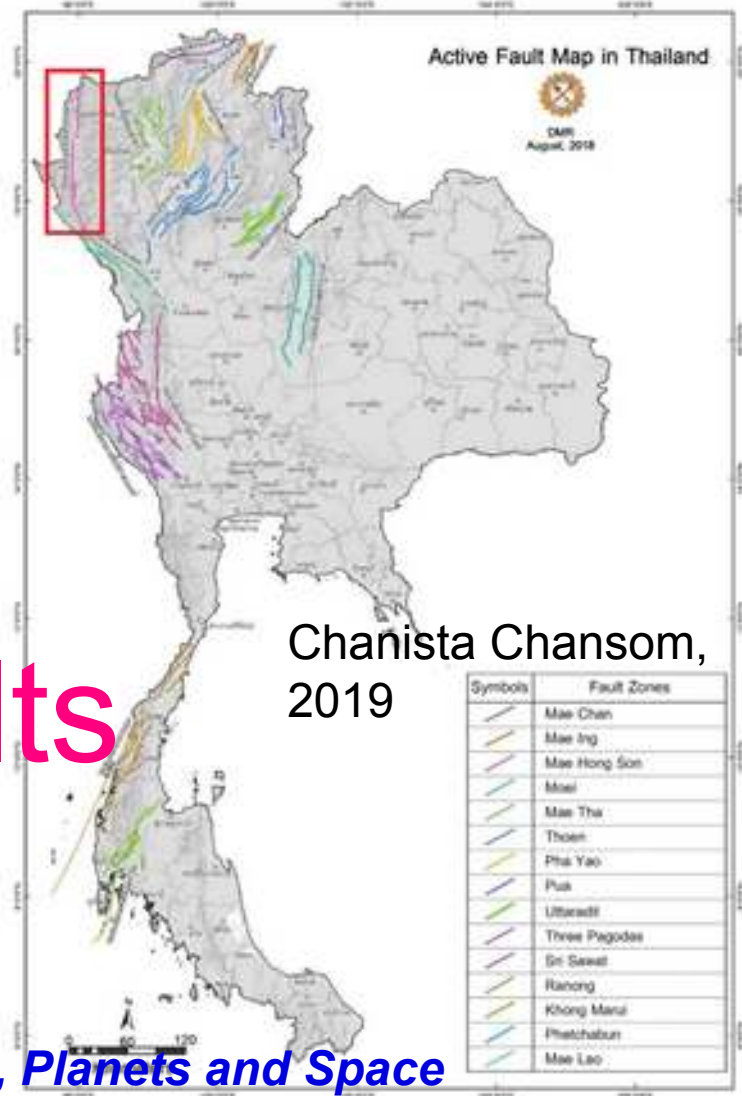
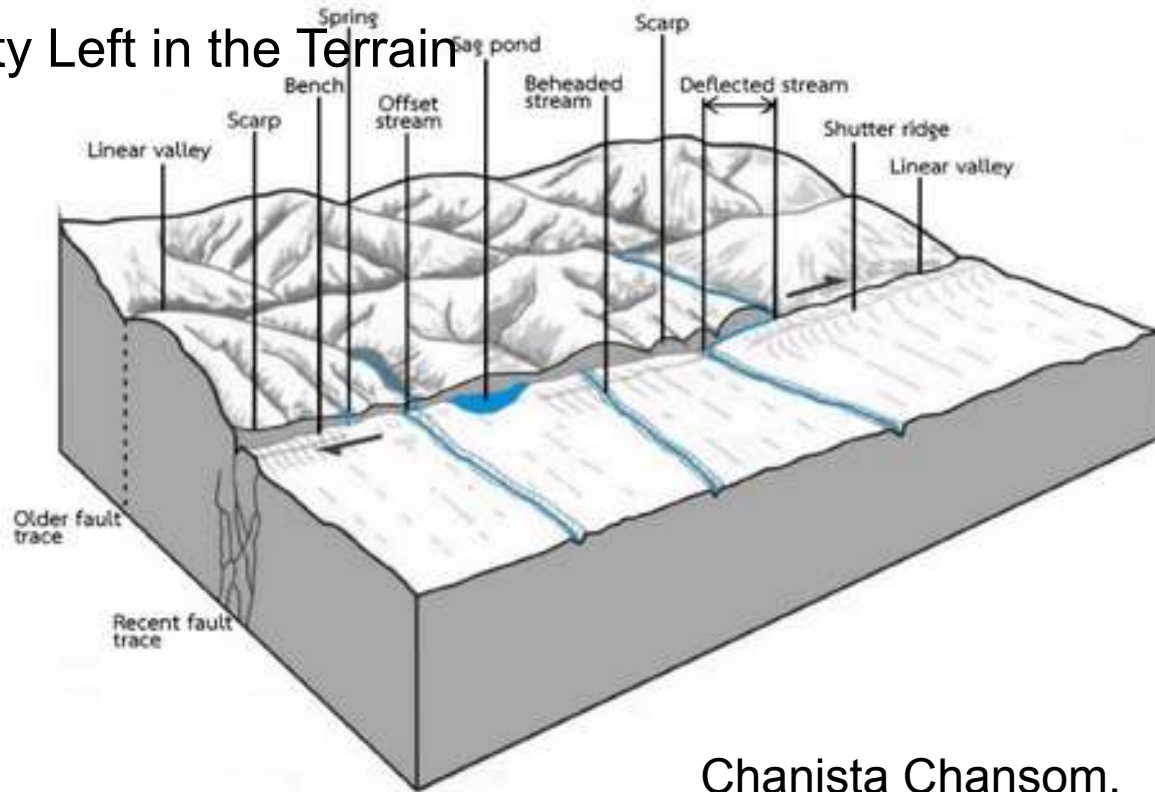


Figure 9 Map shows active faults in Thailand consist of 15 fault zones (from DMR (2018)). Red box shows the study area.

Chanista Chansom, 2019

Traces of Fault Activity Left in the Terrain



Chanista Chansom,
2019

Figure 12 Morphotectonic landforms associated with active strike-slip movement (from Keller and Pinter (1996)).

95°0'0"E 100°0'0"E 105°0'0"E

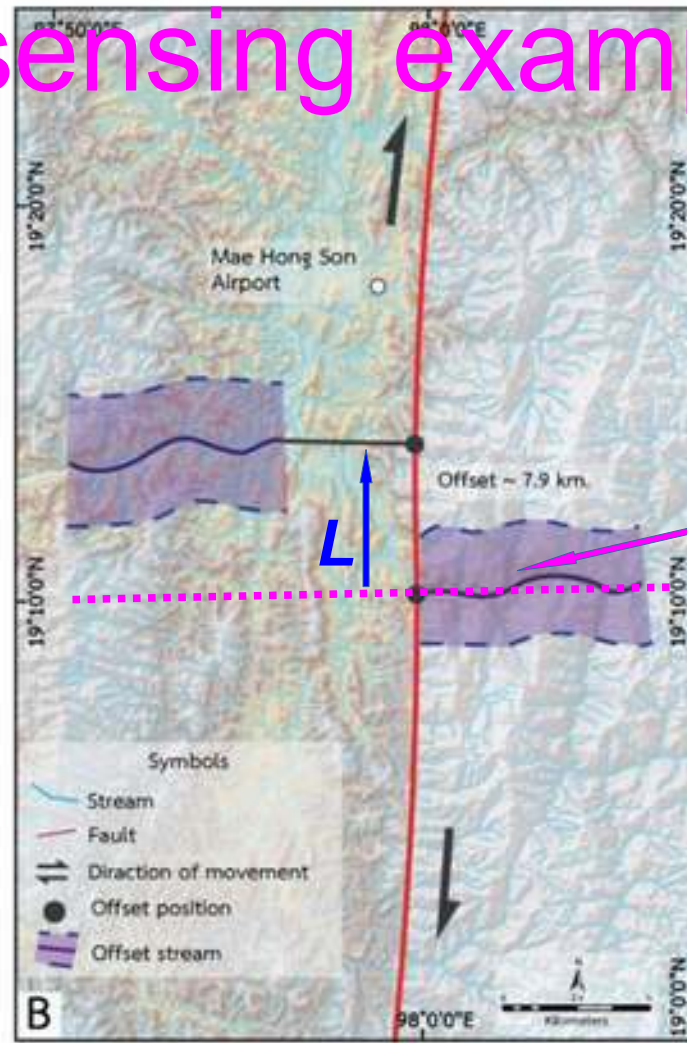
Figure 1 Map of Thailand and adjacent areas showing major active faults (compiled from DMR (2016), Wong et al. (2014) and Morley, Charusiri, and Watkinson (2011)) and epicentral distribution from 1912 to 2018 (ITMD, 2016 and USGS, 2016). The rectangle shows the location of the study area.

Recommended Citation

Chansom, Chanista, "Neotectonics and pale earthquakes along Mae Hong Son Fault, nor (2019). Chulalongkorn University Theses and Dissertations (Chula ETD). 8616. <https://digital.car.chula.ac.th/chulaetd/8616>

Remote sensing example

Chanista Chansom,
2019



$$V = L / T$$

$$T_n - T_o = T$$

Figure 17 Detail interpreted map from ALOS DEM at Ban Pha Bong show offset stream of Sa Mad river is about 7.9 km, from right lateral strike-slip fault movement. Location shows in Figure 16B.

The two important principles in Geology

1. Law of superposition

→ **Layer X is younger than Layer Y**

2. Cross-cutting relationship

→ **U cuts F: U is younger than F**

Then the earthquake event is between X and Y

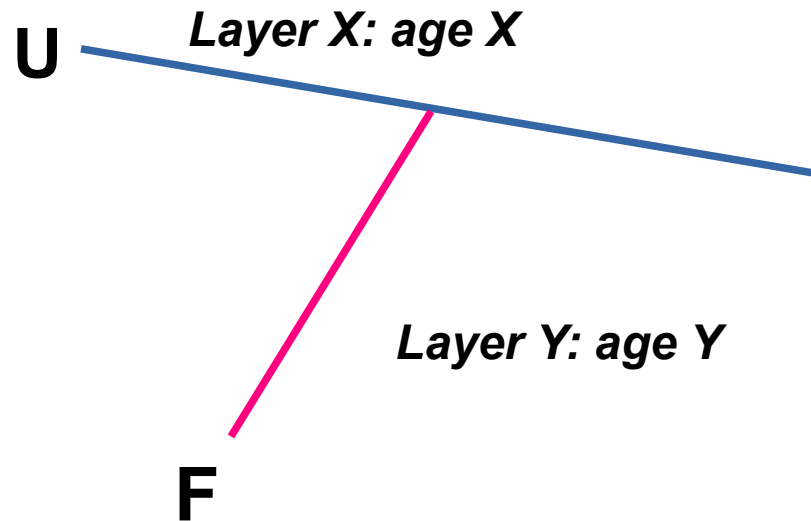
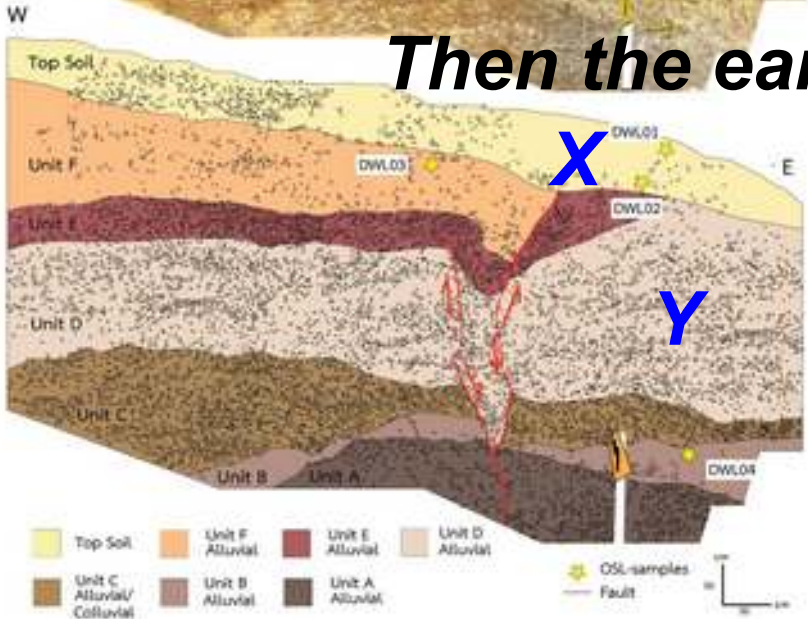
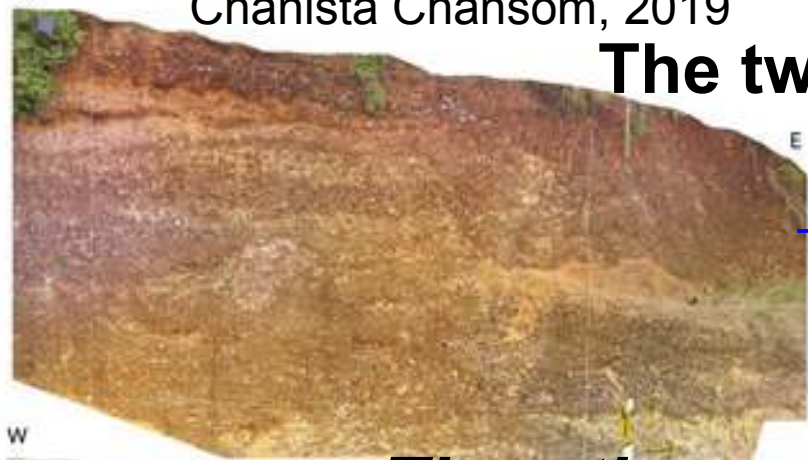


Figure 31 Road cut outcrop section and wall log section on the north wall at Doi Wang Luang showing sediment stratigraphy, fault orientation and sample location for dating. Location shows in Figure 26A.



Chanista Chansom, 2019

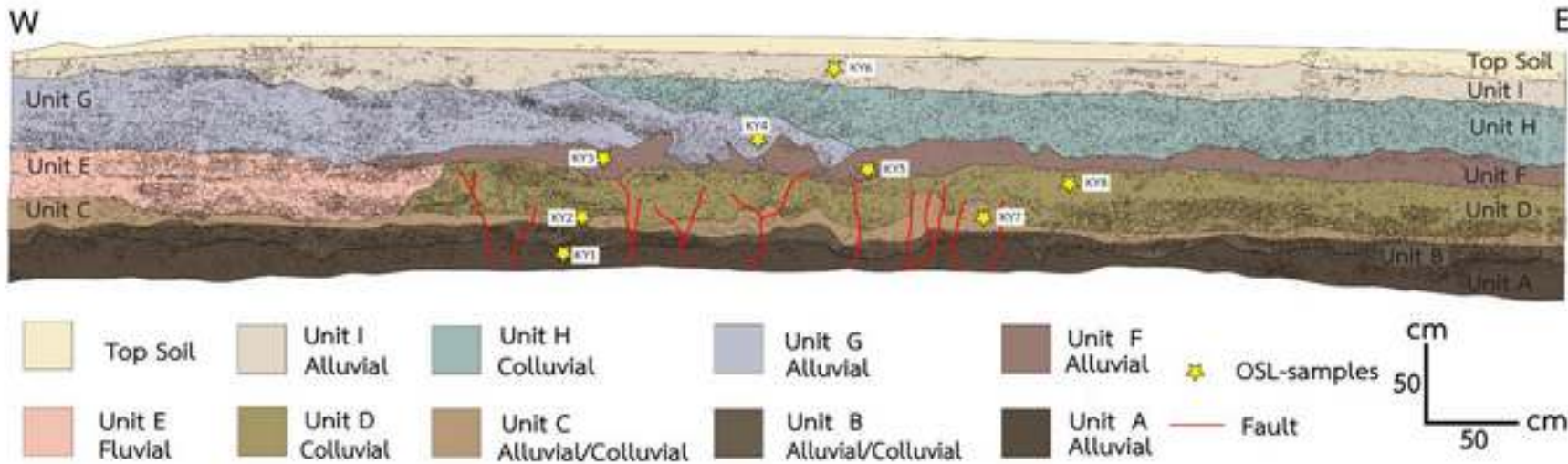
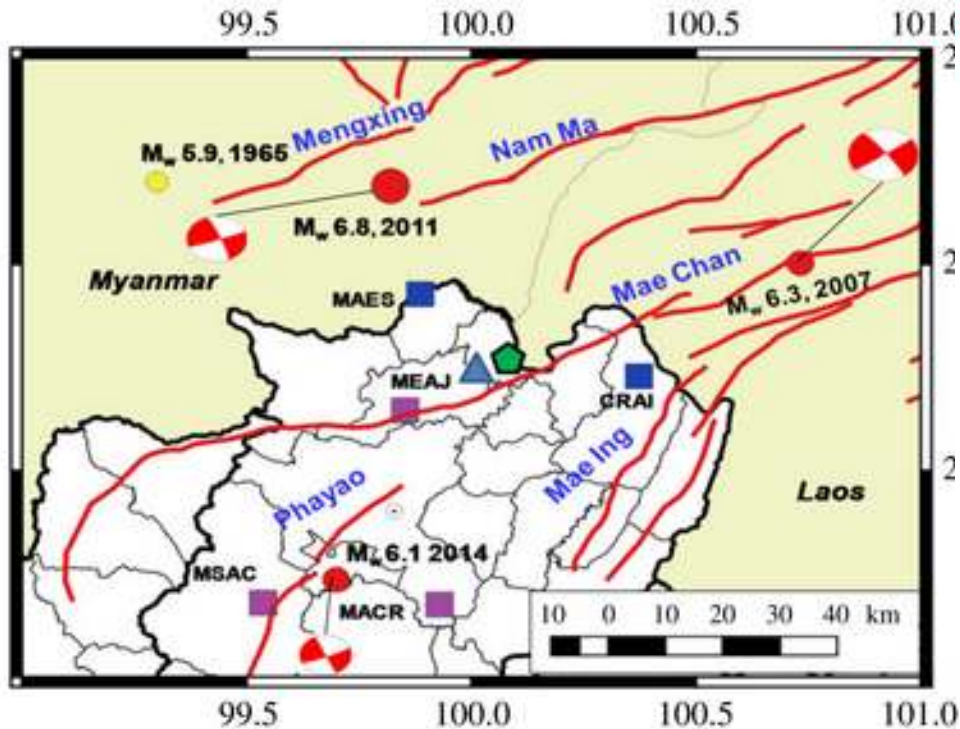


Figure 35 Paleoearthquake trench section and wall log section on the north wall at Ban Khun Yuam showing sediment stratigraphy, fault orientation and sample location for dating. Location shows in Figure 26A.



Research

Cite this article: Ornthammarath T. 2019 Seismic damage to ancient monuments in Chiang Saen (Northern Thailand): implication for historical earthquakes in Golden Triangle area. *Phil. Trans. R. Soc. A* **377**: 20180255. <http://dx.doi.org/10.1098/rsta.2018.0255>

Accepted: 27 June 2019



Seismic damage to ancient monuments in Chiang Saen (Northern Thailand): implication for historical earthquakes in Golden Triangle area

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ORCID: [10.0000-0002-3401-7076](https://orcid.org/10.0000-0002-3401-7076)

Over the last few decades, three moderate

Teraphan Ornthammarath, 2019

Figure 1. Chiang Saen and its surrounding seismicity from earthquakes greater than 5.0 since 1902. The red lines represent active faults from the Department of Mineral Resources (DMR) (http://www.dmr.go.th/main.php?filename=fault_en). The blue and purple squares represent seismic stations that record ground motion from Mw 6.8 2011 and Mw 6.1 2014, respectively.

Many of historical earthquakes were closely related to the **Three Pagoda Fault, the Mae Ping Fault, and the MHSF.**

By Chanista Chansom, 2019

Their estimation

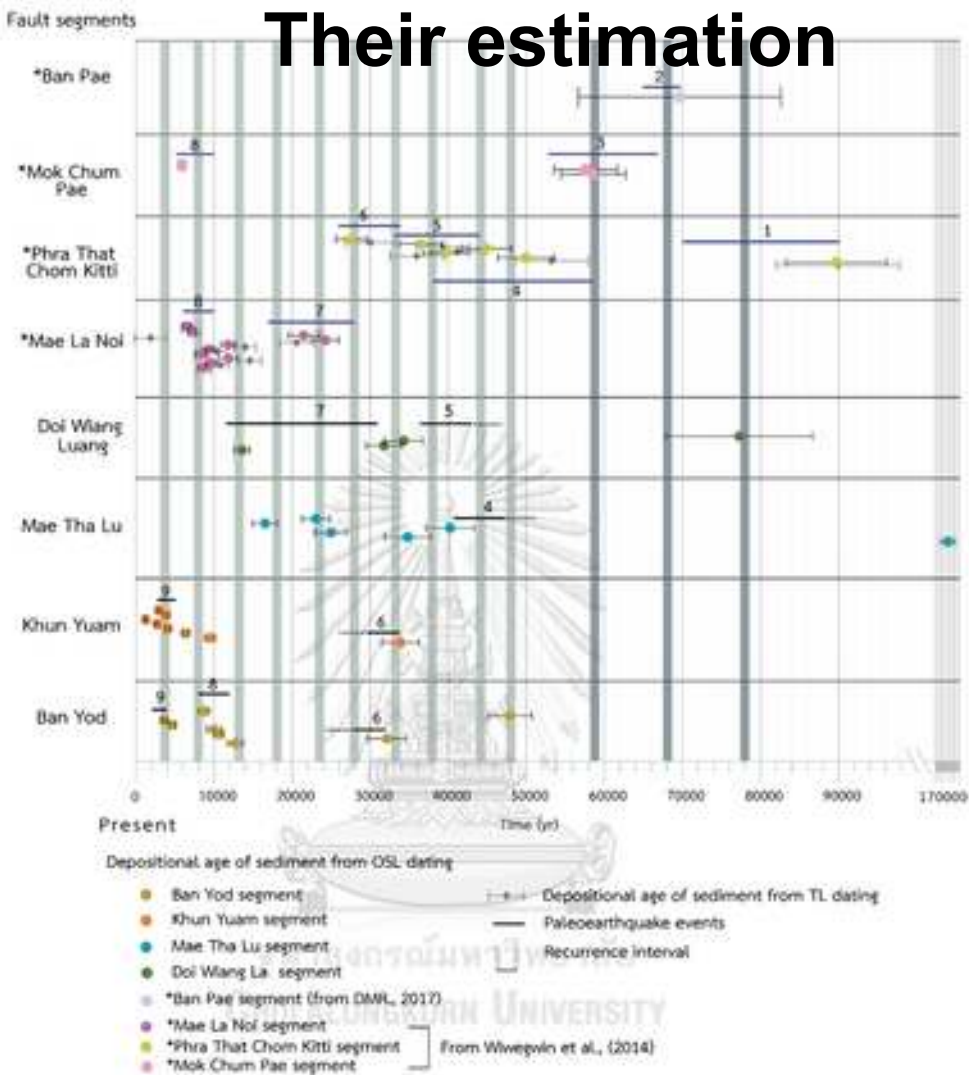


Figure 48 Diagram showing the depositional ages of sediments in the road-cut wall and trenches from the OSL ages and paleoearthquake events.

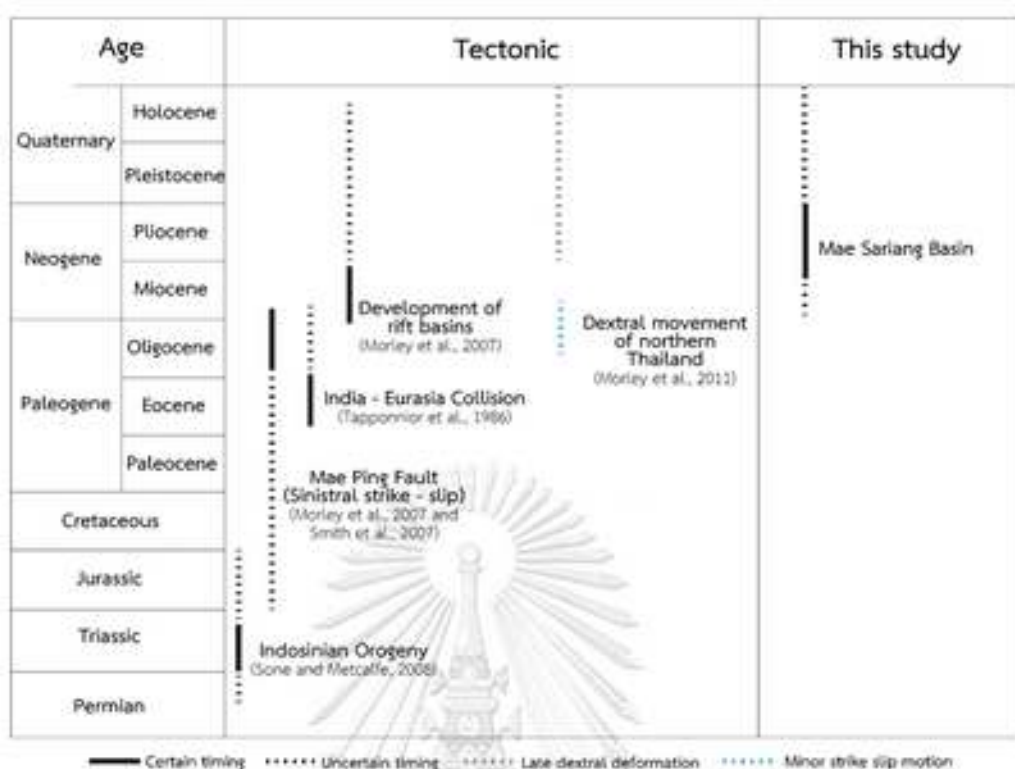


Figure 49 Comparative chart of the regional tectonic events (modified from Kaewpradit., 2018 and Morley et al., 2011) and the evolution of the MSB from this study.

Chanista Chansom, 2019

From the Statistics; my idea!

- Statistics are sometimes boring!
- But it is very important in seismology
- There are two famous empirical laws

Two Empirical Laws in Seismology

- **G-R Law** (Gutenberg-Richter's Law) **G** **R**
- **Omori Law**: Exponential Decay of After-shocks **O**

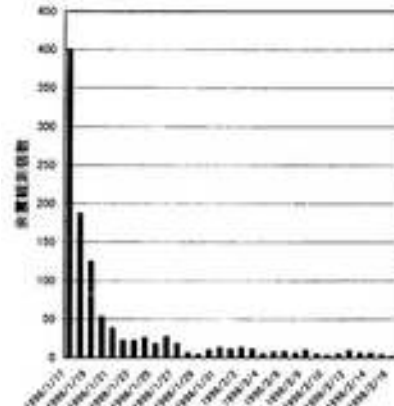


図1 表1のデータをグラフに示したもの(2/18以降は省略)

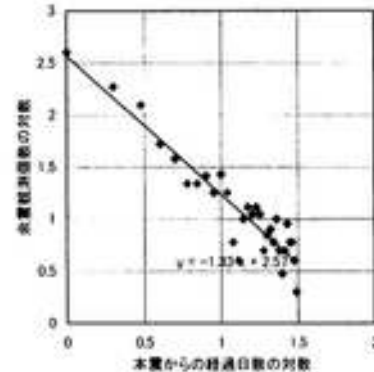


図2 同1のグラフの両軸を対数に代えたもの

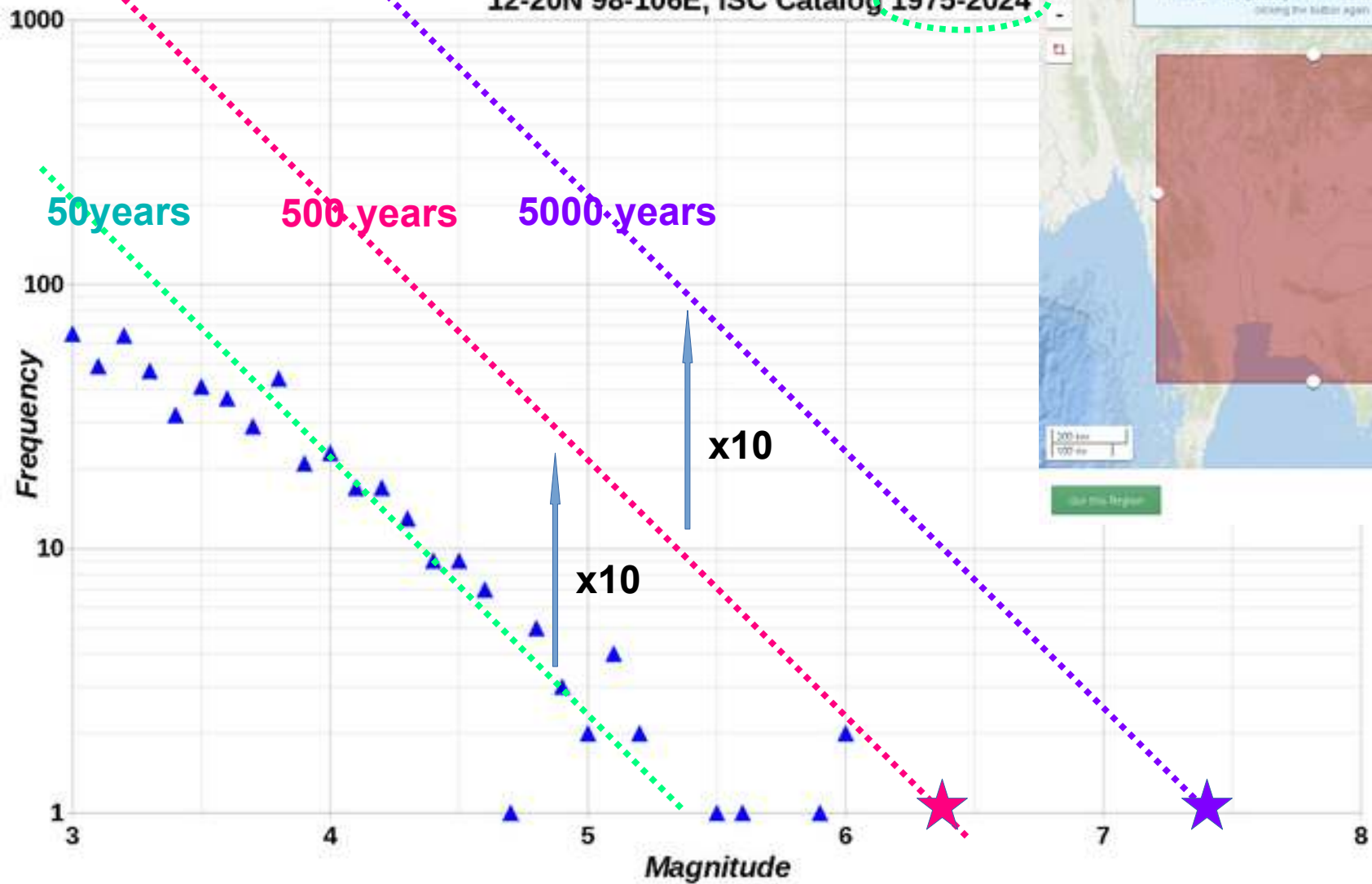
Okamoto, 1999

The Gutenberg-Richter's Law

- Earthquake-size: Magnitude(Size)
- Number of earthquakes (Frequency)
- Examples of South-East Asia and Japan
- Lets' Try!

Around Northern Thailand

12-20N 98-106E, ISC Catalog 1975-2024



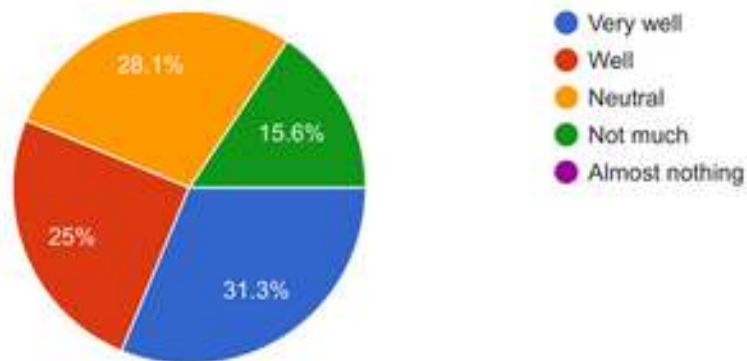
Wave Physics

- I) The strong shaking at Bangkok is explained by a simple wave physics: propagation, amplification, resonance, scattering, directivity, super-sonic etc.
- ii) But **the collapse of building is essentially non-linear process.** → so this forecast is very difficult.
- iii) Also, **the earthquake sources is complicated non-linear process.** → the difficulty of earthquake forecast.
- I hope that many students try to challenge this unsolved target!!

B. Prior Awareness of Earthquakes (Before the Class)

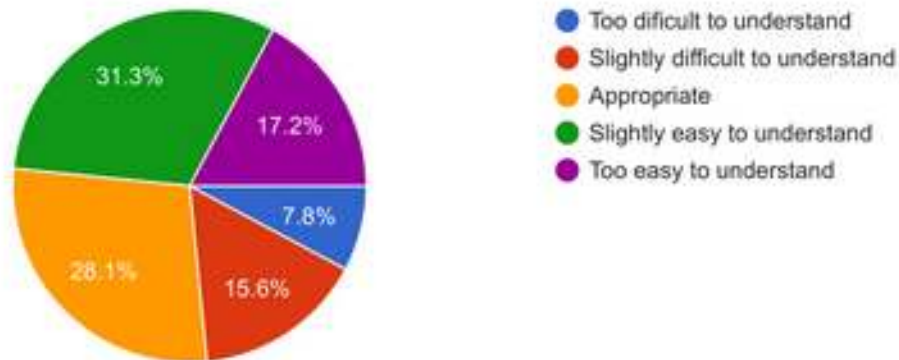
Q3. Before this class, how much did you know about earthquakes?

64 件の回答



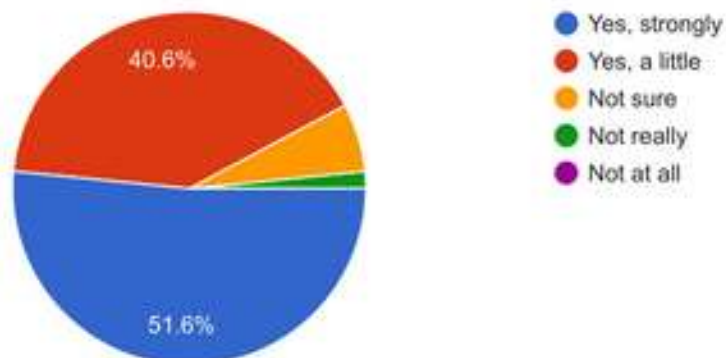
Q6. How about my English

64 件の回答



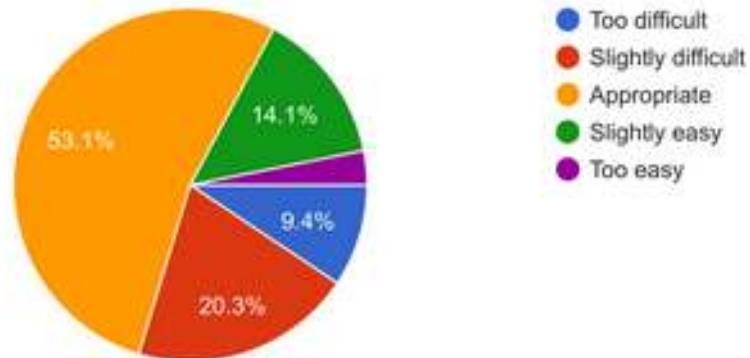
Q4. Before this class, did you think earthquakes could affect Thailand?

64 件の回答



Q9. How appropriate was the level of this class for you?

64 件の回答



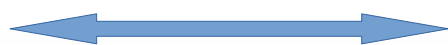
Q5. How well did you understand the following topics?

(5-point scale for each item)

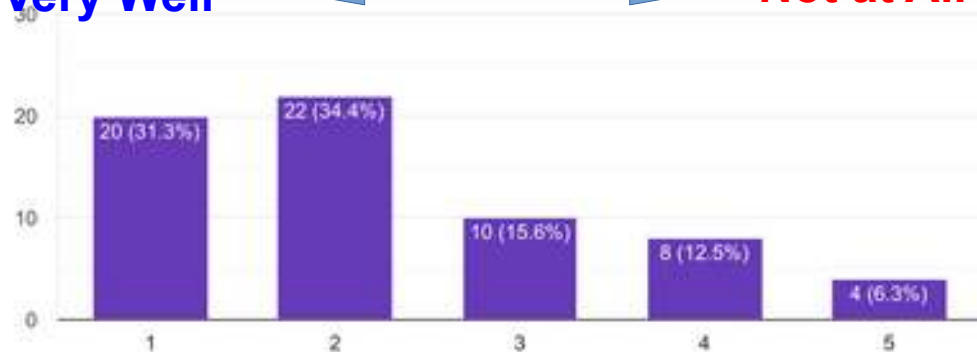
Overview of the March 2025 Myanmar earthquake

64 件の回答

Very Well

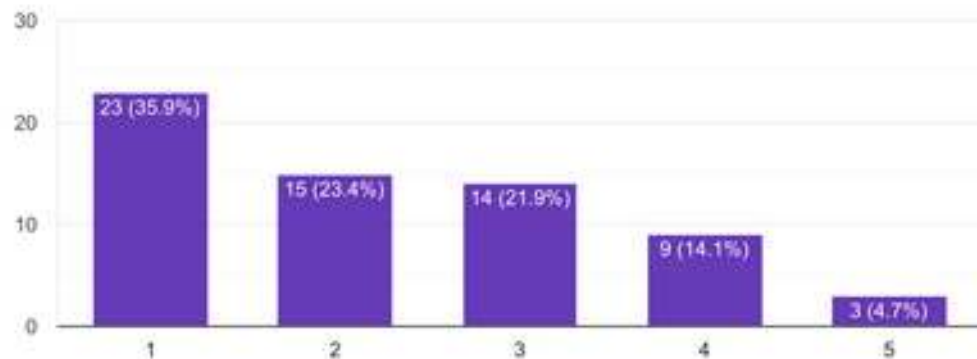


Not at All



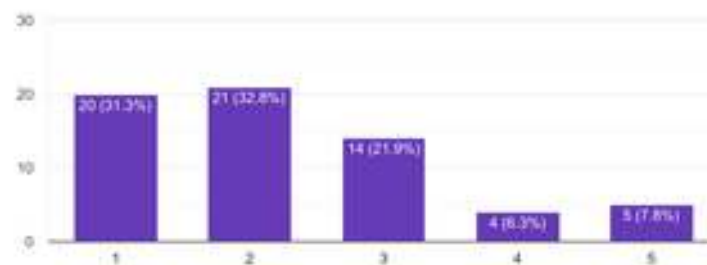
Why shaking was felt in Bangkok

64 件の回答



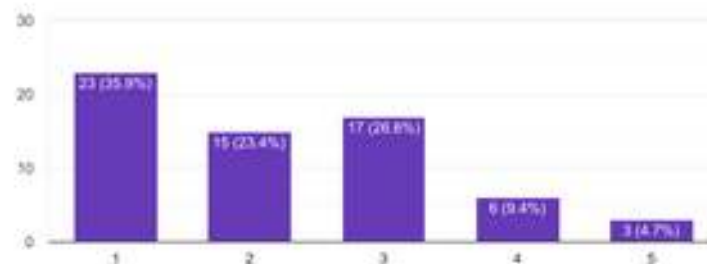
How to determine an earthquake epicenter

64 件の回答



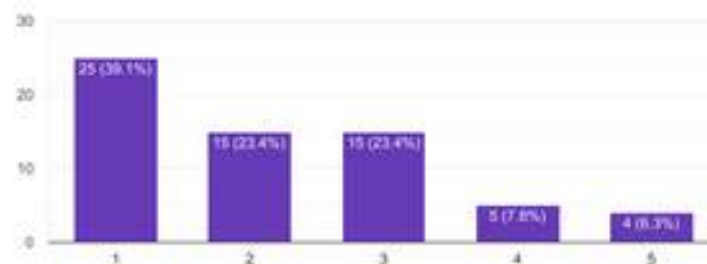
Past earthquake activity in northern Thailand

64 件の回答



Possible future earthquakes in Thailand

64 件の回答



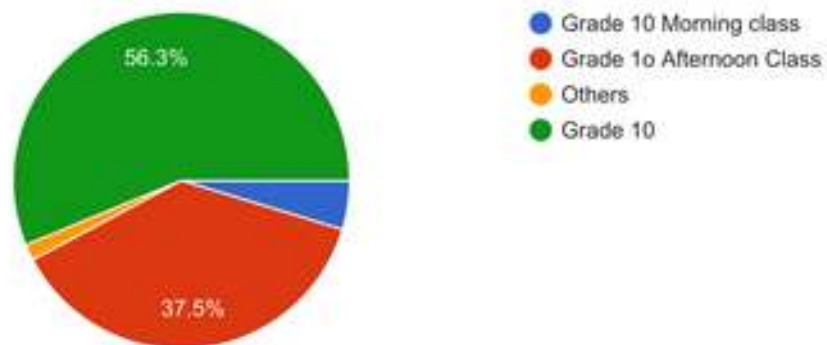
Evaluation of my class

- Google Forms immediately after the class
- The response rate: $64 / (60+30)$ students = 71 %
- As a whole **the evaluation by the students are positive!**
- Particularly, they found Thailand is not safe from the seismic events.
- The challenge was that not all students were proficient in English, and I felt that three hours lecture was somewhat insufficient to discuss the 2025 Myanmar earthquake and earthquake disasters in Thailand.

A. Background

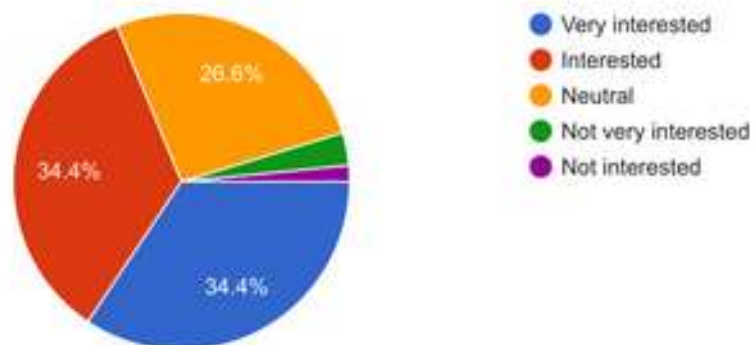
Q1. Your grade

64 件の回答



Q2. Before this class, how interested were you in science (physics / earth science)?

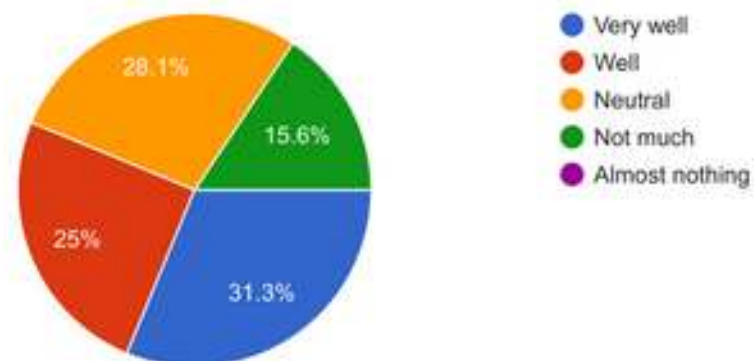
64 件の回答



B. Prior Awareness of Earthquakes (Before the Class)

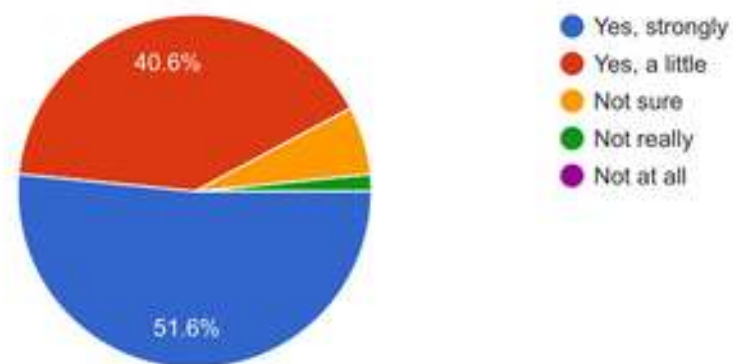
Q3. Before this class, how much did you know about earthquakes?

64 件の回答



Q4. Before this class, did you think earthquakes could affect Thailand?

64 件の回答



H. Open-ended Questions

Q10. What is one new thing you learned from this class?

(Short answer) 64 件の回答

Epicenter plotting

I learned about earthquakes.

Reason why earthquake in Myanmar affected Thailand

I learned a lot. How did earthquakes be in Thailand, Why I felt

shaking when earthquake is

not that close to me. etc.

How to find P,S wave

How to know historical earthquakes is the new thing that I learned

from this class

To find S-P Time on seismograph.

earthquakes

maybe earthquake

How to calculate earthquakes force

We can know an earthquake in future

I thing,it impotant to duscussion of future earthquakes

How to find the epicenter point

Why doesn't the sea flood

Know about some earthquakes happened

S-wave P-wave

Earthquakes can only occur one place at a time.

How to calculate to find focus point of earthquake

Earthquake

Epicenter potting exercise

Determining the distance to an earthquake.

S-P time , how to calculate epi-center

Know about the earthquake.

How to plot Epicenter.

What Earthquake

How to find epicentre

How to calculate the distance of earthquakereal video and Ai video

地震についての新たな知識を得ました。

I learned how to better understand and apply the main concepts taught in this class.

Learn how to find epi-center of earthquake

I learn the basics of finding the epicenter of an earthquake.

Know how to calculate center of earthquake

about an earthquake

How to calculate distance of epicenter

I learned more about earthquakes.

I learned how to locate the epicenter of an earthquake.

The way to find center of earthquake

Very good

Resonance

I learned a lot about earthquakes.

How to find epicenter

Learn about earthquakes

The types of waves that cause earthquakes of varying intensity

Finding the diameter

About to find the epicenter and earthquakes

i like about how to calculate distance (even it's just a old-fashioned style :D but that's fun!

The new thing That I learned is how to search the epicenter by circling

A simpler way to find the epi-center of an earthquake.

Earthquake in Bangkok

Meaning of wave

How to measure earthquakes?

Q11. Do you have any comments or suggestions about this class?

(Optional)

64 件の回答

-

No

Good

No you doing very well

I like your english

Very enjoy

I think you can use English very well

Sensei very kind

先生は素晴らしいです。新しいことを学び、レッスンをとても楽しみました。

This topic is so interesting! I like it. Thanks

you is good teacher you are so kind welcome to Thailand and my school.

The class is interesting and easy to understand. I

don't have any suggestions at the moment.

No comment. It's alreadyba good class

I enjoy it very much

Great!

Nope

Very good

There is no

It's a very good class

im sorry but sometimes I can't understand your English

(just some vocabulary or some

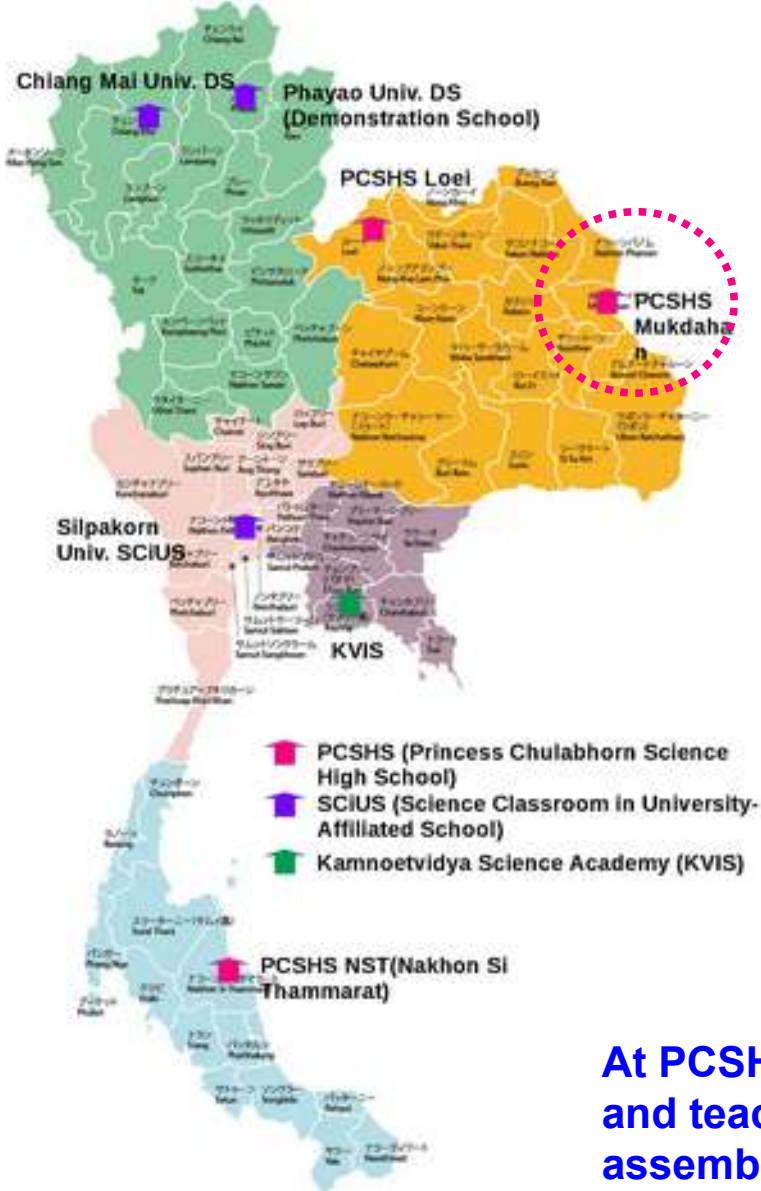
sentences) whatever you describe something hard to

be an easy thing and everyone can

understand ^^ Thank you to give a great knowledge to

us,we hope to see you again someday!!

Next speaker is **Mr. Niwat** at **PCSHS Mukdahan**
He talks our seismometer construction
workshop at their school.



At PCSHS Mukdahan: We held a workshop where high school students and teachers from 12 nearby schools come together to assemble seismometers.

Acknowledgments and References

<Acknowledgments> This project is supported by **WNI WX Bunka Grant 2025**. Also, we thank to all Thailand Science School Staffs.

<Reference>

Y.Okamoto and H.Nemoto: Skeleton Seismometer for Classrooms –Using Acrylic Plates, Neodymium Magnet and ESP32 Board –, The 77th National Conference of the Japan Society for Earth Science Education, Shiga Conference Abstract.

http://www.yossi-okamoto.net/2023_Shiga/Shiga_Seis_EG.pdf

Thank you for your attention!