Mitigasi* Gempa Sesar Aktif

**upaya untuk mengurangi resiko bencana*

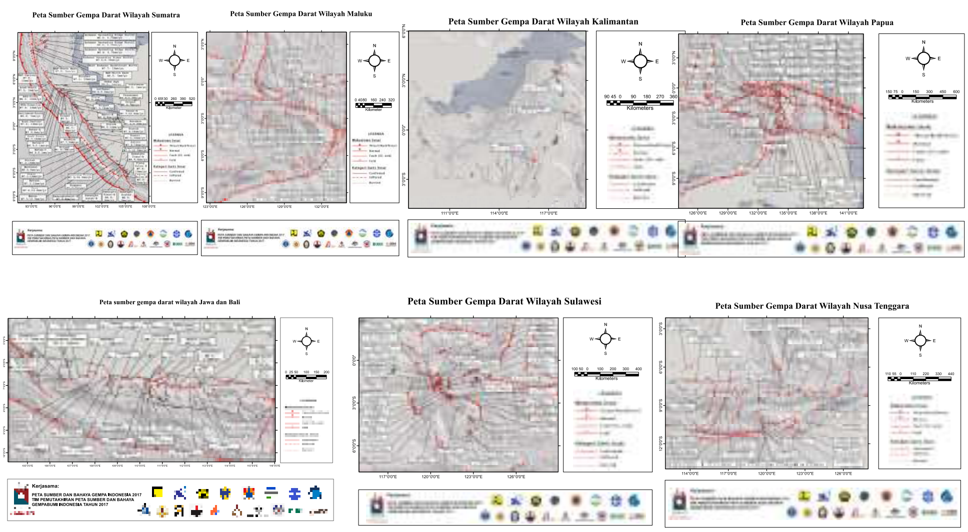
Dr. Mudrik Rahmawan Daryono

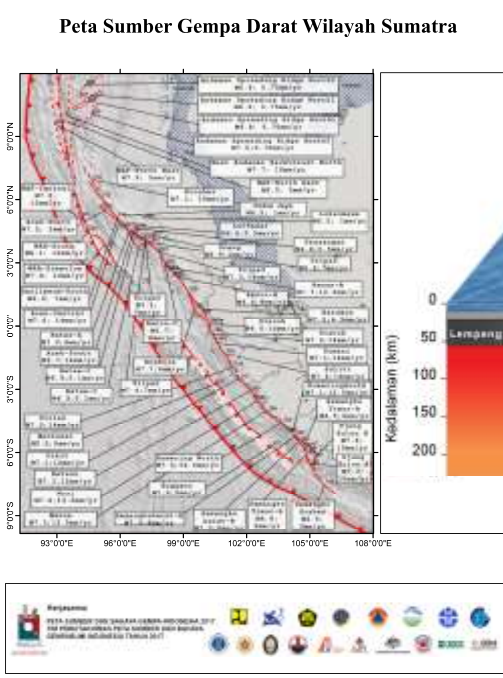
Outlines.

1. Bagaimana Gempabumi terjadi? Penelitian gempabumi di darat, dipantai, di danau.
2. Penelitian Sesar Baribis
3. Mitigasi Gempa Sesar Aktif. Apasaja dan data/info/ilmu yang perlu ada ?
4. Bagaimana posisi penelitian Sesar Aktif di Jawa Timur ....?
5. Kesimpulan

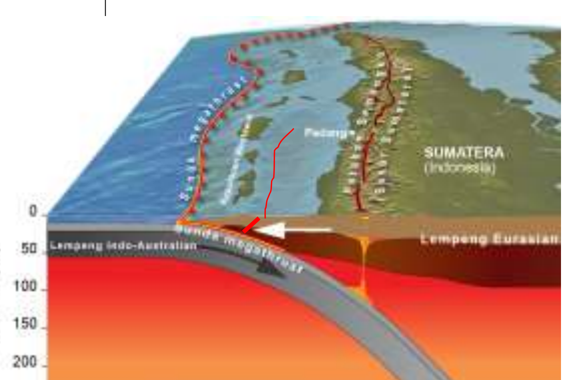
PUSGEN 2017 – ACTIVE FAULT MAP OF INDONESIA

81 Active Fault to be 295 Active Fault

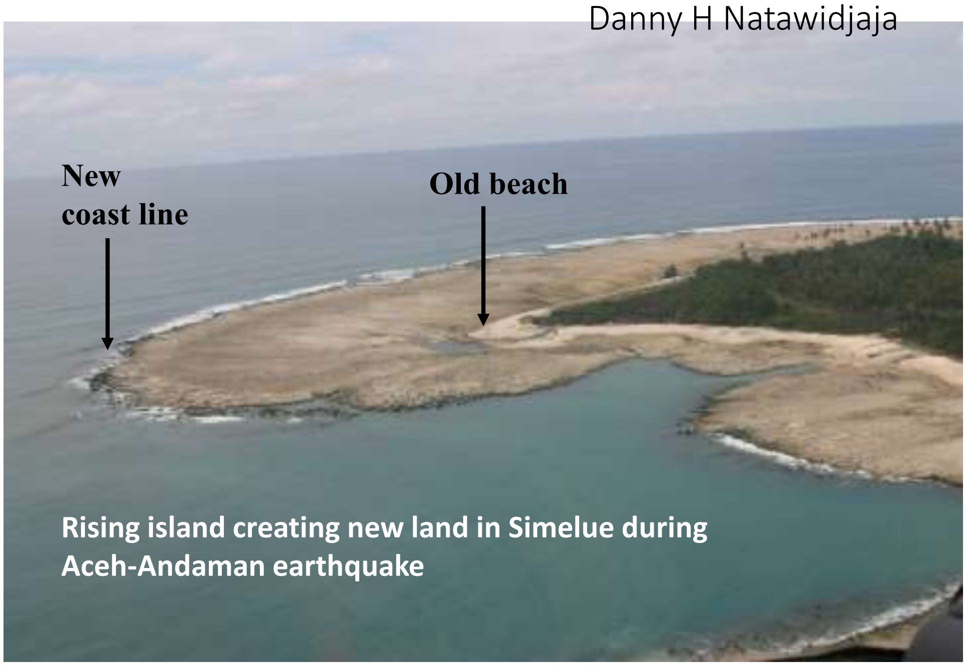




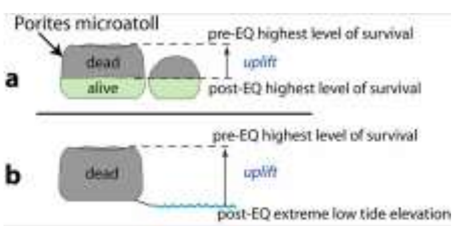
3. Sumatra

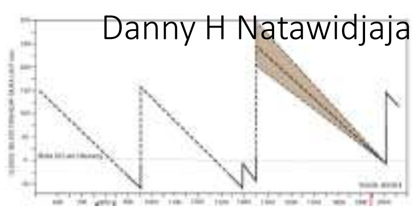


Danny H Natawidjaja

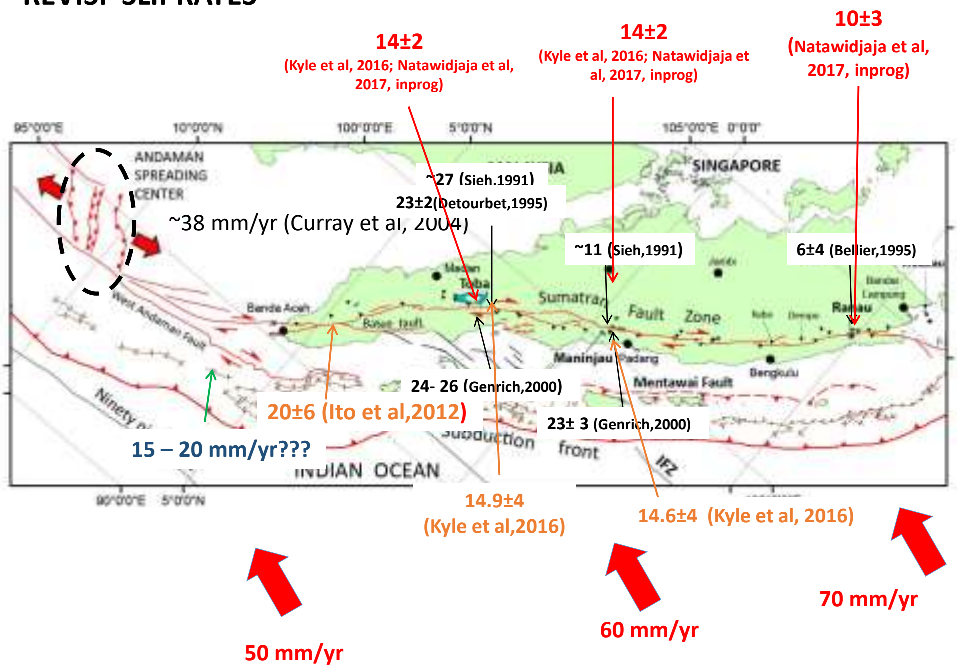


Danny H Natawidjaja

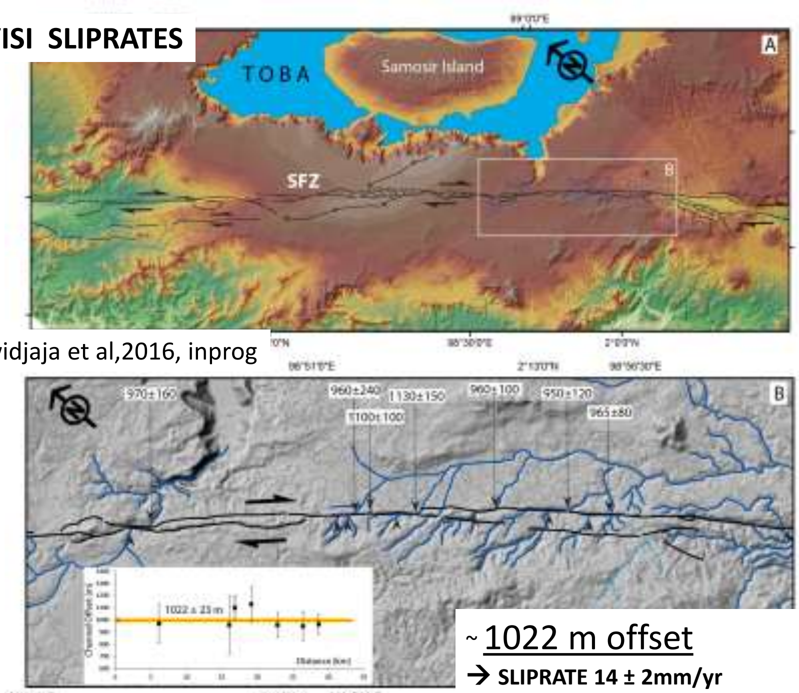




REVISI SLIPRATES



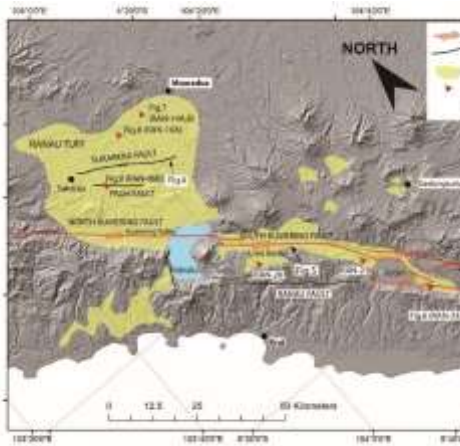
REVISI SLIPRATES

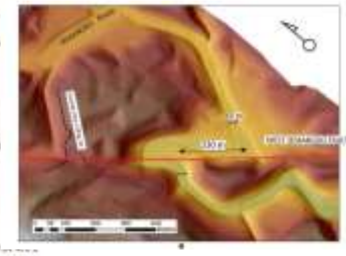


Natawidjaja et al,2016, inprog

~ <u>1022 m offset</u>

→ **SLIPRATE 14 ± 2mm/yr**



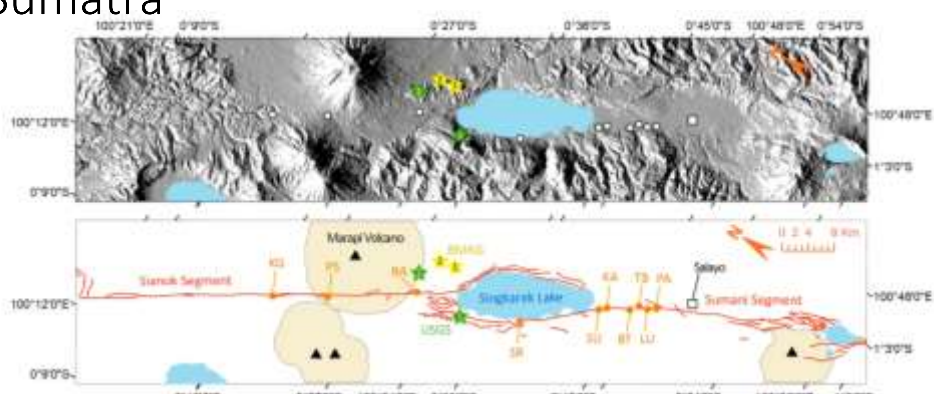


Geoscience Letters

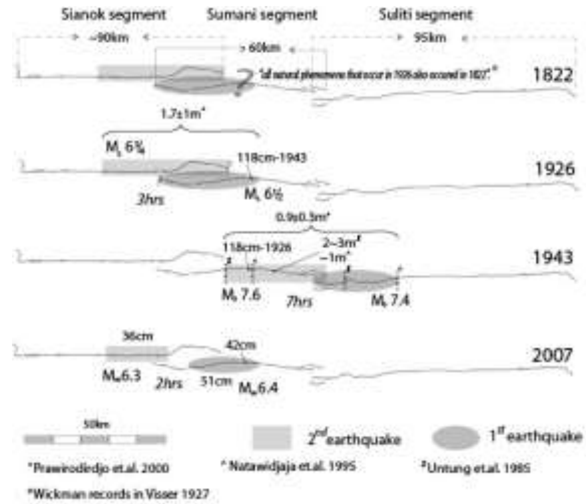
RESEARCH LETTER Open Access

Late Quaternary eruption of the Ranau Caldera and new geological slip rates of the Sumatran Fault Zone in Southern Sumatra, Indonesia

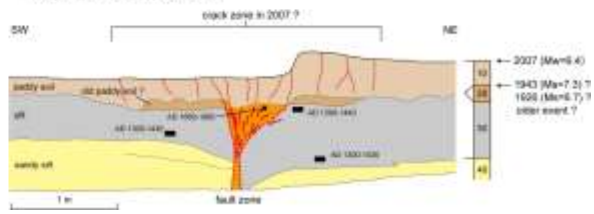
West Sumatra



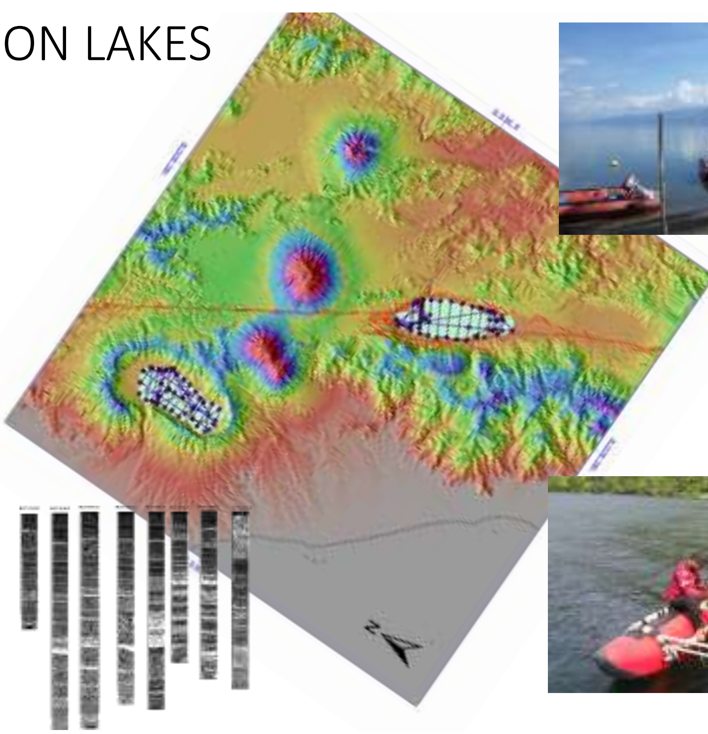
→ Older EQ ?

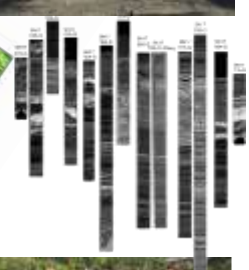


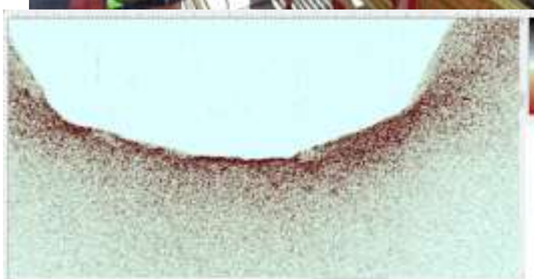
Mudrik Daryono et.al. (2012) @ BSSA

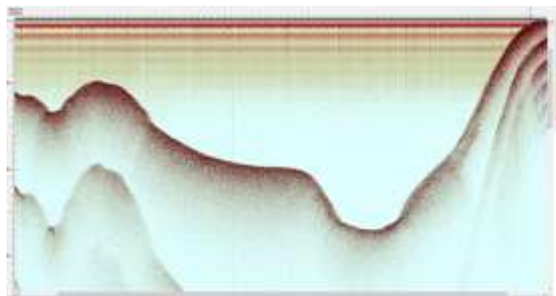


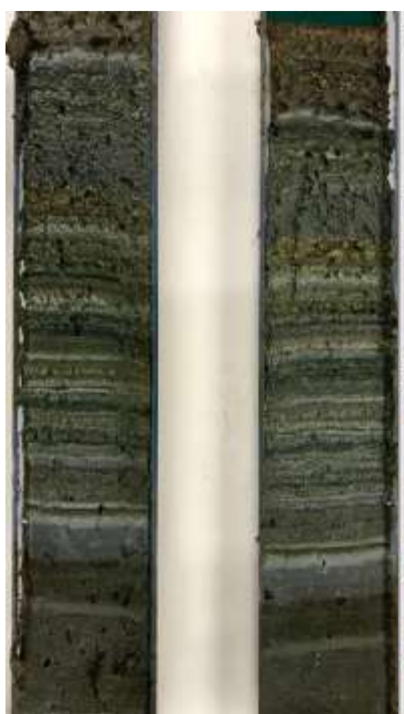
ON LAKES

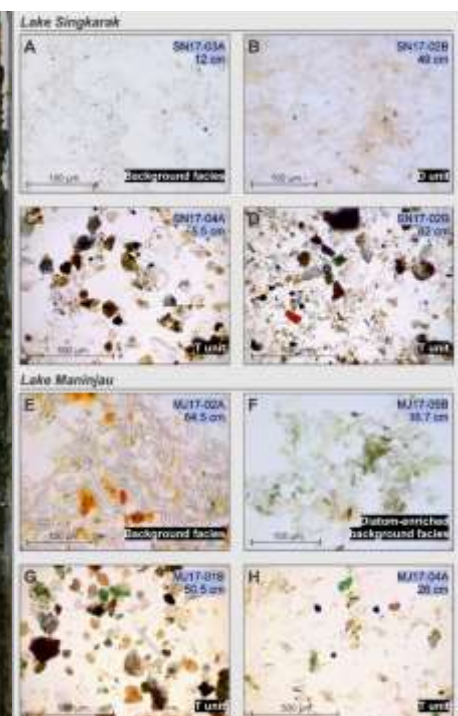


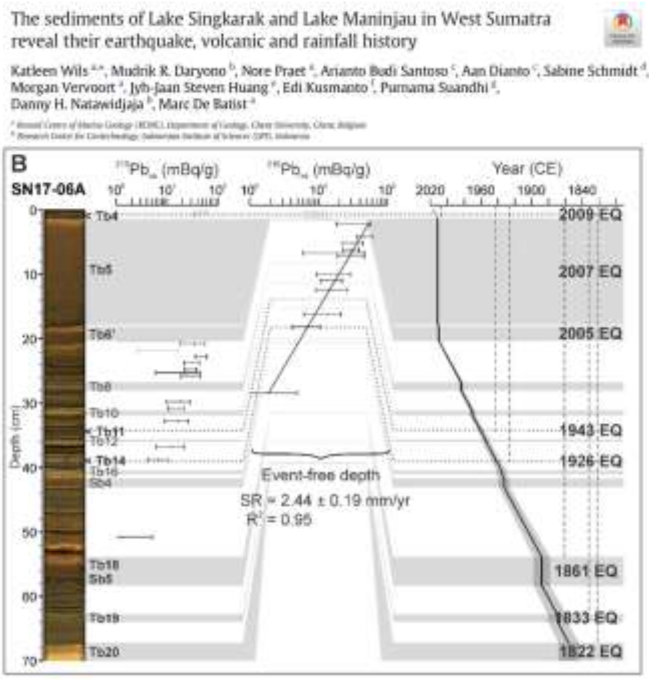


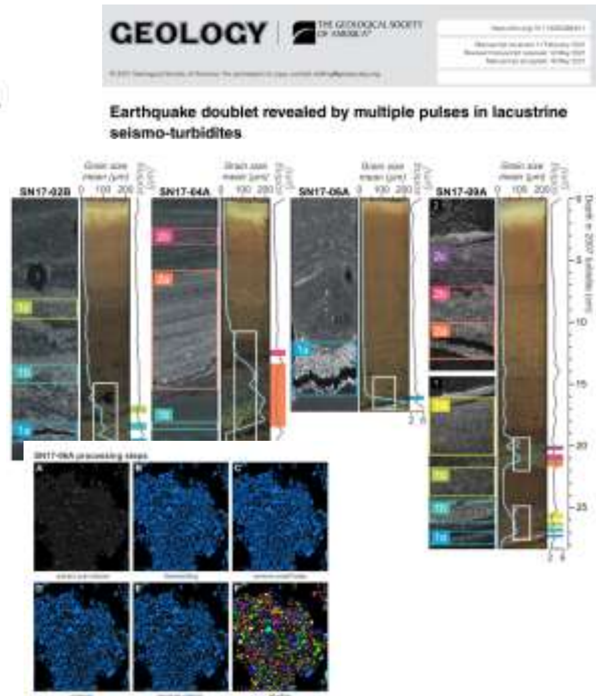


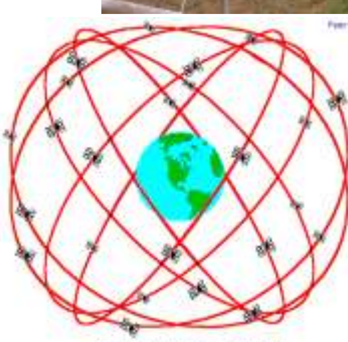




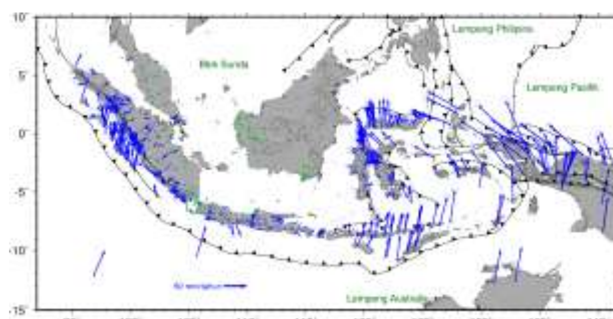

Lake Singkarak
A
SN17-03A
12 cm
Background facies
B
SN17-02B
49 cm
D unit
SN17-04A
5.5 cm
T unit
D
SN17-02B
T unit
Lake Maninjau
E
MJ17-02A
64.5 cm
Background facies
F
MJ17-05B
Diatom-enriched
background facies
G
MJ17-01B
50.5 cm
T unit
H
MJ17-04A
28 cm
T unit

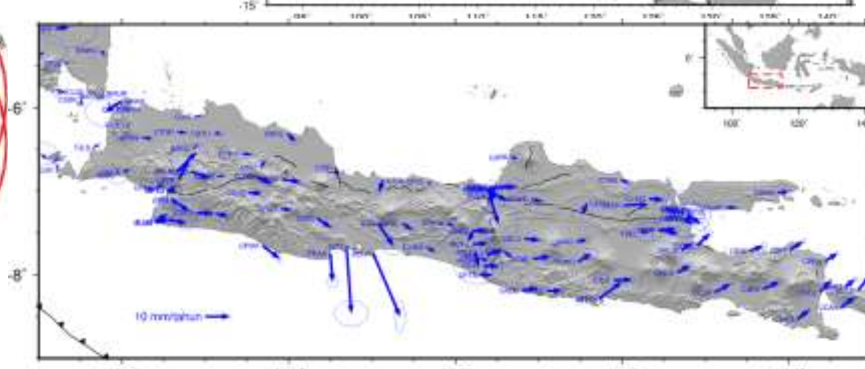




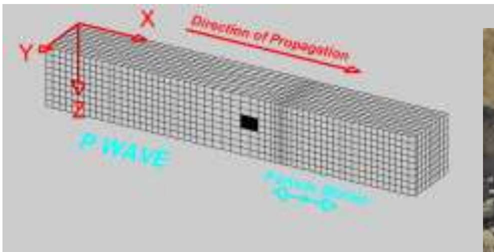


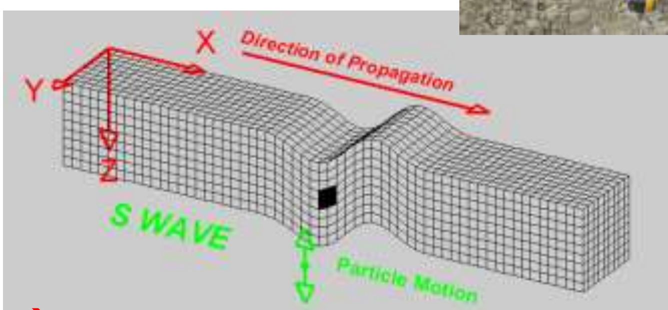
GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination





Irwan Meilano

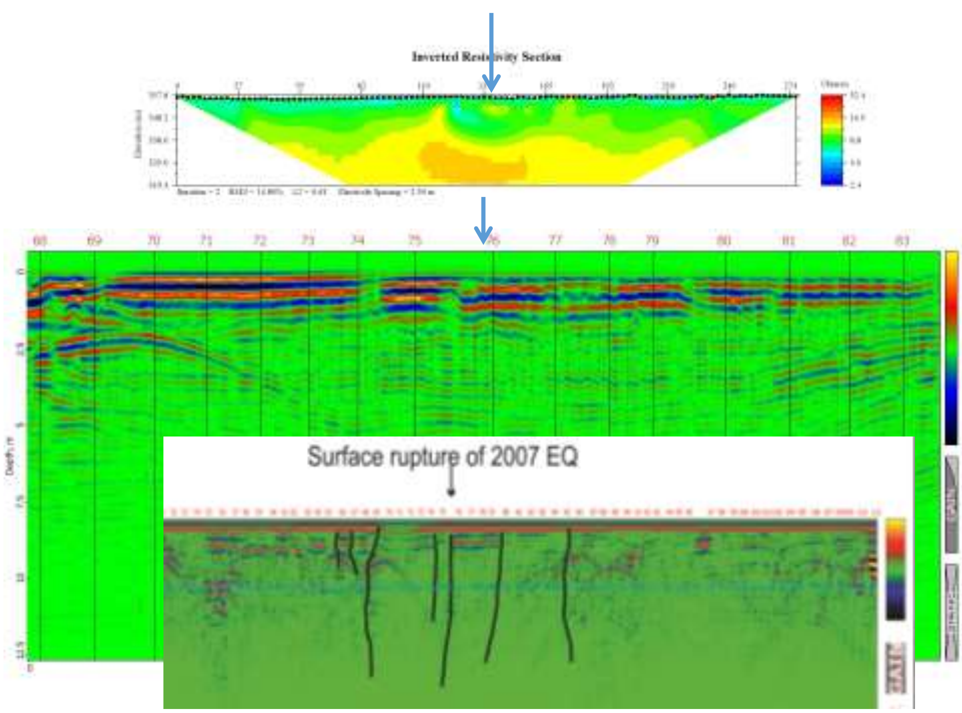




→JURUSAN FISIKA BUMI, TEKNIK GEOFISIKA

Geolistrik

SuperSting R8IP 8 channel, 112 elektroda, spasi kable hingga 5 m.



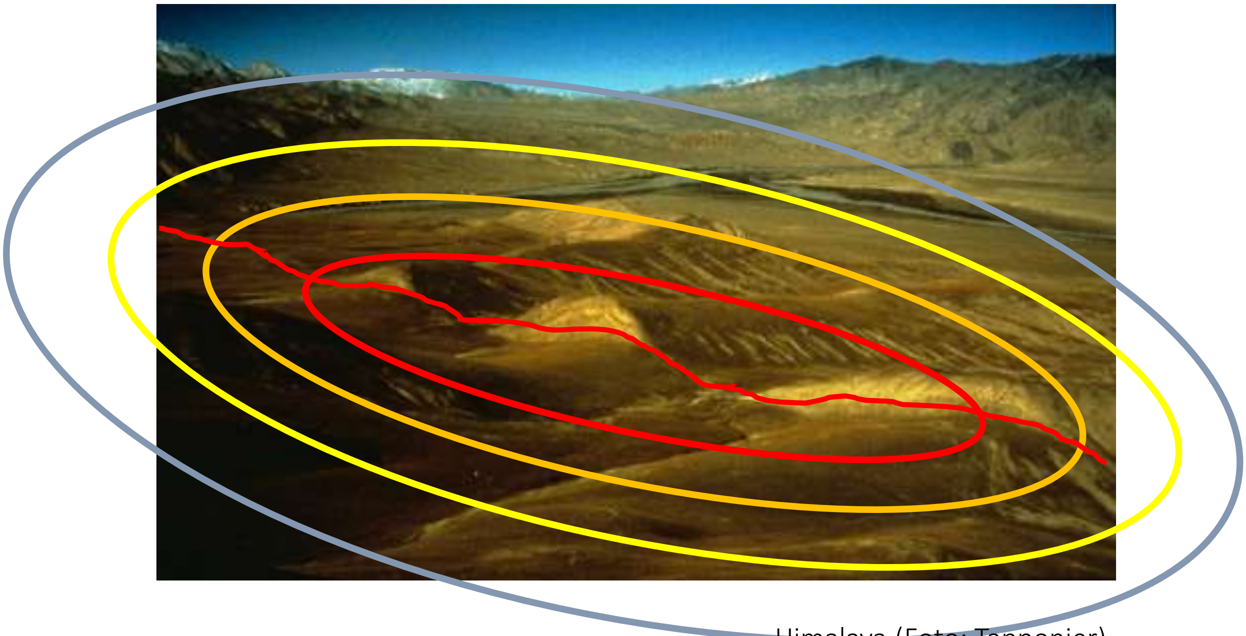
1) Bagaimana gempabumi bisa terjadi ? Kenapa berulang ?

Himalaya (Foto: Tapponier)

1) Bagaimana gempabumi bisa terjadi ? Kenapa berulang ?

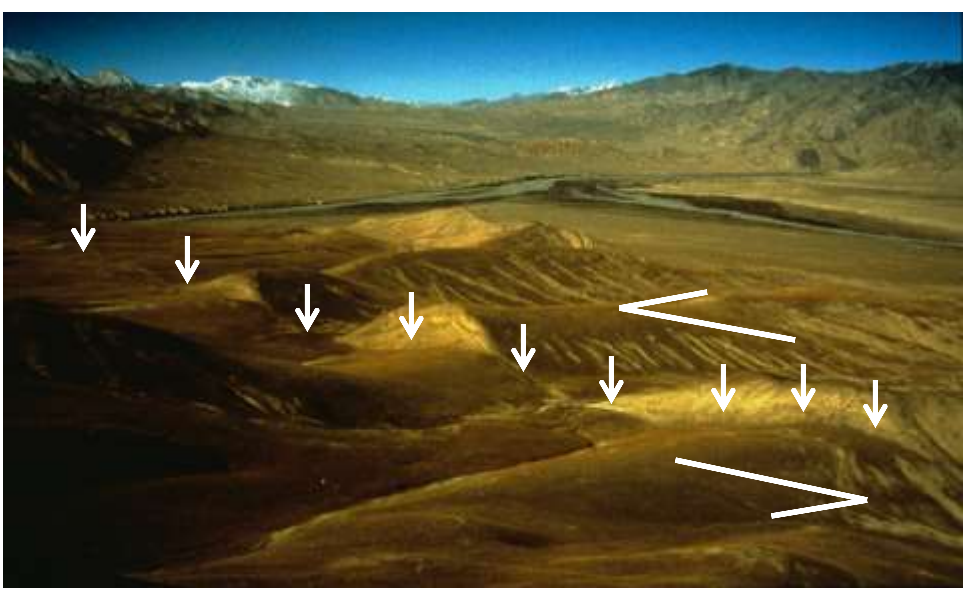
Himalaya (Foto: Tapponier)

1) Bagaimana gempabumi bisa terjadi ? Kenapa berulang ?



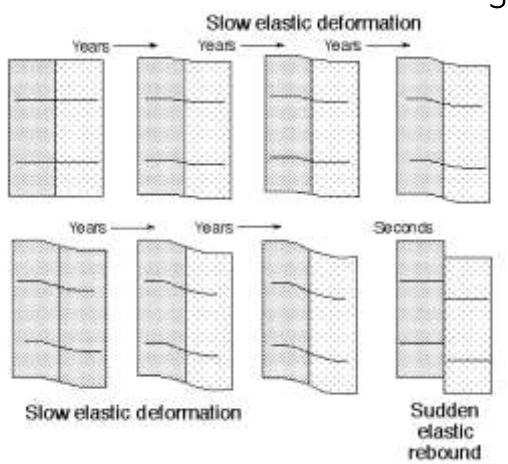
Himalaya (Foto: Tapponier)

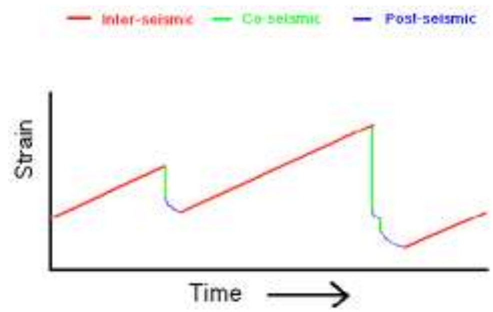
1) Bagaimana gempabumi bisa terjadi ? Kenapa berulang ?

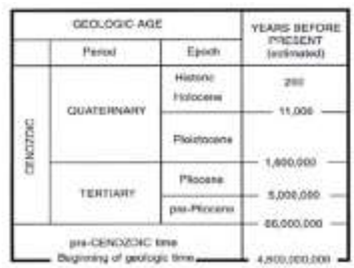


Himalaya (Foto: Tapponier)

SIKLUS GEMPABUMI







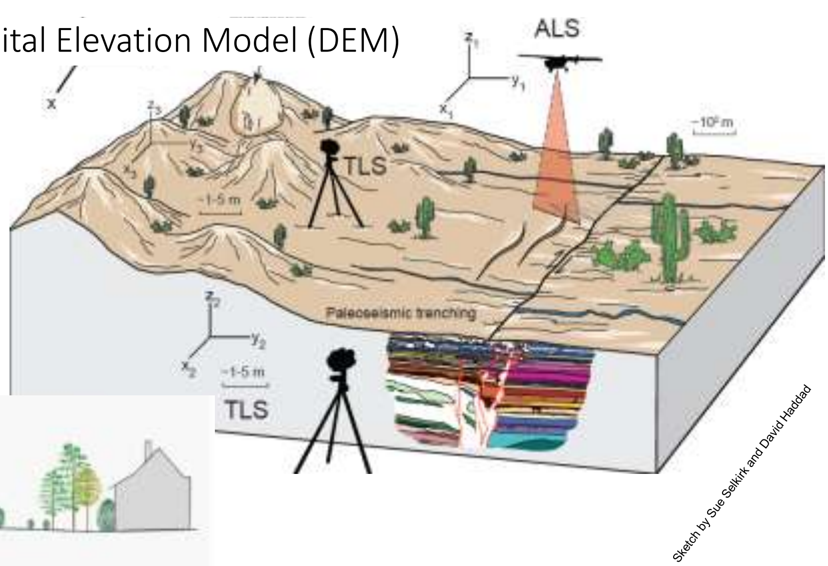
GEOLOGIC AGE			YEARS BEFORE PRESENT (estimated)
	Period	Epoch	
CENOZOIC	QUATERNARY	Historic	200
		Holocene	11,000
		Pleistocene	1,600,000
	TERTIARY	Pliocene	5,000,000
		pre-Pliocene	66,000,000
pre-CENOZOIC time			
Beginning of geologic time			4,600,000,000

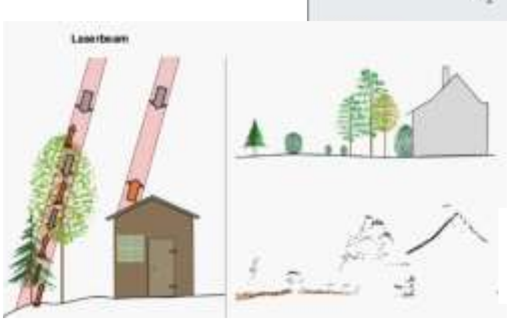
Faults along which movement has occurred during this interval and defined as active by Policies and Criteria of the State Mining and Geology Board.

Faults defined as *potentially active* for the purpose of evaluation for possible zonation.

Figure 2. Geologic time scale.

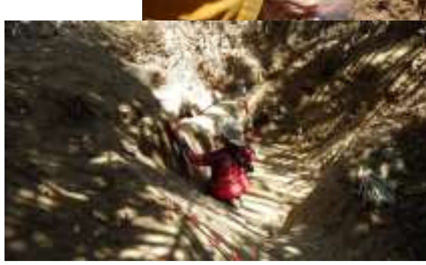
Data Digital Elevation Model (DEM)



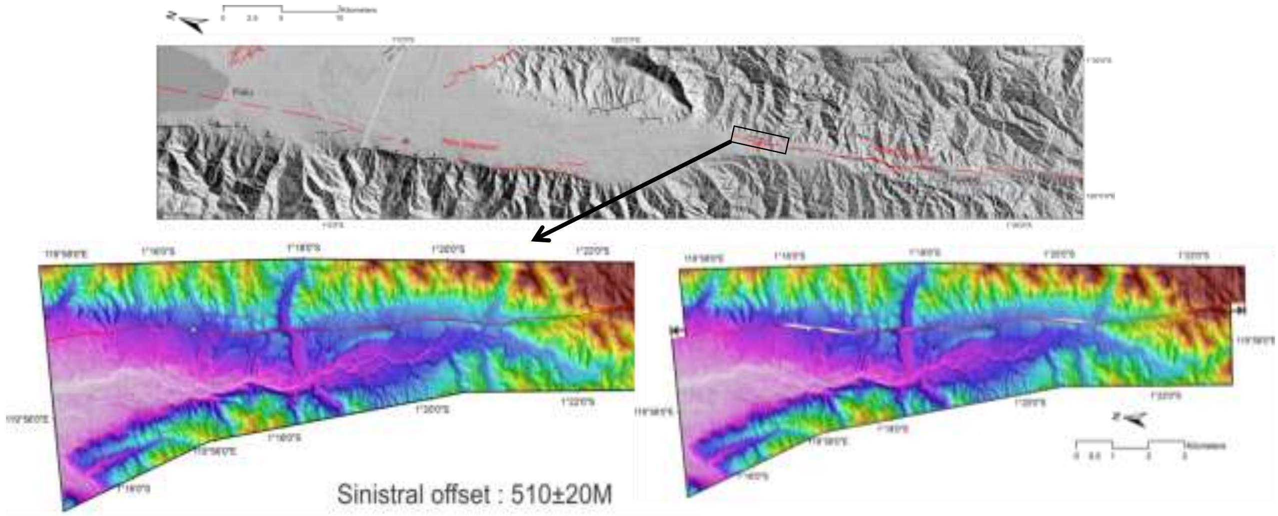


Big problem → finding exact location !

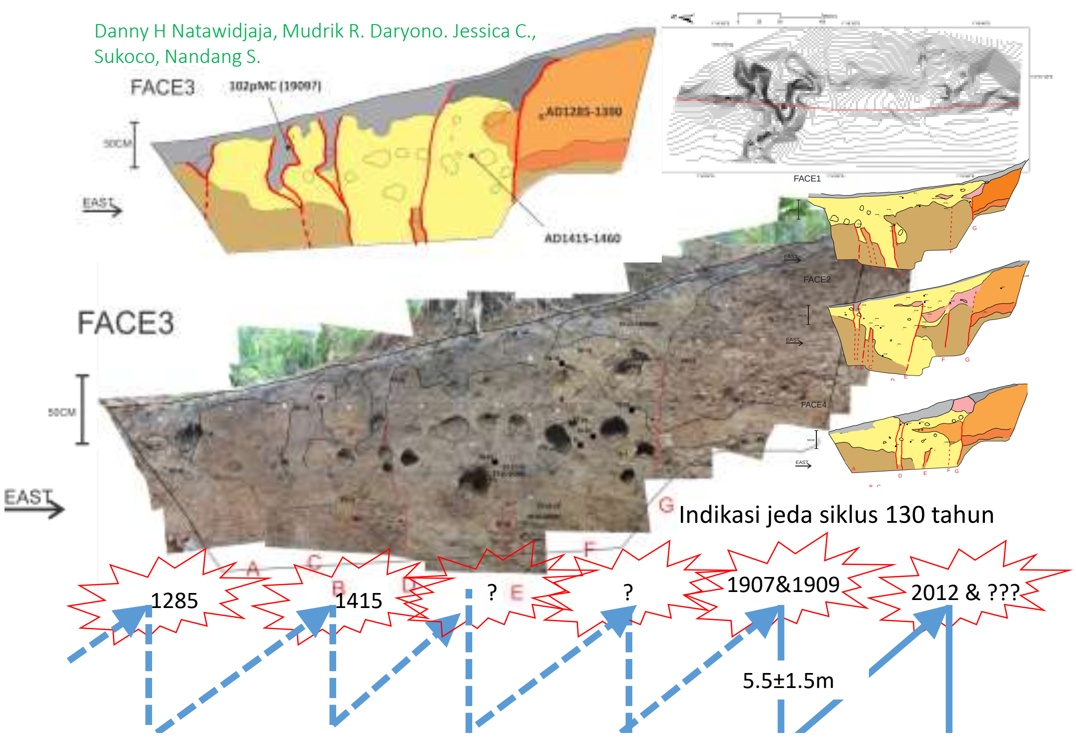
Paleoseismology Trenching



4 Segment - Sesar Palukoro



- Catatan sejarah pernah terjadi gempabumi besar pada tahun 1909.




MENDUGA LINDU DI PATAHAN PALU-KORO

Tim LIPI memprediksi ada ulangan gempa di Sulawesi Tengah tahun ini seperti pada 1907 dan 1909. Pakar lain mengkritik metode paleoseismologi yang dipakai.


IPTEK
KUNGAN & KESEHATAN

Waspadai Gempa Besar di Sulawesi

1. ISEDM 2014 Jogjakarta – presentation session
2. BMKG 2014 Special Lecture
3. Majalah Tempo 2014
4. Disertasi S3 2016
5. Kompas cetak 2017 ,
6. Gubernur Sulteng – Ekspedisi Palukoro , Juli 2018

Surface rupture Gempa 2018 di uji paritan paleoseismologi: 320cmS/70cmD

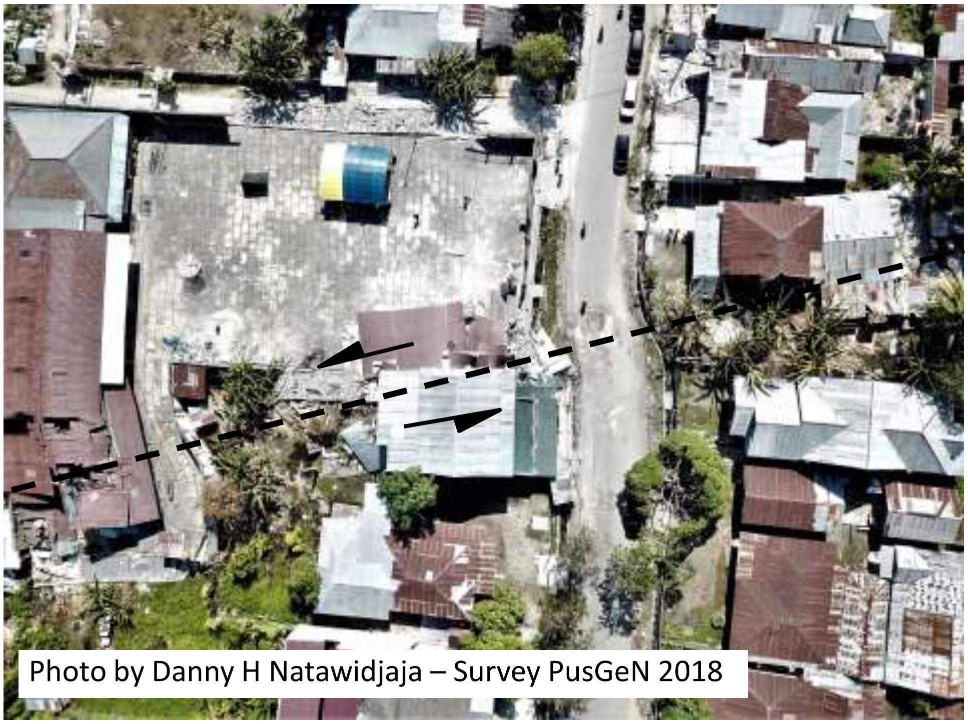


Photo by Danny H Natawidjaja – Survey PusGeN 2018

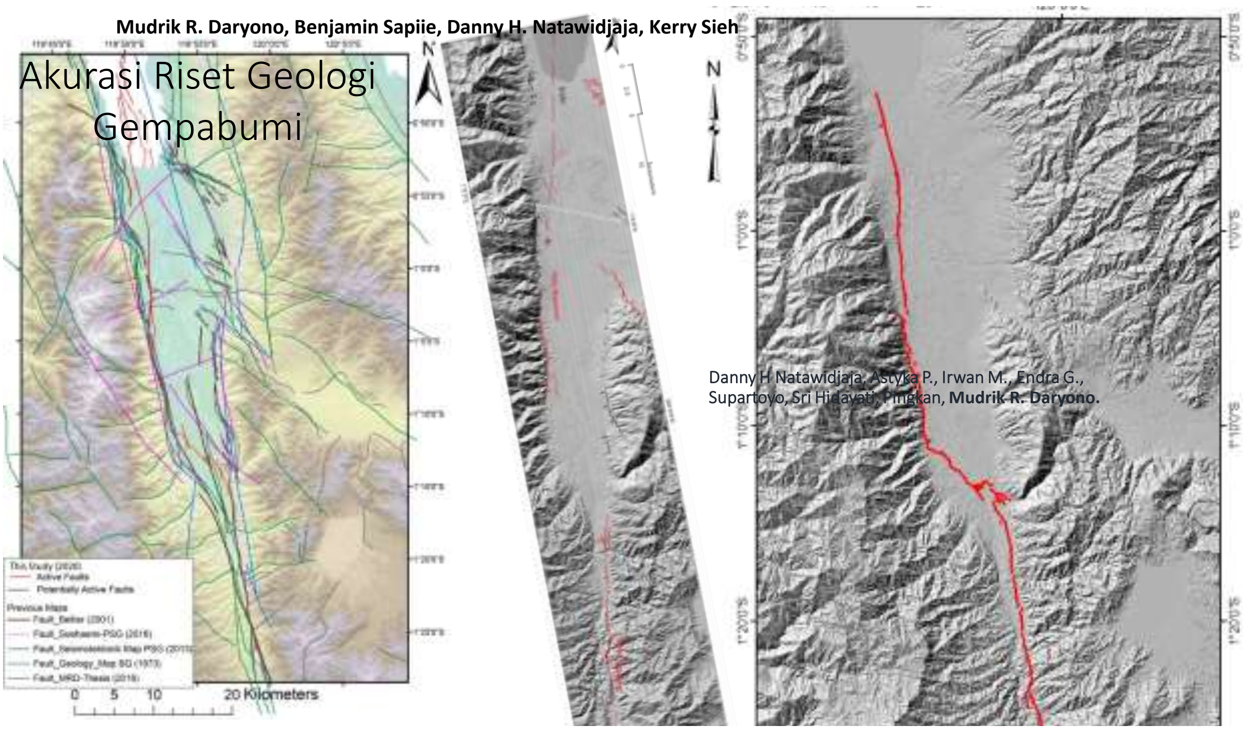

Photo by Danny H Natawidjaja – Survey PusGeN 2018

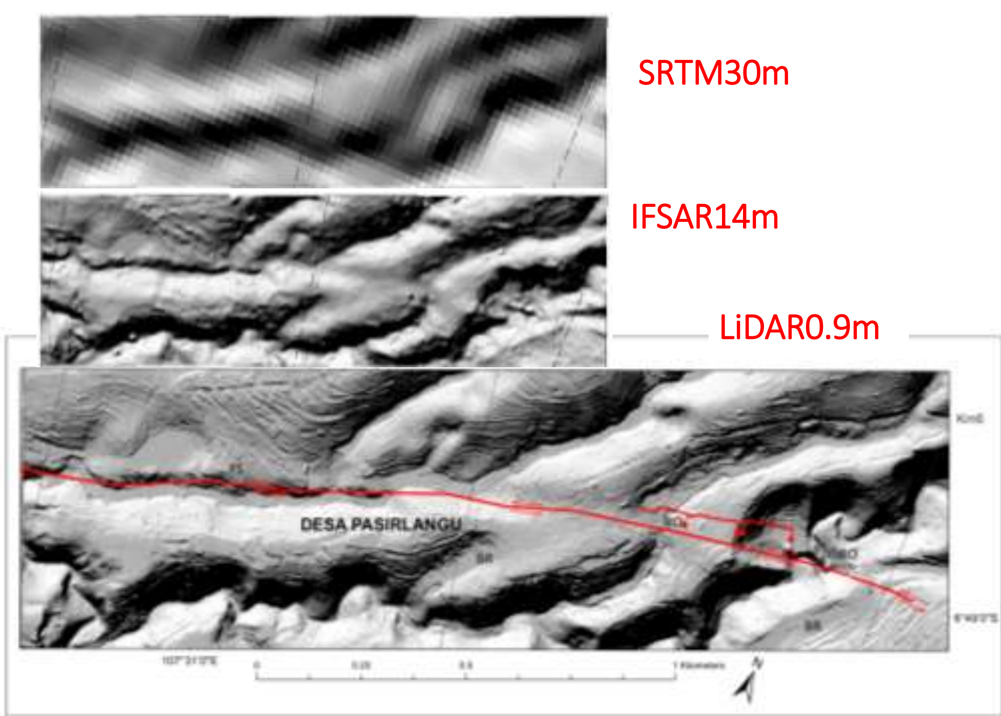
Photo by Danny H Natawidjaja – Survey PusGeN 2018

Photo by Danny H Natawidjaja – Survey PusGeN 2018

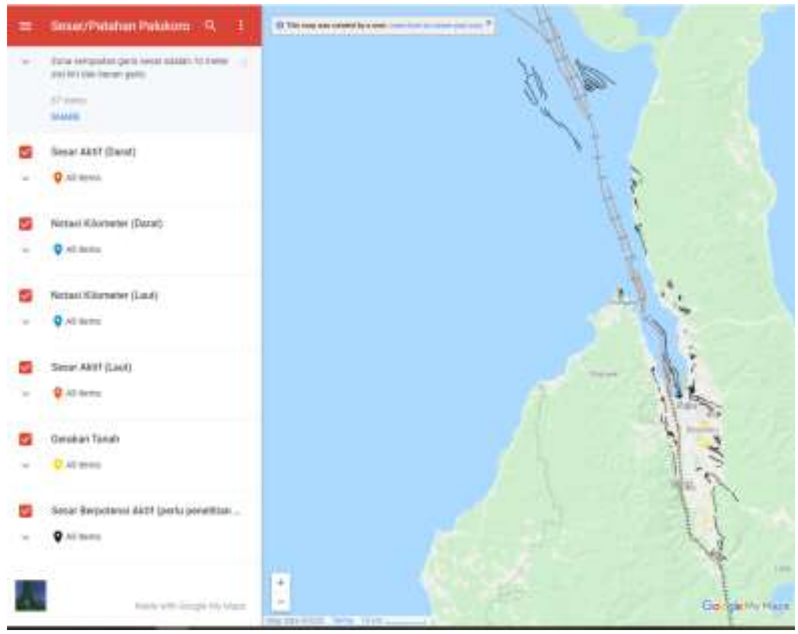
Akurasi Riset Geologi Gempabumi

Mudrik R. Daryono, Benjamin Sapiie, Danny H. Natawidjaja, Kerry Sieh





https://goo.gl/maps/pkiou8t68DVcu2YE6



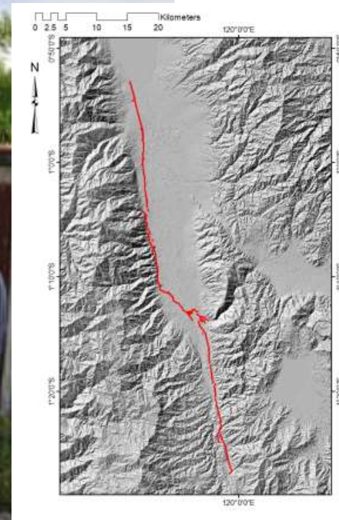
2. PALEOSEISMOLOGI.

Morfogenik gempabumi lampau
=Retakan akibat gempabumi lampau

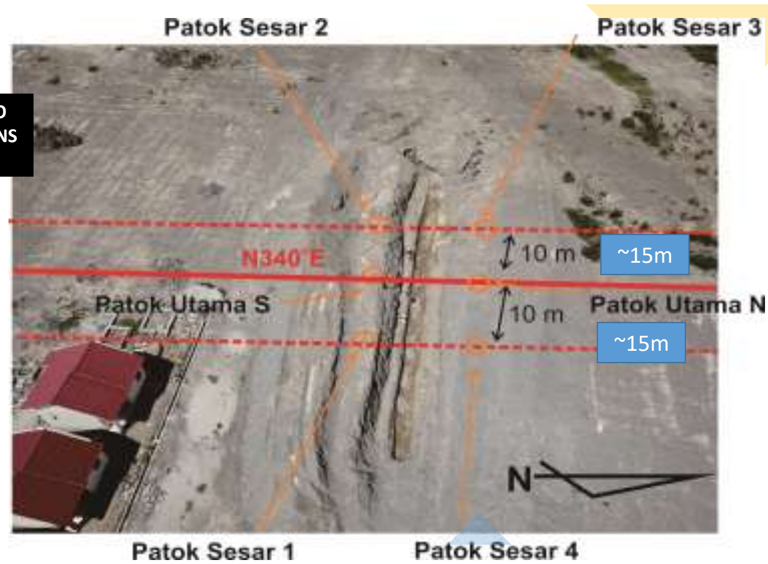
→*Retakan akibat gempabumi masa kini=*
retakan permukaan (surface rupture)

1) <u>Geometri sesar →</u> Lokasi PASTI sumber gempabumi, panjang sesar, dan segmentasi.
2) <u>Kinematika sesar →</u> Rekonstruksi pergeseran sungai
3) <u>Karakteristik gempabumi</u>nya → Besar magnitud, kejadian gempa bumi, pola retakan gempabumi , besar pergeseran, laju pergeseran (*sliprate),* dan siklus gempa bumi.

Membangun Kota dengan Konsep Baru.

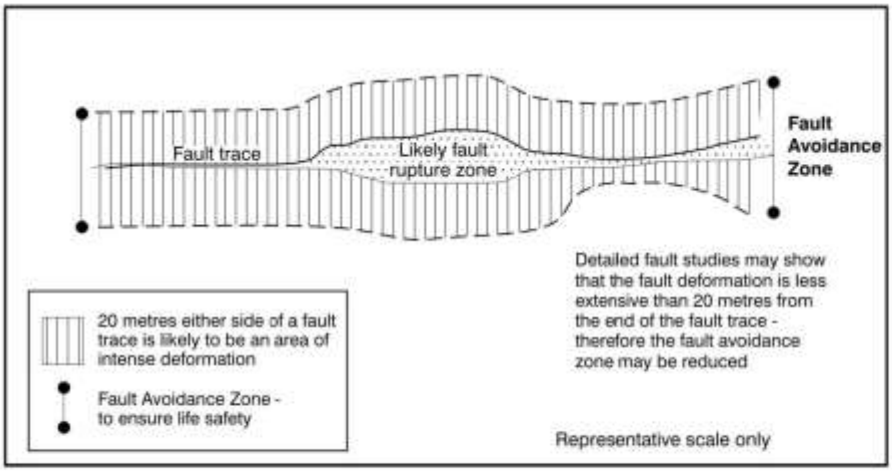


APPLICATION TO FAULT ZONATIONS (BUFFER)



SELAIN ZONASI SEISMIC HAZARDS (=GROUND MOTION) JUGA PERLU DIBUAT

ZONASI BAHAYA DEFORMASI SESAR AKTIF



Catatan: contohnya sudah diterapkan di USA dan New Zealand

Chi-chi Fault 1999 (Taiwan)

SPECIAL CONSTRUCTION

Kerry Sieh

Kerry Sieh

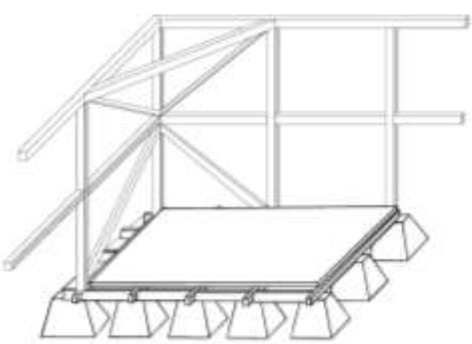
West coast of Nias island, Sumatra after March 2005 earthquake

#Riset&Pendidikan Masyarakat

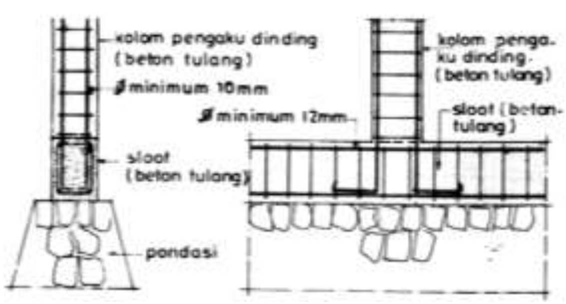
EARTHQUAKE GEOLOGY DATABASE – HIGH RESOLUTION

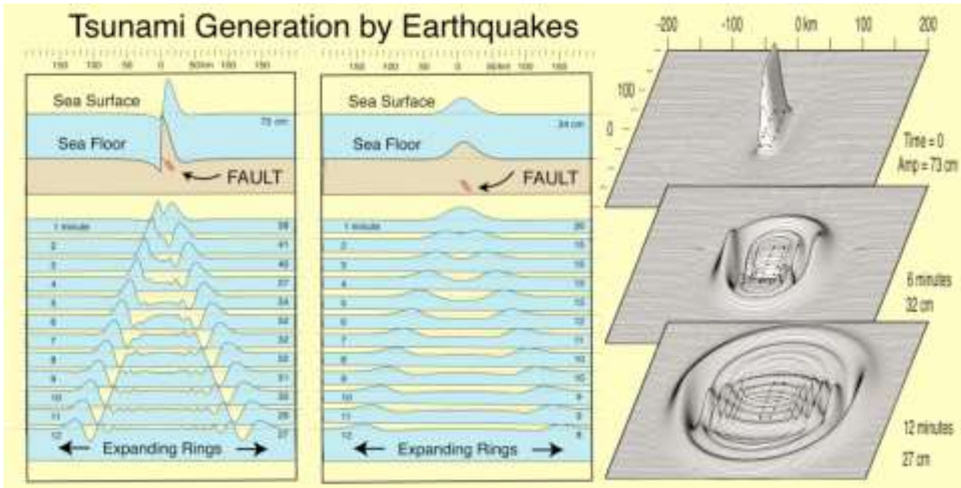
https://goo.gl/maps/pkiou8t68DVcu2YE6

https://goo.gl/maps/C5tV7E56ksUvx9nm8

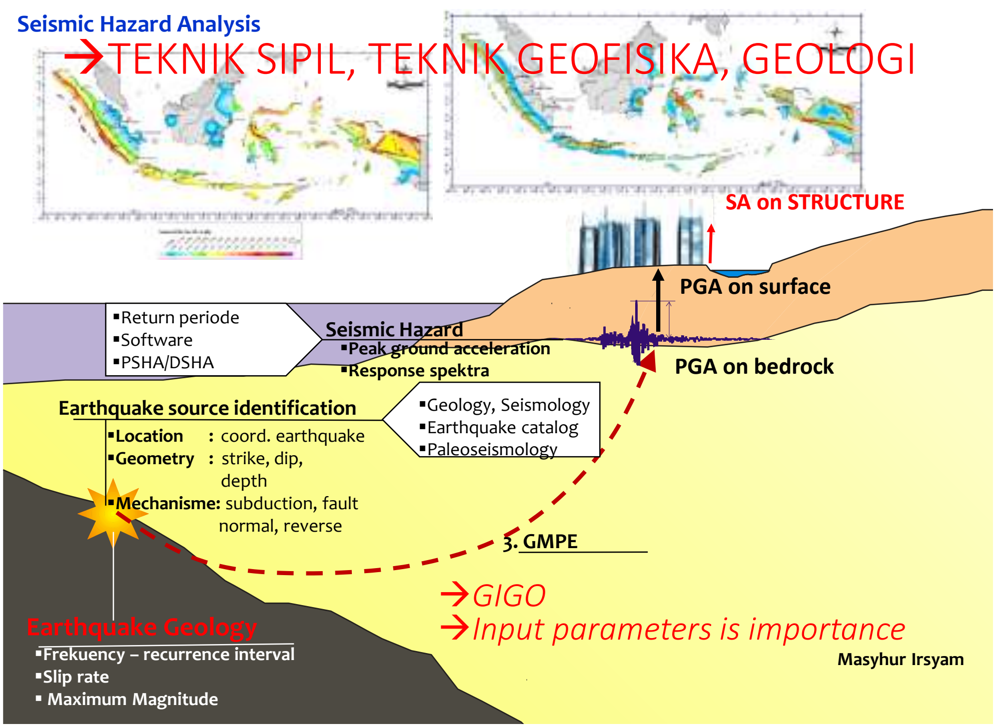


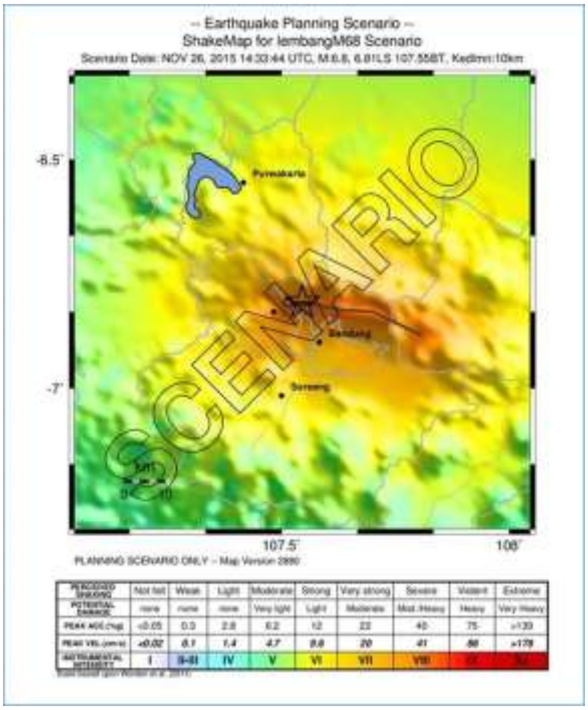
- SNI 03-1726-2002, Tata Cara Perencanaan Ketahanan Gempa Untuk Bangunan.
- SNI 03-2847-1992, Tata Cara Perencanaan Struktur Beton untuk Bangunan Gedung
- RSNI T – 02 - 2003, Tata Cara Perencanaan Konstruksi Kayu Indonesia
- SNI 03 – 1729 - 2002, Tata Cara Perencanaan Struktur Baja untuk Bangunan
- SNI 03 – 6816 – 2002, Tata Cara Pendetailan Penulangan Beton Bertulang Indonesia




Tsunami Generation by Earthquakes
Sea Surface
Sea Floor
FAULT
Expanding Rings
Time = 0
Amp = 73 cm
6 minutes
32 cm
12 minutes
27 cm

Ward, 2010


Seismic Hazard Analysis
→TEKNIK SIPIL, TEKNIK GEOFISIKA, GEOLOGI
SA on STRUCTURE
PGA on surface
PGA on bedrock
▪Return periode
▪Software
▪PSHA/DSHA
Seismic Hazard
▪Peak ground acceleration
▪Response spektra
Earthquake source identification
▪Location : coord. earthquake
▪Geometry : strike, dip, depth
▪Mechanisme: subduction, fault normal, reverse
▪Geology, Seismology
▪Earthquake catalog
▪Paleoseismology
3. GMPE
→GIGO
→Input parameters is importance
Earthquake Geology
▪Frekuency – recurrence interval
▪Slip rate
▪ Maximum Magnitude
Masyhur Irsyam



VIII MMI

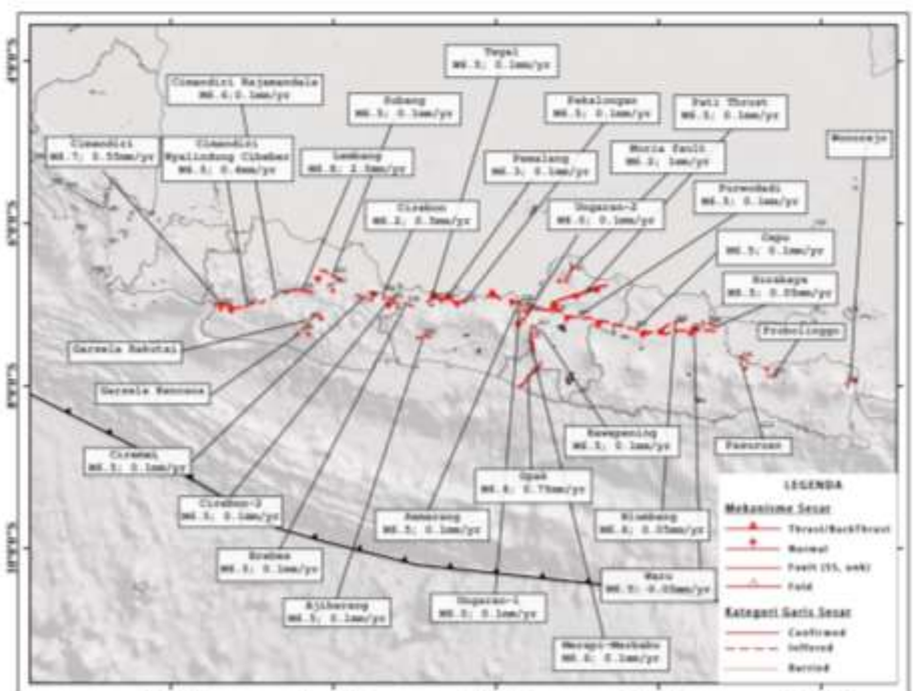
Kerusakan ringan pada bangunan dengan konstruksi yang kuat. Retak-retak pada bangunan degan konstruksi kurang baik, dinding dapat lepas dari rangka rumah, cerobong asap pabrik dan monumen-monumen roboh, air menjadi keruh.

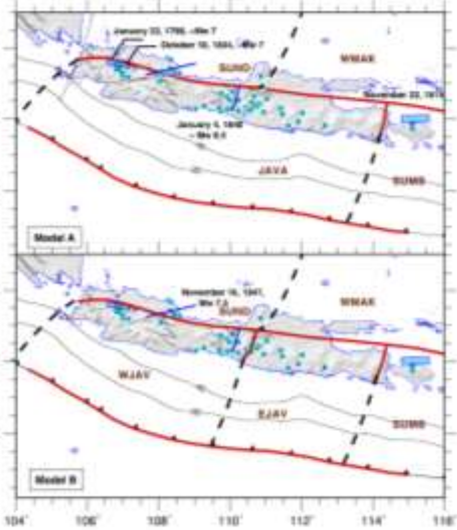
IX MMI

Kerusakan pada bangunan yang kuat, rangka-rangka rumah menjadi tidak lurus, banyak retak. Rumah tampak agak berpindah dari pondamennya. Pipa-pipa dalam rumah putus.

X MMI

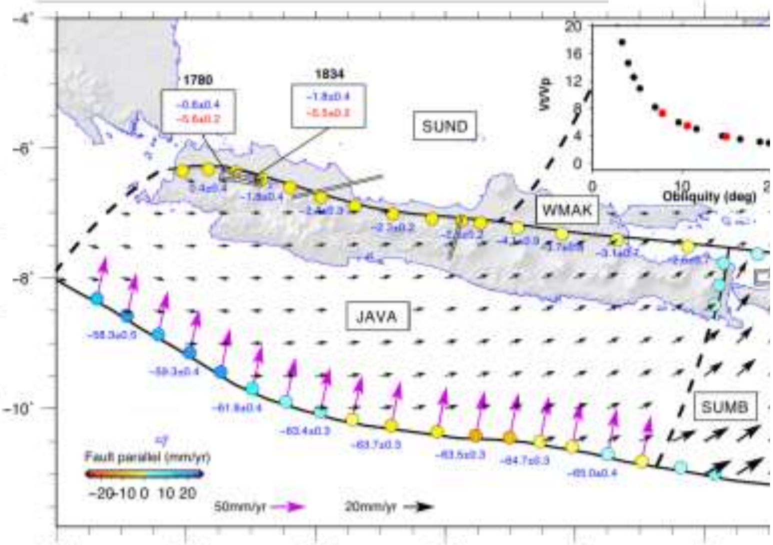
Bangunan dari kayu yang kuat rusak,rangka rumah lepas dari pondamennya, tanah terbelah rel melengkung, tanah longsor di tiap-tiap sungai dan di tanah-tanah yang curam.





The kinematics of crustal deformation in Java from GPS observations: Implications for fault slip partitioning

A. Koulali, S. McClusky, S. Susilo, Y. Leonard, P. Cummins, P. Tregoning, I. Meilano, J. Efendi, A.B. Wijanarto



Indonesia's Historical Earthquakes

Modelled examples for improving the national hazard map

Ngoc Nguyen, Jonathan Griffin, Athanasius Cipta and Phil R. Cummins

Table 2.15 Model parameters for Scenario A: Fault A

Ground Motion Prediction Equation	[illegible]
Moment Magnitude	7.5
Fault type	[illegible]
Earthquake rupture co-ordinates	[illegible]
Earthquake rupture length	[illegible]
Hypocenter/ Depth	[illegible]
Rake	[illegible]
Dip	[illegible]

Table 2.16 Model parameters for Scenario B: Fault B

Ground Motion Prediction Equation	[illegible]
Moment Magnitude	[illegible]
Fault type	[illegible]
Earthquake rupture co-ordinates	[illegible]
Earthquake rupture length	[illegible]
Hypocenter/ Depth	[illegible]
Rake	[illegible]
Dip	[illegible]

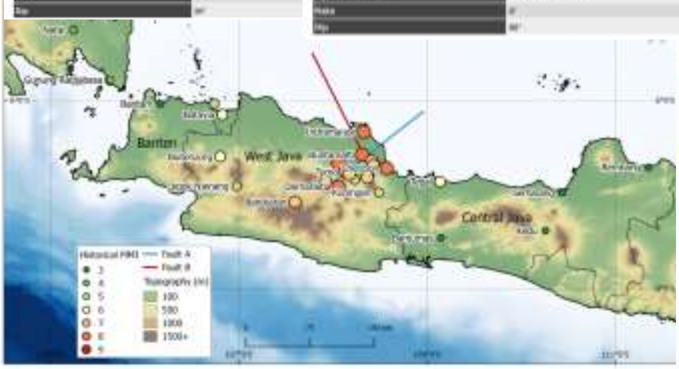


Figure 2.22 Distribution of observed MMI based on historical evidence, and fault traces used to model ground motion shaking for November 16, 1847.

Figure 2.23 Modelled MMI results using parameters outlined in Table 2.15 for Scenario A: Fault A.

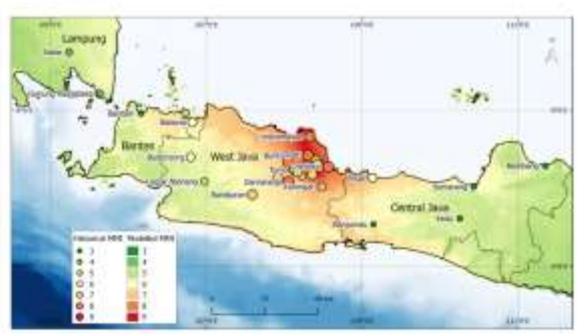
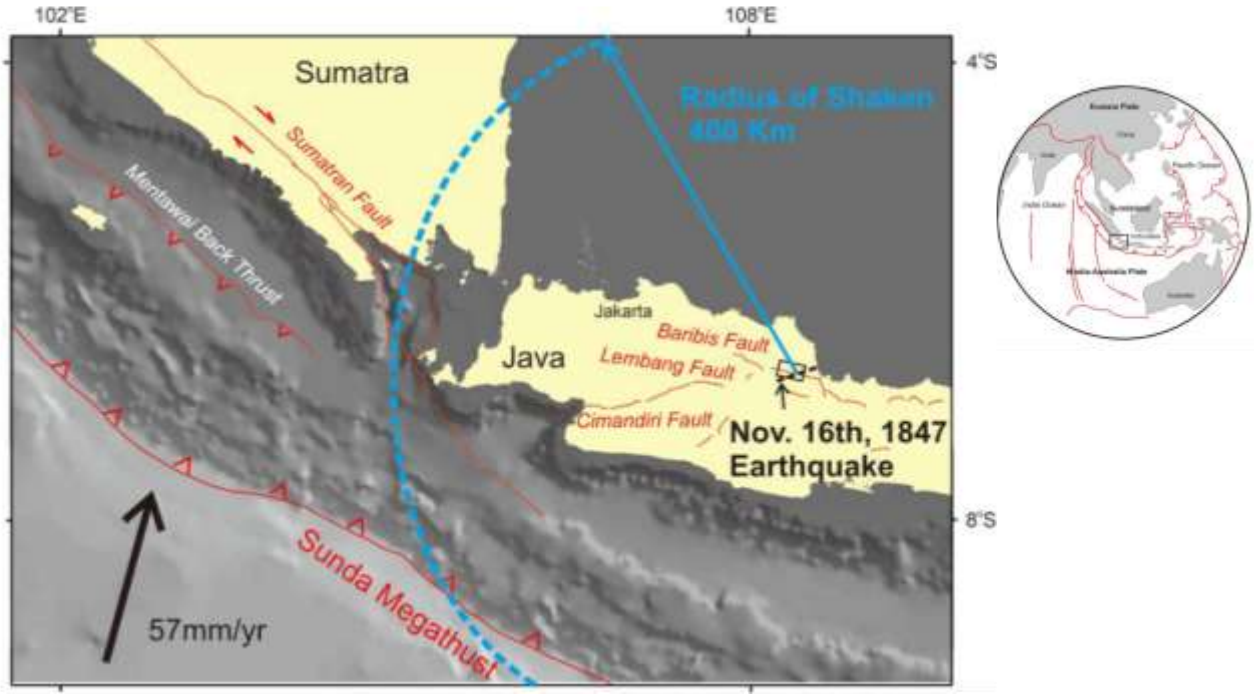
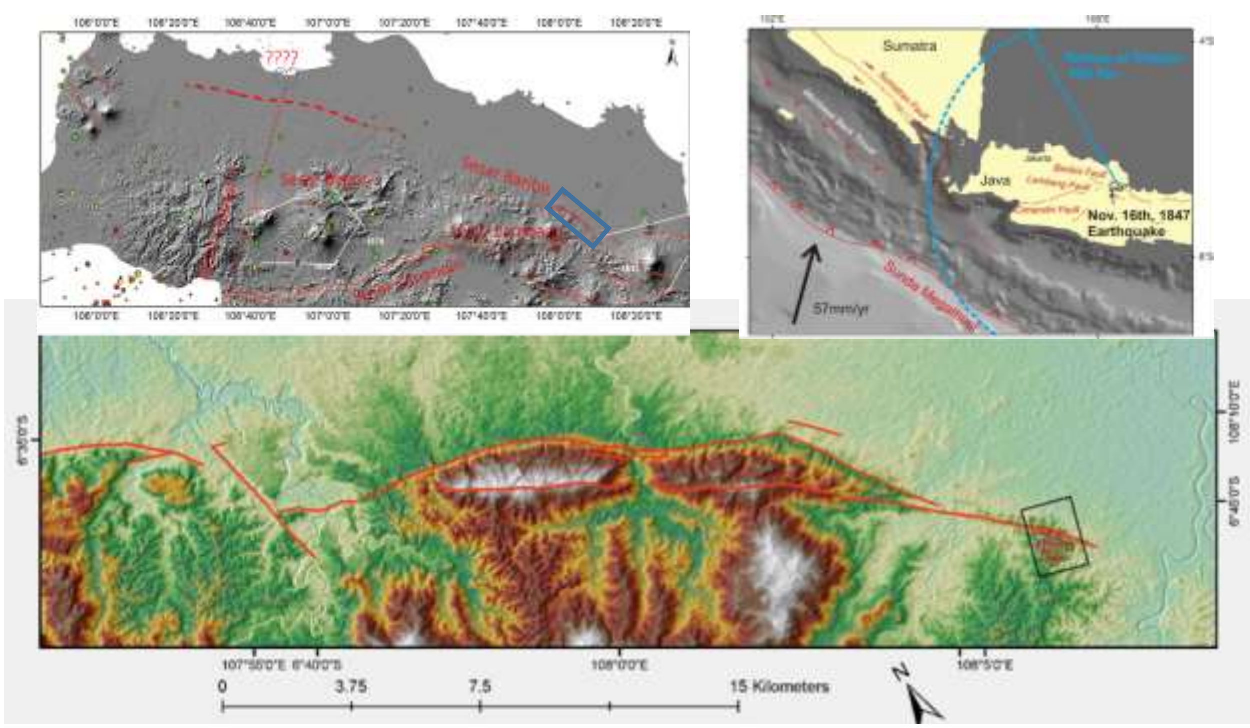
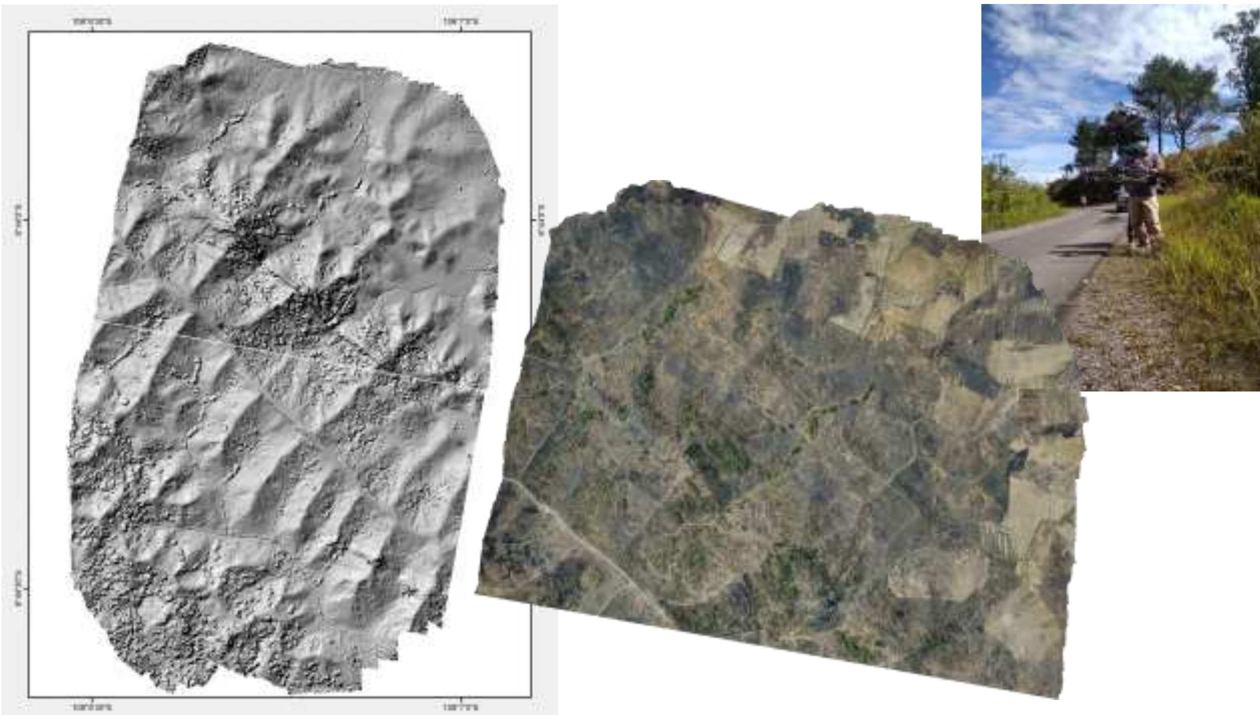
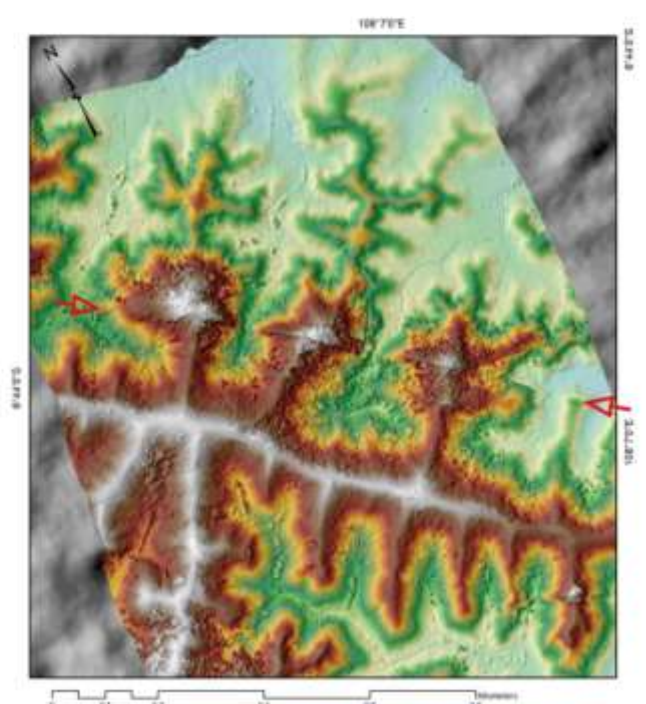


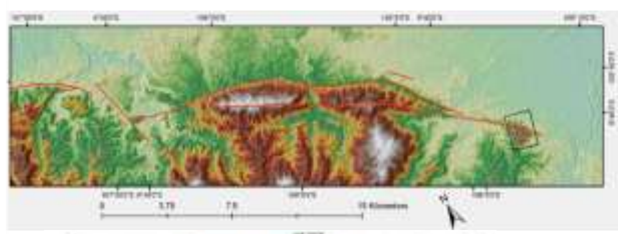
Figure 2.24 Modelled MMI results using parameters outlined in Table 2.16 for Scenario B: Fault B.

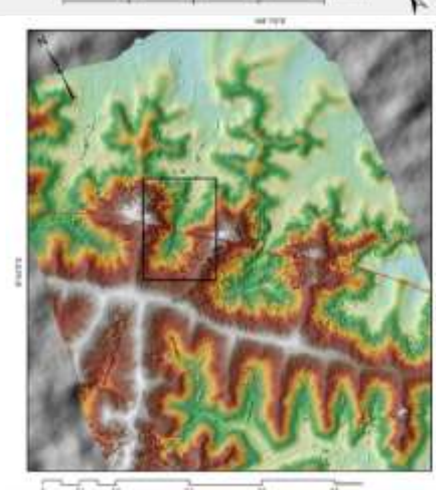

102°E
108°E
4°S
8°S
Sumatra
Radius of Shaken
400 Km
Sumatran Fault
Mentawai Back Thrust
Jakarta
Baribis Fault
Java
Lembang Fault
Cimandiri Fault
Nov. 16th, 1847
Earthquake
Sunda Megathust
57mm/yr

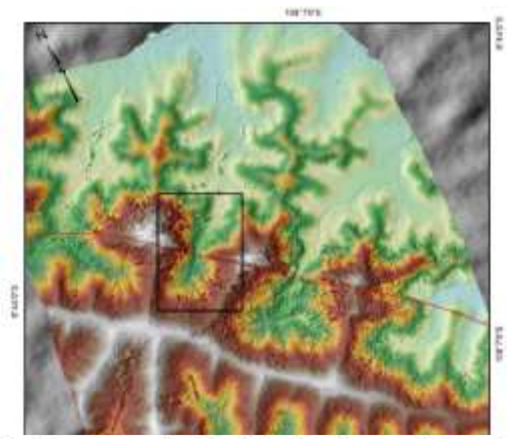

????
Sumatra
Java
Nov. 16th, 1847
Earthquake
57mm/yr
Sunda Megathust
107°55'0"E
108°0'0"E
108°5'0"E
0
3.75
7.5
15 Kilometers
N

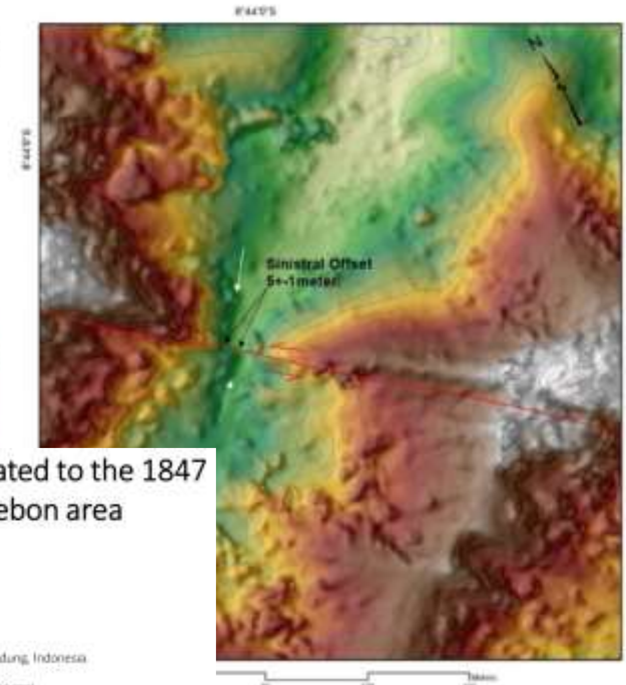












Fault rupture in Baribis Fault possibly related to the 1847 major earthquake event in the Cirebon area

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Danny Hilman Natawidjaja[1]
Anggraini Rizkita Puji[1]
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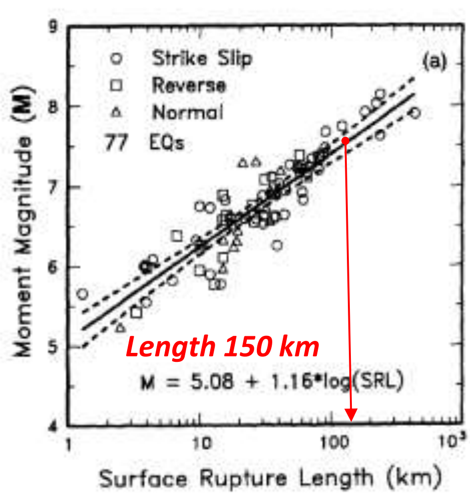
SEACG2020

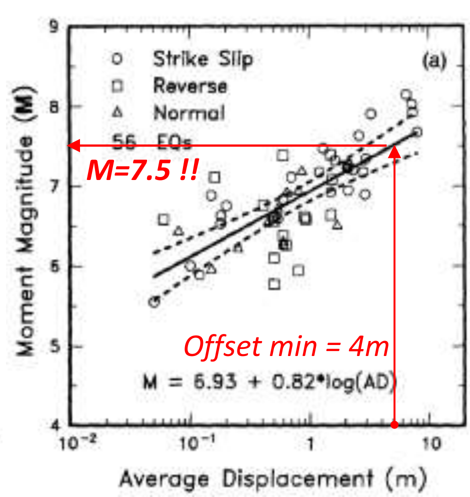
Empirically determined moments

Bulletin of the Seismological Society of America, Vol. 84, No. 4, pp. 974–1002, August 1994

New Empirical Relationships among Magnitude, Rupture Length, Rupture Width, Rupture Area, and Surface Displacement

by Donald L. Wells and Kevin J. Coppersmith

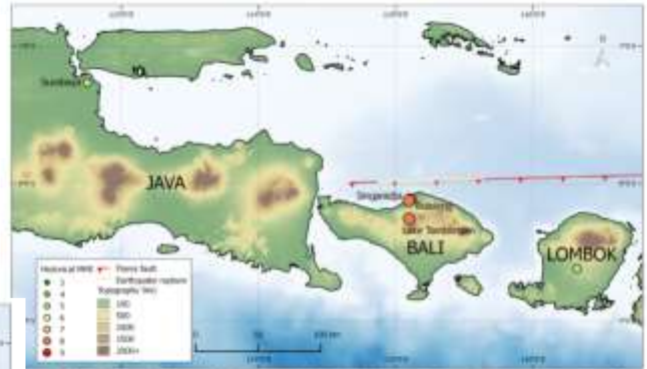




Indonesia's Historical Earthquakes

Modelled examples for improving the national hazard map

Ngoc Nguyen, Jonathan Griffin, Athanasius Cipta and Phil R. Cummins

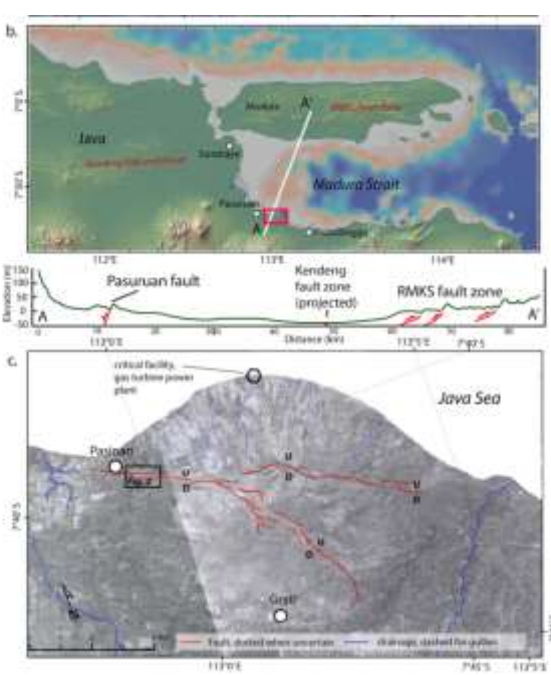


...ure 2.10 Distribution of observed MMI based on historical evidence, and Flores thrust zone with section of ...rthquake rupture for November 22, 1815 highlighted.

Figure 2.11 Modelled MMI results using parameters outlined in Table 2.8 for November 22, 1815.

Table 2.8 Model parameters used for November 22, 1815.

Ground Motion Prediction Equation	ZhaoEtAl2006SInter
Moment Magnitude	7.3
Fault type	Reverse
Earthquake rupture co-ordinates	114.874° -7.996° 115.642° -7.971°
Earthquake rupture length	85 km
Hypocentre/ Depth	115.176° -7.987°/ 10 km
Rake	90°
Dip	30°



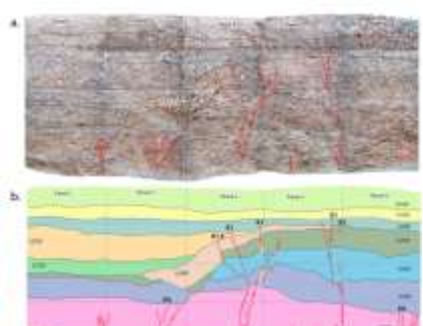
AGU100

Tectonics

RESEARCH ARTICLE

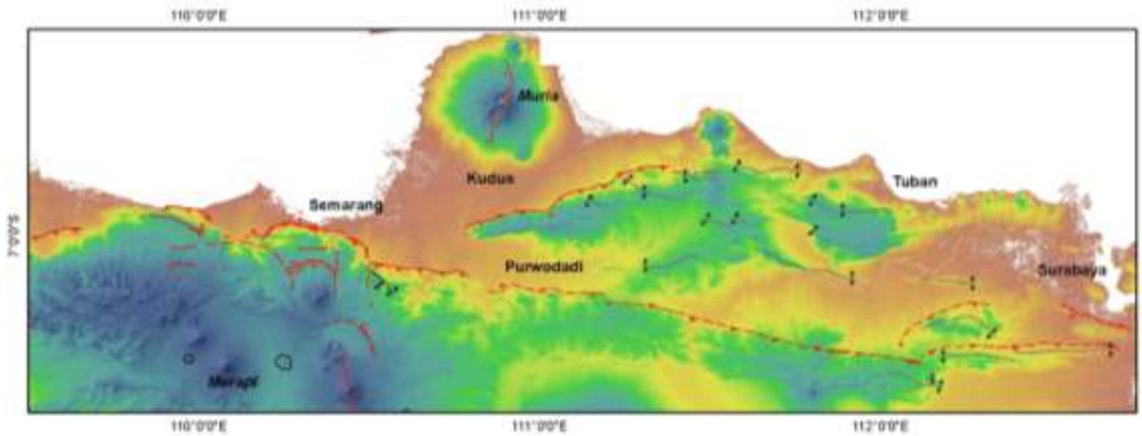
Evidence for Multiple Ground-Rupturing Earthquakes in the Past 4,000 Years Along the Pasuruan Fault, East Java, Indonesia: Documentation of Active Normal Faulting in the Javan Backarc

Abstract



1. Dr. Cecep Pratama (GD-UGM; cecep.pratama@ugm.ac.id)
2. Prof. Takeo Ito (Nagoya Univ.)
3. Dr. Agustan (BPPT/BRIN)
4. Dr. Mudrik R. Daryono

Studi Geodetic: Triple junction – Sesar Kendeng, Lasem dan Semarang.



Kesimpulan

- ✓Buku Sumber Gempa 2017 PUSGEN; buku terbaik (untuk saat ini).
- ✓Sesar Baribis – Kendeng PERLU PENELITIAN LEBIH MENDALAM.
- ✓KECEPATAN GESER / SLIP-RATE ?
- ✓JALUR SESAR AKTIF SKALA BESAR – STREET MAP ?
- ✓GEMPABUMI BESAR YANG PERNAH TERJADI ?
- ✓SEGMENTASINYA ? MMAX ? DAN LAINNYA TTG PARAMETER SESAR AKTIF
- ✓TAHAPAN SIKLUS GEMPA ?
- ✓PERLU UPAYA KEILMUAN BERSAMA: GEOLOGI, GEOLOGI KELAUTAN, GEOFISIKA, SEJARAH, GEODESI, TEKNIK SIPIL, KEBENCANAAN, DLL
- ✓Pemerintah Daerah / Nasional perlu MENCULIK (:dalam arti positif) konsentrasi peneliti untuk lebih cepat/lengkap/dalam di wilayah ini.

QS.An Naml(27)

Terimakasih atas perhatiannya…

QS.An Nahl(16)