

Luncheon Talk

Hidup di Atas Cincin Api

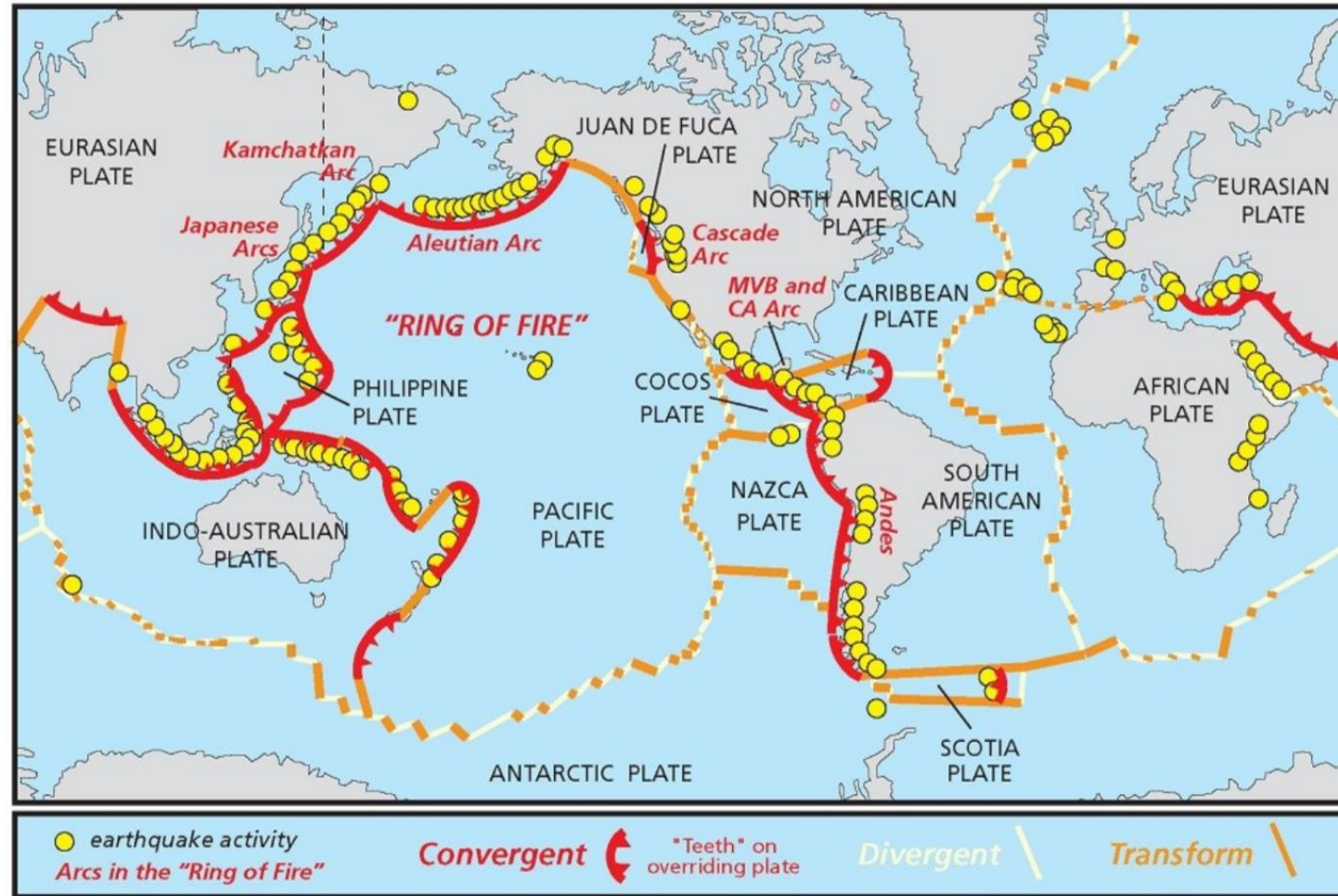
Geologi ITB-72 & ITB-72

Mercure Hotel, Jl. Simatupang, Jakarta

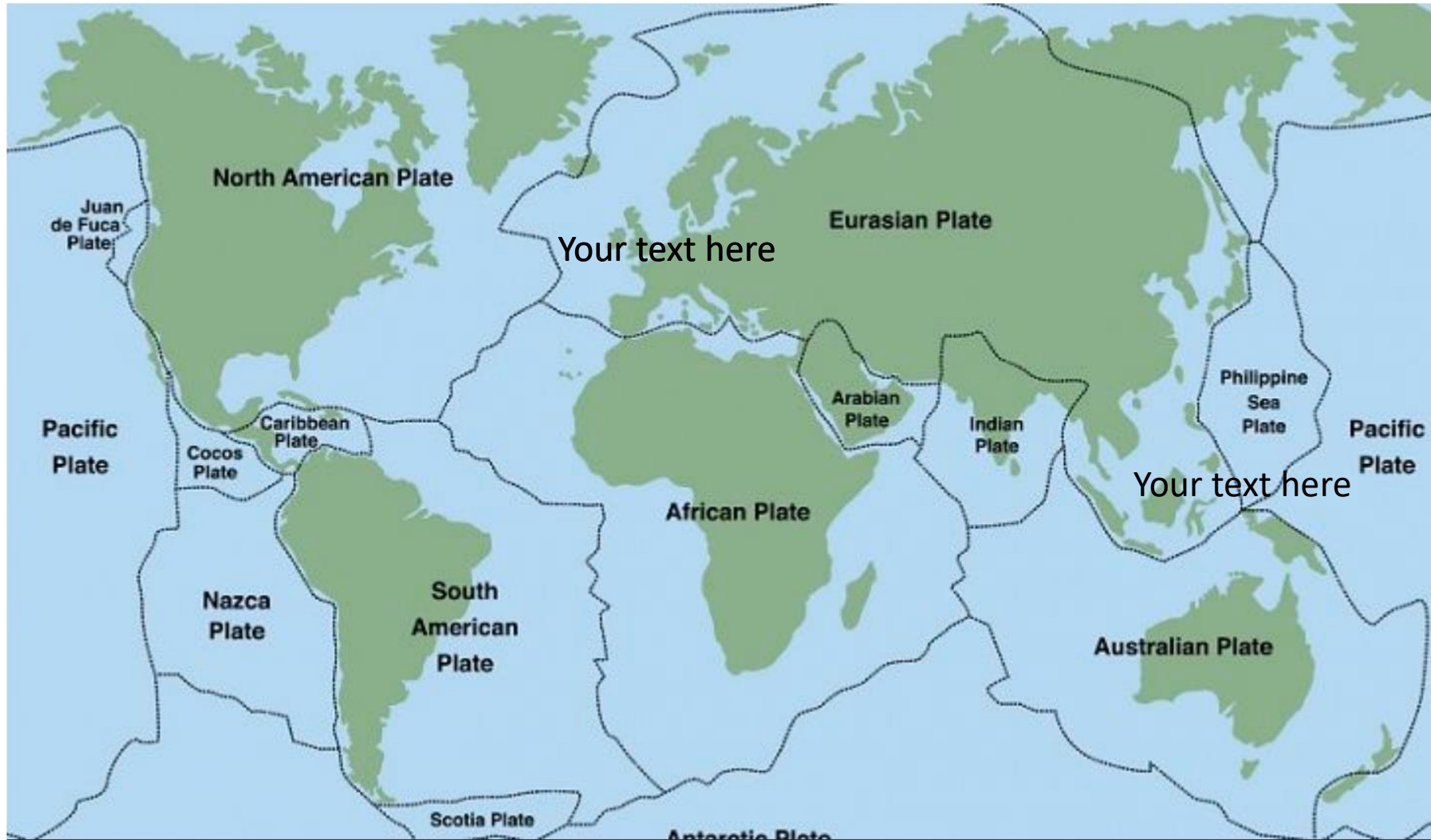
Hery Harjono

7 Oktober 2018

CINCIN API – *RING OF FIRE*



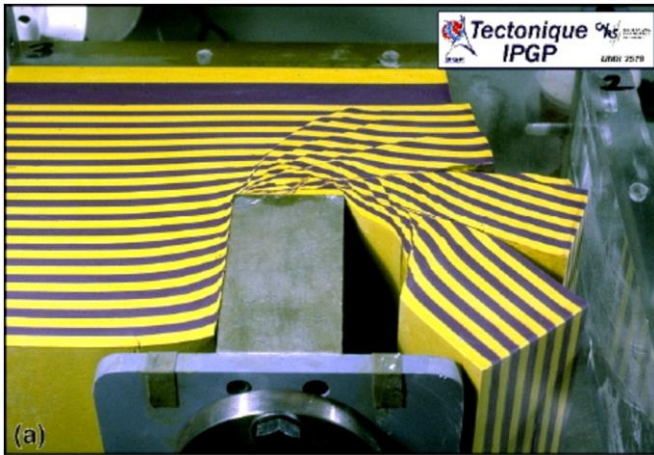
BATAS LEMPENG TEKTONIK



LEMPENG TEKTONIK: ASIA

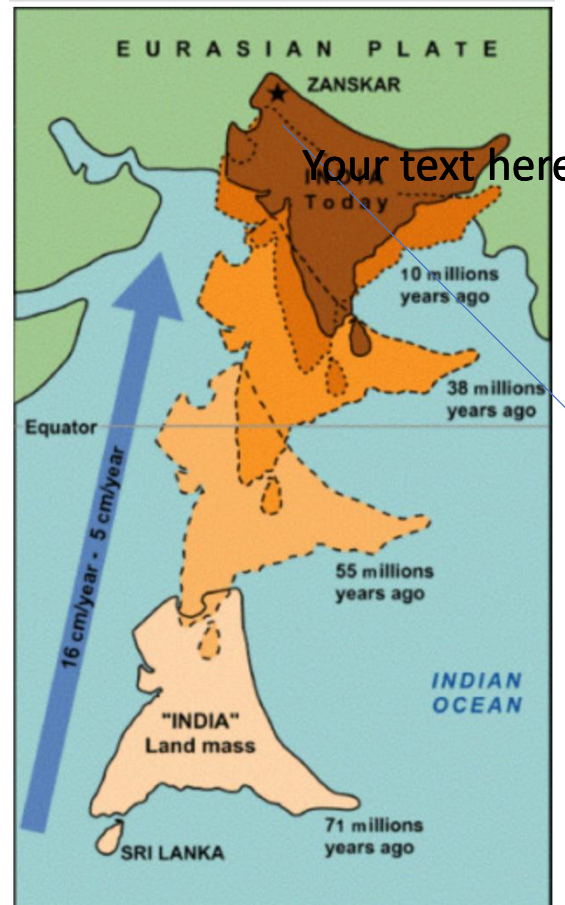


TEKTONIK EKSTRUSI

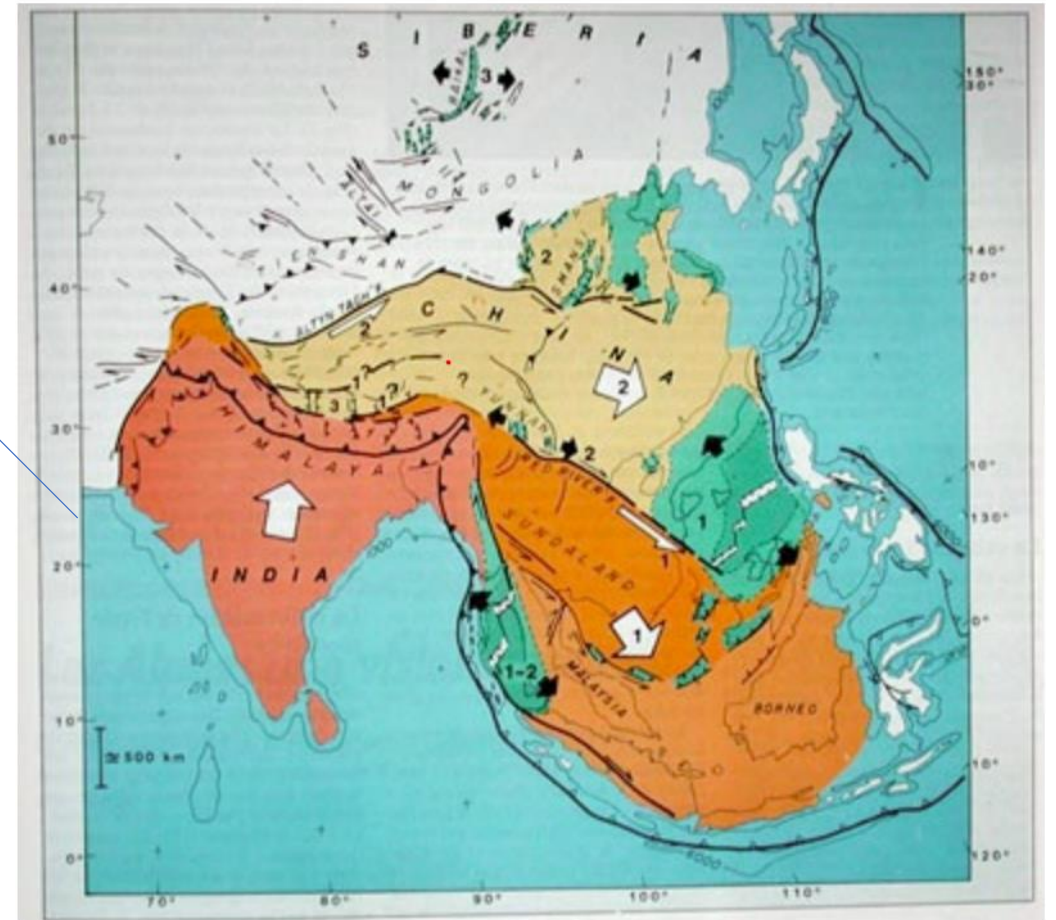


Tapponnier

Tektonik di Indonesia barat, dipengaruhi oleh Tabrakan India – Asia yg menghasilkan Tektonik Ekstrusi



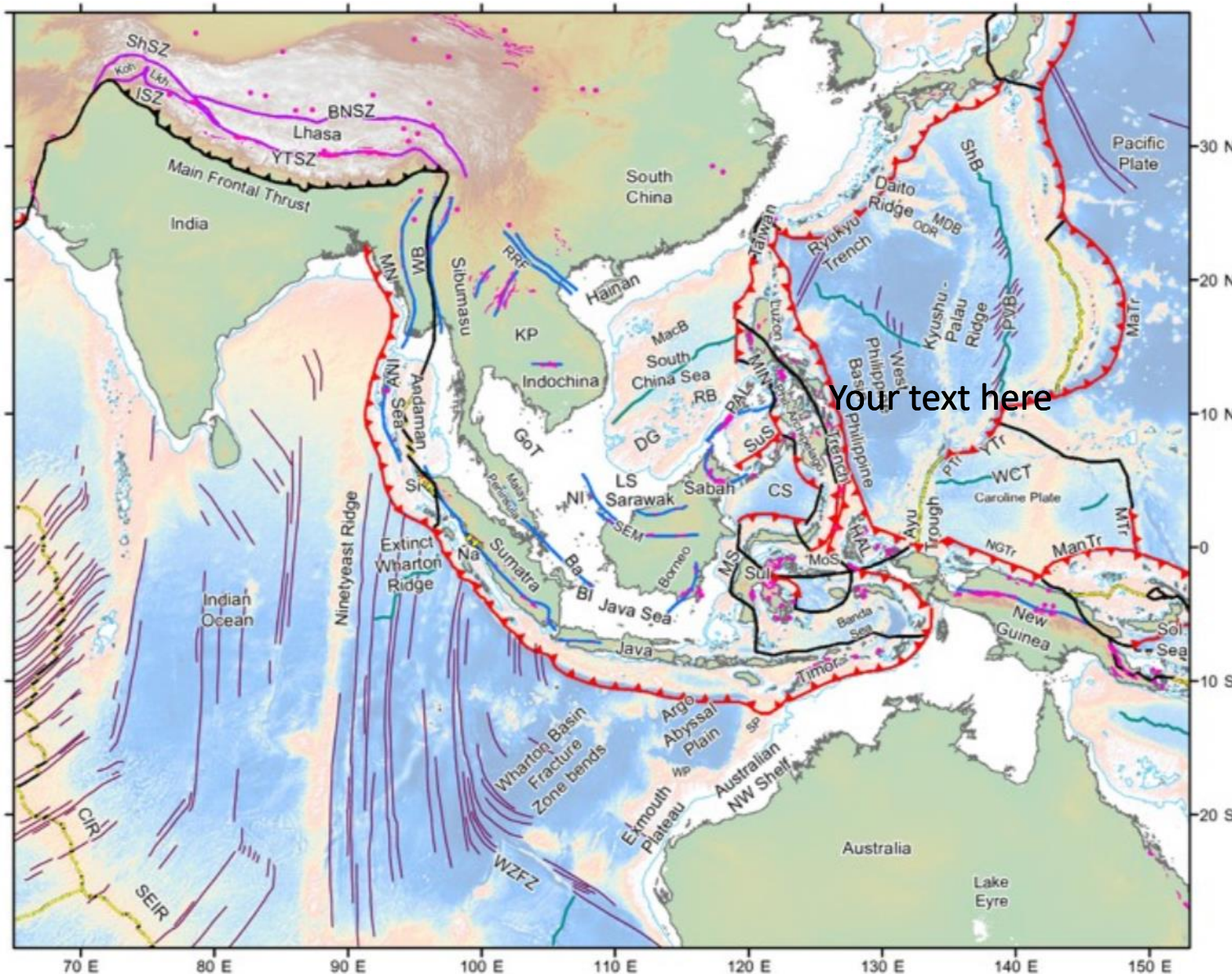
eurasiatectonics.weebly.com



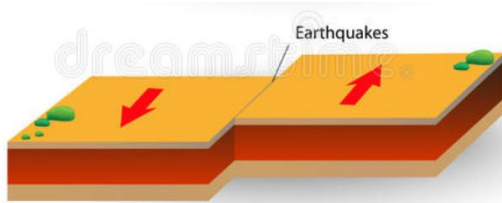
Tapponnier

Tatanan Tektonik Indonesia

- Barat: dipengaruhi tabrakan India-Asia
- Timur: dipengaruhi tabrakan dengan Pasifik, Australia



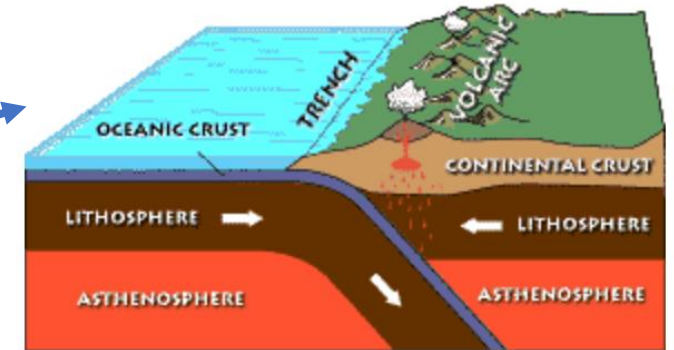
INTERAKSI ANTAR LEMPENG TEKTONIK



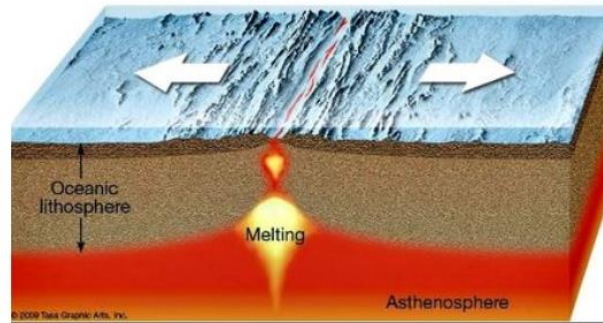
Pergeseran
Horizontal



WorldAtlas.com



Subduksi/Penunjaman: Indonesia



Pemekaran Tengah
Samudra: Atlantik

APA YANG TERJADI PADA RING OF FIRE

- GEMPA BUMI

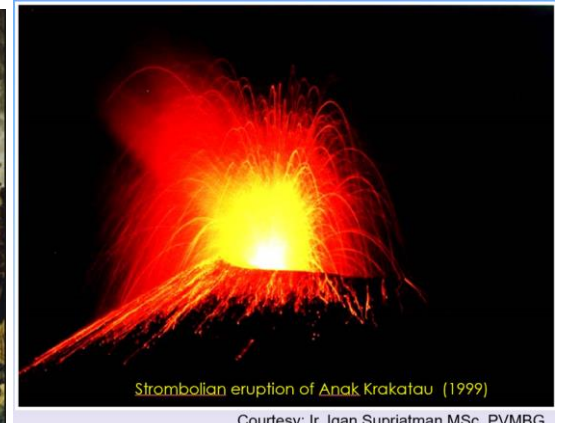
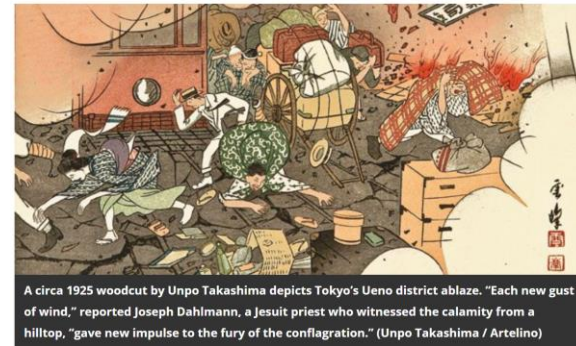
- Pusat gempa bisa dangkal hingga ratusan kilometer (> 700 km)
- Magnitudo bisa hingga M9.5 (gempa Chili, 22 Mei 1960)

- GUNUNG API

- Beberapa letusan besar adalah G. Toba (70 ribu th yl), G. Tambora (1815), Krakatau (1883)....

- GERAK VERTIKAL

- Penurunan atau Kenaikan daratan

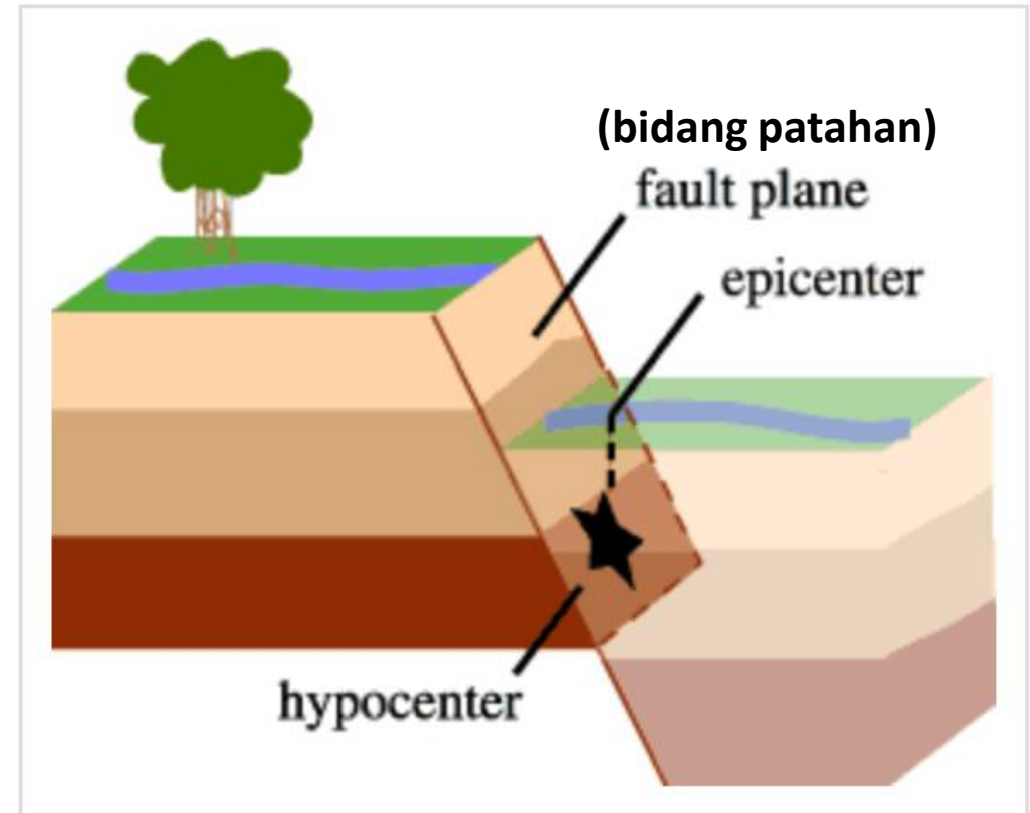


Strombolian eruption of Anak Krakatau (1999)

Courtesy: Ir. Igan Supriatman MSc, PVMBG

APA ITU GEMPA BUMI?

- Gempa adalah dua blok kerak bumi yang bergerak satu sama lain.
- Permukaan, tempat keduanya bergerak di sebut ***patahan (bidang patahan)*** atau juga sering disebut sebagai ***sesar***.
- Sebelum ***gempa utama (main shock)***, kadang ada ***gempa awal (foreshocks)*** dan ***gempa susulan (aftershocks)***

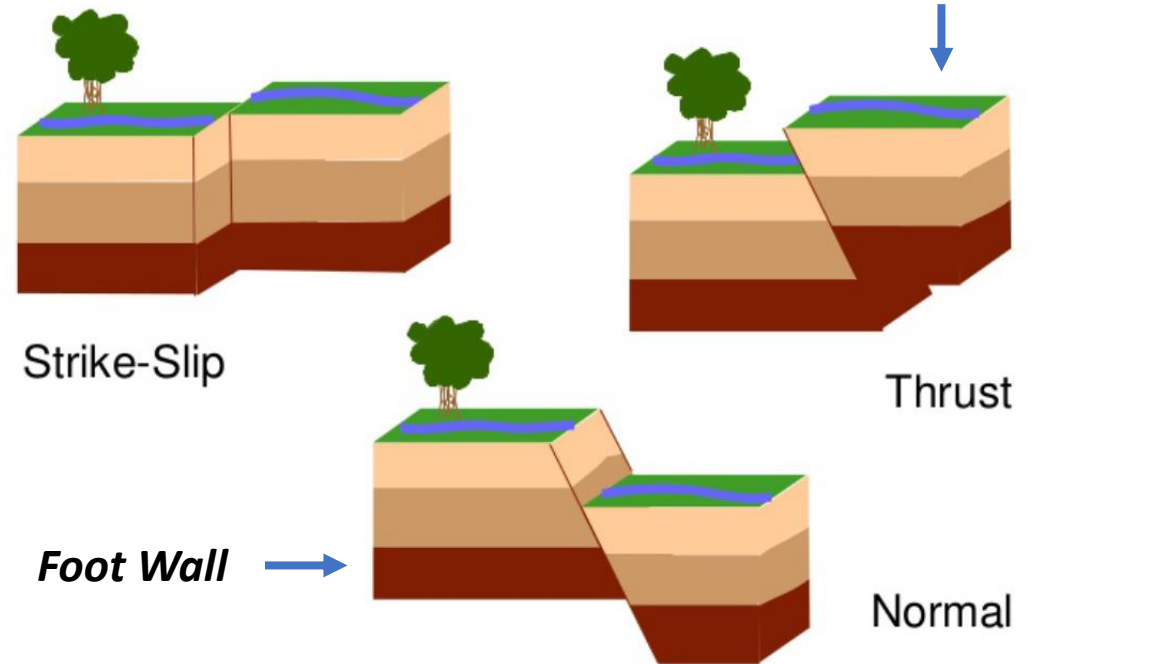


USGS

JENIS PATAHAN

- PATAHAN ***NORMAL (TURUN)***
 - Bagian *hanging wall* turun
 - Tanda pada peta
- PATAHAN ***THRUST (NAIK)***
 - Bagian *hanging wall* naik
- PATAHAN ***STRIKE-SLIP (MENDATAR)***
 - Salah satu bergerak secara mendatar terhadap yang lain

Three Types of Faults



JENIS GEMPA: DARI SISI LOKASI

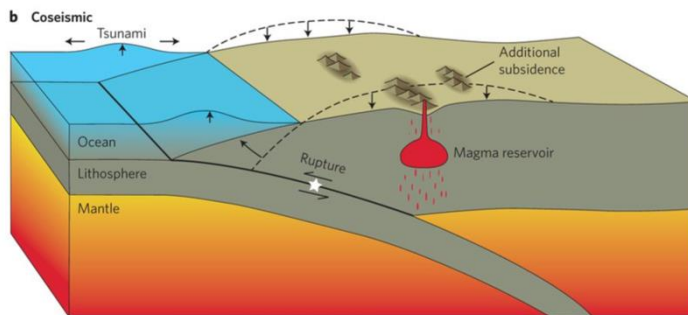
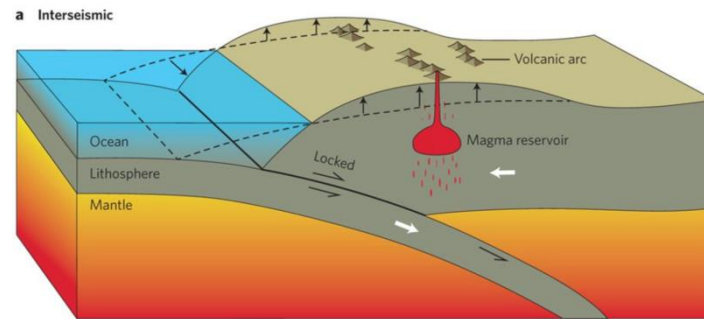
- INTERPLATE : Gempa-gempa yang terjadi pada pertemuan antar lempeng.
 - Gempa-gempa di Indonesia
- INTRAPLATE: Gempa-gempa yang terjadi di dalam lempeng
 - Sangat jarang, kekuatan lebih kecil dibandingkan dengan gempa interplate
 - Penyebab tak diketahui dengan pasti
 - Contoh: Gujarat India (2001), Virginia, USA (2011)



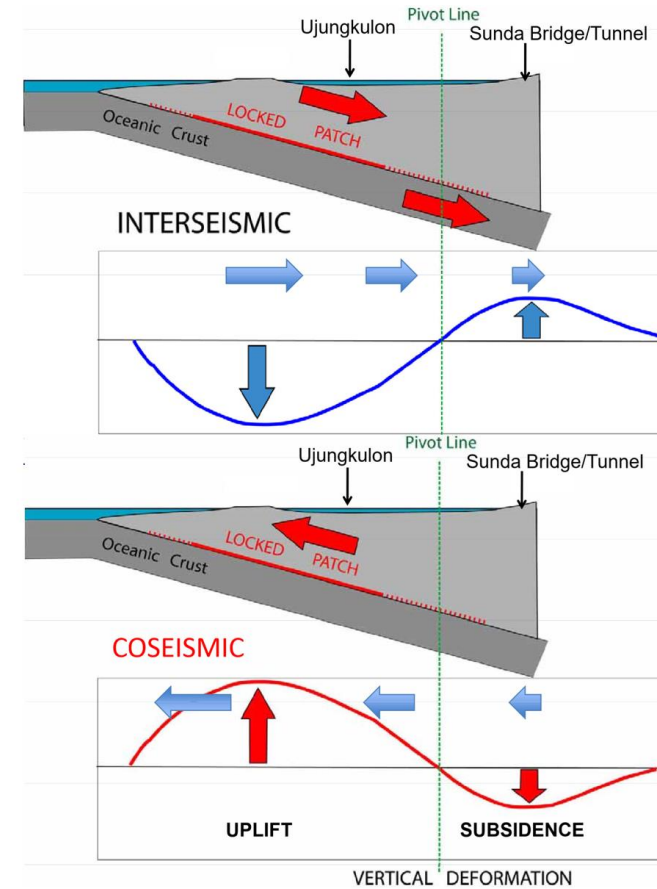
A little girl holds her doll while standing in front of the ruins of her house in western Indian city of Bhuj on 3 April 2001. Reuters

Gempa Gujarat (2001)

MEGATHRUST

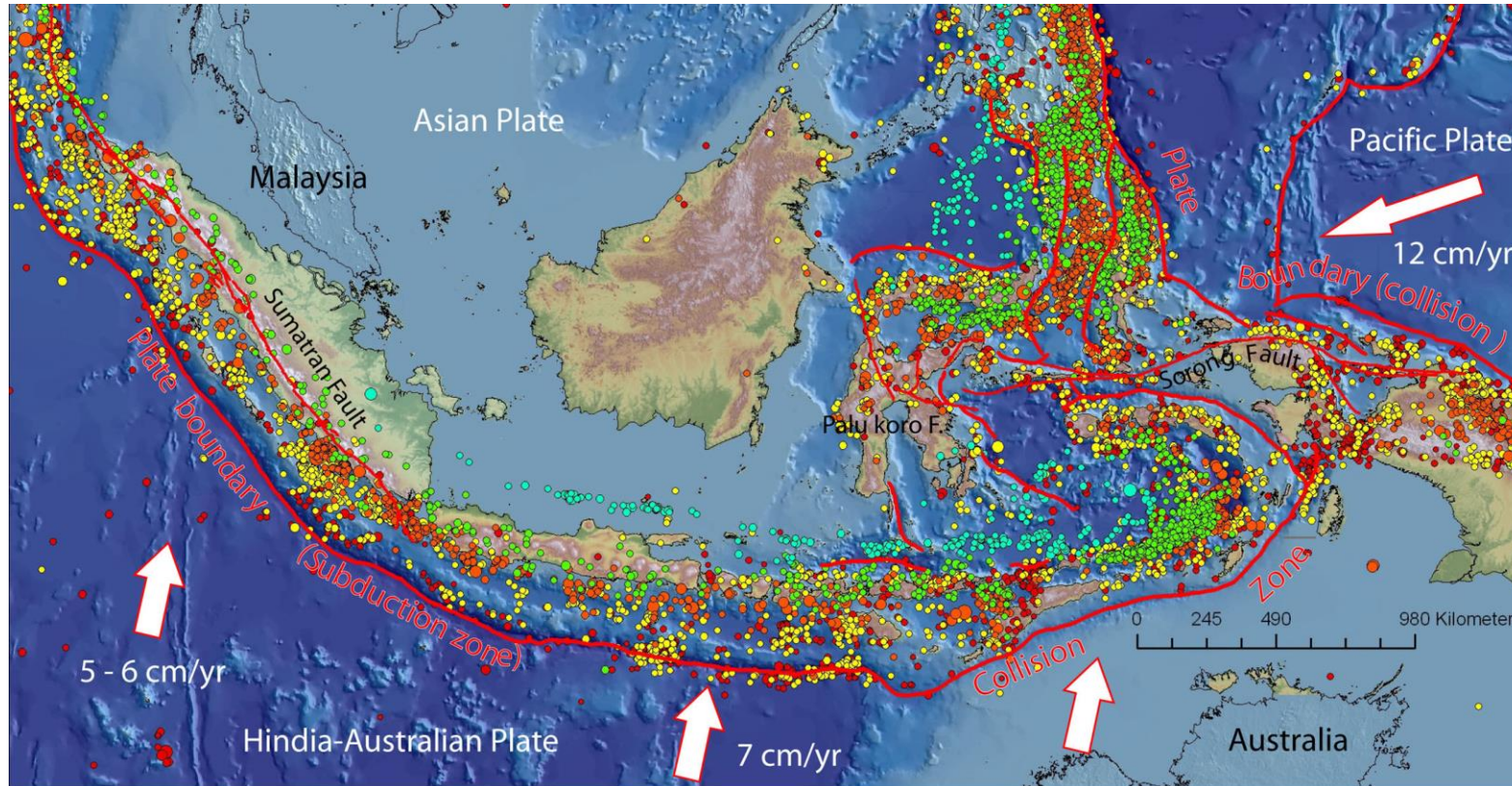


<http://jnewsome1.wixsite.com>



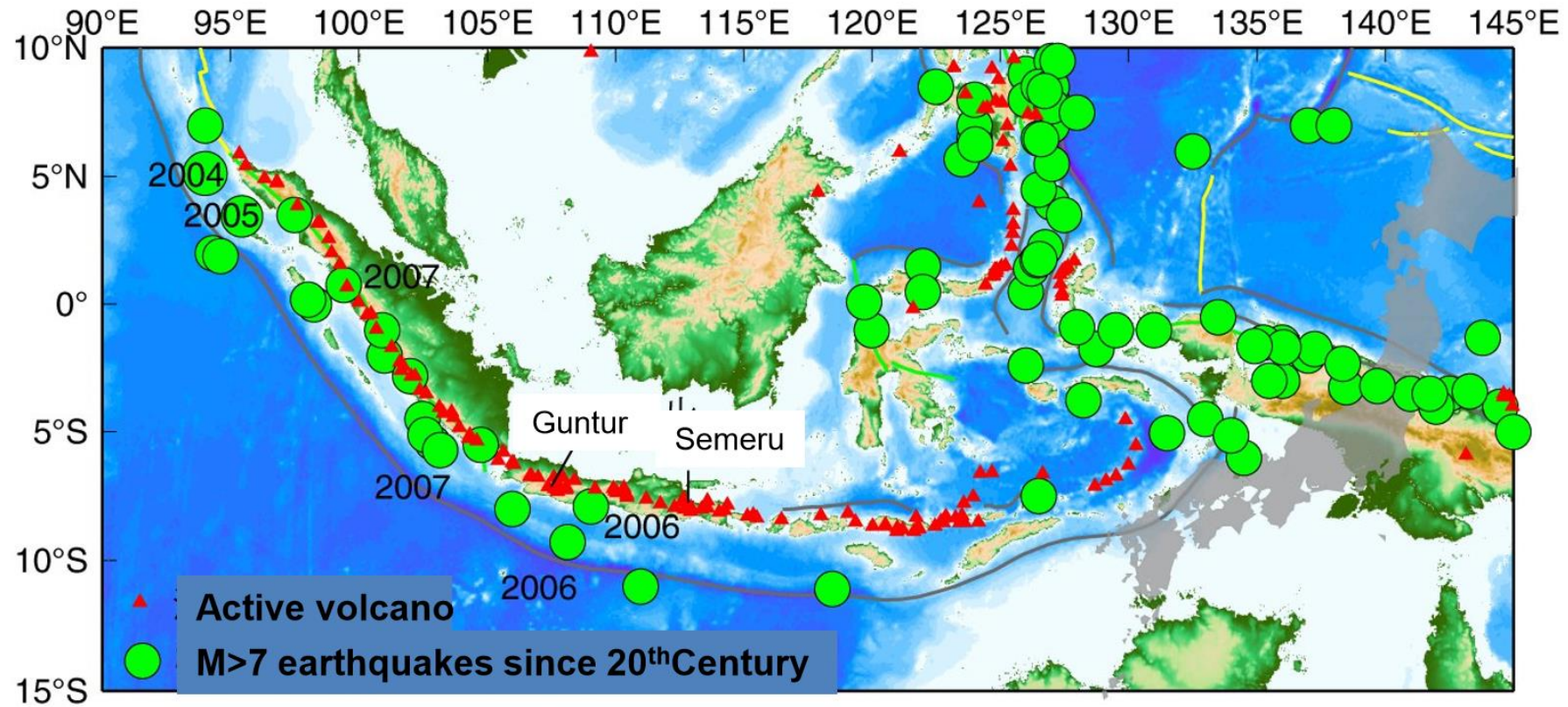
Natawidjaja

PENYEBARAN GEMPA DI INDONESIA



- Hampir semua wilayah Indonesia dipenuhi oleh titik-titik gempa
- Hanya Kalimantan yang relative “aman” dari gempa

GEMPA M>7 SEJAK ABAD 20



Satake (2010)

GEMPA-GEMPA MEMATIKAN

Earthquakes with > 1,000 fatalities in last decade

Date	Region	M	Fatalities
2011/3/11	Tohoku, Japan	9.0	20,896
2010/1/12	Haiti	7.0	222,570
2009/9/30	Padang, Indonesia	7.5	1,117
2008/5/12	Sichuan, China	7.9	87,587
2006/5/26	Java (Jogjakarta), Indonesia	6.3	5,749
2005/10/8	Kashmir, Pakistan	7.6	86,000
2005/3/28	Sumatra (Nias), Indonesia	8.6	1,313
2004/12/26	Sumatra (Aceh), Indonesia	9.1	227,898
2003/12/26	Bam, Iran	6.6	31,000
2003/5/21	Algeria	6.8	2,266
2002/3/25	Afghanistan	6.1	1,000
2001/1/26	Bhuj (Gujarat), India	7.6	20,023

Of these 12 events, 10 occurred in Asia and 4 in Indonesia

Satake (2010)

SUMATRA

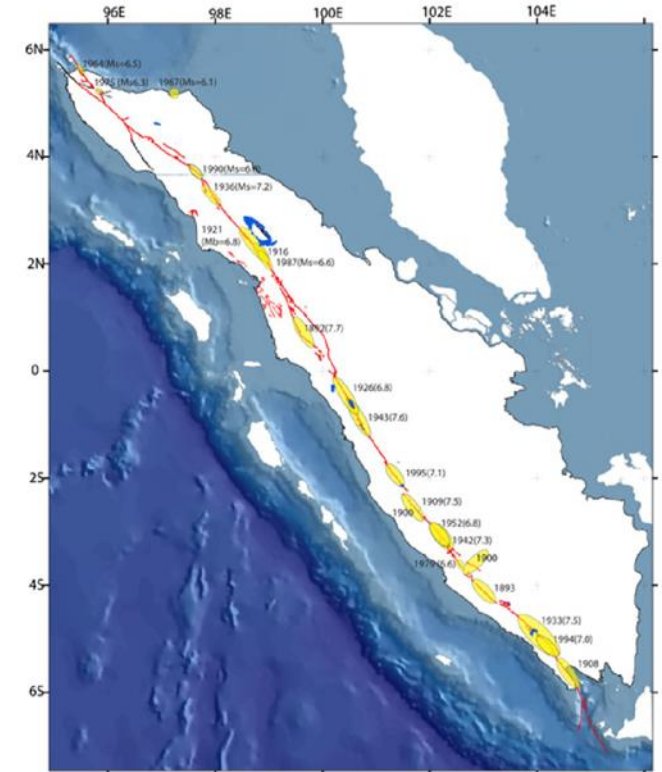
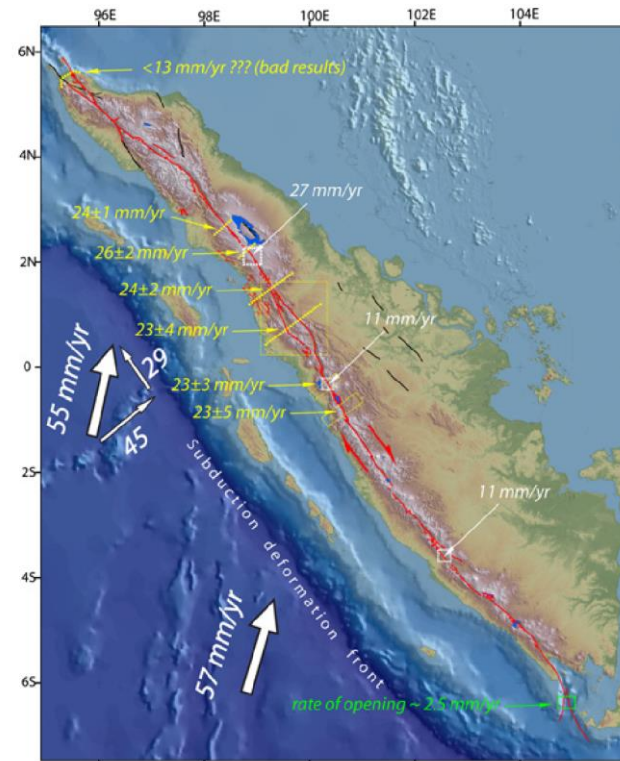
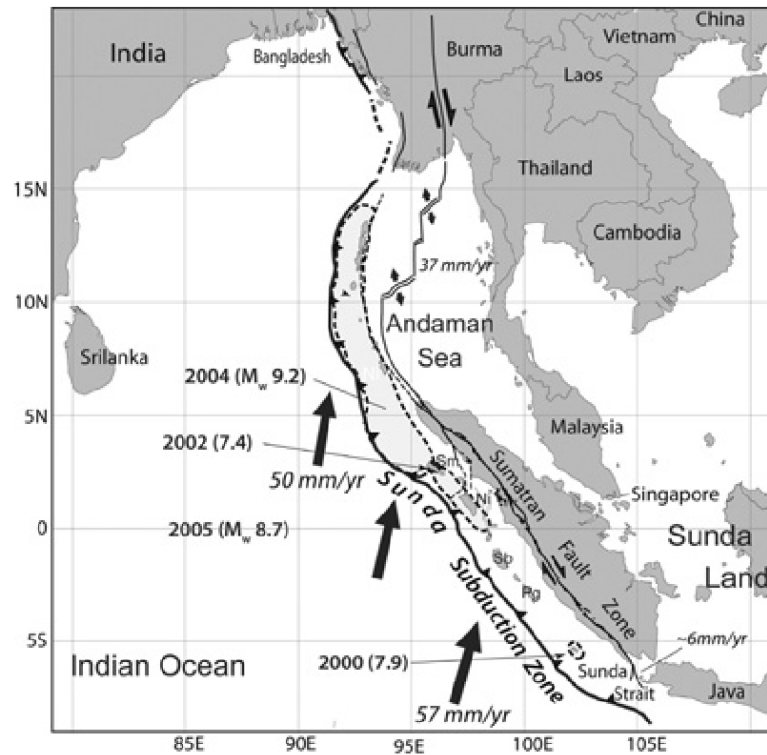
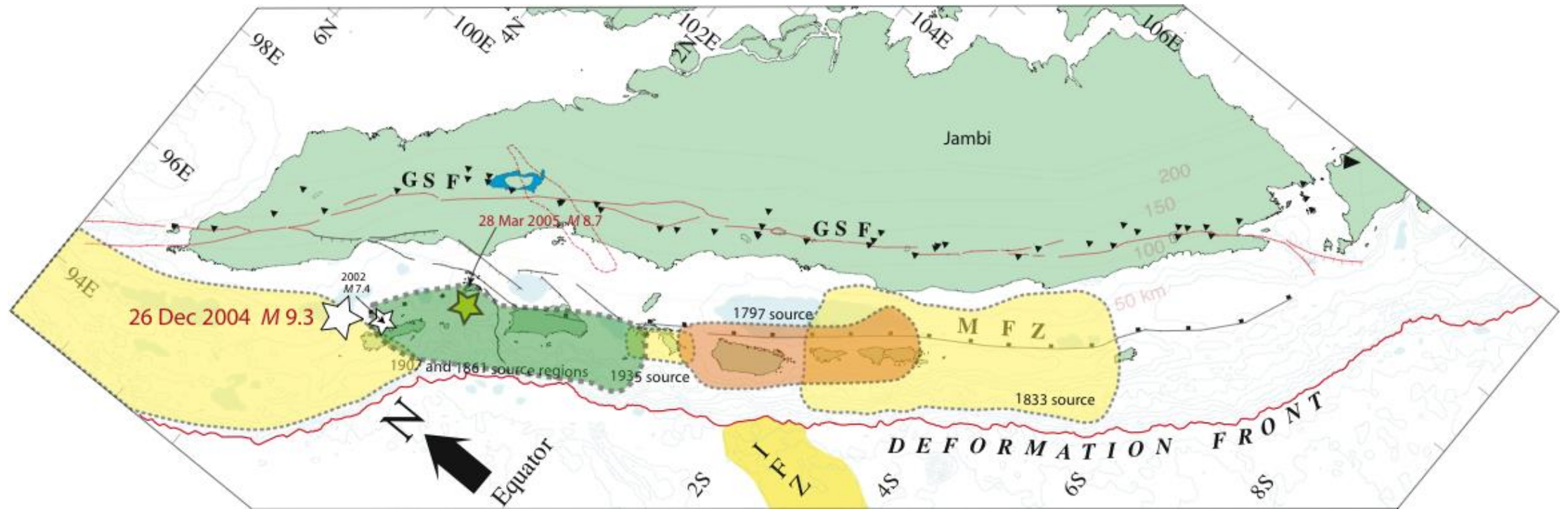


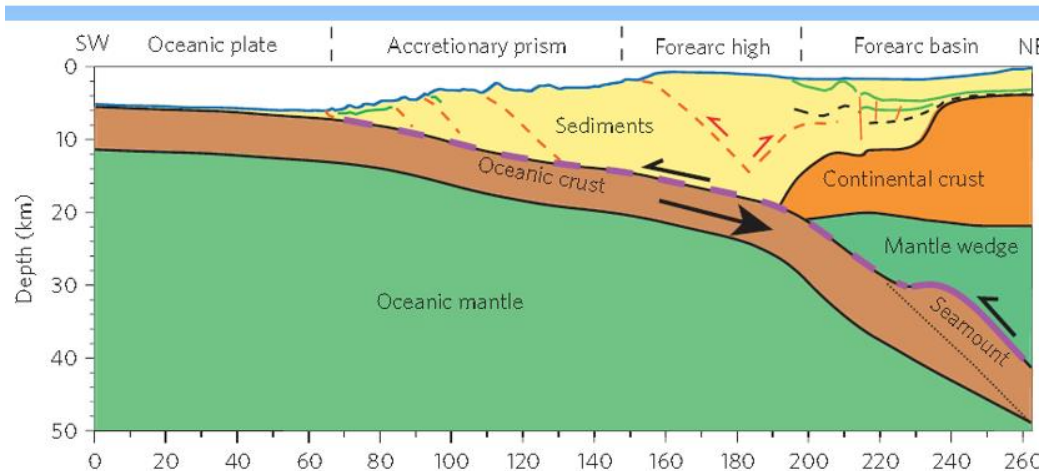
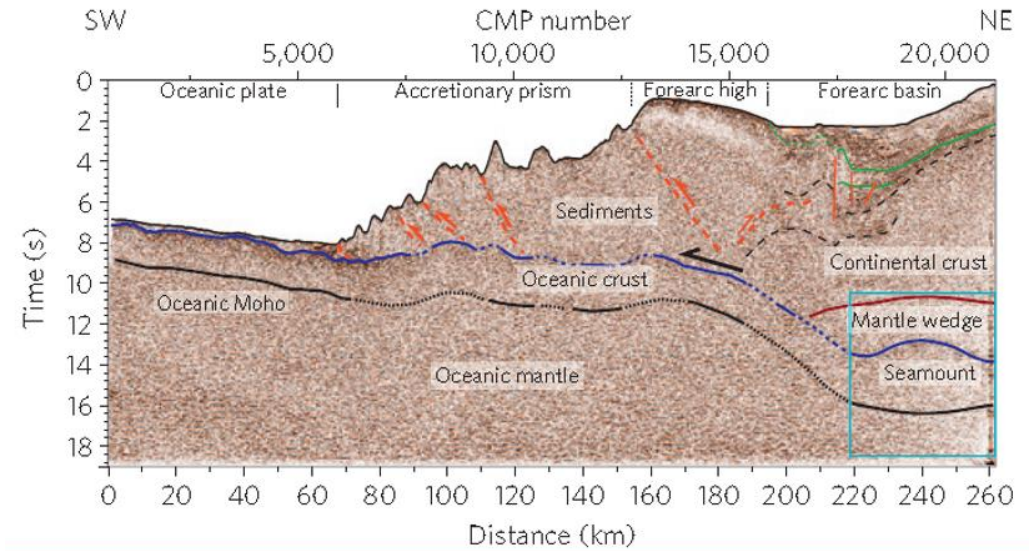
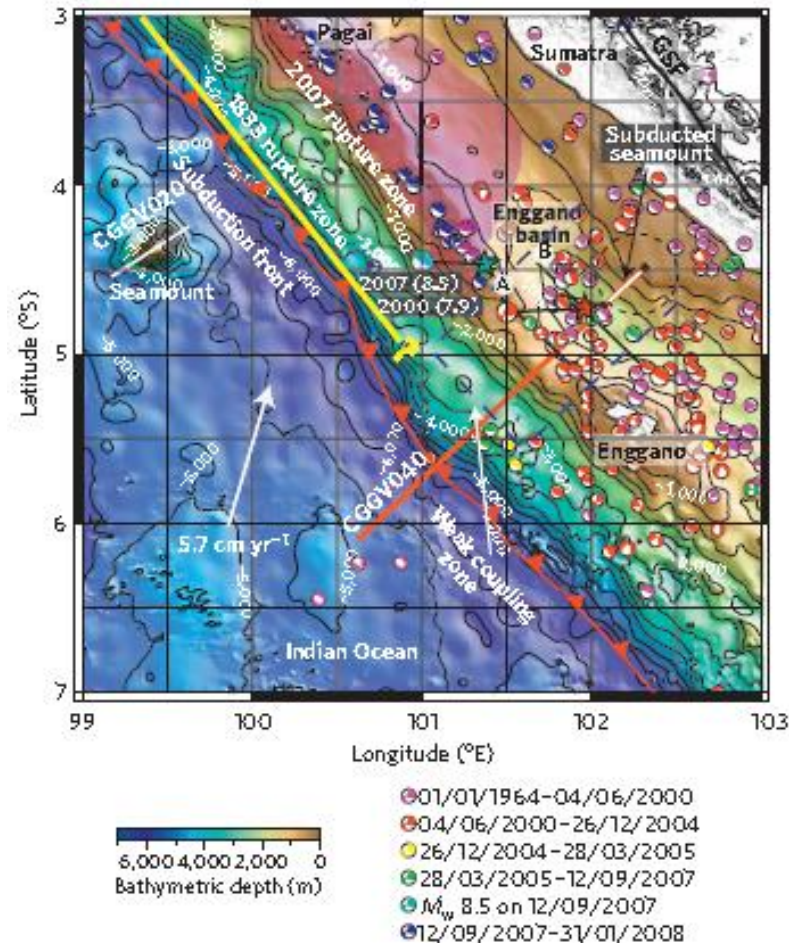
Fig. 5. Historical major earthquakes along the SFZ since 1892. The ellipsoids indicate fault segments that were ruptured during the earthquakes. Numbers indicate years of occurrences and number in brackets are earthquake magnitudes.

MEGATHRUST: GEMPA ACEH DES-2004

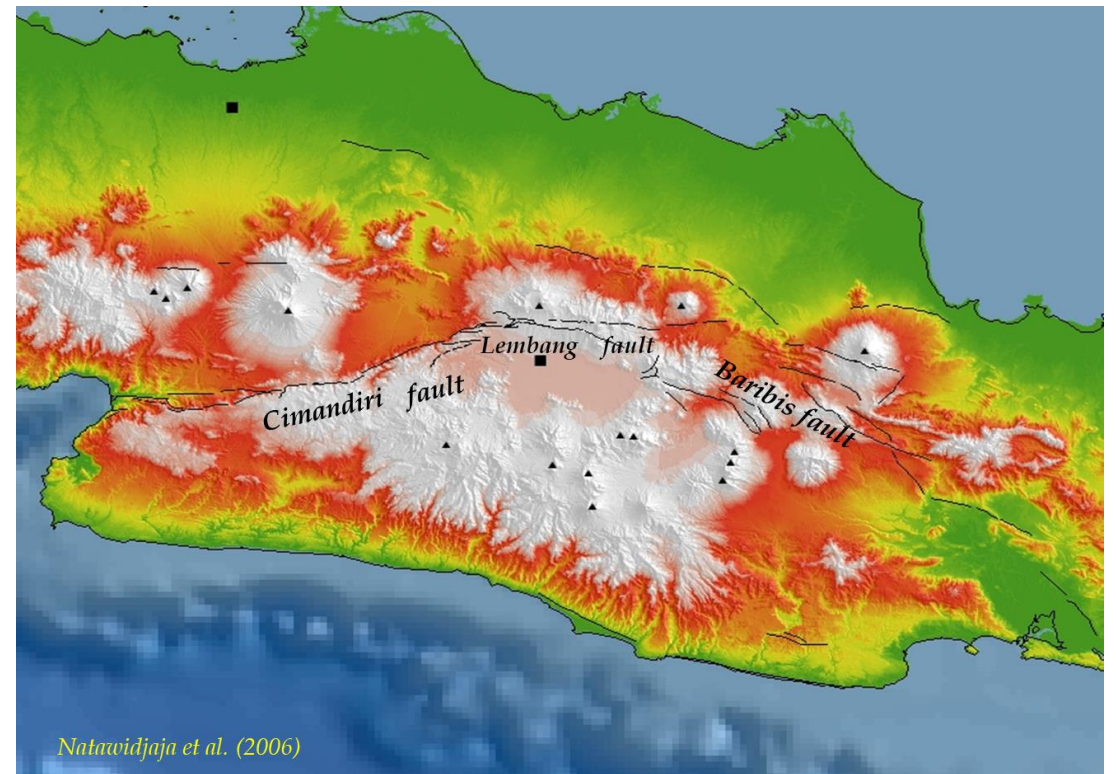
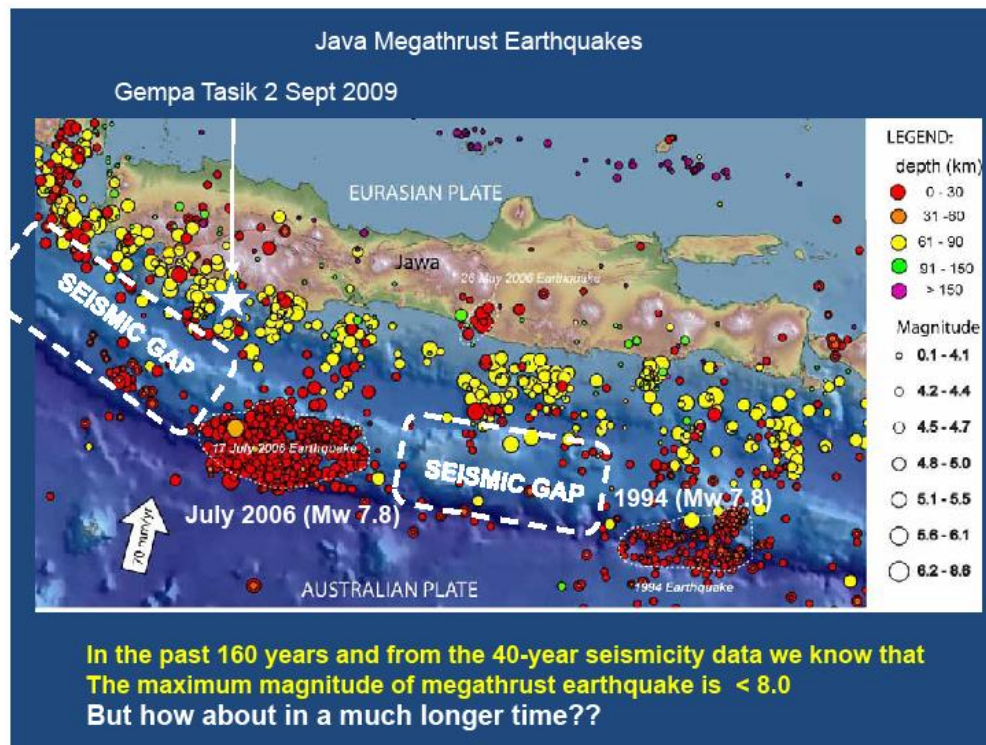


Sieh & Natawidjaja,

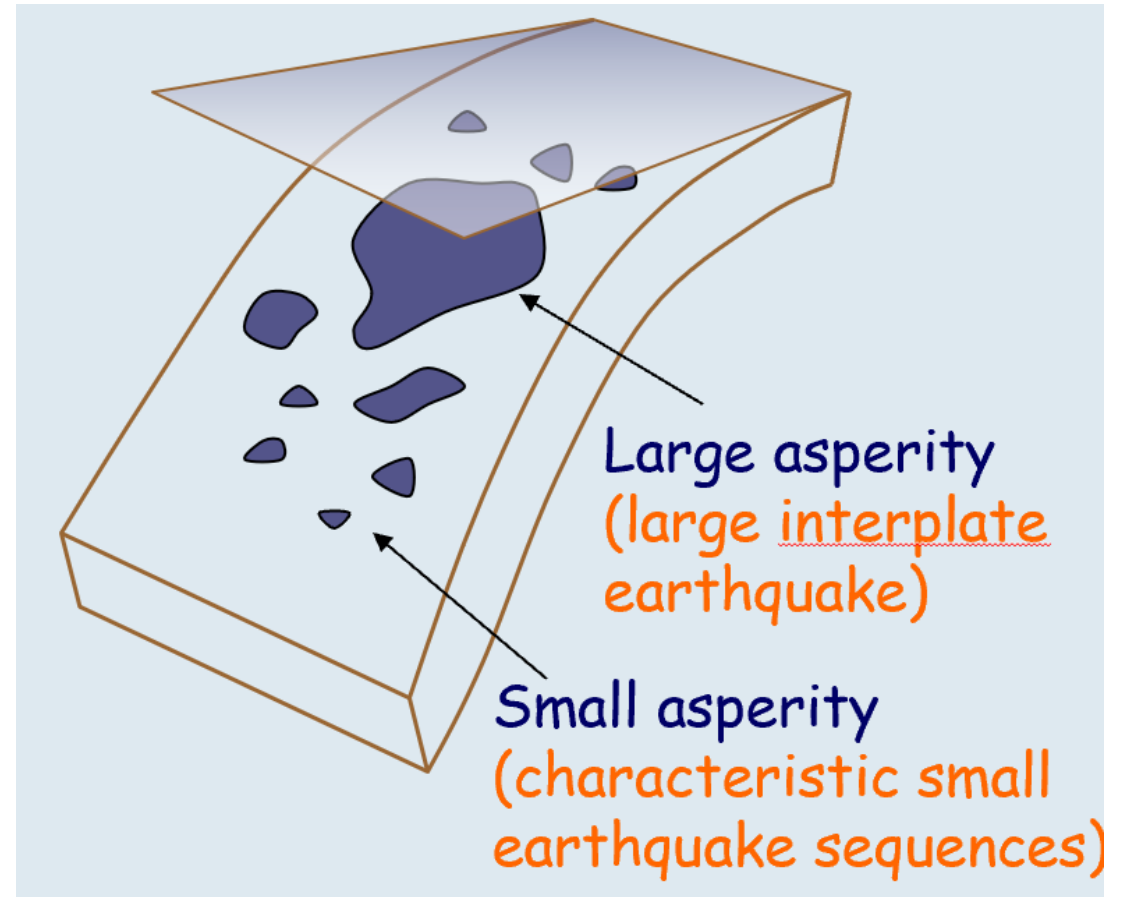
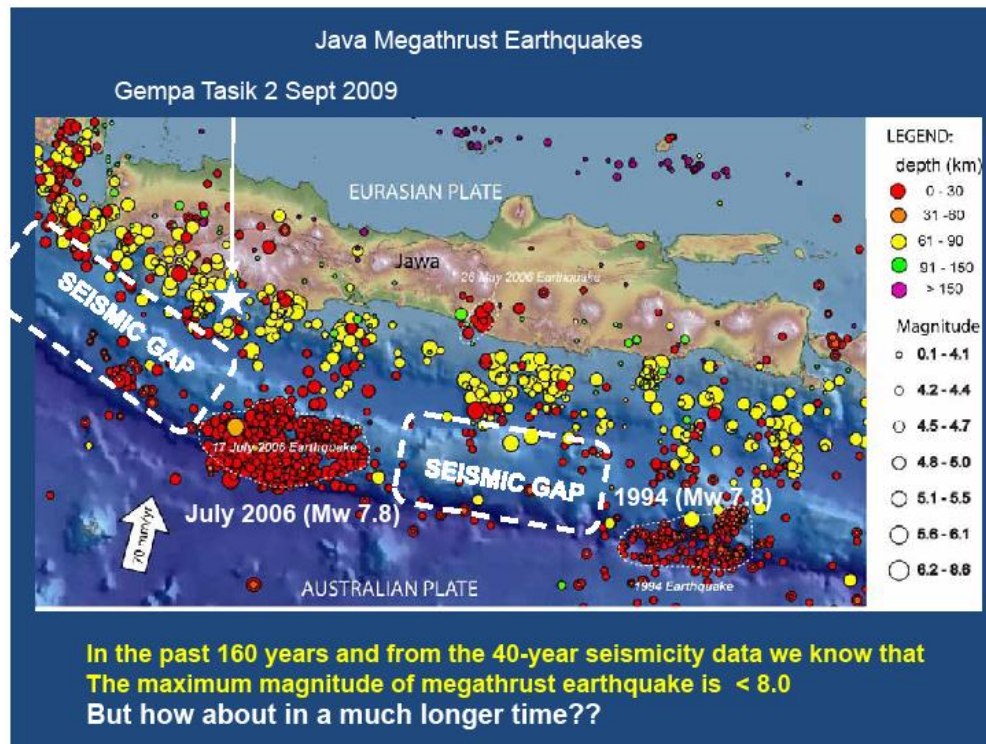
SUBDUKSI DI MENTAWAI SELATAN



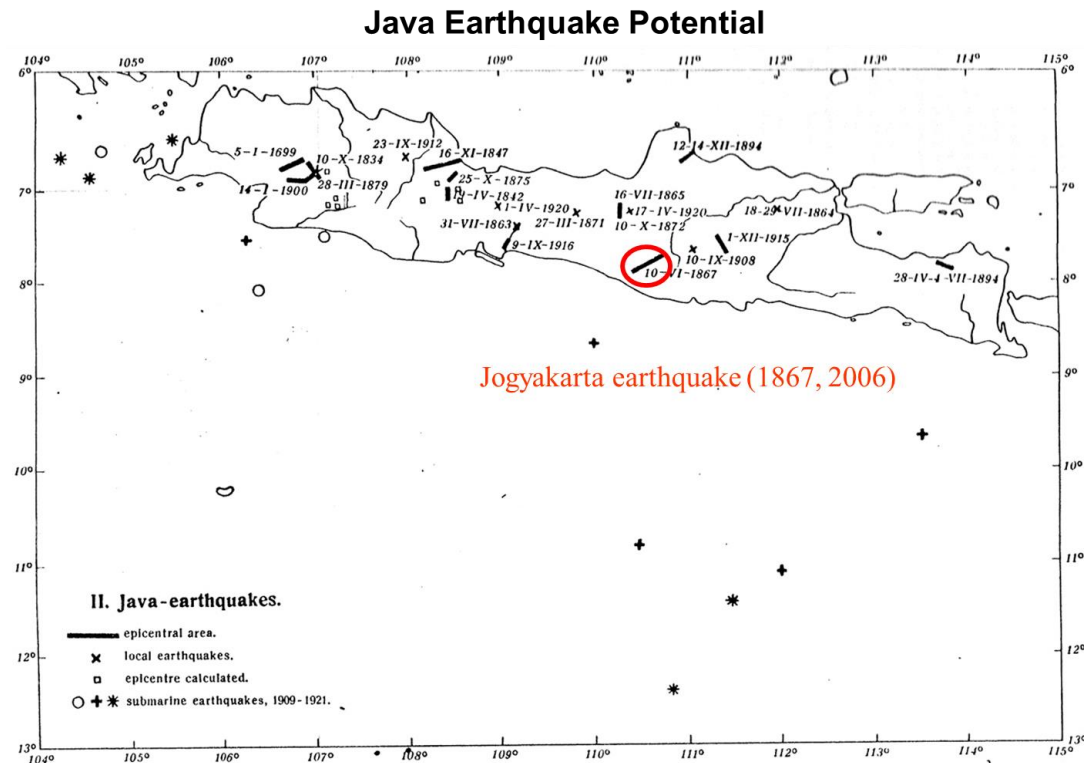
JAWA



MEGATHRUST SELATAN JAWA



SEJARAH GEMPA JAVA-BALI-NTT



On land earthquakes 1600-1921 (Dr. Visser, 1922)

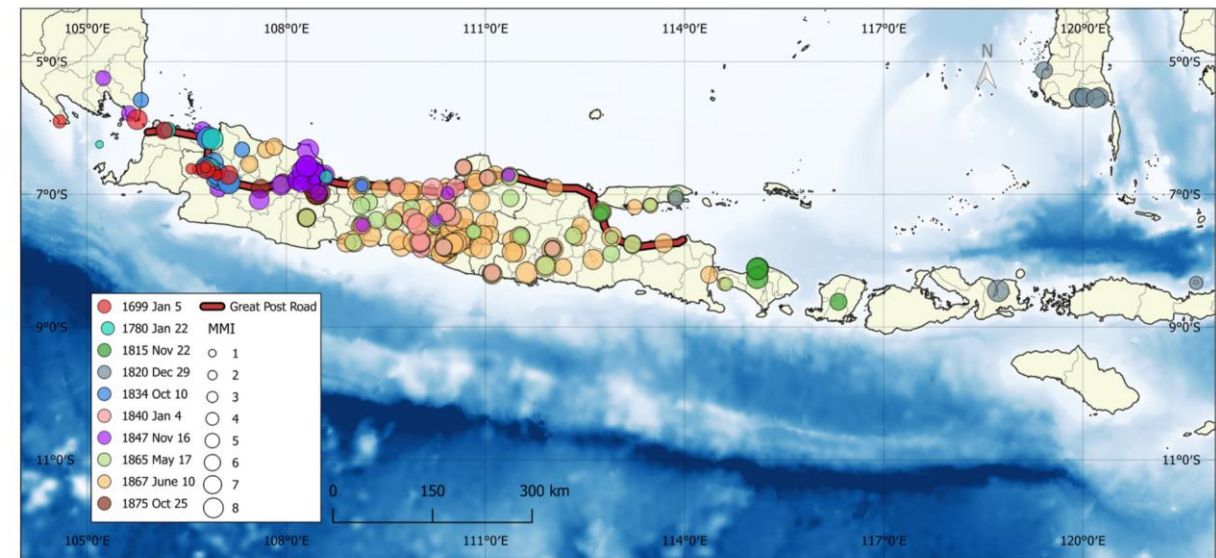
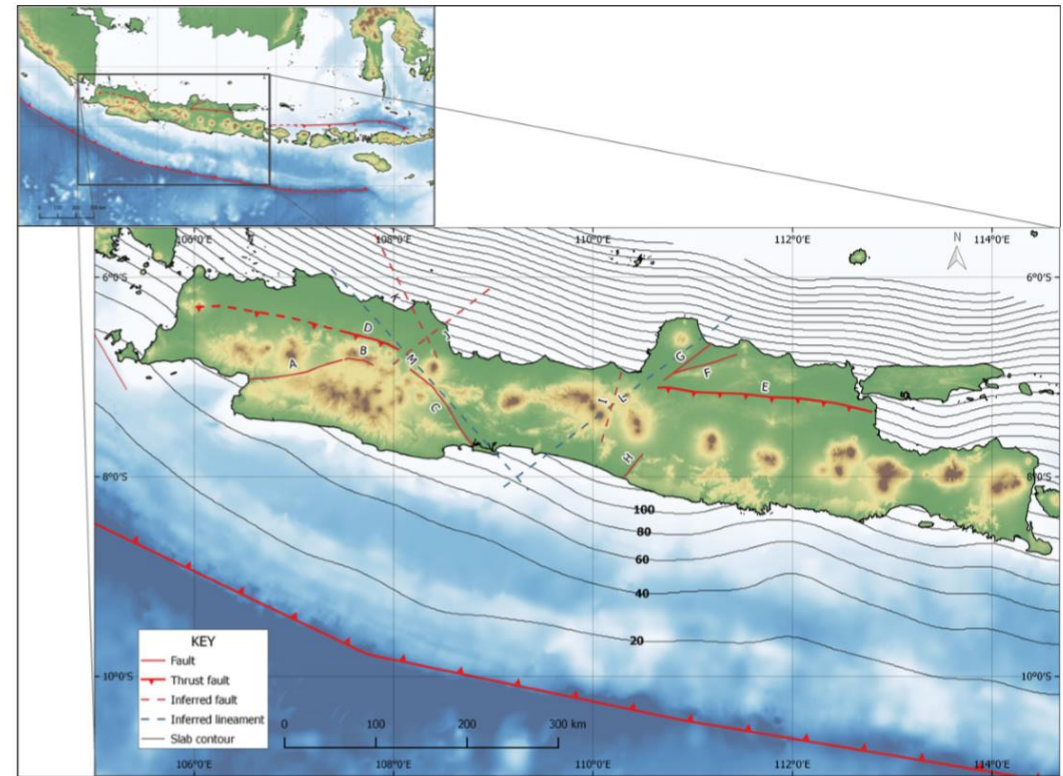
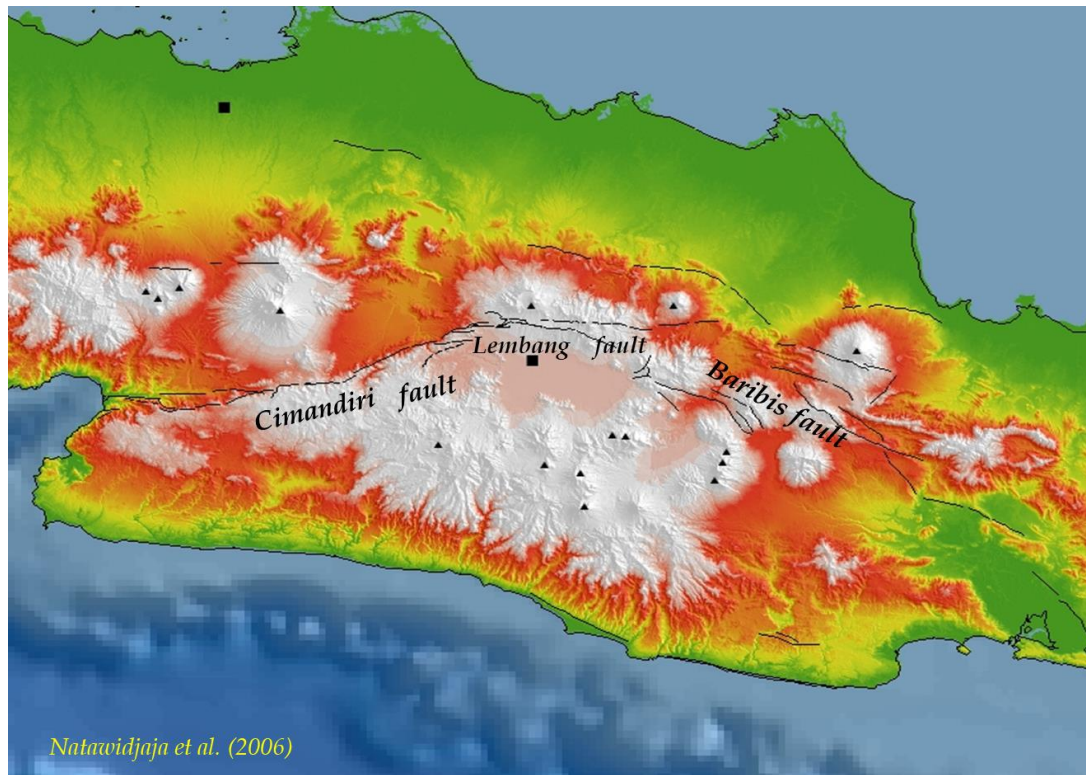


Figure 1.5 Distribution of observed MMI from 1600 to 1900 for events investigated in Java, Bali and Nusa Tenggara.

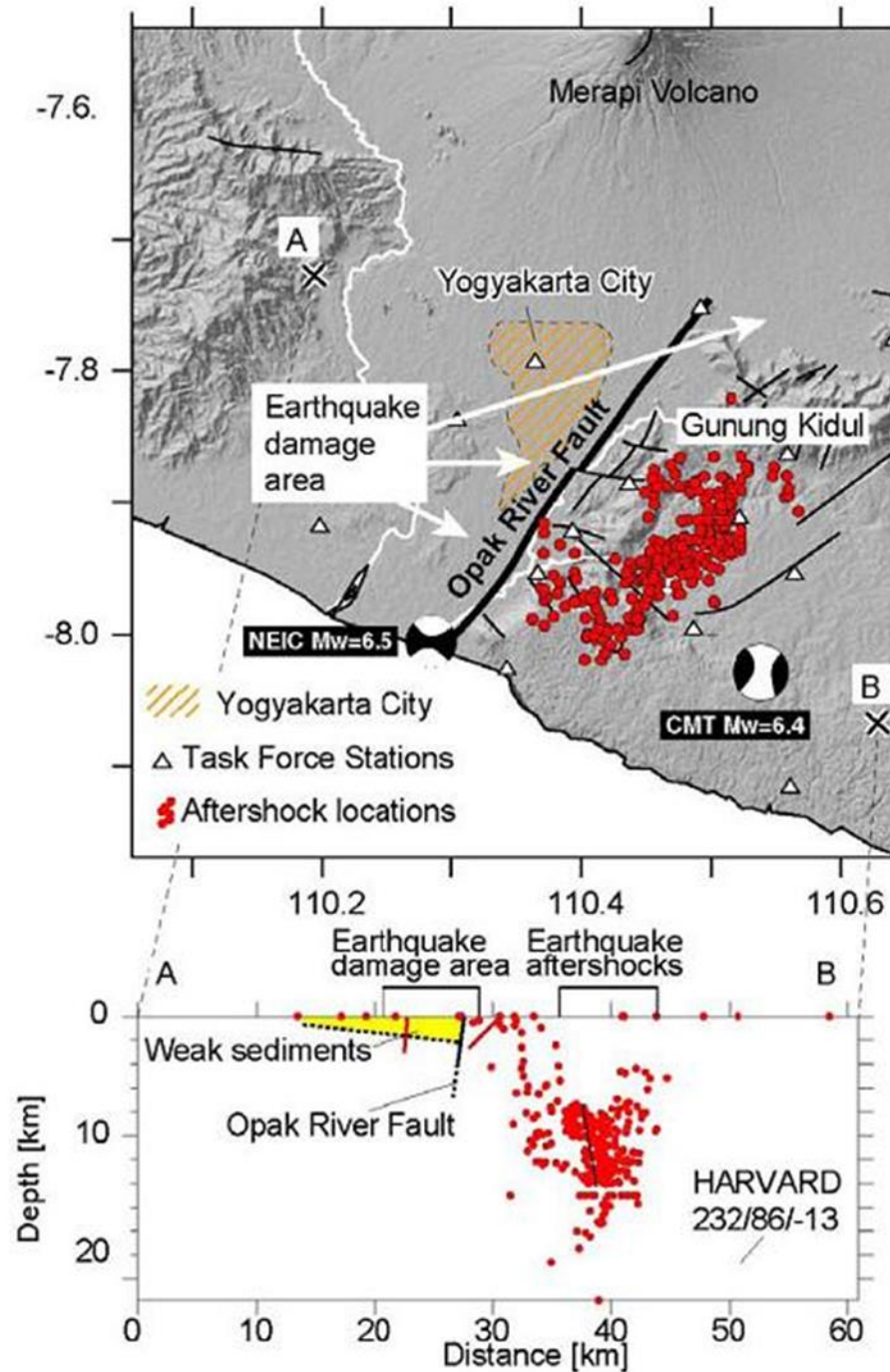
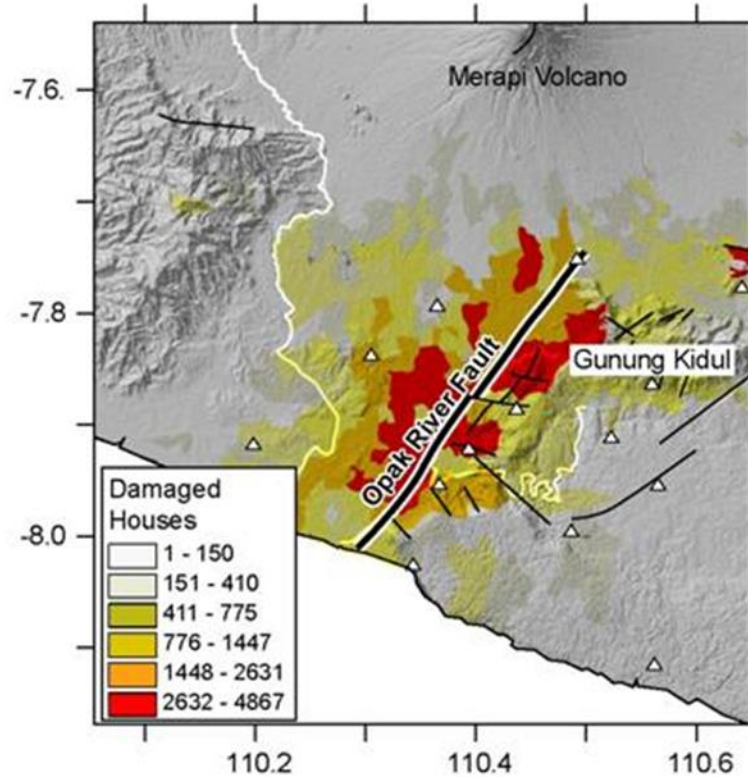
Nguyen et al (2015)

JAWA BAGIAN BARAT

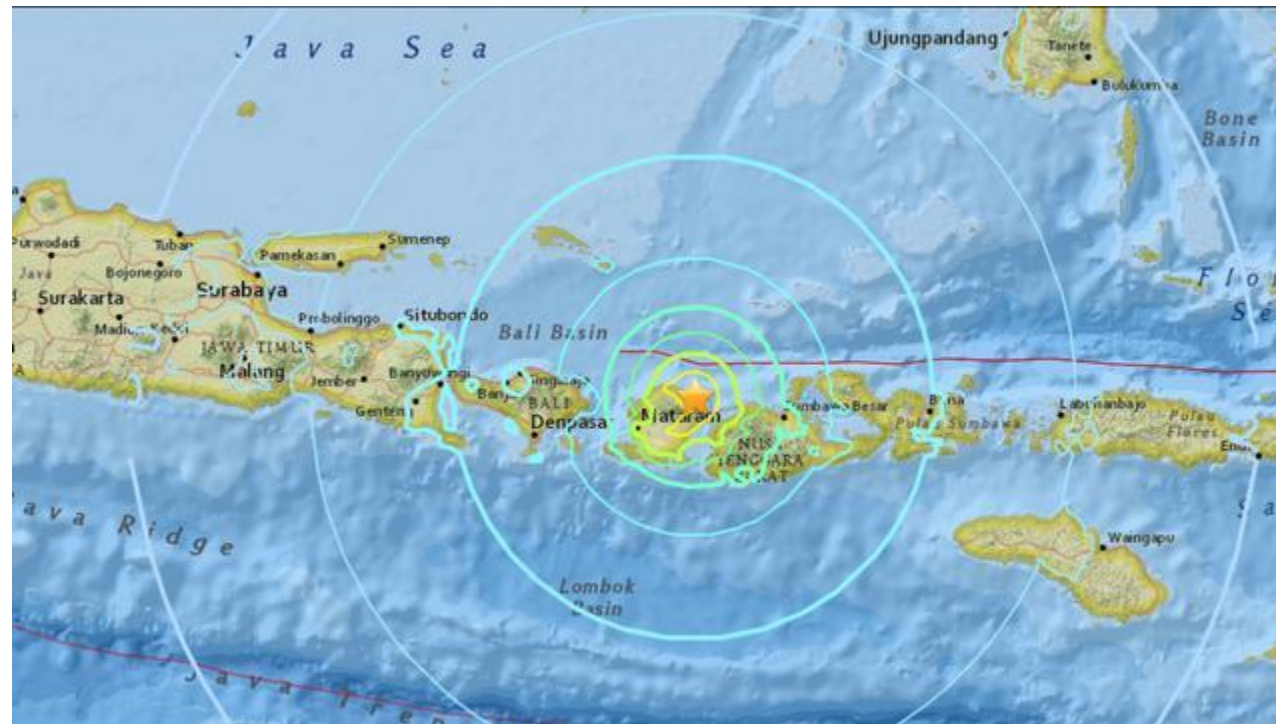


Distribution of destruction, and of 200 aftershocks

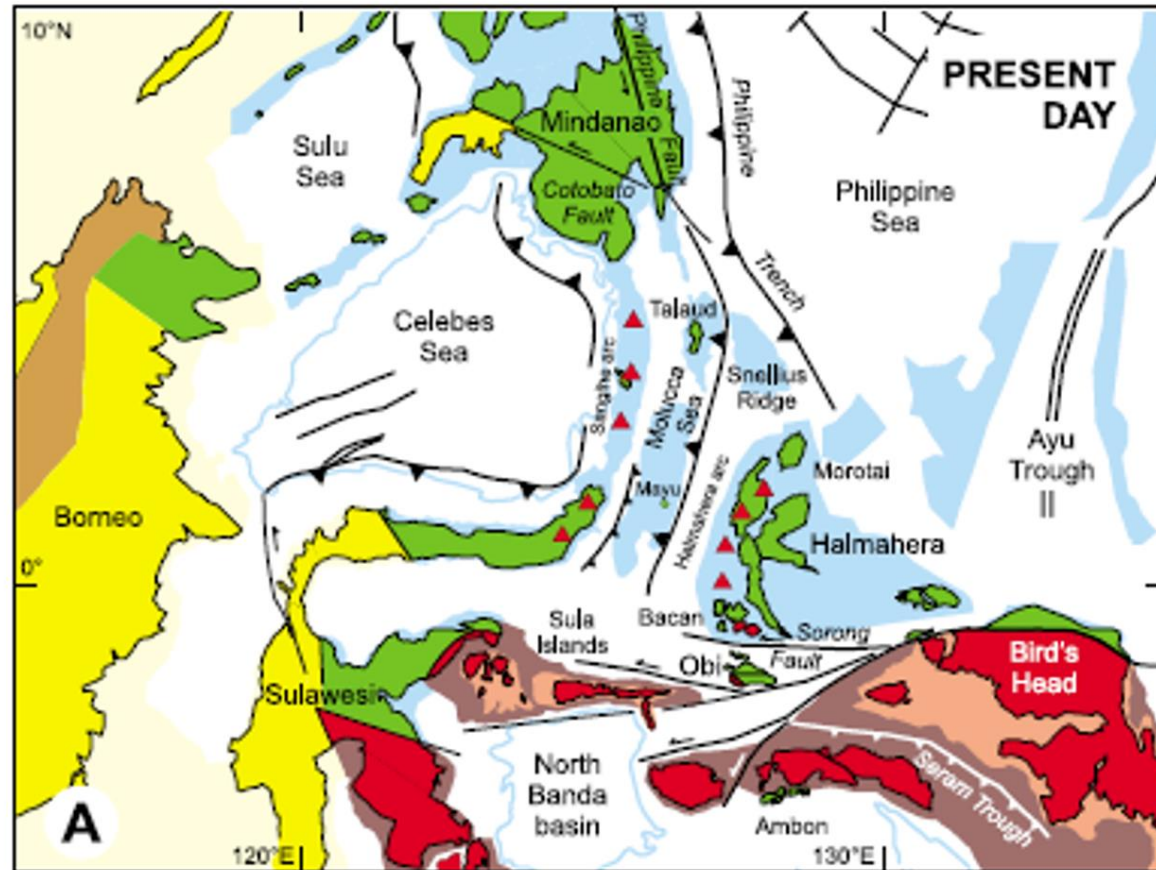
Number houses destroyed or heavily damaged



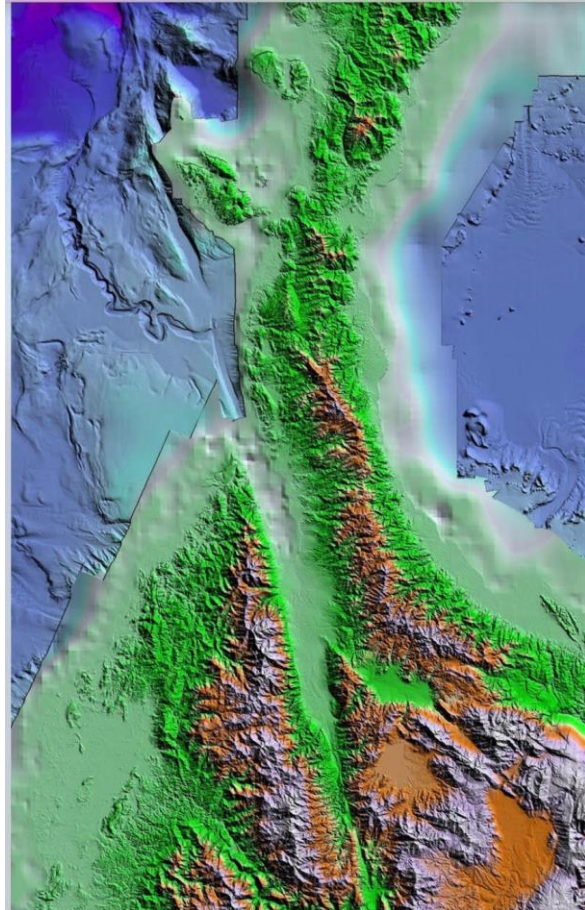
Lombok



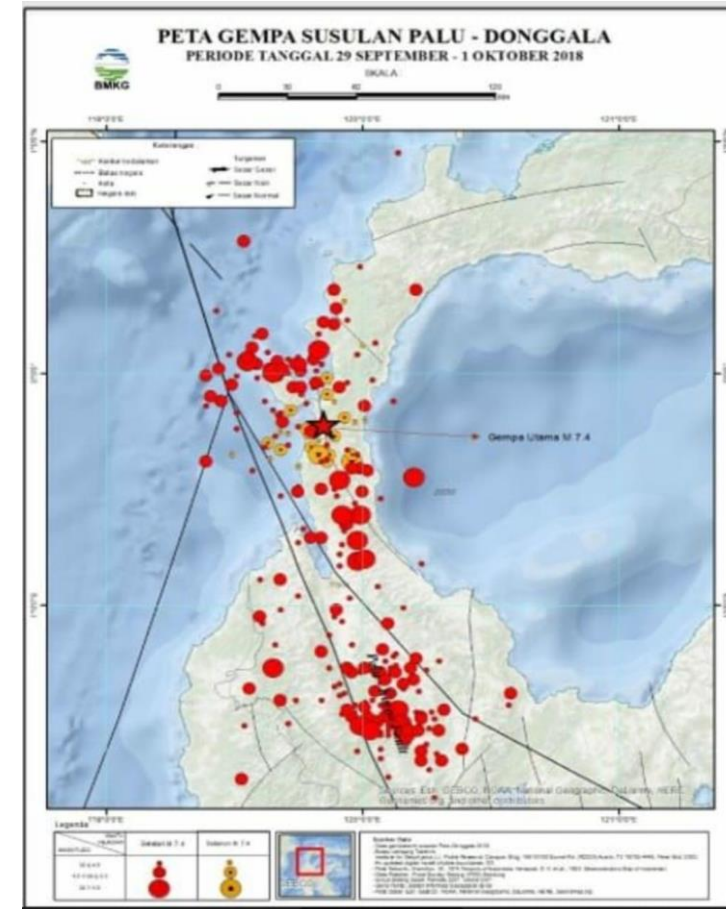
PALIU-KORO



GEMPA PALU-KORO



Courtesy of Widiyantoro



Courtesy of Daryono, BMKG

SEAWALL di TOHOKU



Triyono, 2012

GREAT EAST JAPAN TSUNAMI 2011



Foto: Triyono, 2012

3.2. Japan and Indonesia: Two Earthquake Countries -Short Profile-

JAPAN

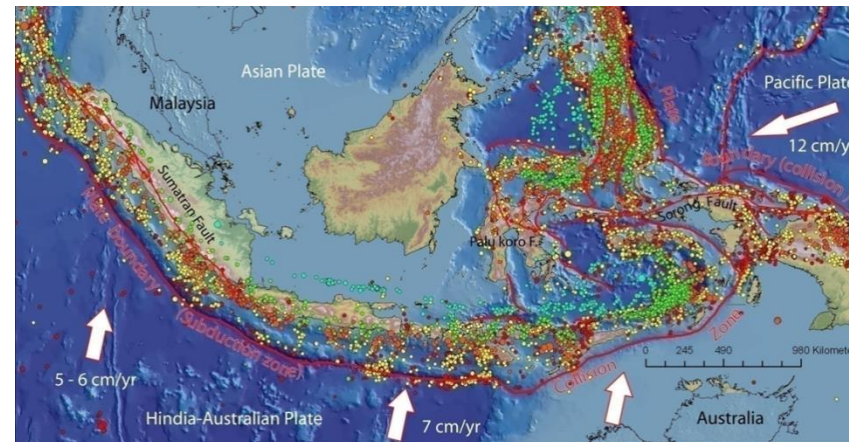
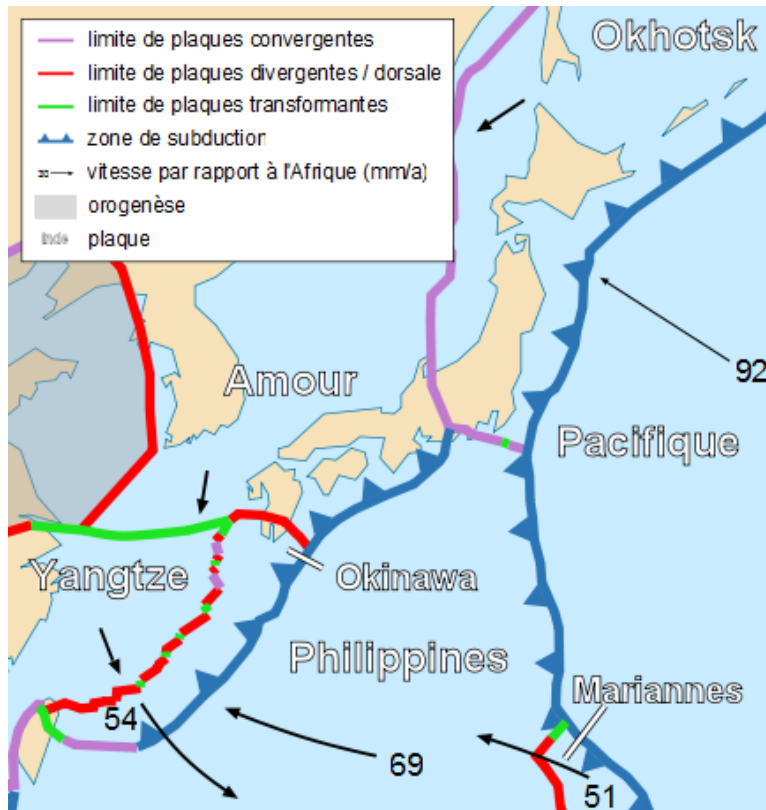
- Island Arc, Northern part of “Ring of Fire”
- Pacific Plate subducts beneath Eurasian plate
- Active faults on land
- More than 100 volcanoes and 50 are actives
- The Big One was the March 2011 Tohoku Mw-9.0 event (followed by tsunami) and fatalities were around 19,000 people and damage: US\$210,000,000.-

INDONESIA

- Island Arc, Southern part of “Ring of Fire”
- Indo-Australian plate sinks under Eurasian plate
- Active faults on land
- More than 400 volcanoes, which 128 are actives
- The Big One was the Dec 2004 Sumatran Mw-9.2 earthquake (followed by giant tsunami), and > 165,000 people were killed, damage: US\$4,451,500.-

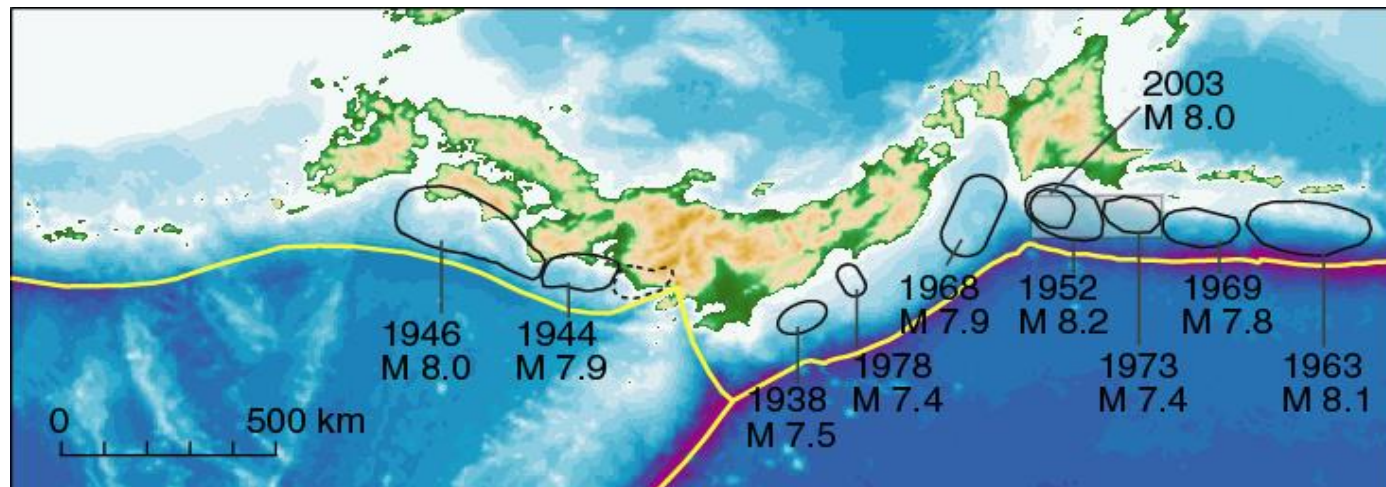
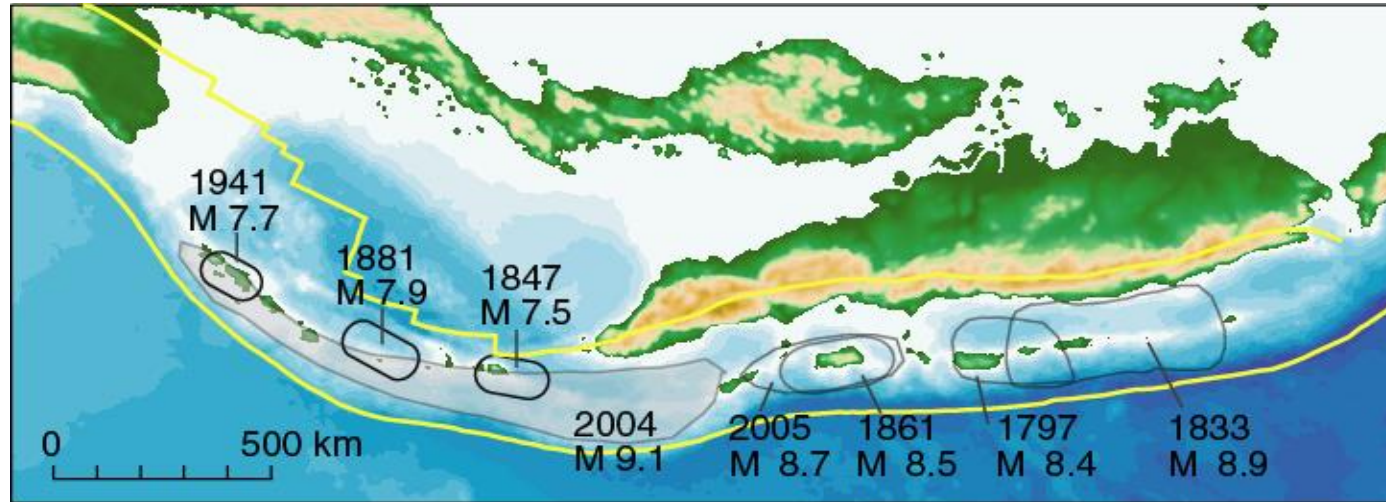
3.2. Two Earthquake Countries: Japan and Indonesia (1)

Geological Background



Presentation of Harjono: CSEAS, Kyoto Univ., 2012

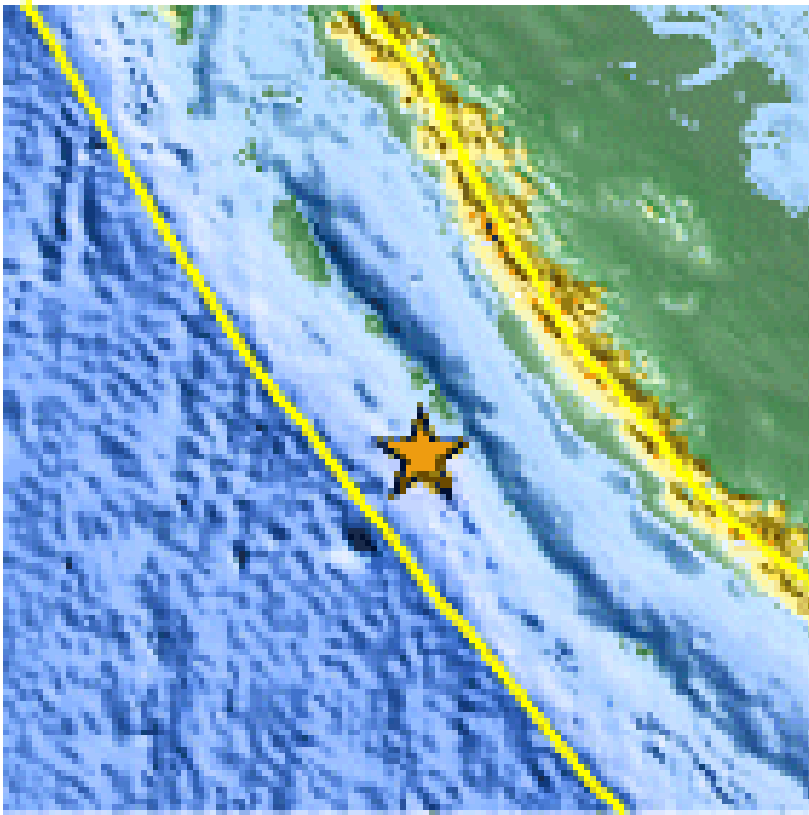
Destructive Earthquakes: Sumatra and Japan



Geological Survey of Japan, courtesy of Satake (2012)

Two Last Events

Mentawai, 25 October 2010



Tohoku, 11 March 2011



Source: USGS

Two Earthquake Countries: Japan and Indonesia

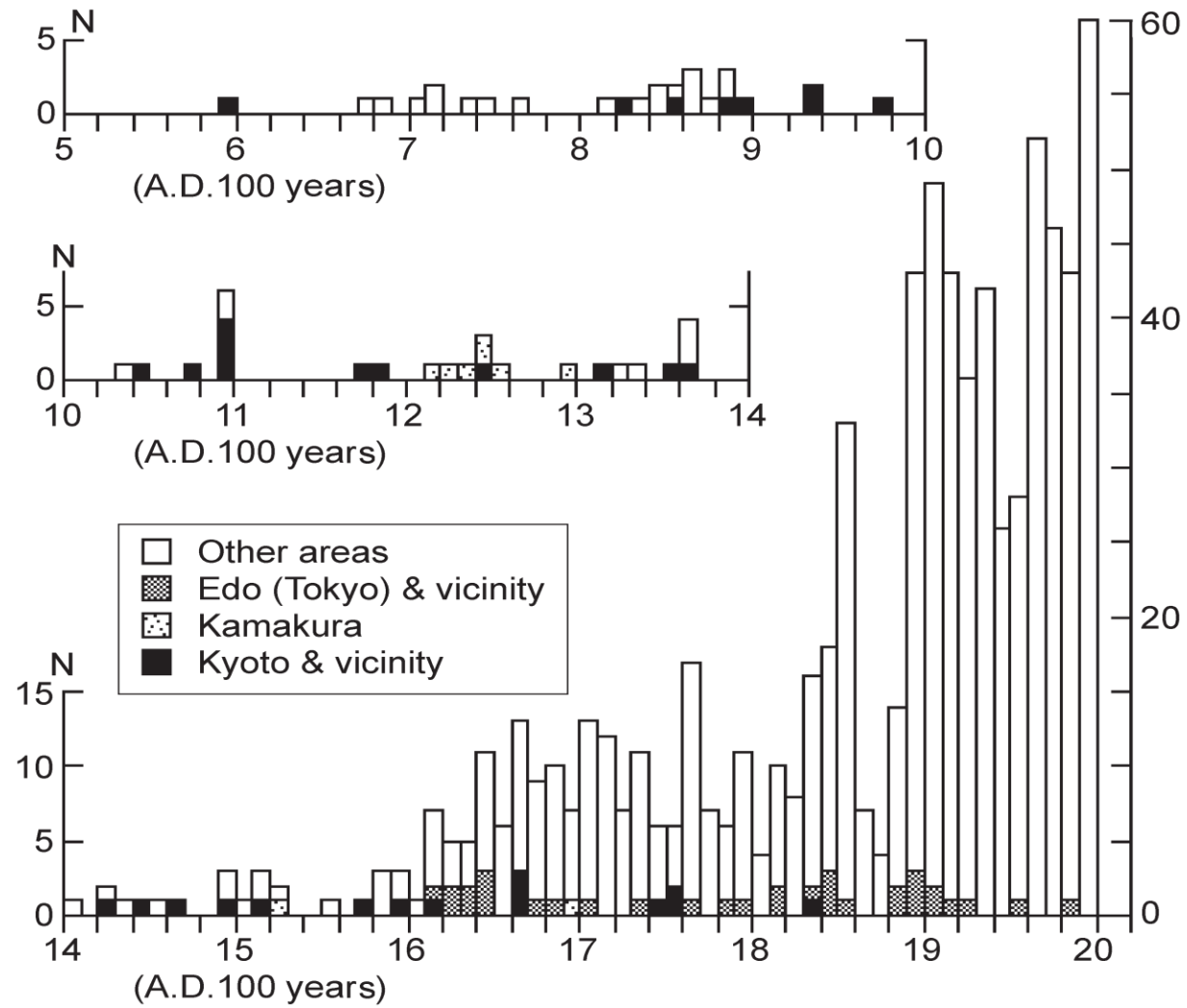
-Brief History-

JAPAN

- 599: Oldest known earthquake
- *Rikkokushi* (Six National Histories) completed in 901, included earthquake, tsunami and volcanic records.
- 1180-1266: *Azuma Kagami* contains earthquake records.
- Edo Era: created many primary documents
- 1868: Meiji Restoration, western science and technology became national mandates. Japanese Seismology began
- 22 Feb 1880: Yokohama earthquake, 26 April 1880: Seismological Society of Japan was established (1st seismological society in the world).
- 28 Oct 1891: Nobi earthquake (M=8.0, killed>7,000)., Earthquake Disaster Prevention Investigation Council was established
- 1 September 1923, Kanto earthquake (M=8.1, killed >140,000). Establishment of Earthquake Research Institute (ERI) of The University of Tokyo
- 17 January 1995, Kobe earthquake. (killed > 5,000)
- 11 March 2011, Tohoku Earthquake and Tsunami.

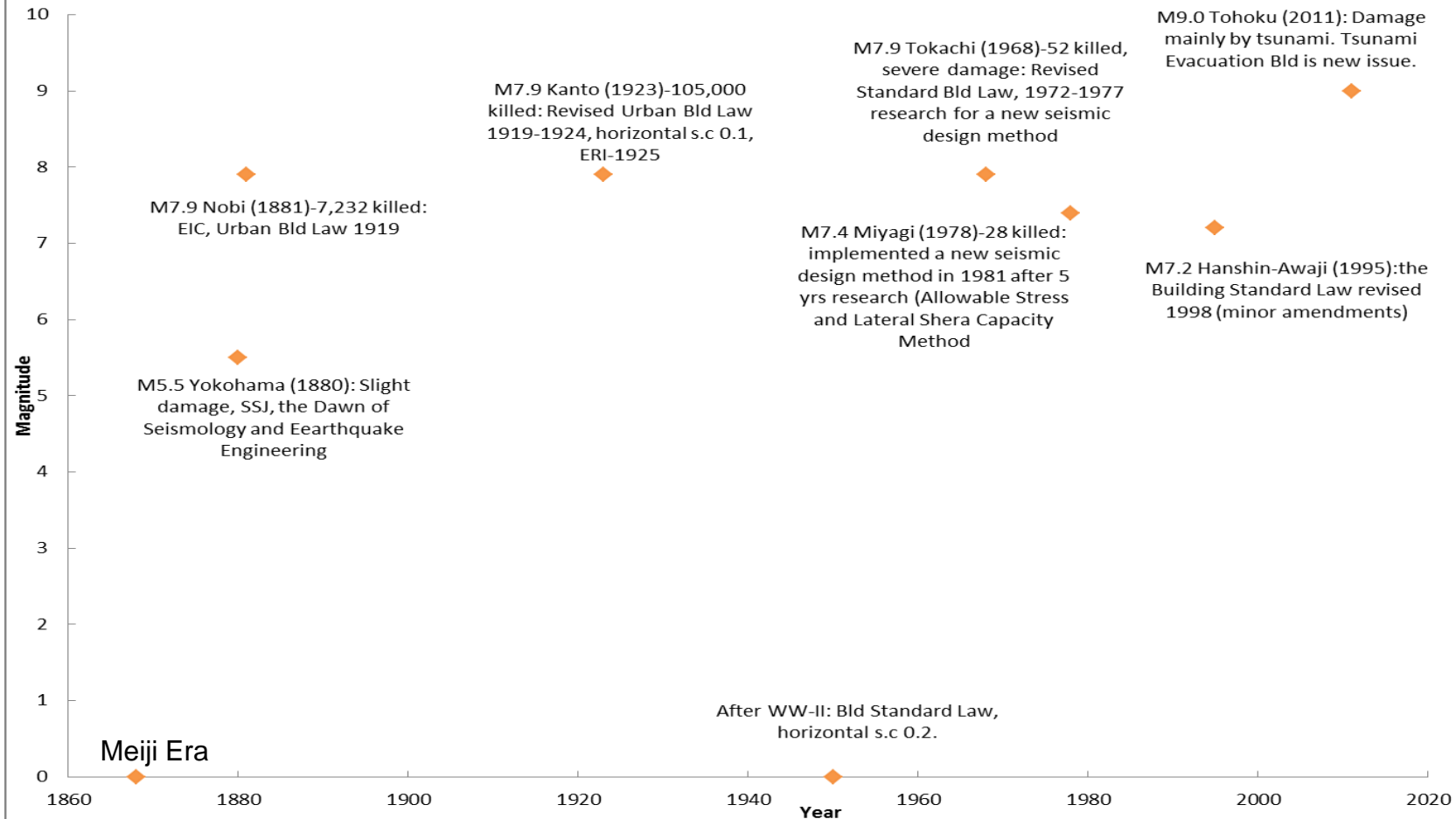
INDONESIA

- 1600: Oldest earthquake identified by Visser (1922)
- 1833: Tsunami in Padang-Bengkulu, Sumatra.
- 1867: Jogjakarta earthquake
- 1883: Krakatau Volcano eruption, and triggered tsunami (killed >36,000).
- 1992: Flores earthquake and tsunami (killed > 2000).
- 2004: The Sumatran-Andaman earthquake and tsunami (killed >200,000). International collaboration in DRR
- 2005: Nias earthquake (killed > 5000)
- 2006: Pangandaran Tsunami (killed > 600), and Jogjakarta Earthquake (killed >5,000)
- 2007: Disaster Management Law is enacted
- 2008: BNPB (National Disaster Management Agency) is established. InaTEWS Inagourate by President.
- 2009: Padang earthquake (killed >1000)
- 2010: Mentawai earthquake and tsunami (killed > 400). Evaluation of InaTEWS
- LIPI and ITB establish Graduate Reseach School on Earthquake and Active Tectonics (GREAT)
- 2012: Indian Ocean earthquake (M=8.6), panic situation in Banda Aceh and Padang. Evaluation of InaTEWS



Presentation of Harjono, 2012 at CSEAS, Kyoto Univ., 2012

Engineering responses since the 1881 Nobi Earthquake



SKALA INTENSITAS GEMPABUMI BMKG

Skala Intensitas Gempabumi BMKG

Skala SIG BMKG	Warna	Deskripsi Sederhana	Deskripsi Rinci	Skala MMI	PGA (gal)
I	Putih	TIDAK DIRASAKAN (Not Felt)	Tidak dirasakan atau dirasakan hanya oleh beberapa orang tetapi terekam oleh alat.	I-II	< 2.9
II	Hijau	DIRASAKAN (Felt)	Dirasakan oleh orang banyak tetapi tidak menimbulkan kerusakan. Benda-benda ringan yang digantung bergoyang dan jendela kaca bergetar.	III-V	2.9-88
III	Kuning	KERUSAKAN RINGAN (Slight Damage)	Bagian non struktur bangunan mengalami kerusakan ringan, seperti retak rambut pada dinding, genteng bergeser ke bawah dan sebagian berjatuhan.	VI	89-167
IV	Jingga	KERUSAKAN SEDANG (Moderate Damage)	Banyak Retakan terjadi pada dinding bangunan sederhana, sebagian roboh, kaca pecah. Sebagian plester dinding lepas. Hampir sebagian besar genteng bergeser ke bawah atau jatuh. Struktur bangunan mengalami kerusakan ringan sampai sedang.	VII-VIII	168-564
V	Merah	KERUSAKAN BERAT (Heavy Damage)	Sebagian besar dinding bangunan permanen roboh. Struktur bangunan mengalami kerusakan berat. Rel kereta api melengkung.	IX-XII	> 564



Tizi, Kidang Pananjung, Bandung, Agustus 2001