Workshop "Dukungan Infrastruktur yang Handal
Untuk Proyek Strategis Nasional (PSN) di Propinsi DIY",
Kemenkomar, 29-30 Agustus 2017

Mengungkap & Menghitung Potensi Bahaya Gempabumi-Tsunami
di Bandara Kulonprogo (NYIAP) dan Metode Mitigasinya

Paleotsunami,
Studi Interdisiplin
Tsunami Raksasa Selatan Jawa

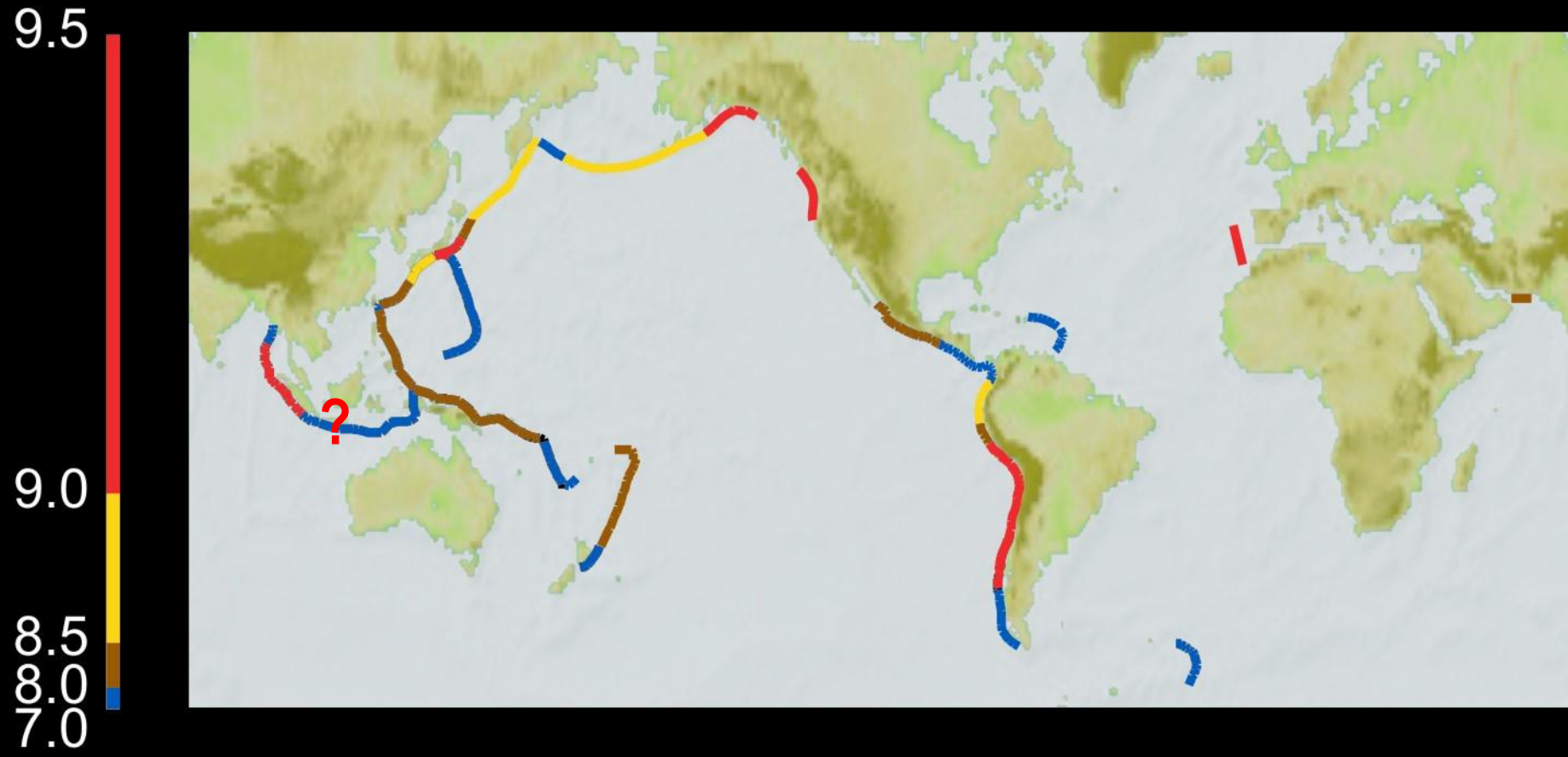
Eko Yulianto, Purna S Putra, Praptisih,
Jonathan Griffin, Nandang Supriatna & Students

Pusat Penelitian Geoteknologi
Lembaga Ilmu Pengetahuan Indonesia
2017

1 Bagaimana cara meyakinkan terhadap adanya ancaman ?

2 Berapakah pengurangan risiko tsunami yang sudah dicapai ?

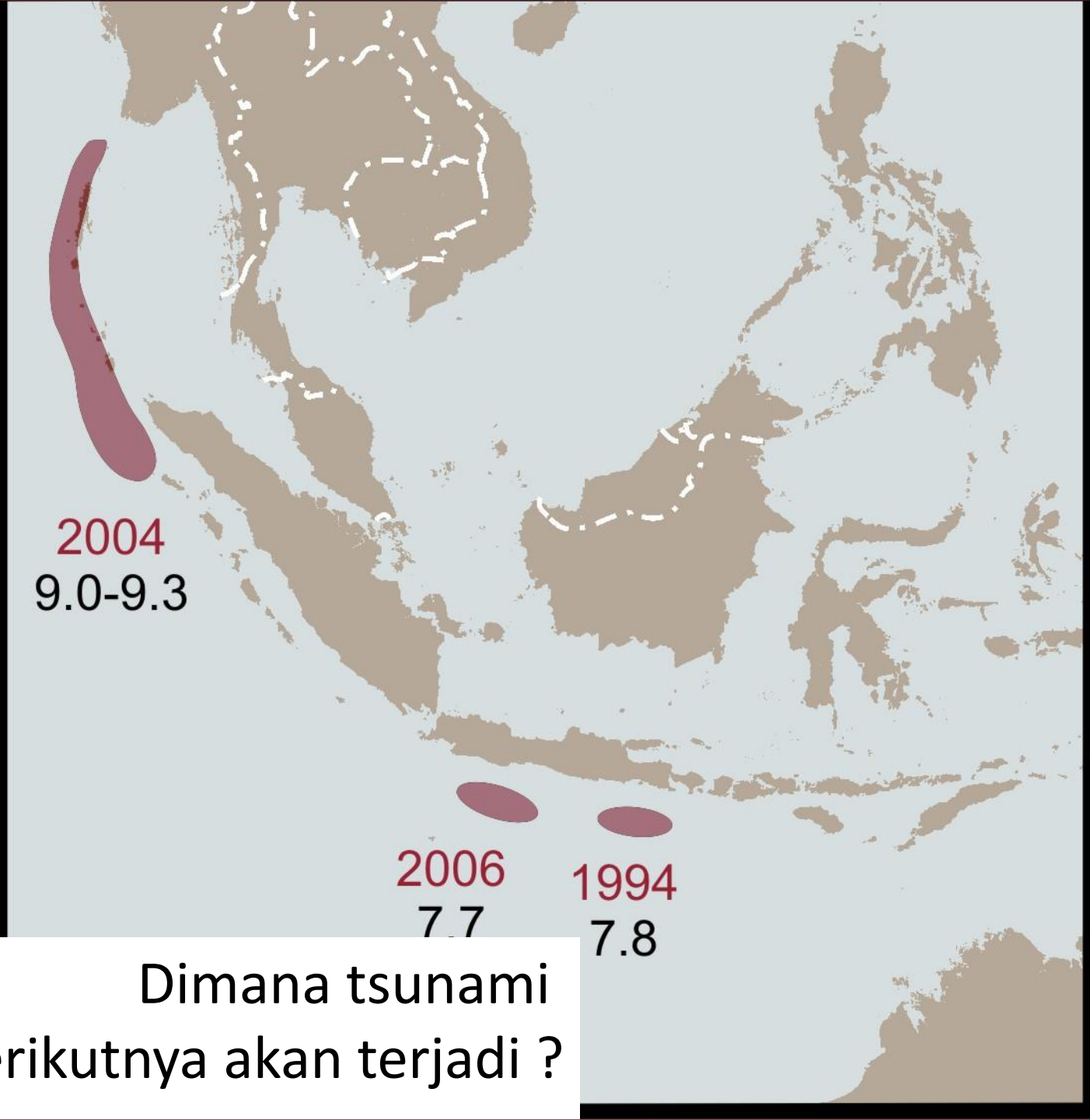
LARGEST THRUST EARTHQUAKE known as of April 2011



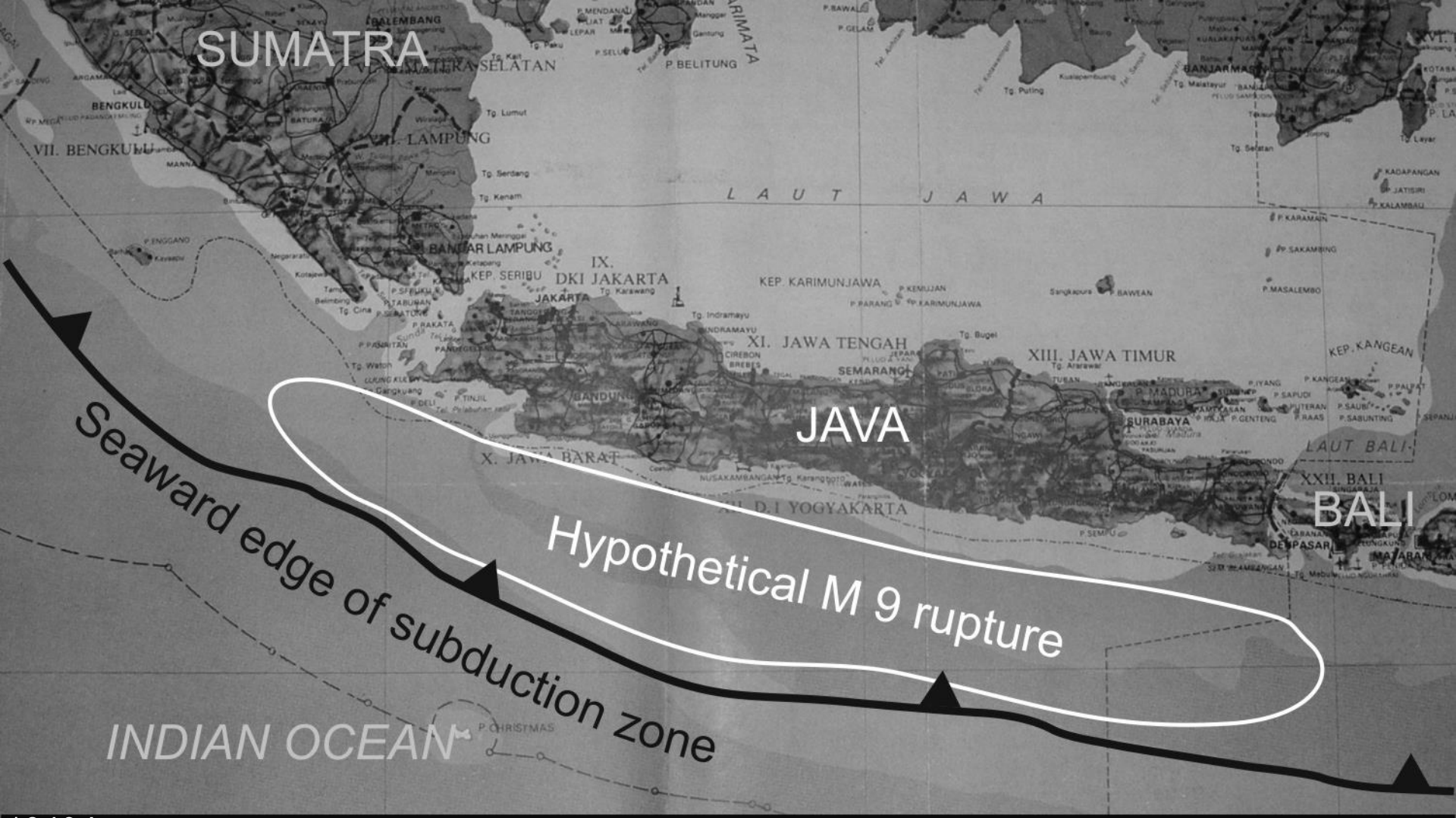
Linear by seismic moment

Stein & Okal (2007)
McCaffrey (2008)
Muir-Wood & Mignan (2009)

3 Dimana tsunami berikutnya akan terjadi ?



3 Dimana tsunami berikutnya akan terjadi ?



1849 km
Interval perulangan 675 tahun
Max Mw 9,6
(*MacCaffrey, 2008*)

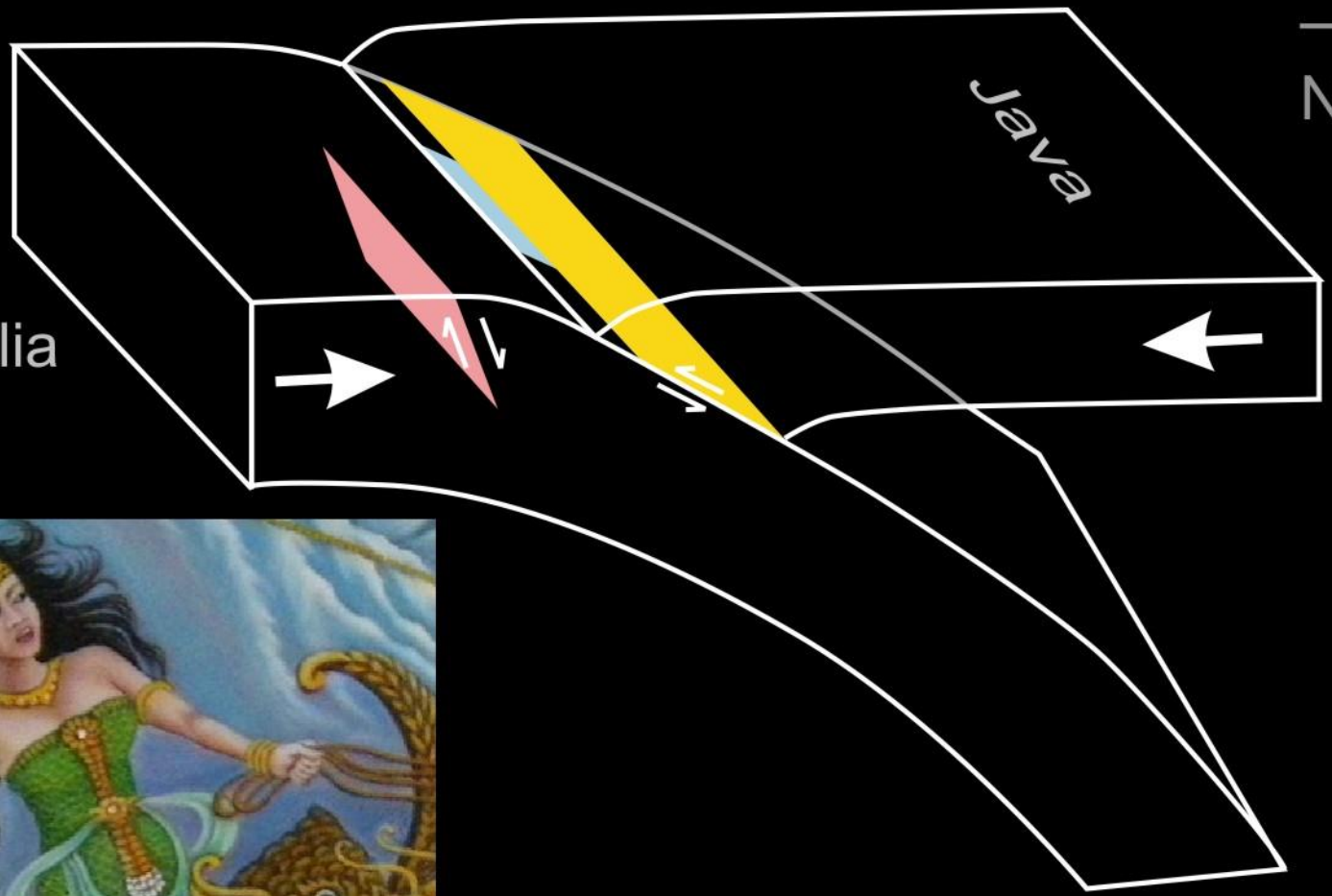
The absence of a megathrust earthquake for at least 300 years implies a minimum accumulated seismic moment as much as 1.6 × 1021 Nm (~Mw 8.7) off Ujung Kulon–Pelabuhan Ratu, and 3.9 × 1021 Nm (~Mw 8.3) off Pangandaran (Hanifa *et al*., 2014)

TSUNAMI SOURCES FACING SOUTH JAVA

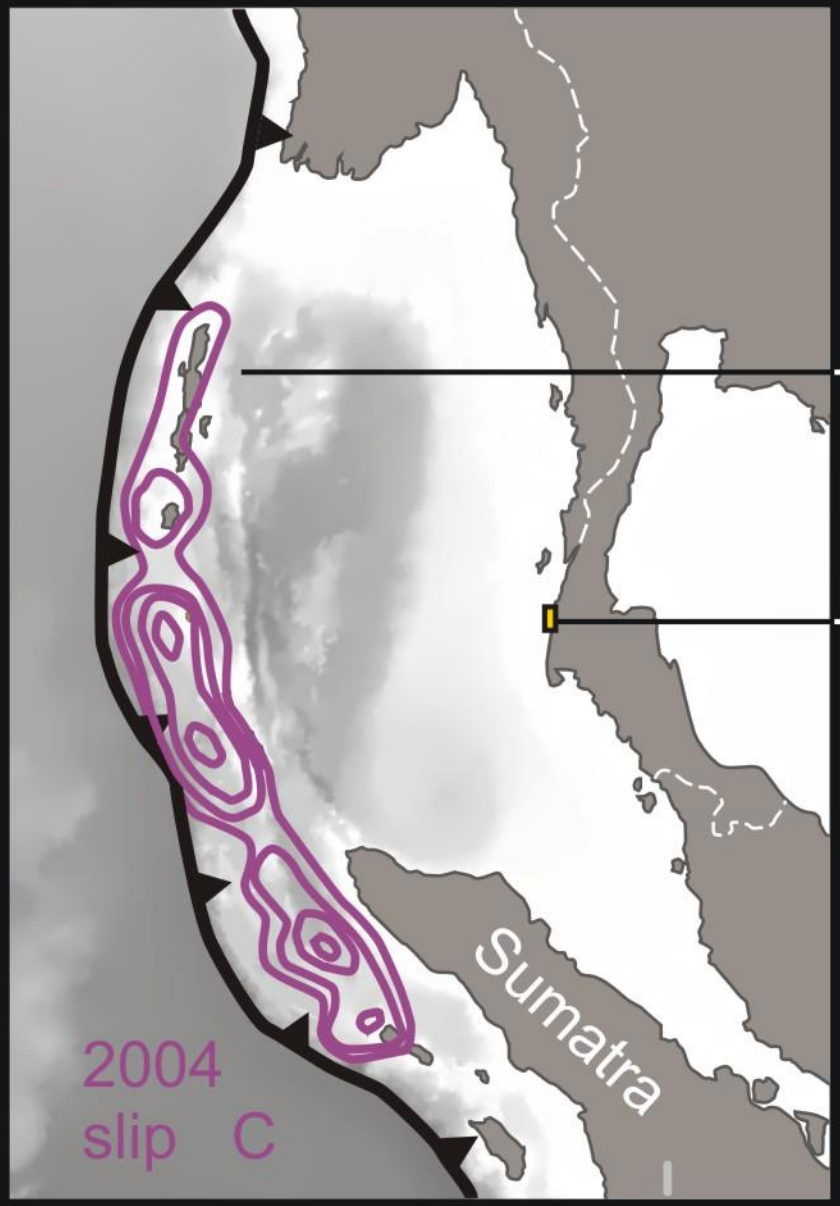
Outer
1921

Slow
1994, 2006

Giant
hypothetical



RECURRENCE



M 9 intervals deduced from seismic slip and plate motions

230- 600 yr a
140- 420 yr b
200-1000 yr c

Intervals between sand sheets <2500-2800 yr old

800- 900 yr average
600 yr most recent

a, Subarya et al. (2006)
b, Chlieh et al. (2007)
c, Stein & Okal (2007)

SEJARAH INDONESIA

Rentang dua tsunami raksasa di Aceh

Catatan tertulis kejadian tsunami di Indonesia

Tahun Masehi

500 1000 1500 2000

Mulawarman

Islam masuk Indonesia

Sam. Pasai

VOC

Sumpah Pemuda

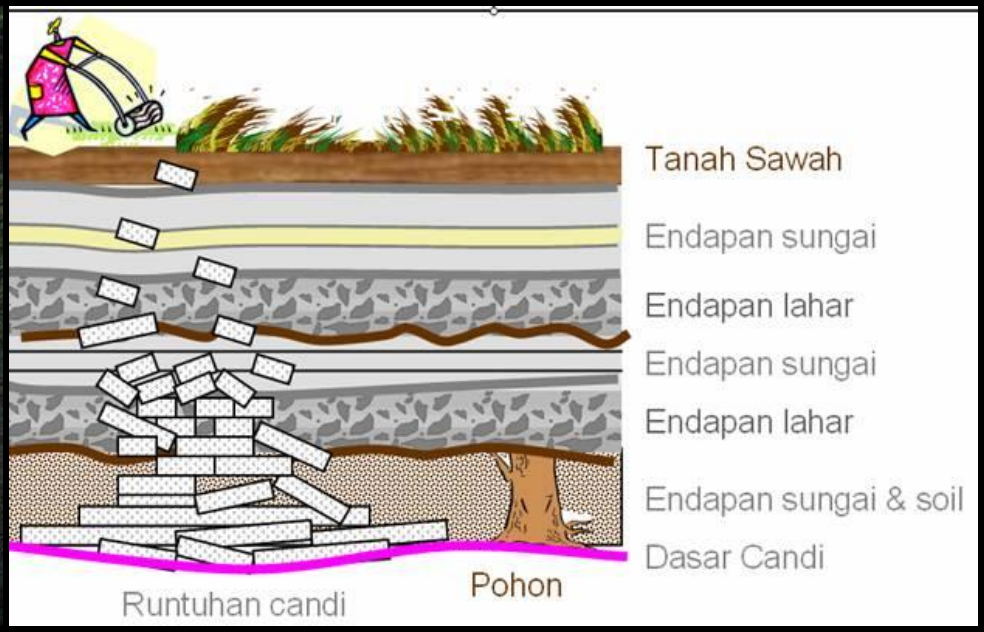
Borobudur

Cheng Ho

1849 km
Interval perulangan 675 th
Max Mw 9,6
(*MacCaffrey, 2008*)

Catatan (mungkin) Terkait dengan Gempabumi dan Tsunami Raksasa Selatan Jawa

Relokasi pusat kerajaan Mataram Hindu ~ Catatan Candi Kedulan (Abad 10)



Berdasarkan prasasti: direnovasi abad 8-9
Digali dari timbunan lahar pada 940 ± 100 yBP
Terkubur awan panas pada 740 ± 50 yBP (1285 M)
Lima lapisan lahar menguburnya setelah 1285 M

Catatan (mungkin) Terkait dengan Gempabumi dan Tsunami Raksasa Selatan Jawa

das Erdbeben mit diesen Worte erwähnt. Die Histoire generale des Voyages 2. La Haye 1747, p. 401 beschreibt, nach der Schilderung von John Saris, das Erdbeben in Bantam von 13. Oktober 1606. Was endlich James (nicht John) Prior betrifft, so langte dieser am 20. August 1811 auf der Reede von Batavia an und erzählt bei dieser Gelegenheit, dass 60 oder 70 Jahre zuvor sich Erdbeben auf Java ereignet, die grosse Bestürzung verursacht hätten. Es können damit also nur seismische Erscheinungen gemeint gewesen sein, die in der Mitte des 18. Jahrhunderts stattgefunden haben (Voyage in the Indian Seas in the Nisus frigate during 1810 and 1811. London 1820; Reise in das Indische Meer. Weimar 1819. p. 171).

1564 oder 1565(ca). Ausbruch des Gam Kunora unweit der Westküste der Nordhalbinsel von Halmahera, begleitet von einem Erdbeben. [1])

1578. Java. Erdbeben. [2])

1584 [Çaka 1506]. Java. Heftiges Erdbeben. [3])

1584 [Çaka 1506]. Java. Violent earthquake. [3]

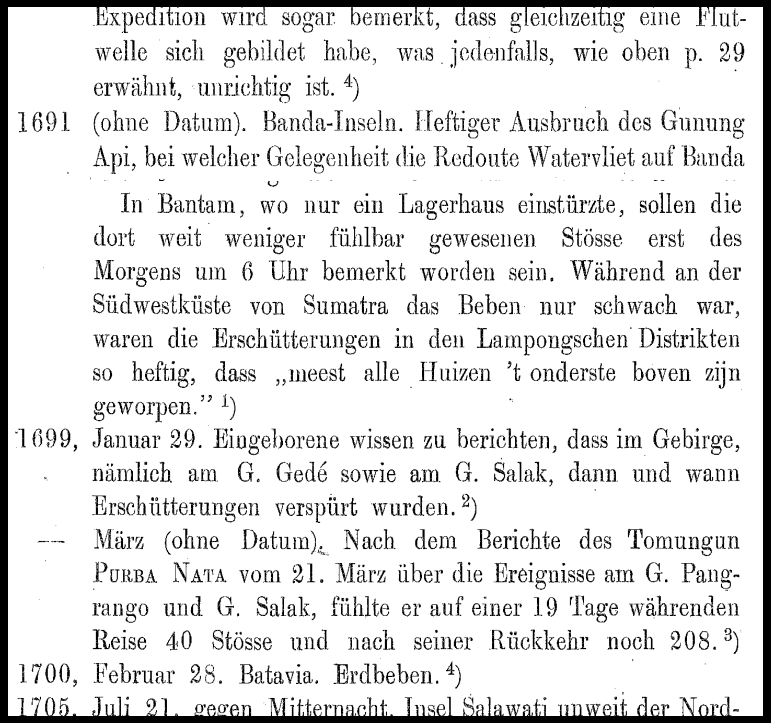
1586 Java. Eruption of Gunung Kelut. [4]

1586 Eruption of Gunung Merbabu, as a consequence the whole island rumbled. [5]

1586 or 1587. Java. Alleged violent eruption of Gunung Ringgit. [6]

1584 ~ 1586 (Wichmann Catalog)

Catatan (mungkin) Terkait dengan Gempabumi dan Tsunami Raksasa Selatan Jawa



Expedition wird sogar bemerkt, dass gleichzeitig eine Flutwelle sich gebildet habe, was jedenfalls, wie oben p. 29 erwähnt, unrichtig ist. [4])

1691 (ohne Datum). Banda-Inseln. Heftiger Ausbruch des Gunung Api, bei welcher Gelegenheit die Redoute Watervliet auf Banda

In Bantam, wo nur ein Lagerhaus einstürzte, sollen die dort weit weniger fühlbar gewesenen Stösse erst des Morgens um 6 Uhr bemerkt worden sein. Während an der Südwestküste von Sumatra das Beben nur schwach war, waren die Erschütterungen in den Lampongschen Distrikten so heftig, dass „meest alle Huizen 't onderste boven zijn geworpen." [1])

1699, Januar 29. Eingeborene wissen zu berichten, dass im Gebirge, nämlich am G. Gedé sowie am G. Salak, dann und wann Erschütterungen verspürt wurden. [2])

— März (ohne Datum). Nach dem Berichte des Tomungun Purba Nata vom 21. März über die Ereignisse am G. Pangrango und G. Salak, fühlte er auf einer 19 Tage währenden Reise 40 Stösse und nach seiner Rückkehr noch 208. [3])

1700, Februar 28. Batavia. Erdbeben. [4])

1705, Juli 21, gegen Mitternacht. Insel Salawati unweit der Nord-

January 5. Powerful earthquake in West Java and the southwest parts of Sumatra. In Batavia under heavy rainstorms there arose at night around 1:30, after the preceding explosion, the vibrations lasting ca. 15 minutes, through which were caused the collapse of 21 houses and 20 barns with the loss of 28 human lives. In the north precipice of Pangrango [Gunung Gede] as well as Gunung Salak near Buitenzorg the quake manifest itself in a particularly violent manner that, notably, on the first mountain caused landslides the debris piles of which stopped up the rivers and produced flooding.

The powerful masses of mud and wood crashed through the Tji Liwung at Batavia into the sea and were all but a calamity for this city.

In Bantam, where only a storage facility collapsed, there far less palpable shocks should have first been perceptible at 6 o-clock in the morning. While on the southwest coast of Sumatra, the quake was but weak, the vibrations in the Lampong-ian Districts were so violent, that, “most all houses the bottom was thrown up.” 1)

1699 (Wichmann Catalog)

Possible tsunami years in historical records:

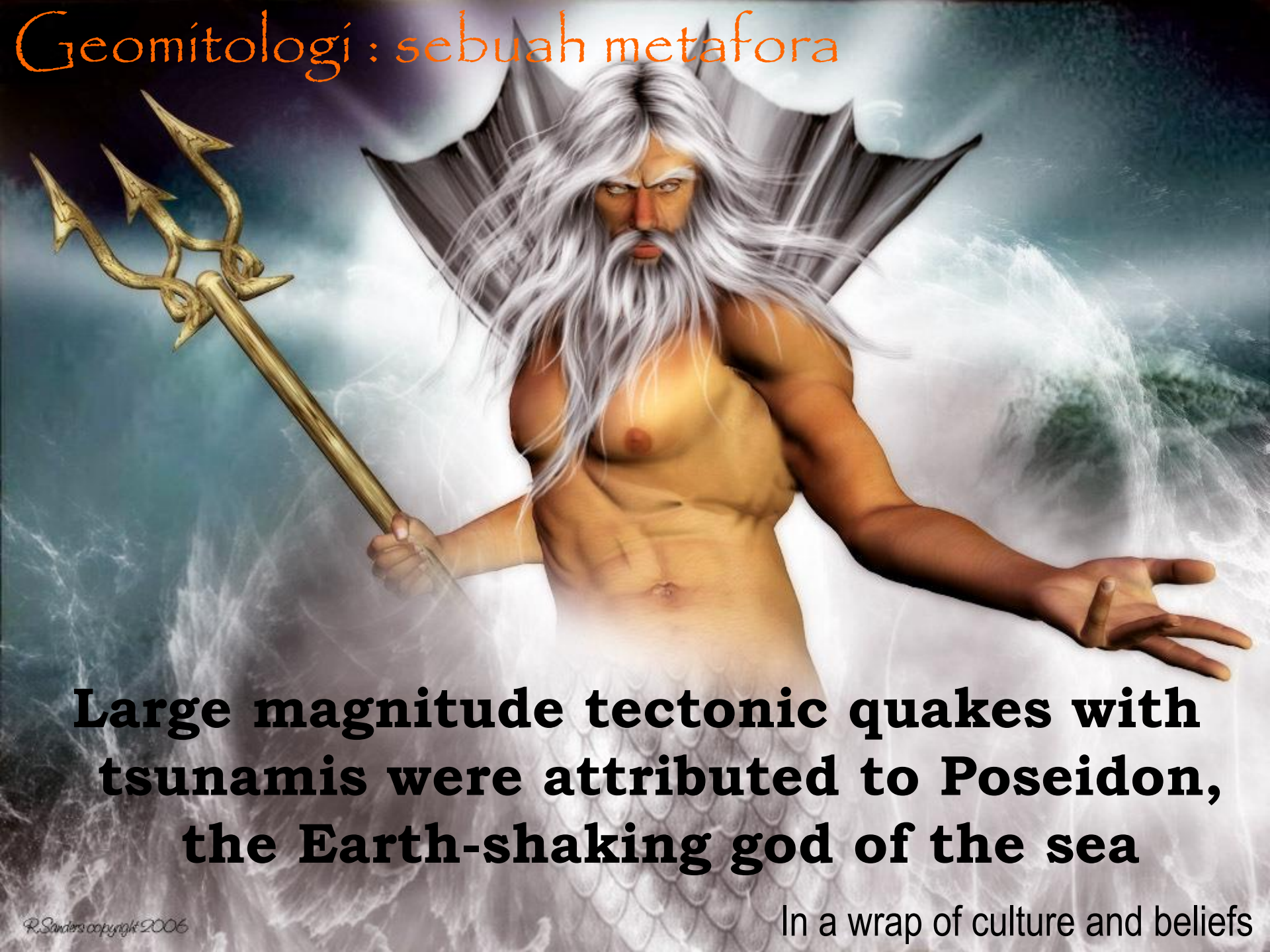
~535 AD

~ 929 AD

~1600 AD

1699 AD

Geomitologi : sebuah metafora

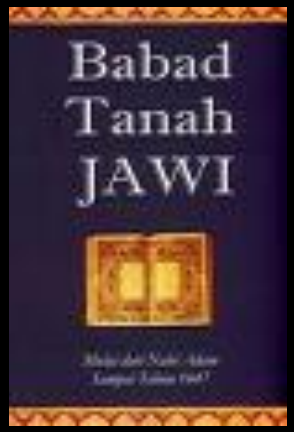


Large magnitude tectonic quakes with tsunamis were attributed to Poseidon, the Earth-shaking god of the sea

In a wrap of culture and beliefs

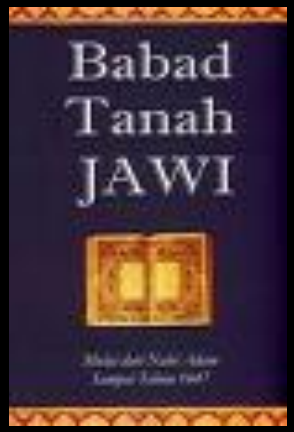
Geomitologi : sebuah metafora

In a wrap of culture and beliefs



Babad Tanah Jawa
halaman 132

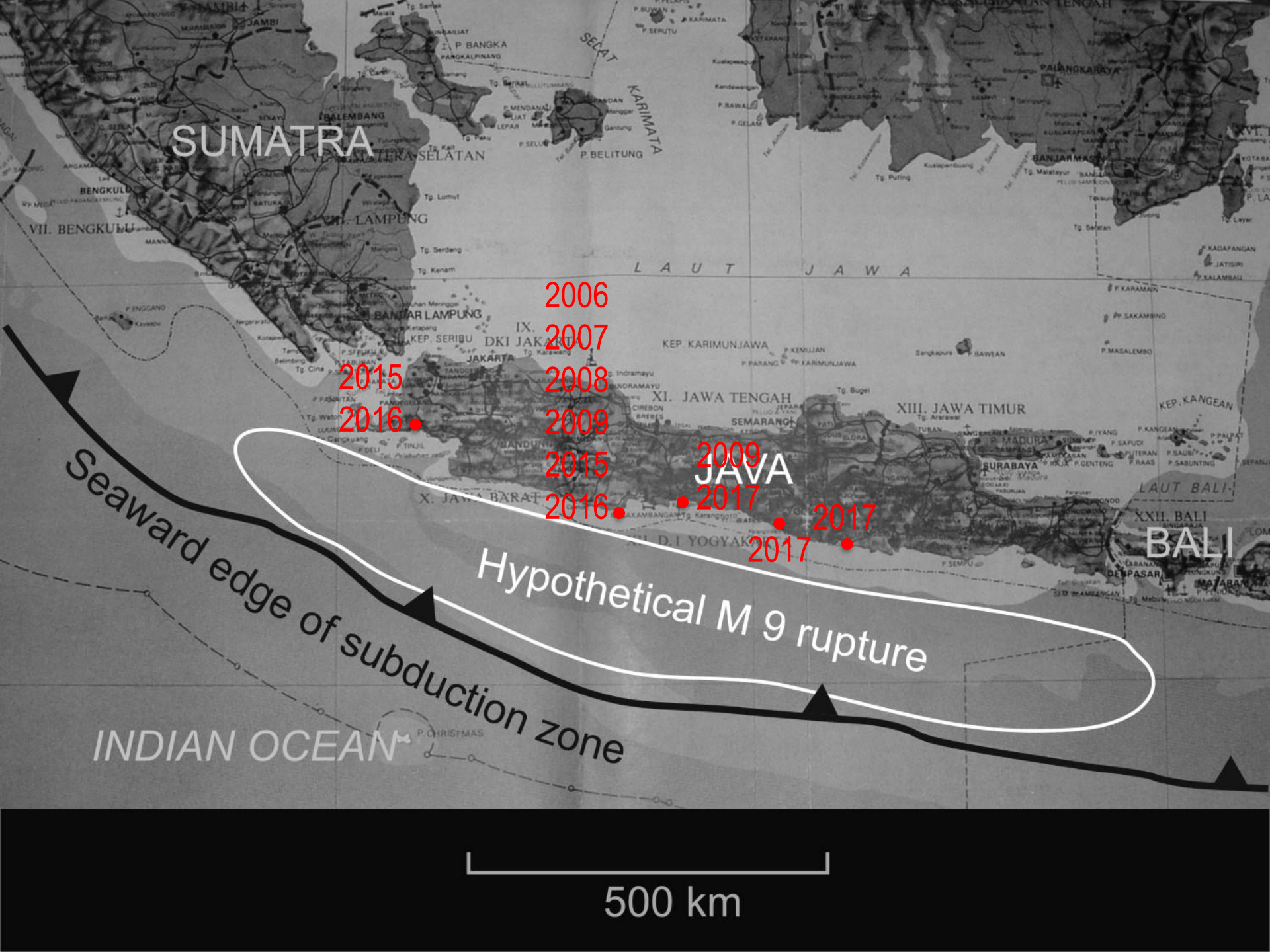
…….Sutawijaya berangkat ke arah timur, lurus menuju kali Opak (ompak), terjun ke sungai dan terus ke laut kidul dengan menghanyutkan diri. Di sungai itu ada ular raksasa bernama Kiai Tunggul Wulung yang pernah ditolong senopati. Ular itu membawa senopati ke laut, berhenti di sawangan. Di situ ia bersemedi lalu masuk ke dalam laut. Kemudian senopati bertapa menghadap diri sepenuh-penuhnya kepada Allah. Senopati tidak basah air, tetapi air laut berkecipak-kecipak menggelombang bukan kepalang, menimbulkan bencana segala makhluk di lautan.



Babad Tanah Jawa
halaman 132

Datanglah prahara. Pepohonan bertumbangan, gelombang setinggi gunung dengan suara mengerikan, air samudera memanas, banyak makhluk air mati. Istana laut kidul menjadi geger, seisi laut lalu ribut. Seluruh penghuninya terkena hawa panas karena cipta dan rasa senopati Sutawijaya yang mengheningkan cipta dengan membaca doa. Keadaan itu mengakibatkan kegelisahan seorang patih Ratu Kidul yakni Nyi Rara Kidul, yang istananya ada di kahyangan Dlepih……..

Adakah kaitannya dengan Sejarah ?
Apa kaitannya dengan rekaman geologi ?


SUMATRA
JAVA
BALI
LAUT JAWA
INDIAN OCEAN
2006
2007
2008
2009
2015
2016
2009
2017
2016
2017
2017
Seaward edge of subduction zone
Hypothetical M 9 rupture
500 km


N
Image © 2015 CNES / Astrium
© 2015 Google
Google earth
483 m
2003
Imagery Date: 10/9/2014 6°48'24.25" S 105°58'39.46" E elev 19 m eye alt 2.24 km











POSDAYA



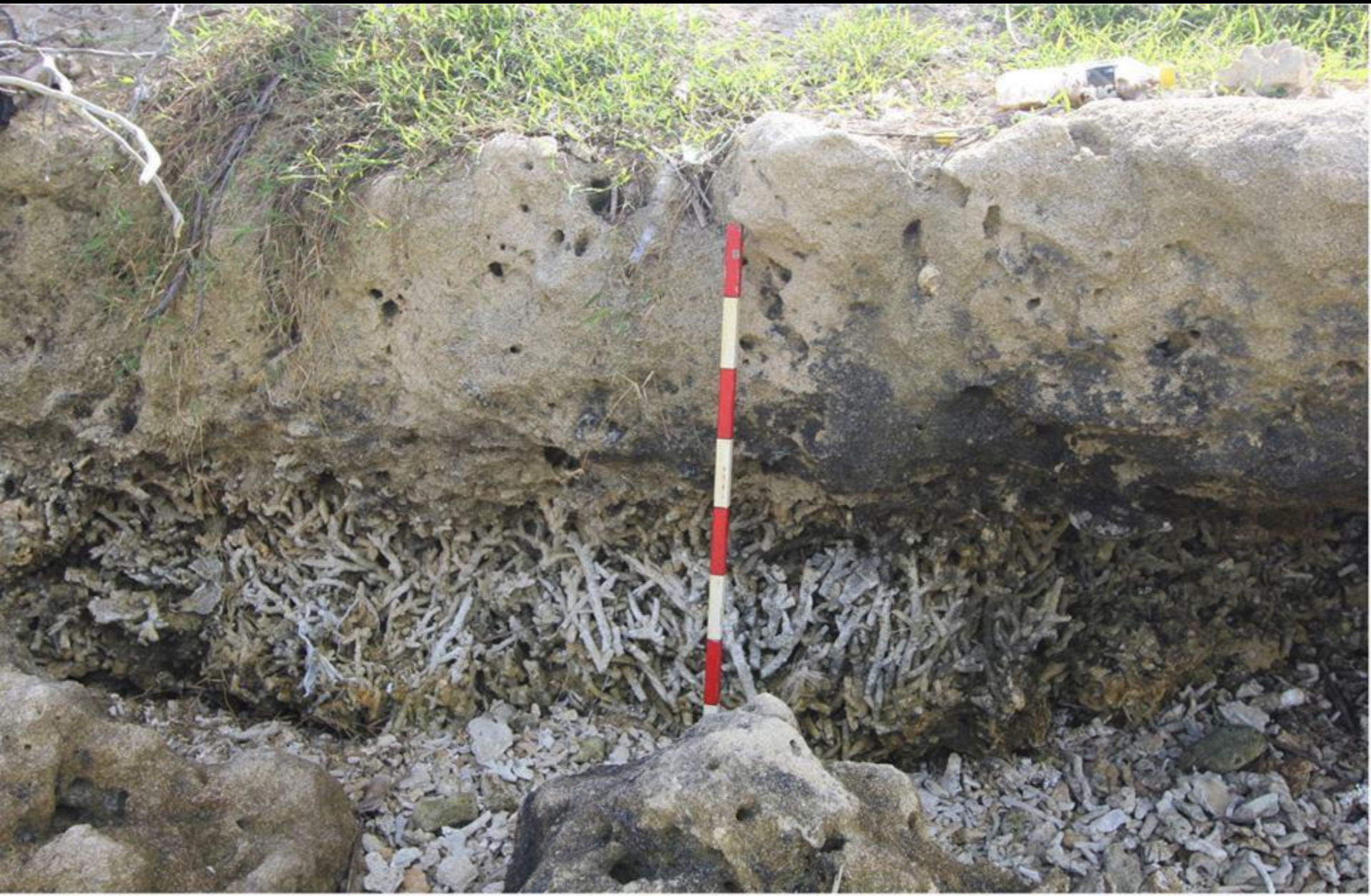




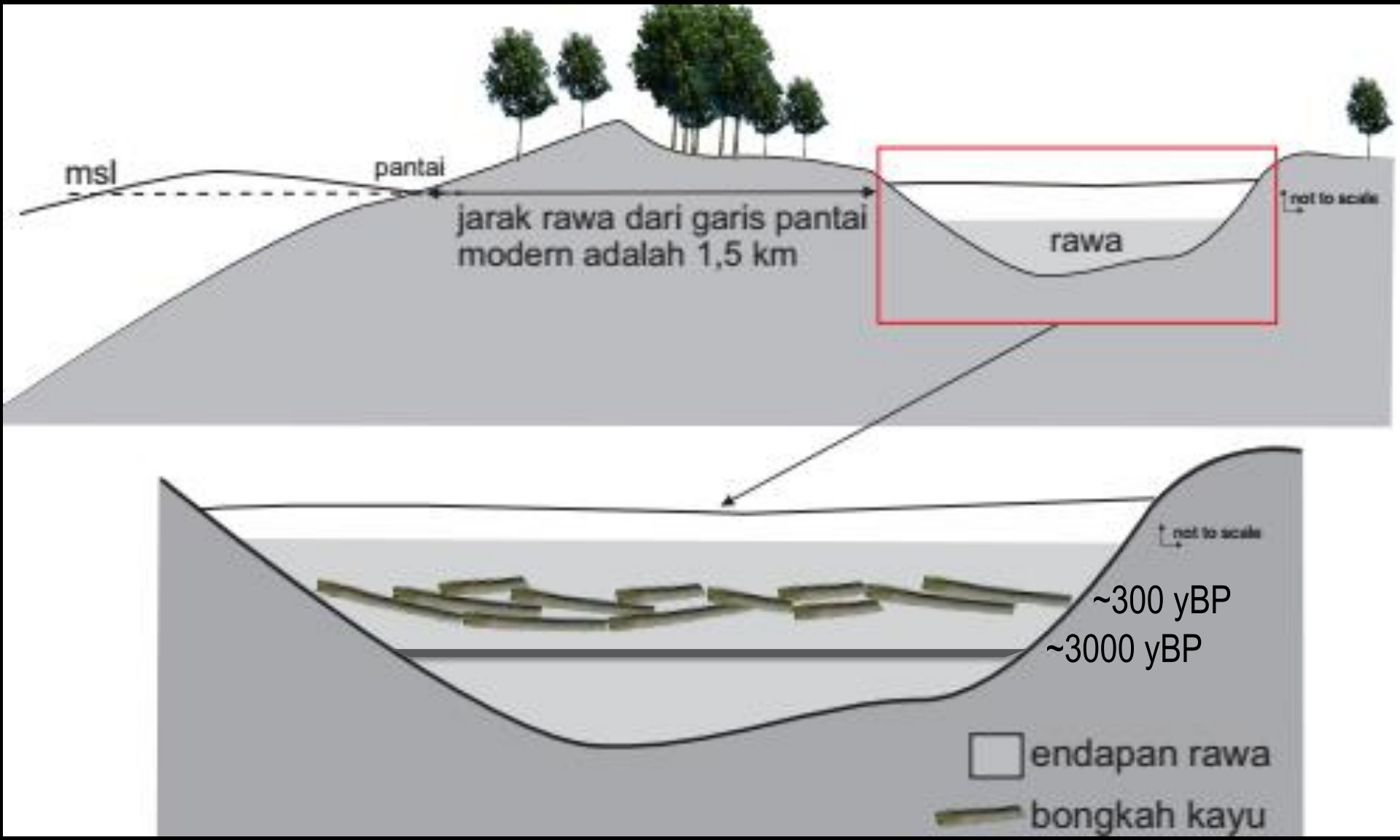






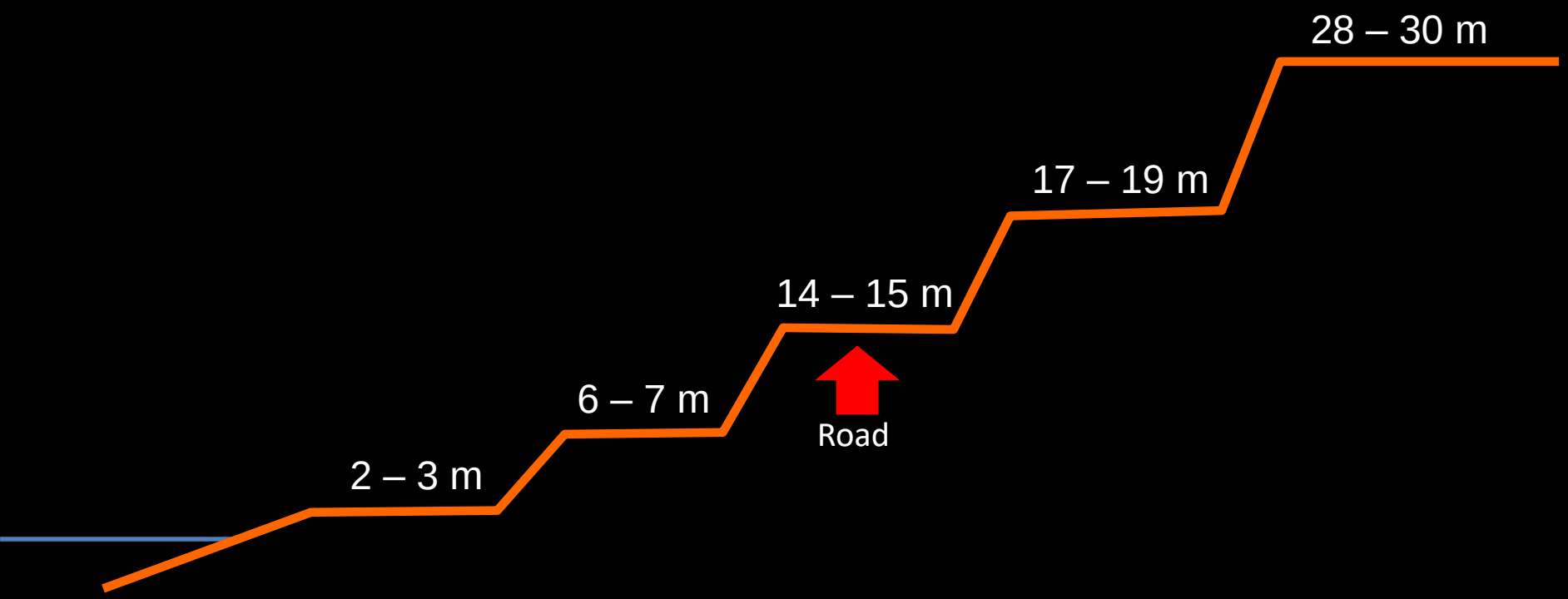


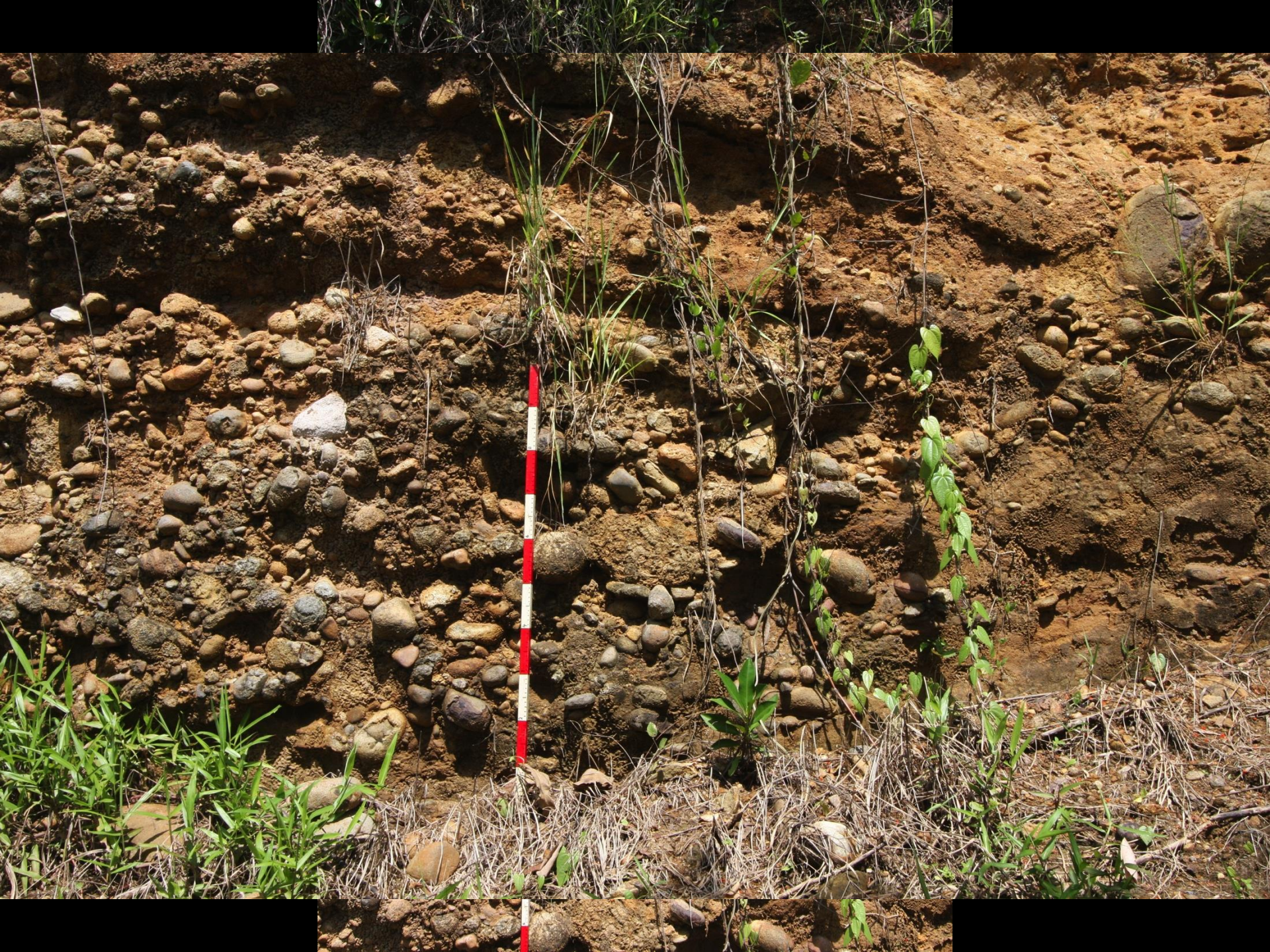
Salah satu tangkapan operasi Peleton Kerbau Rawa 2016 ~ sebuah profil stratigrafi memperlihatkan koloni branching koral dalam posisi tumbuh yang terangkat di atas permukaan air laut dan terkubur oleh lapisan tebal pasir sponge spicule. Posisi tumbuh koral bercabang dan beberapa `coral head` mengindikasikan kematian koloni secara tiba-tiba akibat pengangkatan dan penguburan oleh pasir sponge spicule. Di dalam lapisan pasir sponge spicule tertanam mengambang fragmen-fragmen koral dan cangkang moluska - Bravo Peleton Kerbau Rawa


msl
pantai
jarak rawa dari garis pantai
modern adalah 1,5 km
rawa
not to scale
not to scale
~300 yBP
~3000 yBP
endapan rawa
bongkah kayu

Kedalaman	Foraminifera Plangtonik	Foraminifera Bentonik
64,0 – 65,0	*Globigerina sp.* (40) *Globigerinoides sp.* (100) *Neogloboquadrina sp.* (8) *Globorotalia sp.* (16) *Hastigerina sp.* (3)	*Bathysiphon filiformis* (5), *Bulimina striata* (3), *Cibicides lobatus* (3), *Cibicides praencinctus* (2), *Cibicides wuellerstorfi* (5), *Dentalina sp.* (2), *Nodosaria sp.* (4)
65,0 – 66,0	*Globigerina sp.* (57) *Globigerinoides sp.* (72) *Globorotalia sp.* (22) *Hastigerina sp.* (1)	*Amphycorina sp.* (2), *Bathysiphon filiformis* (9), *Bulimina marginata* (1), *Bulimina striata* (10), *Cibicides lobatus* (7), *Cibicides praencinctus* (4), *Cibicides wuellerstorfi* (4), *Nodosaria sp.* (3)
66,0 – 67,0	*Globigerina sp.* (60) *Globigerinoides sp.* (90) *Globorotalia sp.* (9) *Neogloboquadrina sp.* (6)	*Bathysiphon filiformis* (10), *Bulimina marginata* (7), *Bulimina striata* (9), *Cibicides lobatus* (9), *Cibicides praencinctus* (1), *Cibicides wuellerstorfi* (9), *Nodosaria sp.* (1)
67,0 – 68,0	*Globigerina sp.* (60) *Globigerinoides sp.* (31) *Globorotalia sp.* (9)	*Bathysiphon filiformis* (7), *Bulimina marginata* (3), *Bulimina striata* (19), *Cibicides lobatus* (2), *Cibicides praencinctus* (9), *Cibicides wuellerstorfi* (6), *Nodosaria sp.* (7)
68,0 – 69,0	*Globigerina sp.* (61) *Globigerinoides sp.* (80) *Globorotalia sp.* (6) *Hastigerina sp.* (2) *Globoquadrina sp.* (4)	*Bathysiphon filiformis* (6), *Bulimina marginata* (10), *Bulimina striata* (9), *Cibicides lobatus* (5), *Cibicides praencinctus* (2), *Cibicides wuellerstorfi* (6), *Dentalina sp.* (1), *Nodosaria sp.* (3)
69,0 – 70,0	*Globigerina sp.* (72) *Globigerinoides sp.* (79) *Globorotalia sp.* (8) *Hastigerina sp.* (3) *Globoquadrina sp.* (3)	*Bathysiphon filiformis* (2), *Bulimina marginata* (3), *Bulimina striata* (11), *Cibicides lobatus* (7), *CIbicides dosopusulosus* (4), *Cibicides wuellerstorfi* (6), *Nodosaria sp.* (2)
71,0 – 72,0	*Globigerina sp.* (56) *Globigerinoides sp.* (42) *Globorotalia sp.* (28) *Hastigerina sp.* (12)	*Amphycorina sp.* (1), *Bathysiphon filiformis* (12), *Bathysiphon nodosariaformis* (7), *Brizalina semicarinata* (4), *Bulimina marginata* (12), *Bulimina striata* (5), *Cibicides lobatus* (3), *Cibicides wuellerstorfi* (1), *Dentalina sp.* (1), *Lagena hispidula* (1), *Uvigerina peregrina* (11), *Uvigerina striata* (19)

Teras Laut
Southcoast of West Java
(*Laser Range Finder measurement*)



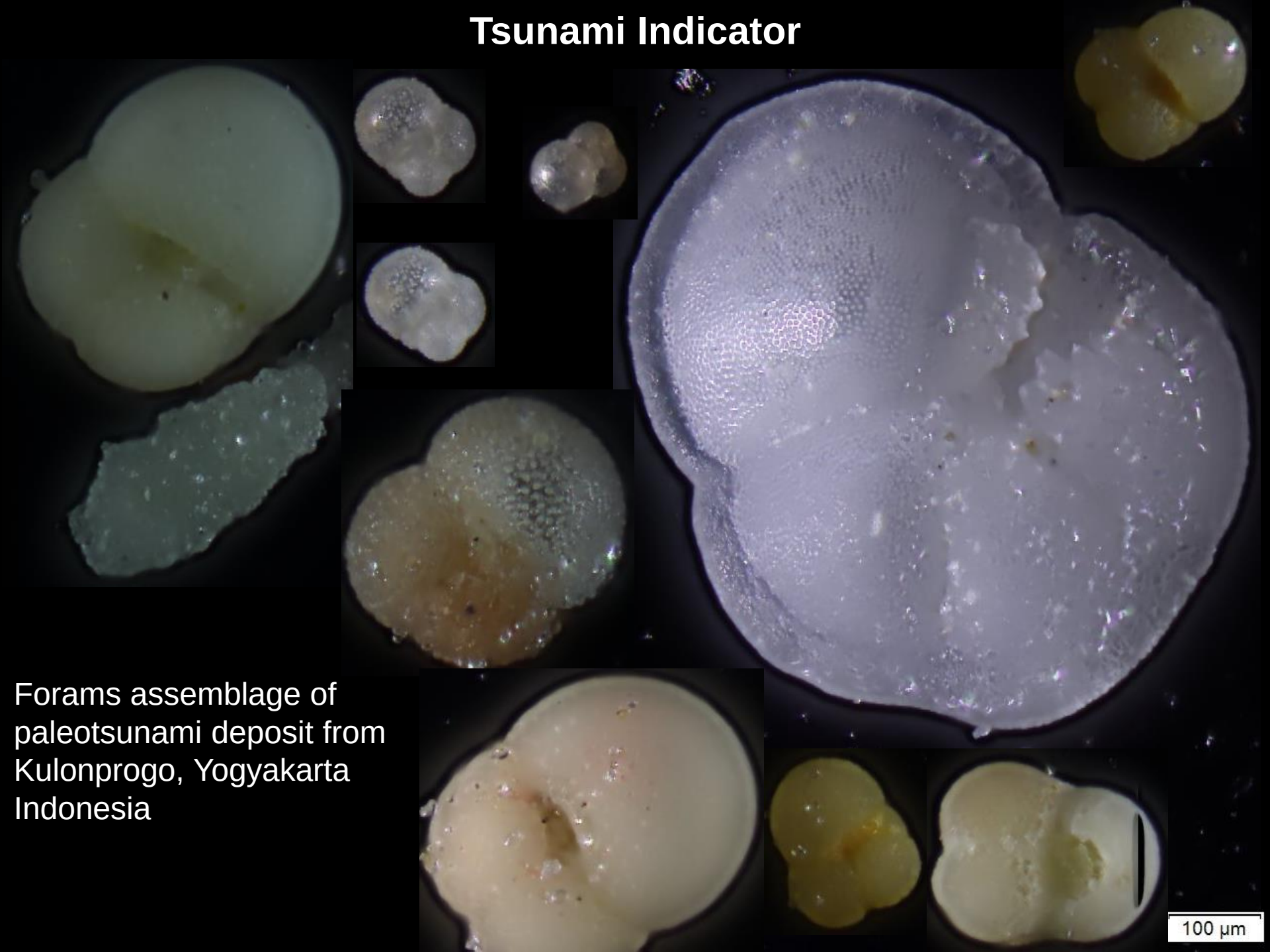



6
8
4

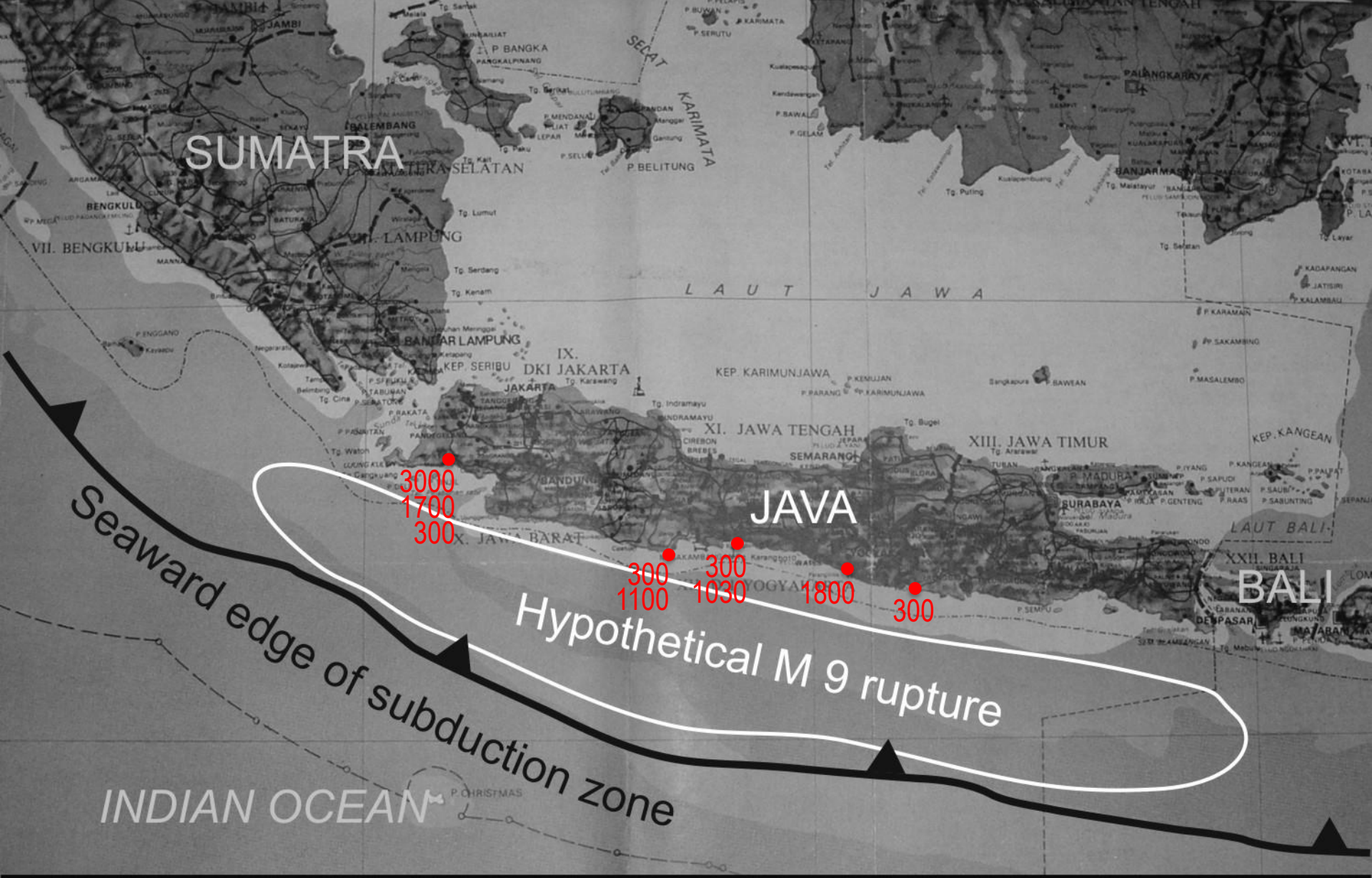
Endapan Paleotsunami di Kulonprogo, Juli 2017

Endapan Paleotsunami di Kulonprogo, Juli 2017

Tsunami Indicator



Forams assemblage of paleotsunami deposit from Kulonprogo, Yogyakarta Indonesia


SUMATRA
JAVA
BALI
INDIAN OCEAN
LAUT JAWA
LAUT BALI
Seaward edge of subduction zone
Hypothetical M 9 rupture
3000
1700
300
300
1100
300
1030
1800
300
1849 km
Interval Perulangan 675 th
Max Mw 9,6
(MacCaffrey, 2008)
500 km

4 Seberapa besar risikonya ?