# BEN

## Bimonthly webinar  on Earthquake Risk in Bangladesh

# Could Bangladesh experience a megathrust induced catastrophic earthquakes?


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Engineering Geologist

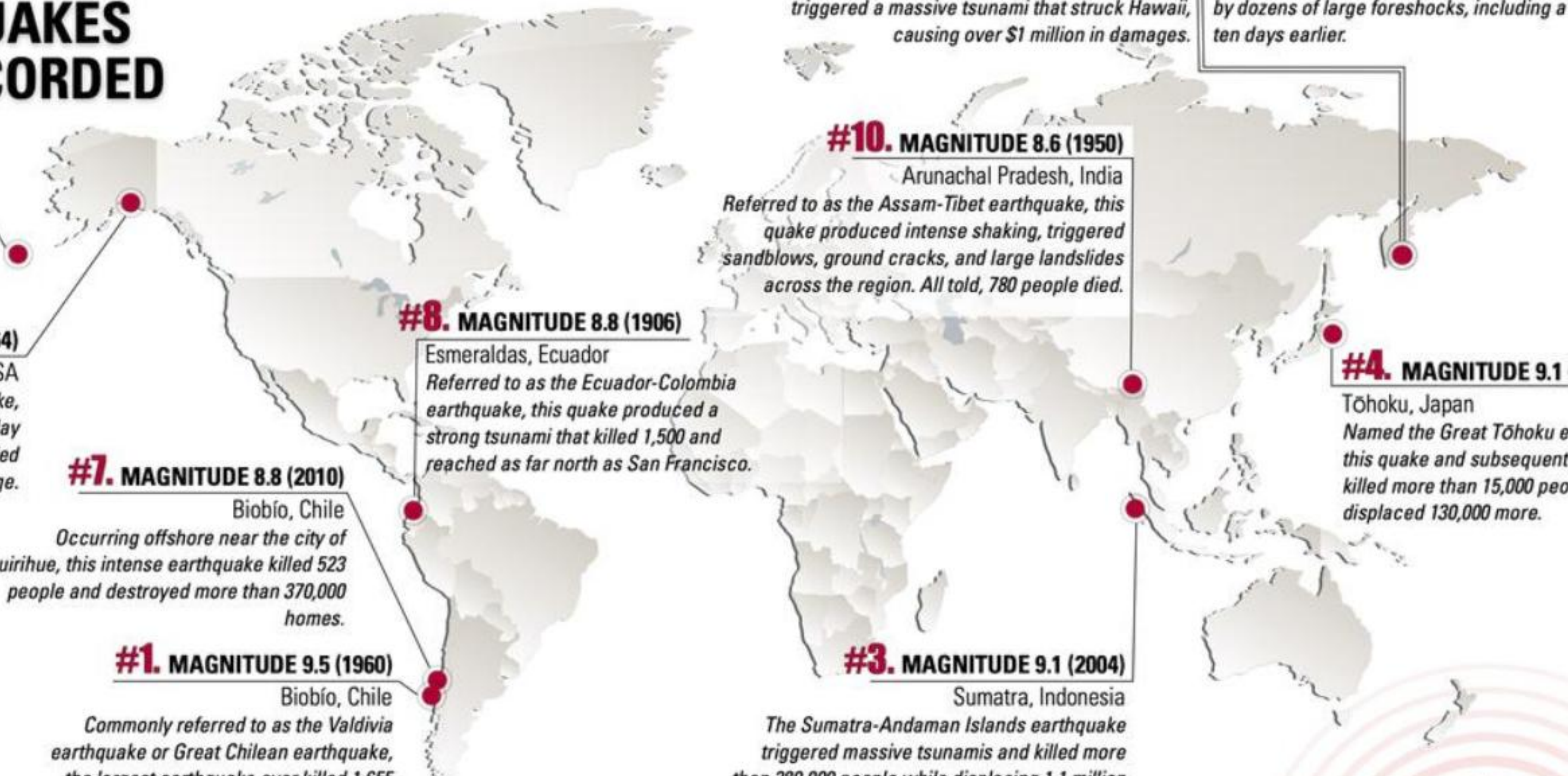
GeoEastern Inc., USA


Saturday, May 30, 2026

With Dr. Roger Bilham
@ South California Earthquake Center 2016 discussing GPS Data Calibration....

Roger Bilham believes, there is a possibility of MegaEarthquakes in the Indian Himalayan Belt

# 10 LARGEST EARTHQUAKES EVER RECORDED



## #1. MAGNITUDE 9.5 (1960)
Biobío, Chile

*Commonly referred to as the Valdivia earthquake or Great Chilean earthquake, the largest earthquake ever killed 1,655 people and left 2 million homeless.*

## #2. MAGNITUDE 9.2 (1964)
Alaska, USA

*Often referred to as the Great Alaska earthquake, Prince William Sound earthquake, or Good Friday earthquake, this quake and ensuing tsunami killed 130 people and caused $2.3 billion in damage.*

## #3. MAGNITUDE 9.1 (2004)
Sumatra, Indonesia

*The Sumatra-Andaman Islands earthquake triggered massive tsunamis and killed more than 280,000 people while displacing 1.1 million across South Asia and East Africa.*

## #4. MAGNITUDE 9.1 (2011)
Tōhoku, Japan

*Named the Great Tōhoku earthquake, this quake and subsequent tsunami killed more than 15,000 people and displaced 130,000 more.*

## #5. MAGNITUDE 9.0 (1952)
Kamchatka, Russia

*The world's first recorded magnitude 9 earthquake triggered a massive tsunami that struck Hawaii, causing over $1 million in damages.*

## #6. MAGNITUDE 8.8 (2025)
Kamchatka, Russia

*Tied for 6th largest, this earthquake was preceded by dozens of large foreshocks, including a M7.4 ten days earlier.*

## #7. MAGNITUDE 8.8 (2010)
Biobío, Chile

*Occurring offshore near the city of Quirihue, this intense earthquake killed 523 people and destroyed more than 370,000 homes.*

## #8. MAGNITUDE 8.8 (1906)
Esmeraldas, Ecuador

*Referred to as the Ecuador-Colombia earthquake, this quake produced a strong tsunami that killed 1,500 and reached as far north as San Francisco.*

## #9. MAGNITUDE 8.7 (1965)
Alaska, USA

*Located near the Rat Islands of Alaska's Aleutian Islands, this earthquake generated a tsunami that was reportedly 35 feet high.*

## #10. MAGNITUDE 8.6 (1950)
Arunachal Pradesh, India

*Referred to as the Assam-Tibet earthquake, this quake produced intense shaking, triggered sandblows, ground cracks, and large landslides across the region. All told, 780 people died.*

## OTHER NOTABLE LARGE EARTHQUAKES

- M 8.6 - *Sumatra, Indonesia (2012)*
- M 8.6 - *Adak, Alaska (1957)*
- M 8.6 - *Singkil, Indonesia (2005)*
- M 8.6 - Unimak Island, Alaska (*1947*)
- M 8.5 -Kuril'sk, Russia (*1963*)
- M 8.5 -Tual, Indonesia (*1938*)
- M 8.5 -Vallenar, Chile (*1922*)

U.S. Department of the Interior
U.S. Geological Survey

SOURCE: https://www.usgs.gov/programs/earthquake-hazards/science/20-largest-earthquakes-world-1900

**UPDATED: Nov. 2025**

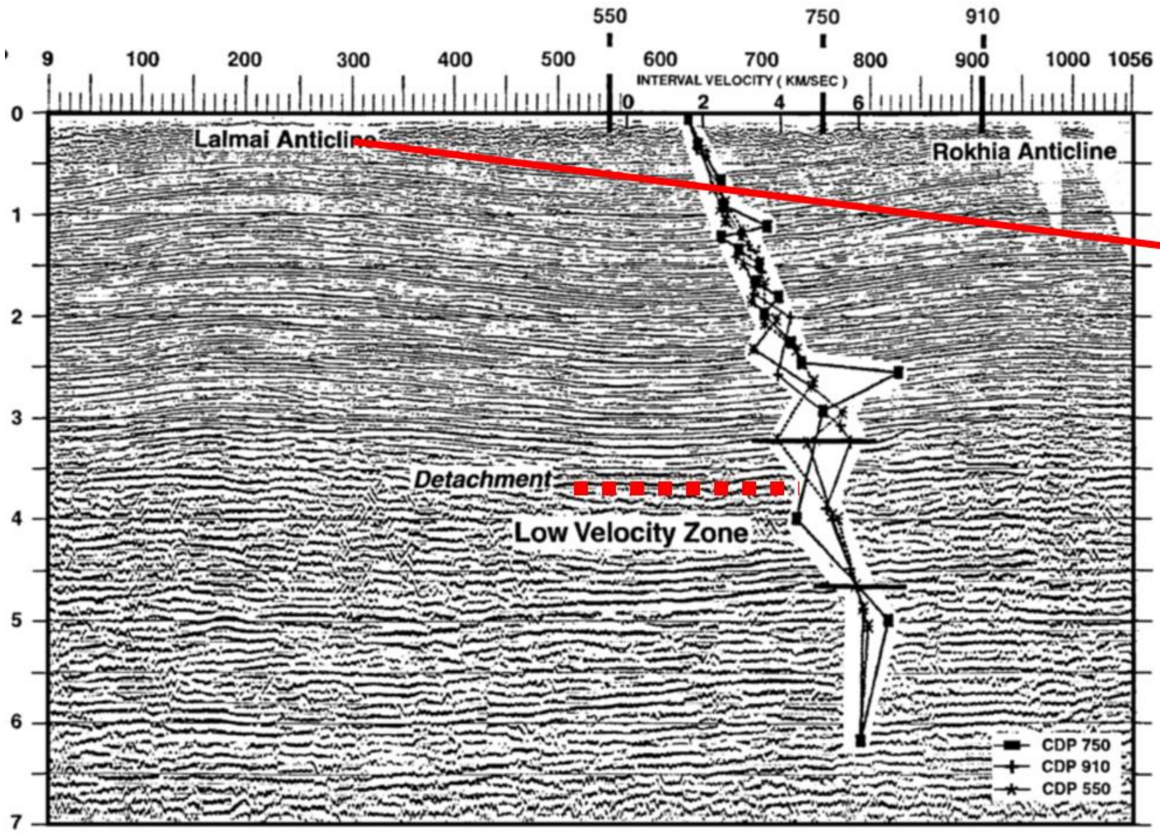
strongest earthquake ever recorded
The **1960 Valdivia earthquake**
**And tsunami Great Chilean earthquake**
22 May 1960. **9.4–9.6 on** the moment magnitude scale,
Occurred in the afternoon (19:11:14 UTC),
Lasted 10 minutes.
Resulted Tsunamis
Affected southern Chile, Hawaii, Japan, the Philippines, eastern New Zealand, southeast Australia, and the Aleutian Islands

# A SCIENTIFIC BLUNDER 2016 AND A DEBATE

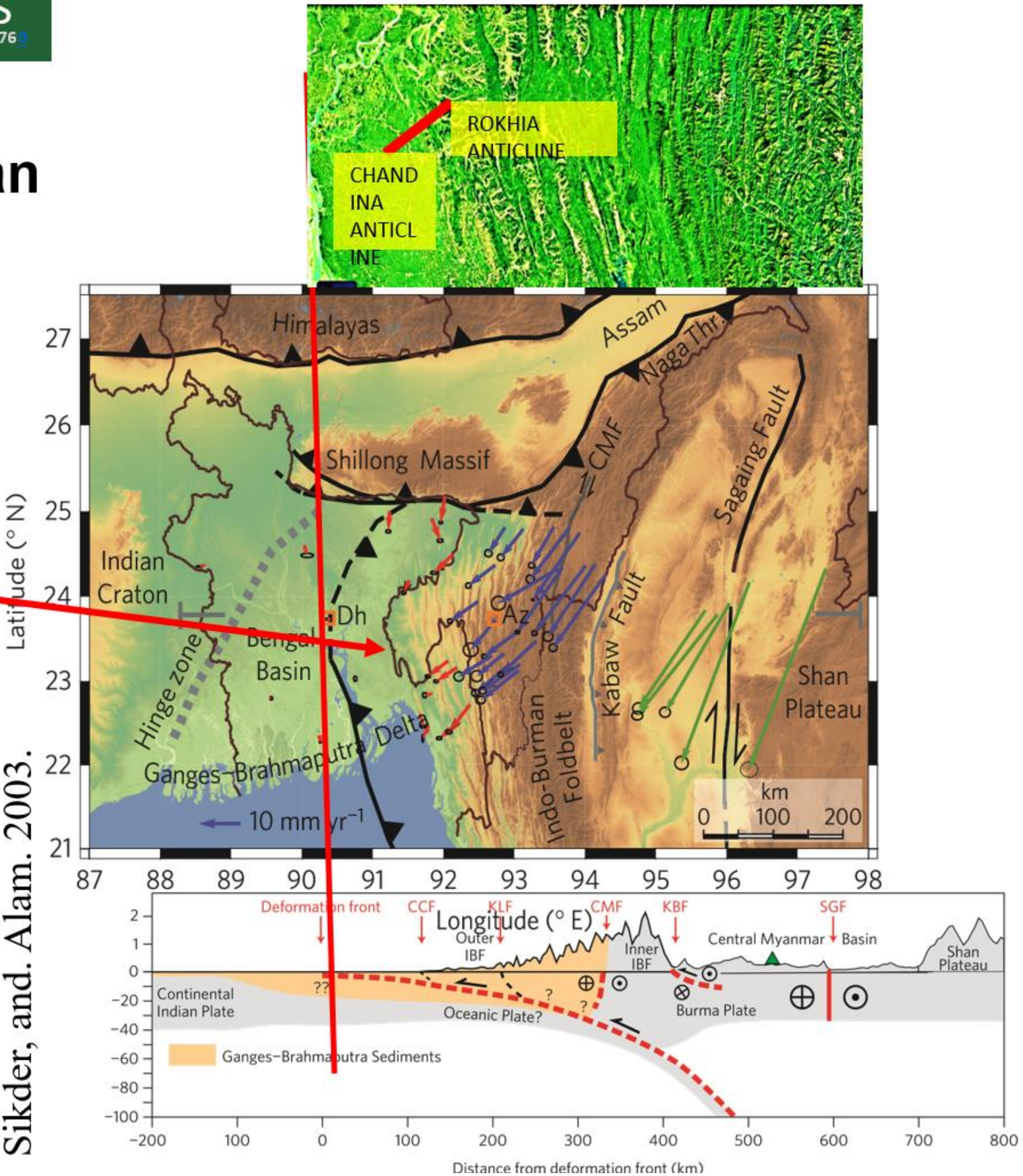
nature geoscience
LETTERS
PUBLISHED ONLINE: 11 JULY 2016 | DOI: 10.1038/NGEO 2760

## Locked and loading megathrust linked to active subduction beneath the Indo-Burman Ranges

Michael S. Steckler[1] et al. 11 JULY 2016




Sikder, and. Alam. 2003.




THE REASON OF DEFYING MICHAEL STECKLER 2016

THE DEBATE

# Could Bangladesh experience a megathrust induced catastrophic earthquakes?

AGU ADVANCING EARTH AND SPACE SCIENCE
American Geophysical Union
San Francisco, USA. December 11 – 15, 2023

Mir Fazlul Karim[1], Abid Lodhi[2] and Arif Mohiuddin Sikder[3]

T33E-0238: Abstract ID: 1452118

1 GeoEastern Inc., MA, USA. (and former Director, Geological Survey of Bangladesh), 2 Consultant Petroleum Geologist, Sylhet Gas Fields Ltd., Bangladesh, 3Center for Environmental Studies, Virginia Commonwealth University, USA

**ABSTRACT :** Bangladesh is a very densely populated country and tectonically located in the active part of the Indian subcontinent. The country occupies a major part of the Bengal Basin, the largest fluvio-deltaic sedimentary system on earth, laid by the Ganges, Brahmaputra, and Meghna (GBM) river systems. The tangential tectonic forces exerting from Indian, Eurasian and Myanmar plate movements put the country under a complex state of tectonic stress and strain situation. Bangladesh needs to adopt an intelligent and rational seismic understanding and management system due to the rapid urban and industrial expansion (the Dhaka Megacity population density ≈87,000/sq mile). Several researchers made predictions of mega-earthquakes based on hypothetical simulation models that are highly conjectural due to lack of sufficient geological evidence. This study comprises available geological, geophysical, geodetic, rheology, micro-seismic, structural, and geometrical datasets to differ the hypothetical catastrophic earthquake predictions from presumed megathrust, concealed under ≈15 miles thick sedimentary sequence of the Bengal Basin. Historically the Srimangal fault, located about 120 miles east of Dhaka city, generated the largest earthquake of Mw ≈7.5 in Bangladesh and no other seismogenic structures have been detected in the studied area that can generate larger earthquakes than the Srimangal Earthquake. In the present study geological, magnetic, gravitational anomaly maps and subsurface data published by the Geological Survey of Bangladesh are used in comprehending the crustal configuration and tectonic scenario of Bangladesh for determining the potential structures and active faults for an appropriate seismic hazard analysis.

**Data and methods:** This work is mainly based on detailed field investigations throughout Bangladesh and neighboring states of India. As Bangladesh doesn't have adequate instrumental geophysical and GPS database, we used required GPS data from Nevada Geodetic Laboratory (Blewitt, et al., 2018) Map Browse GPS Stations and UNAVCO. EQ magnitude, locations and hazard maps are retrieved from IRIS, USGS and Global Earthquake Model (GEM). The deep crustal and Moho configuration data are used from published sources including the seismic, geodetic data & subsurface geological maps. For geometrical array & vector mapping of tectonic deformation, intensive data search is done from published sources. The crustal study indicates that the basin is severely fragmented & topography of the sedimentary sequences are shaped and stressed by various sizes of graben and horsts.

**SEISMICITY OF BANGLADESH**

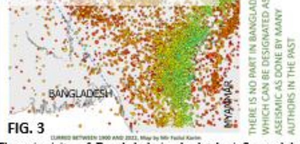



FIG. 3 The seismicity of Bangladesh is absolutely influenced by the regional tectonic structures, increases towards east along subduction and suture zone.

**STATISTICS OF EARTHQUAKE OCCURENCES IN BANGLADESH AND ADJUCENTS**

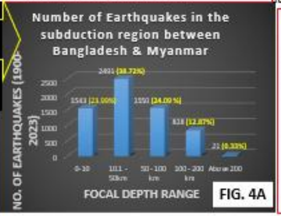



FIG. 4A

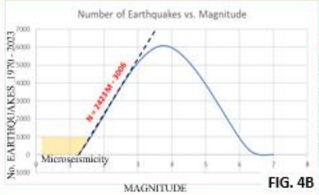



FIG. 4B

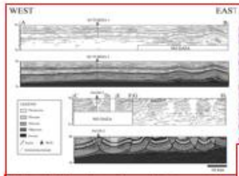


FIG. 7A Line drawing and interpretation of seismic lines in the outer Indo-Myanmar Wedge supported by two wells.

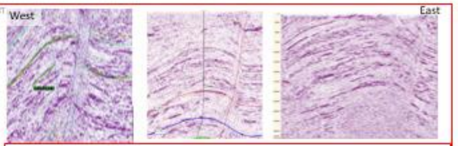



FIG. 7B The examples of west-dipping thrust faults in the EFB, Bangladesh are provided here (East is on the right). The Eastern Fold Belt (EFB) have their west verging thrusts, where the structural pattern suggests that the compressional force is directed from the SW to NE, which is in line with the evidence-based mainstream research opinions that is widely used in the structural interpretation practices for this compressional region.

**ABOVE FIG. 7A & 7B:** An investigation on crustal configuration using available seismic data; velocity images, travel time tomography along number of profiles. the regional structural pattern using Maurin's regional cross-section in figure 7A claiming that the thrusted anticlines in the Eastern Fold Belt (EFB) have their west verging thrusts. This structural pattern suggests that the compressional force is directed from the SW to NE, which is in line with the evidence-based mainstream research opinions that is widely used in the structural interpretation practices for the region. The idea that the compressional force is directed to the west is an off shoot of the mainstream. the regional structural pattern, which should not mislead any seasoned researchers. Understanding the structural pattern correctly is of paramount importance in structural process modeling. In inset a seismic section showing large wavelength folding. Sikder and Alam (2003) proposed that a major structure exists along the Chittagong coastline in Bangladesh and claim that wrenched fold structures underlined this Chittagong Coastal Fault. Wrench tectonic is particularly clear in the southern Chittagong district along the coast.

**INTRODUCTION** The understanding of earthquake risk management in Bangladesh is one of the major socio-economic concerns owing to its high population density, geological and tectonic setting involving complex syntaxial stress-strain and multidimensional differential deformation conditions from the Indian, Tibetan and Burmese tectonic plates. Seismic hazard assessment of an earthquake prone region involves a wide range analysis of seismological and geological data and engineering characterization of geological materials. The earthquake history of Bangladesh and surrounding region indicates that the country is seismically active. This study finds the landmass to be the world's youngest active delta building system fully controlled and trended by the regional or distal tectonic influence. This work draws a relationship among tectonic setting, structural and crustal configuration of Bengal basin to classify the earthquake source areas. The seismic behavior of these source areas is deeply related with the tectonic structure and basement or crustal configuration of Bengal basin. Present study identifies that the Bengal basin is severely segmented due to both vertical and lateral differential stress condition. This study and analysis reveal new insights of tectonics of Bengal Basin and a compelling resolution for a safe and sustainable development of the country. A rational assessment of seismic threats is determined from the locations, depths, intensity of local, regional seismicity, differential tectonic stress conditions and possible highest energy impact. It is speculated that the crustal segmentation has weaken the earthquake source structures. We did not find any seism-genic structure in Bangladesh that would cause earthquakes larger than magnitude 7.5 Mw. This study will provide an improved understanding and coherent considerations in the socio-economic progression, geo-engineering and structural engineering design options, construction practices, factors of safety in respective geological environment, maintenance and continuing sustainable development and building safe cities provided the norms of Bangladesh National Building Codes are maintained.

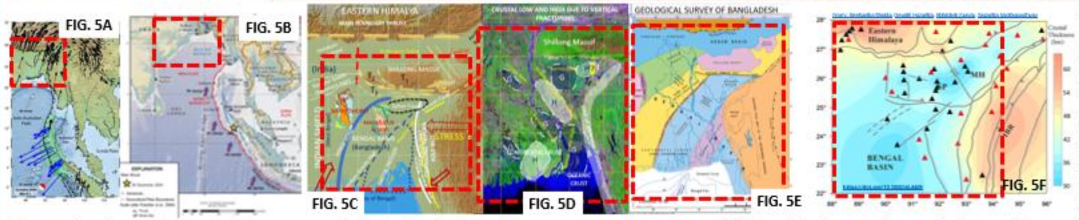
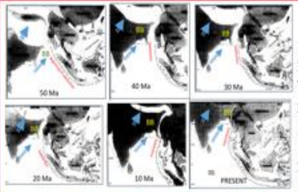



FIG. 5A FIG. 5B FIG. 5C FIG. 5D FIG. 5E FIG. 5F

For a geometrical array and vector-mapping of tectonic deformation, intensive data search is done from published sources. The crustal study indicates that the basin is severely fragmented, and topography of the sedimentary sequences are shaped and stressed by various sizes of crustal graben and horsts in the Bengal Basin (FIG. 5D), the FIG. 5E shows NNE - SSW alignment of the tectonic regimes of the Bengal Basin System as synchronized with India Plate velocity vectors, FIG. 5F shows the crustal thickness indicating crustal attenuation in most of the Bengal Basin and NE India. All along the India-Burma-Sunda systematically evolved tectonic ARCS are SEQANTIALLY formed. The sequential tectonic activities and become independent tectonic structures associated with respective trenches and auxiliary thrust zone in association shortening of adjacent accretionary prisms a subduction deformation zone.



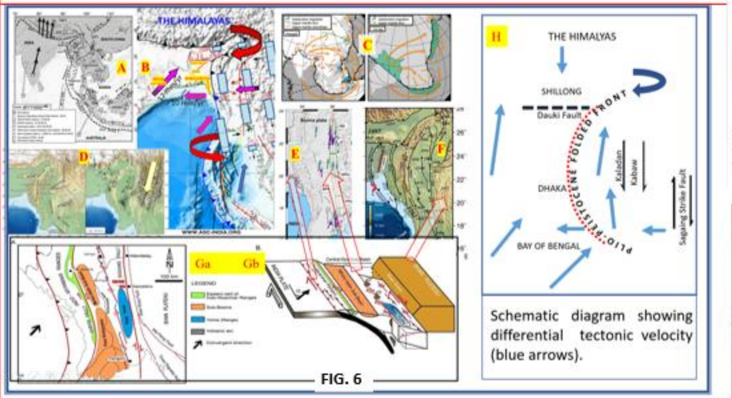

**GEOLOGICAL EVOLUTION OF BENGAL BASIN, INDO-BURMESE SUBDUCTION ARCS**

The geological history of formation of the Bengal basin is very much related to regional tectonic processes, involving movement India, Australia and Eurasian plate motions, followed by deltaic depositional lobs. Sequential formation of tectonic Arcs along the eastern subduction chain from the Indian ocean to Myanmar volcanic arcs (see FIG. 5A and B).

FIG. 1

FIG. 2a FIG. 2b FIG. 2c

**BACKGROUND OF PRESENT STUDY:** In last few decades, an aggressive advancement has taken place for studies and understanding of geodynamic behavior of the basin system (FIG 2a). The discovery of decollement structures and development of Neogene accretionary prism complex in an oblique subduction environment is a very important turning alley in the fold-generating mechanism of the BBS (by Sikder in 1998, FIG 2b and 2c). The Lamont–Doherty Earth Observatory (LDEO) scientists executed a revolutionary sophisticated study in the BBS for a decade for the first time using Global Positioning System (GPS) and computer models. The scientists presume a huge, locked subduction interface or megathrust, extended to the western extremities of folded sediments which appears to be the accretionary prism while physical existence and the spatial configuration are not well defined. The study of LDEO concluded with possibilities of occurrence of great earthquakes from the accumulated elastic strain across the megathrust zone. A scientific research paper was published in 2016 (Steckler et. al., 2016, FIG 2b) in the prestigious journal Nature, proposing a hypothetical megathrust fault capable of producing a high-magnitude earthquake in mainland Bangladesh. Media coverage of the article caused panic among the common people. The policymakers even considered designing civil and engineering structures for an earthquake of magnitude 8.2-9 on the Richter Scale. As a result, the costs of large-scale infrastructure projects increased manifold. Several articles were subsequently published in international scientific publications based on this hypothesis. There was serious lack of geoscientific review of the proposed hypothetical megathrust fault. This work presents a systematic geological review of the proposed blind




Schematic diagram showing differential tectonic velocity (blue arrows).

FIG. 6

**FIG. 6.** The regional seismotectonic interaction and control over the Bengal Basin including the crustal and mantle dynamics and stress pattern. Multiple convergent and divergent vectors make a jargon of the stress environment centering deeper part of the Bengal Basin. Modern days GPS motion data are found contradictory to the major NNE India-Eurasian (inset A) and E-W Sunda-India convergent (inset B, E, F), while syntaxial torsional vector in the NE India at the northern tip (insets B, C, D) of Bengal Basin plays severe deformation causing shallow depth moderate size earthquakes. The N-S strike slip faults (insets E, F, G, H) over the India-Bruma subduction splay generates deep earthquakes due to strike-slip partitioning in an oblique convergence zone between the India Plate and the West Myanmar Block.

**CRUSTAL AND MANTLE DYNAMICS AND STRESS PATTERN:** The map and diagrams in FIG. 6 across the Bangladesh-Myanmar-India show clear differences both vertical and surficial geometry of EQ distribution FIG 8A. The yellow and redlines denote the

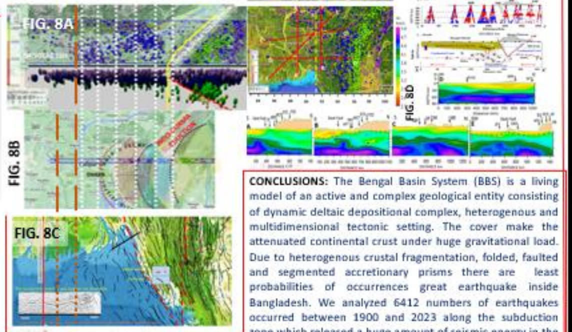


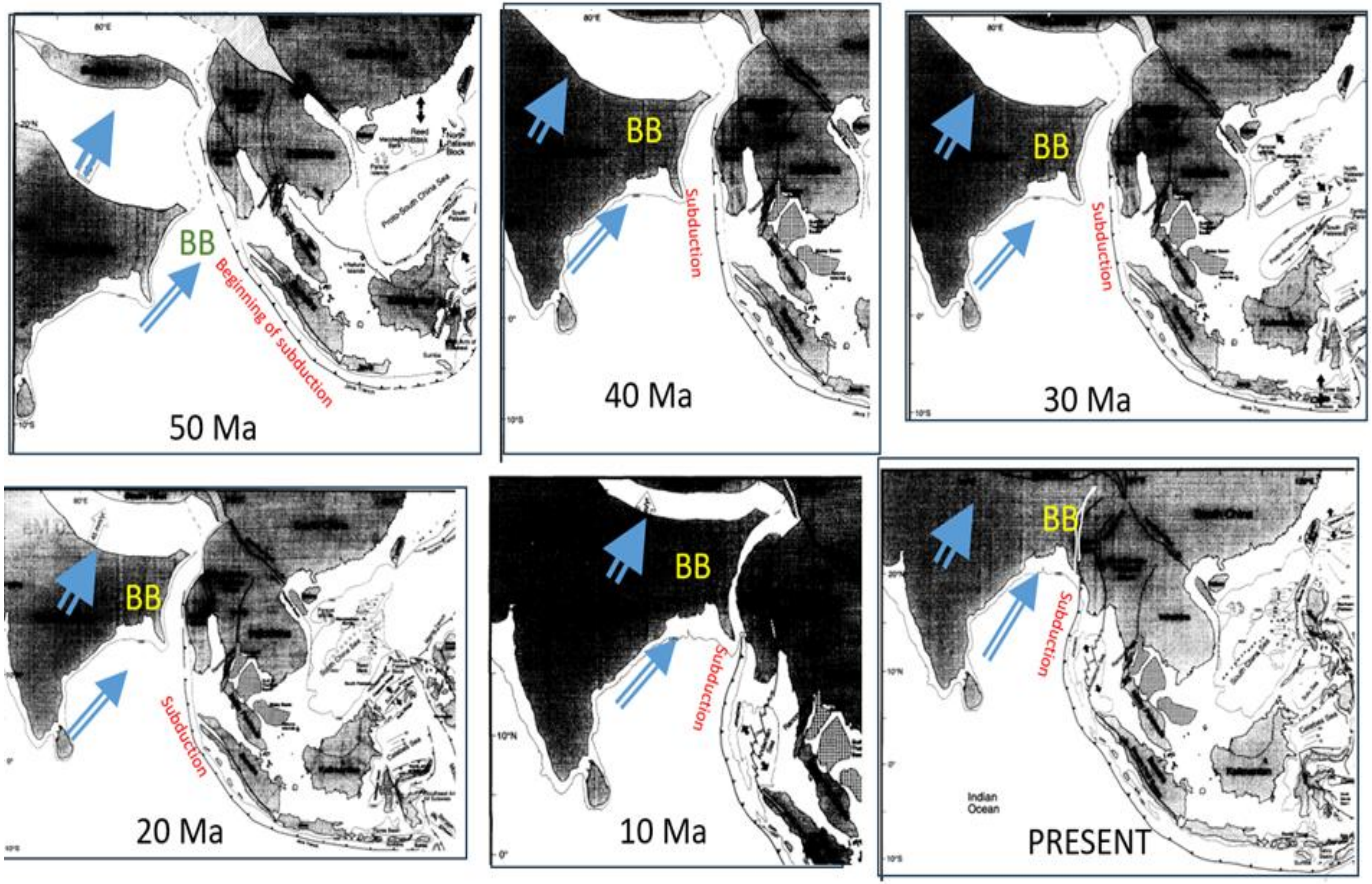
FIG. 8A FIG. 8B FIG. 8C FIG. 8D

locations of anticlines all over Bay of Bengal and large wavelength folding. FIG 8D Tomographic Sections and one NS section across Bangladesh and FIG 8B shows the multiple prisms of the past and future (red dashed lines. FIG 8C presents the locations of anticlines all over Bay of Bengal. In inset a seismic section Shillong Massif to indicate possible[a] absence of subducting structure. FIG 8B shows the multiple prisms of the past and future (red dashed lines. FIG 8C presents the locations of anticlines all

**CONCLUSIONS:** The Bengal Basin System (BBS) is a living model of an active and complex geological entity consisting of dynamic deltaic depositional complex, heterogenous and multidimensional tectonic setting. The cover make the attenuated continental crust under huge gravitational load. Due to heterogenous crustal fragmentation, folded, faulted and segmented accretionary prisms there are least probabilities of occurrences great earthquake inside Bangladesh. We analyzed 6412 numbers of earthquakes occurred between 1900 and 2023 along the subduction zone which released a huge amount of seismic energy in the last 123 years that weakens the so-called locked segments. The geometry of the locked segments does not satisfy enough energy in generating earthquakes of 8.2-9 magnitudes. This research identifies both vertical horizontal locations, sizes and numbers of seismic events in and around Bangladesh. It is very clear that Bangladesh is an EQ susceptible region and EQ hazards can not be ignored but there are least possibilities for occurrences of major or great earthquakes (> Mw 7.5) within the territory of Bangladesh.

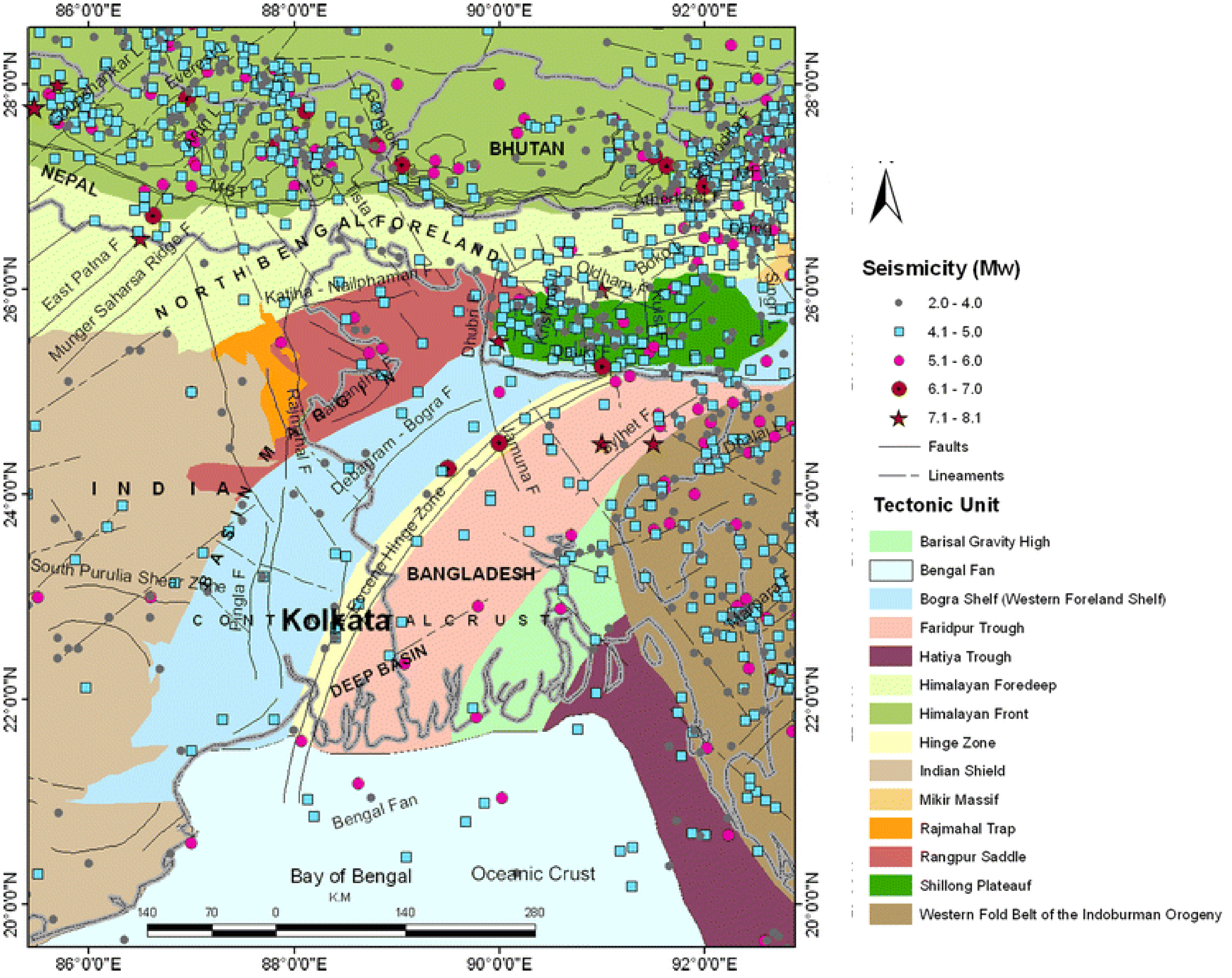
THE DEBATE

# THE BIRTH OF BANGLADESH



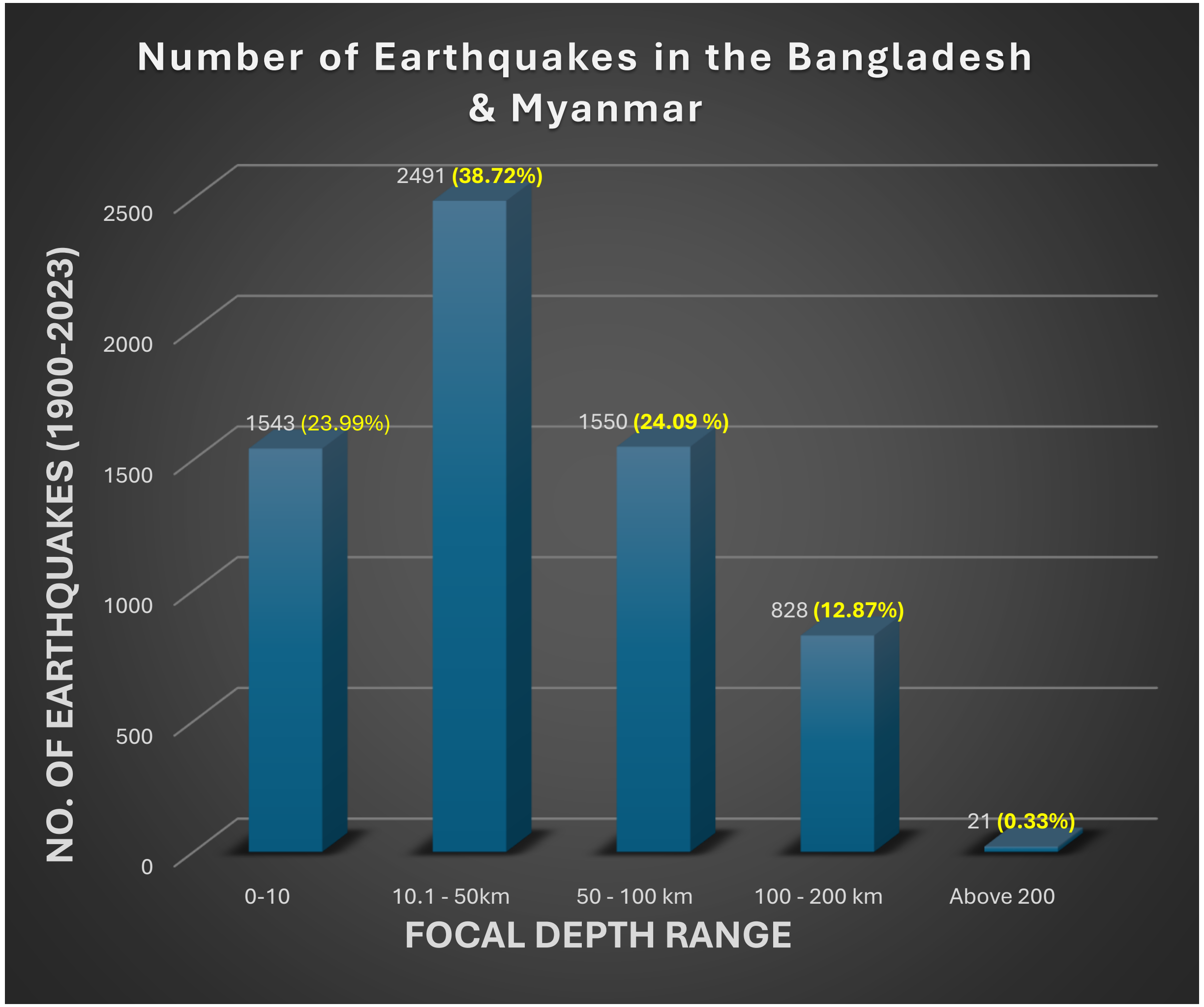

The geological history of formation of Bengal basin is very much related to regional tectonic processes, involving movement of India, Australia and Eurasian plate motions, followed by deltaic depositional lobs. Sequential formation of tectonic Arcs along the eastern subduction chain from the Indian ocean to Myanmar volcanic arcs.

**Modified By Mir F Karim**




# A TECTONIC DEMONSTRATIVE AND SEISMIC MAP OF BANGLADESH AND SURROUNDING AREAS

# STATISTICS OF EARTHQUAKE OCCURENCES IN BANGLADESH AND ADJUCENTS



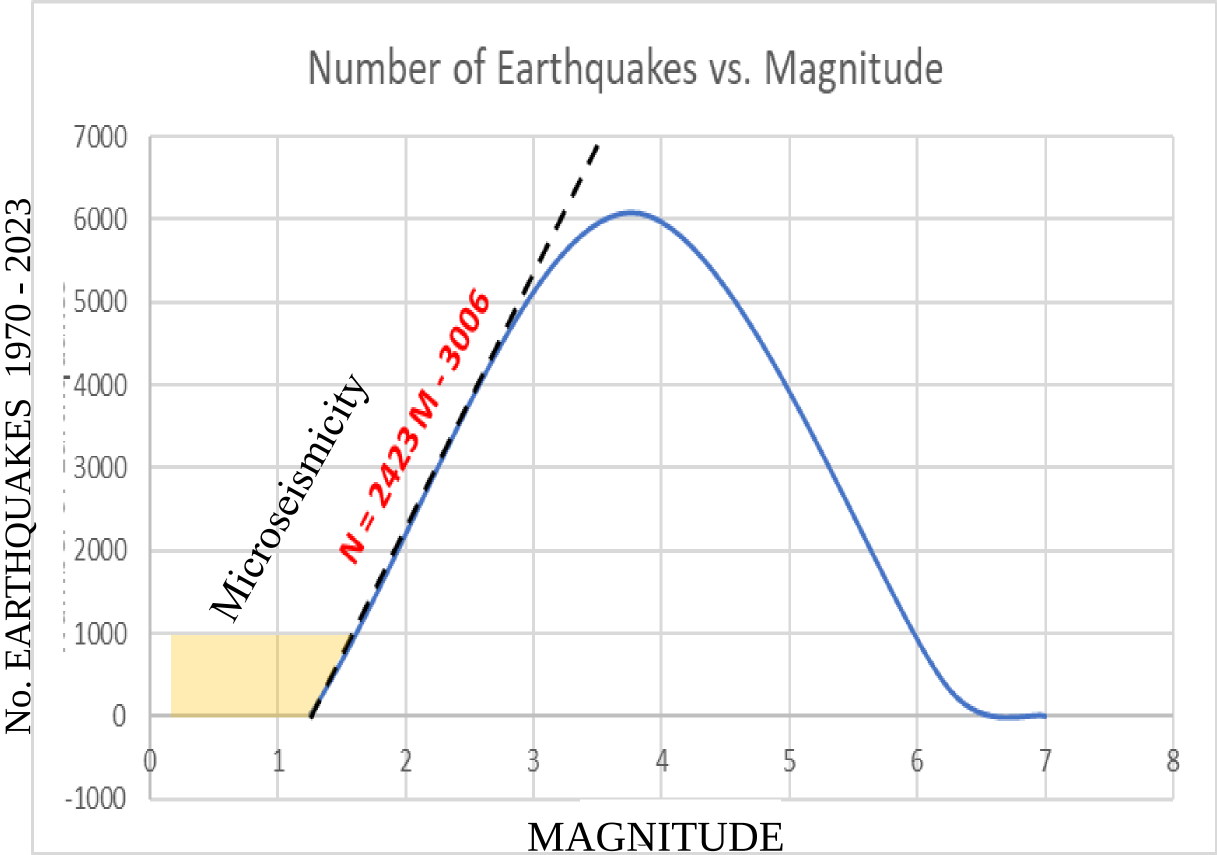
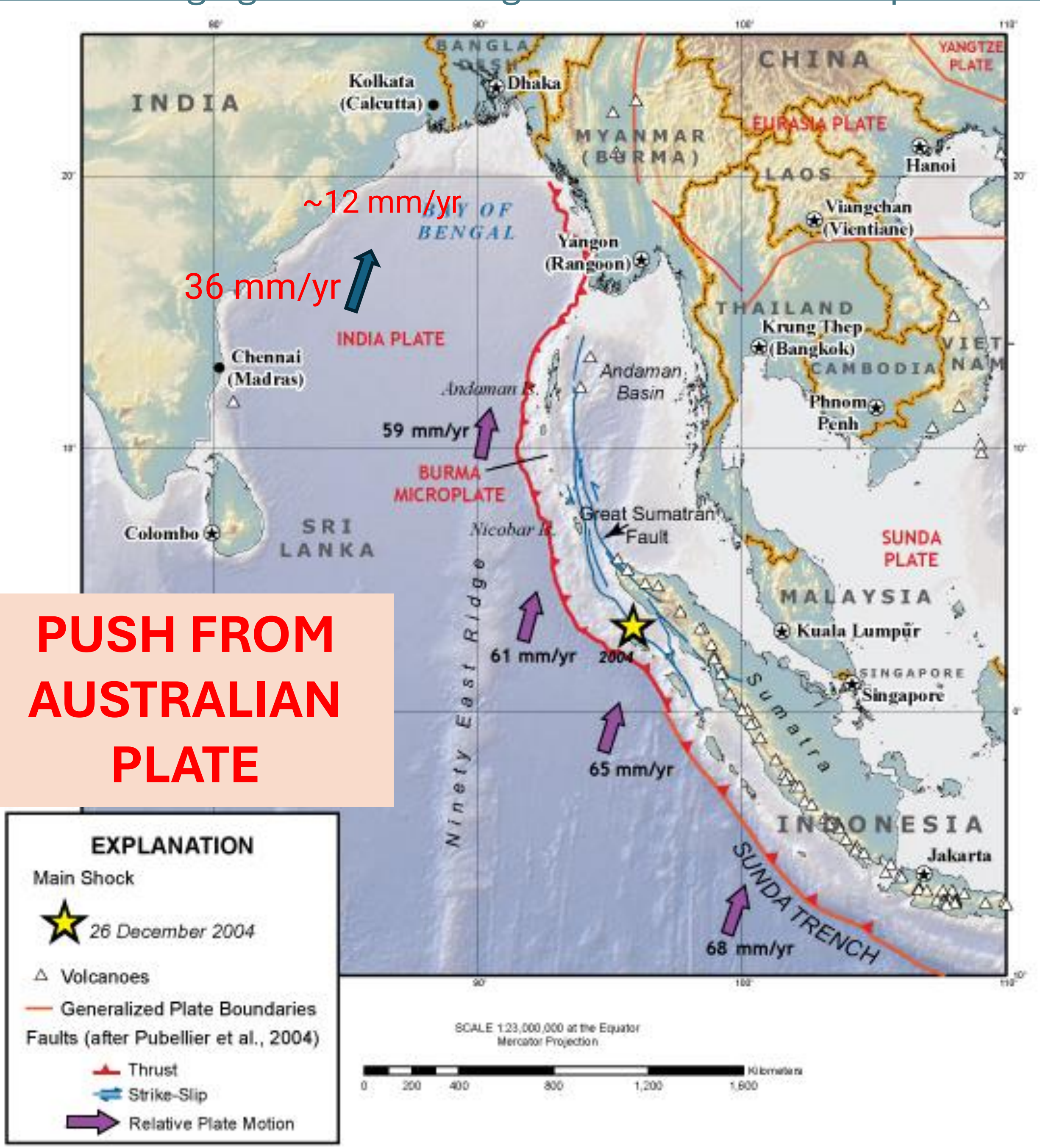




FIG. 4B

https://www.usgs.gov/media/images/tectonic-base-map-sumatra-subduction-zone-showing-major-faults




**PUSH FROM AUSTRALIAN PLATE**

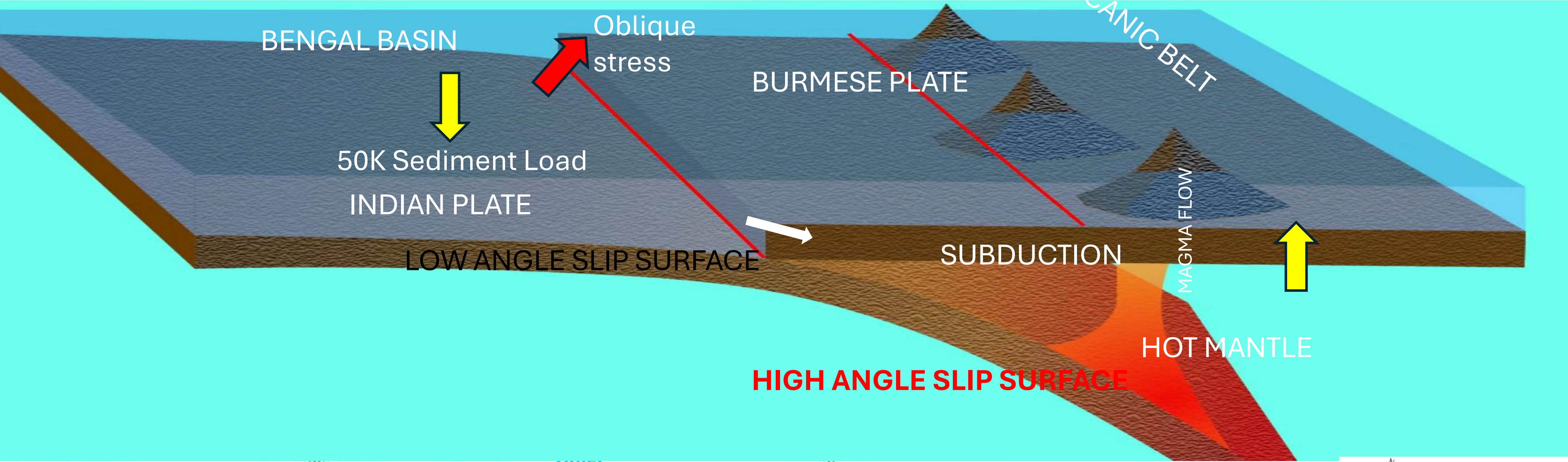

**TIME IS NOT ONLY A FACTOR**

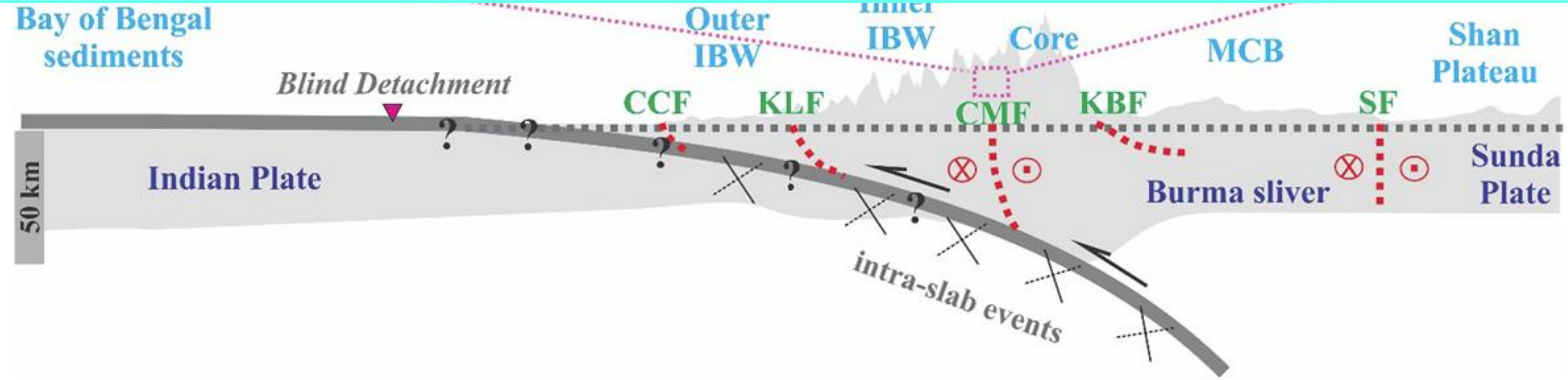
| Mag | Depth km | Day | Time UTC | Lat | Lon | Dist km |
|---|---|---|---|---|---|---|
| 9.1 | 26.1 | 2004-12-26 | 00:58:52 | 3.41 | 95.9 | 0 |
| 8.6 | 30 | 2005-03-28 | 16:09:35 | 2.1 | 97.11 | 199 |
| 8.6 | 26.3 | 2012-04-11 | 08:38:37 | 2.24 | 93.01 | 346 |
| 8.2 | 21.6 | 2012-04-11 | 10:43:10 | 0.77 | 92.43 | 485 |
| 8.5 | 35.5 | 2007-09-12 | 11:10:26 | -4.46 | 101.4 | 1068 |

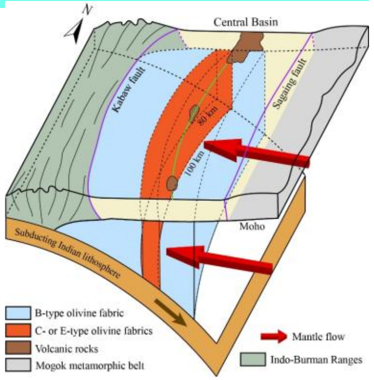
# THE MISSING CONCEPT OF 3D GEOMETRIC CONFIGURATION

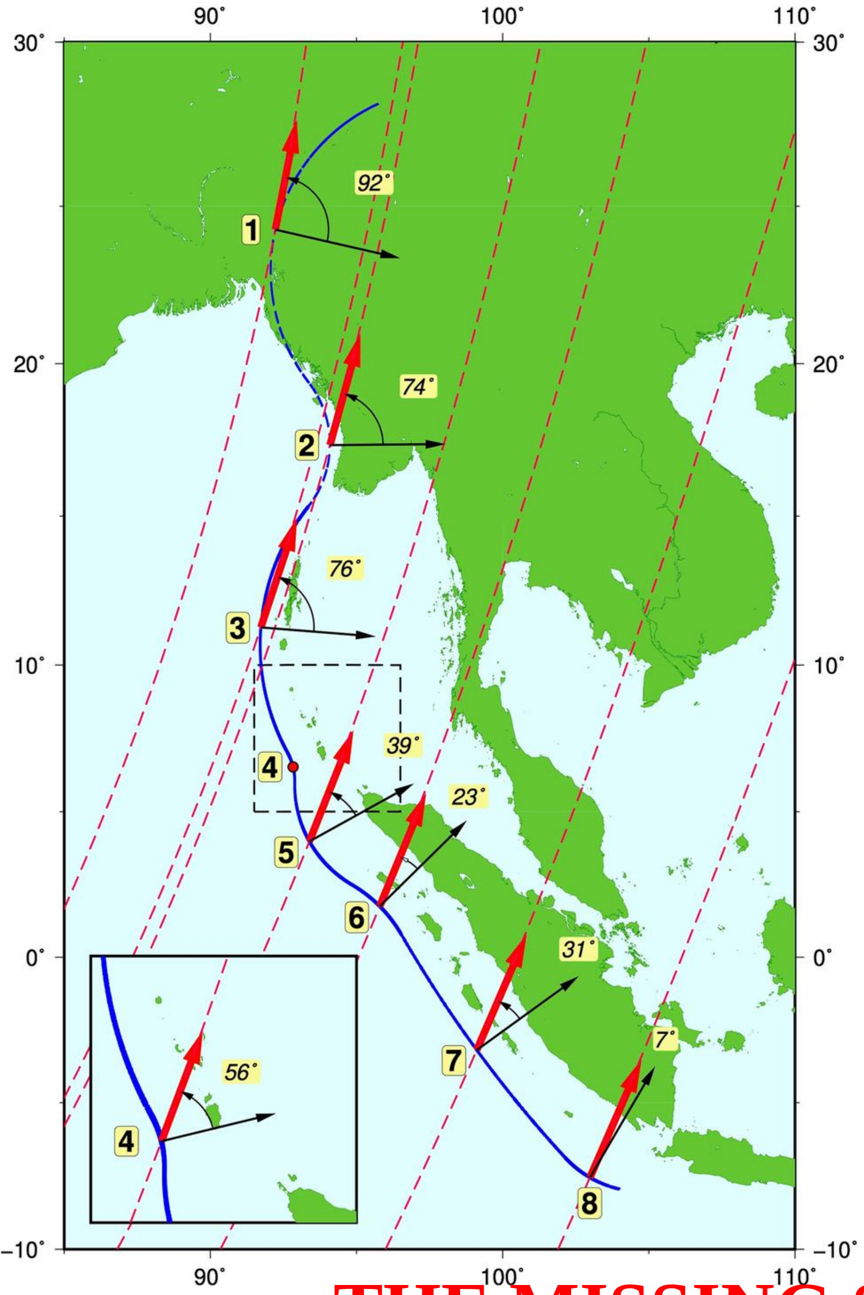
# REGION OF NON-TECTONIC EARTHQUAKES

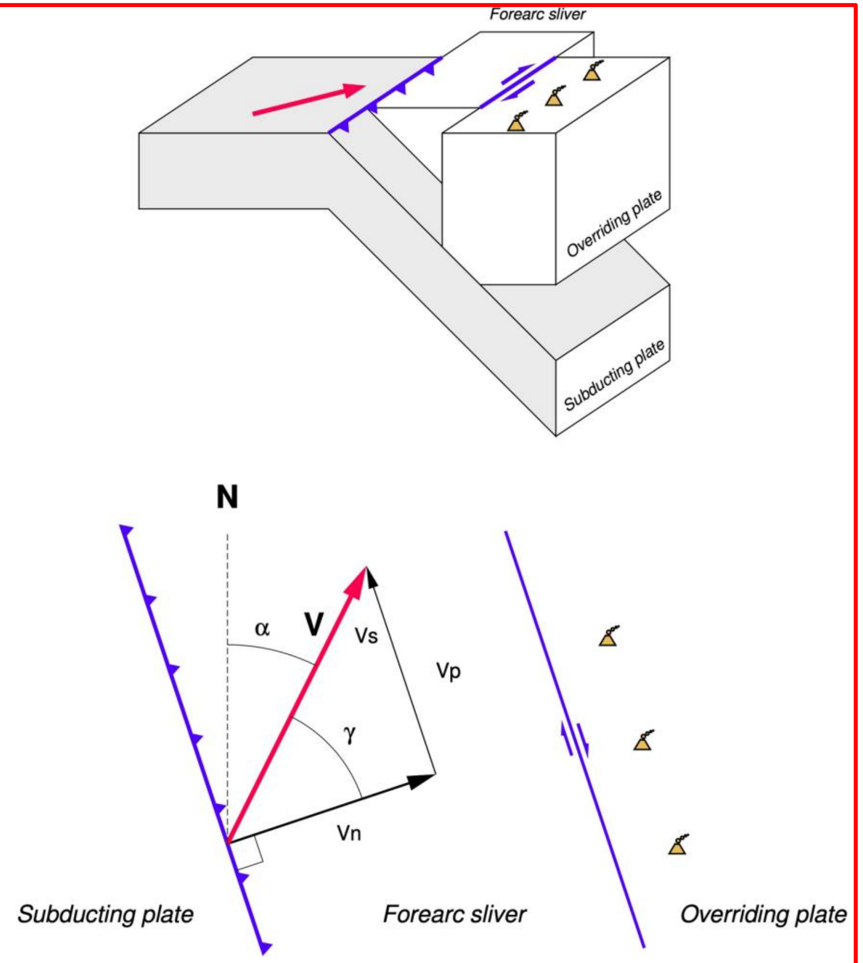
# MEGATHRUST EARTHQUAKE REGION



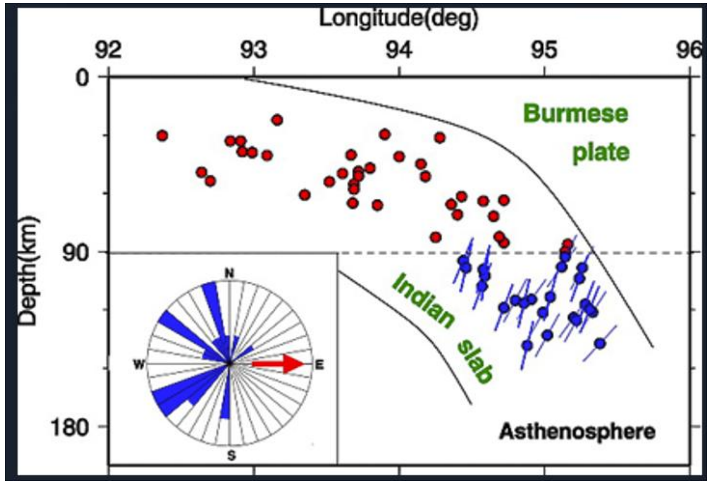






Traditional definition of oblique plate convergence, for a straight trench. **Top.** Block view. **Bottom.** Plan view. *V* is plate convergence vector; *Vn*, vector normal to trench; *Vp*, margin-parallel plate vector. *α* is the azimuth of plate convergence and *γ*, the plate obliquity angle. (Adapted from McCaffrey et al., 2000 and McCaffrey, 2009). All figures were drawn with the help of *The Generic Mapping Tools* software (Wessel and Smith 1991, 1995, 1998; Wessel et al. 2013)




From: **Oblique plate convergence along arcuate trenches on a spherical Earth. An example from the Western Sunda Arc** Research Article – Solid Earth Sciences Open access Published: 04 September 2023 Volume 72, pages 7–27 (2024)

# THE MISSING SUBSURFACE DATA FOR GEOMETRIC CONFIGURATION OF MEGATHRUST @ 93$^0$E

**That is why we rejected the findings of Mega Earthquake .**

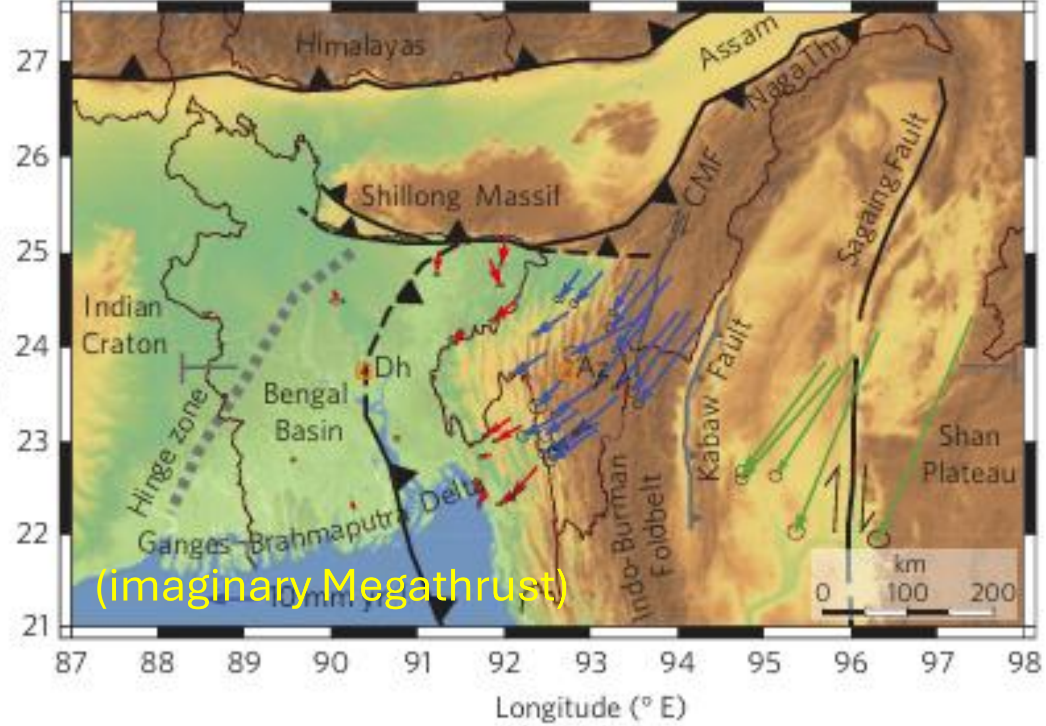
**Prediction of 8.2 - 9 Magnitude Earthquakes to be occurred ?**

**THE CHALLENGE OF PHYSICAL AND REALISTIC SUBSURFACE DATA FOR GEOMETRIC CONFIGURATION OF BENGAL BASIN WAS EFFECTIVE**

**THOUGH THE COLUMBIA UNIVERSITY WAS FAIR TO REVISE THEIR STUDY**

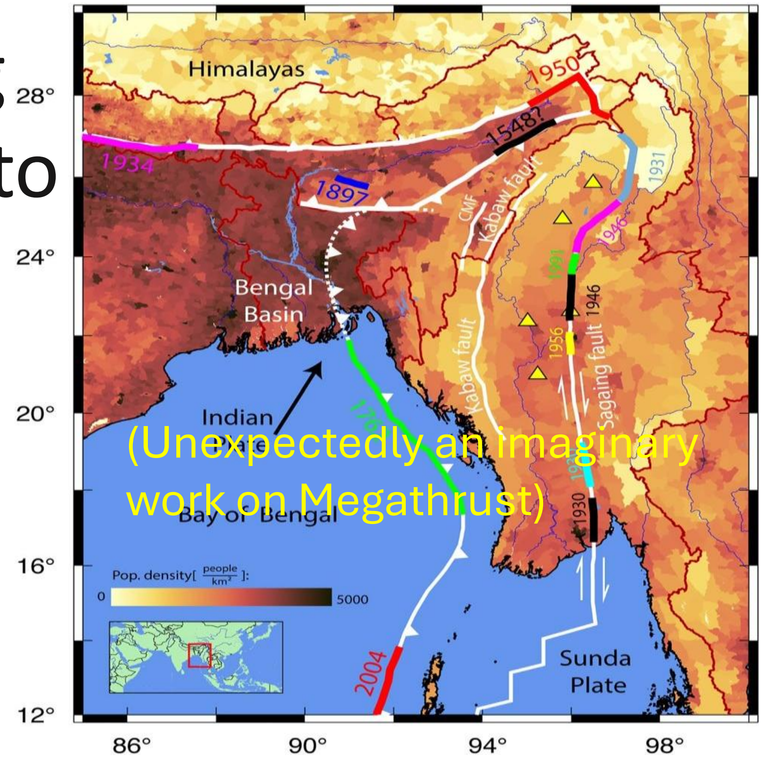
**BUT THE RESULT IS STILL AMBIGUOS AT >8 MAGNITUDE**

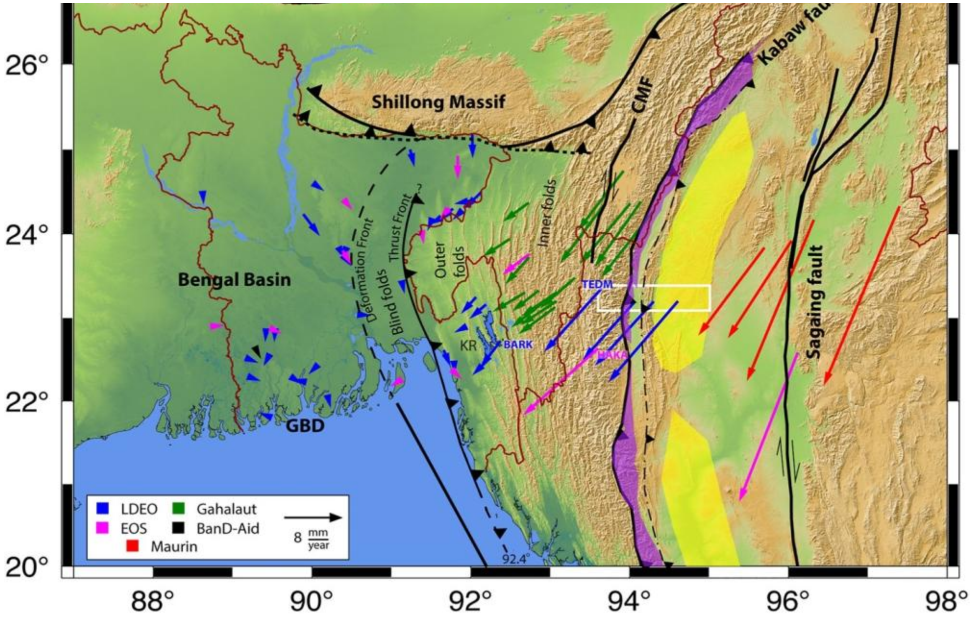
https://earthquake.usgs.gov/earthquakes/




Locked and loading megathrust linked to active subduction beneath the Indo-Burman Ranges

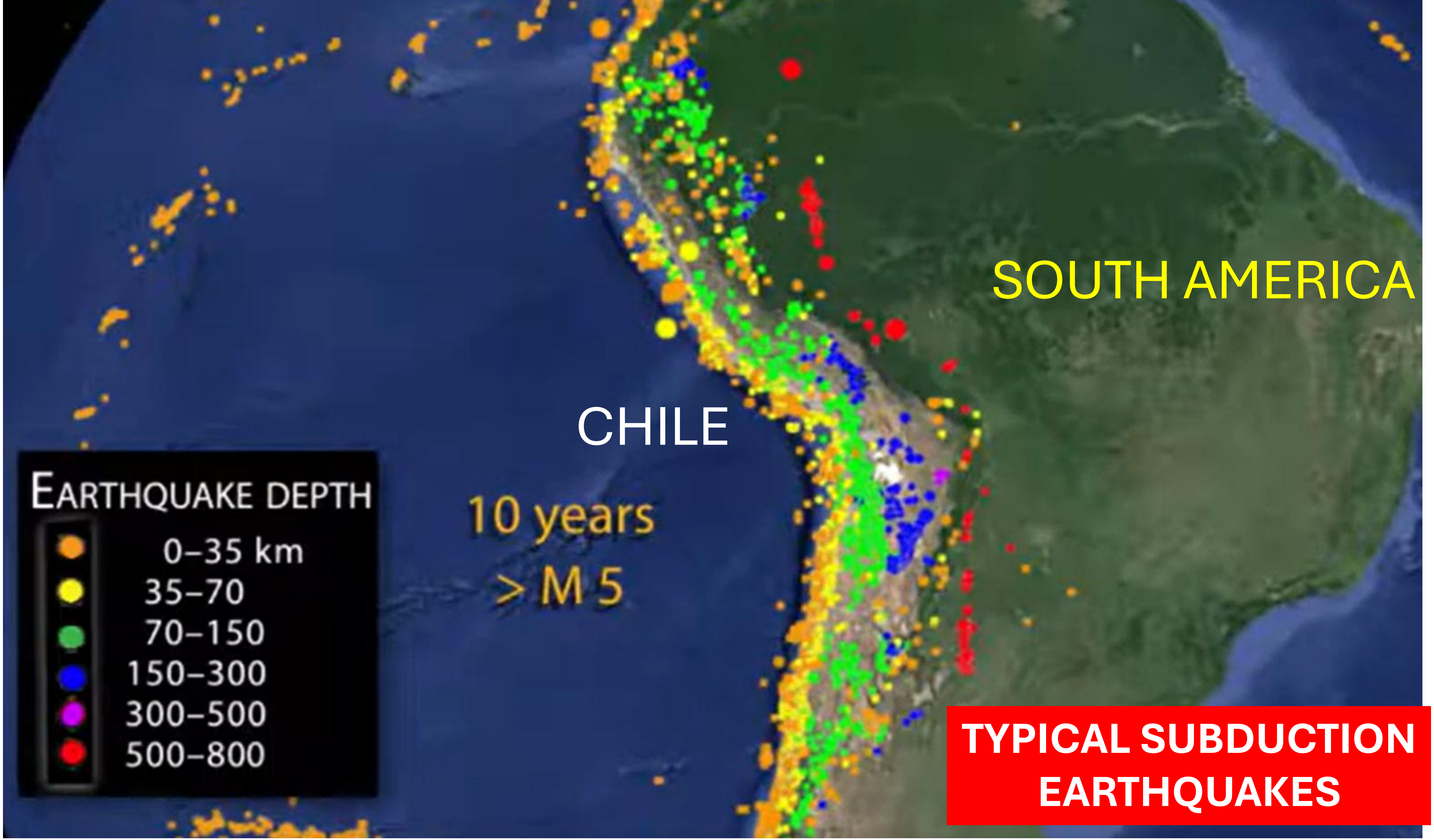
2016/8.2-9 *M*




New GNSS and Geological Data From the Indo-Burman Subduction Zone Indicate Active Convergence on Both a Locked Megathrust and the Kabaw Fault (Bar Oryan ET AL, 2023)

2023/>8.2 $M_w$


SOUTH AMERICA
CHILE
EARTHQUAKE DEPTH
0–35 km
35–70
70–150
150–300
300–500
500–800
10 years
> M 5
TYPICAL SUBDUCTION EARTHQUAKES

THE DEBATE

Dr Micheal Steckler is discussing on ‘Could Bangladesh Experience Megathrust Induced Devastating Earthquakes? Dr Dhiman Mandal is also standing beside me.

THE REVISION

# THANK YOU

LET'S MAKE OUR
KNOWLEDGE OF EARTHQUKE
MORE SCIENTIFIC,
RATIONALE AND REALISTIC

# CHILE  EARTQUAKE 1960

## Fault Geometry and Rupture Details

- **Type:** Low-angle thrust megathrust
- **Rupture Length:** $800$ to $1,000$ km (extending from the Bio Bío region in the north to the Chiloé Archipelago in the south)
- **Fault Width:** Approx. $60$ to $200$ km
- **Focal Depth:** $25$ km to $33$ km
- **Dip Angle:** Shallow, roughly $10^\circ$ to $15^\circ$ eastward
- **Average Slip:** $20$ to $30$ meters, with local slips of up to $40$ meters Britannica +6

| $M_w$ | $E_S$ (Joules) | TNT-equivalency (tons) | equivalence Hiroshima-bomb (12.5 kT TNT) |
|---|---|---|---|
| 3 | $2.0 \cdot 10^9$ | - | - |
| 4 | $6.3 \cdot 10^{10}$ | 15 | 0.0012 |
| 5 | $2.0 \cdot 10^{12}$ | 475 | 0.038 |
| 6 | $6.3 \cdot 10^{13}$ | 15,000 | 1.2 |
| 7 | $2.0 \cdot 10^{15}$ | 475,000 | 38 |
| 8 | $6.3 \cdot 10^{16}$ | 15,000,000 | 1,200 |
| 9 | $2.0 \cdot 10^{18}$ | 475,000,000 | 38,000 |
| 10 | $6.3 \cdot 10^{19}$ | 15,000,000,000 | 1,200,000 |

**Fault Geometry and Rupture Details**

•**Type:** Low-angle thrust megathrust

•**Rupture Length:** 800 km

•**Fault Width:** 60 km

•**Focal Depth:** 25 km

•**Dip Angle:** 10 – 15 dgree

•**Average Slip:** 20 – 40 m