Tectonics of Bengal Basin and Earthquake Risk

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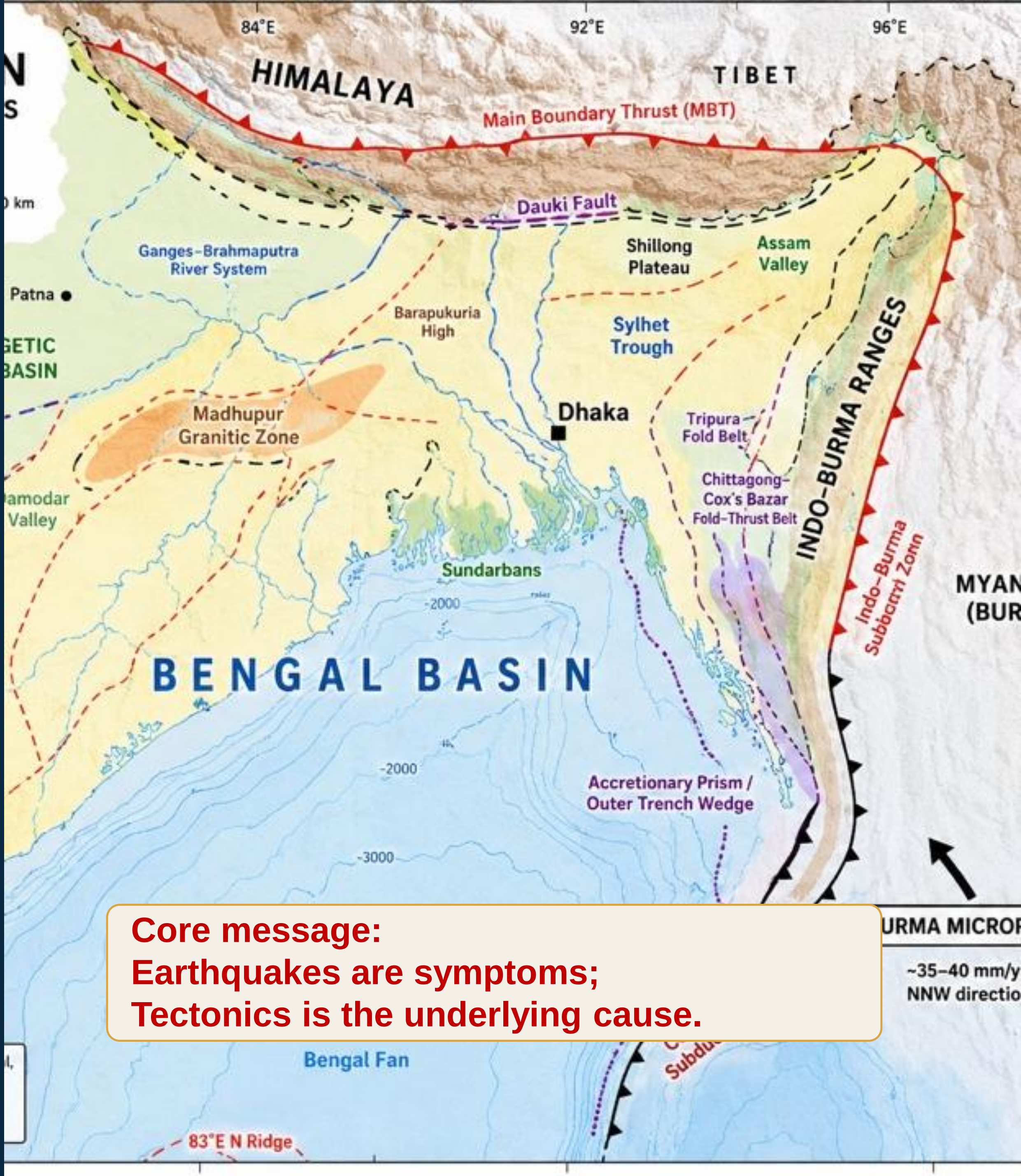

Core message:
Earthquakes are symptoms;
Tectonics is the underlying cause.

From observations to risk: the logic of the presentation

a step-by-step, data-constrained narrative

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1 **Where is the stress?**

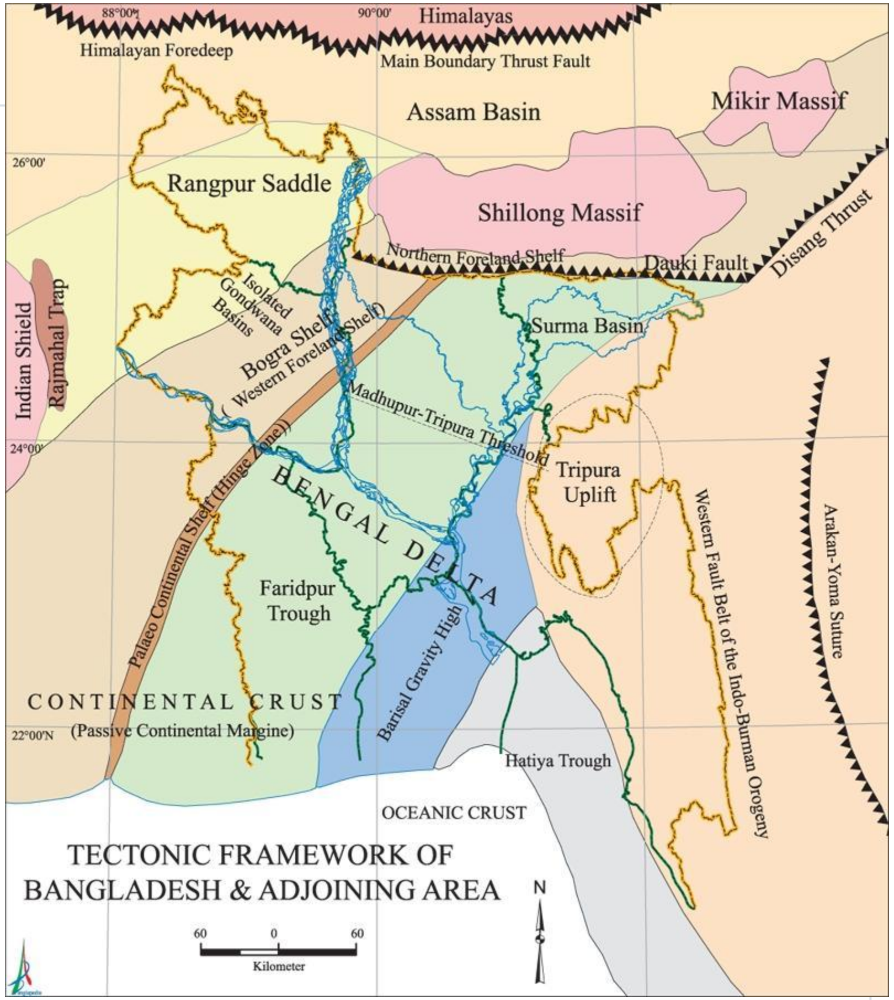
Regional plate convergence, fold–thrust belts, hinge-zone structures and hidden basement faults.

2 **What did the recent earthquakes show?**

M5-class events occurred at different depths beneath/near thick sedimentary cover.

3 **What does it mean for risk?**

Hazard depends on source, crustal path, soft-sediment amplification and exposure—not magnitude alone.

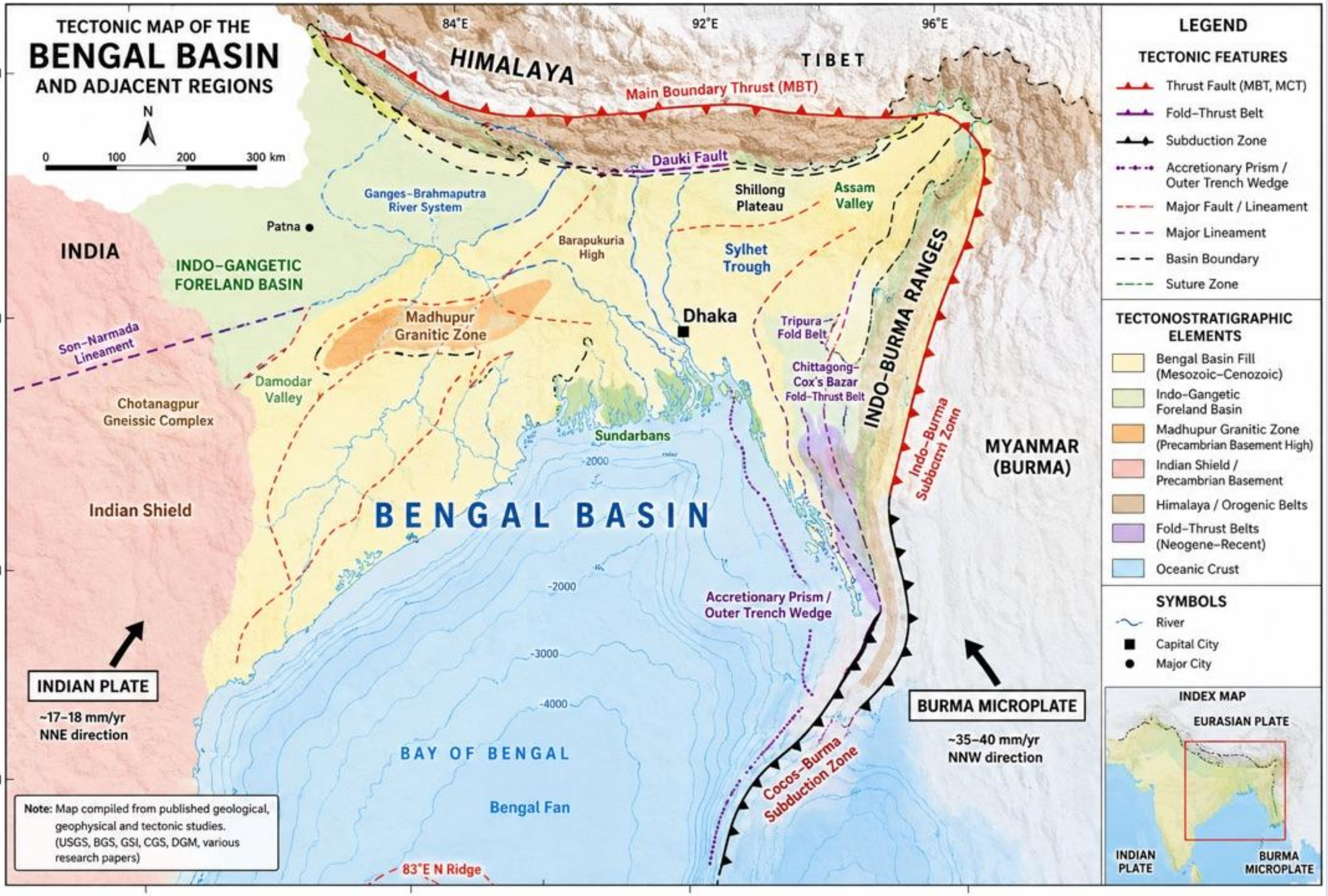


No single earthquake proves a megathrust scenario; the stronger conclusion is active intrabasinal deformation plus regional plate-boundary hazard.

Source basis: uploaded deck plus USGS/NCS/BMD event products and regional tectonic literature.

Regional Tectonic Setting: A basin between converging systems

plate motion is distributed, not a single visible fault line



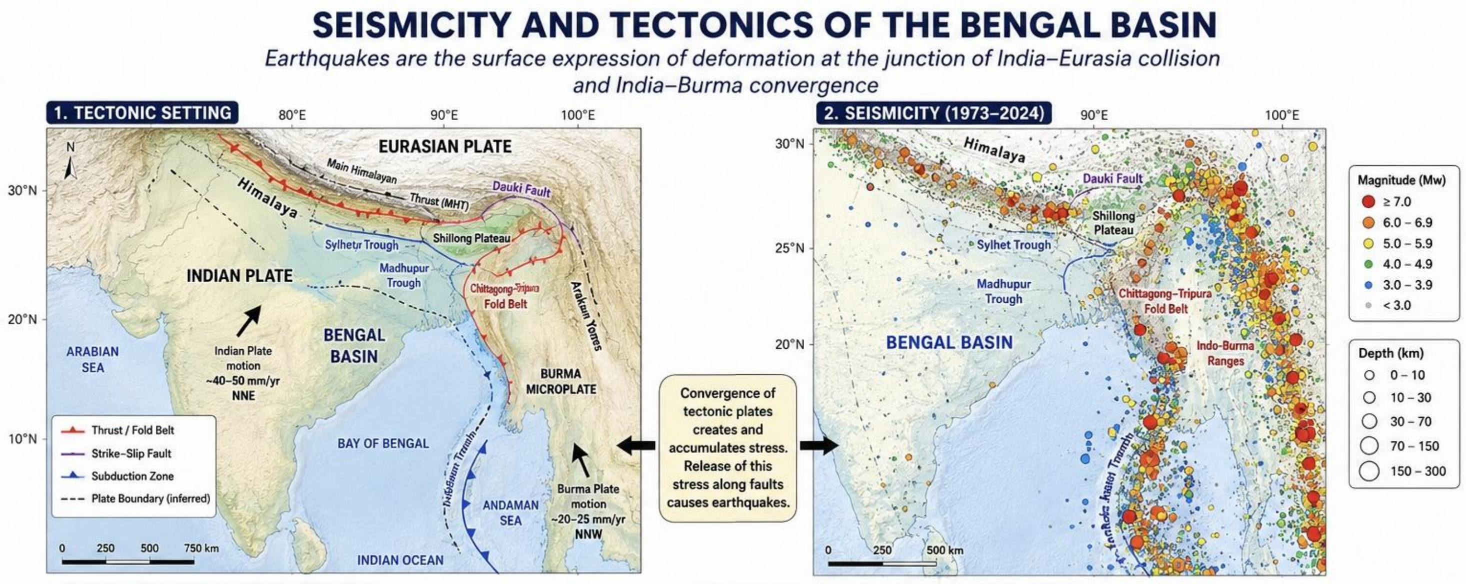
- **The Bengal Basin lies on/near the Indian Plate and is affected by Himalayan loading to the north and Indo–Burma convergence to the east.**
- **The "plate boundary" is best treated as a broad deformation zone around the basin, not a single line through Dhaka.**
- **Buried basement structures, the Hinge Zone, Madhupur High and fold belt can localize intrabasinal seismicity.**

Do not over-interpret: map-scale tectonic domains guide hazard thinking but do not locate every active fault beneath sediment.

Sources: tectonic map in uploaded deck; Steckler et al. 2016; Hossain et al. 2020; Uddin & Lundberg framework.

Seismicity: Earthquakes trace active stress around and within the basin

observations first, interpretations second



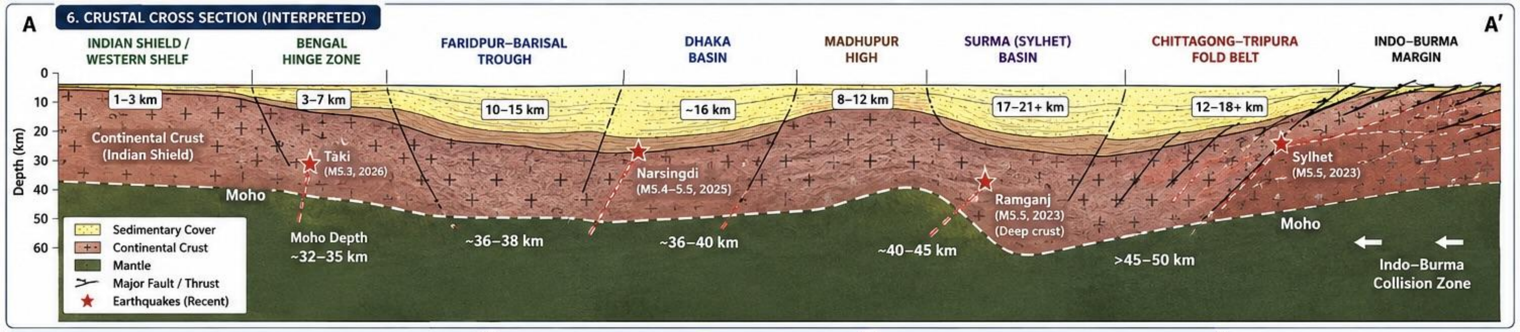
Risk is not controlled only by where earthquakes are most frequent; soft basin sediments and urban exposure can make moderate events consequential.

- High earthquake density to the east reflects active Indo–Burma deformation.
- Central and western basin events require attention because structures may be concealed below thick sediment.
- Depth, magnitude and mechanism must be taken from reviewed catalogs where available.

Source: seismicity figure in uploaded deck; USGS/ISC-type catalog logic; no new earthquake catalog was inferred here.

Crustal architecture: Why buried structures matter

the basin cover hides the mechanical framework



7. SEDIMENT PILE & ISOSTATIC ACCOMMODATION (FIRST ORDER ESTIMATE)

Tectonic Domain	Sediment Thickness h_s (km)	Isostatic Accommodation $S_{load} \approx 1.56\, h_s$ (km)
Indian Shield / Western Shelf	1 – 3	~ 1.6 – 4.7
Bengal Hinge Zone	3 – 7	~ 4.7 – 10.9
Faridpur–Barisal Trough	10 – 15	~ 15.6 – 23.4
Dhaka Basin	~ 16	~ 24.8
Madhupur High	8 – 12	~ 12.5 – 18.7
Surma (Sylhet) Basin	17 – 21+	~ 26.5 – 32.8+
Chittagong–Tripura Fold Belt	12 – 18+	~ 18.7 – 28.1+

8. KEY INTEGRATED INSIGHTS

- Basin deepens eastward from the stable shelf across the Bengal Hinge Zone to the Surma foredeep.
- Gravity lows and magnetic lows coincide with thick sediment depocenters.
- Himalayan loading caused lithospheric flexure and extensive subsidence, creating >20 km accommodation in deep troughs.
- Recent earthquakes occur on basement faults and in the deep crust of major tectonic domains.

9. IMPLICATIONS

- Thick soft sediments amplify seismic shaking in deep basin areas (Dhaka, Sylhet, Barisal).
- Basement structures (Hinge Zone, Madhupur High, Dauki Fault) control present-day seismicity.
- Tectonic setting and basin geometry are critical for earthquake risk, ground motion, and infrastructure planning in Bangladesh.

LEGEND (ABBREVIATIONS)

MPUR – Near Hinge Zone (western sector)
SKPR – Faridpur–Barisal Trough
DHAK – Dhaka Basin
SUST – Surma (Sylhet) Basin
RF – Receiver Function
RTP – Reduced to Pole
mGal – milliGal (gravity unit)
nT – nanoTesla (magnetic unit)

Four risk-relevant domains

Western shelf
shallower cover; inherited basement faults

Hinge zone
rapid sediment thickening and flexural transition

Madhupur High
central-basin structural high / fault focus

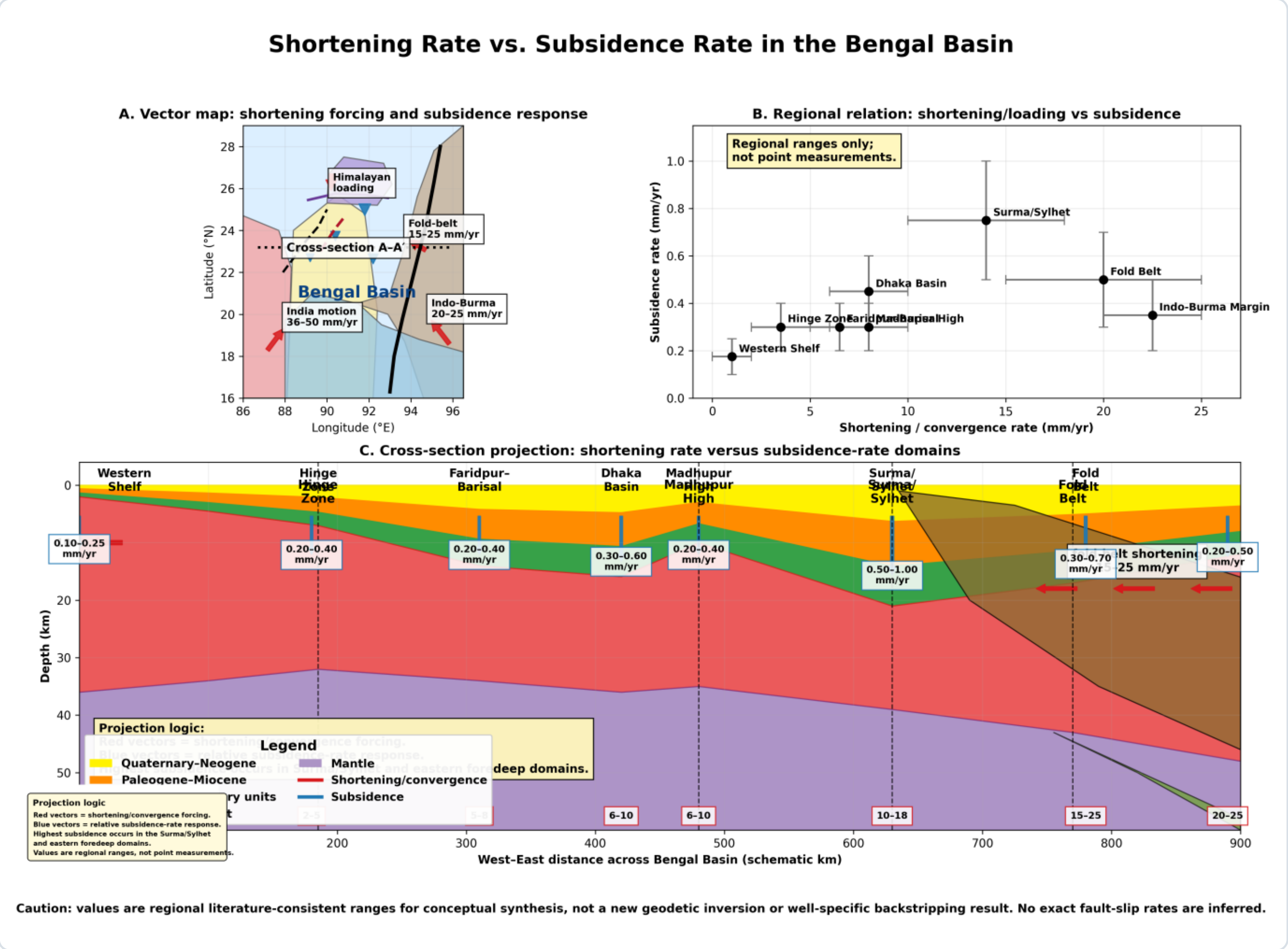
Fold belt & foredeep
active shortening near Indo–Burma margin

Key caution: cross-sections are conceptual syntheses, not balanced structural restorations.

Source: geological cross-section in uploaded deck; interpretation retained as schematic.

Why high subsidence does not contradict lower horizontal shortening

vertical response can exceed the visible horizontal component



Process chain

convergence → flexure → loading → compaction → subsidence

- Subsidence is a vertical accommodation response; convergence is a horizontal forcing term.
- Himalayan and sediment loading bend the lithosphere downward, especially toward the depocenter.
- Compaction of thick, water-rich sediments can add local subsidence independent of plate velocity.
- Basin adjustment can reactivate inherited faults without obvious surface rupture.

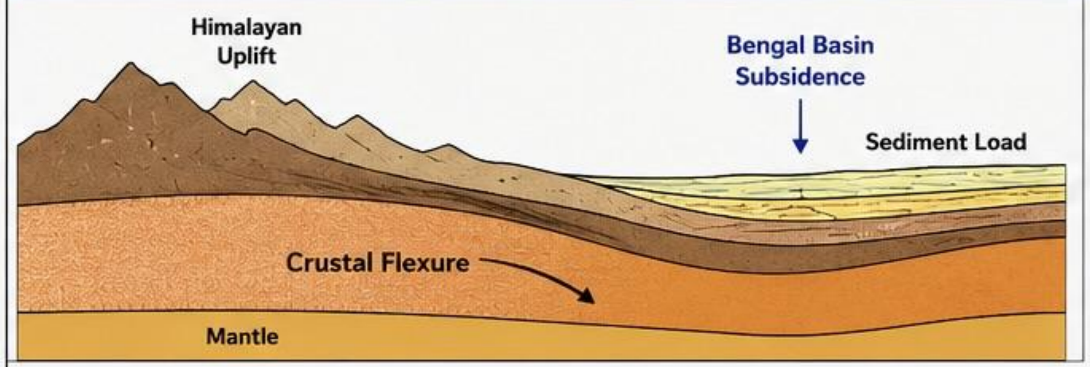
Simple phrase: horizontal squeeze → vertical sag → hidden fault reactivation.

Source: shortening/subsidence synthesis in uploaded deck; flexural foreland basin concept from regional literature.

Flexure and Airy-type load response: why thick sediment piles matter

load can create accommodation and modify shaking behavior

5. ISOSTATIC ADJUSTMENT (AIRY–TYPE LOAD RESPONSE)



The weight of Himalaya and sediment load causes the lithosphere to flex downward (Airy isostasy), producing accommodation space for thick sediments.

$$S_{load} = h_s \left(\frac{\rho_s - \rho_w}{\rho_m - \rho_s} \right)$$

For $\rho_s = 2.4$, $\rho_w = 1.0$, $\rho_m = 3.3$

$$S_{load} \approx 1.56\ h_s$$

Domain	Sediment Thickness h_s (km)	Isostatic Accommodation $S_{load} \approx 1.56\ h_s$ (km)	Meaning
Western Shelf	1 – 3	~1.6 – 4.7	Shallow basin
Faridpur–Barisal Trough	10 – 15	~15.6 – 23.4	Deep foredeep
Dhaka Basin	~16	~24.8	Thick central basin
Surma (Sylhet) Basin	17 – 21+	~26.5 – 32.8+	Deepest basin fill

Isostatic adjustment from Himalayan uplift and sediment loading explains the large accommodation space and thick large accommodation space and thick sediment pile in the central and Bengal Basin.

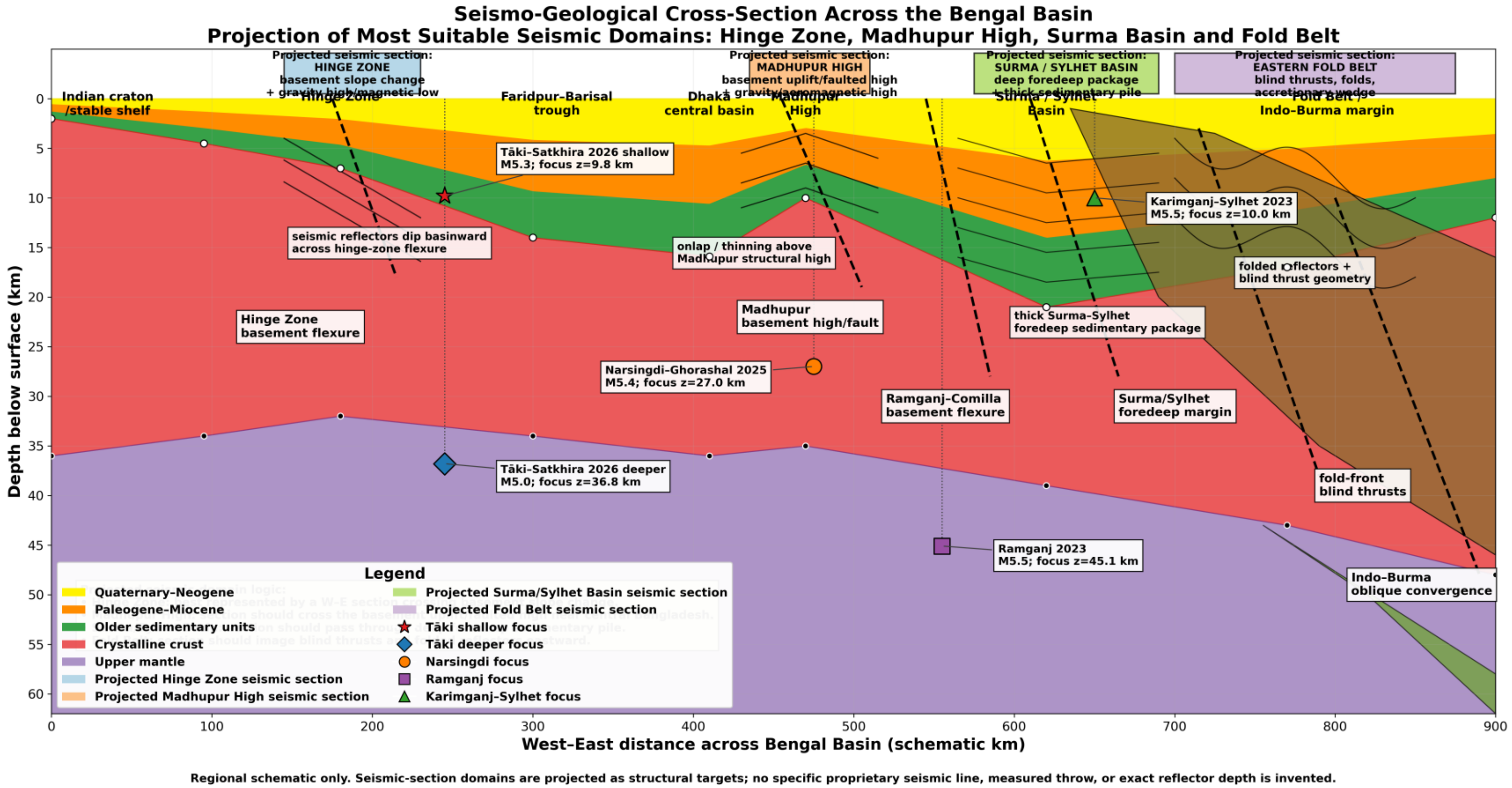
- **Large Himalayan and sediment loads promote long-term flexural subsidence.**
- **Thicker, softer sedimentary sections can amplify long-period ground motion.**
- **The load-response model explains accommodation; it is not an earthquake prediction model.**

This slide to explain mechanics, not to claim a specific rupture size.

Source: Airy-type schematic from uploaded deck; conceptual flexural/isostatic interpretation.

Seismo-geological cross-section: projecting earthquake foci onto basin structure

depth and structural context are interpreted together



- Shallow events can directly affect near-surface sediments and liquefaction-prone zones.
- Deeper crustal events indicate stress in the Indian Plate beneath the sediment pile.
- Projection onto a cross-section is useful, but it cannot prove the exact fault plane.

Label as schematic/data-constrained: not a balanced structural section.

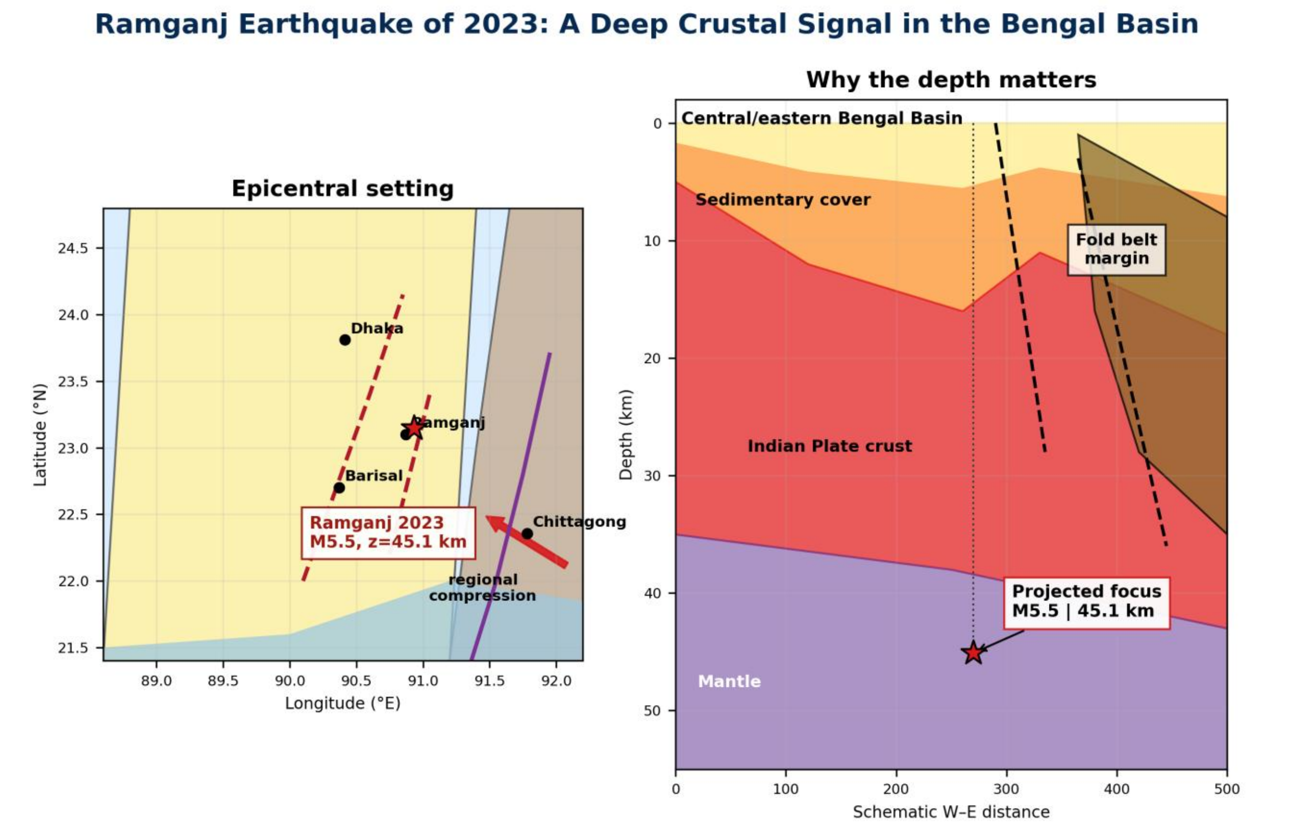
Source: cross-section figure from uploaded deck; earthquake depths retained from catalog/source notes.

Ramganj Earthquake of 2023: A deep crustal signal

USGS reviewed parameters

Date/time	2 Dec 2023, 03:35:33 UTC 09:35:33 Bangladesh time
Magnitude	M 5.5 (mww)
Location	9 km ENE of Rāmganj 23.148°N, 90.932°E
Depth	45.1 km

Interpretation: a compression-related reactivation of a buried basement or deep intrabasinal structure is plausible, but no surface rupture should be inferred.

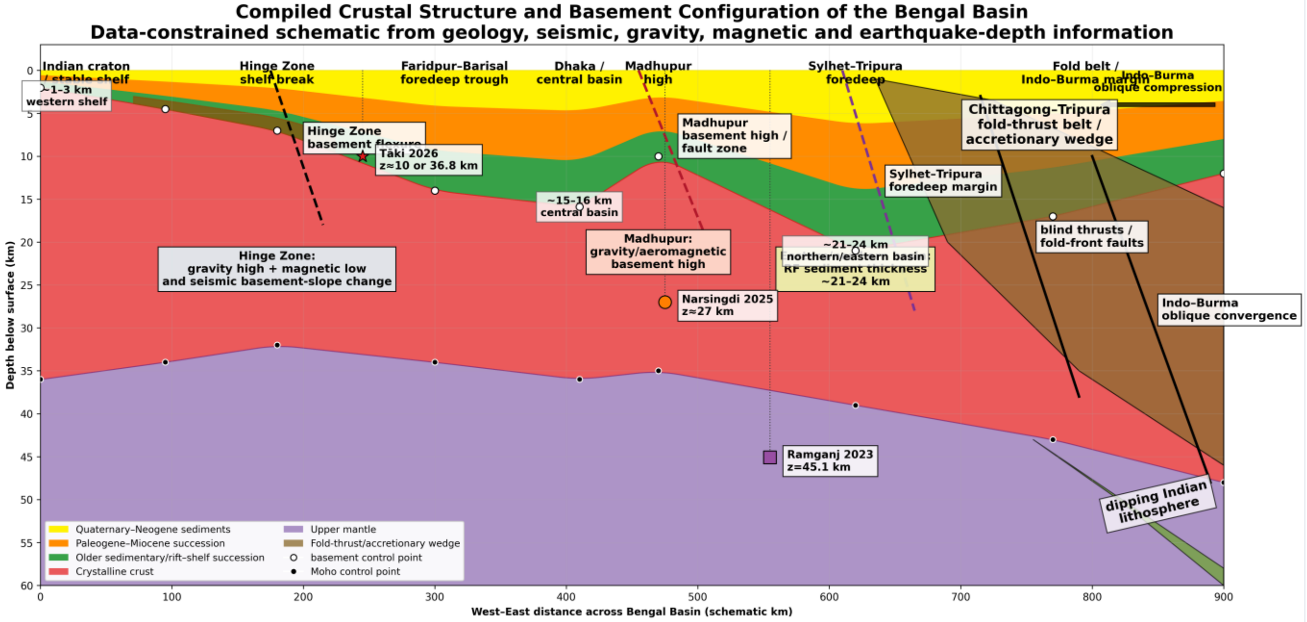


Schematic geological interpretation; not a balanced structural section. Event parameters from USGS; mechanism status from NCS preliminary report.

Source: USGS event us7000lfaa; NCS preliminary report treated as preliminary.

Narsingdi / Greater Dhaka 2025: Central-basin compression signal

often discussed with Madhupur–Narsingdi structural context



Caution: regional schematic, not a balanced structural section. Basement/Moho surfaces are interpolated from published constraints; earthquake markers are contextual depth references.

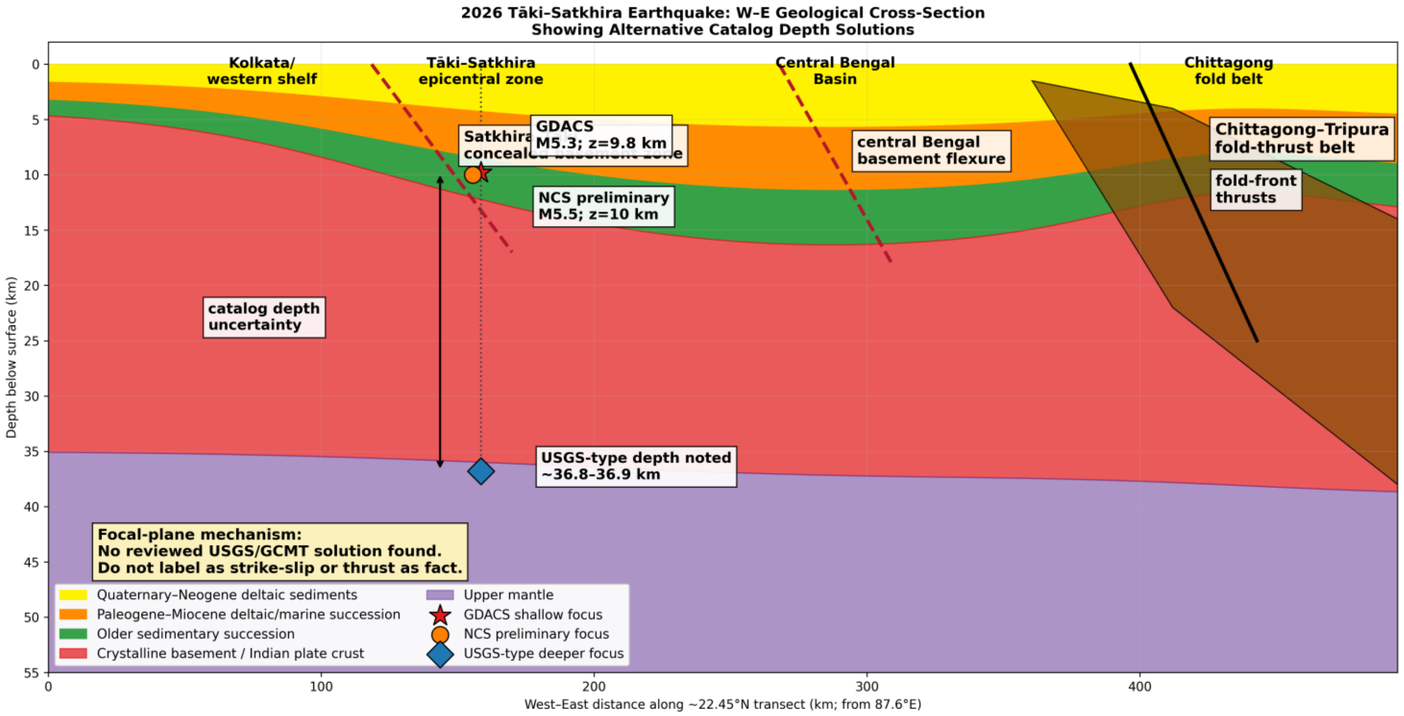
USGS reviewed parameters

Date/time	21 Nov 2025, 04:38:28 UTC 10:38:28 Bangladesh time
Magnitude	M 5.4
Location	14 km ESE of Tungi, Bangladesh 23.858°N, 90.540°E
Depth	27.0 km

Cautious interpretation: the event supports active seismic deformation beneath the central basin. Assigning a specific fault or rupture plane requires the reviewed mechanism and local structural constraints.

Message: moderate magnitude + soft basin + dense urban exposure = serious risk relevance.

Source: USGS event us6000rpht; regional context from Madhupur High/fault discussions in uploaded deck.



Schematic, data-constrained cross-section. Shallow and deeper catalog depth solutions are shown separately; no focal mechanism is assigned.

Catalog facts to keep separate

USGS: M5.0, 24 km SSE of Sātkhira
22.506°N, 89.167°E; depth 36.8 km
27 Feb 2026, 07:52:28 UTC

NCS preliminary: M5.5, ~10 km depth
BMD message: 22.51°N, 89.17°E, 13:52:29 BST

- Thick low-velocity sediments can make depth inversion difficult.
- Station coverage and velocity model choice can shift hypocentral depth.
- No reviewed event-specific focal mechanism should be assumed at this stage.

Most cautious cause: likely reactivation of a concealed basement-related structure near the southwestern basin / hinge-zone domain.

Sources: USGS event us7000s0pc; NCS preliminary report; BMD earthquake occurrence message, 27 Feb 2026.

From Tectonics to Earthquake Risk: Four linked controls

hazard assessment needs more than epicenter maps

Earthquake risk in the Bengal Basin emerges from the interaction of source, path, site and exposure.

1 — Source
Fault geometry, slip potential, depth and mechanism

→

2 — Path
Crustal structure and basin thickness between source and city

→

3 — Site
Soft sediment amplification, liquefaction-prone floodplain deposits

→

4 — Exposure
Population, building vulnerability and critical infrastructure

For Bangladesh, the high-priority risk logic is: concealed sources + thick sediment + dense settlement + limited structural resilience.

Avoid deterministic language: this framework evaluates plausible hazard pathways; it does not predict the date, location or magnitude of the next earthquake.

Sources: tectonic and seismic-risk synthesis in uploaded deck; soft-sediment amplification and liquefaction concepts from regional literature.

What the recent earthquakes tell us—and what they do not prove

a careful synthesis for public communication

Supported by observations

- The Bengal Basin is not aseismic; M5-class events have occurred within or near basin domains.
- Some events are deep enough to indicate stress within the Indian Plate crust below the sediment pile.
- Central and southwestern basin earthquakes highlight concealed intrabasinal structures.

Not proven by these events alone

- A specific megathrust rupture plane beneath Bangladesh.
- A deterministic maximum magnitude for the next event.
- A single fault assignment without reviewed focal mechanism and local geophysical constraints.

convergence | flexure & loading | subsidence | concealed faults | seismic risk

The strongest conclusion is active basin deformation under thick sedimentary cover—an important but still cautious basis for seismic-risk assessment.

Sources: USGS event pages; NCS/BMD preliminary regional products; geological/geophysical synthesis in uploaded deck.

Conclusion: A cautious tectonic synthesis for the Bengal Basin

The Bengal Basin should be treated as a flexural–collisional foreland basin where regional convergence, loading, subsidence and inherited structures combine to create earthquake risk.

Ramganj 2023	Deep crustal M5.5 event beneath eastern-central Bengal Basin; no surface rupture inferred.
Narsingdi / Greater Dhaka 2025	M5.4 central-basin event at 27 km depth; relevant to concealed intrabasinal deformation.
Tāki–Satkhira 2026	Depth estimates differ between catalogs; mechanism should remain unresolved unless a reviewed solution is available.
Risk implication	Hazard assessment must include intrabasinal concealed faults, sediment amplification and adjacent Indo–Burma plate-boundary scenarios.

Recent M5-class earthquakes support active intrabasinal deformation, but they do not by themselves prove a megathrust rupture scenario.

Key sources used in the revised deck: USGS events us7000lfaa, us6000rpht and us7000s0pc; NCS and BMD preliminary regional reports; Steckler et al. (2016); Hossain et al. (2020); Uddin & Lundberg / Uddin sedimentary-tectonic framework; Chamberlain et al. (2024) for earthquake-triggered deltaic hazards.