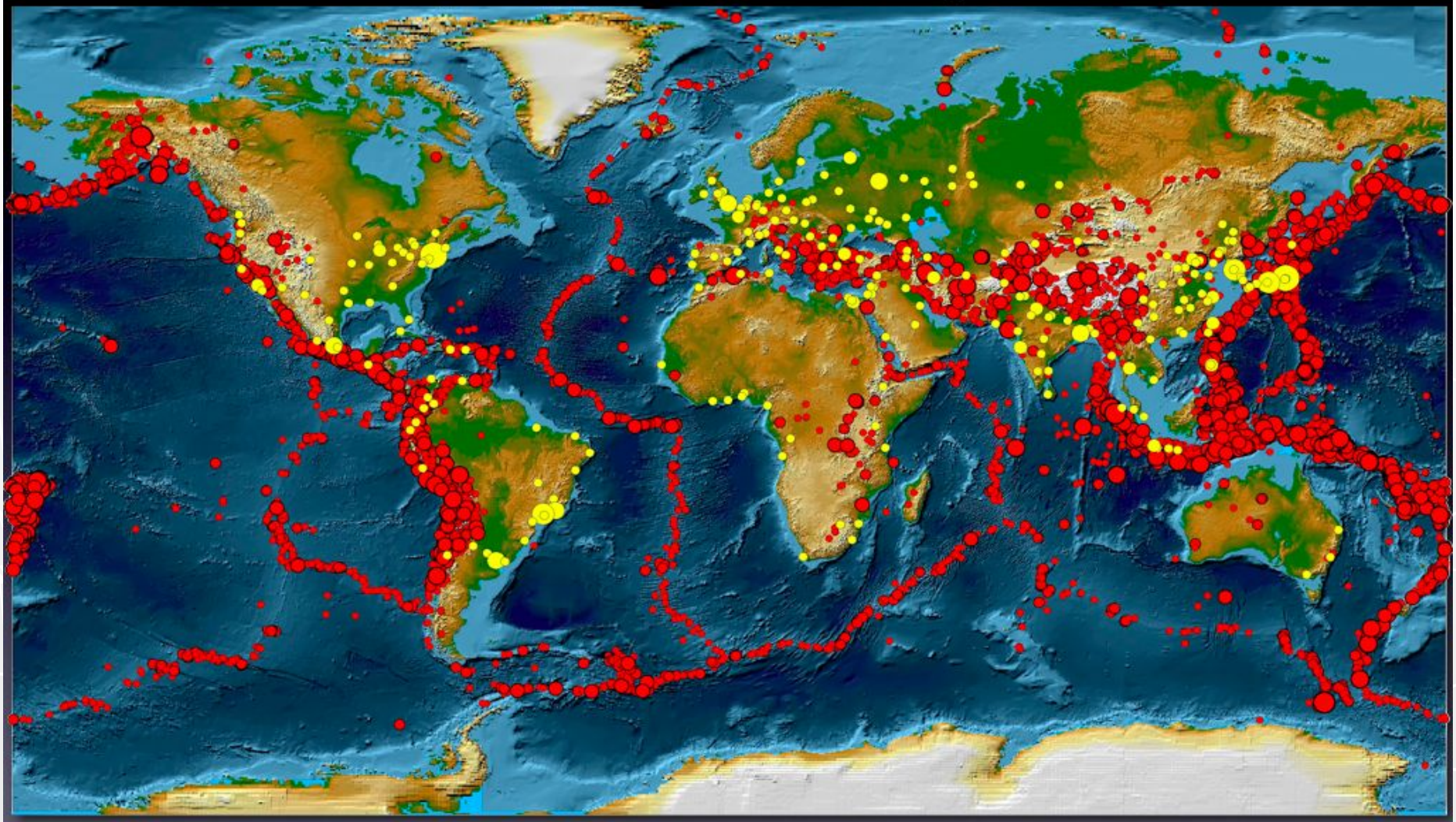
EWCE 203

Geology and Geomorphology

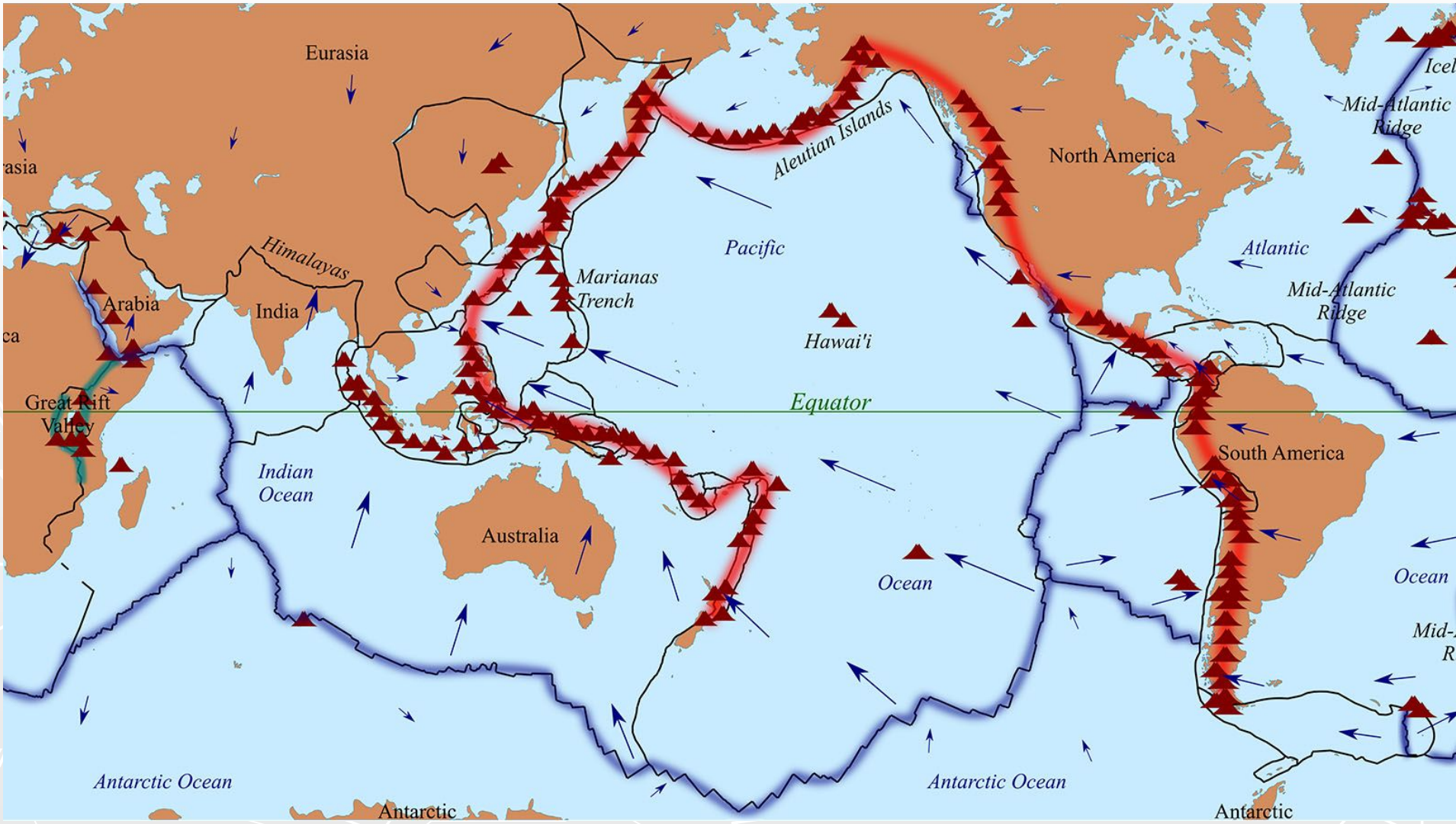
Earthquake

Global Cities & Earthquakes



all earthquakes (red) M ≥ 5.5; cities (yellow) with population > 1000000

Ring of Fire


Eurasia
Aleutian Islands
North America
Mid-Atlantic Ridge
Himalayas
Pacific
Atlantic
Marianas Trench
Arabia
India
Hawai'i
Great Rift Valley
Equator
South America
Indian Ocean
Australia
Ocean
Antarctic Ocean
Antarctic Ocean
Antarctic

Ring of Fire

Ring of Fire is a **horseshoe-shaped region** around the Pacific Ocean that's prone to **earthquakes and volcanic activity**. It's also known as the Circum-Pacific Belt.

What's in the Ring of Fire?

Volcanoes: Contains about 75% of the world's volcanoes.
Earthquakes: Experiences about 90% of the world's earthquakes, including some of the most powerful.
Tectonic plates: The Ring of Fire is the boundary between several tectonic plates.

Tectonic plate movement:

- Plates in the **Ring of Fire move against each other, creating subduction zones** where one plate is forced beneath another.
- Process of melting rock into magma, which fuels volcanic activity.

Government of the People's Republic of Bangladesh
Bangladesh Meteorological Department
Seismic Observatory and Research Centre
E-24, Agargaon, Dhaka-1207

Phone : 41025758/41025730
FAX : 41025727/41025728
E-mail: seismic@bmd.gov.bd

DATE : 24.01.2025

EARTHQUAKE OCCURRENCE MESSAGE

Time of Occurrence	:	01 hours 23 minutes 35 seconds BST (24 January, 2025)
Location	:	Lat.: 24.62°N, Long.: 95.12°E (Myanmer, India-Myanmer Border Region)
Distance of Epicentre	:	489 km (North-East from BMD Seismic Centre, Agargaon, Dhaka.)
Magnitude	:	5.1 Richter scale
Category	:	Moderate

Earthquakes are classified by their magnitude on the Richter scale, which is expressed in whole numbers and decimals.

Small earthquake

- **2.5 or less**: Usually not felt, but can be recorded by a seismograph

Moderate earthquake

- **5.0–5.9**: Causes **slight damage** to buildings and other structures
- **5.3**: A moderate earthquake

Major earthquake

- **7.0–7.9**: Causes very serious damage
- **7.5**: At the lower limit of major earthquakes

Great earthquake

- **8.0 or more**: Causes widespread death and damage and can destroy whole communities near the epicenter

Global Seismographic Network (GSN)

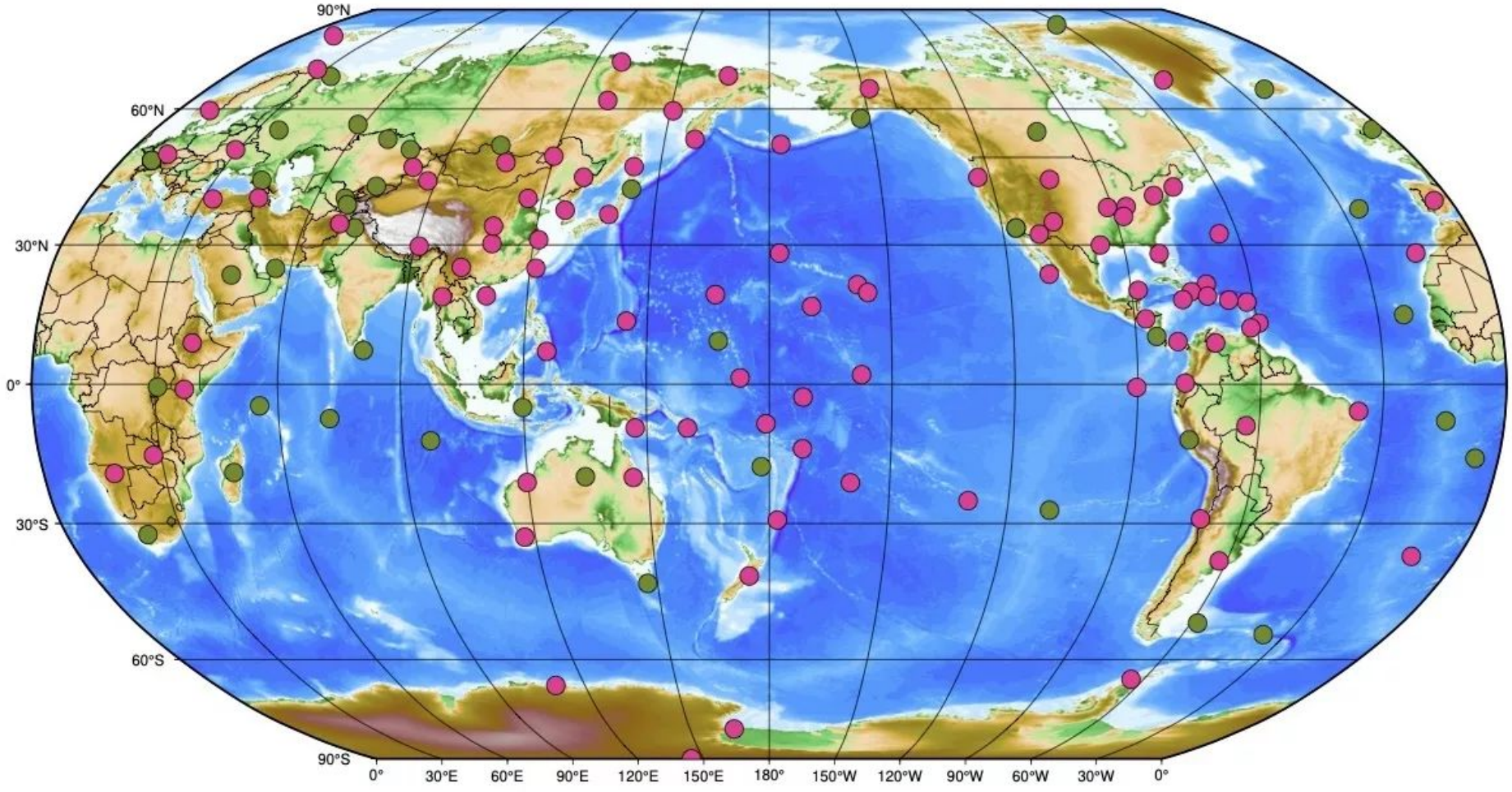
Global Seismographic Network (GSN) is an approximately **150 station**, globally distributed, state-of-the-art digital seismic network that provides free, real-time, open access data.

GSN is a cooperative scientific facility operated jointly by the National Science Foundation (NSF) and the U.S. Geological Survey (USGS), in coordination with the international community.





Worldwide Standard Seismograph Network



USGS GSN sites are shown as pink circles. (Updated October 2024)

- **GSN works closely** with the International Monitoring System (IMS) for the Comprehensive Nuclear-Test-Ban Treaty Organization **(CTBTO),** where nearly **30 GSN stations** are now linked directly to the CTBTO International Data Centre

- GSN record about all the EQs through out the year.

- **Do** the following:

  -Sequencing of EQ activities associated with large shocks.

  -Information on the **size of area involved.**

  -Locating the **epicenter**.


BANGLADESH
NEPAL
INDIA
INDIA
INDIA
MYANMAR
BAY OF BENGAL
Jalpaiguri
Panchagarh
Thakurgaon
Kishanganj
Koch Bihar
Dingram
Brahmaputra
Goalpara
Guwahati
Dhubri
Nilphamari
Pirganj
Lalmanir
Saidpur
Rangpur
Kungramo
Raiganj
Dinajpur
Tura
Gaibandha
RAJSHAHI
Jaipur Hat
Sherpur
Jaria
Sunamganj
Chhatak
Surma
Sylhet
Silchar
Farraka
Bogra
Jamalpur
Rautpara
Gouripur
Mymensingh
Jamuna
Naogaon
Nawabganj
Ganges
Rajshahi
Nator
Sirajganj
Maulvi Bazar
Kishorganj
Habiganj
Tangail
Bhairab Bazar
Meghna
Bahamrapur
Pabna
Gazipur
Narsinghdi
Brahmanbaria
Kushtia
Manikganj
Agartala
Meherpur
Dhaka (Dacca)
Aijal
Dabgram
Chuadanga
Rajbari
Ganges (Padma)
Narayanganj
Jhenida
Faridpur
Munshiganj
Comilla
Burdwan
Santipur
Hooghly
Damodar
Narail
Madaripur
Palong
Chandpur
Laksham
Khagrachari
Bangaon
Jessore
Gopalganj
Lakshmipur
Feni
KHULNA
CHITTAGONG
Barrackpore
Khulna
Habra
Satkhira
Bagherhat
Barisal
Bhola
Noakhali
Kolkata (Calcutta)
Chalna
Pirojpur
Jhalakati
Rangamati
Karnaphuli Res.
BARISAL
Patuakhali
Chittagong
Bungtlang
Diamond Harbour
Barguna
Bandarban
Haldia
Daulatkhan I.
Sandwip I.
Satkania
Sundarbans
Kutubdia I.
Bichari
Matarbari I.
Maishkhal I.
Cox's Bazar
Mouths of the Ganges
Maungdaw
National capital
Provincial capital
Town, village
International boundary
0 25 50 75 100 km
0 25 50 75 mi

Earthquake:

Earthquakes are the **vibrations caused** when the **earth materials have been distorted** until fracture.

Seismology: Scientific study of the Earthquake.

Earthquakes' effects:

- Effects on human being and structures
- Geological effects such as landslides

Severity of EQ Effects depends on:

- Magnitude
- Distance of site from epicenter
- Depth of Focus
- Ground i.e. type of soils
- Duration
- Repetition

Effects:

- Fire
- Damage to structure
- Seismic sea waves (Tsunami)
- Landslides
- Cracks in the ground
- Land movement
- Liquefaction
- Sound

Fire:

- Fire can be **greater hazards** than the shaking of the ground.
- Fire has caused an estimated **95% of the total losses** caused by some EQ.
- One of the reasons for **rapid spread** of fire after the EQ is that the **vibration often disrupt the gas and water systems** in the areas.

Earthquake in **Kobe** **on17th Jan 1995 at 5.46am, M= 7.2 on the Richter scale**



Damage to Structures:

- **Steel-framed construction** can withstand even severe damage.
- **Chimneys** are sensitive to EQ vibration.
- **Tunnels and underground structures are less affected** because they move as an unit with the surrounding ground.
- **Masonry buildings** and **mud houses** are subjected to more damage.
- **Soft storeys** are more subjected to damage.











On **6 February 2023, at 04:17 TRT** a **Mw 7.8** earthquake struck **Southern and Central Turkey** and northern and western Syria.









January 17,1995 Kobe Earthquake

Extends of damages due to vibrations depends on:

- Type of **ground** **o**n which they stand
- **Duration** as well as intensity of ground motion
- **Repetition** of shaking

Seismic Sea Waves:

- **Giant sea waves that are generated due to EQ** is called Seismic sea waves or **Tsunami**.
- Generation of sea waves may be due to:

-**Submarine EQ** abruptly elevate or lower the portion of sea beds, setting up waves.

-**Submarine land slides** at the time of EQ may produce tsunami.

-**Volcanic eruptions** may also generate tsunami.



2011 Tōhoku EQ and Tsunami



Japan earthquake and tsunami of 2011, also called **Great Sendai Earthquake** or **Great Tōhoku Earthquake**, 2011

- **Magnitude-9.0** earthquake struck **at 2:46 PM**. (The early estimate of magnitude 8.9 was later revised upward.)
-
- Epicenter was located some 130 km east of the city of Sendai and the **focus** occurred at a depth of about 30 km) below the floor of the western Pacific Ocean.

Damages due to Tsunami Hunga Tunga Hunga Haapai Volcanic Erruption:

- Tsunami has devastated oceanic islands and continental coastline.





Landslides:

- In areas where there are **many hills with steep slopes** or areas with special soil conditions **sensitive to vibrations**.
- EQs often **accompanied by landslides**.
- These slides occur within a zone of seldom exceeding 40-50 km in radius.





Rangamati, chunks of mud collapsed on tin-shed houses in Kalabagan of the Karnaphuli Paper Mill area, 08 July 2019

Landslide in New Zealand
EQ Nov 2014





Landslies in1999 Chi-Chi earthquake
in Taiwan

Cracks in the Ground:

- During EQ, the earth is **likely to open up** and **swallow** everyone or everything in the vicinity.





Mile Long Cracks in ground from the **Philippine earthquake**, 7.1-magnitude on **October 2013.**

Land Movements:

- Some EQs are accompanied by the significant **vertical and horizontal movement** of the land surface.
- **Surfaces sink** in some places and **rise** in other places.
- Often **tilted** and portions can even be **moved laterally** to great distance.



Earth Moved During **Turkey's Earthquake and Aftershocks 06 February 2023**



A massive 15 foot-high WALL has been created by moving earth in the New Zealand countryside after a 7.8 magnitude quake struck on November 2016.

Liquefaction:

- Occurs in soils which are **thoroughly saturated** such as **along sea coasts**, the **shores of lakes or ponds** or anywhere that **subsurface water has filled the fractures, voids, pores in the ground.**

Phenomena apparently results from liquefaction:

- Damage to structure by **foundation failure** and **sliding**.
- Occurs **after even a few to several minutes** of EQ strikes a region.
- **Underground sewers**, **storage tanks**, **pipes** and **piles** to **float up to the surface**.

- Nearby structures may be **settle several meters** to the ground.
- **Water and sands may be ejected** to a meter or more into the air.









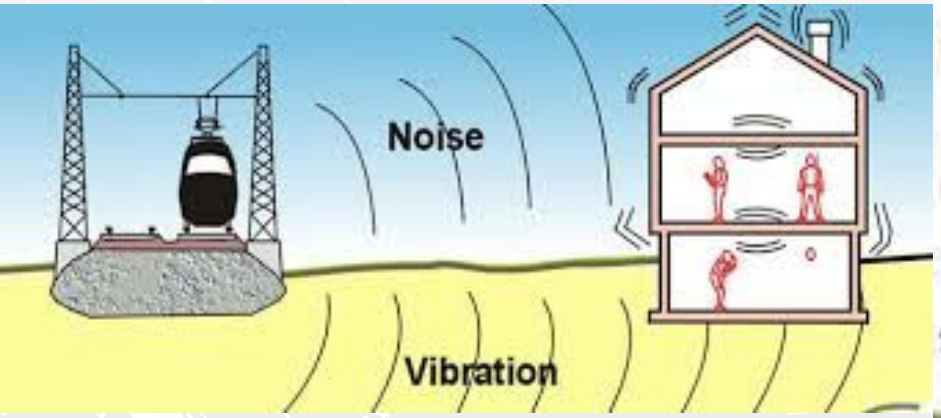
Reclaimed land and river banks which typically consist of **loose deposits** are prime locations for liquefaction in case of strong shaking



Indonesian earthquake causing soil liquefaction,

Sound:

- When an EQ occurs, the **vibration in the ground often disturb the air** and produce **sound waves that are within the range of human ear.**
- Such sound is known as **EQ sound**.





Description of EQ Sound:

Low booming noise.

- **Very near the source** of EQ- **sharp snaps** are sometimes audible, suggesting the **tearing parts of the great blocks** of rocks.

- **Further away from the EQ source**:

  -**Heavy vehicles passing rapidly** over the hard ground.

  -**Dragging of heavy rocks or furniture** over the floor.

-A loud, **distinct clap of thunder**, or **explosion**, boom of distant cannon, or fall of large body or great load of stone.

- **Quite distinct but confusing** to be recognized.



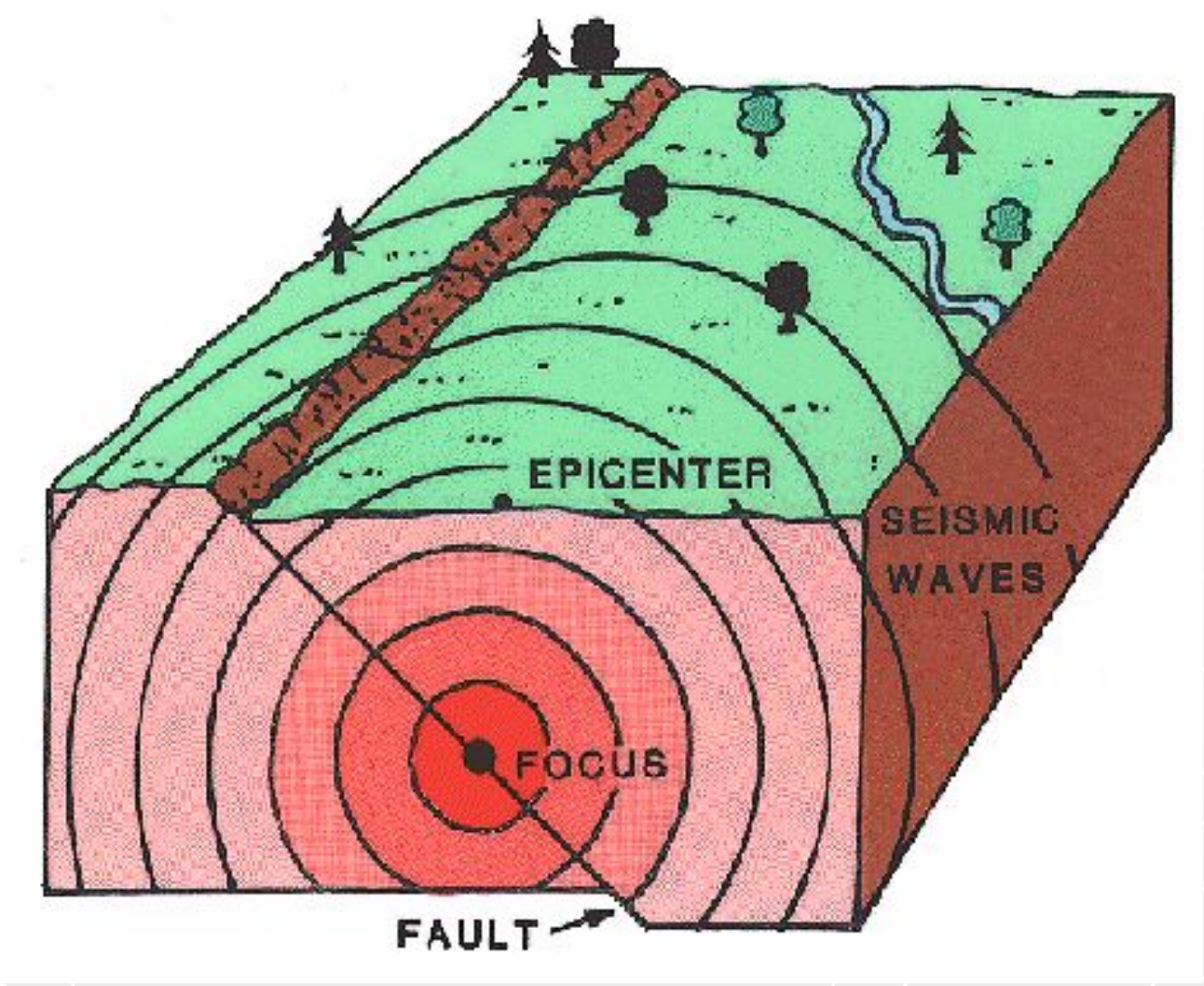
Some people described the earthquake as the sound of an **explosion, thunder, or even a tree falling.**

Earthquake Focus:

In seismology, the term '**focus' designates the source** of a **given set of the EQ waves**.

What is the source of the EQ waves?

- **Waves** that constitute an EQ, that are **generated by the rupture of Earth's materials.**
- When recorded, their **pattern indicates** that they are **originated within a limited region.**
- Most of the sources have the dimensions of about **50 km in length and breadth of about 5 to 500 km.**



Focus of an EQ, is at some depth below the earth's surface. Normally 75 to 500 km.

Shallow, intermediate, and deep foci:

- **Shallow Depth EQ:** Most parts of the world experience at least **occasional shallow earthquakes**, originate within **0-70 km** Earth's outer surface. Responsible for **70–85% of the total energy released** by earthquakes.

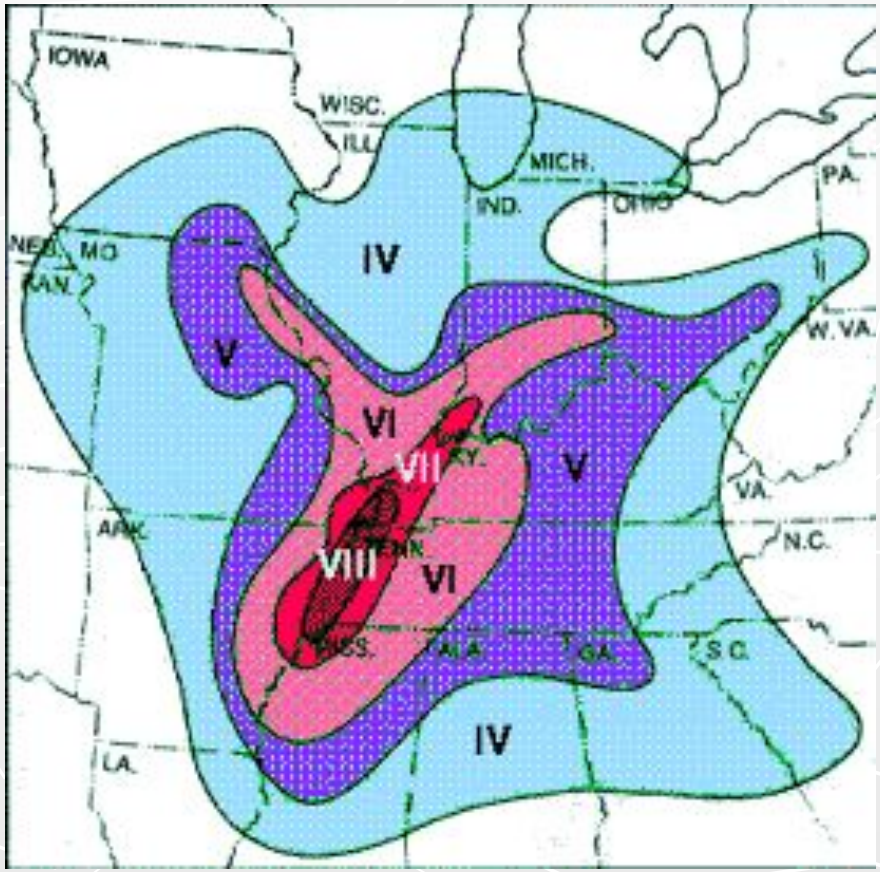
- **Intermediate Depth EQ:** Of the total energy released in earthquakes, **12% from intermediate earthquakes** with a focal depth ranging from **about 70 to 300 km**.

- **Deep EQ: About 3% of total energy comes from deeper earthquakes**. The greatest focal depths, of **about 300-700 km**, are approached.

- Destructive force of an earthquake depends on its **energy release**, depth, and **distance from the epicenter**.

EQ Intensity

Definition: The **intensity** is a number (Roman numeral) **describing the severity** of an **earthquake** in terms of **its effects** on the **earth's surface and on humans and their structures.**



Iso-seismal map

EQ Intensity:

- Way of **specifying the size of EQ.**
- Earlier days, a missionary in remote region would keep a record of an EQ as **weak**, **strong** and **very strong**.
- **In 1883, Intensity scale is developed**.
- USGS uses **Modified Mercalli Intensity scale** (MMI)

What is Intensity of an EQ? Describe the Modified Intensity Scale of EQ.

Modified Mercalli Intensity scale.

Rossi-Forel Intensity Scale:

- In 1883, an intensity scale as developed by M. S. de **Rossi of Italy** and **F. A. Forel of Switzerland**.
- Widely used for about half a century.
- EQ effects were classified in term of 10 degree of intensity.

Write down the limitations of Rossi-Forel Intensity scale of EQ.

Limitations of Rossi-Forel Intensity Scale:

- Has definite limitations. Here, the definition of the degree of intensity are:

  -**General awaking** of those asleep.

  -General ringing of bells

  -**Oscillation of chandeliers**.

  -Stopping of clocks.

  -Some shattered **persons leave their dwellings**

- But an EQ, that produced those effects in Italy and Switzerland **might not even awake the baby in Japan**, but it might have **general stampede in Boston.**

Mercalli Intensity Scale:

- In 1902, **L. Mercalli of Italy** set up a new scale and later on **modified in 1931 by Wood and Frank** which are used by USGS.
- **It has 12 degree of Intensity** and takes into account the various types of constructions.

I – **Not felt** except by a very few.

II – **Felt by only a few persons at rest**, suspended object may swing.

III – **Felt by quite noticeably indoors**.

IV – During the day, **felt indoors by many**, outdoors by a few.

V – **Felt by nearly everyone**, many awakened.

VI – Felt by all, **many frightened and run outdoors**.

VII – **Everybody runs outdoors**, damage negligible in buildings.

VIII – Damage slightly in specially designed structure, fall of chimneys.

IX – Damage considerable, ground cracks conspicuously.

X – Masonry and framed structure destroyed.

XI – Bridges destroyed, underground pipelines completely out of service.

XII – **Damage total**

Thank You