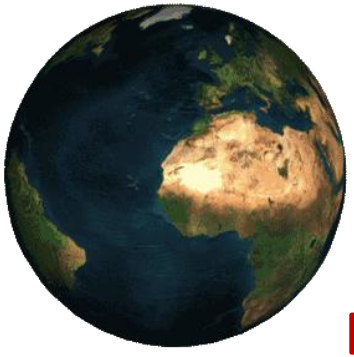

ES 212_303

Earth and Environmental Sciences

(2nd and 3rd Year)

Dr. Venkata Dilip Kumar Pasupuleti

Assistant Professor

School of Engineering Sciences

17th Jan 2019

Mahindra Ecole Centrale

College of Engineering

Team

Faculty

Dr. Venkata Dilip Kumar P

Dr. Somsubhra Chattopadhyay

Research Assistant

Bharat P

Rakesh K

Contents

1. **The Earth System** *Earth in the solar system. Earth layers, Continental Drift Theory, Tectonic Plates, Earthquakes, Atmosphere and oceans: Origin and evolution; Atmosphere-ocean interaction; Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their Interactions.*

2. **Environment and Environmental Studies** *Definition and Components of Environment, Relationship between the different components of Environment, Man and Environment relationship, Impact of technology on Environment, Environmental Degradation, Multidisciplinary nature of the Environment studies, its scope and importance in the present day Education System.*

3. **Ecology and Ecosystems** *Ecology- Objectives and Classification, Concept of an ecosystem- structure and functions of ecosystem, Components of ecosystem- Producers, Consumers, Decomposers. Bio-Geo- Chemical Cycles- Hydrologic Cycle, Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their Interactions, Carbon cycle, Energy Flow in Ecosystem, Food Chains, Food webs, Ecological Pyramids Major Ecosystems: Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem, Estuarine Ecosystem*

Contents

4. Population and Economic Growth *The nature of human population growth, population parameters, industrialisation, urbanisation, sustainable development, sustainable consumption, health and the environmental impacts. Environmental pollution: Types of Environmental Pollution: Water Pollution: Introduction – Water Quality Standards, Sources of Water Pollution: Industrial Agricultural, Municipal; Classification of water pollutants, Effects of water pollutants, Eutrophication Marine pollution- Air Pollution: Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO2, NOX, Natural & Anthropogenic Sources, Effects of common air pollutants Land Pollution: Land uses Land degradation: causes, effects and control, soil erosion. Noise Pollution: Introduction, Sound and Noise, Noise measurements, Causes and Effects Thermal Pollution: Causes and effects, Role of individual in the prevention of pollution.*

5. Social Issues and the Environment *From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization. Environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, and ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation – consumerism and waste products. Environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.*

Evaluation of Course

- Minor-1 15%
- Minor-2 15%
- End Sem 30%
- Project & Assignments 30%
- Random quizzes 10%

Home / Courses / ESS 1: Introduction to Earth System Science

- Information
- Week 1
- Week 2
- Week 3
- Week 4
- Week 5
- Week 6
- Week 7
- Week 8
- Week 9
- Week 10

ESS 1: Introduction to Earth System Science (English)

Course Information

This course introduces Earth System Science, which, at its core, involves viewing Earth's environment in a holistic fashion. Topics covered in the course include: the origin and evolution of the Earth, its atmosphere, and oceans, from the perspective of biogeochemical cycles, energy use, and human impacts on the Earth system.

Earth System Science Dept. | Physical Sciences Sch. | University of California, Irvine

Keywords: earth system science,evolution,earth,oceans,biogeochemical cycles,energy use,Human Impacts on Earth,atmosphere —

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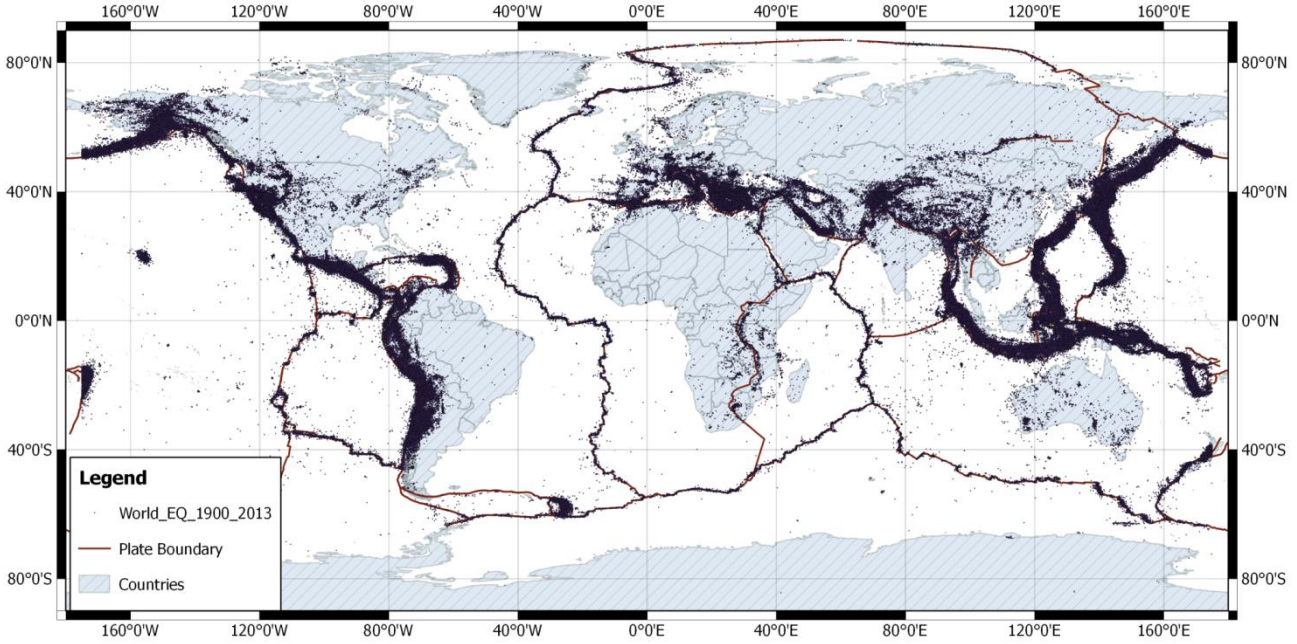
Author:
Julie Ferguson
Title:
Lecturer
Department:
Earth System Science

http://ocw.uci.edu/courses/ess_1_introduction_to_earth_system_science.html

Plate Tectonics, Plate Boundaries and Earthquakes



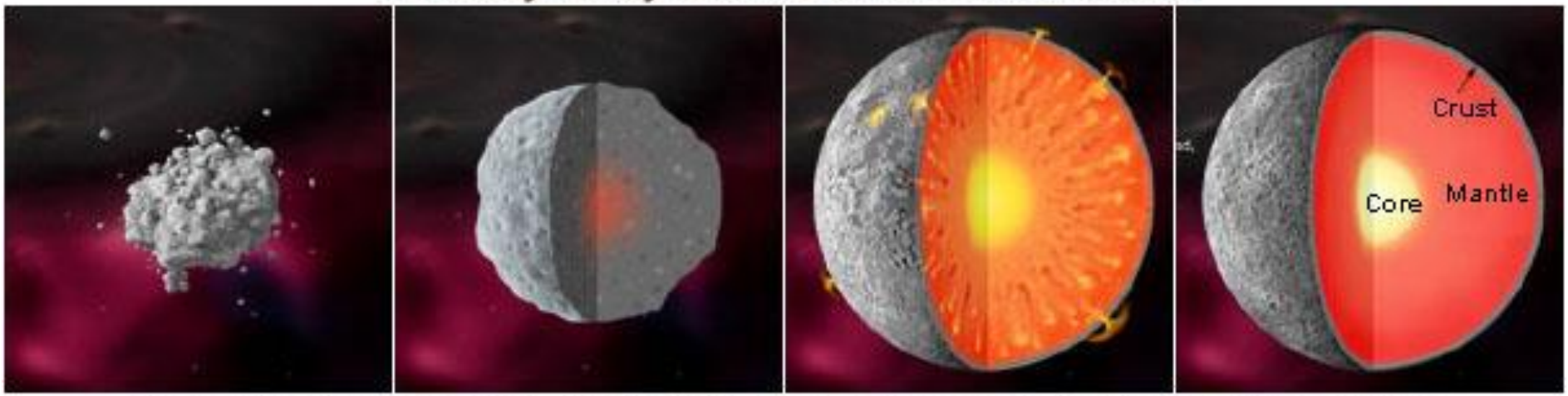
Terrestrial planets undergo differentiation

(melting and separation into layers)

As a rock body builds up through accreation, the energy from the collisions results in some melting which allows different layers to form

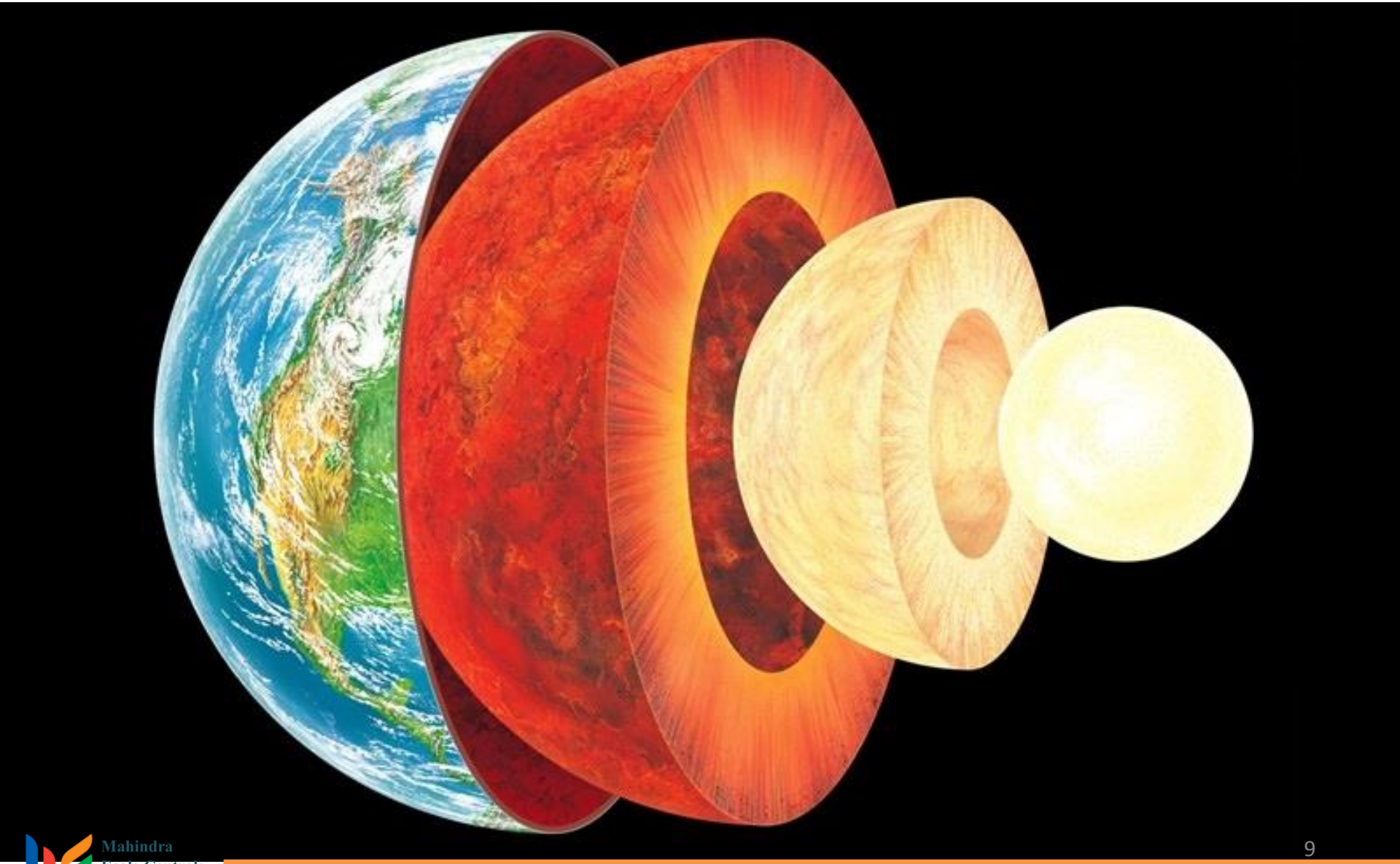
Denser material sinks to center and lighter material rises to surface.

A Rocky Body Forms and Differentiates



(From Smithsonian National Museum of Natural History - http://www.mnh.si.edu/earth/text/5_1_4_0.html)

Layers of Earth



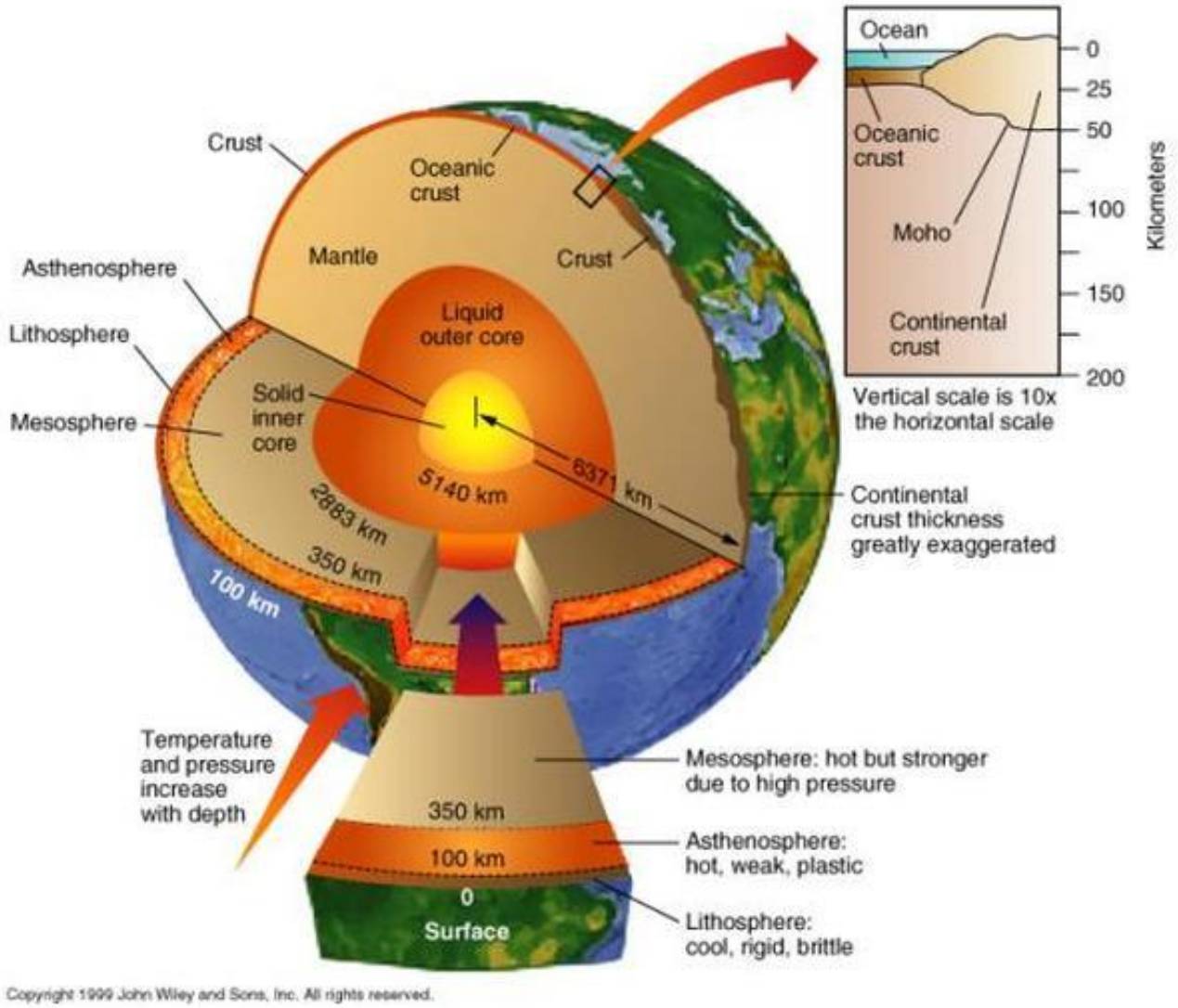
Layers of Earth

Different Composition

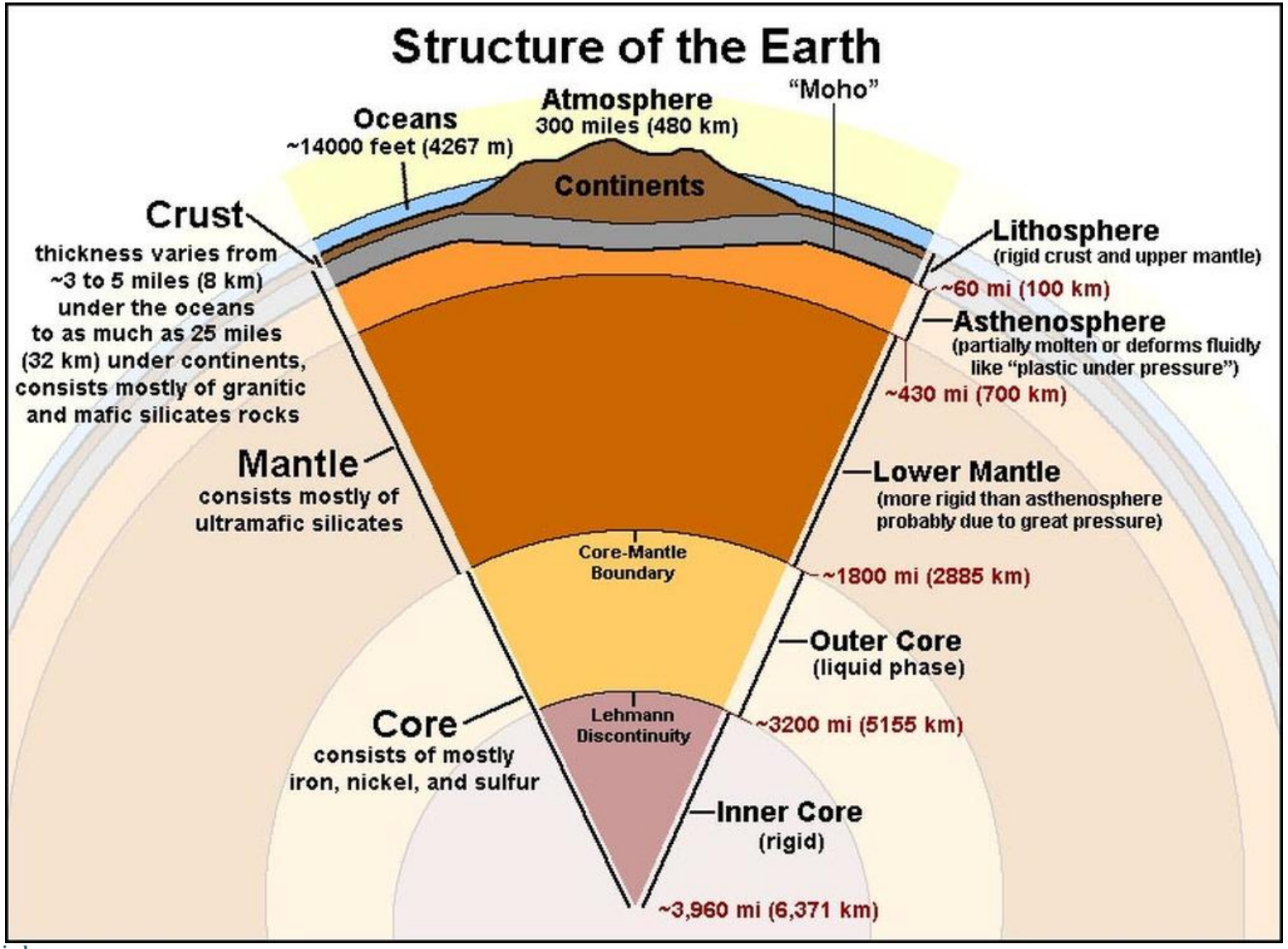
a. Crust
b. Mantle
c. Core (Iron)

Different Strength

a. Mesosphere
b. Asthenosphere
c. Lithosphere



Layers of Earth

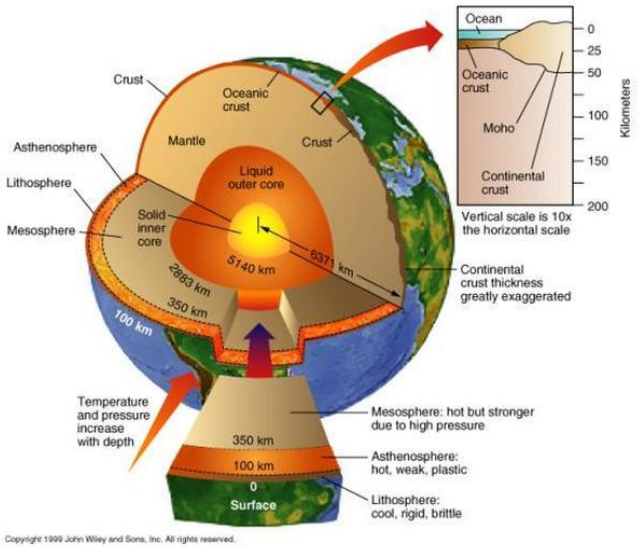


Question:

Is the mantle solid or liquid

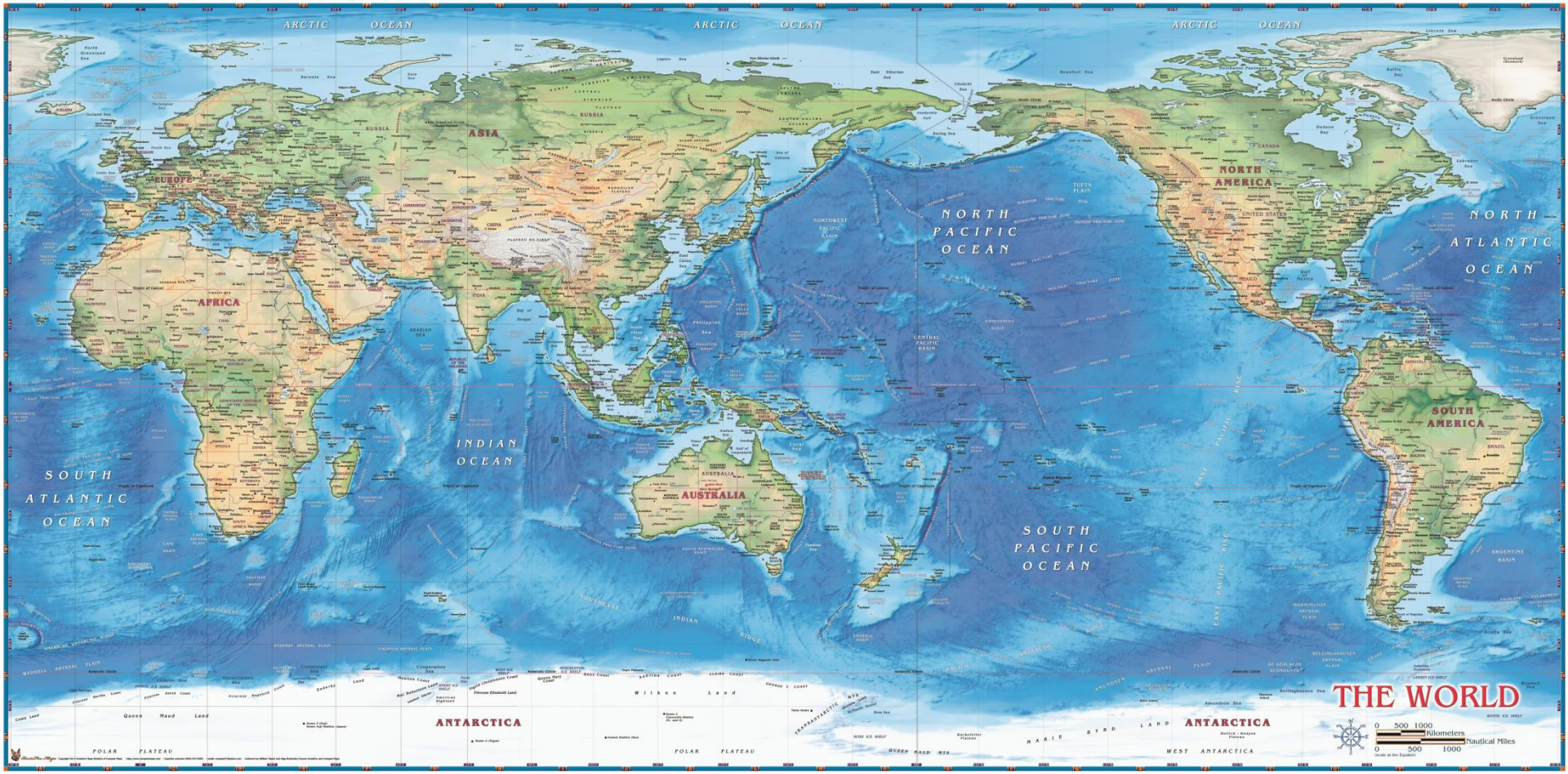
a) Solid

b) liquid

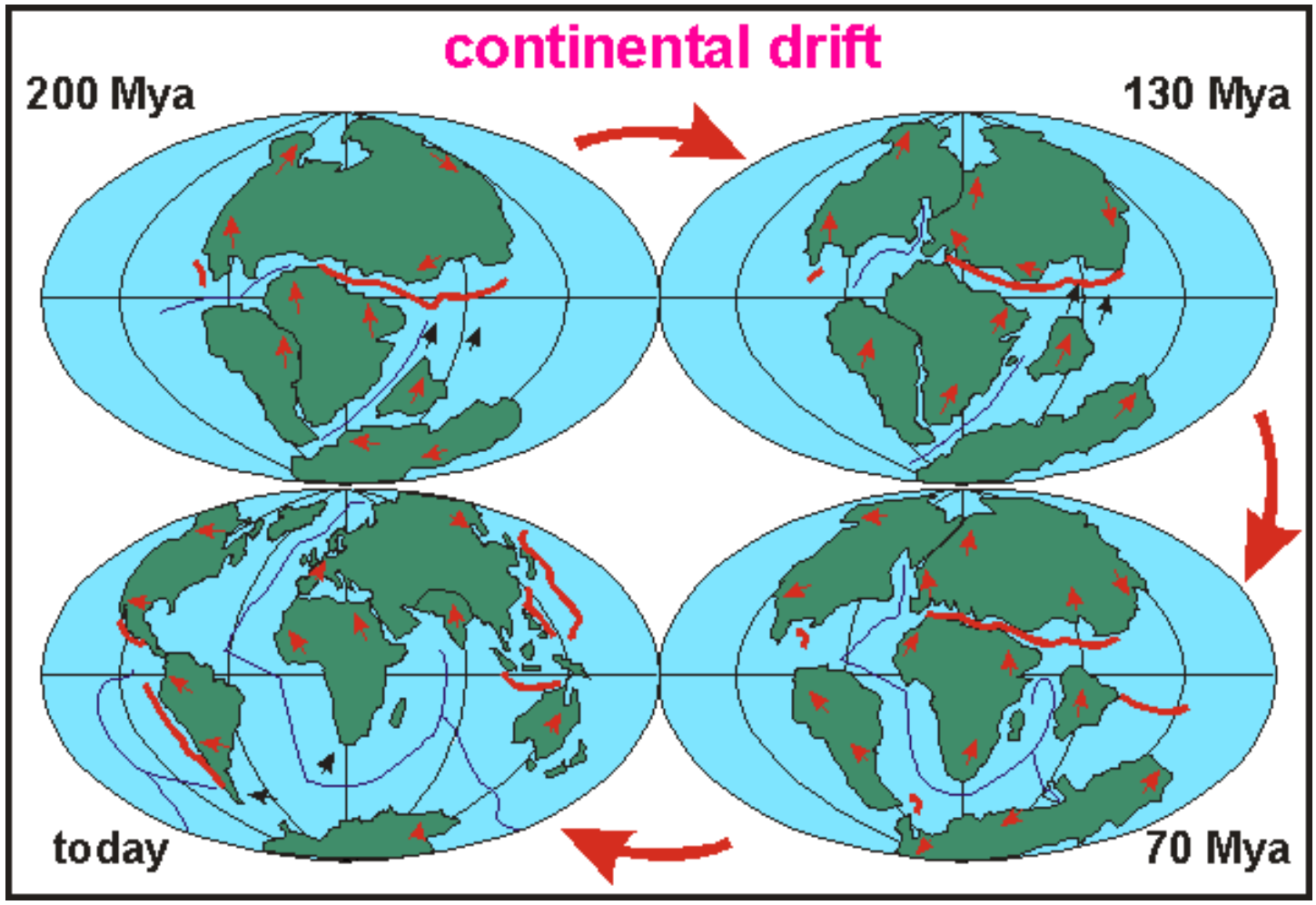


The Earth's **mantle**, on which the crust is lying on, is not made of **liquid** magma. ... The Earth's **mantle** is mostly **solid** from the **liquid** outer core to the crust, but it can creep on the long-term, which surely strengthens the misconception of a **liquid mantle**.

World Map


ARCTIC OCEAN
ARCTIC OCEAN
ARCTIC OCEAN
ASIA
RUSSIA
EUROPE
AFRICA
NORTH AMERICA
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
SOUTH AMERICA
INDIAN OCEAN
SOUTH ATLANTIC OCEAN
AUSTRALIA
SOUTH PACIFIC OCEAN
ANTARCTICA
ANTARCTICA
THE WORLD
0 500 1000 Kilometers
0 500 1000 Nautical Miles

Continental Drift Theory



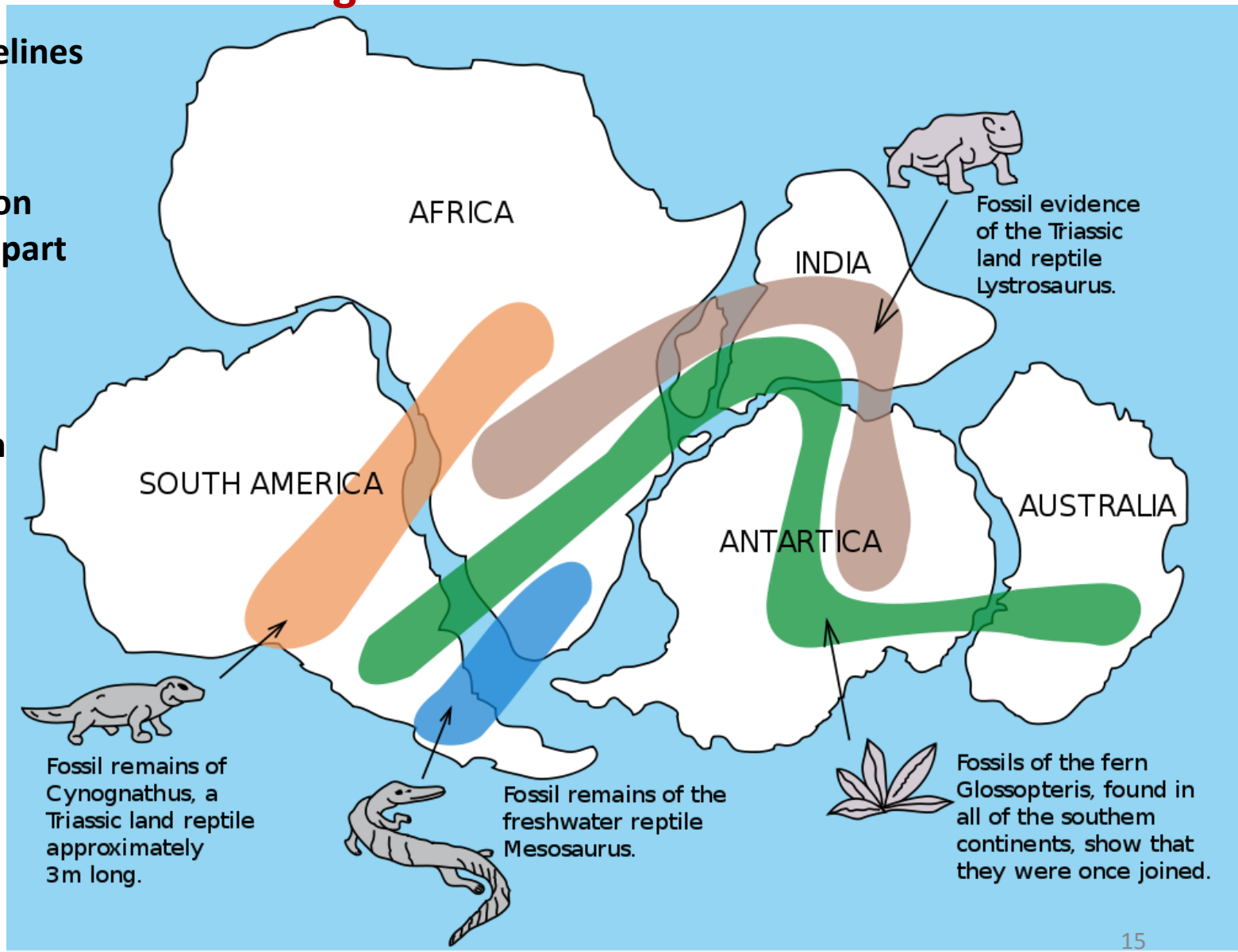
(Alfred Wegener)

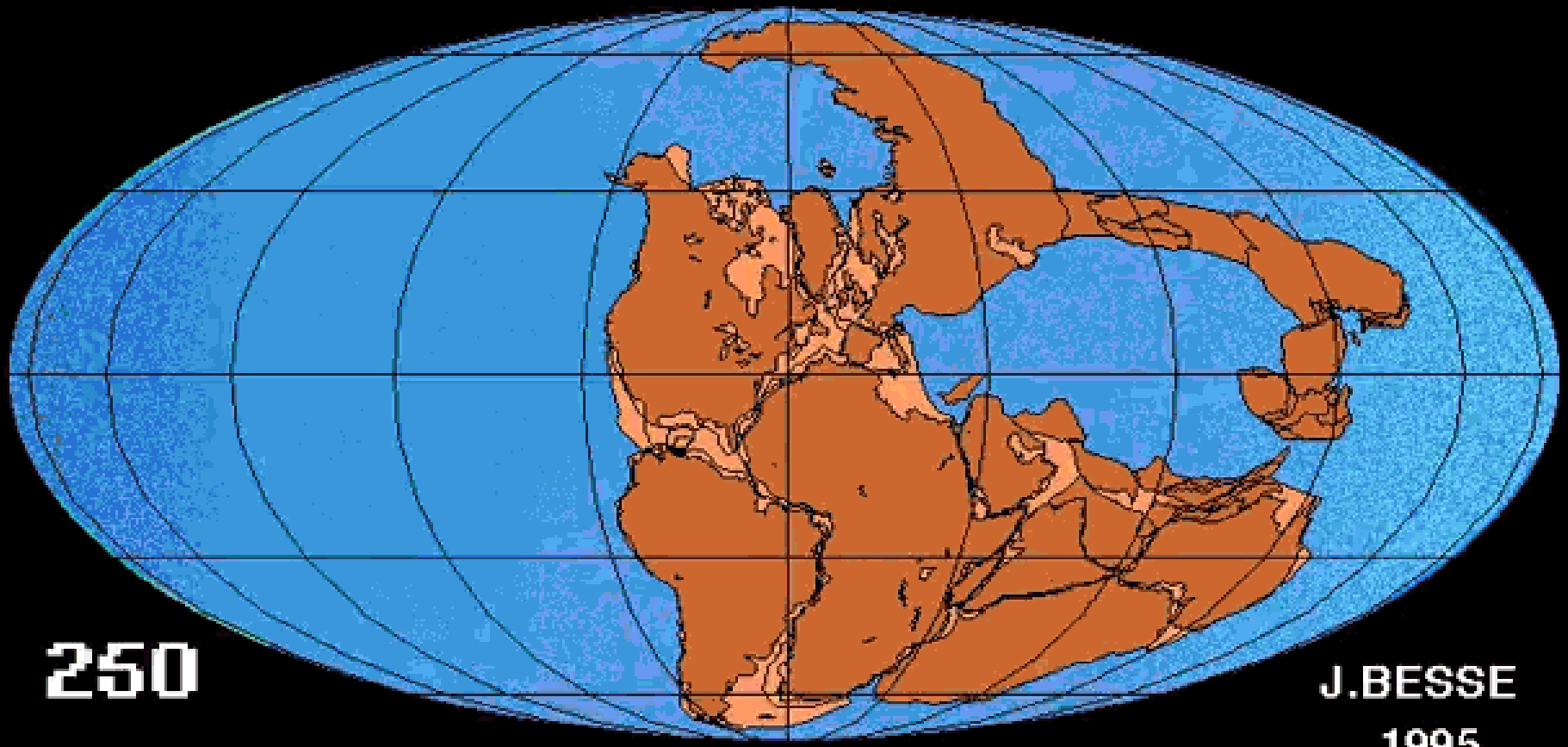
Wegener's Evidence

Continental shorelines

Matching fossils on land masses far apart

Matching rocks and structures on the edges of continents





Wegener failed in explaining the concept of continents moving

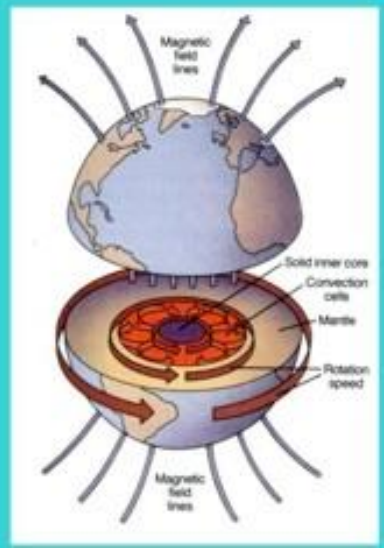
Paleomagnetism

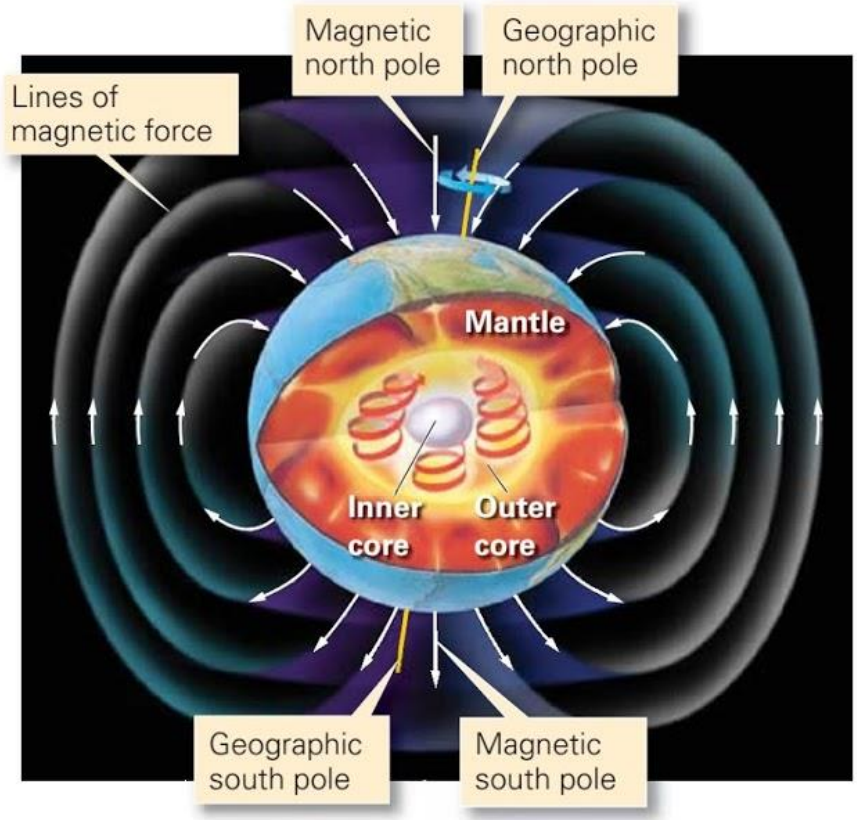
Much of the evidence for plate tectonics was discovered by accident by studying Earth's magnetic field

Earth's magnetic field is caused by convention in the liquid outer core

Origin of the Magnetic field

- Hydromagnetic dynamo in Earth's core
- Earth's core is molten iron (plus other stuff)
- Motions in the core bend and stretch magnetic field, producing more magnetic field!
- Therefore, field structure at core surface is particularly interesting
- We can use the surface field model to map core surface field.
- We can't observe what is happening *in* the core.





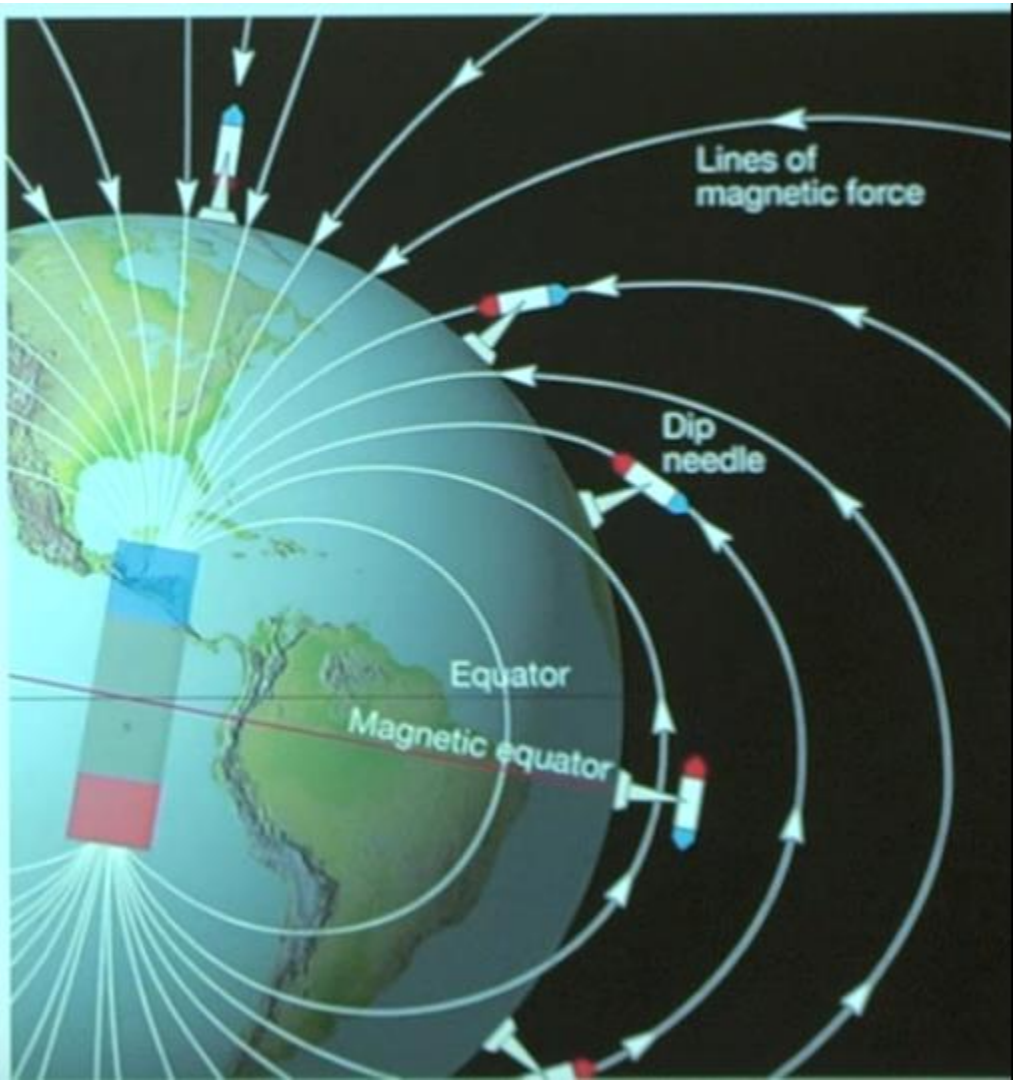
(a) The magnetic axis is not parallel to the spin axis. In 3-D, the Earth's magnetic field can be visualized as invisible curtains of energy, generated by flow to the outer core.

Paleomagnetism

Orientation – Magnetic minerals will point towards the pole just like a compass

Inclination – Angle from the horizontal depends upon latitude.

Paleomagnetism can therefore tell us the latitude and orientation of rocks at the time they formed!

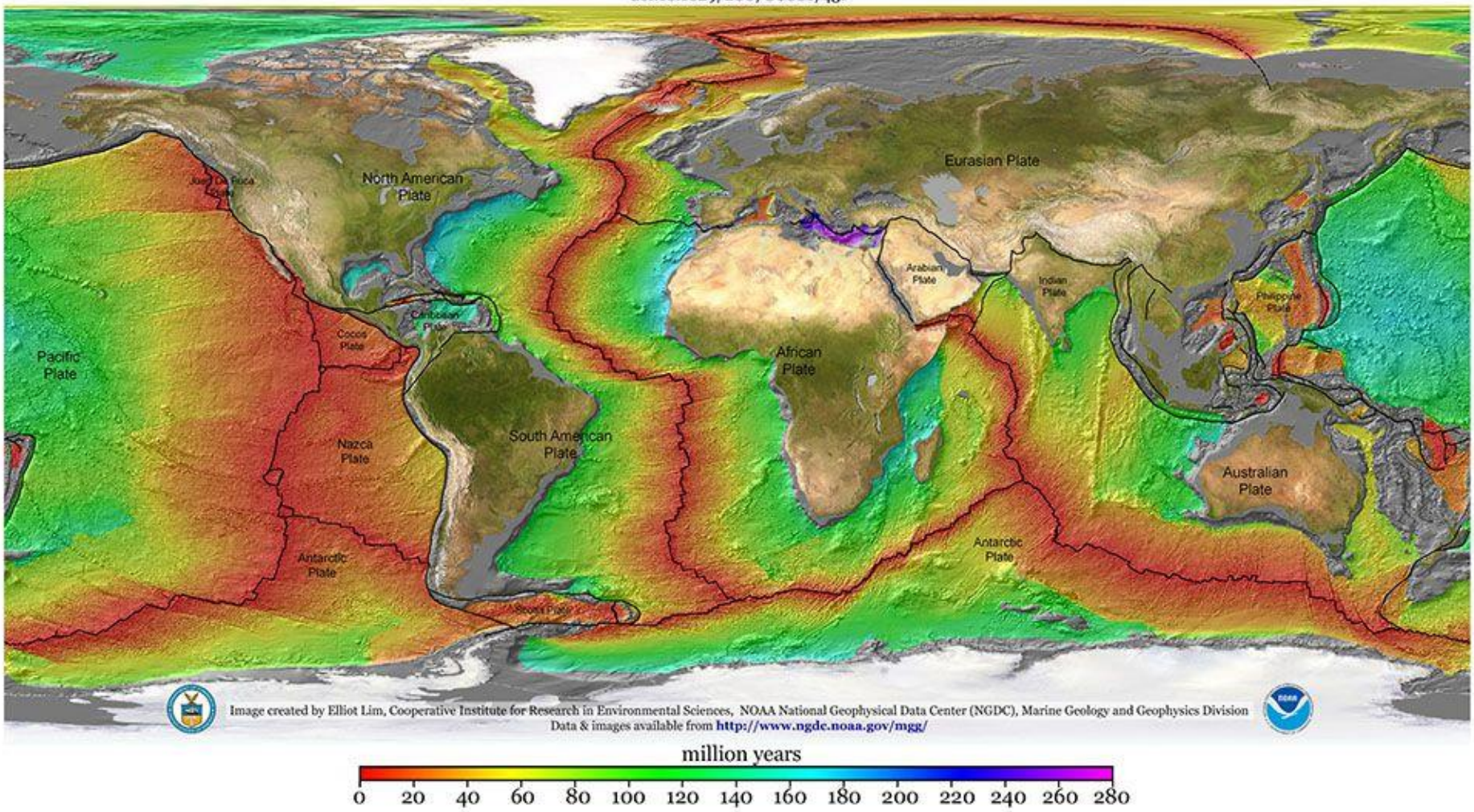


Birth of Plate Tectonics

Age of Oceanic Lithosphere (m.y.)

Data source:

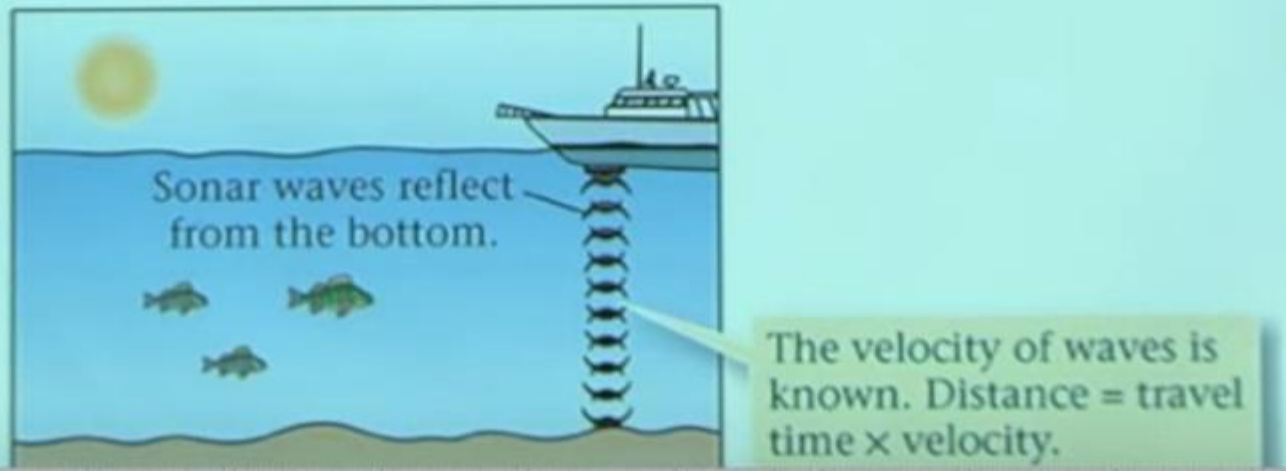
Muller, R.D., M. Sdrolias, C. Gaina, and W.R. Roest 2008. Age, spreading rates and spreading symmetry of the world's ocean crust,Geochem. Geophys. Geosyst., 9, Q04006, doi:10.1029/2007GC001743.



Sea floor spreading Evidence

Evidence:

- Sonar was used to map the ocean bathymetry (depth)
  - The deepest parts of the ocean occur near land
  - A mountain range (ridge) runs through every ocean basin with submarine volcanoes
- Deep-sea drilling
  - Ocean crust warmest near the ridge and coldest near land
  - The thickness of sediment increased towards land



Tectonics Background

GLOBAL & INDIA

World Earthquake Epicenters 1900 -2013 ; Events – 6,82,350

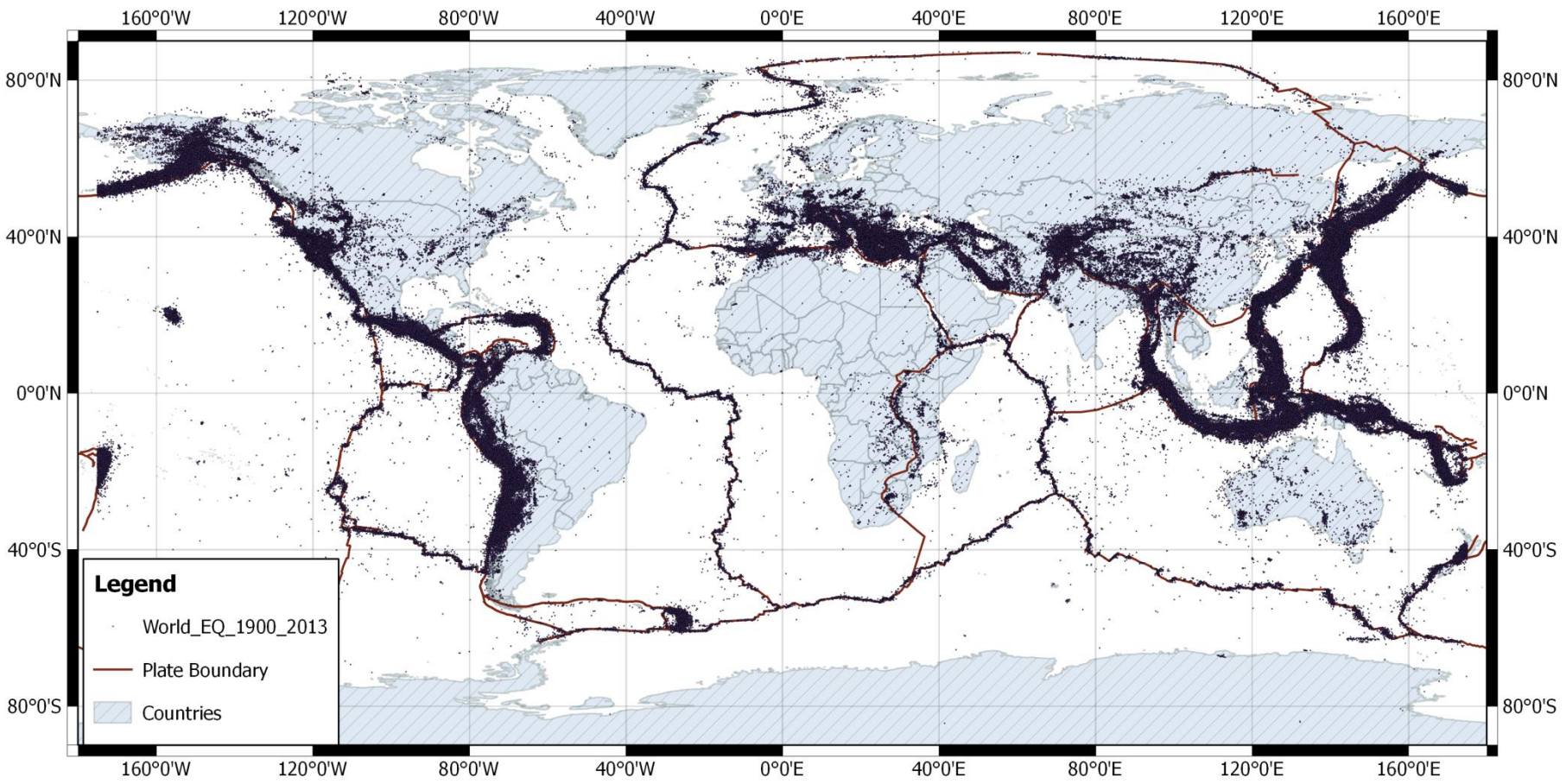


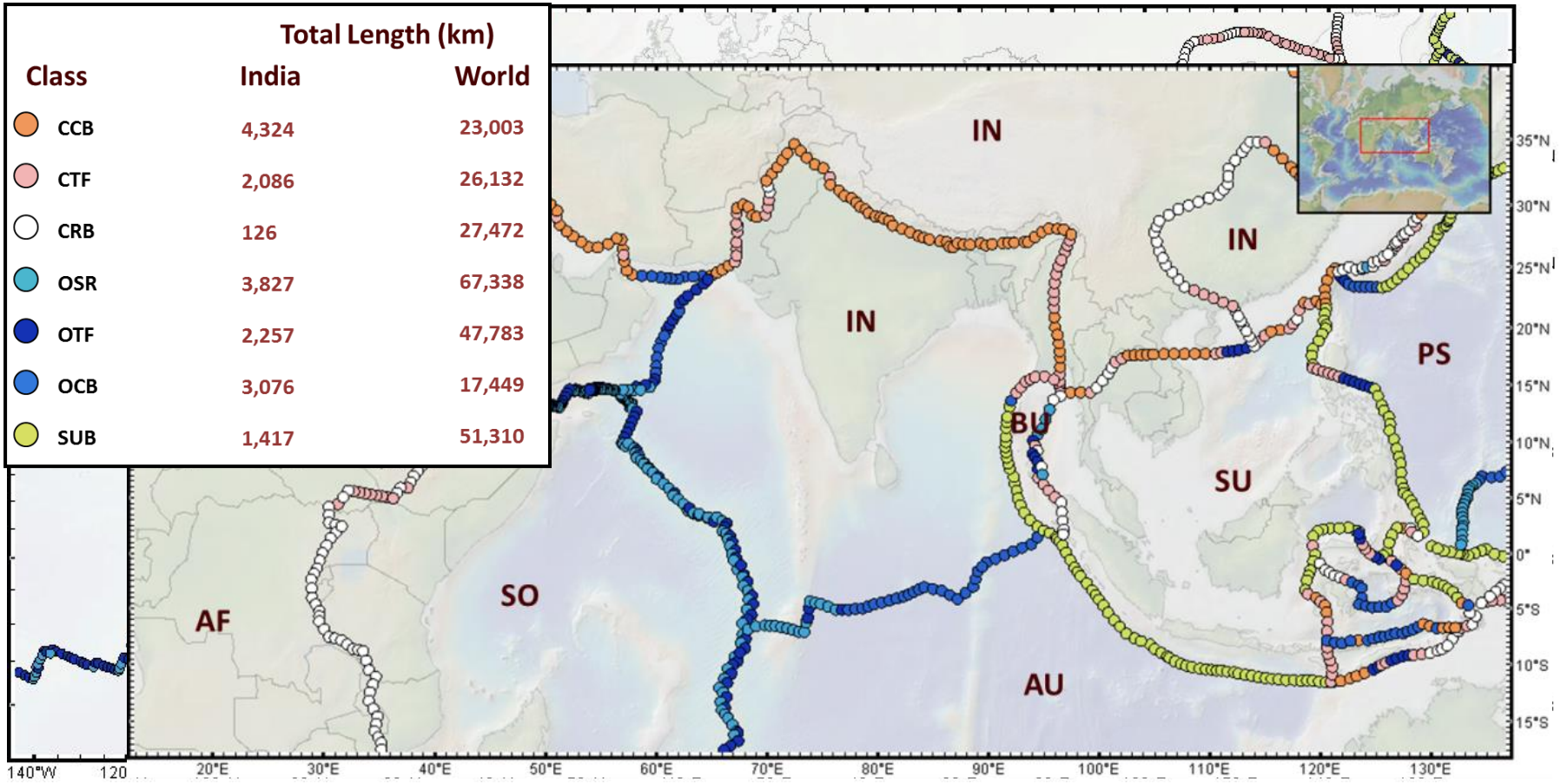
Fig : Epicentral locations of earthquakes occurred during 1900 - 2013

Source: Northern California Earthquake Data Center (NCEDC), Indian Meteorological Department (IMD)

World Tectonic Plates

Tectonic Plates

Class	Total Length (km) India	Total Length (km) World
CCB	4,324	23,003
CTF	2,086	26,132
CRB	126	27,472
OSR	3,827	67,338
OTF	2,257	47,783
OCB	3,076	17,449
SUB	1,417	51,310



CCB Continental Convergent Boundary

CTF Continental Transform Fault

CRB Continental Rift Boundary

OTF Oceanic Transform Fault

OCB Oceanic Convergent Boundary

OSR Oceanic Spreading Ridge

SUB Subduction Zone

Fig : World tectonic plates with interaction types

Data: Peter Bird, 2003

World Tectonic Plates

Great Earthquakes Convergent Margins

Fig : Epicentral locations of great earthquakes of the world 1900 – 2013 with convergent plate tectonic boundaries

Ref: Purnachandra Rao N and Hanumantha Chary A., (2005)

Indian Neighboring Plates

Seismicity (Magnitude)

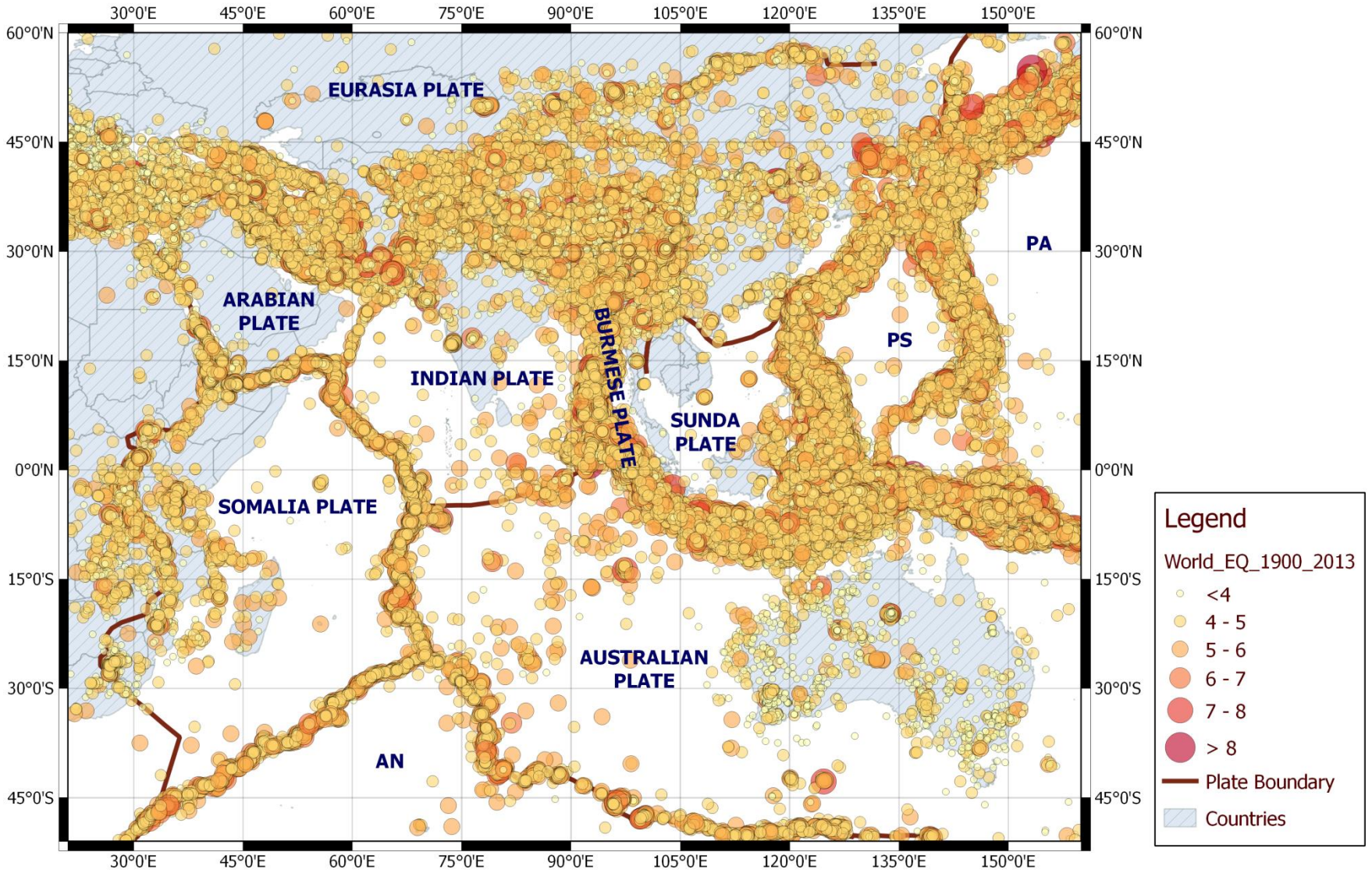


Fig : Epicentral locations in and around Indian tectonic plate categorized under different magnitude scales

Indian Neighboring Plates

Seismicity (Depth)

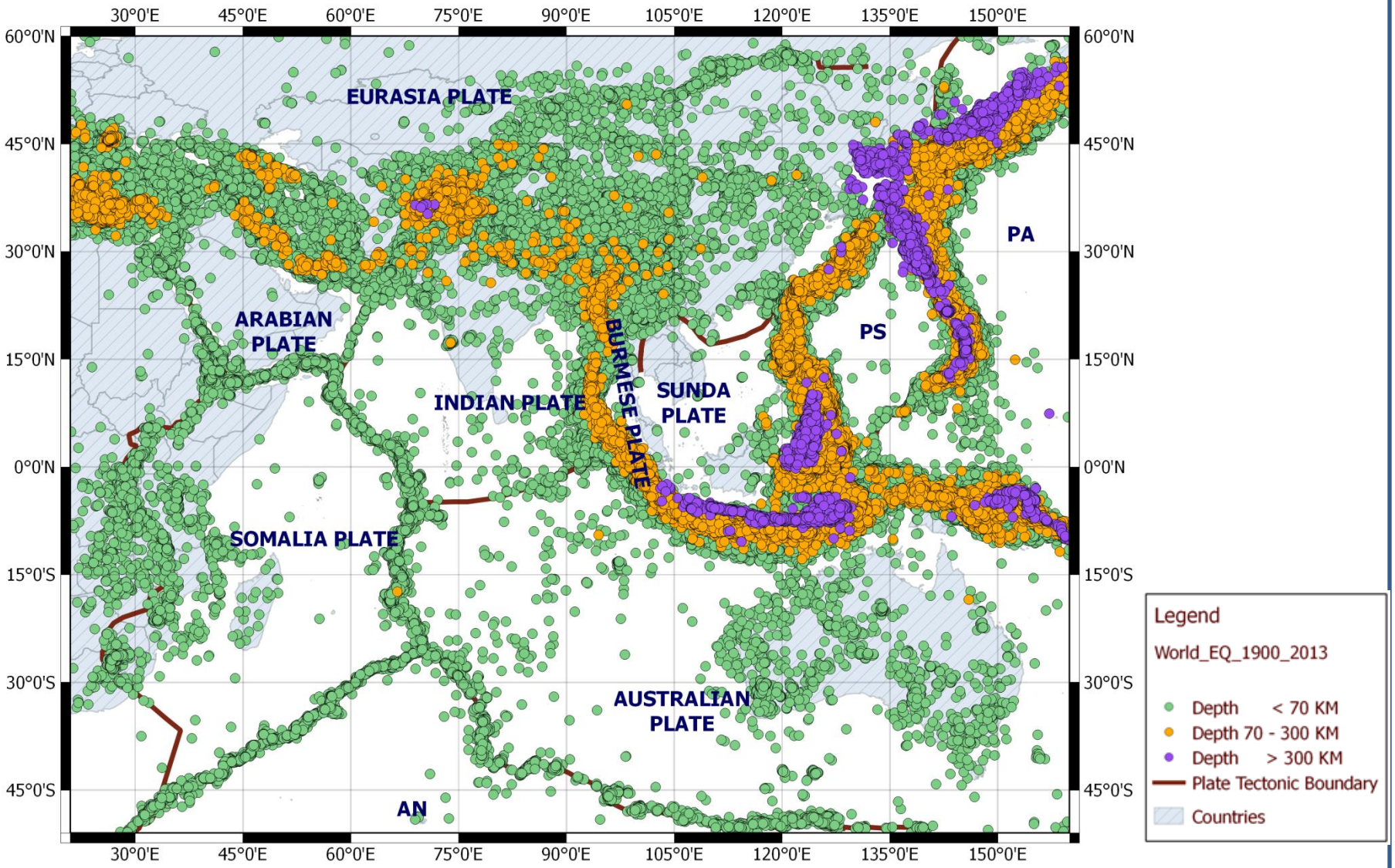


Fig : Epicentral locations in and around Indian tectonic plate categorized under different depth scales

Indian Plate Interactions

INDIAN-EURASIAN

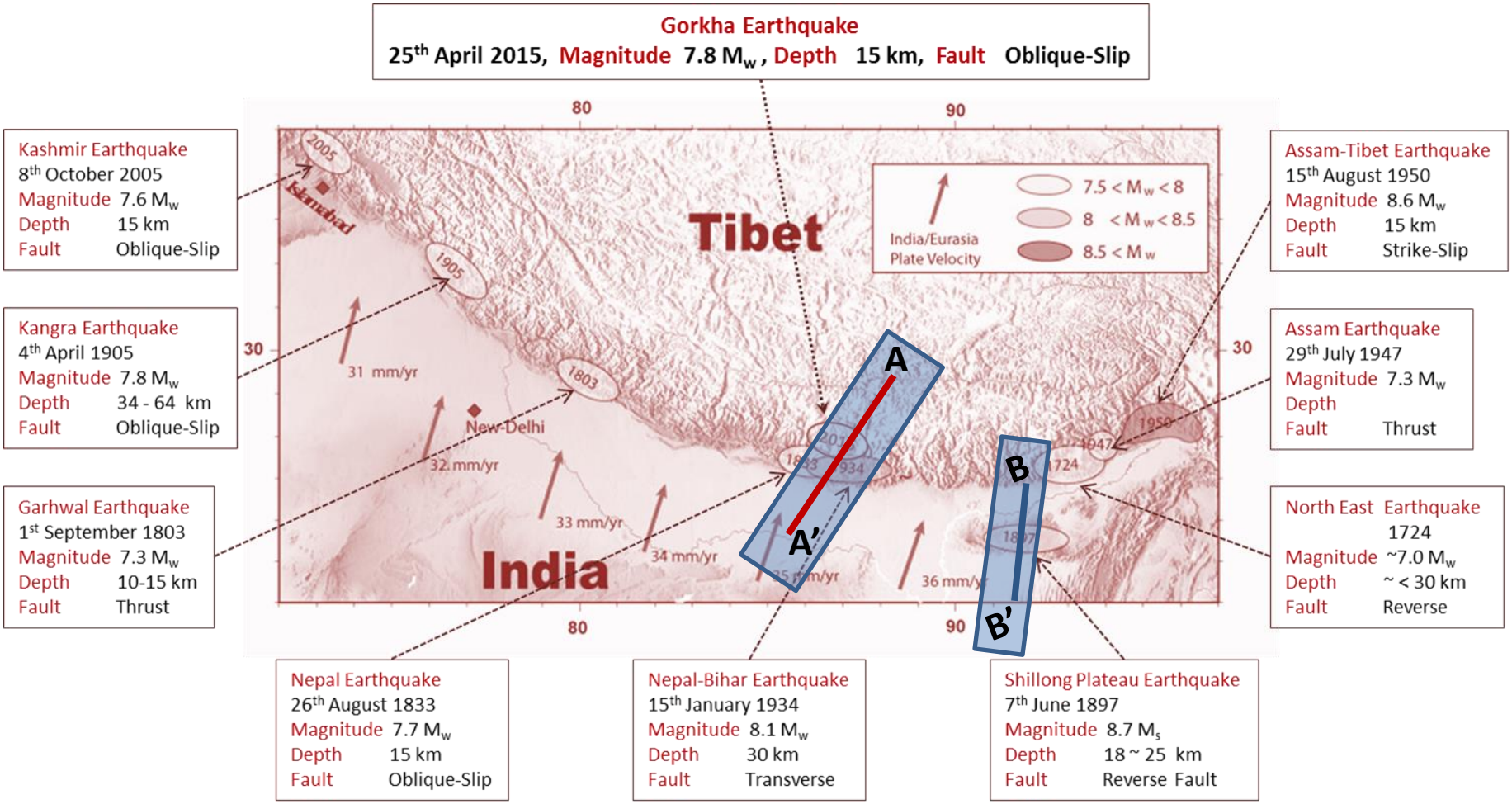


Fig : Locations and details of all the major to great earthquakes occurred along the Himalayan belt, also showing the location Gorkha Earthquake occurred on 25th April 2015. (Modified after Avouac, 2015)

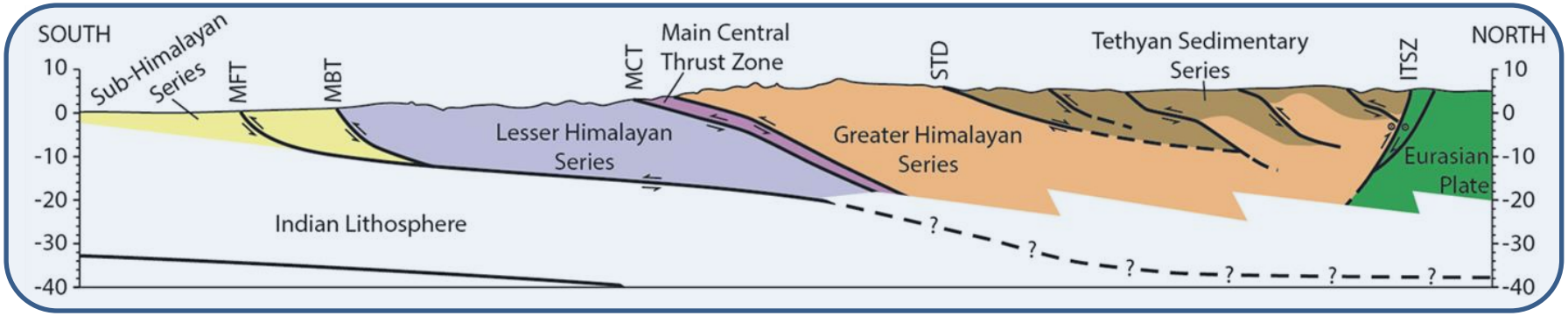
Ref: Avouac. 2015

Indian Plate Interactions

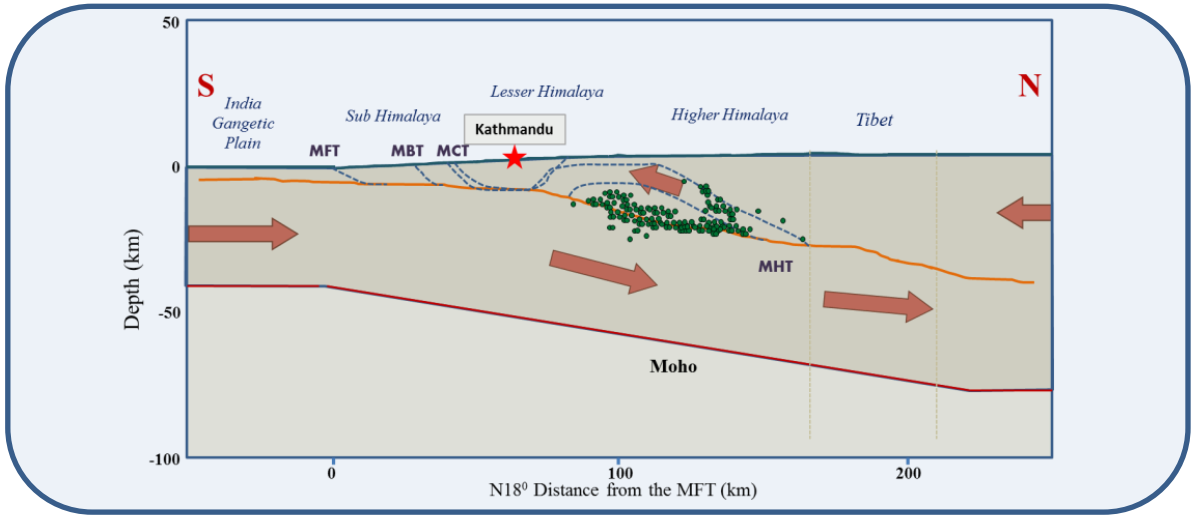
INDIAN-EURASIAN

Study Area

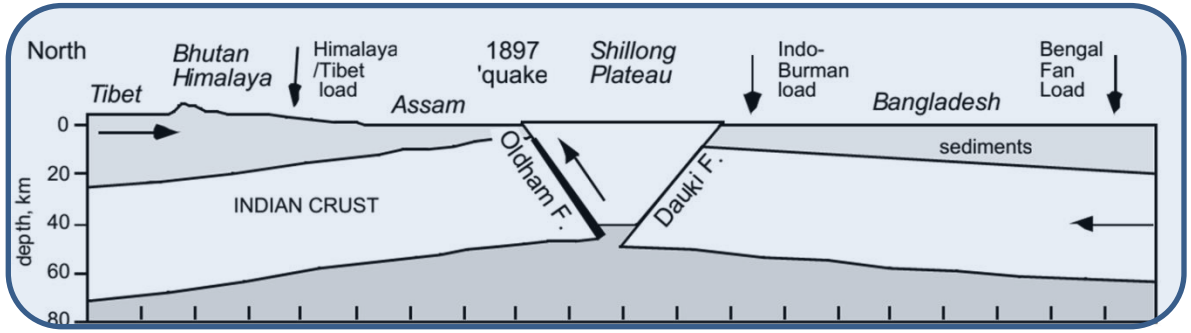
A’ A



A’ A

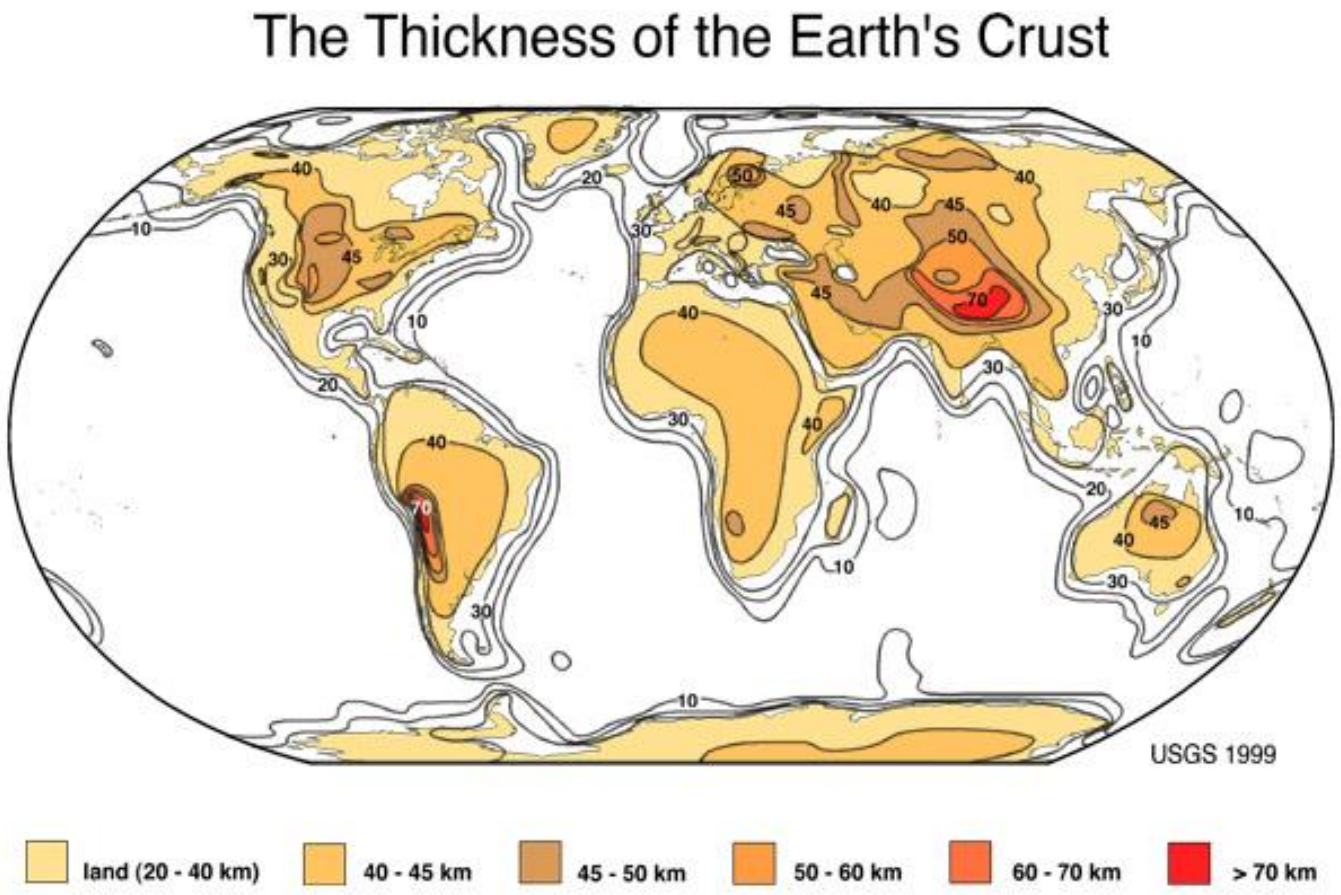


B B’



1. Understanding Plate Tectonics

Field Observations - Modeling **Structure of the Earth**

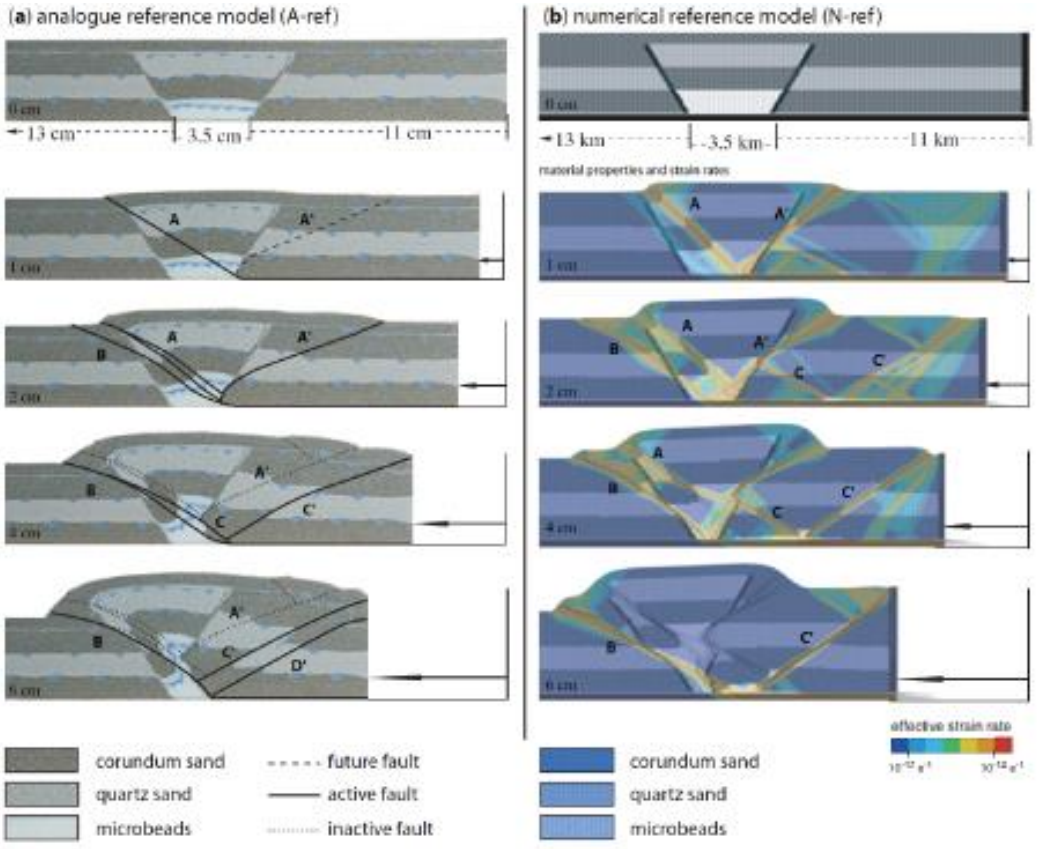


http://earthquake.usgs.gov/data/crust/download.php

2. Understanding Plate Tectonics

Experimental - Laboratory

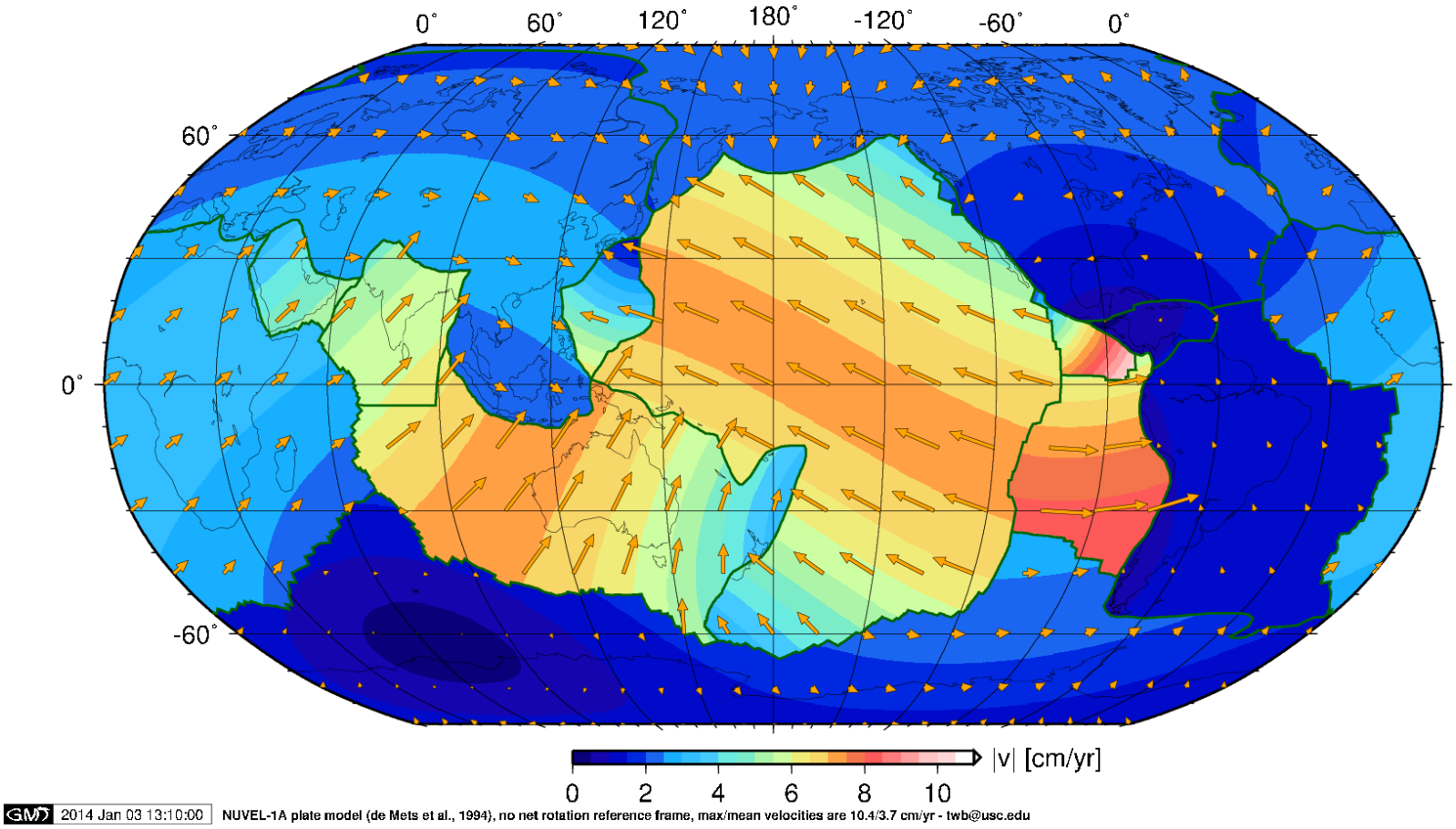
Material Behavior



Ref: Panien, M et al. (2006)

3. Understanding Plate Tectonics

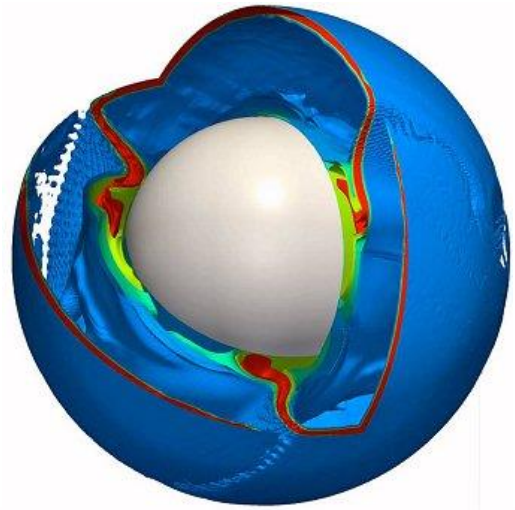
Geodesy and Geodetic Models — ***Tectonic Plate Velocities***

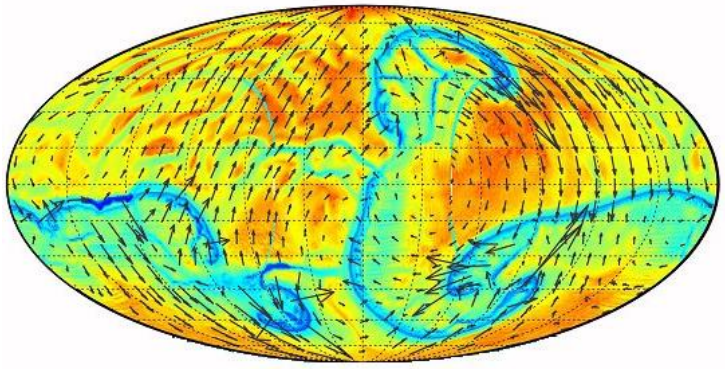


Ref: http://geodynamics.usc.edu/~becker/ftp/maps/plate_tectonics_simple.nnr_nuvel1a.nnr.1.png

4. Understanding Plate Tectonics

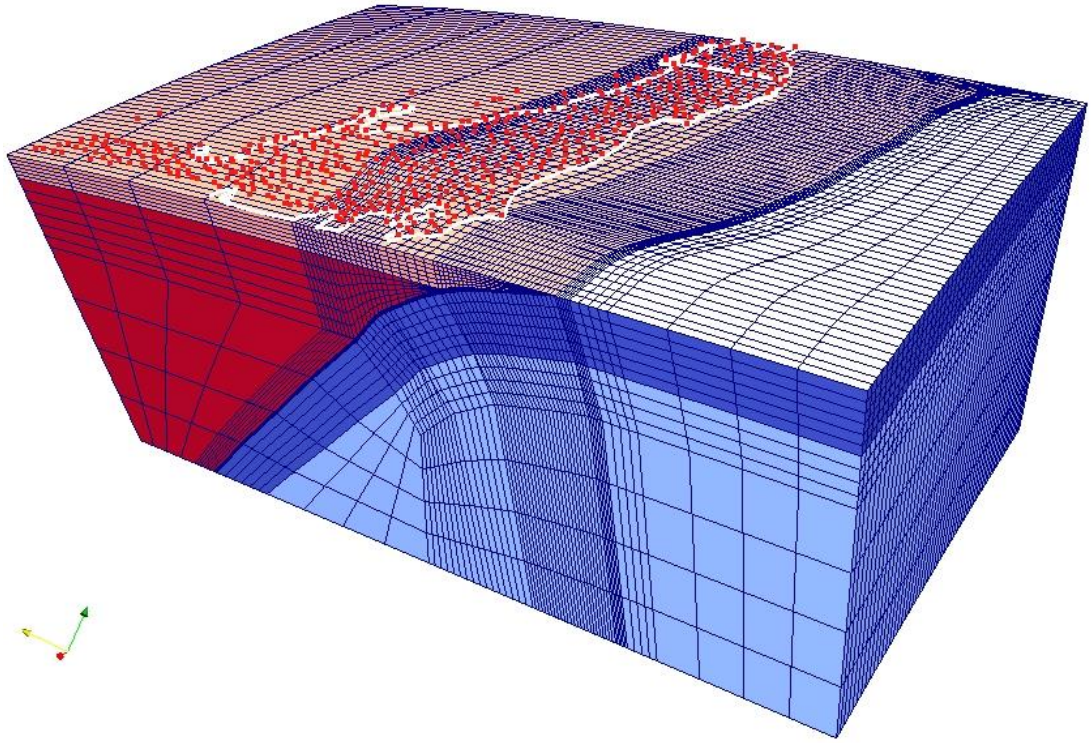
Numerical - Simulations **Understanding and Forecasting**





Ref: Cramery et al. (2012)

Viscoelastic Postseismic Deformation Following the 2011 Mw9.0 Tohoku Earthquake (UCB, 2014)



Ref: Yan Hu, Roland Bürgmann (2014)

Can we Predict Earthquake ?

- *Prediction of Size*
- *Prediction of Place*
- *Prediction of Time*

- *Cause intensive loss to property and life.*

- *Property - recovered to some extent but life loss cannot.*

- *Life loss is mainly due to structural failure.*

- *Very important to know, when and how structure fails.*

Indian Neighboring Plates

Seismicity (M > 6)

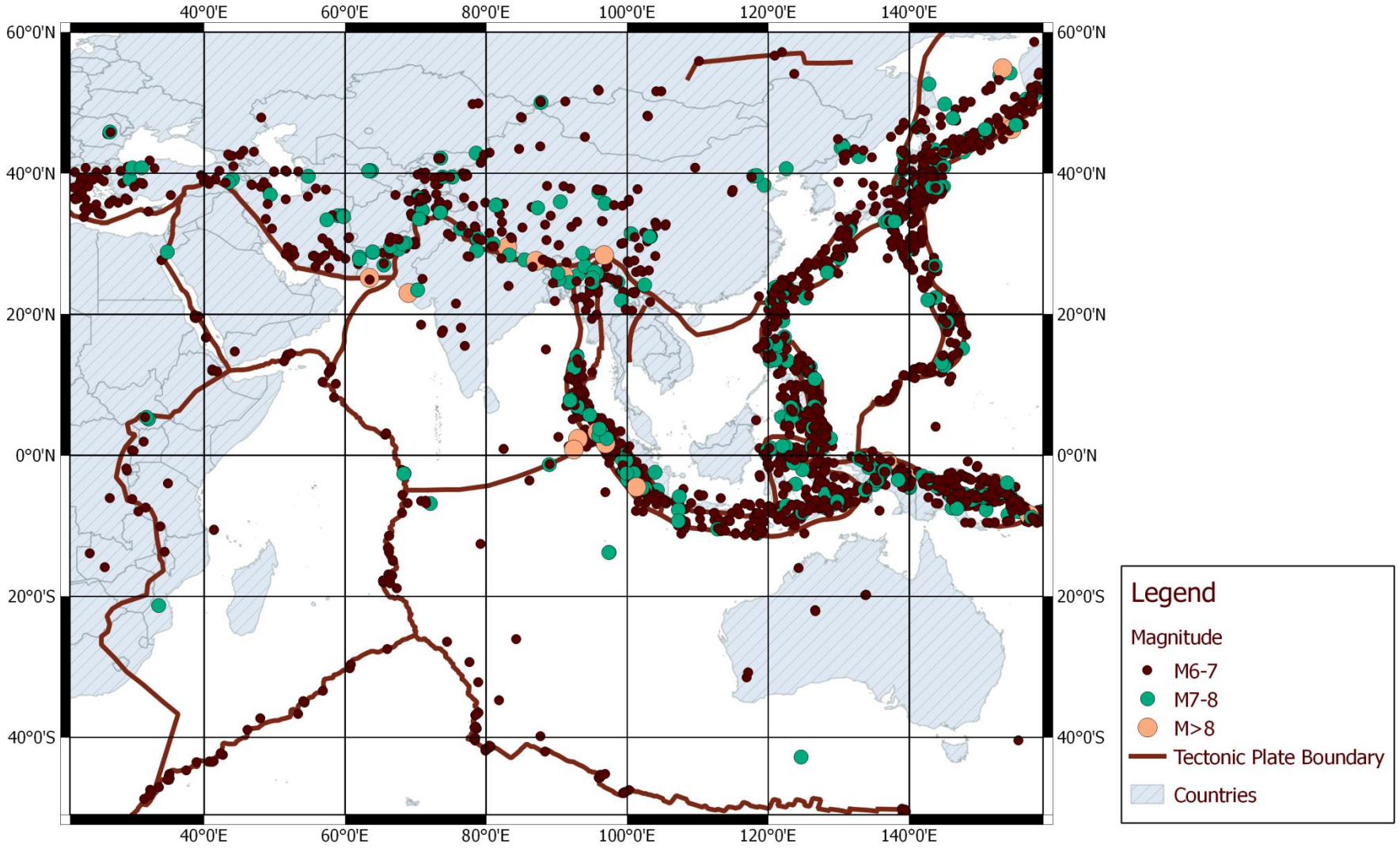


Fig : Epicentral locations in and around of magnitude greater than 6.

Plate Boundaries

- *Convergent plate boundary*
- *Divergent plate boundary*
- *Transform plate boundary*

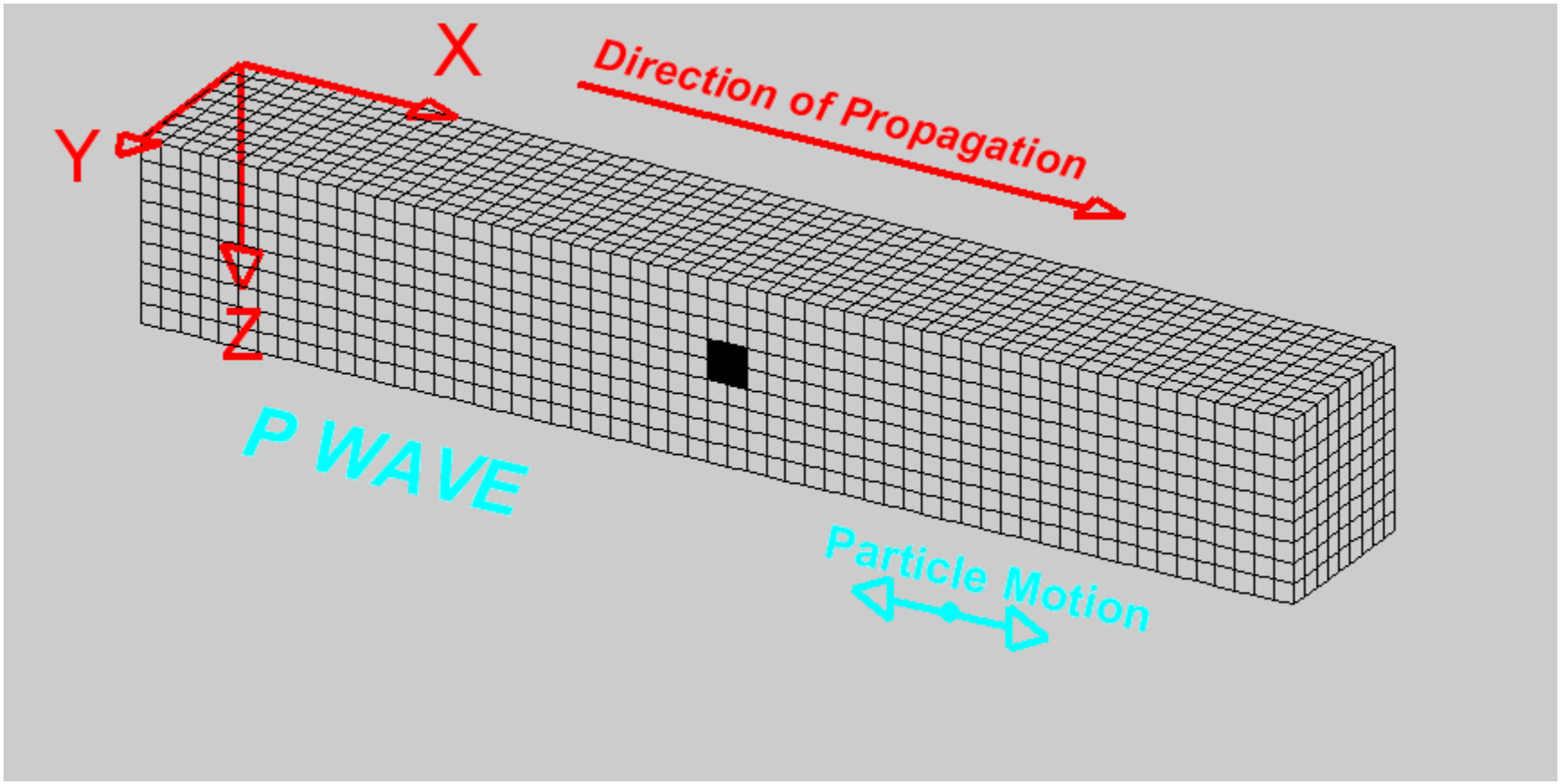
Faults

- ***Dip slip faults***
  - Normal
  - Reverse
- ***Strike slip faults***
  - Right lateral
  - Left lateral

Seismic Waves

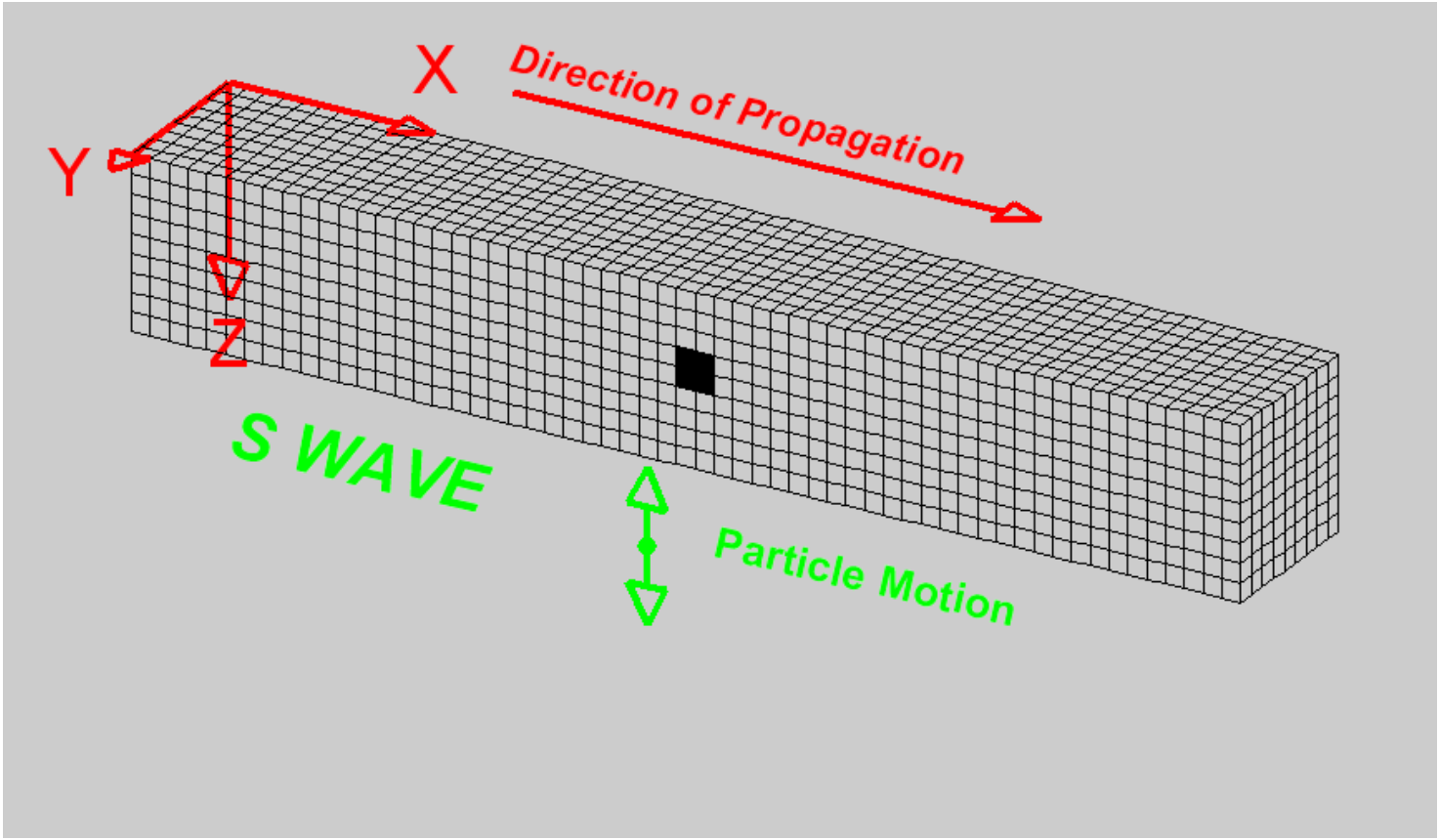
- Body Waves
- Surface waves
  - Body Waves
    - *Primary waves P-waves*
    - *Secondary waves S-waves*
  - Surface Waves
    - *Love waves*
    - *Rayleigh waves*

Compressional Wave (P-Wave) Animation



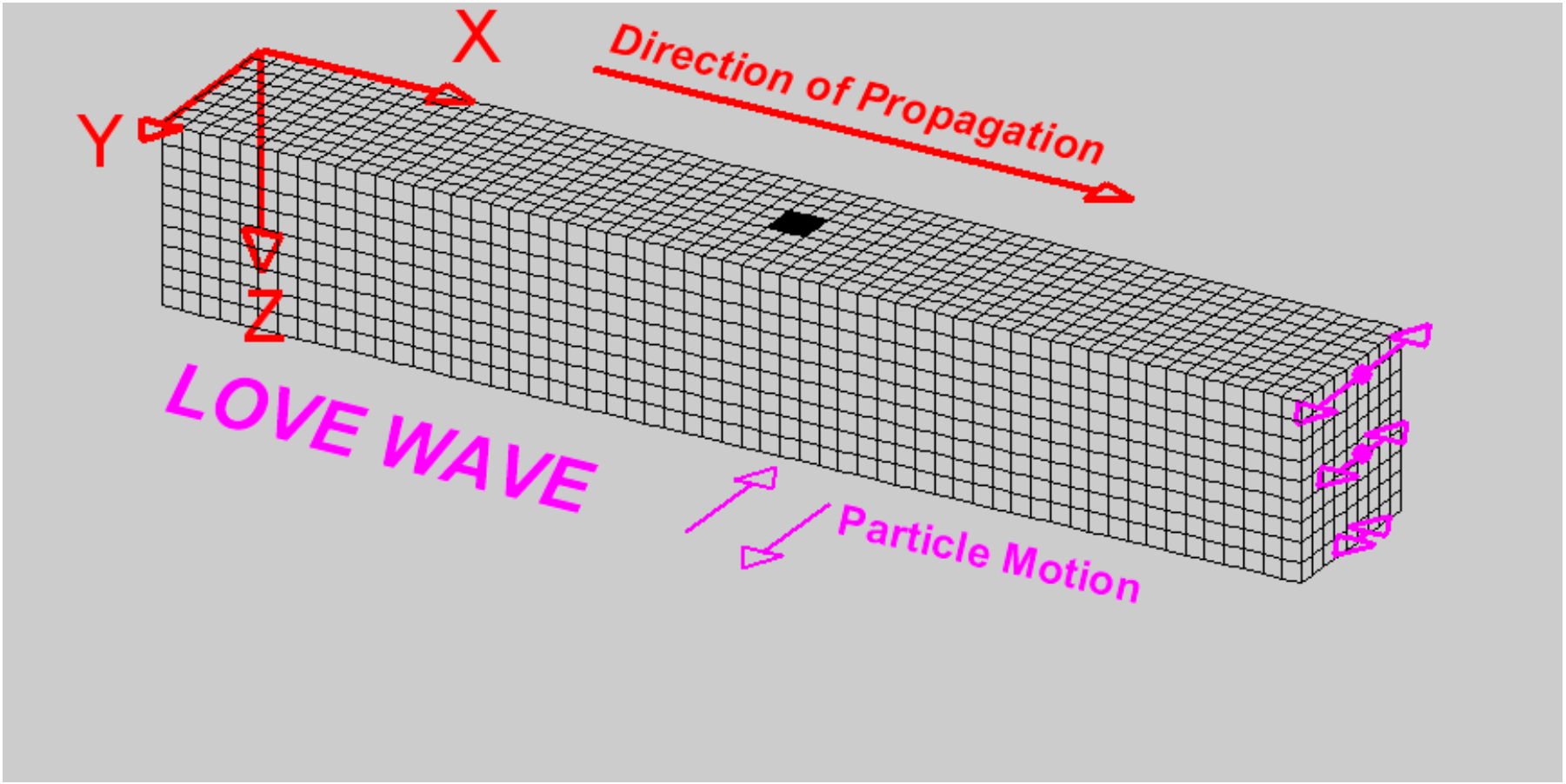
Deformation propagates. Particle motion consists of alternating compression and dilation. Particle motion is parallel to the direction of propagation (longitudinal). Material returns to its original shape after wave passes.

Shear Wave (S-Wave) Animation



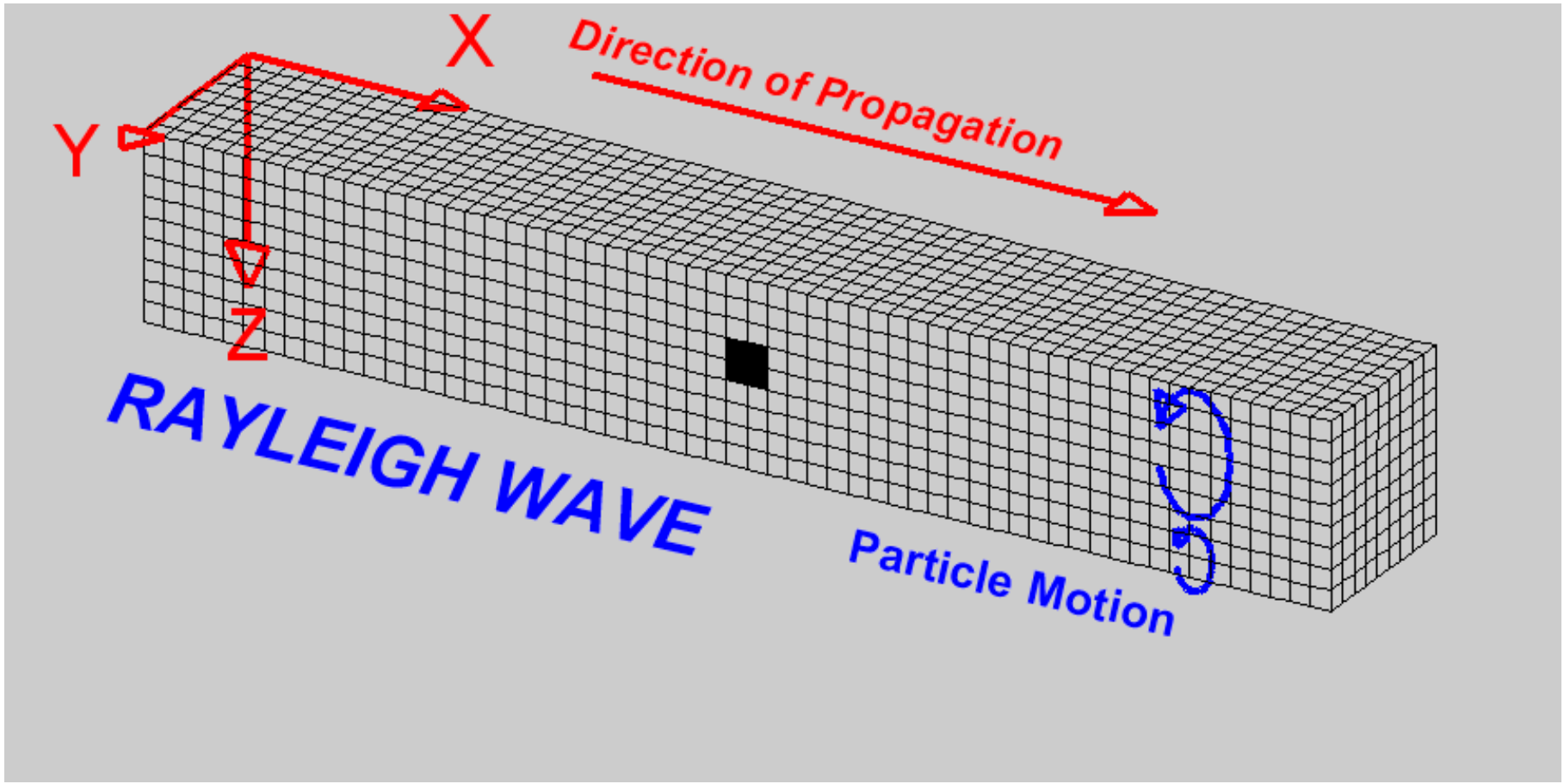
Deformation propagates. Particle motion consists of alternating transverse motion. Particle motion is perpendicular to the direction of propagation (transverse). Transverse particle motion shown here is vertical but can be in any direction; however Earth's layers tend to cause mostly vertical (SV) or horizontal (SH) shear motions. Material returns to its original shape after wave passes..

Love Wave (L-Wave) Animation



Particle motion consists of alternating transverse motions. Particle motion is horizontal and perpendicular to the direction of propagation (transverse). Amplitude decreases with depth. Material returns to its original shape after wave passes.

Rayleigh Wave (R-Wave) Animation



Particle motion consists of elliptical motions in the vertical plane and parallel to the direction of propagation. Amplitude decreases with depth. Material returns to its original shape after wave passes.

Earthquake Magnitude

- Need for the scale
- Richter scale in 1930

"Succeeded beyond expectation"

The magnitude of local earthquake is defined as the logarithm to base 10 of the maximum seismic wave amplitude (in thousandths of a mm) recorded on Wood Anderson seismograph at distance 100 km from earthquake epicenter

$$M = \log_{10} A - \log_{10} A_0$$

Earthquake Magnitude Class

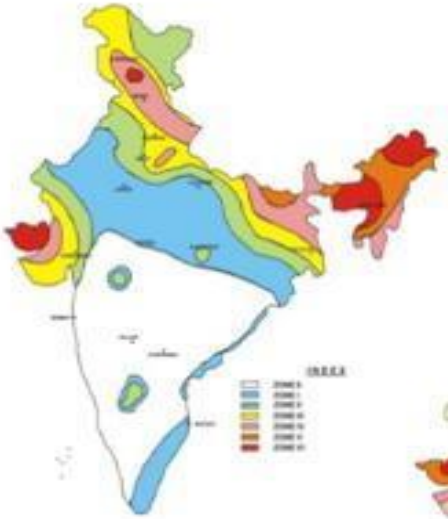
	USGS	IMD
M > 8	Great	Very great
7 - 7.9	Major	Great
6 - 6.9	Strong	Moderate
5 - 5.9	Moderate	Moderate
4 - 4.9	Light	Slight
3 - 3.9	Minor	Slight

Earthquake Intensity

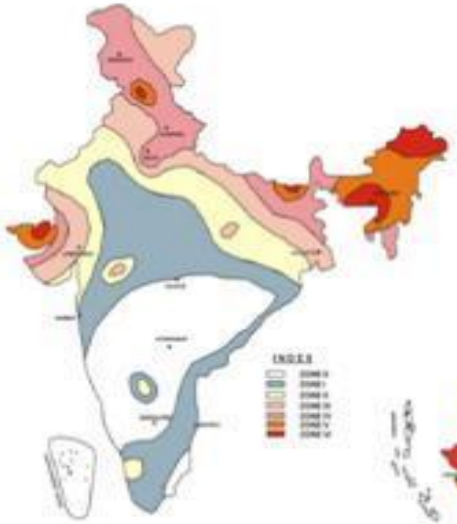
- Indicates the intensity of shaking or the extent of damage
- De Rossi in Italy and Forel in Switzerland proposed I to X Rossi-Forel scale.
- In 1902 Mercalli (Italy) revised it.
- MSK Scale
- JMA Scale

Seismic Zonation Map of India

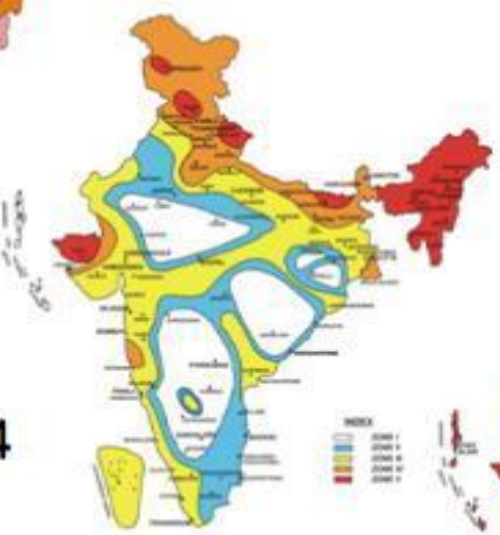
1962



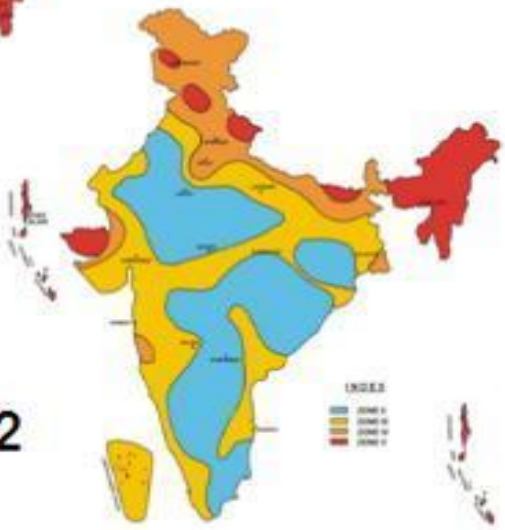
1966



1984



2002



Seismic Zone Map of India: -2002

About 59 percent of the land area of India is liable to seismic hazard damage

Zone	Intensity
Zone V	Very High Risk Zone Area liable to shaking Intensity IX (and above)
Zone IV	High Risk Zone Intensity VIII
Zone III	Moderate Risk Zone Intensity VII
Zone II	Low Risk Zone VI (and lower)

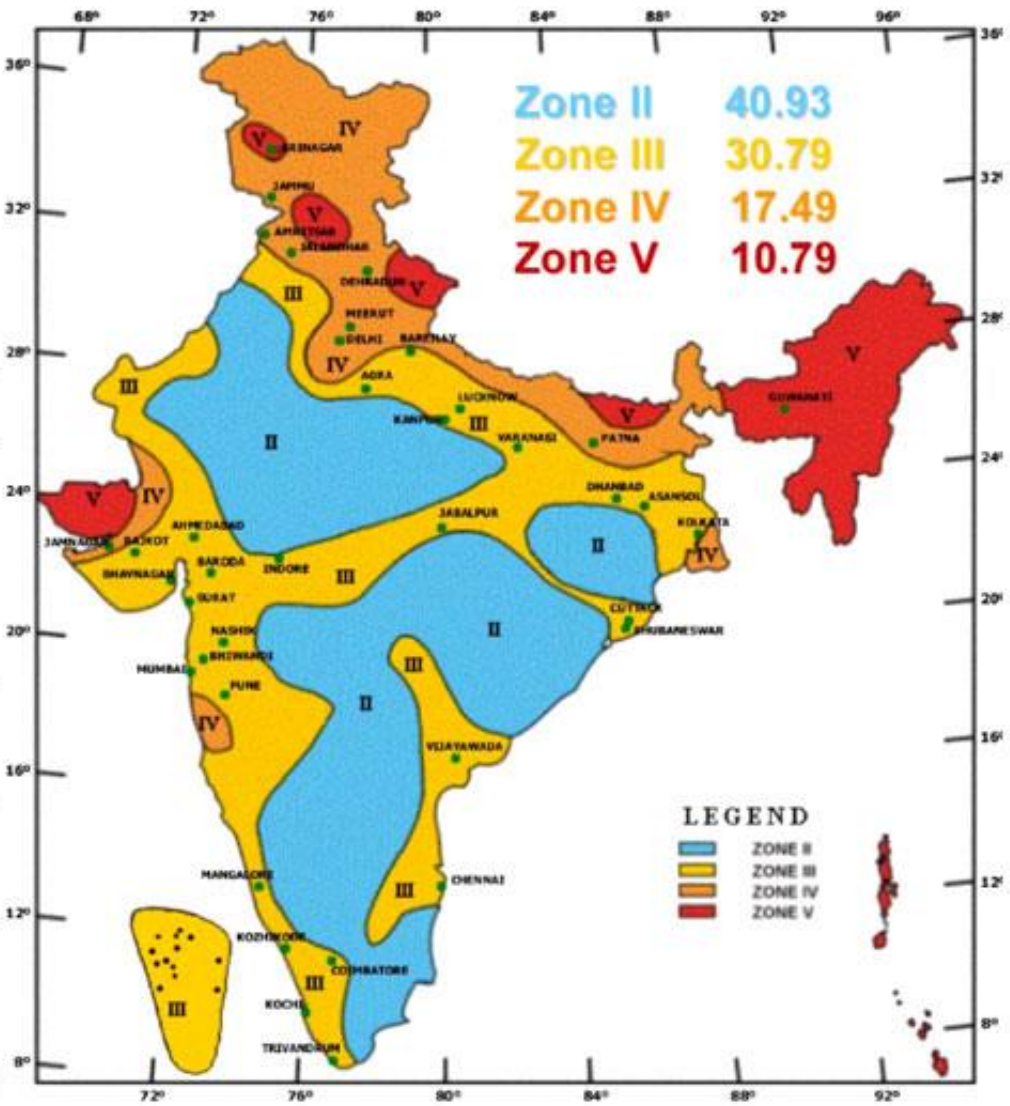


Fig Seismic zonation and intensity map of India


thank you!