

An aerial photograph showing the aftermath of a disaster. The foreground and middle ground are dominated by a vast field of rubble, including twisted metal, broken concrete, and debris from destroyed buildings. In the background, a large, rugged mountain rises, its slopes partially covered with sparse vegetation. The sky is clear and blue. A semi-transparent green rectangular box is overlaid on the lower portion of the image, containing text.

Mohammad Riaz

Assistant Professor

National Centre of Excellence in Geology

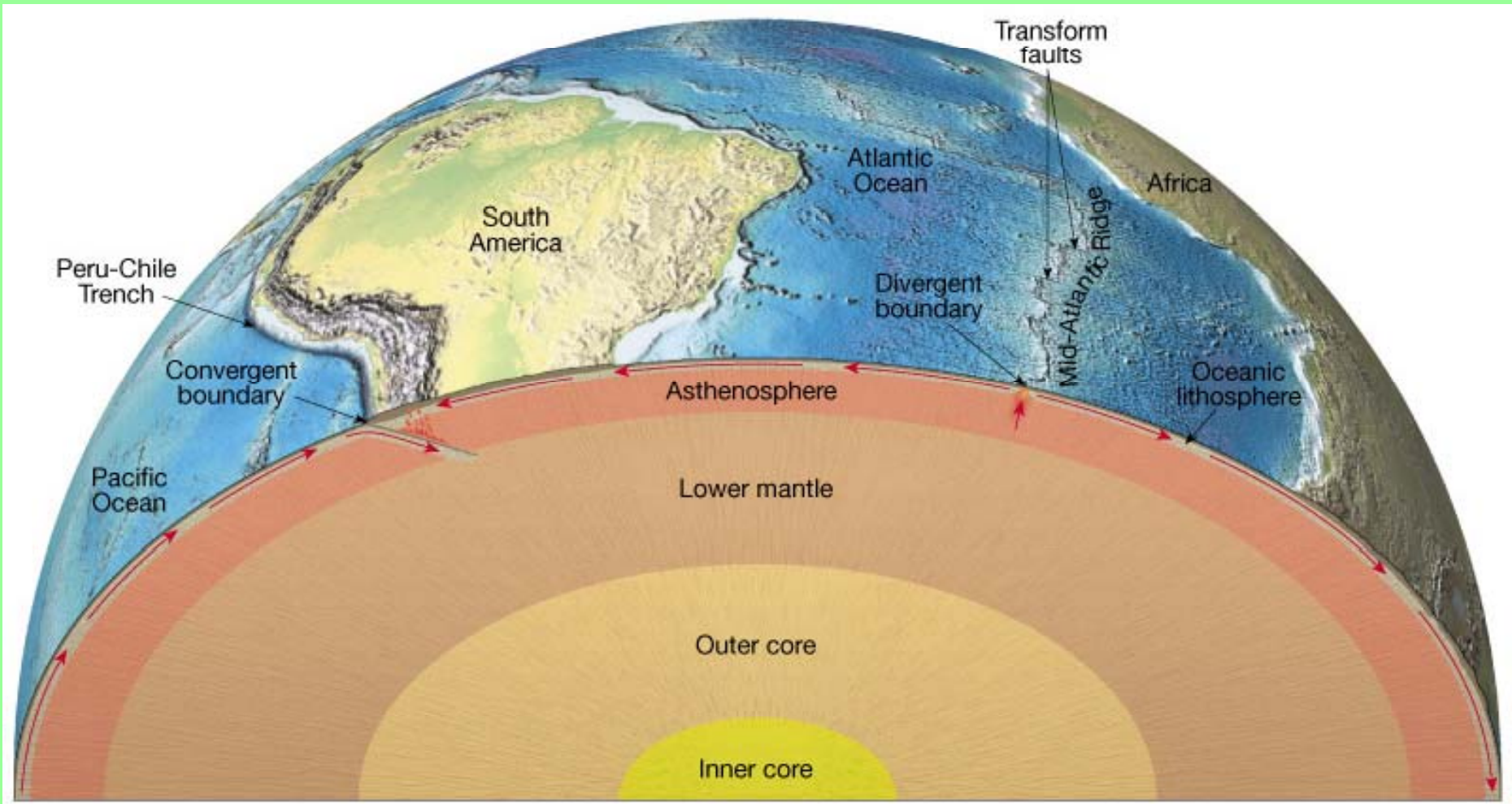
University of Peshawar

Earth Composition

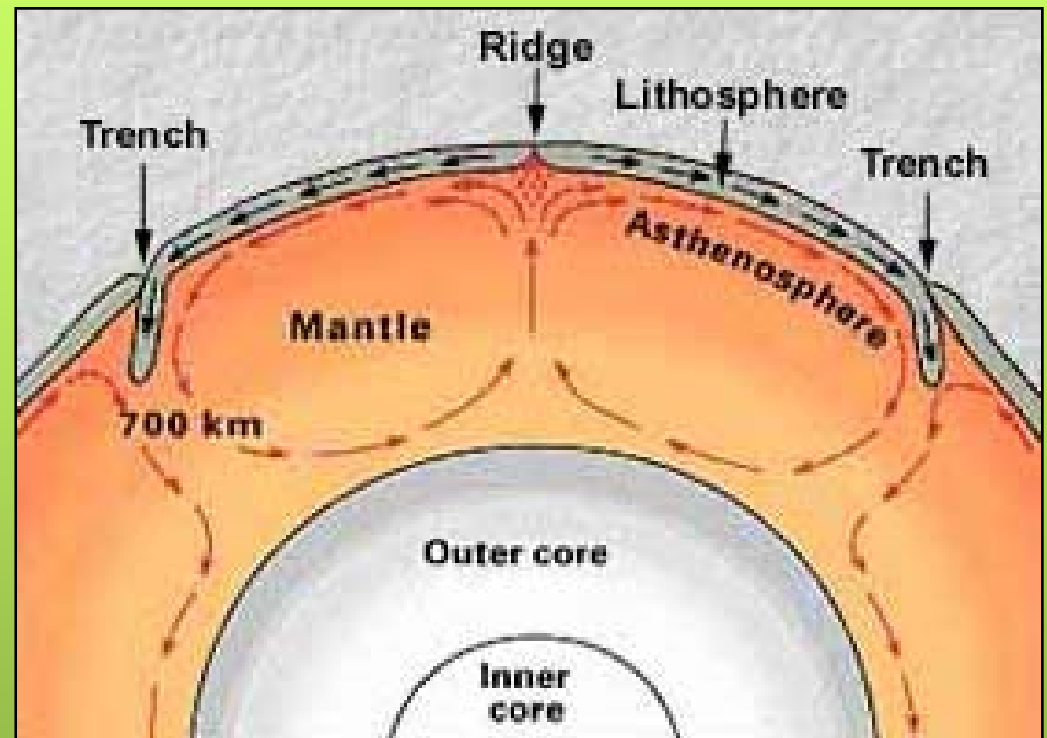
Core (15% area)

Mantle (84% area)

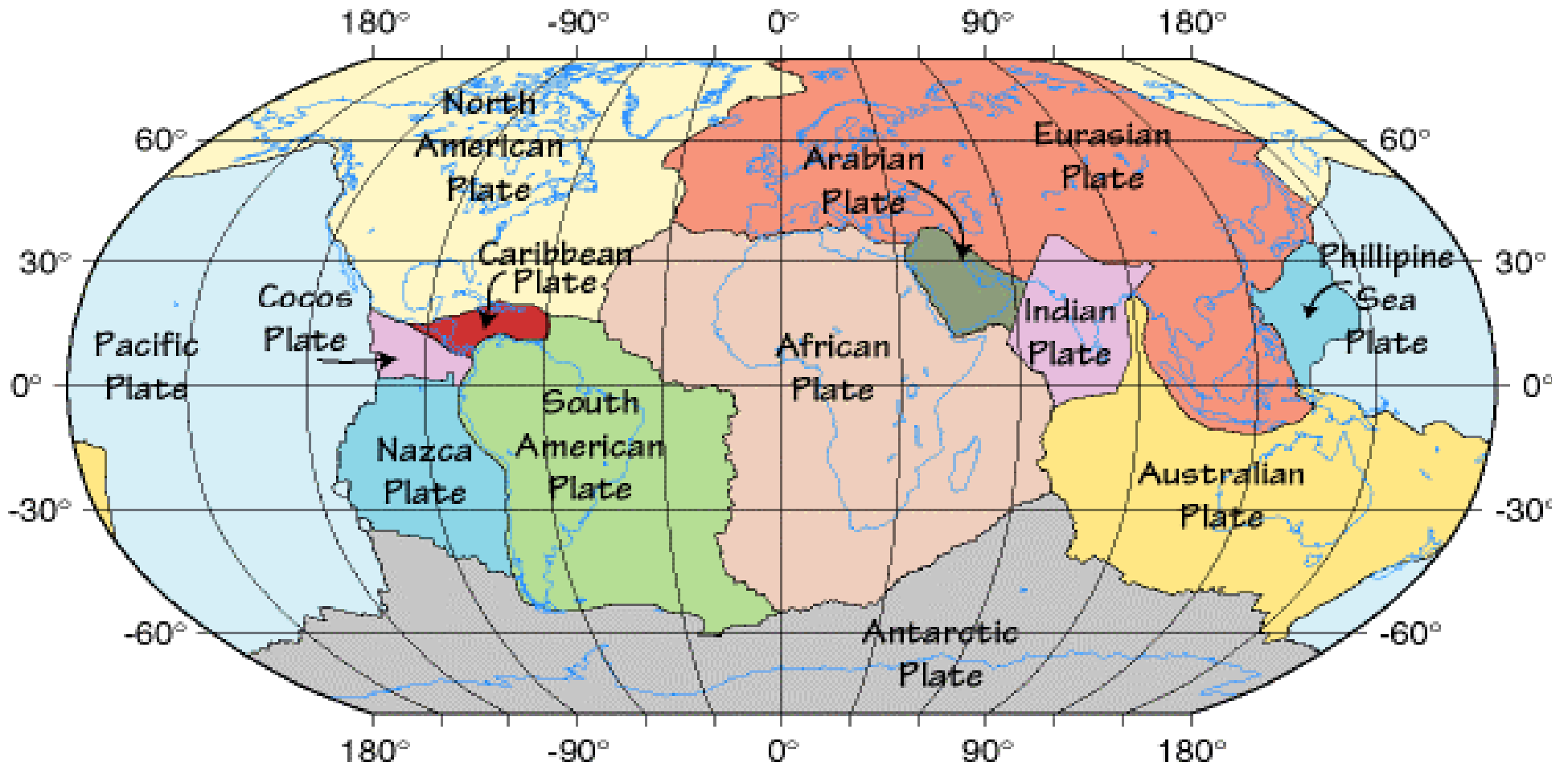
Crust (1% area)



The Plate Tectonics Theory

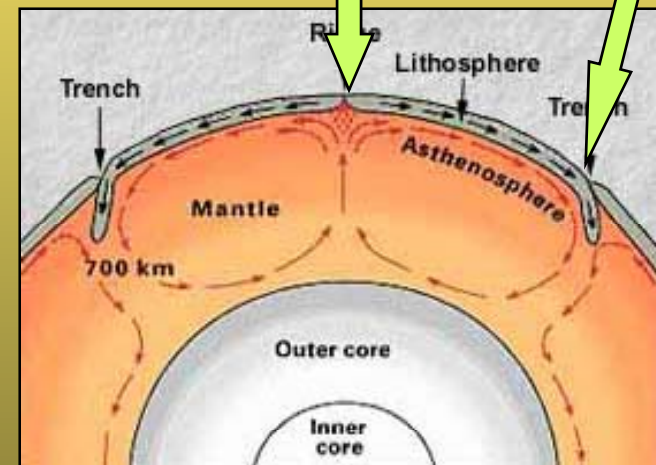


Currents Pattern of Plates

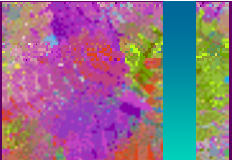




How do faults form?



- Faulting is the sliding (grinding) past each other of plates. The friction causes earthquakes
- Seismicity commonly originates at shallow (~30km) depths
- Aseismic >70 km



Reverse Fault

Hangingwall Up



Normal Fault

Hangingwall Down

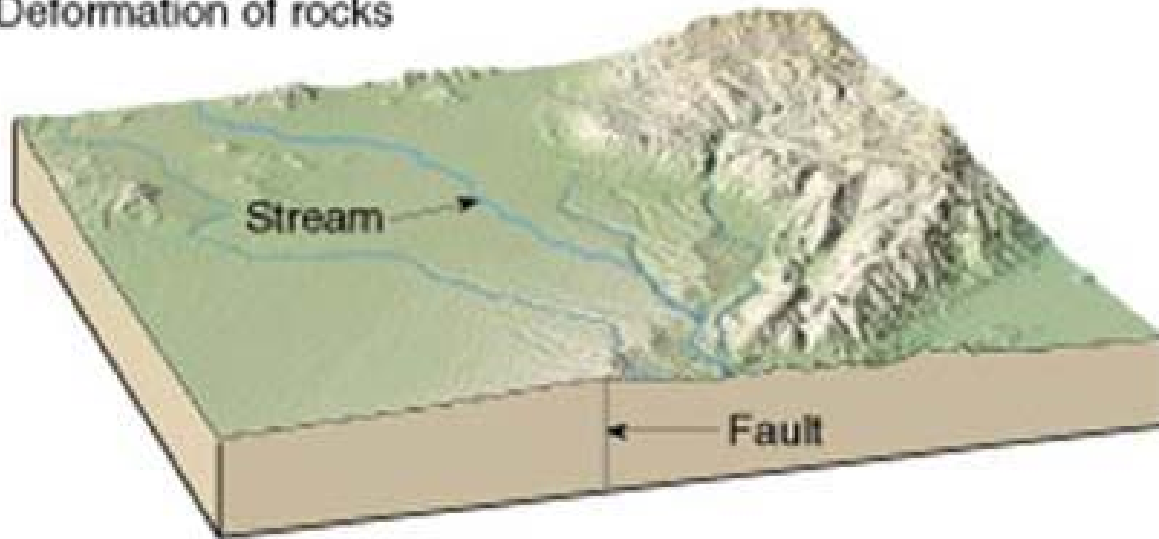


Strike Slip Fault

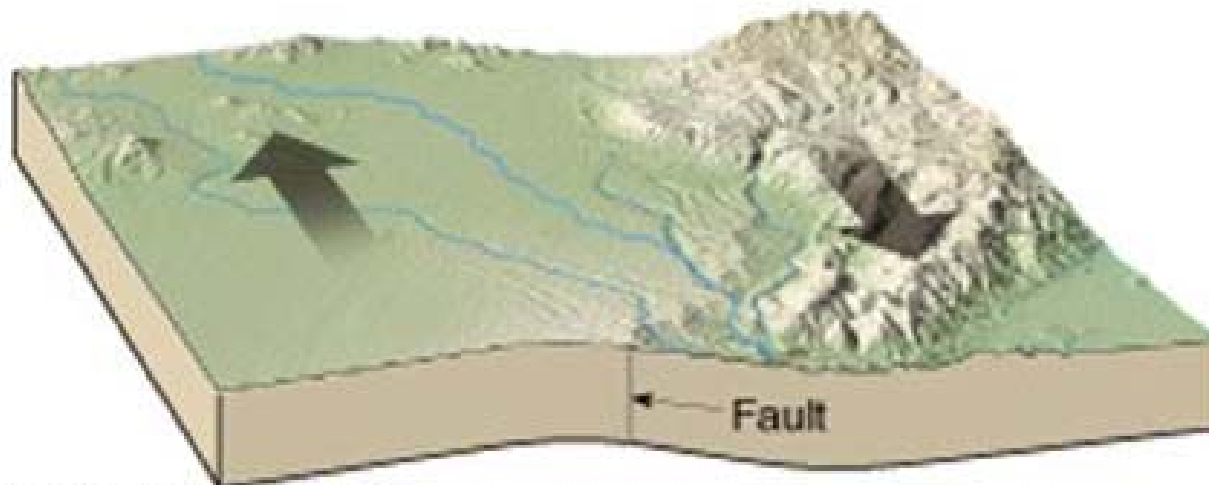


How do earthquakes generate?

Deformation of rocks

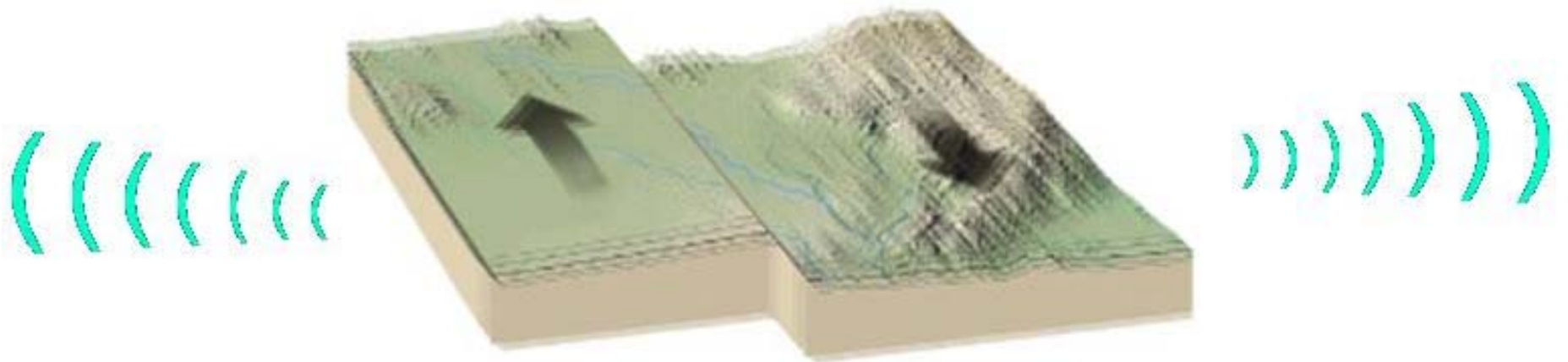


A. Original position

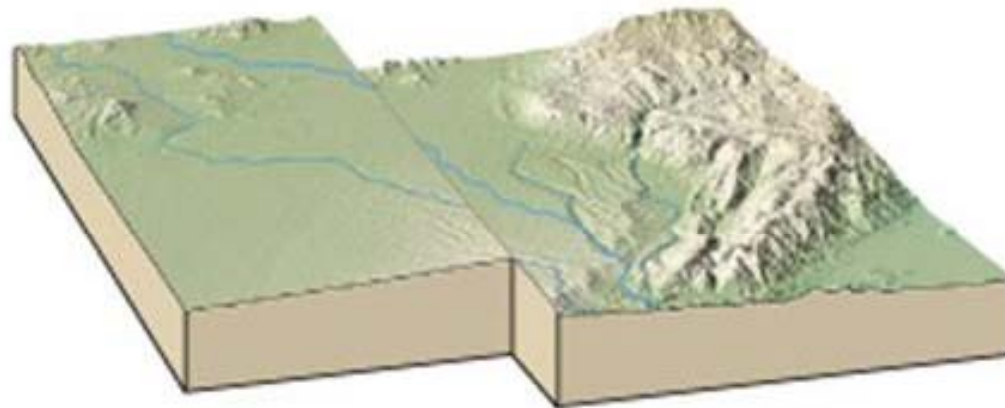


B. Buildup of strain

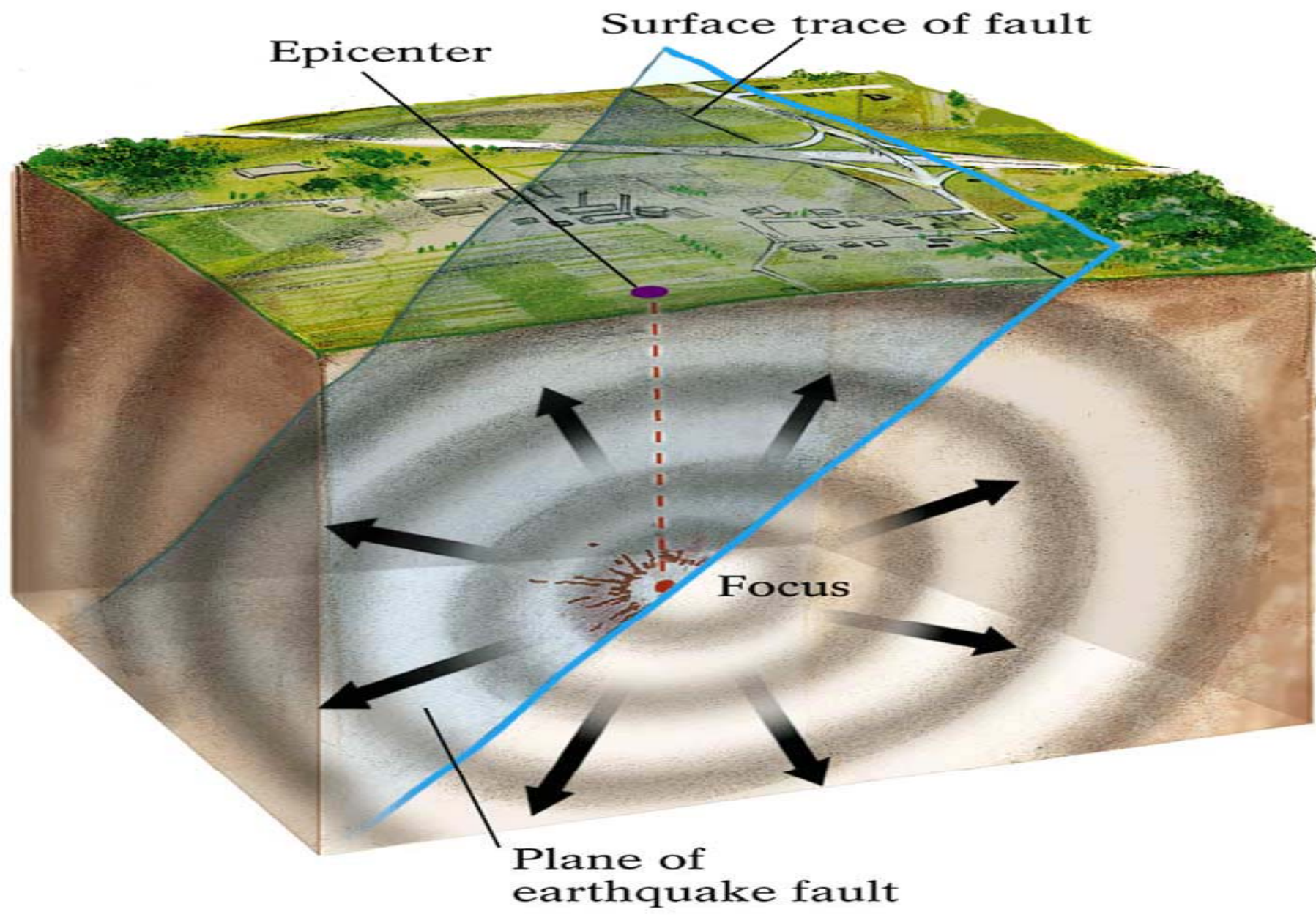
How do earthquakes generate?



C. Slippage



D. Strain released



Epicenter

Surface trace of fault

Focus

Plane of earthquake fault

Earthquake types



Natural

- ⚡ Volcanic
- ⚡ Tectonic
- ⚡ Landslide (e.g. Mantaro River, Peru, 1974)



Anthropogenic

- ⚡ Rock burst (e.g. deep South African mines)
- ⚡ Reservoir-triggered (e.g. Koyna reservoir, India)
- ⚡ Explosion (nuclear & large conventional)

TABLE 16.3 Earthquake Magnitude and Energy Equivalence

Earthquake Magnitude	Energy Released* (Millions of Ergs)	Approximate Energy Equivalence
0	630,000	1 pound of explosives
1	20,000,000	
2	630,000,000	Energy of lightning bolt
3	20,000,000,000	
4	630,000,000,000	1000 pounds of explosives
5	20,000,000,000,000	
6	630,000,000,000,000	1946 Bikini atomic bomb test 1994 Northridge Earthquake
7	20,000,000,000,000,000	1989 Loma Prieta Earthquake
8	630,000,000,000,000,000	1906 San Francisco Earthquake 1980 Eruption of Mount St. Helens
9	20,000,000,000,000,000,000	1964 Alaskan Earthquake 1960 Chilean Earthquake
10	630,000,000,000,000,000,000	Annual U.S. energy consumption

*For each unit increase in magnitude, the energy released increases about 31.6 times.
SOURCE: U.S. Geological Survey.

The Bikini atomic test (21k-ton) was about the same as Hiroshima Bomb (20 k-ton)

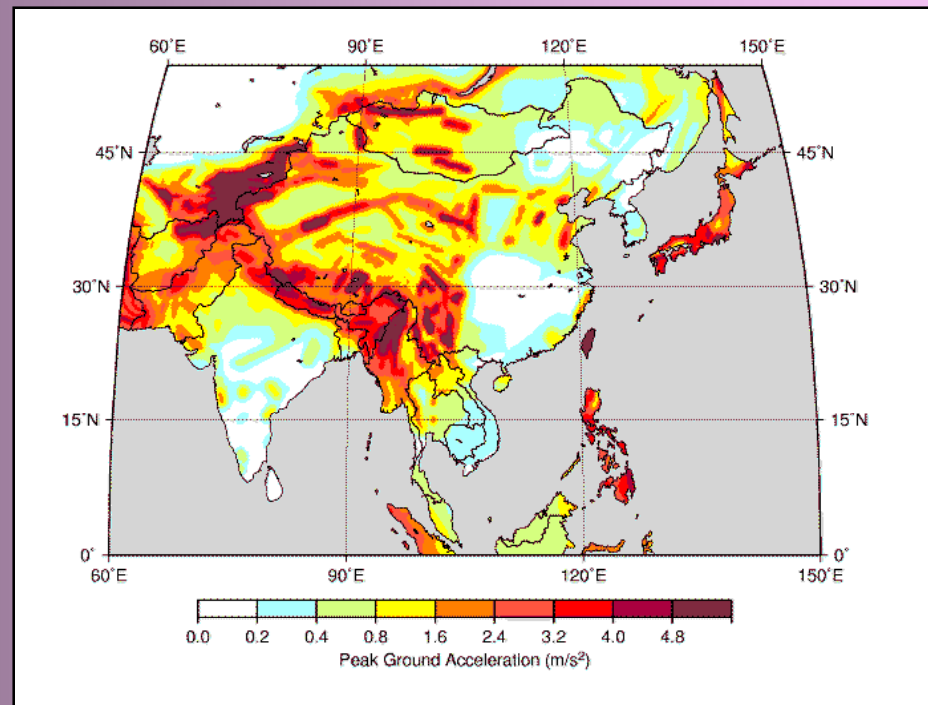


Relation of danger to faults

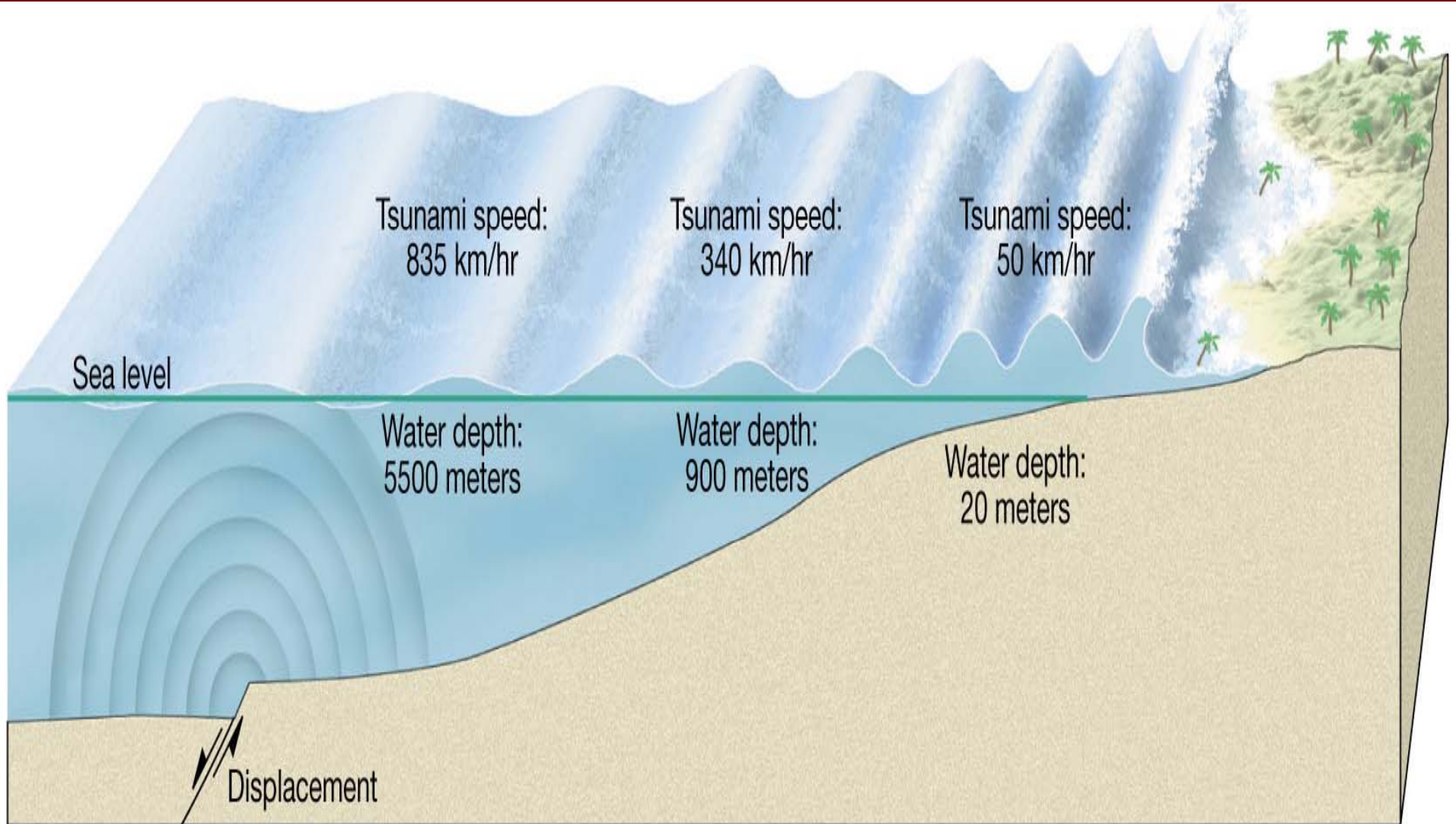
- Worst danger near faults
- Most damage within 50 km
- Occasional pockets of damage out to 100-200 km from rupture
 - Usually due to very soft soil
- $M < 6.5$ form circular isoseismals
- Long rupture: elongated isoseismals

Earthquake Hazard Potential

- **Geology**
- **Peak Ground Acceleration (PGA)**
- **Active faults**

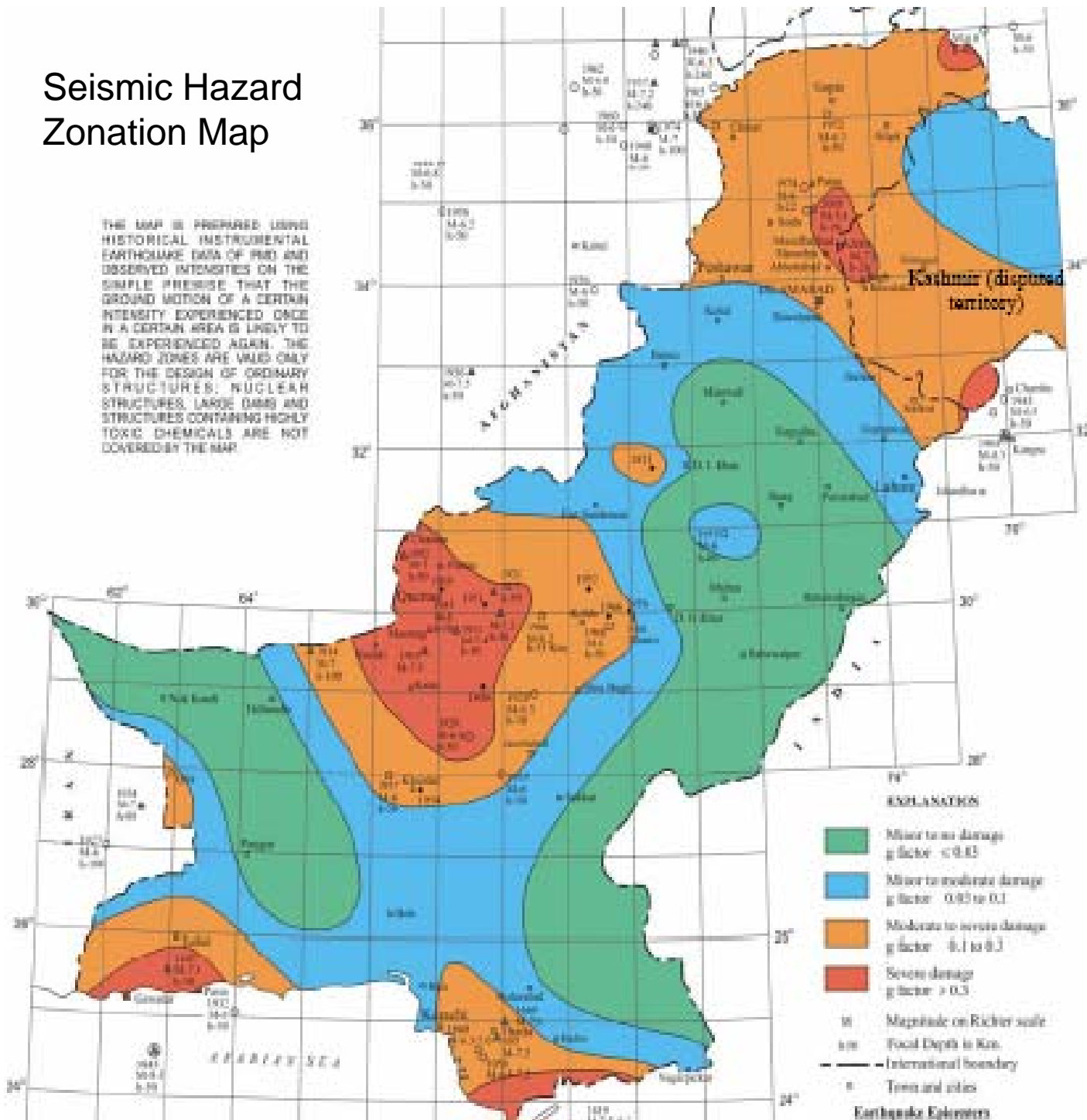


Formation of a tsunami



Seismic Hazard Zonation Map

THE MAP IS PREPARED USING HISTORICAL INSTRUMENTAL EARTHQUAKE DATA OF INDIA AND OBSERVED INTENSITIES ON THE SIMPLE PREMISE THAT THE GROUND MOTION OF A CERTAIN INTENSITY EXPERIENCED ONCE IN A CERTAIN AREA IS LIKELY TO BE EXPERIENCED AGAIN. THE HAZARD ZONES ARE VALID ONLY FOR THE DESIGN OF ORDINARY STRUCTURES. NUCLEAR STRUCTURES, LARGE DAMS AND STRUCTURES CONTAINING HIGHLY TOXIC CHEMICALS ARE NOT COVERED BY THE MAP.





Thank You