Earthquakes and Plate Tectonics

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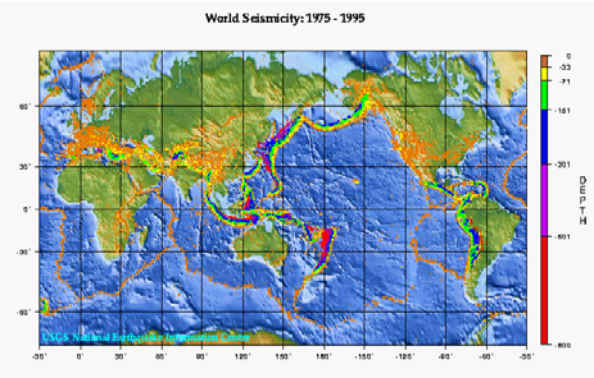

For the above data on worldwide seismicity, try: http://neic.usgs.gov/neis/general/seismicity/world.html

- Plate boundaries, whether active (i.e., divergent or convergent) or passive (i.e., transform faults), are essentially seismic.
- Seismicity at the divergent plate boundaries or spreading submarine ridges and rises tends to be (a) shallow-focussed, (b) low magnitude and (c) less common than at the convergent plate boundaries and transform faults.
- Seismicity at the convergent plate boundaries:
  - Collision-zones or folded mountain belts: (i) have frequent killer earthquakes, usually of intermediate focal depths but high magnitudes, that (ii) in terms of damage and devastation, are among the world's greatest earthquakes (e.g., based on their frequency during this millennium, Indosinian/Yenshan and Himalayan orogenies are associated with one ≥7 magnitude earthquake every 155+107 years).
  - Subduction-zones or deep sea trenches : (i) have frequent, deep-focus and high magnitude seismicity, and (ii) are common in the circum- Pacific region, have associated volcanism and/or folded mountain belts on the continental edges, and also often produce tsunamis.
- Seismicity at the passive plate boundaries: Shallow focus and moderate to high magnitude seismicity is common at the transform fault boundaries like the San Andreas and Dead Sea faults. The Dead Sea fault zone has already experienced one 6.3-7.2 earthquake every 145±82 years through the millenium, for instance.

Plate Boundary	Magni-tude	Fre-quency	Focal Depth
Divergent (Mid-Ocean Ridge)	Low	High	Shallow
Convergent			
Deep Sea Trench —	High	High	Deep
Folded Mountain Belt —	High	High	Moderate
Passive (Transform Faults, Fracture Zones)	Intermediate to High	Low	Shallow to Moderate

Earthquakes in Western North America

- Seismicity in western North America is mostly associated with plate tectonism.
- **Plate tectonism and western North America:**
  - As North America moved westwards, with the opening of the North Atlantic, it collided against and overran the plate east of the East Pacific Rise. This raised the basin and Range Province and created a subduction zone of folded mountain belt (the Cascade Ranges) and volcanism (from Mammoth Lake Caldera to Mt. Shasta, Mt. St. Helens and Mt. Rainer).
  - North America's overrunning of Pacific Ocean spreading center (i.e., East Pacific Rise)
    (a) split Baja California from Mainland Mexico, in the South, and
    (b) created a transform fault (the San Andreas Fault) that now runs through most of California.

    During this motion, North American plate twisted counterclockwise against the Pacific plate and traversed over a "Mantle Hotspot" or thermal plume that is now centered beneath the Old Faithful Geyser, Yellowstone National Park. The result is an east-west running chain of volcanics, from Yellowstone and Snake river in the east (current) to Columbia River Basalts in the west (≤ 15 Ma ago).

Plate tectonics and seismicity in Eastern North America

Compared to the vibrant tectonics of western North America, the Atlantic continental margin is non-tectonic. Using plate tectonics, seismicity there can be explained as follows:

- The 7.3-7.9 magnitude 1811-12 New Madrid earthquakes can be ascribed to the paleosuture line seen as the Mid-Continental gravity high.
- The 6.7-7 magnitude Charleston earthquake of 1886 occurred at the extension of Atlantic fracture zones into the continent.
- The rest of the seismicity here is related to the Appachians folded mountain chain.

- **The associated seismicity:**
  - Subduction Zone Seismicity mostly characterizes Alaska where it is associated with the Aleutian trench (i.e., subduction of the pacific plate beneath North America — note that Alaska itself has joined North America in the geologically recent past).
  - Spreading Center Seismicity is seen in the Salton Sea, Coachella Valley and Imperial Valley regions.
  - Transform Fault Seismicity characterized most of California, e.g., along the San Andreas Fault.

Hotspot or volcanism related seismicity characterizes

- — the entire east-west trending belt from Yellowstone to the Columbia River basin and
- — the volcanic belt from Mammoth Lake to Alaska

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