The Anatomy of an Earthquake

Earthquakes are caused by the sudden release of energy in the Earth's crust, resulting in seismic waves that shake the ground. This energy release typically occurs due to the movement of tectonic plates, which are large sections of the Earth's crust and upper mantle that float on the semi-fluid layer beneath them.

Main Causes of Earthquakes:

1. **Tectonic Plate Movements:**

- **Subduction Zones**: When one tectonic plate is forced under another (subduction), it can cause significant pressure to build up. When this pressure is released, it causes an earthquake. The Sierra Nevada Mountain range in California was formed in such a manner.

- **Transform Boundaries**: Plates slide past each other horizontally. The friction and stress along these boundaries can cause earthquakes. The San Andreas Fault is a transform, and a strike-slip fault. Last major earthquake in the Southern California region was in 1847 and is believed to have been a 7.9 magnitude.

- **Divergent Boundaries**: Plates move away from each other, often causing smaller earthquakes as new crust is formed. The Mid-Atlantic Ridge is an example of a divergent boundary, this is an area where there are two plates that are slowly spreading apart in different directions.

2. **Faults:**

Cracks in the Earth's crust, known as faults, are common sites for earthquakes. The most well-known fault is the San Andreas Fault in California, where the Pacific Plate and the North American Plate meet. When stress builds up along a fault line and is suddenly released, it causes an earthquake. The San Andreas Fault is over 800 miles long and at least 10 miles deep.

3. **Volcanic Activity:**

Earthquakes can also occur due to volcanic activity. As magma moves towards the Earth's surface, it can cause the surrounding rock to fracture and create seismic activity. The most well know volcanoes in the United States are found in the Pacific Northwest, known as the Cascade Range. There are 20 volcanoes, one of the most famously known volcanos is Mount St. Helen which erupted on May 5, 1980. Locally, there is Long Valley Caldera, which is a super volcano found in the Mammoth Lakes area. It last erupted in approximately

50,000 years ago. Yellowstone is also another example of a super volcano, there are many other ones around the world.

4. **Human Activities:**

- **Mining**: The removal of large amounts of earth can destabilize the ground and cause small earthquakes.

- **Reservoir-Induced Seismicity**: Large reservoirs behind dams can increase the pressure on underlying rock, leading to earthquakes.

- **Fracking**: The injection of fluid into the ground during hydraulic fracturing can cause small earthquakes.

5. **Isostatic Rebound:**

After a glacier melts, the Earth's crust can slowly rise as it adjusts to the reduced weight. This adjustment can cause earthquakes over prolonged periods. Scientists believe the series of 1811-1812 New Madrid, Missouri earthquakes totaling in 5 and ranging in 8.0 magnitude or higher that occurred on December 16, 1811, to February 7, 1812, was from this process.

These processes lead to the buildup of stress in the Earth's crust. When the stress exceeds the strength of rocks, it results in a sudden fracture, releasing energy that we experience as an earthquake.

References: California OES, USGS, California Department of Conservation Division of Mines and Geology