GLG 110 – Chapter 6 Review Notes

- Large earthquakes most commonly occur along faults at or near tectonic plate boundaries, and are among the most devastating of natural disasters

- 1906 San Francisco quake produced 700 deaths – more than all other U.S. earthquakes in the following century

- ***Faults*** are fractures along which rocks have been displaced/moved

- When stresses in rocks build up to a level which exceeds the strength of the rocks, a rupture or break occurs, rapidly releasing energy in the form of seismic waves – an ***earthquake*** occurs

- Fault types include:

    - Strike-slip – right-lateral or left-lateral – with side-to-side motion – typical of transform plate boundaries
    - Dip-slip – normal or reverse – with down or up motion – typical of divergent and convergent plate boundaries
    - Intraplate earthquakes can also occur, with New Madrid quakes of 1811-1812 having been perhaps the largest historical quakes in the continental U.S.

- A fault is considered active if movement has occurred along it in the past 10,000 yrs

- Tectonic creep and *slow earthquakes* involve slow, semi-steady motion along faults that may not involve felt earthquakes

- Area beneath the surface (from a few to nearly 700 km deep) where rocks break to produce an earthquake is called the ***focus***

- Area on surface directly above the focus is the ***epicenter***

- Seismic waves are divided into 3 types:

    - Primary (P) waves – fastest – longitudinal motion
    - Secondary (S) waves – slower – transverse motion
    - Surface (R) waves – slowest – can cause much damage close to epicenter

- Earthquake magnitude is a measure of the amount of energy released

    - Richter scale – amount of motion, approximates energy released
    - Moment magnitude – direct measure of energy released

    - Modified Mercalli Scale – intensity of quake as determined by amount of shaking, as reported by eyewitnesses, and the amount of damage to structures

- ***Seismographs*** record ground motion in the form of a printed or digital ***seismogram***

- Epicenter location is determined by using the arrival time differences between P and S waves to determine the distance from seismic station to quake

    - Using 3 distances, from 3 stations, triangulation can be used to plot epicenter

- ***Material amplification*** is the local increase in ground shaking, leading to increased damage and potential death toll, produced by "weaker" or looser materials such as fine-grained sediments, particularly if wet

    - ***Bay fill*** (areas where dirt was used to fill in marshy, muddy areas around San Francisco Bay to allow building on the "new" land) was present in areas of most extreme damages during the magnitude 7.1 Loma Prieta quake in 1989

- Shallower focus earthquakes produce more damage than deep-focus quakes, because energy has been spread out more by the time it reaches the surface

- Human-induced earthquakes have resulted from:

    - Added weight and water pressure from new reservoirs
    - Injection of fluids into fractured rocks via deep wells
    - Underground nuclear explosions

- Earthquake effects:
    - Ground shaking
    - Ground rupture
    - Landslides
    - Liquefaction – "sloshing" around of loose, wet sediments
    - Fires – broken gas and electrical lines; broken water mains
    - Disease – spores in dust; water pollution
    - Tsunamis – seismic sea waves
    - Land elevation changes

- Earthquake risk estimated based on likelihood of an event of a certain magnitude within a period of time, or on a combination of largest quake likely and average amount of motion per year

- Short-term prediction, although still not possible with any consistency, to be based on:
    - Patterns and frequency of earthquakes in an area
    - Pre-quake deformation of the ground surface (GPS and laser ranging)
    - Emission of radon gas and water table changes (from newly fractured rocks)
    - Seismic gaps along faults (strain building up to higher levels over time)
    - Anomalous animal behavior (?)

- Earthquakes may lead to others farther on along active fault zones, however the pattern may be either somewhat regular in time and space or clustered, with centuries of relative quiet in between, further increasing the difficulty of quake prediction

- Reduction of earthquake hazards involves:
    - Develop understanding of quake sources
    - Determine earthquake potential
    - Predict effects of earthquakes
    - Apply research results to improve building methods, land use planning, and improved relief/insurance measures

- Earthquake warning systems may provide seconds to a minute of warning to nearby urban areas once an earthquake has occurred (such systems are currently in use in California and Japan)
    - Community and individual emergency preparedness and response plans and microzonation (taking into account local geology and urban development) are currently the best methods to reduce loss of life and property during future damaging earthquakes, which will certainly occur
    - Ways to be safer during and after a quake:
        - Move to safer areas (beneath sturdy desk, in doorways of interior walls)
        - Duck, cover and hold
        - Everyone in a house should know how to turn off gas
        - Establish out-of-area contact to call after an earthquake
        - Have emergency supplies (food, water, first-aid kit, cash) on-hand
        - Identify elderly or infirmed individuals in local neighborhood to help
        - Assist others in forming their own plans and supply kits