- **Earthquake Magnitude vs. Intensity:**
  - Magnitude: physical size of the earthquake.
  - Intensity: strength of shaking caused by the earthquake.
- **Magnitude Scales Overview:**
  - First developed by Charles Richter in 1935.
    - Focused on regional comparisons in Southern California.
    - Used Wood-Anderson seismograph.
  - Magnitude determined from largest amplitude on a seismogram, corrected for distance.
- **Richter Scale:**
  - Example Calculation:
    - Seismogram shows P-wave and S-wave arrivals, S-P time: 24 seconds → Distance: 220 km, Peak amplitude: 23 mm → Magnitude: 5.0.
    - Amplitude at 100 km distance: 100 mm (Magnitude 5.0 = 100 mm at 100 km).
    - Smaller magnitudes (e.g., increment down to 4.0 = 2.3 mm) demonstrate logarithmic nature.
  - Limitations:
    - Difficult to apply globally.
    - Saturates around magnitude 6.
- **Local Magnitude Scales:**
  - Developed for specific regions (local use only for small earthquakes).
  - Superseded by moment magnitude scale for larger earthquakes.
- **Moment Magnitude Scale (Mw):**
  - Introduced in the 1970s.
  - Based on seismic moment:
    - Seismic moment = rupture area × average slip × shear modulus.
  - Advantages of moment magnitude:
    - Does not saturate, accurate for large earthquakes.
    - Easy calculation from modern data sources.
- **Seismic Moment Explained:**
  - Units in Newton meters (Nm), relates to energy but is a torque measure.
  - A significant increase in moment reflects a large increase in earthquake energy:
    - 1 unit increase in moment magnitude = ≈ 31.6 times increase in seismic moment.
- **Earthquake Size Classification:**
  - Small: Magnitude 2-3
  - Moderate: Magnitude 4-5
  - Large: Magnitude 6-7
  - Great: Magnitude > 8

- **Rupture Area and Slip Relationship:**
    - Average slip correlates with rupture length.
        - Magnitude 6 → 10 km rupture, 30 cm slip.
        - Magnitude 7 → 60 km rupture, 1.5 m slip.
- **Key Faults and Earthquake Potential:**
    - Cascadia Subduction Megathrust (capable of magnitude 9) vs. San Andreas Fault (limited to magnitude 8).
    - The potential size of earthquakes governed by the fault rupture area.
- **Earthquake Statistics (Gutenberg-Richter Law):**
    - Each unit increase in magnitude → tenfold decrease in frequency.
    - Global averages:
        - ~10,000 mag 4 earthquakes/year.
        - ~1,000-2,000 mag 5 earthquakes/year.
        - ~100-200 mag 6 earthquakes/year.
        - ~10-20 mag 7 earthquakes/year.
        - 1-2 mag 8 earthquakes/year, 1-2 mag 9 in a decade.
- **Foreshocks, Mainshocks, and Aftershocks:**
    - Mainshock: largest earthquake in a sequence.
    - Aftershocks: smaller earthquakes following the mainshock.
    - Foreshocks: precede the mainshock, not always present.
- **Ridgecrest Sequence Analysis:**
    - Example: July 3-6, 2019.
        - Initial sequence with magnitude 3.5 (foreshocks), followed by magnitude 6.4 (mainshock), then magnitude 7.1.
    - Highlights the unpredictability of foreshocks and aftershocks and challenges in earthquake prediction.
- **Introduction to Seismic Intensity Scale**
    - Describes the strength of ground shaking from seismic waves.
    - Intensity relates to earthquake effects at specific locations, while magnitude describes the earthquake itself.
    - Single earthquake can cause different intensities at different locations; usually greater near epicenter (attenuation).
- **Modified Mercalli Intensity Scale (MMI)**
    - Developed by Guiseppe Mercalli in 1902 and modified in 1931.
    - Uses Roman numerals to express perceived shaking levels.
        - MMI 1: Instrumental (not perceived by people).
        - MMI 3: Slight shaking (noticed but not recognized as an earthquake).
        - MMI 5: Rather strong (windows may break).

        - MMI 7: Very strong (difficult to stand).
        - MMI 9: Violent (some buildings may collapse).
        - MMI 11: Extreme (few structures remain standing).

- **Iso-seismal Maps**

    - Connect areas of equal strength of shaking.
    - Useful for estimating locations and magnitudes of historic earthquakes.
    - Example: 1811 New Madrid earthquake intensity estimated from felt reports.

- **Factors Affecting Intensity**

    - **Proximity to Population Centers**: Bias due to fewer settlers in the earthquake source region.
    - **Personal Account Exaggeration**: Accounts may be exaggerated or speculative.
    - **Data Sources for Modern Earthquakes**:
        - Accelerometers for strong shaking recording.
        - Felt reports collected via the internet (e.g., USGS "Did You Feel It?" service).

- **Seismic Intensity Control Factors**

    - **Directivity Effect**:
        - Slip migration direction affects ground shaking.
        - Example from 2016 Kaikoura earthquake where directivity amplified shaking.
    - **Geographical Differences**:
        - Mineral Virginia 2011 vs. Mexicali 2009:
            - Mineral Virginia had broader felt reports despite similar magnitudes.
            - Eastern US has less fault activity, enabling wider felt earthquakes.
    - **Depth of Earthquake**:
        - Ridgecrest (2019) vs. Anchorage (2018):
            - Ridgecrest was shallower and had higher peak intensities; localized shaking.
            - Anchorage was deeper with broader area of shaking but lower peak intensities.
    - **Sedimentary Basins**:
        - Anchorage within Cook Inlet amplified shaking due to loose sediments.
        - Basin amplification can prolong shaking duration and increase damage.

- **Examples of Basin Amplification and Liquefaction**

    - **Kathmandu, Nepal during Gorkha earthquake (2015)**:
        - Resonance effects observed in GPS motions due to sedimentary basin.
    - **Puebla Earthquake (2017)**:
        - Strong shaking experienced 100 km from epicenter due to basin effects in Mexico City.

- **Liquefaction Effects**

    - Water-saturated soils lose strength when shaken.
    - Damage observed in Anchorage (2018) linked to liquefaction, specifically in marshy areas.

- **Risk Evaluation for Victoria vs. Vancouver**

    - Victoria closer to subduction zone but built on solid bedrock.
    - Vancouver constructed on softer sediment, likely experiencing more amplification effects.

- **Types of Earthquakes Hazardous to Coastal BC**
    - **Three categories explored**:
        - **Megathrust earthquakes** (magnitude 8-9).
        - **Intermediate depth intraslab earthquakes**.
        - **Shallow crustal earthquakes**.
    - Crustal earthquakes pose localized hazards while megathrust earthquakes present cumulative risks.
- **Global Patterns of Earthquake Damage**
    - Majority of deadliest earthquakes (20th/21st centuries) involve shallow continental faults (magnitude 7-8).
    - Subduction zone earthquakes, although larger, have resulted in fewer fatalities relative to continental earthquakes.