Essentials of Geology

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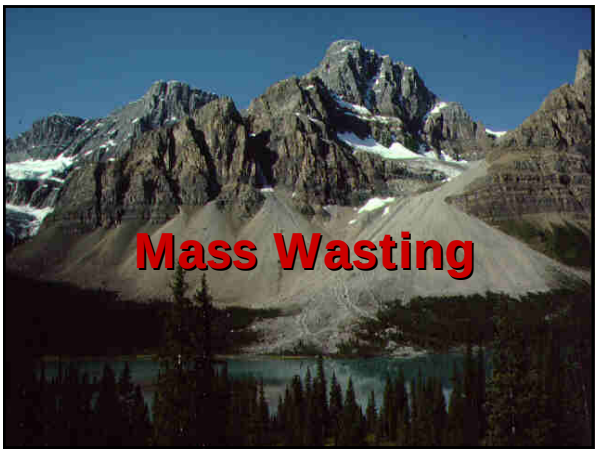
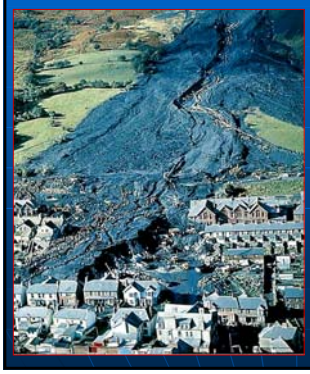
Chapter 8



Mass Wasting

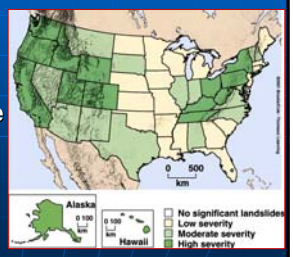
Introduction



- While landslides are a normal part of erosion and surface processes, they can be very destructive to life and property
- Mass wasting is the downslope movement of material under the direct influence of gravity. The rate of movement varies greatly.

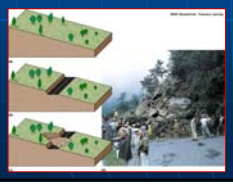
What Factors Influence Mass Wasting?

- Mass wasting occurs when the gravitational force acting on a slope exceeds the resisting force
- Large slope angles have a greater chance for mass wasting
- The steepest angle that a slope can maintain without failure is the angle of repose



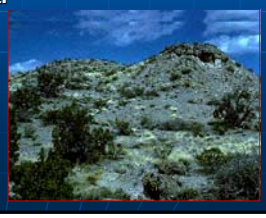
What Factors Influence Mass Wasting?

- Slope angle
  - Stream undercutting or wave erosion can oversteepen slopes
  - Excavation for road and hillside construction is a common and similar problem



What Factors Influence Mass Wasting?

- Weathering and Climate
  - Mass wasting is more common in loose or poorly consolidated material than in bedrock
  - In areas of high temperature and precipitation, weathering is deeper and produces tens of meters of unconsolidated material
  - In arid regions soils are thinner, but heavy localized rainfall may result in mudflows

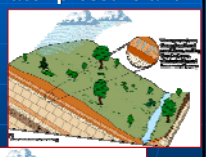


What Factors Influence Mass Wasting?

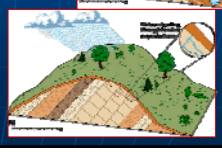
- Water content
  - Water may increase the weight of a slope enough to induce failure
  - Water reduces the amount of friction between particles
  - Because clay particles are platy and slide easily past one another when wet, clay beds are often the layers on which overlying rock units slide
- Vegetation
  - Decreases water content of slope materials
  - Root systems stabilize by binding soil and holding the soil to bedrock
  - Removal of vegetation can lead to mass wasting

What Factors Influence Mass Wasting?

- Overloading
  - Caused by human activities of dumping or piling material onto a slope, increasing water pressure and decreasing shear strength

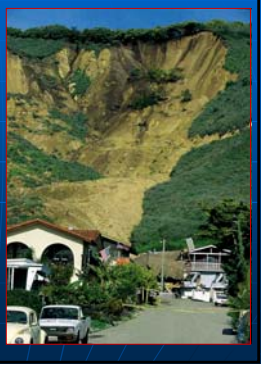


- Geology and Slope Stability
  - When slope and dip direction is the same, mass wasting is more likely to occur
  - Joints may dip in the same direction as the slope, also increasing the chance for mass wasting



What Factors Influence Mass Wasting?

- Triggering mechanisms
  - Most rapid mass movements are triggered by strong vibrations from earthquakes and/or excessive amounts of water
  - Volcanic eruptions, explosions, and even loud thunder may trigger unstable slopes

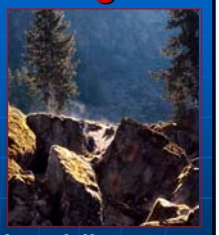


What Are the Different Types of Mass Wasting?

- Classified on the basis of:
  - Rate of movement - fast or slow
  - Type of movement - falling, sliding, or flowing
  - Type of material - rock, soil, and debris
- Rapid movements involve visible movements of material
- Slow movements are imperceptible except from their effects such as cracked walls and tilted trees or power poles

What Are the Different Types of Mass Wasting?

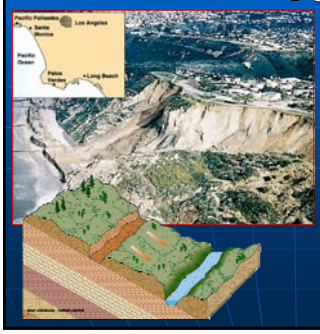
- Falls
  - Rockfalls are a common type of rapid mass wasting
  - May occur along steep canyons, cliffs, and road cuts



  - Talus builds up at the base, where fallen material collects
  - Failure along joints or bedding planes may be caused by undercutting, earthquakes, or frost wedging

What Are the Different Types of Mass Wasting?

- Slides - slumps and block



  - Move along one or more surfaces of failure
  - May consist of soil, rock, or both
  - May move rapidly or slowly
  - Slumps involve movement along a curved surface
  - Rock or block slides move along a planar surface, often where dip is the same as slope direction

What Are the Different Types of Mass Wasting?

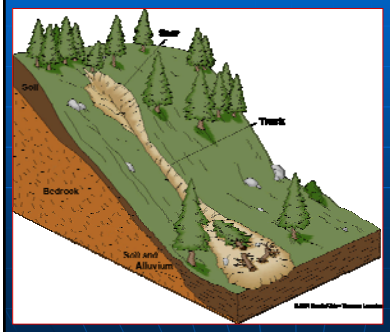
Flows move as a viscous fluid or show plastic movement

*mudflows are fluid and move fastest, common in arid or mountainous regions

*debris flows are more viscous

*earthflows move as thick, viscous masses of wet regolith

Mudflows



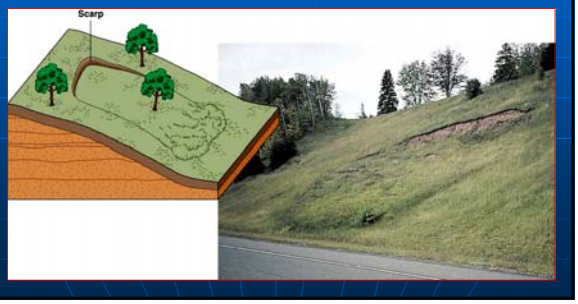
- Consist of at least 50% silt and clay sized particles, at least 30% water
- Usually follow pre-existing channels until the slope decreases, then fan out

Debris flows

- Composed of larger sized particles than mudflows
- Don't contain as much water as mudflows
- Rarely confined to pre-existing channels

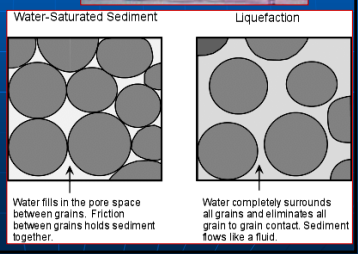
Earthflows

- Slumps from the upper part of a hillside
- Occur most commonly in humid climates



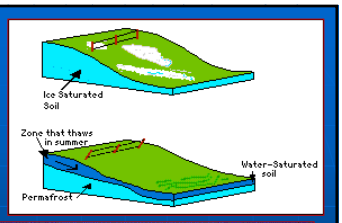
Quickclays

- Spontaneous liquefaction and rapid flow of fine silt and clay
- Original pore space was filled with salt water and ionic bonds strengthened the clay particle attraction
- Salt water flushed out, clays lose cohesion, and sudden movement liquefies



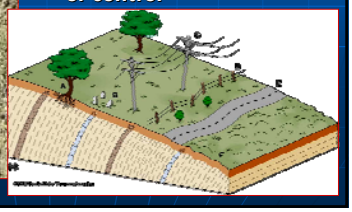
Solifluction

- The slow downslope movement of water-saturated surface sediment
- Most common in areas of permafrost



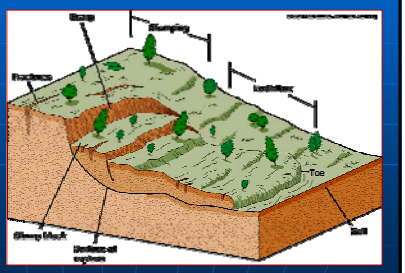
Creep

- Slowest type of flow, most common in humid climates such as the southeastern US
- Extremely destructive over time; difficult to recognize or control

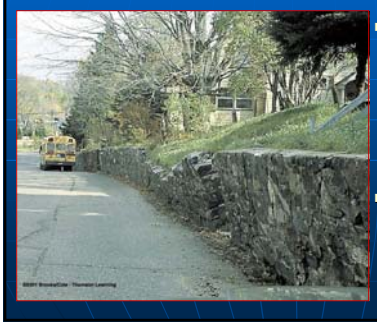


Complex Movements

- Occurs when several of the recognized types are involved in a mass movement
  - slide-flow
  - debris avalanche



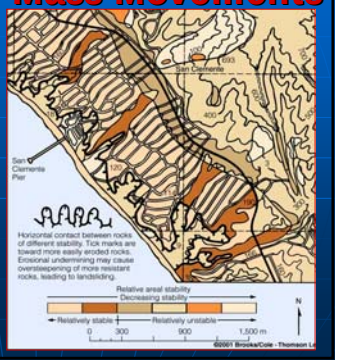
Recognizing and Minimizing the Effects of Mass Movements



- Conduct a thorough geologic investigation of the area in question
- Assess risks and take steps to minimize the effects of events

Recognizing and Minimizing the Effects of Mass Movements

- Slope stability maps indicate where to place roads, developments, and utility lines
- Drainage of high areas or other water control measures helps prevent movement



Recognizing and Minimizing the Effects of Mass Movements

- Reducing the angle of slope using cut-and-fill or benching
- Retaining walls and drainage pipe
- Rock bolts hold unstable surface rock to solid bedrock