Lecture Outlines

Physical Geology, 15/e

Plummer, Carlson & Hammersley

Mass Wasting

Physical Geology 15/e, Chapter 9

Mass Wasting

Mass wasting – downhill movement of masses of bedrock, rock debris or soil, driven by the pull of gravity

- **landslides** have been far more costly in the U.S., in terms of both lives and dollars, than all other geologic and weather hazards combined
- mass wasting is, with proper planning, perhaps the *most easily avoidable* of all major **geologic hazards**

Controlling Factors in Mass Wasting

TABLE 9.2 Summary of Controls of Mass Wasting

Driving Force: Gravity

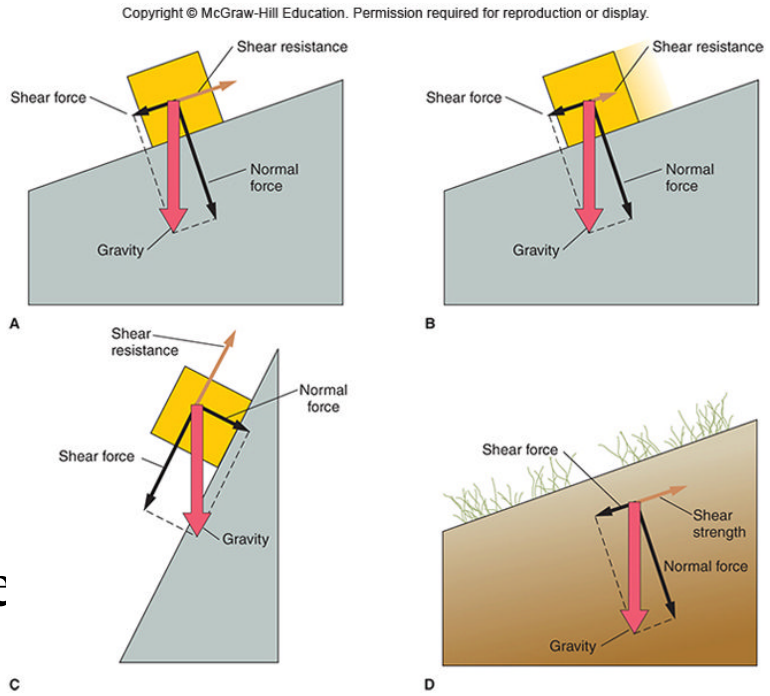
Contributing Factors	Most Stable Situation	Most Unstable Situation
Slope angle	Gentle slopes or horizontal surface	Steep or vertical
Local relief	Low	High
Thickness of soil over bedrock	Slight thickness (usually)	Great thickness
Orientation of planes of weakness in bedrock	Planes at right angles to hillside slopes	Planes parallel to hillside slopes
Climatic factors:		
Ice in ground	Temperature stays above freezing	Freezing and thawing for much of the year
Water in soil or debris	Film of water around fine particles	Saturation of soil with water
Precipitation	Frequent but light rainfall	Episodes of heavy precipitation
Vegetation	Heavily vegetated	Sparsely vegetated

Triggers: (1) earthquakes; (2) weight added to upper part of a slope; (3) undercutting of bottom of slope; (4) heavy rainfall

Controlling Factors In Mass Wasting

Gravity – the driving force for mass wasting

- *Normal Force*
- *Shear Force*
- *Shear Resistance*
- *Shear Strength*



- Steep slopes – shear forces maximized by gravity
- Large relief – large elevation change from top of mountains/hills to valley floor
- Thick layer(s) of loose rock, debris, soil

Controlling Factors In Mass Wasting

Water

- Adds weight
- Reduces viscosity by reducing surface tension

Triggers

- **Seismic (earthquake) activity**
- **Heavy Rainfall**
- **Construction**
- **Lack of vegetation** – no roots to hold rock/soil in place

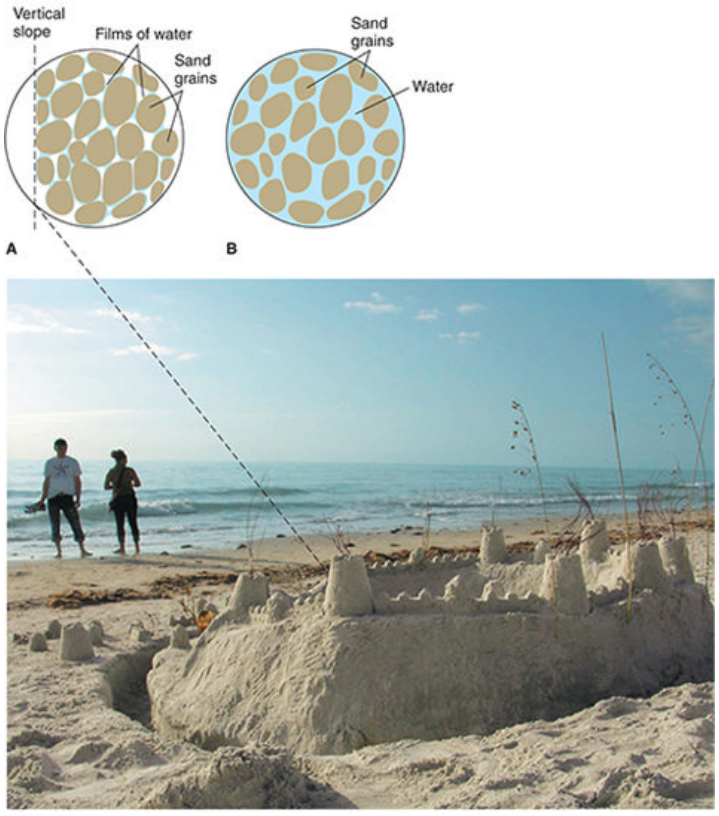


Photo by C. C. Plummer

Classification of Mass Wasting

Rate of movement

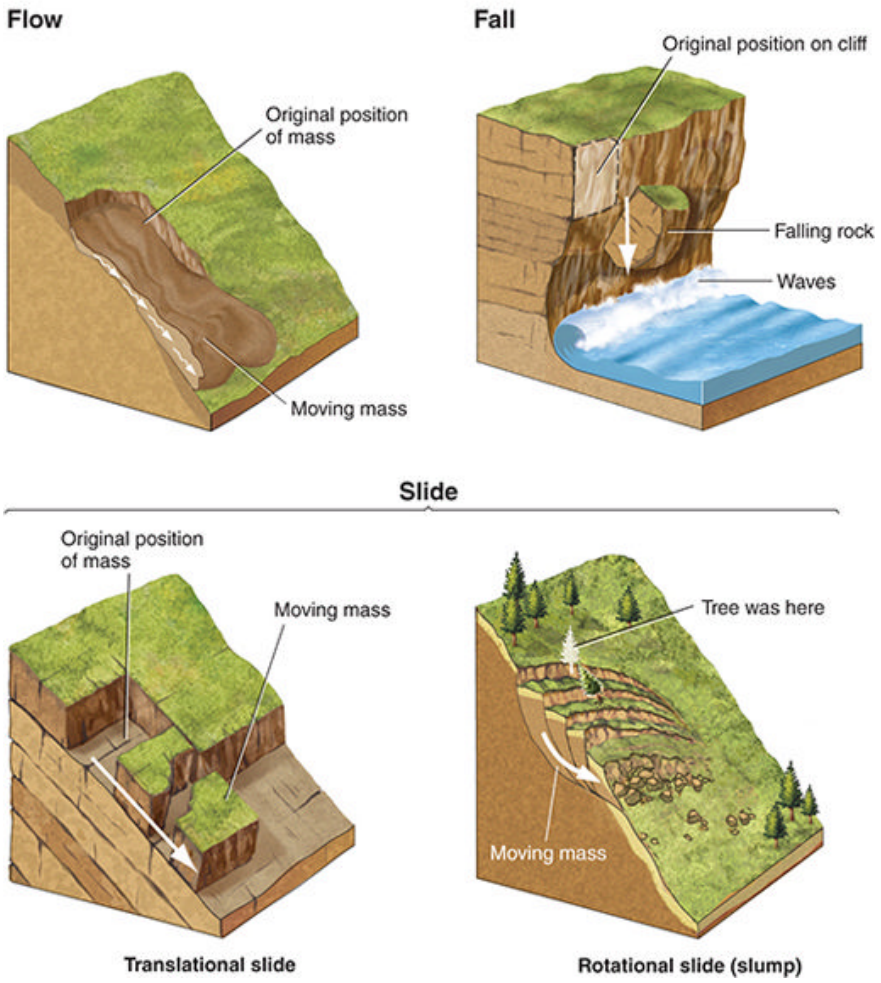
- < 1cm/year – >100 km/hour

Type of material

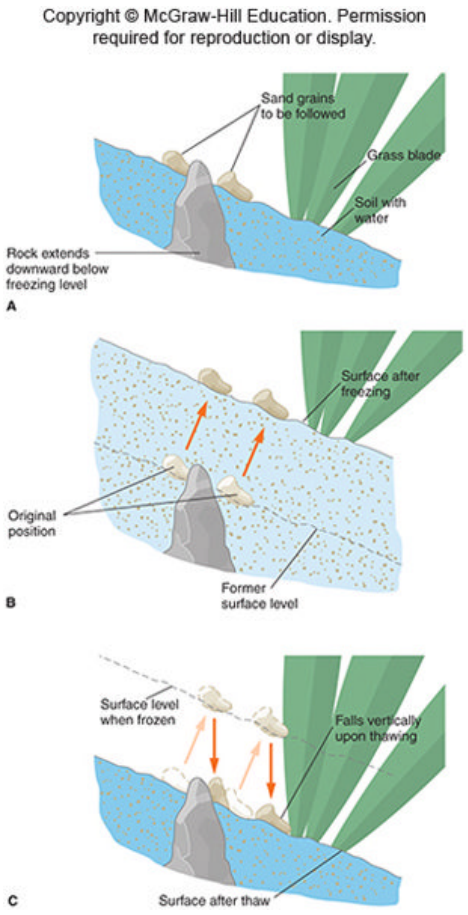
- solid bedrock or **debris** (unconsolidated material at Earth's surface)

Type of movement

flow, **slide**, or **fall**

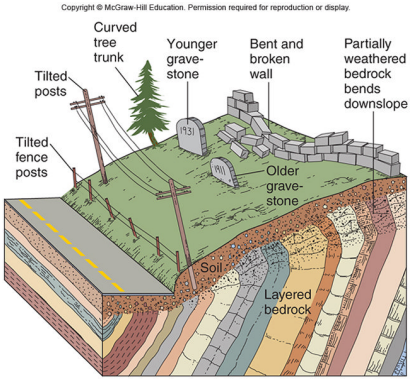


Common Types of Mass Wasting



Creep (or **soil creep**)

- very slow downslope movement of soil
- major contributing factors include water in soil and daily freeze-thaw cycles
- can be costly to maintain homes, etc., on creeping ground as foundations, walls, pipes and driveways crack and shift downslope over time



Common Types of Mass Wasting

Flows – descending mass moves downhill as a viscous fluid

- *Earthflow*
- *Solifluction and Permafrost*
- *Debris Flow and Mudflow*
- *Debris Avalanche*

Falls – material free-falls or bounces down a cliff

Photo by George Plafker, U.S. Geological Survey; c: Photo by C. C. Plummer

Common Types of Mass Wasting

Flow - descending mass moves downhill as a viscous fluid

- *Earthflow* - debris moves downslope, slowly or rapidly, as a viscous fluid
- *Solifluction and Permafrost*
- *Debris Flow and Mudflow* - flowing mixture of debris and water, usually down a channel
- *Debris Avalanches* are very rapid and turbulent

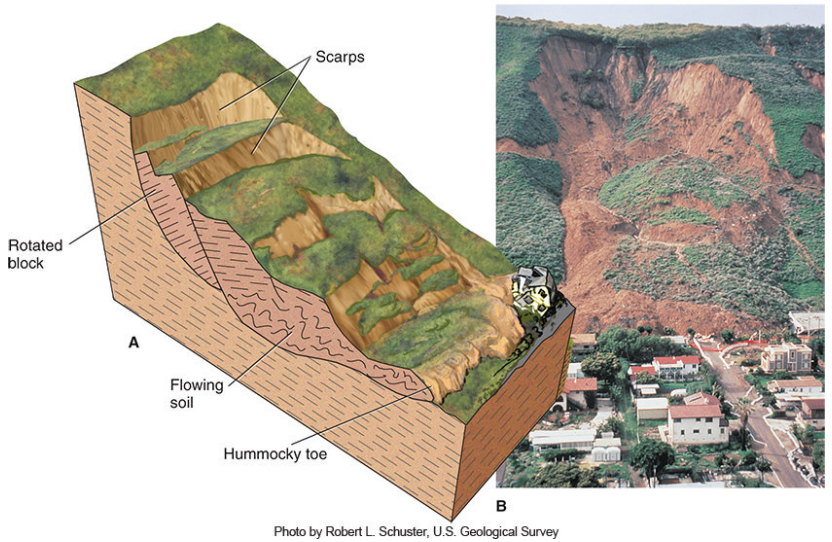


Photo by Robert L. Schuster, U.S. Geological Survey

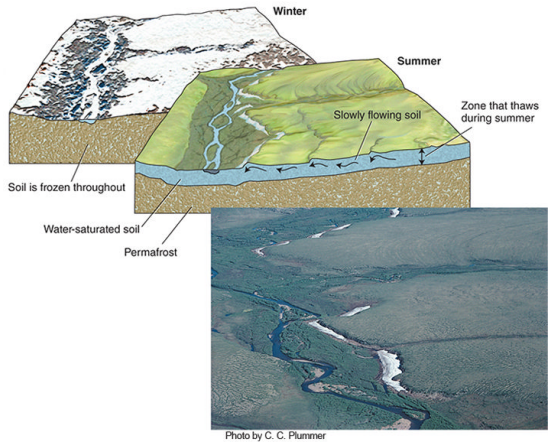


Photo by C. C. Plummer

Common Types of Mass Wasting

Falls - material free-falls or bounces down a cliff

- **Rockfall** - when a block of bedrock breaks free and falls or bounces down a cliff
  - commonly an apron of fallen rock fragments (**talus**) accumulates at cliff base

A

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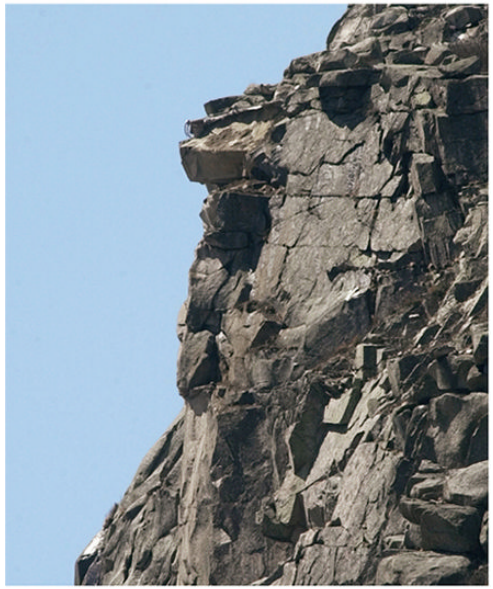

B

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Common Types of Mass Wasting

Slides – descending mass remains relatively intact, and descends along well-defined surfaces

- translational slide - movement along plane *parallel* to motion
- rotational slide (slump) – movement along a curved surface

- *Rockslide and Rock Avalanche* - the rapid sliding of a mass of bedrock along an inclined surface of weakness

Underwater Landslides

- Turbidity Currents

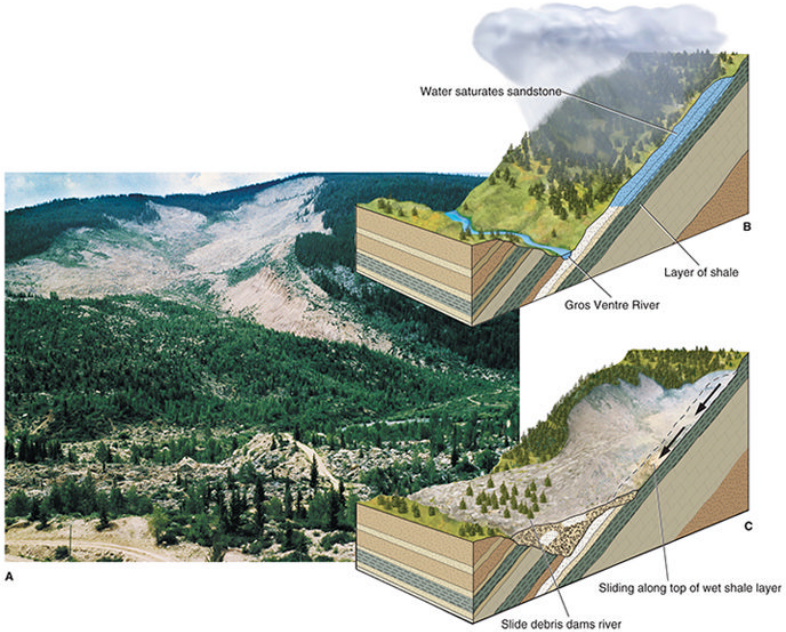
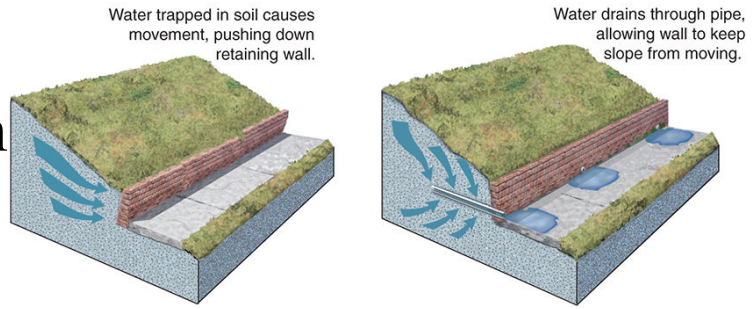


Photo by D. A. Rahm, courtesy of Rahm Memorial Collection, Western Washington University

Preventing Landslides

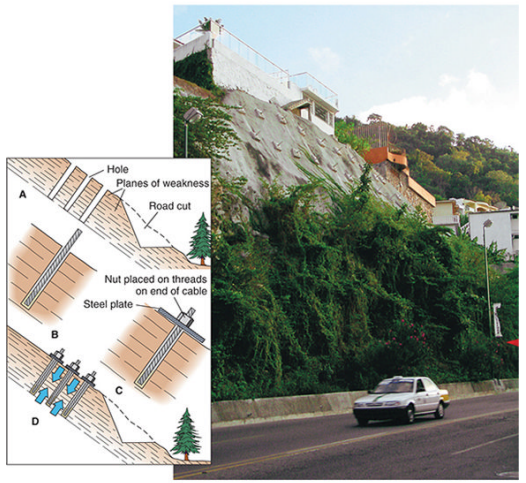
Preventing Mass Wasting of Soil

- Construct retaining wall with drains
- Don’t oversteepen slopes during construction
- Remove all rock that is prone to slidin
- Add vegetative cover
- Cover roads



Preventing Rockfalls and Rockslides on Highways

- Remove Loose material
- Stitch slopes together



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