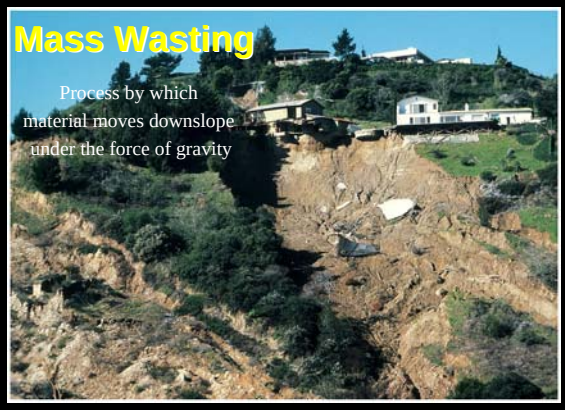
Mass Wasting

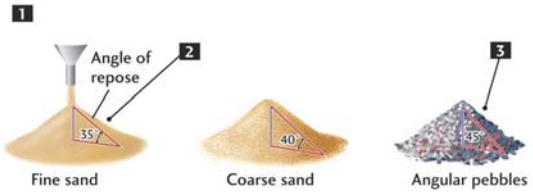


Process by which material moves downslope under the force of gravity

Table 16.1
Factors Influencing Mass Movement

Nature of Slope Material	Steepness of Slope	Water Content	Slope Stability
	UNCONSOLIDATED		
Loose sand or sandy silt	Angle of repose	Dry Wet	High Moderate
Unconsolidated mixture of sand, silt, soil, and rock fragments	Moderate	Dry Wet	High Low
	Steep	Dry Wet	High Low
	CONSOLIDATED		
Rock, jointed and deformed	Moderate to steep	Dry or wet	Moderate
Rock, massive	Moderate	Dry or wet	High
	Steep	Dry or wet	Moderate

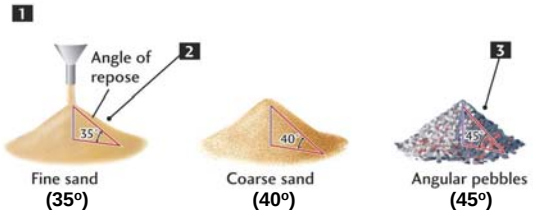
Mass Movement Depends on Nature of Material



Angle of Repose:
the maximum angle at which a pile of unconsolidated particles can rest

Fig. 16.13

Mass Movement Depends on Nature of Material



The angle of repose increases with increasing grain size

Fig. Story 16.3

Fig. 16.15

Origin of Surface Tension

Water molecules in a liquids interior are attracted in all directions…

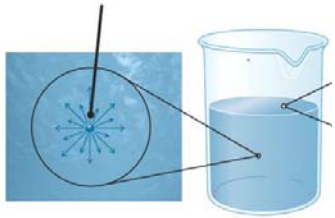


Fig. 16.13

Origin of Surface Tension

Water molecules in a liquids interior are attracted in all directions…

…whereas surface molecules have a net inward attraction that results in surface tension…

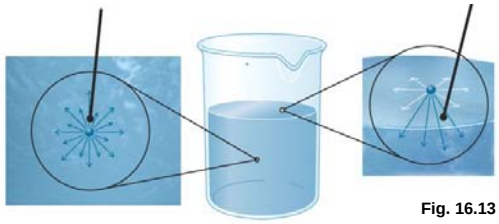


Fig. 16.13

…that acts like a membrane, allowing objects to float.

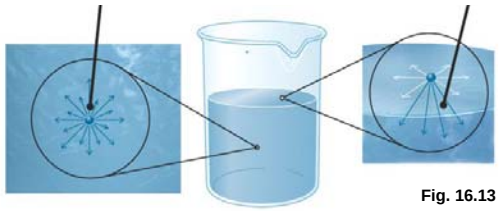


Fig. 16.13

Mass Movement Depends on Water Content

Surface tension in damp sand increases cohesion

Fig. 16.13

Mass Movement Depends on Water Content

Surface tension in damp sand increases cohesion

Dry sand is bound only by friction

Fig. 16.13

Mass Movement Depends on Water Content

Surface tension in damp sand increases cohesion

Dry sand is bound only by friction

Saturated sand flows easily because of interstitial water

Fig. 16.13

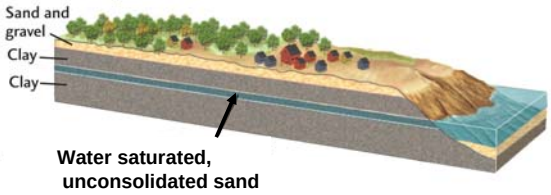
Steep slopes in damp sand maintained by moisture between grains

Fig. 16.14

Yellowstone National Park

Loss of vegetation and root systems increases susceptibility of soils to erosion and mass movement

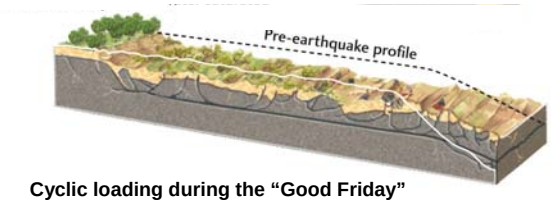
Before the 1964 Alaska Earthquake



Water saturated, unconsolidated sand

Fig. 16.6

After the 1964 Alaska Earthquake

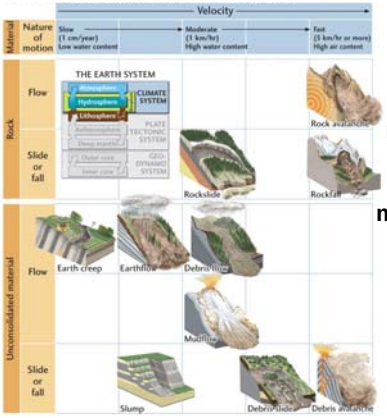


Cyclic loading during the "Good Friday" Earthquake caused the sand beneath Turnagain Heights Subdivision to liquefy.

Fig. 16.6

Turnagain Heights Subdivision, Alaska

Fig. 16.6



Classification of mass movement is based on dominant material, nature of movement, and velocity of movement.

Fig. 16.17

Types of Rock Mass Movement

- rock fall
- rock slide
- rock avalanche

Rockfall

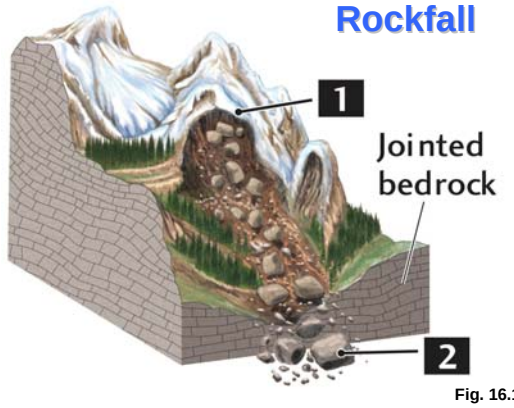


Fig. 16.18

Rockfall in Zion National Park

Fig. 16.18

Rockslide

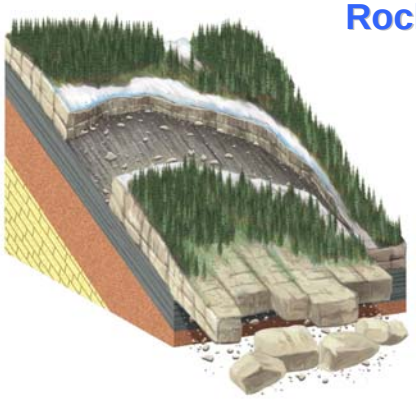


Fig. 16.19

Rockslide

Fig. 16.19

Rock Avalanche

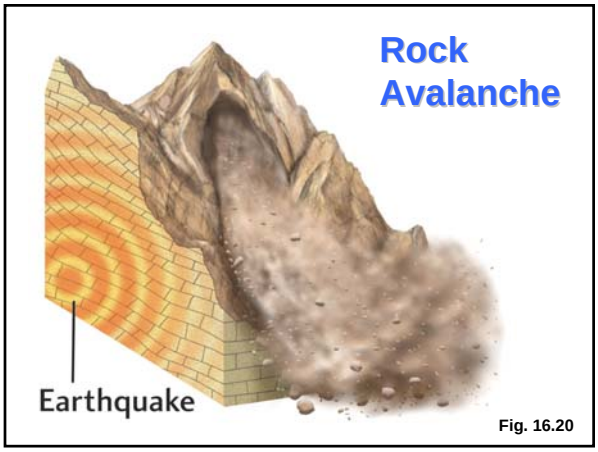


Fig. 16.20

Rock Avalanches Triggered by an Earthquake (Nov. 3, 2002) in Alaska

Fig. 16.20

Types of Unconsolidated Mass Movement

Unconsolidated Flows

Creep

Earth flow

Debris flow Mud flow

Increased velocity

Evidence of Creep

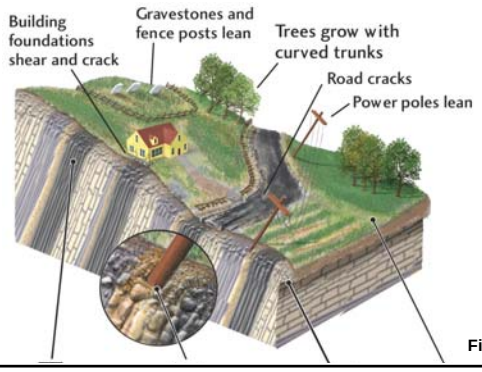
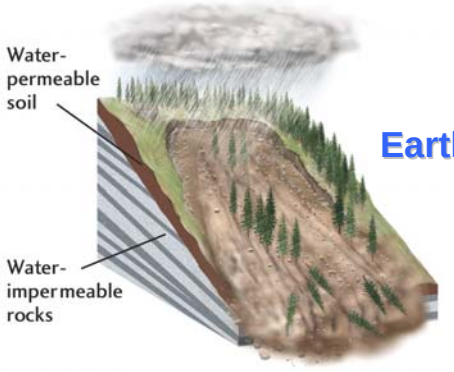


Fig. 12.21

Fig. 16.21



Earthflow

Fig. 16.22

Earthflow

Fig. 16.22

Debris flow

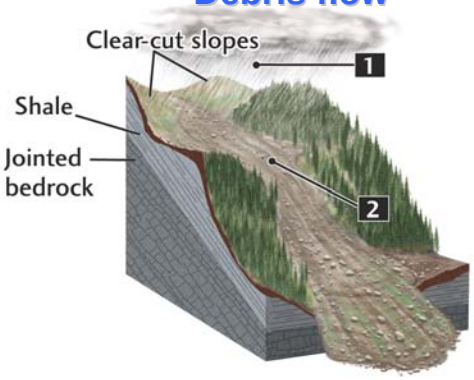


Fig. 16.23

Fig. 16.23

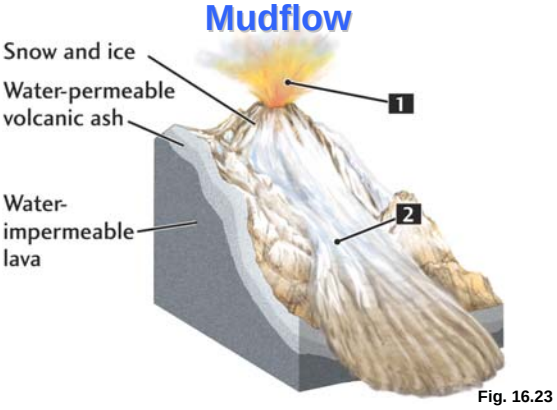


Fig. 16.23

Fig. 16.23

Types of Unconsolidated Mass Movement

Unconsolidated Slides and Falls

Slump

⇩

Debris slide

⇩

Debris avalanche

Increased velocity

Slump

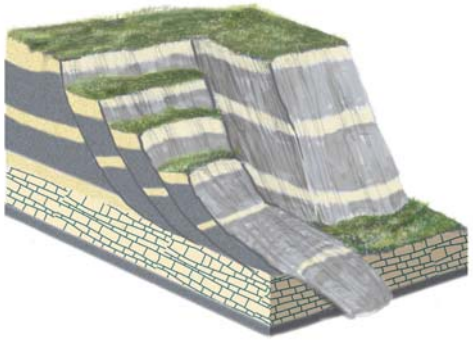


Fig. 16.25

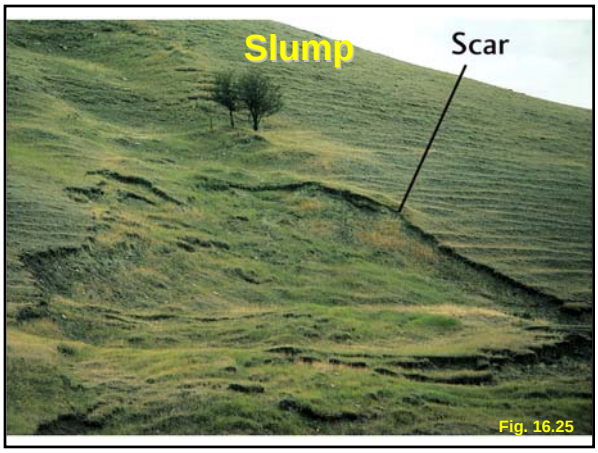


Fig. 16.25

Debris Slide

Fig. 16.26

Debris Slide

Fig. 16.26

Debris Avalanche

Fig. 16.24

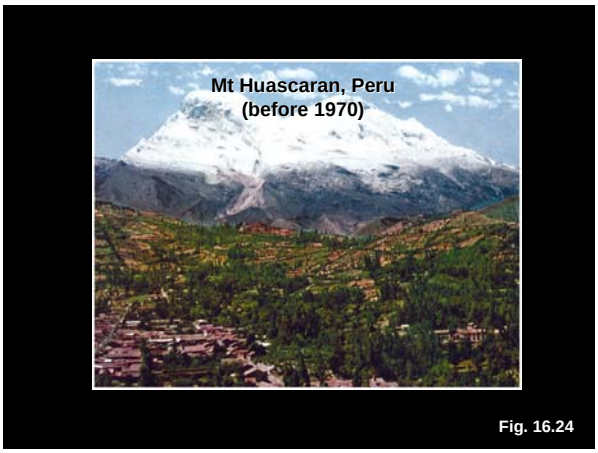


Fig. 16.24

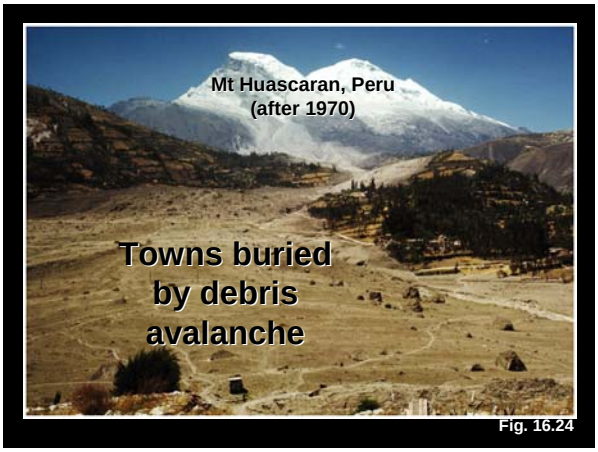


Fig. 16.24

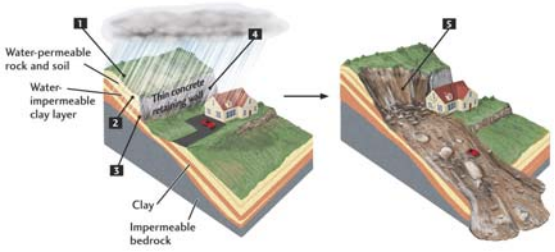
YouTube Video

http://www.youtube.com/watch?v=qEbYpts0Onw

Possible Triggers for Mass Movement

- over-steepened slope:
  - erosion / lateral erosion
  - volcanic ash
  - excavation (manmade)
- increased water content:
  - intense rainfall
  - rising water table (e.g. behind dam)
- cyclic loading:
  - earthquakes
  - storms

Landslide Caused by Undercutting Inclined Strata



1925 Gros Ventre Slide, Wyoming

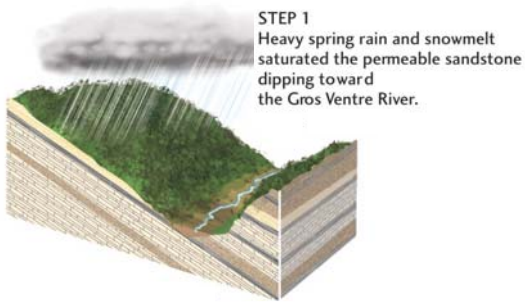
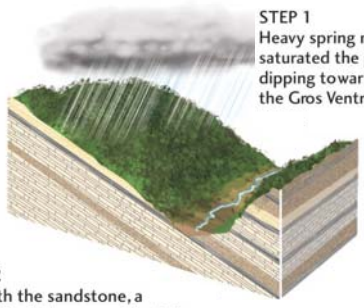


Fig. 16.27

1925 Gros Ventre Slide, Wyoming

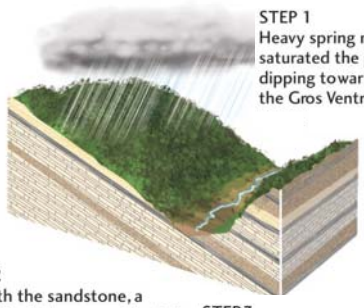


STEP 1
Heavy spring rain and snowmelt saturated the permeable sandstone dipping toward the Gros Ventre River.

STEP 2
Beneath the sandstone, a layer of soft, impermeable shale became slippery when wet.

Fig. 16.27

1925 Gros Ventre Slide, Wyoming



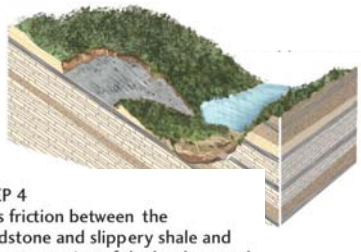
STEP 1
Heavy spring rain and snowmelt saturated the permeable sandstone dipping toward the Gros Ventre River.

STEP 2
Beneath the sandstone, a layer of soft, impermeable shale became slippery when wet.

STEP 3
The sandstone layer—eroded by the river—was unsupported at its lower edge.

Fig. 16.27

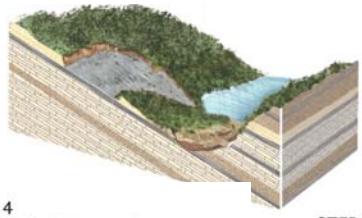
1925 Gros Ventre Slide, Wyoming



STEP 4
Less friction between the sandstone and slippery shale and over-steepening of the bank caused by the erosion, caused the sandstone to detach from the shale and slide.

Fig. 16.27

1925 Gros Ventre Slide, Wyoming

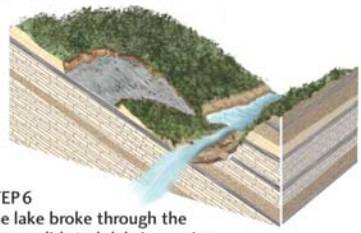


STEP 4
Less friction between the sandstone and slippery shale and over-steepening of the bank caused by the erosion, caused the sandstone to detach from the shale and slide.

STEP 5
The slide created a debris dam that backed up a large lake.

Fig. 16.27

1925 Gros Ventre Slide, Wyoming



STEP 6
The lake broke through the unconsolidated debris, causing sudden, disastrous downstream flooding.

Fig. 16.27

Fig. 16.27

Vaiont Reservoir Slide

Fig. 16.28

Ways to Reduce Losses Due to Landslides Include:

- avoid construction in areas prone to mass movement
- build in a way that does not make naturally stable slope unstable
- engineer water drainage to prevent strata to become water saturated and prone to fail