Chapter 12: Mass Wasting

Fig. 12I

OBJECTIVES

- Define mass wasting and explain why it occurs.
- Identify the various factors that govern mass wasting and the ways in which mass wasting is triggered.
- Describe the mechanisms of mass wasting and the subdivision of mass wasting into falling, sliding, and flow.
- Identify methods that assess the threat of mass wasting and methods that reduce the hazards mass wasting poses.
- Illustrate how mass wasting can be triggered by events linked to plate tectonics.

Mass Wasting: An Overview

- The downslope movement of material moved by the pull of gravity is known as **mass wasting**.
- Surface processes and tectonic activity can make Earth's slopes unstable.
- Mass wasting can be rapid or imperceptibly slow.
- Careful evaluation of slopes and geologic evidence can help prevent consequences of mass wasting.

Fig. 12.16

Mass Wasting: Downslope Movement

- **Mass wasting:**
  - Includes landslides and rockfalls
  - Does not require transporting medium (water, ice, wind)
  - Requires a slope to overcome shear strength
- **Shear strength:** an inherent natural strength of Earth materials
  - Resists downslope movement

Factors That Influence Mass Wasting

- Mass wasting is driven primarily by **gravity.**

- Other factors include
  - Steepness of slope
  - Water content of slope material
  - Amount of vegetation on the slope
  - Natural or artificial controls of slope stability

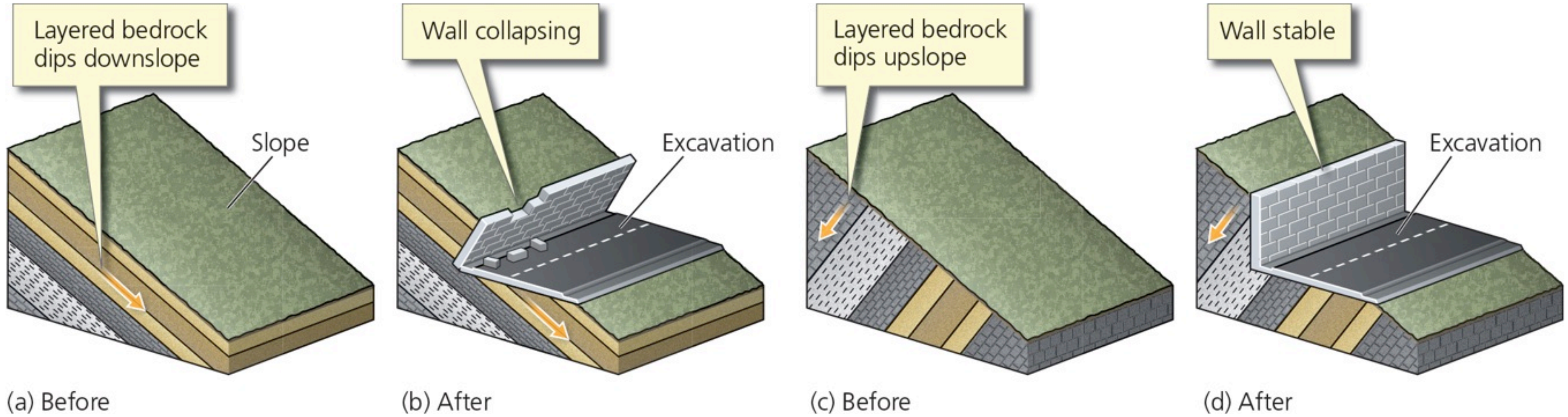


Fig 12.6

Factors That Influence Mass Wasting

- Slope Stability and the Angle of Repose
  - The **angle of repose** is the *maximum slope* that can be sustained without the material sliding downslope.
  - For most unconsolidated materials, the angle of repose is between 25 and 40 degrees.
  - **Talus** (coarse, angular material) has a higher angle of repose (up to 45 degrees).

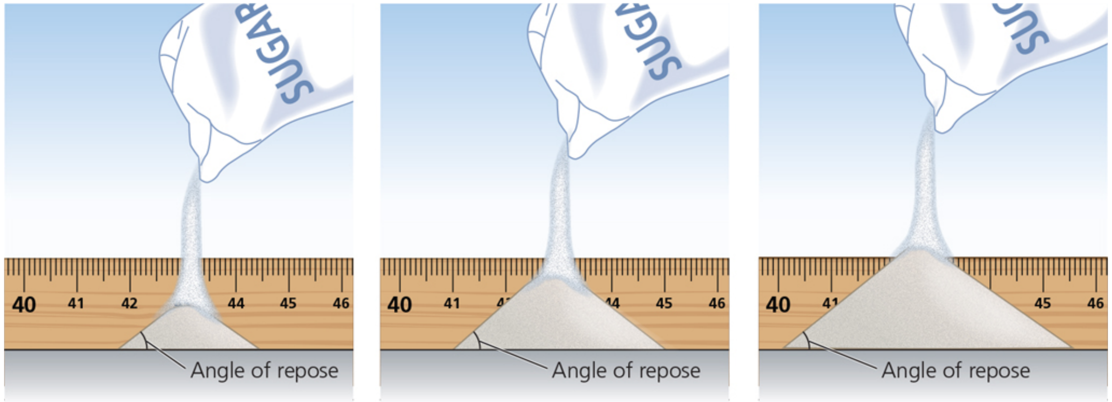


Fig. 12.1

Factors That Influence Mass Wasting

- **Cohesion**
  - A rock's resistance to sliding
- **Oversteepening**
  - When a slope becomes steeper than the angle of repose, the material will slide downslope to restore this angle

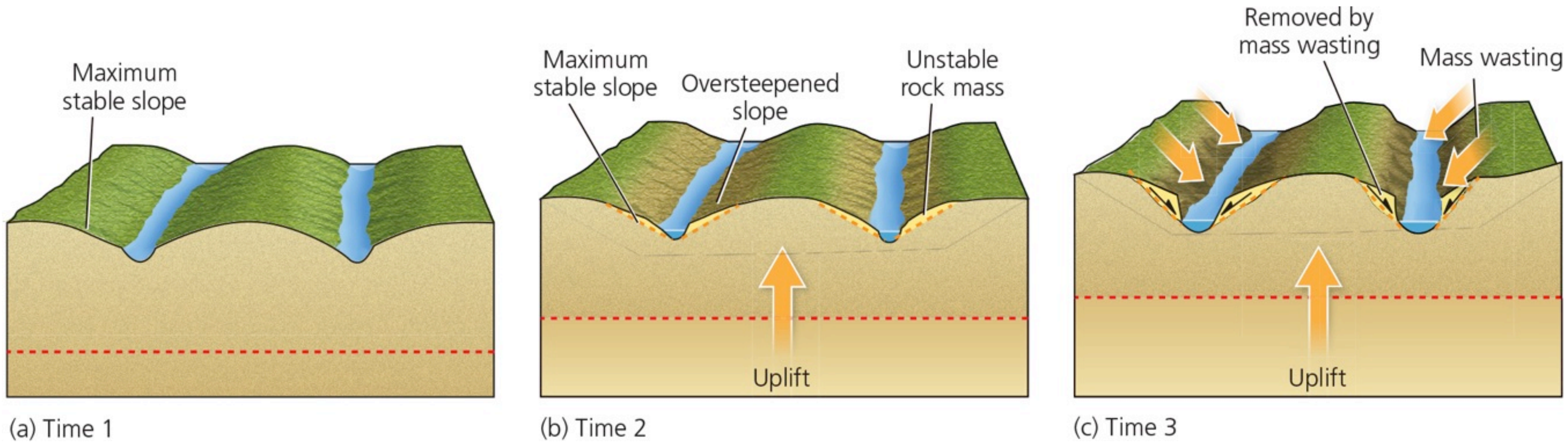


Fig. 12.3

Factors That Influence Mass

- Water Content
  - Water fills the spaces between grains (**pores**) in unconsolidated materials
  - The effect of water content depends on
    - **Porosity:** pore volume
    - **Permeability:** pore connectivity
  - **Surface tension** holds material together
  - **Saturation** allows materials to slide apart

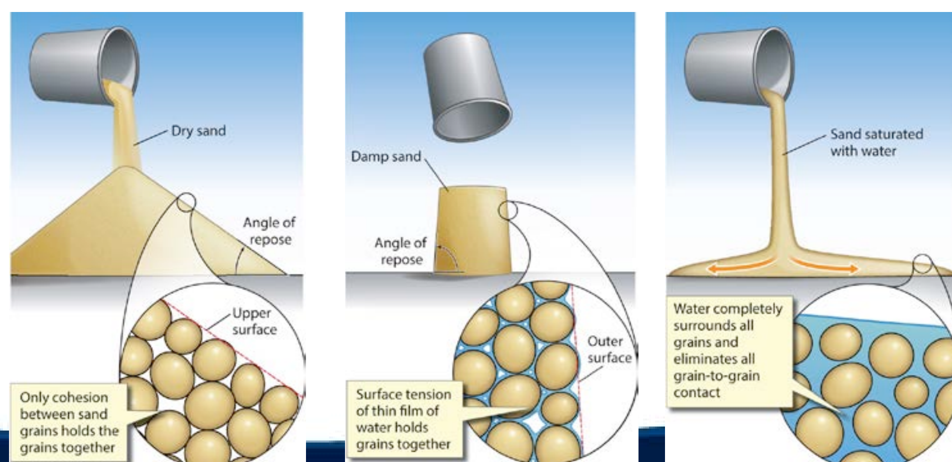


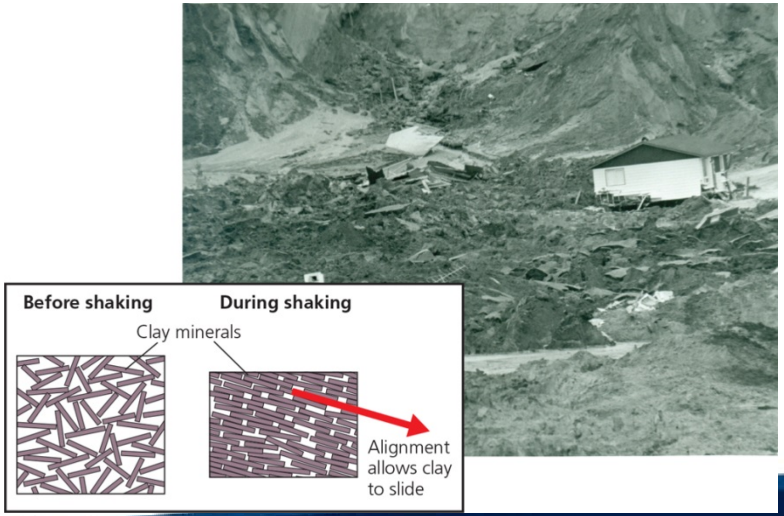
Fig. 12E

Factors That Influence Mass Wasting

- Vegetation and Climate
  - Root systems bind soil together
  - Plants absorb water, protecting soil from water saturation and erosion
  - Normally dry climates experience **infiltration** (water rapidly entering soil) during occasional heavy downpours

- Earthquakes, Volcanoes, and Other Triggering Mechanisms
  - Including roadbuilding and other human activities

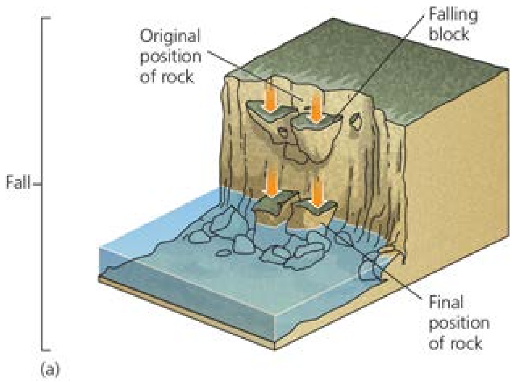
Fig. 12.17

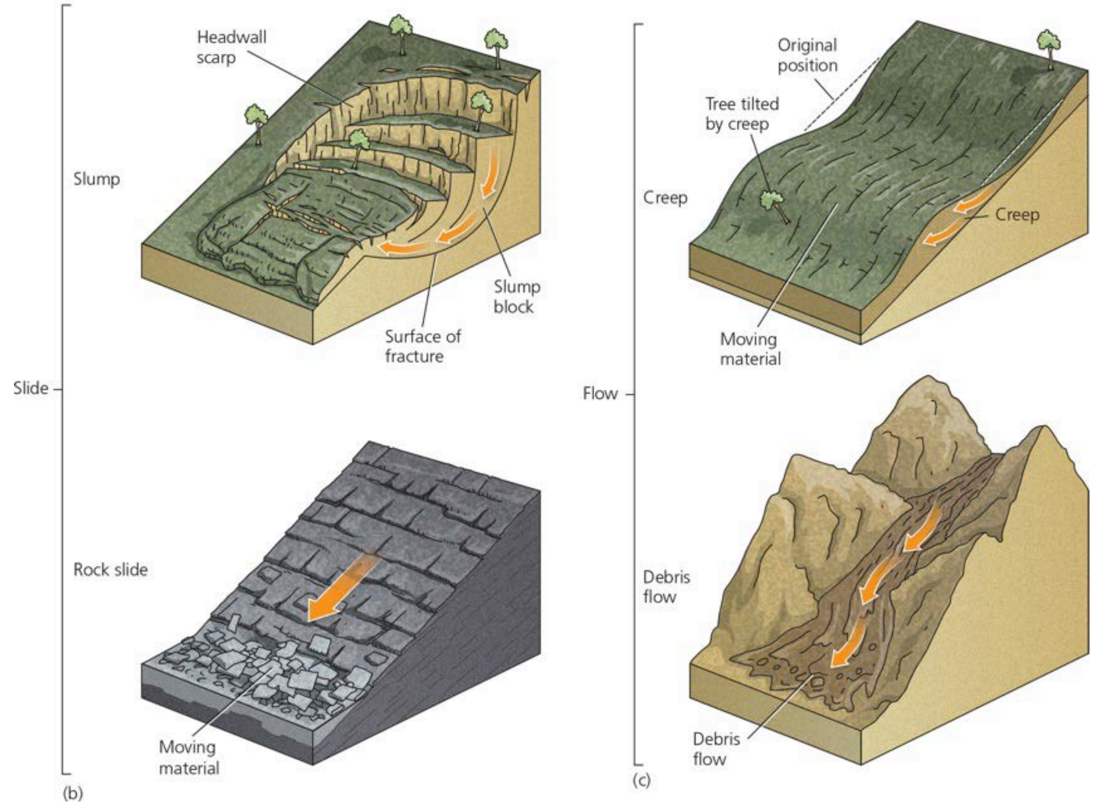


Mass Wasting Mechanisms

- Types of Movement Mechanisms
  - **Fall:** materials free fall in air
  - **Slide:** material moves as coherent mass on well-defined basal surface
  - **Flow:** material moves in fluid-like manner
  - **Creep:** the imperceptible downslope movement of soil

Mass Wasting Mechanisms





Three Mass Wasting Mechanisms: (a) fall, (b) slide, and (c) flow.

Fig. 12.10

Mass Wasting Mechanisms

- **Fall:** when material is detached from precipitous slopes and free-falls to the ground
  - Rockfalls (falls in bedrock)
    - Often the result of frost wedging
  - The fastest mass wasting processes
  - Most are small falls
  - Large rockfalls may trigger avalanches

Fig. 12.11

Mass Wasting Mechanisms

- **Slide:** when material moves as coherent mass on well-defined basal surface.
  - **Rockslides** involve the rapid downslope sliding of segments of bedrock.
    - Occur along planes of weakness: bedding planes, foliation surfaces, or fractures
    - Occur most frequently in mountainous regions
  - **Rock avalanches** are a type of rockslides that travel over a layer of trapped air, reducing friction between rock fragments.
    - Particularly destructive form of slide
    - Can spread over wide areas and reach speeds over 350 kilometers per hour (222 miles per hour)

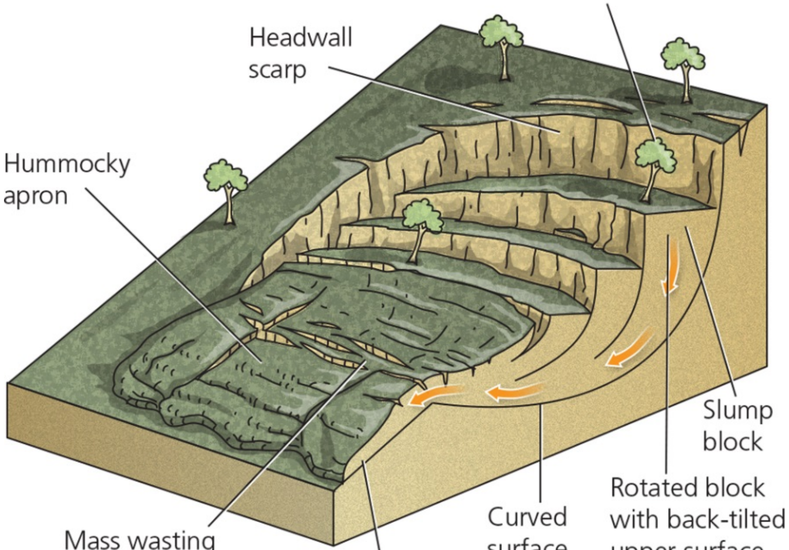
Fig. 12.12

Frank Slide: The 1903 Turtle Mountain rockslide in Alberta, Canada, that caused the scar seen here claimed the lives of at least 90 people. Thirty million cubic meters (a billion cubic feet) of rock broke away and, within two minutes, buried part of the town of Frank.

Mass Wasting Mechanisms

- **Slide (cont'd)**
  - **Slumps** are when blocks of sliding material move downslope along a curved surface.
    - Slump blocks rotate as they slide.
    - Slumps will occur most frequently when a slope is undermined.
    - Slumps have a distinctive, amphitheater-like shape.
    - Most do not move rapidly travel great distances.

Fig. 12.14



Mass Wasting Mechanisms

- **Flow:** when materials move downslope like viscous fluids
  - Materials are usually water-saturated
  - Types include mudflows, debris flows, earthflows, solifluction, and creep

- **Creep:** the imperceptible but more or less continuous downslope movement of soil and weathered bedrock under the influence of gravity.

Figs. 12.21, 12.24b

Debris Flow: Aberfan, South Wales, in 1966 – coal tips were located above the town. Tip number 7 was above a natural spring, which saturated the coal debris and turned it into sludge which moved downhill and buried part of the town.

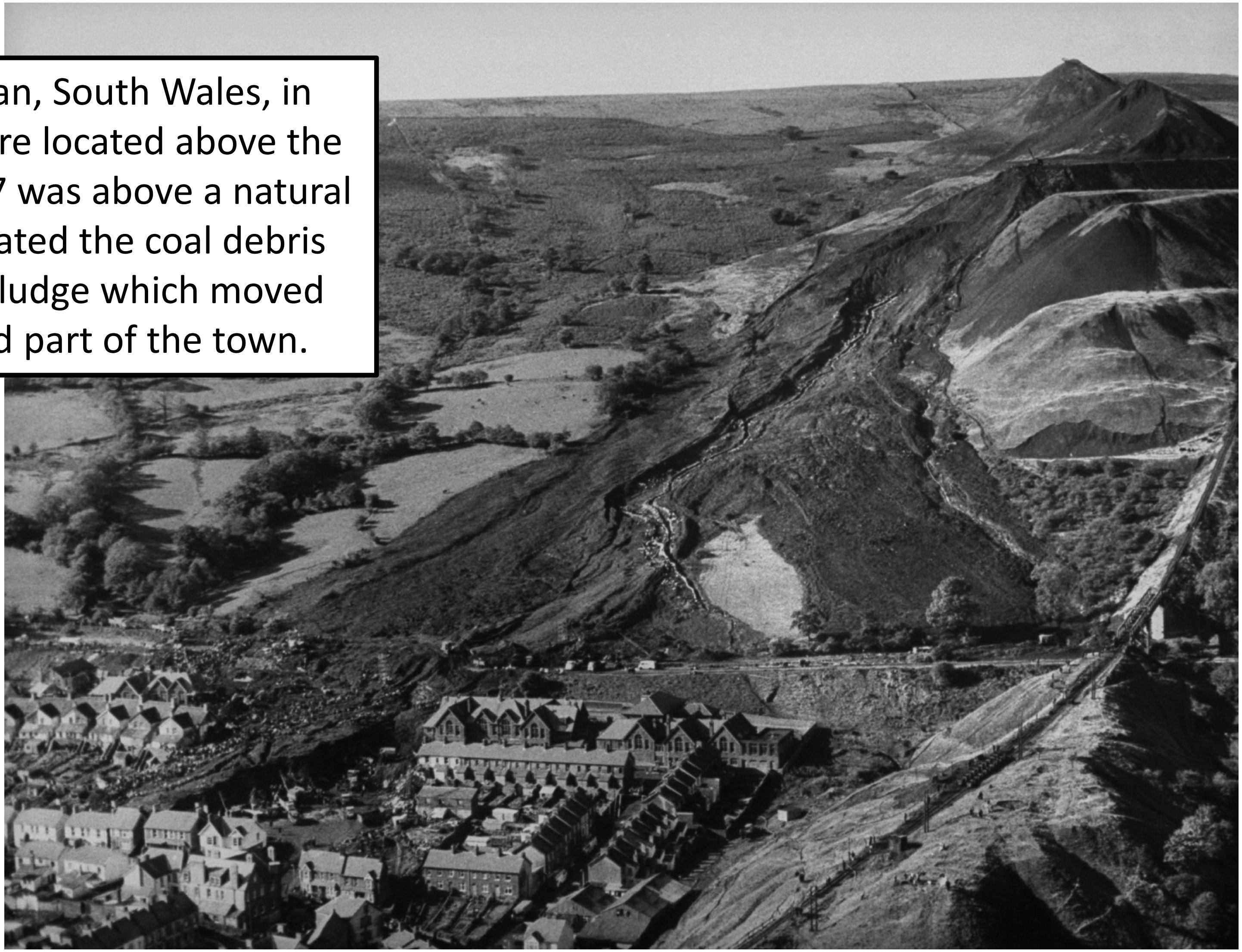


Fig. 12.20

Minimizing Mass Wasting Hazards

- All forms of mass wasting can be very destructive.
- The hazards of mass wasting tend to be predictable and largely avoidable.
- Evidence of past events helps identify areas prone to slope failure.
- Locating potential triggers such as faults and knowing local weather patterns can help predict slope failure.

Slope Stability Map: This slope stability map of part of the Santa Suzanna Mountains north of Northridge, California, highlights areas where landslides are most likely to be triggered by earthquakes.

(Orange is most steep; green is least steep. Flat areas are grey.)

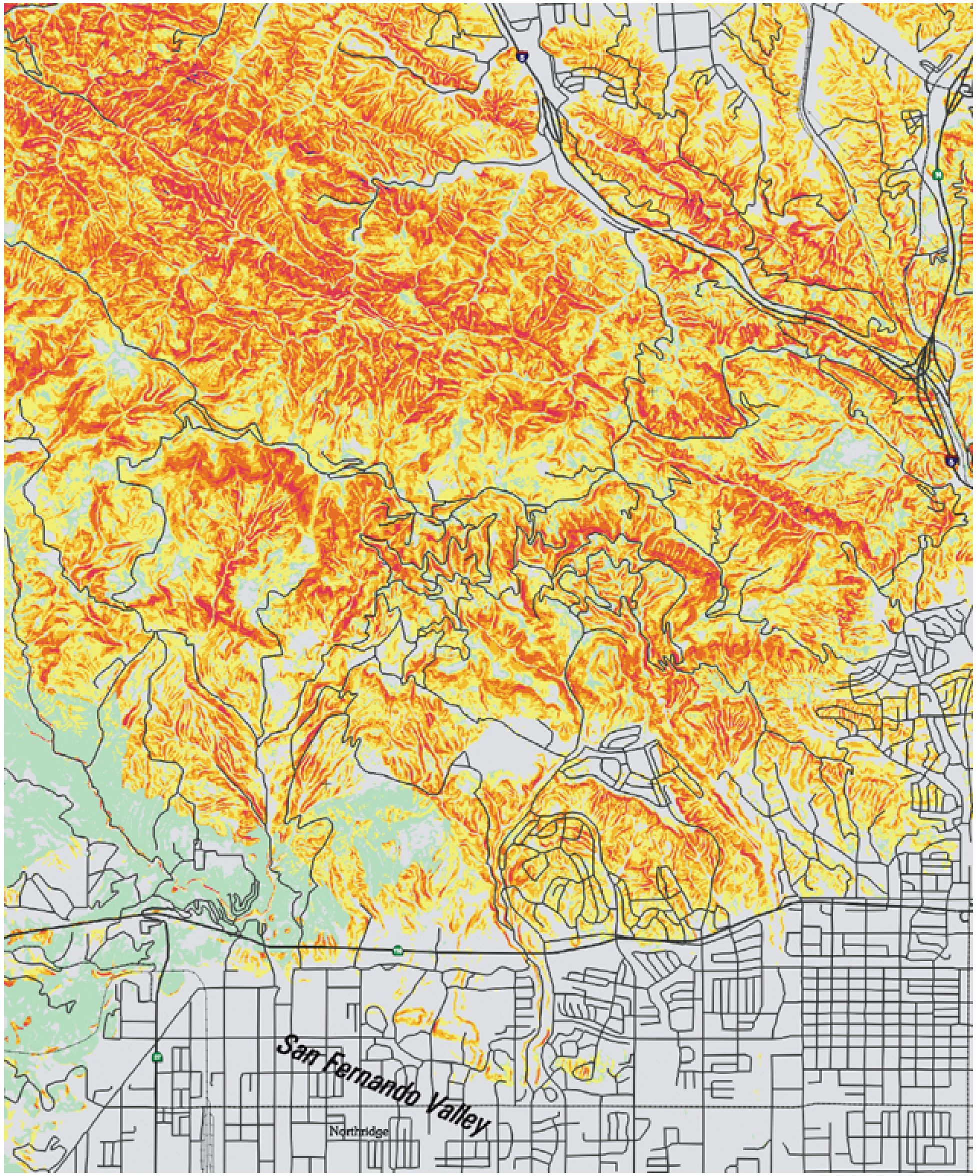
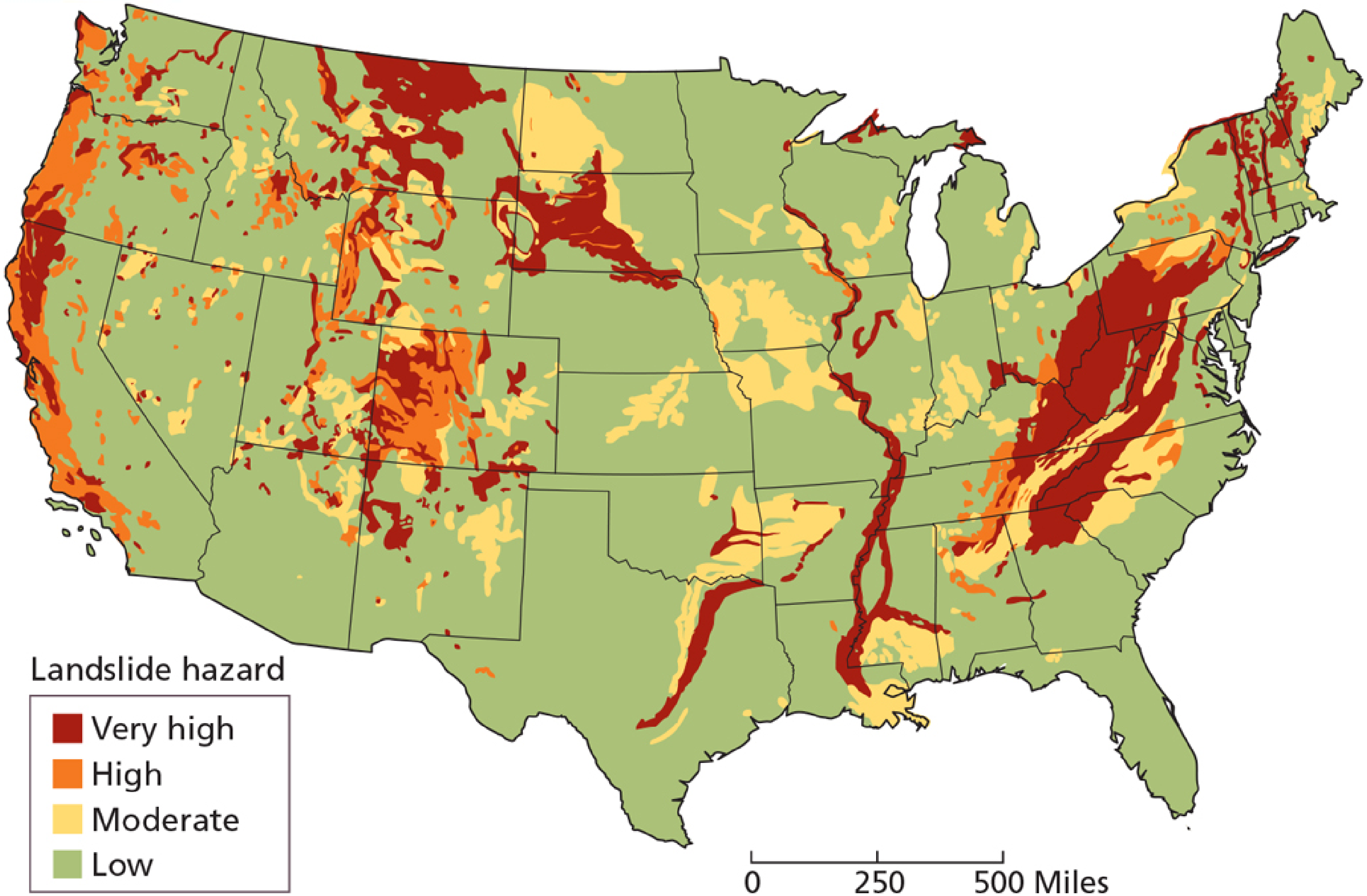


Fig. 12.25



Landslide Hazard Map: This map highlights areas where landslides are most frequent and most likely to occur within the conterminous United States.

Fig. 12.27

Minimizing Mass Wasting Hazards

- Mass wasting and its effects can be minimized through engineering.
  - Reducing slope
  - Increasing drainage
  - Constructing barriers

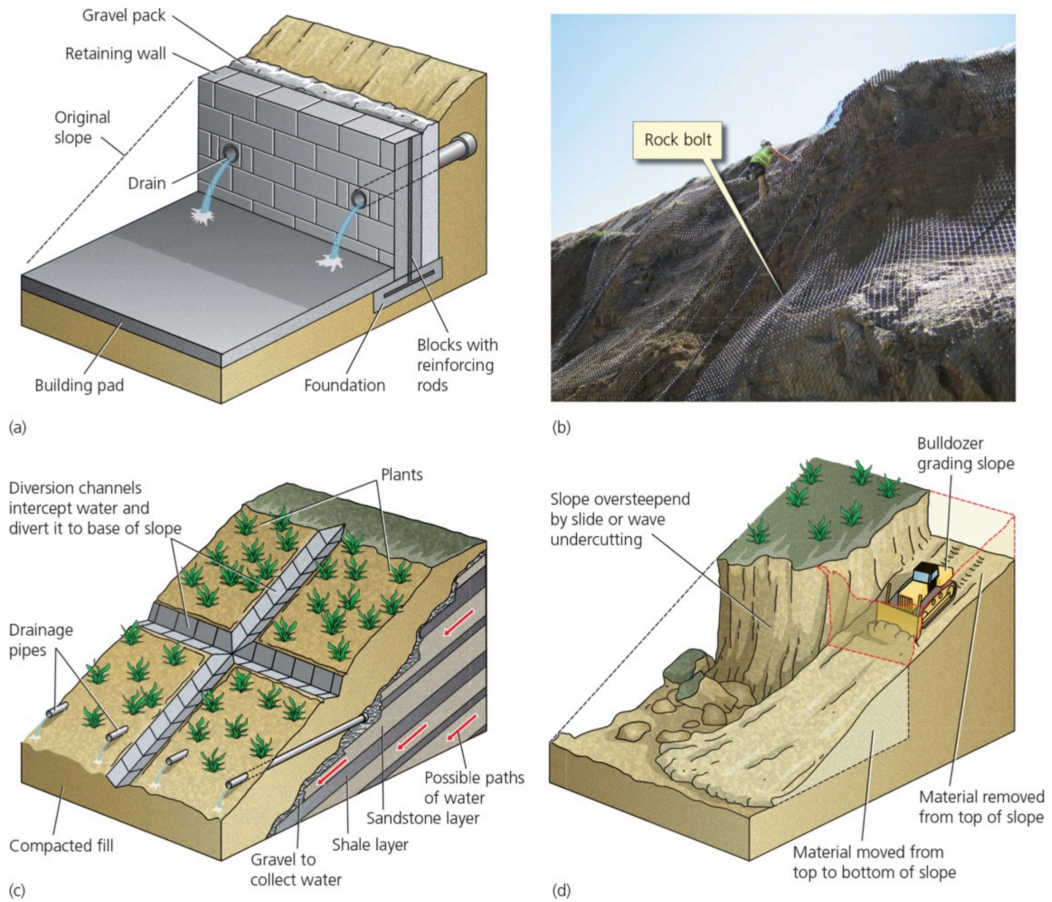


Fig. 12.26

Mass Wasting and Plate Tectonics

- Plate tectonics are responsible for uplift and mountain building that creates and maintains slopes.
- Mass wasting is most common in tectonically active regions.
- Plate movement causes earthquakes that can trigger landslides and cause sediment to lose its strength through liquefaction.
- Plate boundaries are often associated with volcanoes.
  - Eruptions can produce mudflows, lahars, and landslides.

Fig. 12.18

SUMMARY

- Mass wasting is the downhill movement of Earth materials under the pull of gravity.
- Mass wasting is influenced by slope, material strength, water content, and amount of vegetation.
- Mass wasting can be triggered by storms, earthquakes, eruptions, and human activity.
- Fall, slide, flow, and creep are the main categories of mass wasting mechanisms.
- Analyzing geographic evidence can help identify areas prone to mass wasting.
- Mass wasting and its effects can be reduced through monitoring, engineering, and proper planning.
- Areas that are affected by plate tectonics tend to be more prone to mass wasting.