Chapter 16 Opener
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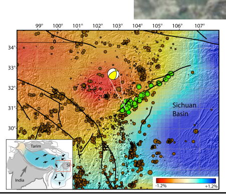
For sale – fixer-upper. No yard work necessary

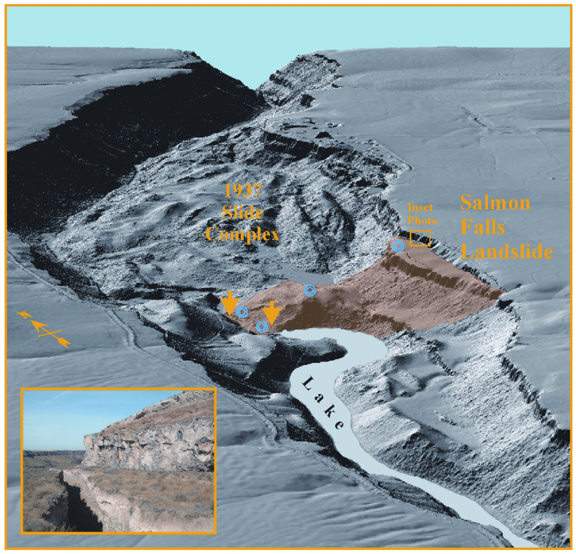
◆ Landslides triggered by 2008 Sichuan, China EQ

Figure courtesy of Dr. Cui Peng, 2009

Ruin of surface 56%



Example of mass wasting in Idaho



Terms

- *Weathering:* produces all the soils, clays, sediments, and dissolved substances (includes physical and chemical weathering processes).
- *Erosion:* removal of sediments by natural processes such as wind and rivers.
- *Mass wasting:* downslope movement of masses of Earth materials.

Table 16.1 Major Factors Controlling Rates of Weathering

Weathering Rate: Slow → Fast

PROPERTIES OF PARENT ROCK			
Mineral solubility in water	Low (e.g., quartz)	Moderate (e.g., pyroxene, feldspar)	High (e.g., calcite)
Rock structure	Massive	Some zones of weakness	Very fractured or thinly bedded
CLIMATE			
Rainfall	Low	Moderate	High
Temperature	Cold	Temperate	Hot
PRESENCE OR ABSENCE OF SOIL AND VEGETATION			
Thickness of soil layer	None—bare rock	Thin to moderate	Thick
Organic content	Low	Moderate	High
LENGTH OF EXPOSURE	Short	Moderate	Long

Table 16-1
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Figure 16-1
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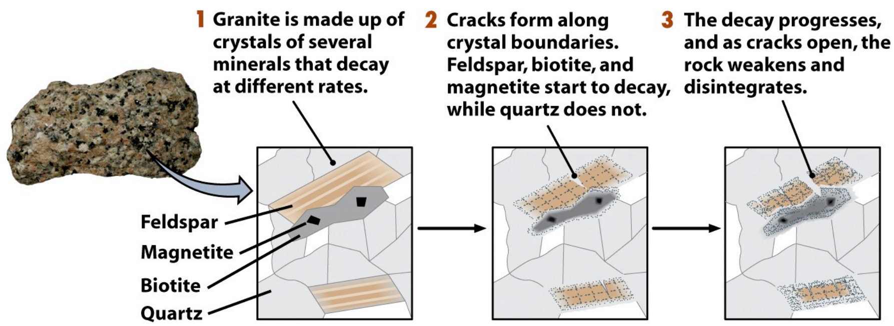

Figure 16-2
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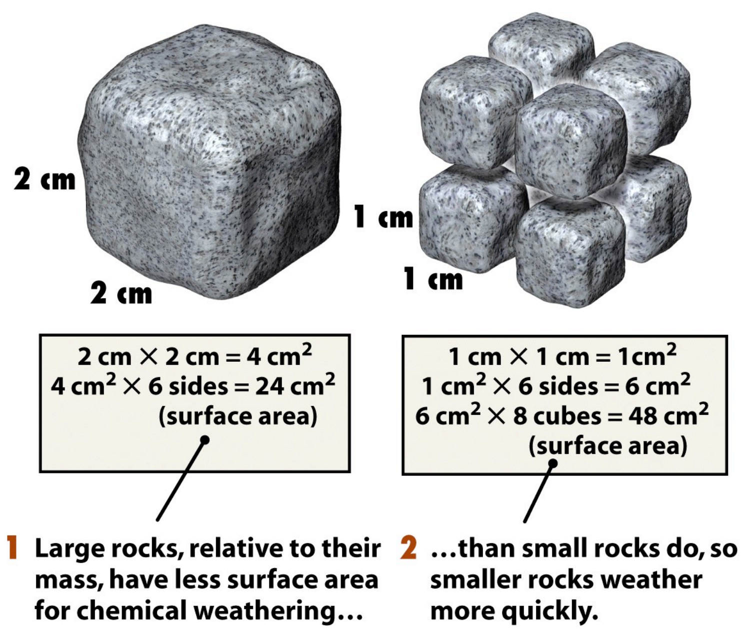

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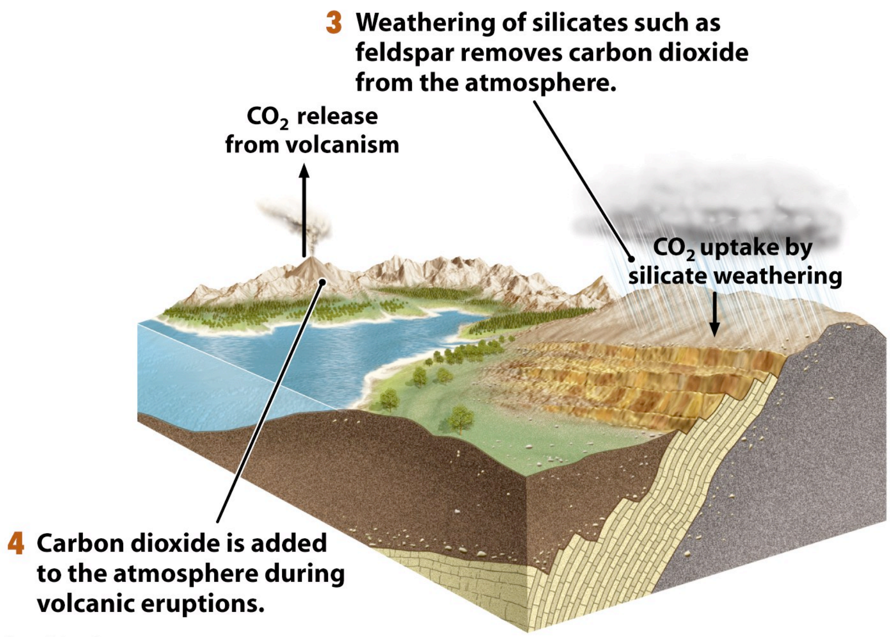

Figure 16-4 part 2
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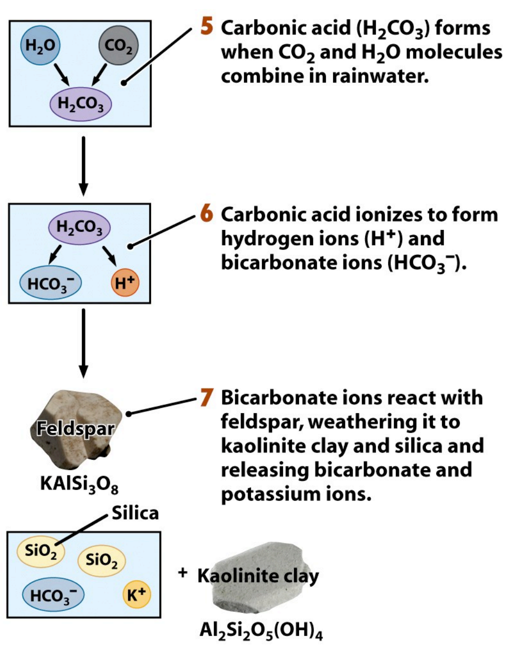

Figure 16-4 part 3
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Table 16.2 Relative Stabilities of Common Minerals Under Weathering

Stability of Minerals	Rate of Weathering
MOST STABLE	Slowest
Iron oxides (hematite)	↓
Aluminum hydroxides (gibbsite)	
Quartz	
Clay minerals	
Muscovite mica	
Potassium feldspar (orthoclase)	
Biotite mica	
Sodium-rich feldspar (albite)	
Amphiboles	
Pyroxene	
Calcium-rich feldspar (anorthite)	
Olivine	
Calcite	
Halite	
LEAST STABLE	Fastest

Table 16-2
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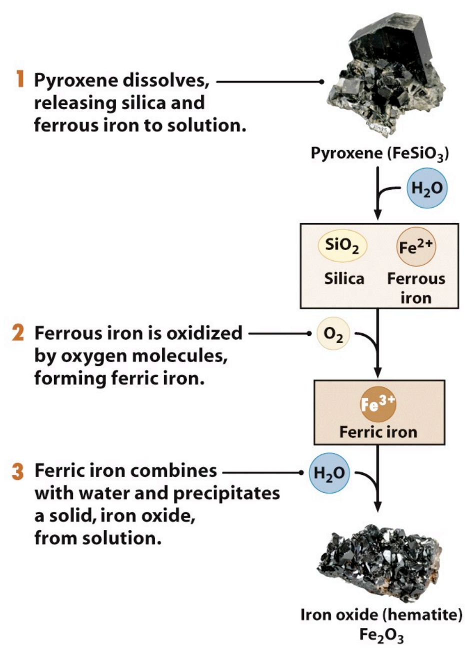

Figure 16-5
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Iron oxides give red hue to landscape

Figure 16-6
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Preferential weathering along volume expansion joints

Figure 16-7
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Prevalance of mechanical weathering at cold temperatures, which slow geochemical reaction rates and have freeze/thaw cycles

Figure 16-9
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Exfoliation

Figure 16-10
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WEATHERING FACTORS

1. Duration of weathering		Less weathering, erosion, and soil formation over short periods of time	More weathering, erosion, and soil formation over long periods of time
2. Bedrock type		More stable minerals, (e.g., quartz), result in lower weathering	Less stable minerals, (e.g., feldspar), result in higher weathering
3. Climate	Lower temperatures	Less chemical weathering (dissolution, alteration to aid physical weathering, production of clay materials)	More physical weathering (thermal expansion and contraction, frost wedging, breakage of bedrock, fragmentation to smaller sizes)
	Higher temperatures	Less physical weathering	More chemical weathering
	Rainfall amount	Little rainfall (less dissolution of minerals, physical weathering, fragmentation, erosion)	Heavy rainfall (more dissolution of minerals, production of clay materials, production of small size particles, erosion)
	Rainfall acidity	Low acidity (less dissolution of minerals, less physical weathering)	High acidity (more dissolution of minerals, more production of clay materials)
4. Topography	Steep slopes	Less chemical weathering	More physical weathering, more erosion
	Gentle slopes	Less physical weathering, less erosion	More chemical weathering

Figure 16-11
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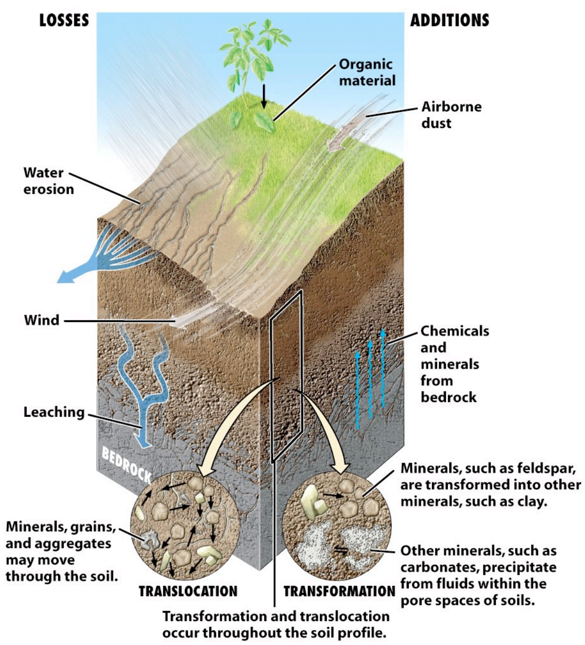

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Table 16.4 Factors That Influence Mass Movements

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

Table 16-4
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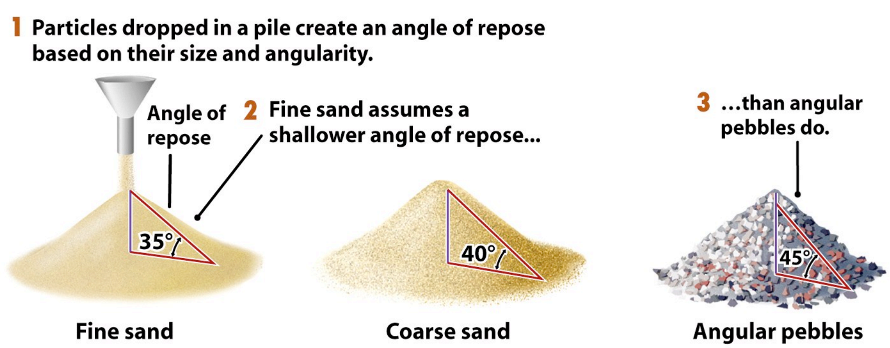

Figure 16-13a
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Figure 16-14
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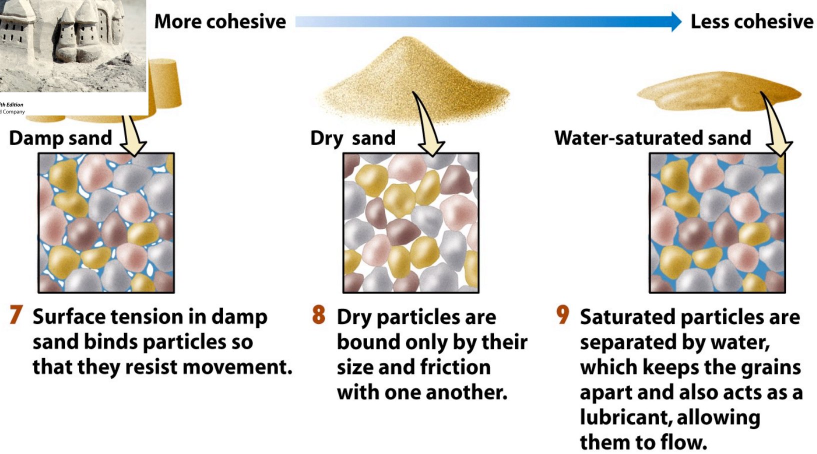

Figure 16-13c
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Slope angle is shallow for unconsolidated material, but steep for rock

Figure 16-15
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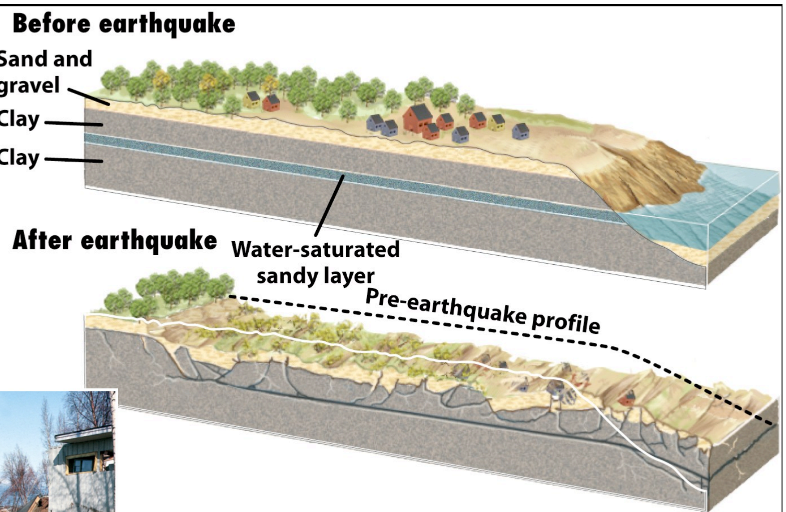
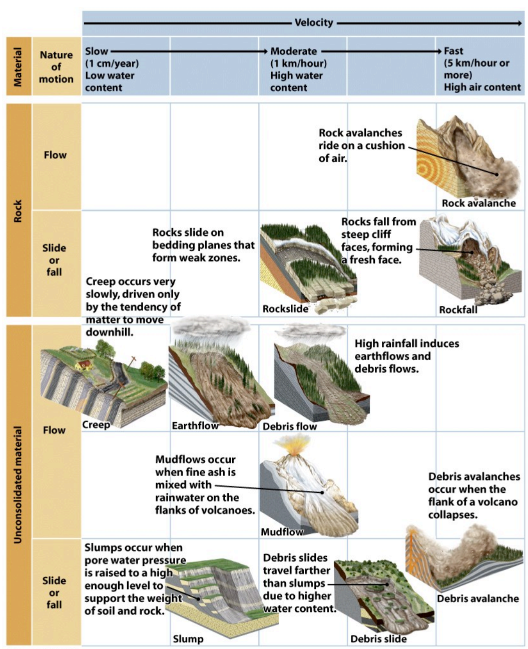


1964 M=9.2 Alaska EQ – Turnagain Heights, Anchorage. Some houses moved as far as 2300 FEET from the liquefaction that occurred during the earthquake



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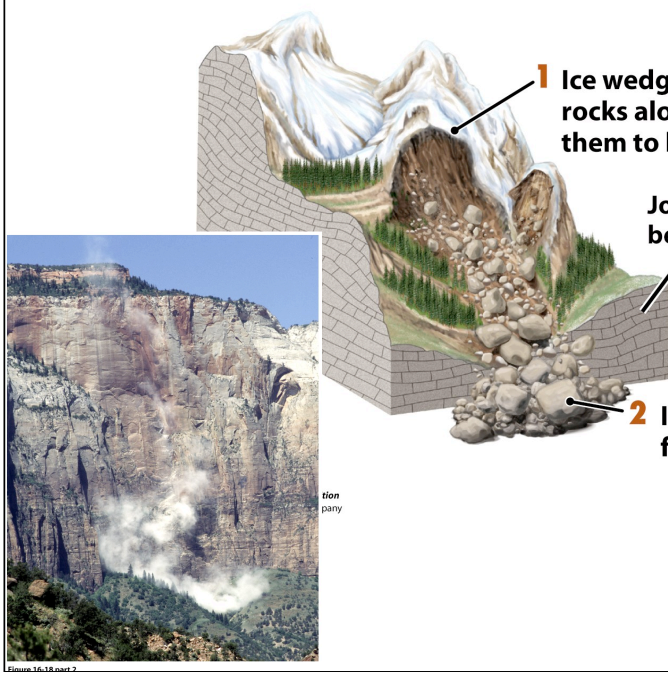

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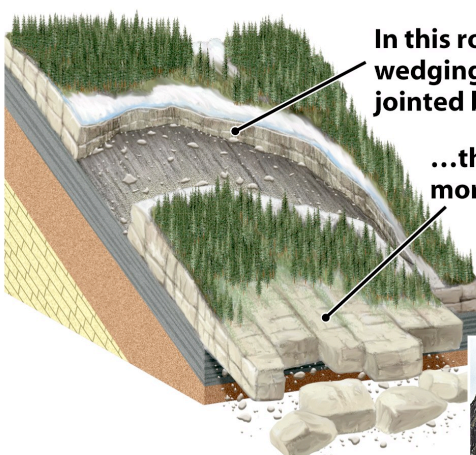
Figure 16-18 part 2



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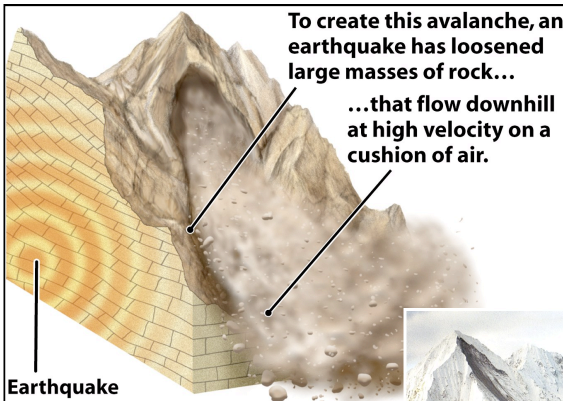

Figure 16-20 part 1
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M=7.9 11/03/2002 Denalia EQ triggered slope failures in SE Alaska

Figure 16-20 part 2
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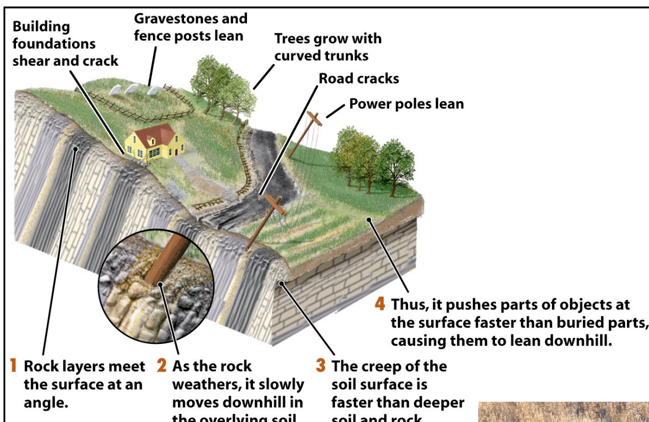

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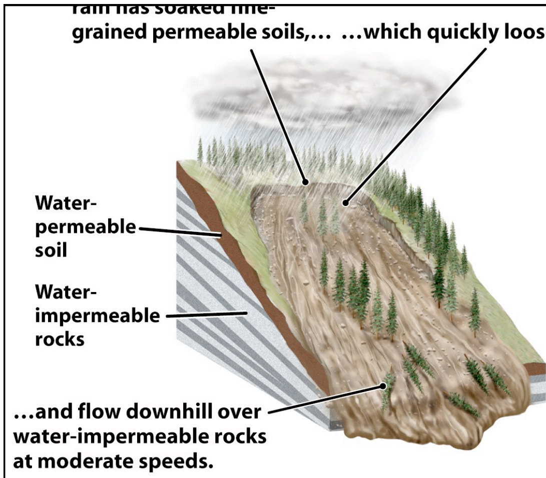

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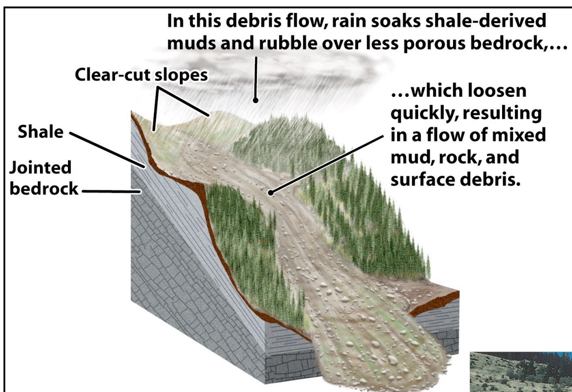

Figure 16-23a part 1
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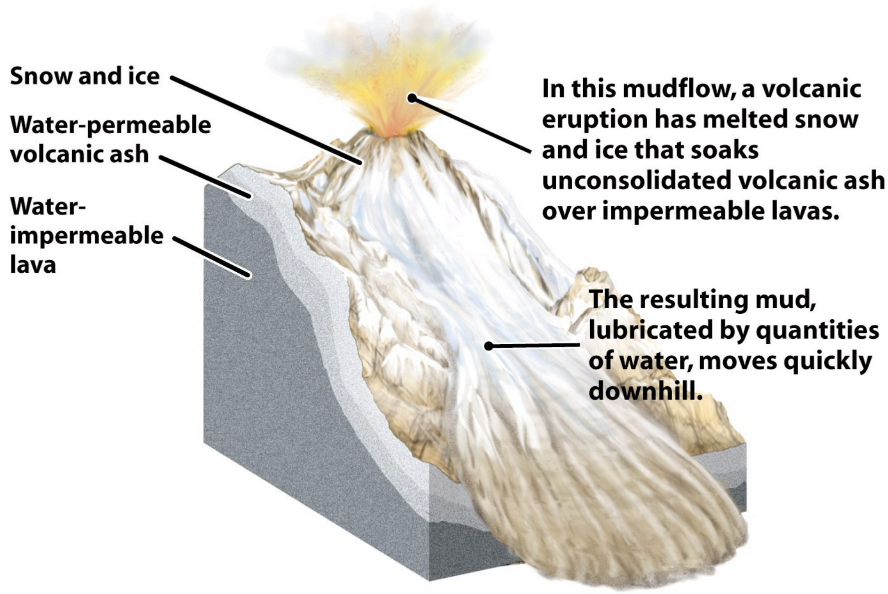

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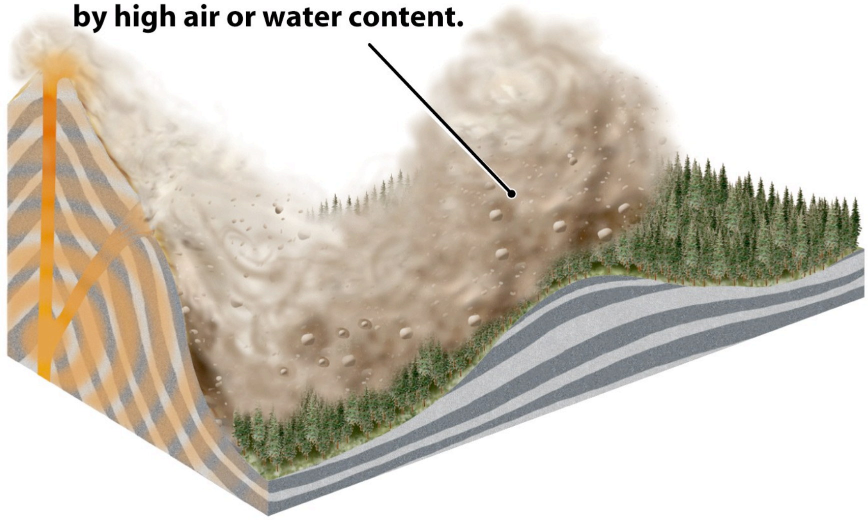

Figure 16-24 part 1
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Towns of Yungay and Ranrahirca before an earthquake-induced debris avalanche on Mount Huascarán, Peru, buried these towns.

Figure 16-24 part 2
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Aftermath of the avalanche.

Figure 16-24 part 3
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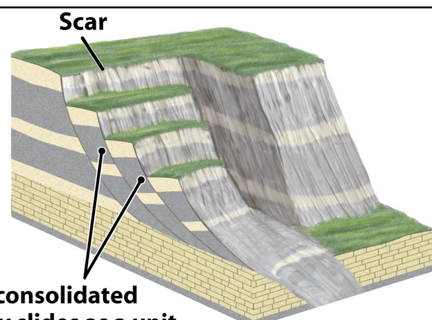

In a slump, unconsolidated material slowly slides as a unit. Sliding is quick, but only for a short distance.

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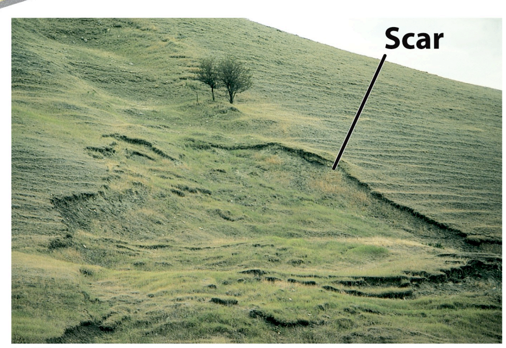

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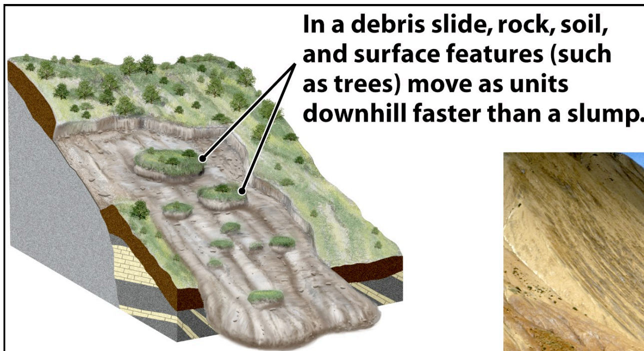

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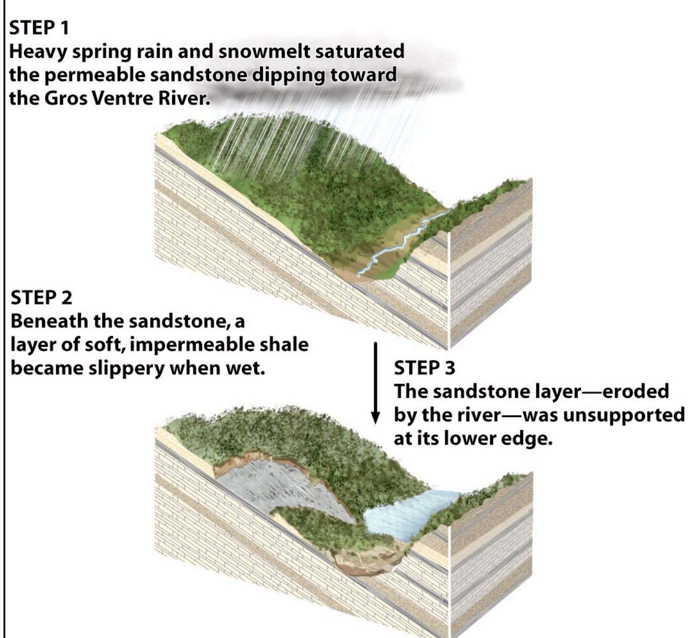

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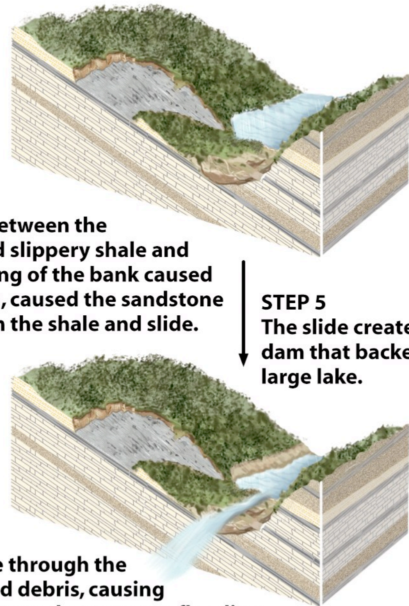

STEP 4
Less friction between the sandstone and slippery shale and over-steepening of the bank caused by the erosion, caused the sandstone to detach from the shale and slide.

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

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

Figure 16-27 part 1b
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Figure 16-27 part 2
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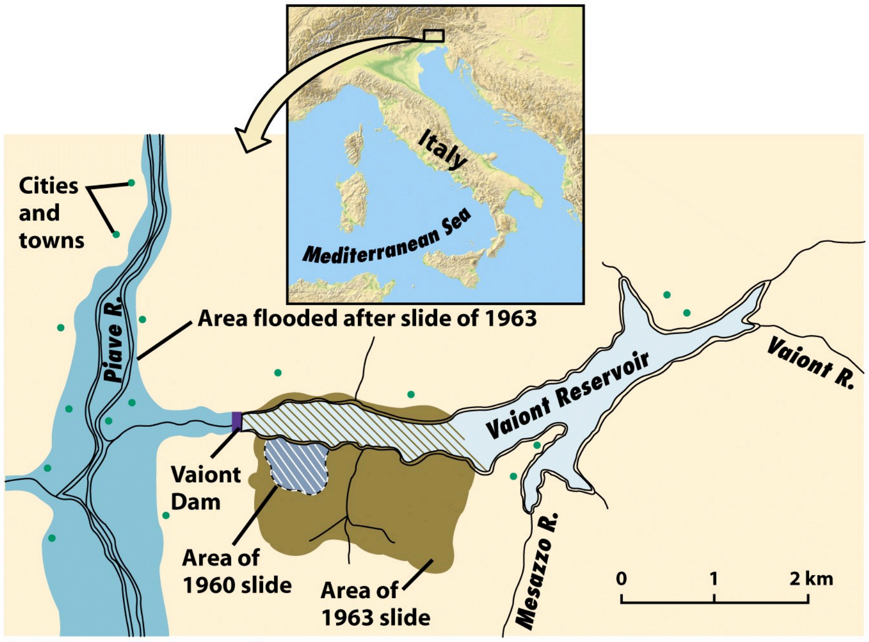

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