

Groundwater



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Importance of groundwater

- **Groundwater is water found in the pores of soil and sediment, plus narrow fractures in bedrock**
- **Groundwater is the largest reservoir of fresh water that is readily available to humans**

Fresh water of the hydrosphere

TABLE 17.1 Fresh Water of the Hydrosphere

Parts of the Hydrosphere	Volume of Fresh Water (km ³)	Share of Total Volume of Fresh Water (percent)	Rate of Water Exchange
Ice sheets and glaciers	24,000,000	84.945	8000 years
Groundwater	4,000,000	14.158	280 years
Lakes and reservoirs	155,000	0.549	7 years
Soil moisture	83,000	0.294	1 year
Water vapor in the atmosphere	14,000	0.049	9.9 days
River water	1,200	0.004	11.3 days
Total	28,253,200	100.000	

Source: U.S. Geological Survey Water Supply Paper 2220, 1987

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Table 17.1

Distribution of groundwater

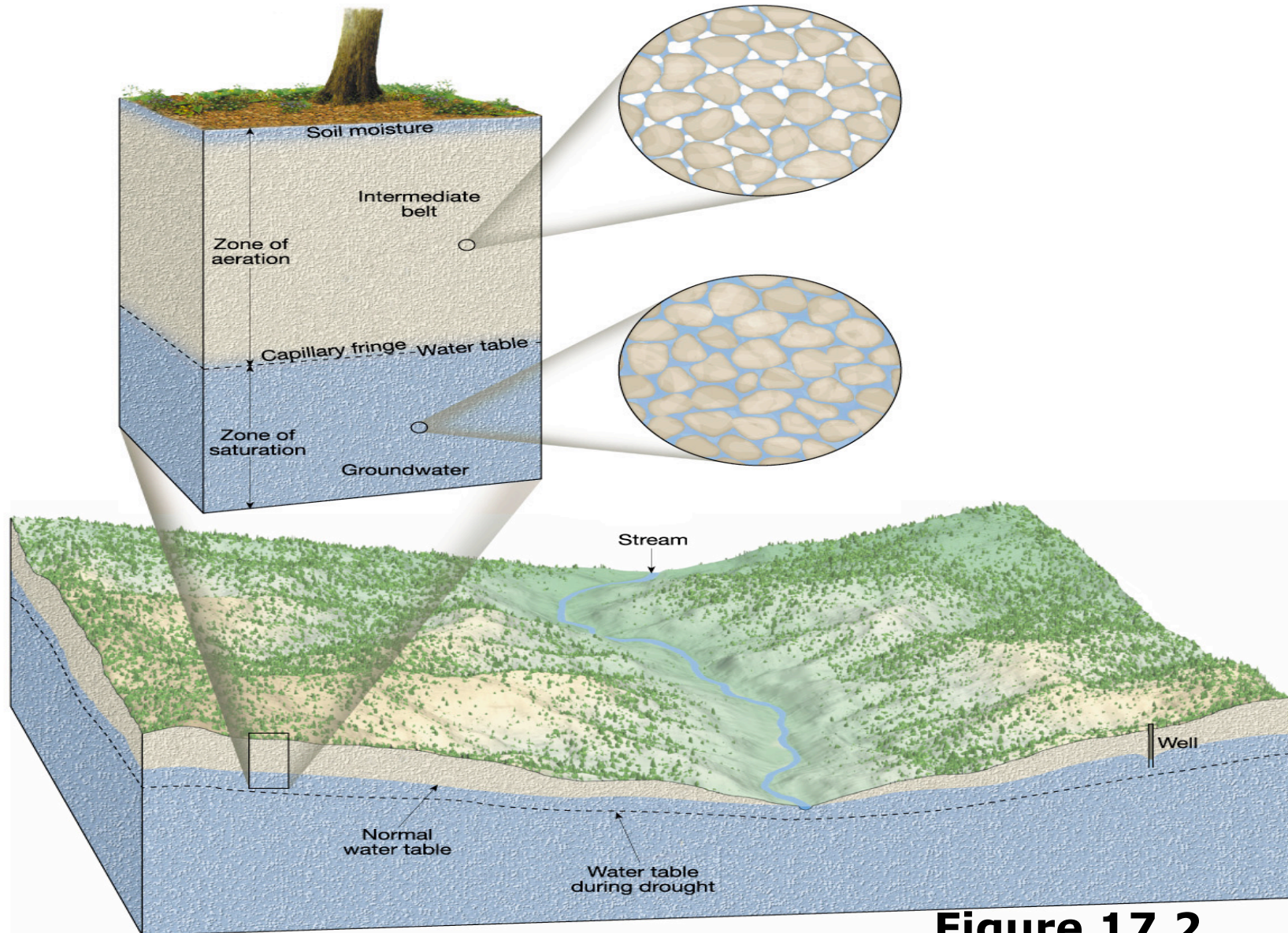
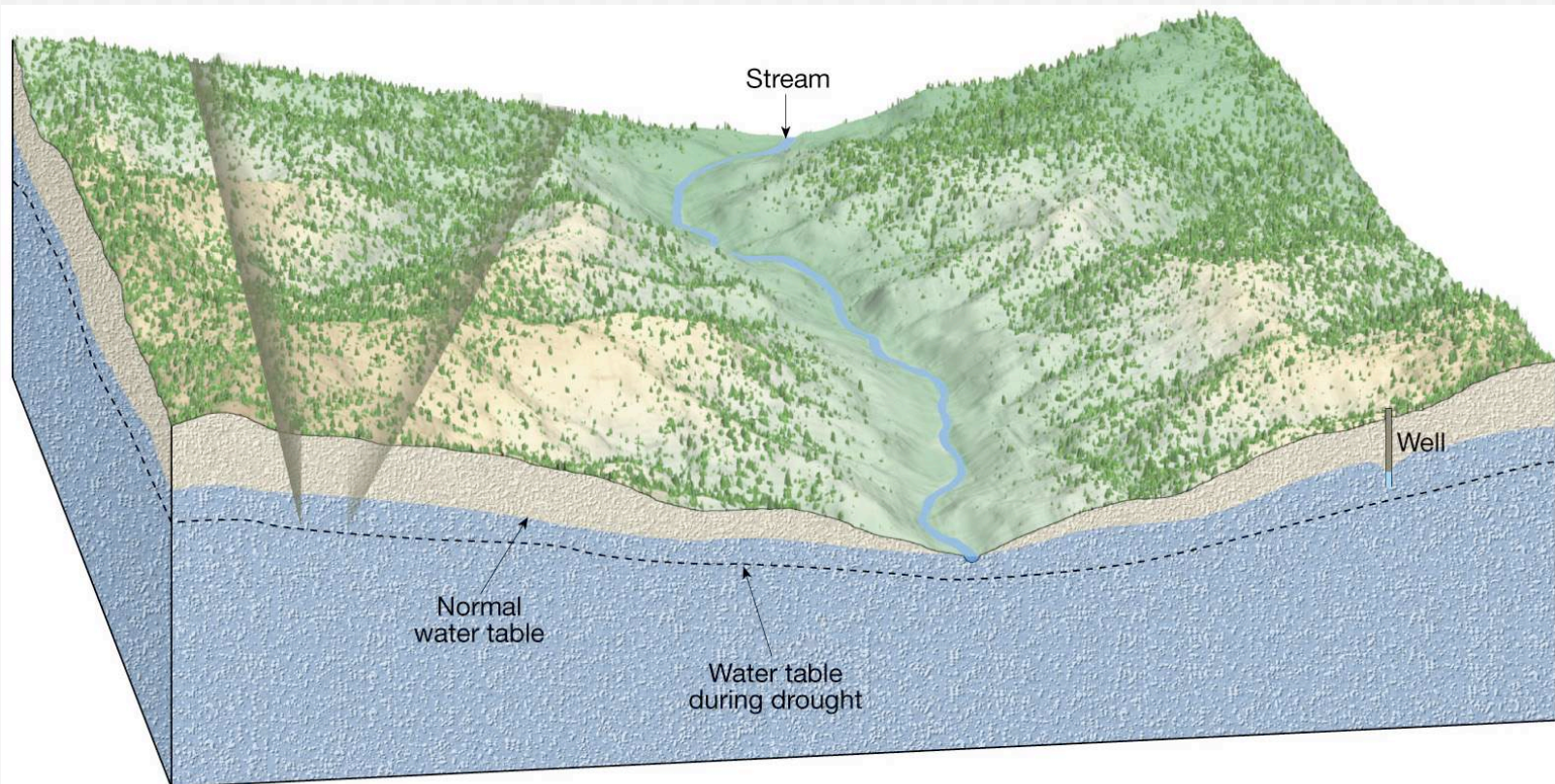


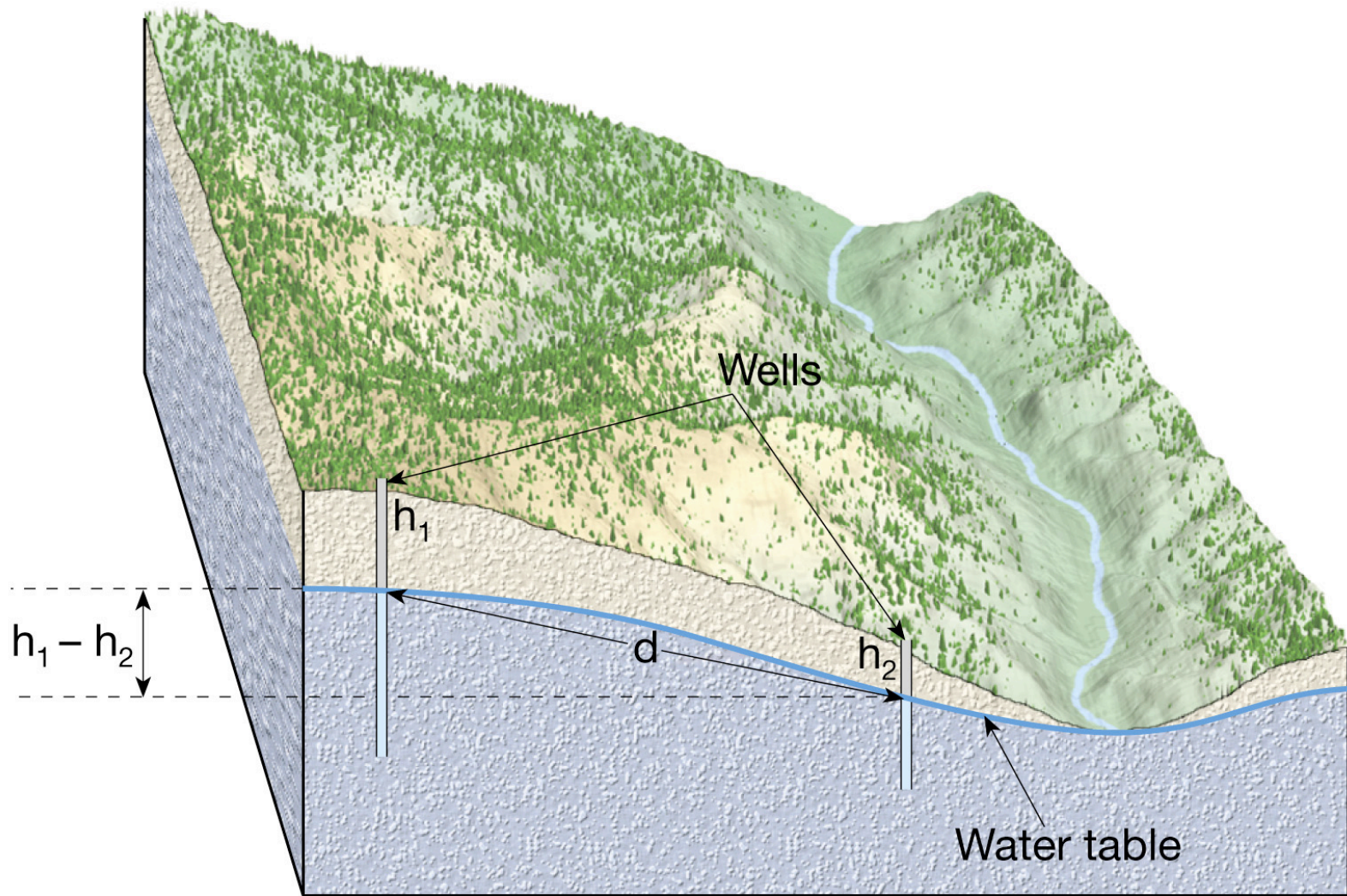
Figure 17.2

The water table



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Hydraulic gradient



$$\text{Hydraulic gradient} = \frac{h_1 - h_2}{d}$$

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Figure 17.6

Storage and movement of groundwater

■ Porosity – openings to store water

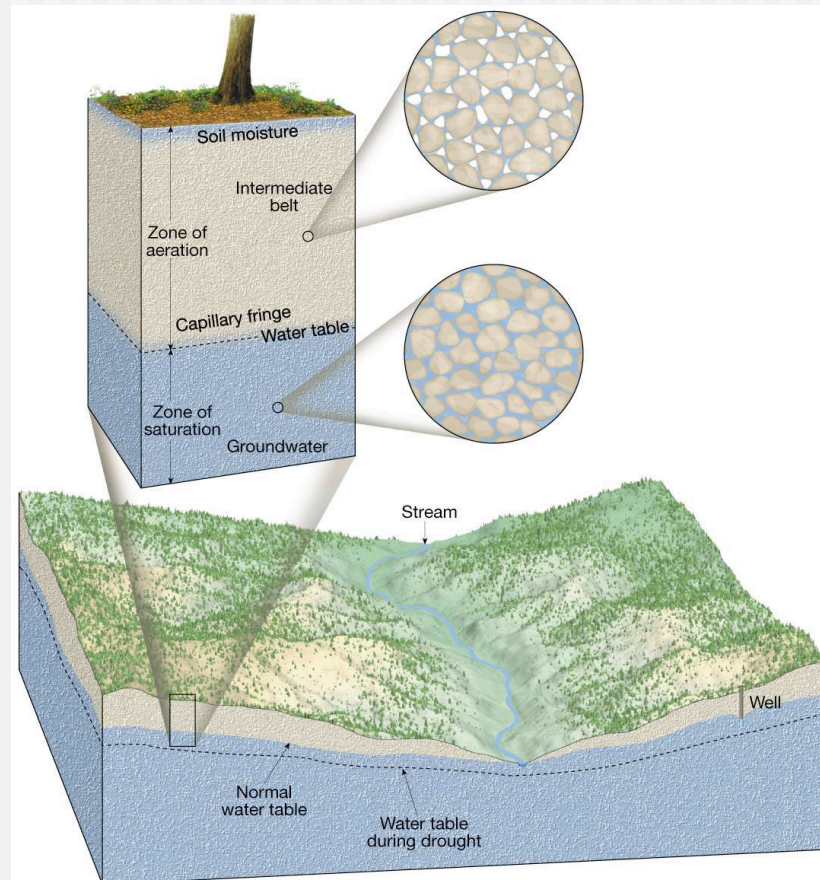


TABLE 17.2 Selected Values of Porosity, Specific Yield, and Specific Retention*

Material	Porosity	Specific Yield	Specific Retention
Clay	50	2	48
Sand	25	22	3
Gravel	20	19	1
Limestone	20	18	2
Sandstone (semiconsolidated)	11	6	5
Granite	0.1	0.09	0.01
Basalt (fresh)	11	8	3

*Values in percent by volume

Source: U.S. Geological Survey Water Supply Paper 2220, 1987

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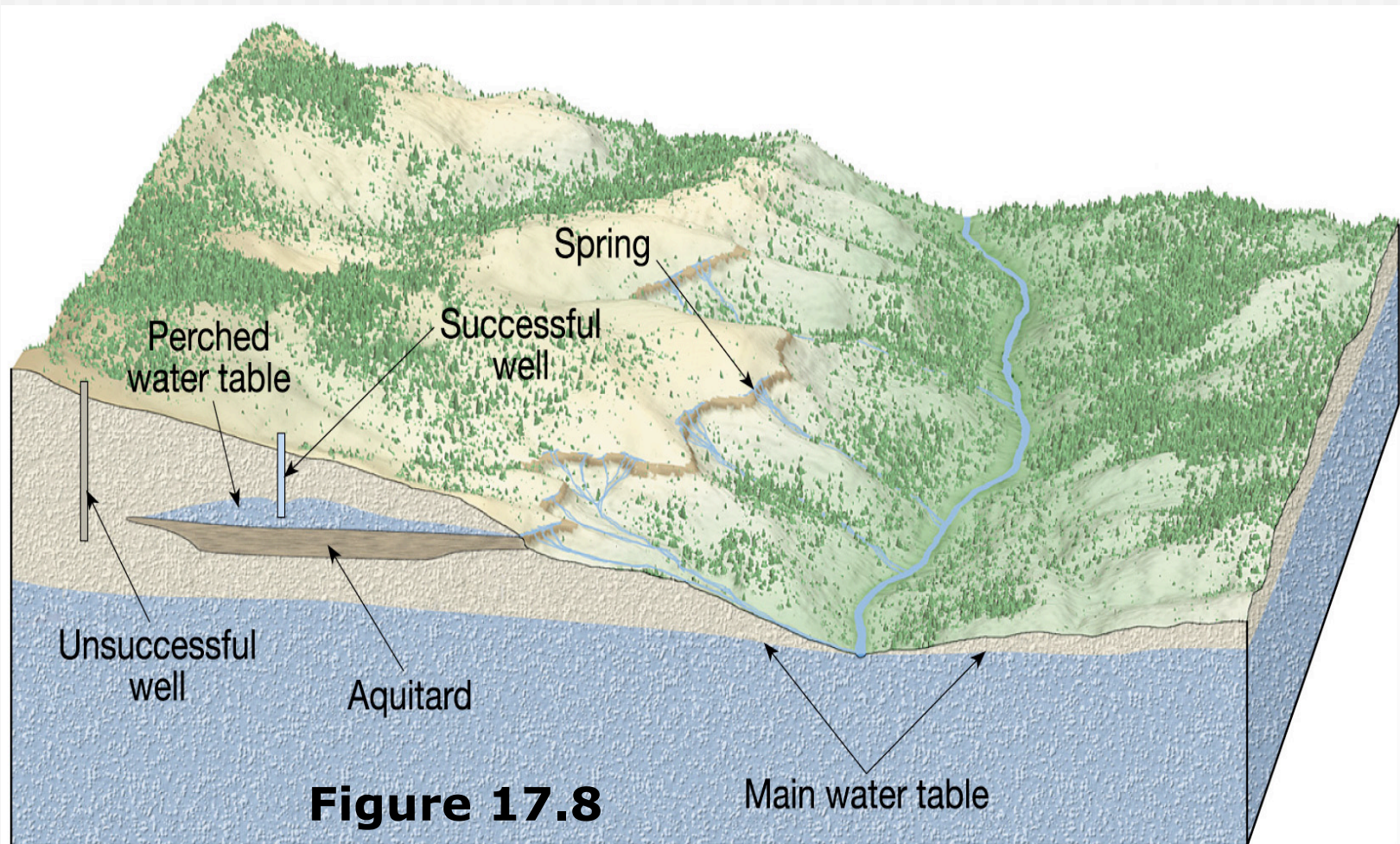
Table 17.2

Storage and movement of groundwater

- **Permeability: rate of flow**
- **The movement of groundwater is measured directly using**
 - **Various dyes**
 - **Carbon-14**



Spring resulting from a perched water table



Unconfined Aquifers

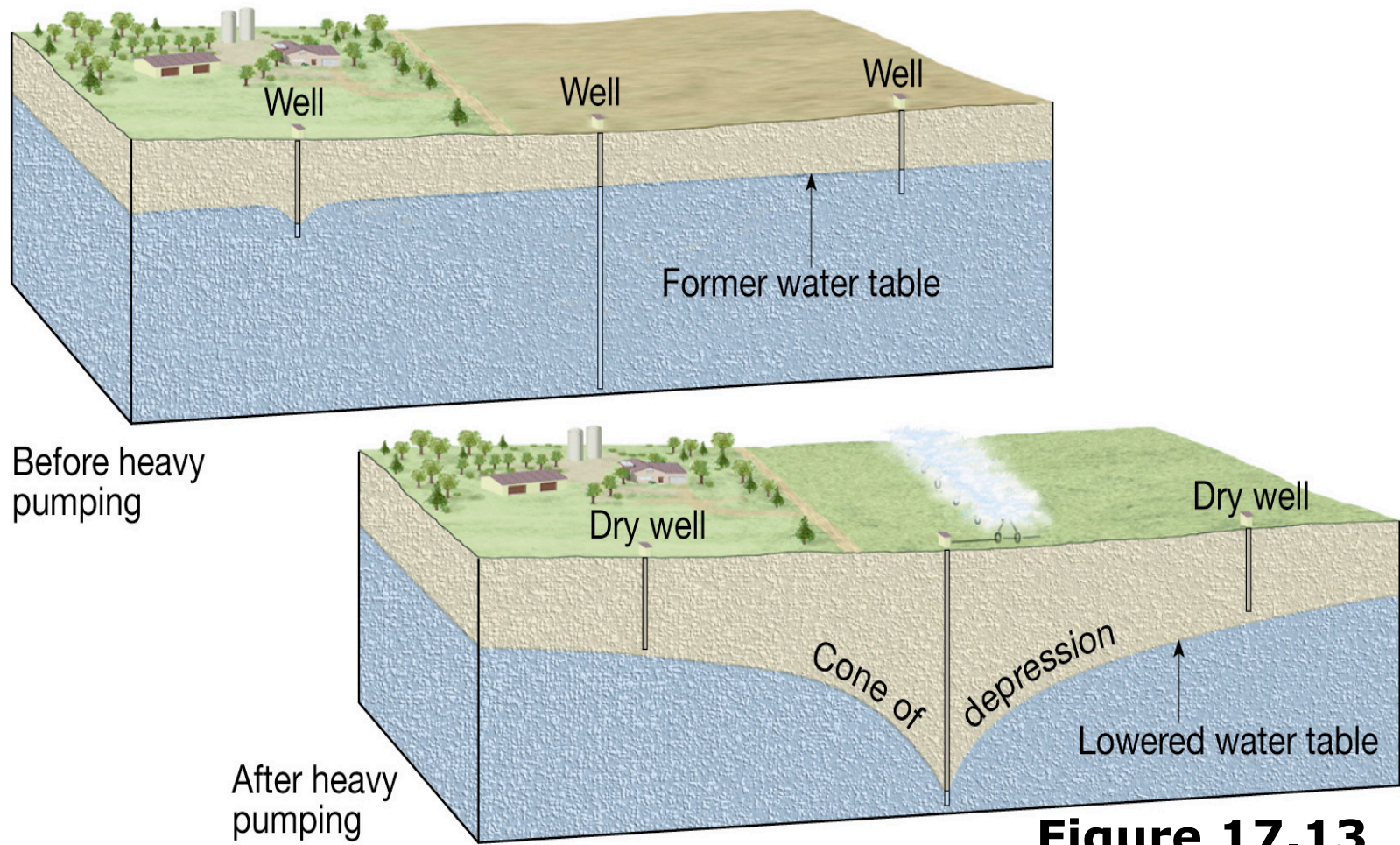


Figure 17.13

Confined Aquifers

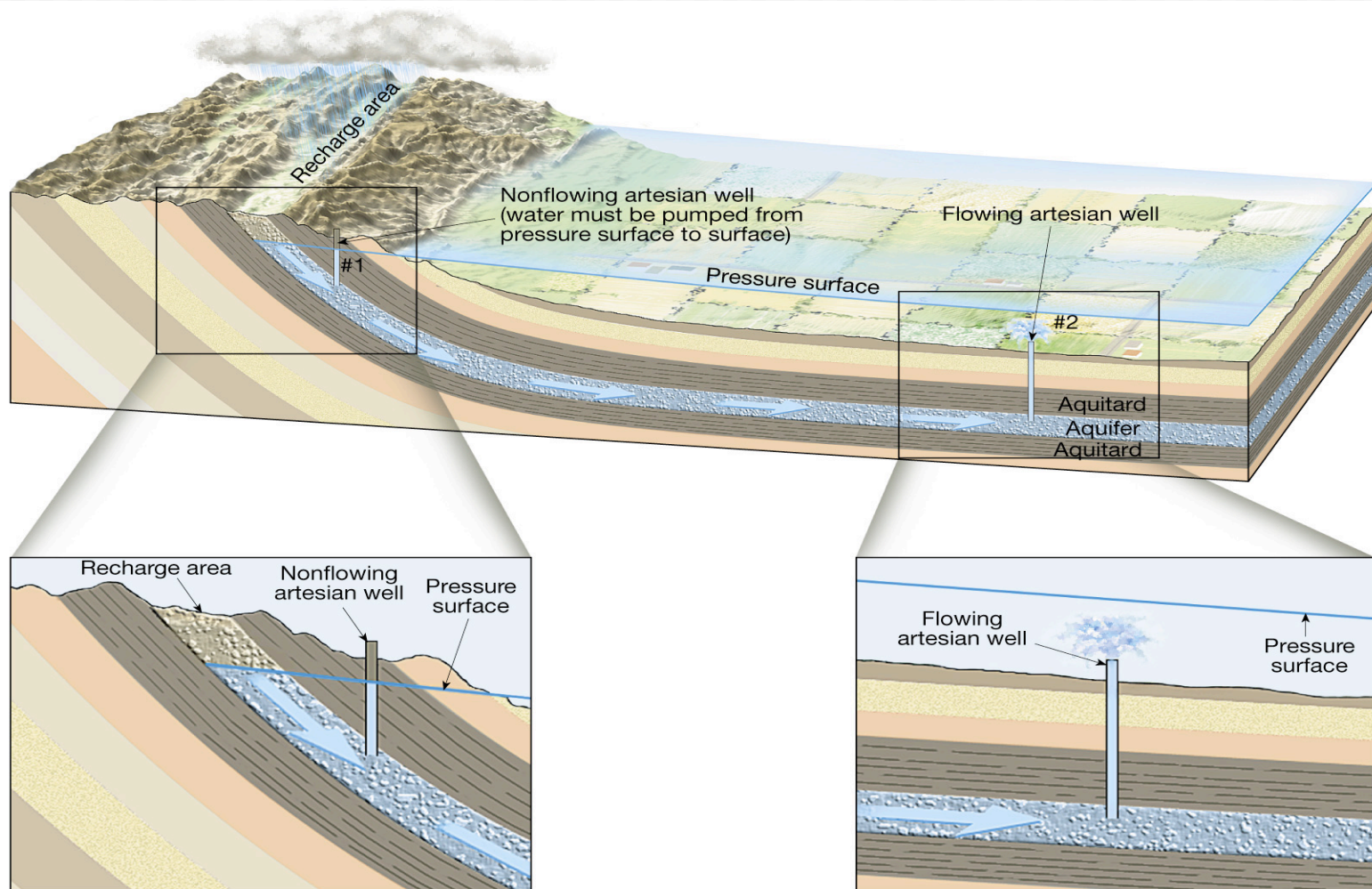


Figure 17.15

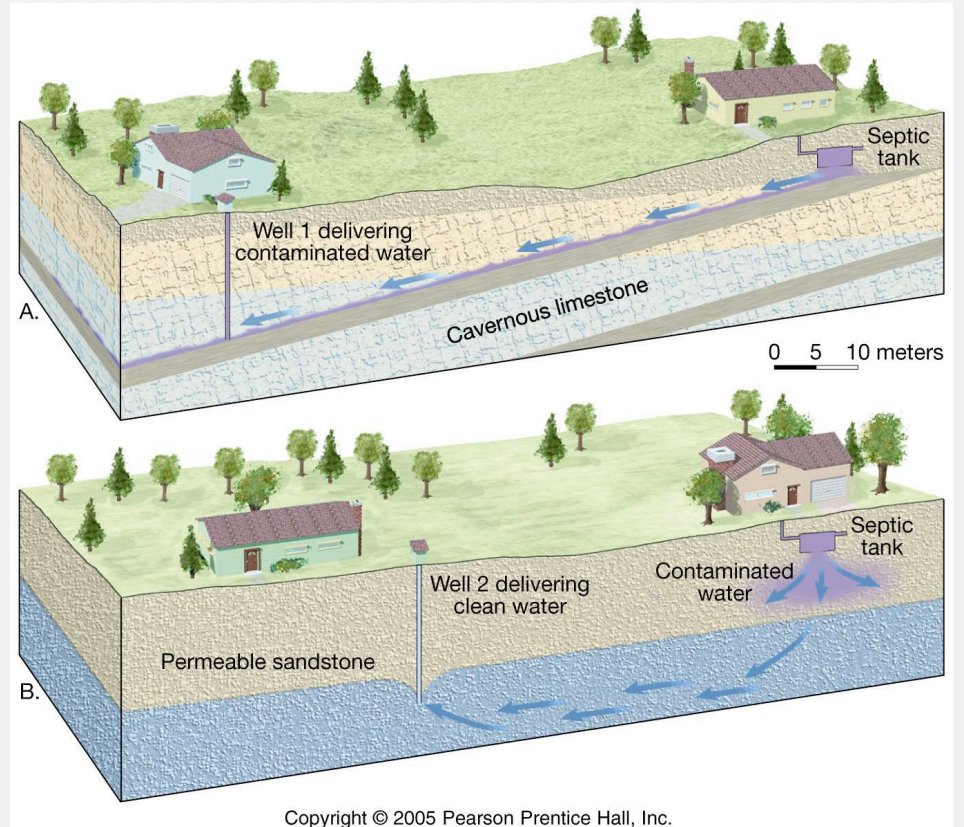
Problems associated with groundwater use



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Saltwater contamination

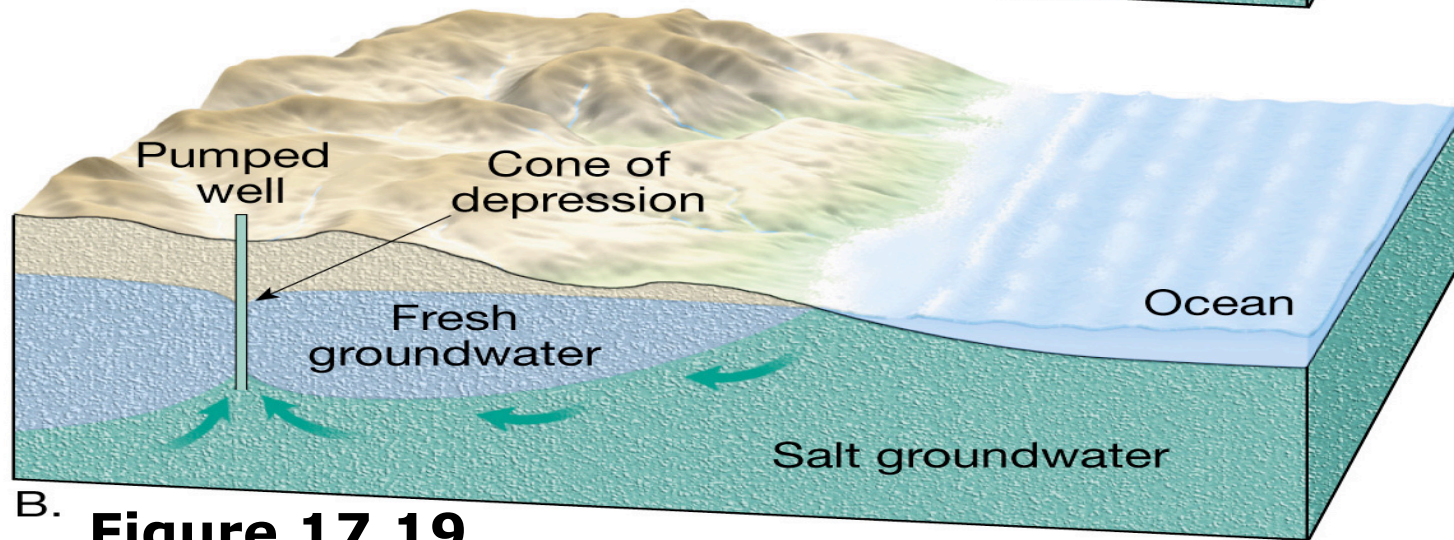
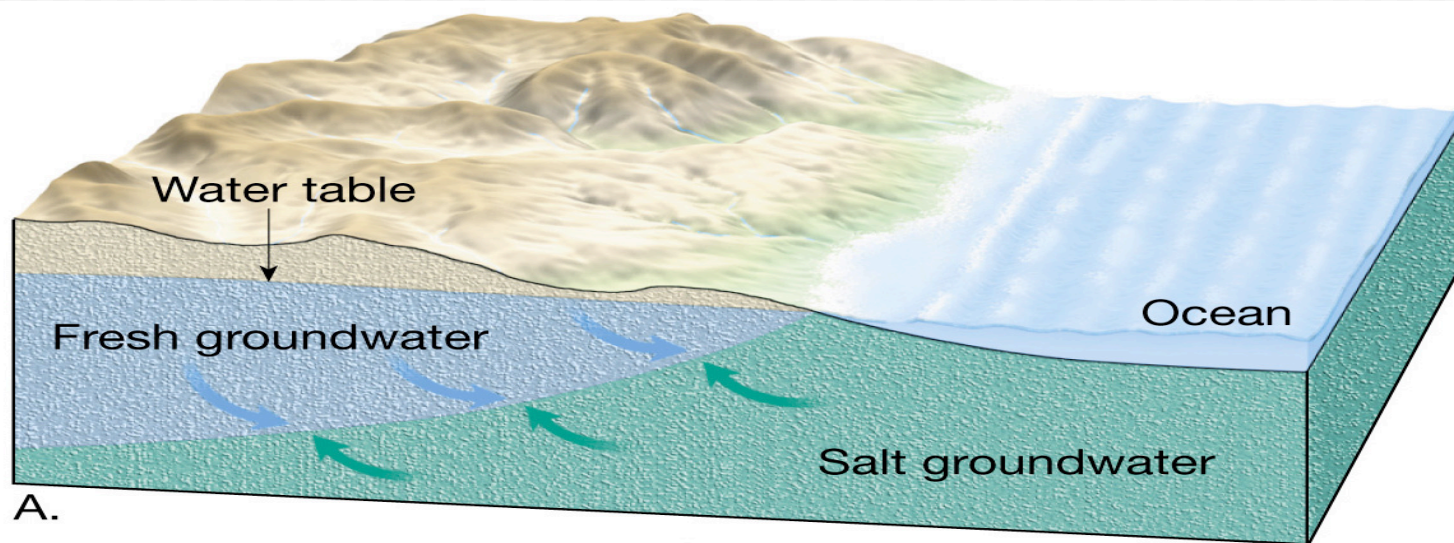
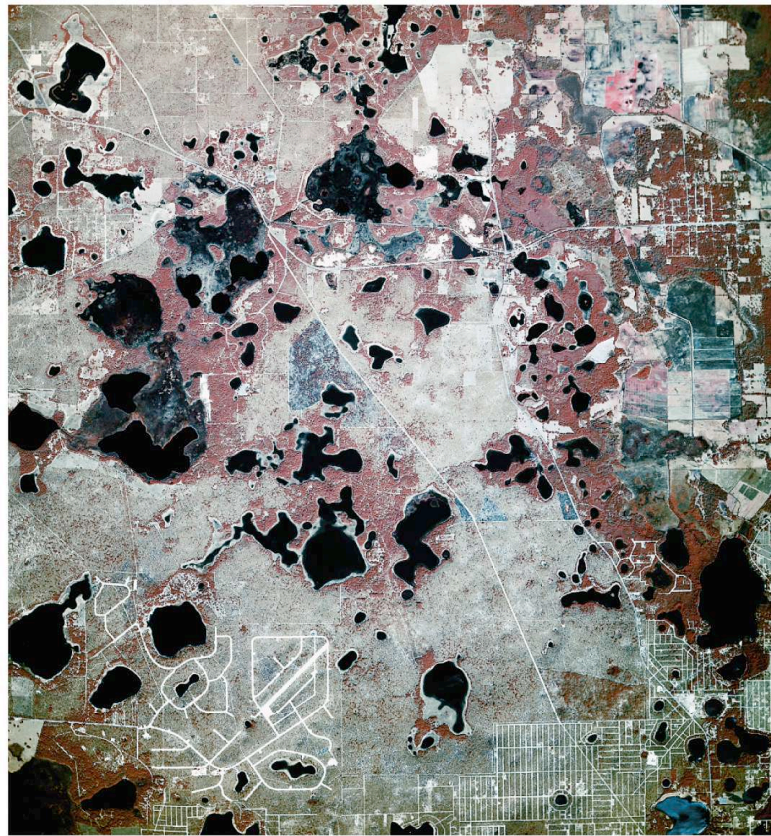


Figure 17.19

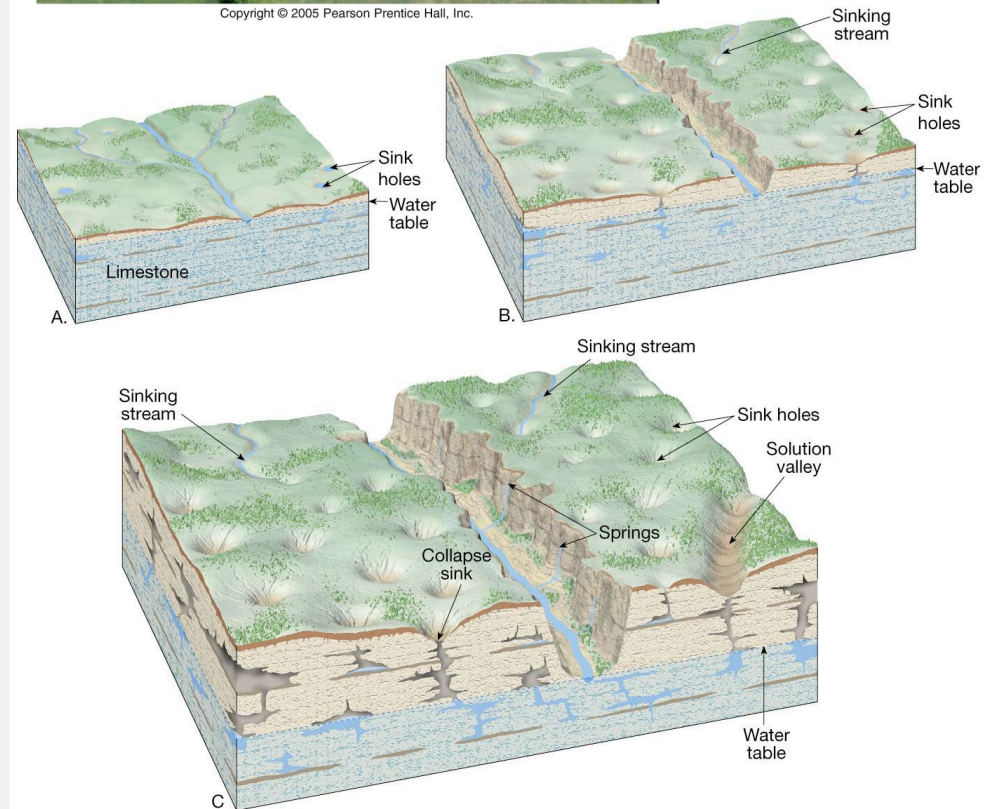
Sinkholes



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Geysers



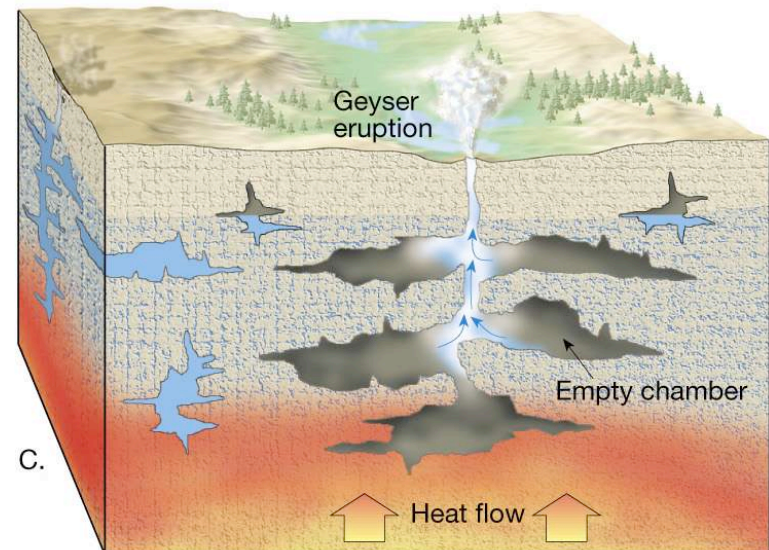
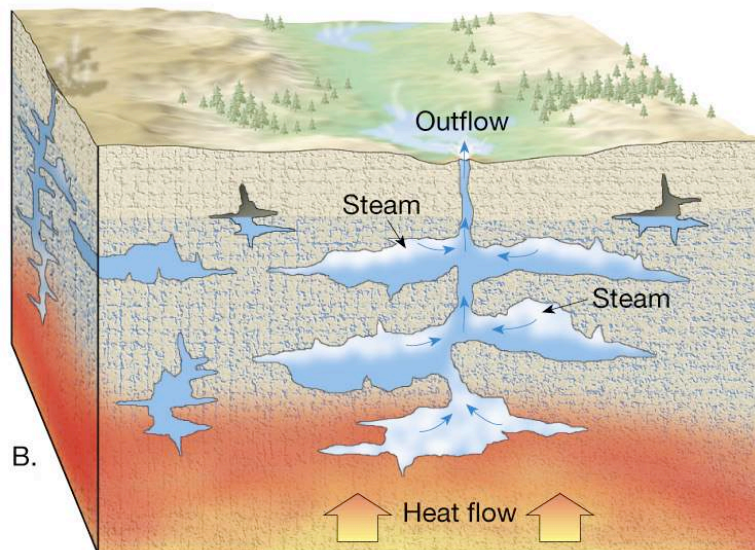
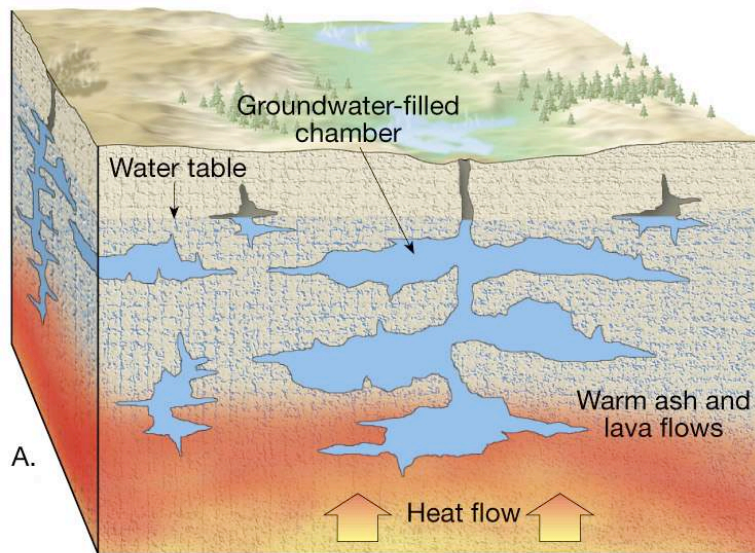
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Travertine & Geyserite

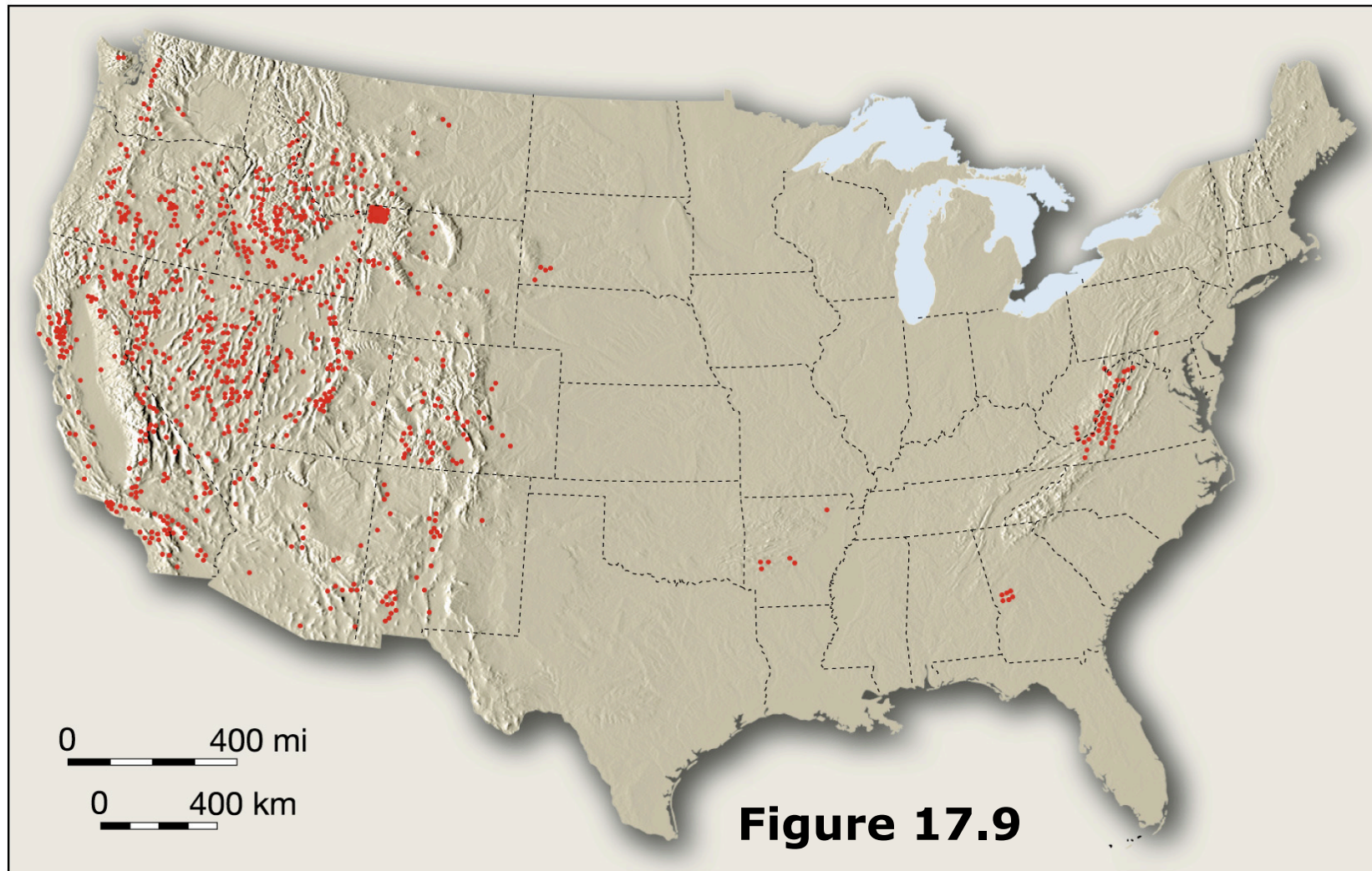


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Formation of Geysers



Distribution of hot springs and geysers in the U.S.



Geologic work of groundwater

- **Caverns-- acidic groundwater**



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Speleothems in Carlsbad Caverns National Park



"Soda straws" in Carlsbad Caverns National Park



End of Chapter 17



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