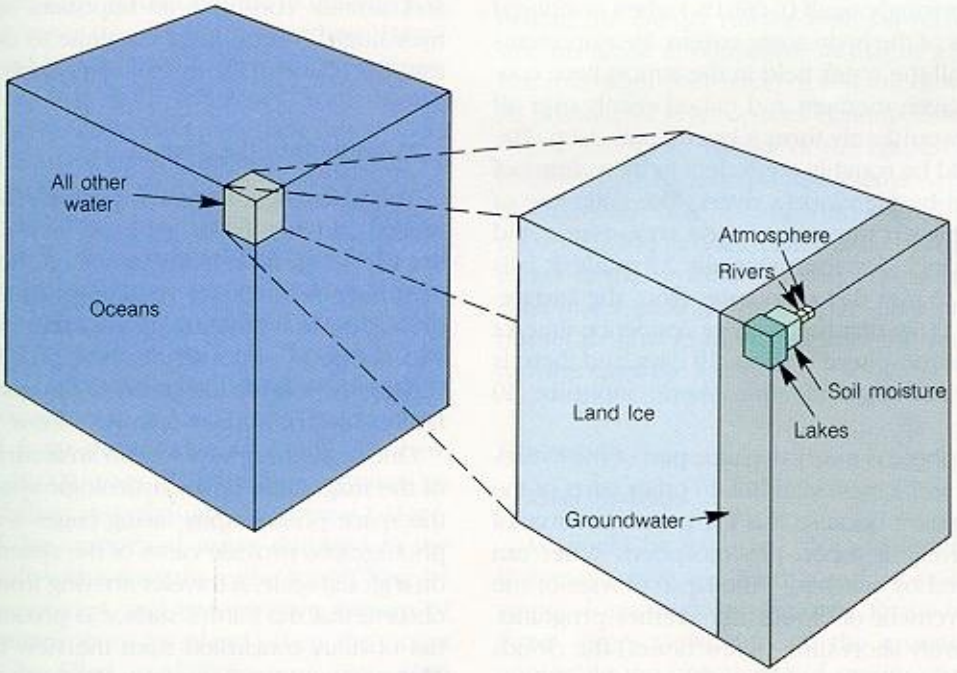



**Figure 2.4**
**The relative amounts of water in each of the major parts of the hydrologic system** can be best appreciated when shown graphically. More than 97% of the water on or near the Earth's surface is in the oceans. Glaciers contain about 1.9%, groundwater—0.5%, rivers and lakes—0.02%, and the atmosphere—0.0001%.

| HİDROSFERİN BÖLÜMÜ | TATLISU HACMİ | TOPLAM TATLISU İÇİNDE PAYI | ÇEVRİMLENME HIZI |
|---|---|---|---|
| Buz levhaları ve buzullar | 24,000,000 | 84,945 | 8000 yıl |
| Yeraltısuyu | 4,000,000 | 14,158 | 280 yıl |
| Göller ve barajlar | 155,000 | 0,549 | 7 yıl |
| Toprak nemi | 83,000 | 0,249 | 1 yıl |
| Atmosferdeki su buharı | 14,000 | 0,049 | 9,9 gün |
| Akarsular | 1,200 | 0,004 | 11,3 gün |

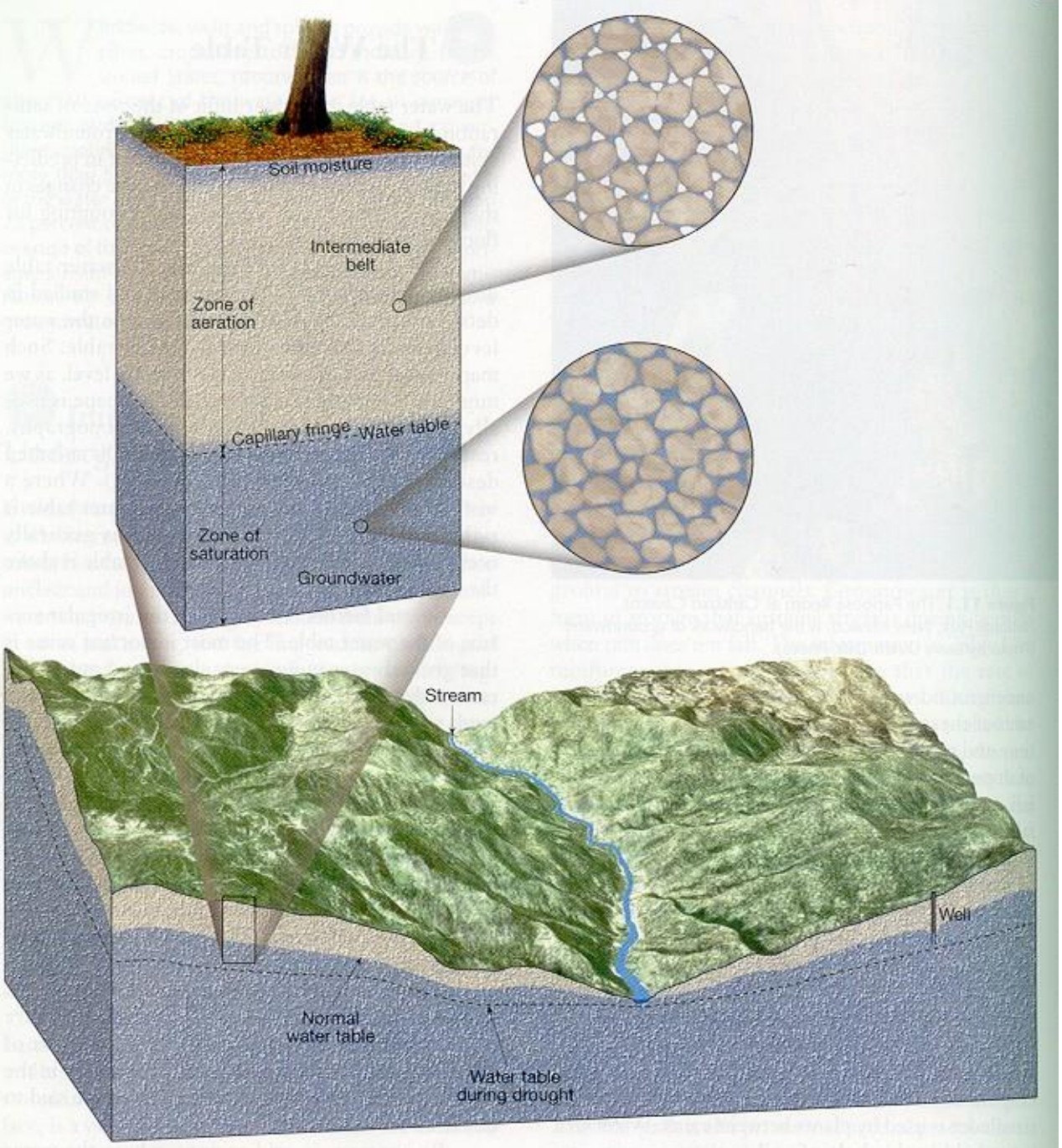



**Figure 11.2** Distribution of underground water. The shape of the water table is usually a subdued replica of the surface topography. During periods of drought, the water table falls, reducing streamflow and drying up some wells.

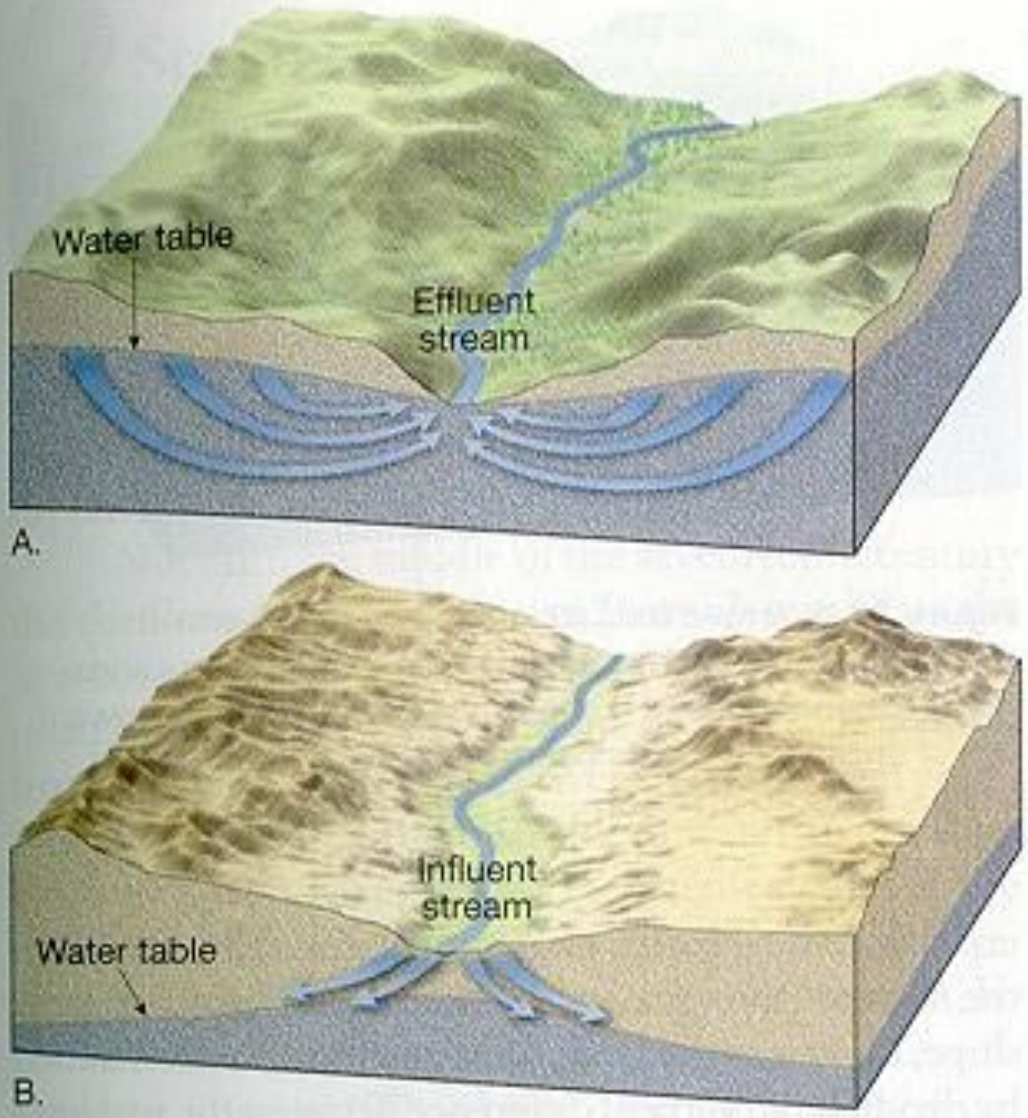



**Figure 11.3** A. Effluent streams are characteristic of humid areas and are supplied by water from the zone of saturation. B. Influent streams are found in deserts. Seepage from such streams produces an upward bulge in the water table.

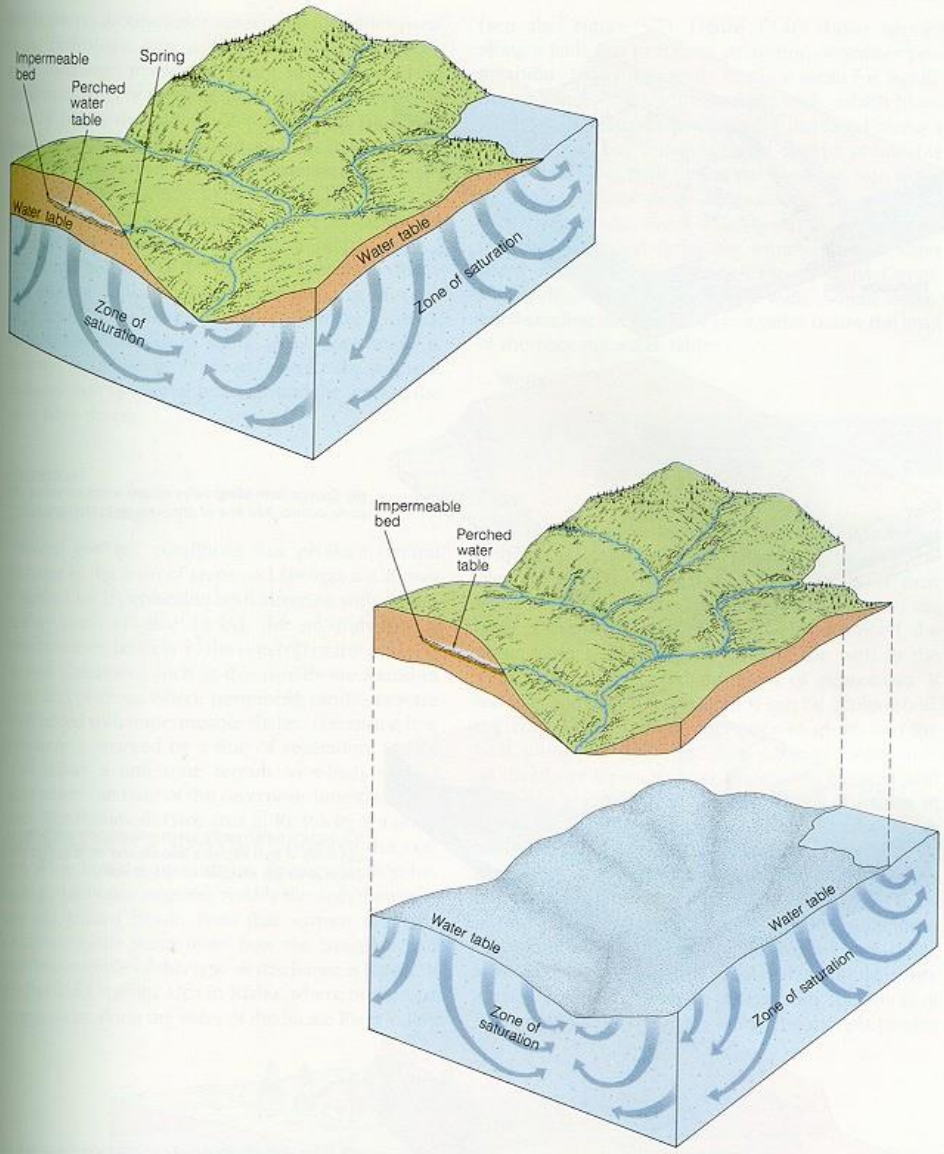



**Figure 13.3**
**The movement of groundwater** is directed toward areas of least pressure. In the idealized system depicted here, groundwater moves downward to the water table (by the pull of gravity) and then moves toward areas of least pressure. The configuration of the water table has a strong influence on the direction of movement. In most areas, the water table is a subdued replica of the topography: the exploded view (B) shows high and low areas in the water table much like the hills and valleys on the surface. Differences in the height of the water table cause differences in the pressure on water in the saturation zone at a given point. Water thus moves downward beneath the high areas of the water table (because of the higher pressure) and upward beneath the low areas. It commonly seeps into streams, lakes, and swamps, where the table is near the surface. In areas where the water table is low, water from streams and lakes moves downward toward the zone of saturation. A line of springs and seeps commonly occurs where an impermeable rock layer that has formed a perched water table is exposed at the surface.

**Table 11.2** Selected Values of Porosity, Specific Yield, and Specific Retention*

| Material | Porosity | Specific Yield | Specific Retention |
|---|---|---|---|
| Soil | 55 | 40 | 15 |
| 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 perc
SOURCE: U.S.

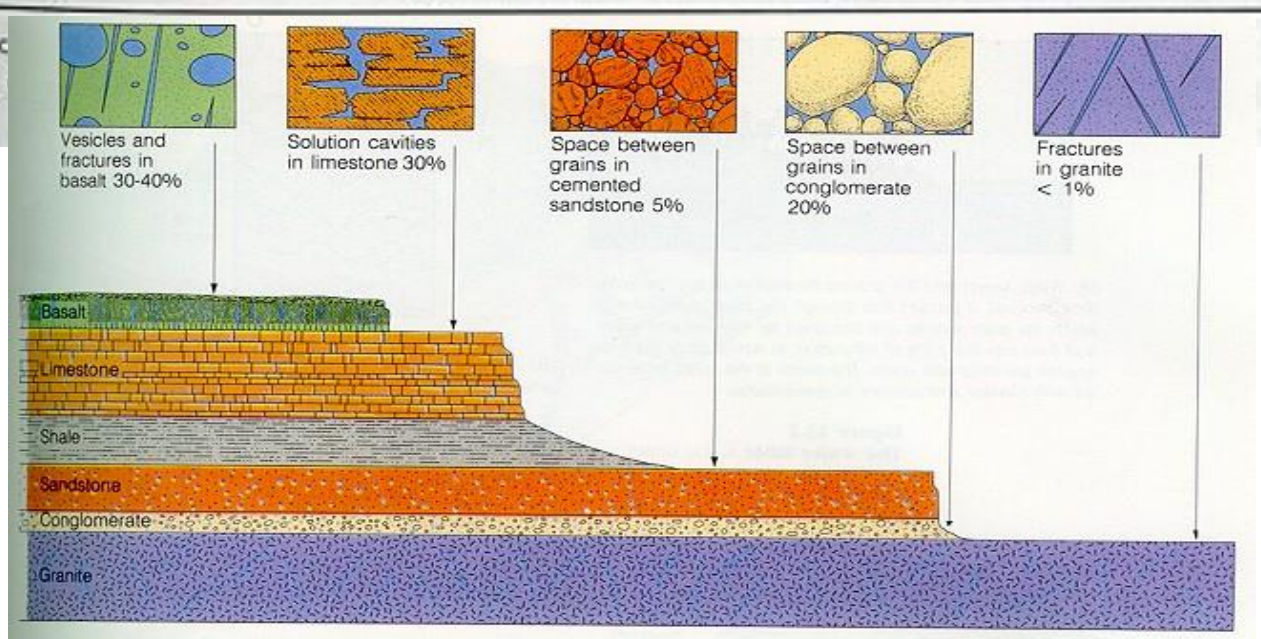



**Figure 13.1**
**Various types of pore spaces** in rocks permit the flow of groundwater. Porosity resulting from vesicles is common in basalt. Porosity resulting from solution activity is common in limestones. Porosity resulting from spaces between grains is exemplified in sandstone and conglomerate. Porosity resulting from fractures occurs in almost all rocks.

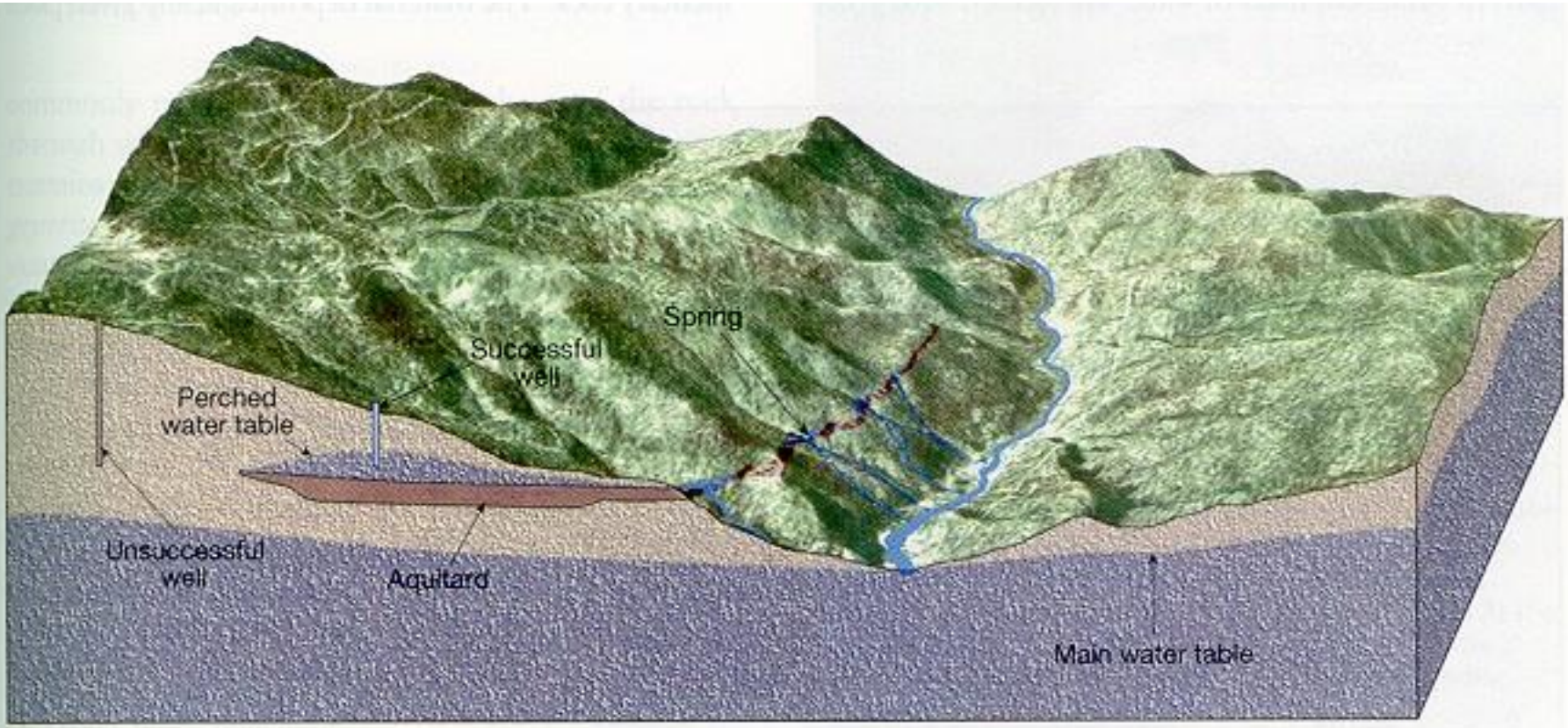
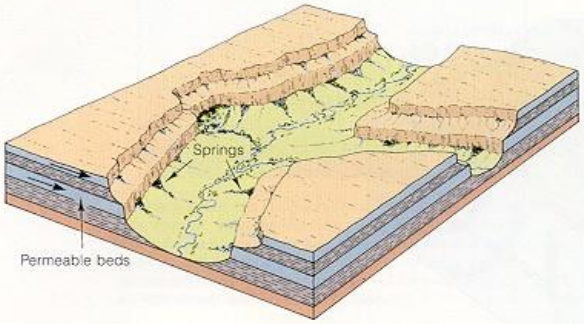
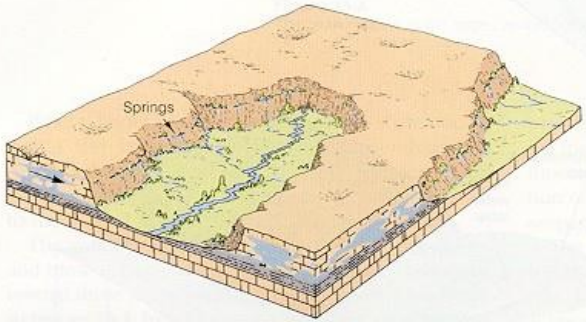
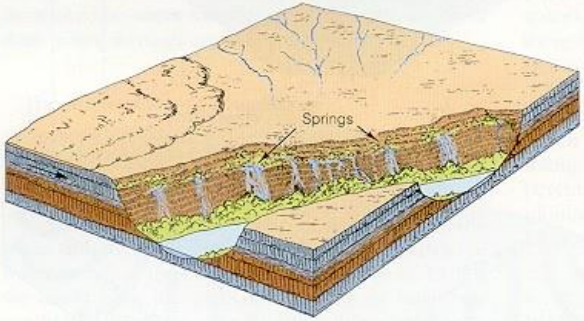


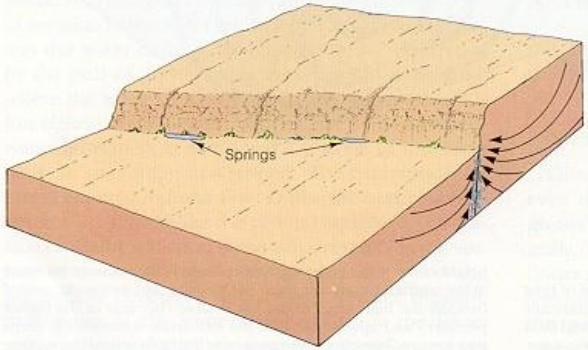

**Figure 11.6** When an aquitard is situated above the main water table, a localized zone of saturation may result. Where the perched water table intersects the side of the valley, a spring flows. The perched water table also caused the well on the right to be successful, whereas the well on the left will be unsuccessful unless it is drilled to a greater depth.




*(A) A spring line develops on valley walls where impermeable beds cause groundwater in permeable layers to migrate laterally and eventually seep out at the surface.*



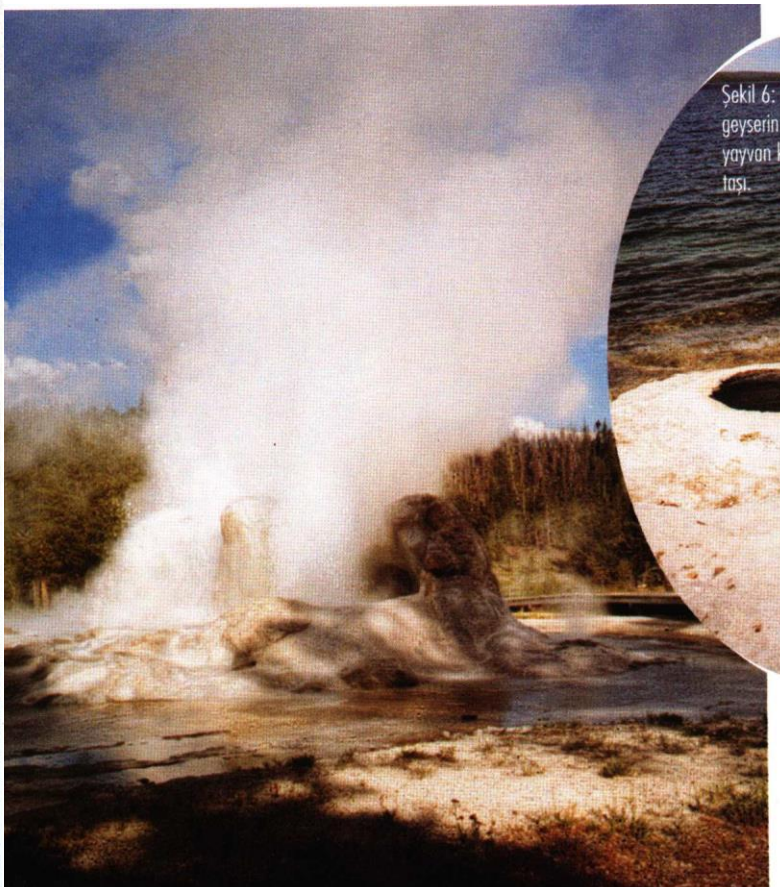




*placed next to permeable beds. A spring line commonly results as groundwater migrates upward along a fault line.*

**Figure 13.4**
**Springs** can be produced under a variety of geologic conditions, some of which are illustrated in the block diagrams here. They are natural discharges of the groundwater reservoir and introduce a significant volume of water to surface runoff.

**Figure 13.7**
**The Thousand Springs, Snake River Canyon, Idaho,** issue from the north wall of the canyon and are fed by water from the mountains apparently 400 km to the northeast.



Şekil 6: Faaliyeti kesilmiş bir geyserin bacası etrafında birikmiş yayvan koni şeklinde geyserit taşı.

5: Fışkırmaya başlayan geyser.

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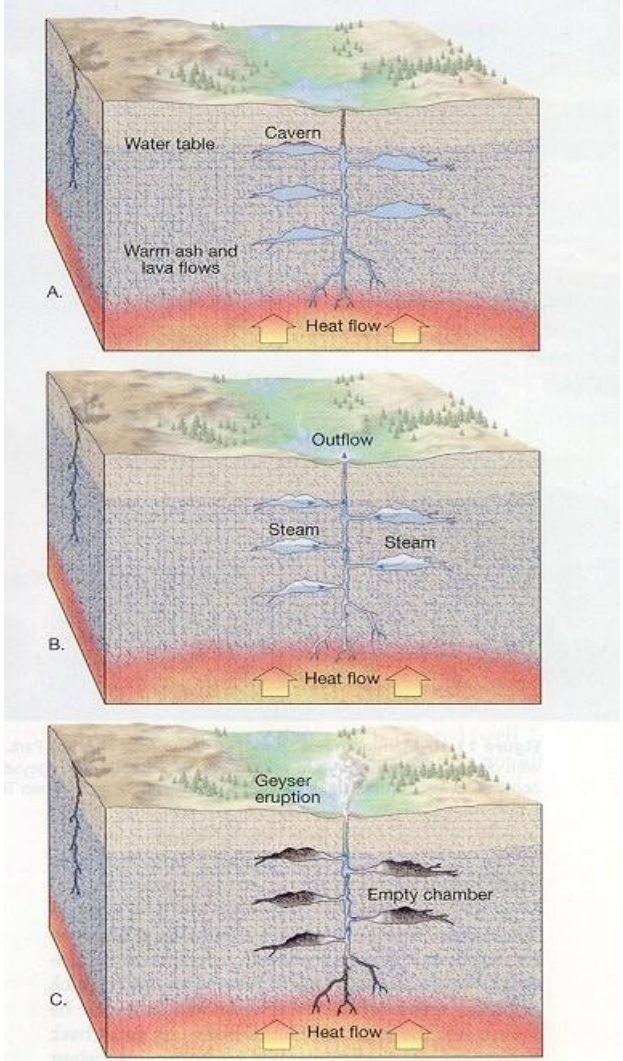



**Figure 11.9** Idealized diagrams of a geyser. A geyser can form if the heat is not distributed by convection. **A.** In this figure, the water near the bottom is heated to near its boiling point. The boiling point is higher there than at the surface because the weight of the water above increases the pressure. **B.** The water higher in the geyser system is also heated; therefore, it expands and flows out at the top, reducing the pressure on the water at the bottom. **C.** At the reduced pressure on the bottom, boiling occurs. Some of the bottom water flashes into steam, and the expanding steam causes an eruption.

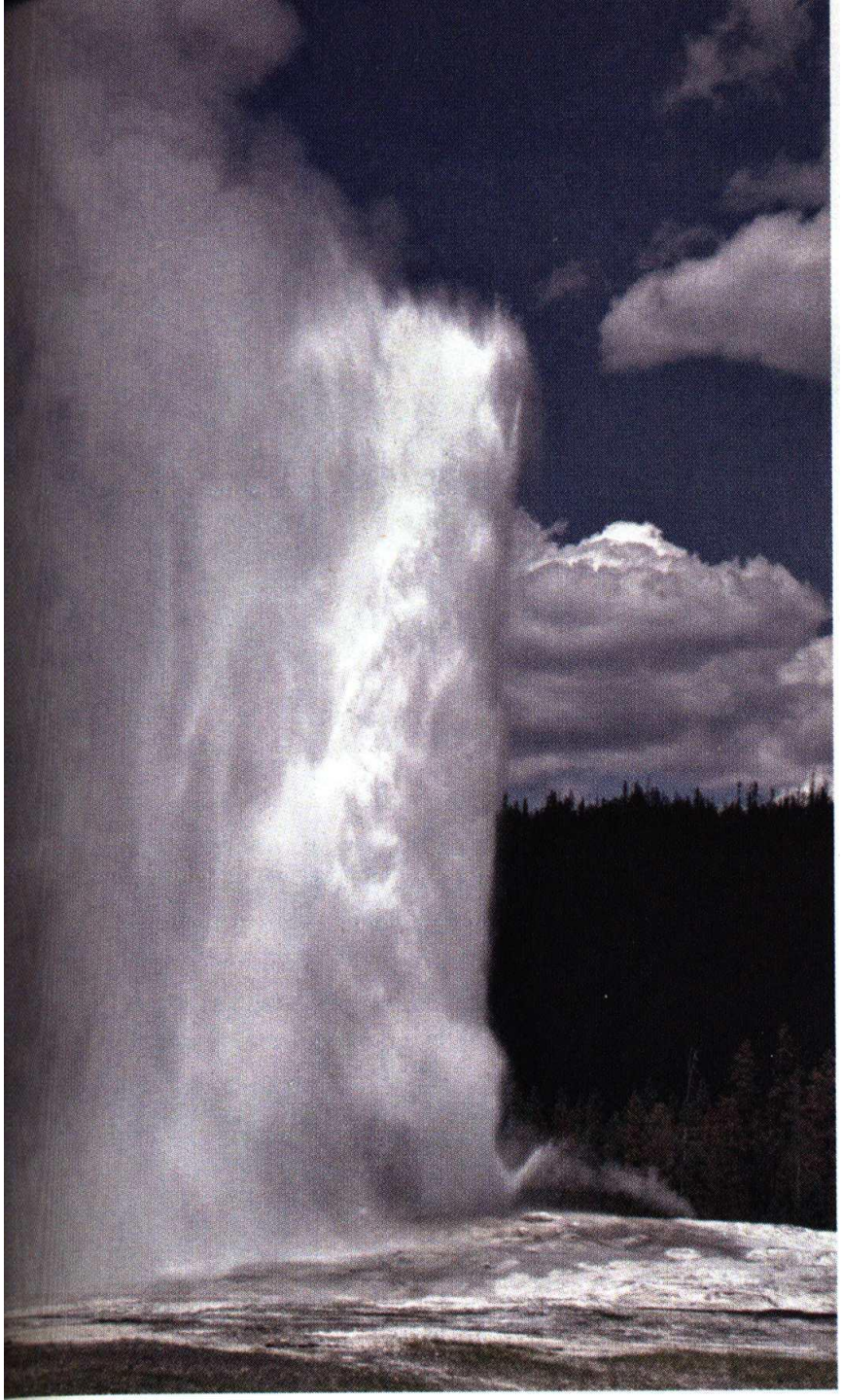


**Figure 13.21**
**Mammoth Hot Springs,** Yellowstone National Park, was formed by the deposition of travertine ($CaCO_3$) as the warm spring water cooled and evaporated.

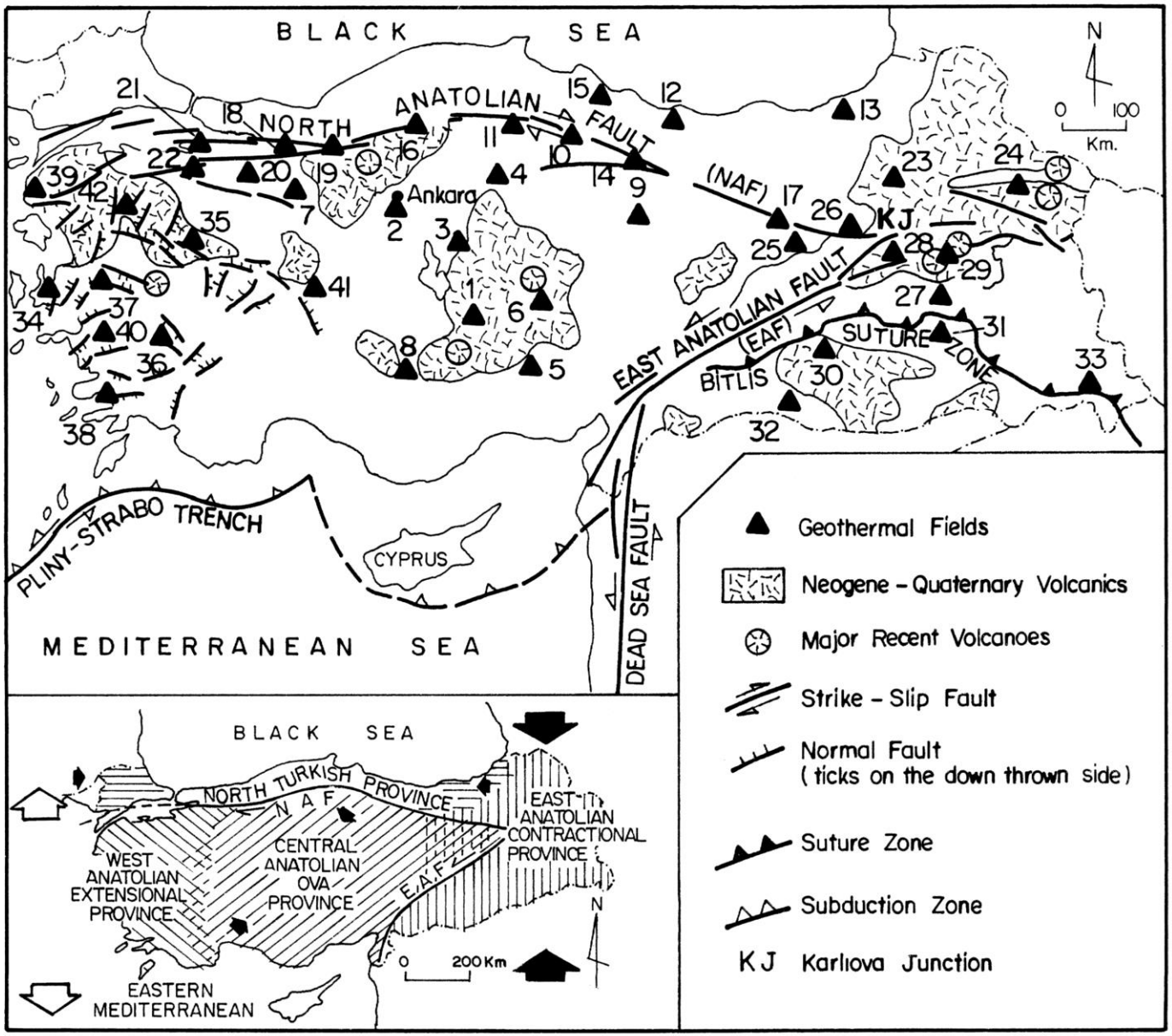



Fig. 1. Distribution of geothermal areas in Turkey in connection with the major tectonic and volcanic features (modified from MTA, 1993). Inset map is from Şengör et al. (1985) and shows the major neotectonic provinces of Turkey. (1) Aksaray, (2) Ankara, (3) Kırşehir, (4) Yozgat, (5) Niğde, (6) Nevşehir, (7) Eskişehir, (8) Konya, (9) Sivas, (10) Amasya, (11) Çorum, (12) Ordu, (13) Rize, (14) Tokat, (15) Samsun, (16) Çankırı, (17) Erzincan, (18) Sakarya, (19) Bolu, (20) Bilecik, (21) Yalova, (22) Bursa, (23) Erzurum, (24) Ağrı, (25) Tunceli, (26) Bingöl, (27) Bitlis, (28) Muş, (29) Van, (30) Diyarbakır, (31) Siirt, (32) Urfa, (33) Hakkari, (34) İzmir, (35) Kütahya, (36) Denizli, (37) Manisa, (38) Muğla, (39) Çanakkale, (40) Aydın, (41) Afyon, (42) Balıkesir.

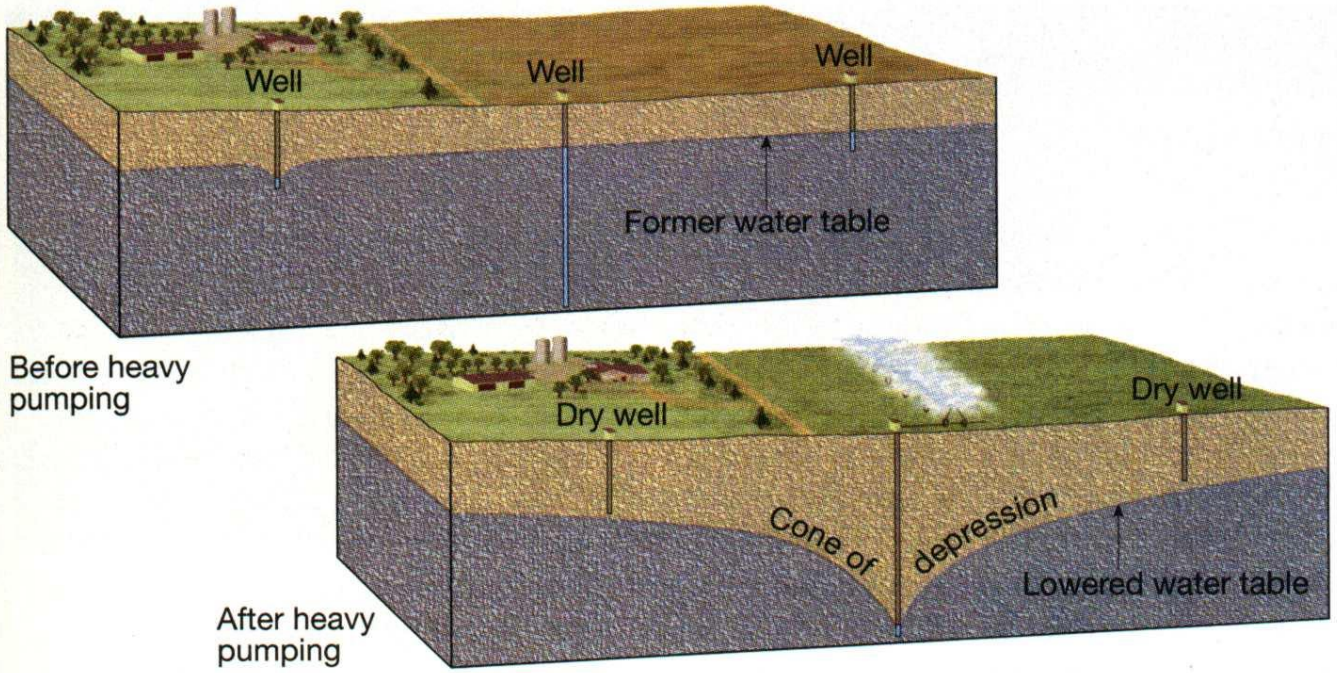



**Figure 11.11** A cone of depression in the water table often forms around a pumping well. If heavy pumping lowers the water table, the shallow wells may be left dry.

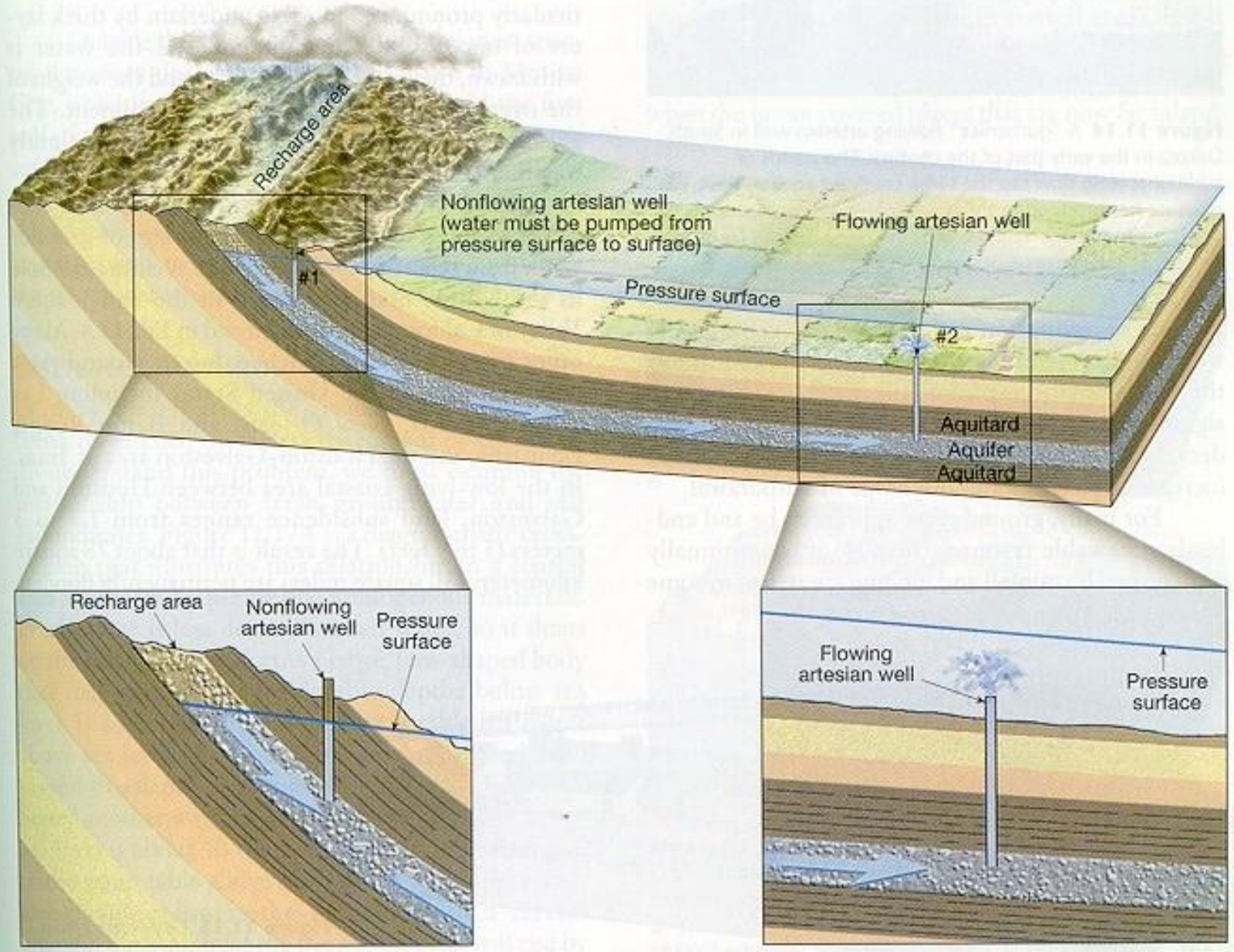



**Figure 11.13** Artesian systems occur when an inclined aquifer is surrounded by impermeable beds.

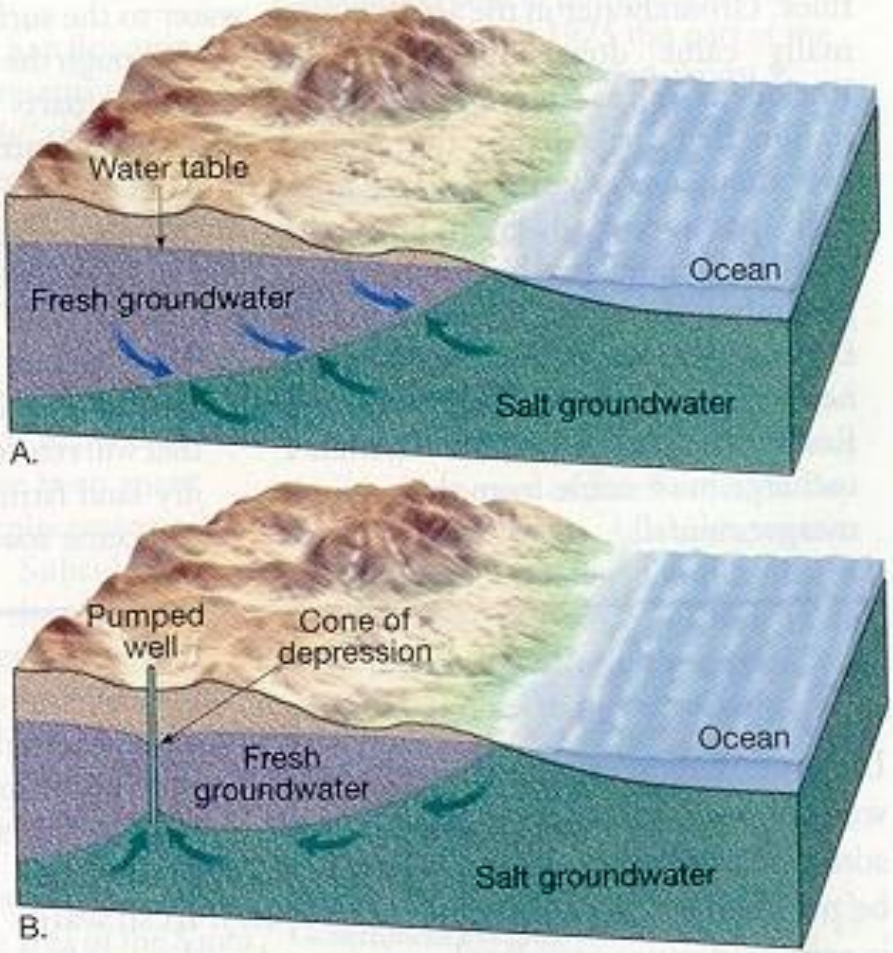



**Figure 11.17** **A.** Because fresh water is less dense than salt water, it floats on the salt water and forms a lens-shaped body that may extend to considerable depths below sea level. **B.** When excessive pumping lowers the water table, the base of the freshwater zone will rise by 40 times that amount. The result may be saltwater contamination of wells.


1925
1955
SAN JOAQUIN VALLEY
CALIFORNIA
BM 5461
SUBSIDENCE, BM
1925-1977
1977

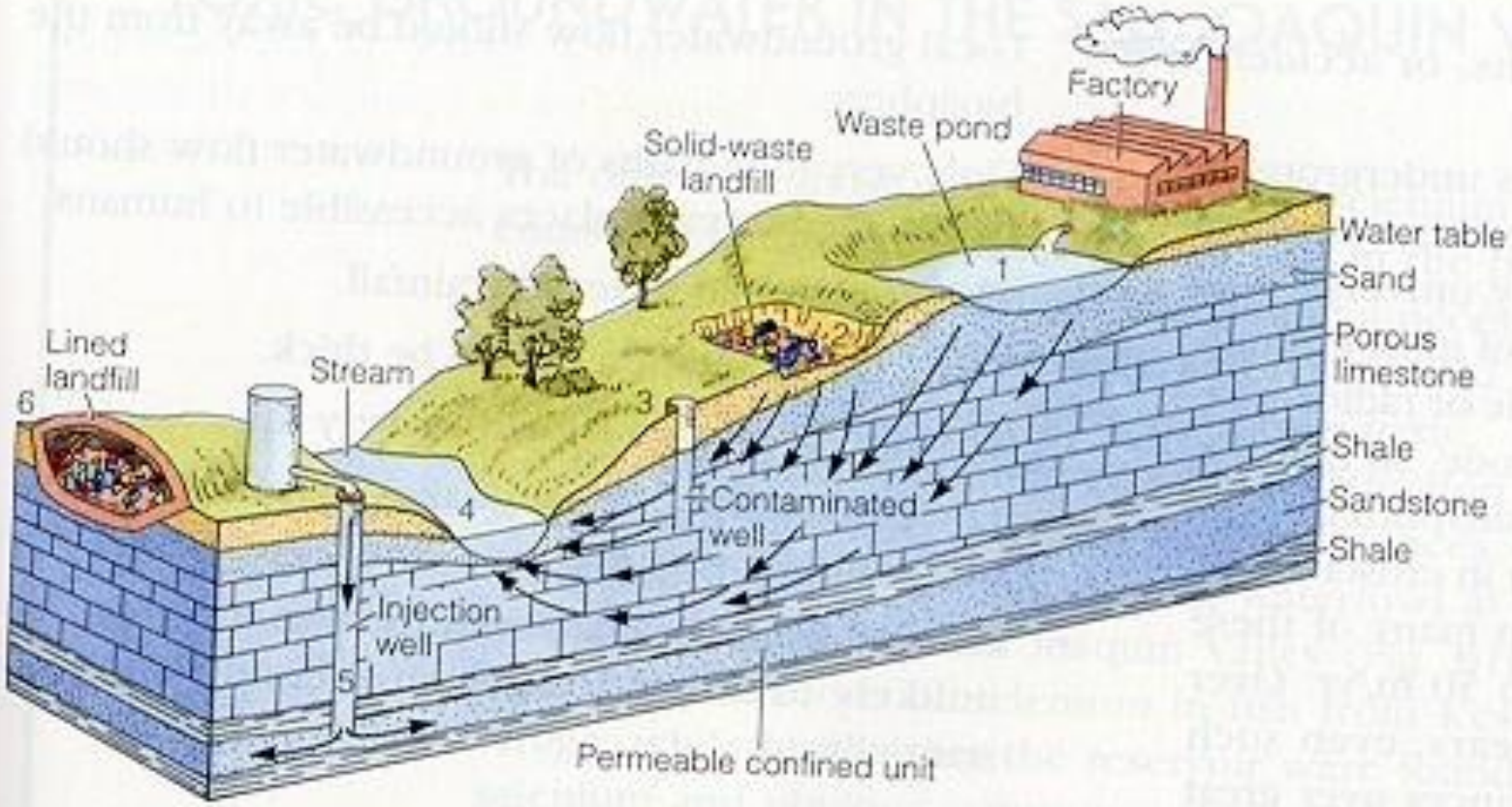



**FIGURE 10.18** A groundwater system contaminated by toxic wastes. Toxic chemicals in an open waste pond (1) and an unlined landfill (2) percolate downward and contaminate an underlying aquifer. Also contaminated are a well downslope (3) and a stream (4) at the base of the hill. Safer, alternative approaches to waste management include injection into a deep confined rock unit (5) that lies well below aquifers used for water supplies, and a carefully engineered surface landfill (6) that is fully lined to prevent downward seepage of wastes. Because neither of the latter approaches is completely foolproof, constant monitoring at both sites would be required.

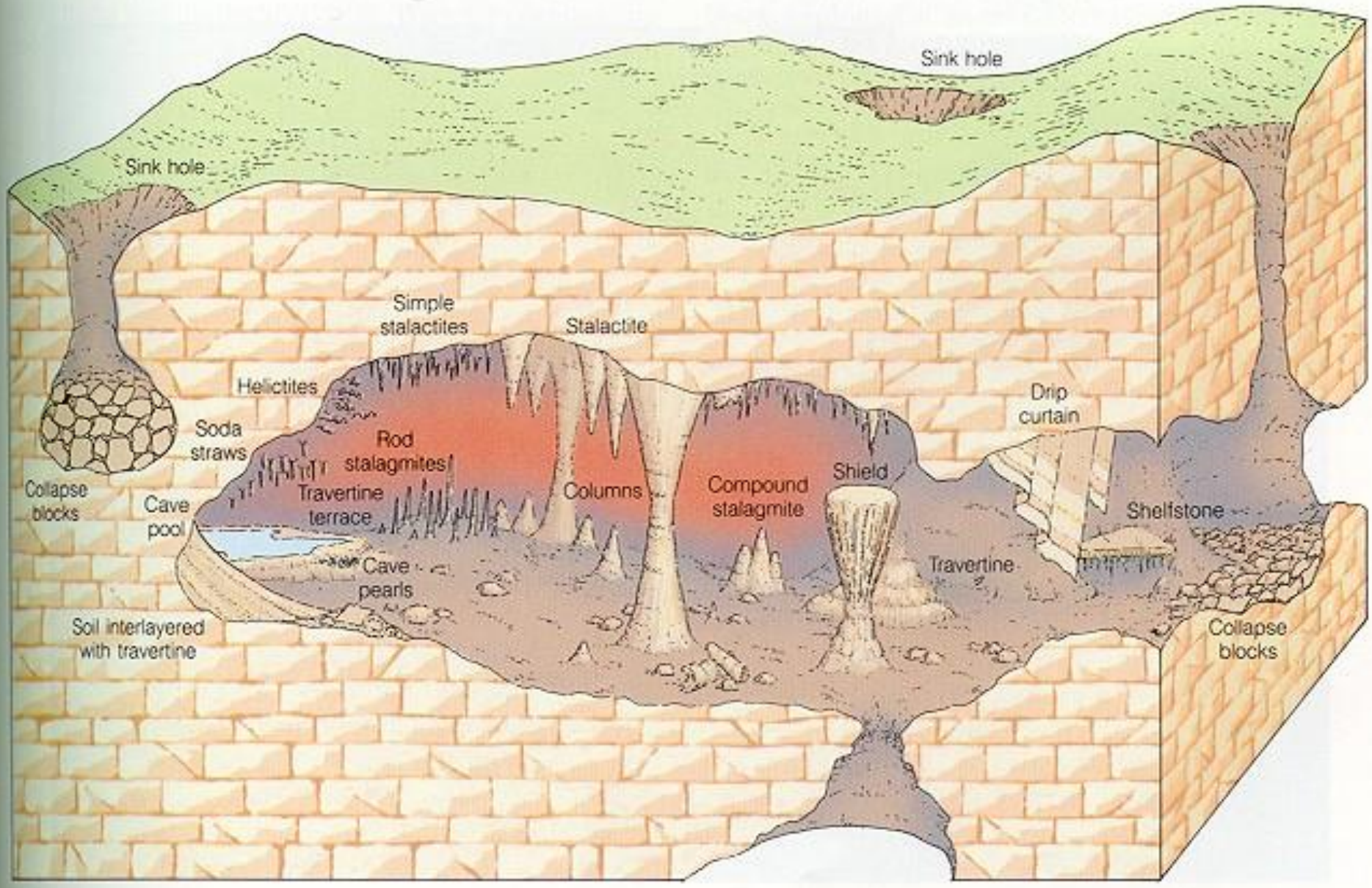
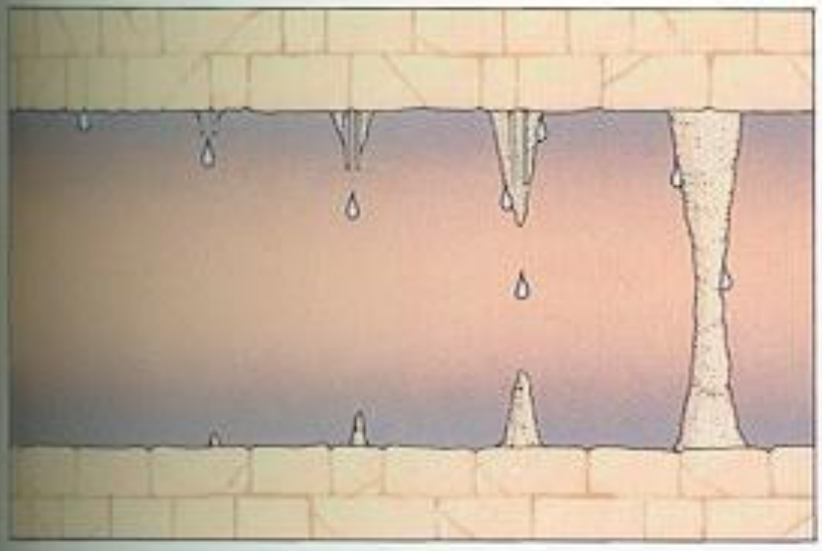



**Figure 13.18**
**Many varieties of cave deposits** have been recognized. All of them are composed of calcite deposited by water that seeps into the cave and then evaporates.



*(A) Diagram showing the evolution of stalagtites— stalagmites— columns.*

*(B) Photograph of long slender stalagtites (soda straws) which grow as the drop of water suspended at the end evaporates.*

**Figure 13.17**
**Dripstone** originates on the ceilings of caves. Water seeps through a crack and partially evaporates. This causes a small ring of calcite to be deposited around the crack. The ring grows into a tube, which commonly acquires a tapering shape, as water seeps from adjacent areas and flows down its outer surface.

A.

B.

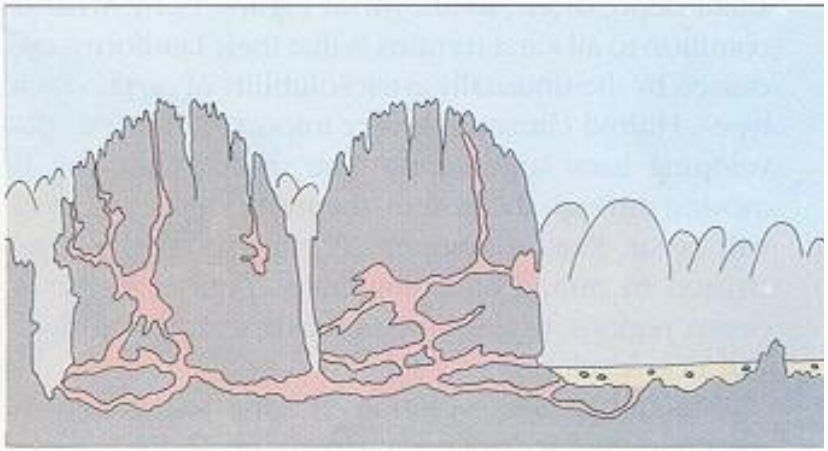
**Figure 11.23** A. This high-altitude infrared image shows an area of karst topography in central Florida. The numerous lakes occupy sinkholes. (Courtesy of USDA–ASCS) B. This small sinkhole formed suddenly in 1991 when the roof of a cavern collapsed, destroying this home in Frostproof, Florida. (Photo by *St. Petersburg Times*/Gamma Liaison)

water with human sacrifices centuries ago.

Yugoslavia (extending from Slovenia to Monte

**FIGURE 10.26.** Most of a city block in Winter Park, Florida disappeard into a widening crater as this sinkhole formed in underlying carbonate bedrock.

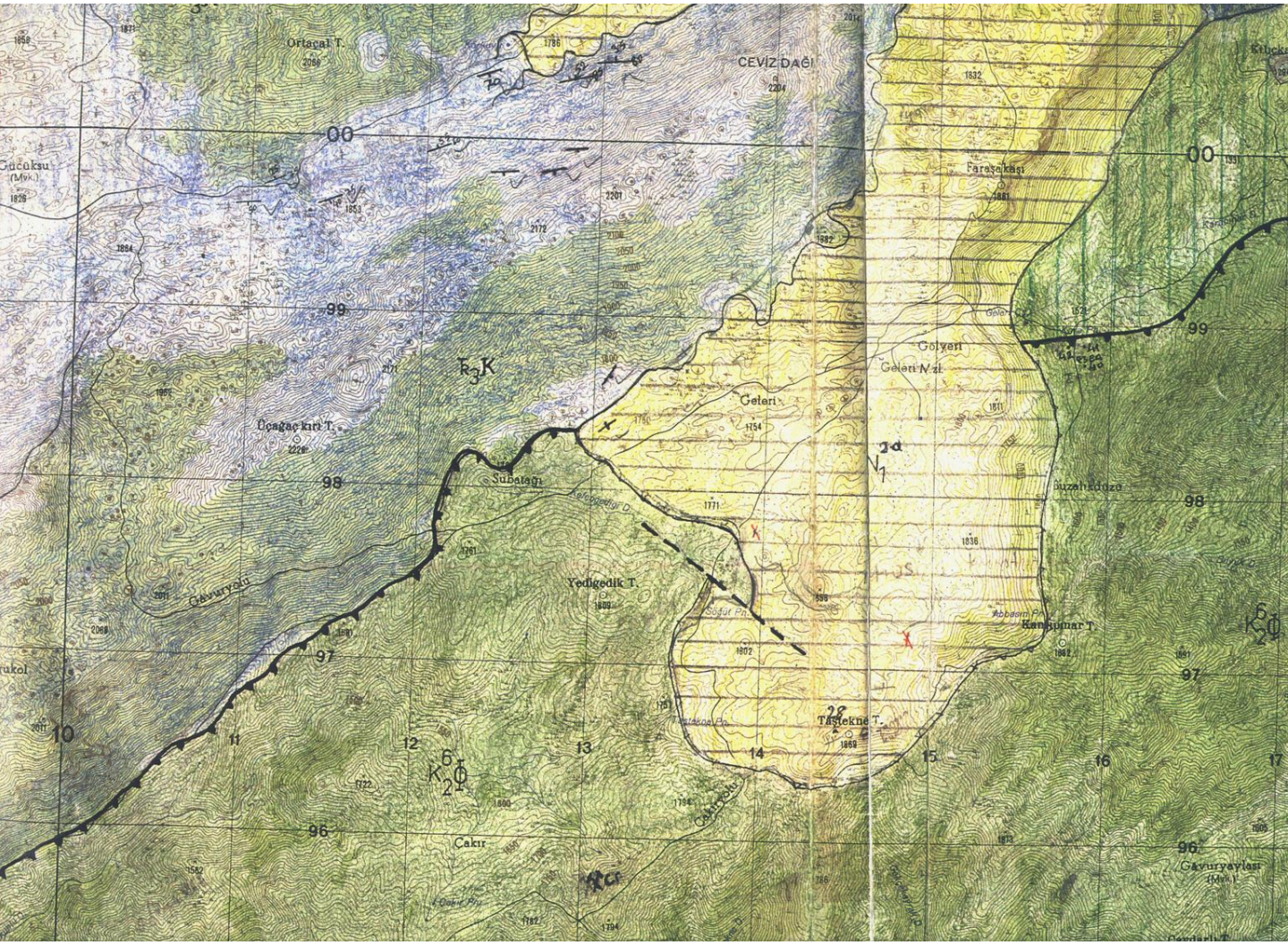
*(A) Tower karst near Guilin, China*



*(B) Diagram showing the general nature of the structure of the towers.*

**Figure 13.13**
**The Tower Kurst topography of Central China** forms some of the most spectacular landforms in the world. The towers are largely residual landforms. Many are laced with caves and caverns.

**Figure 13.14**
**Karst topography** in the limestone region of Kentucky is dominated by sinkholes and solution valleys. Note the absence of an apparent drainage system in this region.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Buzalıdüzü
Kamunar T.
Taşteknе T.
Çakır
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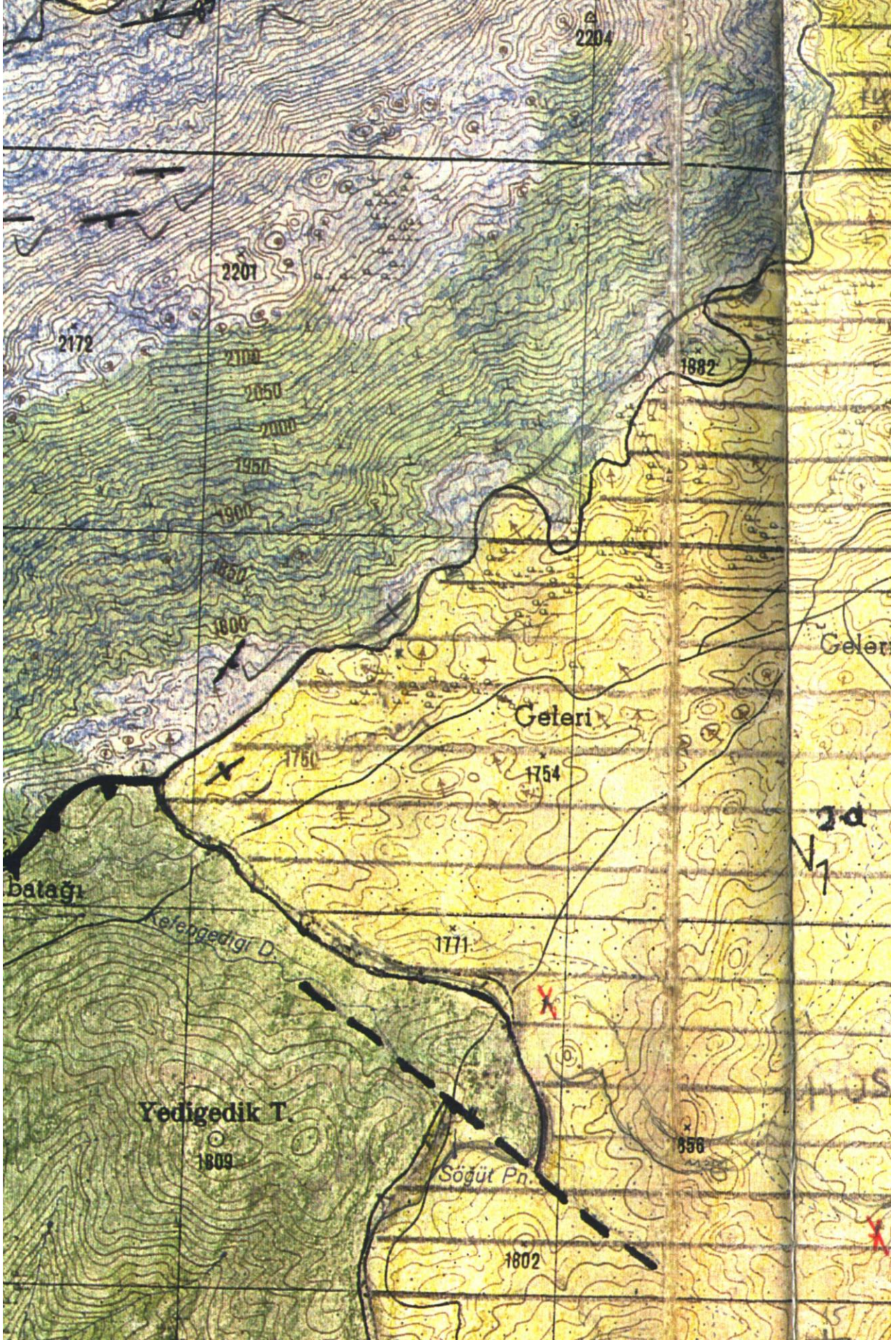
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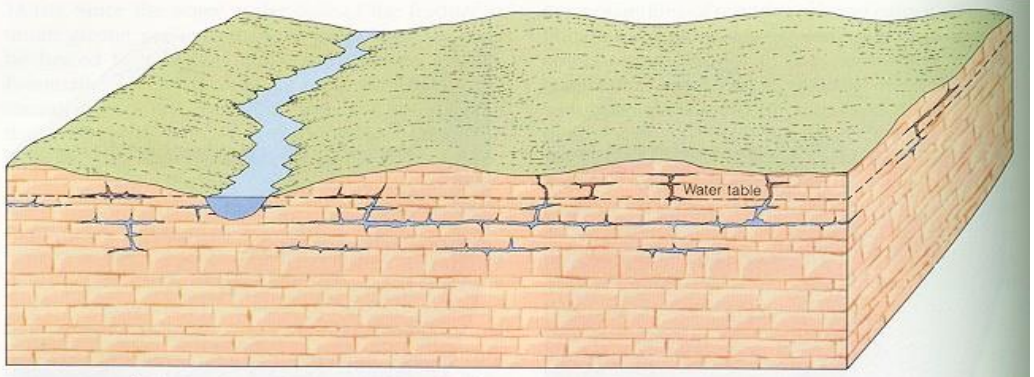
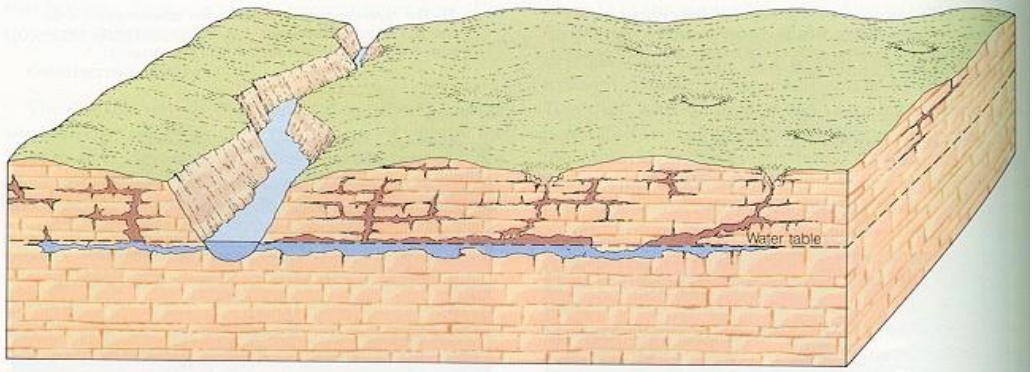
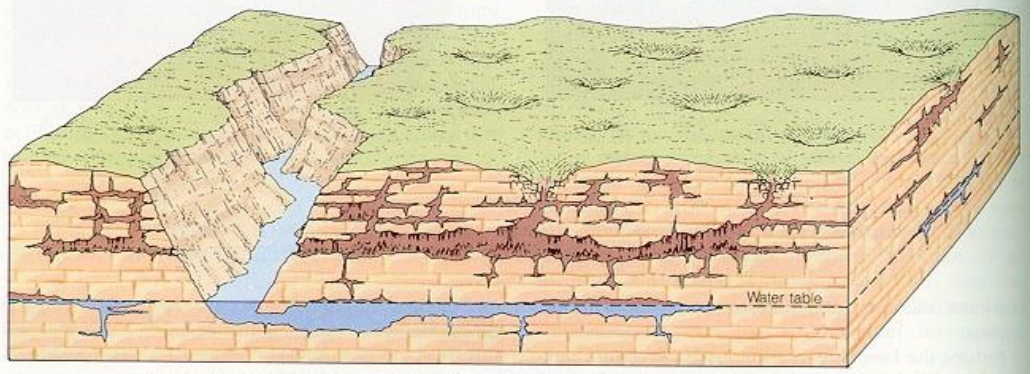
1802




*(A) In the early stages, water seeps through the fractures and bedding planes of limestone formations. It seeps downward to the water table and then moves toward the surface streams.*




*(B) As the surface streams erode the valley floor, the water table drops. The surface water seeping through the zone of aeration enlarges the existing joints and caves. Movement of water toward the surface stream develops a main system of horizontal caverns.*




*(C) As the river erodes a deeper valley, the water in the main underground channel seeks a new path to the lower river level. A new, lower system of horizontal caverns develops. The higher, older caverns may continue to enlarge and ultimately collapse to form sinkholes, or they may be filled with fallen rubble or cave deposits.*

**Figure 13.11**
**The evolution of a cave system** is shown schematically in these diagrams.