Agua subterránea

Sistemas de agua subterránea

El agua subterránea forma un sistema dinámico intimamente relacionado con el drenaje superficial.

Este es un sistema abierto en donde entra agua por medio de infiltración y sale del sistema en general a través de lagos o manantiales

Sistemas de agua subterránea

El agua se puede almacenar o transportar dentro de las rocas. Las características principales de las rocas para permitir este transporte son:

Porosidad

Permeabilidad

Porosidad

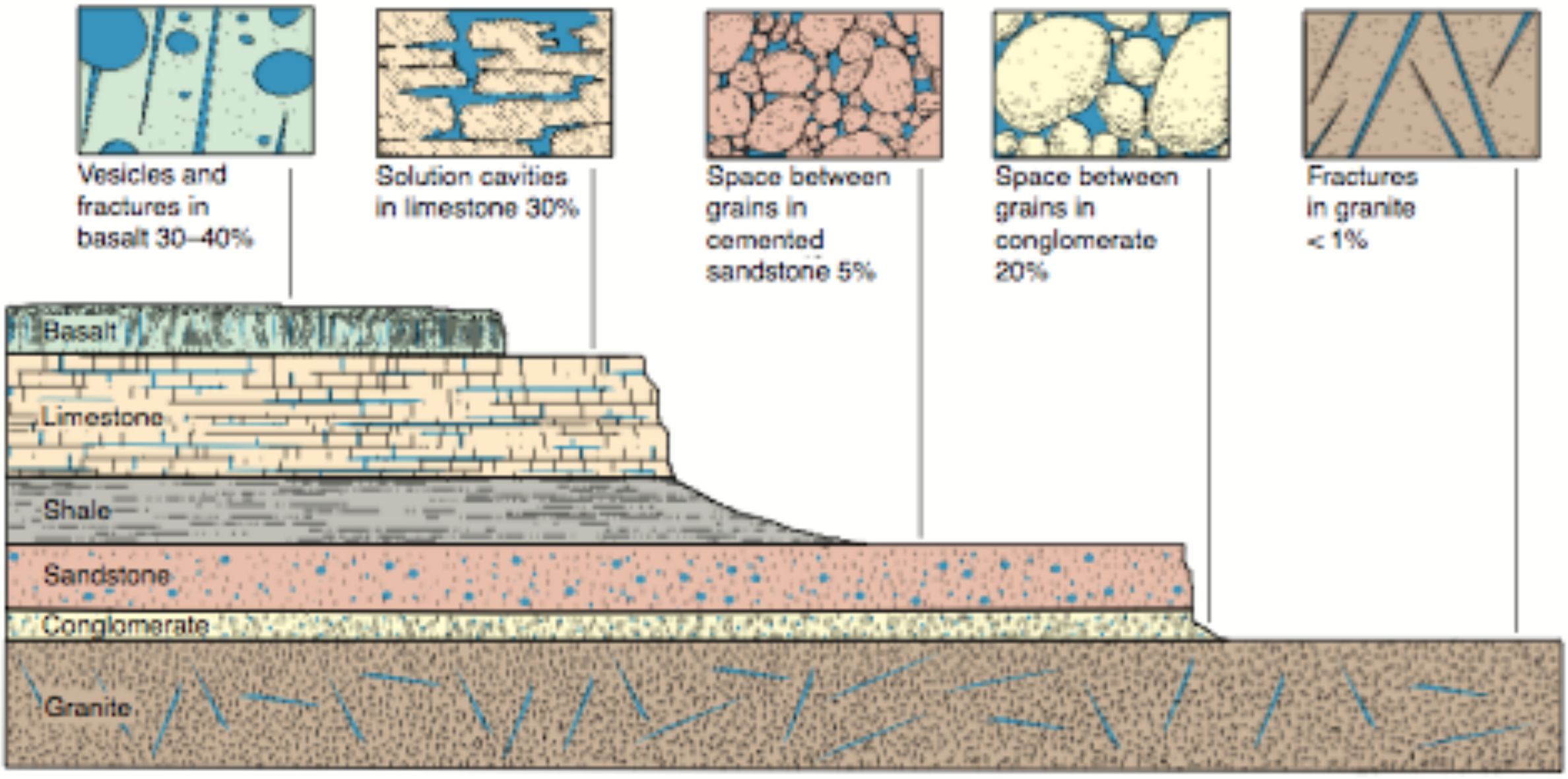
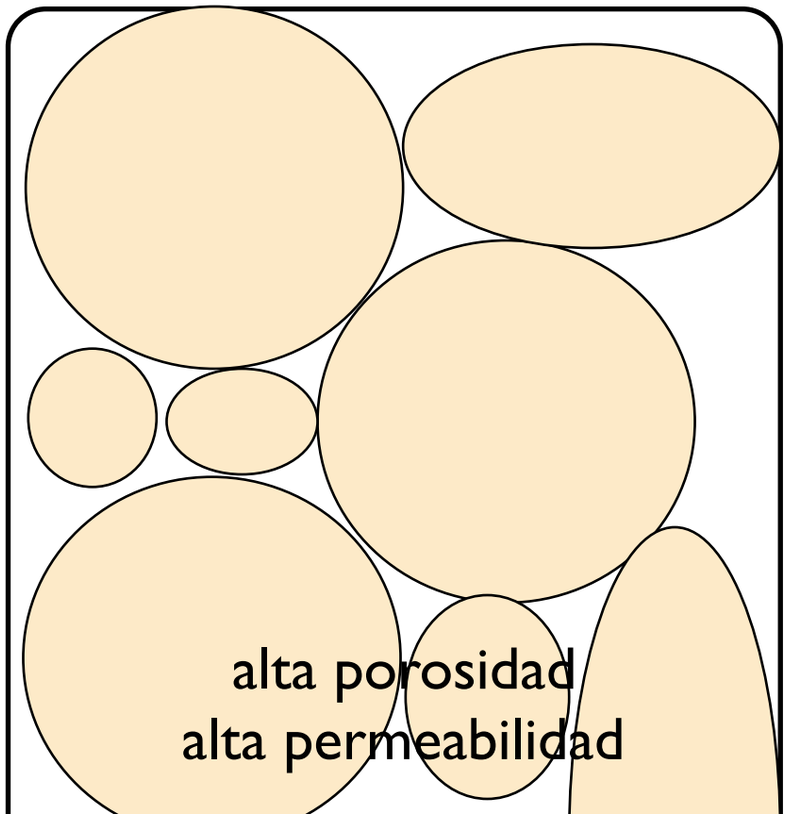


FIGURE 13.1 **Various types of pore spaces** in rocks permit the flow of groundwater.

Permeabilidad

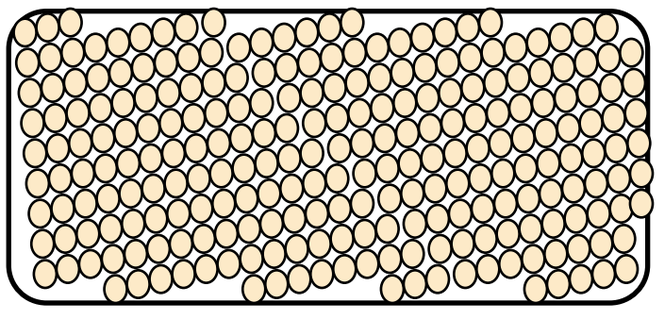
La capacidad de una roca de transmitir un fluido depende de la viscosidad del fluido y de la presión hidrostática, el tamaño y la interconección de los espacios vacíos.

alta porosidad
baja permeabilidad



alta porosidad
alta permeabilidad

baja porosidad
alta permeabilidad



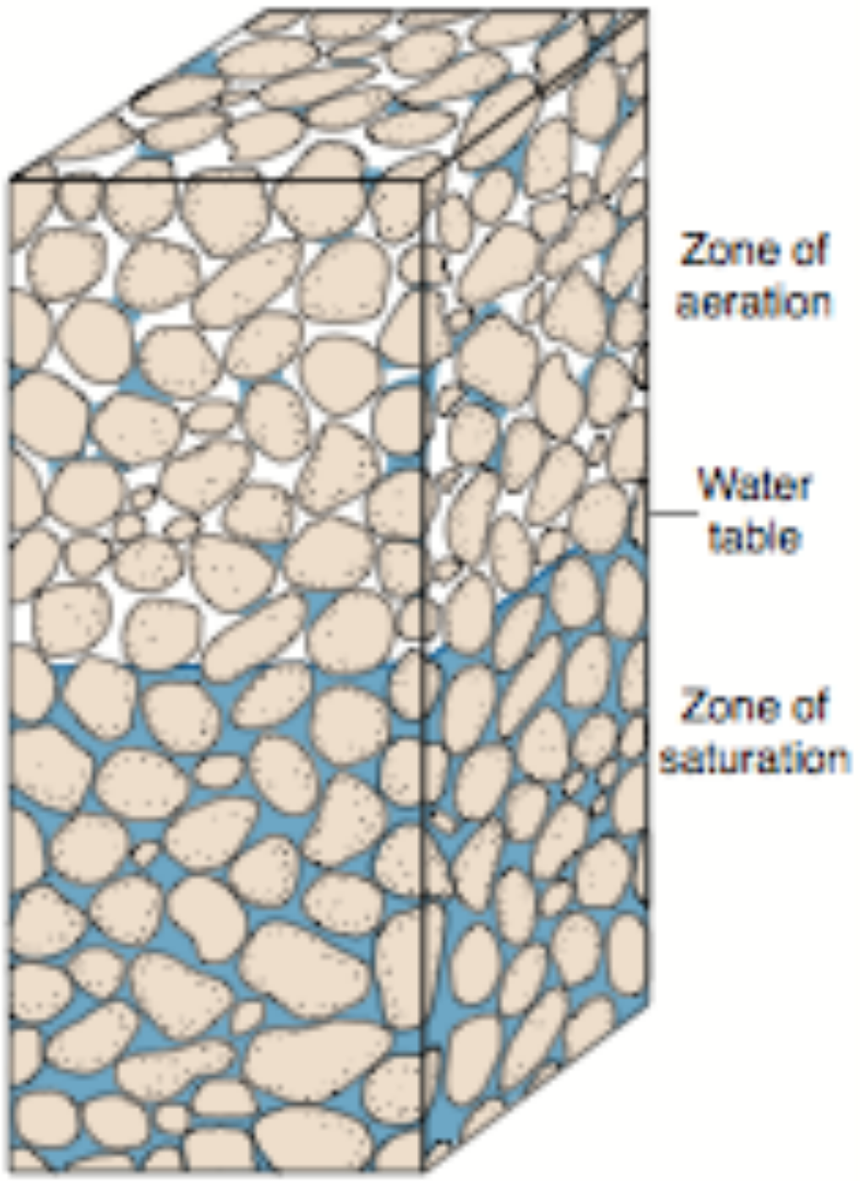


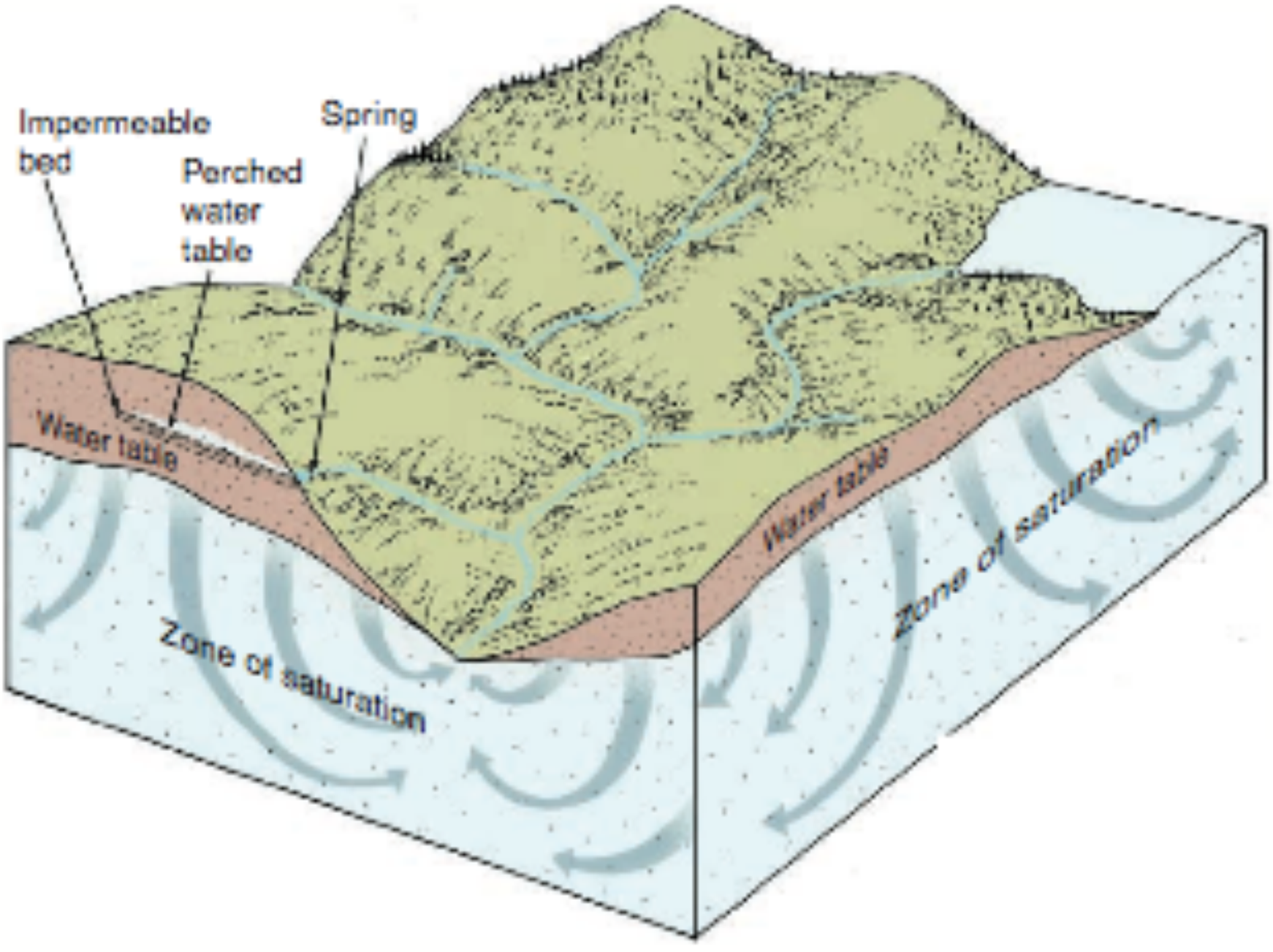
FIGURE 13.2 **The water table** is the upper surface of the zone of saturation. Water seeps into the ground through pore spaces in rock and soil. It passes first through the zone of aeration, in which the pore spaces are occupied by both air and water, and then into the zone of saturation, in which all of the pore spaces are filled with water. The depth of the water table varies with climate and amount of precipitation.

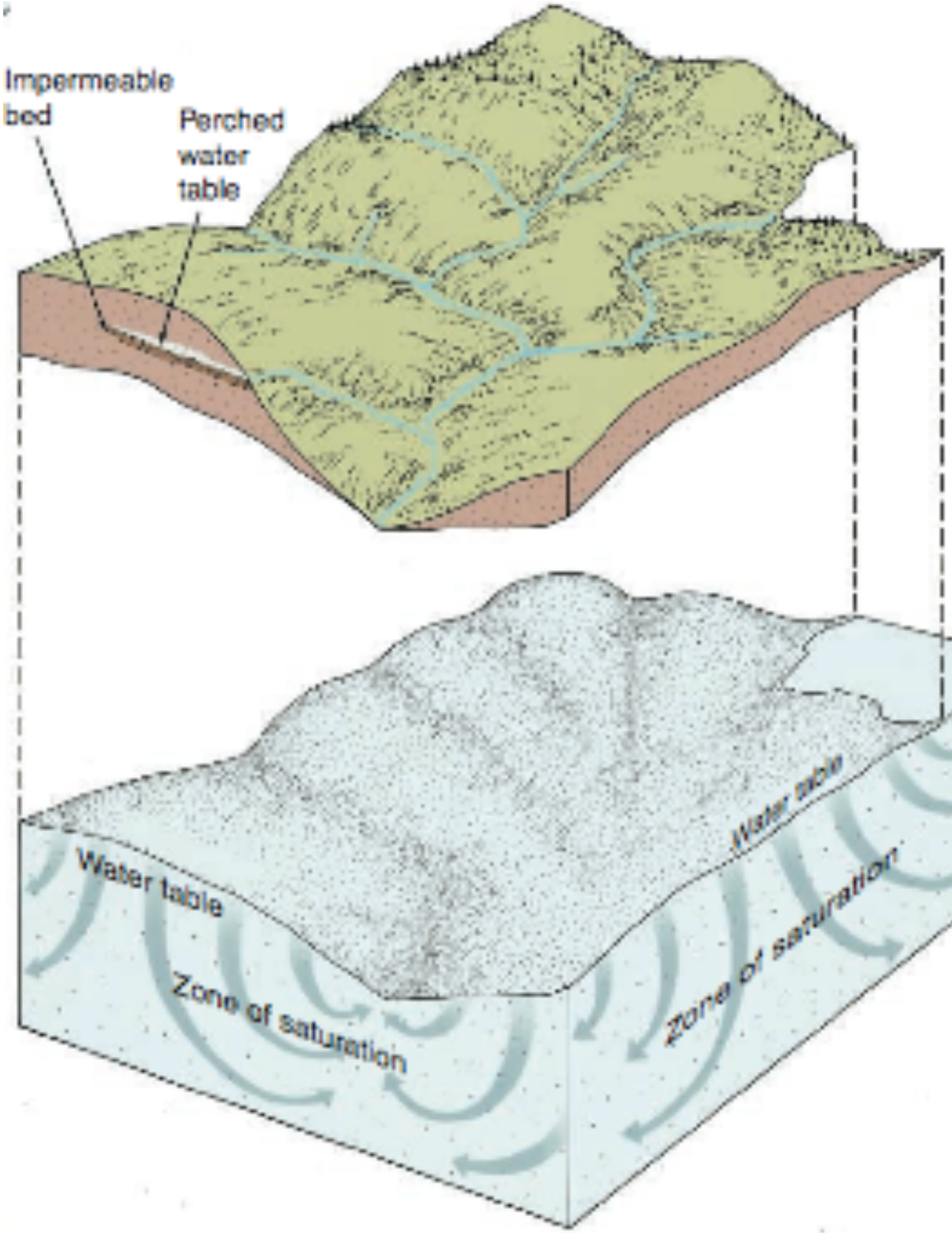
La tabla de agua

La tabla de agua es la superficie superior de la **zona de saturación**.

Los **Aqúiferos** son rocas permeables saturadas, estos pueden estar abiertos o confinados.

La tabla de agua





La tabla de agua

Nivel freático

Aquiferos no-confinados

La base de los aquiferos siempre depende de permeabilidad de la roca. A mayor profundidad, la presión es mayor y los poros de las rocas se cierran, es decir, existe una base en donde la permeabilidad de la roca es casi cero

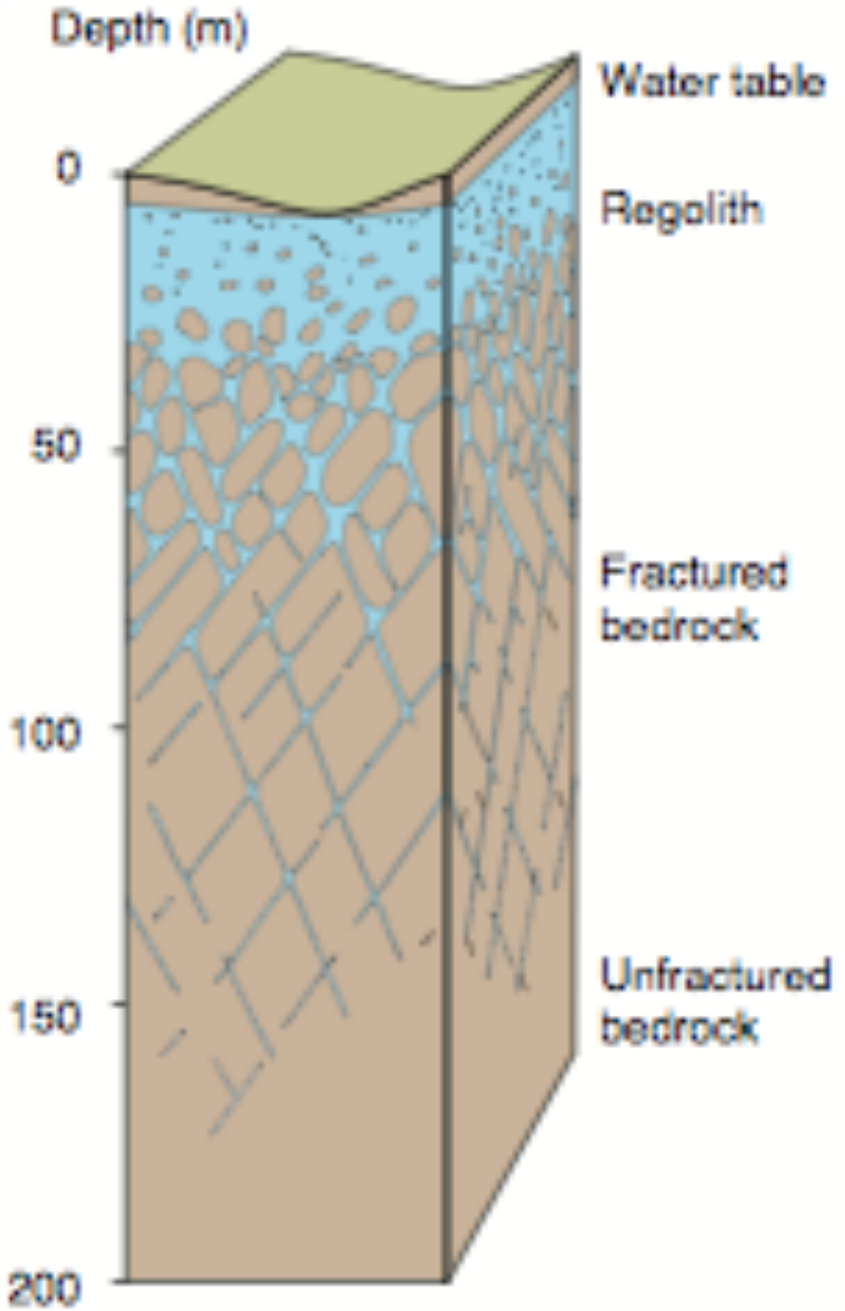


FIGURE 13.5 The base of an unconfined groundwater reservoir is not an abrupt surface like the water table. Most of the groundwater reservoir is in porous regolith and bedrock. Different rock types have substantially different porosities and permeabilities. Open pores gradually close with depth, so the base of the reservoir varies from place to place.

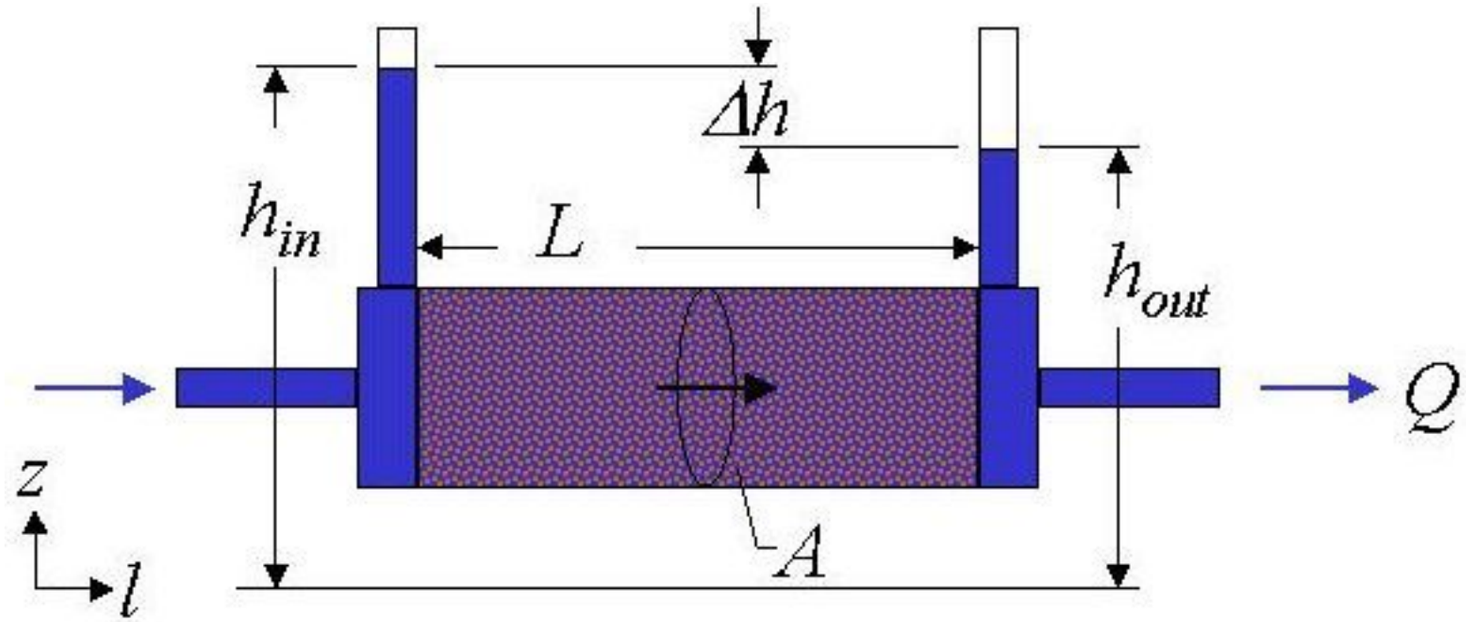
Presión y ley de Darcy

$$Q \propto \frac{A(h_1 - h_2)}{L}$$

En donde Q es el flujo, A es el area perpendicular

L es la longitud del camino

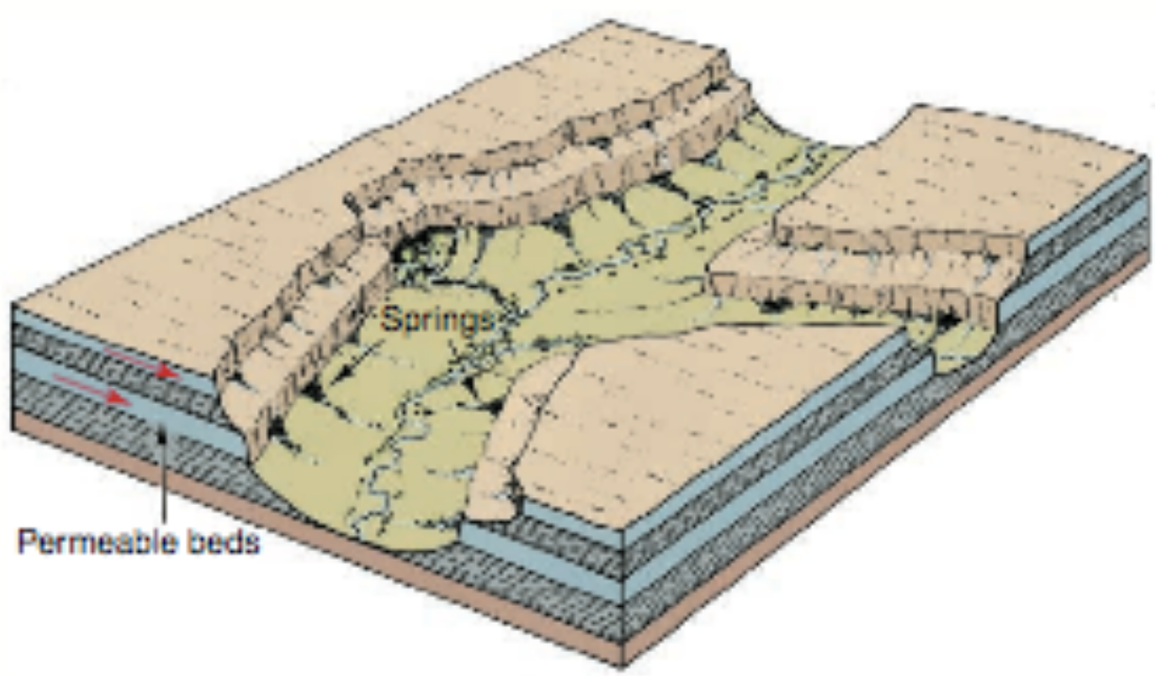
h es la pérdida de carga

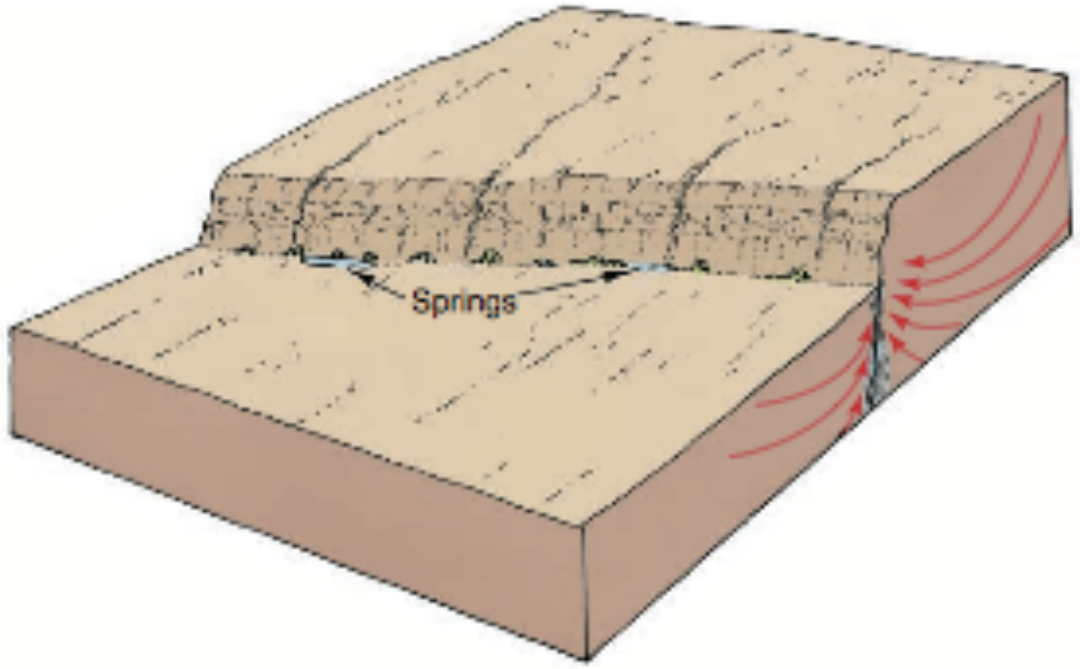


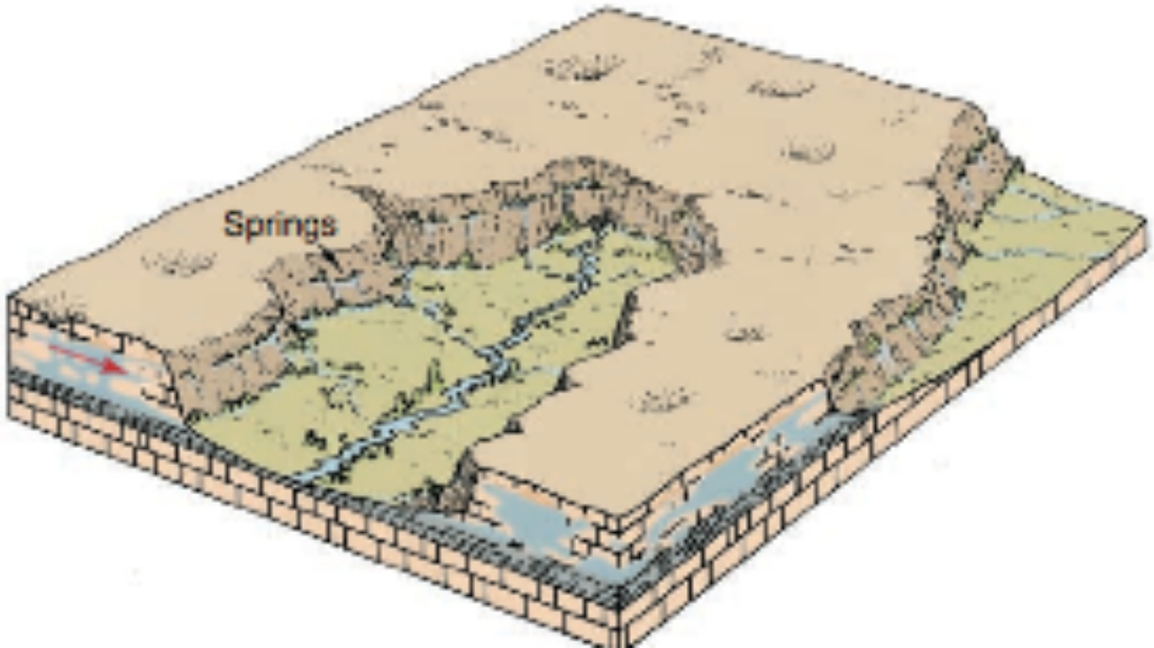
Descargas

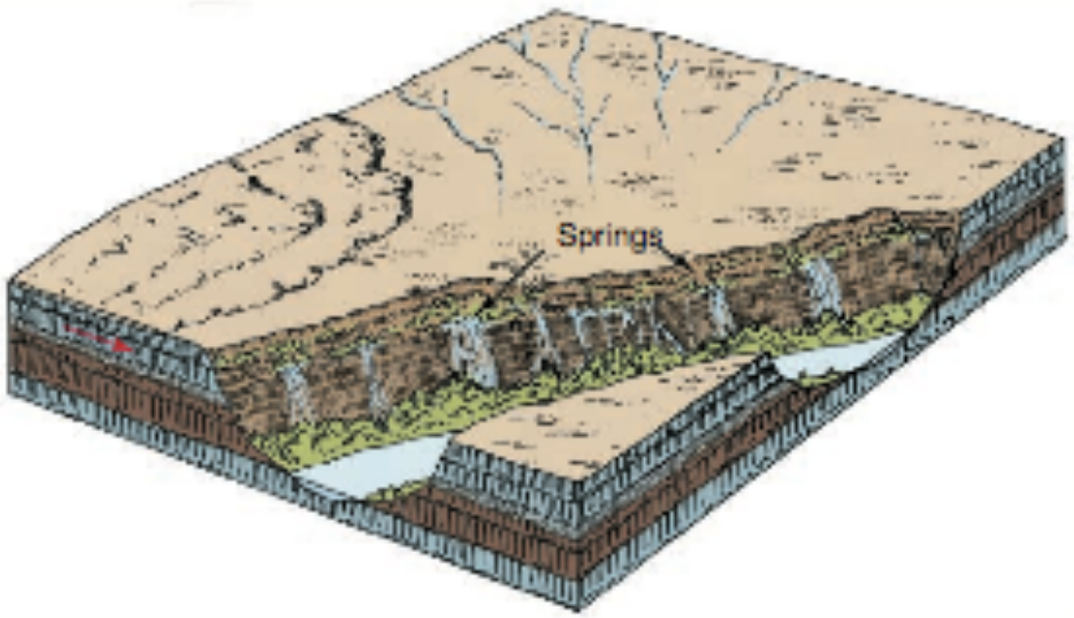
Las descargas de acuíferos ocurre naturalmente cuando la tabla de agua alcanza la superficie. Alli que generan reservorios naturales como lagos, manantiales o en las márgenes de corrientes y rios.

Descarga

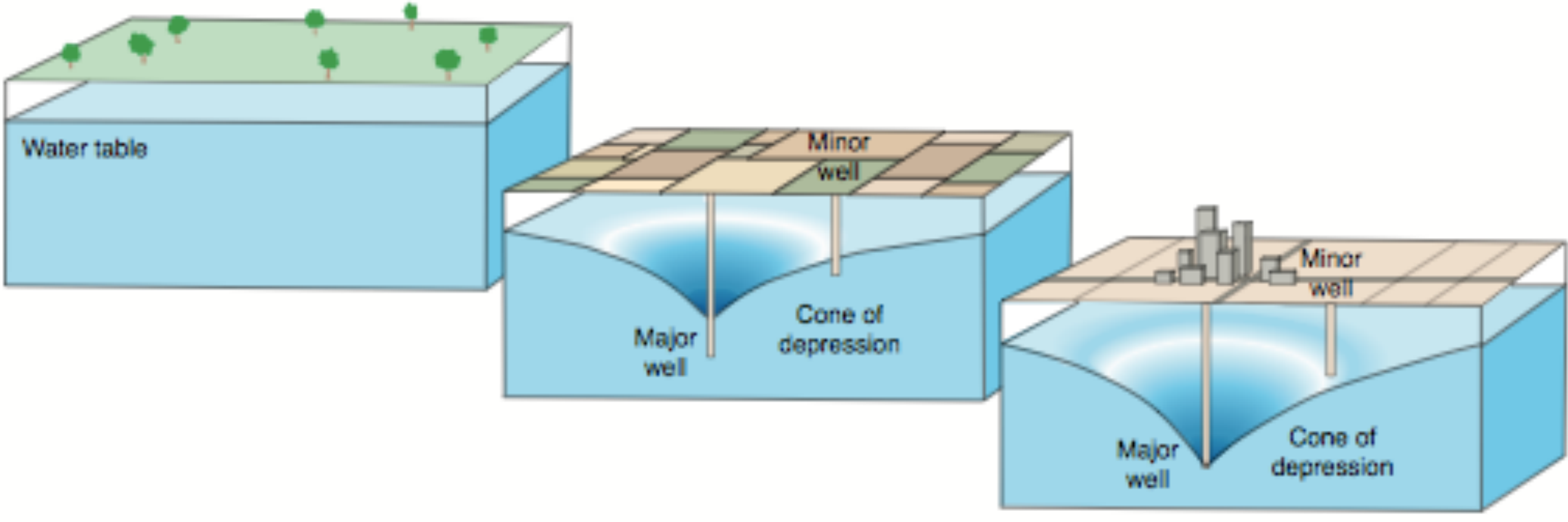




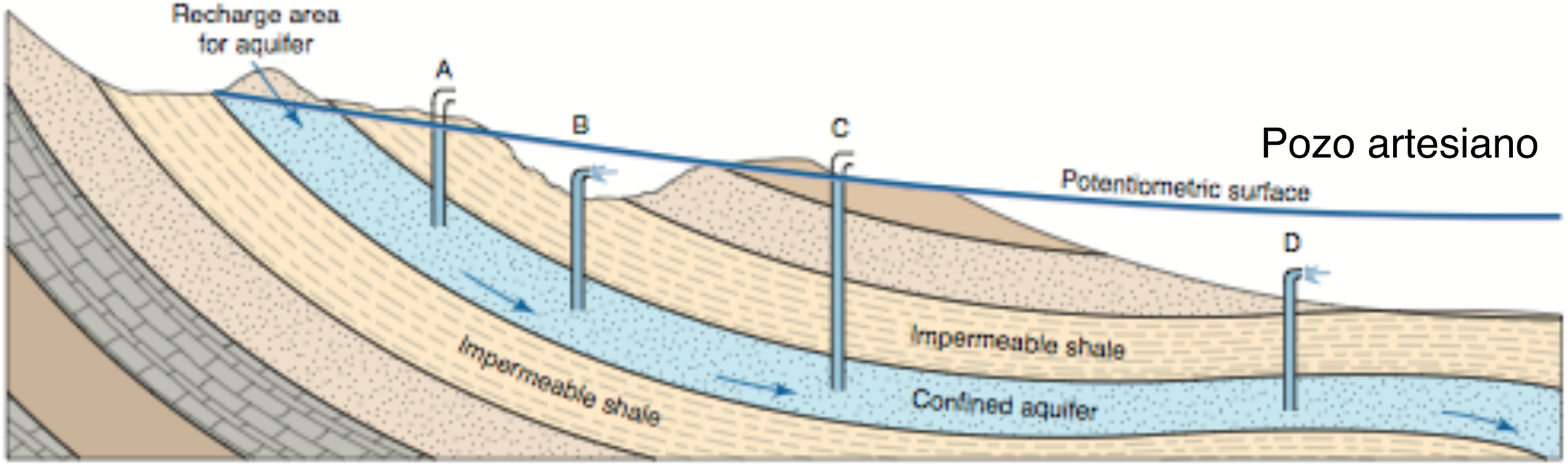




Pozos y descargas artificiales



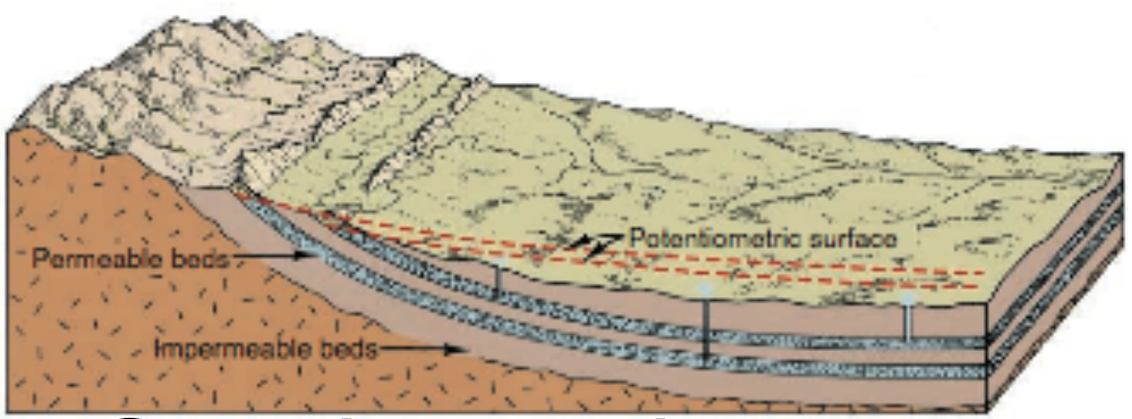
Acuíferos confinados



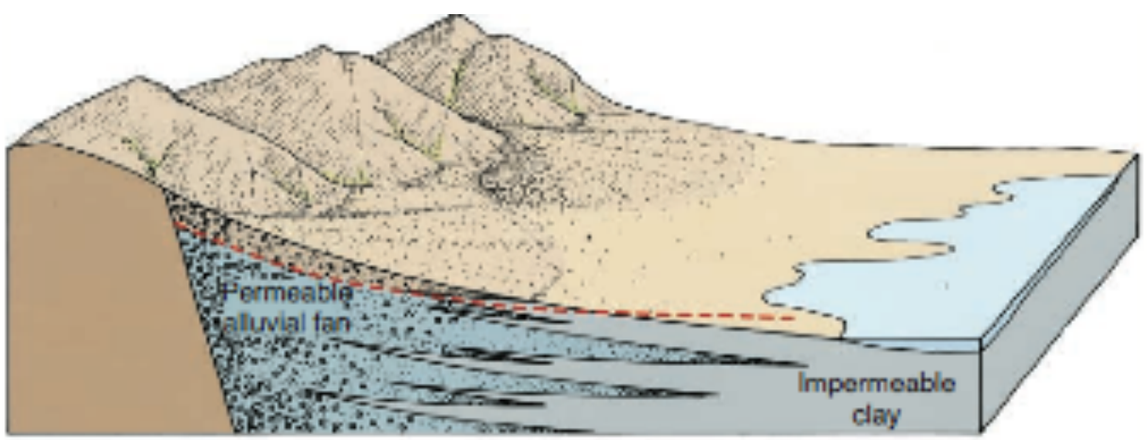
Pozo artesiano

FIGURE 13.9 The necessary geologic conditions for a flowing well include (1) a permeable bed (aquifer, blue) confined between impermeable layers, (2) rocks tilted so the aquifer can receive infiltration from surface waters, and (3) adequate infiltration to fill the aquifer and create hydrostatic pressure. Consequently, water rises in all of the wells (A, B, C, D) to a level called the potentiometric surface. Flowing (or artesian) wells occur only when the top of the well is below the potentiometric surface and require no pumping.

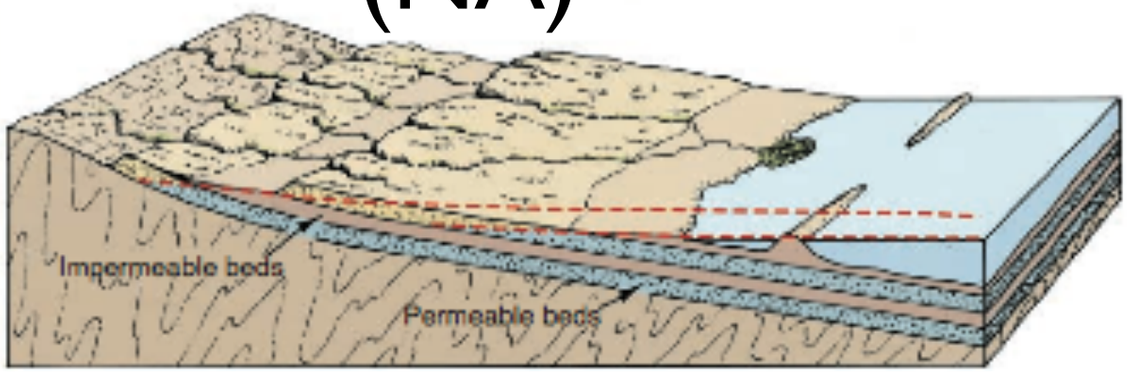
Acuíferos confinados



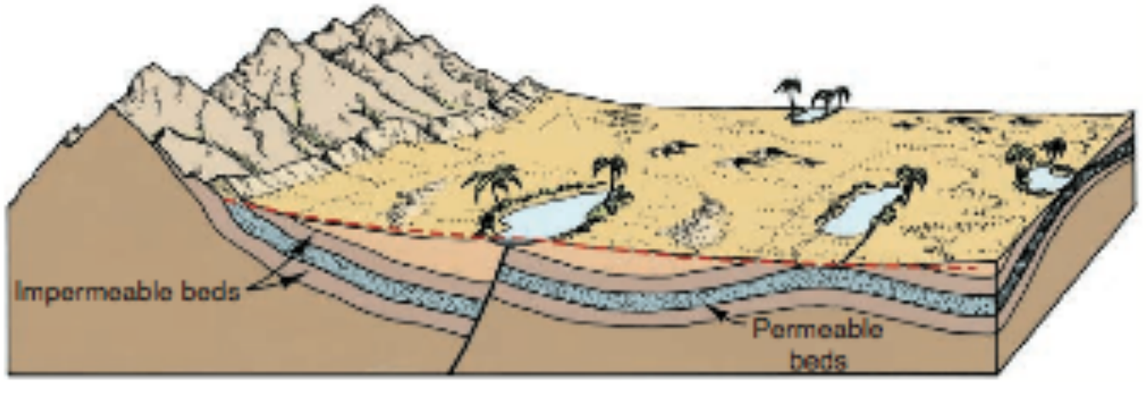
Grandes praderas (NA)



Costas atlánticas



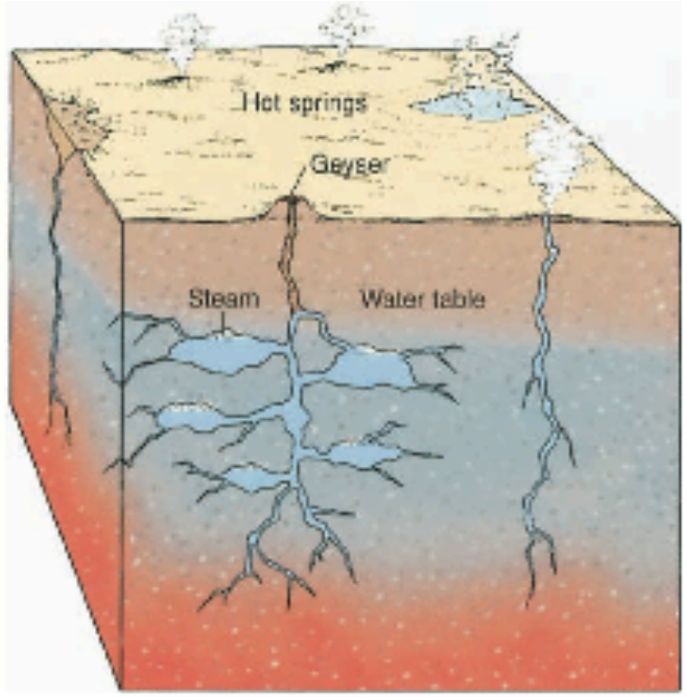
Costas pacíficas



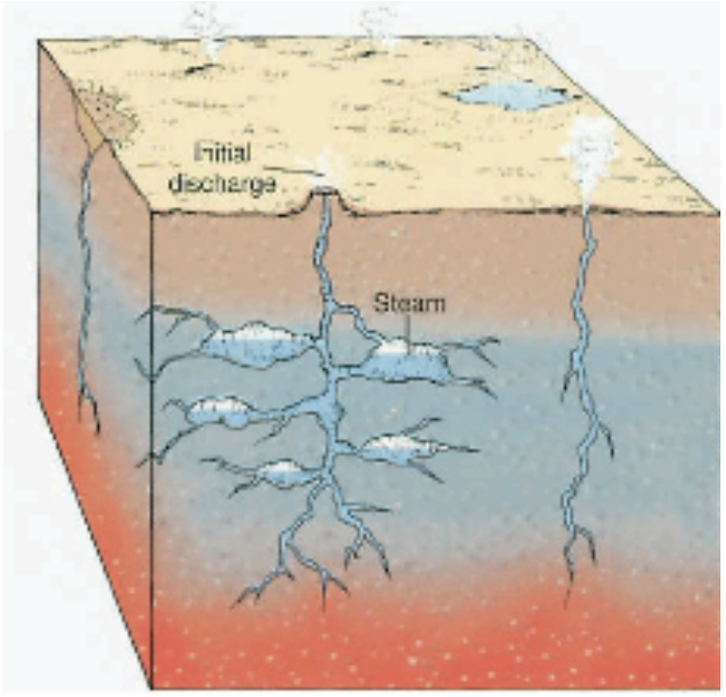
Desierto del sahara

Aguas termales y geysers

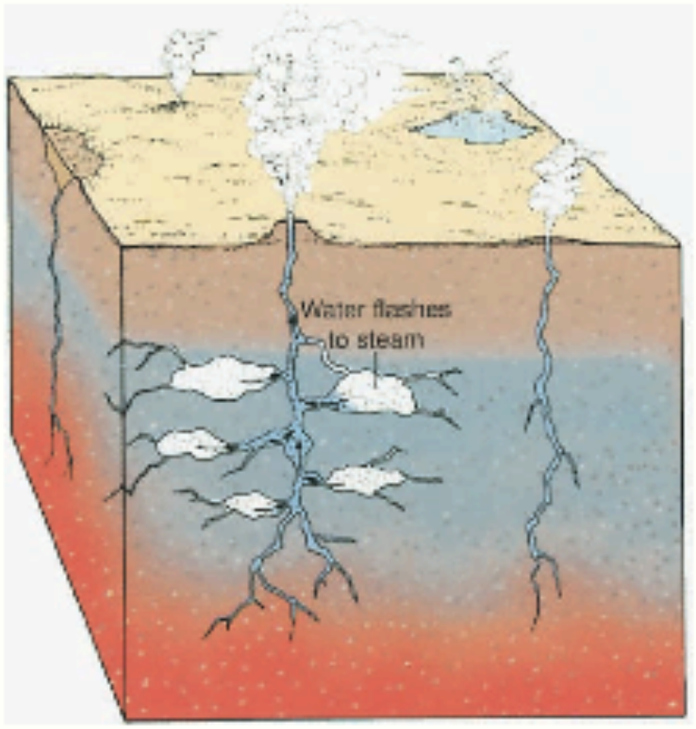
Aquiferos que se encuentran próximos a zonas magmáticas hacen que el agua se caliente y la presión en los acuiferos cambie creando geysers y aguas termales



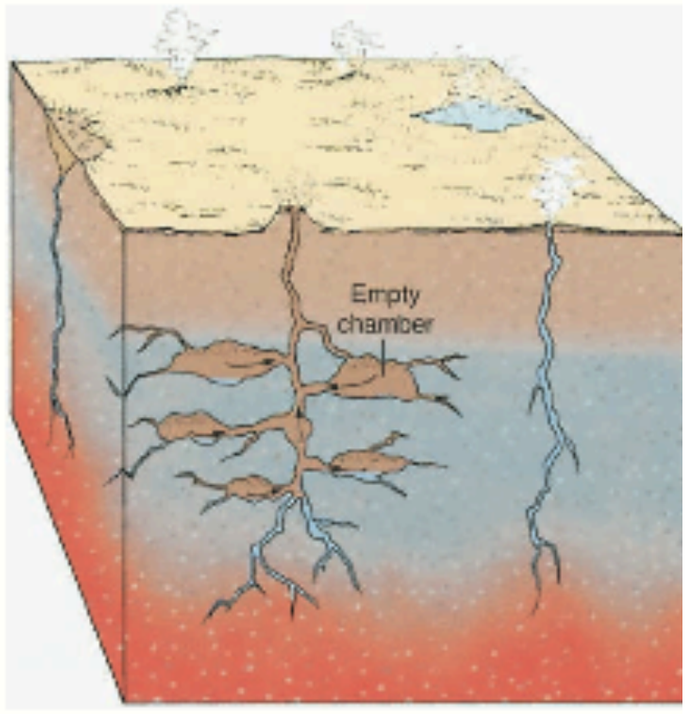
(A) Groundwater circulating through hot rocks in an area of recent volcanic activity collects in caverns and fractures. As temperature rises the water boils and steam bubbles rise, grow in size and number, and may accumulate in restricted parts of the geyser tube.



(B) The expanding steam forces water upward until it is discharged at the surface vent. The deeper part of the geyser system becomes ready for the major eruption.



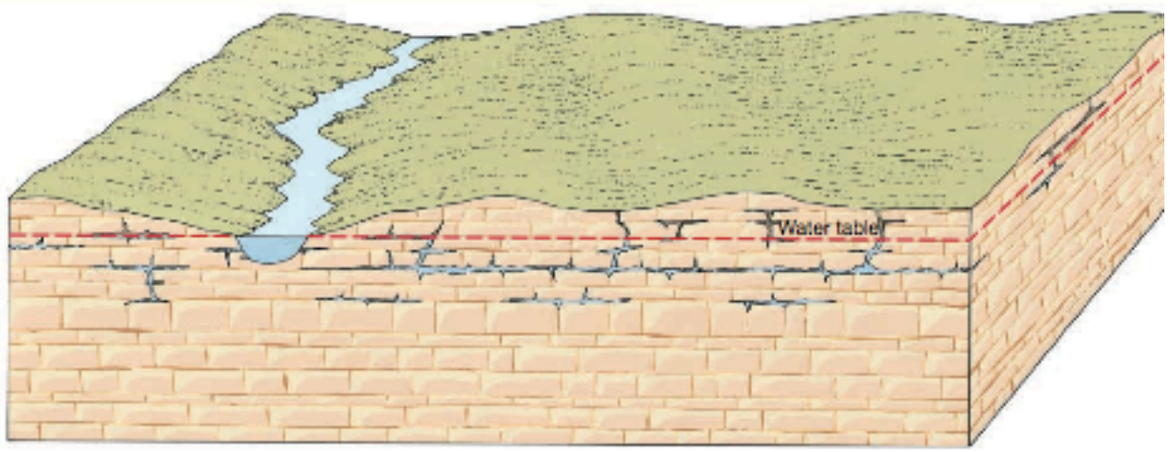
(C) The preliminary discharge of water reduces the pressure on the water lower down. Consequently, water from the side chambers and pore spaces begins to flash into steam, forcing the water in the geyser system to erupt.



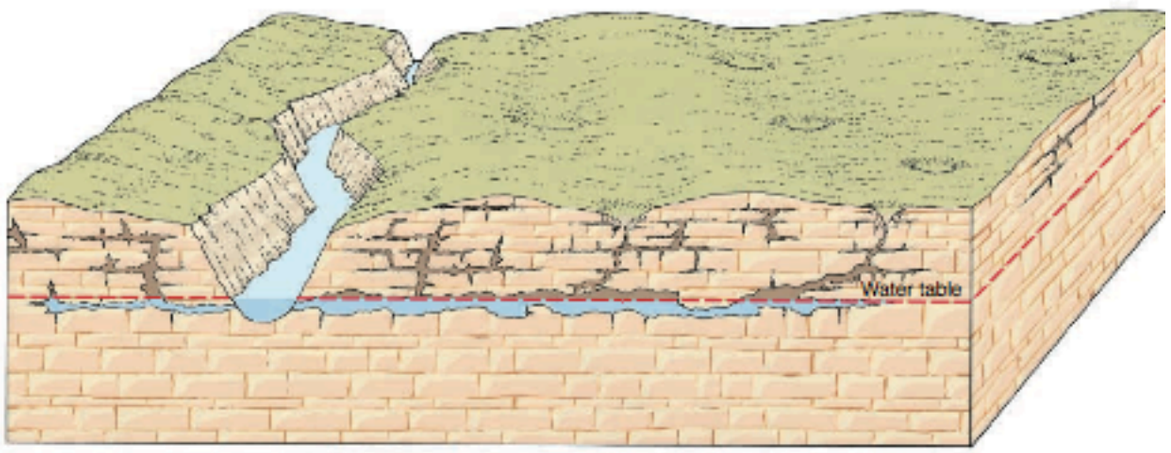
(D) Eruption ceases when the pressure from the steam is spent and the geyser tubes are empty. The system then begins to fill with groundwater again, and the eruption cycle starts anew.

Topografia de Karst

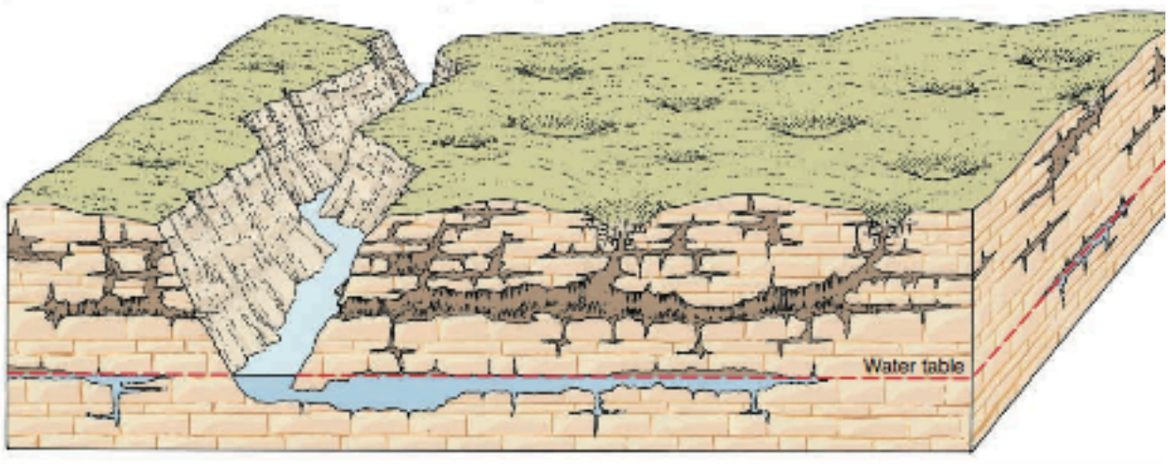
Dependiendo del tipo de roca la presencia de agua puede erosionar significativamente la roca



(A) In the early stages, water seeps through the fractures and bedding planes in limestone. The groundwater seeps downward to the water table and then moves toward the surface streams. Soluble minerals are dissolved and the flow paths become enlarged.



(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.

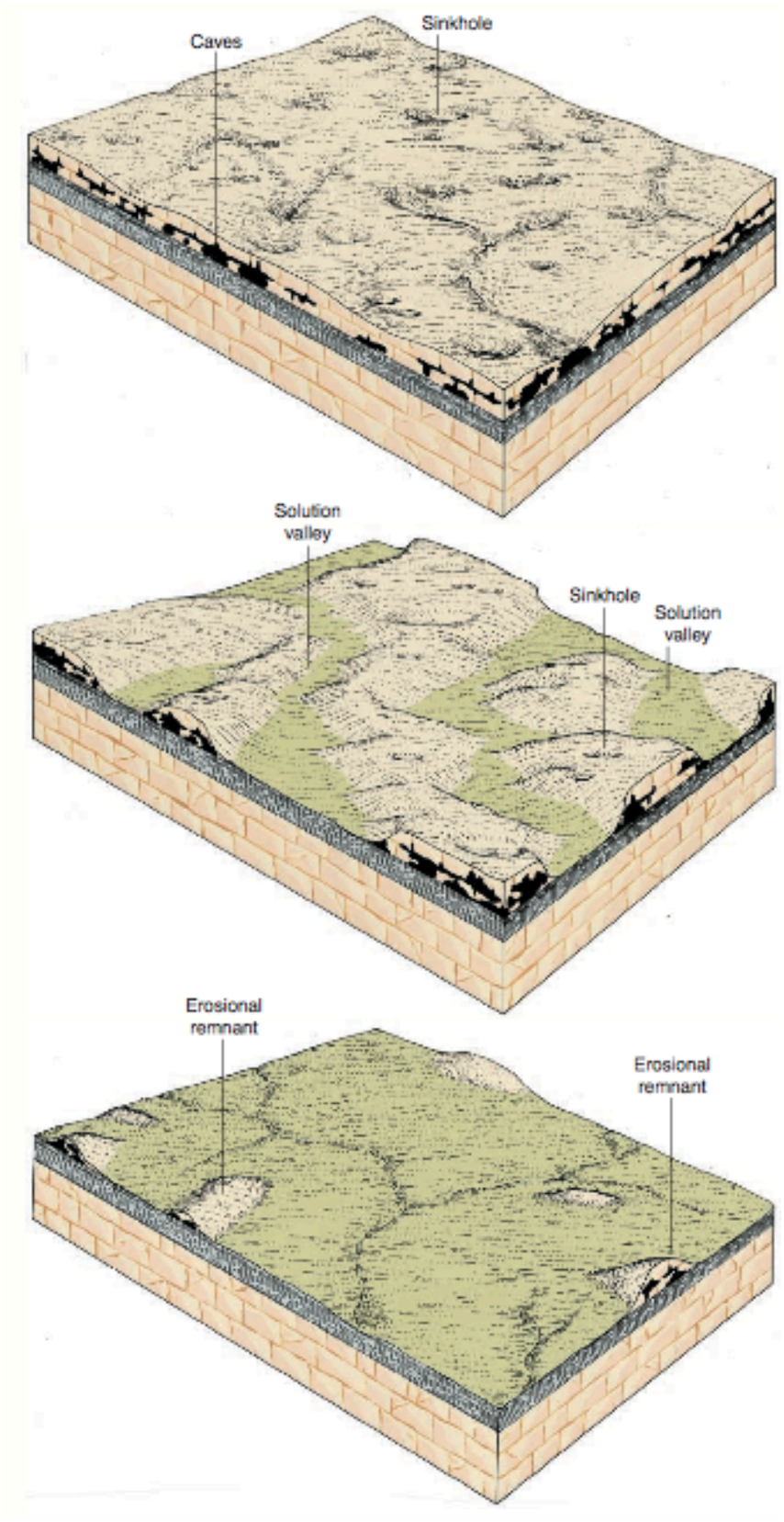


(C) As the river erodes a deeper valley, the water in the main underground channel seeks a new path to the lower river level. A new, lower system of horizontal caverns develops. The older, higher caverns may continue to enlarge and ultimately collapse to form sinkholes, or they may fill with fallen rubble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

FIGURE 13.14 **The evolution of a cave system** is shown schematically in these diagrams. (*Modified from* Underground Worlds, *Planet Earth Series, Time-Life Books, 1982*)

$$\underset{\text{(water)}}{H_2O} + \underset{\text{(carbon dioxide gas)}}{CO_2} = \underset{\text{(carbonic acid)}}{H_2CO_3}$$

$$\underset{\text{(acid)}}{H_2CO_3} + \underset{\text{(calcite)}}{2CaCO_3} = \underset{\text{(calcium bicarbonate)}}{2Ca^{2+} + 2HCO_3^-}$$



Topografia de Karst

- las cuevas se hacen cada vez más grandes
- la creación de fosas de hundimiento y desarrollo de valles
- los valles se hacen más grandes hasta que la roca caliza es completamente destruida.

Fosas de hundimiento

A sinkhole created by tropical storm Agatha covers a street intersection in downtown of Guatemala City on Sunday, May 30, 2010. Torrential rains brought by the first tropical storm of the 2010 season pounded Central America and southern Mexico, triggering deadly landslides. (AP Photo/STR)

Cuevas

Photo credit: eschipulLonghorn Cavern State Park is located near the Texan city of Marble Falls. The land for this state park was acquired in 1932 and was opened to tourists in 1938. Within the state park is a cave called Longhorn Cavern, which can be seen in this photo.

Deposición

Hay minerales que son disueltos por el agua y se pueden depositar de formas diversas. Una de ella son las **estalactitas** y las **estalagmitas**. así mismo se pueden depositar en areniscas y conglomerados, en este caso esta deposicición se encuentra como el material de **cementación** entre los granos.

Desposición

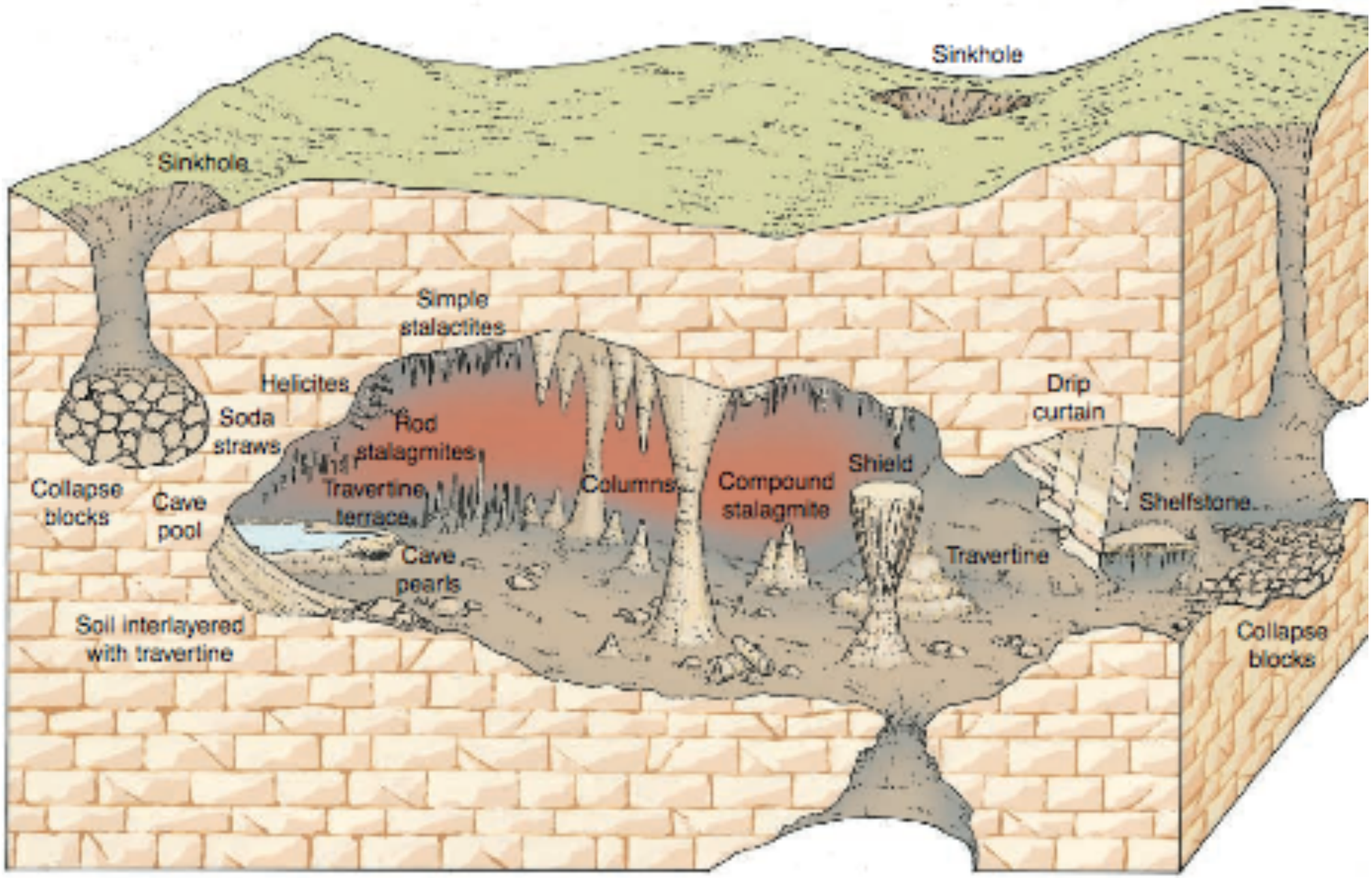


FIGURE 13.21 **Many varieties of cave deposits** are shown in this idealized diagram. Most are composed of calcite deposited by water that seeps into the open cave and then loses carbon dioxide as the water evaporates.

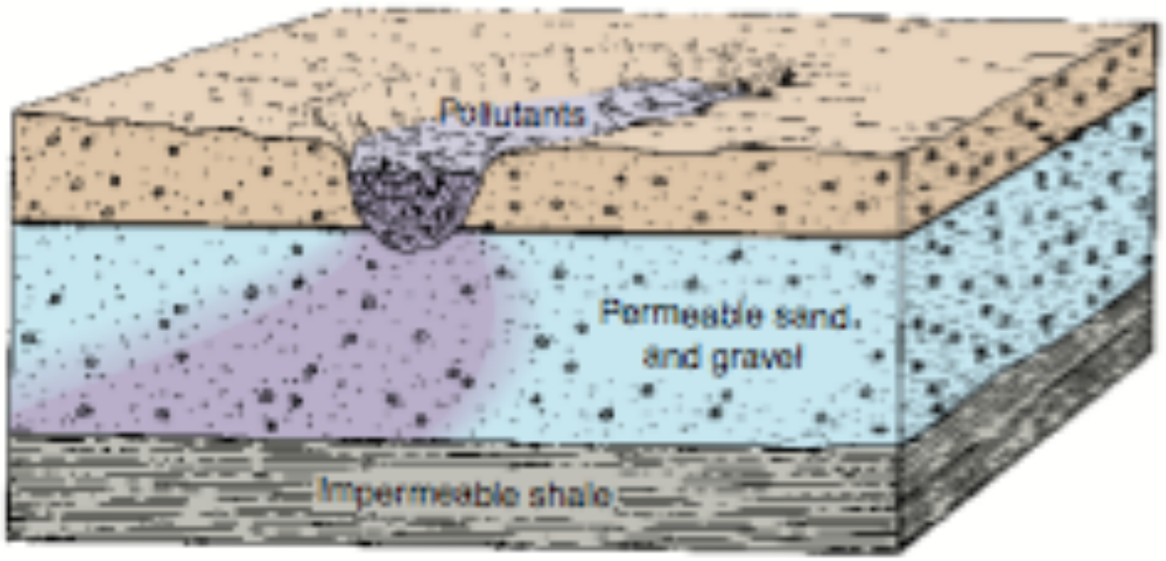
(A) Stalactites and stalagmites formed from calcium carbonate in Lechuguilla Cave.

(B) Gypsum stalactites form coarsely crystalline, clawlike branches. These "chandeliers" are up to 6 m long and are thought to be the world's largest.

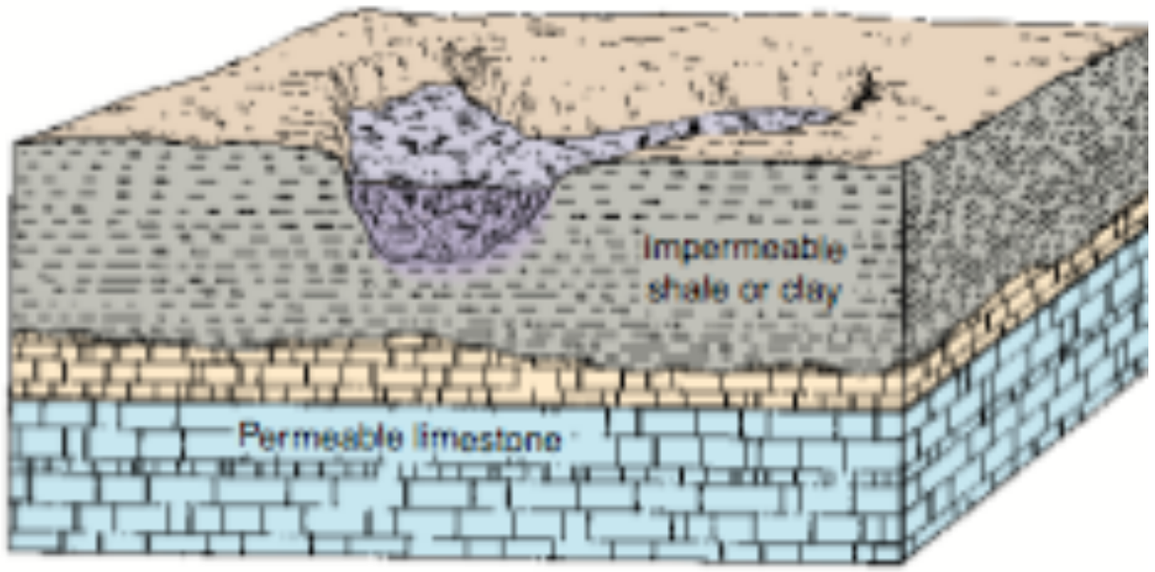
FIGURE 13.22 **Deposits in Lechuguilla Cave,** New Mexico. *(Photographs by Norman R. Thompson)*

Alteración

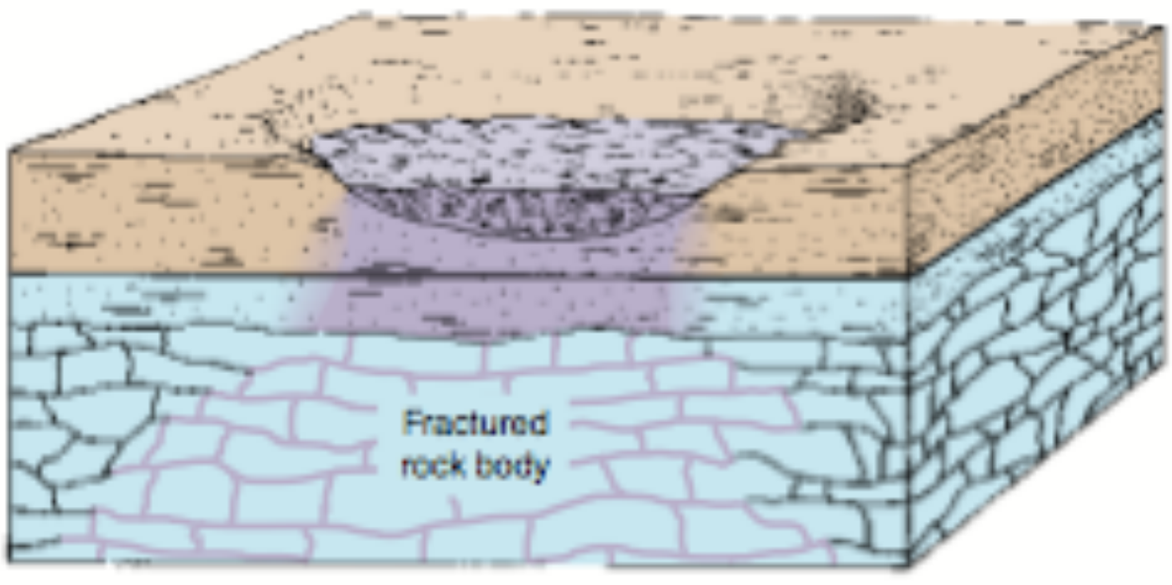
Los efectos humanos en los sistermas de aguas subterraneas son en general debidos a cambios químicos en la composición del agua (debido a polución), invasiones de agua salada, cambios en la posición de nivel freático y subsidencia



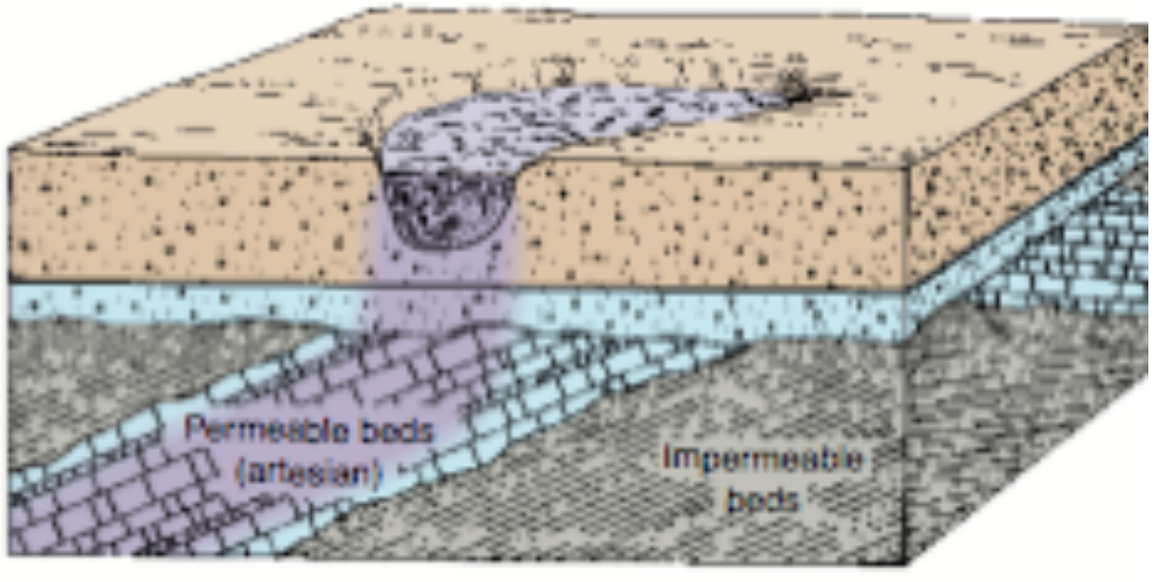
(A) A permeable layer of sand and gravel overlying an impermeable shale creates a potential pollution problem because contaminants are free to move with groundwater.



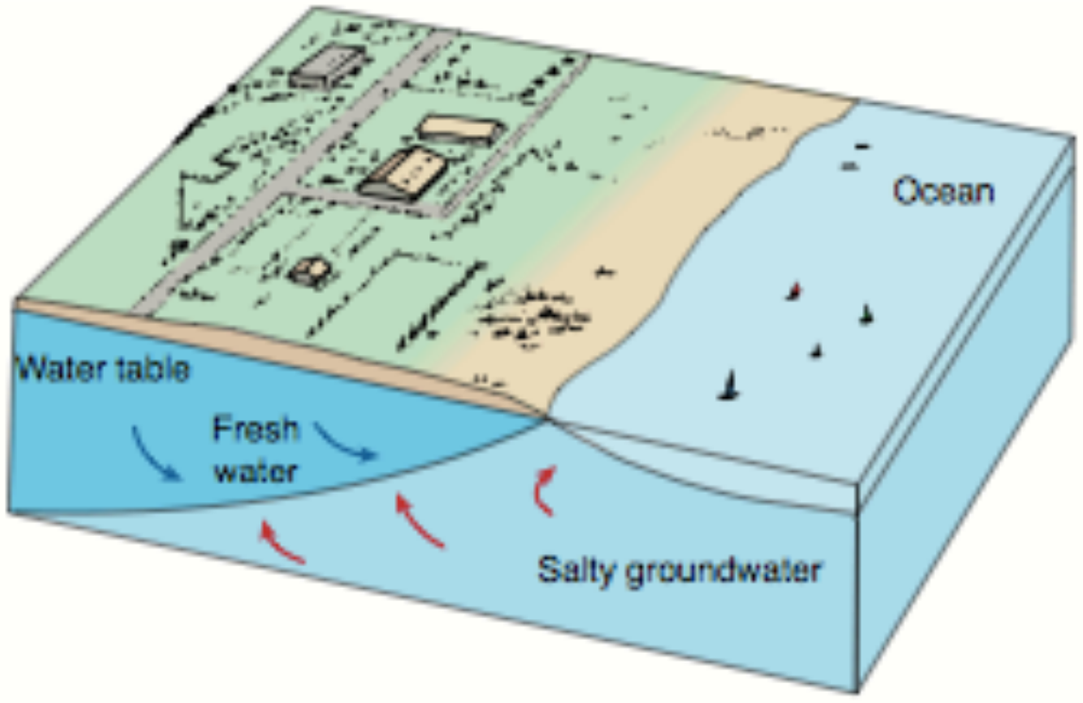
(B) An impermeable shale (or clay) confines pollutants and prevents significant infiltration into the groundwater system in the limestone below.



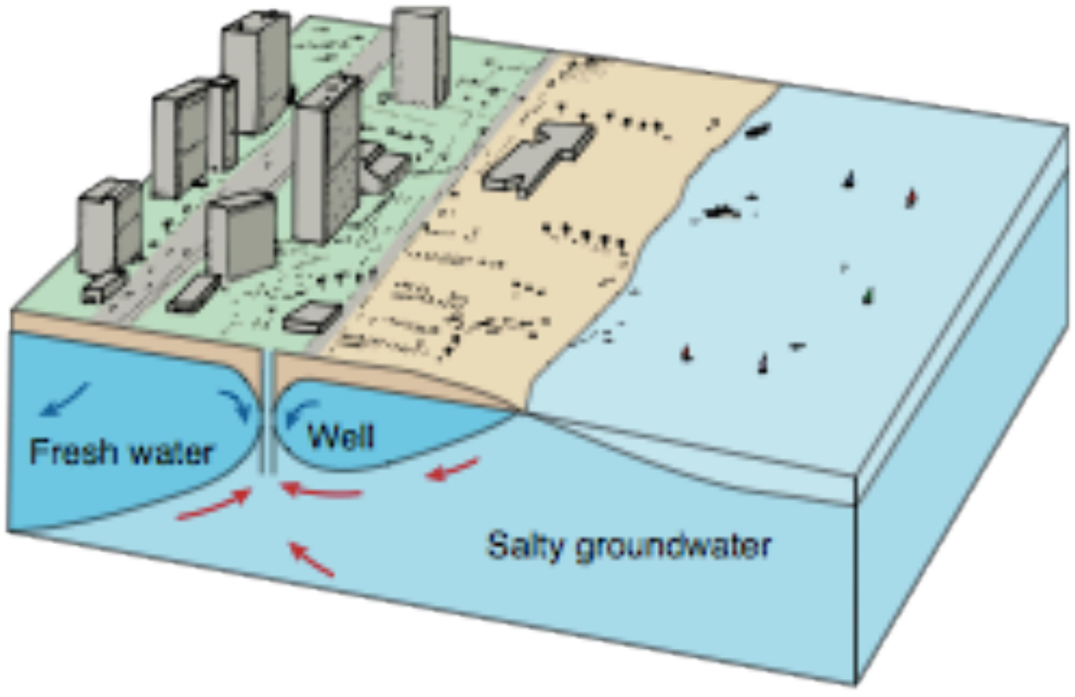
(C) A fractured rock body provides a zone where pollutants can move readily in the general direction of groundwater flow.



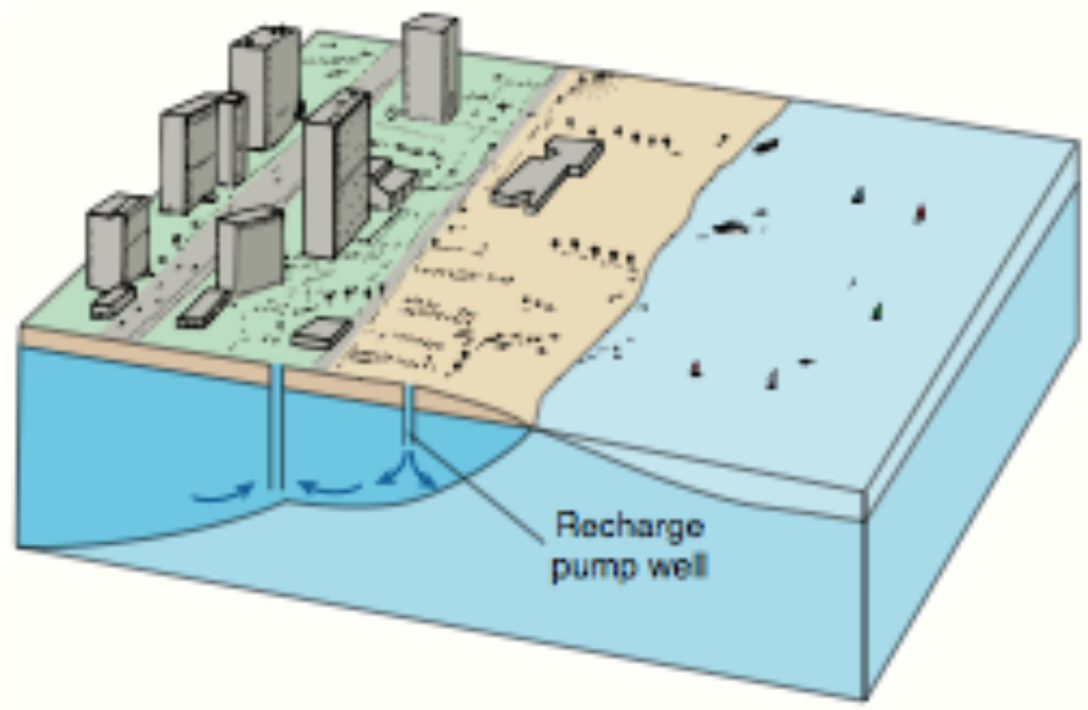
(D) An inclined, permeable aquifer below a disposal site permits pollutants to enter a confined aquifer and move down the dip of the beds, so that they contaminate the system.



(A) A lens of fresh groundwater beneath the land is buoyed up by denser saltwater below.



(B) Excessive pumping causes a cone of depression in the water table on top of the freshwater lens and a cone of saltwater encroachment at the base of the freshwater lens.



(C) Fresh water pumped down an adjacent well can raise the water table around the well and lower the interface between the fresh water and the saltwater.

FIGURE 13.27 The relationship between fresh water and saltwater on an island or a peninsula is affected by the withdrawal of water from wells. Excessive pumping causes a cone of saltwater encroachment, which limits the usefulness of the well.

Stone forest, China