Cave of the Winds Activity Six: Drip, Drip, Drip

Lesson for Grades 6-8
Two 50-minute class periods

Satisfies Colorado Model Content Standard for Science:

Standard 4, Benchmark #3 for grades 6-8. Natural processes shape the Earth's surface (for example: landslides, weathering, erosion, mountain building, volcanic activity).

Standard 4, Benchmark #11 for grades 6-8. The world's water is distributed and circulated through oceans, glaciers, rivers, groundwater, and atmosphere.

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CAVE OF THE WINDS

Drip, Drip, Drip!

Objectives

Students will:

1. Describe factors influencing infiltration rates.
2. Build a model demonstrating the effect of different soil and rock types on infiltration.

Vocabulary

Infiltration
Groundwater
Porosity
Permeability
Aquifer
Aquiclude
Water table
Zone of aeration
Zone of saturation

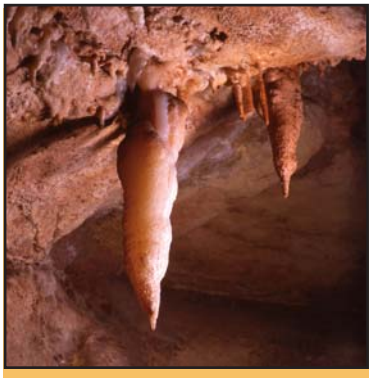
Background

As precipitation falls to the ground, one of three things can happen:

1. It can evaporate and return to the atmosphere as water vapor. Sometimes this happens after the water has been intercepted and held on vegetation for a period of time. It can also happen as water evaporates from puddles left by a rainstorm or as the water held in muddy soil is drawn out and given the energy to evaporate by the sun.
2. Other water can infiltrate into the ground, percolating downward to become groundwater.
3. That which does not evaporate or infiltrate begins to seek low spots and, in the process of moving across the ground, becomes what is called runoff. Runoff can range from large rivers, such as the Mississippi River, to small rills along the edge of a mud puddle in a student's backyard.

This lesson will focus on infiltration. The principle factor affecting the rate of infiltration is the composition of the soil. As water begins to infiltrate it fills the openings, or pores, in the soil as it moves downward. Some soils contain gravel or sand. In these soils, the pores will be larger and the soil will be more permeable. This means that the water can move through the soil faster. The openings are smaller in soils with silt or clay sized particles. Water will move slower through these soils. Additionally, molecular attraction between water molecules and clay particles further slows the rate of infiltration. If the rate of precipitation exceeds the rate of infiltration, the ground becomes saturated with water. That is, all of the pore spaces in the soil fill with water. When this happens, any excess water begins to flow down gradient across the surface as runoff.

As water infiltrates downward, it will eventually reach a permeable layer in which groundwater is stored. This layer is called an aquifer. In the aquifer, the region in which most spaces are filled with air is called the zone of aeration. The region in which most spaces are water filled is called the zone of saturation. The top of the zone of saturation is referred to as a water table. The aquifer is bordered on the bottom, and sometimes on the top, by an impermeable layer called an aquiclude. Sometimes, a small aquiclude will be found higher than the main



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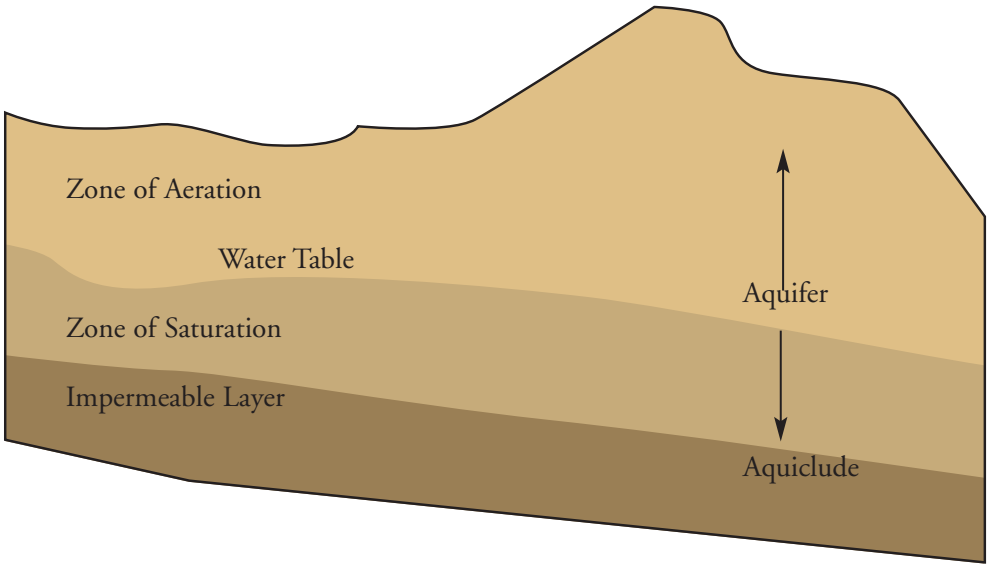
water table for a region and a small aquifer will form. These small aquifers found higher than the main regional water table are called perched aquifers. The area from which an aquifer receives water in the form of infiltrating precipitation is called the recharge zone.



Joints, or cracks, in the rock provide the main form of porosity along which groundwater infiltrates into the Cave of the Winds. Evidence of this can be found by observing the long lines of stalactites, stalagmites, and columns formed along some of the major joint systems that cross the caves. However, the infiltration rates are not uniform throughout the caves.

Materials

Three graduated 250 ml beakers
Three 100 ml beakers
Several 2- or 3-liter soda bottles
Sand (several colors, if possible)
Gravel (several colors, if possible)
Scoria (lava rock)
Clay

Procedure

Warm Up

1. Discuss the concept of groundwater, infiltration, and the movement of groundwater with the class. If possible, secure a groundwater model to use with the class discussion or bring in a speaker with groundwater experience. Your local Soil and Water Conservation offices, county extension office, National Park Service personnel, Forest Service Personnel, or Bureau of Land Management personnel may have the expertise and materials to help with this.
2. Discuss the role of infiltrating water in cave development and potential hazards posed by the infiltration of polluted water.

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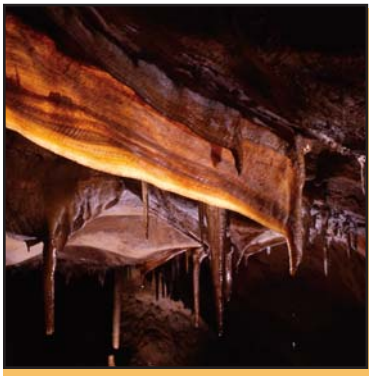

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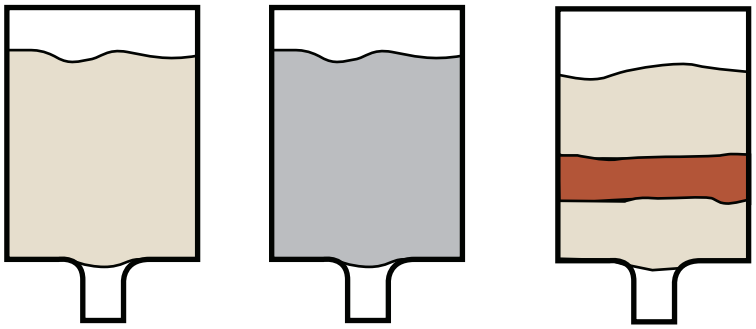
Activity

1. Set up three bottles as shown:



2. Cut the bottom 3 or 4 inches from three 3-liter bottles and turn them over.
3. Glue a single layer of cloth into the bottom of each to keep the sand and gravel from coming out.
4. Fill the bottles as shown.
5. Turn all three bottles upside-down with a graduated 250 ml beaker under each. Ask the students, "If I pour 100 ml of water into each of these at the same time, which will it travel through fastest?" Be open to all suggestions. Have the students justify their guesses. Have students assist you and pour 100 ml into each bottle at the same time. Monitor the 250 ml beakers to see which bottle the water passes through fastest. Discuss the results with the class. Solicit their hypothesis regarding the different rates of infiltration through the bottles.
6. Define porosity for the students. Show students a piece of scoria (lava rock with holes in it), a piece of sandstone, and a piece of conglomerate or a handful of gravel. Ask which of the samples exhibit porosity. Students should answer "all three." Ask which would form a rock through which fluids would move the easiest. Some students may select the scoria, due to the size of the pores. Point out to students that even though all three samples have porosity, the holes are not connected in the scoria, so fluid would not move through it as easily. The pores in the gravel are bigger than the pores in the sand or sandstone, so fluid would move through the gravel easier. Discuss the differences in porosity and permeability.
7. Ask the students what happens if the water reached an opening, like a cave. Have them describe what might happen to the dissolved minerals in the water as it hangs from the ceiling of a cave passage. Have them explain where those minerals come from.
8. Ask the students, "If the water is moving through the ground in a permeable layer of rock, what could stop it?" Entertain all suggestions. Describe aquifers and aquicludes to the students. Using overhead or board drawings, demonstrate and discuss zone of aeration, zone of saturation, aquifer and aquiclude.

Wrap Up: Review the role of groundwater in cave formation.

Ask the students where they get the water they drink. Lead to a discussion of how the water must come from a surface reservoir or from a well before it makes it to them. Discuss potential sources of pollution along that pathway and what should be done to protect their drinking water.