

Debra Butler Mayers  
September 2003

## **KARST, CAVES AND GROUNDWATER CONTAMINATION**

### **SUMMARY**

Students will simulate a stable soil type and a karst soil type and observe accessibility to groundwater.

### **OBJECTIVES**

- To hypothesize about an experiment and draw conclusions
- To observe the differences between rock porosity and susceptibility of groundwater to contaminants
- To model different rock types based on the presence of limestone (calcium carbonate) bedrock
- To realize that substances reach the groundwater by filtering through the ground to the aquifer
- To know that karst regions are characterized by springs, caves and sinkholes
- To simulate rain on a land surface and observe the effects on the ground material and the filtration into an aquifer
- To discuss some possible sources of groundwater pollution

### **CORRELATION TO THE SHOW-ME STANDARDS**

Knowledge Standards: MA-2, 3; SC-1, 5, 7, 8; FA-1; HP-6

Performance Standards: Goal 1- 1, 3, 6

### **MATERIALS**

(Listed for each group set-up)

300 ml colored water

1 funnel (cut 2-liter soda bottles)

2 large gauze pads

4 cups of potting soil

25 sugar cubes

food coloring

2 clear collecting cups (bottom of cut 2-liter bottles) marked for 100, 125, 150, 175, 200, 225, 250, 275, 300 ml

1 cup to receive initial colored water

1 wastewater cup

a watch with a second hand

bucket or container for waste water

pencils

strong garbage bag for disposal

gallon jug to hold water

## **MAKING CONNECTIONS**

Our groundwater is susceptible to contamination, from the impact of surface activities. Groundwater is accessed through ground material and openings in the land surface. Karst topography is a fragile system where groundwater is extremely susceptible to contamination.

## **BACKGROUND**

When water infiltrates the ground and percolates down through the zone of aeration to the zone of saturation, it becomes part of the groundwater system. The top of the zone of saturation is called the water table. Wells must be drilled below the water table.

Characteristics of the rock layers above and below the aquifer, where usable amounts of groundwater are stored, affect the movement of water.

Carbonate bedrock (limestone and dolomite) are the principal sedimentary rocks in Missouri. Rainwater is naturally acidic and dissolves the carbonate rock. Layers of rocks that are fractured and allow water to flow through them are characteristic of limestone and dolomite regions.

Under ordinary conditions, groundwater flows like water on the surface, downhill. If a valley intersects the water table, groundwater may escape to the surface and create a spring. In karst regions like the Missouri Ozarks, limestone is highly fractured creating sinkholes, springs, and caves. Sinkholes help to recharge the groundwater because they are open pathways for water movement from the surface to the underground. Sinkholes are ways for pollutants to quickly reach the water table.

In karst regions, underground water movement may be swift and the level of the water table may be erratic. For this reason, groundwater in the Ozarks can be quickly and easily contaminated by wastewater discharge and improper disposal of hazardous substances. Once groundwater aquifers are contaminated, they are difficult if not impossible to clean up. The best way to protect groundwater quality is to prevent contamination.

## **PROCEDURE**

### **WARM-UP**

Ask students if they have visited a spring, cave or river in the Ozarks (show-of hands). Ask if one of them can explain why we have so many caves in the Ozarks? Proceed to explain about carbonate bedrock, fracturing of it, and what groundwater is.

## THE ACTIVITY

1. Have students look at what the set-up will be like and what all the parts are called.
2. Explain the overall procedure and ask them to hypothesize about which soil sample they think will allow the most water to pass through, in a given amount of time. Record your hypothesis on the **DATA SHEET**. (question #1)
3. Set up at your work area: collecting container with ml marks, funnel, two gauze pads, 25 sugar cubes, and a wastewater cup
4. Put one gauze pad in the funnel neck.
5. Line up to get soil to place in the funnel.
6. Set the funnel into the marked collecting container and one person hold the set-up still while another adds the soil.
7. Line up to collect your cup of colored water.
8. Tell students to pour all of the water quickly into the funnel with soil, but not so fast that any soil or water splashes out. Have all students begin at once by using your watch to count "3, 2, 1, go."
9. Use your watch to time 15 seconds from "go." Count down aloud the last five seconds "5,4,3,2,1, stop." Place the funnel over the wastewater cup to allow any water left to drain into it.
10. Record how much water is in the collecting cup. **USE DATA SHEET** (question #2)
11. Line up to dump the soil into a trash bag.
12. Place 25 sugar cubes into the empty funnel.
13. Line up and receive a cup of soil on top of the sugar cubes, to the marked line.
14. Follow steps 6 – 11, as your instructor tells you, and record data for question #3 on the data sheet.
15. Answer question #4 on your data sheet.

## WRAP-UP (ask orally)

1. Which soil type allowed the most water to pass through in a given amount of time?  
ANSWER: soil with sugar cubes
2. What was used in this experiment to simulate a cave or sinkhole?  
ANSWER: sugar cubes
3. Which of the soil materials we tested was most like Missouri karst areas? ANSWER: the one with the sugar cubes
4. Why does the soil in karst areas allow more water through?  
ANSWER: it is made of limestone which dissolves easily  
How do most rural and small-town Missourians get their drinking water? ANSWER: wells
5. When soil is karst it can lead to problems with our well water, how? ANSWER: it's easier for pollutants to get in the groundwater

6. If the gauze pad was an example of filtering out pollutants, and the food coloring was an example of a pollutant, did it do a good job of filtering out the pollutant? ANSWER: No, pollutants are difficult to filter out, especially in karst soil
7. Once groundwater gets polluted is it easy or difficult to clean up? ANSWER: difficult
8. What would be a safer way for Missourians who live in karst regions, to dispose of their trash, old vehicles, dead farm animals, and other items that can become pollutants? ANSWER: store them away from karst areas, or in areas made to protect groundwater, like plastic lined landfills
9. If you should find a sinkhole or cave on your property, what's the best way to keep possible pollutants out that may contaminate your drinking water? ANSWER: avoid pouring hazardous substances on the land and put a fence around it, 100 feet from the opening.

## EXTENSIONS

1. Calculate the percentage of water that passed through each soil sample. Example: 225ml divided by 300 ml.
2. Have students work with their team and develop a “rap” song that encourages protection of karst topography. As time permits, allow each team time to share their song.

## VOCABULARY

1. **Karst topography** is a landscape created by **groundwater** dissolving sedimentary rock such as **limestone**.

This creates land forms such as **shafts**, **tunnels**, **caves**, and **sinkholes**. **Groundwater** seeps into and through these land forms. The result is a scenic landscape which is beautiful but fragile, and vulnerable to **erosion** and **pollution**.



Components of karst:

**Springs:** Natural resurgence, or discharge, of groundwater from rock or soil to the surface.

**Caves:** Natural cavities beneath the surface of the earth, created by groundwater dissolving rock.

**Sinkholes:** Rounded depressions in the landscape. Sinkholes are often collapsed caves and can be quite deep, or they can be shallow holes. Sinkholes collect surface water running off the surrounding land, and the runoff goes directly into the groundwater.

## DATA COLLECTION SHEET

1. Which set-up do you hypothesize will allow the water to pass through the fastest, (circle one) with sugar cubes, or without sugar cubes?
2. How much water passed through the soil without the sugar cubes?  
\_\_\_\_\_ milliliters
3. How much water passed through the soil with sugar cubes?  
\_\_\_\_\_ milliliters
4. Was your hypothesis correct? \_\_\_\_\_