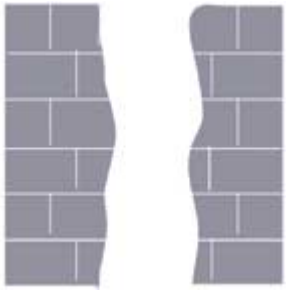
BUILD A MAZE CAVE

This activity can be modified for grades 3-12. Young children can complete the first scenario, while older students can complete all scenarios and do a more complicated analysis.

Objectives:

Students will:



- discover how water travels through a karst system,
- compare how quickly water travels through a cave as compared to solid limestone or sandstone,
- examine how pollution on the surface can affect groundwater quality in a karst system
- describe the complexity of three-dimensional maze caves like Wind Cave.

Materials:

- 20 laminated cave passage cards per student
- 50 laminated limestone cards
- 50 laminated sandstone cards
- Several dry-erase markers in a variety of colors
- Map of Wind Cave.

Background:

Rock dissolution, which is so important to the origin of limestone caves, also affects the land surface in cave areas, this can lead to a distinctive topography know as karst. Karst areas commonly have inward-sloping surface depressions known as sinkholes. Sinkholes look like craters on the ground. They are lands that have sunk or fallen. Sinkholes form because the limestone near the earth's surface has cracks and caves. The ground sinks or falls; when soil falls into the cave or cracks below. The drainage from the sinkhole is through the cave or cracks below. Sinkholes act like the sink you find in your kitchen. Food and liquids that are poured into a sink go down the drain. Materials dumped into sinkholes will go into the ground and the caves or cracks below, eventually reaching the water. Explore the booklet *What are Sinkholes?*

Procedure:

1. Discuss water movement underground and define “karst.” Write the definition on the board and encourage student involvement with several questions. Where does your well water come from? How quickly will rainwater reach the watertable when it passes through a cave? Through solid limestone? Sandstone? Review the properties of limestone and sandstone (porosity, permeability). You may also introduce the symbols used by geologists to represent these rock types (“bricks” for limestone and horizontal lines with small dots for sandstone).
2. Divide students into groups of 5 (or fewer depending on the number of students).

3. Tell them that each group will be making a cave, using the laminated passage cards. Show students how they can connect the cards, drawing an example on the board. Tell them it is OK to leave a few blank spaces in their cave and to create dead-end passages.
4. Give each student 20 cards and allow them a few minutes to construct their cave. (100 cards per cave is a good number.) Encourage each group to name their cave.
5. Fill in any blank spaces in the students' caves with the limestone cards, making each cave into a rectangle.
6. Using the example on the board, show the students how to trace water from the surface to the groundwater. Explain that water will follow the path of least resistance.
7. Ask students to trace the quickest route for water to travel through the cave. Have them mark the route with a dry-erase marker. Students may identify any edge of the cave as the "surface." (For the first activity, it may be best to have them choose a surface with a cave entrance.)
8. Ask them to compute how long it will take the water to reach the watertable in their system. Tell them that each passage card represents 1 day. Write results on the board for each cave. (Older students can record the results on paper.)
9. Ask students what will happen as the watertable fills and water spills into higher passages. Have them compute travel time from one output at the base of the cave to another. Tell them that it takes 1 week for water to fill a passage and begin crossing over to the next card. Record these results.
10. Explain that water will travel through small cracks in the limestone where there are no cave passages. Ask them to pick a point on their "surface" with no cave entrance and have them trace water from this point to the groundwater using a new marker color. Once the water hits the cave, it will travel as it did in the previous activity.
11. Compute the travel time for this new scenario. Travel through the limestone blocks on a passage card equals 1 month. Travel through the cracks of solid limestone cards equals one year. Travel through the passages of passage cards is still 1 day. Record the results. It may also be helpful to write the travel times for each type of card on the board as the activity becomes more complex.
12. Next, add a layer of sandstone cards to the surface of each cave. Discuss the concept of caprock as you do so. Ask students what they think will happen when water enters the sandstone. Have students keep in mind that water will spread out significantly in the sandstone and may reach the limestone at several points. Have them trace the quickest route with a new color. Again compute the travel time, with each sandstone card representing 10 years.
13. Compare the travel times for the three scenarios. Discuss how pollutants such as oil are carried underground by water. Introduce the concept of filtration, and discuss the increased risk of polluted water in karst areas.
14. Ask students how a less complex cave might increase the travel time from the surface. Discuss three-dimensional maze caves. Show students a map of Wind Cave, and explain how the activity they have just completed is a real-life scenario. Discuss cave maps and plan & profile views. The Wind Cave map is a plan (bird's-eye) view, and the students' models are profile views. In profile, Wind Cave looks similar to the students' caves: it is 600 feet deep and has multiple levels!

Variations:

1. Use thin black rectangles of construction paper to represent layers of impermeable chert. Place them between the sandstone and limestone, or imbed them in the limestone. Discuss what happens as water hits a layer of chert (It will run across the top of the chert layer and off the sides.)
2. Have students present their cave to the class. They can show the class how water travels through their system and where pollution spills on the surface would be especially dangerous. In this case, using Velcro to attach the cards to felt boards would be helpful.
3. Have the entire class build a giant maze cave and trace the water. Discuss how "long" their cave is and compare to Wind Cave's ~90 miles. Students can compute the cave length by measuring each passage with a ruler. The cave should be around 100 feet long. Students can also measure the length of their smaller caves.
4. Each layer of cards can represent 50 feet of depth. Have the students compute how deep their cave is. How far beneath the surface is their groundwater?