SALT BLOCK CAVE

OBJECTIVES

Students will learn to:

- show how underground drainage systems, or caves, are carved into soluble rock by moving water

METHOD

Students will build a cave system using salt blocks and water.

BACKGROUND

Most karst is formed where **carbonate rocks** such as **dolostone** and **limestone** are exposed at the earth's surface. The largest and greatest number of caves are found in areas of extensive deposits of limestone. Limestone is composed mainly of the mineral **calcite** ($CaCO_3$), with minor amounts of insoluble minerals (e.g. clays, quartz, feldspar). Limestone is rather soluble as rocks go, but only in acidic water. Raindrops reaching the earth's surface are generally not acidic enough to cause significant dissolution except in rare cases of acid rain caused by industrial emissions or volcanoes. In the underlying soil, however, aerobic bacteria break down dead organisms, producing carbon dioxide concentrations of ten to twenty times that of the outside atmosphere. As precipitation percolates through the soil, some of this CO_2 dissolves to form a **carbonic acid** solution. This slightly acidic water (essentially very flat seltzer water) seeps through cracks in the ground and slowly dissolves calcite out of the limestone and carries it away in the solution of water. People who live in karst areas and depend on **well** water can see evidence of the dissolved rock first-hand, shown by mineral deposits which form in their tea kettles and hot water heaters. These minerals were originally part of the underlying **bedrock**.

The most active dissolution of bedrock occurs just below the water table, where fresh, acidic water from the surface comes in contact with submerged limestone. The **water table** is the elevation below which fractures and voids in the bedrock are completely filled with water. Over thousands of years the water continues to dissolve along underground fractures and rock layers, and it hollows out spaces within the rock. These spaces are called passageways and caverns, or caves.

Rock which has not been significantly eroded and is still connected to the underlying strata is called bedrock. The decomposition of bedrock by the forces of weathering produces a zone of weathered rocks and soil. This layer has been most affected by the forces of weathering (breaking up of rocks, both chemically and physically) and erosion (removal of the weathered materials). Wind, water, and freezing and thawing are constant contributors to the weathering and erosion processes and explain the varying sizes and shapes of sediments found within this top layer. This fairly porous layer has a relatively fast rate of water permeability when compared to the underlying bedrock.

Chemical weathering changes the minerals within the rock, typically softening and weakening them. Rainwater dissolves carbon dioxide in the air and in the soil, where it is produced by organisms during the decay of organic material. This forms a weak acidic solution of carbonic acid that moves through the ground toward the water table. Some minerals react with the acid to make new minerals and release chemicals into solution. The best examples of this are the feldspars, a group of minerals commonly found in granites and some sandstones. Other minerals are soluble; they

GRADES:	3-9
SUBJECTS:	Science
SKILLS:	observing, labeling, sequencing
DURATION:	two days, 45 minutes per day
GROUP SIZE:	any, divide class into groups of 3-4
VOCABULARY:	limestone, carbonic acid, bedrock

dissolve completely into the acidic water but at varying rates. These soluble materials include halite (table salt), gypsum, calcite, and dolomite, in order of decreasing solubility. Because halite is highly soluble, it dissolves completely when exposed at the surface except in the driest of deserts. Gypsum, calcite, and dolomite dissolve more slowly, and produce a characteristic landscape, called karst, when exposed at the earth's surface. Because limestone (dominantly calcite) and dolostone (dominantly dolomite) are much more common than rock gypsum, most of the world's karst topography forms where these rocks are exposed at the earth's surface. A notable exception are the Guadalupe Mountains of New Mexico, which have karst topography developed dominantly in gypsum.

Materials

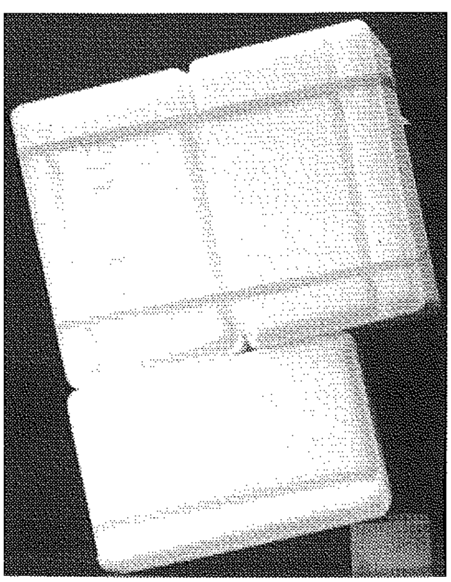
For each group of students:

- three salt blocks, available at country feed stores
- large cup of water
- a rag
- large rubber bands
- sink or a large plastic tub
- handful of stones

Procedure

1. Have students predict the path the water will take.

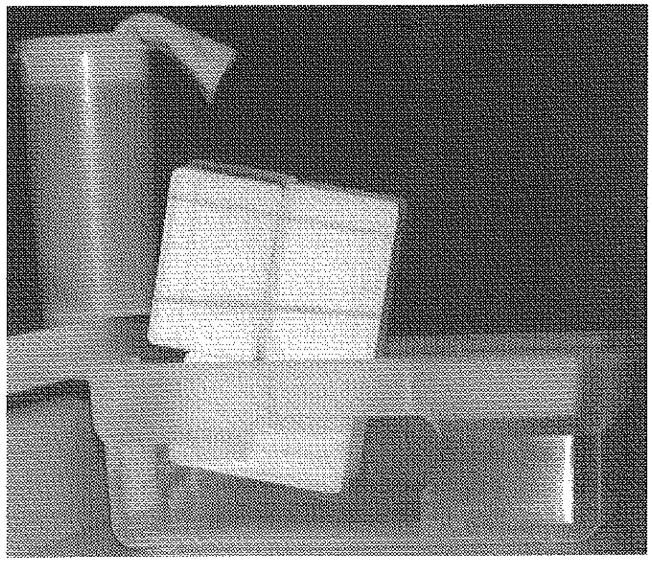
2. Set one salt block inside the tub on its long side. Prop up one end with the stones so that just one corner rests on the bottom of the tub.



3. Place the other two salt blocks side by side at the long side. Put rubber bands around the salt blocks to hold them together. Set these two salt blocks on top of the salt block inside the tub.

4. Place a small rag in a cup of water with one end of the rag sticking over the side of the cup. Very slowly tilt the cup and rag to drip water onto the top of the two salt blocks. Only a few drips a minute works best.

5. Set the cup so that the rag hangs above the salt blocks. Allow the water to drip for at least several hours; overnight or about twelve hours is a good amount of time.



Salt block photos by Joe Zokaites.

6. Remove the rubber bands and open up the blocks to see the cave. Look at the passages formed by the water dissolving the salt.

Evaluation

- Have the students draw and label a diagram of their resulting cave.
- Have the students write a sequence chart describing the path of the water. Did this differ from the predicted pathway? If so, why?

Variations

- Give each student their own set of salt blocks to form their own cave.
- Have several groups stack their salt blocks together to make a larger cave system.
- Layer some toothpicks and/or rocks into one group's setup during Step 3. If paths differ from the normal setups, discuss why.