Sinkhole in a Cup

SUBJECT: Science
GRADES: K-8
DURATION: approximately 30-45 minutes (longer for younger students to ensure they have time to build their models)
ACTIVITY SUMMARY: Students will learn how sinkholes form as well as the impact humans can have on the groundwater supply. (See extension below for the version to illustrate human impact.)

OBJECTIVES:
The students will be able to:

1. Observe and analyze how sinkholes and caves are formed.

MATERIALS REQUIRED:
Per group: 8 oz. Styrofoam cup, ½ sheet clear sheet protector, sharpie marker, ruler, tape, scissors, green rust-free scouring pad or very thin sponge, empty 3-liter soda bottle, sugar, sand

EVALUATION: Students can be assessed by their explanations of the observations made during the activity and analysis questions.

RESOURCES:
https://www.usgs.gov/faqs/what-a-sinkhole

EXTENSIONS:

- To illustrate how pollution from landfills can enter into the water cycle through the groundwater, add Kool-Aid powder to the sugar. As the sugar dissolves, the Kool-Aid will color the groundwater showing the pollution from the landfill contaminating the groundwater. Discuss measures that are taken to prevent this from happening.
- Little plastic houses could also be put on top to illustrate the problems landowners in karst areas face when they try to build on their land. Sinkholes sometimes form after the home is already built.

HELPFUL HINTS:

- Younger students will benefit from watching a teacher build the model before making their own.
- It's easier to keep the transparency tube in place if you use a piece of tape to hold it together.
- Bigger tubes of sugar tend to work better than smaller ones (best is approx. the size of a quarter).
- Coffee filters have also worked well instead of the sponge.
- You don't want the sand to be much higher than the height of the sugar—no more than ½ a centimeter.
- Activity works better if the sand is very dry.
- Be sure the hole is completely open, do not leave the Styrofoam piece hanging there.

Name: _____

Sinkhole in a Cup

Background

Sinkholes are natural depressions in the landscape caused by the dissolving of rock layers and the resulting sinking of the Earth's surface. They form as groundwater removes the subsurface rock and soil. Sinkholes can form by slow, gradual sinking or by the sudden collapse of an underlying void. Sinkholes are common throughout about one quarter of the United States. They can be small and localized or larger than a football field. Both circumstances have one thing in common—they indicate caves and/or bro- ken, weathered limestone bedrock near the soil surface.

The sinkhole at Natural Bridge Caverns.

Materials

- 8 oz. Styrofoam cup, ½ sheet of transparency film, sharpie marker, ruler, tape, scissors, green rust-free scouring pad or very thin sponge, empty 3-liter soda bottle, sugar, sand

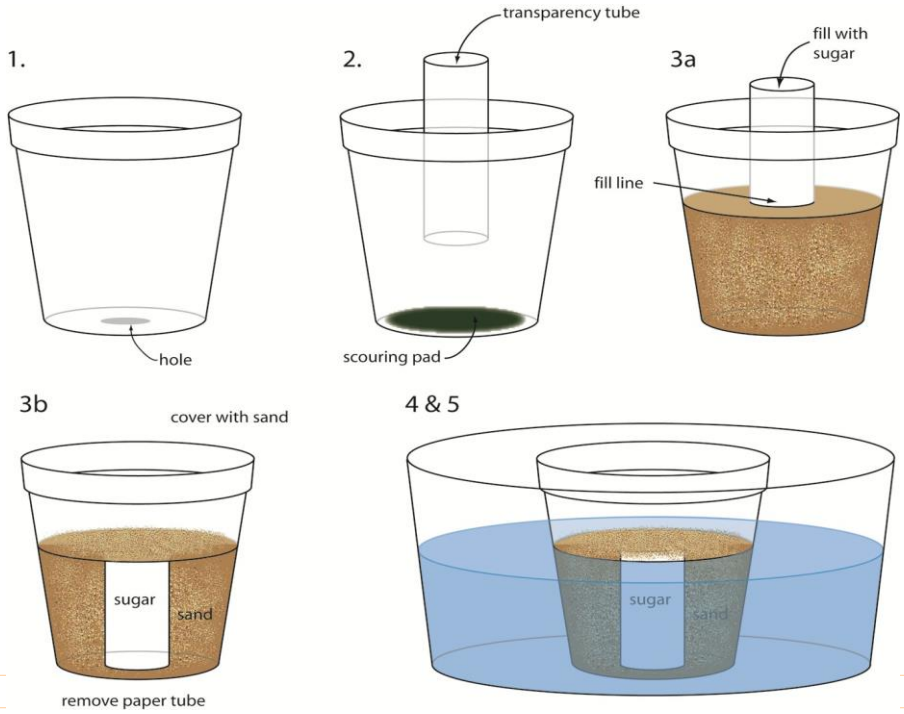
Procedure

1. Make a hole in the bottom of a Styrofoam cup about the size of your thumb. Be sure the hole is completely open, do not leave the Styrofoam piece hanging there.
2. Cut a circle the size of the cup bottom from a thin scouring pad. Place this circle in the bottom of the cup.

3a. Measure the height of the Styrofoam cup. Figure out what ¾ of the height is. Using the ruler and sharpie marker, draw a line on the transparency sheet that is this distance from the edge of the transparency. This will serve as the fill line for the sugar. The sugar should be about ¾ the height of the cup.

3b. Place a column of sugar in the center of the cup and surround it by sand. To do this, make a tube by rolling up the half sheet of transparency film and placing it in the center of the cup. The tube should be about the same width as a quarter. Fill the inside of the tube with sugar up to the fill line and the outside of the tube with sand (the sand is between the transparency tube and sides of the cup). Remove the transparency tube. Place a thin layer of sand over the sugar.

4&5. Cut the bottom off a three-liter soda bottle at about the same height as the cup. Fill it about half full of water. This symbolizes groundwater. (The level of the water in the tub and the sand in the cup should be about the same.)



1. Place the cup with sugar and sand in the water. Watch as the water fills into the cup and the sugar dissolves and runs out. A sinkhole is formed in the cup as the surface sand sinks into the area where the sugar dissolved. (You may need to remove the cup from the water to drain and for the sinkhole to form.) Describe what you see in the space below.

Analysis Questions:

a. What natural process does the water in the soda bottle represent?

b. What type of rock does the sugar represent?

c. What characteristics must a rock have to be suitable for forming sinkholes and caves?

d. Do you think humans can cause sinkholes? Why or why not?

e. What could be warning signs of a developing sinkhole?

TEKS ADDRESSED:

Science

Kindergarten

1(C) identify, describe, and demonstrate safe practices during classroom and field investigations as outlined in Texas Education Agency-approved safety standards
2(A) identify basic advantages and limitations of models such as their size, properties, and materials
3(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats
5(A) identify and use patterns to describe phenomena or design solutions
5(B) investigate and predict cause-and-effect relationships in science
(11) The student knows that earth materials are important to everyday life. The student is expected to observe and generate examples of practical uses for rocks, soil, and water.

1st Grade

1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations
1(B) use scientific practices to plan and conduct simple descriptive investigations and use engineering practices to design solutions to problems
1(C) identify, describe, and demonstrate safe practices during classroom and field investigations as outlined in Texas Education Agency-approved safety standards
1(D) use tools, including hand lenses, goggles, heatresistant gloves, trays, cups, bowls, beakers, sieves/sifters, tweezers, primary balance, notebooks, terrariums, aquariums, stream tables, soil samples (loam, sand, gravel, rocks, and clay), seeds, plants, windsock, pinwheel, student thermometer, demonstration thermometer, rain gauge, straws, ribbons, non-standard measuring items, flashlights, sandpaper, wax paper, items that are magnetic, nonmagnetic items, a variety of magnets, hot plate, aluminum foil, Sun-Moon-Earth model, and plant and animal life cycle models to observe, measure, test, and compare
1(G) develop and use models to represent phenomena, objects, and processes or design a prototype for a solution to a problem
3(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats

2nd Grade

1(B) create and describe food chains identifying producers and consumers to demonstrate how animals depend on other living things
1(C) identify, describe, and demonstrate safe practices during classroom and field investigations as outlined in Texas Education Agency-approved safety standards
1(D) use tools, including hand lenses, goggles, heat resistant gloves, trays, cups, bowls, beakers, notebooks, stream tables, soil, sand, gravel, flowering plants, student thermometer, demonstration thermometer, rain gauge, flashlights, ramps, balls, spinning tops, drums, tuning forks, sandpaper, wax paper, items that are flexible, non-flexible items, magnets, hot plate, aluminum foil, Sun-Moon-Earth model, and frog and butterfly life cycle models to observe, measure, test, and compare
1(G) develop and use models to represent phenomena, objects, and processes or design a prototype for a solution to a problem
3(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats

3rd Grade

1(B) use scientific practices to plan and conduct descriptive investigations and use engineering practices to design solutions to problems
1(C) demonstrate safe practices and the use of safety equipment during classroom and field investigations as outlined in Texas Education Agency-approved safety standards
1(D) use tools, including hand lenses; metric rulers; Celsius thermometers; wind vanes; rain gauges; graduated cylinders; beakers; digital scales; hot plates; meter sticks; magnets; notebooks; Sun, Earth, Moon system models; timing devices; materials to support observation of habitats of organisms such as terrariums, aquariums, and collecting nets; and materials to support digital data collection such as computers, tablets, and cameras, to observe, measure, test, and analyze information;
1(G) develop and use models to represent phenomena, objects, and processes or design a prototype for a solution to a problem
3(A) develop explanations and propose solutions supported by data and models
3(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats

3rd Grade Continued

3(C) listen actively to others' explanations to identify relevant evidence and engage respectfully in scientific discussion.
10(B) investigate and explain how soils such as sand and clay are formed by weathering of rock and by decomposition of plant and animal remains; and
10(C) model and describe rapid changes in Earth's surface such as volcanic eruptions, earthquakes, and landslides

4th Grade

1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations
1(B) use scientific practices to plan and conduct descriptive investigations and use engineering practices to design solutions to problems
1(C) demonstrate safe practices and the use of safety equipment during classroom and field investigations as outlined in Texas Education Agency-approved safety standards
1(D) use tools, including hand lenses; metric rulers; Celsius thermometers; calculators; laser pointers; mirrors; digital scales; balances; graduated cylinders; beakers; hot plates; metersticks; magnets; notebooks; timing devices; sieves; materials for building circuits materials to support observation of habitats of organisms such as terrariums, aquariums, and collecting nets; and materials to support digital data collection such as computers, tablets, and cameras, to observe, measure, test, and analyze information
1(E) collect observations and measurements as evidence
1(F) construct appropriate graphic organizers used to collect data, including tables, bar graphs, line graphs, tree maps, concept maps, Venn diagrams, flow charts or sequence maps, and input-output tables that show cause and effect
1(G) develop and use models to represent phenomena, objects, and processes or design a prototype for a solution to a problem
3(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats
3(C) listen actively to others' explanations to identify relevant evidence and engage respectfully in scientific discussion
10(B) model and describe slow changes to Earth's surface caused by weathering, erosion, and deposition from water, wind, and ice

5th Grade

1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations
1(B) use scientific practices to plan and conduct descriptive and simple experimental investigations and use engineering practices to design solutions to problems
1(C) demonstrate safe practices and the use of safety equipment during classroom and field investigations as outlined in Texas Education Agency-approved safety standards
3(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats
10(C) model and identify how changes to Earth's surface by wind, water, or ice result in the formation of landforms, including deltas, canyons, and sand dunes

6th Grade

1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations
1(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems
1(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards
1(D) use appropriate tools such as graduated cylinders, metric rulers, periodic tables, balances, scales, thermometers, temperature probes, laboratory ware, timing devices, pH indicators, hot plates, models, microscopes, slides, life science models, petri dishes, dissecting kits, magnets, spring scales or force sensors, tools that model wave behavior, satellite images, hand lenses, and lab notebooks or journals
1**(E)** collect quantitative data using the International System of Units (SI) and qualitative data as evidence
1(F) construct appropriate tables, graphs, maps, and charts using repeated trials and means to organize data
1(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems

TEKS CONTINUED:

6th Grade Continued

2(A) identify advantages and limitations of models such as their size, scale, properties, and materials
2(B) analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations
2(C) use mathematical calculations to assess quantitative relationships in data; and
2(D) evaluate experimental and engineering designs.
5(A) identify and apply patterns to understand and connect scientific phenomena or to design solutions
5(B) identify and investigate cause-and-effect relationships to explain scientific phenomena or analyze problems
5(C) analyze how differences in scale, proportion, or quantity affect a system's structure or performance
5(D) examine and model the parts of a system and their interdependence in the function of the system
5(E) analyze and explain how energy flows and matter cycles through systems and how energy and matter are conserved through a variety of systems
5(F) analyze and explain the complementary relationship between the structure and function of objects, organisms, and systems; and
5(G) analyze and explain how factors or conditions impact stability and change

7th Grade

1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations
1(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems
1(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards
1(D) use appropriate tools such as graduated cylinders, metric rulers, periodic tables, balances, scales, thermometers, temperature probes, laboratory ware, timing devices, pH indicators, hot plates, models, microscopes, slides, life science models, petri dishes, dissecting kits, magnets, spring scales or force sensors, tools that model wave behavior, satellite images, hand lenses, and lab notebooks or journals
1(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence
1(F) construct appropriate tables, graphs, maps, and charts using repeated trials and means to organize data
1(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems
2(A) identify advantages and limitations of models such as their size, properties, and materials
2(B) analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations
2(C) use mathematical calculations to assess quantitative relationships in data
11(A) analyze the beneficial and harmful influences of human activity on groundwater and surface water in a watershed

8th Grade

1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations
1(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems
1(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards
1(D) use appropriate tools such as graduated cylinders, metric rulers, periodic tables, balances, scales, thermometers, temperature probes, laboratory ware, timing devices, pH indicators, hot plates, models, microscopes, slides, life science models, petri dishes, dissecting kits, magnets, spring scales or force sensors, tools that model wave behavior, satellite images, weather maps, hand lenses, and lab notebooks or journals
2(A) identify advantages and limitations of models such as their size, scale, properties, and materials
2(B) analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations.