

Sinkholes: Getting to the Bottom of the Problem

Background Testing

Rock(et) Science: How Acid/Rock Reactions Influence Humans

Introduction:

You are an engineer and scientist interested in the effects of acid rain on monuments and as a creation mechanism of sinkholes. You have gathered some evidence of acid rain and its effect on human life.

For each clue, consider the following:

1) Are there imperfections visible?

2) Why do you think the imperfections are there based on the background information?

Write down some observations and descriptions of the clues that you see.

CLUE	OBSERVATIONS	IMPERFECTIONS	WHY?
Clue # 1			
Clue # 2			
Clue # 3			
Clue # 4			
Clue # 5			
Clue # 6			

Now that you have observed all of the clues, let's do some testing of our own!

Rock Testing

There are five different types of rocks on your lab table. Record the names and chemical formulas of the rocks in the table below.

Look at the two solutions provided for you. One is an acid and one is a base. Determine which solution is the acid and which solution is the base.

Acid _____ Base _____

****Check that you have correctly identified the acid and base with your teacher before you proceed.

Test each rock with two drops of both the acid and base and record your observations.

Rock Name	Chemical Formula	Observations with ACID	Observations with BASE
Limestone			
Granite			
Gypsum			
Concrete			
Copper metal			

Discussion Questions:

1. Which rocks reacted with the acid?
2. Which rocks reacted with the base?
3. Which rock(s) do you think are the most susceptible to deterioration from acid rain?
4. Which rock(s) do you think can resist deterioration from acid rain?
5. Which rock type do you believe was found under the sinkhole in clue #6? Why?
6. Looking at the Illinois map of karst formations (porous limestone bedrock), do you think this evidence supports your hypothesis from the background reading? Make sure you give three pieces of evidence for your answer.

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Computational Modeling

Computational Investigation:

In this activity you will be using a NetLogo simulation to observe acid rain percolation through bedrock. You will control the porosity of the limestone bedrock and the pH of the acid rain. This activity will help you visualize how acid rain can dissolve away the limestone creating unstable ground. You will use this knowledge to create your physical model of a sinkhole.

NetLogo Launch Instructions

- ⇒ File
- ⇒ Open *Models Library*
- ⇒ Select *Curricular Models*
- ⇒ Select *Earth Science*
- ⇒ Select *Sinkhole*

The boxed words represent a button or action needed in the NetLogo program.

Activity

- 1) Click **Set-up**
- 2) Click **go/stop** and observe what is happening to the bedrock.
 - a) The black material left at the end of the simulation represents the limestone that has been dissolved by the acid rain. Do you think the town above will survive? Why or why not?
 - b) What are the axes of the top graph?
 - c) Explain the relationship between the axes in this graph.
 - d) What are the axes of the bottom graph?
 - e) Explain the relationship between the axes in the graph.

- 3) Slide the **Porosity** to decrease the porosity and record the % porosity.
- 4) Click **go/stop** and observe what happens.
 - a) What was the percent of layer that water is able to contact in the bedrock?
 - b) What is the maximum amount of water that is able to penetrate the system?
 - c) Do you believe the city will survive? Why or why not?
- 5) Slide the **Porosity** to increase the porosity and record the % porosity.
- 6) Click **go/stop** and observe what happens.
 - a) What was the percent of layer that water is able to contact in the bedrock?
 - b) What is the maximum amount of water that is able to penetrate the system?
 - c) Do you believe the city will survive? Why or why not?
- 7) Based on your investigation, if you intend to create a model that will show how a sinkhole forms, what properties of your substrate are important? (i.e.: Should it be more porous or less porous? Should it be able to dissolve easily in water or not?)
- 8) What types of kitchen materials do you think will be a good representative?

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Model Building

It is hard to get a true sense of a sinkhole without being able to see it. You will be building a model of a sinkhole to show how it may occur in Illinois. Before you can start making your model you need to determine the components of the sinkhole and find materials that can represent each component in your model. Once you have your initial plan, check in with your teacher to get your supplies. Build it, test it, make some modifications.

Brainstorm:

What can you use to represent bedrock? What does the bedrock need to do when exposed to water? Do you want this to happen quickly or take the years it can take in the real world? What can you use to demonstrate soil? Does it need to allow water through? How can you that a sinkhole has formed?

Use the space below to sketch out your model, label it clearly. The label should include both the names of the material being used and what it should represent.

Teacher sign-off _____

Build it!

Make sure you have a table to record your observations and results? Can you think of any quantitative measurements you could make to evaluate your model? Include that in the table you create below.

Discussion Questions

1. Did your model show how a sinkhole forms?
2. What parts of your model worked well? Why?
3. What parts do you think need to be changed? Why?

Preparation of Your Presentation of the Model

In your presentation you must address the following questions.

1. What materials did you choose and why?
2. How much did your building (the mass) sink?
3. What is the effect of acidic water on bedrock?
4. If you were to do this again, what would you change?