Introduction to Speleology
Three Great Caves of Oregon
Grade: 4/5

Overview
Caves are a great way to engage young learners in geology and earth sciences. The study of caves is known as speleology, and those who explore caves are called speleologists. Oregon boasts a number of large and impressive caves. Furthermore, because Oregon is so geologically diverse, there are excellent examples of different types of caves, formed by different geological forces. This lesson will concentrate on three major Oregon cave systems: the Oregon Caves of Josephine County, the Lava River Cave of Deschutes County, and the Sea Lion Caves of Lane County.

Oregon Common Core State Standards
Language Arts Standards:
- CCSS.ELA.RI.4.4 Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.
- CCSS.ELA.W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- CCSS.ELA.W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.
- CCSS.ELA.SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others’ ideas and expressing their own clearly.

Social Studies Standards:
- Geography 4.11: Identify conflicts involving the use of land, natural resources, economy, competition for scarce resources, different political views, boundary disputes, and cultural differences within Oregon and between different geographical areas.

Materials
- Historic Oregon Newspapers website
- Access to the Internet
- Computers
• Cave types self-discovery activity sheet
• Information gathering graphic organizer
• Predictions and observations activity sheet
• Whole group experiment observation sheet
• Science experiment materials
  o 1 box of sugar cubes  
  o Toothpicks  
  o Clear plastic or glass tubs: 1 per partnership or table group  
  o Spray bottles filled with water: 1 per partnership or table group  
  o Modeling clay: 2 lbs. for each partnership or table group  
  o Limestone rocks  
  o A few non-carbonate rocks, various types  
  o Water  
  o Vinegar  
  o Pipettes or eyedroppers  
  o 3 clear jars

Key Vocabulary

• Speleology
• Caverns
• Dissolve
• Limestone
• Acid
• Sulfuric acid
• Carbonic acid
• Solution
• Fissures
• Non-soluble

Lesson

• Introduction: Introduce the different types of caves, emphasizing the difference as a result of the various ways that caves are formed.
  o Have students fill out cave types self-discovery sheet  
  o Lead into class discussion about the cave types
• Some discussion questions to consider:
  o What are the earth forces that form this type of cave?
  o What kinds of rock are they usually formed in?
  o What are some typical shapes and features of this type of cave?
o Where are some places in the world where major examples of this type of cave can be found?

• Activity: Have students browse the following websites to identify Oregon’s caves. A graphic organizer to help students organize their information is provided below.
    ▪ These are impressive examples of solution caves, or caverns, in marble rock, a form of limestone.
  o Sea Lion Caves: http://sealioncaves.com/home/
    ▪ This coastal grotto outside Florence is one of the largest sea caves in the world!
  o Lava River Cave: http://en.wikipedia.org/wiki/Lava_River_Cave
    ▪ As the name implies, this cave is volcanic in origin.

• Optional Jigsaw Activity: To provide even further background information, provide groups of students with one of the articles listed below. Once they have read the whole article as a group or partnership, discuss the most important parts from the article. These articles are primary source documents that provide students with a direct connection to the state of Oregon.
  o “Oregon Caves,” from Portland Sunday Oregonian, August 24, 1902
  o “Mammoth Cave In Southern Oregon,” from Willamette Farmer, June 13, 1879
  o “Another Cave,” from Oregon Sentinel, May 7, 1879
  o “Find a Great Cave: Two Boys Find Immense Cavern Near Grants Pass,” from Daily Journal, April 11, 1903
  o “Great Oregon Caverns,” from Morning Oregonian, August 10, 1901
  o “Ice Caves Are Unique,” from Bend Bulletin, July 3, 1912

• Experiment Introduction: Provide students with some background information about caverns.
  o “Cavern” is a term that refers to a particularly large, underground solution cave. The dissolving power of natural acids—most typically, sulfuric or carbonic acid—in solution with water, forms these types of caves. When the acidified water percolates through small cracks and fissures in limestone rock (i.e. limestone, dolomite, marble), it gradually dissolves the rock until large caverns are eventually formed. A full description of the process can be found online here, as well as in most classroom earth science textbooks. You may also read about the process in a historic Oregon newspaper article from 1875: “Origin and Philosophy of Limestone Caves,” from Willamette Farmer, June 4, 1875. Additionally, the Oregon Caves National Monument was formed this way!

• Science Experiment: Lead this discussion into the science experiment. An instruction sheet and a predictions and observations sheet are provided below.
  o Have students work in partnerships or table groups.
  o Demonstrate experiment and guide students through the experiment, stopping occasionally to fill out the predictions and observations sheet.

• Science Experiment 1: Explain what each material represents.
  o Step 1: Explain how the sugar cubes represent deposits of limestone, and the spaces between the cubes represent natural cracks and fissures.
  o Step 2: Explain that the clay represents the surface layer of soil and non-soluble rock.
  o Step 3: Explain the holes and gaps represent the holes and gaps in the surface layer.
  o Step 4: Explain that the spray represents rainfall. Make sure to stop the students to make observations about what they see in the tub.
• **Science Experiment 2**: Perform experiment in whole group. Make predictions and observations together. Hang up an anchor chart where observations could be written daily.

• **Debrief**: Have students complete the predictions and observations graphic organizer once they are finished with the science experiment. Then bring them together to debrief.

• Some debrief questions to consider:
  o  What is something you learned that was interesting?
  o  Were your predictions correct?
  o  What do you think will happen to the limestone in our three jars?
  o  What kind of cave do you think was created in the first experiment?

**Extension Activity Ideas**
Activities can be modified several different ways, depending on the grade level and focus of study. Listed are activity ideas that can be adapted and extended to and for any grade level.

• **Field Trip**: To provide students with even more realia, organize a field trip to one of Oregon’s famous caves. Have students make observations, and write reflections about their experiences.
  o  For more cave tour information, visit the [National Park Service](https://www.nps.gov) website.
  o  For more information about sea lion caves, visit the [Discover Sea Lion Caves](https://www.discoversealioncaves.com) website.
Sugar Cube Experiment

Materials
- 1 box of sugar cubes
- Toothpicks
- Clear plastic tank or container, one for each partnership or table group
- Spray bottles filled with water, one for each partnership or table group
- 2lbs. of modeling clay per partnership or table group

Procedure
1. Loosely stack sugar cubes along one side of the tank. Do not make a perfect “brick wall”—leave gaps and spaces between the cubes, and stack some higher than others. Make sure the sugar cubes are touching one side of the tank wall so that you can see inside.
2. Use the modeling clay to cover the outside of the sugar structure. Make sure there are no gaps.
3. Use the toothpicks and a pencil to poke several holes through the clay into the sugar. Make different-sized circles.
4. Use the spray bottle to lightly spray the structure with water.
5. Fill out observations sheet.
6. Spray the structure more to dissolve more and more of the sugar.
Whole Group Experiment

Materials

- Limestone rocks
- A few non-carbonate rocks, various types
- Water
- Vinegar
- Pipettes or eyedroppers
- 3 jars

Procedure

1. Pass out a mixture of limestone and non-carbonate rocks to each partnership or table group.
2. Ask students to make observations about the rocks.
   a. What are some things you notice about these rocks?
   b. How do they feel?
   c. What do they look like?
   d. How much do they weigh?
   e. What do they smell like?
3. Instruct students to use dropper to place a few drops of water on the rocks. Make observations about what happens. Record data.
4. Repeat step 3 with vinegar.
5. In the jars, make mixtures of vinegar and water.
   a. In jar 1: Make a 50%-50% mixture of water and vinegar.
   b. In jar 2: Make a 25% water and 75% vinegar mixture.
   c. In jar 3: Make a 75% water and 25% vinegar mixture.
   d. Make sure to label each jar.
   e. Leave plenty of room at the top of the mixture.
6. Measure 3 limestone rocks. Find the mass using a scale, and record these numbers.
   a. Immerse in each jar, making sure to label.
7. Observe the jars.
8. Once the rocks have shrunken, remove from liquid and let dry. Once completely dry, reweigh the rocks on a scale. Record the data.
   a. How much mass has each rock lost due to the dissolving action?
   b. How does this correspond to the strength (acid-to-water ratio) of each liquid sample?

Predictions and Observations Sheet

Whole group observation sheet (recommended transfer to larger paper)
### Driving Question:
What do you think will happen when we spray the sugar structure with water?

### Predictions and Observations Sheet

1. Make a prediction of what you think will happen. Make sure to use phrases like, “I predict...” or “I hypothesize...”
2. Draw a picture with labels of your prediction.
3. After Step 4, what happens when you lightly spray the sugar structure? Write down your observations. Make sure to use phrases like, “I observed...”
4. Draw a picture with labels of your observations.
5. After Step 6, what happens when you heavily spray the sugar structure? Write down your observations.
6. Draw a picture with labels of your observations.
7. Write a conclusion about your findings. Don’t forget to describe the experiment, your predictions, and your observations.

#### Predictions
What do you think will happen?

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<tr>
<th>Draw and label your prediction below.</th>
<th>Write your prediction below.</th>
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#### Observations
What actually happened?

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<tr>
<th>Draw and label your observations at Step 4 below.</th>
<th>Write your observations at Step 4 below.</th>
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## Observations
What actually happened?

<table>
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<th>Draw and label your observations at Step 6 below.</th>
<th>Write your observations at Step 6 below.</th>
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## Conclusion
Write a summary about what you did, predicted, and observed.

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## Observations
Use your magnifying glass, fingers, eyes, etc. to make observations about the rocks.
What do you notice about the rock group?

<table>
<thead>
<tr>
<th>Water Droplets</th>
<th>Use your dropper to place a few drops of water on the rocks.</th>
<th>What do you notice?</th>
</tr>
</thead>
</table>

<p>| Vinegar Droplets | Use your dropper to place a few drops of vinegar on the rocks. | What do you notice? |</p>
<table>
<thead>
<tr>
<th>Jar 1</th>
<th>Rock Mass</th>
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<tbody>
<tr>
<td>50%-50% water and vinegar mixture</td>
<td>Before:</td>
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<tr>
<td>What do you notice in jar 1?</td>
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<thead>
<tr>
<th>Jar 2</th>
<th>Rock Mass</th>
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<tbody>
<tr>
<td>25% water and 75% vinegar mixture</td>
<td>Before:</td>
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<tr>
<td>What do you notice in jar 2?</td>
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<th>Jar 3</th>
<th>Rock Mass</th>
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<td>75% water and 25% vinegar mixture</td>
<td>Before:</td>
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<td>What do you notice in jar 3?</td>
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</table>
Cave Types Self-Discovery Activity Sheet

Cave Types

1. Using the resources available to you, find how the following cave types are formed.
2. You may use the Internet, your science textbooks, or anchor charts.
3. Write how the caves are formed, and where you got the information.

<table>
<thead>
<tr>
<th>Cave types</th>
<th>How they are formed</th>
<th>Where did you find this information?</th>
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<tbody>
<tr>
<td>Eolian</td>
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<td>Glacier</td>
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<td>Volcanic</td>
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<td>Talus</td>
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<td>Tectonic</td>
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<td>Solution</td>
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- Cave types:
  - Eolian Caves—Formed by the wind, usually in sandstone.
  - Glacier Caves—Formed by the action of glaciers.
  - Volcanic Caves—Formed by the flow of lava and volcanic gases.
  - Sea Caves—Formed in seashore areas by the action of waves.
  - Talus Caves—Formed by the uneven piling-up of large boulders.
  - Tectonic Caves—Formed by deep movements of the earth’s crust.
  - Solution Caves—Formed when acid and water dissolve soluble rock, such as limestone.