Getting Salty – High School

STUDENT NAME: ....

STUDENT ACTIVITY

SCIENTIFIC OCEAN DRILLING

Objective(s)/Outcome(s)

Students will be able to use data to describe how evaporation affects the salinity of a body of water.

Materials

- conductivity meter
- hot plate
- 350 mL saltwater
- heat-resistant beaker
- pipette
- goggles
- tongs or heat-resistant gloves
- Petri dish (optional)

Background

Saltwater accounts for approximately 98% of the water on Earth. Bodies of water have different levels of **salinity** depending on the water that has traveled into and out of the water source, the materials the water has encountered, and how the body of water has interacted with the atmosphere (e.g., evaporation, precipitation). Salinity can be measured in a number of ways, but the two most accurate are specific gravity and conductivity.

Specific gravity is a measure of relative density, meaning how dense a substance is in comparison to a reference material, such as pure water. The specific gravity of a sample of saltwater would indicate how much denser it is than the same volume of pure water. **Conductivity** is a measure of how much electricity can flow through a substance. Because water molecules have partial positive and negative charges, water can conduct electricity. The concentration of ions dissolved in water can affect its ability to conduct electricity due to the ions also having charges, so measuring conductivity provides information on the concentration of ions dissolved in a water sample. Both specific gravity and conductivity will vary with temperature, so it is important to make comparisons at a constant temperature.

Activity

1. Take a sample of saltwater from the model and measure the specific gravity and conductivity.
2. Place a beaker on a hot plate and add 40 mL of saltwater. Bring to a boil.
3. **Safety Note:** Goggles must be worn when working with boiling liquid.
4. Once half of the saltwater has boiled off, use a pipette to take a sample of the water. Take the sample from near the bottom of the beaker.
5. Measure the conductivity of the sample.
6. Add another 40 mL of saltwater to the beaker.
7. Repeat steps 2–5 five more times, each time, recording the conductivity and making observations of the beaker.
8. Measure specific gravity of the final sample.
9. Follow your teacher's instructions for removing the beaker from the hotplate.
10. If there is time, set aside the final sample of saltwater in a Petri dish and let it sit overnight.

AGI Developed in collaboration with the American Geosciences Institute

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Analysis

1. Organize the class' conductivity data into a table.

2. Describe how the conductivity changed over time as more saltwater was added and evaporated from the beaker. Relate this to the model your teacher used.

   a. How can you use the model to make water saltier?

   b. How does this relate to the production of saltwater in a natural setting?

3. If you completed step 8, describe what remained once the water had boiled away.

4. Imagine this experimental setup: cover the bottom of a bin with a thin layer of sand, then add enough super saline water to fill the bin to halfway. Let the water evaporate. Make a hypothesis as to what changes you would see in the bin after the water has evaporated.

Synthesis

1. In this experiment, you boiled a small amount of saltwater.

   a. Where might a similar process occur naturally?

   b. How does this model simulate possible effects of climate change?

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2. Hypothesize what would happen in a saline body of water if a large volume of it evaporated, such as the Great Salt Lake or part of a sea.

3. View images showing the circulation patterns in the Mediterranean Sea: **Surface Circulation** and **Vertical Circulation (Figure 1 in the article)**.

   a. From where does water enter and exit this sea?

   b. What effect do you think this has on the circulation patterns?

   c. If the input of water from the land increased, what effect would this have on the salinity of the sea? Explain why. Also, explain what effect this might have on the circulation patterns.

   d. If the average temperature of the atmosphere continues to rise, what will happen to the rate of evaporation off the Mediterranean Sea? What effect will this have on the salinity of the sea?

4. View an image showing what the Mediterranean Sea is estimated to have looked like during a portion of the Miocene epoch referred to as The Messinian Salinity Crisis (**Image 1**, **Image 2**).

   a. Look at a map of the modern-day Mediterranean Sea and make comparisons between the two.

   b. Hypothesize what might have happened between the Miocene epoch and modern day for these changes to have occurred.

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c. During the Miocene epoch, would you expect the Mediterranean to be more or less saline than it is today? Use observations from this experiment to support your answer.

5. Scientists can learn about the past by studying cores that show the interior of the Earth. Sediment cores taken from the Mediterranean seafloor can allow scientists to study the sediment that deposited over time, providing evidence of past conditions in the sea.

   a. Make observations of the core segments, noting differences as you look along its length.

   b. When water levels drop in a body of saltwater, salt deposits are left on the sea floor. This occurred in the Mediterranean during the Messinian Salinity Crisis. Examine the cores and identify where you think the salt deposits begin. How thick is the salt layer in this core sample?

   c. The drilling team was not able to drill all the way through the salt layer because the layer was hard enough to break the drilling equipment. Research the full thickness of this deposit.

6. Look at a **map showing global trends in surface salinity levels in seas and oceans**:

   a. "Map a: Evaporation Minus Precipitation" shows an estimate of how much water evaporates from sea and ocean surfaces each year. It takes into account precipitation amounts. Yellow, orange, and red areas have more evaporation than precipitation. Blue areas gain more water than they lose due to precipitation levels being higher than evaporation rates. Describe trends and any anomalies in the map.

   b. "Map b: Salinity" shows the average surface salinity of the ocean. Describe trends and anomalies in the map.

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c. Look at the two maps together. How do their trends compare?

d. How can “Map a” be used to explain the trends seen in “Map b”?

Extensions

1. Complete the experiment described in Analysis question #4. How do your results compare to your hypothesis? Why did these results occur?

2. Some scientists have studied the **hypothesis that the Messinian salinity crisis was linked with increased volcanic activity**. Summarize why they think this.

3. Research the increasing salinity of rivers. What reasons have been proposed for why this is occurring? What implications could it have on lakes, oceans, and other large bodies of water? Why is this of concern? Use the following articles to start your research:
   a. **Freshwater salinization syndrome on a continental scale**
   b. **EPA Researching the Impacts of Freshwater Salinization Syndrome**
   c. **Common irrigation drivers of freshwater salinisation in river basins worldwide**