NPS Photo by Rick Wood

Porosity of Sediments

Lesson Objective: After completing this activity students will have a better understanding of how to measure and calculate pore space, and what properties influence the porosity of varying sediments.

Key Concepts: sedimentary rock (sandstone); pores and pore space; calculating porosity; particle size; properties that influence porosity: sorting, grain type, grain shape, grain size, grain packing.

Duration: 1 55-minute class period

Audience: Middle school and high school students

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Teacher Copy and Answer Key

POROSITY OF SEDIMENTS LAB [i] ~ TEACHER COPY

How much open space is there in sandstones composed of varying sediment types?

Lesson Objective:

After completing this activity students will gain a better understanding of how to measure and calculate pore space, and what properties influence the porosity of varying sediments.

Background:

Rock formations made from sedimentary rocks have spaces between the sediments called pores. These pores are the result of irregular shaped particles not fitting together. Sedimentary rocks, like sandstone, can be composed of a variety of sediments and each sediment type has a unique number of pores. The difference in pores, and the corresponding pore space, results in different types of rocks having different pore volumes. Liquids, like oil, gas, or water, move through the different types of rocks at different rates due to the difference in pore volumes.

Materials:

- Gravel
- Sand
- Water
- Calculator
- Magnifying Glass
- 100 mL Graduated Cylinder
- Small, plastic beads
- Large, plastic beads
- 4 Beakers

Investigation 1:

1. Beaker #1:----------Fill to 100 mL with the large, plastic beads.
2. Beaker #2:----------Fill to 100 mL with the small, plastic beads.
3. Graduated cylinder: :----------Fill to 50 mL with water.
4. Slowly pour the water into Beaker #1 until the water just reaches the top of the beads.
    a. Record exactly how much water was used in Data Table A.
    b. If you need more than 50 mL, fill the graduated cylinder again.
5. Follow Step 4 again for Beaker #2.
6. Fill the graduated cylinder with 100 mL of water.
7. Now mix the large beads with the small beads.
8. Follow Step 4 again for the mixed beads.

Data Table A:

Type of Sediment	Volume of Water (Pore Space)	Volume of Sediment	% Pore Space (Porosity)
Large Beads			
Small Beads			
Large + Small Beads			

Calculating Porosity:

For each sediment type, calculate the porosity by dividing the volume of water that you were able to pour into the sediment by the total volume of the material. Then express this as a percentage:

$$\frac{\text{Volume of Water (Pore Space)}}{\text{Volume of Sediment}} = \text{\% Pore Space (Porosity)}$$

Investigation 2:

1. Use the magnifying glass and classify the gravel and sand in the table below:

Sediment Type	%Round : % Angular	Well-Sorted	Poorly Sorted
Gravel	*RESULTS MAY VARY*	*NO*	*YES*
Sand	*RESULTS MAY VARY*	*YES*	*NO*

2. Beaker #1:----------Fill to 100 mL with gravel.
3. Beaker #2:----------Fill to 100 mL with sand.
4. Graduated cylinder: :----------Fill to 50 mL with water.
5. Slowly pour water into Beaker #1 until the water just reaches the top of the gravel.
    a. Record exactly how much water was used in Data Table B.
    b. If you need more than 50 mL, fill the graduated cylinder again.
6. Follow Step 5 again for Beaker #2.
7. Fill the graduated cylinder with 100 mL of water.
8. Now mix the gravel with the sand.
9. Follow Step 5 again for the mixed sediments.

Data Table C:

Type of Sediment	Volume of Water (Pore Space)	Volume of Sediment	% Pore Space (Porosity)
Gravel			
Sand			
Gravel + Sand			

Conclusions:

1. Compare the large bead porosity to the small bead porosity.

   THE LARGER BEADS HAVE A GREATER POROSITY THAN THE SMALLER BEADS.

2. Explain how the bead porosity depends on particle size.

   BASED ON THIS INVESTIGATION, THE LARGER BEADS HAVE A LARGER POROSITY AND THE SMALLER BEADS HAVE A SMALLER POROSITY. THIS IS BECAUSE THE LARGER BEADS HAVE BIGGER VOID SPACE IN THE CENTER.

3. Explain the effect of mixing bead sizes on porosity.

   MIXING THE BEAD SIZES LOWERED THE POROSITY BECAUSE THE SMALL BEADS FILLED IN THE VOIDS.

4. Compare the gravel porosity to the sand porosity of the sediments in your investigation.

   RESULTS MAY VARY

5. In general, well-sorted sediments, like sand, have a high porosity and poorly-sorted sediments, like gravel, have a low porosity. Does your porosity values compare to this sorting observation, or not? Explain.

RESULTS MAY VARY

6. In general, sphere-shaped sediments, like sand, will pack more closely together and have a low porosity. Do your observations of grain shape for the sand support this statement? Explain

RESULTS MAY VARY

7. Explain the effect of mixing sediment types on porosity.

MIXING THE SEDIMENT TYPES LOWERED THE POROSITY BECAUSE THE SMALLER, SPHERE-SHAPED SAND PARTICLES FILLED IN THE VOIDS OF THE ANGULAR GRAVEL.

8. Based on these investigations, list 5 properties of sediments that influence porosity:

Property 1: *SORTING*

Property 2: *GRAIN TYPE*

Property 3: *GRAIN SHAPE*

Property 4: *GRAIN SIZE*

Property 5: *GRAIN PACKING (How they are packed together)*

[i] Lab adapted from: http://www.seed.slb.com/en/scictr/lab/porosity/ , and http://www.uwsp.edu/water/portage/undrstnd/soil.htm