Activity #8:

Groundwater Movement: Porosity & Permeability

Soils are made up of particles of rock and the spaces between particles. The porosity of soil indicates how much of its volume is open space. This can be estimated rather accurately by measuring the amount of water it can hold. The permeability of soil indicates how easily water can move through it. It can be estimated by timing how quickly water flows through it.

Physical characteristics of soil particles, such as size and shape, can influence both the porosity and the permeability of soils. Soils that are made up of coarse-grained materials, such as sand or gravel, tend to have large open spaces that can fill with water. These large open spaces allow water to travel much faster than through fine-grained materials such as clay. Fine-grained materials may be able to **hold** a great deal of water, but may transmit very little of it due to the lack of large open spaces between the grains.

Both porosity and permeability are very important in relation to groundwater because they determine how much and how quickly water moves through it into an aquifer.

Objective: Upon completion of this activity, students will be able to:

- describe characteristics of different types of soils.
- determine how water flows through these different soils.
- discuss the relationship between porosity and permeability.

NEVADA SCIENCE STANDARDS 16:8, 22:8

Time: Two or three class periods for discussion and activity

Materials: Separate samples of dry gravel, sand and clay[1]; unknown samples of soils from student homes; high quality topsoil; funnels; filter paper; glass-marking crayon; graduated cylinders; clear cups or beakers; stopwatch or timer clock; goggles; *Student Activity Sheet*; *Student Instructions*

Procedure:

Teacher - Emphasizing the meanings of porosity and permeability, lead the students in a brief discussion of the introductory information. Organize the materials for the activity. Distribute the *Student Instructions* and *Student Activity Sheet*, divide students into work groups and proceed with the investigation.

[1] Gravel, sand and clay may be dried on a cookie sheet in the oven at 250^{o} - 275^{o}F for approximately 15-20 minutes.

Students - Use the *Student Instructions*, *Student Activity Sheet* and the available materials to complete this lab activity.

Activity #8:

Groundwater Movement: Porosity & Permeability
Student Instructions

Objective: Upon completion of this activity, students will be able to describe characteristics of different types of soils, determine how water flows through these different soils and to discuss the relationship between porosity and permeability.

Materials: (per group) separate samples of dry gravel, sand and clay; unknown soil samples; funnel; filter paper; glass-marking crayon; graduated cylinder; beaker; goggles; watch or timer

Procedure:
To measure porosity:

1. Make a crayon mark half way up on the beaker.
2. Fill the beaker to the mark with water.
3. Pour the water into the graduated cylinder.
4. Measure the volume of water and record as “Total Volume” in the data table.
5. Dry the beaker.
6. Fill the beaker to the mark with gravel.
7. Measure 100 ml of water into the graduated cylinder.
8. Pour water into the beaker with the gravel until it reaches the line (top of the gravel).
9. Note the amount of water needed to saturate the gravel and record in the data table as “pore space.”
10. Divide the “pore space” by “total volume.” Multiply your answer by 100 (move the decimal two places to the right). This will give you percent of porosity.
11. Clean and dry the beaker.
12. Repeat steps #1 through #11 for sand, clay and the unknown sample. Record all data in the data table.

To measure permeability:

1. Mark the 50-ml line on the beaker.
2. Insert wet filter paper into the funnel and place the stem of the funnel inside the marked beaker.
3. Fill the filter with gravel to about 2.5 cm from the top.
4. Pour water from the graduated cylinder into the filter.
5. Time how many seconds it takes to fill the beaker to the line.
6. Record these results in the Data Table as “permeability.”
7. Repeat steps #1 - #6 with sand, clay and the unknown sample. Record all data in the data table.

Activity #8:

Groundwater Movement: Porosity & Permeability
Student Activity Sheet

1. Data Table - Record the results in the appropriate spaces in the data table.

Soil Material	Total Volume (ml)	Pore Space (ml)	Permeability (seconds)	% Porosity
Gravel				
Sand				
Clay				
Unknown				

2. Construct bar graphs of your results. Label the independent and dependent variables. Title your graphs.

Activity #8: (continued)

Groundwater Movement: Porosity & Permeability
Student Activity Sheet

3. Rank the materials from the least permeable (#1) to the most permeable (#4).
   A. Sand ____ B. Gravel ____ C. Clay ____ D. Unknown ____
   B.

4. Rank the materials from the least porous (#1) to the most porous (#4).
   A. Sand ____ B. Gravel ____ C. Clay ____ D. Unknown ____

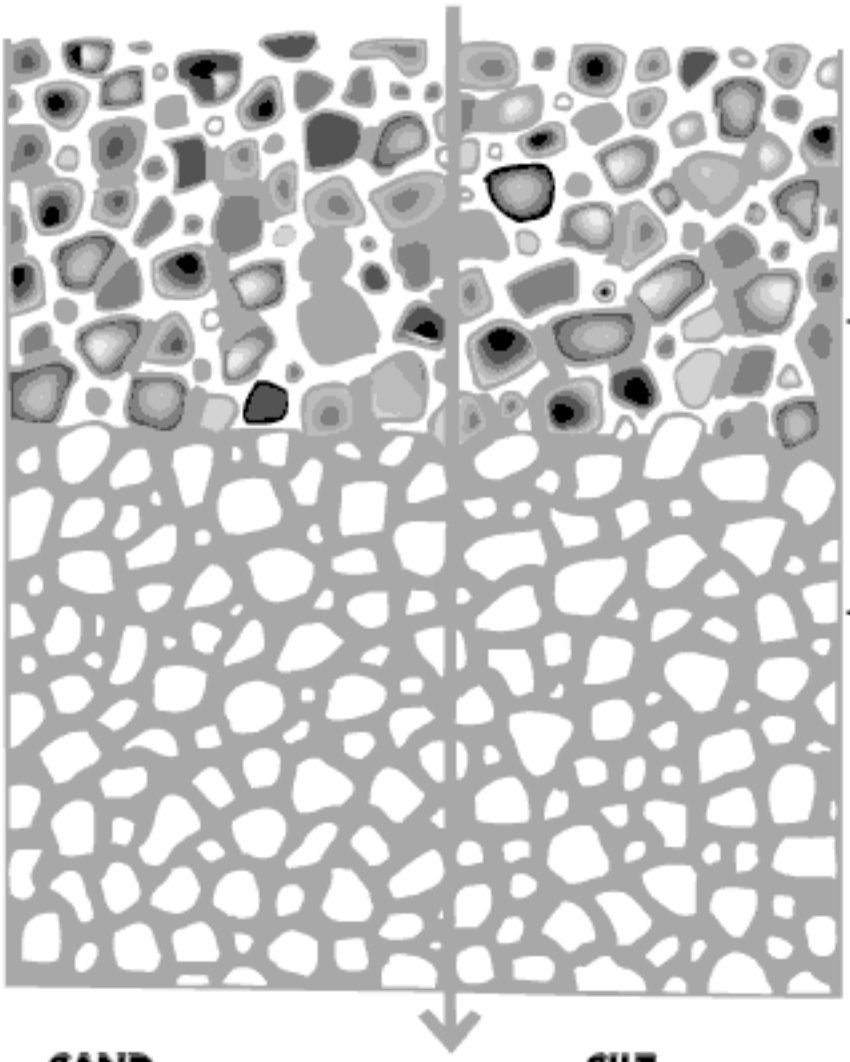
5. What effects do particle sizes have upon groundwater?

6. Compare your data with other groups. Did they get comparable results? Explain.

7. What type of soil materials would you recommend to protect groundwater against contamination? Why?

8. Discuss, in a well-written paragraph, the relationship between porosity and permeability.

POROSITY AND PERMEABILITY

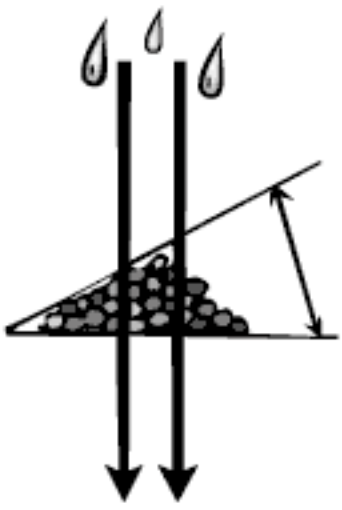


Soils usually consist of many different-sized particles.

—ZONE OF AERATION
Supports plant growth

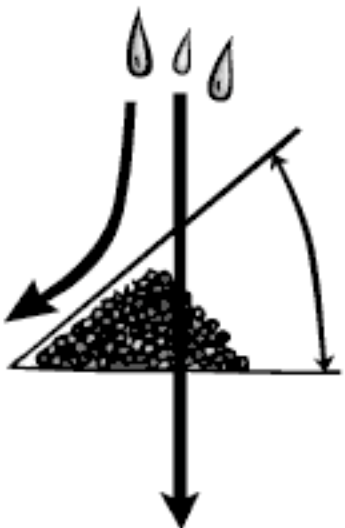
—ZONE OF SATURATION
Groundwater

SAND



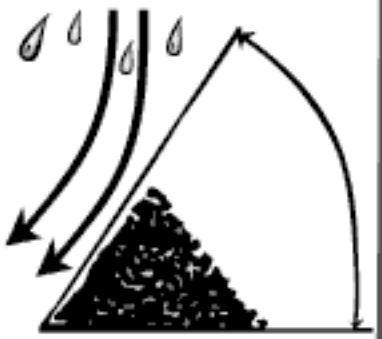
Large particles
Low angle of repose
High permeability

SILT



Medium-sized particles
Medium angle of repose
Medium permeability

CLAY



Small particles
Large angle of repose
Low permeability