# Title Information

Ishika Patel

Porosity and Permeability Lab

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# Data and Observations / Calculations

## Experiment 1: Porosity and Permeability

### Hypothesis

Which of the material will have the highest porosity versus material with highest specific retention?

If porosity is defined as “the percentage of a rock’s total volume that is pore space” (HOL Lab, 2020) then the material that will have the highest porosity will be the Clay because the sediments are loose. Clay also acts as an aquitard; if specific retention is defined as ‘the percentage of water left behind in a material” (HOL Lab, 2020) then Clay will also have the highest specific retention because it is an aquitard.

### Data Table 1. Six Samples of Porous and/or Permeable Materials

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **A** | **B** | **C** | **D** | **E** | **F** |
| **Test Material** | **Material Volume (cc)** | **Saturation Volume (mL)** | **B/A \* 100 =**  **%Porosity** | **Drained Water (mL)** | **D/B \***  **100 = %**  **Specific Yield** | **100 – E =**  **% Specific Retention** |
|  |  |  | ***% Porosity*** |  | ***% Specific Yield*** | ***% Specific Retention*** |
| **Sand** | 100 | 36 | 36 | 5.5 | 15.2777778 | 84.7222222 |
| **Gravel** | 100 | 49 | 49 | 42 | 85.7142857 | 14.2857143 |
| **Squeege\*** | 100 | 38 | 38 | 36 | 94.7368421 | 5.26315789 |
| **Clay** | 100 | 150 | 150 | 0 | 0 | 100 |
| **LabPaq Soil** | 100 | 48 | 48 | 13 | 27.0833333 | 72.9166667 |
| **Student's Soil** | 100 | 45 | 45 | 6 | 13.3333333 | 86.6666667 |

Squeege is a construction material composed of assorted sands and gravels.

### Sample Calculations of % Porosity

% Porosity =

Volume Material = 100

Therefore, % Porosity = Saturated Volume.

Sand % Porosity: 36%

Gravel % Porosity: 49%

Clay % Porosity: 150%

### Sample Calculations of % Specific Yield

Sand % Specific Yield:

15.27

Gravel % Specific Yield:

Clay % Specific Yield:

### Sample Calculations of % Specific Retention

Sand % Specific Retention:

100-15.27 = 84.72

Gravel % Specific Retention:

100-85.71=14.38

Clay % Specific Retention:

100-0= 100

### Illustrative Graph of Materials Based on Data Table 1

## Photo Requirements

A picture containing indoor, table, computer, group

Description automatically generated

Photo after step 7a in procedure.

# Lab Question Answers

1. Compare the testing results with your original hypothesis regarding porosity and specific retention. Discuss how the new data changes or confirms your original hypothesis.

In my original hypothesis I expected the clay to have the greatest porosity and specific retention due to its loose sediments and aquitard use. Given the results of the experiment. the material with the greatest porosity is as expected, clay. The material with the greatest specific retention is also as expected, clay.

1. Study your data graph and analyze the relationships between porosity, specific yield, and specific retention for each material. For each material tested, describe those relationships.

For each of the materials porosity is equal to the mL of water it needed to saturate. The specific yield is the fraction of the water the material drained after being saturated. The specific retention is therefore the fraction of how much water the material kept.

Sand: The sand was 36% porous and absorbed almost 6 times as much water as it released.

Gravel: The gravel was 49% porous and released almost 6 times as much water as it absorbed.

Squeege: The squeege was 36% porous and released almost 19 times as much water as it absorbed.

Clay: The clay was 150% porous and retained all of the saturated volume.

Lab Soil: The lab soil was 48% porous and absorbed almost 3 times as much water as it released.

Student Soil: The student soil was 45% porous and released almost 7 times as much water as it absorbed.

1. Describe the ideal rock layers under the Earth that would support an aquifer. Support your response with adequate details and examples.

The rock that would support the best aquifer would be one that has the lowest specific retention and the highest specific yield. By this experiment, the squeege material made out of sand and gravel would support and aquifer. There are many Roman Aqueducts that began this features legacy. Many of the classics were build using limestone (Encyclopedia Britannica, 2019). Other modern-day aqueducts began to use concrete and ductile iron as technology improved (Encyclopedia Britannica, 2019).

1. Describe the types of materials that would make a poor choice for drilling a well for a landowner. Support your response with adequate details and examples.

Clay would be the material that would make the poorest choice of drilling a well. Clay work as an aquitard for water and functions more like a dam (HOL Lab, 2020). When you drill a well, you are looking for material from which water will escape easily. Clay is porous and hold lots of water but its “minerals are arranged in such a way that the water is essentially trapped” (HOL Lab, 2020).

1. Describe the ideal rock layers for a landfill. Describe how each rock layer would contain the landfill and make it safer for the community.

The rock layers that comprise an ideal landfill include clay, plastic, gravel then soil moving upwards. The clay would be a great base whereby its mineral composition retains great runoff. This is a safe option for a base. The clay is complemented with a plastic bottom liner system that “prevents trash from coming in contact with groundwater” (Freudenrich, 2020). The storm water drainage in the landfill is made by means of gravel lining (Freudenrich, 2020). The covering is by soil after a polyethylene cap and trees are planted right after (Freudenrich, 2020). This secures the landfill above and creates new vegetation.

1. Oil forms in the Earth’s crust and migrates to high porosity rock layers in much the same way as waters for aquifers. When drilling and pumping oil, geologists must consider accidental oil spills in their analysis. Describe how the cleanup of such an oil spill would depend on the material it leaked into?

Based on % Specific Retention, Oil clean-up will look different based on the material. In some cases, the oil solute and the solvent are easily separable. Clay, for example, might be a very useful material to use to clean up oil in water as it is absorbent . Material such as gravel might need a manual clean-up process as it is not necessarily seeping up the oil.

1. Now consider how urbanization significantly increases flooding danger by increasing the runoff into streams, while decreasing the amount of water infiltrated into groundwater aquifers. Performing the following calculations will help illustrate this point.
   1. Over the course of one summer storm, approximately 1 cm of precipitation soaks into the ground. An average house has a roof area measuring 12 m x 18 m and the precipitation that falls on the roof is diverted down the gutters and into a storm drain. Calculate the amount of water that is diverted from the ground into drains in m3. ***Note:*** *Remember that 1 cm = 0.01 m. You must calculate the area (length × width) and then multiply by the depth of rainfall in meters. This will give the rain volume in m3. Now convert this amount into gallons knowing that 1 m3 = 264 gallon.*

The amount of water that is diverted from the ground into drains in m3 is 2.16 m3. Which equates to 570.25 gallons.

1. What if an entire subdivision of homes had 12 m x 18 m roofs as above? Calculate the volume of water that goes down the drain instead of infiltrating into the ground in both m3 and gallons if it rains to a depth of 1 cm on 20 homes in a new subdivision.

The amount of water that is diverted from the ground into drains in m3 from 20 homes is 43.2 m3. Which equates to 11404.8 gallons.

1. Now calculate the volume of a 1 cm rainfall over downtown Denver which has an approximate area of 401 km2. The conversion of km2 to m2 is 1 km2 = 1,000,000 m2. Calculate the amount of water in m3 and gallons.

The amount of water that is diverted from the ground into drains in m3 from downtown Denver is 4010000 m3. Which equates to 1058640000 gallons.

1. In this case, runoff is defined as the amount of water that does not soak into the ground. Runoff promotes erosion when not controlled and intricate storm drains are required when building in an urban or suburban area to prevent erosion and damage to property and buildings. In an urban area, runoff accounts for about 90% of the precipitation that falls to the ground versus 20% in a rural area or an area of undeveloped land. How many gallons of water are going into the storm drains of Denver instead of infiltrating into the ground?

The amount of water that is going in the storm drain in m3 from downtown Denver is 2609000 m3. Which equates to 952776000 gallons.

1. What are some ways we could reduce this problem, assuming that simply abolishing the city and all its dwellings isn’t realistic?

Some ways we can reduce this problem include terrace gardens. This is a method I learned about in AP Human Geography where gardening was used in terraces in ancient times where there was no space. We can also look into land tillage to help with infiltration.

# Conclusions

The porosity and permeability lab was a great exercise in learning a little bit more about the contents of our earth’s crust. In my personal life I never really looked much into landscaping, so this lab becomes more relevant in that aspect.

This lab looks into the porosity, yield, and retention of different materials. I was able to decipher how the most retention material would not function well as an aquifer, rather aquitards or used in dam construction.

Beginning with porosity, I leaned that it is essentially the amount of space in a material that a fluid can take up (HOL Lab, 2020). Porosity in this lab looked as the saturation mL volume of the respective material. Considerations when it comes to porosity are how well the material is packed, its cementation and the space of the particles (HOL Lab, 2020).

Next with specific yield. Specific yield is the percent of the fluid taken in to saturate a material that can be drained out by gravity. In this lab the gravel and the squeege were two great examples of high yield because they did not retain much water.

Specific retention is the remaining percent of the fluid that is trapped in the material. Clay, for example, had the highest porosity with the lowest yield and highest retention. This meant that clay took in the most water (porosity) and when prompted by gravity let go do the least water (0 mL to be specific) and kept the most water in this material.

The conclusion of this lab led us to looking into runoff and how Earth absorbs water. Some of the lab questions even discussed the community impact of water and how material absorption is so relevant to our lives! This lab was a great way to look into how our Earth functions as a system and how we as humans have devised products to create landfills and aqueducts and dams around those systems.

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