Activity sheet

Demonstration of Porosity and Permeability properties

This demonstration aims to simulate the porosity and permeability of sedimentary rocks.

Introduction

A sedimentary rock is composed of a grain framework and pores. The pores are the hollow spaces not occupied by grains. The **porosity** of a rock sample, is the ratio of the space not occupied by the solid grain particles, to the bulk volume of the sample. The porosity value is expressed in %.

A sedimentary rock with 10-20% has average porosity. Porosity of less than 10% is low, and above 20% is high.

Pore spaces may hold significant reserves of oil, water, or gas, and can also be used to sequester captured streams of greenhouse gases, eg carbon dioxide (CO_2) and methane (CH_4).

Permeability is the ability of a liquid or gas to flow through a porous solid.

The permeability value is measured and expressed in Darcy units.

$$\text{Porosity} = \frac{\text{Volume of total pore space}}{\text{Volume of rock sample}} \times 100$$

Equipment and requirements

- Small pebbles, fine gravel
- coarse sand, fine sand (varying selection of particle sizes)
- 1 jar with lid, for each participant
- 1 measuring jug
- water
- spill trays if desired

S. Edwards, CO2CRC
D.Hollands, ASP

Figure 1: examples of pebbles, gravels and sands

Figure 2: example of pebbles

Figure 6: example of fine gravel

Figure 4: example of coarse sand

Figure 5: example of fine sand

Figure 6: Jar and lid

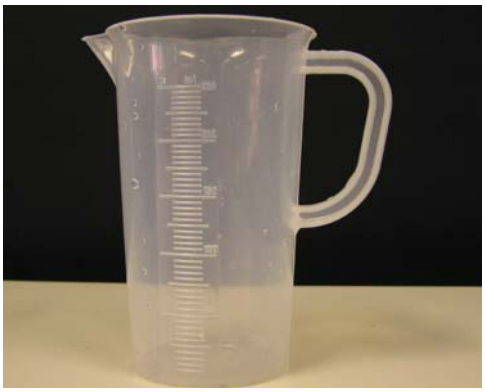
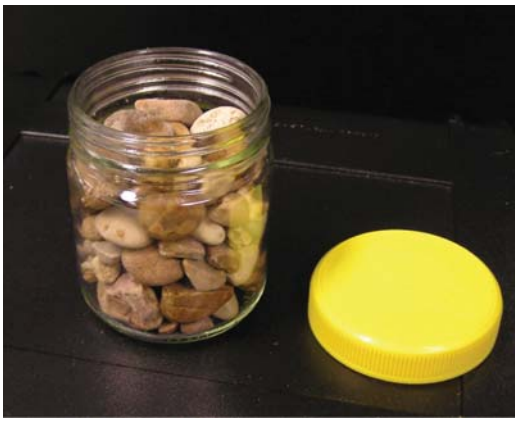


Figure 7: measuring jug

Procedure

It is a good idea to do this experiment outside, or if done inside use a cardboard box lid, or similar, for a spill tray.

1. Start by filling a jar with the small pebbles, the largest particle size you have in your selection. Leave approx 1 cm of space at the top of the jar for shaking room. Shake the jar gently, with a horizontal action, to settle the pebbles.



2. Next use the fine gravel (the next particle size smaller that you have available). Add this to your jar, put the jar lid on. Shake the jar gently, horizontally, or tap the jar, to help the gravel sift down into any spaces between the pebbles. Add as much as you can of this size gravel, shaking it down, but still leaving a bit of space at the top of the jar

3. Next add some coarse sand, put the jar lid on. Shake or tap the jar, to sift the sand down between the gravel. Add as much as you can of this coarse grain sand, still leaving a bit of space at the top of the jar.

4. Next add the fine sand to your jar. Shake or tap the jar, to fit in as much as you can. This time fill the sand right to the top of the jar. The jar should now be totally full of pebbles and sand.

5. Lastly measure how much water can be added to fill the pore spaces, of what appears to be an already 'totally full' jar. You can also measure the time it takes for the water to flow through the particles in the jar and fill up all the pore spaces.

The volume of water that can still be added to the jar demonstrates the porosity of the sample in the jar.

The time taken for the water to flow through the sample in the jar demonstrates the permeability of the sample in the jar.