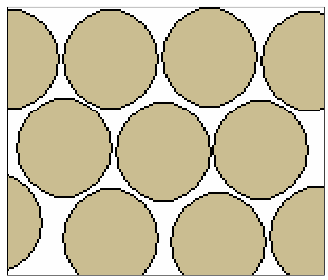
Definitions:

Porosity: Porosity is the percentage of the total volume of rock consisting of voids.

$$\frac{\text{Volume of pore space}}{\text{Total volume of rock}} \times 100$$

Permeability: Permeability is the ability for a fluid to pass from one pore space to another.



Examples: Clay is a highly porous rock but it has a low permeability as the pore spaces a resistant to fluid movement, limestone however may become very permeable because water enlarges cavities. Igneous rocks are not porous or permeable unless it contains fissures.

Aim: To compare how porous and permeable different materials are.

Hypothesis:

- Materials with bigger pore spaces will have greater porosity.
- Porosity is reduced by the presence of small grains between the larger ones.
- There will be no difference in the porosity of different materials.
- The materials with larger pore spaces will be more permeable than materials with smaller pore spaces.
- All materials will have the same permeability

Method:

Porosity Experiment:

This experiment was created to test the first and third hypotheses using analogous materials instead of porous rock this was because rock may already be wet so a lot of time would be spent drying out the rock, also the water is visible in the pore spaces so it was known in 10 minutes how much water had gone into the pore spaces.

Equipment:

- 4 measuring cylinders
- 100ml dry sand
- 100ml dried peas
- 100ml rice
- 100ml wheat
- 400 ml water
- Scales

Firstly 100ml of each material was measured in a measuring cylinder, the material was then placed on some scales to be weighed. After this 100ml of water was poured into each tube. After a set time, the amount of water that had been absorbed into the pore spaces was measured. This was measured by how much water was still on the surface of the material and subtracting it from the original 100ml. As $1cm^2$ = 1 gram the new weight of the substance could now be measured.

Permeability experiment:

This experiment will test the fourth and fifth hypotheses using analogous material to represent porous rocks, such as Sandstone and Clay. Analogous material was used to keep within the time limit of the experiment, as using the real material may take too long, and also because the 'pore spaces' in the analogous material can be seen without using a microscope, unlike in a material such as clay.

Equipment:

- 4 bottomless tubes
- 100g of sand
- 100g dried peas
- 100g wheat
- 100g rice
- 400ml of water
- Muslin
- Elastic bands
- Scales
- Stop clock
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Firstly the correct amounts of materials were weighed out. The muslin was secured to the end of a tube with an elastic band. For the control experiment 100ml of water was poured into this to see how much water passed through in 5 minutes. The amount of water that had passed through was recorded every 30 seconds. The control experiment was then repeated with the different materials in the tubes.

Discussion:

Water Supply:

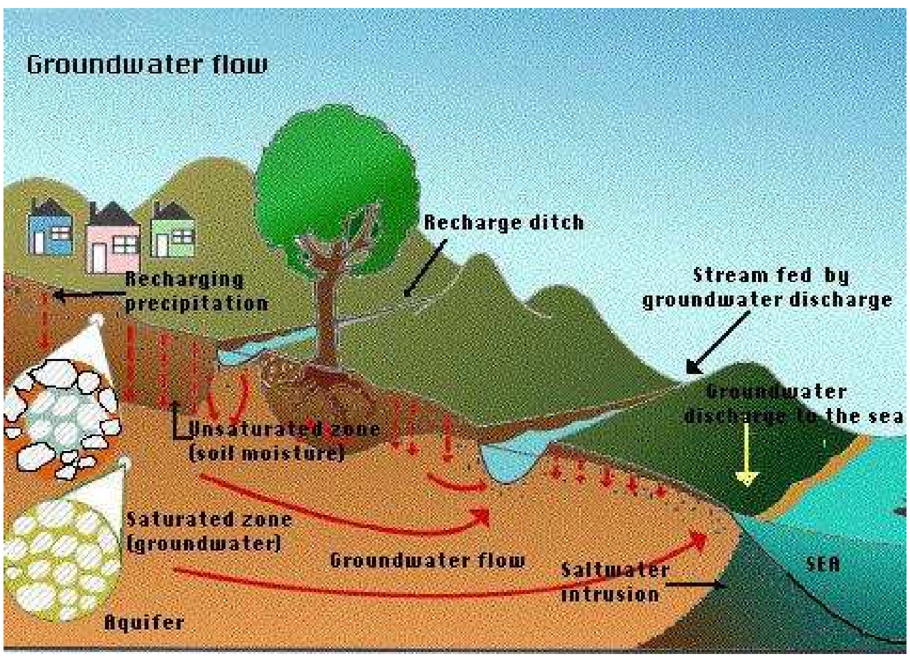
Ground water:

It is sometimes thought that water flows through underground rivers or that it collects in underground lakes. Groundwater is not confined to only a few channels in the same way that surface water is concentrated in streams and lakes. It exists almost everywhere underground. It is found underground in the spaces between particles of rock and soil, or in fissures of rock.

Much of the earth's fresh water is found in these spaces. At greater depths, because of the weight of overlying rock, these openings are much smaller, and therefore hold smaller quantities of water.

Groundwater flows slowly through aquifers at different rates. In some places, where groundwater has dissolved limestone to form caverns, it can flow relatively fast.

The level below which all the spaces are filled with water is called the water table. Above the water table lies the unsaturated zone. Here the spaces in the rock and soil contain both air and water. The entire region below the water table is called the saturated zone, and water in this saturated zone is called groundwater.



Aquifer:

Although groundwater exists everywhere under the ground, some parts of the saturated zone contain more water than others. An aquifer is an underground formation of permeable rock or loose material that can produce useful quantities of water when tapped by a well. Aquifers come in all sizes. They may be small or very large, underlying thousands of square kilometres of the earth's surface. They may be only a few metres thick, or they may measure hundreds of metres from top to bottom.

Aquicludes - are confined aquifers that are sandwiched between two beds of impermeable rock.

Springs: Springs occur where the water table meets the grounds surface. This often happened where the water table has been deflected to the surface by the presence of an impermeable rock.

Oil Reservoir rocks:
It is economically unfriendly for humans to extract oil and gas unless substantial amounts are trapped in reservoirs. An oil reservoir is a rock with many pores that can hold liquids. If the pores are connected, the rock is said to be permeable. Permeability is the ease with which a fluid can move through a porous rock. Sandstone is the most porous and permeable of the sedimentary rocks. That's why much of the world's oil and gas occurs in sandstone. Carbonate rocks such as limestone and dolomite are also good reservoirs for oil and gas.
A reservoir rock must be able to contain oil, gas and water, which are the reservoir fluids. Pores in the reservoir rock are first filled with saltwater from the sea. When oil and gas flow into the rock, some of the water is displaced. Oil and gas travel through pores of the reservoir rock, with the help of water, until they reach an impermeable layer of rock through which they cannot pass. Shales are the most common impermeable rock.
Over many years, rock formations break and slide, causing spaces where petroleum is trapped. The most common type of trap is an anticline, where rocks are pushed up to form a dome. Oil and gas might lie in reservoir rock just under the top of the dome, which is capped by an impermeable layer of rock.
Another common type of trap is the fault trap, which is formed by a fault, or fracture, of the layers of rock. The rock on one side of the fault slips down so that a porous reservoir rock is next to a nonporous rock formation. This creates a seal, and the petroleum is trapped.
Now that the oil has been trapped, it will stay there until rock formation movement causes a change in its surroundings, or until humans decide to drill a well in that spot.

Waste disposal - Leachate:
Leachate is the liquid that results from rain, snow, dew, and natural moisture percolating through waste. Leachate is created within the landfill by the breakdown of organic waste containing water and by water mixing with the waste. The leachate will collect until water-holding capacity of the waste is exceeded; it will then percolate downwards and if the rocks beneath ore porous and/or permeable it can potentially pollute underlying groundwater. Old style dumps had no containment systems to collect leachate whereas modern landfills are capped to reduce the amount of water entering the landfill (and so reduce

the amount of leachate produced) and are contained with a liner that acts as a barrier to prevent leachate seeping into groundwater. Pipes are installed above the liner to collect the leachate for treatment.

Conclusion:

Porosity:

From these results it is suggested that the smallest rounded particles have the largest porosity. The experiment also proves the third hypothesis, 'there will be no difference in porosity' to be wrong as each material had a different porosity.

Permeability:

From the permeability experiment it is suggested that the larger the 'grain size' of the analogous material the higher the permeability. This experiment this agrees with the fourth hypothesis, 'the materials with larger pore spaces will be more permeable'

Evaluation:

Porosity:

The porosity experiment could have been improved by leaving the water longer than 10 minutes although the time the water was left meant that some of the analogous materials might absorb the water.

Also there may have been air pockets in the mater ials causing the water not to fill some spaces. This would mean that the measurement wasn't accurate.

To make the experiment stronger a control experiment could have been used.

The strengths of this experiment are: there was the same amount of material and water to keep the results fair and as accurate as possible.

Permeability:

The permeability experiment could be improved by using porous rocks instead on analogous materials, and also the range of analogous materials could be used i.e. they could have bee n a mix of large and small 'grain sizes e.g. Peas and rice mixed together.

The material may have absorbed water so that it wasn't all passing through the pore spaces.

To make the experiment better a wider range of materials could be used and a wider variety of 'grain' sizes.