SPEED OF COOLING OF AN IGNEOUS BODY

Purpose

To determine what factors affect the speed of cooling of an igneous body.

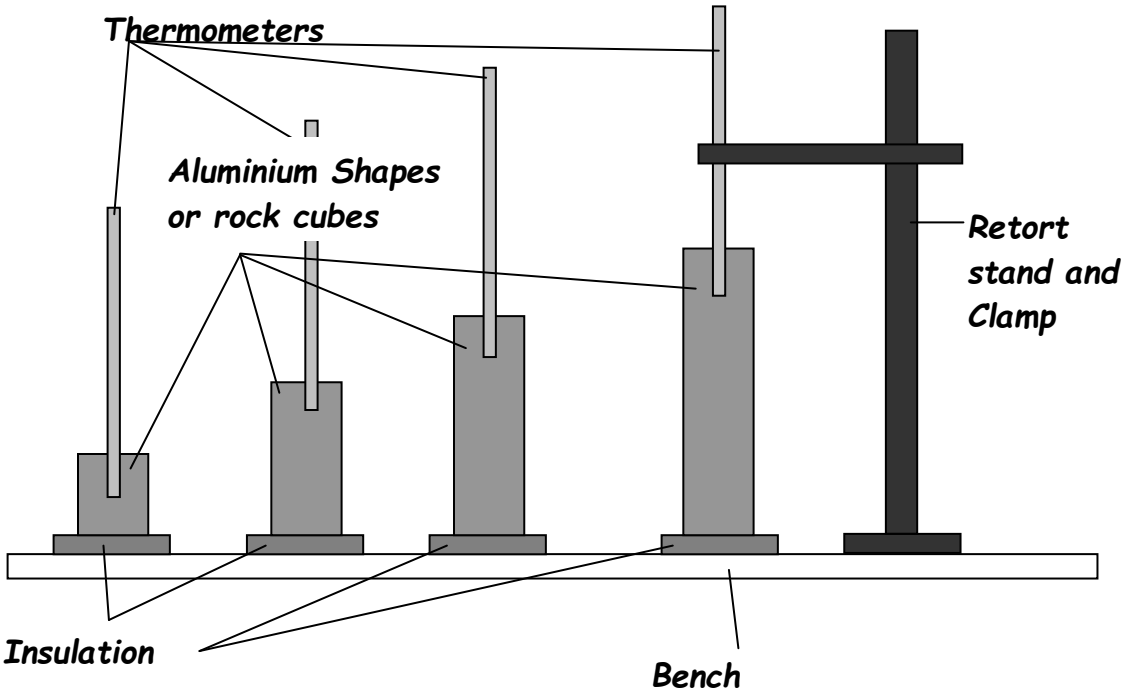
Instructions

Prior to the experiment

1 Select one of the following factors:

Size, Surface area, Shape/surface area, Composition, Grain size, Density

2 Write an hypothesis about how you think cooling will be affected by that variable and give a reason. Select the apparatus you will need and say how you will use it. Decide how you will record the information.



3 Weigh and measure the blocks or rock cubes

After the rocks and aluminium have been heated to just above 100^0C

1 Place the retort stands and insulation ready on the table if needed.

2 Record the temperature of the oven. Start the timer immediately the aluminium blocks or rock cubes are removed from the oven.

3 Place the blocks or cubes with the holes uppermost on the insulation on the table supported if necessary by the retort stands.

4 Quickly place a drop of oil in each hole to ensure good thermal contact with the thermometer.

5 Place a thermometer in each block or rock cube.

6 Record the temperature of every 2 minutes for 30 minutes.

7 Plot temperature against time for your blocks. The initial temperature is the temperature of the oven.

8 Plot rate of cooling over the first 20 minutes against the factor you have chosen.

Question
Give two reasons why a dolerite dyke intruded at 1100°C has a narrower baked edge than a granite batholith intruded at 800°C.

Teacher's Section.

Requirements

For density, grain size and composition

Cubes of granite, basalt, dolerite, and gabbro 5cm by 5cm by 5cm. These can be obtained from a stonemason at about £5 each. The holes, 7mm in diameter, can be drilled with a concrete drilling bit but it would be simpler though more expensive to get the stone masons to do it.

For size

Aluminium cylinders of various weights, say 40g, 120g, 250g, 500g

For shape

Aluminium cylinders of various shapes but all the same weight

> ***Aluminium can be bought in various diameters. 250 g is a suitable weight. Al has a density of 2.65 cm^3 g^{-1} so you will need 94.3 cc for each shape.***

Aluminium cuboids of various shapes but all the same weight 250g is suitable.

The rock cubes and aluminium blocks will need to be heated up to 110° C all aluminium shapes should be drilled with a 7mm hole down to the centre. The hole should be in the centre of the smallest face.

General

Thermometers, scales, timers, oven gloves, polystyrene tiles for insulation, oil (3 in one or similar), retort stand and clamps.
oven.

Notes

Size/surface area is the best factor to test. Grain size and composition do not effect the rate of cooling and involve a significant extra cost.
A much simpler experiment can be done using only aluminium cans and boiling water, see Tuke. Earth Science: Activities and Demonstrations

Results

The larger the size the slower the cooling of similar shapes. Slabs and rods cool quicker than cubes or squat cylinders. There is no detectable difference in speed of cooling between any of the rock cubes.

Students will not have readings for the first couple of minutes while the blocks are being removed from the oven and setup and only those readings after the thermometers have reached maximum temperature need be plotted. This should be explained in their write-up. Students should explain that igneous rocks cool by conduction but in these experiments convection of air and radiation are important.

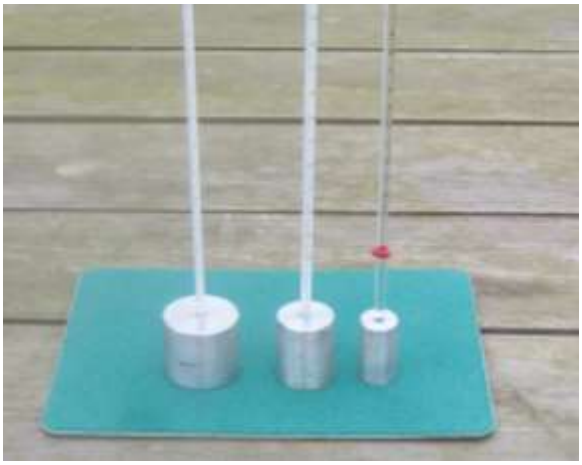
The dyke has a much smaller mass and therefore much less thermal energy and because it is sheet shaped cools more quickly.

Time

1 hour 10 minutes

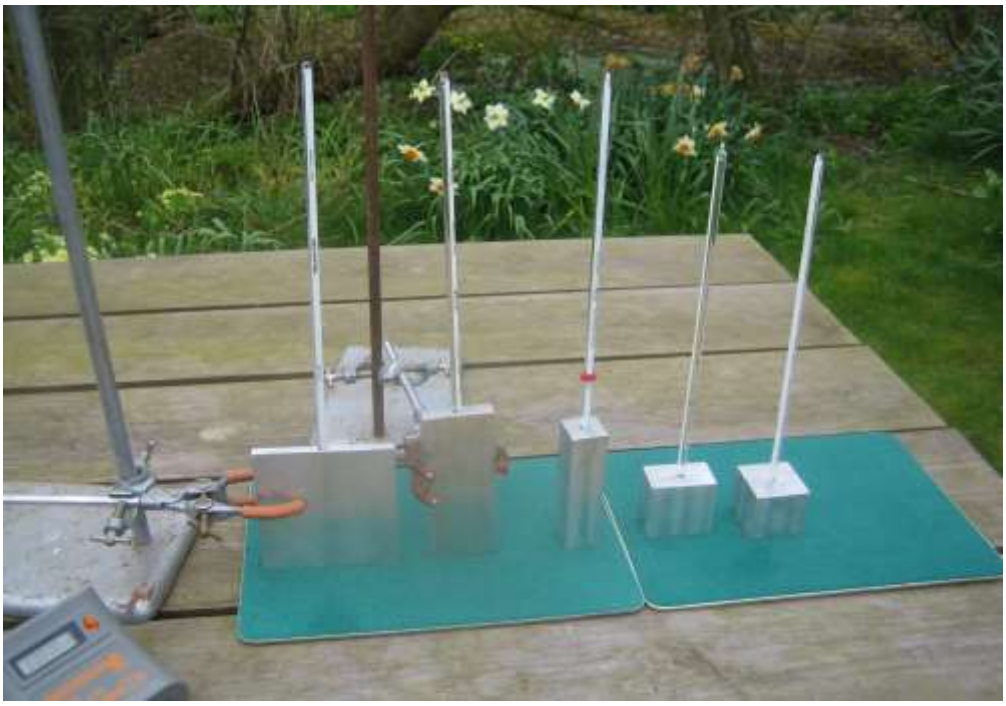
Cost

Blocks of rock about £5.00 each from a stone masons, more if your have them drilled



Cylinders of different sizes

Aluminium cylinders all the same weight



Rectangular aluminium shapes all the same weight