Craters on the Moon

Why are the Moon's craters such different shapes and sizes?

Ask pupils to study the photograph of the Moon – why are its craters so different in shape and size from each other?

The surface of the Moon, showing Mare Imbrium and Copernicus Crater

This picture of Gruithuisen Crater was taken during the Apollo 15 mission to the Moon.

Around 80% of the Moon's surface is covered in craters. The largest (on the Moon's far side) is over 1000 km across, but there are millions of craters which are at least 1m across. We think most craters were caused by meteorites crashing into the moon in the distant past. What controlled the size and shape of these craters? We can model some of the factors by bombarding layers of sand with spherical objects such as glass marbles or ball bearings, and measuring the dimensions of the mini-craters formed.

Give pupils the simple equipment from the resources list and ask them to investigate what things affect: a) the diameter of a crater, b) its depth, c) its shape, e.g. circular or oval, d) the distribution of any ejecta (material which is displaced from the crater by the impact).

Pupils may need to be guided to half-fill a tray with sand and shake it down to give a flat surface. If they sprinkle a different-coloured powder over the surface, it makes the craters easier to see.

One group of pupils could investigate the effects of dropping different sized spheres from the same height; another group could keep the size of the balls the same, but drop them from different heights. A third group could try using balls of different densities, e.g. steel ball bearings, lead shot, plastic beads etc.

With due regard for health and safety, some pupils could be allowed to fire their spheres at an angle, from above the **side** of the tray, using a catapult.

Craters produced by dropping 4 steel ball bearings of different sizes into a tray of sand (with a dusting of cocoa powder) *(Photo: Peter Kennett)*

We know of some craters on the Earth. What might affect their shapes and sizes? There are fewer craters on Earth than on the Moon, why might this be so?

The back up

Title: Craters on the Moon

Subtitle: Why are the Moon's craters such different shapes and sizes?

Topic: An investigation into the factors which affect the dimensions of craters produced by the impact of external bodies, such as meteorites.

Age range of pupils: 12 – 16 years

Time needed to complete activity: 30 mins

Pupil learning outcomes: Pupils can:
- use their manual dexterity to set up simple equipment
- make measurements;
- determine the relationship between a range of variables and the dimensions of an impact crater;
- relate their own investigation to real craters on the Moon.

Context:
This activity can be used in an astronomy lesson, or in a situation where teachers wish to set pupils an investigation in which the procedures are decided by the pupils themselves, rather than following a pre-determined set of instructions. It can also be related to the effects of meteorite impacts on the Earth, past, present and future, with discussion about the possible relationship between meteorite impact and mass extinctions.

Following up the activity:
Pupils can calculate the effects of a meteorite impact on the Earth, using the 'Impact Calculator' found at http://simulator.down2earth.eu/index.html. The Calculator enables pupils to work out the effects of varying the size of the meteorite, its velocity, its density and the angle at which it strikes the Earth's surface. They can also allow for changes to the nature of the surface at the point of impact, from water to sedimentary rocks or igneous rocks. The Calculator shows what damage might be expected at various distances from the impact site, which can be related to a map of the pupils' own home continent. Comparisons may also be drawn with the well-known Barringer (Meteor) Crater in Arizona, USA.

Underlying principles:
- The Barringer Crater in Arizona is more than 1 km across and was created by a meteorite of only about 30m diameter. In the classroom modelling, the craters are much closer to the size of the body which impacted the sand layers – this is an effect of modelling on a small scale.
- The Moon (and some other planets and their moons) display very clear impact craters. They have not been destroyed by plate tectonic processes or by weathering, because these processes, if they were ever present, largely ceased millions of years ago. By contrast, the activity of the Earth (both on and below the surface) has removed the evidence of most impact craters produced by extra-terrestrial meteorites.
- There is a quantifiable relationship between the dimensions of a crater and the mass, drop height and velocity of the object which made it, when it impacted the surface.

Thinking skill development:
A pattern is established of the effects of a range of factors. Cognitive conflict arises when results are not as predicted. Discussion of the results involves metacognition, whilst links to the surface of the Moon and the Earth involve bridging skills.

Resource list:
- a large wooden or cardboard box, or plastic tray, about 50 cm wide by about 10 cm deep
- about 5 kg of medium-grained dry sand, enough to half-fill the container
- powder paint, cocoa powder or similar
- a sifter, such as a flour sifter, or a home-made one, produced by making holes in the bottom of a plastic cup. to sprinkle the powder evenly over the sand
- projectiles, such as ball bearings or glass marbles
- rulers/tape measures

Useful links: http://down2earth.eu

Source: Based on 'Creating Craters', from the website http://down2earth.eu : also from an idea by Peter Brannlund, published by the Association of Teachers of Geology (now the Earth Science Teachers' Association) (1988) *Science of the Earth: Astrogeology – and the clues on the Moon*, Sheffield, Geo Supplies Ltd.