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KS 3&4

Teacher Background

Impact!

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Meteorites

What Are They, and Where Do They Come From?

Meteorites are rocks from space that have passed through the atmosphere and landed on the Earth's surface. Some meteorites are seen or heard when they fall and are picked up soon afterward called 'falls', while most are found much later (called 'finds').

Some meteorites are like igneous rocks on Earth, others are pieces of metal, and others are different from all known Earth rocks. All meteorites are pieces of other bodies in space that give us clues to the origin and history of the solar system.

Meteors and Meteorites

Objects approaching Earth are called meteoroids and come in all sizes from microscopic (and very numerous) to gigantic (and very rare). As the tiniest rocks and dust burn up in our atmosphere they cause meteors, (sometimes called 'shooting stars') bright streaks of light moving rapidly across the sky.

Meteors are fairly common, and on a clear night away you might see an average of three or four an hour. However, very few **meteoroids** actually reach the Earth's surface. Most of the dust and ice particles are small enough that they burn up completely as they pass through the atmosphere.

Larger meteoroids might actually pass through our atmosphere and impact with the ground. These are called **meteorites**. Only a few people each year actually see a meteoroid fall and become a meteorite.

Most meteoroids approach Earth at speeds of about 20-30 km/sec, but are slowed down by friction with the air as they pass through the atmosphere. The heat produced causes their outsides to melt to glass creating a **fusion crust**.

Large meteoroids don't slow down much and make sonic booms as they approach Earth at speeds greater than the speed of sound. Such falls are rare, occurring only once every few decades, but are dramatic, beginning with the bright streak of light and thunderous noise of a **fireball**.

The falls of the **Allende** stony meteorite (in the *Down to Earth* loan box) in rural Mexico and the **Sikhote-Alin** iron meteorite (in the *Down to Earth* loan box) in Siberia, Russia, were two recent large falls. Both meteorite falls began with bright light and explosions that were seen, heard and felt for great distances. The fall sites for the two meteorites were soon found. **Allende** was scattered over a 150 square kilometre area around the town of Pueblito del Allende. The **Sikhote-Alin** site was located from the air as it had devastated a forested area. On the ground scientists found over 100 craters of varying sizes. Both meteorites fell as thousands of fragments covering wide areas.

Meteor Crater in Arizona. This 1.2km wide, 150m deep, crater was made by 30m iron meteorite weighing about 1,000,000,000 kg.

Even larger meteoroids are hardly slowed at all by the Earth's atmosphere and hit the Earth at very high speeds, making large impact craters. Such a fall has never

been observed and recorded by people, but are recorded as craters in the surface of the Earth or other planetary bodies. Meteor Crater in Arizona is the best known impact crater on Earth. It is about 50,000 years old and well preserved in the arid desert. Many small fragments of the **Canyon Diablo meteorite** (in the *Down to Earth* loan box) have been found around the crater. The force of the impact is thought to have vaporized most of the meteor. Imagine how powerful that explosion must have been if anyone were nearby to see and feel it!

Finding Meteorites

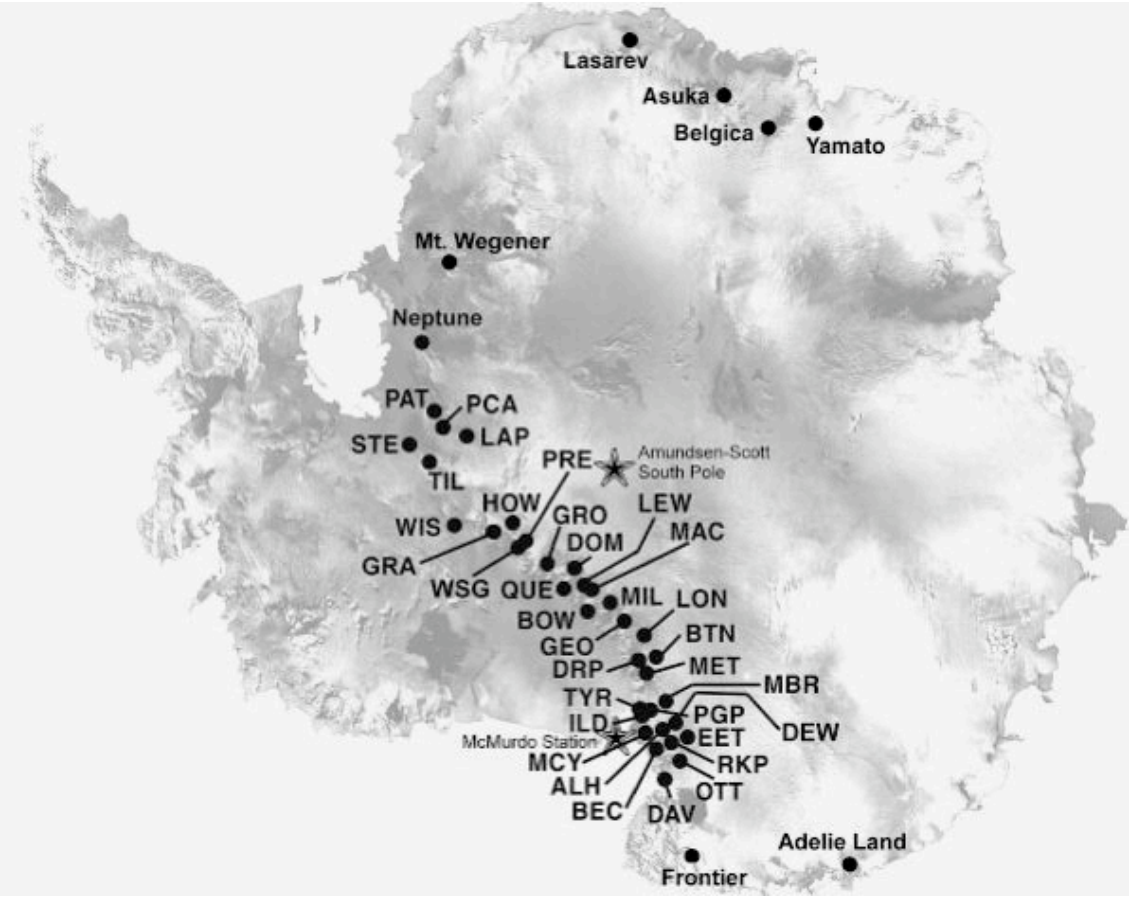
From photographs of small meteorites, scientists have calculated that about 30,000 meteors larger than 100g fall on the Earth's surface each year, but few of these are ever found. Although this sounds like a huge number, there is very little chance of a meteorite falling on you. Most meteorites just go unnoticed because they fall quietly during the night, in unpopulated areas, or in the ocean. However, some meteorites are picked up hundreds or thousands of years after they fall.

Meteorites that no-one has seen falling are called finds and make up most of the world's meteorite collections. Most meteorites contain iron minerals, which easily oxidise and rust in temperate climates. The discoveries of meteorites in desert regions in North America, Africa and especially Australia have added hundreds of new meteorites to the collections in the last few years. But the best area in the world for collecting meteorites is the icy desert of Antarctica.

Dark meteorites are more easily seen on ice, and meteorites rust and weather away more slowly in the cold Antarctic than in warmer countries. Since 1969, collection teams visiting Antarctica have found about 17,000 more meteorite fragments, which is more than in the rest of the world combined!

The search for Antarctic meteorites is also helped by the movement of the ice. The meteorites are enclosed in ice and move with a glacier until it comes to a rock barrier Glaciers slow down as they move around rock barriers, and tend to deposit any meteorites they are carrying in these areas. This tends to concentrate meteorites in certain areas, which are later exposed at the surface as the ice gradually erodes away.

The movement and concentration of Antarctic meteorites makes it difficult to tell whether the meteorites are parts of a meteorite shower, or are individual falls. The 17,000 Antarctic meteorite fragments probably represent about 3,000 separate meteorites.



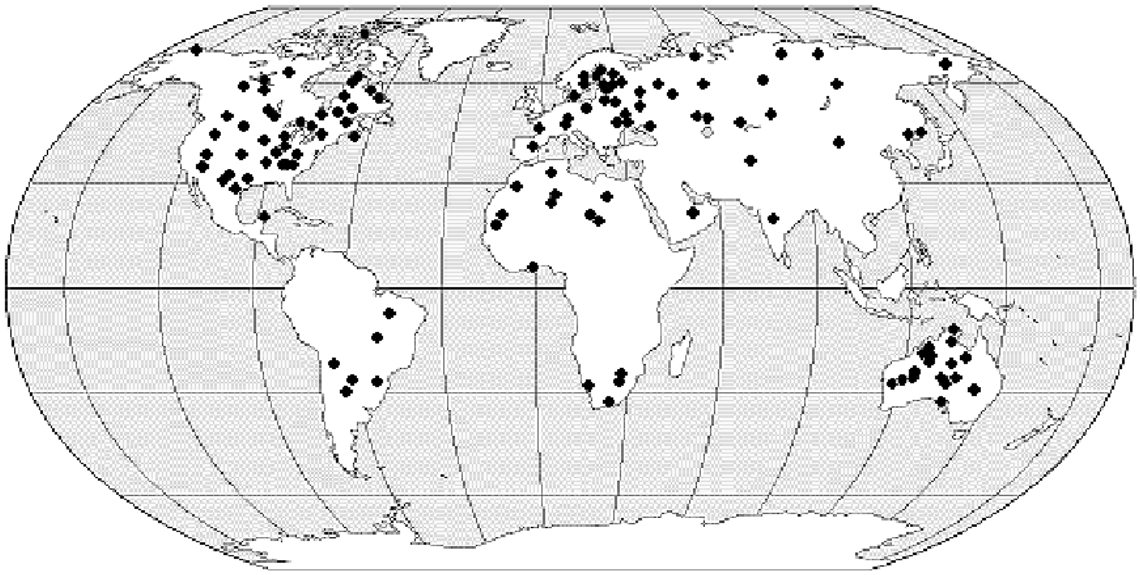
Antarctic meteorite locations. Meteorites are found mostly along the 3,000 km Transantarctic Mountains that diagonally cut the continent.

Impacts and Craters

One of the most significant discoveries from the exploration of the solar system is the importance of meteorite impact. Images of the Moon, Mercury, Mars, asteroids, and the moons of the outer planets show surfaces covered with impact craters. Even radar images of cloud-covered Venus revealed both craters and volcanism on the planet's surface.

The view of the whole Earth from space shows little effect of impact. However, from photos taken in orbit, scientists have identified a number of impact features.

Meteor Crater in Arizona is the most familiar example of an impact crater. It is relatively small (1.2km across), young, and well preserved compared to most impact craters. Many of these craters are old; some craters are circular lakes; others are heavily eroded.

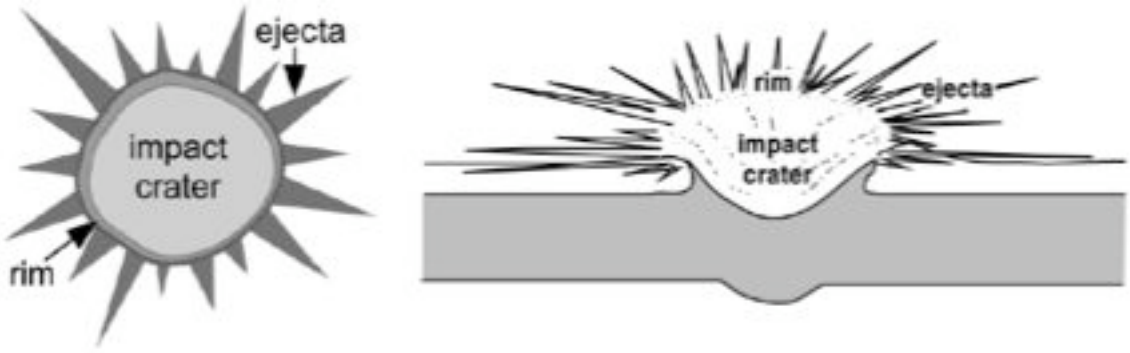


Terrestrial impact craters. This map shows locations of 140 impact craters which have been identified on Earth. The clusters of craters in North America, Europe, and Australia are due to crater search programs.

Studies of Impacts

Recognizing impact craters and understanding how they form requires a combination of field geology and impact experiments. Field studies of well-exposed craters help define crater structure and the nature of the rocks modified by impact.

The speed of the impacting object (about 20-30 km/sec) is greater than the speed of sound in air. The object produces a sonic boom as it passes through the atmosphere and an explosion when it impacts, forming a crater about 10 times larger than that of the impacting object. The crater depth is about 1/10 the crater diameter.



This diagram shows two views of a typical impact crater. The left view shows the circular crater with its rim and scattered ejecta. The right view shows that the rim is above and the crater floor is below the original surface. The ejecta are thickest closest to the rim.

A circular crater could also be a volcanic crater. Impact craters are usually larger than volcanic craters. A volcanic crater's floor is often above the surrounding surface, while an impact crater's floor is below the surrounding terrain.

A fresh impact crater is circular, with a raised rim and a lowered floor. Impact craters are also surrounded by rocky material thrown from the crater, ejecta.

The best proof of an impact crater is meteorite fragments, the next best indicator is the nature of its rocks. They can be broken, distorted or even melted by the shock of the explosive impact. Much of the ejecta outside the crater is broken pieces of various rocks mixed together to form a breccia.