

## AND OTHER SPACE ROCKS

The Solar System is full of lumps of rock and ice. Some are as small as grains of sand, others are the size of mountains. Sometimes they come to visit us here on Earth.

### Types of space rock

Space is full of rocky debris left over from the formation of the Solar System. What they are called depends on what they are made of, how big there are, and where they are.

The very biggest space rocks are known as dwarf planets. They are usually found beyond the orbit of Neptune.

Dwarf planets are massive enough to be shaped by their own gravity, but do not have enough gravity to have cleared the space around them. Pluto is a dwarf planet.

### ASTEROIDS

Asteroids are large chunks of rock, or metallic rock, left over from the formation of the Solar System. Most are located in the **Asteroid Belt** between Mars and Jupiter. It is thought that Jupiter's gravity prevented them from coming together to form a planet.

Asteroids range in size from as little as a metre to thousands of metres. The largest asteroids are known as **planetoids**.

### METEOROIDS

Any chunk of rocky or metallic material that travels through space could be called a **meteoroid**, but the name is usually reserved for rocks that are much smaller than asteroids. Meteoroids can range in size from that of small pebble to a huge boulder weighing several tonnes.

Most meteoroids come from the asteroid belt – either knocked clear by asteroid collisions or disturbed by the gravity of larger objects, such as planets.

Meteors get their name from the Greek *meteōros*, which means 'high in the air'.

### COMETS

Comets differ from asteroids because they are made up of mostly ice. Sometimes called 'dirty snowballs', most comets come from an icy region beyond Neptune called the **Kuiper Belt**.

When their orbit brings them close to the Sun, comets heat up and vent gases and water vapour that form a huge glowing cloud called the 'coma'. The dust and gas form tails that stretch away for millions of kilometres.

Some meteoroids come from the debris left behind by comets

**Gas tail:**  
Charged gas particles pushed from the comet by the solar wind

**Dust tail:**  
Larger dust particles trail behind the comet

**Coma:**  
A hazy cloud of dust and vapour that surrounds the nucleus

**Nucleus:**  
'Dirty snowball', or 'icy dirtball' made up of rock, dust, water ice and frozen gases\*

\*The nucleus in this diagram is not to scale. The coma is many times larger than the nucleus.

Asteroid

### Meteor showers

Lots of meteors appearing in the same part of the sky over a period of time is called a meteor shower. Most meteor showers are associated with comets.

During a meteor shower, the meteors appear to radiate from the same point in the night sky – astronomers call this the 'radiant'.

### Meteor, oid, or ite?

Whether a space rock is called a meteoroid, meteor, or meteorite, depends on where it is at any given time.

#### Meteoroid

While it is floating around in space, a space rock is called a meteoroid. Really small space rocks (space dust) are called **micrometeoroids**.

#### Meteor

When a meteoroid enters the Earth's atmosphere, friction heats it up and it begins to burn. The trail of light left behind by a burning meteoroid is called a **meteor**, or 'shooting star'.

**Millions** of meteoroids travel through the Earth's atmosphere each day.

#### Fireball

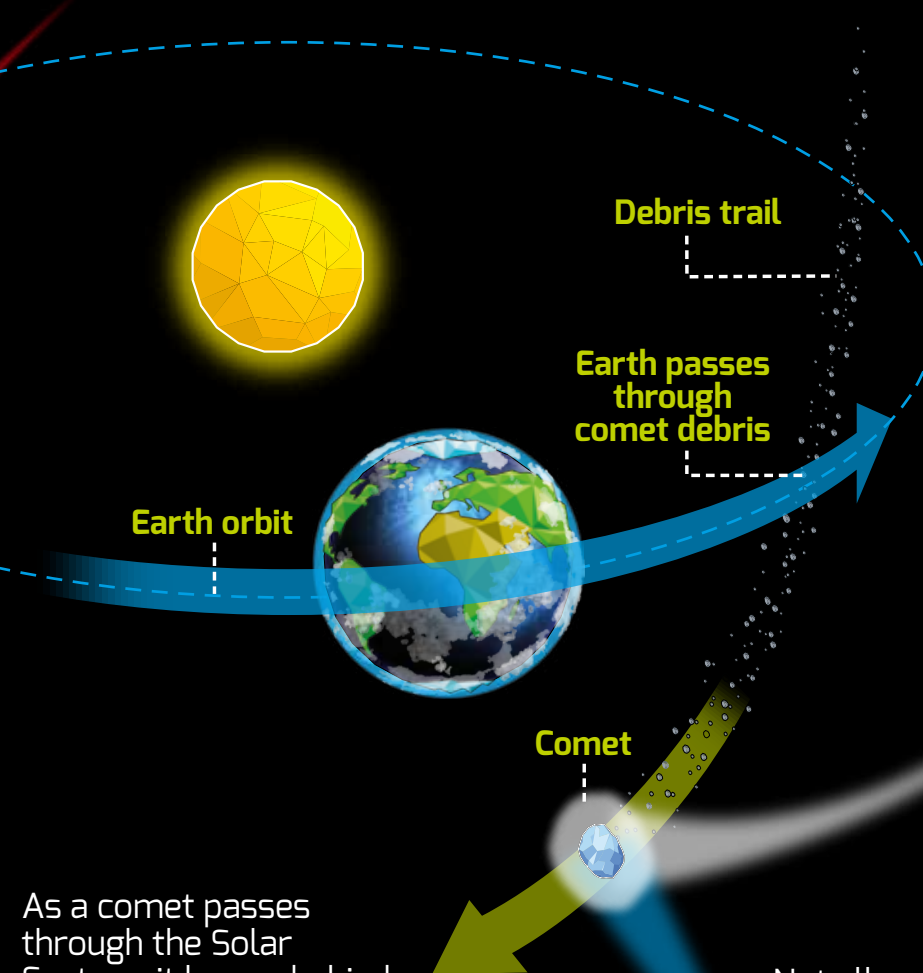
Some meteoroids create more light when they burn up. These extra-bright meteors are called **fireballs** and they can even be seen during the day.

#### Meteorite

Sometimes a meteoroid doesn't completely burn up as it travels through the Earth's atmosphere. If it makes it to the ground, it is called a **meteorite**.

**24%**

of meteoroids survive the journey through the Earth's atmosphere to become meteorites.



As a comet passes through the Solar System, it leaves behind a trail of dusty debris. When the Earth's orbit carries us through the comet's debris, these micrometeoroids burn up in the atmosphere.

Not all meteor showers are caused by comets. There are two showers every year that are created by debris shed by asteroids.



Meteor showers get their name from the constellation from which they appear to radiate. The Orionid meteor shower, for example, appears to radiate from the constellation of Orion.



# The journey to the surface

About 15,000 tonnes of meteoroids, micrometeoroids and space dust enter the Earth's atmosphere every year. So why are meteorites so hard to find?

1. When a meteoroid enters the Earth's atmosphere it can be travelling at many thousands of miles per hour. Compression of the air molecules in the atmosphere causes the meteoroid to heat up.

2. The surface of the meteoroid melts, vapourises and small particles break away and burn up. Most meteors are very small and so burn up completely long before they reach the ground.

3. In larger meteors, the surface layers are melted and burned away, but some material survives. As it melts and shrinks, a meteor can be sculpted into all sorts of interesting shapes.

4. As it slows down, the meteor cools down, the melted surface solidifies and, usually, turns black. This layer is called the fusion crust.

5. Most meteorites are lost at sea, but some do strike land and can be found if you know what to look for and are very lucky.

This meteorite tumbled as it fell and has melted with thumbprint-like indentations called regmaglypts.

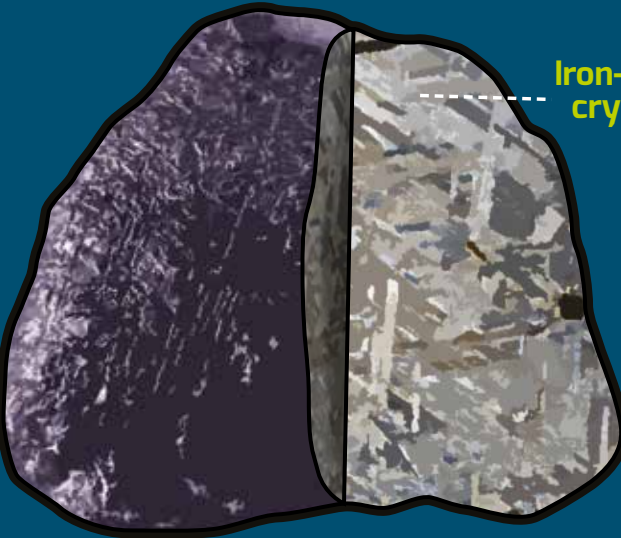
This meteorite didn't tumble and has developed a conical nose a bit like a spacecraft's heat shield.

# Types of meteorites

Meteorites come from many different parts of the Solar System and are formed in many different ways.

## IRON

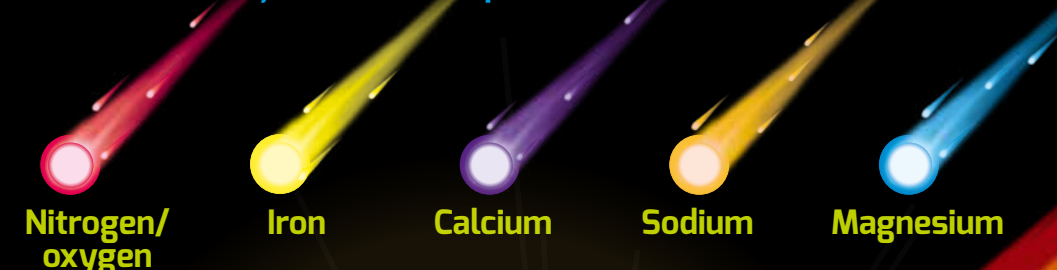
Iron meteorites are made of about 90-95% iron with the rest made up of mostly nickel and some trace elements. It is thought that they come from the metallic cores of asteroids. Iron meteorites are rarer than stony meteorites but their magnetism makes them easier to find.



Iron-nickel crystals

Long before humans discovered how to extract metals from the ground, ancient cultures used metal from iron meteorites to make tools and jewellery.

Meteors burn with different colours depending on the chemicals they are made up of.



Scientists classify meteorites by splitting them into three main groups: **stony**, **iron** and **stony-iron**.

## STONY-IRON

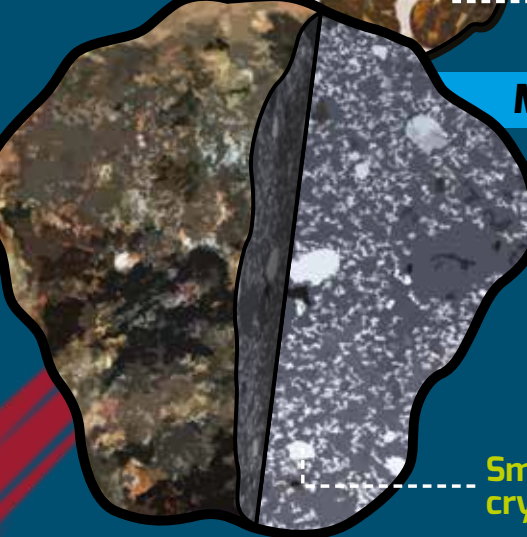
Stony-iron meteorites are made of a mix of both metallic and rocky material. They probably formed when the metal cores and the rocky magmas inside asteroids mixed together, which makes them extremely rare. There are two types of stony-iron meteorites: **pallasites** and **mesosiderites**.



Pallasite

Pallasites have solid bodies of nickel and iron but also contain large translucent crystals of olivine. Pallasites come from the area between the metallic core of an asteroid and the surrounding rocky magma.

Olivine crystals



Mesosiderite

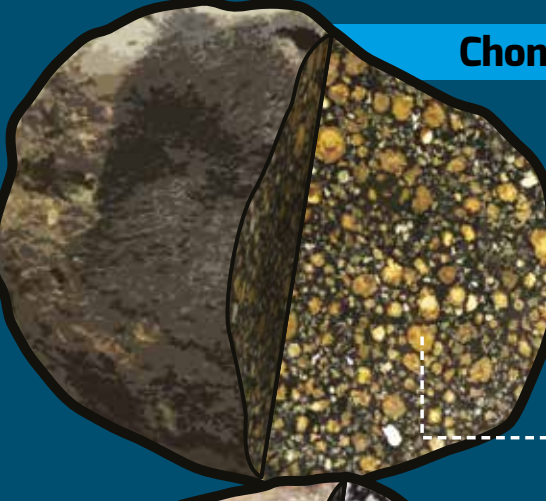
Mesosiderites differ from pallasites in that their crystals are smaller and made of silicate minerals. It is thought that mesosiderites form when magma mixes with the core during a collision between two asteroids.

Small silicate crystals

Meteorites that are spotted as they fall through the Earth's atmosphere and then recovered are called '**falls**', all others are called '**finds**'.

## STONY

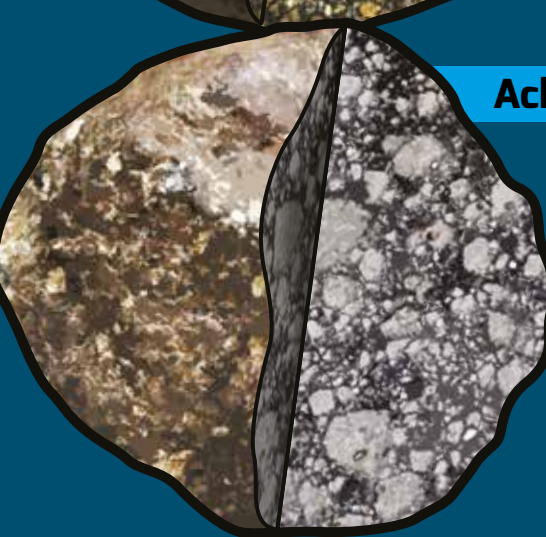
Stony meteorites are the most common type of meteorite. They are made of rock, but can also contain small amounts of iron. There are two types of stony meteorites: **chondrites** and **achondrites**. Achondrite meteorites were once part of the outer crust of a planet or asteroid.



Chondrite

Chondrites contain rock that has changed little since the formation of the Solar System. They are made up of small mineral blobs called chondrules that formed in space billions of years ago and became clumped together.

Chondrules



Achondrite

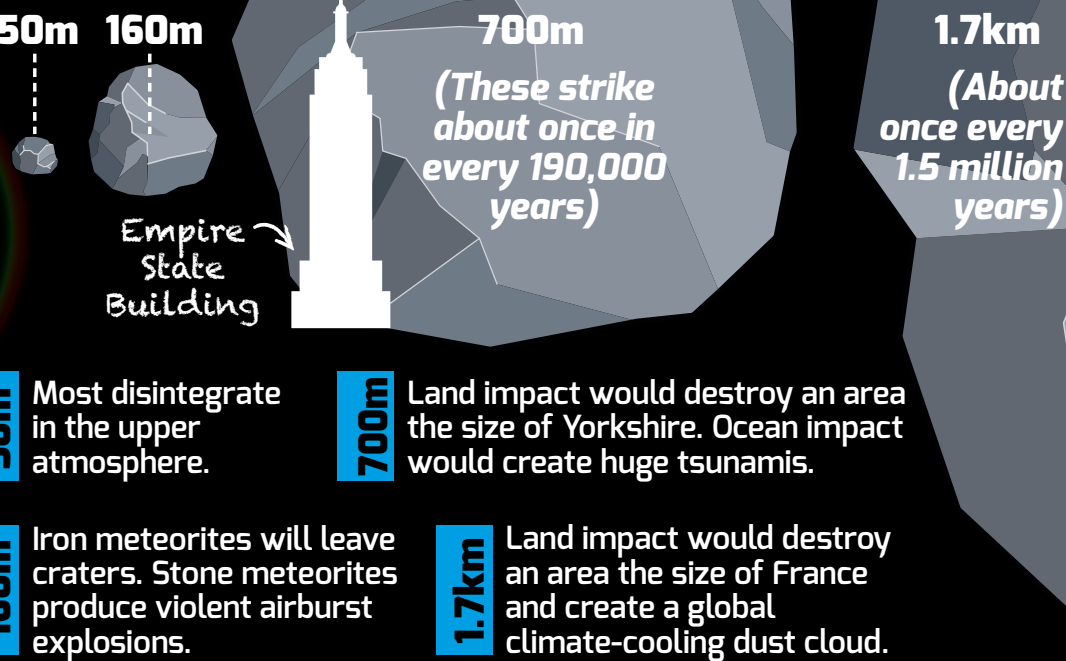
Achondrites are much younger than chondrites. They contain minerals which have been melted, changed and altered since they were formed. Achondrites formed on bodies that were large enough to support a molten interior – such as large asteroids, the Moon and even Mars.

## Killer space rocks!

Not all meteorites are harmless. Sometimes a space rock pays us a visit that is so large it has the potential to destroy a city or even wipe out most of the life on Earth.

65 million years ago a 10 kilometre-wide asteroid smashed into the planet in modern-day Mexico. It formed a crater 180 kilometres wide and caused a global climate shift that helped to kill off 75% of the life on Earth – including the dinosaurs.

Big rocks don't often hit the Earth, but when they do the results can be catastrophic.

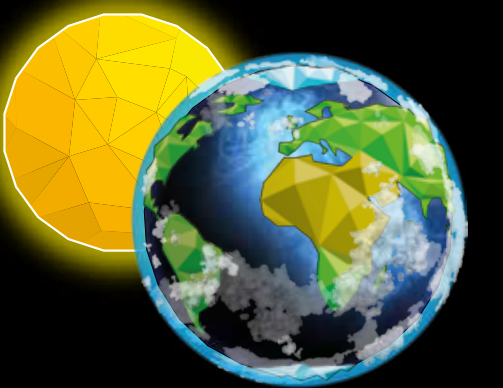


## What can meteorites teach us?

Meteorites contain rocks, metals and minerals so ancient that studying them can help us to understand the origins of the Earth, the Solar System and even life itself.

### STAR BIRTH

Some meteorites contain grains of dust produced by stars before the formation of the Solar System. Studying them can help us understand how stars form and evolve.



### SOLAR SYSTEM

Meteorites are the left over building blocks of the Sun and its planets and moons. Studying their composition helps us to understand how the Solar System was formed.

### THE MOON

Large meteorite impacts have shaped the face of the Earth and Moon. A particularly large impact (with a space rock the size of Mars) is thought to have created the Moon.

### LIFE ON EARTH

Early in Earth's history, meteorites may have been responsible for delivering the organic compounds that are the building blocks of life. Studying meteorites may help us to understand how life first evolved.

You don't have to be scientist to examine meteorites. The STFC runs the only 'Lunar Loans' scheme that allows schools and scientific organisations to borrow meteorites and samples of Lunar material.

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Science & Technology Facilities Council