

Meteorites: witnesses of the solar system's birth

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Have you ever seen shooting stars **streaking** across a clear night sky? These flashes of light often disappear as fast as they appeared, in the blink of an eye... But they actually have nothing to do with stars! Shooting stars, or meteors, are small solid grains entering our atmosphere at high speeds. They are going so fast that the air around them heats up, makes them shine, and usually burns them up.

Fragments of asteroids

During its orbit around the Sun, the Earth is constantly bombarded by particles of all sizes, and **extraterrestrial** stones that make it to the ground are called meteorites. Videos of meteorite falls have allowed scientists to reconstruct the **trajectories** of these objects and to track their **provenance**: meteorites almost invariably come from a region between Mars and Jupiter named the "Main Asteroid Belt". Most of them are indeed fragments of asteroids.

Asteroids are like small planets, although often of

irregular shapes. They are the left-overs of the formation of the bigger planets at the beginning of the Solar System.

The link between meteorites and asteroids was recently spectacularly confirmed by a Japanese probe which returned dust samples from a 600 meter-sized asteroid named Itokawa: these samples were found to be identical with one of the major groups of meteorites, thus proving that the meteorites belonging to this group and Itokawa derived from the fragmentation of the same asteroid.

A glimpse of the past

Most meteorites have undergone little change since their parent asteroid assembled. They thus give us a glimpse at the composition of the Solar System in its first million years. In fact, it is through primitive meteorites that scientists were able to determine the age of the Solar System with great precision: they obtained 4.568 billion years. Our Sun deserves a cheerful "happy birthday", right?

As they represent the original matter from which planets were built, **prim-**



SHOOTING STAR A spectacular meteor fall painted by Frederic Edwin Church in 1860. COLLECTION OF JUDITH FILENBAUM HERNSTADT.

itive meteorites are made of the same chemical elements as the Earth (iron, magnesium, silicon, oxygen, etc.). Yet, they contain distinctive inclusions, the most conspicuous among them being millimeter-sized round grains called chondrules. The origin of chondrules is still a

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mystery, although it seems they were formed as molten droplets which solidified before being incorporated in the asteroid. The temperature must have been very high to melt the minerals they contain, but the

nature of the heating events that lead to their formation is still controversial.

Asteroids have not always been cold **inert** bodies. Like the Earth, they were originally heated up

by **spontaneous** radioactive **disintegration** of atoms within them, as occurs in a nuclear power plant. Some of them were heated so intensely that they experienced a large degree of melting, which erased the primitive structures such as the chondrules. In these asteroids,

- To determine the age of the Solar System, scientists can use radioactive elements in meteorites. The amount of such an element decreases with time, so measuring its abundance yields the age of the meteorite.
- The name "chondrule" comes from the Greek "chondros", which means "small grain". A meteorite with chondrules is called a chondrite.
- Igneous rocks are rocks formed from solidified magma or lava, such as basalt or granite.
- An impressive meteor fall such took place recently in Chelyabinsk, Russia. You can easily find videos of the event on the Internet.

the dense metals separated from the stony material to form a metallic core overlaid by a stony mantle and crust. Some meteorites are fragments of these "differentiated" asteroids.

Meteorites originating from their cores are fully metallic, whereas fragments from the mantle are metal-free and quite similar to terrestrial igneous rocks. In fact, the Earth underwent the very same differentiation between a metallic core and a rocky crust. So, when you hold an iron meteorite, which is a

piece from a shattered celestial body, it is almost as though you were touching the deepest regions of our planet!

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