

# **COSMIC COMPOSITES: ROCKS FROM SPACE AND THEIR ASTONISHING INFLUENCE ON EARTH AND HUMANITY**

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Meteorites are some of the most complex natural materials known. They are incredibly compositionally diverse rocks, ranging from chunks of almost pure iron and nickel metal, which derive from the cores of disrupted planetary bodies, to pristine collections of dust and ice that have existed virtually unmolested since the birth of the Sun. Certain types of meteorites contain the oldest materials ever dated, and some even host the direct remnants of previous generations of stars that contributed material to build our Solar System. Meteorites are time capsules of information about Solar System history and evolution, and, simply put, are a scientific treasure trove. In addition, whereas most meteorites come from the scores of planetary bodies that now reside in the asteroid belt, some even represent samples that originate directly from our Moon and Mars. However, although the value of information we have gained about Earth and the Solar System from studying meteorites as scientific objects cannot be underestimated, the principal importance of meteorites to humanity is far more complex due to their oftentimes spectacular arrivals and important payloads.

From a cultural perspective, many of the world's ancient empires and most popular religions have inflection points in which meteorites played an important role, in some cases drastically altering the course of history. Christianity was an obscure cult followed by relatively few people until a timely meteoritic interaction changed its trajectory. The most venerated object in the Islamic faith almost certainly has a meteoritic origin, and for a short time, worship of a meteorite (adorned with fancy dressings and gemstones) was even the official religion of the Roman Empire. Wars have been waged (and ended) due to encounters with extraterrestrial materials. Temples have been built to honor fallen stones, and early cultures were enamored by the metal found in meteorites, as they did not yet know how to produce such metal themselves. These numerous overlaps between humans and meteorites were critical in shaping modern culture around the world, yet the most important contributions of meteorites to Earth started happening shortly after the planet formed ~4.5 billion years ago.

If meteorites had not interacted with the Earth shortly after its formation, the Moon would not exist. Earth likely would not have liquid water at its surface or offer a habitable atmosphere. The continued bombardment of Earth by space rocks gives humans access to many of the precious metals crucial for modern technology—such as iridium, platinum, and gold—which would otherwise be thoroughly sequestered in Earth's core and inaccessible for exploitation. In addition, and probably most importantly, meteorites were the primary delivery vehicles for the complex organic materials that eventually created the biosphere. Many of the organic building blocks thought essential for the emergence of life are present in primitive meteorites, with one sample alone hosting over 80 amino acids (known life uses only 20 of these). In addition, multiple nucleotide bases of both RNA and DNA as well as other vital biomolecules have been discovered in extraterrestrial specimens, indicating that the building blocks of life could have been created abiotically in the outer Solar System and delivered to Earth via meteorites. And, of course, a meteorite impact was influential to ending the long reign of the dinosaurs, paving the way for mammals to rapidly evolve and thrive, promptly taking over the helm as Earth's dominant class of creature.

In this presentation, I will discuss the immense influence meteorites have had on our planet, spanning from its creation to modern human culture. In addition, I will highlight some of the incredible scientific insights we have gained from the study of these unique materials, and some of the active areas of research in reconstructing the history and evolution of our Solar System.