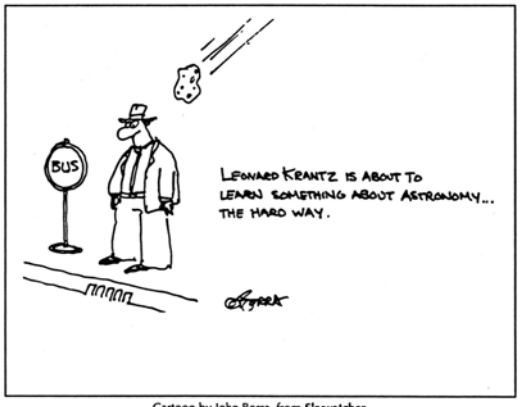
METEORS



Cartoon by John Borra, from **Skywatcher**, newsletter of the Boise [ID] Astronomical Society, May 1992

May, 1993 *REFLECTOR*

Definitions

Meteorites are defined as those extraterrestrial fragments that collide with the Earth and survive to reach the surface. [**Meteoroids** are floating in outer space; **meteors** are "shooting stars" burning up in the atmosphere.]

Extraterrestrial Origin of Meteorites

Until the last century, however, the idea that extraterrestrial materials were reaching the surface of the Earth was scoffed at by educated persons, who placed stories of falling stones in the same category with tales of fairies and dragons.

President Thomas Jefferson, himself a distinguished amateur scientist, is reported to have reacted to information about an 1807 meteorite fall in Connecticut by commenting that he could more easily believe that Yankee professors would lie than that stones would fall from the sky. Such events were so rarely observed by "reliable" witnesses, that it was easy to dismiss them.

Extraterrestrial Origin of Meteorites

By the end of the eighteenth century, however, the special compositions of some meteorites were becoming recognized, and a case was made that they came from beyond the Earth.

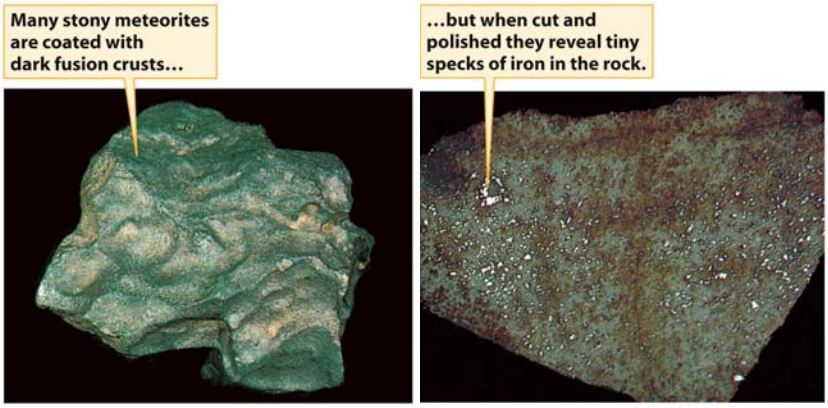
For most scientists of the time, the extraterrestrial origin was proved in April 1803 when a fall of stones from the sky was reported in the village of l'Aigle, France. The French Academy of Science sent a team of reputable scientists to investigate, to interview witnesses, and to collect the fallen stones; further investigation confirmed that these stones were unlike any ordinary rocks. Thus the authenticity of meteorites was established.

Classification and Nomenclature

1. Irons	Differentiated
2. Stones	Primitive
3. Stony-irons	Differentiated

Iron Meteorites

Stone Meteorites



Stony-Iron Meteorites

Falls and Finds

1. **Falls** are seen in the sky
2. **Finds** are recovered on the ground

Percentages of Meteorites

Recovered	Irons	Stones
Finds	90%	10%
Falls	10%	90%

Where Are Meteorites Found?

One has to be able to easily distinguish the Find from terrestrial rocks.

Where are such locations?

Most meteorites are now found in Antarctica and in sandy deserts.

Special Meteorites

Composition
- From the Moon, Mars, and the asteroid Vesta

Composition
- Rare particles and/or amino acids

Location

Famous Impacts

Special Meteorites

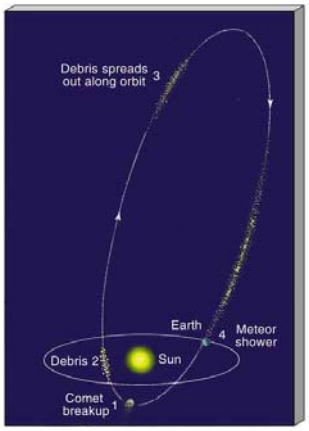
Meteorites are about 4.5 billion years old.

Allende	contains 10% pre-solar nebula material
Murchinson	contains organic and carbon chemicals

Basaltic Sources

1. The Moon
2. Mars
3. Vesta

Meteor Showers



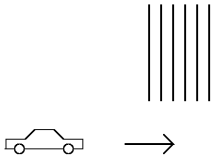
Meteor showers occur when the Earth passes through the debris field left behind by **comets**.

If the path is uniformly dirty, then the meteor shower should be the same each year (e.g, the Perseids).

If it is clumpy, then there will only be certain years for a good display (e.g, the Leonids).

Meteor Showers

When is the best time to view a meteor shower? The situation is similar to that of a car driving through a light rain shower (with no wind). The front windshield is the pane of glass that receives the most impacts. The front windshield is facing the direction of the car's motion.



Meteor Showers

When does the Earth face the direction it is moving around the Sun?

The answer is about 6^{am}, so the best viewing is from 3^{am} to 6^{am}.

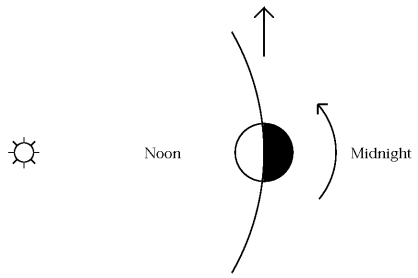


Table of Meteor Showers

table 17-1 Prominent Yearly Meteor Showers

Shower name	Date of maximum intensity*	Typical hourly rate	Average speed (km/s)	Radiant constellation
Quadrantids	January 3	40	40	Boötes
Lyrids	April 22	15	50	Lyra
Eta Aquarids	May 4	20	64	Aquarius
Delta Aquarids	July 30	20	40	Aquarius
Perseids	August 12	50	60	Perseus
Orionids	October 21	20	66	Orion
Taurids	November 4	15	30	Taurus
Leonids	November 16	15	70	Leo
Geminids	December 13	50	35	Gemini
Ursids	December 22	15	35	Ursa Minor

**The date of maximum intensity is the best time to observe a particular shower, although good displays can often be seen a day or two before or after the maximum. The typical hourly rate is given for an observer under optimum viewing conditions. The average speed refers to how fast the meteoroids are moving when they strike the atmosphere.*

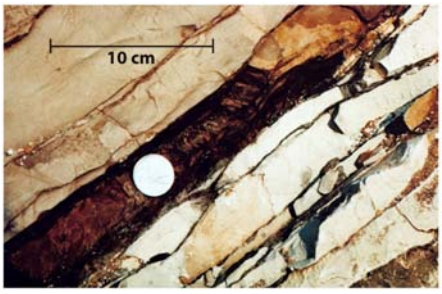
Historic Impacts

Extinction of the Dinosaurs

The body that impacted the Earth at the end of the Cretaceous period was an asteroid with a mass of more than a trillion tons and a diameter of at least 10 km.

There is a worldwide layer of sediment deposited from the dust cloud that enveloped the planet after the impact.

First identified in 1980, this sediment layer is enriched in the rare metal **iridium** and other elements that are relatively abundant in an undifferentiated asteroid but very rare in the crust of the Earth.



Extinction of the Dinosaurs

The Cretaceous impact released energy equivalent to 5 billion Hiroshima-size nuclear bombs, excavating a crater at least 100 km across and deep enough to penetrate the Earth's crust.

The explosion lifted about 100 trillion tons of dust into the atmosphere, as can be determined by measuring the thickness of the sediment layer formed when this dust settled to the surface.

Extinction of the Dinosaurs

Such a quantity of material would have blocked sunlight completely, plunging the Earth into a period of cold and darkness that lasted at least several weeks, and more likely several months.

The impact is also calculated to have produced vast quantities of nitric acid, and there is evidence of widespread fires that must have consumed much of the terrestrial biomass.

Presumably these environmental disasters were responsible for the mass extinctions.

Historic Impacts

Meteor Crater in Arizona is 50,000 years old.

Historic Impacts

Tunguska (June 30, 1908)

No crater was created. The meteor was probably a stony asteroid that was 80 m in diameter. It weighed about 100,000 tons, which is equal to a 10-megaton nuclear bomb.