How do we know meteorites are from space?

WE CAN SEE EVIDENCE OF THEIR FALLING THROUGH SPACE...

Fusion Crust

Holbrook
Fell: Navajo County, AZ, July 19, 1912
Mass: 220 kg
Classification: L/LL6, chondrite
Specimen Wt: 170.2 g
Provenance: Abrams Planetarium

Just like the crust on your bread, some meteorites get a dark crust on their outside layer. On stony meteorites this 1 to 2 millimeter thick crust forms when the meteorite gets very hot while falling to Earth. The outside layer burns and melts! Once cooled down, the melted rock turns into black glass, which creates a glaze-like coating. On iron meteorites the outside turns blue-black in color and is much thinner, around ¼ of a millimeter. Only freshly fallen iron meteorites will have a crust.

Regmaglypts (thumbprints)

NWA XXXX
Found: Morocco, 2015
Mass: Unknown
Classification: Ordinary chondrite
Specimen Wt: 217.1 g
Provenance: C. Whitford

These small dents, called regmaglypts, make meteorites appear as if they are shaped by hand, giving them the nickname thumbprints! The dents are formed on the surface of meteorites by a process called ablation. Ablation happens when a meteoroid passes through the planet's atmosphere, gets hot, and loses some of the material on its surface.

Flow Lines

NWA XXXX
Found: Morocco, 2017
Mass: Unknown
Classification: Ordinary chondrite
Specimen Wt: 89.7 g
Provenance: C. Whitford

Flow lines are ridges that form when molten hot fusion crust beads up and gets pushed around during a meteorite's fall to Earth. The movement of the liquid crust looks similar to melted candle wax. The lines can range in size, sometimes visibly thick ridges, and other times so thin that you can only see them through a magnifying glass.

Orientation

NWA XXXX
Found: Morocco, 2017
Mass: Unknown
Classification: Ordinary chondrite
Specimen Wt: 189.1 g
Provenance: C. Whitford

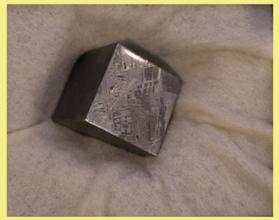
The trip to Earth is not an easy one, and most often meteorites turn and tumble during their fall. However, sometimes a meteorite can stay pointed in one direction the entire trip. This is called orientation. We can tell that a meteorite had a fixed orientation if it has evenly melted or ablated on one side, making it smoother than the other, and creating a nose-like cone shape.

Interior Matrix

NWA XXXX
Found: Morocco, 2020
Mass: Unknown
Classification: Ordinary chondrite
Specimen Wt: 114.0 g
Provenance: C. Whitford

The inside of a meteorite can tell us a great deal about its history in space. The color of the interior can range between light grey and black, and a dark interior matrix occurs when the rock gets hot enough to liquify and then cool down and re-solidify. A rust-colored interior means that the rock has experienced terrestrial weathering, and the iron has been oxidized. Sometimes tiny flecks of metal, most likely nickel iron, are visible, as well as chondrules, those round clumps of minerals.

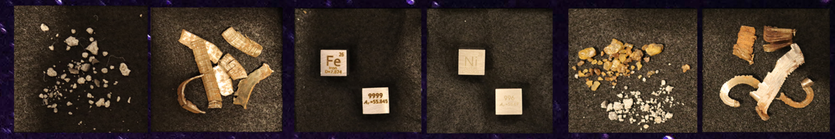
Widmanstätten Pattern



Gibeon
Found: Namibia, SW Africa, 1836
Mass: 26 t
Classification: Iron, IVA
Specimen Wt: 176.1 g
Provenance: AML, Abrams Planetarium

To make it easier to tell what a meteorite is made of, a meteoriticist can do chemical tests. Different minerals and metals have different reactions when they come in contact with chemicals. When the inner matrix of an iron meteorite comes in contact with acid, an etching-like pattern of crossing lines shows up, called a Widmanstätten Pattern. Similarly, an iron-nickel meteorite treated with acid shows a pattern of horizontal lines, called Neuman Lines.

Chemical makeup



Silicates
(Meteorite dust)

Iron and Nickel
(Meteorite filings)

Iron

Nickel

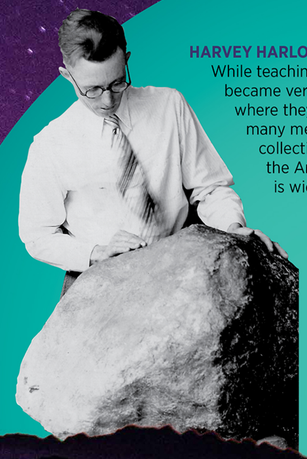
Silicates
(Olivine and Met dust)

Iron and Nickel
(Meteorite filings)

Stony meteorites are made up of minerals that contain silicates, which means the materials are made of a combination of silicon and oxygen. These meteorites can also contain small amounts of some metal, such as nickel and iron.

Iron meteorites are almost entirely made of, you guessed it, iron! Typically they are 90-95% iron, with the remaining 5% being made of nickel and small amounts of other metals, like iridium, gallium, and gold.

Stony-Iron meteorites are nearly equal parts iron and silicates. They have less silicates than Stony meteorites, and less iron than Iron meteorites. They're almost half and half!



HARVEY HARLOW NININGER (January 17, 1887–March 1, 1986)
While teaching geology at McPherson College, Harvey Nininger became very interested in learning more about meteorites and where they came from. As a meteorite hunter, Nininger found many meteorites over his lifetime. At the time, Nininger's meteorite collection was the largest collection in history! He went on to found the American Meteorite Museum in Sedona, Arizona, and is widely considered the father of meteoritics.

Meteoritics is the study of meteors, meteoroids, and meteorites. Scientists who study meteoritics are called meteoriticists. Meteoriticists collect samples, identify what they are, and classify them into groups based on what they are made of or where they come from. In a laboratory scientists are able to determine the chemical composition, the minerals the sample is made of, its approximate age, and how it was formed. Understanding meteorites can lead scientists to better understand our planet, our Solar System, and how the world as we know it was formed.