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A Remarkably Constant History of Meteorite Strikes

Thousands of tons of extraterrestrial material pummel Earth's surface each year. The vast majority of it is too small to see with the naked eye, but even bits of cosmic dust can reveal secrets.

By poring over more than 2,800 grains from micrometeorites, researchers have found that the amount of extraterrestrial material falling to Earth has remained remarkably stable over millions of years. That's a surprise, the team suggested, because it's long been believed that random collisions of asteroids in the asteroid belt periodically send showers of meteoroids toward Earth.

When asteroids collide, Earth doesn't always experience an uptick in meteorite strikes. Credit: iStock.com/dottedhippo

Astronomy by Looking Down

Birger Schmitz, a geologist at Lund University in Sweden, remembers the first time he looked at sediments to trace something that had come from space. It was the 1980s, and he was studying the Chicxulub impact crater. "It was the first insight that we could get astronomical information by looking down instead of looking up," said Schmitz.

Inspired by that experience, Schmitz and his Lund University colleague Fredrik Terfelt, a research engineer, have spent the past 8 years collecting more than 8,000 kilograms of sedimentary limestone. They're not interested in the rock itself, which was once part of the ancient seafloor, but rather in what it contains: micrometeorites that fell to Earth over the past 500 million years.

Some of the reactions that ensued were impressive, said Terfelt, who recalled black smoke filling their laboratory's fume hood.

Dissolving Rocks

Schmitz and Terfelt used a series of strong chemicals in a specially designed laboratory to isolate the extraterrestrial material. They immersed their samples of limestone—representing 15 different time windows spanning the Late Cambrian to the early Paleogene—in successive baths of hydrochloric, hydrofluoric, sulfuric, and nitric acid, to dissolve the rock. Some of the reactions that ensued were impressive, said Terfelt, who recalled black smoke filling their laboratory's fume hood. "The reaction between pyrite and nitric acid is quite spectacular."

The chemical barrage left behind grains of chromite, an extremely hardy mineral that composes about 0.25% by weight of some meteorites. These grains are like a corpse's gold tooth, said Schmitz. "They survive."

Schmitz and Terfelt found that more than 99% of the chromite grains they recovered came from a stony meteorite known as an ordinary chondrite. That's perplexing, the researchers suggested, because asteroids of this type are rare in the asteroid belt, the source of most meteorites. "Ordinary chondritic asteroids don't even appear to be common in the asteroid belt," Schmitz told *Eos.*

An implication of this finding is that most of Earth's roughly 200 known impact structures were likely formed from ordinary chondrites striking the planet. "The general view has been that comets and all types of asteroids were responsible," said Schmitz.

When Schmitz and Terfelt sorted by age the 2,828 chromite grains they recovered, the mystery deepened. The distribution they found was remarkably flat except for one peak roughly 460 million years ago. We were surprised, said Schmitz. "Everyone was telling us [we would] find several peaks."

Making It to Earth

Sporadic collisions between asteroids in the asteroid belt produce a plethora of debris, and it's logical to assume that some of that cosmic shrapnel will reach Earth in the form of meteorites. But of the 15 of these titanic tussles involving chromite-bearing asteroids that occurred over the past 500 million years, that was the case only once, Schmitz and Terfelt showed. "Only one appears to have led to an increase in the flux of meteorites to Earth," said Schmitz.

Perhaps asteroid collisions need to occur in a specific place for their refuse to actually make it to our planet, the researchers propose in the *Proceedings of the National Academy of Sciences of the United States of America* (bit.ly/asteroid-collisions). So-called Kirkwood gaps—areas within the asteroid belt where the orbital periods of an asteroid and the planet Jupiter constitute a ratio of integers (e.g., 3:1 or 5:2)—are conspicuously empty. Thanks to gravitational interactions that asteroids experience in these regions of space, they tend to get flung out of those orbits, said Philipp Heck, a meteorist at the Field Museum of Natural History in Chicago not involved in the research. "Those objects tend to become Earth-crossing relatively quickly."

We're gaining a better understanding of the solar system by studying the relics of asteroids, its oldest constituents, said Heck. But this analysis should be extended to other types of meteorites that don't contain chromite grains, he said. "This method only looks at certain types of meteorites. It's far from a complete picture."

By **Katherine Kornei** (@KatherineKornei), Science Writer