Winchcombe meteorite is helping scientists to understand more about asteroids

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The Winchcombe meteorite was the first meteorite to be recovered in the UK in over 30 years. Credit: The Trustees of the Natural History Museum, London, 2021

One of the U.K.'s most famous meteorites is helping scientists learn more about asteroids millions of kilometers away from Earth.

Knowing more about the chemical composition of the Winchcombe

meteorite and comparing it to asteroid data could help unravel some of the mysteries of our solar system.

Since it crash-landed in the eponymous town in Gloucestershire in 2021, scientists have been attempting to unlock the secrets of the Winchcombe meteorite. The rare piece of space rock is now giving us a pristine look at asteroids that are otherwise difficult to study at great distances.

In a new paper published in *Meteoritics & Planetary Science*, researchers take a closer look at the minerals contained within the meteorite, its bulk elemental composition and water content.

Researchers are now looking to use this data on bulk composition to compare and learn more about similar asteroids that are floating around in space.

As previously suspected, this latest research confirms the Winchcombe meteorite to be a CM carbonaceous chondrite. This type of meteorite is considered among the oldest objects in the solar system and can offer greater insights into the origins of the planets.

Dr. Helena Bates, who researches asteroids at the Museum and is the lead author of the study, says, "We know most meteorites come from asteroids, but as asteroids are really far away we can't really make a direct comparison unless you have what we call 'bulk information' about the meteorites."

"Gathering this information is something that we are good at doing here at the museum, as we've got a technique that's very well practised."

Why is the Winchcombe meteorite important?

On the evening of Sunday 28 February 2021, hundreds of people

witnessed a fireball blazing across the sky in the west of England.

The following day, residents of a house in Winchcombe woke to find fragments of dark rock had crash-landed onto their driveway. Almost 600 grams of this meteorite were quickly recovered and brought to the Museum for intensive analysis and study.

Around two to three small meteorites are believed to fall in the country each year, but it often happens in places that make retrieving them difficult. The Winchcombe event was therefore particularly exciting as it was the first meteorite to be recovered in the U.K. in more than 30 years.

This is important because once a meteorite lands on Earth, it quickly becomes contaminated. But in the case of Winchcombe, as the fragments were recovered within 12 hours the quality of the sample is comparable to those retrieved from asteroids by probes, and so it is highly valuable for research.

"One thing we were able to look at was how much mercury content was in the sample," says Helena.

"Mercury is very hard to measure in meteorites as it is greatly affected by terrestrial contamination. When a rock sits on the Earth, any extraterrestrial mercury it contains gets contaminated by terrestrial mercury. In this case, we have been able to get an excellent measurement of the mercury content because Winchcombe was such a pristine meteorite when it fell, and we were able to collect it really quickly."

The Winchcombe meteorite is thought to come from the asteroid belt, which is made up of rock left over from the beginning of the solar system and orbits the sun between Mars and Jupiter.

For millions of years, the meteorite was part of a larger asteroid, but a collision resulted in the rock breaking apart and being flung away from the asteroid belt. For 300,000 years the fragment traveled through space, eventually coming close enough to be pulled in by Earth's gravity.

How have scientists been studying the meteorite?

For the past two years scientists have been analyzing the Winchcombe meteorite in careful detail to try and understand more about the type of asteroid it came from.

As part of this, the research team dissolved a sample of the meteorite to look at its specific elements. Studying the bulk elemental composition showed that Winchcombe is quite typical for a CM carbonaceous chondrite. They also looked at the iron content and found the iron abundance and amount of oxygen the iron was exposed to was also similar to other CM carbonaceous chondrites.

The study also looked at the bulk mineralogy by taking a 50-milligram sample from the meteorite and firing X-rays at it. The angle at which the X-rays bend is a good indicator of what atoms and bonds are present within the sample, which can then be used to build a picture of the mineralogy.

The mineralogy suggested Winchcombe was once exposed to water, as it was rich in clays and other water-bearing minerals. Scientists wanted to learn more about where this water was contained. To do this, they heated a sample of the meteorite up to 1,000 degrees, and its change in weight was measured as the rock heated up.

Different minerals dehydrate at different temperatures, so by looking at this rate of change over time the researchers were able to tell which minerals were holding the water.

Without water, life on our planet wouldn't exist, so the scientists are trying to understand more about where it came from and how it got here.

To compare the meteorite with asteroids, researchers then used a technique called infrared spectroscopy, where they shine an infrared laser at the meteorite and then look at the light that is reflected back.

Light interacts with specific minerals differently as some absorb the light, and some reflect it. The light that is reflected back contains gaps which are characteristic of specific minerals. This information can then be compared to asteroid data.

"When looking at asteroids in space, we can use the sun like a giant laser," explains Helena. "We look at the reflected sunlight, and again you see these characteristic gaps."

"What we were basically doing in this study was to recreate what we see in asteroids in the lab. First, we completely characterize this meteorite and examine what it might look like out in space, and then we can compare it to bodies that are still out in space."

"We want to compare Winchcombe to asteroids that show signs of having hydration, meaning they've been altered by water. There's a whole group of these called the C complex asteroids."

"The cool thing about that is both OSIRIS-REx and Hayabusa2, which are the [asteroid sample return] missions that the Museum has some involvement with, have visited C complex asteroids. But there's also huge amounts of data collected by ground based and space-based telescopes of C complex asteroids that we can also compare Winchcombe to."

More information: H. C. Bates et al, The bulk mineralogy, elemental

composition, and water content of the Winchcombe CM chondrite fall, *Meteoritics & Planetary Science* (2023). DOI: 10.1111/maps.14043

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