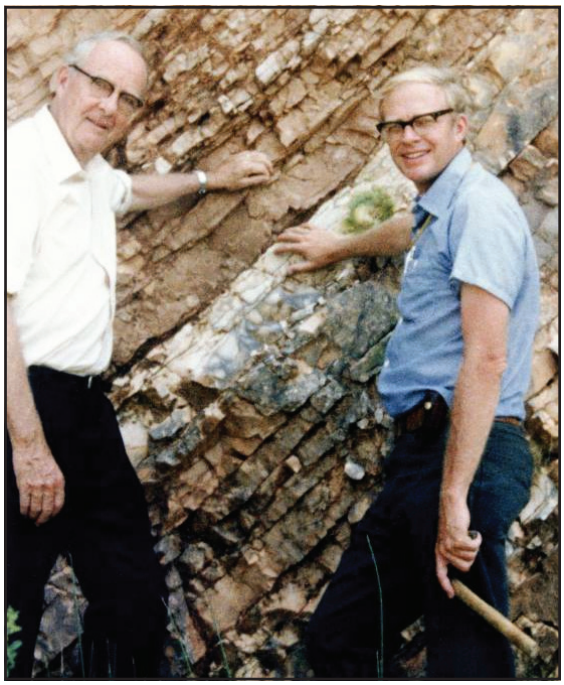
Asteroids and dinosaurs: Unexpected twists and an unfinished story

Science journeys are sometimes not what we expect.

Doing science can be quite an adventure! Sometimes when you try to find an "answer" to a question or problem, you find yourself on an unexpected journey. Walter Alvarez would agree. He started studying rocks to learn how the continents had moved. This led him to one of the greatest questions in paleontology—what caused the extinction of the dinosaurs 65 million years ago?



Luis and Walter Alvarez, father and son, stand by the rock layers in Italy that they tested for iridium.

There are lots of marine fossils before 65 million years ago but not immediately after.

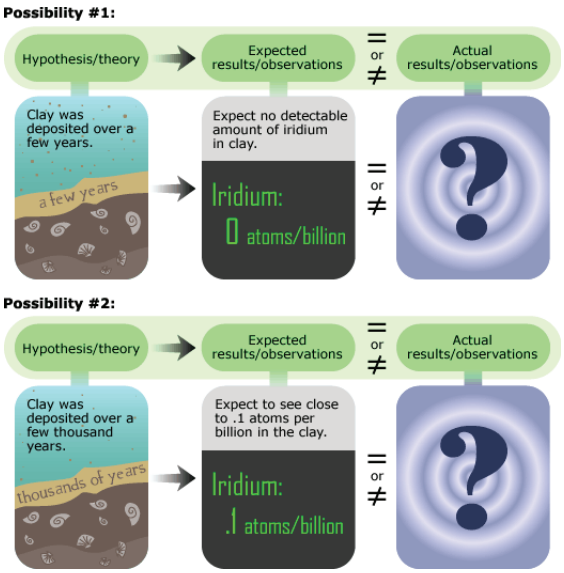
Alvarez was in Italy in the 1970s with other scientists looking for patterns in layers of rocks to learn more about Earth's history. He observed a strange pattern. He saw a layer of clay and dated it. It was 65 million years old. This was the boundary between the Cretaceous and Tertiary time periods (called the KT boundary). Below the clay layer he saw lots of microscopic marine fossils, but above it he did not find many. He wondered: What happened to cause so much marine life to disappear at that time? Did this relate to the disappearance of the dinosaurs at the same time?

Walter wondered how long it took for the clay layer to form.

Alvarez wanted to find out if the clay layer formed quickly or over a long period of time. He wanted to know how long it took for the marine life to disappear. But how could he measure this? He asked his father, a physicist, for help.

His dad suggested looking at the chemical elements in the layer. He decided to look at iridium. Dust from meteors contains iridium. It "rains" down on the Earth's surface very slowly, at a fairly steady rate all the time. Walter and Luis thought that they could tell how long it took the clay layer to form by looking at how much iridium was in the clay. If the clay layer formed quickly, it would not have much iridium. If it formed slowly, it would have more iridium. Helen Michel and Frank Asaro, both scientists, helped them test for iridium in the clay layer. The results were a complete surprise! They found more than 30 times what they expected! They began to ask many new questions.

The team found more iridium than expected.



Were the high iridium levels only in Italy?

First, they wanted to know if this high level of iridium was found only in Italy or if it could be found in other parts of the world too. Alvarez read many scientific articles. He learned that Denmark had a similar clay layer

Luis and Walter Alvarez photo from Ernest Orlando Lawrence Berkeley National Laboratory

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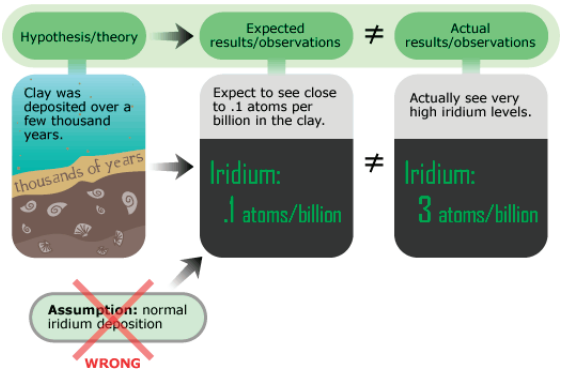
in the rocks. He asked a friend to test it. The iridium was high there too. So whatever happened 65 million years ago must have happened in many places.

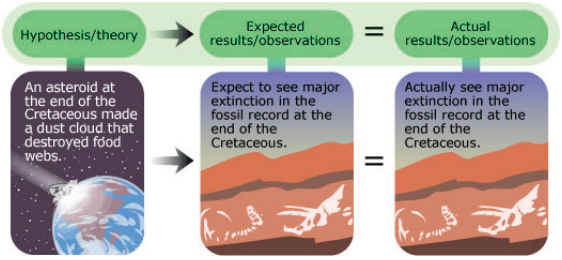


This led to another new question: What caused the high iridium levels? Some scientists thought a supernova caused the death of the dinosaurs. Since iridium is produced by supernovas, Alvarez's discovery supported this hypothesis. They decided to test this idea by looking for other elements such as plutonium-244 that also come from supernovas. Alvarez and his team searched for plutonium in the clay layer and found it! They thought they had more evidence to support the supernova idea. But when they checked their results again, they found that they had accidently added plutonium to the sample while doing the test. There was no plutonium in the original clay layer. There was no evidence that a supernova happened when the clay was being deposited 65 million years ago. Now they had to figure out a new explanation.

What caused the high levels of iridium? A supernova?

What could have caused lots of iridium but no plutonium? After reading and talking to others, they came up with the idea that an asteroid might have hit the Earth 65 million years ago. Asteroids have lots of iridium but no plutonium. This was a new hypothesis and it led to many more new questions: Was there a crater? How could an asteroid hitting the Earth cause the extinction of the dinosaurs and life in the oceans? Was there other evidence that a large asteroid hit the Earth?

What else could have caused the high levels of iridium?



Alvarez worked with other scientists. Eventually, they figured out that if a very large asteroid hits the Earth, it will blow millions of tons of dust into the atmosphere. Scientists can use mathematical calculations to show that this is enough dust to block out the sun around the world and to stop photosynthesis and plant growth. This would cause food webs to fail, which would then cause many animals to die and go extinct.

Was it an asteroid?

In 1980, Alvarez's team published their hypothesis relating the high iridium levels in the clay layer to the dinosaur extinction 65 million years ago. This caused lots of discussion and lots more exploration. Over the next ten years, more than 2,000 scientific papers were published about this. Many different scientists studied many kinds of evidence to test hypotheses about the dinosaurs' death. Their tests included:

There was a lot of evidence for an asteroid.

1) **Extinctions**: If a large asteroid hit the Earth, many groups of plants and animals would not survive. Therefore, if the asteroid hypothesis were correct, we would expect to find a large increase in the number of extinctions 65 million years ago. We do.

1) Extinctions

2) **The impact**: If a large asteroid struck Earth 65 million years ago, it would have thrown out particles from the site where it hit. If the asteroid hypothesis were correct, we should find these particles in the KT boundary layer. We do.

2) Impact

3) **Glass**: If a large asteroid struck Earth 65 million years ago, it would have caused a lot

3) Glass

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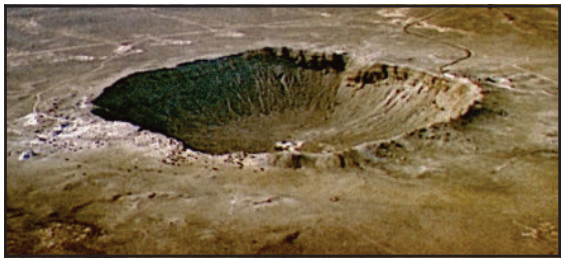
of heat, melting rock into glass, and shooting glass particles away from the area where the asteroid hit the Earth. If the asteroid hypothesis were correct, we should find glass particles in the KT boundary layer. We do.

4) Shock waves

4) **Shock waves**: If a larger asteroid struck Earth 65 million years ago, it would have caused powerful shock waves. If the asteroid hypothesis were correct, we should find evidence of these shock waves, like quartz that has been reshaped. We do.

5) Crater

5) If a larger asteroid struck Earth 65 million years ago, it would have made a huge crater. If the asteroid hypothesis were correct, we should find a very large crater somewhere on Earth that was formed 65 million years ago. We do—the Chicxulub crater on the Yucatan peninsula in Mexico.



Meteor Crater in Arizona does not date to the KT boundary, but suggests the sort of land form that a very large asteroid would leave behind.

Did the asteroid *cause* the extinctions?

Scientists agree that the evidence is strong that dinosaurs went extinct 65 million years ago and that there was a large asteroid impact at the same time. However, scientists do not all agree that the evidence suggests there is a connection between the two events.

New scientific knowledge leads to more questions.

Scientific ideas are always open to new questions and to new types of evidence. Although many observations support the asteroid hypothesis, the investigation continues. The evidence shows that many things were happening near the end of the Cretaceous period. There were very large volcanic eruptions, there were changes in the climate, and the continents were moving. All these changes, including a large asteroid hitting the Earth, certainly would have changed the ecosystems. All these factors could certainly have played a role in causing the extinction of so many plants and animals, but did they? Scientists are still studying these questions.

Definitions

ASTEROID: relatively small rocky object going around the sun.

CRATER: a large, bowl-shaped hole in the ground caused by something hitting the ground.

ECOSYSTEM: all the plants, animals, and other organisms that live in a particular place and interact with each other.

EVIDENCE: test results and/or observations that either support or do not support a scientific idea.

EXTINCTION: dying out or disappearing. If an animal goes extinct, there are no more of that sort of animal.

FOOD WEBS: the ways food chains are connected. They show who eats whom.

HYPOTHESIS: a suggested explanation that can be tested. They are usually based on earlier experience, scientific background knowledge, previous observations, and reasoning.

IRIDIUM: an element, like carbon or oxygen. It is rare on Earth but common in meteors and asteroids. It is also released from supernovas.

MARINE: living in the ocean.

Meteor Crater photo from NASA/photo by D. Roddy

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METEOR: an asteroid or rock that enters the Earth's atmosphere. They usually burn up before they reach the ground.

MICROSCOPIC: size of something so small that you need a microscope to see it.

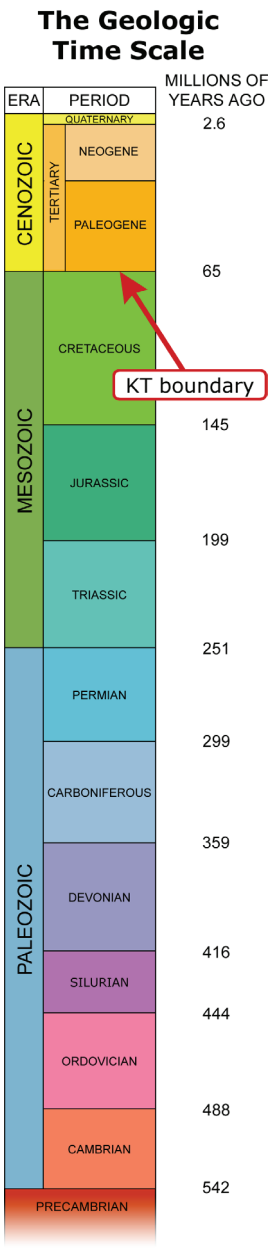
PALEONTOLOGY: study of past life.

- PALEO- : old
- -OLOGY: study of

PHOTOSYNTHESIS: the process that plants use to convert sunlight and carbon dioxide from the air into useable energy.

PLUTONIUM: a radioactive element. It is released from supernovas but is not found in meteors or asteroids.

SUPERNOVA: an exploding star.



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