What killed the dinosaurs?

The impact theory

The impact theory was beautifully simple and appealing. Much of its evidence was drawn from a thin layer of rock known as the 'KT boundary'. This layer is 65 million years old (which is around the time when the dinosaurs disappeared) and is found around the world exposed in cliffs and mines.

For supporters of the impact theory, the KT boundary layers contained two crucial clues. In 1979 scientists discovered that there were high concentrations of a rare element called iridium, which they thought could only have come from an asteroid. Right underneath the iridium was a layer of 'spherules', tiny balls of rock which seemed to have been condensed from rock which had been vapourised by a massive impact.

On the basis of the spherules and a range of other evidence, Dr Alan Hildebrand of the University of Calgary deduced that the impact must have happened in the Yucatan peninsula, at the site of a crater known as Chicxulub. Chemical analysis later confirmed that the spherules had indeed come from rocks within the crater.

The impact theory seemed to provide the complete answer. In many locations around the world, the iridium layer (evidence of an asteroid impact) sits right on top of the spherule layer (evidence that the impact was at Chicxulub). So Hildebrand and other supporters of the impact theory argued that there was one massive impact 65 million years ago, and that it was at Chicxulub. This, they concluded, must have finished off the dinosaurs by a variety of mechanisms**.**

Super Volcanoes

The super volcano theory argues that the asteroid impact was merely a prelude to a number of volcanic eruptions that occurred in an area in India named the Deccan Traps.
Researchers have discovered four separate waves of eruptions that released huge clouds of sulfur dioxide into the air, bringing showers of acid rain in turn. These waves are estimated to have occurred between 67.5 and 65 million years ago.

Geophysicists argue that the asteroid impact could not have kicked up enough dust or sulfur dioxide to cause global climate change. The super volcanoes may have dispersed between 10 and 150 billion tonnes of sulphur dioxide with each 'pulse'.

Geologist Gerta Keller states that after the initial pulse “the species disappear; we have essentially very few left,” and “by the fourth flow, the extinction is complete,”

The super volcano theory is the biggest challenger to the classic impact theory, though Rick Fireston of Lawrence Berkeley National Laboratory isn't swayed by the argument "There was volcanism at the time. There's always volcanism, but that impact is so significant that you can't ignore it."

Combined Theory

Keller, proponent of the Super Volcano theory, stresses that her findings do not deny that an impact occurred, and noted that a combination of the two theories could provide the ultimate answer:
"The dinosaurs might have faced an unfortunate coincidence of a one-two punch - of Deccan volcanism and then a hit from space,
"We just show the Deccan eruptions might have had a significant impact - no pun intended."

Ice Age

A team from Holland and Italy discovered fossilised cold water plankton that dates back 65 million years in an area that had previously been warm see in Tunisia. Dinoflagellates and Benthic Formanifera plankton were found in the first time-dated fossils that provide clear evidence of climate swings.

Matthew Huber of Indiana's Purdue University said: "The fossils indicate that something suddenly made the water cold enough to support these tiny critters."

"We theorise that the meteor strike produced huge quantities of sulfate particles, such as are often blown high into the atmosphere during a volcanic eruption, and these particles shielded the Earth's surface from sunlight. The decrease in solar energy ultimately caused a long cold spell, called an 'impact winter,' that persisted for years."

The hypothesised ice age would have killed off many of the planet's living species into extinction, including dinosaurs.

The find does not however reveal the catalyst for the sudden climate change, so while the ice age may have been the method of extinction, the event that preceded it (widely regarded to be the asteroid impact) would be the cause.

Dinosaur Extinction - Theories and Evidence

Hypothesis: Asteroid Impact

Did a collision with a giant asteroid or comet change the shape of life on Earth forever?
It is widely agreed that such an object -- 10 kilometres across -- struck just off the coast of the Yucatan peninsula (Mexico) 65 million years ago.
According to scientists who maintain that dinosaur extinction came quickly, the impact must have spelled the cataclysmic end.
For months, scientists conclude, dense clouds of dust blocked the sun's rays, darkening and chilling Earth to deadly levels for most plants and, in turn, many animals. Then, when the dust finally settled, greenhouse gases created by the impact caused temperatures to skyrocket above pre-impact levels.
In just a few years, according to this hypothesis, these frigid and sweltering climatic extremes caused the extinction of not just the dinosaurs, but of up to 70 percent of all plants and animals living at the time.

Evidence for the Asteroid Impact Hypothesis

Impact Crater
This 150-kilometer-wide crater lies just off the Yucatan peninsula. Scientists calculate that it was blasted into Earth by a 10-kilometer-wide asteroid or comet traveling 30 kilometers per second -- 150 times faster than a jet airliner.
Scientists have concluded that the impact that created this crater occurred 65 million years ago. The date corresponds perfectly to the date of the dinosaur extinction.

Rare Metal
The metal iridium, which is similar to platinum, is very rare on Earth's surface but is more common in asteroids and in molten rock deep within the planet.
Scientists have discovered levels of iridium 30 times greater than average in the Cretaceous/Tertiary (KT) boundary, the layer of sedimentary rock laid down at the time of the dinosaur extinction.

Melted Rock
These pieces of once-molten rock, called impact ejecta, are evidence of an explosion powerful enough to instantly melt bedrock and propel it more than a hundred miles from its origin.
Ranging in size from large chunks to tiny beads, impact ejecta are common at or near the Cretaceous/Tertiary (KT) boundary, the geological layer that defines the dinosaur extinction.

Fractured Crystals
These crystals, often called "shocked quartz," show a distinctive pattern of fracturing caused by high-energy impacts or explosions.
Some scientists maintain that the fracture pattern in these quartz crystals could only have been caused by a massive asteroid or comet impact. The pattern is prevalent in quartz found at or near the Cretaceous/Tertiary (KT) boundary, the geological layer deposited at the time of the extinction.

Fossil Record
A gradual decline in the number of dinosaur species would likely mirror an equally gradual cause of their ultimate extinction. Conversely, a sudden "now you see them, now you don't" end to the dinosaurs implies a catastrophic cause. Depending on location and interpretation, the fossil record seems to say different things.

Some paleontologists see evidence in the fossil record that dinosaurs were doing quite well prior to the end of the Cretaceous -- that they were in no way declining in abundance when the impact occurred.

Hypothesis: Volcanism

Did dinosaurs lose their dominance suddenly or gradually? Some scientists think the answer lies locked within the remnants of long-dormant volcanoes.
Massive beds of ancient lava found around the world depict an Earth 65 to 70 million years ago where volcanic eruptions were commonplace.
According to the volcanism hypothesis, this global-scale volcanic activity spewed so much gas, ash, and dust into the atmosphere that it kept sunlight from reaching Earth's surface. Temperature and plant production plummeted, and dinosaurs and many other organisms that were poorly adapted to the harsh conditions perished.

Evidence for the Volcanism Hypothesis

Lava Flows
Immense lava flows cover nearly 200,000 square miles of the Deccan region of India, reaching depths of more than 6,500 feet in places.
Lava flows like these provide evidence of a rash of volcanic activity for at least 500,000 years leading up to the extinction of the dinosaurs.

Rare Metal
The metal iridium, which is similar to platinum, is very rare on Earth's surface but is more common in asteroids and in molten rock deep within the planet.
Some scientists think the presence of high concentrations of iridium at the geological layer associated with the dinosaur extinction could be the result of extremely large-scale volcanic activity.

Fractured Crystals
These crystals, often called "shocked quartz," show a distinctive pattern of fracturing caused by high-energy impacts or explosions.
Although geologists generally acknowledge that a comet or asteroid impact would cause these fractures, some scientists conclude that they could also be the result of volcanic eruptions.

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A gradual decline in the number of dinosaur species would likely mirror an equally gradual process like climate change caused by global volcanism.

Hypothesis: Mammal Competition

Extinction implies that the species that perish are poorly adapted to a changing set of conditions.
Faced with an evolving group of competing organisms -- the mammals -- perhaps dinosaurs were driven to extinction by competition.
Packs of small mammals would have competed with dinosaurs for food. And carnivorous mammals would have preyed on dinosaur eggs.
Not only did mammals likely compete with dinosaurs for resources, many species survived the end-Cretaceous extinction and subsequently came to dominate Earth.

Evidence for the Mammal Competition Hypothesis

Fossil Record
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While mammals certainly prospered on the heels of the dinosaur extinction, it is unclear whether mammals and dinosaurs experienced little competition or if they regularly challenged each other for limited resources

Hypothesis: Continental Drift

It's difficult to imagine a process more gradual than continental drift. But some scientists say that, slow or not, this repositioning of the world's landmasses was disastrous for dinosaurs.
As continents heaved upward, pushed by the movement of tectonic plates, ocean currents were redirected and global sea levels fell. The Interior Seaway, for example, which once divided North America in half, simply drained away as the Colorado Plateau rose thousands of feet.
According to this hypothesis, climates in many parts of the world became drier and cooler. The resulting ecosystems produced less food than the environments in which dinosaurs evolved and were unable to sustain them.

Evidence for the Continental Drift Hypothesis

Fossil Record
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According to some scientists, fossil evidence clearly shows a decline in the number of dinosaur species for several million years leading up to the end of the Cretaceous.
Sea Level
The presence of 65- to 70-million-year-old fossilized ocean creatures thousands of feet above present-day sea level strongly suggests that ocean levels fell dramatically as the Cretaceous period came to a close.
According to many scientists, continental drift and ocean regression would have caused continents to become drier, cooler, and less hospitable to dinosaur life than they had been previously.