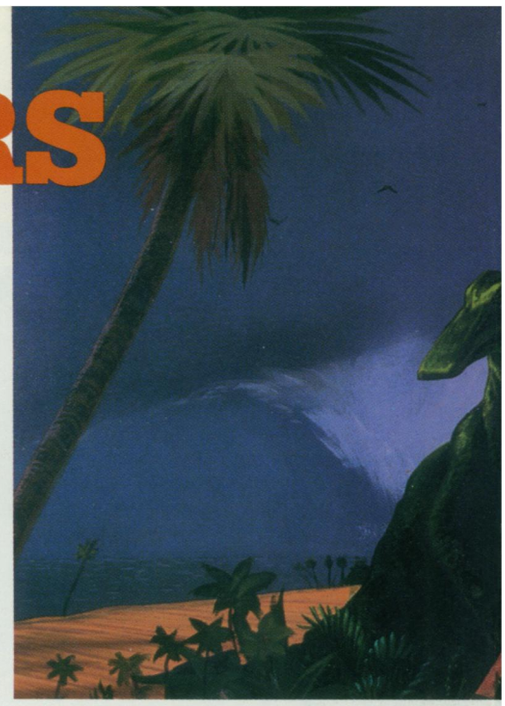
IMPACT WARS

Debate rages over killer comets and dinosaur deaths

By RICHARD MONASTERSKY



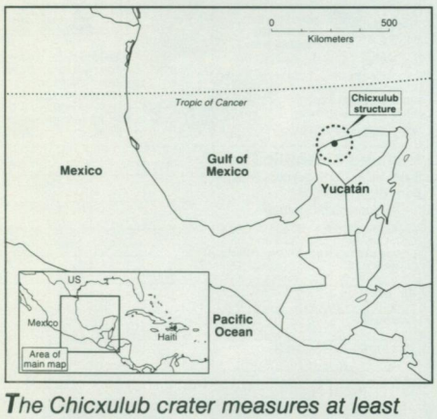
The setting was scholarly, but the university auditorium felt more like a revival tent as Norman MacLeod addressed a scientific conference in Houston last month.

"Although I'm a paleontologist, I'm here to tell you I BELIEVE," MacLeod proclaimed, drawing out the last syllable in true evangelical tradition. "I believe in the impact," announced the researcher from London's Natural History Museum.

While designed to draw a laugh, MacLeod's theatrical conversion also provided a fitting symbol for the Houston meeting, convened to examine the calamity that befell Earth at the end of the Cretaceous period, when the last dinosaurs and two-thirds of living species disappeared. After 14 years of often rancorous debate, nonbelievers such as MacLeod admitted before their peers that they have come to accept the idea that a huge bolide — an asteroid or comet — blindsided Earth 65 million years ago.

"The number of skeptics has really decreased, and that is due to the fact that a lot more evidence has come forward in recent years," says Princeton University paleontologist Gerta Keller, another researcher who had long criticized the bolide theory.

Despite the retreat of Keller, MacLeod, and the rest of the anti-impact squad, the Houston meeting was anything but peaceful. Instead of arguing whether a crash had indeed occurred, participants in the dispute have simply shifted the intellectual battleground, ensuring that the conflict will continue unabated for many years. In terms of resolution, the meeting ended without success. But it offered a revealing glimpse of how ideology and personality are shaping the course of a revolution in the earth sciences.



The Chicxulub crater measures at least 180 kilometers in diameter, making it the largest known on Earth. Some evidence hints that the crater may actually be twice as large.

The impact debate began in 1980, when investigators from the University of California, Berkeley, reported the discovery of an unusual feature in ancient ocean rocks preserved in Italy, Denmark, and New Zealand. While studying a thin layer of clay deposited at the end of the Cretaceous period, Nobel laureate Luis W. Alvarez, Walter Alvarez, Frank Asaro, and Helen V. Michel measured a substantial enrichment in the metal iridium, an element exceedingly rare in Earth's crust.

The Berkeley researchers knew that some meteorites carry relatively high concentrations of iridium. They also recognized that the boundary between Earth's Cretaceous (K) and Tertiary (T) periods marks a mass extinction. Putting the two facts together, the Berkeley team proposed that a mountain-size meteorite slammed into Earth at that time, pulverizing enough rock to create a globe-circling dust cloud that blocked out sunlight. Such a catastrophe, they claimed, caused the well-known extinctions at the K-T boundary.

Many researchers rejected the impact hypothesis from the outset, preferring to stick with previous explanations that blamed the extinctions on volcanic eruptions, changes in sea level, or climate shifts. Paleontology provided many of the impact critics, who believed that species disappeared gradually over millions of years instead of virtually overnight.

Through the 1980s, impact supporters strengthened their case by finding numerous other clues preserved in the K-T boundary clay layer around the world. In 1991, their cause received a dramatic boost when investigators identified what they called "the smoking gun" — an apparent crater buried beneath the northern tip of Mexico's Yucatán Peninsula. They proposed that the 180-kilometer-wide circular structure could be the long-sought scar carved by the K-T blow (SN: 1/25/92, p.56).

Subsequent work has backed that suggestion, convincing many on both sides of the impact issue that the so-called Chicxulub crater does indeed mark ground zero for a colossal crash 65 million years ago (SN: 8/15/92, p.100).

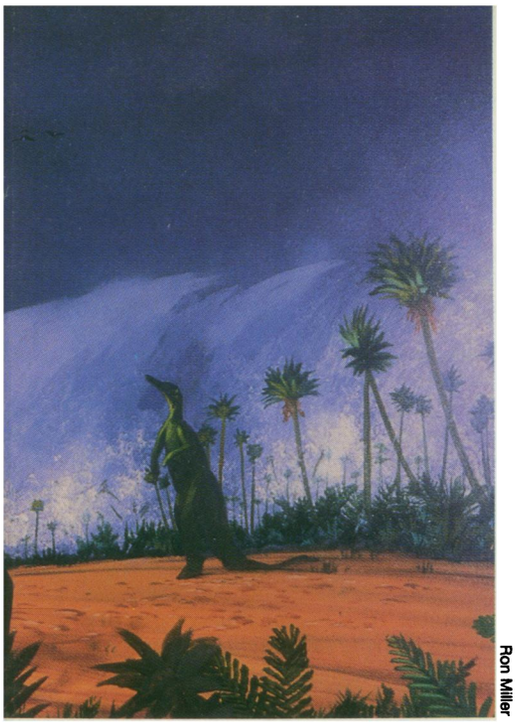
Although agreement about the impact might suggest some degree of reconciliation between opposing camps, the Houston conference showed that the community remains fundamentally split, both philosophically and physically. In the meeting hall, researchers unconsciously divided themselves, with the skeptical minority assembling on the speaker's left and the believers on the right.

As agreement over the impact has grown in recent years, much of the research and debate regarding the K-T mystery has shifted to questions of severity: How devastating was the collision and how did it affect life?

Stolid supporters of the impact hypothesis blame the disaster for most of the extinctions at the end of the Cretaceous. The skeptics, while now accepting the crash, question its role. When they view the extinction record, they see a variety of different traumas plaguing the planet at nearly the same time, with the extraterrestrial wallop playing either a major or minor part.

Which theory eventually prevails will depend largely on the timing and pattern of the die-offs. If animal and plant species disappeared over hundreds of thousands of years, starting before the impact, that would implicate down-to-earth problems and diminish the bolide's role. Some researchers who favor this interpretation point an accusing finger at a series of huge lava flows in India that date to the time of the impact. Such eruptions could have polluted the atmosphere and altered Earth's climate, they say.

While the dinosaurs' demise has long



Ron Miller

excited the public, one of the most spectacular extinctions at the K-T boundary swept away a much smaller, but no less important organism: planktonic foraminifera. These tiny animals form a critical link in the marine food chain, and they suffered tremendous losses at the end of the Cretaceous (SN: 2/1/92, p.72). Researchers on both sides of the debate have argued that this vulnerable group could offer critical information about the cause of the mass extinction.

Six years ago, at the last conference devoted to the K-T question, two paleontologists reported diametrically different findings concerning the speed of foram extinctions, prompting calls for a test to resolve the discrepancy. With that aim, the two main figures in the debate, Princeton's Keller and Jan Smit of the Free University in Amsterdam, traveled to Tunisia in 1992. Working with Tunisian geologists, they collected samples of marine sediments at various levels above and below the K-T boundary, then sent the rocks to the test supervisor, Robert Ginsburg of the University of Miami.

Ginsburg distributed the sediments to four "blind" testers, who recorded the types of forams they found in each sample. To keep the results free from prejudice about extinction rates, the testers did not know the original positions of the samples relative to the boundary.

This procedure might seem definitive. But like opposing political parties reacting to a public opinion poll, Keller and Smit still found room to put different spins on the test results when they were announced at the Houston meeting.

The four paleontologists did not verify Keller's original finding that 12 large, highly ornamented species of forams died out before the boundary. Each analyst did find a few species disappearing early, but the particular species differed from one investigator to the next.

Evidence suggests that the impact spawned a huge tsunami in the Gulf of Mexico. The dust cloud and other effects, however, would have caused truly global damage.

Smit and others assert that the discrepancy is the result of sampling and analysis problems. Any single investigator might find some species dying out early, because one researcher can miss a few species when looking at a limited number of microscope slides. But the combined results from the four testers indicate that all the species in question survived until the boundary, they contend.

"Taken at face value, the results of the blind test suggest that there were no extinctions prior to the impact horizon," says paleontologist Steven D'Hondt of the University of Rhode Island in Narragansett.

Keller disagrees: "From this test, you don't show anything about the time before the K-T boundary." She argues that the blind test has limited value because the four investigators disagreed over the names they gave to individual species, muddling the extinction record.

In theory, the four testers can resolve the debate over early extinctions by agreeing on the names of the species in question, Ginsburg says. They could do that by meeting in person or by sending around micrographs of the disputed forams. Although either method involves considerable work, "it looks like we have to do that," says Ginsburg.

Whatever the results of the test, Keller and Smit do agree on one issue—the need for more studies of extinction patterns. By analyzing which regions and ecosystems suffered and which escaped unharmed, researchers can better decipher what happened to life at the end of the Cretaceous.

While paleontologists have concentrated on counting bodies, geophysicists have attempted to explore the anatomy of the crater and how the crash altered Earth's environment.

Early versions of the impact theory concentrated on the devastating nature of the resulting dust cloud, which could have blocked out sunlight, halted photosynthesis, and killed the plants that sustain larger organisms. Since then, investigators have proposed myriad different ways in which a tremendous impact could have disrupted life. Global wildfires, rainfall as poisonous as battery acid, and a shredded ozone layer might all follow such a collision.

While not denying the importance of such effects, several researchers are now convinced that the bolide may also have knocked Earth's climate off balance. Because the Yucatán Peninsula has a thick cover of sulfur-rich rock, a hit there could have released as much as a trillion tons of sulfur dioxide gas, which reacts in the atmosphere to form droplets of sulfuric acid. Like tiny parasols, these droplets block out sunlight and cool the planet's surface. The most recent demonstration of sulfur cooling occurred courtesy of Mt. Pinatubo, which lofted some 20 million tons of sulfur dioxide into the air and depressed global temperatures by 0.25°C.

Richard Turco of the University of California, Los Angeles, used a simple one-dimensional model of the atmosphere to study the effects of sulfuric acid from an impact. Assuming that the strike liberated roughly 50,000 times more sulfuric acid than did Pinatubo, he found that Earth's temperature could have dropped by 5°C to 10°C for a decade—a staggering cooling when compared to the 4°C drop during the last ice age.

Turco says such simulations are crude and require more information about the actual physical and biological effects of the impact. Geologists will tap a major new source of data when they drill into the Chicxulub structure, a project slated to begin possibly this year. Direct measurements of rock in and under the crater should answer questions about the impact's size, as well as resolve lingering doubts about the age of the crater. Whereas most evidence suggests that the feature formed precisely at the end of the Cretaceous, a few skeptics point to puzzling data that hint of a different age. This discrepancy has kept some conservatives from accepting Chicxulub as the K-T impact crater.

Together with the ongoing arguments over extinctions, debates about the age of the crater and other issues demonstrate the deep rift that continues to divide scientists studying the K-T event. Fundamentally, the controversy centers on philosophical differences about how the world works.

William Glen, a geoscientist and historian with the U.S. Geological Survey in Menlo Park, Calif., has studied the debate for the last 10 years. According to his analysis, the impact theory met such strong resistance, in part, because it challenged the reigning doctrine of uniformitarianism, which includes the idea that changes on Earth occur gradually.

As increasing numbers of geoscientists subscribe to the impact hypothesis, they are stretching the boundaries of the old doctrine to include catastrophic processes that were formerly ignored. "We're seeing a recasting of the definition of uniformitarianism," says Glen.

How long will the debate rage? Glen answers by referring to German physicist Max Planck, who started the quantum mechanics revolution at the turn of the century. "In the case of an upheaval in science in which a new thesis or paradigm is offered up, the last vestiges of debate cease only with the death of the old guard," says Glen. □